GOVERNMENT OF INDIA

CENTRAL BOARD OF IRRIGATION

PUBLICATION No. 48

# DATA OF HIGH DAMS

IN

# INDIA

## VOLUME I

BY

SHRI N. D. GULHATI, I. S. E., M. I. E. (Ind.),

*SECRETARY*

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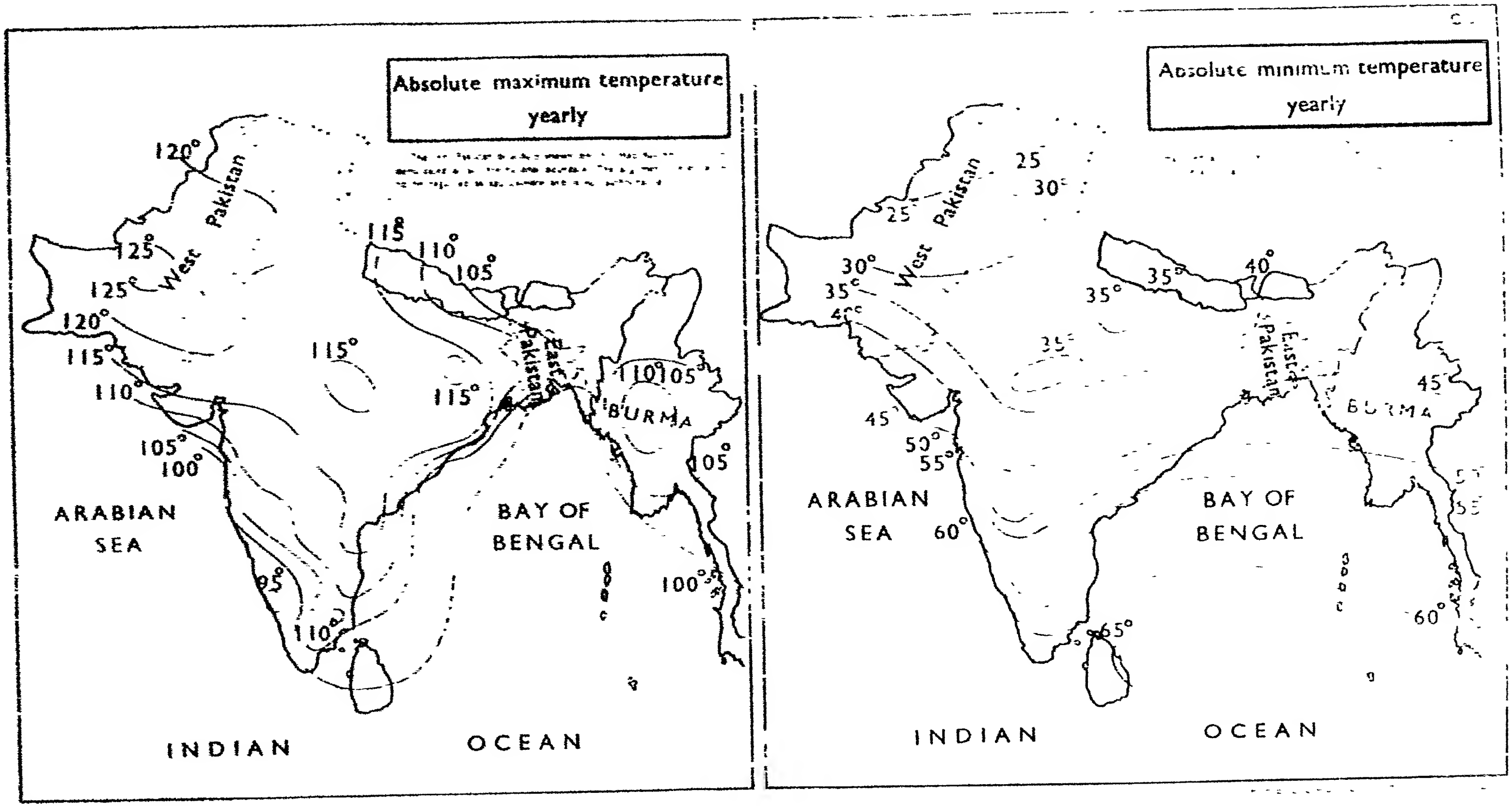


Figure 4:- *Showing yearly isotherms of maximum and minimum temperatures.*

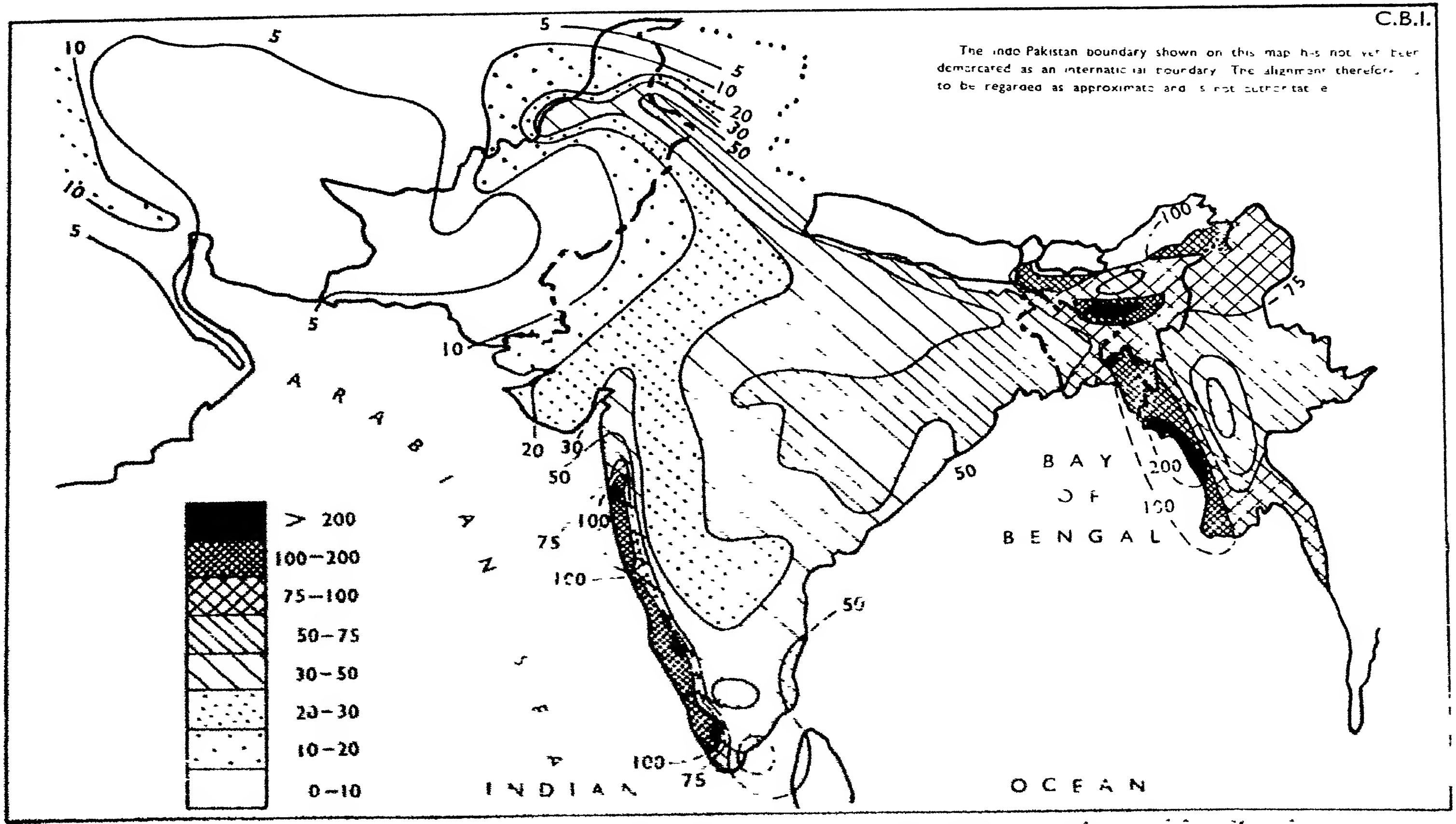


Figure 5:- Map Showing Annual Rainfall in India

## CONTENTS

### VOLUME I

CHAPTER IX.—NARBADA BASIN—*contd.*

## FOREWORD

Data of high dams in India was collected by the Central Board of Irrigation in 1936-39 at the instance of the International Commission on Large Dams. This collection proved useful when after World War II all administrations in India undertook large scale investigations of multi-purpose projects and many enquiries were received asking for information relating to existing dams in India. These enquiries were complied with, so far as possible, on the basis of the information already collected. At its annual meeting held in November, 1945, the Central Board of Irrigation decided that the entire data of high dams (more than 50 feet high) built so far in India should be published for general use.

Accordingly a comprehensive standard form was devised and the information already collected in 1936-39 was tabulated. These forms, duly filled in respect of each dam, were sent to the administrations concerned for check and completion. The Board is grateful to the Chief Engineers concerned who very kindly cooperated and made it possible to present this authentic compilation.

The publication is in two volumes, the data of dams have been grouped basin-wise. Volume I relates to dams in the Cauvery, Kistna and adjacent minor basins. These basins include dams in Travancore and Cochin Unions, Mysore, parts of Madras, Hyderabad and Bombay States. Volume II relates to Basins in the rest of India. Information is furnished on all the salient features of a dam and has been grouped under appropriate heads for facility of reference. A copy of the standard form referred to above will be found in chapter II. For facility of reference, the data of each dam has been indexed in accordance with the standard form.

It will be observed that information relating to some features of certain dams has not been filled in. This is because it is not available. The undersigned will be grateful if this information is supplied to him as soon as it becomes available. It will be printed along with data of high dams that may henceforth be built in India. The binding has been so arranged as to make it easy to insert additional data.

The undersigned acknowledges with thanks the great help rendered by Captain P. R. Ahuja, Deputy Secretary and Shri I. K. Mahajan, Technical Assistant, Central Board of Irrigation in the preparation of this compilation.

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# CHAPTER I

## INTRODUCTION

### GENERAL

Irrigation has been practised in India from prehistoric times. Irrigation from storage works likewise is an ancient practice. There are several very old tanks in India, may be a thousand years old or more, which are still functioning fairly efficiently. It is interesting to note that in Mysore State alone, the number of storage works, big and small, exceeds 25,000, and that in the State of Madras 35,000. Similarly there are a large number of storage works in Bombay, Madhya Pradesh and Hyderabad States. Most of the small works were built in very early days and it is mainly during the past hundred years that big State-managed storage projects have been constructed and facilities of irrigation extended to vast areas.

Of the total of over 50 million acres under irrigation in India, storage works account for over eight millions. Three-fourth of the area protected by storage works is confined to Southern India. On the other hand, except for deltaic canals in Madras, gigantic river diversion works exist mainly in Northern India. Why this great diversity in the nature of irrigation works built so far ? The efforts of those responsible for the early development of irrigation works in India were directed naturally to those resources which were easy to exploit. In Northern India, most of the rivers are snow-fed and perennial and river diversion works are, therefore, easy and economical to construct whereas in Southern India, the rivers though swollen during monsoon, have little flow during dry weather. Irrigation in the South is, therefore, possible only by the construction of storage works to ensure assured and regular supplies. In Northern India also with the almost full utilisation of available perennial supplies, several multi-purpose storage projects are now contemplated and some of them are actually under construction.

In this Publication an attempt has been made to compile important engineering data of all high dams built so far in India. It is the intention that similar data of works to be constructed in future will be added to these Volumes as and when it becomes available.

For a proper appreciation and understanding of the information furnished herein, it appears necessary to devote some space to a description of the physical features of the country which determine mainly her rainfall and climate, soil and crops *etc.* A brief account of the geology of the country is also necessary.

### PHYSIOGRAPHY OF INDIA

Physiographically India may be divided into four parts. These are the Peninsula proper, the Indo-Gangetic Alluvial Plains, and the Himalayan and associated mountains called the Extra Peninsula and the Thar Desert. (see Figure 1).

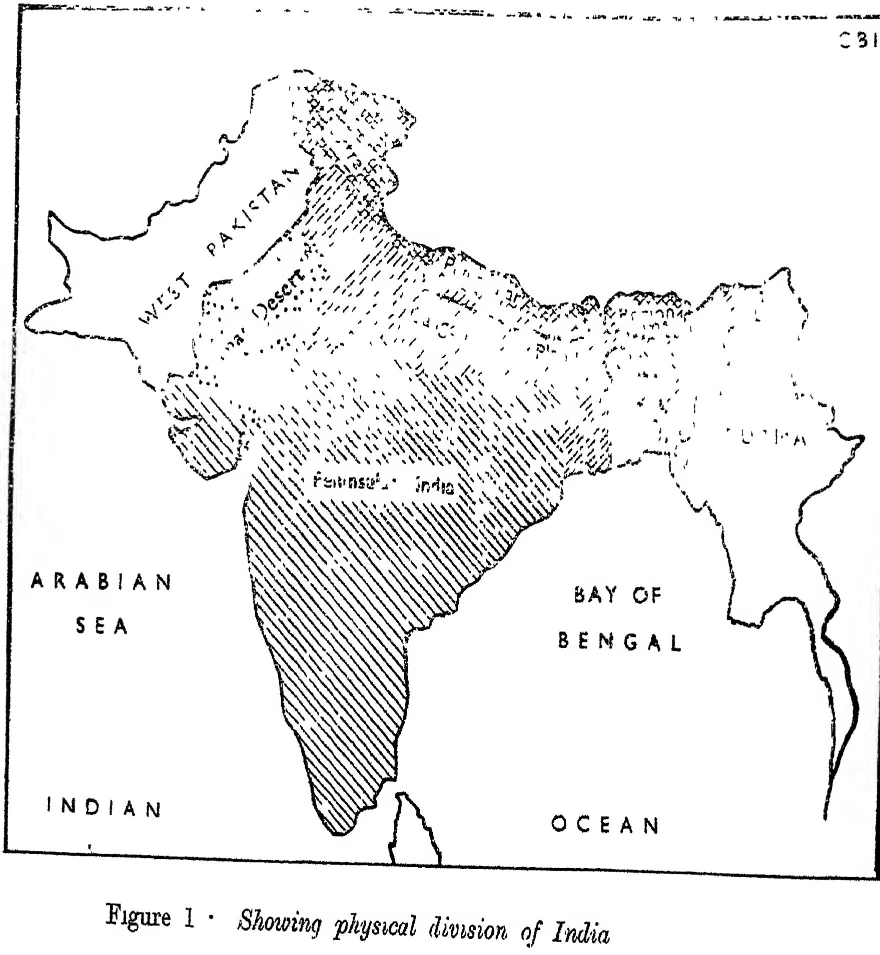



Figure 1 · *Showing physical division of India*

**THE PENINSULA**

The Peninsula is an ancient land mass, owing its present features to denudation and weathering over long ages. The harder rock masses which have resisted weathering stand-out today as mountains, the softer forming the valleys and plains. It represents a stable block of the earth's crust which has not been affected appreciably by earth movements since Pre-Cambrian times, though it has suffered some faulting and secular movements. It is composed, mainly of ancient crystalline and metamorphic rocks which are, in some places covered by later sediments and lava flows. Since the Pre-Cambrian times, marine rocks were deposited only on their fringes in the Upper Mesozoic and Tertiary times. But fluviatile and lacustrine sediments were formed in the Gondwana era in some places.

### Peninsular Mountains

The Peninsular mountains include the Western and Eastern Ghats, Vindhyas, Satpuras, Aravallis and Assam ranges.

*The Western Ghats*—These form a series of ranges running parallel to the western coast of the Peninsula, the coastal strip to their west being comparatively narrow and in general less than 30 miles wide. In their southern part, from Cape Comorin to Dharwar, they are composed of ancient crystalline and metamorphic rocks, while the lavas of the Deccan form their northern part. In different portions these are called the Anaimalais, Cardamom Hills, Nilgiris and Sahyadris.

*The Eastern Ghats*—These are a series of rather disconnected ranges stretching from Orissa to the Nilgiris. They comprise the Eastern Ghats of Orissa and the Northern Circars, the Nallamalais, Javadi Hills, Shevaroys and other hills. They are made up of a variety of rocks, gneisses, khondalites, charnockites and schists of igneous and sedimentary origin.

*The Satpura and Vindhya Mountains*—These are the ranges stretching more or less west to east from the Gulf of Cambay to Bihar. Those to the south of the Narbada are the Satpuras, which extend through the northern part of Madhya Pradesh into Bihar The mountains to the north of the Narbada are the Vindhyas, and a certain group of sedimentary rocks which go largely into their constitution has been named after them.

*The Aravalli Mountains*—These are the major mountain ranges of Rajputana trending in a N. E.-S. W. direction from near Delhi in the north to Gujerat in the south. They tend to spread out in the south, one part leading towards the Western Ghats and the other towards the Satpuras of the Madhya Pradesh. The Aravallis are made up of crystalline and metamorphic rocks and, to some extent, of ancient sedimentaries.

*The Assam Ranges*—The Garo, Khasi, Jaintia and Mikir Hills together make up the mountains of the Peninsular part of Assam. They are composed mostly of ancient gneisses and schists, tapering into a wedge-like mass towards the north-eastern corner.

### THE EXTRA-PENINSULA

The Extra-Peninsula is a region of folded mountains of comparatively late age, that is, formed during the Tertiary era. It has been disturbed by earth movements of great magnitude, as the rocks are seen to have been folded, faulted, overthrust and even carried over considerable distances as thrust-sheets or nappes. The topography is very rugged and the rivers are youthful and torrential, actively eroding their courses.

The rocks comprise sediments of all ages representing the whole of the geological column. Accompanying the earth movements there were also igneous intrusions—mainly granitic—on a large scale, these being seen particularly in the Central Himalayan belt.

The Extra-Peninsular ranges include the Himalayas and their continuation westward into Baluchistan on the one hand and eastward into Burma on the other. Individual units will be found to be approximately parts of circular arcs, with varying radii. All have their convex side turned towards India. The arc-like ranges are arranged one behind the other, the curvature increasing with proximity to India.

*The Himalaya Mountains*—The Himalayas are a series of mountain ranges lying more or less parallel to each other. The different units here are the Hindukush and Karakoram, Kailas Range, Ladakh Range, Zanskar Range, the main Himalayan Range and the mountains of the Sub-Himalayan region. The Himalayas proper comprise four parallel longitudinal zones called respectively (from south to north) the Siwalik Zone of foot-hills, bordering the Indo-Gangetic plains, the Lesser Himalayas or Sub-Himalayan Zone, the Great Himalayas or Central Himalayas containing the high snow-clad peaks, and lastly the Trans-Himalayan Zone. The Siwalik zone consists mainly of sediments of Tertiary age. The Lesser Himalayas are made up of more ancient sediments, which have been very highly disturbed and which often show overthrusts and nappes of great magnitude. The Great Himalayas comprise the same types of sediments, these being profusely intruded by granitic rocks. The Trans-Himalayan region contains fossiliferous marine sediments of various ages laid down in the Tibetan sedimentary zone.

## THE INDO-GANGETIC PLAINS

These lie between the Extra-Peninsular region and the Peninsular India and represent a sag or depression in the crust of the earth filled up with alluvium brought down by the rivers from behind. This is the most interesting and important region. The alluvial land of these plains constitutes one of the most extensive and fertile tracts in the world. The alluvial soils of these plains is being cultivated from times immemorial and yet it shows little sign of exhaustion. The rivers flowing through the tract are snow-fed, very active during rainy season and carry enormous detritus load.

## THE THAR DESERT

The Thar Desert occupies a very large part of Rajputana. There are no high hills in this region to intercept the South-West Monsoons which pass over it. Structurally this region exhibits characteristics intermediate between the Peninsula and the Extra Peninsular Regions. The rocks show only a little disturbance but marine fossiliferous rocks belonging to the Mesozoic and Tertiary ages are also present. Figure 2 shows the geological features of India.

## CLIMATE

India lies partly in the tropical and partly in the sub-tropical regions ; the Tropic of Cancer passes through the Rann of Cutch and the middle of West Bengal *i.e.* almost through the middle of the country. The sub-tropical zone, comprising Rajputana, East Punjab and some Eastern parts of Uttar

Pradesh including Delhi Province, enjoys extreme climate, while the tropical zone is appreciably more equable.

In most parts of the country there are three seasons :

(*i*) Winter : November to March.
(*ii*) Summer : April to June.
(*iii*) Rainy Season : July to October.

The duration of each season, however, varies appreciably in different parts of the country.

Figure 3 shows climatic distribution in India

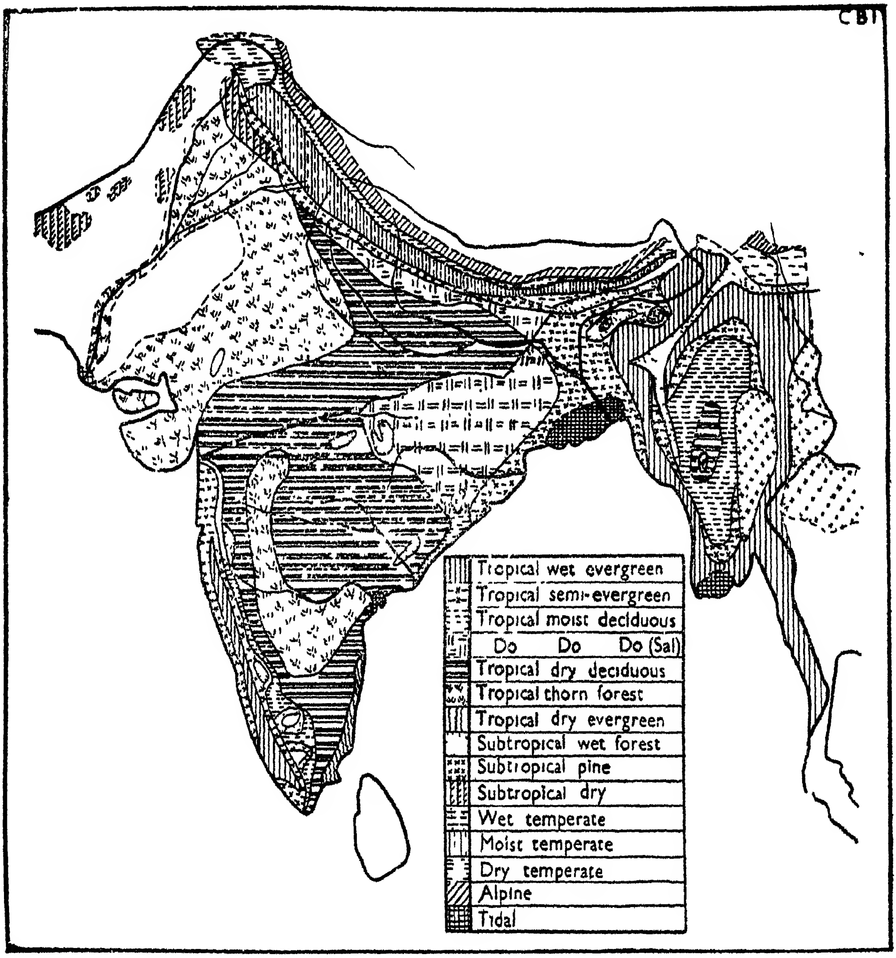



Figure 3 : *Climatic distribution in India*

## TEMPERATURE

The temperature of the air at any place depends upon many factors, of which the most important in India are the altitude of the sun, latitude, elevation, distance from the sea and the character of the prevailing winds. Th

All the rivers flowing in the easterly direction into the Bay of Bengal have built important deltas at their mouths and there is also a wide belt of the river borne detritus on the east coast. All the rivers in the Peninsula run almost dry in the hot season.

The chief rivers of the Peninsula are the Mahanadi, the Godavari, the Kistna and the Cauvery; and the west-ward flowing, the Narbada and the Tapti; also the Chambal, the Betwa and the Sone draining the northern edge of the Peninsula. On some of these rivers storage and other works have been built but the supply so far used is only an insignificant proportion of the supplies running to waste in the sea. The table I on page 9 gives the mean annual yield of the basins, discharges, supplies utilised *etc.* of some of the important rivers of the Peninsula.

There are several important natural falls on some of these rivers in the Peninsula such as Sivasamudram falls of the Cauvery in Mysore, Gerasoppa Falls of the river Sheravati, Gokak Falls of the river Gokak in Bombay, Dhurandhar Falls of the Narbada at Jubbulpore, Yeuna Falls of the Mahableshwer Hills, Pykara Falls in the Nilgiri Hills. They offer opportunities for developing hydro-electric power. There are also a number of gorges on these rivers which offer facilities for building dams to store water supplies.

The Himalayas proper between the North Western Frontier Province (Pakistan) and North-East corner of Assam, give rise to 22 important rivers which make up the Indus, Ganga and Brahmaputra systems. The main water-shed between Tibet and India is in reality the Trans-Himalayan range and not the Great Himalayan range containing the high peaks. Many of the rivers flow, in the mountains, through deep and steep side gorges. The rivers are torrential in the mountains but have low gradients on reaching the plains.

The Indus river system comprises the Indus, Jhelum, Chenab, Ravi, Beas and Sutlej. The Ganga system comprises the Ganga, Yamuna, Sarda, Ramganga, Kosi *etc.*, and their several tributaries. The Brahmaputra system includes the Brahmaputra, Tista, the rivers of Bhutan, the Subanseri, Dibang and Lubit.

As in the South, a very small proportion of the available supplies of the rivers in the North have been utilised. On the other hand the flood havoc caused by these rivers take every year a heavy toll of life, property and crops. The table on page 11 gives some of the important statistics relating to the important rivers of the north.

It has been estimated that the total water flowing into Indian rivers is on the average 2·25 million cusecs and at present only 7 percent is utilised, the rest runs to waste to the sea. These rivers also afford a number of sites for hydro-electric generation and it is estimated that the potential water power resources of India are about 40 million kW out of which only 0·5 million kW have been developed so far.

## TABLE I

| Serial No. | Name of river | Total length of the river in miles | Total catchment area of the river in square miles | Site of observation | Catchment area in square miles above the site of observation | Maximum discharge in cusecs | Average maximum discharge in cusecs | Minimum dry weather flow in cusecs | Average dry weather flow in cusecs | Average total annual yield in acre feet | Percentage at present utilised |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1 | Mahanadi .. | 553 | 51,000 | Hirakud .. | 32,200 | 942,000 | | 900 | 28,000 | 50,000,000 | *Nil* |
| | | | | Tikarpara .. .. | 48,000 | 1,270,000 | | 1,350 | 41,000 | 73 370,000 | *Nil* |
| | | | | Naraj .. .. | 51,000 | 1,571 000 | 1,121 667 | 1,500 | 42,000 | 74,000,000 | *Nil* |
| 2 | Brahmani .. | 433 | 14,000 | Janapore | 14,000 | 643,290 | | 130 | .. | 22 000,000 | .. |
| 3 | Godavari . | 900 | 121,500 | Dowlaishwaram .. | 115,570 | 2,107,660 | 938,621 | *Nil* | 5,100 | 85 000,000 | 7 to 8 |
| 4 | Kistna | 800 | 97,050 | Bezwada . | 97,050 | 1,193,901 | 522,097 | *Nil* | 1,880 | 47,047,500 | 8 |
| 5 | Cauvery | 500 | 31,000 | Post Mettur .. | 16,300 | 186,300 | 139,720 | *Nil* | 2 930 | 12 209,400 | 57 |
| 6 | Narbada | 800 | 33,750 | | . | 2,000,000 to 3,000,000 | | | | 100,000,000 | *Nil* |
| 7 | Tapti | 450 | 25,000 | | | | | | | | |
| 8 | Chambal | 582 | 35,000 | | . | . | . | .. | .. | 3,440,000 | *Nil* |
| 9 | Betwa . | | | Parichha . . | 10,400 | 760,000 | 327 000 | *Nil* | 824 | 7,500,000 | - |
| 10 | Son . | 487 | 26,000 | Dehri .. . | 24,000 | 1,214,450 | 667,225 | 614 | 2,014 | 28,870,000 | 8 |

*A view of the Gerasoppa Falls (Mysore)*

| Serial No. | Name of river | Total length of the river in miles | Total catchment area of the river in square miles | Site of observation | Catchment area in square miles above the site of observation | Maximum discharge in cusecs | Average maximum discharge in cusecs | Minimum dry weather flow in cusecs | Average dry Weather flow in cusecs | Average total annual yield in acre feet | Percentage at present utilized |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 1 | Indus | 1,800 | 311,661 | Kalabagh | 103,648 | 917,015 | 529,420 | .. | . | | . |
| 2 | Jhelum | 450 | 20,482 | Mangla | 13,352 | 760,000 | .. | 4,480 | 8 943 | 23,009 000 | .. |
| 3 | Chenab | .. | 26,725 | Marala | 11,110 | 718,000 | 207,737 | 3,578 | 4,564 | 23,140,000 | . |
| 4 | Sutlej | 900 | 41,085 | Rupar | 24,383 | 190,242 | 135,877 | 2,773 | 3 977 | 13,500,000 | .. |
| 5 | Beas | 390 | 7,122 | Mandi | .. | | | .. | | 12,200,000 | .. |
| 6 | Ganga | 1,557 | 414,313 | Raiwala | 9,928 | 800,000 | 152,849 | 3,907 | 11,726 | 19,900 000 | 21 |
| | | | | Narora | .. | 390,000 | 185,121 | 1,090 | 5,472 | 20,100,000 | 9 |
| | | | | Hardinge Bridge | 361,000 | 1,715,000 | 1,476,455 | . | .. | | |
| 7 | Yamuna | .. | 138,180 | Tajewala | 1,556 | 575,000 | 93,686 | 2,099 | 5,412 | 7,450,000 | 47.5 |
| | | | | Okhla | 6,500 | 197,962 | 57,248 | .. | 1,232 | 3,820,000 | [illegible] |
| 8 | Ramganga | .. | .. | Head at Rama | .. | 74,000 | 50,622 | 100 | 900 | 2 190,000 | 2 |
| 9 | Sarda | .. | .. | Banbassa | 5,758 | 600,000 | 247,524 | 3,802 | 7,584 | 16 730,000 | 20 |
| 10 | Ken | . | | Bariarpur | [illegible] | 591 000 | 296,600 | 50 | 1,098 | 7,700 000 | [illegible] |
| 11 | Dhasan | . | . | Lachura | [illegible] | 97,000 | 153,500 | | 216 | 2,140,000 | [illegible] |
| 12 | Kosi | . | 33,418 | Barahakshetra | 22,086 | 700,000 | .. | 9,000 | | 49,240,000 | |
| 13 | Damodar | 336 | 8,500 | Rhondia | 7,630 | 650,000 | 275,660 | . | 1,060 | 8,110,000 | Nil |
| 14 | Brahmaputra | 1,800 | 227,330 | Amingaon | | 2,550,000* | . | . | | | |

*Observed in 1938

## EARTHQUAKES

Seismic acceleration affect the stability of a dam by producing horizontal forces in it due to inertia of the dam and the inertia of the water upstream. India can be divided into three regions so far as the occurrence of earthquakes is concerned (see Figure 6).

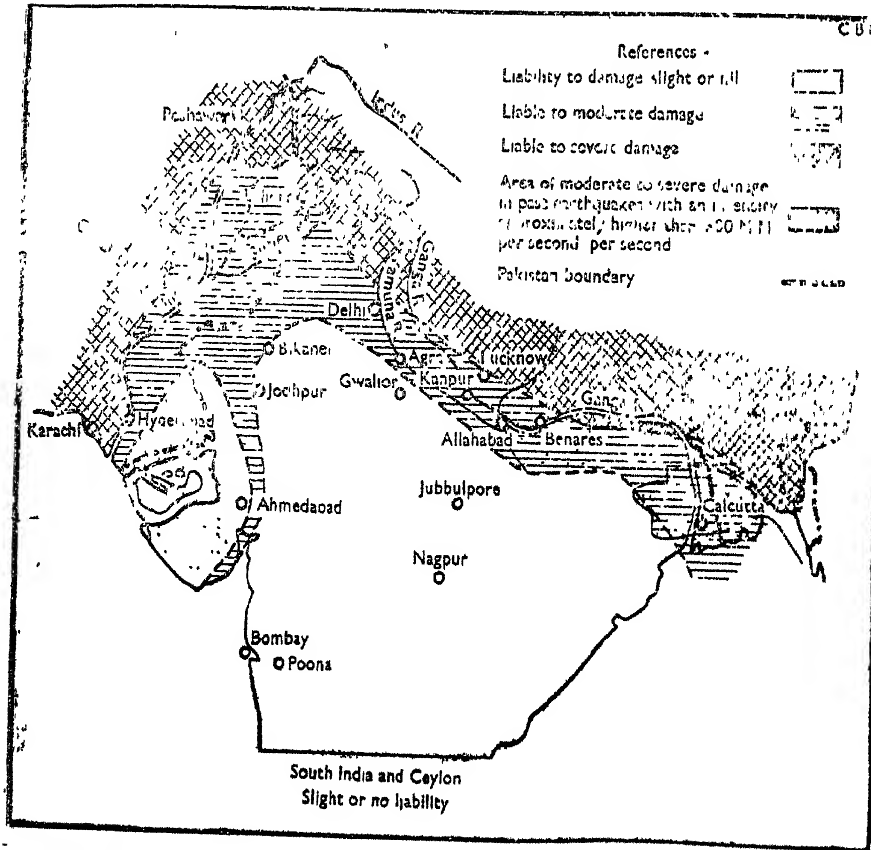



Figure 6 : *Index map of India showing liability to damage by earthquakes.*

1. *Himalayan Region.*—This region forms part of a very unstable land-mass and the Himalayas have not yet attained their final equilibrium and they are still rising. It has been the scene of some extremely violent earthquakes such as Kangra in 1901 and Kashmir in 1885 which have rocked Northern India.

2. *Indo-Gangetic Plains.*—These plains represent the trough or the fore-deep representing the foreland of the Himalayas. These represent the second unit which is affected by earthquakes in a lesser degrees than the Himalaya. Sometimes, however, violent earthquakes like the Bihar earthquakes of 1934 also originate in this region.

3. *Plateau of the Deccan.*—This, as stated earlier, represents a stable land-mass and is practically immune from the occurrence of disastrous earthquakes.

These three-divisions, therefore, represent regions with decreasing intensity of earthquakes from north to south.

# CHAPTER II

## STANDARD FORM

A standard form has been devised for presenting the data of the dams. It includes essential features of all kinds of dams whether masonry, earthen or composite, single purpose or multi-purpose. In individual dams, it is possible that some items of the standard form may not be relevant *e.g.* in an earthen dam items peculiar to masonry structures are not required and *vice versa*. Such items have been omitted where not required but a uniform numbering has been maintained for facility of reference. A complete blank standard form is given below for ready reference of the user of this publication.

Wherever any information is not available, the space has been left blank. Data of a negative character have been clearly indicated as such.

### STANDARD FORMS

#### DAM.

#### I. GENERAL

(1) Height above the lowest river bed
(2) Location
(3) Authority or owner
(4) Purpose-Main and subsidiary
(5) Year of commencement
(6) Year of completion
(7) Capital cost—
 (*a*) Estimated
 (*b*) Actual
(8) Culturable area commanded by the project
(9) Area irrigated
(10) Installed hydro-electric capacity—
 (*a*) Firm
 (*b*) Secondary
(11) Means of access

#### II. GEOPHYSICAL

(1) Area of catchment
(2) Nature of catchment
(3) Mean annual precipitation—
 (*a*) Rainfall
 (*b*) Snow
(4) Total Average annual yield of the catchment
(5) Climate

(6) Temperature conditions and variations

(7) Rate of Flow—

(a) Maximum

(b) Minimum

(8) Detritus charge of the stream

(9) Character (chemical) of the water stored in the reservoir

(10) Geological features—

(a) of foundations

(b) of catchment area

(11) Earthquake (zone and intensities)

## III. TECHNICAL

### A. STATISTICAL

(1) Reservoir Data—

(a) M.W.L.

(b) F.R.L.

(c) Area at M.W.L.

(d) Area at F.R.L.

(e) Maximum length

(f) Maximum width

(g) Length of periphery

(2) Capacity of the reservoir—

(a) Gross

(b) Live

(c) Flood storage

(d) Carry-over

(3) Maximum height above the lowest point of foundations

(4) Height above the lowest river bed at dam

(5) Height of the top of the dam above the crest of the spillway or weir

(6) Maximum width at level of foundation

(7) Width at top

(8) Batter of face slopes—

(a) Upstream

(b) Down tream

(9) Length at top of the dam—
  (a) Non-overflow—
    (i) Main
    (ii) Subsidiary
  (b) Spillway
(10) Cubic volume of the body of the dam

B. OTHERS

(11) Material of which the dam is constructed
(12) Specific gravity—
  (a) Masonry
  (b) Concrete
  (c) Rockfill
  (d) Earthfill
(13) Nature of protection and waterproofing of the upstream and downstream faces
(14) Provision for dealing with seepage and drainage water
(15) Means of securing water tightness of the foundation of the dam
(16) Contraction joints
(17) Principal stresses in the masonry with a note of methods of calculations employed
(18) Maximum pressure on foundations
(19) Uplift pressure, calculated or measured
(20) Measures adopted for preventing or counteracting uplift pressures
(21) Hydraulic gradient for which the embankment is designed
(22) Particular of the berm (if any), width and position
(23) Position and form of the core wall (or other means of securing water tightness)
(24) Batter (if any) of the core wall

(25) Maximum depth below ground surface of core-wall or other means of securing water tightness

(26) Method of keying core-wall or other wall in the under-lying ground

(27) Nature of material forming the core or other wall

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) Land submerged—

(*a*) Crown waste

(*b*) Proprietory

(2) Dislocation—

(*a*) Villages

(*b*) Families

(*c*) Population

(*d*) Roads—

(*i*) Highways

(*ii*) District Roads

(*iii*) Village Roads

(*e*) Railway Lines

(*f*) Temples, Mosques, *etc.*

(*g*) Graves, *etc.*

(*h*) Trees, Gardens, Pastures, Houses, Wells, *etc.*

(*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

(1) Surplusing works

(2) Outlet works

(3) Scouring works

(5) Inspection facilities

(6) Fish-pass

(7) Means for dissipating energy below the spillway

## VI. POWER HOUSE

(1) Hydraulic head

(2) Name and address of Licensee with managing agents (if any)

(3) Generating units—

(a) Type

(b) Number

(c) Capacity—

(i) Firm

(ii) Secondary

(4) Voltage

(5) Number of phases and frequency, A.C. or D.C.

(6) Forebay

(7) A brief description of tunnel and penstocks

(8) Means provided for excluding silt and trash

(9) Tail race

(10) Maximum length of transmission line

(11) Principal towns served

(12) Main and subsidiary purpose of the utilisation of electricity

(13) Any other matter of interest

## VII. NAVIGATION WORKS

(a) Length of river where navigation has been made possible by the construction of the dam

(b) Type of cargo transported

(c) Number of passengers transported annually

(d) Annual income from source at item (b) and (c)

(e) Navigation Lock:

(i) Location

(ii) Lock chamber, clear size

(iii) Lift (i) Maximum
(ii) Minimum

(iv) Estimated lockage time

## VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work.

(3) Noteworthy occurrences and accidents

(4) Operation of the dam—
- (*a*) Regulation
- (*b*) Silting of the reservoir—
  - (*i*) Total silt deposited
  - (*ii*) Rate of silting
  - (*iii*) Density of the silt deposited
  - (*iv*) Rate of advancement of delta
- (*c*) Actual yield as against estimated
- (*d*) Various measurements and observations—
  - (*i*) Evaporation losses
  - (*ii*) Sweating below the dam
  - (*iii*) Temperature measurements
  - (*iv*) Seepage and regeneration
  - (*v*) Settlement
- (*e*) Fish culture
- (*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) **Historical**

(2) **Personnel**

(3) **Bibliography**

## ABBREVIATIONS

In this publication some of the most accepted abbreviations have been used for want of space on drawings etc. These are :

| | | |
|---|---|---|
| F.R.L. | .. .. .. | Full Reservoir Level. |
| M.W.L. | .. .. .. | Maximum Water Level. |
| kW | .. .. .. | Kilowatt. |
| A.C. | .. .. | Alternating Current. |
| D.C. | .. .. .. | Direct Current. |

## DAMS IN THIS VOLUME

The dams, the information regarding which is published in this volume nclude 29 dams of Bombay State, 8 of Mysore State, 12 of Madras state one of Union of Travancore and Cochin State and 7 of Hyderabad State. The information has been published basin-wise and not as per territorial boundaries. Table I gives the main features of the dams. Figure 7 shows their location.

# TABLE I

## Important Statistics of High Dams in Volume I

| Serial No | Name of dam | Type | Purpose | Year of completion | Actual Capital Cost (Rupees) | Catchment area in square miles | Total useful capacity (acre feet) | Height above the lowest river bed (feet) |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | **Cauvery Basin** | | | | | | | |
| 1 | Moti-Talav Dam | Earthen | Irrigation and water supply. | . | | 17·65 | 17,742 | 80 |
| 2 | Glen Morgan Dam | Masonry | To provide subsidiary storage for Pykara Hydro-electric development | 1930 | 4,01,000 | 1·00 | 597 | 48·5 |
| 3 | Forebay Upper Bund Dam. | Earthen . | Forebay storage for Pykara Hydro-electric development | 1932 | 1,61,800 | 0·33 | 1,354 | 40 |
| 4 | Forebay Lower Bund Dam. | Earthen | Do | 1932 | 5,92,000 | 0·33 | 1,354 | 63 |
| 5 | Krishnarajasagar Dam. | Masonry | Power, Irrigation and water supply | 1932 | 2,60,00,000 | 4,100 | 1,010,000 | 134 |
| 6 | Chamarajasagar Dam | Masonry . | Water Supply | 1933 | 22,39,041 | 530 | 54,637 (Gross) | 115 |
| 7 | Mettur Dam | Masonry | Irrigation and Power | 1934 | 6,80,00,000 | 16,300 | 21,46,165 | 176 |
| 8 | Mukurti Dam . | Masonry | To provide subsidiary storage for Pykara Hydroelectric development | 1938 | 17,48,150 | 9·75 | 41,322 | 95 |
| 9 | Markonahally Dam | Composite | Irrigation . | 1941 | 32,00,000 | 1,584 | 49,199 | 65 |
| 10 | Byramangala Dam | Earthen .. | Irrigation | 1945 | 11,00,000 | 147 | 17,148 (Gross) | 65 |
| 11 | Kanva Dam .. | Do | Do . | 1946 | 38,98,800 | 133 | 22,452 | 56 |
| | **Kistan Basin** | | | | | | | |
| 12 | Rajaram Dam .. | Do | Do .. | .. | .. | 1·66 | 712 | 53 |
| 13 | Madag Dam .. | Do | Do .. | 1867 | 1,67,598* | 540 | 1,228 (Gross) | 144 |
| 14 | Ekruk Dam .. | Do | Irrigation, Industry and water supply. | 1871 | 23,68,279 | 159 | 55,946 | 76 |
| 15 | Mayni Dam .. | Do | Irrigation .. | 1873 | 5,98,126 | 54 | 1,854 | 60 |
| 16 | Pingli Dam .. | Do | Do .. | 1878 | 2,80,665 | 20 | 2,35[illegible] | 54 |

| Maximum height of the top of the dam above the lowest level of foundation (feet) | Maximum width at the level of foundation (feet) | Length at top of dam (feet) | Volume of the body of the dam (million cubic feet) | Power: Hydraulic Head (feet) | Power: Generating unit and type | Power: Installed capacity kW | Area irrigated in acres | Cost per foot top length of dam (Rupees) | Cost per acre foot of useful capacity (Rupees) | |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| .. | | | | | | | 725 | | | |
| 53 | 17 75 | 261 | 0 25 | | | | | 1,536 | 672 | |
| 77 | 230 | 400 | 1·41 | 3,074 | 5 Nos. Pelton wheel | ,074 18,430 KVA | .. | 405 | 119 | |
| 97 | 320 | 422 | 3 35 | | | | | 1,403 | 437 | |
| 146 | 111 | 8,600 | 30 00 | 626 for 2 units of 8,000 kW and 420 for the rest | 13 Nos Francis re action turbines. | 61,000 | 92,000 | 3,023 | 26 | |
| 152 | 140 | 1,400 | 0·47 | . | | | . | 1,600 | 41 (Gross) | |
| 224 | 214·15 | 7,070 | 54·6 | 60 to 160 | 4 Nos Francis Turbines | 40,000 | 455,000 | 9,618 | 32 | |
| 112 | 111 5 | 530 | 12 21 | | | . | | 3,300 | 42 | |
| Masonry 87 Earthen 84 | Masonry 56 Earthen 260 | 5,289 | 203 4 | | | . | 8,500 | 605 | 65 | |
| 72 | 393 5 | 7,700 | 2 97 | | | | 3,200 | 147 | 64 (Gross) | |
| 37 | 340 | 4,665 | 7 30 | . | | . | 3,500 | 336 | 174 (Gross) | |
| 54 | 218 | 1,250 | . | | | | 60 | | | |
| . | . | 1,870 | | .. | . | .. | 428 | . | | † Ancient dam old cost o repairs. |
| 91 | 386 | 7,000 | 39·8 | . | .. | .. | 16,942 | 338 | 42 | |
| .. | 312 | 51,00 | 163 87 | .. | .. | .. | 1,500 | 117 | 32·3 | |
| 63 | 274 | 5,603 | 195 0 | . | .. | .. | 1,000 | 50 | 110 | |

| Serial No | Name of dam | Type | Purpose | Year [illegible] | [illegible] | [illegible] | [illegible] | Height [illegible] |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 17 | Matoba Dam . | Earthen | Irrigation | 1878 | 1,61,[illegible] | [illegible] | [illegible] | [illegible] |
| 18 | Shirsuphal Dam | —Do— | —Do— | 1878 | [illegible] | 23 [illegible] | [illegible] | [illegible] |
| 19 | Khadakvasla Dam | Masonry | Irrigation and domestic water supply. | 1879 | [illegible] | [illegible] | [illegible] ,000 ([illegible]) | [illegible] |
| 20 | Nehr Dam .. | Do. | Do. . | 1880 | 7,[illegible] | [illegible] | [illegible] | 74 |
| 21 | Bhadalwadi Dam | Earthen | Irrigation . | 1881 | [illegible] | [illegible] | [illegible] | [illegible] |
| 22 | Ashti Dam . | Do. | Do. | 1883 | 8,[illegible] | [illegible] | [illegible] | [illegible] |
| 23 | Muchkandi Dam | Masonry | [illegible] .. | 1884 | [illegible] | [illegible] | [illegible] | [illegible] |
| 24 | Koregaon Dam | Composite | Do. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | | | | | | | | [illegible] |
| 25 | Mhaswad Dam | Earthen | Do. .. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 26 | Bhatodi Dam | Masonry | Do. .. | 1891-92 | [illegible] | [illegible] | [illegible] | [illegible] |
| 27 | Pathri Dam | Earthen | Irrigation and domestic water supply. | 1904-05 | 6,[illegible] | [illegible]7 | [illegible] | [illegible] |
| 28 | Shetphal Dam | Do. | Irrigation .. | 1906 | 6,16,[illegible] | [illegible] | [illegible] | 66 [illegible] |
| 29 | Vani Vilas Sagar Dam. | Masonry | Irrigation and domestic water supply. | 1907 | 18,50,[illegible] | [illegible] | [illegible] ([illegible]) | 142 |
| 30 | Lonavala Dam | Do. | Power . | 1916 | 85,17,111 (including cost of Walwhan Dam) | 5·4 | 9,[illegible] | 31·5 |
| 31 | Walwhan Dam | Do. | Do .. | 1916 | Do. .. | 5·5 | 58,769 | 71 |
| 32 | Siddapur Dam | Earthen | Irrigation .. | 1919 | 9,48,000 | 45 | 14,828 | 60 |
| 33 | Osmansagar Dam | Composite | Flood absorption and domestic water supply. | 1920 | 51,00,000 (Osmania) | 285 | 90,449 (Gross) | 112 |
| 34 | Shirawta Dam | Masonry .. | Power .. | 1920 | 82,57,145 | 11 | 150,757 | 83 |
| 35 | Thokerwadi Dam | Do. | Do. .. | 1922 | 97,79,000 | 48 | 294,906 | 190 |

| Maximum height of the top of the dam above the lowest level of foundation (feet) | Maximum width at the level of foundation (feet) | Length at top of dam (feet) | Volume of the body of the dam (million cubic feet) | Power: Hydraulic Head (feet) | Power: Generating unit and type | Power: Installed capacity kW | Area irrigated in acres | Cost per foot top length of dam (Rupees) | Cost per acre foot of useful capacity (Rupees) | |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 57 | 228 | 6,055 | 4 03 | | . | | 2,708 | 27 | 38 | |
| 56 | 264 | 2,430 | . | | | . | 1,109 | 92 | 27 | |
| 130 | 75 | 4,827 | 10 25 | . | . | | 12 582 | 808 | [illegible] | |
| . | 370 | 6 520 | 489 77 | . | | . | 3,063 | 135 | 78 | |
| | 261 | 2,680 | 7 02 | . | . | | 1,857 | 195 | 119 | |
| 74 | 405 | 12,700 | 114 86 | | .. | . | 11,280 | 66 | 39 | |
| 63 | 41 | 520 | 0 65 | . | .. | | 5,417 | 505 | 12 | |
| (M) 16 | 366 (E) | 1,770 | | .. | | | 800 | 22 | 20 | |
| 96 5 | 5.1 | 12,000 | 12 19 | . | . | | 24,800 | 175 | 59 | |
| . | .. | 2,747 | .. | . | .. | | 674 | 137 | 409 | |
| 75·75 | 360 | 7,590 | . | . | .. | . | 500 | 85 | 69 | |
| 74·5 | 332 | 12,432 | | .. | . | | 6 280 | 52 | 49 | |
| 63·34 | 105 | 1,330 | 7 65 | .. | . | .. | 12,000 | 1391 | 3 | |
| 52 | 22 | 2,971 | 1·56 | 1 760 | 6 Nos. | 48,000 | . | 1,341 | 134 | |
| 86·5 | 53·6 | 3,380 | 6·44 | 1,726 | (Also includes) No. 34) | | | | | |
| 63 | 291 | 16,092 | 19·00 | .. | . | .. | 1,000 | 59 | 64 | |
| 120 | 91 | 6,200 | 7 63 | . | .. | .. | .. | 857 | | |
| 126 | 84 | 7,000 | 17·00 | 1,726 (Gross) | Included in item Nos. 30 and 31. | . | .. | 1,086 | 55 | |
| 195 | 118 | 1,875 | 7·49 | 1,742 1,670 Maxi head gross | 6 Nos. Hydro Pelton turbines. | 48,000 | . | 5 216 | 33 | |

| Serial No. | Name of dam | Type | Purpose | Year of completion | Actual cost (Rupees) | [illegible] miles | Total useful capacity (acre feet) | Height above the lowest river bed (feet) |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 36 | Sir Pi[illegible]rao Talao Dam | Composite | Irrigation and domestic water supply | 1923 | | 3 | 2,118 | 37 (M) 37 (E) |
| 37 | Himayatsagar Dam | —Do— | Irrigation and water supply | 1926 | 93,05,727 | [illegible] | 87,38[illegible] (Gross) | 93 |
| 38 | Palair Dam | Earthen | Irrigation | 1928 | [illegible],38,751 | 651 24 | 53,653 | 61 [illegible] |
| 39 | Lloyd Dam | Masonry | Irrigation | 1928 | 1,72,00,000 | 12 8 | [illegible] | 168 |
| 40 | Mulshi Dam | Masonry | Power | 1929 | 2,19,64,450 | 95 6 | 423,8[illegible] | 146 |
| 41 | Wyra Dam | Masonry | Irrigation | 1933 | 35,90,276 | 274 | 46,719 | 61 |
| 42 | Visapur Dam | Earthen | Irrigation and domestic water supply | 1936 | 40,44,132 | 159 | 27,961 | 84 |
| 43 | Anjanapur Dam | Earthen | Irrigation | 1938 | 20,50,000 | 201 | 13,368 (Gross) | 63 |
| 44 | Rooty Dam | Earthen | To provide immediate relief to the famine effected area in Bihar District and to develop light irrigation | 1939 | 5,74,076 | 57 55 | 5,330 | 46·5 |
| 45 | Pendlipakala Dam | Earthen | Irrigation | 1940 | 6,57,[illegible] | [illegible] | 11,777 | [illegible] |
| 46 | Nandargi Dam | Earthen | Irrigation | 1942 | 1,19,[illegible] | [illegible] | [illegible] | [illegible]2 |
| 47 | Dindi Dam | Earthen | Irrigation | 1942 | [illegible],31,26[illegible] | .. | [illegible] | 70·[illegible] |
| 48 | Radhanagari Dam | Masonry | Irrigation, water supply and power. | Expected to be completed by the end of 1950 | .. | 12[illegible] | [illegible] | 126 |

| Maximum height of the top of the dam above the lowest level of foundation (feet) | Maximum width at the level of foundation (feet) | Length at top of dam (feet) | Volume of the body of the dam (million cubic feet) | Power | | | Area irrigated in acres | Cost per foot top length of dam (Rupees) | Cost per acre foot of useful capacity (Rupees) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Hydraulic Head (feet) | Generating unit and type | Installed capacity KW. | | | | |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 72(M)<br>37(E) | 46 75<br>(M) | 4,650 | . | .. | .. | .. | .. | . | | |
| 111 | 86·25<br>(M) (E) | 7,473 | .. | .. | .. | .. | .. | 1,232 | 106<br>(Gross) | |
| 67·5 | 289 | 830 | 27·44 | .. | .. | .. | 19,650 | 3,059 | 47 | |
| 194 | 124 | 5,333 | 21·5 | . | .. | .. | 171,079 | 3,225 | 31 | |
| 166 | 108·5 | 5,103 | 22·31 | 1,661<br>Gross | 5 Nos. Pelton wheel driven generators | 84,000<br>(Firm) | .. | 4,892 | 59 | |
| 88 | 45·2 | 5,800 | 4·09 | .. | .. | .. | 17,500 | 620 | 77 | |
| 87 | [illegible] | 9,366 | 49 0 | .. | . | .. | 4,220 | 432 | 145 | |
| 87 | 310 | 5,000 | 5·06 | | .. | . | 10,294 | 410 | 153 | |
| 56·5 | 275 | 4,877 | 10 06 | .. | .. | .. | 4,600 | 118 | 108 | |
| 64 | 318 | 4,492 | 7·8 | .. | .. | .. | .. | 146 | 56 | |
| 59 | 275 | 1,610 | 2·17 | .. | .. | .. | 639 | 75 | 127 | |
| 84 | 359·5 | 6,100 | 12·63 | .. | .. | .. | 40,000 | 661 | 72 | |
| 140 | 100·25 | 3,750 | 13·00 | 46 feet to 4 numbers A C. 120 feet generators driven (variable) by English Electric feathering propeller type | .. | 48,000 | 7,000 | .. | .. | |

M30CBI

| Serial No. | Name of dam | Type | Purpose | Year of completion | Actual Capital Cost (Rupees) | Catchment area in square miles | Total useful capacity (acre feet) | Height above the lowest river bed (feet) |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | MINOR BASIN | | | | | | | |
| 49 | Periyar Dam .. | Masonry .. | Irrigation .. | 1897 | 33,92,000 | 232 | 225,321 | 158 |
| 50 | Kodayar Dam . | Masonry .. | Irrigation .. | 1906 | 26,07,419 | 80 | 80,349 | 99 |
| 51 | Unkal Dam .. | Earthen .. | Domestic Water Supply .. | 1914 | 1,93,084 | 18 | 3,512 | 54 |
| 52 | Mopad Dam .. | Earthen . | Irrigation . | 1921 | 18,38,000 | 250 | 48,003 | 72 |
| 53 | Tansa Dam .. | Masonry .. | Domestic Water supply | 1922 | 1,57,30,000 | 52 57 | 129,500 | 125 |
| 54 | Willingdon Dam | Earthen .. | Irrigation . | 1923 | 23,34,285 | 50 | 59,502 | 51·92 |
| 55 | Thippayapalem Dam | Masonry | Irrigation | 1938 | 4,37,600 | 102 | 4,178 | 40 |
| 56 | Thambraparni Diversion Weir Dam. | Masonry | Power .. | 1941 | 7,07,000 | 128 | 613 | 50 |
| 57 | Thambraparni Dam | Masonry . | To provide subsidiary storage reservoir to meet dry weather demand for power drought for Papanasam Hydro-electric scheme. | 1943 | 43,61,000 | 57 54 | *126,263 Gross | 174 |

*This capacity will be after the installation of spillway gates.

| Maximum height of the top of the dam above the lowest level of foundation (feet) | Maximum width at the level of foundation (feet) | Length at top of dam (feet) | Volume of the body of the dam (million cubic feet) | Power | | | Area irrigated in acres | Cost per foot top length of dam (Rupees) | Cost per acre foot of useful capacity (Rupees) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Hydraulic Head (feet) | Generating unit and type | Installed capacity KW. | | | | |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 176 | 144·5 | 1,241 | 4·99 | .. | .. | .. | 1,95,000 | 2,733 | 15 | |
| 152 | 105 | 1,396 | 4·35 | .. | .. | .. | 55,674 | 1,868 | 32 | |
| 61 | 273 | 2,726 | .. | .. | .. | .. | .. | 71 | 55 | |
| 92 | 639 | 5,458 | .. | .. | .. | .. | 6,000 | 337 | 38 | |
| 133 | 998 | .. | 13·00 | .. | .. | .. | .. | .. | 121 | |
| 56·5 | 362·5 | 1,320 | 137·00 | .. | .. | .. | 22,000 | 1,768 | 39 | |
| 60 | 44·25 | 424 | 0·32 | .. | .. | .. | 1,200 | 1,032 | 105 | |
| 60 | 50 | 1,350 | 1·03 | .. | .. | .. | .. | 568 | 1,193 | |
| 215 | 168 | 1,104 | 4·77 | 300 Gross | 3 numbers Francis turbines | 21,750 KVA | .. | 3,950 | 35 Gross | |

# CHAPTER III

# CAUVERY BASIN

# III. 1. Moti-Talav Dam

## Earthen

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 80 feet |
| (2) Location | Mandya District, Mysore State (sub-serial No. 36 of Lakapavani sub-series of Central Cauvery basin). |
| (3) Authority or owner | Government of Mysore |
| (4) Purpose-Main and subsidiary | Irrigation, and for water supply |
| (5) Year of commencement | It is a very old tank, and therefore, its dates of completion and commencement are not known. |
| (6) Year of completion | |
| (7) Capital cost | Very old tank |
| (a) Estimated<br>(b) Actual | Cost not available |
| (8) Culturable area commanded by the project. | 1,000 acres |
| (9) Area irrigated | 725 acres |
| (11) Means of access | There is a road to the Dam from French Rocks Railway Station on the Bangalore Mysore Section of the Mysore State Railway. |

### II. GEOPHYSICAL

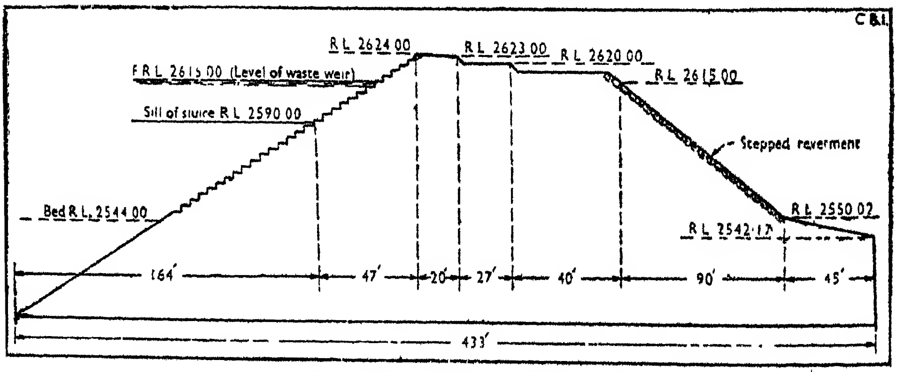
| | |
|---|---|
| (1) Area of catchment | 17·65 square miles |
| (2) Nature of catchment | Hilly |
| (3) Mean annual precipitation | |
| (a) Rainfall | 24 inches |
| (4) Total average annual yield of the catchment. | 2,848 cusecs |

| | |
|---|---|
| (5) Climate | Temperate |
| (6) Temperature conditions and variations | |
| (7) Rate of flow | |
| (*a*) Maximum | (*a*) 4,000 cusecs (rough) |
| (*b*) Minimum | (*b*) |
| (8) Detritus charge of the stream | There is very little flow of detritus material. |
| (9) Character (chemical) of the water stored in the reservoir. | Water is very clean and crystal clear. |
| (10) Geological features | |
| (*a*) of foundations | (*a*) |
| (*b*) of catchment area | (*b*) catchment area is hilly. |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data— | |
| (*a*) M.W. L. | (*a*) |
| (*b*) F.R.L. | (*b*) 2,615·00 |
| (*c*) Area at M.W.L. | (*c*) |
| (*d*) Area at F.R.L. | (*d*) 1,225 acres |
| (*e*) Maximum length | (*e*) 2·5 miles |
| (*f*) Maximum width | (*f*) 1·25 miles |
| (*g*) Length of periphery | (*g*) 10·0 miles (along water-spread) |
| (2) Capacity of the reservoir— | |
| (*a*) Gross | (*a*) 17,742 acre feet |
| (*b*) Live | |
| (*c*) Flood storage | |
| (*d*) Carry-over | |




*Cross section of the Moti Talav Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations. | |
| (4) Height above the lowest river bed at dam. | 80 feet |
| (5) Height of the top of the dam above the crest of the spillway of weir | 4·5 feet (minimum) |
| (6) Maximum width at level of foundation. | |
| (7) Width at top | 47 feet to 50 feet |
| (8) Slopes | |
| (a) Upstream | (a) As per cross section |
| (b) Downstream | (b) As per cross section |
| (9) Length at top of the dam | |
| (a) Non-overflow— | |
| (i) Main | (a) (i) 500 feet |
| (ii) Subsidiary | (ii) |
| (b) Spillway | (b) 15 feet |
| (10) Cubic volume of the body of the dam | |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed. | Earth and boulders |
| (12) Specific gravity | |
| (i) Earthfill | |
| (13) Nature of protection and water-proofing of the upstream and downstream faces | Both upstream and downstream of the bund are provided with revetments which are built in steps. |
| (14) Provision for dealing with seepage and drainage water | There is a small tank to collect the seepage water, and lower down there is a pick-up weir. |
| (15) Means of securing water tightness of the foundation of the dam | |
| (21) Hydraulic gradient for which the embankment is designed | 1 in 4 |
| (22) Particulars of the berm (if any) width and position | |
| (23) Position and form of the core wal (or other means of securing water tightness) | |
| 24) Batter (if any) of the core wall . | |

(25) Maximum depth below ground surface of core-wall or other means of securing water tightness

26) Method of keying core-wall or other wall in the under-lying ground

(27) Nature of material forming the core or other wall

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplusing works | Two waste weirs<br>(*i*) Natural weir 50 feet wide<br>(*ii*) Masonry weir 15 feet wide |
| (2) Outlet works | Masonry sluice 3 feet by 3 feet |
| (3) Scouring works | |
| (4) Inspection facilities | |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway. | |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| 1) Constructional features | It is an old structure, and it cannot be said, what methods were employed for carrying out the construction. It gives an appearance of a huge mass of earth, revetted with boulders. |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | |
| (3) Noteworthy occurrences and accidents | |
| (4) Operation of the dam | |
| (*a*) Regulation | (*a*) Hand operated screw shutter for sluice vent |
| (*b*) Silting of the reservoir— | |
| (*i*) Total silt deposited | |
| (*ii*) Rate of silting | |
| (*iii*) Density of the silt deposited | |
| (*iv*) Rate of advancement of delta | (*iv*) No delta |
| (*c*) Actual yield as against estimated | |

(*d*) Various measurements and observations.

(*i*) Evaporation losses

(*ii*) Sweating below the dam — (*ii*) Very slight—not measured ;

(*iii*) Temperature measurements

(*iv*) Seepage and regeneration — (*iv*) Seepage is picked up by small *anicuts* and utilised again.

(*e*) Fish culture

(*f*) Anti-malaria measures — (*f*) There is a dry-belt round the villages near irrigated area.

(5) Recreation facilities — Swimming and sight seeing

(6) Lessons to be learnt from the construction and utilisation of the dam

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical — This earthen dam is stated to have been constructed during the time of the Great Sree Vaishnava Saint "Sri Ramanujacharya" (who preached Vishishtadwaita philosophy) by about the end of 10th Century A.D.

(2) Personnel

(3) Bibliography

# III.2 Glen Morgan Dam

## (Masonry)

### GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 48·5 feet |
| (2) Location | Nilgiri District, Madras State (Glen Morgan Stream) |
| (3) Authority or owner | Madras Government |
| (4) Purpose—Main and subsidiary | To provide subsidiary storage for Pykara Hydro-Electric Development |
| (5) Year of commencement | 1929 |
| (6) Year of completion | 1930 |
| (7) Capital cost | |
| (a) Estimated | |
| (b) Actual | Rs. 4,01,000 |
| (10) Installed hydro-electric capacity | |
| (a) Firm | 48,430 KVA of Pykara Hydro-Electric Development. |
| (11) Means of access | It is accessible by road from the nearest railway station Ootacamund, which is at a distance of 16 miles from the dam site. |

### II. GEOPHYSICAL

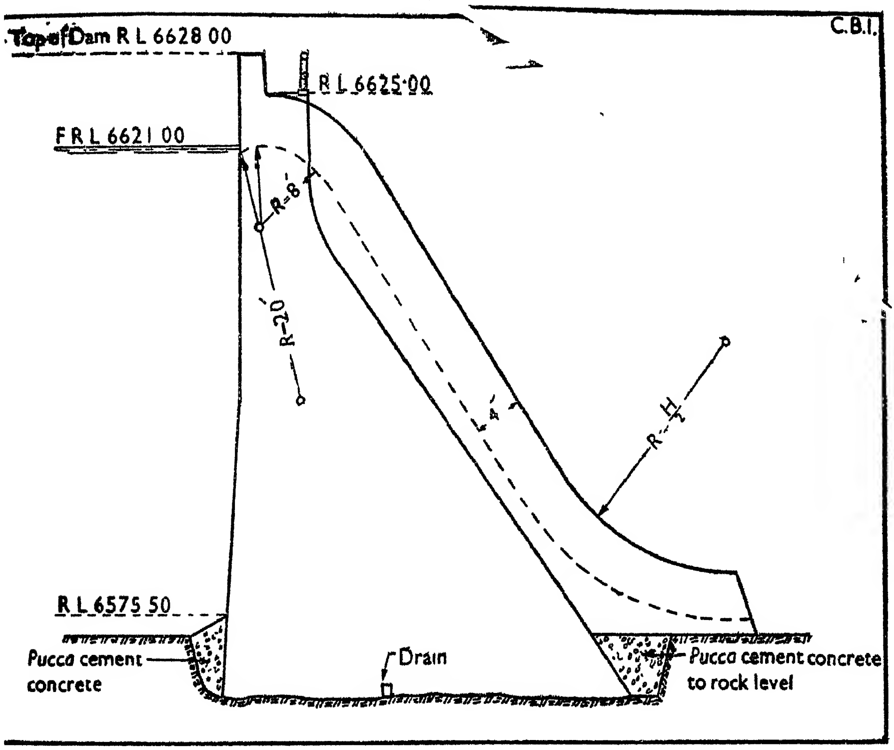
| | |
|---|---|
| (1) Area of catchment | One square mile |
| (2) Nature of catchment | |
| (3) Mean annual precipitation | |
| (a) Rainfall | 75·80 inches |
| (4) Total average annual yield of the catchment | 1,694 acre feet |

| | |
|---|---|
| (5) Climate | The climate is wet and cold during monsoon and cool during the rest of the year. |
| (6) Temperature conditions and variations | Maximum 80° F<br>Minimum 48° F |
| (7) Rate of Flow | |
| (*a*) Maximum | 1,300 cusecs (calculated) |
| (*b*) Minimum | 0·77 cusec |
| (8) Detritus charge of the stream | Very little |
| (9) Character (chemical) of the water stored in the reservoir | Soft and fairly pure |
| (10) Geological features | |
| (*a*) of foundations | The rock belongs to the "Charnockite series" and is a species of granite foundations carried to hard rock. |
| (*b*) of catchment area | The catchment is of surface soil four feet to five feet depth with moorum and boulders. |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (*a*) M.W.L. | |
| (*b*) F.R.L. | R. L. 6621·00 |
| (*c*) Area at M.W.L. | 0·072 square mile |
| (*d*) Area at F.R.L. | 0·064 square mile |
| (*e*) Maximum length | |
| (*f*) Maximum width | |
| (*g*) Length of periphery | |
| (2) Capacity of the reservoir | |
| (*a*) Gross | |
| (*b*) Live | 597 acre feet |
| (*c*) Flood storage | |
| (*d*) Carry-over | |




*Cross Section of the Glen Morgan Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 50 feet+3 feet parapet depth=53 feet |
| (4) Height above the lowest river bed at dam | 45·5 feet+3 feet parapet depth=48·5 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir. | 4·0 feet+3 feet parapet depth=7·0 feet. |
| (6) Maximum width at level of foundation | 47·75 feet |
| (7) Width at top | 6 feet for non-over flow section<br>7 feet for over-flow section. |
| (8) Batter of face slopes | |
| (a) Upstream<br>(b) Downstream | As per sketch cross |
| (9) Length at top of the dam | 261·00 feet |
| (a) Non-overflow | |
| (i) Main | 131 feet |
| (b) Spillway | 100 feet |
| (10) Cubic volume of the body of the dam | 251,500 cubic feet |

## B. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed. | Random rubble masonry in cement mortar for hearting and ashlar dressed facing in cement mortar 1 : 4 |
| (12) Specific gravity | |
| (a) Masonry | 2·32 |
| (13) Nature of protection and water-proofing of the upstream and down-stream faces | Cement pointing |
| (14) Provision for dealing with seepage and drainage water | One longitudinal drain built of masonry 9 inches to 12 inches square about 15 feet from the heel of the dam built on rock foundations connected with cross drains about 50 feet apart carried through the toe of the dam. |
| (15) Means of securing water tightness of the foundation of the dam | |
| (16) Contraction joints | 213 feet apart |
| (17) Principal stresses in the masonry with a note of methods of calculations employed | It is safe against overturning, vertical compressive stresses and sliding due to inclined stresses |
| (18) Maximum pressure on foundations | Overflow section—3·82 tons per square foot Non-overflow section 3·65 tons per square foot |
| (19) Uplift pressure calculated or measured | It is taken $\frac{1}{2}$ at heel and 0 at toe and total$=\frac{w\times h\times b}{4}$ |
| (20) Measures adopted for preventing or counteracting uplift pressures | The upstream and downstream side excavated trenches beyond dam section were filled with cement concrete and finished off at the top. 3 inches diameter grout holes were bored to varying depths at the base of the dam and grouted with liquid cement. One longitudinal drain built of masonry 9 inches to one foot square about 15 feet from heel of dam built on rock foundation, connected with cross drain about 50 feet apart carried through the toe of the dam. |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged* :

(a) Crown waste

(b) Proprietory

(2) *Dislocation* :

(a) Villages

(b) Families

(c) Population

(d) Roads :

(i) Highways

(ii) District Roads

(iii) Village Roads

(e) Railway Lines

(f) Temples, mosques, etc.

(g) Graves, etc.

(h) Trees, gardens, pastures, houses, wells, etc.

(i) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | One spillway of 100 feet length with a maximum discharging capacity of 1,611 cusecs |
| (2) Outlet works | There are two outlet pipes one of 24 inches diameter and the other of 36 inches diameter which have since been closed. Their discharging capacities are as under :—<br>24 inches diameter pipe at M.W.L.—97 cusecs<br>24 inches diameter pipe at F.R.L.—93 cusecs<br>36 inches diameter pipe at M.W.L.—218 cusecs<br>36 inches diameter pipe at F.R.L.—209 cusecs |
| (3) Scouring works | Not provided |
| (4) Inspection facilities | |
| (5) Fish pass | |
| (6) Means for dissipating energy below the spillway | |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | Nil |
| (3) Note worthy occurrences and accidents | Nil |
| (4) Operation of the dam | |
| (a) Regulation | |
| (b) Silting of the reservoir | |
| (i) Total silt deposited | |
| (ii) Rate of silting | |
| (iii) Density of the silt deposited | |
| (iv) Rate of advancement of delta | |
| (c) Actual yield as against estimated | |
| (d) Various measurements and observations | |
| (i) Evaporation losses | (i) Annual—53·5 inches |
| (ii) Sweating below the dam | |
| (iii) Temperature measurements | |
| (iv) Seepage and regeneration | |
| (e) Fish culture | |
| (f) Anti-malaria measures | |
| (5) Recreation facilities | |
| (6) Lessons to be learnt from the construction and utilisation of the dam | Nothing in particular |

## IX. BIBLIOGRAPHY AND HISTORICAL

| | |
|---|---|
| (1) Historical | The investigation was made in 1921 by Mr. B. D. Richards, M.I.C.E. of Messrs Alfred Dickenson and Co., Consulting Engineer, who acquired a concession to utilize the Pykara and Avarai rivers for power purposes. The concession was purchased by other companies also. In 1925 the Madras Government adopted the policy of development of water power resources of the presidency by the State and the project was sanctioned by the Secretary of |

State in 1929. The work on the main scheme was commenced in January 1930. The first generating unit was placed in service in October 1932 and the third in January 1933, thus completing the first stage of the scheme.

**(2) Personnel**

1. Chief Engineer :—
   Major H.G. Howard, M.C., M.I.E.E., M. Am. Soc. C.E.
2. Resident Engineer :—
   Mr. G.B.E. Truscote, Assoc. Am. Soc. C.E., M.I.E. (India), M.I.E.E.
3. Executive Engineer,
   Lt. Colonel M.G. Platts, O B E., M.C., B Sc., M.I.C.E.
4. Assistant Executive Engineer :—
   Shri S.R. Krishnamurthi, B.E., A.M. I E. (Ind.)
   (Incharge of dam and headworks)

**(3) Bibliography**

Printed Report on Pykara Hydro-Electric Development published in 1928

# III. 3. Forebay Upper Bund Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 40 feet |
| (2) Location | Nigiri district, Madras State (Small tributary stream to Pykara). |
| (3) Authority or owner | Madras Government |
| (4) Purpose-Main and subsidiary | Forebay storage for Hydro-electric Development |
| (5) Year of commencement | 1930 |
| (6) Year of completion | 1932 |
| (7) Capital cost | |
| (a) Estimated | Rs. 70,000 |
| (b) Actual | Rs. 1,61,800 |
| (10) Installed hydro-electric capacity— (a) Firm | 48,430 KVA |
| (11) Means of access | The dam is situated 10 miles North-West of Ootacamund and is 6 miles by road from the mile stone 10th of Ootacamund Gudalur Road. |

### II. GEOPHYSICAL

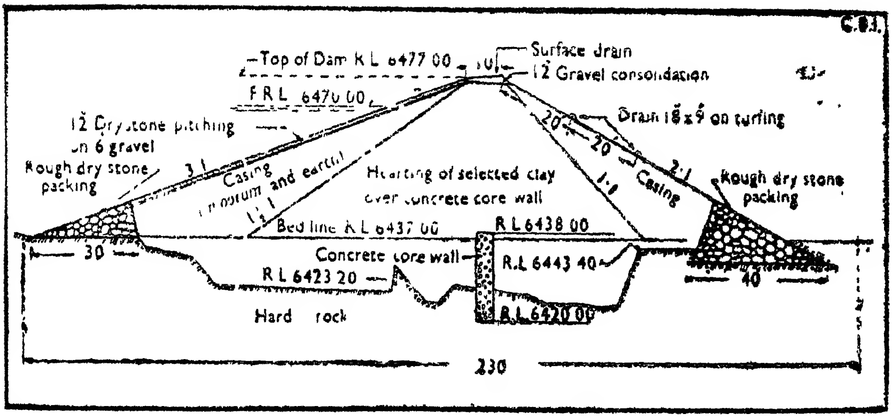
| | |
|---|---|
| (1) Area of catchment | 0·33 square mile |
| (2) Nature of catchment | |
| (3) Mean annual precipitation | |
| (a) Rainfall | 72·06 inches |
| (4) Total average annual yield of the catchment | The yield of the catchment is itself negligible |
| (5) Climate | The climate is wet and cold during monsoon and cool during the rest of the year |
| (6) Temperature conditions and variation | Maximum temperature—88°F<br>Minimum temperature—40°F |

| | |
|---|---|
| (7) Rate of Flow | |
| (a) Maximum | 621 cusecs (calculated) |
| (b) Minimum | |
| (8) Detritus charge of the stream | No appreciable quantity of silt |
| (9) Character (chemical) of the water stored in the reservoir | *Quantitative* (in part per 100,000) |
| | Total solids . .. 2·4 |
| | Temporary hardness .. |
| | Permanent hardness .. 0·5 |
| | Total hardness .. 0·5 |
| | Chlorine .. .. 0·4 |
| | Ammoniacal Nitrogen .. Trace |
| | Albuminoid .. .. 0·004 |
| | Oxygen observed .. 0·150 |
| | Nitric Nitrogen . . |
| | *Qualitative*— |
| | Nitrates .. .. . |
| | Sulphates .. .. . |
| | Phosphates .. .. .. |
| | Iron poisonous .. .. |
| (10) Geological features | |
| (a) foundations | Core walls have been carried down to hard rock of Charnokite variety. |
| (b) of catchment area | The catchment is of surface soil four to five feet depth with moorum and boulders below. |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data— | |
| (a) M.W.L. | |
| (b) F.R.L. | R.L. 6470·00 |
| (c) Area at M.W.L. | |
| (d) Area at F.R.L. | 0·1 square mile |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | |
| (2) Capacity of the reservoir | |
| (a) Gross | |
| (b) Live | 1,354 acre feet |
| (c) Flood storage | |
| (d) Carry-over | |




*Cross Section of Forebay Upper Bund Dam.*

(3) Maximum height above the lowest point of foundations — 57 feet

(4) Height above the lowest river bed at dam — 40 feet

(5) Height of the top of the dam above the crest of the spillway or weir — 7 feet

(6) Maximum width at level of foundation — 230 feet

(7) Width at top — 10 feet

(8) Batter of face-slopes
- (a) Upstream — 3 : 1
- (b) Downstream — 2 : 1

(9) Length at top of the dam — 400 feet
- (a) Non-overflow—
  - (i) Main — 400 feet

(10) Cubic volume of the body of the dam — 1,410,000 cubic feet

**B. OTHERS**

(11) Material of which the dam is constructed — Hearting of selected clay over concrete core-wall and casing of *moorum* and earth. Upstream and downstream toes are of rough stone dry packed.

(12) Specific gravity
- (d) Earthfill

| | |
|---|---|
| (13) Nature of protection and water proofing of the upstream and downstream faces | Upstream face has been pitched for its full width with 12 inches dry stone over 6 inches thick layer of gravel |
| (14) Provision for dealing with seepage and drainage water | As per cross section |
| (15) Means of securing water tightness of the foundation of the dam | By means of concrete core wall |
| (21) Hydraulic gradient for which the embankment is designed | |
| (22) Particulars of the berm (if any) width and position | |
| (23) Position and form of the core wall (or other means of securing water tightness) | As per cross section |
| (24) Batter (if any) of the core wall | Vertical faces |
| (25) Maximum depth below ground surface of core-wall or other means of securing water tightness | 18 feet |
| (26) Method of keying core-wall or other wall in the underlying ground | By means of concrete core-wall trenching |
| (27) Nature of material forming the core or other wall | Concrete |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*

(*a*) Crown waste

(*b*) Proprietory

(2) *Dislocation*

(*a*) Villages

(*b*) Families

(*c*) Population

(*d*) Roads—

(*i*) Highways

(*ii*) District Roads

(*iii*) Village Roads

(*e*) Railway Lines

(*f*) Temples, mosques, *etc.*

(*g*) Graves, *etc.*

(*h*) Trees, gardens, pastures, houses, wells, *etc.*

(*i*) Bridges

| | |
|---|---|
| (3) Compensation paid under each category of item (2) | |
| (4) Method of compensating for land of dispossessed landholders | |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | No spillway |
| (2) Outlet works | Six feet six inches diameter outlet pipe |
| (3) Scouring works | No scouring works |
| (4) Inspection facilities | |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | |

## VI. POWER HOUSE

| | |
|---|---|
| (1) Hydraulic head | Maximum gross head of 5 numbers generating units—3,074 feet |
| (2) Name and address of Licensee with managing agents (if any) | The Superintending Engineer, Pykara Electricity System, Coimbatore |
| (3) Generating units | Hydro |
| (a) Type | Pelton wheel |
| (b) Number | Five |
| (c) Capacity | |
| (i) Firm | 48,430 KVA |
| (4) Voltage | |
| (5) Number of phases and frequency, A.C. or D.C. | 3 ph. A.C. 50 cy. and one of 1 ph. A.C. 50 cy. |
| (6) Forebay<br>(7) A brief description of tunnel and penstocks. | From the forebay, through a gate, water is taken by a tunnel, 240 feet in length under the road, and then a steel rivetted pipe 78 inches diameter, 1,700 feet long laid in covered section to the top of the penstock. Here it branches off in three high pressure penstock lines, having different diameters. The total length of the penstock is 10,000 feet. The penstock is supported by 28 anchors which constitute the main support. |

| | |
|---|---|
| (8) Means provided for excluding silt trash | The water, so diverted flows through a trash rack and over a weir into the flume channel. The intake is specially designed to deposit sand and other solid matter and may be submerged by floods without effecting the water supply to the fore bay. |
| (9) Tail race | |
| (10) Maximum length of transmission line | 628 circuit miles (66 & 110 kV) |
| (11) Principal towns served | Ootacamund, Coonor, Coimbatore, Tiruppur, Erode, Pollachi, Palghat, Calicut, Cannanou, Madura. |
| (12) Main and subsidiary purpose of the utilisation of electricity | Textile Mills, Rice Mills, Ginning Factories, Presses, agricultural load and other miscellaneous small power and lighting *etc.* |
| (13) Any other matter of interest | It may be interesting to learn that at the time of its construction, it was considered the highest head plant to be operating anywhere in the world. |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | The material used for the construction of the dam was brought to the site by 2 foot gauge side tipping wagons on rails, and dumped and spread in six inches layers, which were consolidated by Petrol Rollers. In dry weather the consolidated surface was hosed and raked before a new layer was spread. Each layer was rolled three times and this gave better and satisfactory consolidation. The more water tight material was used throughout the upstream side and more porous on the downstream side. |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | |
| (3) Noteworthy occurrences and accidents | |

**(4) Operation of the dam**

(a) Regulation
(b) Silting of the reservoir
  (i) Total silt deposited
  (ii) Rate of silting
  (iii) Density of the silt deposited

  (iv) Rate of advancement of delta
(c) Actual yield as against estimated

(d) Various measurements and observations
  (i) Evaporation losses — Annual—53·5 inches
  (ii) Sweating below the dam
  (iii) Temperature measurements
  (iv) Seepage and regeneration — On completion of the work the seepage was measured as follows :—
  With forebay empty—1/40 cusec
  With 35 feet of water in forebay—1/16 cusec.
  These measurements were made in dry weather, and seepage through the dam for 35 feet of water or 20 feet below F.R.L. would appear to be 1/7 cusec.
  **(v) Settlement** — Settlement after completion was measured along the crest of the Lower Bund of Forebay during the period mid March to mid August 1933 as below :—
  Maximum $1\frac{3}{4}$ inches. Minimum $\frac{1}{2}$ inch. Average $1\frac{1}{4}$ inches.
(e) **Fish culture**
(f) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

## VII. BIBLIOGRAPHY AND HISTORICAL

(1) Historical — The investigation was made in 1921 by Mr. B. D Richards, M.I.C.E. of Messrs Alfred Dickenson and Co. Consulting Engineer, who acquired a concession to utilize the Pykara and Avarai rivers for power purposes. The concession was purchased by other companies also.

In 1925 the Madras Government adopted the policy of development of water power resources of the presidency by the State and the project was sanctioned by the Secretary of State in 1929 The work in the main scheme was commenced in January 1930. The first generating unit was placed in service in October 1932 and the third in January 1933, thus completing the first stage of the scheme

(2) Personnel

1. Chief Engineer :-
Major H. G. Howard, M.C., M.A.I.E.E., M. Am Soc C E.

2. Resident Engineer :--
Mr. G. B. E.Truscott Assoc Am. Soc. C.E., M.I.E. (India) ; M.I E.E.

3. Executive Engineer :-
Lt.-Colonel M. G Platts, O.B.E., M.C., B.Sc., M.I C.E

4. Assistant Executive Engineer :—
Shri S. R. Krishnamurthy, B.E. A.M.I.E. (India) Incharge of dam and headworks.

(3) Bibliography

Printed Report of Pykara Hydro-electric Development published in 1928.

# III. 4. Forebay Lower Bund Dam (Earthen)

## I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 63 feet |
| (2) Location | Nilgiri district, Madras State. (Small tributary stream to Pykara river) |
| (3) Authority or owner | Madras Government |
| (4) Purpose-Main and subsidiary | Fore-Bay Storage for Pykara Hydro-Electric Development |
| (5) Year of commencement | 1930 |
| (6) Year of completion | 1932 |
| (7) Capital cost | |
| (a) Estimated | Rs. 3,51,000 |
| (b) Actual | Rs. 5,92,000 |
| (10) Installed hydro-electric capacity | |
| (a) Firm | 48,430 KVA |
| (b) Secondary | |
| (11) Means of access | The dam is situated 10 miles North-West of Ootacamund and is 6 miles by road from the mile stone 10/4 of Ootacamund Gudalur road. |

## II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 0·33 square mile |
| (2) Nature of catchment | |
| (3) Mean annual precipitation | |
| (a) Rainfall. | 72·06 inches. |
| (4) Total average annual yield of the catchment | The yield of the catchment is itself negligible |
| (5) Climate | The climate is wet and cold during monsoon and cool during the rest of the year. |

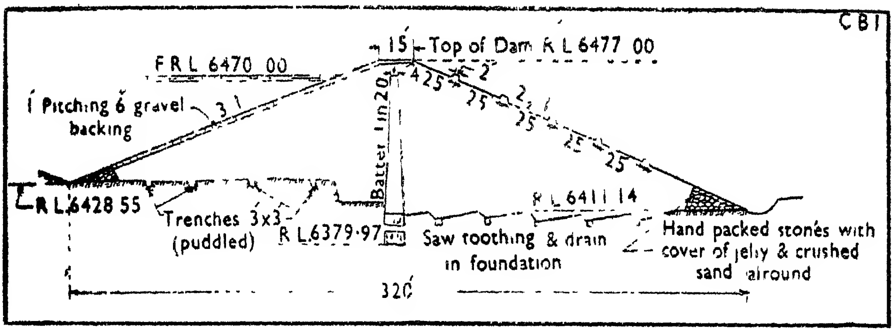
| | |
|---|---|
| (6) Temperature conditions and variations | Maximum temperature 88°F. Minimum temperature 40°F. |
| (7) Rate of Flow | |
| (a) Maximum | 621 cusecs (calculated) |
| (b) Minimum | |
| (8) Detritus charge of the stream | No appreciable quantity of solids |
| (9) Character (Chemical) of the water stored in the reservoir | *Quantitative* (in part per 100,000) |
| | Total solids .. .. 2·4 |
| | Temporary hardness . .. |
| | Permanent hardness . 0·5 |
| | Total hardness 0·5 |
| | Chlorine .. 0·4 |
| | Albuminoid . . 0·004 |
| | Ammoniacal Nitrogen .. Trace |
| | Oxygen absorbed (tidy) 0·150 |
| | Nitric Nitrogen . .. |
| | *Qualitative* |
| | Nitrates .. .. |
| | Sulphates . |
| | Phosphates .. .. |
| | Iron poisonous metals .. |
| (10) Geological features | |
| (a) of foundations | Core walls have been carried down to hard rock of charnokite variety. |
| (b) of catchment area | The catchment is of surface soil for four feet to five feet depth with moorum and boulders below. |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (a) M.W.L. | |
| (b) F.R.L. | R.L. 6470·00 |
| (c) Area at M.W.L. | |
| (d) Area at F.R.L. | 0·1 square mile |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | |
| (2) Capacity of the reservoir | |
| (a) Gross | |
| (b) Live | 1,354 acre feet |
| (c) Flood storage | |
| (d) Carry-over | |

FOREBA' LOWERBUND( MADRAS)




*Cross section of Forebay Lower Bund Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 97 feet. |
| (4) Height above the lowest river bed at dam | 63 feet |
| (5) Height of the top of the dam above the crest of the spill-way or weir | 7 feet |
| (6) Maximum width at level of foundation | 320 feet |
| (7) Width at top | 15 feet |
| (8) Batter of face-slopes | |
| (*a*) Upstream | 3 : 1 |
| (*b*) Downstream | $2\frac{1}{2}$ : 1 |
| (9) Length at top of the dam | 422 feet |
| (*a*) Non-overflow | |
| (*i*) Main | 322 feet |
| (*b*) Spillway | One spillway 100 feet in length |
| (10) Cubic volume of the body of the dam | (*a*) Earthfill- 2,850,000 cubic feet<br>(*b*) Core wall—concrete 25,230 cubic feet<br>masonry—144,700 cubic feet.<br>(*c*) Rough stone dry packing in feet toes—155,000 cubic feet.<br>Dry stone pitching—178,000 cubic feet<br>**Total 3,353,000 cubic feet** |

B. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed | Bund constructed with 50% of eart and 50% clay over core wall wit a covering of gravel and moorum |
| (12) Specific gravity | |
| (a) Masonry | |
| (b) Concrete | |
| (d) Earthfill | |
| (13) Nature of protection and waterproofing of the upstream and downstream faces | The upstream face has been pitche with dry stone 15 inches thick fo the full width over 6 inches grave and downstream face turfed for th entire width. |
| (14) Provision for dealing with seepage and drainage water | Puddle trenches, saw toothing an drain (*vide* cross section). |
| (15) Means of securing water tightness of the foundation of the dam. | By means of concerete core-wall. |
| (21) Hydraulic gradient for which the embankment is designed | |
| (22) Particular of the berm (if any) width and position | |
| (23) Position and form of the corewall (or other means of securing water tightness) | As per cross section (Masonry core wal above the ground level and concrete corewall below the ground level) |
| (24) Batter (if any) of the core wall | 1. in 20 for both masonry and concret portion |
| (25) Maximum depth below ground surface of core-wall or other means of securing water tightness | 38 feet |
| (26) Method of keying core-wall or other wall in the under lying ground | By means of concrete core-wall trenching |
| (27) Nature of material forming the core or other wall | Random rubble masonry in 1 : 3 cement mortar and cement concrete 1:3:5 in the bottom portion |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (a) Crown waste
  (b) Proprietory
(2) *Dislocation*
  (a) Villages
  (b) Families

(c) Population
(d) Roads
(i) Highways
(ii) District Roads
(iii) Village Roads
(e) Railway Lines
(f) Temples, Mosques, *etc.*
(g) Graves, *etc.*
(h) Trees, gardens, pastures, Houses, wells, *etc.*
(i) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | One open spillway, 100 feet in length and having a discharging capacity of 877 cusecs. |
| (2) Outlet works | Six feet six inches diameter pipe at the head works of the Pykara Hydro-Electric Scheme |
| (3) Scouring works | One pipe 18 inches diameter |
| (4) Inspection facilities | |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | |

## VI. POWER HOUSE

| | |
|---|---|
| (1) Hydraulic head | Maximum gross head of 5 numbers generating units— 3,074 feet |
| (2) Name and address of Licensee with managing agents (if any) | The Superintending Engineer, Pykara Electricity System, Coimbatore |
| (3) Generating units | Hydro |
| (a) Type | Pelton wheel |
| (b) Number | 5 Nos. |
| (c) Capacity | |
| (i) Firm | 48,430 KVA |
| (4) Voltage | |
| (5) Number of phases and frequency, A.C. or D.C. | 3 Ph. A.C., 50 cy. and one of 1 Ph. A. C., 50. cy. |

| | |
|---|---|
| (6) Forebay | From the forebay, through a gate, water is taken by a tunnel, 240 feet in length under the road, and then a steel rivetted pipe 78″ diameter, 1,700 feet long, laid in covered section to the top of the penstock Here it branches off in three high pressure penstock lines, having different diameters. The total length of the penstock is 10,000 feet. The penstock is supported by 28 anchors which constitute the main support. |
| (7) A brief description of tunnel and penstocks. | |
| (8) Means provided for excluding silt trash | The water, so diverted flows through a trash rack and over a weir into the flume channel The intake is specially designed to deposit sand and other solid matter and may be submerged by floods without effecting the water supply to the forebay. |
| (9) Tail race | |
| (10) Maximum length of transmission line | 628 circuit miles (66 and 110 kV) |
| (11) Principal towns served | Ootacamund, Coonoor, Coimbatore, Tiruppur, Erode, Pollachi, Palghat, Calicut, Cannanour and Madura. |
| (12) Main and subsidiary purpose of the utilisation of electricity | Textile mills, rice mills, ginning factories, presses, agricultural load and other miscellaneous small power and lighting *etc.* |
| (13) Any other matter of interest | It may be interesting to learn that at the time of its construction, it was considered the highest head plant to be operating anywhere in the world. |

## VIII. SUPPLEMENTARY INFORMA ION

| | |
|---|---|
| (1) Constructional features | The material used for the construction of dam was brought to the site by 2 foot gauge side tipping wagons on rails and dumped and spread in 6 inches layers which were consolidated by petrol rollers. In dry weather, the consolidated |

surface was hosed and raked before a new layer was spread. Each layer was rolled three times and this gave better and satisfactory consolidation. The more water tight material was used throughout the upstream side and more porous on the downstream side.

(2) Changes introduced in the plans of the dam and in the method of carrying out the work.

(3) Noteworthy occurrences and accidents

(4) Operation of the dam
- (*a*) Regulation
- (*b*) Silting of the reservoir
  - (*i*) Total silt deposited
  - (*ii*) Rate of silting
  - (*iii*) Density of the silt deposited
  - (*iv*) Rate of advancement of delta.
- (*c*) Actual yield as against estimated.
- (*d*) Various measurements and observations
  - (*i*) Evaporation losses — Annual 53·5 inches
  - (*ii*) Sweating below the dam
  - (*iii*) Temperature measurements
  - (*iv*) Seepage and regeneration — On completion of the work the seepage was measured as follows :—

    With forebay empty—1/40 cusec

    With 35 feet of water in forebay—1 16 cusec

    These measurements were made in dry weather and the seepage through the dam for 35 feet of water or 20 feet below F.R.L. would appear to be 1/7 cusec.
  - (*v*) Settlement — Settlement after completion was measured along the crest during the period mid March to mid August 1933 as below.

    Maximum $1\frac{3}{4}$ inches. Minimum $\frac{1}{2}$ inch. Average $1\frac{1}{4}$ inches.
- (*e*) Fish culture.
- (*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

The investigation was made in 1921 by Mr. B.D. Richards, M.I.C.E. of Messrs Alfred Dickenson and Co., Consulting Engineer, who acquired a concession to utilize the Pykara and Avarai rivers for power purposes. The concession was purchased by other companies also. In 1925 the Madras Government adopted the policy of development of water power resources of the presidency by the State and the project was sanctioned by the Secretary of State in 1929. The work in the main scheme was commenced in January 1930. The first generating unit was placed in service in October 1932 and the third in January 1933, thus completing the first stage of the scheme.

(2) Personnel

1. Chief Engineer :—
   Major H. G. Howard. M. C., M. A.I.E.E., M. Am. Soc. C.E.
2. Resident Engineer :—
   Mr. G.B.E. Truscote Assoc. Am. Soc. C.E., M.I E. (India) M.I.E.E.,
3. Executive Engineer :—
   Lt. Colonel M.G. Platts, O.B.E., M.C., B.Sc., M.I.C.E.
4. Assistant Executive Engineer :—
   S.R. Krishnamurthi B.E., A.M. I.E., (India) (in charge of Dam & Headworks).

(3) Bibliography

Printed Report on Pykara H.E.D. Published in 1928.

# III. 5. Krishnarajasagar Dam

## (Masonry)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 134 feet (To top of parapet) |
| (2) Location | Mandya district, Mysore State (Cauvery River) |
| (3) Authority or owner | Mysore Government |
| (4) Purpose-Main and subsidiary | For power, irrigation and water supply |
| (5) Year of commencement | 1911 |
| (6) Year of completion | 1932 |
| (7) Capital cost | |
| (a) Estimated | (a) Rs. 2,50,00,000 |
| (b) Actual | (b) Rs. 2,60,00,000 |
| (8) Culturable area commanded by the project | 300,000 acres |
| (9) Area irrigated | 92,000 acres up to end of 1947 out of 120,000 acres irrigable |
| (10) Installed hydro electric capacity | |
| (a) Firm | (a) 61,000 kW |
| (11) Means of access | It is situated at about 12 miles North West of Mysore and 8 miles above the historic island of Seringapatam. Good motorable roads exist from both places. Krishnarajasagar Railway Station is within a mile from the Dam and Belagola Railway Station is about 2½ miles from the Dam. |

## II. GEOPHYSICAL

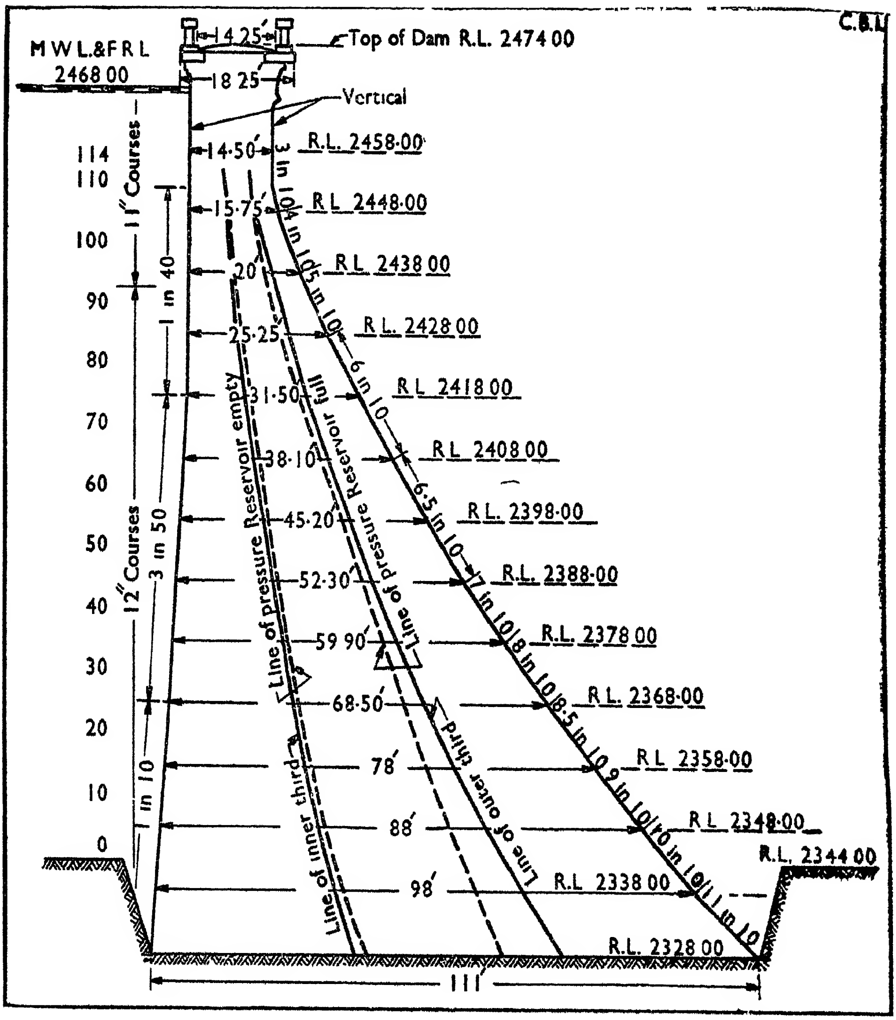
| | |
|---|---|
| (1) Area of catchment | 4,100 square miles |
| (2) Nature of catchment | The Malnad portion of the catchment is hilly and thickly wooded. It gets heavy rainfall mostly in the South West monsoon than the Maidan portion. |
| (3) Mean annual precipitation (a) Rainfall | (a) 63·37 inches |
| (4) Average total annual yield of the catchment | 5. 54 million acre feet |
| (5) Climate | Temperate |
| (6) Temperature conditions and variations | Maximum 99° F<br>Minimum 55° F |
| (7) Rate of Flow | |
| (a) Maximum | (a) 279,089 cusecs on July 26, 1924 |
| (b) Minimum | (b) 20 cusecs |
| (8) Detritus charge of the stream | Very little solid material is carried down by the rivers |
| (9) Character (chemical) of the water stored in the reservoir | Contains slight suspended impurities of silica and mica. The water is pleasant to the taste and is being used for water supply of the town of Mysore, after being treated with chlorine after filteration. During floods the water is silt laden for short period. |
| (10) Geological features (a) of foundations | (a) Gneissic granite with band of Horn-Blend Schist |
| (b) of catchment area | (b) Catchment around Krishnarajasagar reservoir is mostly gravel three to four feet thick, top soil over-lying soft rock disintegrated granitic below. |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (a) M.W.L. | (a) R.L. 2468·00 |
| (b) F.R.L. | (b) R.L. 2468·00 |

| | |
|---|---|
| (c) Area at M.W.L. | (c) 49·9 square miles |
| (d) Area at F.R.L. | (d) 49·9 square miles |
| (e) Maximum length | (e) 25 miles |
| (f) Maximum width | (f) 5 miles |
| (g) Length of periphery | (g) 82 miles |
| (2) Capacity of the reservoir | |
| (a) Gross | (a) 1,120,000 acre feet |
| (b) Live | (b) 1,010,000 acre feet |
| (c) Flood storage | (c) 1,140,000 acre feet |
| (d) Carry-over | (d) 3,710,000 acre feet |




*Cross Section of the Krishnarajasagar Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 146 feet |
| (4) Height above the lowest river bed at dam | 134 feet |
| (5) Height of the top of the dam above the crest of the weir | 20 feet |
| (6) Maximum width at level foundation | 111 feet |
| (7) Width at top | 14·5 feet |
| (8) Batter of face-slopes | |
| (a) Upstream | (a) As per cross section |
| (b) Downstream | (b) As per cross section |
| (9) Length at top of the dam | 8,600 feet |
| (a) Non-overflow | |
| (i) Main | (i) 8,600 feet |
| (b) Spillway | |
| (10) Cubic volume of the body of the dam | 30,000,000 cubic feet |

## E. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed. | Granite stone in *surkhi* mortar |
| (12) Specific gravity | |
| (a) Masonry | 2·33 |
| (13) Nature of protection and water-proofing of the upstream and downstream faces | Cement pointing on the upstream and *surki* mortar pointing on the downstream face |
| (14) Provision for dealing with seepage and drainage water | .. |
| (15) Means of securing water tightness of the foundation of the dam | .. |
| (16) Contraction joints | .. |
| (17) Principal stresses in the masonry with a note of methods of calculations employed | The weight of masonry is taken at 145·8 lb. per cubic-foot as a result of tests conducted. Stability calculations were made for one foot length of dam standing without lateral support |

| | |
|---|---|
| | Both Unwins' and Bovier's formulae have been used in the caluclations of the maximum stress. In calculating the hydraulic pressure on the front face of dam, wave action in conformity with Hughe' formula has been allowed. Temperature stresses were not taken into account, as there is little variation in temperature, the maximum stress near the outer face is 6·11 tons per square foot. Taking the obliquity of pressure into account on M. Bouvier's principle, the maximum stress at a depth of 120 feet below the crest of the dam on the downsteam face is 8·30 tons per square foot. |
| (18) Maximum pressure on foundations | 8·9 tons per square foot |
| (19) Uplift pressure, calculated or measured | No uplift pressure considered, as the dam is founded on hard rock. |
| (20) Measures adopted for preventing or counter-acting uplift pressures | |

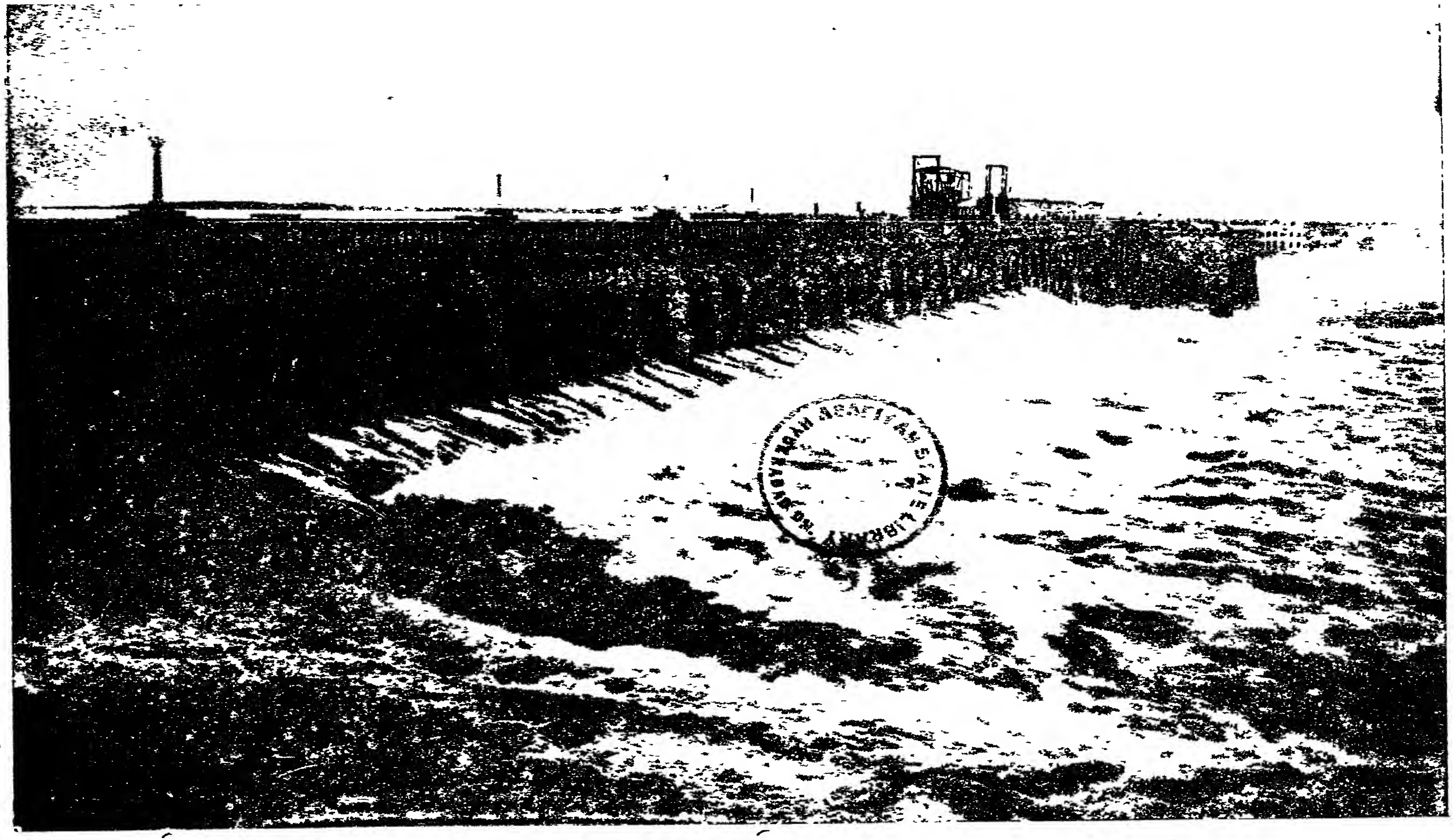
## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

| | |
|---|---|
| (1) Land submerged | |
| (*a*) Crown waste | 8,500 Acres |
| (*b*) Proprietory | 95·20 acres irrigated and 13,923 dry land |
| (2) Dislocation | |
| (*a*) Villages | 25 |
| (*b*) Families | 3,000 |
| (*c*) Population | 15,000 people |
| (*d*) Roads | |
| (*i*) Highways | 24 miles |
| (*ii*) District Roads | 30 miles |
| (*iii*) Village Roads | 40 miles |
| (*e*) Railway L nes | .. |
| (*f*) Temples, Mosques, *etc.* | 8 temples |
| (*g*) Graves, *etc.* | .. |
| (*h*) Trees, gardens, pastures, houses, wells, *etc.* | .. |
| (*i*) Bridges | One |

| | |
|---|---|
| (3) Compensation paid under each category of item 2 | Total Rs 46,50,000 |
| (4) Method of compensating for land of dispossessed landholders | Compensation paid partly by cash and partly by exchange of land as per option of the dispossessed landholders. |

## V. AUXILIARY WORKS

| | | |
|---|---|---|
| (1) Surplussing works | At 80 feet above bed 16 openings of 10 feet by 20 feet, discharge, 7,620 cusecs each.<br>At 103 feet above bed 48 openings of 10 feet by 8 feet discharge, 2,136 cusecs each.<br>At 106 feet above bed 40 openings of 8 feet by 12 feet discharge, 1,780 cusecs each.<br>At 114 feet above bed 48 openings of 10 feet by 10 feet discharge, 948 cusecs each. | Total discharge 340, 864 cusecs |
| | Gates at 114 feet above bed are automatic in action. | |
| | Irrigation sluices— | |
| (2) Outlet Works | At 60 feet above bed level one sluice of 6 feet by 8 feet. Discharge 250 cusecs, against 1,860 designed for | |
| | At 60 feet above bed level 3 sluices of 6 feet by 12 feet. Discharge—2,360 cusecs | |
| | Turbine sluices—For power generation at 53 feet above bed, four pipes of 6 feet diameter, total discharge, 1,167 cusecs. | |



*A view of waste weir sluices of the Krishnarajasagar Reservoir during floods.*

| | |
|---|---|
| (3) Scouring works | Scouring sluices—<br>At 12 feet above bed 8 sluices of 6 feet by 12 feet, discharge 3,752 cusecs each.<br>At 50 feet above bed 3 sluices of 6 feet by 15 feet, discharge 3,770 cusecs each. |
| (4) Inspection facilities | Large draw-off vents, easily accessible through vertical wells from top of the dam and through the tunnel in the rear.<br>Flood control sluices easily accessible through inspection passages. |
| (5) Fish-pass | .. |
| (6) Means for dissipating energy below the spillway. | Waste weir valleys protected by pin stone sloping apron with longitudinal and cross walls in between. |

## VI. POWER HOUSE

| | |
|---|---|
| (1) Hydraulic head | (*a*) 420 feet for 4 units of 6,000 kW each and for 7 units of 3,000 kW each.<br>(*b*) 626 feet for 2 units of 8,000 kW each |
| (2) Name and address of Licensee with managing agents (if any) | The Chief Electrical Engineer to the Government of Mysore, Bangalore. |
| (3) Generating units | |
| (*a*) type | (*a*) Francis reaction turbine. |
| (*b*) Number | (*b*) 13 Nos. (Hydro) |
| (*c*) Capacity | (*c*) .. |
| (*i*) Firm | (*i*) 4 (units) 6,000, kW each<br>7 (units) 3,000 kW each<br>2 (units) 8,000 kW each<br>Total 61,000 kW |
| (4) Voltage<br>(5) Number of phases and frequency, A. C. or D. C. | Voltage / Number of Phases etc. A. C. or D. C.<br>13,200 3 ph : A. C. 25 Cy<br>11,000 3 ph : A. C. 25 Cy<br>4,600 3 ph : A. C. 25 Cy<br>2,300 1 ph : A. C. 60 Cy<br>2,300 3 ph : A. C. 25 Cy<br>230 3 ph : A. C. 25 Cy<br>220 3 ph : A. C. 25 Cy<br>230 1 ph : A. C. 25 Cy<br>220 1 ph : A. C. 25 Cy<br>230 1 ph : A. C. 60 Cy<br>220 1 ph : A. C. 60 Cy |

| | |
|---|---|
| (6) Forebay | |
| (7) A brief description of tunnel and penstocks. | |
| (8) Means provided for excluding silt and trash. | |
| (9) Tail race | |
| (10) Maximum length of transmission line. | |
| (11) Principal towns served | Mysore, Bangalore, Tumkur, Kolar, Davangere, Shimoga. |
| (12) Main and subsidiary purpose of the utilisation of electricity. | Kollar gold-fields, cotton mills, pumping stations, Railway workshops, lighting and power service. Electricity is of late being utilised for lift irrigation and various industries—big and small. |
| (13) Any other matter of interest | |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | The work was practically completed entirely with manual labour, using local materials. No big machinery for hauling materials was used except the trolleys for carrying materials and power mills for grinding mortar. The mortar used was lime *surkhi*. |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work. | .. |
| (3) Noteworthy occurrences and accidents. | In order to fulfil the terms of Agreement with the Gold Mining Co., Kolar, the dam had to be raised to a height of 60 feet above bed within a period of 3½ years from the date of agreement September, 1911. The work was started in November 1911. Both the banks and foundations were completed in the river bed by September 1912. The work progressed very briskly and the storage to plus 60 feet was secured in July 1915. At one time nearly 10,000 people were employed on the different sections of the works. No serious accident happened during the construction. |

(4) Operation of the dam

| | |
|---|---|
| (*a*) Regulation | (*a*) Through sluices |
| (*b*) Silting of the reservoir— | |
| (*i*) Total silt deposited<br>(*ii*) Rate of silting<br>(*iii*) Density of the silt deposited<br>(*iv*) Rate of advancement of delta | There has not been any appreciable silting of the reservoir so far. Proposals for determining this are under way. |
| (*c*) Actual yield as against estimated | |
| (*d*) Various measurements and observations | |
| (*i*) Evaporation losses | (*i*) 5½ inches to 8 inches per month |
| (*ii*) Sweating below the dam | (*ii*) It has been found from the results so far obtained and recorded, that the value of sweating decreases with the age of construction. It depends upon its level, temperature and humidity of the atmosphere. |
| (*iii*) Temperature measurements | (*iii*) 55° to 99° |
| (*iv*) Seepage and regeneration | |
| (*e*) Fish culture | (*e*) .. |
| (*f*) Anti-malaria measures | (*f*) Elaborate antimalarial measures are undertaken in the irrigable tract and nothing at the dam site. |
| (5) Recreation facilities | Below the dam is laid out the exquisite fountain-garden known as Brindavan. It has become a theme for poets, alike for its natural setting for the ingenuity expended in harmonising the effects of light, colour and water in the creation of this fairy land. The exquisite fountains, flower beds and silvery cascades which are wonderful to behold are rendered even more enchanting when lit up. The electric lights in seried rows, the floodlit beds of flowers, the flowing cascades are things of unforgetable beauty. The garden is illuminated on week-ends and on special occasions. |

The Hotel Krishnarajasagar which overlooks the gardens is maintained by the Government of Mysore. It is a splendid three-storied structure equipped in up-to-date style and is replete with all modern conveniences. It is a very restful spot and is an ideal holiday resort.

(6) Lessons to be learnt from the construction and utilisation of the dam.

The work was done by piece work agencies and labour on daily wages, under Departmental supervision, which was found to be more economical.

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

The idea of constructing a dam across the Cauvery was mooted as early as 1870 when Col. Sankey, the then Chief Engineer, Mysore ordered investigation for an irrigation reservoir project. As a result of the surveys, it was reported that there was only one site for a high dam on the Cauvery, and that was at Ramaswamy Kanave close to the borders of Coorg and Mysore . the cost of a reservoir at this site was considered prohibitive. About the year 1885, Mr. McLanghin, Executive Engineer, was placed on special duty by Colonel Bowen, the then Chief Engineer, to investigate a reservoir scheme for the combined purpose of irrigation and water supply to the city of Mysore. This scheme was also abandoned on account of its cost. By the installation of a power house at Shivasamadram in 1902 and its subsequent expansion, the construction of a reservoir on the Cauvery or on one of its tributaries with a view to ensuring constant water supply for the power house became an urgent necessity. A number of sites were examined for the location of a dam and in his final report dated April 25, 1907 Captain Dawes proposed to construct a dam 70 feet high to be eventually raised to 115 feet on the Cauvery near Kannambadi. This Scheme was also not carried to the stage of practical action partly on account of heavy cost and partly because of the expenditure on works contemplated outside the State.

It was in July 1910 that surveys were again commenced for the final preparation of the project. Work was commenced in 1911 and storage to plus 60 was secured by July 1915. The first stage, 80 feet high was completed in 1920, and had a storage capacity of 252,525 acre feet. The second stage which comprised the construction of the dam to the present height of 134 feet was completed in 1932.

(2) Personnel

*Chief Engineers*—

(1) Sir M. Visvesvaraya, K. C. I. E., L.L. D., D. Sc., M. Inst. C. E.

(2) Rajasabhabhushana Kharpur Shreenivasa Rao, B.Sc., L.C.E.

(3) Rajasilpivisarada Rao Bahadur B. Subha Rao, L.C.E.

(4) Rajasabhabhnshana I. Cadamtri B.A., L.C.E.

(5) Rajasabhabhushano Rao Bahadur K. Krishna Iyengar, B.A., I.C.E.

(6) Rajasae Vasakta John Bhore, A.M.I.C.E.

(7) Rajasevasa Kta Dewan Bahadur K. R. Seshachar, B.A., B.E., C.E.

(8) Sri S. Sreenivasa Aiyar, B.A. B.E.

*Superintending Engineers—*

(1) Sri B B. Garudacharya, L.C.E.

(2) Sri Y. Aswathanarana Rao, B.A., B.E., C E.

(3) Rai Sahib R.A. Srinivasa Iyengar, B.A., B.C.E.

(4) Sri Srinivasa Aiyar, B.A., C.E.

*Executive Engineers—*

Sri K. Ananthacharya, L.C.E.

Sri M. A. Anaandalwar, B.A., B.C.E.

Sri T. G. Lakshmana Rao, L.C.E.

Sri .A. Puttaswamiah, B.A., L. C. E.

Sri V. V. Patankar, B.A., L.C.E.

Sri M. G. Rangaiya, B.A., B.E.

Sri L. A. H. Winckler, A.C.G.I.

Sri N. Sarabhoja, L.C.E.

B. Krishnaswamy Iyengar, L.C.E.

Sri N. Krishnieagar, B.E.

(3) Bibliography

(1) Public Works Department, Government of Mysore, " Cauvery Reservoir " Project, 1911.

(2) Public Works Department, Government of Mysore, " Cauvery Reservoir Project in Mysore, Revised Edition 1934 ".

(3) Sri N. Sarabhoja's 'Note on Krishnarjasagar Works' paper No. 9, Silver Jubilee Publications, (1932), by the Mysore Engineers' Association.

(4) A brochure on salient features for the Krishnarajasagar Project.

(5) " Flood Absorption in Krishnarajasagar Hydraulic Research Station, Report ending with the year 1946.

# III-6—Chamarajasagar Dam

## (Masonry)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 115 feet |
| (2) Location | Bangalore district, Mysore State (Arkavathi river) |
| (3) Authority or owner | Government of Mysore |
| (4) Purpose—Main and subsidiary | Water supply to Bangalore city |
| (5) Year of commencement | March 1930 |
| (6) Year of completion | March 1933 |
| (7) Capital cost (for 1st Stage) | |
| (a) Estimated | (a) Rs. 18,20,000 |
| (b) Actual | (b) Rs. 22,39,041 to end of 1941-42 |
| (11) Means of access | It is accessible from Bangalore city by metalled road, situated 20 miles west of it. |

### II. GEOPHYSICAL

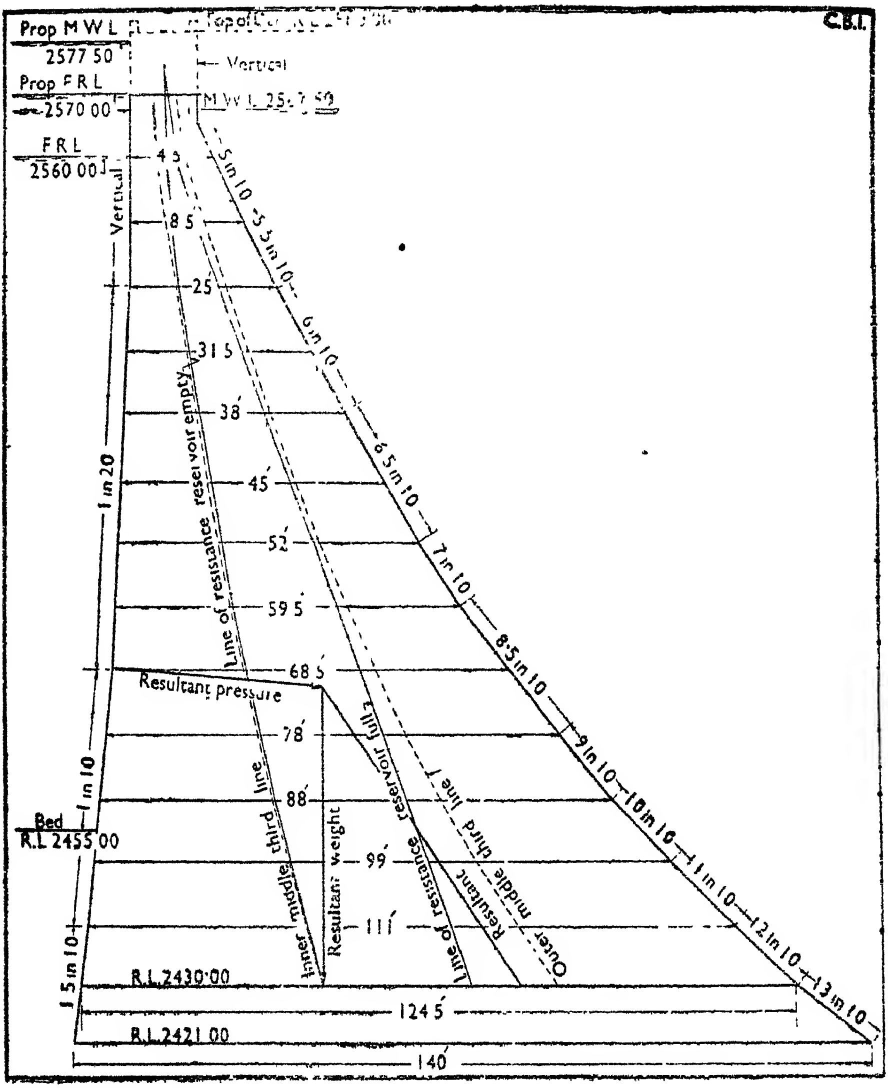
| | |
|---|---|
| (1) Area of catchment | 530 square miles |
| (2) Nature of catchment | Partly hilly and partly cultivated |
| (3) Mean annual precipitation | |
| (a) Rainfall | (a) 30·0 inches |
| (4) Average total annual yield of the catchment. | 77,260 acre feet |
| (5) Climate | Moderate |
| (6) Temperature conditions and variations | Maximum temperature 96°F. Minimum temperature 68°F. |
| (7) Rate of Flow | |
| (a) Maximum | (a) 50,000 cusecs as designed |
| (b) Minimum | (b) No flow and 36,704 as observed in 1943. |

| | |
|---|---|
| (8) Detritus charge of the stream | It carries considerable quantity of silt during floods. |
| (9) Character (chemical) of the water stored in the reservoir. | Soft. |
| (10) Geological features | |
| (a) of foundations | (a) Grey gneiss |
| (b) of catchment area | (b) Rocky and red soil |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (a) M. W. L. | (a) 2,567·5 present to 2,577·5 (proposed) |
| (b) F. R. L. | (b) R. L. 2,560·00 and this will be finally raised to R. L. 2570·00. |
| (c) Area at M. W. L. | |
| (d) Area at F. R. L. | (d) 2·5 square miles at R. L. 2570·00 and 1·80 square miles at R. L. 2560·00 |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | (g) 21 miles |
| (2) Capacity of the reservoir | |
| (a) Gross | (a) At R. L. 2560·00- 54,637 acre feet. At R. L. 2570·00—69.743 acre feet. |
| (3) Maximum height above the lowest point of foundations | Upto the existing top R.L. 2570·00 — 152 feet<br>Upto the proposed top R.L. 2580·00—162 feet |
| (4) Height above the lowest river bed at dam | Upto the existing top R. L. 2570·00—115 feet<br>Upto the proposed top R. L. 2580·00.—125 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 10 feet, with the existing top R. L. 2570·00 |
| (6) Maximum width at level of foundation | 140 feet |
| (7) Width at top | 12 feet |
| (8) Slopes | |
| (a) Upstream | (a) } As per cross-section |
| (b) Downstream | (b) } |




*Cross Section of Chamarajasagar Dam*

(9) Length at top of the dam — 1,400 feet

(a) Non-overflow

(i) Main — (i) 1,220 feet

(b) Spillway — (b) 180 feet (excluding scouring sluices)

(10) Cubic volume of the body of the dam — 468, 000 cubic feet

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed. | Rubble masonry in *surkhi* mortar |
| (12) Specific gravity | |
| (*a*) Masonry | (*a*) 2·32 |
| (13) Nature of protection and water-proofing of the upstream and downstream faces | Deep cement pointing |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundation of the dam | Deep cement pointing is done on front face after raking the joints 2 inches deep. Foundation is grouted with cement. |
| (16) Contraction joints | |
| (17) Principal stresses in the masonry with a note of methods of calculations employed | This is a masonry gravity dam designed so as to be safe against—(*i*) overturning, (*ii*) sliding, (*iii*) crushing and rupture from tension. Its resultant pressure falls within middle third of the base. |
| (18) Maximum pressure on foundations | 7 tons per square foot. |
| (19) Uplift pressure, calculated or measured | |
| (20) Measures adopted for preventing or counteracting uplift pressure | |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

| | |
|---|---|
| (1) *Land submerged* | |
| (*a*) Crown waste | |
| (*b*) Proprietory | |
| (2) *Dislocation* | |
| (*a*) Villages | |
| (*b*) Families | |
| (*c*) Population | |
| (*d*) Roads— | |
| (*i*) Highways | |
| (*ii*) District Roads | 3 miles |
| (*iii*) Village Roads | |
| (*e*) Railway Lines | |
| (*f*) Temples, Mosques, *etc.* | One temple. |
| (*g*) Graves, *etc.* | .. |
| (*h*) Trees, Gardens, Pastures, Houses, Wells, *etc.* | .. |
| (*i*) Bridges | One |

| | |
|---|---|
| (3) Compensation paid under each category of item (2) | |
| (4) Method of compensating for land of dispossessed landholders | Cash payment |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | (a) *Under sluices*—There are vents of 10 feet by 20 feet each to discharge 36,000 cusecs.<br>(b) *Open weir*—It is 180 feet long and its discharging capacity is 14,000 cusecs with 10 feet depth over crest. |
| (2) Outlet works | Water is drawn from the reservoir by 30 inches and 24 inches diameter cast iron pipes. |
| (3) Scouring works | *The under sluices*—4 vents each of 10 feet by 20 feet are used for scouring purposes. These are also used as surplussing works. |
| (4) Inspection facilities | |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | To prevent any scour in the draft channel of the sluice, two sets of cushions have been constructed, 300 feet and 1,500 feet downstream of the sluices. |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | |
| (3) Noteworthy occurrences and accidents | |
| (4) Operation of the dam | |
| (a) Regulation | (a) The gates are operated by electric motors of 4 horse power and can be lifted fully within 10 minutes.<br>They can also be operated independently by manual labour in 6 hours. |

| | |
|---|---|
| (b) Silting of the reservoir | |
| (*i*) Total silt deposited | |
| (*ii*) Rate of silting | |
| (*iii*) Density of the silt deposited | |
| (*iv*) Rate of advancement of delta | |
| (c) Actual yield as against estimated | |
| (*d*) Various measurements and observations | |
| (*i*) Evaporation losses | |
| (*ii*) Sweating below the dam | |
| (*iii*) Temperature measurements | |
| (*iv*) Seepage and regeneration | |
| (*e*) Fish culture | |
| (*f*) Anti-malaria measures | (*f*) Spraying for ½ in 6 zone and canalising valleys |
| (5) Recreation facilities | Social clubs, play grounds and radio |
| (6) Lessons to be learnt from the construction and utilisation of the dam. | |

## IX. BIBLIOGRAPHY AND HISTORICAL

| | |
|---|---|
| (1) Historical | Due to the rapid increase in population of Bangalore, the supply from the Hessaraghatta tank proved inadequate. A committee presided over by Sir M. Visvesvarya was appointed by the Government in 1926 to investigate a permanent and satisfactory water supply scheme. This committee recommended construction of a dam across the Arkavathi river at Thippagondanahalli, 20 miles west of Bangalore as a permanent measure. Accordingly the estimate for Rs. 50·33 *lakhs* was framed and submitted to Government in 1924. On its sanction the construction work was started in March 1930. |

**(2) Personnel**

*Chief Engineers*—

(i) Mr. Rajesevasakta J Bhore· A. M. I. C. E.

(ii) Mr. M. G. Rangaiya, B.A.. B.E

(iii) Mr. N. N. Ayyangar. B.A., L.C.E.

*Executive Officers*—

Executive Engineers—

(i) Mr. H. R. Venkatasubha Rao, B.A. L.C.E.

(ii) Mr. N. Lakshminarasimhaiya, B.A., B.E.

Assistant Engineers—

(iii) Mr. B.S. Narasinga Rao, B.A , B.E.

(iv) Mr. K. S. Chakravarthy, B.E.

(v) Mr. K. Govindaraj Pillay, Sub-Engineer.

(vi) Mr. H. C. K. Bhatta, B.A., B.E.

**(3) Bibliography.**

Souvenir of Sri Chamrajendra reservoir and water works, Bangalore.

# III. 7.—Mettur Dam

## (Masonry)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 176 feet |
| (2) Location | At Mettur, Salem District, Madras Presidency (Cauvery river) |
| (3) Authority or owner | Madras Government |
| (4) Purpose—Main and subsidiary | Irrigation and power supply |
| (5) Year of commencement | 1927 |
| (6) Year of completion | 1934 |
| (7) Capital cost— | |
| (*a*) Estimated | Rs. 5,09,00,000/- |
| (*b*) Actual | Rs. 6,80,00,000/- |
| (8) Culturable area commanded by the project | 497,200 acres |
| (9) Area irrigated | 301,000 I crop paddy. |
| (10) Installed hydro-electric capacity— | 154,000 II crop. |
| (*a*) Firm | 14,000 kW minimum. |
| (*b*) Secondary | 30,000 kW. (extra seasonal). |
| (11) Means of access | It is built across the river Cauvery at a place known as Mettur. It is accessible by railway *via* Salem Junction (South Indian Railway) which is 25 miles from the site of the dam. It is also accessible by road from Erode Junction which is 36 miles off. There is also a good road from Salem City leading to the dam site (distance 32 miles). |

### II. GEOPHYSICAL

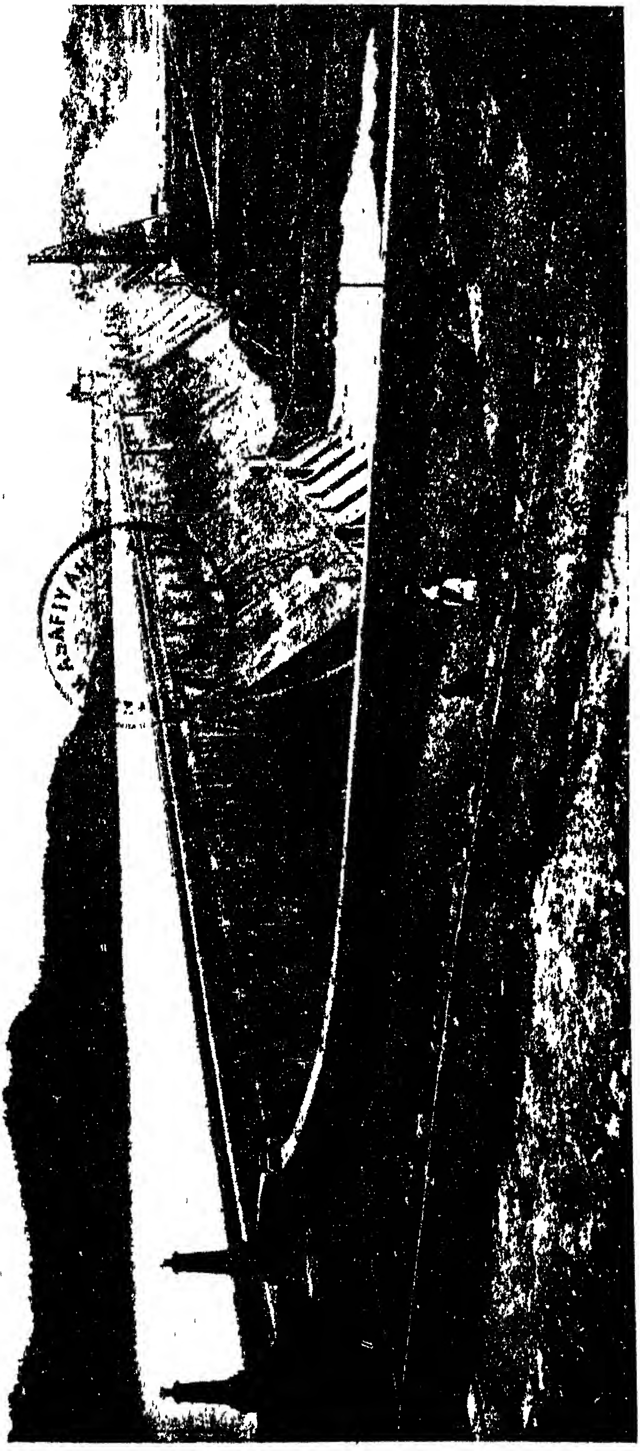
| | |
|---|---|
| (1) Area of catchment | 16,300 square miles |
| (2) Nature of catchment | Hilly tract |

| | |
|---|---|
| (3) Mean annual precipitation— | |
| (a) Rainfall | Coorg Province 200 inches, Madras 45 inches and Mysore 35 inches, thus there is great variation in rainfall in the catchment area. |
| (4) Total average annual yield of the catchment | 7,871,197 acre feet |
| (5) Climate | Tropical |
| (6) Temperature conditions and variations | Maximum temperature 109·8°F<br>Minimum temperature 57·0°F |
| (7) Rate of Flow— | |
| (a) Maximum | 456,000 cusecs |
| (b) Minimum | 1,000 cusecs |
| (8) Detritus charge of the stream | The water stored in the reservoir is more or less pure and carries comparatively little silt for the greater part of the year except during flood periods. The river passes through the hilly tract, rocky bed. Besides, it has to pass through the Kannambady Reservoir, and there fore, it does not carry much silt. |
| (9) Character (chemical) of the water stored in the reservoir | |
| (10) Geological features— | |
| (a) of foundations | The rock over which the foundation is laid, is of hard and solid variety. |
| (b) of catchment area | Hilly tracts |
| (11) Earthquakes (Zone and intensities) | Earthquake shocks of slight intensity have been noted at Mettur during the past few years. |

## III. TECHNICAL

### A. STATISTICAL

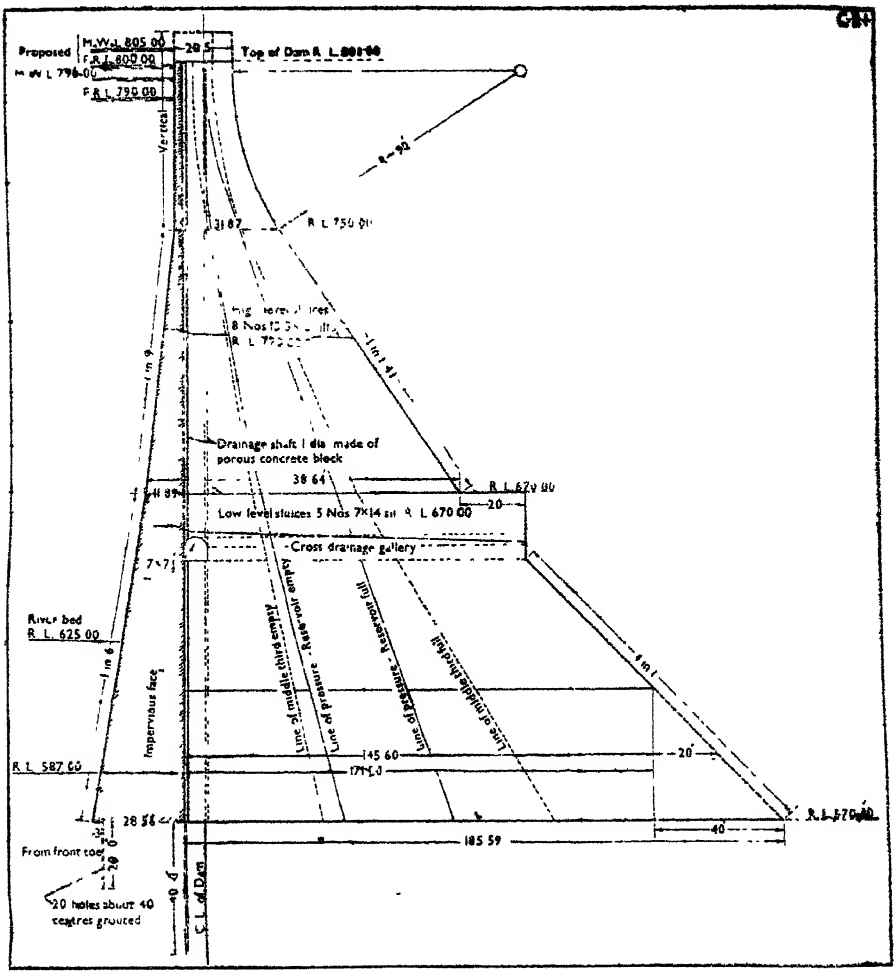
| | |
|---|---|
| (1) Reservoir Data — | |
| (a) M.W.L. | R.L. 796·00 |
| (b) F.R.L. | R.L. 790·00 |
| (c) Area at M.W.L. | |
| (d) Area at F.R.L. | 59·25 square miles |
| (e) Maximum length | 33 miles |
| (f) Maximum width | 5½ miles |
| (g) Length of periphery | 183 miles |



*Mettur Dam*

**(2) Capacity of the reservoir—**

| | |
|---|---|
| (*a*) Gross | 2,196,098 acre feet |
| (*b*) Effective storage | 2,146,465 acre feet |
| (*c*) Flood storage | 2,370.753 acre feet |
| (*d*) Carry-over | |




*Cross Section of Mettur Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 231 feet |
| (4) Height above the lowest river bed at dam | 176 feet |

| | |
|---|---|
| (5) Height of the top of the dam above the crest of the spillway or weir | 10 feet |
| (6) Maximum width at level of foundation | 214·15 feet |
| (7) Width at top | 20·5 feet |
| (8) Batter of face slopes— | |
| (*a*) Upstream | Vertical from R.L. 801 to 750; 1 in 9, R.L. 750 to 670, 1 in 6, R.L. 670 to foundation R.L. 570. |
| (*b*) Downstream | Curve with 90 feet radius up to R.L.750 from R.L. 801, 1 in 1·41 from R.L. 750 to 670 and 1 : 1 from R.L. 670 to 570 |
| (9) Length at top of the dam— | |
| (*a*) Non-overflow— | |
| (*i*) Main | 5,300 feet |
| (*b*) Spillway | (1) F. Saddle escape -810 feet<br>(2) Ellis saddle surplus sluices Nos. 16, each 60′×20′ *i.e.* total 1,770 feet escape |
| (10) Cubic volume of the body of the dam | 54,600,000 cubic feet |

B. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed | Rough stone masonry in red cement mortar and red cement concrete |
| (12) Specific gravity— | |
| (*a*) Masonry | 2·40 |
| (*b*) Concrete | 2·47 |
| (13) Nature of protection and water proofing of the upstream and downstream faces | Upstream face has been built in rich red cement mortar 1 : 2¾ and it has also been applied with cement pointing (1 *surkhi* 4 cement). |
| (14) Provision for dealing with seepage and drainage water | In consideration of tendency of percolation of water under the foundation under pressure, vertical drainage shafts have been provided from rock level just in rear of the impervious zone to the drainage gallery so that these shafts may intercept the leakage and convey it to the drainage gallery whence it will flow out. |

(15) Means of securing water tightness of the foundation of the dam — The upstream side of the dam from foundation to the top has been made impervious using rich mortar and by grouting 20 feet deep into the body of the dam at 12 feet intervals and at 16 feet stages in height. Besides it has been cement pointed too.

(16) Contraction joints — Contraction joints have been provided at 126 feet intervals.

(17) Principal stresses in the masonry with a note of methods of calculations employed — The stresses have been calculated by the Bouviers and Unwins methods—

Bouviers' formula—

Maximum stress intensity, reservoir full

$$\frac{2W}{L}(2-\frac{3W}{L})\,\text{Sec}^2\ \varphi_1$$

Maximum stress intensity, reservoir empty

$$\frac{2W}{L}(2-\frac{3W}{L})$$

Unwins' formula—

Maximum stress intensity, reservoir full

$$\frac{2W}{L}(2-\frac{3W}{L})\text{Sec}^2\ \varphi_2$$

Maximum stress intensity, reservoir empty

$$\frac{2W}{L}(2-\frac{3W}{L})\text{Sec}^2\ \varphi_1$$

(18) Maximum pressure on foundations — 15·238 tons per square foot at heel

(19) Uplift pressure, calculated or measured

(20) Measures adopted for preventing or counteracting uplift pressures

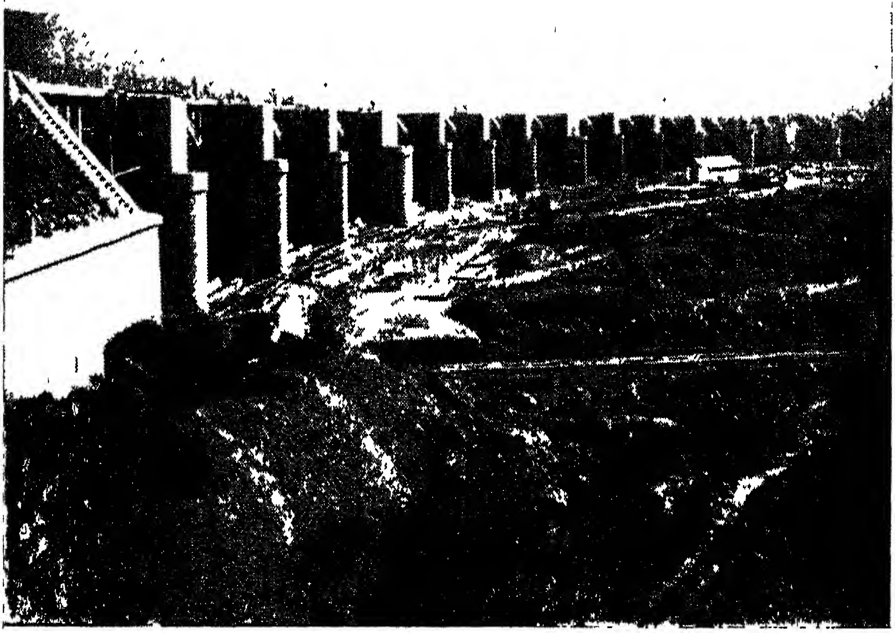
It rests on hard foundation rock, but with a view to be on the safe side, experiments were carried out to find out the hardness and depth of hard rock and it was found to be 40 feet in depth. The following precautions have been provided. In the rear of the watertight masonry, vertical shafts have been provided. They start from the foundations and go right upto the top of the dam.

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

| | |
|---|---|
| (1) *Land submerged*— | |
| (*a*) Crown waste | |
| (*b*) Proprietory | |
| (2) *Dislocation*— | |
| (*a*) Villages | 25 Nos. |
| (*b*) Families | |
| (*c*) Population | |
| (*d*) Roads — | |
| (*i*) Highways | |
| (*ii*) District Roads | |
| (*iii*) Village Roads | |
| (*e*) Railway Lines | |
| (*f*) Temples, Mosques, *etc.* | Only idols. |
| (*g*) Graves, *etc.* | |
| (*h*) Trees, Gardens, Pastures, Houses, Wells, *etc.* | |
| (*i*) Bridges | |
| (3) Compensation paid under each category of item (2) | |
| (4) Method of compensating for land of dispossessed landholders | |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | F. saddle escape 810 feet long and another Ellis saddle surplussing sluices 16 Nos. 60 feet span and 20 feet in height, both have maximum discharging capacity of 550,000 cusecs. |
| (2) Outlet works | High level sluices 8 Nos. each $10\frac{1}{2}$ feet $\times 16$ feet. Low level sluices 5 Nos. each 7 feet—14 feet. Hydro-electric pipes 4 Nos. each $8\frac{1}{2}$ feet diameter. |
| (3) Scouring works | .. |
| (4) Inspection facilities | Road is carried over the dam. There are steps in rear slope at definite intervals. Drainage gallery is also provided at rear ground level for a length of about 4,000 feet. |



*Ellis Saddle Surplus Bridge*

| | |
|---|---|
| (5) Fish-pass | Fish ladder has been provided in the dam |
| (6) Means for dissipating energy below the spillway | |

## VI. POWER HOUSE

| | |
|---|---|
| (1) Hydraulic head | 60 feet to 160 feet (according to the storage in the reservoir) |
| (2) Name and address of Licensee with managing agents (if any) | The Superintending Engineer, Mettur Electricity System. Mettur Dam. |
| (3) Generating units | Hydro. |
| (a) Type | Francis turbines. |
| (b) Number | 4 |
| (c) Capacity— | |
| (i) Firm | 14,000 kW. |
| (ii) Secondary | 30,000 kW. |
| (4) Voltage | 11 K.V. |
| (5) Number of phases and frequency, A.C. or D.C. | 3 ph. A.C. 50 cy. and 1 ph. A C. 50 cy. |
| (6) Forebay | There are no penstocks *etc.* leading to the powerhouse. Water from the reservoir enters the Hydro-Electric pipes through 8 inlets, each of which is provided with screen ; thus there are 8 sets of screens for 4 sets of pipes. Should the screens become partially or wholly choked with debris, spare screens can be lowered for which extra grooves have been provided and the choked screen can be raised for cleaning. The Power House has four large turbines, for generating power. The water after passing through the turbines is let into the river and is utilized for irrigation. |
| (7) A brief description of tunnel and penstocks | |
| (8) Means provided for excluding silt and trash | |
| (9) Tail race | |
| (10) Maximum length of transmission line | 66 K.V. 645 miles<br>33 K.V. 204 miles<br>22 K.V. 869 miles |
| (11) Principal districts served | Salem, North and South Arcot, Chingleput, Tanjore, Trichy. |
| (12) Main and subsidiary purpose of the utilisation of electricity | Domestic and industrial purposes |
| (13) Any other matter of interest | |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | The dam is entirely constructed of masonry in cement mortar and cement concrete. "Red" cement consisting of 20 per cent of finely pulvarised *surkhi* and 80 per cent of portland cement was used for mortar and concrete alike. Red cement was in proportion of 1 : 2¾ sand for the impervious face and one of red cement with 4 of sand for the rear masonry up to level 720·00 and 1 : 5 above that. |
| | The concrete was chiefly laid by the aid of concreting towers moving in rear of the Dam. In later stages these concrete towers were used for mixing mortar and hoisting the same and delivering it on to the Dam. Also stones were delivered on to the works by these towers. |
| | Outside the reach of towers, where the dam was almost built of hand placed masonry, red cement mortar was mixed in concrete mixers and conveyed to the top of the dam by coolies or by mechanical means. In certain places mixers were located on the dam itself. |
| | As the dam progressed higher and higher the flanks were completed and material were supplied to the middle portion along the tram lines on the dam for the flanks. In certain places, fixed electrically operated lifts in towers were used for elevating materials in truck loads and delivered on to the dam. |
| **(2) Changes introduced in the plans of the dam and in the method of carrying out the work** | The cement concrete construction for the dam which was previously approved, was subsequently changed in a large measure to rubble in cement, as it was found that cement concrete specified was more porous and costlier than rubble masonry in cement. About 4/5th of the dam was constructed in masonry and 1/5th in cement concrete. |

(3) Noteworthy occurrences and accidents

For such a magnitude of work, there occurred a few accidents. Mostly the accidents were due to the carelessness of the people concerned and disobedience to orders, particularly in the case of blasting. There were 421 accidents throughout the construction period and of which 36 proved fatal.

In April 1929, when the work was in progress in the bed of the river, an unexpected rainfall of 7·2 inches in 4 hours caused a sudden rise in the river and filled up the excavation for the foundations measuring 500 feet by 200 feet to a depth of 45 feet with sand and shingle, and its clearance again cost the Government more than Rs. 20,000/-.

(4) Operation of the dam—

(*a*) Regulation

The issues at Mettur are left down through Low level sluices for the reservoir reading to 50 and through high level sluices between 50 and 100 and through Ellis Saddle surplus over 100 feet.

(*b*) Silting of the reservoir—

(*i*) Total silt deposited — 1941-1948 = 676 million cubic feet

(*ii*) Rate of silting — 84·5 million cubic feet per year

(*iii*) Density of the silt deposited — Assumed as 100 ℔ cubic feet

(*iv*) Rate of advancement of delta

(*c*) Actual yield as against estimated.

(*d*) Various measurements and observations —

(*i*) Evaporation losses

The average evaporation in March for the six years 1929-1934 amounts over 12½ inches

(*ii*) Sweating below the dam

(*iii*) Temperature measurements

The maximum variations between new and old mass masonry was found by tests to be nearly 18°F, the temperature of new masonry rising in 14 days to 102°F and falling gradually to 84°F in about 12 months.

| | |
|---|---|
| (*iv*) Seepage and regeneration | Seepage along the body of the dam is collected by drainage shafts which empty into side drains in the drainage gallery and at the exit of side drains. Quantity is measured by V-notch. Leakage is of the order of 2·31 million cubic feet per year. |
| (*e*) Fish culture | The physical features of the lake are in themselves conducive to the successful development of fish. It is always attempted to produce and enrich the lake with valuable North Carp, Catla and Exotio Fish. |
| (*f*) Anti-malaria measures | |
| (*g*) Recreation facilities | Facilities for sight seeing are provided. |
| (6) Lessons to be learnt from the construction and utilization of the dam | From the construction of the dam it was found that the concrete laid by the towers was poor in quality. The chief defects of the tower placed concrete were due to segregation of the stone from the mortar while chuting and tendency to form laminations, despite the most careful rodding and tamping. This shows the chuting of cement is a bad practice and that if concrete is to be used it must be tamped in complete batches by other methods. Besides these were found to be costlier than hand placed concrete, especially in India where labour is cheap. |

## IX. BIBLIOGRAPHY AND HISTORICAL

| | |
|---|---|
| (1) Historical | The idea of improving the conditions of irrigation in the Cauvery Delta by daming Cauvery river, had been under consideration for over a century. It was first in 1834 that investigation was made for daming the Cauvery river. Several schemes in the Cauvery and its tributaries were considered but it was finally decided in 1901 that the scheme on the Cauvery proper would be more fruitful. |

(2) Personnel

Accordingly a project was drawn up by Mr. H. A. Moss and submitted to the Govt. of India for sanction. The Project could not be sanctioned due to some suggestions abandoning the channels taking off direct from the reservoir. The scheme led to further investigations.

In 1910 Col. W. M. Ellis, R. S. was appointed as special Superintending Engineer who prepared a detailed scheme and submitted it to the Government of India. The scheme was yet under consideration of the Government of India, when unexpected dispute arose between Madras and Mysore. The Mysore Government had already decided to construct a dam for the storage of water at Kannambadi, on the Cauvery, some 12 miles above the Mysore City. The dispute carried on till 1922-23 and a final and amicable decision was reached in 1924. In view of the unfavourable award of 1914 necessitating reduction in the new area, to be irrigated under the Mettur Reservoir, Col. Ellis undertook the revision of his 1910 estimates and again submitted the revised scheme to the Government of India in 1916. There the matter rested pending the final orders of the Secretary on the two Governments case.

In 1921 the revised rules approved by both the Governments again necessitated further revision of the scheme but by beginning of 1924, when the dispute was finally settled, the revised scheme, according to the settlement between the two Governments was again submitted to the Government which was approved and the inauguration ceremony was performed at the site by His Excellency the Right Honourable Viscount Goschen Governor of Madras on the July 20, 1925.

(3) Bibliography

" The History of the Cauvery Mettur Project " by C. G. Barber.

Public Works Department " Papers connected with the Cauvery Reservoir Project ".

Public Works Department " Notes on design and construction of the Mettur Dam " Typed Note.

Public Works Department " Souvenir of the Cauvery Mettur System ".

# III. 8. Mukurti Dam

## (Masonry)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 95 feet |
| (2) Location | Nilgiris district, Madras State (Mukurti stream). |
| (3) Authority or owner | Madras Government |
| (4) Purpose-Main and subsidiary | To provide subsidiary storage for Pykara Hydro Electric Development. |
| (5) Year of commencement | January 1935 and gates in 1945 |
| (6) Year of completion | June 1938 and gates in 1946 |
| (7) Capital cost | |
| (a) Estimated | Rs. 21,25,000/-+2,60,000 for spillways gates=Rs 23,85,000. |
| (b) Actual | Rs. 14,95,150 + 2,53,000 for spillways gates=Rs. 17,48,150. |
| (11) Means of access | It is accessible from Octacamando railway station on the Nilgiri Mountain Branch Railway line (South Indian Railway). It is situated 10 miles west of Ootacamand and is 7½ miles by road from the mile stone 14/6 of Ootacamand-Gudalur road |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 9·75 square miles |
| (2) Nature of catchment | Practically barren with a few patches of trees but is mostly covered with grass. |
| (3) Mean annual precipitation | |
| (a) Rainfall | 161·01 inches |
| (4) Total average annual yield of the catchment | 95,207 acre feet |

| | |
|---|---|
| (5) Climate | Situated in ghats, and has severe monsoon conditions and low temperature in cold season. |
| (6) Temperature conditions and variations | Maximum 77° F<br>Minimum 35° F |
| (7) Rate of Flow | |
| (a) Maximum | 4,300 cusecs. |
| (b) Minimum | 1 cusecs. |
| (8) Detritus charge of the stream | No appreciable quantity of solids enter into the reservoir. |
| (9) Character (chemical) of the water stored in the reservoir | *Analysis of water Quantitative* (in part per 100,000). |

| | | |
|---|---|---|
| 1. | Total solids | 2·4 |
| 2. | Temporary hardness | *Nil* |
| 3. | Permanent | 0·5 |
| 4. | Chlorine hardness | 0·4 |
| 5. | Ammoniacal Nitrogen | Trace |
| 6. | Alluminoid | 0 004 |
| 7. | Oxygen absorbed | 0·150 |
| 8. | Nitric Nitrogen | *Nil* |

*Qualitative*

| | | |
|---|---|---|
| 1. | Nitrates | *Nil* |
| 2. | Sulphates | *Nil* |
| 3. | Phosphates | *Nil* |
| 4. | Iron, poisonous metals | *Nil* |

(10) Geological features

| | |
|---|---|
| (a) of foundations | Charneckite rock |
| (b) of catchment area | |

## III. TECHNICAL

### A. STATISTICAL

(1) Reservoir Data

| | |
|---|---|
| (a) M.W.L. | R.L. 6886·33 |
| (b) F.R.L. | R.L. 6884·00 |
| (c) Area at M.W.L. | 1·5 square miles |
| (d) Area at F.R.L. | 1·3 square miles |
| (e) Maximum length | 2·8 miles |
| (f) Maximum width | 1·4 miles |
| (g) Length of periphery | |

(2) Capacity of the reservoir

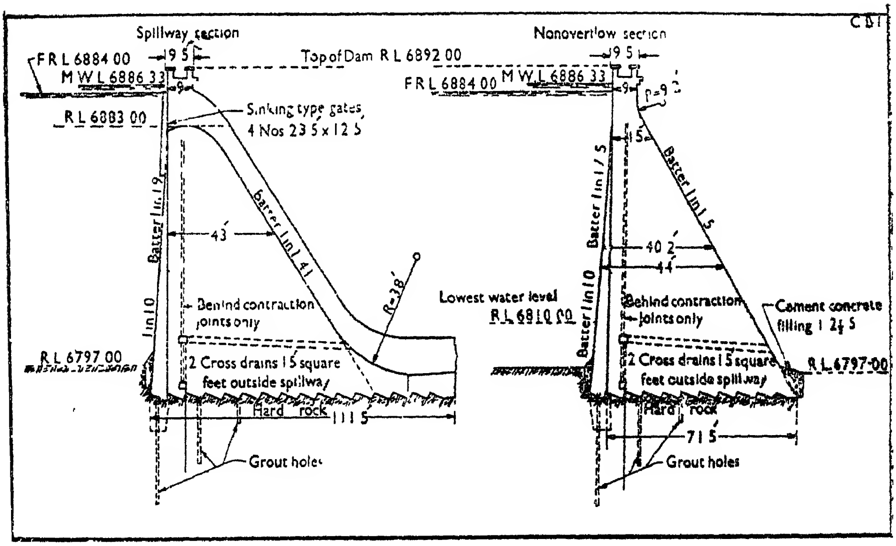
(a) Gross 41,322 acre feet

(b) Live

(c) Flood storage

(d) Carry-over

MUKURTI DAM (MADRAS)




*Cross Section of Mukurti Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 112 feet |
| (4) Height above the lowest river bed at dam. | 95 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir. | 18 feet (inclusive of 3 feet depth of parapet). |
| (6) Maximum width at level of foundation. | 111·5 feet |
| (7) Width at top | 9 feet |
| (8) Batter of face-slopes | |
| (a) Upstream | As per cross section |
| (b) Downstream | |
| (9) Length at top of the dam | |
| (a) Non-overflow | |
| (i) Main | 420 feet |
| (ii) Subsidiary | |
| (b) Spillway | 110 feet |
| (10) Cubic volume of the body of the dam. | 12,23,800 cubic feet |

### B. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed | Random rubble masonry in cement mortar with coursed rubble facing |
| (12) Specific gravity. | |
| (a) Masonry | Design provides for 145 lb. per cubic foot i.e. (2·32) but actually it is more. |
| (13) Nature of protection and water-proofing of the upstream and down-stream faces | Upstream face is pointed with cement mortar 1 cement 1/10 lime and 2 sand. Ends have been banked with earth pitched with stones and turfed in rear. |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundation of the dam | Front face masonry wall upto 5 feet depth is provided with 1 : 2½ cement mortar and pointed with 1:2 cement mortar. |
| (16) Contraction joints | From contraction joints 100 feet apart at chainage 110 ,220 ,330 and 430 and they have been provided with flexible copper strip seal and special asphaltam fill. |
| (17) Principal stresses in the masonry with a note of methods of calculations employed | |
| (18) Maximum pressure on foundations | 5·86 tons per square foot at toe |
| (19) Uplift pressure, calculated or measured. | Uplift pressure at joints and at bed with different depths is calculated by the formula $\frac{W \times H \times B}{2}$. |
| (20) Measures adopted for preventing or counteracting uplift pressures | It is so designed that it is sufficiently safe against uplift pressure. Besides the foundations have been pressure grounted in three rows. |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*

(a) Crown waste

(b) Proprietory

(2) *Dislocation.*

(a) Villages

(b) Families

(c) Population

(d) Roads.

(i) Highways

(ii) District Roads

(iii) Village Roads

(e) Railway Lines

(f) Temples, Mosques, etc

(g) Graves, etc.

(h) Trees, Gardens, Pastures, Houses, Wells, etc.

(i) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplusing works | Spillway portion is 110 feet and sinking type of gates are provided for storing and control of surplus discharge when necessity arises. |
| (2) Outlet works<br>(3) Scouring works | Two cast iron outlet pipes each 24 inches diameter with sluice gates in front and needle valves with dispersers in the rear. |
| (4) Inspection facilities | |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | Streamlines Bucket |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | The work was carried on as per specifications stated below.<br>(i) In the hearting, stones must be laid as far as possible on their largest face and not on their ends.<br>(ii) Stones must be as heavy as can be handled by men and no stone should weigh less than 60 lb. except chips etc. |

| | |
|---|---|
| | (*iii*) Stones must be laid over a good bed of mortar and then driven home with a mallet or hammer weighing about 8 lb. and the sides must then be filled with mortar and spalls wedged in between irregular joints. All excess mortar should then be scrapped off. This will ensure that no voids are left. |
| | (*iv*) Masons should be sufficiently supplied with chips and spalls. |
| | (*v*) Chips should not be driven under a stone as this may lift it off its bed. |
| | (*vi*) The stones and spalls should be completely wetted before use so that any dirt or dust adhering to the stone may be washed off and the stones may remain cool. |
| | (*vii*) The joints of any part of the masonry which has been built for a long time should be raked out, the loose stones removed and the surface thoroughly cleaned and washed before new work is done. |
| | (*viii*) Masonry should be built in uniform layers not more than one foot thick. No levelling up of surface is permitted. |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | On the left flank it was decided to continue the full section to the ground level at R.L. 6889; the rest of the portion to be built in the form of a core wall 40 feet in length. On the right flank on account of deeper foundation beyond chain 460, a tapered section from chain 480 to 520 was provided for economy sake, and a reinforced concrete corewall from chain 520 to 570 was decided upon to take the core walls into the hill to get sufficient cut off since the trial borings in section 460 to 520 revealed ratification rock, which is roughly 30 feet below the foundation level at chain 460. |
| (3) Noteworthy occurrences and accidents | |

(4) Operation of the dam—

(a) Regulation

(b) Silting of the reservoir—

(i) Total silt deposited

(ii) Rate of silting

(iii) Density of the silt deposited

(iv) Rate of advancement of delta

(c) Actual yield as against estimated

(d) Various measurements and observations

(i) Evaporation losses — Annual-53·5 inches.

(ii) Sweating below the dam

(iii) Temperature measurements

(iv) Seepage and regenerating

(e) Fish culture

(f) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam.

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical — The construction of the dam was included as the original scheme of Pykara Hydro-electric Project and was to be started only during the 10th year of operation of the Pykara Hydro-electric scheme. On account of the rapid growth of load of the Pykara system, the earlier construction of the dam was found necessary and was taken up in third year of Pykara operation. An estimate amounting to Rs. 21,25,000 was sanctioned for the scheme and the work started in January 1935 and completed in June 1938.

| | |
|---|---|
| (2) Personnel | Chief Engineer |
| | 1. Major H. G. Howard, M. AM. Soc. C.E. |
| | Engineering Charge Construction Branch. |
| | Mr. M.G. Platts, B.Sc , M.I.C.E. |
| | Executive Engineer |
| | 1. Mr. S.R. Krishnamurti, B.E. A.M. I.E. India. |
| (3) Bibliography | Public Works Department Madras "History of the dam" (Typed note) |

# III. 9.—Marconahally Dam

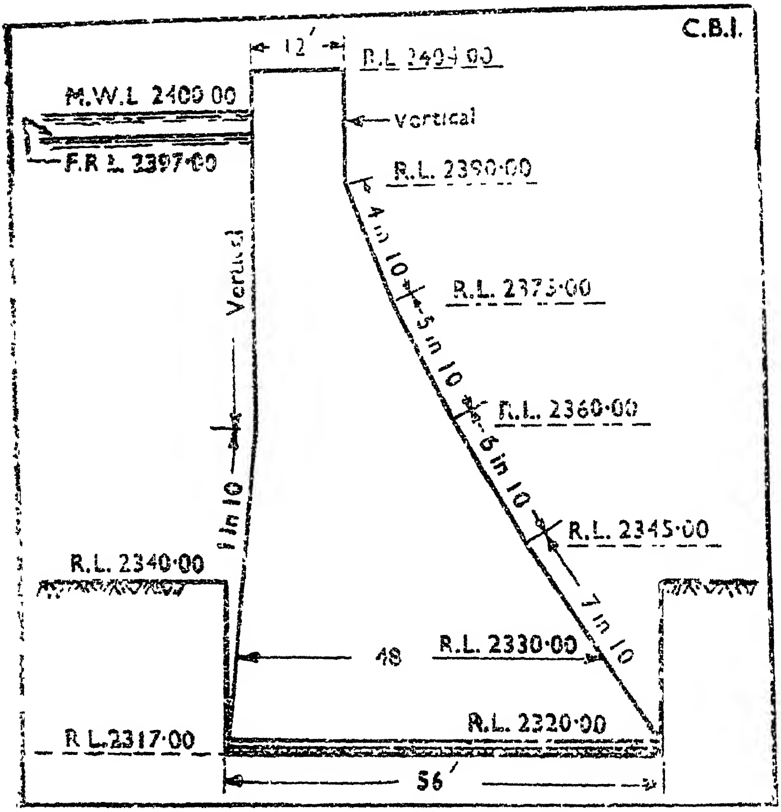
## (Composite)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 65 feet (above average bed level). |
| (2) Location | Tumkur district, Mysore State. (the Shimsa River). |
| (3) Authority or owner | Government of Mysore |
| (4) Purpose—Main and subsidiary | Irrigation |
| (5) Year of commencement | 1937 |
| (6) Year of completion | 1941 |
| (7) Capital cost | |
| (a) Estimated | (a) Rs. 22,00,000 |
| (b) Actual | (b) Rs. 32,00,000 |
| (8) Culturable area commanded by the project. | 10,000 acres |
| (9) Area irrigated | 8,500 acres |
| (10) Means of access | By road from Bangalore City at a distance of 60 miles. |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 1,584 square miles |
| (2) Nature of catchment | |
| (3) Mean annual precipitation | |
| (a) Rainfall | (a) 26 inches |
| (4) Average total annual yield of the catchment | |
| (5) Climate | Moderate |
| (6) Temperature conditions and variations | |




*Cross Section of Murconahally Dam (Masonry portion)*

Rate of Flow

(a) Maximum — (a) 60,000 cusecs

(b) Minimum — (b) No flow.

(8) Detritus charge of the stream — Does not carry big solids Water is heavily charged with silt during floods

(9) Character (chemical) of the water stored in the reservoir

(10) Geological features—

(a) of foundations — (a) Except for a thin covering of soil, the area is mostly a

(b) of catchment area — (b) complex of gneissic rocks

## III. TECHNICAL

### A. STATISTICAL

(1) Reservoir Data—

(a) M.W. — (a) R.L 2400·00.

(b) F.R.L. — (b) R.L. 2397·00.

(c) Area at M.W.L. — (c) 5·2 square miles

(d) Area at F.R.L. — (d) 4·84 square miles

(e) Maximum length

(f) Maximum width

(g) Length of periphery

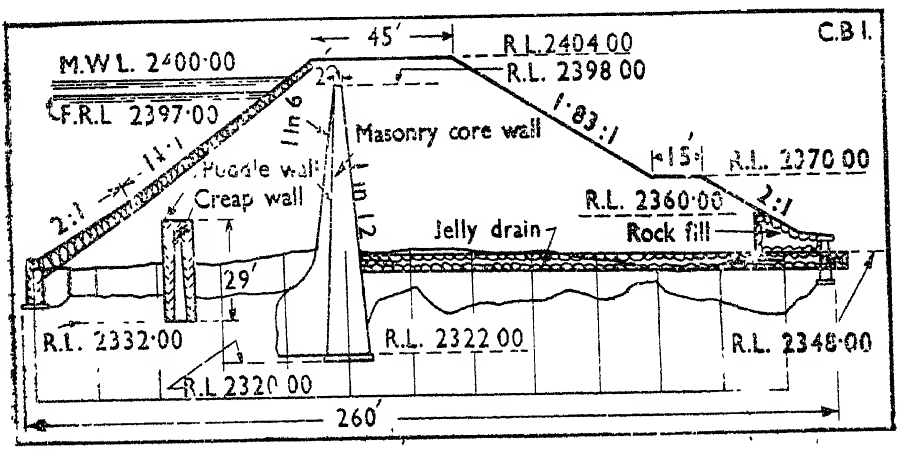
(2) Capacity of the reservoir—

(a) Gross — (a) 53,339 acre feet.

(b) Live — (b) 49,199 acre feet.

(c) Flood storage

(d) Carry-over




*Cross section of Marconahally Dam (Earthen portion).*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | Earthen portion 84·0 feet (the depth includes the core wall depth below formation level). Masonry portion, 87·0 feet. |
| (4) Height above the lowest river bed at dam | 65·0 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 7·0 feet |
| (6) Maximum width at level of foundation | Earthen portion, 260 feet<br>Masonry portion, 56·0 feet |
| (7) Width at top | Width of earthen portion, 16 feet to 45 feet.<br>Width of masonry portion, 12 feet |
| (8) Batter of face-slopes | |
| (a) Upstream | (a) As per cross section |
| (e) Downstream, | (b) As per cross section |
| (9) Length at top of the dam | (i) Masonry portion 465 feet<br>(ii) Left flank earthen portion, 2,310 feet<br>(iii) Right flank earthen portion, 2,514 feet.<br>5,289 |
| (a) Non-overflow | |
| (i) Main | (a) (i) 4,489 feet. |
| (b) Spillway | (b) 800·0 feet on right flank |
| (10) Cubic volume of the body of the dam | (i) Stone work 917,000<br>(ii) Earth work 260,000,000<br>(iii) Puddle 2,500,000<br>Total 263,417,000 cubic feet. |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Earthen portion gravel, puddle. Masonry portion, stone in cement mortar and stone in *surkhi* mortar. |
| (12) Specific gravity | |
| (a) Masonry | (a) 2·33 |
| (d) Earthfill | (d) |

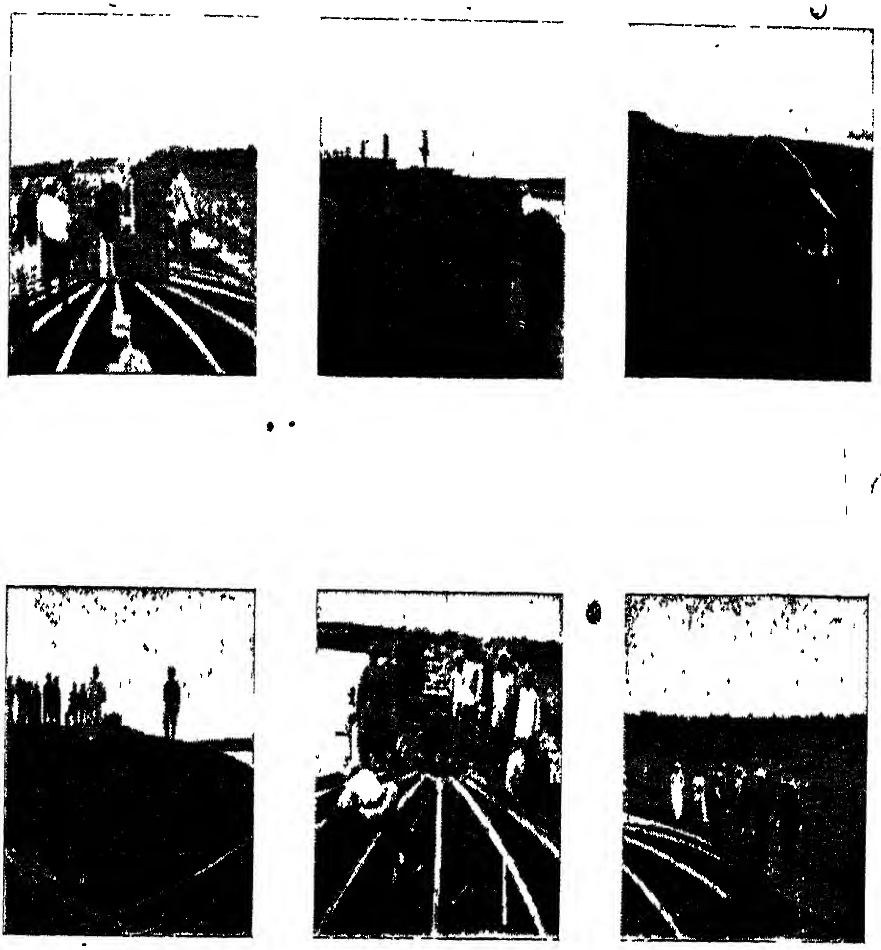
| | |
|---|---|
| (13) Nature of protection and water-proofing of the upstream and down-stream faces | In the earthen portion rough stone revetment is provided on the upstream side, thickness varying from 1·5 feet to 5·5 feet and on the rear side rock fill is provided |
| (14) Provision for dealing with seepage and drainage water | Jelly drains with longitudinal drains behind core-wall and one at the toe of the *bund* with cross drains at interval laid at a slope of 1 in 50. and provided with boulder filling in the rear of the dam |
| (15) Means of securing water tightness of the foundation of the dam | Masonry core-wall for a length of 100 feet each in continuation of the masonry dam on either side. In the remaining portion puddle core-wall is provided. |
| (16) Contraction joints | |
| (17) Principal stresses in the masonry with a note of methods of calculations employed .. | |
| (18) Maximum pressure on foundations | |
| (19) Uplift pressure, calculated or measured | |
| (20) Measures adopted for preventing or counteracting uplift pressures | |
| (21) Hydraulic gradient for which the embankment is designed | 1 in 4 |
| (22) Particular of the berm (if any) width and position. | As per cross section |
| (23) Position and form of the core-wall (or other means of securing water tightness). | Puddle core-wall in the centre and masonry core-wall in the rock portion. |
| (24) Batter (if any) of the core-wall | *Puddle core-wall*—1 in 6<br>*Masonry core-wall*—1 in 12. |
| (25) Maximum depth below ground surface of core-wall or other means of securing water tightness | 18·0 feet at ends and 28 feet at the gorge portion. |
| (26) Method of keying core-wall or other wall in the underlying ground | Grip trenches 20 feet by 23 feet by 3 feet with 1 : 1 slope are provided for foundation of earthen embankments. For puddle core-wall trenches are dug with 1 in 4 slopes. |
| (27) Nature of material forming the core or other wall | Puddle and stone masonry in cement mortar |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

| | |
|---|---|
| (1) *Land Submerged* | |
| (a) Crown waste | 1,290 acres |
| (b) Proprietory | 1,797 acres |
| (2) *Dislocation* | |
| (a) Villages | Six |
| (b) Families | |
| (c) Population | |
| (d) Roads: | |
| (i) Highways | |
| (ii) District Roads | |
| (iii) Village Roads | Yediyur-Devalapura Road has been deviated in rear of dam. |
| (e) Railway Lines | |
| (f) Temples, Mosques, *etc.* | 5 temples |
| (g) Graves, *etc.* | |
| (h) Trees, Gardens, Pastures, Houses, Wells, *etc.* | 7·2 acres gardens and 1289·5 acres pastures. |
| (i) Bridges | |
| (3) Compensation paid under each category of item (2) | |
| (4) Method of compensating for land of dispossessed landholders | |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | Under sluices, open weir, hood syphons and volute syphons. |
| (2) Outlet works | One sluice of 4·5 feet by 7·0 feet on the left bank. |
| (3) Scouring works | Under sluices 5 numbers 10 feet by 20 feet each. |
| (4) Inspection facilities | By steps at either ends of the Masonry dam. |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway. | |



*Some views of the Marconahally volute siphons during construction*

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | It is a composite dam (with masonry portion at centre and earthen portion at flanks). The masonry portion is founded on hard rock and earthen embankment is raised on gravel and soft rock. |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | Originally it was proposed to discharge the flood water by an open weir, and this was later altered to hood syphons, volute syphon and open weir. |
| (3) Noteworthy occurrences and accidents | |
| (4) Operation of the dam | |
| (a) Regulation | (a) By 5 scouring sluices 10×20 feet |
| (b) Silting of the reservoir | |
| (i) Total silt deposited | |
| (ii) Rate of silting | |
| (iii) Density of the silt deposited | |
| (iv) Rate of advancement of delta | |
| (c) Actual yield as against estimated | |
| (d) Various measurements and observations | |
| (i) Evaporation losses | |
| (ii) Sweating below the dam | |
| (iii) Temperature measurements | |
| (iv) Seepage and regeneration | |
| (e) Fish culture | |
| (f) Anti-malaria measures | |
| (5) Recreation facilities | |
| (6) Lessons to be learnt from the construction and utilisation of the dam | Discharge of flood water by means of volute syphons proved a success |

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

The question of constructing a reservoir across the Shimsha was under contemplation for over 50 years. In 1887 Mr. C. T. Dalal prepared a project to impound 12,000 units to irrigate 25,000 acres. The scheme was later on investigated in greater detail by the Special Division under Mr. V. H. Karve, and an estimate amounting to Rs. 7,91,592 was prepared by him. This provided for the construction of an earthen bund across the river just below its confluence with the Viravaishnavi. The above estimate was submitted to the Chief Engineer in October 1902. An alternative estimate amounting to Rs. 8,27,782 providing for a masonry dam in the river portion and earthen Bund for the flanks was also prepared with a weir 1,000 feet long on the right saddle. The Government ordered that this project would be taken up when funds became available.

Two similar estimates were prepared in 1909 for Rs. 9,69,985 and Rs. 11,30,000 for entire earthen bund and masonry dam and earthen flanks with a weir of 1,900 feet long in the one case and in the other the dam 400 feet long also to act as a weir with an open weir 1,100 feet on the right side. The former was submitted to Government for sanction recommending, however the composite dam scheme for adoption as being the safer.

In 1918 the Executive Engineer, Tumkur Division (Mr. G. Krishna Iyengar) prepared an alternative alignment about two furlongs higher up along the line of rocky boulders in the Shimsha and Viravaishnavi. This was not pursued further because the length of the bund and the dam made the scheme costlier.

In pursuance of the policy of taking up irrigation works in all the Districts, this large scheme was again taken up and the estimates prepared in 1909 were revised and two estimates, one amounting to Rs. 18,00,000 and the other to Rs 15,75,000 were prepared in 1928. The latter was for constructing an earthen bund along the entire length The financial and revenue aspects of the scheme were gone into incomplete detail.

The Dewan inspected the site in October 1934 and ordered that the project should be further examined. Plans and estimates amounting to Rs. 22,00,000 were prepared thereafter in accordance with the instructions of the Chief Engineer.

(2) Personnel

Executive Engineer—Shri M. Narasimhiah B.A., C.E., M.I.E. (Ind.)

(3) Bibliography

(3) (i) Administration Report of the Public Works Department, Mysore State, ending 30th June 1937-1938.

(ii) Marconahally Reservoir Project "Address presented to His Highness the Maharaja of Mysore, by the then Chief Engineer of Mysore."

(iii) Marconahalli Reservoir Project Kunigal Taluk, Tumkar District, Mysore State (Typed note).

# III. 10. Byramangala Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| 1) Height above the lowest river bed | 65 feet |
| (2) Location | Mysore State, Bangalore District, (Vrishabhavati River) |
| (3) Authority or owner | Government of Mysore |
| (4) Purpose—Main and subsidiary | Irrigation |
| 5) Year of commencement | July 1939 |
| 6) Year of completion | December 1945 |
| 7) Capital cost | |
| (a) Estimated | (a) Rs. 9,38,720 |
| (b) Actual | (b) Rs. 11,00,000 |
| (8) Culturable area commanded by the project | 4,000 acres |
| (9) Area irrigated | 3,200 acres |
| (11) Means of access | By an approach road from 7/20 mile of Madras Cananano̧t Road |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 147 square miles |
| (2) Nature of catchment | Hilly |
| (3) Mean annual precipitation | |
| (a) Rainfall | (a) 30 inches (average of 40 years) |
| (4) Mean annual yield of the catchment | 26,718 acre feet |
| (5) Climate | Moderate |
| (6) Temperature conditions and variations | |
| (7) Rate of Flow | |
| (a) Maximum | (a) 8,100 cusecs (calculated) |
| (b) Minimum | (b) No flow |
| (8) Detritus charge of the stream | There is a considerable quantity of silt in water during flood days. |

(9) Character (chemical) of the water stored in the reservoir

(10) Geological features

(a) of foundations — (a) It has rocks in the river portion and gravel on the flanks.

(b) of catchment area

## III. TECHNICAL

### A. STATISTICAL

(1) Reservoir Data

(a) M. W. L. — (a) R. L. 108·00 from datum line as per cross section

(b) F. R. L. — (b) R. L. 105·00.

(c) Area at M. W. L. — (c) 1·57 square miles

(d) Area at F. R. L

(e) Maximum length

(f) Maximum width

(g) Length of periphery

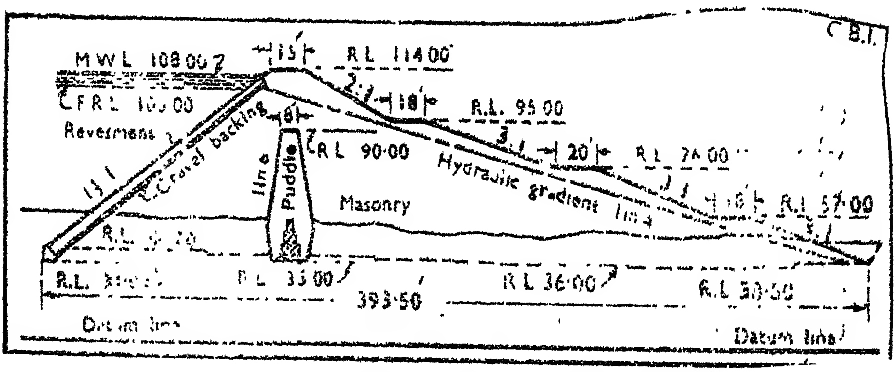
(2) Capacity of the reservoir

(a) Gross — (a) 17,148 acre feet.

(b) Live

(c) Flood storage

(d) Carryover




*Cross Section of Byramangala Dam*

(3) Maximum height above the lowest point of foundations — 72 feet

(4) Height above the lowest river bed at dam — 65 feet

| | |
|---|---|
| (5) Height of the top of the dam above the crest of the spillway or weir | 9 feet |
| (6) Maximum width at level of foundation | 393·5 feet |
| (7) Width at top | 15 feet from waste weir to sluice and 12 feet from sluice to end. |
| (8) Slopes | |
| (a) Upstream | (a) As per cross section |
| (b) Downstream | (b) As per cross section |
| (9) Length at top of the dam | 7,500 feet |
| (a) Non-overflow | |
| (i) Main | |
| (ii) Subsidiary | |
| (b) Spillway | (b) 500 feet |
| (10) Cubic volume of the body of the dam. | 2,970,000 cubic feet |

B. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed | Earth with gravel casing on the exterior, puddle and masonry for core-wall and rough stone for revetment |
| (12) Specific gravity | |
| (a) Masonry | |
| (d) Earthfill | |
| (13) Nature of protection and water-proofing of the upstream and downstream faces | Upstream is protected with rough stone revetment starting 4 feet above maximum water level going down to river bed level. Thickness of revetment increases 9 inches for every 10 feet, starting with a thickness of $1\frac{1}{2}$ feet at the top. |
| (14) Provision for dealing with seepage and drainage water | Longitudinal and transverse jelly drains at ground level in rear half of the bund are provided which finally join on to the catch-water drain. |
| (15) Means of securing water tightness of the foundation of the dam | This is secured by means of consolidated gravel embankment with puddle and masonry core walls which are inside the bund and by the rough stone revetment which is placed on the upstream side. |

| | |
|---|---|
| (16) Hydraulic gradient for which the embankment is designed | 1 in 4 |
| (17) Particular of the berm (if any) width and position | |
| (18) Position and form of the core wall (or other means of securing water tightness) | Puddle core-wall is provided throughout in the centre of the dam with an additional masonry core-wall which is provided only over the rocky portion. |
| (19) Batter (if any) of the core wall | In the puddle core-wall—<br>1 in 6 above the formation level<br>1 in 4 below the formation level |
| (20) Maximum depth below ground surface of core-wall or other means of securing water tightness | 15 feet |
| (21) Method of keying core-wall or other wall in the underlying ground | Key trenches |
| (22) Nature of material forming the core or other wall | *Puddle Core wall*<br>Puddle of a good mixture of clay and gravel.<br>*Masonry Core-wall*<br>Stone in 1 : 6 cement mortar. |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

| | |
|---|---|
| (1) *Land submerged* | |
| (*a*) Crown waste | 198 acres |
| (*b*) Proprietory | 820 acres |
| (2) *Dislocation* | |
| (*a*) Villages | |
| (*b*) Families | |
| (*c*) Population | |
| (*d*) Roads : | |
| (*i*) Highway | |
| (*ii*) District Roads | |
| (*iii*) Village Roads | |
| (*e*) Railway Lines | |
| (*f*) Temples, Mosques, *etc.* | |
| (*g*) Graves, *etc.* | |
| (*h*) Trees, Gardens, Pastures, Houses, Walls, *etc.* | |
| (*i*) Bridges | |
| (3) Compensation paid under each category of item | Total Rs. 1,19,500 |
| (4) Method of compensating for land of dispossessed landholders | Cash compensation |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | Surplussing works consist of 500 feet long open weir, with a darft channel which can discharge 14, 000 cusecs |
| (2) Outlet works | Two sluices with gear rod and shutters |
| (3) Scouring works | |
| (4) Inspection facilities | |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | |

## VIII. SUPPLE MENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | |
| (3) Noteworthy occurrences and accidents | |
| (4) Operation of the dam | |
| (a) Regulation | (a) By sluice gear rod and vent-type shutter. |
| (b) Silting of the reservoir | |
| (i) Total silt deposited | |
| (ii) Rate of silting | |
| (iii) Density of the silt deposited | |
| (iv) Rate of advancement of delta | |
| (c) Actual yield as against estimated | |
| (d) Various measurements and observations | |
| (i) Evaporation losses | |
| (ii) Sweating below the dam | |
| (iii) Temperature measurements | |
| (iv) Seepage and regeneration | |
| (e) Fish culture | |
| (f) Anti-malaria measures | (e) By canlisation of valleys. |
| (5) Recreation facilities | |
| (6) Lessons to be learnt from the construction and utilisation of the dam. | |

## VI. BIBLIOGRAPHY AND HISTORICAL

| | |
|---|---|
| (1) Historical | The project was designed to irrigate 4,000 acres of land, and was sanctioned in June 1939. |
| | It was financed from the irrigation development fund of the Mysore Government and was programmed to be completed in two and a half years but it was actually completed in December, 1945 |
| (2) Personnel | |
| (3) Bibliography | Public Works Department Mysore State " Administration report for the year ending with 30th June 1940 ". |

# III. 11. Kanva Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 56 feet |
| (2) Location | Bangalore District, Mysore State (Kanva river) |
| (3) Authority or owner | Government of Mysore |
| (4) Purpose Main and subsidiary | Irrigation |
| (5) Year of commencement | July 1940 |
| (6) Year of completion | 1946 |
| (7) Capital cost— | |
| (a) Estimated | (a) Rs. 15,72,760 |
| (b) Actual | (b) Rs. 38,98,800 |
| (8) Cultivable area commanded by the project. | 5,000 acres |
| (9) Area irrigated | 3,500 acres |
| (10) Means of access | By road.—40 miles from Bangalore. By rail.—From Closepet on Bangalore Mysore railway line the site is 9 miles. |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 133 square miles (total). 93 square miles (independent). |
| (2) Nature of catchment | Hilly |
| (3) Mean annual precipitation— | |
| (a) Rain fall | (a) 34·0 inches |
| (4) Total average annual yield of the catchment. | 36,918 acre feet |
| (5) Climate | Moderate |
| (6) Temperature conditions and variations | |
| (7) Rate of flow — | |
| (a) Maximum | (a) 14,000 cusecs |
| (b) Minimum | (b) No flow |

(8) Detritus charge of the stream — It carries considerable quantity of silt during floods. Very little solid material is carried.

(9) Character (chemical) of the water stored in the reservoir,

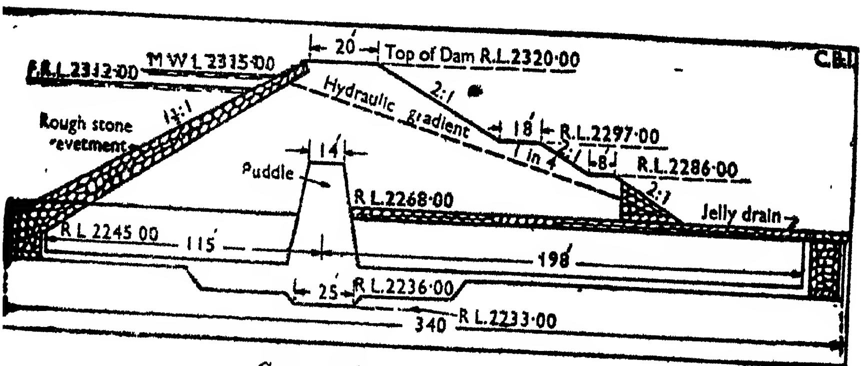
(10) Geological features—
- (a) of foundations — (a) Foundation is laid gravel.
- (b) of catchment area — (b) Catchment is mostly three feet to four feet thick top soil of red earth or gravel on soft rock

## III. TECHNICAL

### A. STATISTICAL

(1) Reservoir Data.
- (a) M. W.L. — (a) R. L. 2315·00
- (b) F.R.L. — (b) R.L. 2312·00
- (c) Area at M.W.F. — (c) 1·72 square miles
- (d) Area at F.R.L.
- (e) Maximum length — (e) 2½ miles
- (f) Max mum width — (f) 1 mile
- (g) Length of periphery — (g) 6 miles

(2) Capacity of the reservoir
- (a) Gross — (a) 22,425 acre feet
- (b) Live
- (c) Flood storage
- (d) Carry over




*Cross section of Kanva Dam*

(3) Maximum height above the lowest point of foundations. — 87 feet

(4) Height above the lowest river bed at dam. — 56 feet

(5) Height of the top of the dam above the crest of the spillway of weir — 8·0 feet

| | |
|---|---|
| (6) Maximum width at level of foundation. | 340 feet nearly |
| (7) Width at top | 20 feet |
| (8) Slopes | |
| (a) Upstream | |
| (b) downstream | As per cross section |
| (9) Length at top of the dam | 4,635 feet. |
| (a) Non overflow | |
| (i) Main | |
| (ii) Subsidiary | |
| (b) Spillway | |
| (10) Cubic volume of the body of the the dam | 7,497,000 cubic feet |

**B. OTHERS**

| | |
|---|---|
| (11) Materials of which it is constructed | Earthen with an outer casing of gravel and core walls are of puddle and stone. |
| (12) Specific gravity— | |
| (a) Earthfill | |
| (13) Nature of protection and water proofing of the upstream and downstream faces | Front slope is protected with rough stone of revetment and the rear is protected with turfing above rockfill. |
| (14) Provision for dealing with seepage and drainage water | At the ground level jelly drains have been provided to drain off all the seepage water. Cross drains have also been constructed at intervals to lead all the seepage to the main valley. |
| (15) Means of securing water tightness of the foundation of the dam | On the front side, this is secured by means of rough stone revetment laid over well puddled earth. It is further provided with a masonry wall in mud to serve as foundation of revetment. In the centre a puddle core wall has been provided. |
| (21) Hydraulic gradient for which the embankment is designed | 1 in 4 |
| (22) Particular of the berm (if any) width and position | 8·0 feet at R. L. 2286.<br>18 feet at R. L. 2297. |

| | |
|---|---|
| (23) Position and form of the core wall or other means of securing water tightness. | A puddle core wall in the centre is provided with 1 in 6 batters above formation level and 1 in 4 batter below formation level. For masonry core wall batter is either taken in steps or given 1 in 12 on each side. |
| (24) Batter (if any) of the core wall | |
| (25) Maximum depth below ground surface of core wall or other means of securing water tightness | The depth of the puddle core wall is 15 feet (maximum) below ground level, and in case of river portion it is 30 feet below bed level. A number of puddle cut off walls, have been provided at 50 feet apart. In addition to the above there is one puddle trench in the front portion up to ground level. |
| (26) Method of keying corewall or other wall in the underlying ground. | By constructing grip trenches |
| (27) Nature of material forming the core or other wall. | Puddle, and stone masonary 1 in 6 cement mortar |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

| | |
|---|---|
| (1) *Land Submerged*— | |
| (*a*) Crown waste | 50 acres |
| (*b*) Proprietory | 1,100 acres |
| (2) *Dislocation*— | |
| (*a*) Villages | 4 |
| (*b*) Families | 285 |
| (*c*) Population | 2,280 |
| (*d*) Roads | |
| (*k*) Highways | |
| (*ii*) District Roads | |
| (*iii*) Village Roads | |
| (*e*) Railway Lines | |
| (*f*) Temples, Mosques, *etc.* | 10 |
| (*g*) Graves, *etc.* | 8 |
| (*h*) Trees, Gardens, Pastures. Houses, Wells, *etc.* | |
| (*i*) Bridges | |
| (3) Compensation paid under each category of item (2) | Rs. 10,92,000 |
| (4) Method of compensating for land of dispossessed landholders. | Cash compensation |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | Flood discharge effected by hood syphons. |
| (2) Outlet works. | Ordinary sluice with gear rod and shutter (sluice 3·5 feet by 5·5 feet) |
| (3) Scouring works | |
| (4) Inspection facilities | |
| (5) Fish pass | |
| (6) Means for dissipating energy below the spillway. | There is a fall of nearly 50 feet from the crest of the hood syphon to the river bed. This fall has been negotiated by the construction of three masonry drops with solid masonry aprons. |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | Consolidation of earth has been done by using road rollers, the earth was put in an six inches to nine inch layers and watered by means of hose pipes. Both revetment work and bund work were done simultaneously. |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | At the preparation of the project open weir was proposed for flood discharge, which was later altered to siphon spillway. |
| (3) Noteworthy occurrences and accidents. | |
| (4) Operation of the dam— | |
| (a) Regulation | (a) By sluice gear rod and shutter (vent type). |
| (b) Silting of the reservoir— | |
| (i) Total silt deposited | |
| (ii) Rate of silting | |
| (iii) Density of the silt deposited | |
| (iv) Rate of advancement of delta | |
| (c) Actual yield as against estimatted. | |
| (d) Various measurements and observations— | |
| (i) Evaporation losses | |
| (ii) Sweating below the dam | |
| (iii) Temperature measurements | |
| (iv) Seepage and regeneration | (iv) Jelly drains provided. |

| | |
|---|---|
| (*e*) Fish culture | |
| (*f*) Anti-malaria measures | (*f*) Village reserve trenches at one furlong zone and canalisation of valleys. |
| Recreation facilities | |
| (6) Lessons to be learnt from the construction and utilisation of the dam | |

## VI. BIBLIOGRAPHY AND HISTORICAL

| | |
|---|---|
| (1) Historical | |
| (2) Personnel | |
| (3) Bibliography | Administration report for the year ending June 1941 of Mysore Public Works Department. |

# CHAPTER IV

# KISTNA BASIN

# IV. 1 Rajaram Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 52 feet |
| (2) Location | Kolhapur, Bombay State, (Local stream). |
| (3) Authority or owner | Bombay Government |
| (4) Purpose—Main and subsidiary | Irrigation |
| (5) Year of commencement | |
| (6) Year of completion | |
| (7) Capital Cost<br>(a) Estimated<br>(b) Actual | |
| (8) Culturable area commanded by the project. | |
| (9) Area irrigated | About 50 acres of sugarcane and 10 acres of other crops. |
| (11) Means of access | The dam is approached by the Provincial road from Kolhapur to Belgram and is three miles from Kolhapur. An approach road, is about half mile long from the trunk road to the dam site. |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 1·66 square miles. 4·25 square miles including that of the feeder channel. |
| (2) Nature of catchment | |
| (3) Mean annual precipitation<br>(a) Rainfall | 40 inches |
| (4) Total average annual yield of the catchment | 920 acre feet |

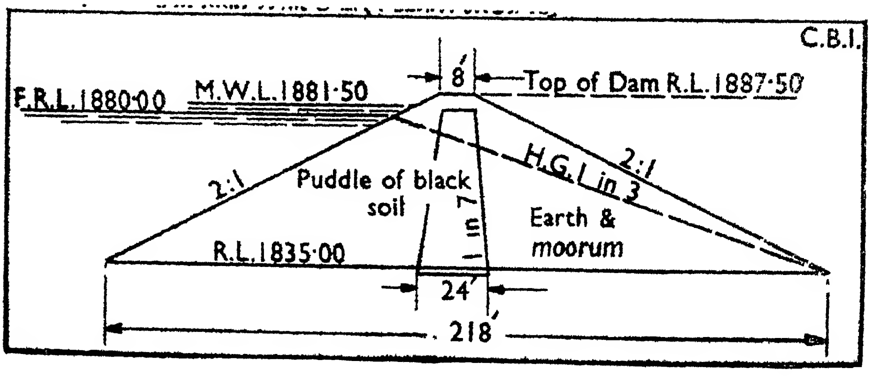
## II. GEOPHYSICAL—*contd.*

| | |
|---|---|
| (5) Climate | Temperate. |
| (6) Temperature conditions and variations. | |
| (7) Rate of Flow | |
| (*a*) Maximum | |
| (*b*) Minimum | |
| (8) Detritus charge of the stream | |
| (9) Character (Chemical) of the water stored in the reservoir. | The water is good and potable |
| (10) Geological features | |
| (*a*) of foundations | Rock |
| (*b*) of catchment area | Rock |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (*a*) M.W.L. | R.L. 1881·50. |
| (*b*) F.R.L. | R.L. 188··00. |
| (*c*) Area at M.W.L. | 0·1 square mile. |
| (*d*) Area at F.R.L. | |
| (*e*) Maximum length | |
| (*f*) Maximum width | |
| (*g*) Length of periphery | |
| (2) Capacity of the reservoir | |
| (*a*) Gross | |
| (*b*) Live | 712 acre feet |
| (*c*) Flood storage | |
| (*d*) Carry-over | |




*Cross section of Raja Ram Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 54·0 feet |
| (4) Height above the lowest river bed at dam | 52·5 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 5·5 feet |
| (6) Maximum width at level of foundation | 218 feet |
| (7) Width at top | 8 feet |
| (8) Slopes | |
| (a) Upstream | As per cross section |
| (b) Downstream | As per cross section |
| (9) Length at top of the dam | 1,350 feet |
| (a) Non-overflow | |
| (i) Main | 1,290 feet |
| (ii) Subsidiary | |
| (b) Spillway or waste weir | 60 feet |
| (10) Cubic volume of the body of the dam | |

B. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed | Earth and *moorum* |
| (12) Specific gravity | |
| (d) Earthfill | |
| (13) Nature of protection and waterproofing of the upstream and downstream faces | |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundation of the dam | |
| (21) Hydraulic gradient for which the embankment is designed. | 1 in 3 |
| (22) Particular of the berm (if any) width and position | |
| (23) Position and form for the core wall (or other means of securing water tightness) | As per cross section |

| | |
|---|---|
| (24) Batter (if any) of the core-wall | |
| (25) Maximum depth below ground surface of core-wall or other means of securing water tightness | |
| (26) Method of keying core-wall or other wall in the underlying ground | - |
| (27) Nature of material forming the core or other wall | Puddle of black soil |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged:*
  (a) Crown waste
  (b) Proprietory

(2) *Dislocation:*
  (a) Villages
  (b) Families
  (c) Population
  (d) Roads:
    (i) Highways
    (ii) District Roads
    (iii) Village Roads
  (e) Railway Lines
  (f) Temples, Mosques, *etc.*
  (g) Graves, *etc.*
  (h) Trees, Gardens, Pastures, Houses, Wells, *etc.*
  (i) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | An ordinary waste weir 60 feet long. |
| (2) Outlet works | One sluice gate one foot by one foot. |
| (3) Scouring works | One sluice gate one foot by one foot. |
| (4) Inspection facilities | One metal gate constructed 1 foot 3 inches by 1 foot nine inches with a sliding shutter actuated by screw-work and a tunnel of the same size running through under the embankment. |

(5) Fish-pass

(6) Means for dissipating energy below the spillway.

## VI. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work.

Originally it was intended to raise its top 20 feet higher, than that constructed at present. Later the design was changed while commencing the embankment above the ground level.

(3) Noteworthy occurrences and accidents.

There was one accidental death of a coolie, and that was due to having fallen a part of earthen embankment on his body while working.

(4) Operation of the dam
- (a) Regulation
- (b) Silting of the reservoir
  - (i) Total silt deposited
  - (ii) Rate of silting
  - (iii) Density of the silt deposited
  - (iv) Rate of advancement of delta
- (c) Actual yield as against estimated.
- (d) Various measurements and observations.
  - (i) Evaporation losses
  - (ii) Sweating below the dam
  - (iii) Temperature measurements
  - (iv) Seepage and regeneration
- (e) Fish culture
- (g) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam.

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

(3) Bibliography

# IV. 2. Madag Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 144·00 feet |
| (2) Location | Located in the Mysore territory bordering on the extreme south-west of the Dharwar Collectorate (Kumudati river). |
| (3) Authority or owner | Bombay Government |
| (4) Purpose—Main and subsidiary | Irrigation |
| (5) Year of commencement | 1861 |
| (6) Year of completion | 1866 to 1867. The original dam was an ancient* work which was repaired on a smaller scale |
| (7) Capital cost | |
| (a) Estimated | (a) Rs. 2,49,407/- only for improvements and repairs such as (i) Constructing a drain outlet. (ii) Closing the breach in the dam. and (iii) Constructing left and right bank canals. |
| (b) Actual | (b) Rs. 1,67,598. |
| (8) Culturable area commanded by the project. | 1,345 acres |
| (9) Area irrigated | 428 acres |
| (11) Means of access | It is accessible from Rani Bennur Station on Poona Bangalore section (M. and S.M. Railway) and by metalled road, 4 miles, upto the dam site. |

*The original work done by the Kings of Vijayanagar.

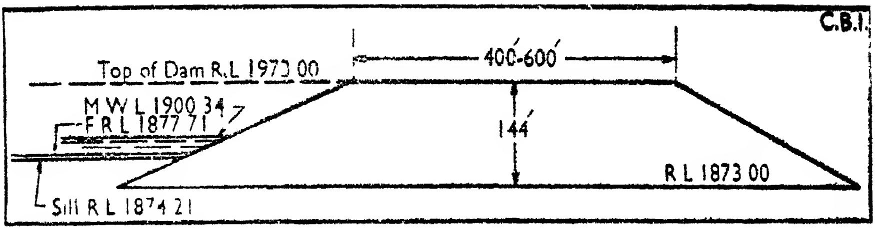
## II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 540 square miles |
| (2) Nature of catchment | Hilly and plain |
| (3) Mean annual precipitation | |
| (a) Rainfall | (a) 31·77 inches |
| (4) Total average annual yield of the catchment. | |
| (5) Climate | Temperate |
| (6) Temperature conditions and variations | Average summer 87°F and Maximum 105°F. Average Winter 79°F and Minimum 60°F. Average Monsoon 80°F. |
| (7) Rate of Flow | |
| (a) Maximum | |
| (b) Minimum | |
| (8) Detritus charge of the stream | There is some silting, but no observations have been made. |
| (9) Character (chemical) of the water stored in the reservoir | Suitable for irrigation purposes. |
| (10) Geological features | |
| (a) of foundations | (a) Slaty clay |
| (b) of catchment area | (b) Black soil |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (a) M.W.L. | (a) R.L. 1900·34 |
| (b) F.R.L. | (b) R.L. 1877·71 |
| (c) Area at M.W.L. | (c) 1·40 square miles |
| (d) Area at F.R.L. | |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | |
| (2) Capacity of the reservoir | |
| (a) Gross | (a) 1,288 acre feet |
| (b) Live | |
| (c) Flood storage | |
| (d) Carry-over | |




*Cross section of Madag Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | |
| (4) Height above the lowest river bed at dam | 144 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 95·29 feet |
| (6) Maximum width at level of foundation | . |
| (7) Width at top | 400 feet to 600 feet |
| (8) Slopes | |
| (a) Upstream | (a) 2½ : 1 |
| (b) Downstream | (b) 2 : 1 |
| (9) Length at top of the dam | 1,850 feet |
| (a) Non-overflow | |
| (i) Main | (a) (i) 1,700 feet |
| (b) Spillway | (b) 150 feet |
| (10) Cubic volume of the body of the dam | .. .. .. .. |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Natural soil or rock |
| (12) Specific gravity | |
| (13) Nature of protection and waterproofing of the upstream and downstream faces | |
| (14) Provision for dealing with seepage and drainage water | |
| (21) Hydraulic gradient for which the embankment is designed | |
| (22) Particular of the berm (if any), width and position | |

(23) Position and form of the core-wall (or other means of securing water tightness)

(24) Batter (if any) of the core-wall

(25) Maximum depth below ground surface of core-wall or other means of securing water tightness

(26) Method of keying core-wall or other wall in the under lying ground

(27) Nature of material forming the core or other wall

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | Protective masonry waste weir is 150 feet long and its average discharging capacity is 444 cusecs. The tank breached in the western embankment, and masonry weir was constructed across the breach to protect it from further erosion. |
| (2) Outlet works | Its culvert is provided with shutter and screw rod arrangement. |
| (3) Scouring works | |
| (4) Inspection facilities | |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | |

## VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents.

**(4) Operation of the dam**

**(a) Regulation**

**(b) Silting of the reservoir**

**(i) Total silt deposited**

**(ii) Rate of silting**

**(iii) Density of the silt deposited**

(*iv*) Rate of advancement of delta

(*c*) Actual yield as against estimated

(*d*) Various measurements and observations

(*i*) Evaporation losses

(*ii*) Sweating below the dam

(*iii*) Temperature measurements

(*iv*) Seepage and regeneration

(*e*) Fish culture

(*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

It is situated in the Mysore territory bordering on the extreme south west of the Dharwar Collectorate. It was formed by constructing three embankments, across gorges in the range of hills. It is believed that the work was carried out in the time of Vijaynagar kings (1335-1570). There is no record of any active step having been taken to utilize the water standing in the tank, until captain Playfair, R.E., the then Executive Engineer took the matter in 1858 and constructed a culvert waste weir and right and left bank canals at a cost of Rs. 1,67,598.

(2) Personnel

(3) Bibliography

# IV. 3. Ekruk Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 76·0 feet |
| (2) Location | Sholapur district, Bombay State (Adhila *Nala*, 15 miles from Sholapur) |
| (3) Authority or owner | Bombay Government |
| (4) Purpose—Main and Subsidiary | Irrigation, Industry and water supply |
| (5) Year of commencement | 1866 |
| (6) Year of completion | 1871 |
| (7) Capital cost | |
| (*a*) Estimated | Rs. 21,35,580 |
| (*b*) Actual | Rs. 23,68,279 |
| (8) Culturable area commanded by the project | 17,152 acres |
| (9) Area irrigated | 16,942 acres |
| (11) Means of access | It is situated at a distance of five miles North East of Sholapur, and is approachable by a motorable road. |

### II. GEOPHYSICAL

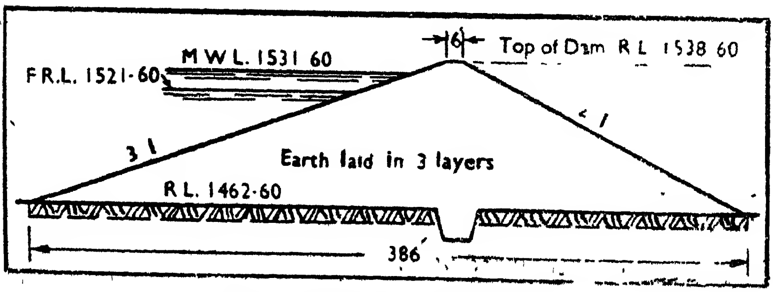
| | |
|---|---|
| (1) Area of catchment | 159 square miles |
| (2) Nature of catchment | Flat, grazing land (soil and *moorum*) |
| (3) Mean annual precipitation | |
| (*a*) Rainfall | 28·5 inches |
| (4) Total average annual yield of the catchment. | 55,555 acre feet |
| (5) Climate | Hot |
| (6) Temperature conditions and variations. | Maximum 115°F<br>Minimum 50°F |

| | |
|---|---|
| (7) Rate of Flow | |
| (*a*) Maximum | Discharge through waste weir 43,763 cusecs |
| (*b*) Minimum | |
| (8) Detritus charge of the stream | |
| (9) Character (chemical) of the water stored in the reservoir | Sweet, it is impounded during monsoon period. |
| (10) Geological features | |
| (*a*) of foundations | *Moorum* |
| (*b*) of catchment area | Earth and *moorum* over Deccan trap |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (*a*) M. W. L. | R. L. 1531·60 |
| (*b*) F. R. L. | R. L. 1521·60 |
| (*c*) Area at M.W.L. | 7·0 square miles |
| (*d*) Area at F. R. L. | 6·5 square miles |
| (*e*) Maximum length | 5·25 miles |
| (*f*) Maximum width | 2·25 miles |
| (*g*) Length of periphery | |
| (2) Capacity of the reservoir | |
| (*a*) Gross | (*i*) As originally designed—76,446 acre feet<br>(*ii*) As recently surveyed—55,946 acre feet |
| (*b*) Live | 55,946 acre feet |
| (*c*) Flood storage | 4,320 acre feet |
| (*d*) Carry-over | 15,128 acre feet |




*Cross section of Ekruk Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 91·0 feet |
| (4) Height above the lowest river bed at dam | 76·0 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 17·0 feet |
| (6) Maximum width at level of foundation | 386·0 feet |
| (7) Width at top | 6·0 feet |
| (8) Slopes | |
| (a) Upstream | 3 to 1 |
| (b) Downstream | 2 to 1 |
| (9) Length at top of the dam | 7,000 feet |
| (a) Non-overflow | |
| (i) Main | (i) 6,250 feet |
| (b) Spillway | (i) Right bank 300 feet<br>(ii) Left bank 450 feet |
| (10) Cubic volume of the body of the dam | 39,800,000 cubic feet |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed. | Earth and *moorum* |
| (12) Specific gravity<br>(d) Earthfill | |
| (13) Nature of protection and water-proofing of the upstream and downstream faces | Stone pitching on upstream side up to highest flood level and flank wall at ends |
| (14) Provision for dealing with seepage and drainage water | Cross and longitudinal drains of dry rubble stone |
| (15) Means of securing water tightness of the foundation of the dam | By means of a puddle trench |
| (21) Hydraulic gradient for which the embankment is designed | 1 : 4 (observed) |
| (22) Particular of the berm (if any) width and position | No berm was provided originally. A berm (100′×45′×10′) has been constructed as a repair work. |
| 23) Position and form of the core wall (or other means of securing water tightness) | There is no core-wall, but a puddle trench at bottom is made below ground level. |

| | |
|---|---|
| 24) Batter (if any) of the core-wall | Puddle trench 1 in 5 |
| (25) Maximum depth below ground surface of core-wall or other means of securing water tightness | Puddle trench is 5 feet below ground level. |
| (26) Method of keying core-wall or other wall in the underlying ground | There is no core-wall, but a puddle trench below ground level. |
| (27) Nature of material forming the core or other wall | There is no core-wall constructed. |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

| | |
|---|---|
| (1) *Land submerged*— | |
| (*a*) Crown waste<br>(*b*) Proprietory | 6·5 square miles |
| (2) *Dislocation* | |
| (*a*) Villages | Hipprga and Ekruk village submerged and subsequently shifted. |
| (*b*) Families | |
| (*c*) Population | 1,500 souls approximately |
| (*d*) Roads : | |
| (*i*) Highways | |
| (*ii*) District Roads | |
| (*iii*) Village Roads | |
| (*e*) Railway Lines | |
| (*f*) Temples, Mosques, etc. | Temples in above villages |
| (*g*) Graves, *etc.* | |
| (*h*) Trees, gardens, pastures, Houses, Wells, etc. | |
| (*i*) Bridges | |
| (3) Compensation paid under each category of item (2) | Villages shifted and land given in exchange |
| (4 Method of compensating for land of dispossessed landlords | As for item (3) above |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | Waste weir : Discharging capacity 43,763 cusecs<br>Right bank 300 feet long 10 feet depth<br>Left bank 250 feet long 10 feet depth<br>Left bank 200 feet long $7\frac{1}{2}$ feet depth |

| | |
|---|---|
| (2) Outlet works (3) Scouring Work | Sluice gate No. 1—4 feet by 4 feet, No. 4 conical bucket valve 2 feet diameter on low level perennial canal. Tower sluice gate No. 1, 2 feet by 2 feet and No 2 conical bucket valve 2 feet diameter on each tower of the high level left and right bank canal. A-30 inch diameter C. I. pipe with sluice valve connected to the break pressure tank of the gravitation main of the Sholapur water works. |
| (4) Inspection facilities | (*i*) Draw off tunnel<br>(*ii*) Foot bridge<br>(*iii*) Valve tower |
| (5) Fish-pass | |
| (6) Means fordissipating energy below the spillway. | Drowned channel through hard rock |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | The following improvements, found necessary during construction were carried out *viz.*, (1) increasing the former waste weir on the Right Bank of the river from 250 to 300 feet in length, (2) adding a second weir on the Left Bank 500 feet in length but at a level higher by 3 feet, (3) changing the design for the perennial canal to give a discharging capacity to 70 cusecs, (4) provision of a 1st class residence for the officer-in-charge of the work and (5) constructing the dam entirely of earth instead of the original proposal to have the flanks of masonry and the middle portion of earth as it was found that the foundations of the extremities were deeper than anticipated. |

| | |
|---|---|
| | In 1870 it was found that the actual flood discharge during extraordinary falls of rain was much more than that arrived at from observations and enquiry, and it was necessary to raise the dam by four feet and to lower the crest of the right bank waste weir by one foot. These proposals were sanctioned in the same year and were carried out. |
| (3) Noteworthy occurrences and accidents. | (3) Small slips occurred in 1872 and 1883 in heavy rains near chainage 36, which was subsequently repaired by additional berme (45′ width × 10′ high) with earth and *moorum* and boulder drains. This was ascribed to black soil foundation. There was no leakage. |
| (4) Operation of the dam | |
| (*a*) Regulation | By outlet sluice valves |
| (*b*) Silting of the reservoir | |
| (*i*) Total silt deposited | 893 million cubic feet |
| (*ii*) Rate of silting | 11·6 million cubic feet per year |
| (*iii*) Density of the silt deposited | |
| (*iv*) Rate of advancement of delta | |
| (*c*) Actual yield as against estimated | About 73% since 1923 |
| (*d*) Various measurements and observations | |
| (*i*) Evaporation losses | |
| (*ii*) Sweating below the dam | |
| (*iii*) Temperature measurements | |
| (*iv*) Seepage and regeneration | |
| (*e*) Fish culture | |
| (*f*) Anti-malaria measure | |
| **(5) Recreation facilities** | |

(6) Lessons to be learnt from the construction and utilisation of the dam

It was originally constructed for irrigation only but later on when the town of Sholapur developed, the Municipality provided for a water supply scheme in the year 1881. The mills originally depended for their water supply on their wells, but as these were increased they also drew water from the tank. Later on non-agricultural purposes increased to such an extent that water for irrigation had to be limited and Government, in 1929, fixed the maximum draw off for a major part of revenue from the mills and Municipality.

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

The tank was suggested and roughly surveyed in May 1863 by Major General (Then Captain) Fife, R. E. with a view to finding out the possibility of constructing a tank which would save the tract during seasons of draught and would also command a large area for cultivation. As a result of the rough survey, the Ekruk tank was found to meet these requirements and detailed survey was started in 1863. Plans and estimates were submitted to Government in 1866. The work was sanctioned and started in 1866.

(2) Personnel

Major General (then Captain) Fife R. E., Superintending Engineer specially appointed for its construction.

(3) Bibliography

History of canal head works Ekruk Tank, Sholapur (Typed note).

# IV. 4. Mayni Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed. | 60 feet |
| (2) Location | Satara district, Bombay State, (Wong *Nala*). |
| (3) Authority or owner | Bombay Government |
| (4) Purpose—Main and Subsidiary | Irrigation |
| (5) Year of commencement | 1868 |
| (6) Year of completion | 1873 |
| (7) Capital cost | |
| (*a*) Estimated | (*a*) Rs. 501,339 |
| (*b*) Actual | (*b*) Rs. 598,126 |
| (8) Culturable area commanded by the project. | 4,625 acres |
| (9) Area irrigated | 1,500 acres average |
| (11) Means of access | (*a*) It is accessible from Karad railway station (Madras and Southern Mahratta Railway) by road *via* Vita town.<br>*or*<br>(*b*) From Koregaon Railway Station (on M. & S. M. Railway) *via* Vaduj. |

### II. GEOPHYSICAL

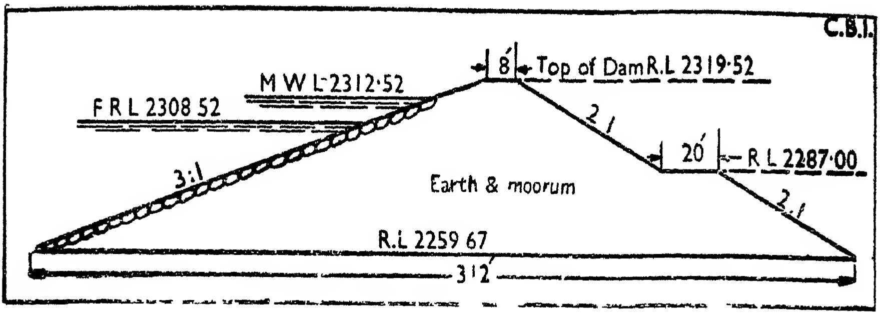
| | |
|---|---|
| (1) Area of catchment | 54 square miles |
| (2) Nature of catchment | Hilly catchment |
| (3) Mean annual precipitation | |
| (*a*) Rainfall | (*a*) 25·42 inches |

| | |
|---|---|
| (4) Total average annual yield of the catchment. | 5,380 acre feet. |
| (5) Climate | Temperate. |
| (6) Temperature conditions and variations. | Maximum temperature 105°C<br>Minimum temperature 45°C |
| (7) Rate of flow | |
| (a) Maximum | |
| (b) Minimum | |
| (8) Detritus charge of the stream | During monsoon there is a heavy flow of silt |
| (9) Character (chemical) of the water stored in the reservoir | Sweet |
| (10) Geological features | |
| (a) of foundations | (a) Earth and moorum |
| (b) of catchment area | (b) Earth and moorum overlying Daccan trap |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (i) M. W. L. | (a) R. L. 2312·52 (At present) |
| (b) F. R. L. | (b) R. L. 2308·52 (At present) |
| (c) Area at M. W. L. | |
| (d) Area at F. R. L. | (d) 0·70 square miles |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | |
| (2) Capacity of the reservoir | |
| (a) Gross | (a) 4,201 acre feet (in the beginning) 1,854 acre feet (at present) |
| (b) Live | (b) 1,854 |
| (c) Flood storage | |
| (d) Carry-over | |




*Cross Section of Mayni Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | |
| (4) Height above the lowest river bed at dam. | 59·5 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir. | 11 0 feet |
| (6) Maximum width at level of foundation. | 31·2 feet |
| (7) Width at top | 8 feet |
| (8) Slopes | |
| (a) Upstream | (a) 3 : 1 |
| (b) Downstream | (b) 2 : 1 |
| (9) Length at top of the dam | |
| (a) Non- overflow | |
| (i) Main | (a) (i) 3,95 feet |
| (b) Spillway | (b) 1,150 eet |
| (10) Cubic volume of the body of the dam. | 63,870,000 cubic feet |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Earth and *moorum* |
| (12) Specific gravity | |
| (d) Earthfill | |
| (13) Nature of protection and waterproofing of the upstream and down stream faces | Upstream side is pitched with stones upto highest flood level. |
| (14) Provision for dealing with seepage and drainage water | |

| | |
|---|---|
| (15) Means of securing water tightness of the foundation of the dam | |
| (21) Hydraulic gradient for which the embankment is designed | 1 in 4 |
| (22) Particular of the berm (if any) width and position | 20 feet wide at R. L. 2287·00. |
| (23) Position and form of the core-wall (or other means of securing water tightness) | |
| (24) Batter (if any) of the core-wall | |
| (25) Maximum depth below ground surface of core-wall or other means of securing water tightness | |
| (26) Method of keying core-wall or other wall in the underlying ground | |
| (27) Nature of material forming the core or other walls | |

## V. AUXILIARY WORKS

| | |
|---|---|
| Surplussing works | Waste weir which is 1,150 feet in length is built in masonry, but 550 fect portion of this length faced with concrete. Its discharging capacity is 38,668 cusecs. |
| (2) Outlet works | Circular sluice of 3 feet diameter |
| (3) Scouring works | |
| (4) Inspection facilities | |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway. | |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | The work of raising and strengthening the waste-weir and earthen dam of Mayni Tank by four feet has been completed very recently. |
| (3) Noteworthy occurrences and accidents | Owing to heavy rains on October 17 and 18, 1889 considerable damage occurred to the waste-weir and channel. |

(4) Operation of the dam

| | |
|---|---|
| (*a*) Regulation | (*a*) By sluice arrangements |
| (*b*) Silting of the reservoir | (*b*) 107·4 million cubic feet during 75 years |
| (*i*) Total silt deposited | (*i*) 2,470 acre feet |
| (*ii*) Rate of silting | (*ii*) about 33 acre feet per year |
| (*iii*) Density of the silt deposited | |
| (*iv*) Rate of advancement of delta | |
| (*c*) Actual yield as against estimated | |
| (*d*) Various measurements and observations | |
| (*i*) Evaporation losses | |
| (*ii*) Sweating below the dam | |
| (*iii*) Temperature measurements | |
| (*iv*) Seepage and regeneration | |
| (*e*) Fish culture | |
| (*f*) Anti-malaria measures | |

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam.

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

(3) Bibliography — Public Works Department Bombay "History of the tank"

# IV. 5. Pingli Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 53·5 feet |
| (2) Location | Satara district, Bombay Presidency (Upper Man River Works) |
| (3) Authority or owner | Bombay Government |
| (4) Purpose-Main and subsidiary | Irrigation |
| (5) Year of commencement | 1876 |
| (6) Year of completion | 1878 |
| (7) Capital cost | |
| (a) Estimated | |
| (b) Actual | (b) Rs. 2,80,665 |
| (8) Culturable area commanded by the project. | 7,623 acres |
| (9) Area irrigated | 1,000 acres |
| (11) Means of access | It is accessible from Koregaon rail way station (M. & S.M. Railway) by road known as Satara Pandharpur road. |

### II. GEOPHYSICAL

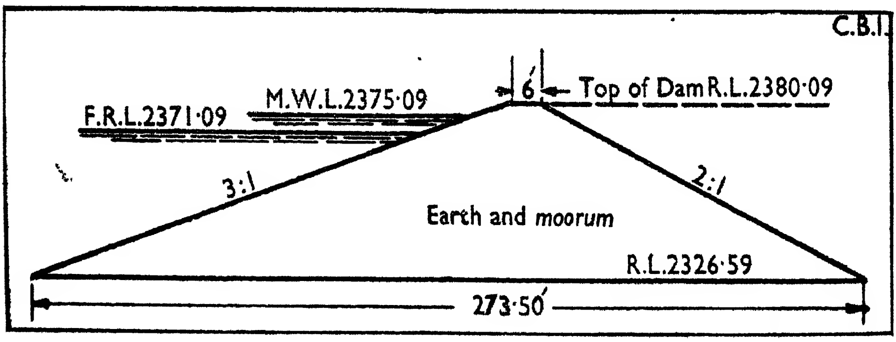
| | |
|---|---|
| (1) Area of catchment | 20 square miles |
| (2) Nature of catchment | Fairly hilly |
| (3) Mean annual precipitation | |
| (a) Rainfall | (a) 21·65 inches |
| (4) Total average annual yield of the catchment. | 4,032 acre feet |
| (5) Climate | Temperate |
| (6) Temperature conditions and variations. | Maximum temperature 105° F<br>Minimum temperature 45° F |

| | |
|---|---|
| (7) Rate of Flow | |
| (a) Maximum | |
| (b) Minimum | (b) No flow |
| (8) Detritus charge of the stream | Water carries silt and brush wood in monsoon period. |
| (9) Character (Chemical) of the water stored in the reservoir. | Sweet |
| (10) Geological features | |
| (a) of foundations | (a) Earth and *moorum* |
| (b) of catchment area | (b) Earth and *moorum* overlying Deccan trap |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data— | |
| (a) M.W.L. | (a) R.L. 2375·09 |
| (b) F.R.L. | (b) R.L. 2371·09 |
| (c) Area at M.W.L. | (c) 0·55 square miles |
| (d) Area at F.R.L. | (d) 0·52 square miles |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | |
| (2) Capacity of the reservoir— | |
| (a) Gross | (a) 4,558 acre feet (old) |
| (b) Live | (b) 2,350 acre feet (present) |
| (c) Flood storage | |
| (d) Carry-over | |




*Cross section of Pingli Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 62·5 feet |

| | |
|---|---|
| (4) Height above the lowest river bed at dam | 53·5 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 9 feet |
| (6) Maximum width at level of foundation | 273·5 feet |
| (7) Width at top | 6 feet |
| (8) Slopes | |
| (a) Upstream | (a) As per cross section |
| (b) Downstream | (b) As per cross section |
| (9) Length at top of the dam | 5,603 feet |
| (a) Non-overflow | (a) |
| (i) Main | (i) 4,803 feet |
| (b) Spillway | (b) 800 feet |
| (10) Cubic volume of the body of the dam. | 195,000,000 cubic feet |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Natural ground earth and *moorum* |
| (12) Specific gravity (d) Earthfill | |
| (13) Nature of protection and water-proofing of the upstream and downstream faces | Stone pitching on upstream side upto highest flood level. |
| 14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundation of the dam | |
| (21) Hydraulic gradient for which the embankment is designed | 1 in 4. |
| (22) Particular of the berm (if any), width and position | |
| (23) Position and form of the core-wall (or other means of securing water tightness) | |
| (24) Batter (if any) of the core wall | |
| (25) Maximum depth below ground surface of core-wall or other means of securing water tightness | |

| | |
|---|---|
| (26) Method of keying core-wall or other wall in the under-lying ground | |
| (27) Nature of material forming the core or other wall | |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | Waste weir, 800 feet in length is built in masonry and faced with concrete. Its discharging capacity is 12,862 cusecs. |
| (2) Outlet works<br>(3) Scouring works | One sluice |
| (4) Inspection facilities | |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | Not necessary being natural rock at bed. |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | |
| (3) Noteworthy occurrences and accidents | |
| (4) Operation of the dam | |
| (*a*) Regulation | (*a*) By means of one sluice |
| (*b*) Silting of the reservoir | |
| (*i*) Total silt deposited | (*i*) 89,000,000 cubic feet in 69 years |
| (*ii*) Rate of silting | (*ii*) About 1,300,000 cubic feet every year |
| (*iii*) Density of the silt deposited | |
| (*iv*) Rate of advancement of delta | |
| (*c*) Actual yield as against estimated | |

(*d*) Various measurements and observations.

(*i*) Evaporation losses

(*ii*) Sweating below the dam

(*iii*) Temperature measurements

(*iv*) Seepage and regeneration

(*e*) Fish culture

(*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

(3) Bibliography

# IV. 6. Matoba Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 57·41 feet |
| (2) Location | Poona district. Bombay State (Fed by the Mutha right bank canal). |
| (3) Authority or owner | Bombay Government |
| (4) Purpose-Main and subsidiary | Irrigation |
| (5) Year of commencement | 1876 |
| (6) Year of completion | 1878 |
| (7) Capital cost— | |
| (a) Estimated | Rs. 2,10,500 |
| (b) Actual | Rs. 1,61,000 |
| (8) Culturable area commanded by the project | 7,133 acres |
| (9) Area irrigated | 2,708 acres |
| (11) Means of access | It is accessible from Yewat railway station on the Great Indian Pennisular Railway. |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 10 square miles |
| (2) Nature of catchment | This is fed by the Mutha Right Bank canal in the monsoon season. |
| (3) Mean annual precipitation | |
| (a) Rainfall | 15·28 inches |
| (4) Total average annual yield of the catchment. | 230 to 345 acre feet |
| (5) Climate | Hot in April to July. Rainfall mostly occurs towards the end of August and September with occasional storms in October and November. |

(6) Temperature conditions and variations — Maximum temperature 110° F. Minimum temperature 40°F. Normal temperature 75° F—95°F.

(7) Rate of Flow
- (a) Maximum
- (b) Minimum

(8) Detritus charge of the stream

(9) Character (chemical) of the water stored in the reservoir — Sweet, suitable for irrigation purposes.

(10) Geological features—
- (a) of foundations — Hard trap rock
- (b) of catchment area — *Moorum soil*

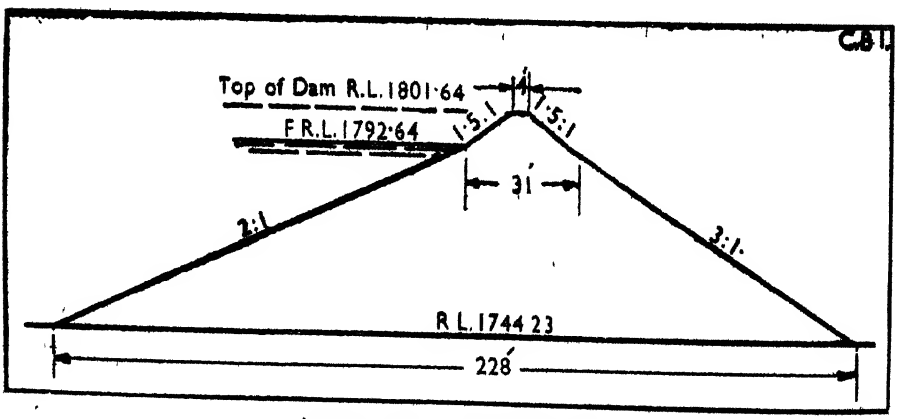
## III. TECHNICAL

### A. STATISTICAL

(1) Reservoir Data

| | |
|---|---|
| (a) M.W.L. | R. L. 1792-64 |
| (b) F.R.L. | R.L. 1792·64. |
| (c) Area at M.W.L. | 0·74 square mile |
| (d) Area at F.R.L. | 0·74 square mile |
| (e) Maximum length | 1·5 miles |
| (f) Maximum width | 0·9 mile |
| (g) Length of periphery | 3·85 miles (approximately) |

(2) Capacity of the reservoir
- (b) Gross — 5,256 acre feet at the beginning of the dam, owing to silting, the present capacity is 4,223 acre feet.
- (a) Live
- (c) Flood storage
- (d) Carry-over




*Cross section of Matoba Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 57·41 feet |
| (4) Height above the lowest river bed at dam | 57·41 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 9 feet |
| (6) Maximum width at level of foundation. | 228 feet |
| (7) Width at top | 4 feet |
| (8) Slopes | |
| (a) Upstream | 3 to 1 and $1\frac{1}{2}$ to 1 |
| (b) Downstream | 2 to 1 and $1\frac{1}{2}$ to 1 |
| (9) Length at top of the dam | |
| (a) Non-overflow | |
| (i) Main | 5,455 feet |
| (b) Spillway or waste weir | 600 feet |
| (10) Cubic volume of the body of the dam | 4,030,000 cubic feet |

B. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed | Soil and *moorum* |
| (12) Specific gravity | |
| (d) Earthfill | |
| (13) Nature of protection and water-proofing of the upstream and down-stream faces | Stone pitching done from bottom to F.R.L. |
| (14) Provision for dealing with seepage and drainage water | Shallow drain at toe. |
| (21) Hydraulic gradient for which the embankment is designed | |
| (22) Particular of the berm (if any), width and position | |
| (23) Position and form of the core-wall (or other means of securing water tightness). | |
| (24) Batter (if any) of the core-wall | |
| (25) Maximum depth below ground surface of core-wall or other means of securing water tightness | |

| | |
|---|---|
| (26) Method of keying core-wall or other wall in the under-lying ground | |
| (27) Nature of material forming the core or other wall | |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

| | |
|---|---|
| (1) *Land submerged* | |
| (*a*) Crown waste | 475 acres |
| (*b*) Proprietory | |
| (2) *Dislocation* | |
| (*a*) Villages | — |
| (*b*) Families | — |
| (*c*) Population | — |
| (*d*) Roads : | — |
| (*i*) Highways | — |
| (*ii*) District Roads. | — |
| (*iii*) Village Roads. | — |
| (*e*) Railway Lines | — |
| (*f*) Temples, Mosques, *etc.* | |
| (*g*) Graves, *etc.* | |
| (*h*) Trees, Gardens, Pastures, Houses, Wells, *etc.* | — |
| (*i*) Bridges | |
| (3) Compensation paid under each category of item (2) | |
| (4) Method of compensating for land of dispossessed landholders. | |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | Masonry waste weir, 600 feet wide with 3 feet depth of flood over weir. |
| (2) Outlet works | Two pipe sluices, each 12 inches diameter. |
| (3) Scouring works | |
| (4) Inspection facilities | Footpath on top of dam |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway. | Natural rock |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | |
| (3) Noteworthy occurrences and accidents | |
| (4) Operation of the dam | |
| (a) Regulation | By regulating the pipe valves |
| (b) Silting of the reservoir— | First 9·5 feet of the capacity is silted up. |
| (i) Total silt deposited | |
| (ii) Rate of silting | |
| (iii) Density of the silt deposited | |
| (iv) Rate of advancement of delta | |
| (c) Actual yield as against estimated | |
| (d) Various measurements and observations | |
| (i) Evaporation losses | 0·05 foot per day |
| (ii) Sweating below the dam | Percolation at toe |
| (iii) Temperature measurements | |
| (iv) Seepage and regeneration | The percolation is of the order of 3 cusecs when dam is full. The percolation stops when water level goes below 20 feet height. |
| (e) Fish culture | |
| (f) Anti-malaria measures | |
| (5) Recreation facilities | |
| (6) Lessons to be learnt from the construction and utilisation of the dam | |

## IX. BIBLIOGRAPHY AND HISTORICAL

| | |
|---|---|
| (1) Historical | The tank formed by this dam was designed to store surplus water from the Mutha Main Right Bank canal. The storage is used for irrigating the lands lying between the Mula and the Mutha rivers. The earthwork of the dam was taken up as a famine work in 1876 to afford employment to famine labour and it was completed in 1878. |
| (2) Personnel | S.D. William Clerke, Executive Engineer. |
| (3) Bibliography | |

# IV. 7. Shirsuphal Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 56·32 feet |
| (2) Location | Poona district, Bombay State (Shirsa local stream). |
| (3) Authority or owner | Bombay Government |
| (4) Purpose-Main and subsidiary | Irrigation |
| (5) Year of commencement | 1876 |
| (6) Year of completion | 1878 |
| (7) Capital Cost— | |
| (*a*) Estimated | Rs. 2,24,568 |
| (*b*) Actual | Rs. 2,24,568 |
| (8) Culturable area commanded by the project. | 2,500 acres |
| (9) Area irrigated | 1,109 acres |
| (11) Means of access | It is accessible from Sirsuphal railway station on the Dhond Baramati Branch line (Great Indian Peninsular Railway). It is also accessible from Poona Sholapur road mile 8 F. Stone 52/3 by a cart track near Ramanagar village. |

### II. GEOPHYSICAL

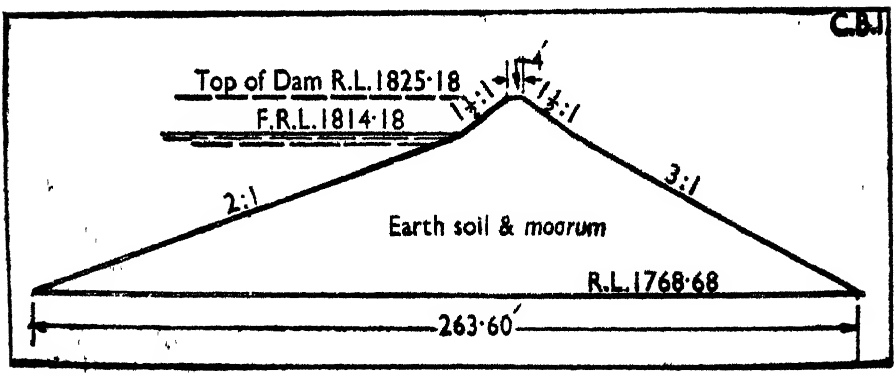
| | |
|---|---|
| (1) Area of catchment | 23·5 square miles |
| (2) Nature of catchment | Fan catchment and rocky |
| (3) Mean annual precipitation— | |
| (*a*) Rainfall | 16 inches |
| (4) Total average annual yield of the catchment | 3,031 acre feet |
| (5) Climate | Hot from April to July. Rainfall mostly occurs from August to September. |

| | |
|---|---|
| (6) Temperature conditions and variations | Maximum 110°F. Minimum 40°F. |
| | Normal temperature 75° F to 95°F |
| (7) Rate of Flow— | |
| (a) Maximum | |
| (b) Minimum | |
| (8) Detritus charge of the stream | |
| (9) Character (chemical) of the water stored in the reservoir. | Sweet, suitable for irrigation. |
| (10) Geological features— | |
| (a) of foundations | Hard trap rock foundations |
| (b) of catchment area | Hilly tract |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data— | |
| (a) M. W. L. | |
| (b) F. R. L. | R. L. 1814 18 |
| (c) Area at M. W. L. | |
| (d) Area at F. R. L. | 1·3 square miles |
| (e) Maximum length | 7,920 feet |
| (f) Maximum width | 7,590 feet |
| (g) Length of periphery | 60,060 feet |
| (2) Capacity of the reservoir— | |
| (a) Gross | |
| (b) Live | 8187·32 acre feet |
| (c) Flood storage | |
| (d) Carry-over | |




*Cross section of Shirsuphal Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 56·32 feet |
| (4) Height above the lowest river bed at dam | 56·32 feet |
| (5) Height of top of the dam above the crest of the spillway or weir | 11·0 feet |
| (6) Maximum width at levels of foundation | 263·60 feet |
| (7) Width at top | 4·0 feet |
| (8) Slopes— | |
| (*a*) Upstream | (*i*) 1½ to 1 and 3 to 1 |
| (*b*) Downstream | (*ii*) 1½ to 1 and 2 to 1 |
| (9) Length at top of the dam | 2,430 feet |
| (*a*) Non-overflow— | |
| (*i*) Main | |
| (*ii*) Subsidiary | |
| (*b*) Spillway or waste weir | 300 feet (Natural Channel width at hollows). |
| (10) Cubic volume of the body of the dam | |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Soil and *moorum* locally available |
| (12) Specific gravity | |
| (d) Earthfill | |
| (13) Nature of protection and water-proofing of the upstream and down-stream faces | *Moorum* Casing. Pitching on inside slope of dam upto F. R. L. |
| (14) Provision for dealing with seepage and drainage water | Cross drains and longitudinal drains |
| (15) Means of securing water tightness of the foundation of the dam | |
| (21) Hydraulic gradient for which the embankment is designed | |
| (22) Particular of the berm (if any), width and position | |
| (23) Position and form of the core wall (or other means of securing water tightness) | |

(24) Batter (if any) of the core wall

(25) Maximum depth below ground surface of core-wall or other means of securing water tightness

(26) Method of keying core-wall or other wall in the underlying ground

(27) Nature of meterial forming the core or other wall

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*—

(*a*) Crown waste

(*b*) Proprietory

(2) *Dislocation*—

(*a*) Villages

(*b*) Families

(*c*) Population

(*d*) Roads—

(*i*) Highways

(*ii*) District Roads

(*iii*) Village Roads

(*e*) Railway Lines

(*f*) Temples, Mosques, *etc.*

(*g*) Graves, *etc.*

(*h*) Trees, Gardens, Pastures, Houses, Wells, *etc.*

(*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | Natural spillway and channel in rock 300 feet in length. Height of flood over weir is 5 feet. |
| (2) Oulet works | Three pipe sluices each 12 inches diameter with valves on inside face. |
| (3) Scouring Works | |
| (4) Inspection facilities | Top 4 feet width with curbing |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | |
| (2) Changes introduced in the plans of the dam and in the method of carying out the work | |
| (3) Noteworthy occurrences and accidents | A slip occurred in 1927 |
| (4) Operation of the dam— | |
| (a) Regulation | |
| (b) Silting of the reservoir— | |
| (i) Total silt deposited | It has silted upto 11·25 feet depth |
| (ii) Rate of silting | |
| (iii) Density of the silt deposited | |
| (iv) Rate of advancement of delta | |
| (c) Actual yield as against estimated. | |
| (d) Various measurements and observations— | |
| (i) Evaporation losses | |
| (ii) Sweating below the dam | |
| (iii) Temperature measurements | |
| (iv) Seepage and regeneration | |
| (e) Fish culture | |
| (f) Anti-malaria measures | |
| (5) Recreation facilities | |
| (6) Lessons to be learnt from the construction and utilisation of the dam | None of special value. The current theories and principles on which the dam was designed, have been confirmed by its construction. It is used for irrigation. |

## IX. BIBLIOGRAPHY AND HISTORICAL

| | |
|---|---|
| (1) Historical | The dam was constructed in 1876-78 across Shirsa Odha to form a storage for irrigation of the lands on the left bank of Roti *Nala*. The earth work of the dam was commenced as a famine work for the famine effected people during 1876-77. It was completed in 1878. |

The construction was carried under the supervision of Mr. S. D. William Clerke, Executive Engineer for Irrigation.

(2) Personnel

Mr. S. D. William Clerke, Executive Engineer.

( ) Bibliography

# IV. 8 Khadakwasla

## (Masonry)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed. | 130 feet |
| (2) Location | Poona district, Bombay State (the Mutha river) |
| (3) Authority or owner | Bombay Government |
| (r) Purpose-Main and subsidiary | Irrigation and domestic water supply |
| (5) Year of commencement | 1870 |
| (6) Year of completion | 1879 |
| (7) Capital cost | |
| (*a*) Estimated | Rs. 30,05,825 |
| (*b*) Actual | Rs. 39,00,000 |
| (8) Culturable area commanded by the project | 49, 800 acres |
| (9) Area irrigated | 12,582 acres |
| (11) Means of access | It is accessible from Poona on the Great Indian Peninsula Railway by the Poona Singhgarh road. |

### II. GEOPHYSICAL

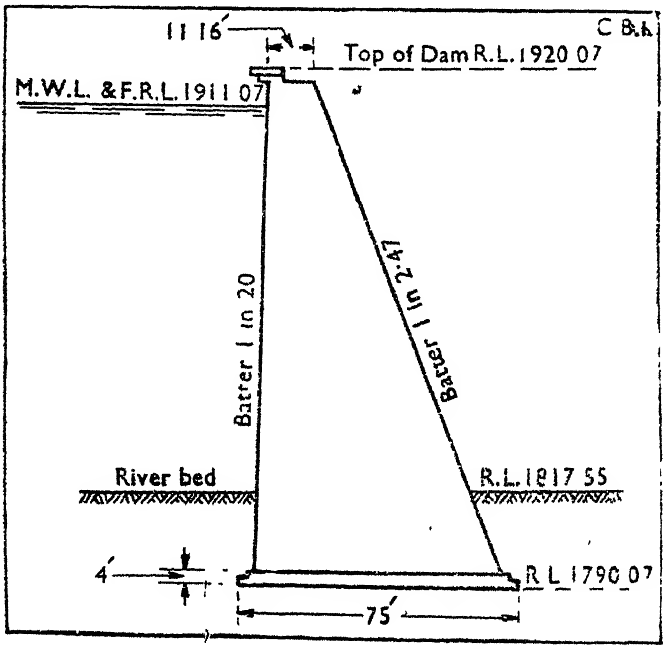
| | |
|---|---|
| (1) Area of catchment | 196 square miles |
| (2) Nature of catchment | Hilly country with rice fields in the valleys. |
| (3) Mean annual precipitation— | |
| (*a*) Rainfall | 250 inches, at the head of the lake 28 inches at the dam site. |
| (4) Total average annual yield of the catchment | 1,120,936 acre feet |
| (5) Climate | Hot from April to May, heavy rains in July to September, strong winds throughout the year. |
| (6) Temperature conditions and variations | Maximum temperature 105° F, Minimum temperature 35°F, Normal temperature 70° F. |
| (7) Rate of Flow— | |
| (*a*) Maximum | 81, 270 cusecs |
| (*b*) Minimum | |

| | |
|---|---|
| (8) Detritus charge of the stream | Very little silt is carried down. |
| (9) Character (chemical) of the water stored in the reservoir | Excellent being soft and easily purified. |
| (10) Geological features— | |
| (*a*) of foundations | Hard rock |
| (*b*) of catchment area | Basalt rock in the upper reach and *moorum* in the rest. |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data— | |
| (*a*) M. W. L | R. L. 1991·07 |
| (*b*) F. R. L | R. L. 1911·07 |
| (*c*) Area at M. W. L | 6 square miles |
| (*d*) Area at F. R. L | 6 square miles |
| (*e*) Maximum length | 11 miles |
| (*f*) Maximum width | 0·75 mile |
| (*g*) Length of periphery | 43·75 miles |
| (2) Capacity of the reservoir— | |
| (*a*) Gross | 70,960 acre feet |
| (*b*) Live | |
| (*c*) Flood storage | |
| (*d*) Carry-over | |




*Cross section of Khadakwasla Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 130 feet |
| (4) Height above the lowest river bed at dam. | 102·52 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir. | 9·0 feet |
| (6) Maximum width at level of foundation | 75·0 feet |
| (7) Width at top | 11·16 feet |
| (8) Slopes— | |
| (a) Upstream | 1 in 20 |
| (b) Downstream | 1 in 2·47 |
| (9) Length at top of the dam | 4,827 feet |
| (a) Non-overflow— | |
| (i) Main | 3,431 feet |
| (b) Spillway | 1,396 feet (fitted with automatic gates). |
| (10) Cubic volume of the body of the dam | 10,250 ; 1,000 cubic feet |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Masonry wall with concrete hearting |
| (12) Specific gravity— | |
| (a) Masonry | Specific gravity 150 lb. per cubic foot (approximately). |
| (b) Concrete | |
| (13) Nature of protection and waterproofing of the upstream and downstream faces | Cement pionting |
| (14) Provision for dealing with seepage and drainage water | Cement pointing |
| (15) Means of securing water tightness of the foundation of the dam | |
| (16) Contraction joints | |
| (17) Principal stresses in the masonry with a note of methods of calculation employed | The maximum compressive stress on the bottom joint 152 lb. per square inch. The tension at the inner edge of the base is 22½ lb. per square inch. These calculations are based at masonry 150 lb. per cubic foot and water 62·5 lb. per cubic foot. |

(18) Maximum pressure on foundations

(19) Uplift pressure, calculated or measured

(20) Measures adopted for preventing or counteracting uplift pressures

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*—

(*a*) Crown waste

(*b*) Proprietory

(2) *Dislocation*—

(*a*) Villages

(*b*) Families

(*c*) Population

(*d*) Roads—

(*i*) Highways

(*ii*) District Roads

(*iii*) Village Roads

(*e*) Railway Lines

(*f*) Temples, Mosques, *etc.*

(*g*) Graves, *etc.*

(*h*) Trees, Gardens, Pastures, Houses, Wells, *etc.*

(*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

## V. AUXILLIARY WORKS

(1) Surplusing works — 88 automatic gates each 10 feet 3 inches by 8 feet. 12 rolling gates each 10 feet 3 inches by 7 feet. 3 wooden needle gates each 10 feet by 5 feet 9 inches.

(2) Outlet works
(3) Scouring works — 13 sluice gates each 2 feet by 2 feet. 8 turbine pipes each 2½ feet diameter.

(4) Inspection facilities — An inspection path on top of the dam 8′ to 14′ wide.

(5) Fish-pass

(6) Means for dissipating energy below the spillway — Natural hard rock.

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Construction features | Stone masonry in lime with concrete hearting. |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | |
| (3) Noteworthy occurrences and accidents | |
| (4) Operation of the dam— | |
| (a) Regulation | |
| (b) Silting of the reservoir | The silting is 12 million cubic feet per year. |
| (i) Total silt deposited | |
| (ii) Rate of silting | |
| (iii) Density of the silt deposited | |
| (iv) Rate of advancement of delta. | |
| (c) Actual yield as against estimated | |
| (d) Various measurements and observations— | |
| (i) Evaporation losses | |
| (ii) Sweating below the dam | |
| (iii) Temperature measurements | |
| (iv) Seepage and regeneration | |
| (e) Fish culture | |
| (f) Anti-malaria measures | |
| (5) Recreation facilities | |
| (6) Lessons to be learnt from the construction and utilisation of the dam | None of special value. The current theories and principles on which these dams have been designed, have been confirmed by their construction. |

## IX. BIBLIOGRAPHY AND HISTORICAL

| | |
|---|---|
| (1) Historical | The dam is constructed across the Mutha river at Khadakwasla about 11 miles from Poona. Two canals, the Mutha right bank canal and Mutha left bank canal take off directly from the dam and draw the supply from the storage mainly for irrigation. Water is also supplied from this storage through |

the canal to Poona, and its extension for domestic purposes. It was the first of the large irrigation dam built in the Deccan and was completed in 1879. It was proposed by and constructed under the direction of the late Col. Fife, Royal Engineer after whom the lake formed by the dam is named.

(2) Personnel — Colonel Fife, Royal Engineer.

(3) Bibliography

# IV. 9. Nehr Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 74·0 feet |
| (2) Location | Satara district, Bombay Presidency (Yerla river). |
| (3) Authority or owner | Bombay Government |
| (4) Purpose-Main and subsidiary | Irrigation |
| (5) Year of commencement | 1876 |
| (6) Year of completion | 1880 |
| (7) Capital cost | |
| (a) Estimated | (a) Rs. 6,71,465 |
| (b) Actual | (b) Rs. 7,45,314 |
| (8) Culturable area commanded by the project | 10,680 acres |
| (9) Area irrigated | 3,063 acres |
| (10) Means of access | It is accessible from Koregaon railway station (Madras and Southern Marhatta Railway) by road. *i.e.* 14 miles from Koregaon and 25 miles from Satara |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 59·55 square miles |
| (2) Nature of catchment | Fan shaped, bounded by hilly range. Gentle slopes in the main catchment. *Moormy*, grassy and not wooded. |
| (3) Mean annual precipitation | |
| (a) Rainfall | (a) 36·97 inches |
| (4) Total average annual yield of the catchment | 24,130 acre feet |
| (5) Climate | Temperate |
| (6) Temperature conditions and variations | Maximum temperature 105° C. Minimum Temperature 45° C. |

(7) Rate of flow—
(a) Maximum — (a) The maximum discharge over wasteweir is 6,200 cusecs.
(b) Minimum

(8) Detritus charge of the stream — Disintegrated *moorum* silt

(9) Character (chemical) of the water stored in the reservoir — Sweet

(10) Geological features—
(a) of foundations — (a) Earth and *moorum*
(b) of catchment area — (b) Earth and *moorum* overlying Deccan trap

## III. TECHNICAL

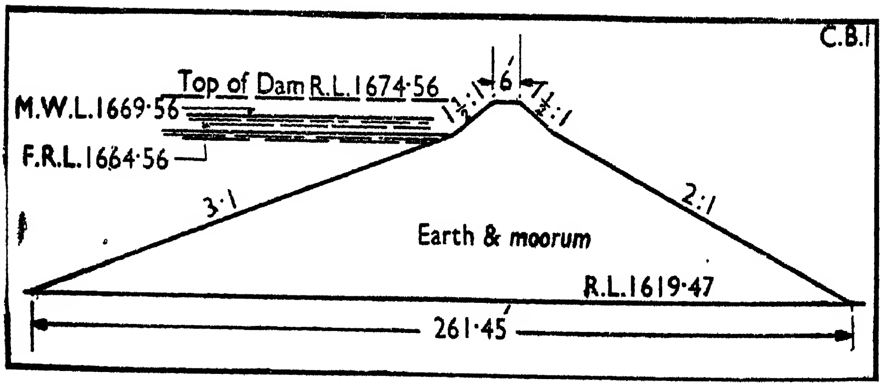
### A. STATISTICAL

(1) Reservoir Data

| | |
|---|---|
| (a) M.W.L. | (a) R.L. 2673·02 |
| (b) F.R.L. | (b) R.L. 2666·02 |
| (c) Area at M.W.L. | 1·77 square miles (calculated). |
| (d) Area at F.R.L. | (d) 1·26 square miles |
| (e) Maximum length | (e) 10,600 feet |
| (f) Maximum width | (f) 8.800 feet |
| (g) Length of periphery | (g) 47,400 feet |

(2) Capacity of the reservoir

| | Designed | As per survey of 1942. |
|---|---|---|
| (a) Gross | (a) 12,000 acre feet | 9,510 acre feet |
| (b) Live | (b) 11,244 acre feet | 9,510 acre feet |
| (c) Flood storage | | |
| (d) Carry-over | | |




*Cross Section of Nehr Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | |
| (4) Height above the lowest river bed at dam | 74 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 13·01 feet |
| (6) Maximum width at level of foundation. | 370 feet |
| (7) Width at top— | 8 feet |
| (8) Slopes— | |
| (a) Upstream | (a) 2½ to 1 |
| (b) Downstream | (b) 2 to 1 |
| (9) Length at top of the dam— | |
| (a) Non-overflow— | |
| (i) Main | (a) (i) 4,820 feet |
| (b) Spillway | (b) 700 feet |
| (10) Cubic volume of the body of the dam | 489,770,000 cubic feet |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | *Moorum* and earth |
| (12) Specific gravity | |
| (d) Earthfill | (d) 1·025 approximate |
| (13) Nature of protection and water-proofing of the upstream and downstream faces | Stone pitching on upstream side upto highest flood level |
| (14) Provision for dealing with seepage and drainage water | Cross drains and one longitudinal drains are provided. |
| (15) Means of securing water tightness of the foundation of the dam | |
| (21) Hydraulic gradient for which the embankment is designed | 1 in 4 |
| (22) Particular of the berm (if any), width and position | 20 feet to 30 feet wide in the gorge portion and 15 feet wide at the flanks. |
| (23) Position and form of the core wall (or other means of securing water tightness) | |
| (24) Batter (if any) of the core-wall | |
| (25) Maximum depth below ground surface of core-wall or other means of securing water tightness | |

(26) Method of keying core-wall or other wall in the underlying ground

(27) Nature of material forming the core or other wall

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged* —
- (a) Crown waste
- (b) Proprietory

} 1·77 square miles

(2) *Dislocation*—
- (a) Villages — Part areas of Nehr, Zalgun and Budh villages submerged but no village site.
- (b) Families
- (c) Population
- (d) Roads—
  - (i) Highways
  - (ii) District Roads
  - (iii) Village Roads
- (e) Railway Lines
- (f) Temples, Mosques, *etc.*
- (g) Graves, *etc.*
- (h) Trees, Gardens, Pastures, Houses, Wells, *etc.*
- (i) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders — Compensation in cash only seems to have been paid.

## V. AUXILIARY WORKS

(1) Surplusing works — Clear over fall waste weir, 700 feet long is built in concrete faced with masonry and coping on top. Its discharging capacity is 38,720 cusecs.

(2) Outlet works — Circular sluice of four feet diameter

(3) Scouring works

(4) Inspection facilities — There is a *moorum* approach road 3 miles long, from Puregaon on Satara Pandharpur Road in mile No. 22 maintained under the Yerala River Works.

| | |
|---|---|
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | Natural very good rock downstream. |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | During the famine of 1876 increase of 10 feet to the height of the dam was sanctioned. |
| (3) Noteworthy occurrences and accidents | A portion of dam slipped down from chainage 2,800 to 3,150 in the year 1914 and was strengthened by providing additional berm after getting all the repairs completed in the year 1916. Actual cost of the repairs was Rs. 22,382/-. |
| (4) Operation of the dam— | |
| (*a*) Regulation | (*a*) Regulated by circular sluice gate 4 feet diameter. |
| (*b*) Silting of the reservoir— | (*b*) |
| (*i*) Total silt deposited | (*i*) 108·40 million cubic feet in 62 years. |
| (*ii*) Rate of silting | (*ii*) 1·75 million cubic feet per year. |
| (*iii*) Density of the silt deposited | (*iii*) 92·5 lb. per cubic foot |
| (*iv*) Rate of advancement of delta. | (*iv*) 46·4 feet per year |
| (*c*) Actual yield as against estimated | (*c*) Actual average annual yield per last 10 years is 24,130 acre feet |
| (*d*) Various measurements and observations— | |
| (*i*) Evaporation losses | |
| (*ii*) Sweating below the dam | |
| (*iii*) Temperature measurements | |
| (*iv*) Seepage and regeneration | |
| (*e*) Fish culture | |
| (*f*) Anti-malaria measures | |
| (5) Recreation facilities | |
| (6) Lessons to be learnt from the construction and utilization of the dam | |

| | |
|---|---|
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | Natural very good rock downstream. |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | During the famine of 1876 increase of 10 feet to the height of the dam was sanctioned. |
| (3) Noteworthy occurrences and accidents | A portion of dam slipped down from chainage 2,800 to 3,150 in the year 1914 and was strengthened by providing additional berm after getting all the repairs completed in the year 1916. Actual cost of the repairs was Rs. 22,382/-. |
| (4) Operation of the dam— | |
| (*a*) Regulation | (*a*) Regulated by circular sluice gate 4 feet diameter. |
| (*b*) Silting of the reservoir— | (*b*) |
| (*i*) Total silt deposited | (*i*) 108·40 million cubic feet in 62 years. |
| (*ii*) Rate of silting | (*ii*) 1·75 million cubic feet per year. |
| (*iii*) Density of the silt deposited | (*iii*) 92·5 lb. per cubic foot |
| (*iv*) Rate of advancement of delta. | (*iv*) 46·4 feet per year |
| (*c*) Actual yield as against estimated | (*c*) Actual average annual yield per last 10 years is 24,130 acre feet |
| (*d*) Various measurements and observations— | |
| (*i*) Evaporation losses | |
| (*ii*) Sweating below the dam | |
| (*iii*) Temperature measurements | |
| (*iv*) Seepage and regeneration | |
| (*e*) Fish culture | |
| (*f*) Anti-malaria measures | |
| (5) Recreation facilities | |
| (6) Lessons to be learnt from the construction and utilization of the dam | |

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

Proposal of scheme was brought forward in 1863 by Mr. Jacob, the then Executive Engineer for Irrigation. The site was surveyed in 1868 by Mr Cambell, Executive Engineer for Irrigation, Satara and was designed to supplment the discharges of the Yerala Canals for irrigation purposes. The plans and estimates were sanctioned in 1876 and construction estimate was closed with effect from the 31st March 1895, and its— Completion Report was sanctioned in Govt. resolution. No. 96 W.I. 1022, dated 23rd July, 1897.

(2) Personnel

(3) Bibliography

File of—Descriptive record in the Executive Engineer Satara Division Office.

# IV. 10. Bhadalwadi Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 55·09 feet |
| (2) Location | Poona District, Bombay State. |
| (3) Authority or owner | Bombay Government |
| (4) Purpose—Main and subsidiary | Irrigation |
| (5) Year of commencement | 1876 |
| (6) Year of completion | 1881 |
| (7) Capital cost— | |
| (*a*) Estimated | Rs. 4,92,905 |
| (*b*) Actual | Rs. 5,21,817 |
| (8) Culturable area commanded by the project | 2,400 acres |
| (9) Area irrigated | 1,857 upto 1,500 acres average |
| (11) Means of access | It is accessible from Diksal on the Great Indian Peninsula Railway and Poona-Sholapur road at mile 65/6 by D.L.B. road to Kalas. |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 23 square miles |
| (2) Nature of catchment | Rocky |
| (3) Mean annual precipitation— | |
| (*a*) Rainfall | 19·8 inches |
| (4) Total average annual yield of the catchment | 2,999 acre feet |
| (5) Climate | Hot in April to July, rainfall mostly occurs at the end of August and September. |
| (6) Temperature conditions and variations | Maximum temperature—110°F<br>Minimum temperature—40°F<br>Normal temperature—75°F to 90°F |

(7) Rate of Flow—
  (a) Maximum
  (b) Minimum

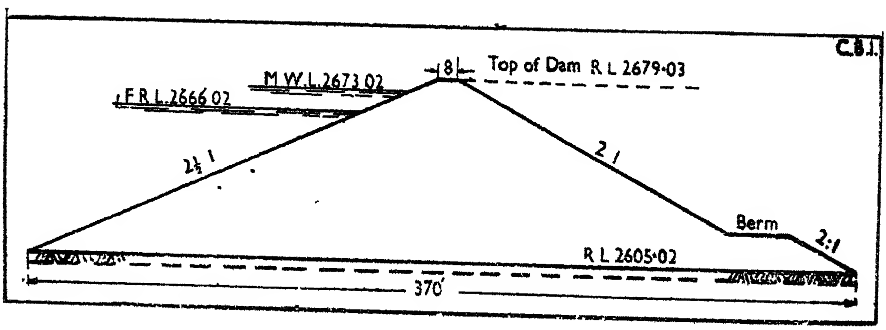
(8) Detritus charge of the stream

| | |
|---|---|
| (9) Character (chemical) of the water stored in the reservoir | Sweet, fit for irrigation |
| (10) Geological features— | |
| (a) of foundations | Hard rock foundation |
| (b) of catchment area | Hilly track |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data— | |
| (a) M.W.L. | R.L. 1669·56 |
| (b) F.R.L. | R.L. 1664·56 |
| (c) Area at M.W.L. | |
| (d) Area at F.R.L. | 0·5 square mile |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | |
| (2) Capacity of the reservoir— | |
| (a) Gross | |
| (b) Live | 4,379 acre feet |
| (c) Flood storage | |
| (d) Carry-over | |




*Cross Section of Bhadalwadi Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | |
| (4) Height above the lowest river bed at dam | 55·09 feet |

| | |
|---|---|
| (5) Height of the top of the dam above the crest of the spillway or weir | 10·0 feet |
| (6) Maximum width at level of foundation | 261·45 feet |
| (7) Width at top | 6 feet |
| (8) Slopes— | |
| (a) Upstream | $1\frac{1}{2}$ : 1 and 3 : 1. |
| (b) Downstream | $1\frac{1}{2}$ : 1 and 2 : 1. |
| (9) Length at top of the dam | 2,680 feet |
| (a) Non-overflow— | |
| (i) Main | (i) 2,060 feet |
| (b) Spillway or waste weir | 550 feet |
| (10) Cubic volume of the body of the dam | 7,020,000 cubic feet |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Earth and *moorum* locally available |
| (12) Specific gravity— | |
| (d) Earthfill | |
| (13) Nature of protection and water-proofing of the upstream and down-stream faces | Stone pitching on upstream upto full reservoir level and there is no revetment on downstream side. |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundation of the dam | |
| (21) Hydraulic gradient for which the embankment is designed | |
| (22) Particular of the berm (if any), width and position | |
| (23) Position and form of the core wall (or other means of securing water tightness) | |
| (24) Batter (if any) of the core wall | |
| (25) Maximum depth below ground surface of core-wall or other means of securing water tightness | |
| (26) Method of keying core-wall or other wall in the underlying ground | |
| (27) Nature of material forming the core and other wall | |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*—
  (*a*) Crown waste
  (*b*) Proprietory
(2) *Dislocation*—
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads :
    (*i*) Highways
    (*ii*) District Roads
    (*iii*) Village Roads
  (*e*) Railway Lines
  (*f*) Temples, Mosques, *etc.*
  (*g*) Graves, *etc.*
  (*h*) Trees, Gardens, Pastures, Houses, Wells, *etc.*
  (*i*) Bridges
(3) Compensation paid under each category of item (2)
(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplusing works | Masonry wall and weir length 550 feet and height of flood over crest is 5 feet |
| (2) Outlet works | 3 pipe sluices each 12 inches diameters |
| (3) Scouring works | |
| (4) Inspection facilities | From top width of the dam |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | |
| (3) Noteworthy occurrences and accidents | A small slip occurred at the outside of the toe in 1947. The pitching inside is slipping a former F.R.L. (5 feet below the present F.R.L). |

(4) Operation of the dam—

(*a*) Regulation

(*b*) Silting of the reservoir—

| | |
|---|---|
| (*i*) Total silt deposited | The reservoir is silted upto 23 feet above the invert of outlet pipe and the capacity of tank above invert of outlet is reduced from 6158·17 acre feet to 4950·64 acre feet. |
| (*ii*) Rate of silting | |
| (*iii*) Density of the silt deposited | |
| (*iv*) Rate of advancement of delta | |
| (*c*) Actual yield as against estimated | |
| (*d*) Various measurements and observations— | |
| (*i*) Evaporation losses | |
| (*ii*) Sweating below the dam | |
| (*iii*) Temperature measurements | |
| (*iv*) Seepage and regeneration | |
| (*e*) Fish culture | |
| (*f*) Anti-malaria measures | |
| (5) Recreation facilities | |
| (6) Lessons to be learnt from the construction and utilisation of the dam | None of special value. The current theories and principles on which the dam was designed, have been confirmed by its construction. The storage is mainly used for irrigation. |

## IX. BIBLIOGRAPHY AND HISTORICAL

| | |
|---|---|
| (1) Historical | The earth work of this dam was commenced as a famine work in 1875 for the employment of famine labour and was completed in 1881 under the supervision of Mr. S. D. William Clerke, Executive Engineer for Irrigation Poona. |
| **(2) Personnel** | **Mr. S. D. William Clerke, Executive Engineer.** |
| **(3) Bibliography** | |

# IV. 11. Ashti Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 57·75 feet |
| (2) Location | Sholapur District, Bombay State (Ashti *Nala*). |
| (3) Authority or owner | Bombay Government |
| (4) Purpose-Main and subsidiary | Irrigation |
| (5) Year of commencement | 1876 |
| (6) Year of completion | 1883 |
| (7) Capital cost— | |
| (a) Estimated | Rs. 8,34,927/-. |
| (b) Actual | Rs. 8,41,708/-. |
| (8) Culturable area commanded by the project | 17,823 acres |
| (9) Area irrigated | 11,280 acres |
| (11) Means of access | Nearest railway station is Babhulgaon on Kurduwadi Pandharpur Line of B.L. Railway. Dam is 6 miles from the Railway Station by road. |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 92·5 square miles |
| (2) Nature of catchment | Soil and *moorum* |
| (3) Mean annual precipitation— | |
| (a) Rainfall | 23·75 inches |
| (4) Total average annual yield of the catchment. | 33,789 acre feet |
| (5) Climate | Hot |
| (6) Temperature conditions and variations | Maximum 105°. Minimum 75°. |
| (7) Rate of Flow— | |
| (a) Maximum | 48,000 cusecs (estimated) |
| (b) Minimum | |
| (8) Detritus charge of the stream | |

(9) Character (chemical) of the water stored in the reservoir — Sweet

(10) Geological features—

(a) of foundations — Soil of various sorts and *moorum*

(b) of catchment area — Earth and *moorum*

## III. TECHNICAL

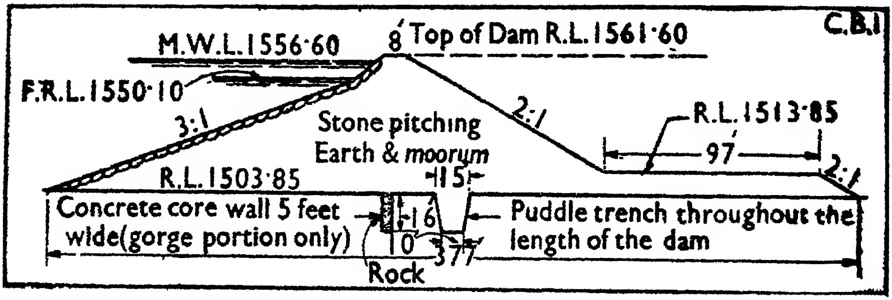
### A. STATISTICAL

(1) Reservoir Data –

| | |
|---|---|
| (a) M.W.L. | R.L. 1556·60 |
| (b) F.R.L. | R.L. 1550·10 |
| (c) Area at M.W.L. | 4·56 square miles |
| (d) Area at F.R.L. | 3·92 square miles |
| (e) Maximum length | 3·25 miles |
| (f) Maximum width | 2·80 miles |
| (g) Length of periphery | 12·5 miles |

(2) Capacity of the reservoir—

| | |
|---|---|
| (a) Gross | 32, 388 acre feet |
| (b) Live | 21,640 acre feet |
| (c) Flood storage | |
| (d) Carry-over | |




*Cross section of Ashti Dam*

(3) Maximum height above the lowest point of foundations — 73·75 feet

(4) Height above the lowest river led at dam — 57·75 feet

(5) Height of the top of the dam above the crest of the spillway or weir — 11·50 feet

(6) Maximum width at level of foundation — 377 feet (original) subsequently increased to 405 feet from chain 7,000 to 8,000.

| | |
|---|---|
| (7) Width at top | 8·0 feet |
| (8) Slopes— | |
| (*a*) Upstream | 3 to 1 upto F.R.L. and 1½ to 1 above |
| (*b*) Downstream | As shown in the cross section |
| (9) Length at top of the dam— | |
| (*a*) Non-overflow— | 12,700 feet |
| (*i*) Main | (*i*) 11,900 feet |
| (*b*) Spillway or water waste weir | 800 feet |
| (10) Cubic volume of the body of the dam | 114,864,000 cubic feet |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Earth and *moorum* |
| (12) Specific gravity— | |
| (*d*) Earthfill | |
| (13) Nature of protection and waterproofing of the upstream and downstream faces | Pitching on upstream side only |
| (14) Provision for dealing with seepage and drainage water | Provided with longitudinal and cross drains |
| (15) Means of securing water tightness of the foundation of the dam | Puddle trench 10 feet to 15 feet wide throughout the length of the dam and concrete core wall 5 feet wide in gorge portion only. |
| (21) Hydraulic gradient for which the embankment is designed | |
| (22) Particular of the berm (if any), width and position | Berm width 97 feet at R.L. 1513·85 |
| (23) Position and form of the core wall (or other means of securing water tightness) | Puddle trench 10 feet to 15 feet wide and 16 feet deep through-out the dam. Concrete core wall 5 feet wide in gorge portion only. |
| (24) Batter (if any) of the core wall | 1 in 4 and puddle trench wall 10 feet wide at bottom and 15 feet wide at top |
| (25) Maximum depth below ground surface of core-wall or other means of securing water tightness | 16 feet |
| (26) Method of keying core-wall or other wall in the under-lying ground | Vertical concrete wall and puddle trench |
| (27) Nature of material forming the core or other-wall | (*i*) Core wall made in concrete<br>(*ii*) Puddle trench wall made in clay and earth |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

| | |
|---|---|
| (1) *Land submerged*— | |
| (a) Crown waste | |
| (b) Proprietory | |
| (2) *Dislocation*— | |
| (a) Villages | Yeoti village was displaced. |
| (b) Families | .. |
| (c) Population | .. |
| (d) Roads— | .. |
| (i) Highways | .. |
| (ii) District Roads | .. |
| (iii) Village Roads | .. |
| (e) Railway Lines | .. |
| (f) Temples, Mosques, *etc.* | .. |
| (g) Graves, *etc.* | .. |
| (h) Trees, Gardens, Pastures, Houses, Wells, *etc.* | .. |
| (i) Bridges | |
| (3) Compensation paid under each category of item (2). | |
| (4) Method of compensating for land of dispossessed landholders | |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplusing works | Drowned open channel waste weir with masonry crest, 800 feet in length. The maximum discharge is equal to 48,000 cusecs and the depth of water over the waste wei is 6·5 feet (designed). |
| (2) Outlet works | There are two masonry outlets on each bank. |
| (3) Scouring works | .. |
| (4) Inspection facilities | .. |
| (5) Fish-pass | .. |
| (6) Means for dissipating energy below the spillway. | .. |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | Concrete core wall 5 feet in width in gorge portion only and puddle trench throughout the length of the dam. |

| | |
|---|---|
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | The section of the dam was strengthened in the length between chainage 7,000 feet and 8,000 feet in the year 1935. This length had gone sufficiently weak due to cracks and slips. |
| (3) Noteworthy occurrences and accidents | The toe of the dam slipped in 1933. Additional drainage and berm were provided downstream. |
| (4) Operation of the dam— | |
| (*a*) Regulation | Head regulators for canals. Left Bank Canal two sluices $2' \times 2'$. |
| (*b*) Silting of the reservoir— | Right Bank Canal three sluice valves one foot dia. are fixed. |
| (*i*) Total silt deposited | Not surveyed. |
| (*ii*) Rate of silting | |
| (*iii*) Density of the silt deposited | |
| (*iv*) Rate of advancement of delta | |
| (*c*) Actual yield as against estimated | |
| (*d*) Various measurements and observations— | |
| (*i*) Evaporation losses | |
| (*ii*) Sweating below the dam | |
| (*iii*) Temperature measurements | |
| (*iv*) Seepage and regeneration | |
| (*e*) Fish culture | |
| (*f*) Anti-malaria measures | |
| (5) Recreation Facilities | |
| (6) Lessons to be learnt from the construction and utilisation of the dam | Dams to conserve waters of rivers otherwise going to waste, are necessary, especially in the tracts subject to frequent draughts. The results obtained in the present case have amply borne out the above fact fully justifying the construction of the dam. |

## IX. BIBLIOGRAPHY AND HISTORICAL

| | |
|---|---|
| (1) Historical | The project was originally drawn up by Major Penny R. E. and by subsequent officers in 1876. The dam construction was completed in July 1881 and canal was completed in 1883. The dam is entirely of earth, and of the usual section. |
| (2) Personnel | (*i*) Mr. A. Devison, Executive Engineer.<br>(*ii*) Major Penny Royal Engineer. |
| (3) Bibliograph | History of tank maintained by P.W.D. (Bombay). |

# IV. 12. Muchkundi Dam

## (Masonry)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 60 feet |
| (2) Location | Bajapur district, Bombay State, Ghataprabha river Basin (Two *Nalas*). |
| (3) Authority or owner | Bombay Government |
| (4) Purpose-Main and subsidiary | Irrigation |
| (5) Year of commencement | 1879 |
| (6) Year of completion | 1884 |
| (7) Capital cost | |
| (a) Estimated | Rs. 1,68,420 |
| (b) Actual | Rs. 1,58,707 |
| (8) Culturable area commanded by the project | 5,417 acres |
| (9) Area irrigated | The storage of water in the tank is uncertain owing to the scantly rainfall in the area and the smallness of catchment. Hence the area irrigated is varying every year depending upon the water in the tank. Average area being 10 acres. |
| (11) Means of access | It is accessible by a road from Bagalkot. |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 26·76 square miles |
| (2) Nature of catchment | Hilly country |
| (3) Mean annual precipitation | |
| (a) Rainfall | 19·94 inches |

| | |
|---|---|
| (4) Total average annual yield of the catchment | 3.123 acre feet |
| (5) Climate | Hot |
| (6) Temperature conditions and variations | Maximum summer 110° F, minimum winter 65°F. Average summer 108·5°F. Average winter 68°F. Average monsoon 74·5° F. |
| (7) Rate of Flow | |
| (a) Maximum | |
| (b) Minimum | |
| (8) Detritus charge of the stream | The percentage is not observed but there is silting upstream the dam. |
| (9) Character (Chemical) of the water stored in the reservoir | Rain water. Fit for irrigation. |
| (10) Geological features | |
| (a) of foundations | Crystalline rock, strata veritcally tilted and the direction of drainage at right angles to the line of strat a, and strongly contrary to the direction of the valley. It is of red soil and sandy stone. |
| (b) of catchment area | It is generally consisting of red and black soil. |

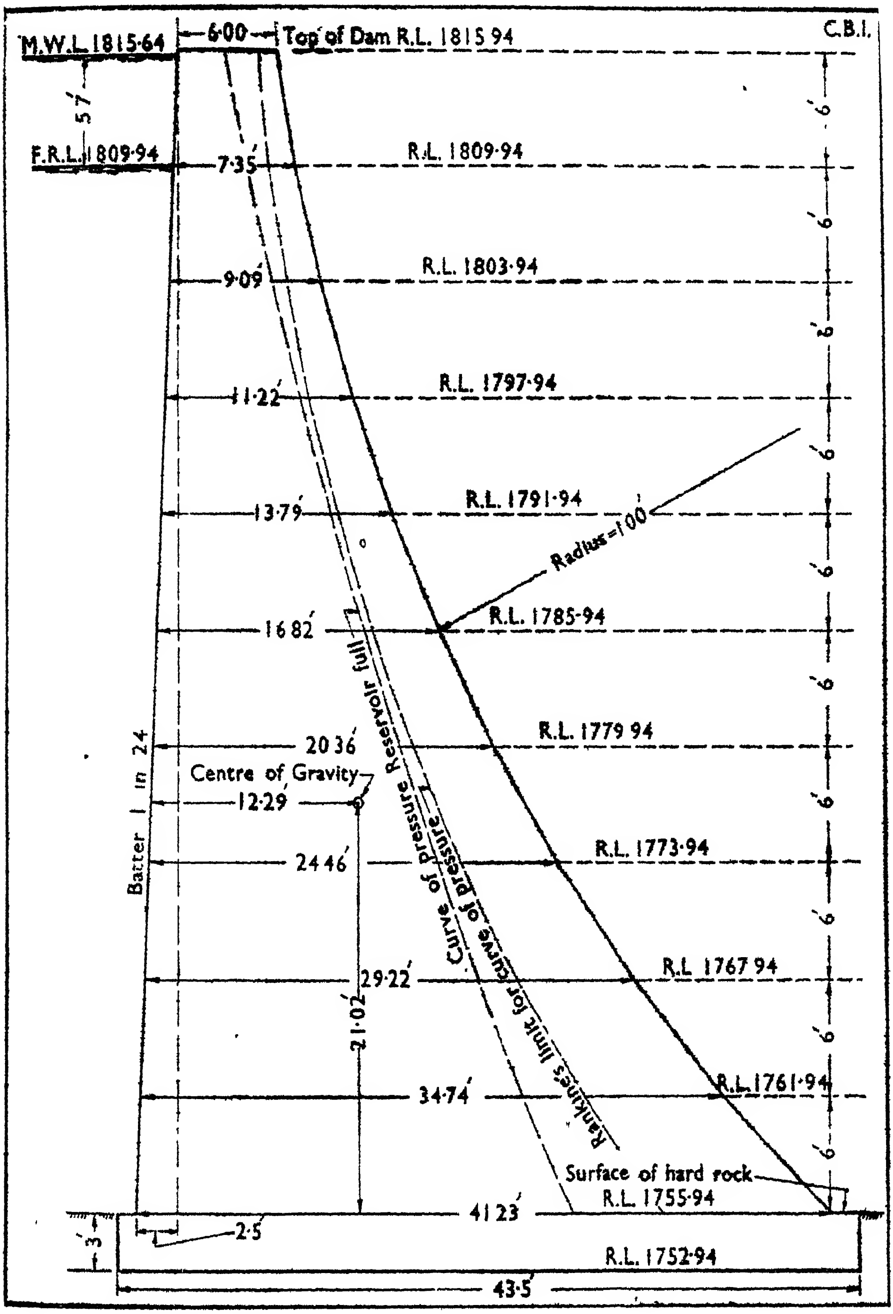
## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (a) M. W. L. | R. L. 1815·64 |
| (b) F. R. L. | R. L. 1809·94 |
| (c) Area at M. W. L. | 1·91 square miles |
| (d) Area at F. R. L. | 1·6 square miles |
| (e) Maximum length | 2½ miles |
| (f) Maximum width | 1·38 miles |
| (g) Length of periphery | 12·5 miles |
| (2) Capacity of the reservoir | |
| (a) Gross | 14,352 acre feet |
| (b) Live | 13,292 acre feet |

(*c*) Flood storage

(*d*) Carry-over




*Cross section of Muchkundi Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 63 feet |
| (4) Height above the lowest river bed at dam | 60 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 6·0 feet |
| (6) Maximum width at level of foundation | 43·5 feet |
| (7) Width at top | 6·0 feet |
| (8) Slopes | |
| (*a*) Upstream | 1 in 24 |
| (*b*) Downstream | Radius 100 feet |
| (9) Length at top of the dam | 520 feet |
| (*a*) Non-overflow | |
| (*i*) Main<br>(*ii*) Subsidiary | 420 feet |
| (*b*) Spillway or waste weir | 100 feet |
| (10) Cubic volume of the body of the dam | 651,000, cubic feet |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Stone and lime |
| (12) Specific gravity | |
| (*a*) Masonry | |
| (13) Nature of protection and waterproofing of the upstream and downstream faces | |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundation of the dam | |
| (16) Contraction joints | |
| (17) Principal stresses in the masonry with a note of methods of calculations employed | |
| (18) Maximum pressure on foundations | |
| (19) Uplift pressure, - calculated or measured | |
| (20) Measures adopted for preventing or counteracting uplift pressures | |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

| | |
|---|---|
| (1) *Land submerged* : | |
| (*a*) Crown waste | — |
| (*b*) Proprietory | 900 acres |
| (2) *Dislocation* : | — |
| (*a*) Villages | — |
| (*b*) Families | — |
| (*c*) Population | — |
| (*d*) Roads— | — |
| (*i*) Highways | — |
| (*ii*) District Roads | — |
| (*iii*) Village Roads | — |
| (*e*) Railway Lines | — |
| (*f*) Temples, Mosques, *etc.* | — |
| (*g*) Graves, *etc.* | — |
| (*h*) Trees, Gardens, Pastures, Houses, Wells, *etc.* | — |
| (*i*) Bridges | — |
| (3) Compensation paid under each category of item (2) | |
| (4) Method of compensating for land of dispossessed landholders | |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplusing works | Submerged waste weir |
| (2) Outlet works | One outlet with three openings 12 inches diameter each, two openings at the same level and one opening 2½ feet below. |
| (3) Scouring works | The lower opening of the above three openings is a scouring sluice. This has been found insufficient to prevent silting. The tank bed is now silted up more than 3 feet above outlet sill level. |
| (4) Inspection facilities | The work can be inspected in the hot weather when water goes down. No special devices are provided. |

| | |
|---|---|
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway. | |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | The former design was for an earthen dam prepared by Mr. Cambell and sanctioned in the year 1879. This was subsequently dropped and a design for a masonry dam was approved and the work carried out accordingly. |
| (3) Noteworthy occurrences and accidents | |
| (4) Operation of the dam | |
| (a) Regulation | Hand-regulated sluice valves with 12 inches opening for discharging water through the outlet. |
| (b) Silting of the reservoir | |
| (i) Total silt deposited | |
| (ii) Rate of silting | The tank bed is silted up to about 3 feet over the outlet sill level. |
| (iii) Density of the silt deposited | |
| (iv) Rate of advancement of delta | |
| (c) Actual yield as against estimated. | |
| (d) Various measurements and observations | |
| (i) Evaporation losses | |
| (ii) Sweating below the dam | |
| (iii) Temperature measurements | |
| (iv) Seepage and regeneration | — |
| (e) Fish culture | — |
| (f) Anti-malaria measures | — |
| (5) Recreation facilities | — |
| (6) Lessons to be learnt from the construction and utilisation of the dam | |

## VI. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

Previously it was designed an earthen dam, prepared by Mr. Cambell and was sanctioned in the the year 1879. Later on the proposal of an earthen dam was dropped, and design of masonry dam was prepared and approved. The work was carried on under the supervision of Mr. R. E. Joyner.

(2) Personnel

Mr. Cambell
Mr. R. B. Joyner

(3) Bibliography

# IV. 13. Koregaon Dam

## (Composite)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 71 feet |
| (2) Location | Barsi *Taluka* Sholapur district, Bombay State (Koregaon *nala*) |
| (3) Authority or owner | Bombay Government |
| (4) Purpose—Main and subsidiary | Irrigation |
| (5) Year of commencement | |
| (6) Year of completion | 1888 |
| (7) Capital cost | |
| (*a*) Estimated | (*a*) Rs. 42,079 |
| (*b*) Actual | (*b*) Rs. 37,923 |
| (8) Culturable area commanded by the project | |
| (9) Area irrigated | 800 acres average |
| (10) Means of access | It is at a distance of 19·5 miles from Yedsi railway station (on Barsi Light Railway) |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 7 square miles |
| (2) Nature of catchment | Hilly and steep |
| (3) Mean annual precipitation | |
| (*a*) Rainfall | (*a*) 25·96 inches |
| (4) Total average annual yield of the catchment. | 2,460 acre feet |
| (5) Climate | Tropical |
| (6) Temperature conditions and variations | 104°F Maximum<br>60°F Minimum |
| (7) Rate of flow | |
| (*a*) Maximum | |
| (*b*) Minimum | |

(8) Detritus charge of the stream

(9) Character (chemical) of the water stored in the reservoir — Sweet

(10) Geological features

(a) of foundations — (a) *Moorum*, soft and hard rock (Deccan trap)

(b) of catchment area — (b) Earth and *moorum* overlying Deccan trap.

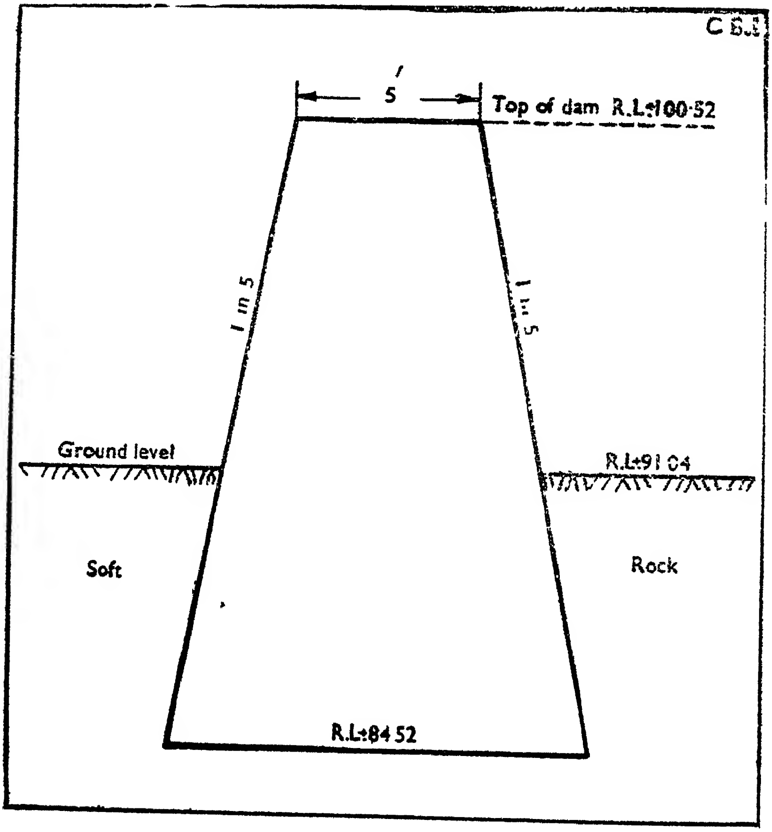
## III. TECHNICAL

### A STATISTICAL

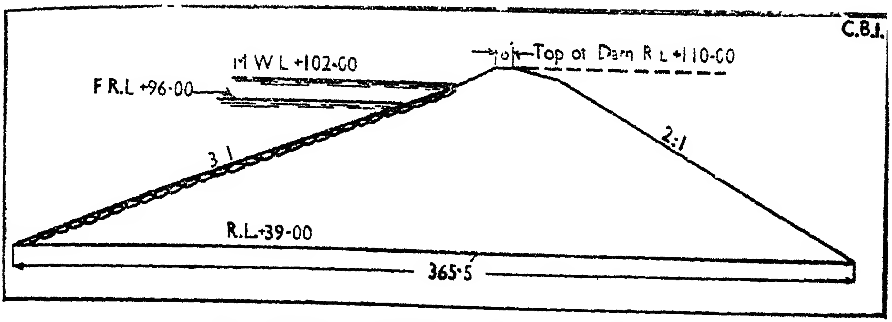
(1) Reservoir Data

(a) M. W. L. — (a) R. L. 102.00 from an arbitrary datum.

(b) F. R. L. — (b) R. L. 96.00




*Cross Section of Koregaon Dam*
*Masonry portion*




*Cross Section of Koregaon Dam (Earthen portion)*

| | |
|---|---|
| (*c*) Area at M. W. L. | (*c*) 0·32 square miles |
| (*d*) Area at F. R. L. | |
| (*e*) Maximum length | (*e*) 1,650 feet (approximate) |
| (*f*) Maximum width | (*f*) 4,700 feet (approximate) |
| (*g*) Length of periphery | (*g*) About 4 miles |
| (2) Capacity of the reservoir | |
| (*a*) Gross | |
| (*b*) Live | (*b*) 1,916 acre feet |
| (*c*) Flood storage | |
| (*d*) Carry-over | |
| (3) Maximum height above the lowest point of foundations | 16 feet (Masonry dam) |
| (4) Height above the lowest river bed at dam | 71 feet (Earthen)<br>16 feet (Masonry) |
| (5) Height of the top of the dam above the crest of the spillway or weir | 14 feet and 4·52 feet respectively for the earthen and masonry positions |
| (6) Maximum width at level of foundation | 365·5 feet (earthen dam) |
| (7) Width at top | Earthen dam 6 feet<br>Masonry dam 5 feet |
| (8) Slopes | |
| (*a*) Upstream | (*a*) } As per cross sections |
| (*b*) Downstream | (*b*) } |
| (9) Length at top of the dam | |
| (*a*) Non-over flow | (*a*) Earthen dam 1,000 feet<br>Masonry dam 435 feet |
| (*b*) Spillway | (*b*) 295 feet |
| (10) Cubic volume of the body of the dam | |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Earth, *moorum* and masonry |
| (12) Specific gravity | |
| (a) Masonry | |
| (d) Earthfill | |
| (13) Nature of protection and waterproofing of the upstream and downstream faces | Upstream side is pitched from bottom to highest flood level with trap stones. |
| (14) Provision for dealing with seepage and drainage water | Longitudinal and cross drains of dry rubber stone |
| (15) Means of securing water tightness of the foundation of the dam | |
| (16) Contraction joints | |
| (17) Principal stresses in the masonry with a note of methods of calculations employed | |
| (18) Maximum pressure on foundations | |
| (19) Uplift pressure, calculated or measured | |
| (20) Measures adopted for preventing or counteracting uplift pressures | |
| (21) Hydraulic gradient for which the embankment is designed | 1 in 4 |
| (22) Particular of the berm (if any), width and position | |
| (23) Position and form of the core wall (or other means of securing water tightness) | |
| (24) Batter (if any) of the core wall | |
| (25) Maximum depth below ground surface of corewall or other means of securing water tightness | |
| (26) Method of keying core-wall or other wall in the underlying ground | |
| (27) Nature of material forming the core or other walls | |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged* :

(*a*) Crown waste

(*b*) Proprietory

(2) *Dislocation* :

(*a*) Villages

(*b*) Families

(*c*) Population

(*d*) Roads ·

(*i*) Highways

(*ii*) District Roads

(*iii*) Village Roads

(*e*) Railway Lines

(*f*) Temples, Mosques, *etc.*

(*g*) Graves, *etc.*

(*h*) Trees, Gardens, Pastures, Houses, Wells, *etc.*

(*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | Waste weir—Part of smaller masonry dam serves as a waste weir, its discharging capacity is 5,535 cusecs |
| (2) Outlet works | Two circular sluices, 12 inches diameter of cast iron pipes. |
| (3) Scouring works | |
| (4) Inspection facilities | |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | |

## VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

| | |
|---|---|
| Changes introduced in the plans of the dam and in the method of carrying out the work | The original work consisted of two earthen dams, smaller and bigger. Smaller one existed on the East side and the bigger one on the West. The dam on the East side used to breach and it was substituted by a masonry dam which was started in 1888 and completed in 1890. |
| (3) Noteworthy occurrences and accidents | Slips occurred in the dam in 1904, 1910, 1914, 1919 and 1926. It was due to the outlet, being on the left side and the canal water being taken to the right side over the outer slope of the dam, percolation from which caused slips in the body of the dam. In 1923, a new outlet was constructed on the right side, and since then there have been no slips. |
| **(4) Operation of the dam** | |
| (*a*) Regulation | (*a*) Oultet sluice 12 inches diameter. |
| (*b*) Silting of the reservoir | |
| (*i*) Total silt deposited | |
| (*ii*) Rate of silting | |
| (*iii*) Density of the silt deposited | |
| (*iv*) Rate of advancement of delta | |
| (*c*) Actual yield as against estimated | |
| (*d*) Various measurements and observations | |
| (*i*) Evaporation losses | (*i*) 5 feet depth is allowed for all losses |
| (*ii*) Sweating below the dam | |
| (*iii*) Temperature measurements | |
| (*iv*) Seepage and regeneration | |
| (*e*) Fish culture | |
| (*f*) Anti-malaria measures | |

| | |
|---|---|
| (5) Recreation facilities | |
| 6) Lessons to be learnt from the construction and utilisation of the dam | Percolation from the canals running on the slopes of dam, saturate the body of the dam which results in damage, both to the dam and the canal. |

## VI. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

(3) Bibliography

# IV. 14. Mhaswad Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 79·79 feet |
| (2) Location | Satara district, Bombay State (Man river valley). |
| (3) Authority or owner | Bombay Government |
| (4) Purpose—Main and subsidiary | Irrigation |
| (5) Year of commencement | 1876-77 |
| (6) Year of completion | 1888-89 |
| (7) Capital cost | |
| (a) Estimated | Rs. 27,84,496 |
| (b) Actual | Rs. 20,96,016 |
| (8) Culturable area commanded by the project | 106,214 acres |
| (9) Area irrigated | 24,800 acres |
| (11) Means of access | Bombay to Poona 119 miles, Poona to Koregaon 84 miles Koregaon to Mhaswad 43 miles — Railway G.I.P. Railway M & S. Road along Satara Pandarpur road. Mhaswad to dam site (Rajewadi) 8 miles — Road 5 miles further on the Satara Pandharpur road and 3 miles to the right on cross country road |

### II. GEOPHYSICAL

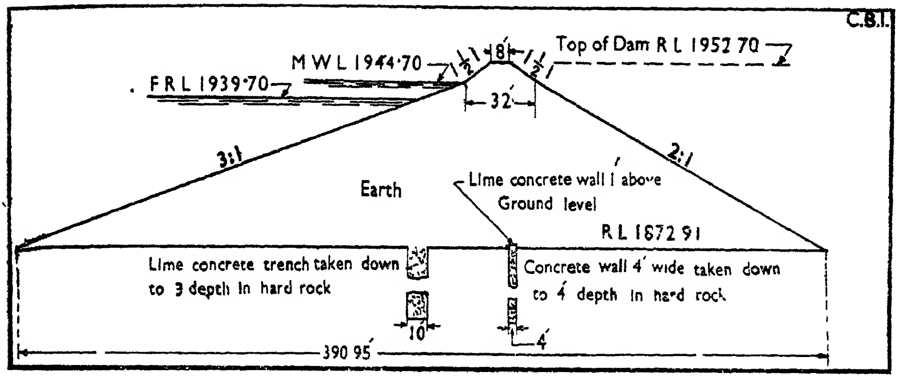
| | |
|---|---|
| (1) Area of catchment | 480 square miles |
| (2) Nature of catchment | Deccan Tract |
| (3) Mean annual precipitation Rainfall | 21 Inches |

| | |
|---|---|
| (4) Total average annual yield of the catchment | 68,982 acre feet |
| (5) Climate | Hot from April to end of May, heaviest rains normally occur in October. Cold moderate from November to March. |
| (6) Temperature conditions and variations | Maximum during summer—115°F<br>Minimum during winter 65°F<br>Normal temperature 70°F to 90°F |
| (7) Rate of Flow | |
| (a) Maximum | 43,389 cusecs on 2·11·1934. |
| (b) Minimum | |
| (8) Detritus charge of the stream | |
| (9) Character (chemical) of the water stored in the reservoir | |
| (10) Geological features | |
| (a) of foundations | *Moorum* at surface, *moorum* and boulders upto 8·0 feet below, and hard rock underneath. In the river bed the top stratum is hard "*Man*" interposed with layers of sand for 10 to 15 feet below surface and hard rock below. |
| (b) of catchment area | *Moorum* at surface, and rock below. |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (a) M.W.L. | R.L. 1944·70 |
| (b) F.R.L. | R.L. 1939·70 |
| (c) Area at M.W.L. | 9·23 miles |
| (d) Area at F.R.L. | 6·25 square miles |
| (e) Maximum length | 5 miles |
| (f) Maximum width | 3 miles |
| (g) Length of periphery | 17·5 Miles |
| (2) Capacity of the reservoir | |
| (a) Gross | 70,505 acre feet |
| (b) Live | 35,311 acre feet |
| (c) Flood storage | |
| (d) Carry-over | |




*Cross section of Mhaswad Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 96·5 Feet |
| (4) Height above the lowest river bed at dam | 79·7 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 13·0 feet |
| (6) Maximum width at level of foundation | 390·95 feet |
| (7) Width at top | 8·0 feet |
| (8) Slopes | |
| (a) Upstream | 1½ to 1 upto 8 feet from top and 3 to 1 below. |
| (b) Downstream | 1½ to 1 upto 8 feet from top and 2 to 1 below. |
| (9) Length at top of the dam | 12,000 feet |
| (a) Non-overflow | |
| (i) Main | 9,000 feet |
| (b) Spillway or waste weir | 3,000 feet |
| (10) Cubic volume of the body of the dam | 41,494,471 cubic feet |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Earth |
| (12) Specific gravity | |
| (a) Earthfill | |

| | |
|---|---|
| (13) Nature of protection and water-proofing of the upstream and downstream faces | Upstream slope pitched with stone six inches thick from R.L. 1909·70 to R.L. 1915·70, the depth of the pitching gradually increasing to 2 feet to R.L. 1944·70 and thence decreasing to 9 inches to R.L. 1949·70. |
| (14) Provision for dealing with seepage and drainage water | Longitudinal and cross-drains on downstream side |
| (15) Means of securing water tightness of the foundation of the dam | By means of concrete treanches |
| (21) Hydraulic gradient for which the embankment is designed | |
| (22) Particular of the berm (if any), width and position<br>(23) Position and form of the core wall (or other means of securing water tightness)<br>(24) Batter (if any) of the core wall<br>(25) Maximum depth below ground surface of core-wall or other means of securing water tightness<br>(26) Method of keying core-wall or other wall in the underlying ground | Core wall 10 feet wide of puddle carried down to impermeable stratum to a maximum depth of 40 feet throughout the dam. In the river portion concrete core wall 4 feet thick taken down 4 feet in rock and another concrete trench 10 feet wide at a distance of 1/3 width at the base from the centre taken down to 3 feet in rock and turned round to meet the central concrete trench on both sides. |
| (22) Nature of the material forming the core or other wall | Puddle and concrete core wall |

## PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged* :

(*a*) Crown waste

(*b*) Proprietory

(2) *Dislocation* :

(*a*) Villages

(*b*) Families

(*c*) Population

(d) Roads :
(i) Highways
(ii) District Roads
(iii) Village Roads
(e) Railway Lines
(f) Temples, Mosques, *etc.*
(g) Graves, *etc.*
(h) Trees, Gardens, Pastures, Houses, Wells, *etc.*
(i) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | One overflow waste weir 3,000 feet long constructed in lime concrete faced with masonry at sides and top. The top width is five feet with side batters of 1 in 10 and 1 in 6 on the inside and outside respectively. Maximum discharging capacity is 103,536 cusecs. |
| (2) Outlet works | Five culvert sluices 2 feet by 2·5 feet each worked by ordinary screw rod lifting gates. |
| (3 Scouring works | An escape in the main off-take channel of 5 openings 4 feet by 3 feet each of masonry pillars grooved to take two rows of wooden planks, the space between being filled with puddle for closing the escape. |
| (4) Inspection facilities | The sluices and gates are accessible for inspection through the tunnel under the dam embankment. |
| (5) Fish-pass | — |
| (6) Means for dissipating energy below the spillway | — |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | Concrete wall 4 feet wide taken 4 feet deep in hard-rock, in the bed of the river. It is an earthen dam. |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | |
| (3) Noteworthy occurrences and accidents | |
| (4) Operation of the dam | |
| (*a*) Regulation | Head regulators for canal 5 sluice openings 2 feet × 2·5 feet. |
| (*b*) Silting of the reservoir | |
| (*i*) Total silt deposited | 1,277 million cubic feet |
| (*ii*) Rate of silting | 24·09 million cubic feet per year. |
| (*iii*) Density of the silt deposited | |
| (*iv*) Rate of advancement of delta | |
| (*c*) Actual yield as against estimated | |
| (*d*) Various measurements and observations | |
| (*i*) Evaporation losses | |
| (*ii*) Sweating below the dam | |
| (*iii*) Temperature measurements | |
| (*iv*) Seepage and regeneration | |
| (*e*) Fish culture | Ordinary |
| (*f*) Anti-malaria measures | — |
| (5) Recreation facilities | — |
| (6) Lessons to be learnt from the construction and utilisation of the dam | Dams to conserve waters of rivers otherwise going to waste are necessary especially in tracts subject to frequent draughts. The results obtained in the present case have amply borne out the above fact, fully justifying the construction of the dam<br>As only seasonal crop has been mainly irrigated (water during hot weather being uncertain), the financial return is not very attractive in such tanks with upcountry catchment. |

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

The scheme was taken in hand in 1867. The Collector and the Executive Engineer of the time submitted a joint report regarding the necessity of irrigation in Satara district, the eastern part of which suffered heavily from frequent draughts.

Major Penny took the proposal in hand, and a rough project for a tank at Rajewadi was drawn up. But as the whole area under porposal was entirely in a native state, further investigations were made with a view to get all irrigation in British territory as far as possible. This was considered feasible and a project was framed accordingly in the year 1877.

(2) Personnel

1. Mr. Cambell
2. Major C.B.F. Penny Royal Engineer.
3. MR. A. Davidson, Executive Engineer.

(3) Bibliography

1. Merriman C.J. " Printed report on Mhaswad tank " (A Bombay Government Publication, dated 1st September 1877).
2. Milsom B P. " Printed completion report of Mhaswad tank " (A Bombay Government Publication dated 15th October 1901).
3. History of the Mhaswad Tank and canals (Bombay Presidency) upto the year 1936-37.

## IX. B'BLIOGRAPHY AND HISTORICAL

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Major Penny took the proposal in hand, and a rough project for a tank at Rajewadi was drawn up. But as the whole area under porposal was entirely in a native state, further investigations were made with a view to get all irrigation in British territory as far as possible. This was considered feasible and a project was framed accordingly in the year 1877.

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1. Merriman C.J. " Printed report on Mhaswad tank " (A Bombay Government Publication, dated 1st September 1877).
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3. History of the Mhaswad Tank and canals (Bombay Presidency) upto the year 1936-37.

# IV. 15. Bhatodi Dam

## (Masonry)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 50 feet. |
| (2) Location | Ahmednagar district, Bombay State, (Mehekari River). |
| (3) Authority or owner | Bombay Government |
| (4) Purpose-Main and subsidary | Irrigation |
| (5) Year of commencement | Bhatodi Lake built by Salabatkhan, the famous Minister of the four Nizam Shahi King Murtaza Nizam Shah (1565-1588) and restored by Government in 1877. Since then it is in charge of the Public Works Department. |
| (6) Year of completion | 1891-92. |
| (7) Capital cost | |
| (*a*) Estimated | Rs. 3,79,707 |
| (b) Actual | Rs. 3,76,250 |
| (8) Culturable area commanded by the project | 13,657 acres |
| (9) Area irrigated | 674 acres |
| (11) Means of access | The Ahmednagar railway station on the Dhond Manmed line (Great Indian Peninsula Railway) is 14 miles from the tank. In mile No. 9 of Nagar Shevgaon metalled road a *moorum* service road starts for the tank. It is a motorable road and is about 3 miles. Ahmednagar town in length is 12 miles from the tank. |

## II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 44 square miles |
| (2) Nature of catchment | Hilly |
| (3) Mean annual precipitation | |
| (a) Rainfall | 18 inches |
| (4) Total average annual yield of the catchment | 6,570 acre feet |
| (5) Climate | The climate of the district is on the whole extremely genial. |
| (6) Temperature conditions and variations. | May is the hottest month with maximum of 114° F. and minimum of 68° F. December is the coldest month with maximum of 80° F and minimum of 40° F. |
| (7) Rate of Flow | |
| (a) Maximum | |
| (b) Minimum | |
| (8) Detritus charge of the stream | |
| (9) Character (chemical) of the water stored in the reservoir | Sweet, fit for irrigation. |
| (10) Geological features | |
| (a) of foundations | The foundations are on hard trap rock and are excellent throughout. |
| (b) of catchment area | The catchment is hilly and with a little rainfall the tank gets full. |

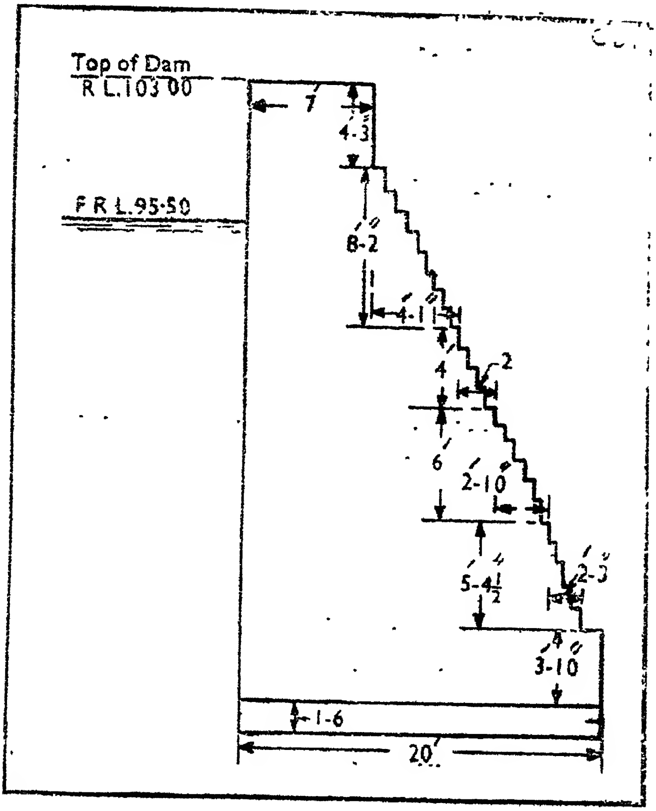
## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (a) M.W.L. | |
| (b) F.R.L. | 95·50 |
| (c) Area at M.W.L. | 0·434 square miles |
| (d) Area at F.R.L. | |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | |
| (2) Capacity of the reservoir | |
| (a) Gross | |
| (b) Live | 920 acre feet |

(c) Flood storage

(d) Carry-over




*Cross section of Bhatodi Dam*

(3) Maximum height above the lowest point of foundations

(4) Height above the lowest river bed at dam — 50 feet

(5) Height of the top of the dam above the crest of the spillway or weir — 7·50 feet

(6) Maximum width at level of foundation

(7) Width at top — 7·0 feet

(8) Slopes

(a) Upstream

(b) Downstream

| | |
|---|---|
| (9) Length at top of the dam | 2,747 feet |
| (a) Non-overflow | |
| (i) Main | 2,316 feet |
| (b) Spillway or waste weir | 431·0 feet |
| (10) Cubic volume of the body of the dam | |

B. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed | The foundations are excellent throughout. The dam is constructed of boulder stone and lime. Big boulders are available within a radius of 8 miles. |
| (12) Specific gravity | |
| (a) Masonry | 2·4 |
| (13) Nature of protection and waterproofing of the upstream and downstream faces | It is a masonry dam constructed of boulder stones in lime; it rests on an excellent foundation throughout. |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundation of the dam | The tank is much silted up and the silt practically makes the dam watertight. |
| (16) Contraction joints | —— |
| (17) Principal stresses in the masonry with a note of methods of calculations employed | |
| (18) Maximum pressure on foundations | |
| (19) Uplift pressure, claculated or measured | |
| (20) Measures adopted for preventing or counteracting uplift pressures | |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | Broad-crested weir. Discharging capacity with three feet water over crest, is 15,192 cusecs. |
| (2) Outlet works<br>(3) Scouring works | 4 outlet sluices $1\frac{1}{2}$ feet by $1\frac{1}{2}$ feet at chainage 568 feet of the masonry dam. |
| (4) Inspection facilities | |

(5) Fish-pass —

(6) Means for dissipating energy below the spillway

## VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

(4) Operation of the dam

(*a*) Regulation

(*b*) Silting of the reservoir

(*i*) Total silt deposited

(*ii*) Rate of silting

(*iii*) Density of the silt deposited

(*iv*) Rate of advancement of delta

(*c*) Actual yield as against estimated

(*d*) Various measurements and observations

(*i*) Evaporation losses

(*ii*) Sweating below the dam

(*iii*) Temperature measurements

(*iv*) Seepage and regeneration

(*e*) Fish culture

(*g*) Anti-Malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

Bhatodi tank takes its name from a nearby village situated 10 miles North East of Ahmednagar. It was built four centuries back in (1565-1588) by the famous minister of the four Nizam Shahi King Murtza Nizam Shaha, and restored by Government in 1877. Since then it is in charge of the Public Works Department.

(2) Personnel

(3) Bibliography

# IV. 16. Pathri Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 63.75 feet |
| (2) Location | Sholapur district Bombay State—(Yerai river). |
| (3) Authority or owner | Bombay Government |
| (4) Purpose-Main and subsidiary | Irrigation and domestic supply |
| (5) Year of commencement | 1896-97 |
| (6) Year of completion | 1904-05 |
| (7) Capital cost | |
| (a) Estimated | (a) Rs. 6,72,856 |
| (b) Actual | (b) Rs. 6,42,646 |
| (8) Culturable area commanded by the project | 2,500 acres |
| (9) Area irrigated | 1,500 acres average |
| (11) Means of access | It is accessible from Kulsamba railway station (Barsi Light Railway) by road at a distance of 6 miles from Barsi town in Sholapur District. |

### II. GEOPHYSICAL

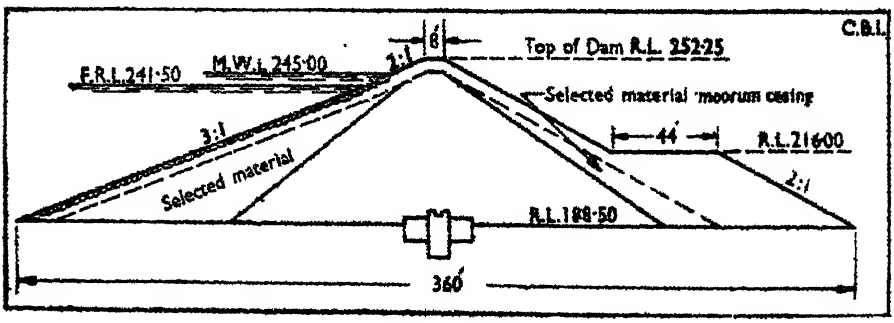
| | |
|---|---|
| (1) Area of catchment | 27·5 square miles |
| (2) Nature of catchment | Hilly and steep |
| (3) Mean annual precipitation | |
| (a) Rainfall | (a) 29·49 inches |
| (4) Total average annual yield of the catchment | 13,651 acre feet |
| (5) Climate | Hot |
| (6) Temperature conditions and variations | Maximum temperature 108°F<br>Minimum temperature 60°F |

| | |
|---|---|
| (7) Rate of Flow | |
| (a) Maximum | |
| (b) Minimum | |
| (8) Detritus charge of the stream | |
| (9) Character (chemical) of the water stored in the reservoir. | Sweet |
| (10) Geological features— | |
| (a) of foundations | (a) Sand, gravel, and boulders overlying Deccan trap |
| (b) of catchment area | (b) Earth and *moorum* overlying Deccan trap |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data— | |
| (a) M.W.L. | (a) R.L. 245·25 (from an arbitrary datum). |
| (b) F.R.L. | (b) R.L. 241·50. |
| (c) Area at M.W.L. | |
| (d) Area at F.R.L. | (d) 1·06 square miles |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | (g) About 6·25 miles |
| (2) Capacity of the reservoir | |
| (a) Gross | (a) 9,867 acre feet |
| (b) Live | (b) 9,361 acre feet |
| (c) Flood storage | |
| (d) Carry over | |




*Cross section of Pathri Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 75·75 feet |

| | |
|---|---|
| (4) Height above the lowest river bed at dam | 63·75 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir. | 10·75 feet |
| (6) Maximum width at level of foundation. | 360 feet |
| (7) Width at top | 8 feet |
| (8) Slopes | |
| (a) Upstream | (a) As per cross section |
| (b) Downstream | (b) As per cross section |
| (9) Length at top of the dam | 6,790 feet (exclusive of waste-weir length). |
| (a) Non-overflow | |
| (i) Main | |
| (ii) Subsidiary | |
| (b) Spillway | (b) 800 feet |
| (10) Cubic volume of the body of the dam. | |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed. | Black soil and moorum |
| (12) Specific gravity | |
| (d) Earthfill | |
| (13) Nature of protection and water-proofing of the upstream and down-stream faces | There is a trap stone pitching from bottom to highest flood level on upstream side. |
| (14) Provision for dealing with seepage and drainage water | Cross and longitudinal drains of rubble and shingle covered with stone slabs are provided. |
| (15) Means of securing water tightness of the foundation of the dam. | By means of puddle ond concrete trench |
| (21) Hydraulic gradient for which the embankment is designed. | 1 in 4 |
| (22) Particular of the berm (if any), width and position. | 44 feet wide at R.I. 214·00 with 2 to 1 outer slope. |
| (23) Position and form of the core wall (or other means of securing water tightness). | As per cross section |

| | |
|---|---|
| (24) Batter (if any) of the core wall | Vertical |
| (25) Maximum depth below ground surface of core-wall or other means of securing water tightness. | 12 feet |
| (26) Method of keying core-wall or other wall in the under-lying ground | By means of key trenching |
| (27) Nature of material forming the core or other wall | Concrete trench in centre faced with puddle trenches both in front and rear sides |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*—
- (*a*) Crown waste
- (*b*) Proprietary

(2) *Dislocation*—
- (*a*) Villages
- (*b*) Families
- (*c*) Population
- (*d*) Roads:
  - (*i*) Highways
  - (*ii*) District Roads
  - (*iii*) Village Roads.
- (*e*) Railway Lines
- (*f*) Temples, Mosques, *etc.*
- (*g*) Graves, *etc.*
- (*h*) Trees, Gardens, Pastures, Houses, Wells, *etc.*
- (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | Waste weir, excavated in hard *moorum*, discharging capacity 18,093 cusecs. Its crest is of masonry. |
| (2) Outlet works | Two sluices 21 inches diameter each of cast iron pipes. |
| (3) Scouring works | |

(4) Inspection facilities.

(5) Fish-pass

(6) Means for dissipating energy below the spillway

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | This was taken up as a famine work and was mostly completed by famine labour. |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work. | |
| (3) Noteworthy occurrences and accidents | |
| (4) Operation of the dam— | |
| (*a*) Regulation | (*a*) Through outlet sluices |
| (*b*) Silting of the reservoir | |
| (*i*) Total silt deposited | |
| (*ii*) Rate of silting | |
| (*iii*) Density of the silt deposited | |
| (*iv*) Rate of advancement of delta | |
| (*c*) Actual yield as against estimated. | |
| (*d*) Various measurements and observations | |
| (*i*) Evaporation losses. | |
| (*ii*) Sweating below the dam | |
| (*iii*) Temperature measurements | |
| (*iv*) Seepage and regeneration | |
| (*e*) Fish culture | |
| (*f*) Anti-malaria measues | |
| (5) Recreation facilities | |
| (6) Lessons to be learnt from the construction and utilisation of the dam | |

## IV. BIBLIOGRAPHY AND HISTORICAL

| | |
|---|---|
| (1) Historical | |
| (2) Personnel | Mr. K. R. Godledge, Executive Engineer. |
| (3) Bibliography | Public Works Department, Bombay "History of the tank". |

# IV. 17. Shetphal Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 66·00 feet |
| (2) Location | Shetphal *nalla* valley, Poona district, Bombay State (fed by the Nira left bank canal). |
| (3) Authority or owner | Bombay Government |
| (4) Purpose—Main and subsidiary | Irrigation |
| (5) Year of commencement | 1897 |
| (6) Year of completion | 1906 |
| (7) Capital cost | |
| (*a*) Estimated | Rs. 7,50,877 |
| (*b*) Actual | Rs. 6,46,061 |
| (8) Culturable area commanded by the project | 13,288 acres |
| (9) Area irrigated | 6,230 acres |
| (11) Means of access | It is accessible from Baramati railway station (Dhond Baramati Branch line of the Great Indian Peninsular Railway) by the Baramati Indapur road upto Nimbgaon Ketki and thence by a branch road. |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 2·33 square miles. |
| (2) Nature of catchment | Flat open country, but the tank is fed from the Nira Left Bank Canal. |
| (3) Mean annual precipitation | |
| (*a*) Rainfall | 16 inches |
| (4) Total average annual yield of the catchment. | 436 acre feet (The tank is fed from the Left Bank Canal). |
| (5) Climate | It is hot from April to June. Rainfall occurs in September and October, with storms in December and January. |

(6) Temperature conditions and variations. — Maximum temperature 110° F. Normal temperature 70°F to 90°F. Minimum temperatuse 40°F.

(7) Rate of flow
- (a) Maximum
- (b) Minimum

(8) Detritus charge of the stream — No detritus of any sort enters into the tank as the tank is at the tail of the canal.

(9) Character (chemical) of the water stored in the reservoir — Sweet, and suitable for irrigation.

(10) Geological features
- (a) of foundations — Hard rock foundations
- (b) of catchment area — Hilly tract of basalt type

## III. TECHNICAL

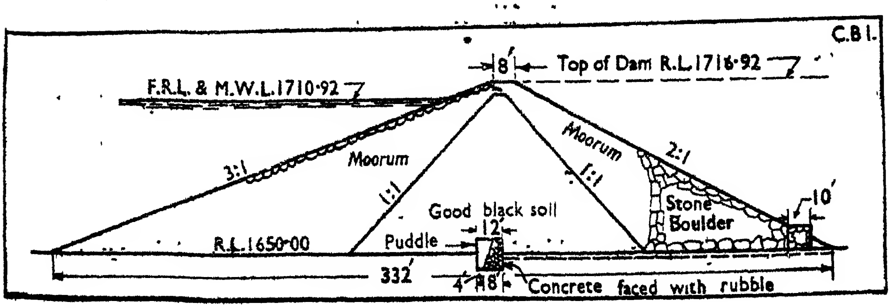
### A. STATISTICAL

(11) Reservoir Data

| | |
|---|---|
| (a) M.W.L. | R.L. 1,710·92 |
| (b) F.R.L. | R.L. 1,710·92 |
| (c) Area at M.W.L. | 1·35 square miles |
| (d) Area at F.R.L. | 1·35 square miles |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | 7 miles approximate |

(2) Capacity of the reservoir

| | |
|---|---|
| (a) Gross | 13,590 acre feet |
| (b) Live | 13,145 acre feet |
| (c) Flood storage | |
| (d) Carry-over | |




*Cross section of Shetphal dam*

(3) Maximum height above the lowest point of foundations — 74·5 feet

| | |
|---|---|
| (4) Height above the lowest river bed at dam | 66·00 above river level |
| (5) Height of the top of the dam above the crest of the spillway or weir | 6·0 feet |
| (6) Maximum width at level of foundation | 332 feet |
| (7) Width at top | 8·0 feet |
| (8) Slopes | |
| (*a*) Upstream | 3 : 1 |
| (*b*) Downstream | 2 : 1 |
| (9) Length at top of the dam | 12,432 feet |
| (*a*) Non-overflow | |
| (*i*) Main | (*i*) 12,082 feet |
| (*b*) Spillway | 350 feet |
| (10) Cubic volume of the body of the dam. | |

B. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed | *Moorum* sides good core wall and key of concrete wall faced with rubble and puddle backing. |
| (12) Specific gravity | |
| (*d*) Earthfill | |
| (13) Nature of protection and waterproofing of the upstream and downstream faces | Upstream side pitched upto 12 inches thickness and downstream side provided at the toe with loose, hand-packed boulder stones as per cross section |
| (14) Provision for dealing with seepage and drainage water | Downstream toe of boulder stones |
| 15) Means of securing water tightness of the foundation of the dam | By means of concrete faced with rubble and puddle core-wall |
| 21) Hydraulic gradient for which the embankment is designed | |
| 22) Particular of the berm (if any), width and position | |
| 23) Position and form of the core wall (or other means of securing water tightness) | As per cross section |
| **24) Batter (if any) of the core wall** | **1 in 1 on both sides** |

| | |
|---|---|
| (25) Maximum depth below ground surface of core-wall or other means of securing water tightness. | 8 feet. |
| (26) Method of keying core-wall or other wall in the under-lying ground. | By concrete faced with boulders and puddle core-wall |
| (27) Nature of material forming the core or other wall | Black soil or clayey earth and concrete |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged* :

(*a*) Crown waste

(*b*) Proprietory

(2) *Dislocation*—

(*a*) Villages

(*b*) Families

(*c*) Population

(*d*) Roads :

(*i*) Highways

(*ii*) District Roads

(*iii*) Village Roads

(*e*) Railway Lines

(*f*) Temples, Mosques, *etc.*

(*g*) Graves, *etc.*

(*h*) Trees, Gardens, Pastures, Houses, Wells, *etc.*

(*i*) Bridges

| | |
|---|---|
| (3) Compensation paid under each category of item (2). | Total Rs. 32,660 |
| (4) Method of compensating for land of dispossessed landholders | |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | Natural spillway, 350 feet wide, with a 2·82 feet depth of flood water over weir |
| (2) On let warks | Two pipes outlet each 15 inches diameter |
| (3) Scouring works. | |
| (4) Inspection facilities | — |
| (5) Fish-pass | — |
| (6) Means for dissipating energy below the spillway | — |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | --- |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | --- |
| (3) Noteworthy occurrences and accidents | |
| (4) Operation of the dam | |
| (a) Regulation | The Outlet consists of a masonry culvert built under the dam with 15 inches cast iron pipes laid through it. The inlet end of the culvert is closed with cement concrete for a length of 8 feet. Two sluice valves are provided for each of the two pipes. |
| (b) Silting of reservoir | |
| (i) Total silt deposited | |
| (ii) Rate of silting | |
| (iii) Density of the silt deposited | |
| (iv) Rate of advancement of delta | |
| (c) Actual yield as against estimated | |
| (d) Various measurements and observations | |
| (i) Evaporation losses | 31 million cubic feet per year |
| (ii) Sweating below the dam | |
| (iii) Temperature measurements | |
| (iv) Seepage and regeneration | |
| (e) Fish culture | — |
| (f) Anti-malaria measures | — |
| (5) Recreation facilities | — |
| (6) Lessons to be learnt from the construction and utilisation of the dam | None of special value. The current theories and principles on which the dam was designed have been confirmed by its construction. |

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

The tank formed by this dam serves as a tail tank to the Nira Left Bank canal and is supplied mainly by the surplus water in the canal. The storage is used for irrigating the lands below the tank. The work was completed at a cost of Rs. 6,46,000/-.

(2) Personnel

(3) Bibliography

# IV. 18. Vani Vilas Sagar Dam

## (Masonry)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 142 feet |
| (2) Location | Chitaldurg district, Mysore State (Vedavati river) Hiriyar Taluk |
| (3) Authority or owner | Mysore Government |
| (4) Purpose—Main and Subsidiary | Irrigation. A pipe in the right channel in the 9th mile serves drinking water supply to the Hiriyur town. |
| (5) Year of commencement | August 1898 |
| (6) Year of completion | August 1907. Taken to service during 1909. |
| (7) Capital cost— | |
| (*a*) Estimated | Rs. 18,30,472 (approximate). |
| (*b*) Actual | Rs. 18,50,000 |
| (8) Culturable area commanded by the project | 25,000 acres |
| (9) Area irrigated | 12,000 acres |
| (11) Means of access | (*i*) It is 30 miles by road from the Hosadurg railway station, which is situated on the Bangalore Poona line.<br>(*ii*) It is 35 miles by road from Chitaldurg railway station, situated on the Chitaldurg-Chickjajur line. This road is motorable throughout the year.<br>(*iii*) It is 69 miles from Tamkur railway station situated on the Bangalore Poona line. There is also a motorable road. |

## II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 2,075 square miles |
| (2) Nature of catchment | Hilly and forest area of portions of Kadun, Hassun, Tumkan and Chitaldurg Districts |
| (3) Mean annual precipitation— | |
| (a) Rainfall | 24·2 inches |
| (4) Average total annual yield of the catchment | |
| (5) Climate | Tropical |
| (6) Temperature conditions and variations | Maximum 102·6°F. Minimum 48·5°F |
| (7) Rate of Flow— | |
| (a) Maximum | (a) 35,000 cusecs |
| (b) Minimum | (b) |
| (8) Detritus charge of the stream | |
| (9) Character (chemical) of the water stored in the reservoir | Soft and sweet |
| (10) Geological features— | |
| (a) of foundations | (a) The rock in the gorge consists of alternate layers of haematite quartzite and chlorite schist, dipping steeply to the East at an angle of 70°, the chlorite schist being considerably softer in composition than the haematite. Both the heel and toe of the dam abut against massive beds of banded haematite quartzite. |
| (b) of catchment area | |

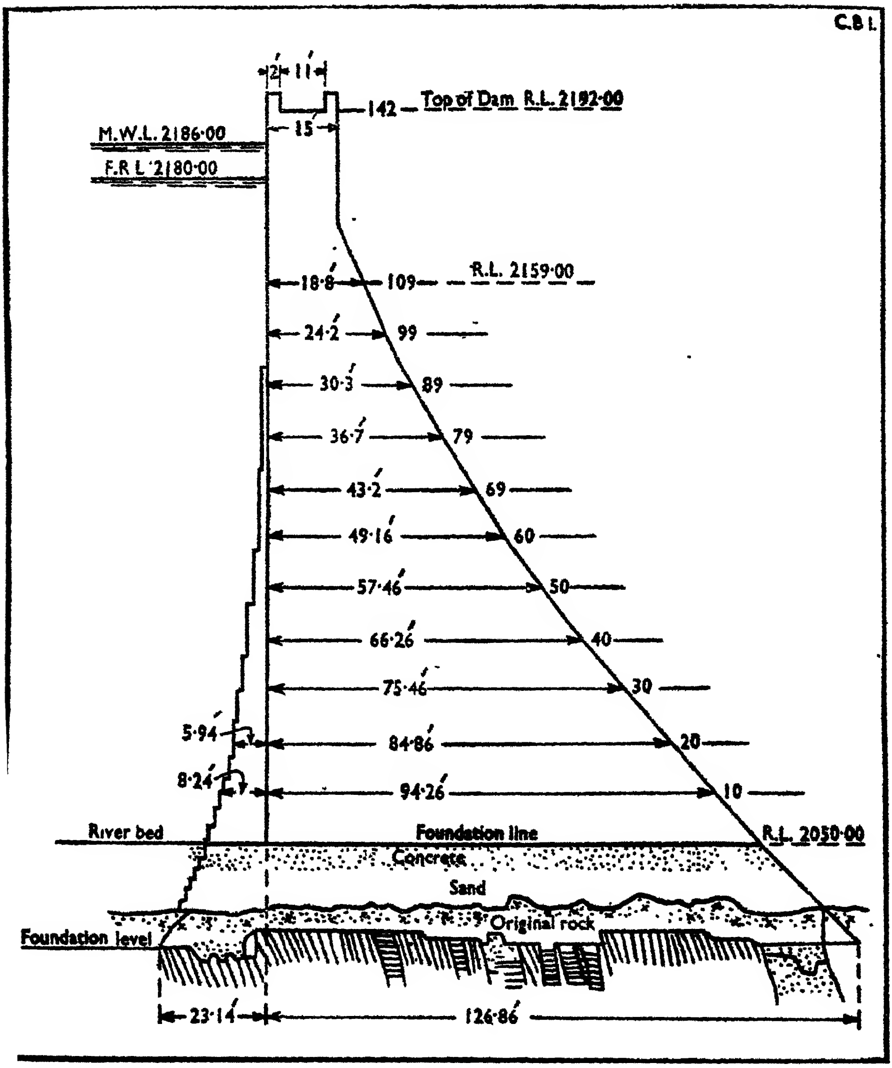
## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data— | |
| (a) M.W.L. | R.L. 2186·00 |
| (b) F.R.L. | R.L. 2180·00 |
| (c) Area at M.W.L. | |
| (d) Area at F.R.L. | 33·82 square miles |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | |

(2) Capacity of the reservoir—

- (*a*) Gross 688,705 acre feet
- (*b*) Live
- (*c*) Flood storage
- (*d*) Carry-over




*Cross Section of Vani Vilas Sagar Dam*

(3) Maximum height above the lowest point of foundations 163·34 feet

(4) Height above the lowest river bed at dam 142 feet

| | |
|---|---|
| (5) Height of the top of the dam above the crest of the spillway or weir | 12 feet |
| (6) Maximum width at level of foundations | 150 feet |
| (7) Width at top | 15 feet |
| (8) Batter of face-slopes— | |
| (*a*) Upstream | (*a*) As per cross section |
| (*b*) Downstream | (*b*) As per cross section |
| (9) Length at top of the dam— | 1,330 feet |
| (*a*) Non-overflow— | |
| (*i*) Main | (*i*) 862 feet |
| (*ii*) Subsidiary | (*ii*) |
| (*b*) Spillway | 468 feet |
| (10) Cubic volume of the body of the dam | 7,650,000 cubic feet |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed. | Rubble masonry in *surkhi* mortar with a facing of dressed trap stones both in front and rear. Rear face is concreted and plastered, in the central portion fully and in the battered portion only at flanks. The vertical portion is pointed with *surkhi* mortar. |
| (12) Specific gravity— | |
| (*a*) Masonry | (*a*) 2·40 |
| (13) Nature of protection and water-proofing of the upstream and downstream faces. | Cement pointing and plastering |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundations of the dam | The rock, under foundations was thoroughly cleaned by a jet of water under high pressure and by scrubbing with wire brushes. A wash of neat cement was then immediately applied and this was followed by a layer of cement mortar plaster composed of 1 cement and 1½ sand. The softer beds of chlorite schist were removed several feet lower than the harder haematite beds and these softer beds were filled with cement concrete to the level of the harder haematite rock. |

| | |
|---|---|
| (16) Contraction joints | |
| (17) Principal stresses in the masonry with a note of methods of calculations employed | This is a gravity dam designed so as to be safe against (i) Overturning (ii) Crushing (iii) Sliding (iv) Rupture from tension. Its resultant pressure falls within the middle third of the base at every horizontal joint. To attain security against sliding smooth joints have been avoided For testing stability against overturning, the method of moments has been employed. The dam has been divided up into a suitable number of horizontal layers, and then for each section moments have been taken round a vertical axis at any convenient distance from the upstream face. Further verifications have been made by graphical methods. |
| (18) Maximum pressure on foundations | 8·0 tons per square foot |
| (19) Uplift pressure, calculated or measured. | |
| (20) Measures adopted for preventing or counteracting uplift pressures | |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

| | |
|---|---|
| (1) *Land submerged* | |
| (a) Crown waste, Proprietory | 21,645 acres |
| (2) *Dislocation* | |
| (a) Villages | 32 |
| (b) Families | |
| (c) Population | |
| (d) Roads— | |
| (i) Highways | |
| (ii) District Roads | |
| (iii) Village Roads | |

(e) Railway Lines

(f) Temples, Mosques, *etc.*

(g) Graves, *etc.*

(h) Trees, gardens, pastures, houses, wells, *etc.*

(i) Bridges

(3) Compensation paid under each category of item (2) — Rs. 60,000

(4) Method of compensating for land of dispossessed landholders.

## V. AUXILIARY WORKS

(1) Surplussing works — The weir is 468 feet long having a central gap 68 feet wide at R.L. 124·00, the sides being kept at R.L. 130·00. The central gap is temporarily raised to 130·00 by putting a rough stone bund. The bed wall of a draft channel being 1 in 1,000 and the maximum discharge so far passed is 1,173 cusecs on 19-11-1919.

(2) Outlet works — Two vents of 5·5 feet by 12·75 feet with two gates stoneys Pattern in each vent. The discharging capacity of each vent is 1,000 cusecs.

(3) Scouring works

(4) Inspection facilities

(5) Fish-pass

(6) Means for dissipating energy below the spillway. ...

## VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features — The stone used was the haematite quartzite from the adjacent hills; the stone being quarried in sizes and taken on trolley lines to the work. Stones were imbedded in the mortar by gentle blows from a wooden mallet. Stones used were about 0·75 feet thin, and the joints between them were filled with chips and concrete. All carriage was done by manual labour. The mortar used was one part of unslaked lime to four parts of *surkhi*.

Above 80 feet level, the use of haematite for masonry was discontinued and trap stone was used upto top level. The near portion of the dam was built in three high steps. In order to avoid the growth of small vegetation on the steps on rear portion, they were filled in with fine concrete formed with one uniform slope.

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

During construction it was discovered that at higher elevation of the dam, along the original axis proposed, the flanks would rest on weaker rock. The axis line was, therefore, altered and the body of the dam thrown forward so that flanks were entirely on hard rock.

(3) Noteworthy occurrences and accidents

The preliminary works in connection with the construction of the dam were actually started in August 1898 : but in November of the same year due to a severe outbreak of cholera epidemic the labour engaged stopped all work for two months. The outbreak was traced to river water which many people were drinking. This was contaminated by a village higher up where cholera prevailed at the time. To prevent people from drinking river water, a reservoir was constructed on the hill at 80 feet above datum and was filled daily by a pump. The water was filtered and supplied by pipes to nearly all the collie camps and staff. Along with this, the hutting arrangement was also improved. These precautions improved the health of people.

**THE "FAULT"**

At 65 feet above datum, on the North hill, a distinct "fault", 33 feet in width, was encountered composed of disintegrated trap running at right angles to the heamatite quartzite and chlorite schist. This was very remarkable, as the possibility of a fault occurring concealed in the rocks below the river bed had been mooted at the time of examination by the Committee of Engineers and Geologists. It was then recorded that it was practically certain that the rocks had not been faulted at any intermediate point, as the strata on the north and south banks of the gorge were bed for bed in exact continuation of one another.

Before sound rock was met within the fault, the excavation had to be taken down to 5, or 70 feet in all. There was considerable percolation of water into this, but it was pumped out successfully, and after putting in three feet of cement concrete the fault was filled with ordinary masonry. To avoid risk the dam was made thicker for some 50 feet on either side of the fault so as to keep the heel well on the bed of haematite.

(4) Operation of the dam

(a) Regulation

(b) Silting of the reservoir

(i) Total silt deposited

(ii) Rate of silting — (ii) 0·25 foot depth every year.

(iii) Density of the silt deposited

(iv) Rate of advancement of delta

(c) Actual yield as against estimated — (c) 72,000 to 108,000 acre feet.

(d) Various measurements and observations

(i) Evaporation losses — (i) Observations during the year 1906 to 1909 revealed an annual evaporation of 3·75 feet to 4·75 feet.

(ii) Sweating below the dam

(iii) Temperature measurements

(iv) Seepage and regeneration

(e) Fish culture

(f) Anti-malaria measures

**(5) Recreation facilities**

What was formerly an arid and uninteresting valley is now a picturesque lake, surrounded on all sides by conical hills and dotted over with many islands. The scenery is charming for six months in the year, when all the hills are clothed in green, but in the hot weather, in spite of the near proximity of the water, the hills present a parched and dusty aspect. The Lake abounds with fish of many kinds and has become the home of many varieties of wild fowl. Duck, teal and geese are to be found in immense numbers from December to March, but owing to the great expanse of water they are difficult to obtain.

The steam launch and boats provided by Government have been in constant use for the past seven years. A Thorneycroft motor launch has also been added to the fleet to enable visitors to view the beauties of the lake. The lake is within five hours' run from Bangalore by motor, the distance by road being only 110 miles.

(6) Lessons to be learnt from the construction and utilisation of the dam.

A good construction

## VII. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

The suitability of the Marikanava Gorge for the construction of a dam and formation of a large reservoir was brought forward more than a century ago, but the first definite proposal was suggested in the year 1855. After that, till 1873, no less than eight schemes were framed for dams with varying heights and costs, but all were dropped for one reason or the other.

In 1892 the matter was taken up again and in 1894, the Government of Madras, who had formerly objected to the construction of the dam on the ground that the supply of water in the Bellary district would be lessened, withdrew their objections.

Later on, when rock in foundations was examined, it was declared unfit for the erection of the dam. The project was, therefore, condemned. An alternative project was investigated higher up the river at a place named Attimoge. This also did not take practical shape as the dam site was such that all the water available in a good year could not be impounded.

In 1897 Sir K. Seshadri, K.C.S.I. Dewan of Mysore, again took the scheme in hand. A Committee of engineers and geologists was again formed to report upon the nature and quality of the rock in the foundations. The Committee, under Colonel McNeil Campbell, R.E., the then Chief Engineer to the Mysore Government met at Mari Kanava in June 1898 and after a careful examination, reported that the rock was sound and incompressible and that a dam of any height could safely be built upon. The Mysore Government, therefore, decided to construct the dam, and operations were at once started, and the necessary funds were provided.

The work was actually started in August 1898 and it was completed in August 1907.

(2) Personnel

*Chief Engineers*

Colonel D. McNeil Campbell, R.E., Captain A.C. Joller, D.E., Lobbiniere

*Superintending Engineer*, : C. T., Dalal, Esqr., L.C.E.

(3) Bibliography

Rice, H. D., " Brief History of the Marikanava Project, in the Mysore State, India ".

# IV. 19. Lonavla Dam

## Masonry)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 34·5 feet |
| (2) Location | Poona District, Bombay State (Indrayani river, Bhoreghat) |
| (3) Authority or owner | The Tata Hydro Electric Supply Company Limited |
| (4) Purpose—Main and subsidiary | Power |
| (5) Year of commencement | 1910 |
| (6) Year of completion | 1916 |
| (7) Capital cost | |
| (a) Estimated | |
| (b) Actual | (b) Rs. 85,17,111 (including cost of Walwhan dam) |
| (10) Installed hydro-electric capacity— | |
| (a) Firm | (a) 48,000 kW. |
| (11) Means of access | It is accessible from Lonavla railway station by a motorable road. |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 5·4 square miles |
| (2) Nature of catchment | Wooded and mountainous |
| (3) Mean annual precipitation | |
| (a) Rainfall | (a) 163 inches |

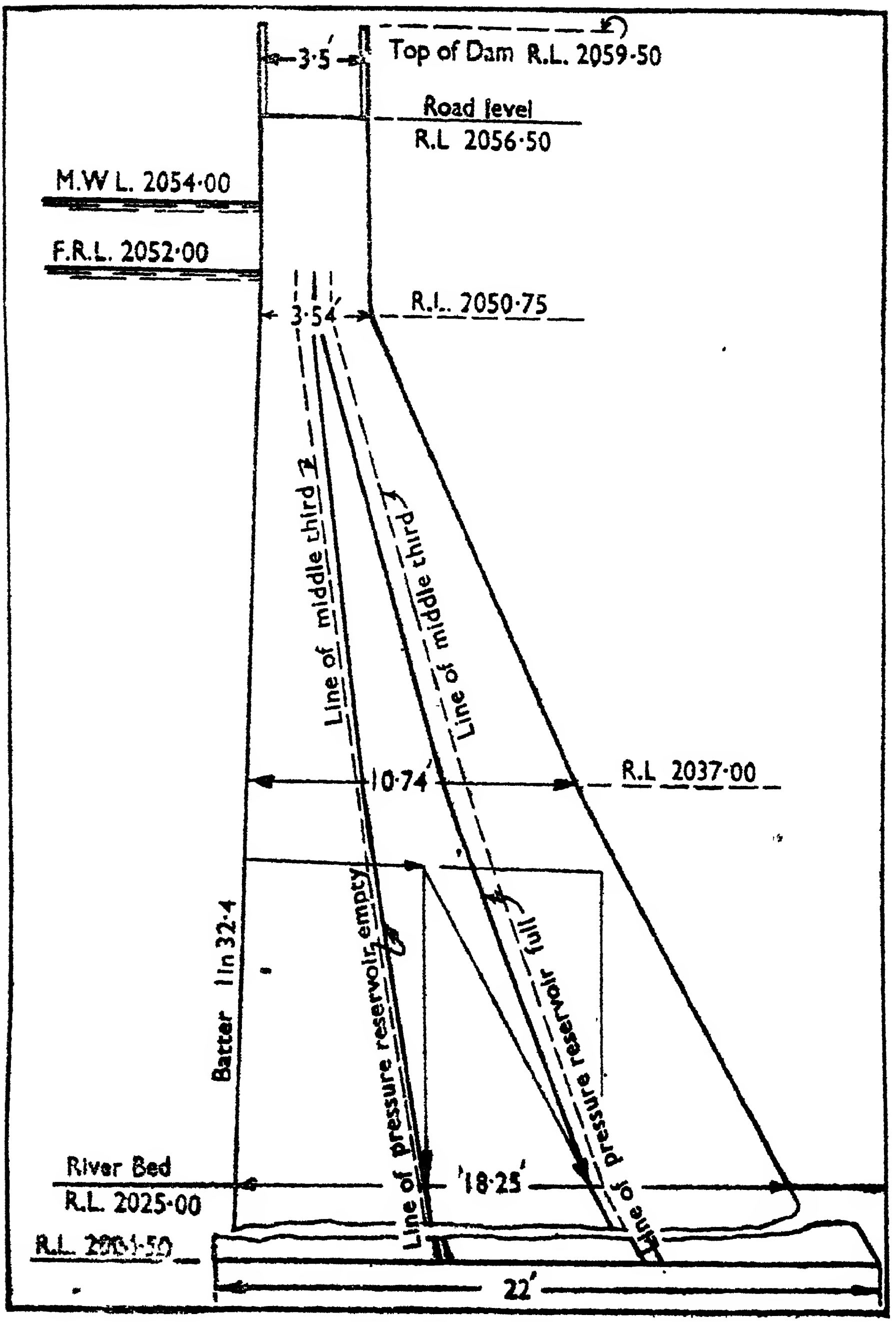
| | |
|---|---|
| (4) Mean annual yield of the catchment | 39,945 acre feet |
| (5) Climate | Tropical |
| (6) Temperature conditions and variations | Maximum temperature 100°F.<br>Minimum temperature 55°F. |
| (7) Rate of Flow | |
| (a) Maximum | (a) 2,700 cusecs |
| (b) Minimum | (b) — |
| (8) Detritus charge of the stream | The entire catchment is wooden and rocky. There is very little flow of solids into the lake |
| (9) Character (chemical) of the water stored in the reservoir | Sweet water impounded during monsoon |
| (10) Geological features | |
| (a) of foundations | (a) Deccan trap rock |
| (b) of catchment area | (b) Mountainous country |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (a) M.W.L. | (a) R.L. 2054·00 |
| (b) F.R.L. | (b) R.L. 2052·00 |
| (c) Area at M.W.L. | |
| (d) Area at F.R.L. | (d) 1·5 square miles |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | |
| (2) Capacity of the reservoir | |
| (a) Gross | |
| (b) Live | (b) 9,504 acre feet |

(*c*) Flood storage
(*d*) Carry-over




*Cross Section of Lonavla Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 52·0 feet |
| (4) Height above the lowest river bed at dam | 34·5 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 4·5 feet |
| (6) Maximum width at level of foundations | 22·0 feet |
| (7) Width at top | 3·5 feet |
| (8) Slopes | |
| (*a*) Upstream | (*a*) 1 in 32·4 |
| (*b*) Downstream | (*b*) As per cross section |
| (9) Length at top of the dam | 2971·0 feet |
| (*a*) Non-overflow | |
| (*i*) Main | |
| (*b*) Spillway | (*b*) Main waste weir 525 feet and an auxiliary waste weir 1,000 feet long |
| (10) Cubic volume of the body of the dam | 1,562,000 cubic feet |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Uncoursed rubble masonry in lime mortar |
| (12) Specific gravity | |
| (*a*) Masonry | (*a*) 2·28 |
| (13) Nature of protection and waterproofing of the upstream and downstream faces | Upstream and downstream faces originally pointed with lime mortar but upstream face has since been repointed with cement, sand, and ironite 1 cement, 2 sand and 12½ per cent ironite for cement by weight. |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundations of the dam | Original construction was provided with lime mortar only. This has since been raked out on upstream side and replaced with cement sand, and ironite mortar. |
| (16) Contraction joints | |

(17) Principal stresses in the masonry with a note of methods of calculations employed

(18) Maximum pressure on foundations

(19) Uplift pressure, calculated or measured

(20) Measures adopted for preventing counteracting uplift pressures

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*

(*a*) Crown waste

(*b*) Proprietory

(2) *Dislocation*

(*a*) Villages

(*b*) Families

(*c*) Population

(*d*) Roads

(*i*) Highways

(*ii*) District Roads

(*iii*) Village Roads

(*e*) Railway Lines

(*f*) Temples, Mosques, *etc.*

(*g*) Graves, *etc.*

(*h*) Trees, gardens, pastures, houses, wells, *etc.*

(*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

(1) Surplusing works — One main and one auxiliary waste weir ; the former is in continuation of the main dam having 35 openings, 15 feet each making a total escape length of 525 feet and 2 feet depth. The crest width is 3 feet with roadway above. The latter is an open weir 1,000 feet long with a crest width of 15 feet in continuation of the auxiliary dam.

| | |
|---|---|
| (2) Outlet works | 4 stoney sluices by Ransomes and Rapier each 6 feet by 6 feet clear opening located in the auxiliary dam at R.L 2026·00. |
| (3) Scouring works | Simple cast iron and bronze faced sluice gate 5 feet by 5 feet located at about the middle third of the dam at R.L. 2027·00. |
| (4) Inspection facilities | |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | |

## VI. POWER HOUSE

| | |
|---|---|
| (1) Hydraulic head | Maximum head gross 1,726 feet |
| (2) Name and address of Licensee with managing agents (if any) | The Tata Hydro-electric Power Supply Company Limited |
| (3) Generating units | |
| (a) Type | |
| (b) Number | (b) 6 Nos |
| (c) Capacity | |
| (i) Firm | (i) 48,000 kW |
| (4) Voltage | 5,000 |
| (5) Number of phases and frequency, A.C. or D.C. | 3 Ph.A.C. 50 cycles per second |
| (6) Forebay | Three reservoirs formed by constructing dams across valleys known as Lonavla, Walwhan, and Shirawta. |
| (7) A brief description of tunnel and pen-stocks | From the reservoirs water is conveyed in an open duct to the forebay and thence through pipe lines to the power house, a distance of 13,000 feet, in which length there is a fall of 1,725 feet. |
| (8) Means provided for excluding silt and trash. | |
| (9) Tail face | |
| (10) Maximum length of transmission line | 43 miles |
| (11) Principal towns served | Bombay |
| (12) Main and subsidiary purpose of the utilisation of electricity | |
| (13) Any other matter of interest | |

## VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

(4) Operation of the dam
- (*a*) Regulation
- (*b*) Silting of the reservoir
  - (*i*) Total silt deposited
  - (*ii*) Rate of silting
  - (*iii*) Density of the silt deposited
  - (*iv*) Rate of advancement of delta
- (*c*) Actual yeild as against estimated
- (*d*) Various measurements and observations
  - (*i*) Evaporation
  - (*ii*) Sweating below the dam
  - (*iii*) Temperature measurements
  - (*iv*) Seepage and regeneration
- (*e*) Fish culture
- (*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

(3) Bibliography

Dickinson A, " The Bombay Hydro-Electric Scheme " Institute of Electrical Engineers, Journal, Volume 53, No, 248, May 1915.

# IV. 20. Walwhan Dam

## (Masonry)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 71·0 feet |
| (2) Location | Indrayani river, Poona district, Bombay presidency. |
| (3) Authority or owner | The Tata Hydro-electric Power Supply Co. Ltd. |
| (4) Purpose—Main and subsidiary | Power |
| (5) Year of commencement | January 1911 |
| (6) Year of completion | Novermber 1916 |
| (7) Capital cost | |
| (a) Estimated | |
| (b) Actual | (b) Rs. 85,17,111/ (including cost of Lonavla) |
| (10) Installed hydro-electric capacity | |
| (a) Firm | (a) The Lonavla, Walwhan, and Shirawta dams supply water to Khopoli Hydro-Electric Power Station where the installed capacity is 48,000 kW. |
| (11) Means of access | It is accessible from Lonavla railway station by road. |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 5·5 square miles |
| (2) Nature of catchment | Wooded and mountainous |

| | |
|---|---|
| (3) Mean annual precipitation | |
| (a) Rainfall | (a) 133 inches |
| (4) Total average annual yield of the catchment | 40,863 acre feet |
| (5) Climate | Tropical |
| (6) Temperature conditions and variations | Maximum temperature 100°F<br>Minimum temperature 55°F |
| (7) Rate of Flow | |
| (a) Maximum | (a) 950 cusecs |
| (b) Minimum | |
| (8) Detritus charge of the stream | The entire catchment is wooded and rocky. There is very little flow of solids into the reservoir and consequently there is no silting behind the dam |
| (9) Character (chemical) of the water stored in the reservoir | Sweet water, impounded in lakes during monsoon |
| (10) Geological features | |
| (a) of foundations | (a) Deccan trap rock |
| (b) of catchment area | (b) Mountainous country |

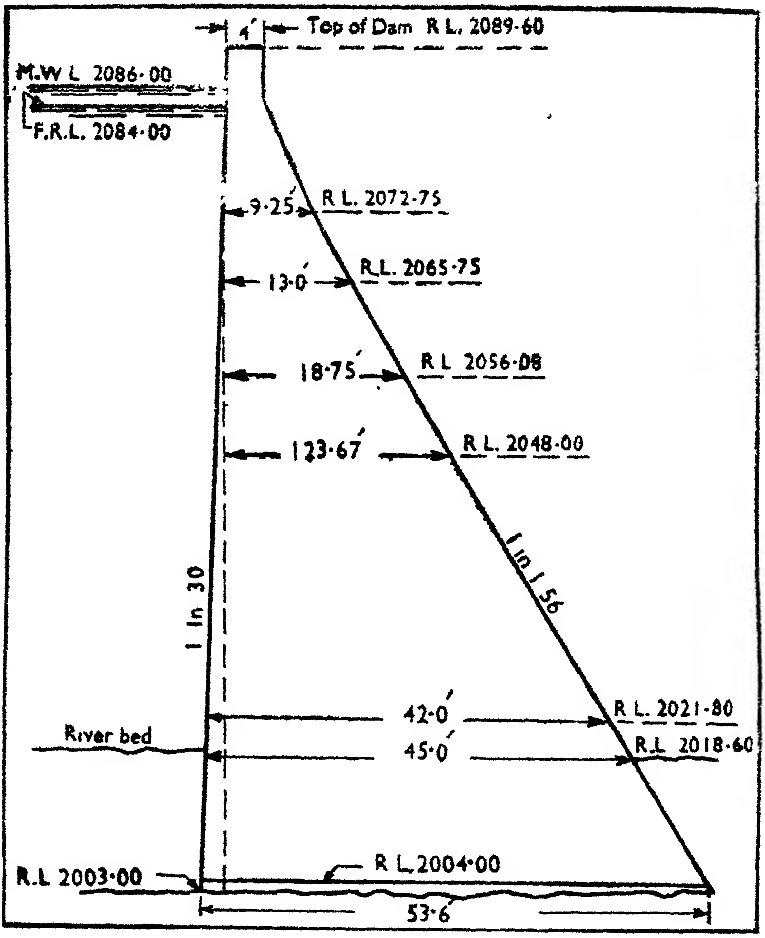
## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (a) M.W.L. | (a) R.L. 2086·00 |
| (b) F.R.L. | (b) R.L. 2084·00 |
| (c) Area at M.W.L. | |
| (d) Area at F.R.L. | (d) 2·4 square miles. |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | |
| (2) Capacity of the reservoir | |
| (a) Gross | |
| (b) Live | (b) 58,769 acre feet |

(*c*) Flood storage

(*d*) Carry-over




*Cross Section of Walwhan Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 86·5 feet |
| (4) Height above the lowest river bed at dam | 71 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 5·6 feet |
| (6) Maximum width at level of foundations | 53·6 feet |
| (7) Width at top | 4·0 feet |

| | |
|---|---|
| (8) Slopes | |
| (a) Upstream | (a) 1 in 30 |
| (b) Downstream | (b) 1 in 1·56 |
| (9) Length at top of the dam | 4,450 feet |
| (a) Non-overflow | |
| (i) Main | (a) (i) 3,380 feet |
| (b) Spillway | (b) 1,070 feet |
| (10) Cubic volume of the body of the dam | 6,440,000 cubic feet |

B. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed | Uncoursed rubble masonry in lime mortar with coursed rubble masonry face work on upstream and downstream faces |
| (12) Specific gravity | |
| (a) Masonry | (a) 2·28 |
| (13) Nature of protection and waterproofing of the upstream and downstream faces | Upstream face originally pointed in cement and downstream in lime mortar. Upstream face has since been repointed with cement, sand and ironite–1 cement, 2 sand, and 12½ per cent ironite to cement by weight. |
| (14) Provision for dealing with seepage and drainage water. | |
| (15) Means of securing water tightness of the foundation of the dam | Original construction was provided cement only to upstream face. This has since been raked out and replaced with a waterproof mixture of 1 cement, 2 sand and 12½ per cent ironite to cement by weight. |
| (16) Contraction joints | |
| (17) Principal stresses in the masonry with a note of methods of calculations employed | It is so designed that the resultant of the water pressure and the dam weight at any height cuts the width at that point within the middle third. |
| (18) Maximum pressure on foundations | |
| (19) Uplift pressure, calculated or measured | |
| (20) Measures adopted for preventing or counter-acting uplift pressures | |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
- (*a*) Crown waste
- (*b*) Proprietory

(2) *Dislocation*
- (*a*) Villages
- (*b*) Families
- (*c*) Population
- (*d*) Roads
  - (*i*) Highways
  - (*ii*) District Roads
  - (*iii*) Village Roads
- (*e*) Railway Lines
- (*f*) Temples, Mosques, *etc.*
- (*g*) Graves, *etc.*
- (*h*) Trees, gardens, pastures, houses, wells, *etc.*
- (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | One main waste weir of normal dam section located at east end of the dam and consisting of 58 arched-openings each 12 feet long giving a net clear water way 696 feet in length and 2 feet in depth and crest width of 4 feet with a road-way above. |
| (2) Outlet works | Five Stoney sluices, by Ransomes and Rapier, each 6 feet by 6 feet clear opening, located about 300 feet from the west end of the dam at R.L. 2032·00 |
| (3) Scouring works | Simple cast iron and bronze faced sluice gate 3 feet by 3 feet located about the middle of the dam, chain 2370 at R.L. 2025·00 |

| | |
|---|---|
| (4) Inspection facilities | |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | |

## VI. POWER HOUSE

| | |
|---|---|
| (1) Hydraulic head | Maximum head gross 1,726 feet |
| (2) Name and address of Licensee with managing agents (if any) | The Tata Hydro-Electric Power Supply Company Limited |
| (3) Generating units | |
| (*a*) Type | |
| (*b*) Number | (*b*) 6 numbers |
| (*c*) Capacity | |
| (*i*) Firm | (*i*) 48,000 kW |
| (*ii*) Secondary | |
| (4) Voltage | 5,000 |
| (5) Number of phases and frequency, A.C. or D.C. | 3 Ph. A.C. 50 cycles per second |
| (6) Forebay | The reservoirs formed by constructing dams across valleys are known as Lonavla, Walwhan and Shirawta. |
| (7) A brief description of tunnel and penstocks | From the reservoirs water is conveyed in an open duct to the forebay and thence through pipe lines to the Power house a distance of 13,000 feet in which length there is a fall of 1,726 feet. |
| (8) Means provided for excluding silt and trash | |
| (9) Tail race | |
| (10) Maximum length of transmission line | 43 miles |
| (11) Principal towns served | Bombay |
| (12) Main and subsidiary purpose of the utilisation of electricity | |
| (13) Any other matter of interest | |

## VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

(4) Operation of the dam

- (*a*) Regulation
- (*b*) Silting of the reservoir
  - (*i*) Total silt deposited
  - (*ii*) Rate of silting
  - (*iii*) Density of the silt deposited
  - (*iv*) Rate of advancement of delta
- (*c*) Actual yield as against estimated
- (*d*) Various measurements and observations
  - (*i*) Evaporation losses
  - (*ii*) Sweating below the dam
  - (*iii*) Temperature measurements
  - (*iv*) Seepage and regeneration
- (*e*) Fish culture
- (*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

(3) Bibliography

Dickinson A, " The Bombay Hydro-Electric scheme " Institute of Electrical Engineers, Journal, volume 53, No. 248, May 1915.

# IV. 21. Siddapur Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 60 feet |
| (2) Location | Kurnool district, Madras State (Bhavnasi river) |
| (3) Authority or owner | Madras Government |
| (4) Purpose—Main and subsidiary | Irrigation |
| (5) Year of commencement | 1908 |
| (6) Year of completion | 1919 |
| (7) Capital cost | |
| (a) Estimated | Rs. 5,04,600 |
| (b) Actual | Rs. 9,48,600 |
| (8) Culturable area commanded by the project | |
| (9) Area irrigated | 1,000 acres |
| (11) Means of access | It is accessible from Kurnool Town railway station, by road, and is at a distance of 50 miles. It is also approachable from Nandyal railway station which is 40 miles away from the dam. |

### II. GEOPHYSICAL

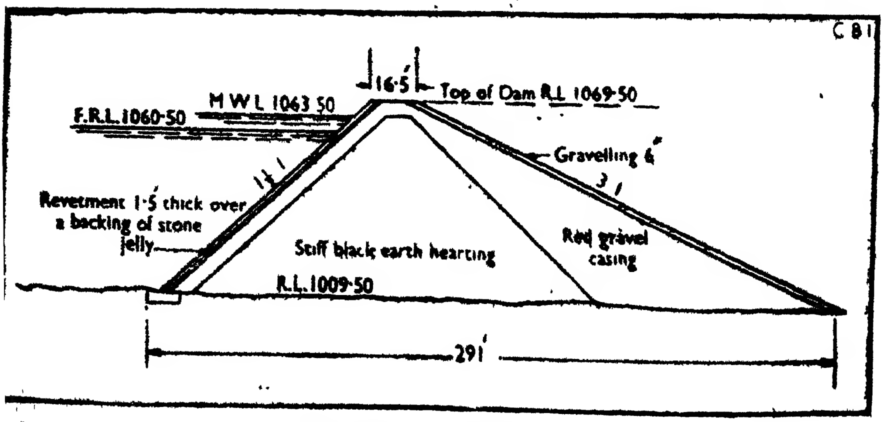
| | |
|---|---|
| (1) Area of catchment | 45 square miles |
| (2) Nature of catchment | Hilly |
| (3) Mean annual precipitation | |
| (a) Rainfall | 27 inches |
| (4) Total average annual yield of the catchment | About 4,013 acre feet |
| (5) Climate | Tropical |
| (6) Temperature conditions and variations | Maximum temperature 107° F<br>Minimum temperature 68° F |
| (7) Rate of Flow | |
| (a) Maximum | 7,590 cusecs |
| (b) Minimum | |

| | |
|---|---|
| (8) Detritus charge of the stream | The supply of water is from the Nallamalai hills and it brings down all the jungle drift wood, leaves, bamboos and also silt which is made of fine particles of earth and stone from the top of the hills, and alluvial silt formed out of decayed leaves. |
| (9) Character (chemical) of the water stored in the reservoir | Sweet, and it does not seem to contain any deleterious matter. |
| (10) Geological features | |
| (a) of foundations | Shale |
| (b) of catchment area | |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (a) M.W.L. | (a) R. L. 1063·50 |
| (b) F. R.L. | (b) R.L. 1060·00 |
| (c) Area at M.W.L. | (c) 2·12 square miles approximately |
| (d) Area at F.R.L. | (d) 1·86 square miles |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | |
| (2) Capacity of the reservoir | |
| (a) Gross | (a) 20·038 acre feet roughly |
| (b) Live | (b) 14,828 acre feet |
| (c) Flood storage | (c) 4,384 acre feet roughly |
| (d) Carry-over | (d) 1,976 acre feet roughly (assuming culturable area as 2,800 acres and water required for irrigation 0·2 million cubic feet per acre) |




*Cross Section of Siddapur Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 63 feet |
| (4) Height above the lowest river bed at dam. | 60 feet |
| 5) Height of the top of the dam above the crest of the spillway or weir | 9·5 feet |
| (6) Maximum width at level of foundation | 291 feet |
| (7) Width at top | 7·5 feet to 16·5 feet |
| (8) Slopes | |
| (a) Upstream | $1\frac{1}{2}$ to 1 |
| (b) Downstream | 2 to 1 and 3 to 1 |
| (9) Length at top of the dam | 16,092 feet |
| (a) Non-overflow | |
| (i) Main | (i) 15,491 feet |
| (b) Spillway | 601 feet |
| (10) Cubic volume of the body of the dam | 19,000,000 cubic feet |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Soil sufficiently rich in clay provided for hearting and the outer casing of porous material |
| (12) Specific gravity | |
| (d) Earth fiill | |
| (13) Nature of protection and waterproofiing of the upstream and downstream faces | Upstream side revetted 1·5 feet in thickness over a backing of stone jelly, and downstream side has been provided with 6 inches gravelling |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundations of the dam | Foundation at deepest bed taken to shale and the bund bonded to shale by cutting trenches in shale |
| (21) Hydraulic gradient for which the embankment is designed | 1 in 5 approximately |
| (22) Particular of the berm (if any), width and position | |
| (23) Position and form of the core wall (or other means of securing water tightness) | No core wall. Only hearting with stiff black clay and casing with porous material |

| | |
|---|---|
| (24) Batter (if any) of the core wall | |
| (25) Maximum depth below ground surface of core-wall or other means of securing water tightness | |
| (26) Method of keying core-wall or other wall in the underlying ground | |
| (27) Nature of material forming the core or other wall | At the breached section stiff black earth hearting was provided |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

| | |
|---|---|
| (1) *Land submerged* | |
| (*a*) Crown waste | The work is only a restoration of a Pre-British tank |
| (*b*) Proprietory | |
| (2) *Dislocation* | |
| (*a*) Villages | |
| (*b*) Families | |
| (*c*) Population | |
| (*d*) Roads | |
| (*i*) Highways | |
| (*ii*) District Roads | |
| (*iii*) Village Roads | |
| (*e*) Railway Lines | |
| (*f*) Temples, Mosques, *etc.* | |
| (*g*) Graves, *etc.* | |
| (*h*) Trees, gardens, pastures, Houses, wells, *etc.* | |
| (*i*) Bridges | |
| (3) Compensation paid under each category of item (2) | |
| (4) Method of compensating for land of dispossessed landholders | |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplusing works | There is a masonry bye-wash 601 feet in length. Its discharging capacity is 8,116 cusecs with a depth of 3·5 feet over crest |
| (2) Outlet works | Two pipe sluices |
| (3) Scouring works | |

| | |
|---|---|
| **(4) Inspection facilities** | The tunnels of the two sluices are accessible for inspection from the rear. The sluices have wooden shutters with screw gearing arrangements |
| **(5) Fish-pass** | |
| **(6) Means for dissipating energy below the spillway** | |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| **(1) Constructional features** | Consolidation of bund was first tried by loaded carts. Carts were driven to and fro and across until the whole area to be consolidated had been covered by the wheels. This gave fairly good results. After that two steam road rollers one of 8-ton and other of 10-ton were used to consolidate the earth. The thickness of the layers varied from 4 inches to 6 inches and the maximum size of clods to 3 inches cube. The surface was rolled three times and the result was quite satisfactory<br>Sufficiency of consolidation was tested by digging pits in each completed layer filling them with water and observing its behaviour. A roller was found to consolidate satisfactorily ten units per day and the rate worked out at from 8 to 10 annas per unit of 1,000 cubic feet |
| **(2) Changes introduced in the plans of the dam and in the method of carrying out the work** | The original proposal was to restore the full length of the old bund so as to impound the yield from the full catchment of (7 + 45) 52 square miles. But estimated cost of the proposal was found to be out of proportion to the corresponding advantage to be derived from the additional catchment of seven square miles. It was finally decided to improve only the portion of the old tank bund south of the road and to form a new bund in continuation taken parallel to the south of the Dornal pass road |

| | |
|---|---|
| (3) Noteworthy occurrences and accidents | The tank breached in September 1949, due to unprecedented rains. The bund did not breach at the deepest portion |
| (4) Operation of the dam | |
| (a) Regulation | |
| (b) Silting of the reservoir | |
| (i) Total silt deposited | |
| (ii) Rate of silting | |
| (iii) Density of the silt deposited | |
| (iv) Rate of advancement of delta | (iv) Advanced to 660 acres in the second year after completion. Further advancement slowed down. Maximum cultivation is 1,203 acres in 1946-47 |
| (c) Actual yield as against estimated. | |
| (d) Various measurements and observations | |
| (i) Evaporation Losses | (i) Above 9 inches to 10 inches during summer and 5 inches to 6 inches in other seasons |
| (ii) Sweating below the dam | |
| (iii) Temperature measurements | |
| (iv) Seepage and regeneration | (iv) Small quantity of percolation through bund |
| (e) Fish culture | |
| (f) Anti-malaria measures | |
| (5) Recreation facilities | |
| (6) Lessons to be learnt from the construction and utilisation of the dam | The tank has not surplussed till now and it has thus been revealed that the run-off from the catchment had been over-estimated. The anticipated ultimate area commanded under the tank had, therefore, to be cut down (from 4,250 acres to 1,000 acres). From this point of view, the project cannot be considered a success |

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

The project provided for restoring and enlarging an old breached tank on the Bhavanasi river seven miles east of Atmakur. In 1901 the preliminary report on the project was submitted by Mr. H. E. Clerk, Special Superintending Engineer. Detailed investigation was then carried out from 1903-1905 by Mr. R. N. Arogyaswami Mudalliar under the guidance of the Special Superintending Engineer, Mr. J. H. Medlicott. Final shape to the proposal was given by his successor Mr. H. E. Clerk. An estimate amounting to Rs. 5,04,000 was sanctioned by the Government of India in 1907. The work was started in 1908 and completed in 1919.

(2) Personnel

*Chief Engineers.*—

C. A. Smith, Esquire.
H. E. Clerk, Esquire.

*Superintending Engineers.*—

R. A. Allen, Esquire.
A. C. Langston, Esquire.
W. J. Howley, Esquire.

*Executive Engineers.*—

M. R. Ry. G. S. Rama Ayyar Avl.
M. R. Ry. L. D. Venkatarama Ayyar Avl.
A. S. Laurie Esquire.

(3) Bibliography

# IV. 22. Osmansagar Dam

## (Composite)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 112 feet |
| (2) Location | Atraf Balda, Madak District (Musi river). |
| (3) Authority or owner | Hyderabad Government |
| (4) Purpose—Main and subsidiary | Water supply and flood absorption |
| (5) Year of commencement | 1912 |
| (6) Year of completion | 1920 |
| (7) Capital cost | |
| (a) Estimated | (a) (i) original O.S. Rs. 30,77,669<br>(ii) Revised O.S. Rs. 58,40,000 |
| (b) Actual | (b) O.S. Rs. 54,00,000 |
| (11) Means of access | |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 285 square miles |
| (2) Nature of catchment | |
| (3) Mean annual precipitation | |
| (a) Rainfall | (a) 24·65 inches |
| (4) Total average annual yield of the catchment | 70, 832 acre feet |
| (5) Climate | Tropical |
| (6) Temperature conditions and variations | |
| (7) Rate of Flow | |
| (a) Maximum | |
| (b) Minimum | |
| (8) Detritus charge of the stream | |
| (9) Character (chemical) of the water stored in the reservoir | Sweet |

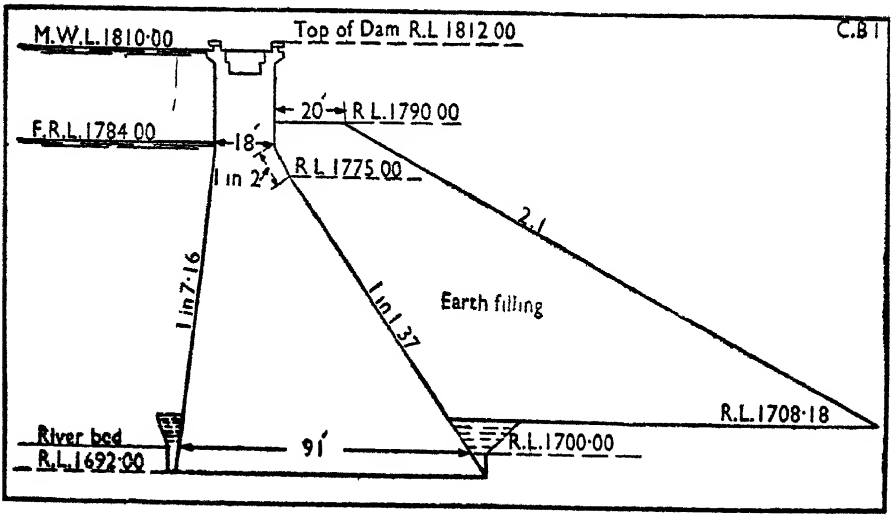
(10) Geological features
(a) of foundations
(b) of catchment area

## III. TECHNICAL

### A. STATISTICAL

(1) Reservoir Data
(a) M.W.L. — (a) R. L. 1810·00
(b) F.R.L. — (b) R. L. 1784·00
(c) Area at M.W.L. — (c) 16·22 square miles.
(d) Area at F.R.L. — (d) 8·67 square miles
(e) Maximum length
(f) Maximum width
(g) Length of periphery

(2) Capacity of the reservoir
(a) Gross — (a) 90,449 acre feet
(b) Live
(c) Flood storage
(d) Carry-over




*Cross Section of Osmansagar Dam*

(3) Maximum height above the lowest point of foundations — 120 feet

(4) Height above the lowest river bed at dam — 112 feet

(5) Height of the top of the dam above the crest of the spillway of weir — 38 feet above silt level of flood gates

| | |
|---|---|
| (6) Maximum width at level of foundations | 91 feet |
| (7) Width at top | 18 feet |
| (8) Batter of face-slopes | |
| (a) Upstream | (a) As per cross section |
| (b) Downstream | (b) As per cross section |
| (9) Length at top of the dam | 6,300 feet |
| (a) Non-overflow | |
| (i) Main | (i) 4,610 feet. |
| (b) Spillway | (b) 1,690 feet (Bye-wash) |
| (10) Cubic volume of the body of the dam. | 7,627,181 cubic feet |

B. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed | Uncoursed rubble stone in *surkhi* mortar and earth filling in the rear. |
| (12) Specific gravity | |
| (a) Masonry | (a) 2·25 |
| (d) Earthfill | |
| (13) Nature of protection and water-proofing of the upstream and downstream faces | |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundations of the dam | Built on hard rock devoid of all fissures and faults. |
| (16) Contraction joints | |
| (17) Principal stresses in the masonry with a note of methods of calculations employed | |
| (18) Maximum pressure on foundations. | 5·52 tons per square foot |
| (19) Uplift pressure, calculated or measured | |
| (20) Measures adopted for preventing or counteracting uplift pressures | |
| (27) Nature of material forming the core or other wall | |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged* :

(a) Crown waste

(b) Proprietory

(2) *Dislocation* :

(a) Villages

(b) Families

(c) Population

(d) Roads :

(i) Highways

(ii) District Roads

(iii) Village Roads

(e) Railway Lines

(f) Temples, mosques, *etc.*

(g) Graves, *etc.*

(h) Trees, gardens, pastures, houses, wells, *etc.*

(i) Bridges

(3) Compensation paid under each category of item (2).

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

(1) Surplussing work — 15 open vents each 6 feet in width at R. L. 1790.

(2) Outlet works — The lowest sill of the water supply sluice is at R. L. 1757 and sill valves are arranged at every 5 feet to be able to draw water at suitable levels.

(3) Scouring works

(4) Inspection facilities

(5) Fish-pass

(6) Means for dissipating energy below the spillway

(1) Constructional features — The section of the dam is such as will stand by itself without taking the earth filling into account. However earthfilling in the rear is done to add to the factor of safety against sliding.

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

(4) Operation of the dam

(*a*) Regulation

(*b*) Silting of the reservoir

(*i*) Total silt deposited

(*ii*) Rate of silting

(*iii*) Density of the silt deposited

(*iv*) Rate of advancement of delta

(*c*) Actual yield as against estimated

(*d*) Various measurements and observations

(*i*) Evaporation losses

(*ii*) Sweating below the dam

(*iii*) Temperature measurements

(*iv*) Seepage and regeneration

(*e*) Fish culture

(*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

After the disastrous flood of 1908, ways and means were investigated for preventing a recurrence of the same and proposals were formulated for constructing two reservoirs, one on the river Musi and the other on the river Easi. The cost of this combined scheme as worked out as Rs. 128 *lakhs* which was duly sanctioned by H. E. H. on 22nd Safer 1328 H. (5th March, 1910). The sole object of these reservoirs was to reduce the floods of great height and high intensity into low floods of long duration. While discussing the order in which these works were to be started, other side issues were happily conceived and thoughts were directed to fully utilise this huge investment which in its original form as destined to lie inert for the greater part of its existence. The pressing need of the time was the question of finding a permanent source of water supply for the City of Hyderabad and Secunderabad. The position of the Musi reservoir afforded facilites for combining the water supply scheme with it and that of the Easi reservoir for subsidiary public utility services. In view of this decision the scope of the original proposal was enlarged and by merit of importance, work was started on the Musi reservoir on October 1912 and on the Easi in June 1920.

(2) Personnel

Designed by Sri Visveswarayya.
Costructed by Mr. C. T. Dalal.

(3) Bibliography

(*i*) Report to accompany the revised estimate for Osmansagar reservoir.

(*ii*) A typed note on Osmansagar and Himayatsagar Reservoirs.

# IV. 23. Shirawta Dam

## (Masonry)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 83 feet |
| (2) Location | Poona district, Bombay State (Indrayani river, Bhore Ghat). |
| (3) Authority or owner | The Tata Hydro-Electric Power Supply Co., Limited. |
| (4) Purpose-Main and subsidiary | Power |
| (5) Year of commencement | December 1912 |
| (6) Year of completion | June 1920 |
| (7) Capital cost | |
| (a) Estimate | |
| (b) Actual | (b) Rs. 82,56,145 |
| (10) Installed hydro-electric capacity | |
| (a) Firm | (a) The Lonavla, Walwhan and Shirawta dams supply water to the Khopoli Hydro-Electric Power Station where the installed capacity is 48,000 kW. |
| (b) Secondary | |
| (11) Means of access | It is accessible from Lonavla railway station on Great Indian Peninsula Railway by motorable road. |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 11 square miles |
| (2) Nature of catchment | Wooded and mountainous |
| (3) Mean annual precipitation | |
| (a) Rainfall | (a) 139 inches |
| (4) Total average annual yield of the catchment | 81,956 acre feet |

| | |
|---|---|
| (5) Climate | Tropical |
| (6) Temperature conditions and variations | Maximum temperatue 100° F<br>Minimum temperature 55° F |
| (7) Rate of Flow | |
| (a) Maximum | (a) 2,310 cusecs. |
| (b) Minimum | |
| (8) Detritus charge of the stream | Due to entire catchment being wooded and rocky, very little or no solids find their way to the reservoir. |
| (9) Character (chemical) of the water stored in the reservoir | Sweet water, impounded in lakes during monsoon |
| (10) Geological features | |
| (a) of foundations | (a) Deccan trap rock |
| (b) of catchment area | (b) Mountainous country |

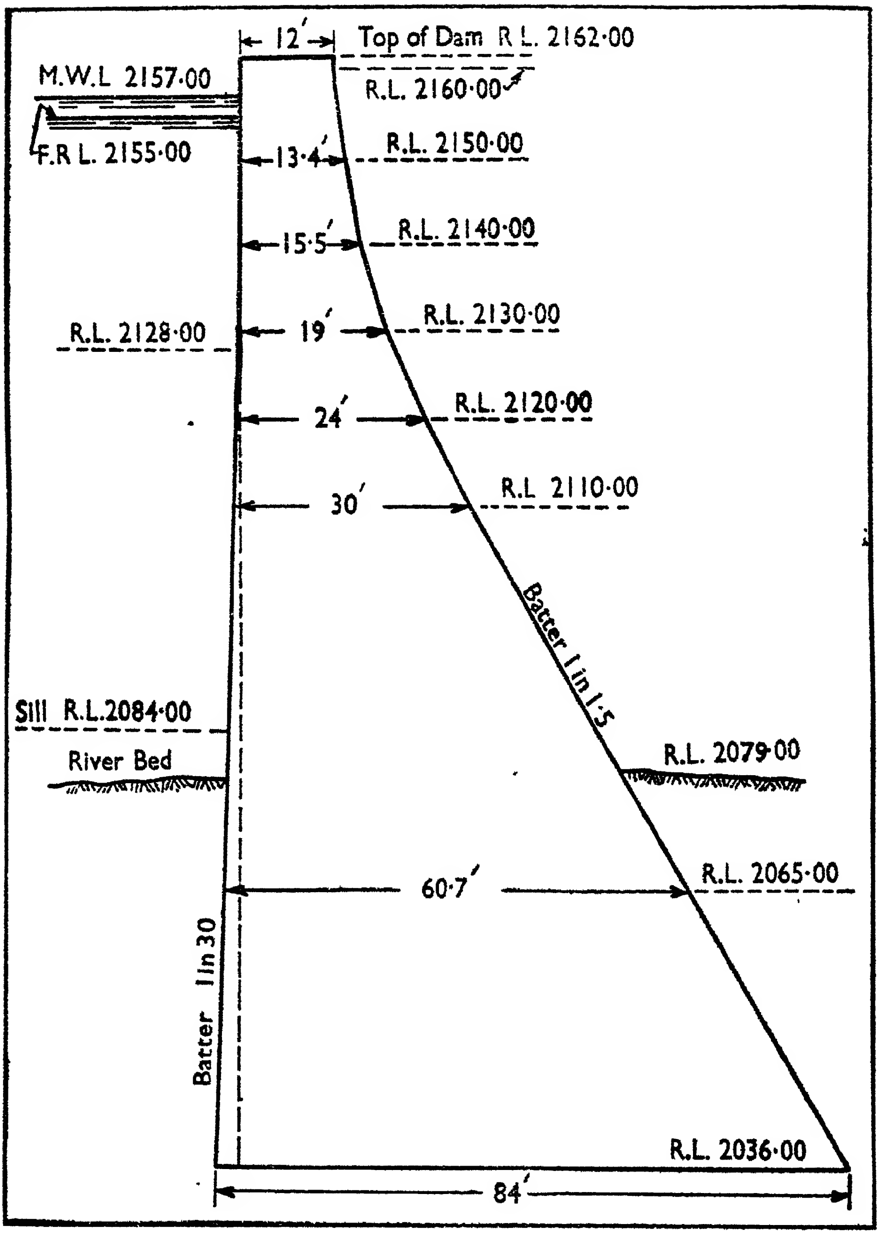
## III. TECHNICAL

## A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (a) M.W.L. | (a) R.L. 2157·00 |
| (b) F.R.L. | (b) R.L. 2155·00 |
| (c) Area at M.W.L. | |
| (d) Area at F.R.L. | (d) 5·05 square miles |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | |
| (2) Capacity of the reservoir | |
| (a) Gross | |
| (b) Live | (b) 150,757 acre feet |

(c) Flood storage

(d) Carry over




*Cross Section of Shirawta dam*

(3) Maximum height above the lowest point of foundations 126·0 feet

| | |
|---|---|
| (4) Height above the lowest river bed at dam | 83 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 7 feet |
| (6) Maximum width at level of foundations. | 84 feet |
| (7) Width at top | 12 feet |
| (8) Slopes | |
| (a) Upstream | (a) 1 in 30 |
| (b) Downstream | (b) As per cross section |
| (9) Length at top of the dam | 7,600 feet |
| (a) Non-overflow | |
| (i) Main | (i) 6,600 feet |
| (b) Spillway | (b) 1,000 feet. |
| (10) Cubic volume of the body of the dam. | 17,000,000 cubic feet. |

B. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed | Uncoursed rubble masonry in lime mortar with coursed rubble masonry face work upstream side and downstream faces. |
| (12) Specific gravity | |
| (a) Masonry | (a) 2·34 |
| (13) Nature of protection and waterproofing of the upstream and downstream faces | Upstream face pointed with cement mortar, downstream face pointed with lime mortar. |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundations of the dam | Original construction provided cement pointing to upstream face. The entire structure including foundations have since been injected with cement by the Francis Cementation Co. |
| (16) Contraction joints | |
| (17) Principal stresses in the masonry with a note of methods of calculations employed | It is so designed that the resultant of the water pressure and the dam weight at any height cuts the sectional width at the point within the middle third. |
| (18) Maximum pressure on foundations | |

(19) Uplift pressure calculated or measured

(20) Measures adopted for preventing or counteracting uplift pressures

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*—
- (*a*) Crown waste
- (*b*) Proprietory

(2) *Dislocation*—
- (*a*) Villages
- (*b*) Families
- (*c*) Population
- (*d*) Roads—
  - (*i*) Highways
  - (*ii*) District Roads
  - (*iii*) Village Roads
- (*e*) Railway Lines
- (*f*) Temples, mosques, *etc.*
- (*g*) Graves, *etc.*
- (*h*) Trees, gardens, pastures, houses, wells, *etc.*
- (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | One main waste weir of thickness 2 feet greater than normal dam section located on the North. It originally consisted of an open weir 1,000 feet long and 14·0 feet wide at the crest, but has since been remodelled to 750 feet long at 3 feet lower crest level. |
| (2) Outlet works | 4 stoney sluices by Ransomes and Rapier each 5 feet by 5 feet clear opening located in a separate head-works of the outlet tunnel about 2 miles upstream of the dam. |

| | |
|---|---|
| (3) Scouring works | Simple cast iron and bronze faced sluice gate 5·0 feet by 5·0 feet, located about 4,700 feet from the south end of the dam at R.L. 2080·00. |
| (4) Inspection facilities | — |
| (5) Fish-pass | — |
| (6) Means for dissipating energy below the spillway | — |

## VI. POWER HOUSE

| | |
|---|---|
| (1) Hydraulic head | Maximum head gross 1,726 |
| (2) Name and address of Licensee with managing agents ( if any). | The Tata Hydro-Electric Power Supply Co. Limited. |
| (3) Generating units | |
| (a) Type | |
| (b) Number | (b) 6 Nos. |
| (c) Capacity | |
| (i) Firm | (i) 48,000 kW. |
| (4) Voltage | 5,000 |
| (5) Number of phases and frequency, A.C. or D.C. | 3 Ph. A.C. 50 cycles per second. |
| (6) Forebay | The reservoir formed by constructing dams across valleys are known as Lonavla, Walwhan, and Shirawta. From the reservoir water is conveyed in an open duct to the forebay, and thence through pipe lines to the power house for a distance of 13,000 feet in which length there is a fall of 1725 feet. |
| (7) A brief description of tunnel and penstocks | |
| (8) Means provided for excluding silt and trash | |
| (9) Tail face | |
| (10) Maximum length of transmission line. | 43 miles |
| (11) Principal towns served | Bombay |
| (12) Main and subsidiary purpose of the utilisation of electricity | |
| (13) Any other matter of interest | |

## VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents.

(4) Operation of the dam

(a) Regulation

(b) Silting of the reservoir

(i) Total silt deposited

(ii) Rate of silting

(iii) Density of the silt deposited

(iv) Rate of advancement of delta

(c) Actual yield as against estimated.

(d) Various measurements and observations

(i) Evaporation losses

(ii) Sweating below the dam

(iii) Temperature measurements

(iv) Seepage and regeneration

(e) Fish culture

(f) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

(3) Bibliography

Dickinson A " The Bombay Hydro-Electric scheme. Institute of Electrical Engineers Journal volume 53, No. 248, May 1915. "

# IV. 24. Thokerwadi Dam

## (Masonry)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 190 feet |
| (2) Location | Bhore Ghat, Poona district, Bombay Presidency (Andhra river) |
| (3) Authority or owner | The Andhra Valley Power Supply Co. Ltd. |
| (4) Purpose, Main and subsidiary | Power |
| (5) Year of commencement | November 1916 |
| (6) Year of completion | May 1922 |
| (7) Capital cost | |
| (*a*) Estimated | |
| (*b*) Actual | (*b*) Rs. 97,79,009 |
| (10) Installed hydro-electric capacity | |
| (*a*) Firm | (*a*) 48,000 kW |
| (*b*) Secondary | |
| (11) Means of access | It is accessible by road from Wadgaon railway station, on Great Indian Peninsula Rly. |

### II. GEOPHYSICAL

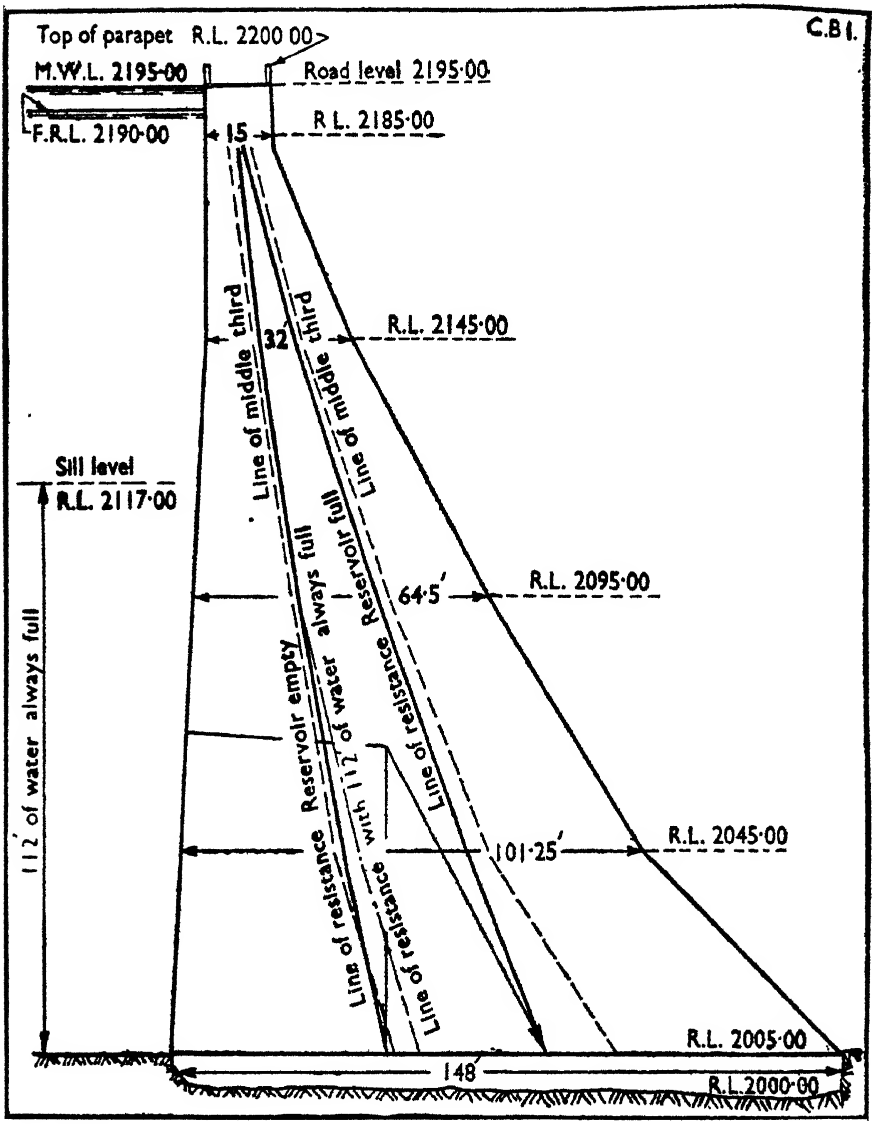
| | |
|---|---|
| (1) Area of catchment | 18 square miles |
| (2) Nature of catchment | Mountainous coutury |
| (3) Mean annual precipitation | |
| (*a*) Rainfall | 103·00 inches |
| (4) Total average annual yield of the catchment | 229,568 acre feet |
| (5) Climate | Tropical |
| (6) Temperature conditions and variations. | Maximum 110°F<br>Minimum 50°F |

| | |
|---|---|
| (7) Rate of Flow | |
| (a) Maximum | 4,010 cusecs |
| (b) Minimum | |
| (8) Detritus charge of the stream | As the entire catchment is wooded or rocky, no solids find their way to the reservoir, consequently there is no silting behind the dam. |
| (9) Character (chemical) of the water stored in the reservoir | Sweet |
| (10) Geological features | |
| (a) of foundations | Deccan trap rock |
| (b) of catchment area | Mountainous country |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (a) M.W.L. | (a) R.L. 2195·00. |
| (b) F.R.L. | (b) R.L. 2190·00 |
| (c) Area at M.W.L. (2195) | (c) 12·52 square miles |
| (d) Area at F.R.L. (2190) | (d) 11·61 square miles. |
| (e) Maximum length (2195) | (e) 13·5 miles |
| (f) Maximum width (2195) | (f) 1·5 miles |
| (g) Length of periphery | (g) 91 miles |
| (2) Capacity of the reservoir | |
| (a) Gross | |
| (b) Live | (h) 294,908 acre feet |
| (c) Flood storage | |
| (d) Carry-over | |
| (3) Maximum height above the lowest point of foundations | 195 feet |
| (4) Height above the lowest river bed at dam | 190 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 5 feet |
| (6) Maximum width at level of foundations | 148 feet |
| (7) Width at top | 15 feet |




*Cross Section of Thokerwadi Dam*

(8) Batter of face-slopes
  (a) Upstream } As per cross section
  (b) Downstream

(9) Length at top of the dam — 1,875 feet
  (a) Non-overflow
    (i) Main — (i) 1,318 feet
  (b) Spillway — (b) 557 feet

| | |
|---|---|
| (10) cubic volume of the body of the dam | Main dam, 7,492,612 cubic feet. Waste weir, 90,200 cubic feet. |
| (11) Material of which the dam is constructed | Rubble masonry and lime concrete and water proof diaphragm of cement , sand and ironite. |
| (12) Specific gravity | |
| (a) Masonry | (a) 2·56 |
| (b) Concrete | |
| (13) Nature of protection and water-proofing of the upstream and down-stream faces | From foundation level R. L. 2000 to R.L. 2080 the dam consists of lime concrete between heavy upstream and downstream rubble masonry walls with a vertical water proof diaphragm of cement, sand and ironite 11 feet from the upstream face at base. From R.L. 2080 to R.L. 2195, the dam is constructed of uncoursed rubble masonry with coursed rubble facing. The upstream is pointed with cement and ironite and downstream face is pointed with lime. |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundations of the dam | The orginial design provided for a water proof diaphragm of cement, sand and ironite but since then the entire structure has also been injected with cement. |
| (16) Contraction joints | |
| (17) Principal stresses in the masonry with a note of methods of calculations employed | |
| (18) Maximum pressure on foundations | 10·42 tons per square feet. |
| (19) Uplift pressure, calculated or measured | |
| (20) Measures adopted for preventing or counteracting uplift | |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*

(a) Crown waste

(b) Proprietory

(2) *Dislocation*

(a) Villages

(b) Families

(c) Population

(d) Roads :

(i) Highways

(ii) District Roads

(iii) Village Roads

(e) Railway Lines

(f) Temples, mosques, *etc.*

(g) Graves, etc.

(h) Trees, gardens, pastures, houses, wells, *etc.*

(i) Bridges

(3) Compensation paid under each category of item (2).

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplusing works | One main natural waste weir open type 557 feet long with a crest width of 13 feet is located at the south and is in continuation of the dam. It is distinctly separate from the main dam and is only 9 feet high. |
| (2) Outlet Work | One main and one emergency sluice stony type in series each 10 ft. by 10 ft. clear opening is located in the head-works of the outlet tunnel about 9 miles upstream of the dam with sill level at R. L. 2108. |
| (3) Scouring works | No sluices are provided in the dam and consequently no provision made to drain the lake below draw off sill level R. L. 2117 |

(5) Inspection facilities

(6) Fish-pass

(7) Means for dissipating energy below the spillway

(2) *Dislocation*

(a) Villages

(b) Families

(c) Population

(d) Roads :

(i) Highways

(ii) District Roads

(iii) Village Roads

(e) Railway Lines

(f) Temples, mosques, *etc.*

(g) Graves, etc.

(h) Trees, gardens, pastures, houses, wells, *etc.*

(i) Bridges

(3) Compensation paid under each category of item (2).

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplusing works | One main natural waste weir open type 557 feet long with a crest width of 13 feet is located at the south and is in continuation of the dam. It is distinctly separate from the main dam and is only 9 feet high. |
| (2) Outlet Work | One main and one emergency sluice stony type in series each 10 ft. by 10 ft. clear opening is located in the head-works of the outlet tunnel about 9 miles upstream of the dam with sill level at R. L. 2108. |
| (3) Scouring works | No sluices are provided in the dam and consequently no provision made to drain the lake below draw off sill level R. L. 2117 |
| (5) Inspection facilities | |
| (6) Fish-pass | |
| (7) Means for dissipating energy below the spillway | |

## VI. POWER HOUSE

| | |
|---|---|
| (1) Hydraulic head | Maximum head gross 1,742 feet<br>Minimum head gross 1,670 feet |
| (2) Name and address of licensee with managing agents (if any) | Andhra Valley Company, Bombay |
| (3) Generating units | |
| (a) Type | (a) Pelton turbines |
| (b) Number | (b) 6 number (Hydro). |
| (c) Capacity | |
| (i) Firm | (i) 48,000 K.W. |
| (ii) Secondary | (ii) 48,000 K.W. plus 20% O.L. for 10 hours. |
| (4) Voltage | 5,000 volts |
| (5) Number of phases and frequency, A.C. or D.C. | 3 Ph. A.C. 50 Cy. |
| (6) Forebay | |
| (7) A brief description of tunnel and penstocks | Length of tunnel is 2,700 feet, exclusive of cut and cover in valley before reaching the entrance to the manifold pipe tunnel. The manifold pipe is for the purpose of connecting the tunnel single outlet with the penstock pipes and is designed to provide a smooth flow to the water in its distribution to 8 penstock pipes and thus reduce any water eddies to a minimum. |
| (8) Means provided for excluding silt and trash. | At the entrance to the tunnel a reinforced concrete structural screen of the parallel bow type is erected to prevent any bulky bodies entering the tunnel. |
| (9) Tail race | Masonry tail race 320 feet long discharging in original river. |
| (10) Maximum length of transmission line | 56·75 miles. |
| (11) Principal towns served | Industrial area of Bombay |
| (12) Main and subsidiary purpose of the utilisation of electricity | Mills and other industries |
| (13) Any other matter of interest | |

## VII. NAVIGATION WORKS

| | |
|---|---|
| (*a*) Length of river where navigation has been made possible by the construction of the dam | 13·5 miles |
| (*b*) Type of cargo transported | |
| (*c*) Number of passengers transported annually | |
| (*d*) Annual income from source at item (2)and (3). | |
| (*e*) Navigation Lock | |
| (*i*) Location | |
| (*ii*) Lock chamber. clear size | |
| (*iii*) Lift (*i*) Maximum | |
| (*ii*) Minimum | |
| (*iv*) Estimated leakage time | |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | |
| (3) Noteworthy occurrences and accidents. | |
| (4) Operation of the dam | |
| (*a*) Regulation | |
| (*b*) Silting of the reservoir | |
| (*i*) Total silt deposited | |
| (*ii*) Rate of silting | |
| (*iii*) Density of the silt deposited. | |
| (*iv*) Rate of advancement of delta | |
| (*c*) Actual yield as against estimated | (*c*) 229,568 acre feet |
| (*d*) Various measurements and observations | |
| (*i*) Evaporation losses | (*i*) Estimated to be 5 feet in a year approximately. |
| (*ii*) Sweating below the dam | |
| (*iii*) Temperature measurements. | |
| (*iv*) Seepage and regeneration | (*iv*) Maximum 0·440 cusecs with lake full. |

(e) Fish culture

(f) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

## IX. BIBLIOGRAPHY AND HISTORICAL

| | |
|---|---|
| (1) Historical | The Company was floated, when it was found that the Tata Hydro-Electric P.S.Co. could not meet with the increasing demand for power by the mills and railways of Bombay and its suburbs. It was developed by Mr. H P. Gibbs, the General Manager. The Company supplies power only to the mills while the Tata Power Co. supplies power to the Great Indian Peninsula and Bombay, Baroda and Central India Railways. |
| (2) Personnel | |
| (3) Bibliography | Chatterjee, Bhim Chandra " The Hydro-Electric Practice in India " |

# IV. 25. Sir Pirajirao Talao Dam

## (Composite)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 37 feet |
| (2) Location | Kolhapur, Bombay State (Local stream). |
| (3) Authority or owner | Bombay State Government |
| (4) Purpose-Main and subsidiary | Irrigation and domestic supply |
| (5) Year of commencement | 1919 |
| (6) Year of completion | 1923 |
| (7) Capital cost— | |
| (a) Estimated | |
| (b) Actual | |
| (8) Culturable area commanded by the project | |
| (9) Area irrigated | |
| (11) Means of access | It is situated, 38 miles away from Kolhapur and is accessible from Kolhapur railway station (Madras and Southern Marhatta Railway) by a metalled road upto Nipani, 25-miles distant (on Poona Bangalore road) and from Nipani to Murgud 13 miles on the Nipani Phonda Road. |

### II. GEOPHYSICAL

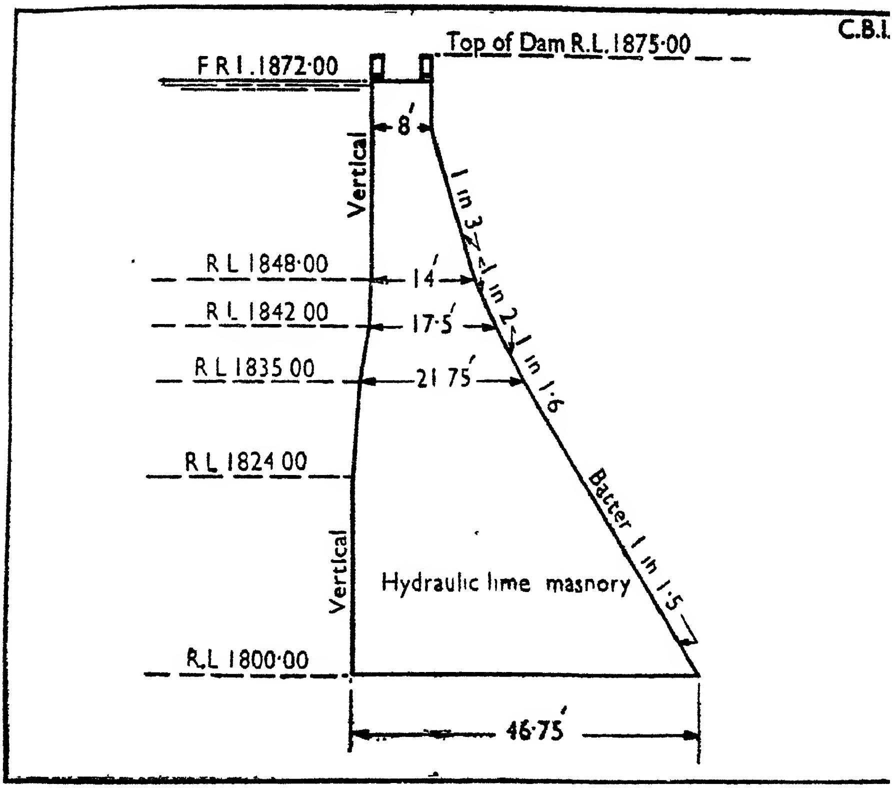
| | |
|---|---|
| (1) Area of catchment | 3 square miles |
| (2) Nature of catchment | A hilly catchment covered with forest |
| (3) Mean annual precipitation— | |
| (a) Rainfall | 32·5 inches. |
| (4) Total average annual yield of the catchment | |

| | | |
|---|---|---|
| (5) Climate | Temperate | |
| (6) Temperature conditions and variations | | |
| (7) Rate of Flow— | | |
| (a) Maximum | | |
| (b) Minimum | | |
| (8) Detritus charge of the stream | | |
| (9) Character (chemical) of the water stored in the reservoir | | |
| (10) Geological features— | | |
| (a) of foundations | (a) Deccan trap. | |
| (b) of catchment area | (b) Hard *moorum*. | |

## III. TECHNICAL

### A. STATISTICAL

| | | |
|---|---|---|
| (1) Reservoir Data— | | |
| (a) M.W.L. | | |
| (b) F.R.L. | (b) R.L. 1872·00. | |
| (c) Area at M.W.L. | | |
| (d) Area at F.R.L. | (d) 0·19 square mile | |
| (e) Maximum length | | |
| (f) Maximum width | | |
| (g) Length of periphery | | |
| (2) Capacity of the reservoir— | | |
| (a) Gross | | |
| (b) Live | 2,348 acre feet | |
| (c) Flood storage | | |
| (d) Carry-over | | |
| (3) Maximum height above the lowest point of foundations | Masonry | 72 feet |
| | Earth | 37 feet |
| (4) Height above the lowest river bed at dam | Masonry | 37 feet |
| | Earth | 37 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | Masonry | 4 feet |
| | Earth | 7 feet |
| (6) Maximum width at level of foundations | Masonry | 46·75 feet |
| | Earth | |
| (7) Width at top | Masonry | 8 feet |
| | Earth | 7 feet |




*Cross Section of Sir Piraji Rao Talao Dam (Masonry portion)*

| | | |
|---|---|---|
| (8) Slopes— | | |
| (a) Upstream | Masonry | As per cross section |
| (b) Downstream | Earth | Upstream 3 to 1, downstream 2 to 1. |
| (9) Length at top of the dam— | Masonry | 750 feet } Total-4,650 feet |
| | Earth | 31,900 feet } |
| (a) Non-overflow— | | |
| (i) Main | 4,250 feet | |
| (b) Spillway or waste weir | 400 feet | |
| (10) Cubic volume of the body of the dam | | |

B. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed | Hydraulic lime masonry and earth with *moorum* |
| (12) Specific gravity— | |
| (a) Masonry | 2·4 |
| (d) Earthfill | |

| | |
|---|---|
| (13) Nature of protection and water-proofing of the upstream and down-stream faces | |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundations of the dam | By means of core-wall in earthen portion |
| (16) Contraction joints | |
| (17) Principal stresses in the masonry with a note of methods of calculations employed | |
| (18) Maximum pressure on foundations | |
| (19) Uplift pressure, calculated or measured | |
| (20) Measures adopted for preventing or counteracting uplift pressures | |
| (21) Hydraulic gradient for which the embankment is designed | |
| (22) Particular of the berm (if any), width and position | |
| (23) Position and form of the core wall (or other means of securing water tightness) | |
| (24) Batter (if any) of the core wall | 1 to 1. |
| (25) Maximum depth below ground surface of core-wall or other means of securing water tightness | 25 feet. |
| (26) Method of keying core-wall or other wall in the underlying ground | By trenching |
| (27) Nature of material forming the core or other wall | Black cotton soil |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*—

(*a*) Crown waste

(*b*) Proprietory

(2) *Dislocation*—

(*a*) Villages

(*b*) Families

(c) Population
(d) Roads—
(i) Highways
(ii) District Roads
(iii) Village Roads
(e) Railway Lines
(f) Temples, mosques, *etc.*
(g) Graves, *etc.*
(h) Trees, gardens, pastures houses, wells, *etc.*
(i) Bridges

(3) Compensation paid under each category of item (2).

(4) Method of compensating for land of dispossessed landholders.

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | A waste weir, 400 feet in length with the maximum one foot depth of water over the crest. |
| (2) Outlet works | A draw off pipe one foot diameter |
| (3) Scouring works | |
| (4) Inspection facilities | |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | |

## VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accident

(4) Operation of the dam—
(a) Regulation
(b) Silting of the reservoir—
(i) Total silt deposited
(ii) Rate of silting
(iii) Density of the silt deposited
(iv) Rate of advancement of delta

(c) Actual yeild as against estimated

(d) Various measurements and observations—

(i) Evaporation losses

(ii) Sweating below the dam

(iii) Temperature measurements

(iv) Seepage and regeneration

(e) Fish culture

(f) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam.

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

Mr. B. P. Jagtap L.C.E., M.R.S.I., Executive Engineer.

Mr. S. S. Gupta, L.C.E., Executive Engineer.

Mr. A. K. Sarnaik, Overseer.

(3) Bibliography

# IV. 26 Himayatsagar Dam

## (Composite)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 93 feet |
| (2) Location | Atrafe-balda, Medak District (Issa river). |
| (3) Authority or owner | Hyderabad Government |
| (4) Purpose-Main and subsidiary | Irrigation and water supply |
| (5) Year of commencement | 1919 |
| (6) Year of completion | 1926 |
| (7) Capital cost— | |
| (a) Estimated | (a) O.S. Rs. 92,72,000 |
| (b) Actual | (b) O.S. Rs. 93,05,727 |
| (8) Culturable area commanded by the project | |
| (9) Area irrigated | |
| (11) Means of access | |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 505 square miles |
| (2) Nature of catchment | |
| (3) Mean annual precipitation— | |
| (a) Rainfall | 28·17 inches |
| (4) Mean annual yield of the catchment | 55,632 acre feet |
| (5) Climate | Tropical |
| (6) Temperature conditions and variations | |
| (7) Rate of Flow— | |
| (a) Maximum | |
| (b) Minimum | |
| (8) Detritus charge of the stream | |

(9) Character (chemical) of the water stored in the reservoir — Sweat

(10) Geological features—
- (a) of foundations
- (b) of catchment area

## III. TECHNICAL

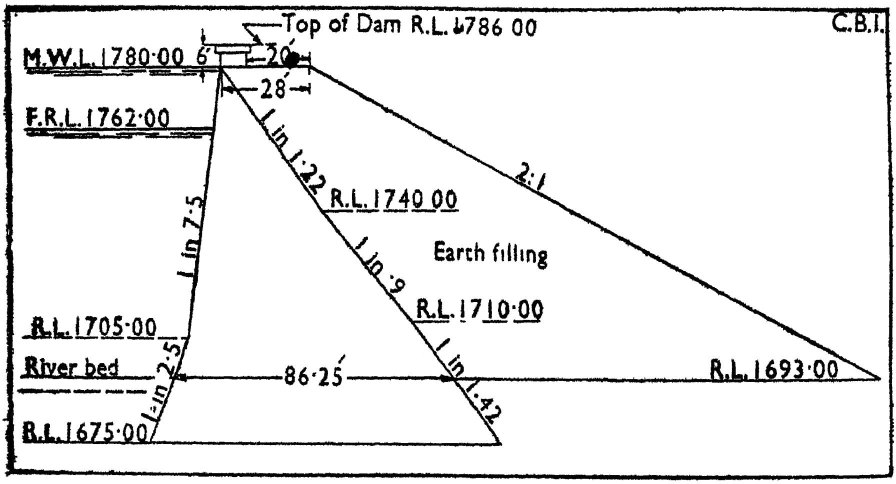
### A. STATISTICAL

(1) Reservoir Data—

| | |
|---|---|
| (a) M.W.L. | (a) R.L. 1780·00 |
| (b) F.R.L. | (b) R.L. 1762·00 |
| (c) Area at M.W.L. | (c) 14·7 square miles |
| (d) Area at F.R.L. | (d) 7·6 square miles |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | |

(2) Capacity of the reservoir—

| | |
|---|---|
| (a) Gross | (a) 87,336 acre feet |
| (b) Live | |
| (c) Flood storage | |
| (d) Carry-over | |




*Cross Section of Himayatsagar Dam*

(3) Maximum height above the lowest point of foundations — 111 feet

(4) Height above the lowest river bed at dam — 93 feet

| | |
|---|---|
| (5) Height of the top of the dam above the crest of the spillway or weir | |
| (6) Maximum width at level of foundation. | 85·25 feet |
| (7) Width at top | 28 feet |
| (8) Batter of face-slopes— | |
| (a) Upstream | (a) As per cross section |
| (b) Downstream | (b) As per cross section |
| (9) Length at top of the dam | 7,473 feet |
| (a) Non-overflow— | |
| (i) Main | 4,914 feet |
| (b) Spillway | 2,559 feet |
| (10) Cubic volume of the body of the dam | |

B. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed | Uncoursed rubble stone in *surkhi** mortar |
| (12) Specific gravity— | |
| (a) Masonry | (a) 2·25 |
| (d) Earthfill | |
| (13) Nature of protection and waterproofing of the upstream and downstream faces | |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundations of the dam | Built on hard rock devoid of all fissures and faults |
| (16) Contraction joints | |
| (17) Principal stresses in the masonry with a note of methods of calculations employed | |
| (18) Maximum pressure on foundations | |
| (19) Uplift pressure, calculated or measured | |
| (20) Measures adopted for preventing or counteracting uplift pressures | |
| (27) Nature of material forming the core or other wall | |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land Submerged*—
(*a*) Crown waste
(*b*) Proprietory

(2) *Dislocation*—
(*a*) Villages
(*b*) Families
(*c*) Population
(*d*) Roads—
(*i*) Highways
(*ii*) District Roads
(*iii*) Village Roads
(*e*) Railway Lines
(*f*) Temples, mosques, *etc.*
(*g*) Graves, etc.
(*h*) Trees, gardens, pastures, houses, wells, *etc.*
(*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

(1) Surplussing works — Waste weir at the left flank.

(2) Outlet works — Two irrigation vents in the body of the dam with sills at R.L. 1733·00.

(3) Scouring works

(4) Inspection facilities

(5) Fish-pass

(6) Means for dissipating energy below the spillway

## VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features — The section of the dam is such as will stand by itself without taking the earth-filling into account. However, earth filling in the rear is done to add to the factor of safety against sliding.

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

(4) Operation of the dam—

  (*a*) Regulation

  (*b*) Silting of the reservoir

    (*i*) Total silt deposited

    (*ii*) Rate of silting

    (*iii*) Density of the silt deposited

    (*iv*) Rate of advancement of delta

  (*c*) Actual yield as against estimated

  (*d*) Various measurements and observations

    (*i*) Evaporation losses

    (*ii*) Sweating below the dam

    (*iii*) Temperature measurements

    (*iv*) Seepage and regeneration

  (*e*) Fish culture

  (*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

(3) Bibliography

# IV. 27. Palair Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 61·5 feet. |
| (2) Location | Warangal District, Hyderabad State. (Palair River) |
| (3) Authority or owner | Hyderabad Government |
| (4) Purpose Main and subsidiary | Irrigation |
| (5) Year of commencement | March 1923 |
| (6) Year of completion | September 1928 |
| (7) Capital cost | |
| (a) Estimated | (a) Rs. 24,65,000 |
| (b) Actual | (b) Rs. 25,33,751 |
| (8) Culturable area commanded by the project | 31,000 acres |
| (9) Area irrigated | 19,650 acres. |
| (11) Means of acess | The dam is situated 16 miles from Khammamet railway station (Secunderabad Bezwada Lines) and is also accessible by road from Hyderabad. |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 651·24 square miles |
| (2) Nature of catchment | |
| (3) Mean annual precipitation of Rainfall | 28·5 inches |
| (4) Total average annual yield of the catchment. | 82·656 acre feet |
| (5) Climate | Tropical |
| (6) Temperature conditions and variations. | Maximum 107° F<br>Minimum 62·3° F |
| (7) Rate of Flow : | |
| (a) Maximum | 13,015 cusecs (Actual observation in 1932) |
| (b) Minimum | |

(8) Detritus charge of the stream — The river passes through a flat country and is fed from a catchment which is intercepted by a number of minor tanks. Hence the deposit of silt is very little.

(9) Character (chemical) of the water stored in the reservoir — Sweet and clear

(10) Geological features
- (a) of foundations — Granite
- (b) of catchment area

## III. TECHNICAL

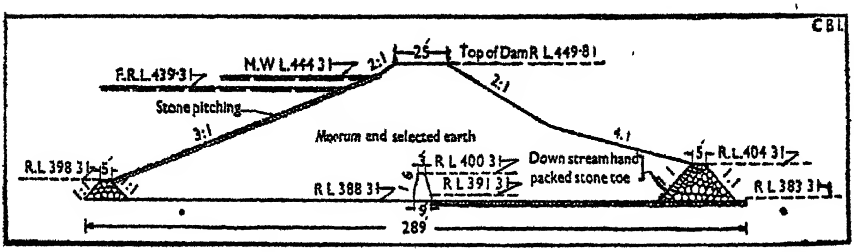
### A. STATISTICAL

(1) Rrservoir Data

| | |
|---|---|
| (a) M.W.L. | (a) R. L. 444·31 from an arbitrarry datum) |
| (b) F.R.L. | (b) R.L. 439·31 (from an arbitrary datum). |
| (c) Area at M.W.L. | (c) 8·4 square miles |
| (d) Area at F.R.L. | (d) 6·6 square miles |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | |

2. Capacity of the reservoir

| | |
|---|---|
| (a) Gross | (a) 58·755 acre feet. |
| (b) Live | (b) 53,653 acre feet. |
| (c) Flood storage | |
| (d) Carry over | |




*Cross Section of Palair Dam*

3. Maximum height above the lowest point of foundations — 67·5 feet

4. Height above the lowest river bed at dam — 61·5 feet

| | |
|---|---|
| 5. Height of the top of the dam above the crest of the spillway or weir | 9·5 feet |
| 6. Maximum width at level of foundations | 289 feet |
| 7. Width at top | 25 feet |
| 8. Slopes | 323 feet |
| (a) Upstream<br>(b) Downstream | As per cross section |
| 9. Length at top of the dam | 8,300 feet |
| (a) Non over flow | |
| (i) Main | |
| (ii) Subsidiary | |
| (b) Spillway or waste weir | 2,350 feet (including 6 automatic shutters each 50 feet×4 feet=323 feet (1). |
| 10. Cubic volume of the body of the dam. | 27,440,000 cubic feet |

B. OTHERS

| | |
|---|---|
| 11. Material of which the dam is constructed. | *Moorum* and selected earth |
| 13. Nature of protection and waterproofing of the upstream and downstream faces | Revetment on the upstream side |
| (14) Provision for dealing with seepage and drainage water | Provided with infiltration drains |
| (15) Means of securing water tightness of the foundations of the dam | By means of masonry core wall |
| (21) Hydraulic gradient for which the embankament is designed. | |
| (22) Particular of the berm (if any), width and position. | |
| (23) Position and form of the core wall (or other means of securing water tightness). | Core wall, 3 feet wide at top, built in centre of the dam at the gorge portion only. |
| 24. Batter (if any) of the core wall | 1 in 6 |
| 25. Maximum depth below ground - surface of corewall or other means of securing water tightness | 6 feet |
| 26. Method of keying corewall or other wall in the underlying ground. | Benching founds. |
| 27. Nature of material forming the core or other wall. | Coursed rubble stone masonry in *surkhi* mortar. |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged* :

(*a*) Crown waste

(*b*) Proprietory

(2) *Dislocation* :

(1) Villages

(*b*) Families

(*v*) Population

(*d*) Roads :

(*i*) Highways

(*ii*) District Roads

(*iii*) Village Roads

(*e*) Railway Lines

(*f*) Temples, mosques, *etc.*

(*f*) Graves, etc.

(h) Trees, gardens, pastures, houses, wells, *etc.*

(*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

| | |
|---|---|
| 1. Surplussing works | Weir, 2,350 feet in length including six automatic gates each 50 feet × 4 feet, length 323 feet. |
| 2. Outlet works | Two head sluices :— Left flank head sluice, 4 vents each 4 feet by 6 feet. Right flank head sluice, one vent of 4 feet by 5 feet. |
| 3. Scouring works | |
| 4. Inspection facilities | |
| 3. Fish pass | |
| 6. Means for dissipating energy below the spillway | |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| 1. Constructional features | The work of construction especially in the river portion of the dam was done departmentally. The flank portion was carried on by contract agencies.<br><br>Earth was carried to the side by Tippers by Locomotive power. |
| **Changes introduced in the plans of the dam and in the method of carrying out the work** | (*i*) Six automatic gates 50 feet × 4 feet were installed in the weir length to reduce the depth of over flow over weir.<br><br>(*ii*) Lowering of F.R.L. and Top Bund Level by two feet.<br><br>(*iii*) Raising of sill of Right Flank Sluice by two feet.<br><br>(*iv*) Constructing a cause way 1,999 feet long with 125 vents each 6 feet wide instead of bridges at the Right Flank on the diversion road.<br><br>(*v*) Provision of 40 shutters 10 feet ×4 feet in weir at Right Flank and heavier section of body wall of weir, as proposed, was omitted.<br><br>(*vi*) Provision of subsidiary weir and construction of a masonry wall 1,350 feet in length and 2 feet wide with its crest at R. L. 172·50 (0·5 foot above the F. S. L. of the channel) to serve as an intercepting dam to lead water from the high level sluice to the Right Flank and to protect the weir from being undermined.<br><br>(*vii*) Construction of masonry core wall along the axis line of the Dam at R. L. 400·31 in the centre and at R. L. 408·81 at either sides abutting against hard ground with a top width of 3 feet and batter of 1 in 6 on either side, was considered necessary to prevent creeep in the earth work. |

Construction of dry rubble toe walls coursed rubble wall in front to R. L. 398·81 between ch. 63-65 with a top width of 5 feet and rear toe wall to R. L. 405·31 was also provided latter on.

(*viii*) Abandoning the storm water outlet at Left Flank.

(3) Noteworthy occurrences and accidents.

4. Operation of the dam

(*a*) Regulation

(*b*) Silting of the reservoir

(*i*) Total silt deposited
(*ii*) Rate of silting
(*iii*) Density of the silt deposited
(*iv*) Rate of advancement of delta

(*c*) Actual yield as against estimated

(*d*) Various measurements and observations

(*i*) Evaporation losses.
(*ii*) Sweating below the dam
(*iii*) Temperature measurements
(*iv*) Seepage and regeneration

(*e*) Fish culture

(*f*) Anti malaria measures

5. Recreation facilities

6. Lessons to be learnt from the construction and utilisation of the dam. — In work executed departmentaly, out-put by labour is definitely more than the works carried out on contract.

## IX. BIBLIOGRAPHY AND HISTORICAL

1. Historical

(2) Personnel — Nawab Ali Nawaj Jung Bahadur, F.C.H., Chief Engineer.

(3) Bibliography

# IV. 28. Lloyd Dam

## (Masonry)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 168·0 feet |
| (2) Location | Poona District, Bombay State (Yelwandi river valley) |
| (3) Authority or owner | Bombay Government |
| (4) Purpose-Main and subsidiary | Irrigation |
| (5) Year of commencement | 1913 |
| (6) Year of completion | 1928 |
| (7) Capital cost | |
| (a) Estimated | (a) Rs. 1,75,95,157 |
| (b) Actual | (b) Rs. 1,72,00,000 |
| (8) Culturable area commanded by the project | 2,81,829 acres |
| (9) Area irrigated | 1,71,079 acres |
| (11) Means of access | It is accessible from Poona railway station (Great Indian Peninsula Railway) by the Poona Bangalore Road up to Mile No. 25 and thence by a branch road to Bhor. |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 128 square miles |
| (2) Nature of catchment | Ghat catchment |
| (3) Mean annual precipitation or Rainfall | (i) At the head of the lake—250 inches<br>(ii) At the dam site—40 inches. |
| (4) Mean annual yield of the catchment | 802,525 acre feet |
| (5) Climate | Hot from April to end of May. Heavy rainfall in July to September, with occasional sharp storm in October. Strong wind blows all the year round. |

| | |
|---|---|
| (6) Temperature conditions and variations | Maximum temperature 105° F<br>Minimum temperature 35° F<br>Normal temperature 70° F to 90° F |
| (7) Rate of flow | |
| (a) Maximum | 51,505 cusecs |
| (b) Minimum | — |
| (8) Detritus charge of the stream | Very little silt is carried |
| (9) Characteristics (chemical) of the water stored in the reservoir ) | Sweet, and suitable for irrigation |
| (10) Geological features | |
| (a) of foundations | Basalt-Deccan trap |
| (b) of catchment area | Rocky in the upper reach, and *murrumy* in the rest. |

# III. TECHNICAL

## A. STATISTICAL

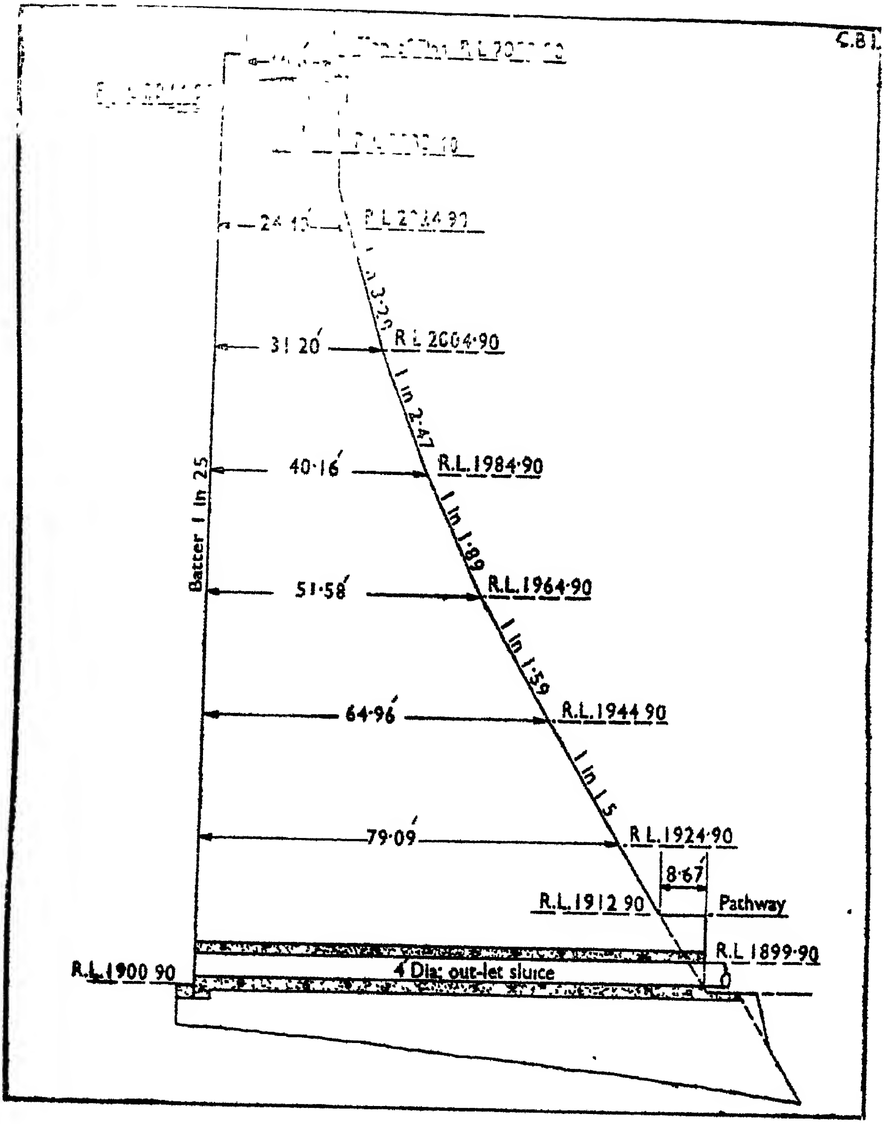
| | |
|---|---|
| 1) Reservoir Data | |
| (a) M.W.L. | (a) R. L. 2044·90 |
| (b) F.R.L. | (b) R.L. 2044·90 |
| (c) Area at M.W.L. | (c) 14·0 square miles |
| (d) Area at F.R.L. | (d) 14·0 square miles |
| (e) Maximum length | (e) 17 miles |
| (f) Maximum width | (f) 1·2 miles approximately |
| (g) Length of periphery | (g) 59 miles |
| (2) Capacity of the reservoir | |
| (a) Gross<br>(b) Live | (a)<br>(b) } 555cro |
| (c) Flood storage | |
| (d) Carry-over | |
| (3) Maximum height above the lowest point of foundations | 194·0 feet |
| 4) Height above the lowest river bed at dam | 168·0 feet |
| 5) Height of the top of the dam above the crest of the spillway or weir | 4·5 feet above top of waste weir gates *i.e.* F.R.L.<br>12·5 feet above waste weir sill |
| 6) Maximum width at level of foundations | 124 feet |
| (7) Width at top | 19·0 feet |

| | |
|---|---|
| (6) Temperature conditions and variations | Maximum temperature 105° F<br>Minimum temperature 35° F<br>Normal temperature 70° F to 90° F |
| (7) Rate of flow | |
| (a) Maximum | 51,505 cusecs |
| (b) Minimum | — |
| (8) Detritus charge of the stream | Very little silt is carried |
| (9) Character (chemical of the water stored in the reservoir ) | Sweet, and suitable for irrigation |
| (10) Geological features | |
| (a) of foundations | Basalt-Deccan trap |
| (b) of catchment area | Rocky in the upper reach, and *murrumy* in the rest. |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| 1) Reservoir Data | |
| (a) M.W.L. | (a) R. L. 2044·90 |
| (b) F.R.L. | (b) R.L. 2044·90 |
| (c) Area at M.W.L. | (c) 14·0 square miles |
| (d) Area at F.R.L. | (d) 14·0 square miles |
| (e) Maximum length | (e) 17 miles |
| (f) Maximum width | (f) 1·2 miles approximately |
| (g) Length of periphery | (g) 59 miles |
| (2) Capacity of the reservoir | |
| (a) Gross<br>(b) Live | (a)<br>(b) } 555cre |
| (c) Flood storage | |
| (d) Carry-over | |
| (3) Maximum height above the lowest point of foundations | 194·0 feet |
| 4) Height above the lowest river bed at dam | 168·0 feet |
| 5) Height of the top of the dam above the crest of the spillway or weir | 4·5 feet above top of waste weir gates i.e. F.R.L.<br>12·5 feet above waste weir sill |
| 6) Maximum width at level of foundations | 124 feet |
| (7) Width at top | 19·0 feet |




*Cross Section of Lloyd Dam*

(8) Slopes

| | |
|---|---|
| (a) Upstream | (a) Vertical, 1 in 50, 1 in 20, and in 15, |
| (b) Down stream | (b) 1 in 1·5, 1 in 1·59, 1 in 1·89, 1 in 2·47, 1 in 3·28 and vertical. |
| 9) Length at top of the dam | 5·333 feet (including the waste weir portion) |
| (a) Non-overflow | (a) 4265·75 feet |
| (i) Main | |

| | |
|---|---|
| (b) Spillway | (b) 1,067 feet |
| (10) Cubic volume of the body of the dam | 21,500,000 feet |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Stone and lime masonry |
| (12) Specific gravity | |
| (a) Masonry | 2·56 |
| (13) Nature of protection and water-proofing of the upstream and down-stream faces | Face work of *kar* boulder stone on both sides. |
| (14) Provision for dealing with seepage and drainage water | To drain off water oozing out the foundations, a collecting drain has been built in the masonry. |
| (15) Means of securing water tightness of the foundations of the dam | No special precautions were taken. |
| (16) Contraction joints | |
| (17) Principal stresses in the masonry with a note of methods of calculations employed | The maximum intensity of stress when the reservoir is full is 215 lb per square inch, at the downstream toe. It is 191·29 lb per square inch upstream when reservoir is empty. The minimum intensity, when reservoir is full is 5·01 lb at the upstream toe and 3·42 lb per square inch at the upstream toe and 3·42 lb per square inch at the downstream toe when empty. |
| (18) Maximum pressure on foundations | 224·15 lb per square inch |
| (19) Uplift pressure, calculated or measured. | 24 lb per square foot |
| (20) Measures adopted for preventing or counteracting uplift pressures | A powerful spring in the foundations has been given an outlet on the downstream. A cut off trench is provided on the upstream in the river bed. |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged—*

| | |
|---|---|
| (a) Crown waste<br>(b) Proprietory | 4,712 acres |

(2) *Dislocation*

| | |
|---|---|
| (a) Villages | (a) 39 |
| (b) Families | |
| (c) Population | |
| (d) Roads: | |
| (i) Highways | |
| (ii) District Roads | |
| (iii) Village Roads | Yes, for every village. |
| (e) Railway Lines | |
| (f) Temples, mosques, *etc.* | |
| (g) Graves, *etc.* | |
| (h) Trees, gardens, pastures, houses, wells, *etc.* | |
| (i) Bridges | |
| (3) Compensation paid under each category of item (2) | Rs. 4,42,651 only for merged land has been paid |
| (4) Method of compensating for land of dispossessed landholders | |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | There are 45 automatic and 36 rolling gates each 10 feet 3 inches × 8 feet. |
| (2) Outlet works | Six upper and six intermediate sluices each 8 feet × 4 feet. 8 outlet sluices each 4 feet diameter. Three turbine pipes one 5 feet 6 inches diameter ; one 6 feet 7½ inches diameter and one 8 feet 9 inches diameter and one water supply pipe 10 inches diameter. |
| (3) Scouring works | |
| (4) Inspection facilities | Inspection galleries and recording instruments have been fixed for recording the temperature *etc.* In order to provide for inspection of and repairs to the lowest pipe outlets and their sluices two emergencies face sluices are provided which can be let down on the upstream by means of a travelling winding drum. |
| (5) Fish-pass | |

(6) Means for dissipating energy below the spillway — The height of waterfall on downstream side of 60 automatic gates varies from 22 feet to 35 feet. Erosion and scour are prevented by providing a water cushion formed by a sbusidiary weir, suitable divide and training walls. The fall below 21 rolling gates is about 60 feet and advantage is taken of the old dam which, is outside the position of the new dam, to forms a basin for water cushion there.

## VII. NAVIGATION WORKS

(1) Length of river where navigation has been made possible by the construction of the dam — For about 12 miles from the dam side

(2) Type of cargo transported — "Hirda'

(3) Number of passengers transported annually

(4) Annual income from source at item (2) and (3).

(5) Navigation Lock:
- (a) Location
- (b) Lock chamber, clear size
- (c) Lift:
  - (i) Maximum
  - (ii) Minimum
- (d) Estimated lockage time

## VIII. SUPPLEMENTARY INFORMATION

(1) Methods of construction — Face stones of *kar* (boulder) stone have been set at right angles to the batter of the dam with backing for a width of 2 feet to 5 feet. Face stones not less than 7 inches in height have been used; large courses being laid at the lower levels. Headers, not less than 21 inches in length and 60 square inches face area, have been spaced not more than 8 feet clear in every course so as to break joint vertically with those in the courses above and below. To ensure proper bond between the face work and the hearting, face stones have

been so used that they break joint at least 3 inches with the stone next to it *i.e.*, stones 9 inches, 12 inches, 15 inches in length have been used. Pointing was done as the work proceeded. The thickness of joint is less than one inch. Hearting was laid in uncoursed rubble masonry simultaneously with the face work in horizontal layers well bonded with it. No stone less than 60 lb in weight was allowed and generally as large stones as could be conveniently handled were used. The surface of each layer was not allowed to be levelled up with chips but was left uneven and rugged with mortar between and not over the stones.

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents.

(4) Operation of the dam

(*a*) Regulation

The dam is designed to store 24,198 million cubic feet of water with a depth of 143 feet in the tank *i.e.* R. L.2044·90 High flood water depth does not rise above this 143 feet level, as the automatic gates which have sills 8 feet below *i.e.* at 135 feet height, open out automatically as soon as the level rises about 141 feet and pass out all the floods by the close of rainy season, the last flows are held in the tank up to maximum depth of 143 feet.

(*ii*) There are 3 sets of sluices to let down water for irrigation

(*a*) upper sluices 6 in Nos. size 8′×4′ at 95 feet (R.L. 1996·90) These are worked when water level is (R.L. 2039·90.)

| | |
|---|---|
| | (b) Intermediate sluices 6 in Nos. size 8′ × 4′ at level 60 (R.L. 1961·90). These are worked when water level is at 102 feet (R.L. 2003·90). |
| | (c) Lower sluices 8 in Nos. 4 feet diameter at level 0·0 (R.L. 1901·90). These are worked when water level is 75 feet (R.L. 1976·90.) |
| (b) Silting of the reservoir | |
| (i) Total silt deposited | |
| (ii) Rate of silting | |
| (iii) Density of the silt deposited. | |
| (iv) Rate of advancement of delta. | |
| (c) Actual yield as against estimated. | 24,198 million cubic feet |
| (d) Various measurements and observations | |
| (i) Evaporation losses | 22,62 million cubic feet per year |
| (ii) Sweating below the dam | |
| (iii) Temperature measurements | To measure the variations of temperature in the masonry of the dam, eleven distance thermometers have been built in solid masonry in two sets at different levels. The lower set is 95 feet below the F.R.L. while the upper one is only 17 feet below the F.R.L. One thermometer is fixed outside on the downstream side to give the air temperature for comparison. The important conclusions arrived at from observations are :— (1) The thermometers on the downstream side of the dam are affected by the heat of the sun while those on the upstream side by the cooling effect of water. |

(2) Time of penetration of the effects of atmospheric changes through the masonry increases with the width of the masonry.

(3) There appears to be a tendency to offer greater resistance to outside influences as the masonry sets.

(iv) Seepage and regeneration

(e) Fish-culture

(f) Anti-malaria Measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam — None of special value. The current theories and principles on which these dams have been designed, have been confirmed by their construction. It is meant for irrigation purpose.

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical — There existed an old dam at Bhatgar storing water for one canal only, the Nira Left Bank Canal, supplying mainly the Poona District. The Lloyd Dam was constructed in order to store additional supply for the other canal—the Nira Right Bank Canal, supplying water to the usually famine striken areas of Satara and Sholapur District. Raising the old dam was considered as an alternative scheme but a separate dam on the downstream of the old dam for a major portion of it was found more suitable. During the construction of the new dam, special arrangements had to be made for supplying water for irrigation from the old storage. The storage is used mainly for irrigation. It is let down into the Nira River as required and is picked up by the two canals—the Nira Left Bank canal and the Nira Right Bank Canal at the Head works at Vir about 17 miles from the dam.

The dam was designed by Mr. C. B. Pooley, Executive Engineer in 1912-13. Actual work was started in October 1913 and completed in 1928. The work of constructing the dam was in the charge of the Executive Engineer, Lake Whiting Division.

(2) Personnel

*Chief Engineers for Irrigation*

Mr. H. F. Beale, M.I.C.E.

Sir F. St. J. Gebbie, Kt., C.I.E.

Mr. H. O. B. Shoubridge, C.I.E., M.I.C.E.

Mr. R. T. Harrison.

Mr. V. M. Griffiths.

*Superintending Engineers*

Mr. P. J. Fitzgibbon, M.I.C.E.

Mr. S. Cadambi, B.A., L.C.E.

Mr. V. N. Vartak, M.A., L.C.E.

Mr. A. B. DeSouza, L.C.E.

Mr. C. B. Pooley

Mr. D. R. H. Browne, O.B.E., A.K.C.

Mr. P. L. Bowers, C.I.E., M.C., A.M.I.E.

*Executive Engineers*

Mr. C. B. Pooley

Mr. C. G. Haws, M.C., B.Sc. A.C.G.I A.M.I.C.E.

Mr. W. A. Evershed, B.Sc. A.M.I.C.E.

Mr. N. B. Baxter.

Mr. W.H. E. Garrod, A.M.I.C.E.

Mr. J. A. S. Manson.

Mr. M. T. Gibling, B.A.

Mr. R. H. Hammett, A.M.I.C.E.

(3) Bibliography

History of the Nira Canals Head-works (Lloyd Dam and Pick up Weir at Vir) (typed-note).

# IV. 29. Mulshi Dam

## (Masonry)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 146 feet |
| (2) Location | Poona District, Bombay State (Nila and Mula River Valley). |
| (3) Authority or owner | The Tata Power Company Limited. |
| (4) Purpose—Main and subsidiary | Power |
| (5) Year of commencement | October, 1921. |
| 6) Year of completion | May, 1929. |
| 7) Capital cost | |
| (a) Estimated | (a) Rs. 1,73,00,000 |
| (b) Actual | (b) Rs. 2,49,64,450 |
| (8) Installed hydro-electric capacity | The Mulshi dam supplies water to the Tata Power Supply Station at Bhira where the installed capacity is 110,000 kW. The actual capacity of the station is, however, reduced to 84,000 kW. at minimum lake level. |
| (11) Means of access | It is situated 8 miles towards west of Poud which is connected to Poona by fairly a good road. |

### II. GEOPHYSICAL

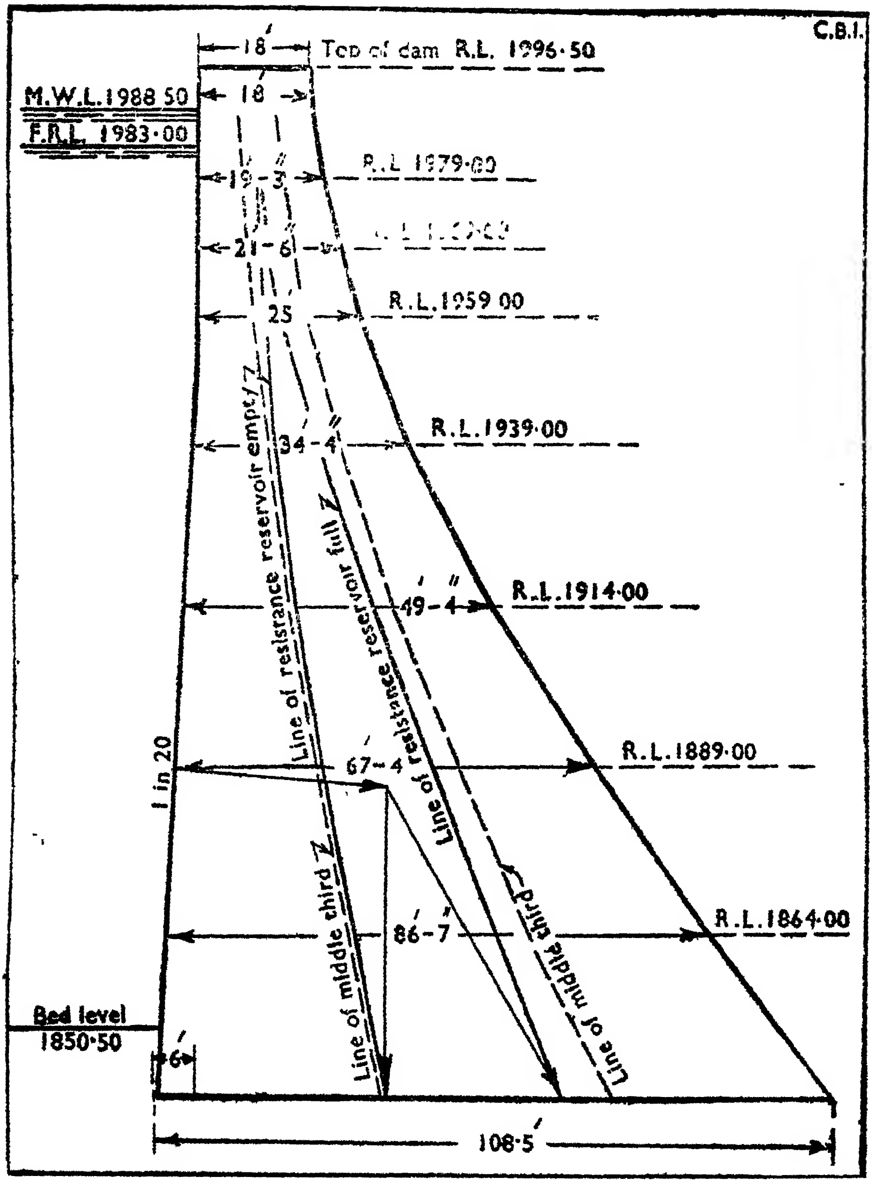
| | |
|---|---|
| (1) Area of catchment | 95·6 square miles |
| (2) Nature of catchment | Wooded and mountainous country |
| (3) Mean annual precipitation :— | |
| Rainfall | 210 inches |
| (4) Total average annual yield of the catchment | 858,586 acre feet |
| (5) Climate | Tropical |

| | |
|---|---|
| (6) Temperature conditions and variations | Maximum 100° F, Minimum 45° F. |
| (7) Rate of Flow | |
| (a) Maximum | 49,215 cusecs<br>68,477 cusecs (calculated). |
| (b) Minimum | .. |
| (8) Detritus charge of the stream | As the entire catchment is wooded or rocky, little or no solids find their way to the reservoir. |
| (9) Character (chemical) of the water stored in the reservoir | Sweet water impounds in lakes during monsoon. |
| (10) Geological features :— | |
| (a) of foundations | Deccan trap |
| (b) of catchment area | Rocky |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data— | |
| (a) M. W. L. | (a) R. L. 1988·50 |
| (b) F. R. L. | (b) R. L. 1983·00 |
| (c) Area at M. W. L. | (c) 15·58 square miles |
| (d) Area at F. R. L. | |
| (e) Maximum length | (e) 12 miles |
| (f) Maximum width | (f) 1⅝ miles |
| (g) Length of periphery | |
| (2) Capacity of the reservoir :— | |
| (a) Gross | |
| (b) Live | (b) 423,806 acre feet with atomatic gates |
| (c) Flood storage | |
| (d) Carry-over | |
| (3) Maximum height above the lowest point of foundations | 166 feet |
| (4) Height above the lowest river bed at dam | 146 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 13·5 feet |
| (6) Maximum width at level of foundations | 108·5 feet |




*Cross Section of Mulshi Dam*

(7) Width at top 18·0 feet

(8) Slopes :—

(*a*) Upstream (*a*) 1 in 20

(*b*) Downstream (*b*) As per cross section

| | |
|---|---|
| (9) Length at top of the dam | 3,600 feet plus 1,503 feet length of waste weir, Total=5,103 feet |
| (a) Non-overflow— | |
| (i) Main | (i) 3,600 feet |
| (b) Spillway or waste weir | (b) 1,503 feet |
| (10) Cubic volume of the body of the dam. | (i) Dam 1,841,900 cubic feet<br>(ii) Waste weir 471,000 cubic feet<br>Total=22,312,900 cubic feet |

**B. OTHERS**

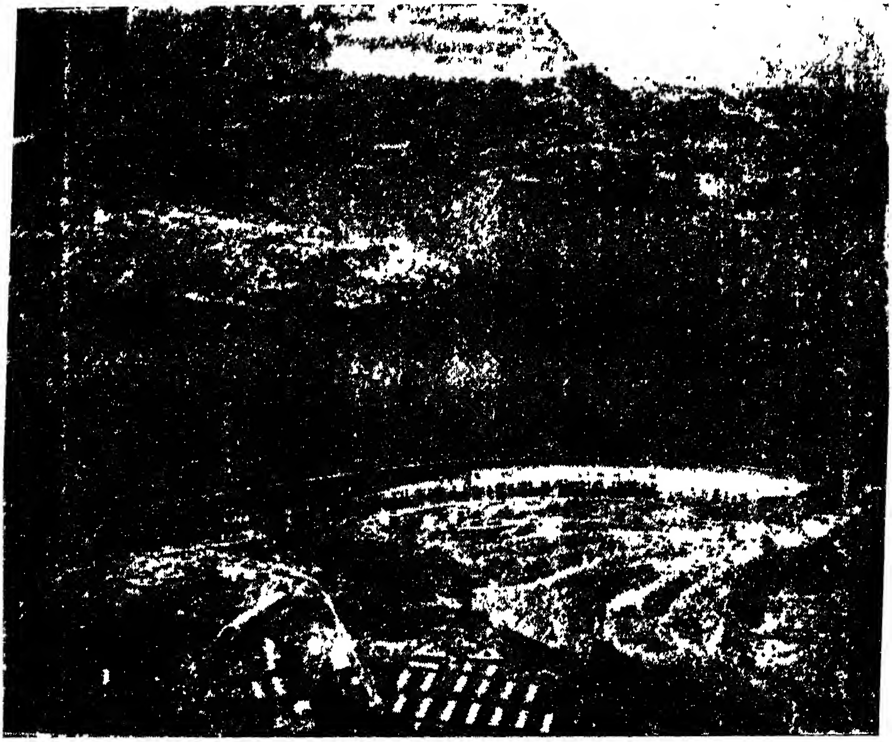
| | |
|---|---|
| (11) Material of which the dam is constructed | Uncoursed rubble masonry in lime mortar with coursed rubble face work |
| (12) Specific gravity— | |
| (a) Masonry | 2·38 |
| (13) Nature of protection and water-proofing of the upstream and down-stream faces | Upstream side pointed with mixture of cement, sand and ironite plaster Downstream face pointed with lime mortar |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundations of the dam | Upstream face pointed with cement, sand and ironite |
| (16) Contraction joints | |
| (17) Principal stresses in the masonry with a note of methods of calculations employed | |
| (18) Maximum pressure on foundations | Reservoir empty —9·4 tons<br>Reservoir full —9·1 tons<br>@ 140 lb. per cubic foot of masonry. |
| (19) Uplift pressure, calculated or measured. | |
| (20) Measures adopted for preventing or counteracting uplift pressures | |

## IV PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*:

(a) Crown waste

(b) Proprietory



*A view of the Mulshi Dam*

*Mulshi Dam—Showing spillway and automatic gates*

(2) *Dislocation* :

(*a*) Villages

(*b*) Families

(*c*) Population

(*d*) Roads :

(*i*) Highways

(*ii*) District Roads

(*iii*) Village Roads

(*e*) Railway Lines

(*f*) Temples, mosques, *etc.*

(*g*) Graves, *etc.*

(*h*) Trees, gardens, pastures, houses, wells, *etc.*

(*i*) Bridges

(3) Compensation paid under each category of item (2).

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | Main waste weir of 36 automatic gates 40 feet by 5 feet 6 inches each. |
| (2) Outlet works | 3 cast iron bronze faced sluice gate by Glenfield and Kennedy each 8½ feet by 10 feet clear opening located in the head-works of the outlet tunnel about 8 miles up-stream of the dam with sill level at R. L. 1922·00. |
| (3) Scouring works | No provision is made for scouring or emptying the lake other than through the main sluices, but a 18 inches valve is located in the dam at R. L. 1930·75 for the purposes of river replenishment. |
| (4) Inspection facilities | |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | |

## VI. POWER-HOUSE

| | |
|---|---|
| (1) Hydraulic head | Gross head—1661·0 feet |
| (2) Name and address of Licensee with managing agents (if any). | Tata Power Co. Limited, Bombay. |
| (3) Generating units :— | |
| (a) Type | Pelton-wheel-driven generators. |
| (b) Number | 5 (Hydro) |
| (c) Capacity— | |
| (i) Firm | 84,000 kW. |
| (4) Voltage | 11,000 |
| (5) Number of phases and frequency, A.C. or D.C. | 3 ph. A. C. 50 cy. |
| (6) Forebay | Approach channel and a tunnel. |
| (7) A brief description of tunnel and penstocks | The main tunnel is 14,850 feet long and 140 square feet in section. The connection of three sluices being by three feet 6 inches tunnels approximately 57 square feet in section and each 100 feet long with a slope, leading from the sill of the main gates to the bottom of No. 1 shaft. |
| (8) Means provided for excluding silt and trash. | The gates are protected by screens of 6 inches by $\frac{3}{4}$ inch bars, spaced 4 inches apart centre to centre. The bars are built into reinforced concrete beams embedded in the sluice gate piers. The screens are placed diagonally in the approach cut which ensures a natural self cleaning effect. |
| (9) Tail race | |
| (10) Maximum length of transmission line. | 76·46 miles |
| (11) Principal towns served | Bombay |
| (12) Main and subsidiary purpose of the utilisation of electricity. | Textile mills, factories, railways etc. |
| (13) Any other matter of interest | |

## VI. POWER-HOUSE

| | |
|---|---|
| (1) Hydraulic head | Gross head—1661·0 feet |
| (2) Name and address of Licensee with managing agents (if any). | Tata Power Co. Limited, Bombay. |
| (3) Generating units :— | |
| (a) Type | Pelton-wheel-driven generators. |
| (b) Number | 5 (Hydro) |
| (c) Capacity— | |
| (i) Firm | 84,000 kW. |
| (4) Voltage | 11,000 |
| (5) Number of phases and frequency, A.C. or D.C. | 3ph. A. C. 50 cy. |
| (6) Forebay | Approach channel and a tunnel. |
| (7) A brief description of tunnel and penstocks | The main tunnel is 14,850 feet long and 140 square feet in section. The connection of three sluices being by three feet 6 inches tunnels approximately 57 square feet in section and each 100 feet long with a slope, leading from the sill of the main gates to the bottom of No. 1 shaft. |
| (8) Means provided for excluding silt and trash. | The gates are protected by screens of 6 inches by ¾ inch bars, spaced 4 inches apart centre to centre. The bars are built into reinforced concrete beams embedded in the sluice gate piers. The screens are placed diagonally in the approach cut which ensures a natural self cleaning effect. |
| (9) Tail race | |
| (10) Maximum length of transmission line. | 76·46 miles |
| (11) Principal towns served | Bombay |
| (12) Main and subsidiary purpose of the utilisation of electricity. | Textile mills, factories, railways etc. |
| (13) Any other matter of interest | |

## VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features — Very careful tests had been made before decided on the proportions for the mortar which was the same for both the random rubble and the hearting.

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

(4) Operation of the dam :—

(a) Regulation

(b) Silting of the reservoir—

(i) Total silt deposited

(ii) Rate of silting

(iii) Density of the silt deposited

(iv) Rate of advancement of delta

(c) Actual yield as against estimated

(d) Various measurements and observations—

(i) Evaporation losses

(ii) Sweating below the dam

(iii) Temperature measurements

(iv) Seepage and regeneration

(e) Fish culture

(f) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical — This is an ideal position having a large storage capacity with a reasonable size of dam, located by Mr. Gibbs early in 1918 at the junction of rivers Nila and Mula. The Tata Power Company Limited was floated in 1919 to develop it. The scheme was known as the Tata Power scheme. The scheme was taken in hand to fulfil the continued and keen demand for power in Bombay.

| | |
|---|---|
| (2) Personnel | Mr. N. J. Cursetjee, B.Sc., Chief Engineer and Messrs. the Tata Engineering Company Limited. |
| (3) Bibliography | (i) Chatterjee, Bhim Chandra, the Hydro-Electric Practice in India Volume I and Volume II. |
| | (ii) Cursetjee, B.Sc., the Tata Hydro-Electric Scheme, paper No. LXXXVI. Minutes of Proceedings of the Bombay Engineering Congress 1924, Volume XIII. |
| | (iii) Public Electric Supply, All India Statistics, 1944. |
| | (iv) Shiv Narayan, Indian Wate Power Plants. |

# IV. 30. Wyra Dam

## (Masonry)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed. | 61 feet |
| (2) Location | Warangal district, Hyderabad State (Wyra river). |
| (3) Authority or owner | Hyderabad State Government |
| (4) Purpose—Main and subsidiary | Irrigation |
| (5) Year of commencement | November 1922 |
| (6) Year of completion | October 1933 |
| (7) Capital cost— | |
| (a) Estimated | (a) Rs. 24,90,000 |
| (b) Actual | (b) Rs. 35,90,266 |
| (8) Culturable area commanded by the project | 31,000 acres |
| (9) Area irrigated | 17,500 acres |
| (11) Means of access | It is situated 16 miles from Khammamett railway station on the Secunderabad Bajwada line and is also accessible by road from Hyderabad district 135 miles. |

### II. GEOPHYSICAL

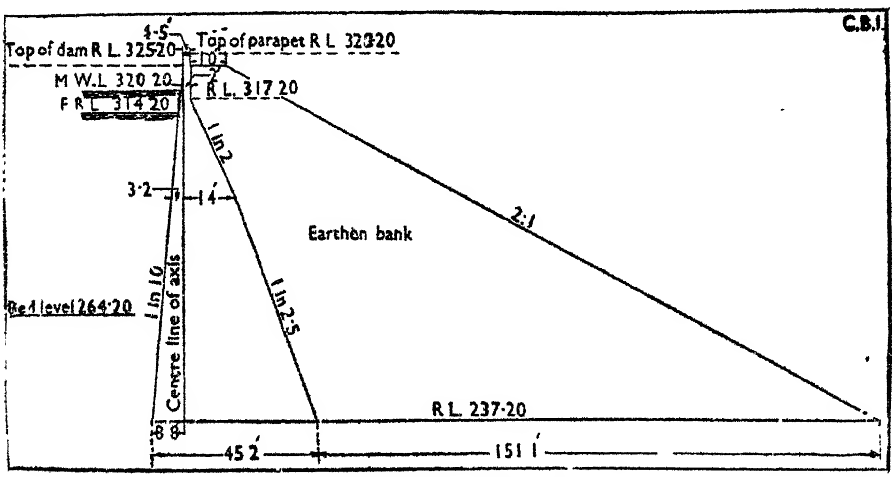
| | |
|---|---|
| (1) Area of catchment | 274 square miles |
| (2) Nature of catchment | |
| (3) Mean annual precipitation | |
| (a) Rainfall | 36·5 inches |
| (4) Total average annual yield of the catchment. | 66,470 acre feet |
| (5) Climate | Tropical |
| (6) Temperature conditions and variations | Maximum 121°F<br>Minimum 55°F |
| (7) Rate of Flow— | |
| (a) Maximum | (a) 33,722 cusecs |
| (b) Minimum | (b) Negligible. |

| | |
|---|---|
| (8) D itus charge of the stream | The catchment is mostly covered with jungle and there is very little accumulation of silt. |
| (9) Character (chemical) of the water stored in the reservoir | Sweet and clear |
| (10) Geological features— | |
| (a) of foundations | Gneisses and trap |
| (b) of catchment area | Limestones and Gneisses |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data— | |
| (a) M. W. L. | (a) R. L. 320·20 |
| (b) F. R. L. | (b) R. L. 314·20 |
| (c) Area at M. W. L. | |
| (d) Area at F. R. L. | (d) 7·04 square miles. |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | |
| (2) Capacity of the reservoir | |
| (a) Gross | (a) 56,290 acre feet |
| (b) Live | (b) 46,719 acre feet |
| (c) Flood storage | |
| (d) Carry over | |




*Cross Section o Wyra Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 88 feet |
| (4) Height above the lowest river bed at dam. | 61 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir. | 11 feet |
| (6) Maximum width at level of foundations | 45·2 feet for masonry |
| (7) Width at top | 2 feet masonry<br>10 feet embankment |
| (8) Slopes—<br>(a) Upstream<br>(b) Downstream | As per cross section |
| (9) Length at top of the dam :—<br>(a) Non-overflow—<br>(i) Main<br>(ii) Subsidiary<br>(b) Spillway or waste weir | 5,800 feet<br><br><br><br>(b) 1,320 feet |
| (10) Cubic volume of the body of the dam. | 4,090,000 cubic feet. |

**B OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Uncoursed rubble masonry in *surkhi* mortar with coursed rubble facing and earthen embankment for backing. |
| (12) Specific gravity<br>(a) Masonry | <br>(a) 2·25 |
| (13) Nature of protection and water proofing of the upstream and downstream faces | — |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundations of the dam | — |
| (16) Con raction joints | |
| (17) Principal stresses in the masonary with a note of methods of calculations employed | — |
| (18) Maximum pressure on foundations | |
| (19) Uplift pressure, calculated or measured | |
| (20) Measures adopted for preventing or counteracting uplift pressure. | |

(8) D  itus charge of the stream — The catchment is mostly covered with jungle and there is very little accumulation of silt.

(9) Character (chemical) of the water stored in the reservoir — Sweet and clear

(10) Geological features—

- (a) of foundations — Gneisses and trap
- (b) of catchment area — Limestones and Gneisses

## III. TECHNICAL

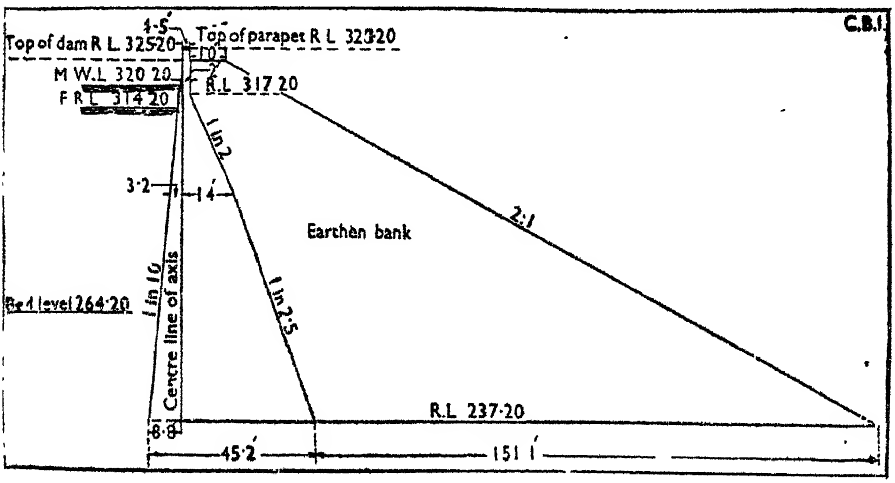
### A. STATISTICAL

(1) Reservoir Data—

- (a) M. W. L. — (a) R. L. 320·20
- (b) F. R. L. — (b) R. L. 314·20
- (c) Area at M. W. L.
- (d) Area at F. R. L. — (d) 7·04 square miles.
- (e) Maximum length
- (f) Maximum width
- (g) Length of periphery

(2) Capacity of the reservoir

- (a) Gross — (a) 56,290 acre feet
- (b) Live — (b) 46,719 acre feet
- (c) Flood storage
- (d) Carry over




*Cross Section o  Wyra Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 88 feet |
| (4) Height above the lowest river bed at dam. | 61 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir. | 11 feet |
| (6) Maximum width at level of foundations | 45·2 feet for masonry |
| (7) Width at top | 2 feet masonry<br>10 feet embankment |
| (8) Slopes—<br>(a) Upstream<br>(b) Downstream | As per cross section |
| (9) Length at top of the dam :— | 5,800 feet |
| (a) Non-overflow—<br>(i) Main<br>(ii) Subsidiary | |
| (b) Spillway or waste weir | (b) 1,320 feet |
| (10) Cubic volume of the body of the dam. | 4,090,000 cubic feet. |

**B OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Uncoursed rubble masonry in *surkhi* mortar with coursed rubble facing and earthen embankment for backing. |
| (12) Specific gravity | |
| (a) Masonry | (a) 2·25 |
| (13) Nature of protection and water proofing of the upstream and downstream faces | — |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundations of the dam | — |
| (16) Con raction joints | |
| (17) Principal stresses in the masonary with a note of methods of calculations employed | — |
| (18) Maximum pressure on foundations | |
| (19) Uplift pressure, calculated or measured | |
| (20) Measures adopted for preventing or counteracting uplift pressure | |

## IV PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged* :

(*a*) Crown waste

(*b*) Proprietory

(2) *Dislocation* :

(*a*) Villages

(*b*) Families

(*c*) Population

(*d*) Roads :

(*i*) Highways

(*ii*) District Roads

(*iii*) Village Roads

(*e*) Railway Lines

(*f*) Temples, mosques, *etc.*

(*g*) Graves, *etc.*

(*h*) Trees, gardens, pastures, houses, wells, *etc.*

(*i*) Bridges

(3) Compensation paid under each category of item (2).

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | Four free overfall weirs, 1,320 feet in length in all, one of the weirs is provided with 3 automatic shutters each 50 feet by 4 feet. |
| (2) Outlet works | Right flank sluice of 3 vents each 5 feet by 6 feet.<br>Left flank sluice of 2 vents each 4 feet by 5 feet. |
| (3) Secouring works | |
| (4) Inspection facilities | |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | Materials for masonry, as stone, mortar, *etc.* were taken by tippers with motive power and the work was executed departmentally. Earth was carried by tippers and the work was done under piece work agencies. |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | The composite dam between Ch. 53 and 58 was replaced by an earthen Dam, 8 feet top width and 2 to 1 earthen slopes and $1\frac{1}{2}$ to 1 revetment slopes.<br>The top width of the earth backing to main dam was reduced from 15 to 10 feet.<br>Sanctioned proposal was for weirs 950 feet and 785 feet respectively at Left and Right flanks discharging with a head of 5 feet. The weir at right flank was abandoned due to bad founds and 3 new weirs at left flank were built. The length of weirs built at left flank are 120 feet, 170 feet and 90 feet. The head over the crest was raised from 5 feet to 6 feet. The length of 950 feet weir was curtailed by 10 feet.<br>The sanctioned design of both right flank and left flank sluices were changed. The vent and shutters at right flank are the same as sanctioned while at left flank 2 vents, $4' \times 5'$ were provided instead of 3 vents, $4' \times 5'$.<br>It was raised by one foot above the proposed top of the dam. |
| (3) Noteworthy occurrences and accidents | |
| (4) Operation of the dam :— | |
| (*a*) Regulation | |
| (*b*) Silting of the reservoir— | |
| (*i*) Total silt deposited | |
| (*ii*) Rate of silting | |
| (*iii*) Density of the silt deposited | |
| (*iv*) Rate of advancement of delta | |

(c) Actual yield as against estimated

(d) Various measurements and observations—

(i) Evaporation losses

(ii) Sweating below the dam

(iii) Temperature measurements

(iv) Seepage and regeneration

(e) Fish culture

(f) Anti-malaria measures

| | |
|---|---|
| (6) Lessons to be learnt from the construction and utilisation of the dam. | Better work can be executed departmentally. |

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

(3) Bibliography

Nawab Ali Nawaj Jung Bahadur, F.C.H.,
*Chief Engineer.*

# IV. 31. Visapur Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 84 feet |
| (2) Location | Ahmednagar District, Bombay State (Hanga River Valley) |
| (3) Authority or owner | Bombay Government |
| (4) Purpose—Main and subsidiary | Water Supply to jail (Visapur) Railway and Irrigation |
| (5) Year of commencement | 1896 |
| (6) Year of completion | 1936 |
| (7) Capital cost | |
| (a) Estimated | (a) Rs. 8,44,599 |
| (b) Actual | (b) Rs. 40,44,132 |
| (8) (a) Culturable area commanded by the project. | 80,000 area. |
| (b) Area irrigated | 4,220 acre |
| (11) Means of access | The dam is accessible by a metalled road from Visapur railway station, distance 2 miles from the dam site. It is also connected by a metalled road to Ahmednagar, distance 25 miles. |

### II. GEOPHYSICAL

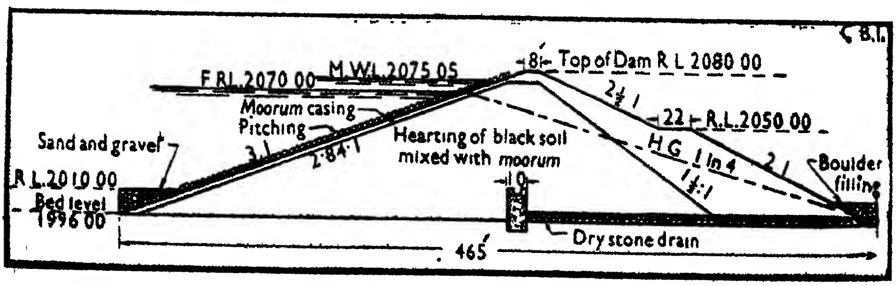
| | |
|---|---|
| (1) Area of catchment | 159 square miles |
| (2) Nature of catchment | The upper portion of the catchment is hilly and rocky but lower down, it is of rich black soil. |
| (3) Mean annual precipitation | |
| (a) Rainfall | (a) 1881-1900 22 inches.<br>1900-1924 23 inches. |
| (4) Total average annual yield of the catchment | 50,506 acre feet |

| | |
|---|---|
| (5) Climate | The climate, on the whole is extremely genial. |
| (6) Temperature conditions and variations | Maximum 114° F. Minimum 40° F. |
| (7) Rate of Flow | |
| (a) Maximum | 1,8000 cusecs (Approximately). |
| (b) Minimum | — |
| (8) Detritus charge of the stream | |
| (9) Character (chemical) of the water stored in the reservoir | Sweet—suitable for irrigation. |
| (10) Geological features | |
| (a) of foundations | |
| (b) of catchment area | The upper portion of the catchment is hilly and rocky, but lower down, it is of rich black soil. |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (a) M. W. L. | (a) R. L. 2075·05 |
| (b) F. R. L. | (b) R. L. 2070·00 |
| (c) Area at M. W. L. | (c) 2·55 square miles |
| (d) Area at F. R. L. | |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | |
| (2) Capacity of the reservoir. | |
| (a) Gross | |
| (b) Live | (b) 27,961 acre feet |
| (c) Flood storage | |
| (d) Carry-over | |




*Cross Section of Visapur dam.*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 87 feet |
| (4) Height above the lowest river bed at dam | 84 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 10 feet |
| (6) Maximum width at level of foundations | 465 feet |
| (7) Width at top | 8·0 feet |
| (8) Slopes | |
| (a) Upstream | (a) 3 to 1 |
| (b) Downstream | (b) $2\frac{1}{2}$ to 1 from top to 22 feet berm at R.L. 2050 and 2 : 1 from outer edge of berm to ground levels |
| (9) Length at top of the dam | 9,366 feet |
| (a) Non-overflow | |
| (i) Main | (i) 7,440 feet |
| (b) Spillway or waste weir | (b) 1,926 feet |
| (10) Cubic volume of the body of the dam | 49,000,000 cubic feet |

B. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed | Black and brown soil mixed with *moorum* for bank and casing of *moorum* on both sides. |
| (12) Specific gravity | |
| (d) Earthfill | |
| (13) Nature of protection and waterproofing of the upstream and downstream faces | Upstream slope of the dam is pitched throughout upto 3 feet above the highest flood level. |
| (14) Provision for dealing with seepage and drainage water | Upstream and dowstream toes provided with boulder stones. |
| (15) Means of securing water tightness of the foundations of the dam | By means of core-wall |
| (21) Hydraulic gradient for which the embankment is designed | 1 in 4 |
| (22) Particular of the berm (if any), width and position. | Berm width 22 feet at R.L. 2050·00 |
| (23) Position and form of the core wall or other means of securing water tightness | As per cross section. |
| (24) Batter (if any) of the core wall | Inner slope 2·84 : 1 and outer slope $1\frac{1}{2}$ : 1. |

(25) Maximum depth below ground surface of core wall or other means of securing water tightness

(26) Method of keying core-wall or other wall to the underlying ground

(27) Nature of material forming the core or other wall — Black soil mixed with *moorum*

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged* :

(*a*) Crown waste

(*b*) Proprietory

(2) *Dislocation* .

(*a*) Villages

(*b*) Families

(*c*) Population

(*d*) Roads :

(*i*) Highways

(*ii*) District Roads

(*iii*) Village Roads

(*e*) Railway Lines

(*f*) Temples, mosques, *etc.*

(*g*) Graves, *etc.*

(*h*) Trees, gardens, pastures, houses, wells, *etc.*

(3) Compensation paid under each category of item (2) (*a*) — Rs. 92,803

(4) Method of compensating for land of dispossessed landholders.

## V. AUXILIARY WORKS

(1) Surplussing works — Waste weir, 1,926 feet in length is built in masonry. Depth of water over crest is 5·05, feet and discharging capacity 69,500 cusecs.

(2) Outlet works
(3) Scouring works — Two outlet gates each three feet by three feet.

(4) Inspection facilities

(5) Fish-pass

(6) Means for dissipating energy below the spillway

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | In order to provide relief for the famine stricken people in Shrigondu Taluka, the work on the scheme was commenced in 1896. In 1900 Govt. handed it over to the Jail Dept. for construction by the Deccan gang and for 27 years it provided an excellent form of extra mural work for convicts. In 1927 when the gang was moved at Nasik central prison the Govt. decided to push the work forward to the completion. |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | -- |
| (3) Noteworthy occurrences and accidents | — |
| (4) Operation of the dam | |
| (a) Regulation | |
| (b) Silting of the reservoir | |
| (i) Total silt deposited | |
| (ii) Rate of silting | |
| (iii) Density of the silt deposited | |
| (iv) Rate of advancement of delta | |
| (c) Actual yield as against estimated | |
| (d) Various measurements and observations | |
| (i) Evaporation losses | 36·20 million cubic feet |
| (ii) Sweating below the dam | |
| (iii) Temperature measurements | |
| (iv) Seepage and regeneration | |
| (e) Fish culture | Fauna |
| (f) Anti-malaria measures | |
| (5) Recreation facilities | |
| (6) Lessons to be learnt from the construction and utilisation of the dam | |

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

The scheme was originated in the year 1876-77, a great famine year to have some storage works in the Hanga river valley. schemes were surveyed, but finally the existing site was selected, but it could not be started until the famine of 1896-97 broke out. This scheme was commenced to provide relief for the famine-stricken people.

(2) Personnel

(i) P. J. Fitzgibban, M.I.C.E., Executive Engineer.

(ii) J. J. B. Benson, M.I.C.E., Executive Engineer.

(iii) T. S. Pipe, M.I.C.E., Executive Engineer.

(iv) F. J. Von Bock, M.I.C.E., Executive Engineer.

(v) C. O. Lowsloy, M.I.C.E., Executive Engineer.

(vi) H. J. M. Cousens, B.Sc., A.M.I.C.E, Executive Engineer.

(vii) E. T. Rock, Executive Engineer.

(3) Bibliography

# IV. 32. Anjanapur Dam

## Earthen

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 63·0 feet |
| (2) Location | Shimoga district, Mysore State, (Kumudvati Stream). |
| (3) Authority or owner | Government of Mysore |
| (4) Purpose-Main and subsidiary | Irrigation |
| (5) Year of commencement | 1925 |
| (6) Year of completion | 1938 |
| (7) Capital cost | |
| (a) Estimated | (a) Rs. 17,85,000 |
| (b) Actual | (b) Rs. 20,50,000 including additional works. |
| (8) Culturable area commanded by the project | |
| (9) Area irrigated | 10,294 acres |
| (10) Means of access | By road from Shimoga town, distance 40 miles. |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | (1) 201 square miles |
| (2) Nature of catchment | (2) Hilly |
| (3) Mean annual precipitation | |
| (a) Rainfall | (a) 37·5 inches |
| (4) Average Total annual yield of the catchment | 134,174 acre feet |
| (5) Climate | Tropical |
| (6) Temperature conditions and variations. | 68° F to 88° F *i.e.* variation of 20° F. |
| (7) Rate of Flow : | |
| (a) Maximum | (a) 2,500 cusecs |
| (b) Minimum | — |

(8) Detritus charge of the stream — Very little

(9) Character (chemical) of the water stored in the reservoir — Fairly clear

(10) Geological features :

(a) of foundations — Black cotton soil with li· *kankar* nodules

(b) of catchment area — Black cotton soil with lime *kankar* nodules

## III. TECHNICAL

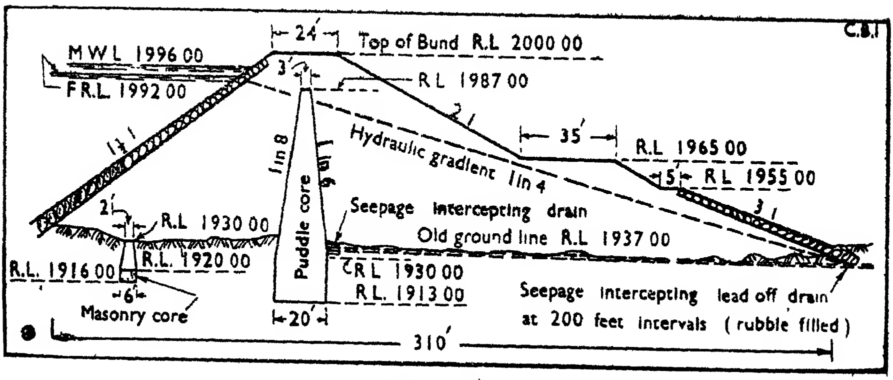
### A. STATISTICAL

(1) Reservoir Data

| | |
|---|---|
| (a) M. W. L. | (a) R. L. 1996·00. |
| (b) F. R. L. | (b) R. L. 1992·00. |
| (c) Area at M.W.L. | (c) 4·38 square miles |
| (d) Area at F. R. L. | (d) 1·89 square miles |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | |

(2) Capacity of the reservoir

| | |
|---|---|
| (a) Gross | (a) 13,368 acre feet. |
| (b) Live | |
| (c) Flood storage | |
| (d) Carry-over | — |




*Cross Section of Anjanapur Dam*

(3) Maximum height above the lowest point of foundations — 87 feet

(4) Height above the lowest river bed at dam — 63 feet

| | |
|---|---|
| (5) Height of the top of the dam above the crest of the spillway or weir | 8 feet |
| (6) Maximum width at level of foundations | 310 feet |
| (7) Width at top | 24 feet |
| (8) Slopes | |
| (a) Upstream | (a) As per cross section |
| (b) Downstream | (b) As per cross section |
| (9) Length at top of the dam | 5,000 feet |
| (a) Non-overflow | |
| (i) Main | (i) 4,189 feet |
| (b) Spillway | (b) 811 feet |
| (10) Cubic volume of the body of the dam | (i) Earth work 4,255,326 cubic feet |
| | (ii) Puddle wall 357,669 cubic feet |
| | (iii) Revetment 302,508 cubic feet |
| | (iv) Gravel backing 140,553 cubic feet. |
| | Total 5,056,056 cubic feet |

## B. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed | Mixture of earth and gravel with puddle core wall |
| (12) Specific gravity (d) Earthfill | |
| (13) Nature of protection and water-proofing of the upstream and down-stream faces | Upstream side is revetted with stone 5,000 feet long (full length). Down-stream side is revetted 300 feet long at gorge portion only. |
| (14) Provision for dealing with seepage and drainage water | Open seepage drains packed with dry rubble. |
| (15) Means of securing water tightness of the foundations of the dam | Puddle wall in the entire length of the dam and masonry core-wall near the front face in the portion of the gorge length as shown in the cross section. |
| (21) Hydraulic gradient for which the embankment is designed | 1 in 4 |
| (22) Particular of the berm (if any), width and position | Berm width 35 feet at R.L. 1965·0 and 5 feet at R. L. 1955. |

| | |
|---|---|
| (23) Position and form of the core wall (or other means of securing water tightness) | As per cross section |
| (24) Batter (if any) of the core wall | Front side 1 in 8, rear side 1 in 6. |
| (25) Maximum depth below ground surface of core-wall or other means of securing water tightness | 24 feet |
| (26) Method of keying core-wall or other wall in the under lying ground | By key trenching |
| (26) Nature of material forming the core or other walls | Puddle and masonry |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | Stone masonry weir 811 feet clear length. |
| (2) Outlet works | Right and left bank, head sluices for channels. Total capacity 285 cusecs. |
| (3) Scouring works | Securing sluice, with sill at R.L. 1978 has 1,000 cusecs discharging capacity. |
| (4) Inspection facilities | Head sluices ; regulator, scouring sluices and channels all are open and accessible for inspection. |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | The earth was trolleyed on to the top of the bank, which was consolidated by using rollers. Core-walls were constructed, one in masonry and the other of puddle as shown in the cross section. |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | The site for the waste weir was changed after investigation |
| (3) Noteworthy occurrences and accidents. | |
| (4) Operation of the dam | |
| (*a*) Regulation | |
| (*b*) Silting of the reservoir | |
| (*i*) Total silt deposited | |
| (*ii*) Rate of silting | |

(*iii*) Density of the silt deposited

(*iv*) Rate of advancement of of delta

(*c*) Actual yield as against estimated

(*d*) Various measurements and observations

(*d*) Few pressure pipes were inserted into the body of the dam to ascertain the slope of the hydraulic gradient. Observations were made, but no definite results were arrived at.

(*i*) Evaporation losses

(*ii*) Sweating below the dam

(*iii*) Temperature measurements

(*iv*) Seepage and regeneration

(*e*) Fish culture

(*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

The construction of Anjanapur Reservoir was sanctioned for Rs. 17,85,000 in November 1927. It was designed to command an area of 9,302 acres but is actually commanding 10,036 acres of land.

(2) Personnel

*Chief Engineers*

(*i*) Rajasevasakta J. Bhore, A.M.I.C.E.

(*ii*) Rajasevasakta M. G. Rangaiya B.A.B.E.

(*iii*) Dewan Bahadur N. N. Ayyanger B.A., L.C.E., M.I.E. (Ind.) I.S.E.

*Superintending Engineers* :

(*i*) Mr. R. W. Scoldwell

(*ii*) Mr. V. V. Karve, L.C.E.

*Executive Engineers* :—

(1) Mr. C. T. Narasimba Iyengar, L.C.E.

(2) Mr. M. Narasimhaiya, B.A., C.E., M.I.E. (Ind.).

(3) Mr. K. Garudachar, B.A., B.E.

(3) Bibliography

(*i*) Anjanapur Reservoir, across the Kumudvati Shikarpur Taluka.

(*ii*) Public Works Department Mysore State, " Annual administration report ending with 30th June 1939 ".

# IV. 33. Rooty Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 45·50 feet |
| (2) Location | Bhir District, Hyderabad State (Bokdi Nala, tributary to Bhima river Kistna Basin) |
| (3) Authority or owner | Hyderabad State Government |
| (4) Purpose—Main and subsidiary | To provide immediate relief to famine affected area in Bhir District and to develope irrigation. |
| (5) Year of commencement | 1937 |
| (6) Year of completion | 1939 |
| (7) Capital cost | |
| (a) Estimated | (a) Rs. 4,46,000/- |
| (b) Actual | (b) Rs. 5,74,073/- |
| (8) Culturable area commanded by the project | 7,890 acres |
| (9) Area irrigated | 4,600 acres |
| (11) Means of access | About 4 miles from Ashti on the Ahmadnagar-Gamkhed Road |

### II. GEOPHYSICAL

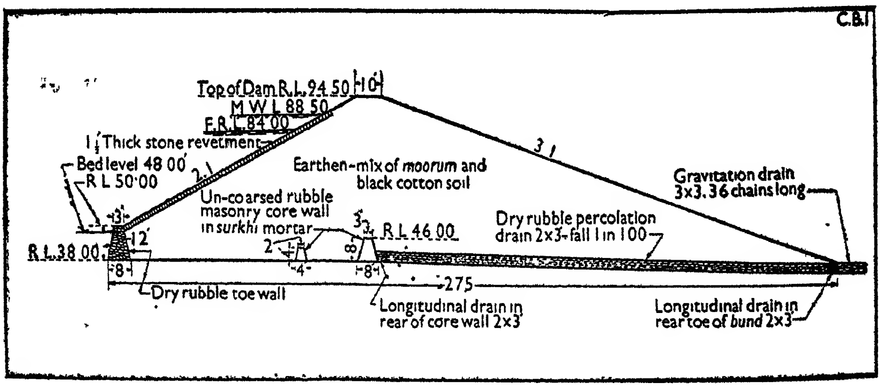
| | |
|---|---|
| (1) Area of catchment | 57·55 square miles |
| (2) Nature of catchment | Upper reaches hilly and lower down fallow land |
| (3) Mean annual precipitation | |
| (a) Rainfall | 25·00 inches |
| (4) Total average annual yield of the catchment | 9,252 acre feet |
| (5) Climate | Hot and dry from March to end of May and temperate during the rest of the year |

| | |
|---|---|
| (6) Temperature conditions and variations | Maximum temperature 102·1°F<br>Minimum temperature 59·0°F |
| (7) Rate of flow | |
| (a) Maximum | (a) 17,880 cusecs (calculated) |
| (b) Minimum | |
| (8) Detritus charge of the stream | |
| (9) Character (chemical) of the water stored in the reservoir | |
| (10) Geological features | |
| (a) of foundations | Trap at the centre and *moorum* at the sides- |
| (b) of catchment area | |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (a) M.W.L. | (a) R.L. 88·50 (from an arbitrary datum) |
| (b) F.R.L. | (b) R.L. 84·00 |
| (c) Area at M.W.L. | (c) 1·25 square miles |
| (d) Area at F.R.L. | (d) 0·96 square mile |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | |
| (2) Capacity of the reservoir | |
| (a) Gross | (a) 6,598 acre feet |
| (b) Live | (b) 5,330 acre feet |
| (c) Flood storage | |
| (d) Carry-over | |




*Cross section of Rooty Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations- | 56·50 feet |
| (4) Height above the lowest river bed at dam | 46·50 feet- |
| (5) Height of the top of the dam above the crest of the spillway or weir | 10 5 feet- |
| (6) Maximum width at level of foundations | 275 feet- |
| (7) Width at top | 10 feet |
| (8) Slopes | |
| (a) Upstream | (a) 2 : 1 |
| (b) Downstream | (b) 3 : 1 |
| (9) Length at top of the dam | 4,877 feet- |
| (a) Non-overflow | |
| (i) Main | (i) 4,202 feet- |
| (b) Spillway or waste weir | (b) 3.5 feet- |
| (10) Cubic volume of the body of the dam- | 10,000.000 cubic feet |

B. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed- | Mixed soil consisting of black cotton soil of 1·5 and I *moorum* |
| (13) Nature of protection and water proofing of the upstream and down stream faces | Upstream face revetted with 1·5 feet thick stones |
| (14) Provision for dealing with seepage and drainage water- | Infiltration drains are provided at the rear base of the dam |
| (15) Means of securing water tightness of the foundations of the dam | By means of masonry corewall in the gorge portion (bed of the streams and upstream face revetted with 1·5 feet thick stones · |
| (22) Particular of the berm (if any), width and position | |
| (23) Position and form of the core-wall or other means of securing water tightness | The corewall is located in the river bed from chainage 38·36 to 41·91 seated on hard rock |
| (24) Batter (if any) of the core-wall | As per cross section- |
| (25) Maximum depth below ground surface of core-wall or other means of securing water tightness- | 10 feet from river bed level |

| | |
|---|---|
| (26) Method of keying core-wall or other wall in the underlying ground. | By benching the rock |
| (27) Nature of material forming the core or other wall | Masonry wall in *surkhi* mortar |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | It is provided with 275 feet free over fall weir and 400 feet rough paved Byewash. The discharge capacity of the weir and Byewash is 17,880 cusecs. |
| (2) Outlet works | One irrigation sluice at left flank with two vents 1·75 feet square each |
| (3) Scouring works | |
| (4) Inspection facilities | |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | The layers were spread in one foot depth and consolidated to nine inches. Before spreading the next layer the consolidated surface was raked to remove the crust on the surface, to provide a better and firm grip between the layers. The consolidation was done with 6 to 8 ton diesel rollers. |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | |
| (3) Noteworthy occurrences and accidents | |
| (4) Operation of the dam | |
| (a) Regulation | |
| (b) Silting of the reservoir | |
| (i) Total silt deposited | |
| (ii) Rate of silting | |
| (iii) Density of the silt deposited | |
| (iv) Rate of advancement of delta | |
| (c) Actual yield as against estimated. | |

| | |
|---|---|
| (*d*) Various measurements and observations | |
| (*i*) Evaporation losses | |
| (*ii*) Sweating below the dam. | |
| (*iii*) Temperature measurements | |
| (*iv*) Seepage and regeneration. | |
| (*e*) Fish culture | |
| (*f*) Anti-malaria measures | |
| (5) Recreation facilities | |
| (6) Lessons to be learnt from the construction and utilisation of the dam | The project was constructed as an experiment in the famine zone and since its construction its techanism has been satisfactory. Due to its storage the water table in the command has raised and has proved helpful for the *ryots*. Its replenishment from the Basin is such that the reservoir is usually always full. |

## IX. BIBLIOGRAPHY AND HISTORICAL

| | |
|---|---|
| (1) Historical | |
| (2) Personnel | Nawab Ali Nawaz Jang Bahadur, F.C.H., Chief Engineer. |
| (3) Bibliography | |

# IV. 34. Pendlipakala Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 54·18 feet |
| (2) Location | Daverkonda *Taluka*, Nalgonda District Hyderabad-Deccan (Uppu Vagu of Kistna River Basin) |
| (3) Authority or owner | Hyderabad State Government |
| (4) Purpose—Main and subsidiary | irrigation |
| (5) Year of commencement | 1935 |
| (6) Year of completion | 1946 |
| (7) Capital cost · | |
| (a) Estimated | (a) Rs. 3,24,984 (O.S.) |
| (b) Actual | (b) Rs. 6.57,872 (O.S.) |
| (8) Culturable area commanded by the project | 5,000 acres |
| (9) Area irrigated- | Varying upto 5,000 acres |
| (11) Means of access | The dam is situated 5 miles from Devarkanda Nalgonda District and is also accessible by road from Hyderabad, distance 102 miles- |

### II. GEOPHYSICAL

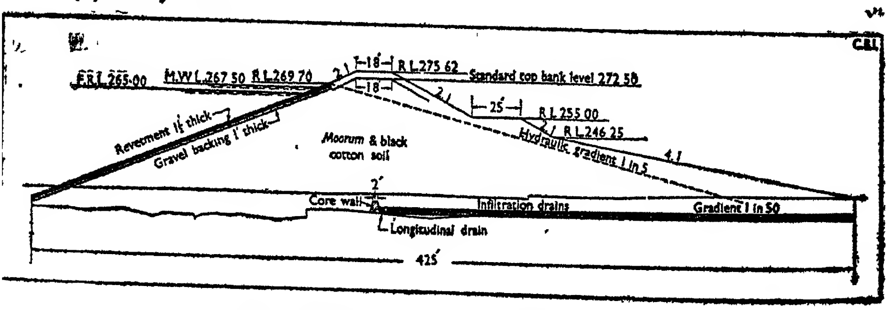
| | |
|---|---|
| 1 Area of catchment | 115 sq. miles { 12·25 square miles Free catchment; 102·75 square miles Intercepted } |
| 2 Nature of catchment | |
| 3 Mean annual precipitation | |
| (a) Rainfall | a) 20·71 inches |
| 4 Total average annual yield of the catchment | 12,488 acre feet |
| 5- Climate | Tropical |

| | |
|---|---|
| 6 Temperature conditions and variations | Maximum temperature 107°F. Minimum temperature 62·8°F |
| 7 Rate of Flow— | |
| (a) Maximum | 35,050 cusecs. |
| (b) Minimum | Negligible. |
| 8 Detritus charge of the stream | Not perceptible |
| 9 Character (chemical) of the water stored in the reservoir | The water is appreciably alkaline. It is harmful for *rabi* cultivation. |
| 10 Geological features— | |
| (a) of foundations | Rocky |
| (b) of catchment area | The catchment of both the streams of Pedda Vagu and Uppoo Vagu is amidst rocky surroundings and contains *moorum* and loamy soils. |
| 11 Earthquake (Zone and intensities) | |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| 1 Reservoir Data— | |
| (a) M.W.L. | (a) R.L. 267·50 |
| (b) F.R.L. | (b) R.L. 265·00 |
| (c) Area at M.W.L. | (c) 1·75 square miles |
| (d) Area at F.R.L. | (d) 1·52 square miles |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | (g) 8·86 miles |
| 2 Capacity of the reservoir— | |
| (a) Gross | (a) 12,419 acre feet |
| (b) Live | (b) 11,777 acre feet |
| (c) Flood storage | |
| (d) Carry over | |




*Cross Section of Pendlipakala Dam*

| | |
|---|---|
| 3 Maximum height above the lowest point of foundations | 65·47 feet |
| 4 Height above the lowest river bed at dam | 54·18 feet |
| 5 Height of the top of the dam above the crest of the spillway or weir- | 7·5 feet |
| 6 Maximum width at level of foundation | 425 feet |
| 7 Width at top | 8 feet on flanks and |
| 8 Slopes— | 18 feet in the centre |
| (a) Upstream | 2 : 1 at the flanks and 3 : 1 in the gorge portion only |
| (b) Downstream | 2 : 1 4 : 1 |
| 9 Length at top of the dam— | 4,521 feet |
| (a) Non-overflow— | |
| (i) Main | 1,654 feet |
| (ii) Subsidiary | — |
| (b) Spillway or weir | (b) 2,867 feet |
| 10 Cubic volume of the body of the dam | 7,800,000 cubic feet (Earthwork) |

**B. OTHERS**

| | |
|---|---|
| 11 Material of which the dam is constructed | Mixed soil (*Moorum* and black cotton) |
| 12 Specific gravity— | |
| (d) Earthfill | |
| 13 Nature of protection and water proofing of the upstream and downstream faces | Upstream side revetted ; 1·5 feet thick over 1·0 foot gravel backing. In the rear turfing is provided |
| 14 Provision for dealing with seepage and drainage water | Infiltration drains are provided |
| 15 Means of securing water tightness of the foundations of the dam | By means of core-wall and revetment on upstream side |
| 21 Hydraulic gradient for which the embankment is designed | 1 in 5 |
| 22 Particular of the berm (if any), width and position | Berm 25 feet wide at R.L. 255 in the gorge portion only. |

| | |
|---|---|
| 23 Position and form of the core-wall (or other means of securing water tightness) | Masonry core-wall two feet wide at top, is constructed in the gorge portion along the centre line of the *bund* wherever rock is not met with. |
| 24 Batte (if any), of the core-wall | 1 in 4 |
| 25 Maximum depth below ground surface of core-wall or other means of securing water tightness | 9·01 feet |
| 26 Method of keying core-wall or other wall in the underlying ground | Where found on rock, benching is done. |
| 27 Nature of material forming the core or other wall | Core-wall is constructed with rubble masonry in lime. |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

| | |
|---|---|
| 1) *Land Submerged*— | |
| (*a*) Crown waste | — |
| (*b*) Proprietory | — |
| 2) *Dislocation*— | |
| (*a*) Villages | — |
| (*b*) Families | — |
| (*c*) Population | — |
| (*d*) Roads— | |
| (1) Highways | — |
| (2) District Roads | — |
| (3) Village Roads | — |
| (*e*) Railway Lines | — |
| (*f*) Temples, Mosques, *etc.* | — |
| (*g*) Graves, *etc.* | — |
| (*h*) Trees, gardens, pastures, houses, wells, *etc.* | — |
| (*i*) Bridges | — |
| 3) Compensation paid under each category of item (2) | — |
| 4) Method of compensating for land of dispossessed landholders | — |

## V. AUXILIARY WORKS

| | |
|---|---|
| 1 Surplussing works | Weir 2,867 feet in length, with crest at R.L. 265·0. The water can pass over it with a maximum depth of 2·5 feet of water over the crest. |
| 2 Outlet works | One sluice of 3 vents each 2′—8″ by 3′—8″. |
| 3 Scouring works | — |
| 4 Inspection facilities | — |
| 5 Fish pass | — |
| 6 Means for dissipating energy below the spillway | — |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| 1 Constructional features | Consolidation of earth-work was carried on with steam road rollers. The earth-work was not built with full sinkage height but was raised only about 3 feet above the actual top *bund* level with the idea to do the balance of work later on if appreciable sinkage was found. To examine this, four inches thick pegs about 3 feet long were driven on the top of the earth-work, and the levels were observed on the top of the pegs every month for about two years and practically no sinkage was found. |
| 2 Changes introduced in the plans of the dam and in the method of carrying out the work | (i) Instead of building two berms, only one berm is put taking care that there is 6 feet of earth above the hydraulic gradient of 1 in 5.<br>(ii) A gravitation channel from the lowest bed of infiltration drain in the rear is executed having a fall of 1 in 500 to meet the bed of the river lower down.<br>(iii) The front half of the dam is composed of mixed soils of *moorum* and black cotton and the rear portion is made up purely of *moorum* soil. |
| 3 Noteworthy occurrences and accidents | — |
| 4 Operation of the dam— | |
| (*a*) Regulation | |
| (*b*) Silting of the reservoir— | |
| (*i*) Total silt deposited | |
| (*ii*) Rate of silting | |
| (*iii*) Density of the silt deposited | |
| (*iv*) Rate of advancement of delta | |
| (*c*) Actual yield as against estimated | (c) 12,488 acre feet |
| (*d*) Various measurements and observations | (d) 2,370 acre feet |

| | |
|---|---|
| (*i*) Evaporation Losses | — |
| (*ii*) Sweating below the dam | — |
| (*iii*) Temperature measurements | — |
| (*iv*) Seepage and regeneration | — |
| (*e*) Fish culture | — |
| (*f*) Anti-malaria measures | (f) Being carried out by the Public Health Department. |
| 5 Recreation facilities | — |
| 6 Lessons to be learnt from the construction and utilisation of the dam | Mixed soil is quite impervious. |

## IX. BIBLIOGRAPHY AND HISTORICAL

1. Historical

Pendlipakala tank was an old breached tank and the question of its restoration was under consideration from 1904. It had a feeder channel drawn from Pedda Vagu with an old leaky *anicut* across it for diverting the water to the channel. These were in disuse for a very long time.

In 1912 an estimate for improving the *anicut* and feeder channel and for restoring the tank was sanctioned by Government and the work was started. Subsequently on closer examination, the proposals were found to be defective. A revised estimate was submitted in 1913 but on account of the low return, the work was ordered to be closed.

In 1921 the restoration proposals were again taken up and revised. The *anicut* site was shifted lower down and consequently the length of the feeder channel reduced. The case was under correspondence till sanction was accorded to start the work in 1935 under famine grant and it was completed in 1940 at a total cost of O. S. Rs. 6,57,872.

2. Personnel

3. Bibliography

# IV. 35. Nandargi Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 42·0 feet |
| (2) Location | Bijapur district, Bombay State (Local *Nala*) Bhima River Basin. |
| (3) Authority or owner | Bombay Government |
| (4) Purpose—Main and subsidiary | Irrigation |
| (5) Year of commencement | 1939 |
| (6) Year of completion | 1942 |
| (7) Capital Cost— | |
| (*a*) Estimated | (a) Rs. 1,25,965 |
| (*b*) Actual | (b) Rs. 1,19,946 |
| (8) Culturable area commanded by the project | 863 acres |
| (9) Area irrigated | 693 acres |
| (11) Means of access | It is situated at a distance of 2½ miles from the milestone 36 of Hubli-Sholapur road. The approach road is a motorable one. |

### II. GEOPHYSICAL

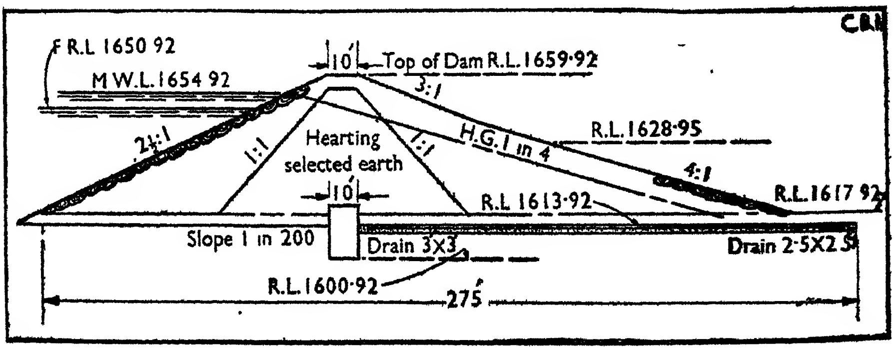
| | |
|---|---|
| (1) Area of catchment | 10 square miles |
| (2) Nature of catchment | It is hilly and *moorum* at the ridge and *moorum* with an average slope in plains. |
| (3) Mean annual precipitation— | |
| (*a*) Rainfall | 22·62 inches |
| (4) Total average annual yield of the catchment | 1,226 acre feet |
| (5) Climate | Hot and dry |
| (6) Temperature conditions and variations | Maximum 108° F<br>Minimum 68° F |

| | |
|---|---|
| (7) Rate of flow— | |
| (a) Maximum | |
| (b) Minimum | |
| (8) Detritus charge of the stream | |
| (9) Character (chemical) of the water stored in the reservoir | Ordinary, portable water. |
| (10) Geological features— | |
| (a) of foundations | Soft and hard *moorum*, soft rock for foundations. |
| (b) of catchment area | Catchment area partly *moorumy* and partly of soil. |

## III. TECHNICAL

### STATISTICAL

| | |
|---|---|
| (1) Reservoir Data— | |
| (a) M.W.L. | (a) R.L. 1654·92 |
| (b) F.R.L. | (b) R.L. 1650·92 |
| (c) Area at M.W.L. | (c) 0·26 square mile |
| (d) Area at F.R.L. | (d) 0·19 square mile |
| (e) Maximum length | (e) 1·12 miles |
| (f) Maximum width | (f) 3,000 feet |
| (g) Length of periphery | (g) 4·09 miles |
| (2) Capacity of the reservoir— | |
| (a) Gross | (a) 1,207 acre feet |
| (b) Live | (b) 947 acre feet |
| (c) Flood storage | |
| (d) Carry-over | |




*Cross Section of Nandargi Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 59 feet |
| (4) Height above the lowest river bed at dam | 42 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 9 feet |
| (6) Maximum width at level of foundation | 275 feet |
| (7) Width at top | 10 feet |
| (8) Slopes— | |
| (a) Upstream | $2\frac{1}{2}$ to 1 |
| (b) Downstream | 3 to 1 and 4 to 1 |
| (9) Length at top of the dam | 1,610 feet |
| (a) Non-overflow— | |
| (i) Main<br>(ii) Subsidiary | 1,250 feet |
| (b) Spillway or waste weir | (b) 360·0 feet |
| (10) Cubic volume of the body of the dam | 2,170,000 cubic feet |

B. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed | Puddle core-wall, hearting of selected materials, and casing of *moorum*. |
| (12) Specific gravity— | |
| (d) Earthfill | |
| (13) Nature of protection and waterproofing of the upstream and downstream faces | Pitching 1·0 foot thick on upstream side on a layer of 6 inches backing of quarry chips. On downstream side pitching 12 inches thick for sloping portion 2 feet above the F.R.L. |
| (14) Provision for dealing with seepage and drainage water | Longitudinal and cross drains provided at intervals |
| (15) Means of securing water tightness of the foundations of the dam | Puddle trench |
| (21) Hydraulic gradient for which the embankment is designed | 1 in 4 |
| (22) Particular of the berm (if any), width and position | |
| (23) Position and form of the core-wall (or other means of securing water tightness). | Puddle core-wall, running longitudinally at the centre of the dam with a hearting of selected material. |

| | |
|---|---|
| 24) Batter (if any) of the core-wall | 1 to 1 for hearting |
| 25) Maximum depth below ground surface of core-wall or other means of securing water tightness | 16·5 feet for puddle trench at the central gorge portion. |
| 26) Method of keying core-wall or other wall in the underlying ground. | Trenching vertically |
| (27) Nature of material forming the core or other wall | Puddle |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

| | |
|---|---|
| 1) *Land submerged*— | |
| (*a*) Crown waste | |
| (*b*) Proprietory | (b) 119 acres |
| (2) *Dislocation*— | |
| (*a*) Villages | |
| (*b*) Families | |
| (*c*) Population | |
| (*d*) Roads— | |
| (*i*) Highways | |
| (*ii*) District Roads | |
| (*iii*) Village Roads | |
| (*e*) Railway Lines | |
| (*f*) Temples, mosques, *etc.* | |
| (*g*) Graves, *etc.* | |
| (*h*) Trees, gardens, pastures, houses, wells, *etc.* | |
| (*i*) Bridges | |
| (3) Compensation paid under each category of item (2) | |
| (4) Method of compensating for land of dispossessed landholders | Land compensation was paid in cash |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | Drowned channel waste weir 360 feet in length. |
| (2) Outlet works | One masonry outlet 2 feet×2 feet. |
| (3) Scouring works | |
| (4) Inspection facilities | The work can be inspected in the hot weather, when water goes down. No special devices are provided. |

| | |
|---|---|
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | Has a drowned waste-weir in rock. |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | The casing and hearting of the dam were placed in position together in thin layers. |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | |
| (3) Noteworthy occurrences and accidents | — |
| (4) Operation of the dam— | |
| (*a*) Regulation | (*a*) Hand regulated gate for discharging water through the outlet. |
| (*b*) Silting of the reservoir— | |
| (*i*) Total silt deposited | |
| (*ii*) Rate of silting | |
| (*iii*) Density of the silt deposited | |
| (*iv*) Rate of advancement of delta | |
| (*c*) Actual yield as against estimated | |
| (*d*) Various measurements and observations— | |
| (*i*) Evaporation losses | |
| (*ii*) Sweating below the dam | |
| (*iii*) Temperature measurements | |
| (*iv*) Seepage and regeneration | |
| (*e*) Fish culture | |
| (*f*) Anti-malaria measures | |
| (5) Recreation facilities | |
| (6) Lessons to be learnt from the construction and utilisation of the dam | The seepage water through the body of the dam is drained by means of cross and longitudinal drains. The advisability of providing drains in the body of the dam has been confirmed by the appreciable flow in the drain at the end. |

## IX. BIBLIOGRAPHY AND HISTORICAL

**(1) Historical**

The scheme was investigated in 1910 by the Superintending Engineer on Special Duty and sanctioned by Government, as a Famine Relief Work. The *Nala* had a flow upto end of January every year. The site was selected—above the site of a *kacha* Bandhara existing then with a " pat " irrigating about 340 acres. The work was started as a scarcity work in 1938 and the dam was completed in 1941, and the channel in 1944. When the work was in progress in 1940 and earth-work had come to F.R.L. in the gorge portion, there were heavy rains in the catchment area having an intensity of about 2·7 inches in two hours and the water rose to the level of earth-work. There were chances of the dam being over-topped but fortunately the rains subsided and the calamity was averted. Since completion, the waste-weir is found to overflow in years of normal rain-fall.

**(2) Personnel**

1. Mr. L. E. Greening
2. Mr. N. G. K. Murty
3. Mr. S. K. Karandikar
4. Mr. H. K. Thakor
5. Mr. D. B. Anand

**(3) Bibliography**

# IV. 36. Dindi Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 77 feet |
| (2) Location | Mahboobnagar District, Hyderabad State. (Dindi River). |
| (3) Authority or owner | Hyderabad State Government |
| (4) Purpose—Main and subsidiary | Irrigation |
| (5) Year of commencement | 1940 |
| (6) Year of completion | 1943 |
| (7) Capital cost— | |
| (a) Estimated | (a) Rs. 35,30,000 |
| (b) Actual | (b) Rs. 40,34,260 |
| (8) Culturable area commanded by the project | |
| (9) Area irrigated | 40,000 acres |
| (11) Means of access | It is located across the river Dindi near Gundlapally village, Mahboobnagar District. It is 45 miles from the nearest railway station of Jedcherla on Secundrabad Dronachellam line and 14 miles in the interior from the nearest Public Works Department road to Devarkonda which is now connected by an approach road. |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 1530·50 square miles of which 1,158 square miles are intercepted. |
| (2) Nature of catchment | The catchment is partly hilly and partly plain. |

| | |
|---|---|
| (3) Mean annua l precipitation— | |
| (*a*) Rainfall | (*a*) 26·2 inches |
| (4) Total average annual yield of the catchment | 105,600 acre feet |
| (5) Climate | The climate is hot and damp from March to end of September, and temperate during the remaining months. |
| (6) Temperature conditions and variations | Maximum temper ature 105°F<br>Minimum temperature 85·05°F |
| (7) Rate of Flow— | |
| (*a*) Maximum | 271,500 cusecs (calculated). |
| (*b*) Minimum | |
| (8) Detritus charge of the stream | |
| (9) Character (chemical) of the water stored in the reservoir | |
| (10) Geological features— | |
| (*a*) of foundations | (*a*) The foundation rocks in the river gorge consists of archosen granitoid gniese, and technically termed the Peninsula crystalline complex. |
| (*b*) of catchment area | |

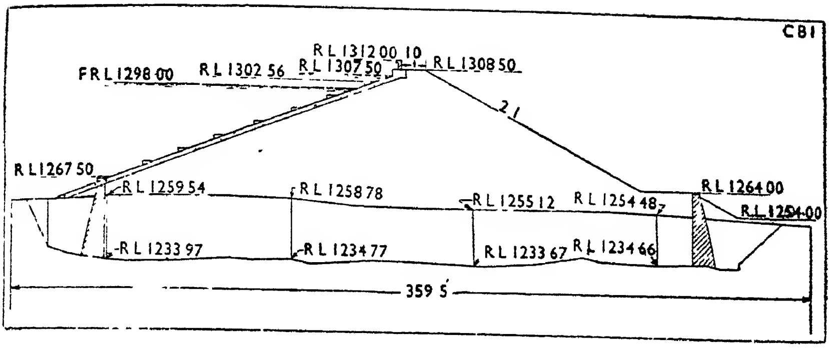
## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data— | |
| (*a*) M.W.L. | (*a*) R.L. 1307·50 |
| (*b*) F.R.L. | (*b*) R.L. 1298·00 |
| (*c*) Area at M.W.L. | (*c*) 7·5 square miles |
| (*d*) Area at F.R.L. | (*d*) 5·3 square miles |
| (*e*) Maximum length | |
| (*f*) Maximum width | |
| (*g*) Length of periphery | |
| (2) Capacity of the reservoir— | |
| (*a*) Gross | (*a*) 59,900 acre feet |
| (*b*) Live | (*b*) 55,676 acre feet |

(e) Flood storage

(d) Carry over




*Cross Section of Dindi Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 84 feet |
| (4) Height above the lowest river bed at dam | 77 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 14·5 feet above the spillway and 11·5 feet above the weir |
| (6) Maximum width at level of foundations. | 359·5 feet |
| (7) Width at top | 12 feet |
| (8) Batter of face-slopes— | |
| (a) Upstream | (a) 3 : 1 |
| (b) Downstream | (b) 2 : 1 |

| | |
|---|---|
| (9) Length at top of the dam— | 6,100 feet |
| (a) Non-overflow— | |
| (i) Main | (i) 3,400 feet |
| (b) Spillway or weir | (b) 1,000 feet (Ogee spillway) and 1,000 feet and 700 feet, weirs. |
| (10) Cubic volume of the body of the dam | 12,625.510 cubic feet |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | *Moorum* soil available at site. |
| (12) Specific gravity | |
| (d) Earth fill | |
| (13) Nature of protection and water-proofing of the upstream and down-stream faces | It is provided with 1·5 feet thick concrete slab on upstream side and the downstream side is turfed. |
| (14) Provision for dealing with seepage and drainage water. | |
| (15) Means of securing water tightness of the foundations of the dam | Upstream face provided with 1·5 feet concrete slab |
| (16) Constraction joints | |
| (17) Principal stresses in the masonry with a note of methods of claculations employed | Stresses in Ogee Spillway Section 0·57 ton. (a) Maximum tensile stress 0·57 ton per square foot. (b) Maximum compressive stress as per Principle of Hostwork 3·25 tons per square foot. (c) Maximum compression stress as Bouviers' principle 4·75 tons per square foot. |
| (18) Maximum pressure on foundations | |
| (19) Uplift pressure calculated or measured | |
| (20) Measures adopted for preventing or counteracting uplift pressures | |
| (21) Hydraulic gradient for which the embankment is designed | 1 in 1·94 |
| (22) Particular of the berm (if any), width and position | |
| (23) Position and form of the core wall (or other means of securing water tightness) | |

(24) Batter (if any) of the core wall

(25) Maximum depth below ground surface of corewall or other means of securing water tightness

(26) Method of keying corewall or other wall in the underlying ground

(27) Nature of material forming the core or other wall

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*—
- (*a*) Crown waste
- (*b*) Proprietory

(2) *Dislocation*—
- (*a*) Villages
- (*b*) Families
- (*c*) Population
- (*d*) Roads:
  - (*i*) Highways
  - (*ii*) District Roads
  - (*iii*) Village Roads
- (*e*) Railway Lines
- (*f*) Temples, Mosques, *etc.*
- (*g*) Graves, *etc.*
- (*h*) Trees, Gardens, Pastures, Houses, Wells, *etc.*
- (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplusing works | **Ogee spillway in the centre 1,000 feet long in addition to two free overfall weirs 1,000 feet and 700 feet long respectively at right flanks.** |

(2) Outlet Works — One regulator at left flanks with 3 vents of $4' \times 4'$ each.

(3) Scouring works

(4) Inspection facilities

(5) Fish pass

(6) Means for dissipating energy below the spillway

## VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features — The layers were spread in one foot depth and consolidated to 9 inches. Before spreading another layer the consolidated surface was raked to remove the thin crest on the surface. During construction the surface was a kept at a slight cross fall or slope towards the centre. For consolidation 6-ton roller was used. Each layer was consolidated by rolling five times. The roller was shifted three inches at a time.

(2) Changes introduced in the plans of the dam and in the method of carrying out the work.

(3) Noteworthy occurrences and accidents

(4) Operation of the dam—

(*a*) Regulation

(*b*) Silting of the reservoir—

(*i*) Total silt deposited

(*ii*) Rate of silting

(*iii*) Density of the silt deposited

(*iv*) Rate of advancement of delta

(*c*) Actual yield as against estimated

(*d*) Various measurements and observations—

(*i*) Evaporation losses

(*ii*) Sweating below the dam

(*iii*) Temperature measurements

(*iv*) Seepage and regeneration

(e) Fish culture

(f) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

## IX. BIBLIOGRAPHY AND HISTORICAL

| | |
|---|---|
| (1) Historical | The object of constructing the dam was to protect Deverkonda and Miryalguda *Talukas* from the frequent attacks of famines due to in sufficient rainfall and to develop the rice cultivation in these *talukas*. Secondly it is proposed to generate hydro-electric power on a later stage. |
| (2) Personnel | Nawab Ali Nawaj Jung Bahadur, F.C.H., Chief Engineer. |
| (3) Bibliography | |

# IV. 37. Radhanagari Dam

## (Masonry)

### I. GENERAL

| | |
|---|---|
| (1) Height of the Dam above the lowest river bed | 126 feet |
| (2) Location | Kolhapur District, Bombay State (Bhogavati River) Western Ghats |
| (3) Authority or Owner | Bombay Government |
| (4) Purpose—Main and subsidiary | Irrigation, Power Generation and water supply to Kolhapur City |
| (5) Year of commencement | In the year 1909-1910 and stopped in 1918. Again resumed in 1940. |
| (6) Year of completion | Expected to be completed by the end of 1951. |
| (7) *Capital cost* | |
| (*a*) Estimated | (*a*) Rs. 1,70,00,000 |
| (*b*) Actual | (*b*) Work still in progress |
| (8) Culturable area commanded by the project | 14 000 acres |
| (9) Area Irrigated. | 7,000 acres |
| (10) Installed Hydro-Electricity | 4,800 kW |
| (*a*) Firm | (*a*) 3,750 kW. 40% load factor. |
| (11) Means of access | It is situated 32 miles from Kolhapur, (on Kolhapur Malvan metalled road). Kolhapur City is on a branch of Madras and Southern Maratha Railway (on Poona Hubli Section). |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 42·5 Square miles |
| (2) Nature of catchment | Steep, and fairly wooded |

| | |
|---|---|
| (3) **Mean annual precipitation** | |
| (*a*) **Rain-fall** | (*a*) 200 inches average |
| (4) Total average annual yield of the catchment | 550,966 acre feet |
| (5) Climate | Temperate |
| (6) Temperature conditions and variations | Maximum 100°F.<br>Minimum 50°F. |
| (7) Rate of flow | |
| (*a*) Maximum | (*a*) 27,000 cusecs. |
| (*b*) Minimum | (*b*) Practically nil in summer |
| (8) Detritus charge of the stream | Very little detritus and mostly fine silt |
| (9) Character (chemical) of the water stored in the reservoir | Results of examination of water dated 30-8-1943 by Public Health Laboratory Poona-Parts for 100,000 |

Chemical

| | |
|---|---|
| Total solids .. | 5 |
| Calcium carbonate .. | 1·15 |
| Magnesium carbonate | 0·30 |
| Sodium chloride . | 1·52 |
| Ferric oxide . | 0·09 |
| Sodium sulphate .. | 0·61 |
| Silica organic matter | 1·33 |
| Permanent hardness | .. |
| Temporary hardness | *CaCo3* |
| Free and saline .. | 1·5 |
| Ammonia .. | 0·0008 |
| Alluminoid Ammonia | 0·001 |
| Chloride as *cl* .. | 0·92 |
| Oxygen absorbed in 4 hours at 37°C .. | 0·030 |
| Nitrites poisonous and phosphates | . |

Physical characteristics :—
No Smell
Slight deposit of mud.

| | |
|---|---|
| (10) **Geological Features :—** | |
| (*a*) **of foundations** | (*a*) Deccan trap rock |
| (*b*) **of catchment area** | (*b*) The top surface of the catchment area contains a layer of reddish soil and boulders formed from weathering of trap and laterite overlying trap formation. |

*Dam works in progress--View from south end showing trolley line etc.*

# III. TECHNICAL

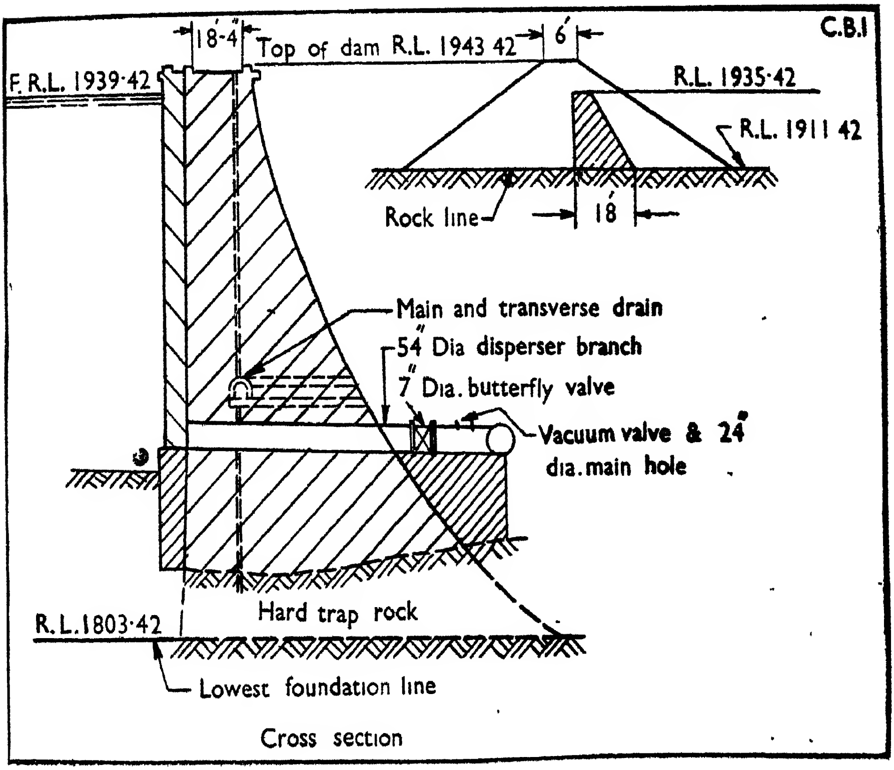
## A. STATISTICAL

(1) Reservoir data :—

| | |
|---|---|
| (*a*) M.W.L. | (*a*) R.L. 1939·42 |
| (*b*) F.R L. | (*b*) R. L. 1939·42 |
| (*c*) Area at M.W.L. | (*c*) 7 square miles |
| (*d*) Area at F.R.L. | (*d*) 7 square miles |
| (*e*) Maximum length | (*e*) 10 miles |
| (*f*) Maximum width | (*f*) 1·5 miles |
| (*g*) Length of periphery | (*g*) 55 miles |

(2) Capacity of the reservoir :—

| | |
|---|---|
| (*a*) Gross | (*a*) 190,000 acre feet |
| (*b*) Live | (*b*) 137,000 acrefeet |
| (*c*) Flood storage | |
| (*d*) Carry over | (*d*) 45,914 acre feet |




*Cross Section of Radhanagari Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations. | 140 feet |
| (4) Height above the lowest river bed at Dam | 126 feet |
| (5) Height of the top of the Dam above the crest of the spillway or weir | 8 feet |
| (6) Maximum width at level of foundations | 100·25 feet |
| (7) Width at top | 18·4 feet |
| (8) Slopes | |
| (*a*) Upstream | (*a*) From R. L. 1797·42—1867·42 1 in 16·6<br>R.L. 1867·42--1939·42, 1 in 28·5 |
| (*b*) Downstream | (*b*) From R. L. 1797·42—1867·42 1 in 1·02<br>R.L. 1867·42—1939·42, 1 in 2.9 |
| (9) Length of the top of the Dam | 3,750 feet |
| (*a*) Non-overflow | |
| (*i*) Main | 2,863 feet |
| (*b*) Spillway | (*b*) 887 feet |
| (10) Cubic volume of the body of the dam | 13,000,000 cubic feet |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Hearting is of random rubble, and face work of coarse rubble in *surkhi* lime mortar proportion 2 : 1 |
| (12) Specific Gravity :— | |
| (*a*) Masonry | (*a*) 2·25 |
| (13) Nature of protection and water proofing of the upstream and downstream faces | Deep pointing with cement on up stream side and *surkhi* mortar on down stream side |
| (14) Provision for dealing with drainage and seepage water | One longitudinal drainage gallery with cross drains at 300 feet intervals, at R.L. 1861.42 |
| (15) Means of securing water lightness of the foundations of the dam. | The front portion is filled with fine clay |
| (16) Construction joints | |

| | |
|---|---|
| (17) Principal stresses in the masonry with a note of methods of calculations employed | Calculations have been based upon the usual method of moments given in "The theory of structure" by Moreley and Coultas. Maximum principal (compressive stress) at R.L. 1797·42 = 244 lb. per square inch and maximum shear stress at R.L. 1797·42 at the down stream toe = 120 lb. per square inch. |
| (18) Maximum pressure | Maximum vertical pressure on foundations (*i*) Dam full : –111·80 lb. per square inch. (*ii*) Dam empty :—129·50 lb per square inch. |
| (19) Uplift pressure claculated or measured | |
| (20) Measure adopted for preventing or counteracting uplift pressures | The foundation strata on the upstream face of the dam are consolidated by cementation (grouting with cement slurry under pressure) varying from 60 to 100 lb. per square inch. Vertical drainage holes 4 inch diameter right from the foundations of the dam and opening into the drainage gallery are provided. These measures are expected to prevent uplift pressure on the dam. Moreover the section provided is heavy enough to counteract 25 per cent uplift. |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

| | |
|---|---|
| (1) Land submerged : | |
| (*a*) Crown waste | (*a*) 4,256 acres |
| (*b*) Proprietory | (*b*) 4,100 acres approximately |
| (2) Dislocation : | |
| (*a*) Villages | (*a*) 8 Nos. |
| (*b*) Families | (*b*) 461 Nos. |
| (*c*) Publication | (*c*) 2,468 Nos. |
| (*d*) Roads :— | |
| (*i*) Highways | |
| (*ii*) District Roads | (*ii*) Nipani Phonda Road for a length of 10 miles |
| (*iii*) Village Roads | |
| (*e*) Railway lines | |
| (*f*) Temples, mosques, *etc.* | (*f*) Only minor ones in the villages |

| | |
|---|---|
| (*g*) Graves | |
| (*h*) (1) Trees, (2) Gardens, (3) Pastures, (4) Houses, (5) Wells, *etc.* | (*h*) (1) Very little (2) (3) About 600 acres (4) 231+111=342 (5) |
| (*i*) Bridges | (*i*) 4 Bridges |
| (3) Compensation paid under each category of item (2) | Nearly Rs. 4 *lakhs* for buildings houses and in addition to this the lands were given in exchange. |
| (4) Method of compensating for land of dispossessed landholders | Houses are built for them by Government and lands given in exchange. |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplusing works | It has been provided with 5 undersluices each 8 feet by 18 feet 9 inches height having a discharging capacity of 6,000 cusecs each with a mean head of 63 feet, when the tank is full. The total discharging capacity is 30,000 cusecs. Additional provision is made to surplus 10,000 cusecs at the time of extraordinary floods over a weir of 350 feet in length with 4 feet spillage constructed in the saddle on the north flank. |
| (2) Outlet Works | (*a*) 2 Nos. welded steel pipes ½ inch thick and 7 feet diameter.<br>(*b*) 2 Nos. of C. I. Pipes 3 feet diameter.<br>(*c*) 1 disperser pipe ½ inch thick and 54 inches diameter. |
| (3) Scouring works | |
| (4) Inspection facilities | (1) The undersluices are provided with one emergency shutter.<br>(2) For turbines a gate has been provided at the entry with manholes on the pipe.<br>(3) The entrance to the drainage gallery at both ends are provided by means of manholes left in the body of the dam and also cross drains are made sufficiently big. |

5) Fish-pass

6) Means of dissipating energy below the spillway — Since there is hard trap rock for a great depth, no works are found necessary.

## VI. POWER HOUSE

| | |
|---|---|
| 1) Hydraulic head | 46 feet to 120 feet (variable) |
| 2) Name and address of Licensee with managing agents (if any). | Government of Bombay |
| 3) Generating units :— | |
| (*a*) Type | (*a*) A. C. Generators driven by English Electric feathering propeller type. |
| (*b*) Number | (*b*) Four |
| (*c*) Capacity | |
| (*i*) Firm | (*i*) 1,200 kW. each |
| (*ii*) Secondary | (*ii*) 1,300 kW. by an oil Engine, Power House at Kolhapur |
| (4) Voltage | 6,600 kV. |
| (5) Number of phases and frequency, A.C., or D.C. | A.C. 3 phases 50 cycles |
| (6) Forebay | |
| (7) A brief description of tunnel and penstocks | Two penstock pipe of ½ inch thick steel plate and 7 feet diameter pass through the Dam and branches into two by a Y-Bend just outside the Dam, the thickness of this is 3/8 inch and 54 inches diameter with maximum discharge. Capacity 350 cusecs. |
| (8) Means providing for excluding silt trash | An earthen bund is constructed about 30-40 feet away from the front face of the dam with crests 10 feet above the silt of the pipe slopes to serve as a silt trap. The bed of the trap is pitched with stone and the slopes of the *bund* stone pitched with cement lining. The entrance to the trap is given by an opening parallel to the dam, to prevent the current directly entering the pipes. |

| | |
|---|---|
| (9) Tail race | The channel is 600 feet long with 50 feet bed width and 1 to 1 side slopes and designed to discharge 800 cusecs maximum with 4 feet depth of water. The channal is led into the original river below the dam. |
| (10) Maximum length of transmission line | (*i*) H.T.T. Line 33 k.V. 35 miles<br>(*ii*) L.T.T. Line 11 k.V. 33 miles<br>(*iii*) L. T. T. Line 440 Volts 15 miles |
| (11) Principal towns served | Kolhapur City |
| (12) Main and subsidiary purpose of utilisation of electricity | Lifting water for irrigation, electrification of Kolhapur City and minor industries |
| (13) Any other matter of interest | |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | The masonry of the Dam consists of *Khandaki* coursed rubble masonry or *Kali* (random rubble) facing, the stones being quarried from Kar, (trap boulders) found in the vicinity. The thickness of the courses is 8 inches and stones tail one to two feet into masonry. The hearting consists of random rubble masonry in *surkhi* lime mortar proportion 2 : 2¼ to 1. The size of the rubble varies from 1/3 to ½ cubic foot and is obtained from local trap stone quarries. The percentage of mortar used is 44-45 of the total volume of the masonry. The mortar for the upstream face for 6 feet to 7 feet width of dam was gauged with 20 per cent of cement and upstream joints are cement pointed for 1 to 1½ inches. The *surkhi* lime mortar was manufactured from burnt bricks prepared from local clay with slaked lime manufactured from field *kankar* or quarried *kankar* in a |

proportion of 1 : 2 and $2\frac{1}{2}$ by volume. The grinding was done in power driven mortar mills. The materials are conveyed by mortar lorries and trollies on rails. Masonry construction work including conveyance of material is done by manual labour.

(2) Changes introduced in the plans of the dam and in the method of carrying out the works.

(*i*) Height of the top of the dam as originally designed was upto

| | |
|---|---|
| F.R.L. | R.L. 1932-42 |
| Top of dam | R.L. 1937-42 |

but actually it is raised to

| | |
|---|---|
| F.R.L. | R.L.1939-42 |
| Top of dam | R.L.1943-42 |

(*ii*) In the design it was presumed that there would be black trap rock throughout in founds. Actually it did not happen. There were found verticular trap with cavities filled with zeolities on both flanks to a depth of 20 feet to 55 feet. To meet with this fault the strata was grouted with cement slurry under pressure and the dam is founded on this strata.

(*iii*) (*a*) Originally it was proposed to use sand lime mortar in masonry, and was used for the first two seasons. Later on it was found that sand contained a large proportion of laterite particles and was found to be week in strength. Therefore, further construction was done in *surkhi* lime mortar. The work done in sand lime for the first two years mortar was strengthened by injecting cement slurry under pressure.

(*b*) Originally the dam was intended entirely as an irrigation dam, but later on in the year 1940 it was proposed to serve 3 purposes *viz.* irrigation, generating water power and water supply to the town of Kohlapur.

(*iv*) Originally the dam was proposed to be only a solid structure, and no special drainage arrangements were contemplated but now a drainage gallery with cross drains in the body of the dam are constructed.

(*v*) The upstream face work masonry to a depth of 7 feet in the body of the dam, has been built in lime *surkhi* mortar gauged with 20 per cent of cement by volume to ensure more water tightness and this provision was not made in the original design.

(*vi*) Originally no undersluices were contemplated in the body of the dam. Provision was made in the revised proposal for 5 undersluices with 63 feet head, between chainages 2,190 to 2,300. These undersluices will pass the normal floods.

(3) Noteworthy occurrence and accidents

(4) Operation of the dam :—

(*a*) Regulations — (*a*) Is done by crab winch fixed at the top of the dam—operated with electrically.

(*b*) Silting of the reservoir :—

(*i*) Total silt deposited

(*ii*) Rate of silting

(*iii*) Density of silt deposited

(*iv*) Rate of advancement of delta

(*c*) Actual yield as against estimated

(*d*) Various measurements and observations :—

(*i*) Evaporation losses

(*ii*) Sweating below the dam — (*ii*) As the head of water is low the sweating is very little

(*iii*) Temperature measurements

(*iv*) Seepage and regeneration

(e) Fish culture

(f) Anti-malaria measures

| | |
|---|---|
| (5) Recreation facilities | There is a club run by the staff and labour and provides out-door games, such as foot-ball, volley-ball, badminton and tennis courts *etc.*, in addition to a reading room, and a library. |
| (6) Lessons to be learnt from the construction and utilisation of the dam | While resuming the work of its further raising after 25 years interval, several controversies were promulgated. Some of them are mentioned below :—<br>(i) Whether the quantity of masonry was sufficiently strong enough to admit further raising This was found quite satisfactory.<br>(ii) Whether *surkhi*-lime mortar retains its original strength after a lapse of time or if it gets weaker due to leaching of lime. It was found that *surkhi* lime mortar has retained its strength all right as disclosed by tests conducted with mortar obtained from old dismantled masonry.<br>(iii) Which of the two whether cement sand mortar, or *surkhi* lime mortar is better suited for construction of masonry dams. The *surkhi* lime mortar is to be preferred on account of its homogeneity, flexibility slow setting, no rise in temperature during setting and availability of material locally. These factors go against cement sand mortar. |

(*iv*) At both the flanks a reddish variety of amegdoloidal trap containing zeolites was met with depths extending from 18 feet to 50 feet. This was considered softer and porous as compared to the sound hard trap rock met with in the gorge portion and it was prohibitive to excavate through and go to the hard trap rock After a good deal of discussion and experimenting it was decided to treat this portion by cementation process and then built masonry directly over it. This decision was adopted mainly due to the fact that there exists a super-incumbent strata of trap and hard *moorum* to a depth of 30 feet.

(*v*) The cavities in the foundation are not interconnected and absorb comparatively very small quantity of cement grout.

(*vi*) The cavities in the Deccan trap rock met within the foundations are not interconnected, and absorb comparatively very small quantity of cement grout. The foundations are of Deccan trap and being igneous contains lot of cavities. When these were grouted under pressure, very small quantity was absorbed which clearly shows, these are not interconnected but are local. Cementation was not, therefore, very effective in respect of consolidating and sealing the leakages in the foundation strata. The same cause was applicable to the old masonry which being quite sound and watertight did not absorb much grout.

## IX. BIBLIOGRAPHY AND HISTORICAL

1) Historical

2) Personnel

(i) Mr. H.G. Howard, C.I.E., M.I.C., M.I.E., Chief Electricity Engineer to Govt. of Madras and Consulting Engineer R.H.E. Scheme.

(ii) Mr. P. K. Shinde, B.A., M.I.E., I.S.E. Chief Engineer.

(iii) Mr. V. K. Majagaokar, B.E., B.S.E.. Bombay P.W.D. Executive Engineer, R H.E. Works.

(iv) Mr. P. R. Joshi, B.E.. B.S.E., M.I.E., (Ind.) Bombay, P. W. D. Executive Engineer R.H.E. Works.

(v) Mr. K. V. Karve, B.Sc. B.E., Mysore P.W.D., Superintendent R.H.E. Works.

3) Bibliography

(i) Vichare D. A. " A printed report on the Radhanagari Dam," Kolhapur 1939.

(ii) Shinde P. K., " A preliminary report of the Dam " Kolhapur 1938.

(iii) Howard H.G., Report of an examination of the "Radhanagari Hydro-Electric Work (Scheme) Kolhapur 1942, 43 and 1946. "

(iv) Visvesarayya, M. " A note on the public utility schemes" Kolhapur 1939.

(v) Kale C.G "Report on R.H.E. Works 1948. "

# CHAPTER V

# MINOR BASINS

# V. 1. Periyar Dam

## (Masonry)

### I. GENERAL

| | |
|---|---|
| 1) Height above the lowest river bed | 158 feet |
| 2) Location | Madura District, Madras State (Periyar River) |
| 3) Authority or owner | Madras Government |
| 4) Purpose—Main and subsidiary | Irrigation |
| 5) Year of commencement | August 1887 |
| 6) Year of completion | March 1897 |
| 7) Capital cost | |
| (*a*) Estimated | |
| (*b*) Actual | (*b*) Rs. 33,92,000 |
| 8) Culturable area commanded by the project | |
| 9) Area irrigated | About 195,000 acres |
| 10) Means of access | It is accessible from Madura by a road to Thekkadi—84 miles and from Thekkadi to dam site, a distance of about ten miles has to be covered by motor launch on the lake and this launch is available for hire. |

### II. GEOPHYSICAL

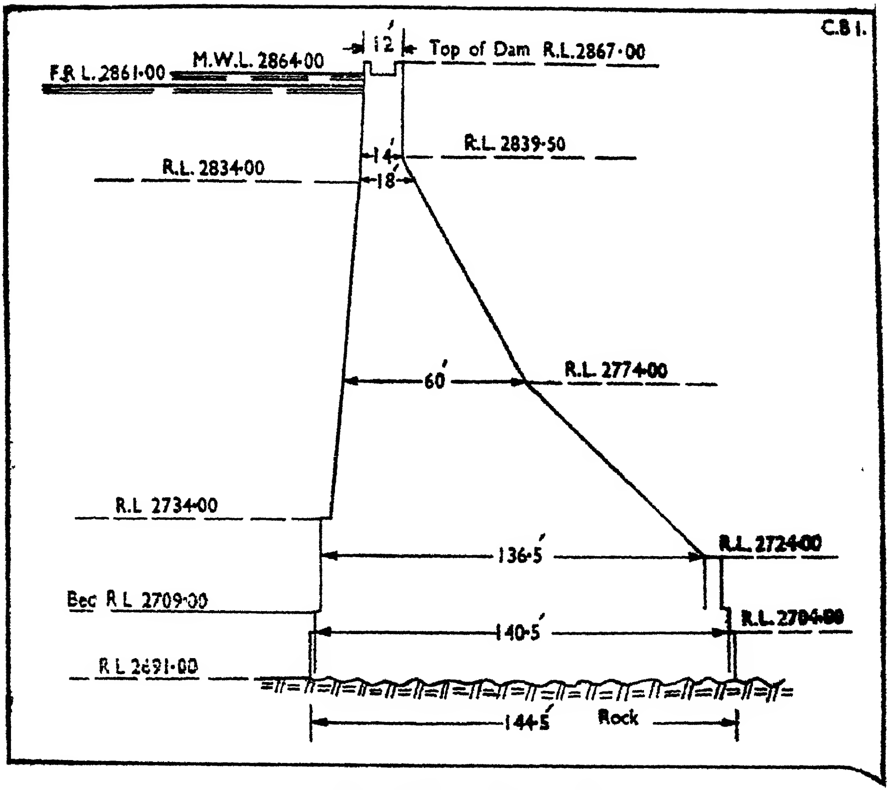
| | |
|---|---|
| 1) Area of catchment | 232 square miles |
| 2) Nature of catchment | Hilly with vegetation and forest |
| 3) Mean annual precipitation | |
| (*a*) Rainfall | (*a*) 91·76 inches |
| 4) Total average annual yield of the catchment | 638,729 acre feet |
| 5) Climate | Tropical. |

| | |
|---|---|
| (6) Temperature conditions and variations. | Temperature varies from 65° to 96°. The weather is pleasant. |
| (7) Rate of Flow— | |
| (a) Maximum | (a) 300,000 cusecs |
| (b) Minimum | (b) 20 cusecs |
| (8) Detritus charge of the stream | The silting above the dam is almost nil; no solids of any magnitude are brought down into the reservoir by the river. |
| (9) Character (chemical) of the water stored in the reservoir | Water collected from rains in the hilly catchment of the Western *Ghats* covered with dense forest |
| (10) Geological features | |
| (a) of foundations | (a) Rocks |
| (b) of catchment area | (b) Hilly catchment of the Western *Ghats* covered with dense forests |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data : | |
| (a) M. W. L. | (a) R. L. 2864·00 |
| (b) F. R. L. | (b) R. L. 2861·00 |
| (c) Area at M. W. L. | (c) 12·5 square miles |
| (d) Area at F. R. L. | (d) 11·2 square miles |
| (e) Maximum length | (e) 8½ miles |
| (f) Maximum width | (f) 1½ miles |
| (g) Length of periphery | (g) 79 miles |
| (2) Capacity of the reservoir : | |
| (a) Gross | (a) 359,550 acre feet |
| (b) Live | (b) 225,321 feet |
| (c) Flood storage | |
| (d) Carry-over | |
| (3) Maximum height above the lowest point of foundations | 176 feet |
| (4) Height above the lowest river bed at dam | 158 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 6 feet |
| (6) Maximum width at level of foundations | 144·5 feet |




*Cross Section of Periyar Dam*

| | |
|---|---|
| (7) Width at top | 12 feet |
| (8) Batter of face-slopes :— | |
| (*a*) Upstream<br>(*b*) Downstream | (*a*)<br>(*b*) } As per cross section. |
| (9) Length at top of the dam :— | 1,241 feet |
| (*a*) Non-overflow— | |
| (*i*) Main | (*i*) 881 feet |
| (*ii*) Subsidiary | (*ii*) 200 feet |
| (*b*) Spillway | (*b*) 360 feet |
| (10) Cubic volume of the body of the dam | 4,993,947 cubic feet |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | The front and rear face walls of the dam are built of rubble masonry and hearting is done with concrete in *surkhi* mortar. |

(12) Specific gravity :

| | |
|---|---|
| (*a*) Masonry | (*a*) 2·25 approximate |
| (*b*) Concrete | (*b*) 2·4 |
| (13) Nature of protection and water-proofing of the upstream and down-stream faces | Cement pointing was applied on the front face and further drilling and grouting was done from the top. |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundations of the dam | The front face was gunnited $\frac{3}{4}$ inch in thickness with admixture of cement, sand and hydraulic lime. |
| (16) Contraction joints | |
| (17) Principal stresses in the masonry with a note of methods of calculations employed | |
| (18) Maximum pressure on foundations | 18,000 lb. per square foot |
| (19) Uplift pressure, calculated or measured | |
| (20) Measures adopted for preventing or counteracting uplift pressures | |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

1) Land submerged :

| | |
|---|---|
| (*a*) Crown waste | |
| (*b*) Proprietory | 11·20 square miles in Union of Travancore and Cochin |

2) Dislocation :

(*a*) Villages
(*b*) Families
(*c*) Population
(*d*) Roads
  (*i*) Highways
  (*ii*) District Roads
  (*iii*) Village Roads
(*e*) Railway Lines
(*f*) Temples, Mosques, *etc.*
(*g*) Graves, *etc.*
(*h*) Trees, gardens, pastures, houses, wells, *etc.*
(*i*) Bridges

| | |
|---|---|
| (3) Compensation paid under each category of item (2). | |
| (4) Method of compensating for land of dispossessed landholders. | Royalty of Rs. 48,000 per *annum* is paid to the Government of the Union of Travancore and Cochin. |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplusing works | Escape of 10 vents 36 feet by 16 feet each |
| (2) Outlet works<br>(3) Scouring works | One head sluice of one vent 12 feet by 9 feet |
| (4) Inspection facilities | |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | Over rock and hence no other special means |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | The originally proposed escape on the left flank was abandoned and the depression was filled by masonry with its top 2 feet higher than the main dam, and the surplus escape was formed on the right flank of the dam, about 400 feet in length. It did not permit of storage sufficient to meet the demand. The F. R. L. of lake was, therefore, raised from R. L. 2853·00 to R. L. 2861·00. Consequently the surplus works had to be improved. The crest of the escape was lowered by 8 feet from R. L. 2853·00 to R. L. 2845·00 and it was converted into a Regulator of 10 vents of 36 feet by 16 feet, fitted with Stoney's Patent Shutters operated by hands. |
| (3) Noteworthy occurrences and accidents. | The site of the dam was highly malarial and fever, rheumatism, dysentry and pulmonary complaints were common. |

There were heavy rains in 1922 and 1924 which resulted in erosion and deep scour on the left flank in rear of the regulator. This necessitated the construction of a long and expensive wing wall on that flank and a series of training walls in the bed of the surplus course. These works were completed in 1933.

(4) Operation of the dam :

(a) Regulation — (a) By hand operated shutters

(b) Silting of the reservoir

(i) Total silt deposited

(ii) Rate of silting

(iii) Density of the silt deposited

(iv) Rate of advancement of delta

(c) Actual yield as against estimated

(d) Various measurements and observations

(i) Evaporation losses

(ii) Sweating below the dam — (ii) Soon after the construction of the dam sweating and leaks were noticed, which have been gradually tried to be stopped with various methods such as grouting on the top of the dam throughout and gunnited on the suspected places which could not be completely arrested by grouting.

(iii) Temperature measurements

(iv) Seepage and regeneration — (iv) 0·071 cusec recorded by 'V' notch

(e) Fish culture

(f) Anti-malaria measures — (f) Pyrotheram sprayed

(5) Recreation facilities — There are facilities for sight seeing and game shooting. Permission of Government of the Union of Travancore and Cochin is necessary.

(6) Lessons to be learnt from the construction and utilisation of the dam — It is best to provide suitable foundations below G. L. to admit raising at a subsequent date if the yield from catchment results in surplusing.

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

The proposal had been under consideration for a long time but it was merely an idea. Nothing substantial was done till 1808, when Sir James Coldwell who visited the site made some investigations and came to the conclusion that the proposal was unworthy of its taking practical shape.

In 1850, the scheme took a little practical shape and a small dam and a diverting channel were actually begun for diverting a small tributary from the Periyar river. After some time the construction was stopped on account of fever among coolies and by the excessive wages demanded by them.

It was not till 1862 that the project was again revived by Major Ryves, R. E. and Major Payne who started investigations practically, of course experienced great difficulties. In 1867 Major Ryves submitted the proposal with full details and an estimate amounting to Rs. 17,94,000.

The proposal after being examined, could not be approved as it was considered that complete and sufficient information was lacking.

The matter was then committed to the charge of Lieutenant Pennyquick, R.E., but shortly after he left for England and the scheme was handed over to Mr. R. Smith who after necessary investigation, submitted the proposal (earthen dam) complete in all details in April 1782. His proposals were generally approved.

General Walker, the then Chief Engineer, was opposed to start the construction of work of such a magnitude without sufficient experience and knowledge of the silting. He asked Mr. Smith and

Captain Pennyquick for further reports on the project with an alternative of masonry dam. Mr. R. Smith reported that he had already estimated the cost of a masonry construction but this was costlier than earthen dam.

Captain Pennyquick proposed a masonry dam with section based on Molesworth's formula and having front and rear faces of solid masonry with longitudinal and cross walls of the same material and the cells to be filled with concrete. His proposal was also objected to as involving risk of unequal settlement. The proposal was not yet finally approved and in 1876-77 famine broke out, resulting in temporary suspension of work. In 1882 again Major Pennyquick who was relieved of all other duties was entirely deputed on the revision of the plans and estimates for the entire project (masonry). He submitted the report and the revised proposals in the same year with detailed estimates and these were sanctioned.

**(2) Personnel**

Superintending Engineers

1. Lt. Col. D. McNeil Campbell
2. Mr. H. S. Taylor
3. Mr. W. B. Dewincton
4. Mr. S. D. Pears

Executive Engineers

5. Mr. A. T. Mackenzie
6. Mr. P. R. Allen
7. Mr. H. T. Keeling

Assistant Engineers

8. Mr. L. L. Wickham
9. Mr. W. Hutton
10. Mr. J. M. Lacey
11. Mr. R.A. Bragg

**(3) Bibliography**

Mackenzie, A. T. " History of Periyar Project ".

# V. 2. Kodayar Dam

## (Masonry)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 99 feet (including 3 feet depth of parapet) |
| (2) Location | Union of Travancore and Cochin State, Kodayar river |
| (3) Authority or owner | Union of Travancore and Cochin Government |
| (4) Purpose-Main and subsidiary | Irrigation |
| (5) Year of commencement | 1895 |
| (6) Year of completion | 1906 |
| (7) Capital cost | |
| (a) Estimated | (a) Rs. 24,99,971 |
| (b) Actual | (b) Rs. 26,07,419 |
| (8) Culturable area commanded by the project | |
| (9) Area irrigated | 55,674 acres of *ayacut* lands |
| (11) Means of access | By rail up to Trivandrum 24½ miles up to Thoduvetty *via* concreted road and 13½ miles thereafter up to Pechipara metalled road. |

### II. GEOPHYSICAL

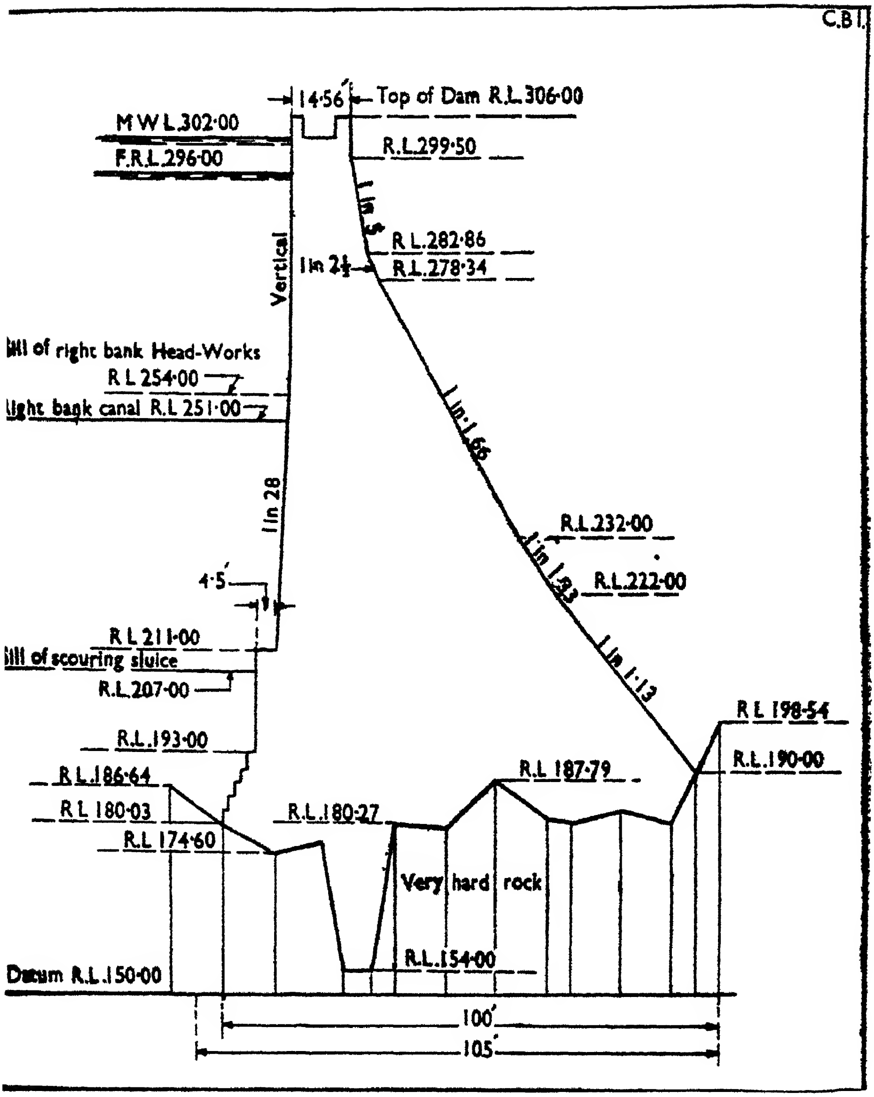
| | |
|---|---|
| (1) Area of catchment | 80 square miles |
| (2) Nature of catchment | Hilly—Covered with forest and pasture or reserve forests |
| (3) Mean annual precipitation | |
| (a) Rainfall | (a) 87·93 inches at Pechipara. It may be twice as much in t mountains high above. |
| (4) Total average annual yield of the catchment | 371,671 acre feet |

| | |
|---|---|
| (5) Climate | Chilly in wet weather and very hot in dry weather; effected by North East and South West Monsoons. |
| (6) Temperature conditions and variations | 70° F to 100° F |
| (7) Rate of flow | |
| (a) Maximum | (a) 5,728 cusecs |
| (b) Minimum | (b) 29 cusecs |
| (8) Detritus charge of the stream | |
| (9) Character (chemical) of the water stored in the reservoir | Suitable for irrigation |
| (10) Geological features | |
| (a) of foundations | Very hard rock |
| (b) of catchment area | There are high ridges of gravel and rocky soil covered with thick forest in the catchment area. |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (a) M.W.L. | R. L. 302·00 |
| (b) F.R.L. | R.L. 296·00 |
| (c) Area at M.W.L. | 5·85 square miles |
| (d) Area at F.R.L. | 5·47 square miles |
| (e) Maximum length | 5·75 miles |
| (f) Maximum width | 3 miles |
| (g) Length of periphery | 25 miles |
| (2) Capacity of the reservoir | |
| (a) Gross | 97,567 acre feet |
| (b) Live | 80,349 acre feet |
| (c) Flood storage | |
| (d) Carry-over | |
| (3) Maximum height above the lowest point of foundations | 152 feet (including 3 feet depth of parapet) |
| (4) Height above the lowest river bed at dam | 99 feet (including 3 feet depth of parapet) |
| (5) Height of the top of the dam above the crest of the spillway of weir | 10 feet to the top of parapet |
| (6) Maximum width at level of foundations | 105 feet |
| (7) Width at top | 14·56 feet |




*Cross Section of Kodayar Dam*

(8) Slopes

(a) Upstream } As per cross section

(b) Downstream

(9) Length at top of the dam

(a) Non-overflow

(i) Main

(ii) Subsidiary

| | |
|---|---|
| (*b*) Spillway | (*b*) 2 spillways total length 736 feet |
| (10) Cubic volume of the body of the dam | Concrete 3,596,747 Cubic feet<br>Rubble masonry 726,869 Cubic feet<br>Cut stone work 24,069 Cubic feet<br>Total 4,347,685 Cubic feet |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Blasted rubble stone masonry in lime *surkhi* mortar on sides and top. The blasted metal concrete in lime *surkhi* mortar with plum stones is embedded inbetween the sides. *Bunds* are made of hard gravelly earth. |
| (12) Specific gravity | |
| (*a*) Masonry | (*a*) 2·4 |
| (*b*) Concrete | (*b*) 2·4 |
| (13) Nature of protection and water-proofing of the upstream and downstream faces | Upstream face grouted and cement pointed. Downstream face pointed with *surkhi* mortar. (It is proposed to gunite the upstream and pressure grout the main body face of the dam to stop small leaks which are showing out). |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundations of the dam | On the completion of the dam, upstream face of the dam was deeply raked out and after that it was grouted and cement pointed. Special precautions were taken in the case of suspected places or where oozing was noticed. In addition to this boring and grouting was done from the top of the dam and on the upstream side of the dam. |
| (16) Contraction joints | |
| (17) Principal stressss in the masonry with a note of methods of calculations employed | It is designed tosatisfy the following conditions.<br>(1) The resultant line of pressure when empty or full should fall within the middle third. |

(2) that the maximum pressure at foundations be kept within the safe crushing strength of 8 tons per square foot for the material of the dam.

(3) that the dam should be safe against sliding The ratio of horizontal thrust to vertical pressure is kept within 0·75.

| | |
|---|---|
| (18) Maximum pressure on foundations | 7·54 tons per square foot |
| (19) Uplift pressure, calculated or measured | |
| (20) Measure adopted for preventing or counteracting uplift pressures | |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | Two separate spillways, total length 736 feet |
| (2) Outlet works | Left bank canal sluice gate with two vents each 7 feet by 9½ feet |
| (3) Scouring works | One scouring sluice of two vents each 4 feet by 10 feet, and blocked up since 1917 |
| (4) Inspection facilities | |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | Natural rocky surface and in others ashlar aprons |

## VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

(4) Operation of the dam

(*a*) Regulation — (*a*) By screw gearing shutters

(*b*) Silting of the reservoir

(*i*) Total silt deposited

(*ii*) Rate of silting

(*iii*) Density of the silt deposited

(*iv*) Rate of advancement of delta

(c) Actual yield as against estimated

(d) Various measurements and observations

(i) Evaporation losses

(ii) Sweating below the dam

(iii) Temperature measurements

(iv) Seepage and regeneration

(e) Fish culture

(f) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

*Chief Engineers* :

Mr. G. T. Walsh M.I.C.E.
Mr. A. H. Jacob M.I.C.E.
Mr. W. Jopp M.I.C.E.
Mr. C.A. Smith M.I.C.E.
Mr. A. H. Bastow A.M.I.C.E.

*Executive Engineers* :

Mr. F. J. Jacob C.E.
Mr. N. A. Minchin A.M.I.C.E.
Mr. O. S. Barrow

(3) Bibliography

# V. 3. Unkal Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 54 feet |
| (2) Location | Dharwar District, Bombay State Kalhalla stream |
| (3) Authority or owner | Bombay Government now in charge of Hubli Municipal Borough |
| (4) Purpose—Main and subsidiary | Water supply to Hubli City and formerly to M and S. M. Rly. |
| (5) Year of commencement | 1891 |
| (6) Year of completion | 1894 (Waste weir raised by 5 feet from 1911—1914) |
| (7) Capital cost | |
| (*a*) Estimated | (*a*) Rs. 1,92,074 |
| (*b*) Actual | (*b*) Rs. 1,93,084 |
| (11) Means of access | It is accessible from Hubli railway Station (M & S. M. Railway, Bangalore section) by an asphalt road |

### II. GEOPHYSICAL

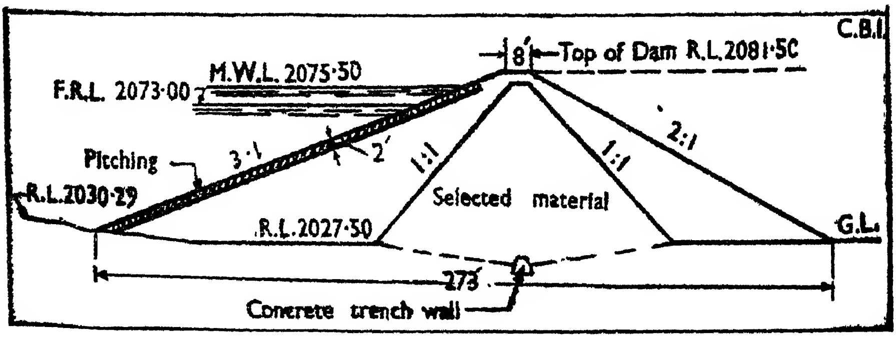
| | |
|---|---|
| (1) Area of catchment | 18 square miles |
| (2) Nature of catchment | Partly plain and partly hilly |
| (3) Mean annual precipitation | |
| (*a*) Rainfall | (*a*) 26·67 inches |
| (4) Total average annual yield of the catchment | 1971 acre feet |
| (5) Climate | Hot (mild) |
| (6) Temperature conditions and variations | Maximum temperature 103° F. Minimum temperature 58° F. |
| (7) Rate of Flow | |
| (*a*) Maximum | |
| (*b*) Minimum | |
| (8) Detritus charge of the stream | |

| | |
|---|---|
| (9) Character (chemical of the water stored in the reservoir | Potable |
| (10) Geological features | |
| (a) of foundations | (a) The rock of metamorphic schist type |
| (b) of catchment area | |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (a) M.W.L. | (a) R.L. 2075·50 |
| (b) F.R.L. | (b) R.L. 2073·00 |
| (c) Area at M.W.L. | |
| (d) Area at F.R.L. | |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of Periphery | |
| (2) Capacity of the reservoir | |
| (a) Gross | |
| (b) Live | (b) 3,512 acre feet |
| (c) Flood storage | |
| (d) Carry-over | |




*Cross Section of Unkal Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 61 feet |
| (4) Height above the lowest river bed at dam | 54 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 8·5 feet |

| | |
|---|---|
| (6) Maximum width at level of foundation | 273 feet |
| (7) Width at top | 8 feet |
| (8) Slopes | |
| (a) Upstream | (a) 3 : 1 |
| (b) Downstream | (b) 2 : 1 |
| (9) Length at top of the dam | 2,726 feet |
| (a) Non-overflow | |
| (i) Main | (i) 2,442 feet |
| (ii) Spillway | |
| (b) Spillway | (b) 284 feet. |
| (10) Cubic volume of the body of the dam | |

B. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed | Black soil and *moorum* |
| (12) Specific gravity | |
| (d) Earthfill | |
| (13) Nature of protection and waterproofing of the upstream and downstream faces. | Upstream face pitched upto 3 feet above M. W. L. |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundations of the dam | By means of hearting of selected material and concrete trench wall |
| (16) Hydraulic gradient for which the embankment is designed | |
| (17) Particular of the berm (if any), width and position | |
| (18) Position and form of the core wall (or other means of securing water tightness) | As per cross section. |
| (19) Batter (if any) of the core wall | Top width 1·5 feet; bottom width 5 feet and height 5 feet |
| (20) Maximum depth below ground surface of core-wall or other means of securing water tightness | 12·5 feet |
| (21) Method of keying core-wall or other wall in the underlying ground | By means of concrete trenching |
| (22) Nature of material forming the core or other wall | Concrete and selected material |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

| | |
|---|---|
| (1) Land **Submerged:**<br>(*a*) Crown waste<br>(*b*) Proprietory<br>(2) Dislocation :<br>(*a*) Villages<br>(*b*) Families<br>(*c*) Population<br>(*d*) Roads :<br>(*i*) Highways<br>(*ii*) District Roads<br>(*iii*) Village Roads<br>(*e*) Railway Lines<br>(*f*) Temples, Mosques, etc.<br>(*g*) Graves, etc.<br>(*h*) trees, gardens, pastures, houses, wells, etc.<br>(*i*) Bridges | Not available. The Poona Bangalore road was directed near the Village Unkal. |
| (3) Compensation paid under each category of items (2) | Rs. 2,77,330/- |
| (4) Method of compensating for land of dispossessed landholder | |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplusing works | The clear overfall waste weir is 240 feet in length |
| (2) Outlet works | Masonry tower with 3 sluice valves at different levels |
| (3) Scouring works | The tower is fitted with two scouring sluices, each 18 inches diameter with sill level at 2 feet below the lowest outlet |
| (4) Inspection facilities | |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | |

## VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features — It was constructed on the method usually adopted in Bombay Deccan, that is without a puddle wall, but having a hearting and an outer casing of good selected material. For hearting—two parts of black clayey soil to one part of *moorum* or gravelly red soil. For outer casing, on tank side, it is provided with equal proportion of black clayey soil and *moorum* or gravelly soil, and for downstream covering 3 parts of *moorum* of any coarse soil available to one part of black clayey soil.

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

(4) Operation of the dam

- (*a*) Regulation
- (*b*) Silting of the reservoir
  - (*i*) Total silt deposited
  - (*ii*) Rate of silting
  - (*iii*) Density of the silt deposited.
  - (*iv*) Rate of advancement of delta
- (*c*) Actual yield as against estimated
- (*d*) Various measurements and observations
  - (*i*) Evaporation loss
  - (*ii*) Sweating below the dam
  - (*iii*) Temperature measurements
  - (*iv*) Seepage and regeneration
- (*e*) Fish culture
- (*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

*Executive Engineers*

(1) Mr. E. F. Dawson, A.M.I.E.E.
(2) Mr. C. A. Goodfellow, V.C.R.E.
(3) Mr. F. B. Maclaran, M.I.C.E.

(3) Bibliography

Maclaran, F. B. " Hubli water works, P. W. D., Bombay. "

# V. 4. Mopad Dam

## Earthen

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 72 feet |
| (2) Location | Nellore District, Madras State (Manneru river—Manneru River Basin) |
| (3) Authority or owner | The Government of Madras |
| (4) Purpose—Main and subsidiary | Irrigation |
| (5) Year of commencement | December 1905 |
| (6) Year of completion | April 1921 |
| (7) Capital cost | |
| (*a*) Estimated | (a) Rs. 20,22,000/- |
| (*b*) Actual | (b) Rs. 18,38,000/- |
| (8) Culturable area commanded by the project | 12,500 acres |
| (9) Area irrigated | 6,000 acres |
| (11) Means of access | It is 42 miles distant by road from Sigarayakonda railway station on the Bezwada section of the M. and S. M. Railway. |

### II. GEOPHYSICAL

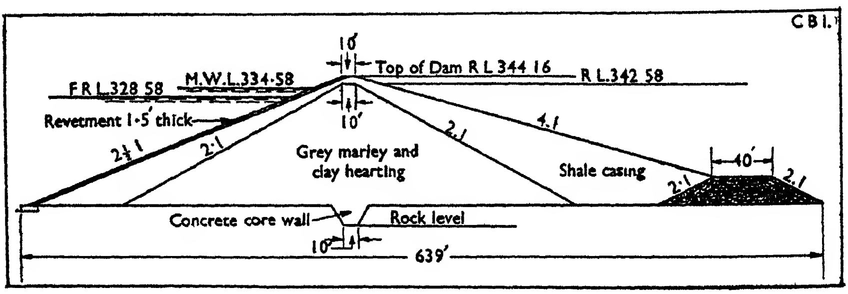
| | |
|---|---|
| (1) Area of catchment | 250 square miles |
| (2) Nature of catchment | Almost hilly and barren |
| (3) Mean annual precipitation | |
| (*a*) Rainfall | 26·65 inches |
| (4) Total average annual yield of the Catchment | 49,133 acre feet |
| (5) Climate | Tropical |
| (6) Temperature conditions and variations | Maximum temperature 112°F. Minimum temperature 77° F. |

| | |
|---|---|
| (7) Rate of Flow | |
| (*a*) Maximum | (*a*) 19,549 cusecs on 27-10-30 |
| (*b*) Minimum | |
| (8) Detritus charge of the stream | |
| (9) Character (chemical) of the water stored in the reservoir | The river water and water of its tributaries above the site of the dam impounded in the reservoir is not saline. It is of average hardness. |
| (10) Geological features | |
| (*a*) of foundations | (*a*) The foundation is partly on hard rock and partly on disintegrated and fissured rock under the flanks. |
| (*b*) of catchment area | (*b*) Partly hills and partly dry lands. |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (*a*) M.W.L. | (*a*) R.L. 334·58 |
| (*b*) F.R.L. | (*b*) R.L. 328·58 |
| (*c*) Area at M.W.L. | (*c*) 6.54 square miles |
| (*d*) Area at F.R.L. | (*d*) 5·14 square miles |
| (*e*) Maximum length | (*e*) 4 miles |
| (*f*) Maximum width | (*f*) 3 miles |
| (*g*) Length of periphery | (*g*) 19.5 miles |
| (2) Capacity of the reservoir | |
| (*a*) Gross | (*a*) 70,204 acre feet |
| (*b*) Live | (*b*) 48,003 acre feet |
| (*c*) Flood storage | |
| (*d*) Carry-over | |




*Cross Section of Mopad Reservoir*

| | |
|---|---|
| 3) Maximum height above the lowest point of foundations | 92 feet |
| (4) Height above the lowest river bed at dam | 72 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 15·58 feet |
| (6) Maximum width at level of foundations | 639 feet |
| 7) Width at top | 10 feet |
| (8) Slopes | |
| (a) Upstream | (a) As per Cross Section |
| (b) Downstream | (b) As per Cross Section |
| (9) Length at top of the dam | 5,458 feet |
| (a) Non-overflow | |
| (i) Main | (i) 3,958 feet |
| (b) Spillway | (b) 1,500 feet |
| (10) Cubic volume of the body of the dam | |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Shale casing and marly clay hearting |
| (12) Specific gravity | |
| 13) Nature of protection and waterproofing ni the upstream and downstream faces | Upstream face revetted 1·5 feet thick. |
| (14) Provision for dealing with seepage and drainage water | Longitudinal rough stone drains 3 feet by 2 feet and under the casing, cross drains have been provided 300 feet apart and at the end necessary, lead off drains have been added. |
| (15) Means of securing water tightness of the foundation of the dam. | By means of concrete trenching |
| 21) Hydraulic gradient for which the embankment is designed | 1 in 4. |
| 22) Particular of the berm (if any) (width and position) | 40 feet wide berm at rear toe between chainage 650 and 1,150. |

| | |
|---|---|
| (23) Position and form of the core wall (or other means of securing water tightness) | As per cross-section hearting of grey marly clay with 10 feet width at top and concrete core wall in rock portion and puddle trench core wall for a length of 5,290 feet excluding the deepest portion which have been provided with concrete core wall. |
| (24) Batter (if any) of the core wall | 1 in 4 |
| (25) Maximum depth below ground surface of core-wall or other means of securing water tightness. | 35 feet |
| (26) Method of keying core-wall or other wall in the underlying ground | By means of concrete trenching |
| (27) Nature of material forming the core or other wall | Puddle core wall and trench in the deepest portion filled in with concrete in *surkhi* mortar. |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) Land submerged :
- (*a*) Crown waste
- (*b*) Proprietory

(2) Dislocation :
- (*a*) Villages
- (*b*) Families
- (*c*) Population
- (*d*) Roads :
  - (*i*) Highways
  - (*ii*) District Roads
  - (*iii*) Village Roads
- (*e*) Railway Lines
- (*f*) Temples, mosque, etc.
- (*g*) Graves, *etc.*
- (*h*) Trees, gardens, pastures, houses, wells, *etc.*
- (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplus work | Masonry weir 1,500 feet long |
| (2) Outlet works<br>(3) Scouring works | A head sluice of one vent 6 feet by 5 feet with counter-balancing shutter of the stoney type. |
| (4) Inspection facilities | There is only one head sluice through which water for irrigation is drawn off. It is of simple design. The gearing arrangement is on a platform which is easy of access and control. The sluice shutter can be inspected only when there is no water against it in front. |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | The dam consists of a hearting and a casing section revetted in front throughout. There is also a stone toe on the rear of the dam at the site of the river crossing between chainage 650 and chainage 1,150. The hearting section mainly consisted of grey coloured marly clay. |
| (2) Changes introduced in the plans of the dam and in the method of carrying out the work | The sections of the dam originally proposed were revised as per Mr. Hill's recommendations adopting a hydraulic gradient 1 in 4, in the river portion. A masonry core wall was provided with its top level at Maximum water level. The top width was made 4 feet and battered down to a 10 feet base width. |
| (3) Noteworthy occurrences and accidents. | |

| | |
|---|---|
| (4) Operation of the dam | |
| (*a*) Regulation | (*a*) Manual operation. The sliding shutter provided in the head sluice is capable of operation through geared wheels arranged in a platforms easy of access and control. |
| (*b*) Silting of the reservoir | |
| (*i*) Total silt deposited | |
| (*ii*) Rate of silting | |
| (*iii*) Density of the silt deposited | |
| (*iv*) Rate of advancement of delta | |
| (*c*) Actual yield as against estimated | |
| (*d*) Various measurements and observations. | |
| (*i*) Evaporation losses | |
| (*ii*) Sweating below the dam | |
| (*iii*) Temperature measurements | |
| (*iv*) Seepage and regeneration | |
| (*e*) Fish culture | Fish culture is being experimented |
| (*f*) Anti-malaria measures | |
| (5) Recreation facilities | |
| (6) Lessons to be learnt from the construction and utilisation of the dam | The shrinkage allowance in embankment of the dam is taken 2 per cent. Extra for the loss in transmission from the pit to the dam site in addition to Parker's figure of 12½ per cent. for settlement and then total works out to 14½ per cent. During construction of the project, several observations were carried out, and actually it was found that 100 cubic feet of natural pit earth, three to four years after being deposited and rolled and with superimposed weight to induce settlement will not give more than 90 cubic feet of settled embankment. If to this the waste in transmission and little allowance for further settlement is also added, the above figure 14½ per cent over the actual section of the bank will not be far from the truth. |

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

In 1895 the Collector of Nellore represented to the Government the inability of the northern portion of the district to withstand the effects of even a partial failure of crops in an adverse season and urged the necessity for carrying out protective works. The Government deputed the special staff to investigate the suitable site and report. Accordingly the staff inspected the Manneru Valley, selected the site near Mopad: also submitted the proposals with plan and estimate *etc.* making a provision for the masonry dam across the river portion. In 1902—a special party, an outcome of the recommendation of Irrigation Commission, was organised to continue the investigation already begun which came to the conclusion that the nature of rock found in the bed of the river was unsuitable for the construction of a masonry dam and proposed only an earthen dam in place of the masonry dam originally proposed. The estimate for the project was prepared accordingly and sanctioned and the work was commenced in 1905 under a special Division. The executive engineer incharge of the Division raised some doubts about the suitability of the available earth for the construction of the dam. The Government after necessary investigations requested the Bombay Government to advise them. So a special officer was deputed by the Bombay Government who inspected and suggested a large addition to the section of the dam originally proposed. The revised estimate was soon sanctioned by the Secretary of State and the work was again started and completed in 1921.

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

In 1895 the Collector of Nellore represented to the Government the inability of the northern portion of the district to withstand the effects of even a partial failure of crops in an adverse season and urged the necessity for carrying out protective works The Government deputed the special staff to investigate the suitable site and report. Accordingly the staff inspected the Manneru Valley, selected the site near Mopad; also submitted the proposals with plan and estimate *etc.* making a provision for the masonry dam across the river portion. In 1902—a special party, an outcome of the recommendation of Irrigation Commission, was organised to continue the investigation already begun which came to the conclusion that the nature of rock found in the bed of the river was unsuitable for the construction of a masonry dam and proposed only an earthen dam in place of the masonry dam originally proposed. The estimate for the project was prepared accordingly and sanctioned and the work was commenced in 1905 under a special Division. The executive engineer incharge of the Division raised some doubts about the suitability of the available earth for the construction of the dam. The Government after necessary investigations requested the Bombay Government to advise them. So a special officer was deputed by the Bombay Government who inspected and suggested a large addition to the section of the dam originally proposed. The revised estimate was soon sanctioned by the Secretary of State and the work was again started and completed in 1921.

(2) Personnel

1. Mr. Ushar, Executive Engineer
2. Mr. Marshal, Executive Engineer
3. Mr. A. Hill, Chief Eng., Bombay Government
4. Mr. H. S. Northey, Executive Engineer
5. Mr. P. Ranganayakulu, Executive Engineer

(3) Bibiliography

# V-5. Tansa Dam

## Masonry

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed. | 125 feet |
| (2) Location | Thana District, Shahpore taluka, Bombay State (Tansa River) |
| 3) Authority or owner | Bombay Municipal Corporation |
| (4) Purpose--Main and subsidiary | Water supply to the city of Bombay |
| (5) Year of commencement<br>(6) Year of completion | 1st stage started in 1886--completed in 1892 upto R. L. 324·75<br>2nd stage started in 1912, completed in 1915 upto R. L. 334·33<br>3rd stage started in 1921, completed in 1922 upto top |
| (7) Capital cost | |
| (a) Estimated | |
| (b) Actual | (b) Rs. 1,57,30,000 |
| (11) Means of access | It is accessible from Atgaon railway station (Great Indian Peninsular Railway) by road, distance 8 miles from the dam. |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 52·57 square miles |
| (2) Nature of catchment | Hilly country |
| (3) Mean annual precipitation | |
| (a) Rainfall | (a) 97·14 inches |
| (4) Total average annual yield of the catchment | 215,012 acre feet |
| (5) Climate | |

| | |
|---|---|
| (6) Temperature conditions and variations | Ranging from 54° F-120° F during winter, 1939<br>Ranging from 68°F—112° F during summer, 1939 |
| (7) Rate of flow | |
| (a) Maximum | 59,700 cusecs November 1948 |
| (b) Minimum | |
| (8) Detritus charge of the stream | There is very little silt passing into the reservoir, as the entire catchment is wooded and hilly. |
| (9) Character (chemical) of the water stored in the reservoir. | (i) Physical characteristics of Tansa Water. |
| | (a) Turbidity (p.p.m.) 0·12 |
| | (b) Colour 15 |
| | (ii) Chemical characteristics |
| | (a) pH range 7·4 |
| | (b) Residue on evaporation (total solids p.p.m.) 9 |
| | (c) Total hardness as $CaCo_3$ (p.p.m.) 54 |
| | (iii) Minerals : |
| | (a) Silicia $SiO_2$) 1·5 |
| | (b) Iron ($Fe$) 0·01 |
| | (c) Calcium ($Ca$) 1·62 |
| | (d) Magnesium ($M_g$) 0·92 |
| | (e) Sodium ($Na$ & $K_2O$) 9·21 |
| | (f) Bicarbonate ($HCO_3$) 7·17 |
| | (g) Sulphate ($SO_4$) .. |
| | (h) Chloride ($CI$) 1·42 |
| | (i) Nitrate ($NO_3$) Trace |
| (10) Geological features | |
| (a) of foundations | (a) Amygdaloid trap with masses of crystalline besalt at places |
| (b) of catchment area | (b) Amygdaloid trap with masses of crystalline besalt at places |

## III. TECHNICAL

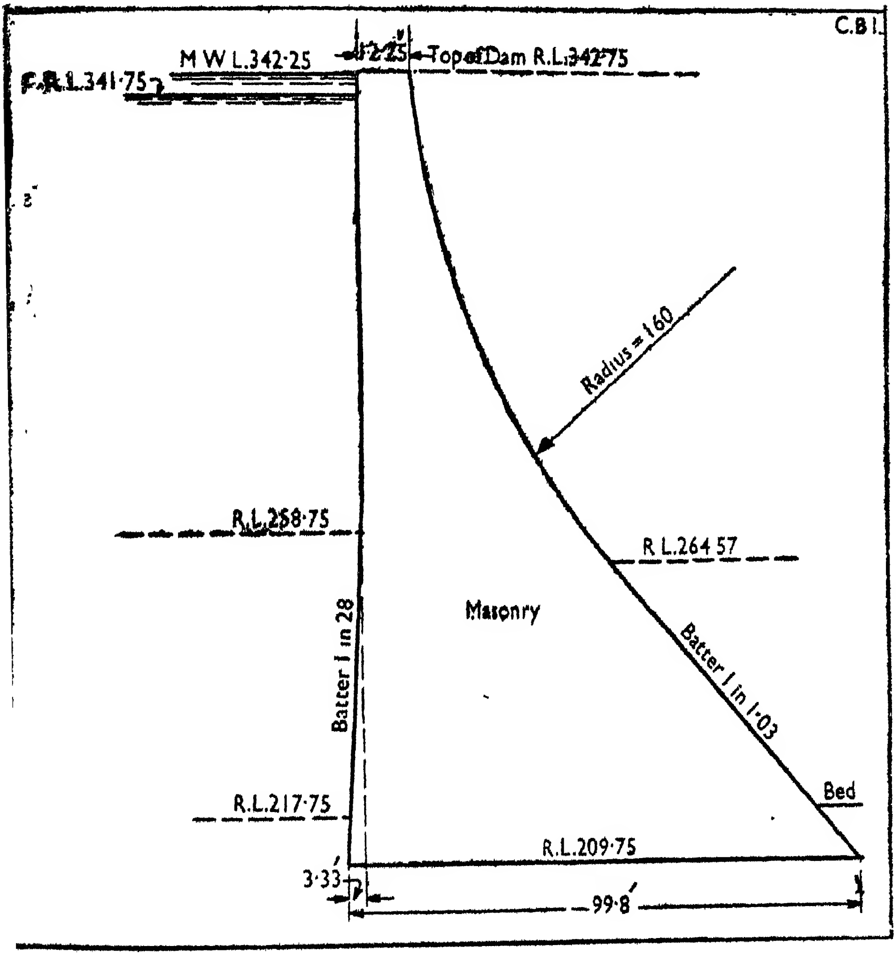
### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (a) M. W. L. | R. L. 342·25 |
| (b) F. R. L. | R. L. 341·75 |
| (c) Area at M. W. L. | |
| (d) Area at F. R. L. | 7·38 square miles |

| | |
|---|---|
| (e) Maximum length | 7·52 miles |
| (f) Maximum width | 3·2 miles |
| (g) Length of periphery of water spread | 33·68 miles |

(2) Capacity of the reservoir

| | |
|---|---|
| (a) Gross | 149,500 acre feet |
| (b) Live | 129,500 acre feet |
| (c) Flood storage | |
| (d) Carry-over | |




*Cross Section of Tansa Dam*

| | |
|---|---|
| (3) **Maximum height above the lowest point of foundations** | 133·0 feet. |

| | |
|---|---|
| (4) Height above the lowest river bed at dam | 125 feet |
| (5) Height of the top of the dam above the crest of the spillway or weir | 4·45 feet and 1 foot above automatic shutters |
| (6) Maximum width at level of foundation | 99·8 feet |
| (7) Width at top | 12·25 feet |
| (8) Slopes | |
| (a) Upstream<br>(b) Downstream | As per cross section |
| (9) Length at top of the dam | |
| (a) Non-overflow | |
| (i) Main | (i) 7283 feet |
| (ii) Subsidiary | |
| (b) Spillway or waste weir | 1,900 feet; an additional waste weir is proposed to be provided to the south of dam. |
| (10) Cubic volume of the body of the dam | 13,000,000 cubic feet |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Coursed rubble masonry in hydraulic lime mortar for both faces and random rubble for hearting |
| (12) Specific gravity | |
| (a) Masonry | (a) 2·4 |
| (13) Nature of protection and waterproofing of the upstream and downstream faces. | Originally one inch thick cement pointing was done on the upstream face. After some time reinforced gunite 2 inches thick was applied upto a depth of 25 feet to 30 feet on the upstream face for protection against leaks. |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundation of the dam | Cement grouting injected under pressure of 80 to 100 lb. per square inch at suspected places and for the waste weir portion |
| 16) Contraction joints | |
| 17) Principal stresses in the masonry with a note of methods of calculations employed. | Calculations based on 2·4 specific gravity of masonry and Mr. Bovier's modified formula |

| | |
|---|---|
| (18) Maximum pressure on foundations | 128·5 lb. per square inch at bed when reservoir is empty.<br>129·5 lb. per square inch at the toe when reservoir is full. |
| (19) Uplift pressure, calculated or measured | In order to find out the uplift pressure acting at the base of the dam inclined holes, 1⅞ inches diameter, were taken with percussion drilling machines, from the toe of the dams. In all, 49 inclined holes were taken along the entire length of the dam. The majority of holes (*i.e.*, 32 in number) were dry and did not tap water. 11 holes between chainage 1,800 and 2,200 tapped very slight water but there was no indication of any pressure. Only 5 holes between chainge 6,850 and 6,970 made water with a head of 18 to 22 feet, after penetrating 2 to 3 feet into the base rock. All these five holes were in vicinity of one another. This shows that the whole dam is not in danger o far as uplift pressure is concerned except the two spots which are being attended to. |
| (20) Measures adopted for preventing or counteracting uplift pressures | Cement grouting has been injected under pressure where wet-mass in foundation joints was observed between chainages 18 to 22, 64 to 71 and 84 to 88. |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

| | |
|---|---|
| (1) Land submerged : | |
| (*a*) Crown waste | 4·6 square miles |
| (*b*) Proprietory | |
| (2) Dislocation : | |
| (*a*) Villages | |
| (*b*) Families | |
| (*c*) Population | |

(*d*) Roads :

(*i*) Highways

(*ii*) District Roads

(*iii*) Village Roads

(*e*) Railway Lines

(*f*) Temples, Mosques, *etc.*

(*g*) Graves, *etc.*

(*h*) Trees, gardens, pastures, Houses, wells, *etc.*

(*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

(1) Surplussing works — Waste weir 2,000 feet in length is constructed on the southern end of the main body of the dam with top level 1·45 feet lower than the top of the dam which is designed to pass a flood of 24,533 cusecs.

(2) Outlet works — Twelve penstocks each 27 inches by 30 inches at different levels discharge water into a rectangular outlet well 170′ × 30′ from which water is led into two 72 inches main and a masonry duct 7 feet × 6 feet section through 48 inches sluice valves.

(3) Scouring works — The lowest outlets so far were at R. L. 299·75 G. T. S. In 1948 one more outlet (50 inches diameter) at R.L. 294·75 was made to avail of the lower contents of the lake. The outlet was driven from the upstream side by an Italine diver and fixing a 50 inches diameter steel flanged piped plug and concreting the same. The remaining work was done from downstream side.

Another additional 50 inches outlet was made at R. L. 314·75 and a floating pump (40 m.g.p.d ) on pontoons was erected to pump water into this outlet through a 50 inches diameter flexible floating pipeline. This enables the lower contents of about 11,000 million gallons to be utilised in case of an extreme emergency.

(4) Inspection facilities

(5) Fish-pass

(6) Means for dissipating energy below the spillway

## VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

The dam was constructed of uncoursed rubble masonry throughout. Anything approaching regular horizontal joints was carefully avoided, and every care was taken to preserve a good bond throughout the whole breadth of the work. The stones were set in the work as received from the quarries, without further dressing of any sort beyond knocking off weak corners and edges with the hammer. The greater part of the stones used in the work was small, not averaging more than 1/2 cubic foot. Every stone was laid full in mortar each one being selected so as to roughly fit the place it was to be laid in ; it was then driven home in its bedding of mortar with a light mallet, and all spaces between it and the adjacent stones were filled flush with mortar ; spalls or small stones were then inserted in the mortar between the joints. Great care was taken, by a system of close supervision, to prevent, as far as possible any dry work or hollow spaces being allowed in the masonry. There is no ashlar work in the faces, though the face-stones had to be roughly shaped with the hammer, so as to preserve the outline of the profile. Where it was convenient to do so, large masses of stone were placed in the body of the work, each mass was bedded full in mortar, and built round with rubble masonry. The use of this method of construction was very limited, and it formed an insignificant portion of the bulk of the work.

The stone used is the trap and besalt obtained from numerous quarries opened in the neighbourhood. In quality it varied greatly, and its weight varied between 165 and 185 lb. per cubic foot. The inferior qualities, which were usually the lighter, were such as would probably disintegrate by exposure to weather, though quite reliable for use in the heart or body of masonry. Care was taken to select the best qualities for the exposed surfaces. From the quarries on the downstream side of the dam tramways were laid to its site, and the material was brought in trucks moved by coolies. There were about 7 miles of tramway laid from the various quarries to the site of the work. From the quarries on the upstream side of the dam the stone was brought in barges. As the lake grew in size with the raising of the dam, these barges were towed by steam-launches, two of which were employed for the purpose. The whole of the stone used in the work was carried by coolie labour from the place where it was deposited by trucks or barges, on to the work, the bulk of it being in blocks which could be carried by one coolie on the head or shoulder. A small portion of the stone was larger than could be carried by one coolie, and was carried by "Nowgunnies" that is, a party of four coolies, who sling the load to be carried from bamboo poles which rest on their shoulders. As the Dam was raised, numerous rough wooden gangways were constructed up the faces for carrying the material.

The lime for the work was obtained from "*Kankar*", a form of nodular limestone, found deposited over the greater part of India. The quantity in the vicinity of the works was limited, and the bulk of it had to be brought from the Nasik Districts, above the *Ghats*, which entailed long carriage by country-cart and railway. The nearest railway-station to the works is Atgaon, on the Great Indian Peninsula Railway, distant 8 mies from the dam. To thisstation the bulk of the *kankar* was brought. A considerable portion of it was carted thence to Tansa, where it was burned on the site of the works. Lime-kilns were also erected at Atgaon station. During the last two seasons in which the work was in progress, when the consumption of material was very great a portion of the *kankar* was burned where it was obtained, above the *Ghats*, and the lime was brought by rail to Atgaon Station. The fuel for burning the *kankar* was principally wood obtained from the surrounding forests. In some cases the wood was converted into charcoal before being used in the kilns, and coal ash, obtained from the Railway locomotive yards, was made use of to a limited extent. The quality of the lime did not vary to any appreciable extent with the fuel used. The lime yielded by the *kankar* is fairly hydraulic. 3-inch cubes, moulded from the mortars, if allowed to remain in the air for periods varying from twenty-four to forty-eight hours, continued to set on being immersed in water.

The sand used for mortar was obtained from the beds of the rivers in the neighbourhood of the works. The greater portion of it was brought from the Vaitarna River, distant about 8 miles from the work. It consisted entirely of disintegrated trap-rock. It could not be classed as either very hard or sharp, and should probably not commend itself to engineers accustomed to deal with quartzite sands. The results, however, had been satisfactory. The mortar was composed of 1 part of measure of slaked lime to 1½ part by measure of washed sand. On each bank of the river, close to the line of dam, four pan-mills driven by steam-power were erected, and in these the bulk of the mortar used in the work was mixed. For the flanks of the dam or positions at some distance from the river, the mortar was mixed in mills known as "*ghanis*". These consist of a circular trough of masonry 30 to 40 feet in diameter, in which edge-stones some 3 feet in diameter are made to revolve, the motive-power being furnished by bullocks or buffaloes. This process of mixing is slow, but it has the advantage that a cheap mill can be erected quickly close to the spot where the mortar was required. At one time there were about thirty such mills in use; in addition to the two sets of steam-mills which were situated one on each bank of the river.

The results of tests made during the operations showed that the mortar mixed in the steam-pans was somewhat better than that mixed in the "*ghams*". The mortar was carried from the ground on to the work by coolie labour. As the height of the dam increased, the amount of labour employed in carrying materials was very great. During the last two seasons there were often between 500 and 600 masons employed on the work. In the month of January 1891, the masonry work amounted to 705,000 cubic feet, or 27,000 cubic feet per day. At this period the total number of persons employed in connection with the dam works, including those engaged in the quarries, lime-getting, sand getting *etc.*, was 8,000. The total quantity of masonry in the dam is above 13,000,000 cubic feet. The mortar used in the work averaged 32 cubic feet in each 100 cubic feet of masonry. The total quantity of excavation for the foundation was 6,780,000 cubic feet, of which 4,800,000 cubic feet had to be got by blasting. On the water-face of the dam, the joints were raked out to a depth of one inch and filled in with mortar gauged 1 of Portland cement to 1 of fine sand.

There is no flow in the Tansa River after November, and in January 1886, when work was started, the nearest water was more than a mile lower down the stream than the site of the work, where a natural barrier across the river had formed a pond. A steam-pump was erected there and water was pumped up to the works both for use in construction and for the water-supply of the large body of labourers who had come and settled there. In a climate such as that of India, an abundant supply of water is essential to the production of good masonry, and the object aimed at in the first season's operations at

Tansa was to get a portion of the dam built across the river-bed so as to impound water above it for the next season's work. It was the middle of March before the foundations in the river-bed were ready. This left only two months and a half to the time when the works would have to be suspended owing to the approach of the monsoon. The dam at this place has a width of 100 feet at the base and the quantity of masonry in the full section and 20 feet high across the river-bed, would have been 600.000 cubic feet when the resources at command it was not considered possible to build this quantity of masonry in the time at disposal. It was, therefore, decided to build only a portion of the cross-section of the dam, finishing it off according to the drawing on the up-stream face, and racking it off on the downstream side so as to admit of the completed section being bonded to it in the following season. The section was commenced 40 feet wide at the base, and was racked back at a slope of 1 to 1 on the downstream side. This dam was raised to a height of 20 feet before operations had to be suspended. The storage thus formed provided an ample supply of water for the next season's work, and, as the storage was increased in each succeeding year, there was no further anxiety regarding sufficiency of water for all purposes. The water was pumped from the lake by steam pumps into cisterns in elevated positions, and from these it was distributed over the works by a system of piping. From these cisterns, water was also supplied to stand-pipes situated in convenient positions for the use of the work-people who had settled in the vicinity.

The passing of the flood-waters in each monsoon, during the time of construction, was a subject which required consideration. The magnitude of the floods which had to be dealt with did not admit of their being passed, as is the usual practice in this country, through culverts in the lower part of the dam. For the first three seasons of construction, namely those of 1886, 1887 and 1888, the floods were allowed to pass directly over the portion of the dam across the river-bed. The length of weir available here was somewhat less than 400 feet, and in heavy floods the water used to pass over it to a depth exceeding 6 feet. The top of the dam was left quite rough, ready for work to be resumed on it, and it is perhaps, worthy of note that not a stone was at any time displaced on the top of the dam by the action of this large body of water passing over it. In the season of 1888, the height of the dam across the river was 51 feet above the foundations in the river bed, and in the next season the height would have been 70 to 80 feet.

It was considered inadvisable to subject the foundations to the shock which the fall of so large a body of water through this height, would cause, and it was determined not to pass the flood-water over the dam directly into the river after the season of 1888. For passing off the floods in the following year a portion of the dam, about 450 feet in length, on the north-bank of the river, was left at R. L. 276·75. The natural surface of the ground along this length varied between R. L. 275·75 and R. L. 282·75 and considerable excavation was necessary to provide a temporary channel for the passage of the flood-water into the bed of the river. A wall was built across the foundation trench from the face of the dam into the natural ground, to prevent the water from passing down directly by the toe of the dam into the river-bed. This acted efficiently for a time but in a heavy flood the ground became eroded from the end of the cross-wall, and some of the flood-water turned round it and flowed down by the toe of the dam at a high velocity into the river-bed. The Deputy Executive Engineer, Mr. T. C. H. White, Assoc., M. Inst. C. E. who was on the dam at the time, noticed the sound of some very heavy action taking place at the toe of the dam in the river-bed. After the floods had subsided, it was found that large masses of rock which were lying in the river-bed had been churned about by the action of the water, knocking against the toe of the dam. Some of these masses of rock which had been very rough had their surfaces worn quite smooth, and their action on the face of the dam near its toe was clearly perceptible. After the close of the monsoon, excavations were made at the toe of the dam, and the water was pumped out. The dam and the rock foundations on which it rested were carefully examined, and it was found that no injury had been sustained. For passing off the floods of 1890, a portion of the dam 450 feet in length, on the south bank of the river, was left at R. L. 299·75. From this a channel was excavated which allowed the flood-water to pass into the river-bed some distance below the point where the dam crosses it. Before the monsoon of 1891 the dam was completed, and the floods of that season passed off by the waste-weir, 1,650 feet in length, provided on the south flank of the work. The flood-waters pass from this waste-weir into the original bed of the river by depressions in the natural ground. In finding its way back to the river, the water had excavated several new channels scouring away all the softer material till it came to the hard rock. Some of these channels now appear as chasms upwards of 40 feet in depth below the surface of the ground.

Original level of the dam was 324·75. The dam was raised by 9·50 feet in 1912-15 and 5·42 feet in 1921-22 thereby increasing the lake capacity by 10·191 million gallons and 6,559 million gallons respectively. The mode and method of construction was the same as in 1886-92 as narrated above. Though every care was taken to making a good bond between the old and new masonry, the construction joints remained weak spots in the dam and leaked profusely.

) Changes introduced in the plans of the dam and in the method of carrying out the work

In 1938 it was proposed to increase the storage of the reservoir by raising the water level by 2½ feet. Automatic falling shutters were, therefore provided over the waste weir of the dam to impound additional 2,900 million gallons between levels 341·75 and 339·75 by raising the F. R. L. to 341·75. The shutters remain in position till the level in the lake reaches 341·75 but fall automatically due to the unbalanced weight of increasing water and allow floods to pass over the weir and return to their normal position as soon as water level reaches 341·75. There are 38 gates each 50 feet by 4 feet 1$\frac{15}{16}$.

inches with intervening reinforced concrete piers 3 feet wide and 5 feet long. The length of the waste weir was increased to 2,017 feet—including the thickness of piers. The waste weir had to be cut to R. L. 338·30 to accommodate 4 feet deep gates, the former sill level being R. L. 339·75. This work was sanctioned by the Corporation in 1946 and has been completed by M/s. Duncan Stratton & Co. Ltd. at a cost of Rs. 13,00,000.

Experiments were carried out at Khadakwasla on a ½ size model to design the shape of piers and the top profile for obtaining maximum flood discharge. After a number of experiments the Palair Profile in modified form was selected. The coefficient of discharge as per experiment was found to be 3·14 giving a normal flood discharge of 33,000 cusecs, over the whole of the weir. As the maximum flood that can be expected is about 60,000 cusecs. Proposals for providing additional waste weir are being formed also.

(3) Noteworthy occurrences and accidents

(4) Operation of the dam

(a) Regulation

(b) Silting of the reservoir

(i) Total silt deposited

(ii) Rate of silting

(iii) Density of the silt deposited

(iv) Rate of advancement of delta

(c) Actual yield as against estimated

(d) Various measurements and observations

(i) Evaporation losses

(ii) Sweating below the dam — Very small on account of gunite curtain on the upstream side

(iii) Temperature measurements

(iv) Seepage and regeneratior

(e) Fish culture

(f) Anti-malaria measures — A dispensary has been recently opened at Tansa and all along the line a malaria oil is sprayed in pools and *nallahs* frequently. Medicine including Palludrin Mepacrine is given to labour staff, public is educated regarding anti-malaria measures through posters, lectures, literature and film slides.

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam — An extract from Mr. Clerke's (who was the Engineer-in-Charge of the original Tansa work) report may be of interest as regards foundations in trap formations. He said "In a trap formation, until the entire length of foundations has been opened, it is impossible to say how the line of rock may run". The results verified this forecast. In one place the foundations had to be carried 30 feet below the rock level, as ascertained from the trial shafts. This was due to the fact that the rock reached by the trial shafts was, in many cases, a mass of crystalline besalt overlying the bed of amygdaloid trap, which forms the true basin of the valley. This besalt, so far as regards stability, was as good a foundation as could be desired, but it was intersected by veins of soft material (clay, ash *etc.*) varying between ½ inch and 2 inches in width, which, under the heavy water-pressure to which they would be subjected, would probably be washed out and form re gular passages for the water, thus entailing a serious loss by leakage.

The cross-section of the dam has been cut down too much to allow for stresses due to uplift *etc.* which have not been considered in the original shape, nor should it allow the lake surface to be drained below a certain level.

The hearting of the dam for the original work is much superior and more homogeneous than the top 15 feet which was constructed subsequently in two stages.

The weight of the masonry is on an average (of 3 samples selected at random from different cores) is 155 lb per cubic foot and is far in excess of the theoretical weight taken in calculations for the design of the dam. This adds to the factor of safety and lessens to that extent the danger of uplift, if any, existing in the dam.

At the north end about 200 feet of masonry is very poor with plenty of voids in it. This has recently been injected with "Colcrete" and made homogeneous.

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

Major Hector Tullock, R. E. Executive Engineer of the Municipality reported on Tansa Scheme in 1872. This was revised by Mr. W. J. B. Clerk, (afterwards C. I. E.) in 1883 and the work was finally approved by the Corporation on 10-8-1883 when Mr. E.C.K. Ollivaut (afterwards K.C.I. E. was the Commissioner. The work was commenced in 1886 and brought to its first stage of completion in 1892 and was opened by His Excellency the Marquis of Lansdowne. G. C. M., G.S.M.S.I., G.M.I.E. Viceroy and Governor General of India, when Mr. H. A. Acworth, C. S., was the Commissioner. The further raising of the dam commenced in 1912 and completed in 1915 according to the plans and under the direction of Mr. H. J. Trivess Smith, the Hydraulic Engineer, Mr. P. R. Cadell, C.I.E., being the Municipal Commissioner. The dam was completed to its present height in 1921 (when Mr. H. J. Trivess Smith was the Hydraulic Engineer and Mr. (afterwards Sir) Hugh Clayton C.I.E., I.C.E., J. P. was the Commissioner) and was inaugurated by Her Excellency Lady Irwin. The upstream face of the Dam was heavily pointed with cement mortar upto a depth of 20 ft. in the year 1928-30, when Mr. W. A. Niven, A.M.I.C.E., M.I.E., was the Hydraulic Engineer. Exploratory borings with a view to determining the quality of masonry and to ascertain the amount of uplift pressure were taken in the year 1937-38, Mr. E. A. Nadirshah, B.A., B.E., B.Sc., (Eng.), M. Inst. C.E., M.I.E., F.I S.E., J. P., being the Hydraulic Engineer. Gunite carpet on the upstream face was put up for a depth of 25 to 30 feet for stoppage of leaks.

The work of providing automatic shutters, the low level outlets and floating pump and the floating pipeline so as to draw water from the lower contents of the lake in times of emergency and failure of the monsoon were completed in 1948-49 during the regime of Mr. K. B. Carnae, B.E., A.M.I.E., A.M.I.C., the present Hydraulic Engineer.

(3) Bibliography

(i) Nadirshah, E. A. " Report on Exploratory Borings on Tansa Dam " 1939.

(ii) Early History of Tansa water, works, paper No. 2730 by Mr. W. J. Cerk Inst. of Civil Engineers, (Vol. CXV of 21st November, 1893).

(iii) Tansa Water Works—paper by Mr. E. A. Nadirshah, Bombay Engineering Congress, 6th January 1339.

(iv) Bombay, Water Supply, by Mr. E. A. Nadirshah Silver Jubilee, Volume of Insitutute of Engineers, (India)

# V. 6. Willingdon Dam

## (Earthen)

### I. GENERAL

| | |
|---|---|
| **(1)** Height above the lowest river bed | 54·92 feet |
| **(2)** Location | South Arcot district, Madras State (Periya Odai *Nala*) |
| **(3)** Authority or owner | Madras Government |
| **(4)** Purpose-Main and subsidiary | Irrigation |
| **(5)** Year of commencement | December 1913 |
| **(6)** Year of completion | September 1923 |
| **(7)** Capital cost— | |
| (*a*) Estimated | Rs. 20,64,380 |
| (*b*) Actual | Rs. 23,34,285 |
| **(8)** Culturable area commanded by the project | 26,851 acres |
| **(9)** Area irrigated | 22,000 acres |
| **(10)** Means of access | The reservoir is nine miles from Pennadam railway station on chord line along the (S. I. Railway) Vridhachalam Toludur Road. |

### II. GEOPHYSICAL

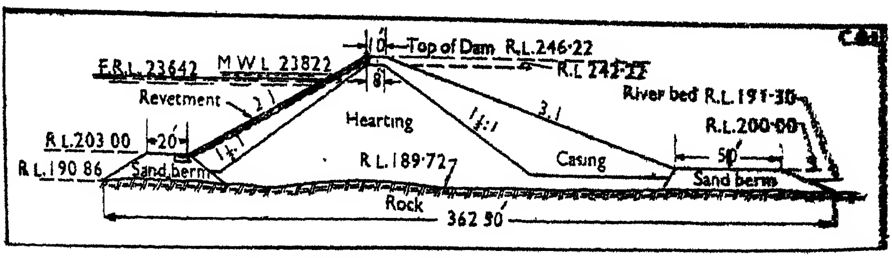
| | |
|---|---|
| **(1)** Area of catchment | 50 square miles, main supply is received by a channel from Vellar River and supplemented by the Peria Odai, a local stream. |
| **(2)** Nature of catchment | Plain country with cultivated fields. |
| **(3)** Mean annual precipitation— | |
| (*a*) Rainfall | (*a*) 40 inches |
| **(4)** Total average annual yield of the catchment | |
| **(5)** Climate | Tropical |

| | |
|---|---|
| (6) Temperature conditions and variations | Maximum temperature 100°F. Minimum temperature 70°F |
| (7) Rate of Flow— | |
| (a) Maximum | 2,360 cusecs |
| (b) Minimum | |
| (8) Detritus charge of the stream | |
| (9) Character (chemical) of the water stored in the reservoir | The water was analysed by the agricultural chemist for salinity and other properties and was found to be satisfactory. |
| (1) Geological features— | |
| (a) of foundations | (a) The nature of ground at foundations of the dam is of sand deposited partly on stiff grey clay and partly on decomposed rock. |
| (b) of catchment area | Heavy and black clay at surface, believed to be clay and gravelly in sub soil. |

## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data— | |
| (a) M.W.L. | (a) R.L. 238·22 |
| (b) F.R.L. | (b) R.L. 236·42 |
| (c) rea at M.W.L. | |
| (d) Area at F.R.L. | (d) 6·09 square miles |
| (e) Maximum length | (e) 3.5 miles |
| (f) Maximum width | (f) 3 miles |
| (g) Length of periphery | (g) About 10 miles |
| (2) Capacity of the reservoir— | |
| (a) Gross | (a) 59,502 acre feet |
| (b) Live | (b) 59,502 acre feet |
| (c) Flood storage | |
| (d) Carry-over | |




*Cross Section of Willingdon Dam*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 56·5 feet |
| (4) Height above the lowest river bed at dam | 54·92 feet |
| (5) Height of the top of the dam above the crest of the spillway of weir. | 9·8 feet |
| (6) Maximum width at level of foundations | 362·5 feet |
| (7) Width at top | 10 feet |
| (8) Slopes— | |
| (*a*) Upstream | (*a*) As per cross section |
| (*b*) Downstream | (*b*) As per cross section |
| (9) Length at top of the dam | 13,200 feet |
| (*a*) Non-overflow— | |
| (*i*) Main | |
| (*ii*) Subsidiary | |
| (*b*) Spillway | 30 vents of 10 feet span each = 300 feet |
| (10) Cubic volume of the body of the dam | 137,000,000 cubic feet |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Black soil and *moorum* for hearting and *moorum* or disintegrated soft rock for casing |
| (12) Specific gravity— | |
| (*d*) Earthfill | (*d*) 2·0 |
| (13) Nature of protection and water-proofing of the upstream and downstream faces | Upstream face pitched with boulder stones |
| (14) Provision for dealing with seepage and drainage water | |
| (15) Means of securing water tightness of the foundations of the dam | By means of hearting of selected material as shown in the cross section |
| (21) Hydraulic gradient for which the embankment is designed | 1 in 4 |
| (22) Particular of the berm (if any), width and position | As per cross section |
| (23) Position and form of the core wall (or other means of securing water tightness) | As per cross section |
| (24) Batter (if any) of the core wall | $1\frac{1}{2}$ : 1 on both upstream and downstream sides |

| | |
|---|---|
| (25) Maximum depth below ground surface of core-wall or other means of securing water tightness | Foundation trench taken to 6½ feet below original ground level |
| (26) Method of keying core wall or other wall in the under-lying ground | By foundation trench as described above and with 16 feet base width for it |
| (27) Nature of material forming the core or other wall | Selected material (balck soil) |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

| | |
|---|---|
| (1) Land submerged— | |
| (*a*) Crown waste | (*a*) 50 acres |
| (*b*) Proprietory | (*b*) 1,495 acres |
| (2) Dislocation— | |
| (*a*) Villages | (*a*) 6 |
| (*b*) Families | |
| (*c*) Population | (*c*) 3,687 |
| (*d*) Roads— | |
| (*i*) Highways | |
| (*ii*) District Roads | |
| (*iii*) Village Roads | (*iii*) A few village roads |
| (*e*) Railway Lines | |
| (*f*) Temples, mosques, *etc.* | |
| (*g*) Graves, *etc.* | |
| (*h*) Trees, gardens, pastures, houses, wells, *etc.* | |
| (*i*) Bridges | |
| (3) Compensation paid under each category of item (2) | Total Rs. 43,800/- |
| (4) Method of compensating for land of dispossessed landholders | Providing land elsewhere |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | Surplussing sluices 30 vents each of 10 feet span with a total discharging capacity of 14,323 cusecs |
| (2) Outlet works<br>(3) Scouring works | There is one head sluice of 3 vents each 5 feet by 4 feet. |

| | |
|---|---|
| (4) Inspection facilities | The head sluice and tunnel are accessible and can be inspected from rear after closing down the head sluice. The wet tower in which the head sluice is housed can be made dry when the water level is about 11 feet or lower, by inserting needle shutters in grooves that are provided in the front inner face of the chamber for the purpose. |
| (5) Fish-pass | The head sluice serves as fish pass. |
| (6) Means for dissipating energy below the spillway | |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | The hearting is of clay (black soil) deposited in layers and consolidated by steam rollers. The casing is of gravel rather of a poor quality. The front slope of the *bund* is revetted with stones for the full length and for the full height *i.e.* upto top of the *bund*. |
| 2) Changes introduced in the plans of the dam and in the method of carrying out the work | Borings were taken in the foundation, but afterwards some radical alterations were made in the foundations of the *bund*. In place of separate high and low level sluices a combined sluice was built. |
| (3) Noteworthy occurrences and accidents | The revetment of the *bund* had been slipping bodily in certain places of the dam year by year, when the water level was falling down. Repairs were undertaken every time. Many measures were adopted to check the slips but without any satisfactory result. It was concluded that cause of slipping was mainly due to the absence of proper toe walls and want of good material for the casing of the *bund*. Necessary remedial measures were adopted to check slipping. |

(4) Operation of the dam—

(a) Regulation

(b) Silting of the reservoir—

(i) Total silt deposited

(ii) Rate of silting

(iii) Density of the silt deposited

(iv) Rate of advancement of delta

(c) Actual yield as against estimated

(d) Various measurements and observations—

(i) Evaporation losses

(ii) Sweating below the dam

(iii) Temperature measurements

(iv) Seepage and regeneration

(e) Fish culture

(f) Anti-malaria measures

5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam — Mud dams with sufficient revetment protection are suitable for similar reservoirs in South India.

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical — The idea of utilizing the flood waters of the Vellar for the successful irrigation of the unprotected areas had been under consideration for a very long time. A scheme to bring under direct irrigation the lands on both banks of the river by means of an *anicut* at the crossing of the Trichinopoly Madras Road was at one time fully investigated, but the work could not be put in hand owing to the breaking out of the Great Indian Mutiny, and it was lost sight of entirely till 1867, when its further investigation was held over till the completion of the Pelandoria *anicut* (across the same river), then in progress. The project was again revived in 1889 but it was then ordered that it might be included in

the list of famine relief works, with the remark that it should not be lost sight of. In 1896 a scheme known as the Akkanur project was proposed with the object of storing the surplus waters of the Vellar in a series of small tanks on the left side of the river, but the site for the *anicut* at Akkanur was not found suitable as the one at the point where the Trichinopoly Madras road crosses the river. In 1903 the project was again revised by the Superintending Engineer on Special Duty in a practical form and was investigated in detail. The estimates as revised by the Chief Engineer for Irrigation and amounting to Rs. 20·64 *lakhs* was sanctioned by the Secretary of State in 1913.

**(2) Personnel**

Mr. W. J. Davis, Executive Engineer
Mr. N. Swaminatha Ayyer Avl, B.A. B.E., Executive Engineer

Mr. H. E. Clark, Special Superintending Engineer

**(3) Bibliography**

History of the project by Mr. N. Swaminatha Iyer, B.A.,B.E.

History of the slip of the Willingdon Reservoir

# V. 7. Thippayapalem Dam

## (Masonry)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 40 feet |
| (2) Location | Kurnool district, Madras Presidency (Ralla Vagu Cumbum minor basin) |
| (3) Authority or owner | Madras Government |
| (4) Purpose-Main and subsidiary | Irrigation |
| (5) Year of commencement<br>(6) Year of completion | Earthen Dam 300 feet long and 50 feet high with a masonry core wall in the centre was begun in 1933 and completed in May 1935. The earthen *bund* breached for a length of 30 feet on 26-8-35 due to heavy rainfall in the catchment. The construction of a masonry dam was commenced in December 1936 and completed in February 1938. |
| (7) Capital cost | |
| (a) Estimated | (a) Earthen dam (breached) Rs. 4,18,000<br>(Masonry dam in place of earthen dam Rs. 4,67,600 |
| (b) Actual | (b) Masonry dam—Rs. 4,37,600 |
| (8) Culturable area commanded by the project | 1,200 acres |
| (9) Area irrigated | 1,200 acres |
| (11) Means of access | It is accessible from Cumbum railway station (M. and S.M. Railway line) by a road journey of 8 miles on the Cubum—Markapur Road |

## II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 102 square miles |
| (2) Nature of catchment | Hilly covered with reserve forests |
| (3) Mean annual precipitation | |
| (a) Rainfall | (a) 25 inches |
| (4) Total average annual yield of the catchment | 4,942 acre feet approximately |
| (5) Climate | Generally dry, Rainfall light and irregular |
| (6) Temperature conditions and variations | Maximum temperature 112°F.<br>Minimum temperature 67° F.<br>Average temperature 82° F. |
| (7) Rate of Flow | |
| (a) Maximum | (a) 2,500 cusecs |
| (b) Minimum | (b) .. |
| (8) Detritus charge of the stream | |
| (9) Character (chemical) of the water stored in the reservoir | |
| (10) Geological features | |
| (a) of foundations | (a) Shale rock of hard variety |
| (b) of catchment area | (b) The catchment is hilly and covered with reserved forests |

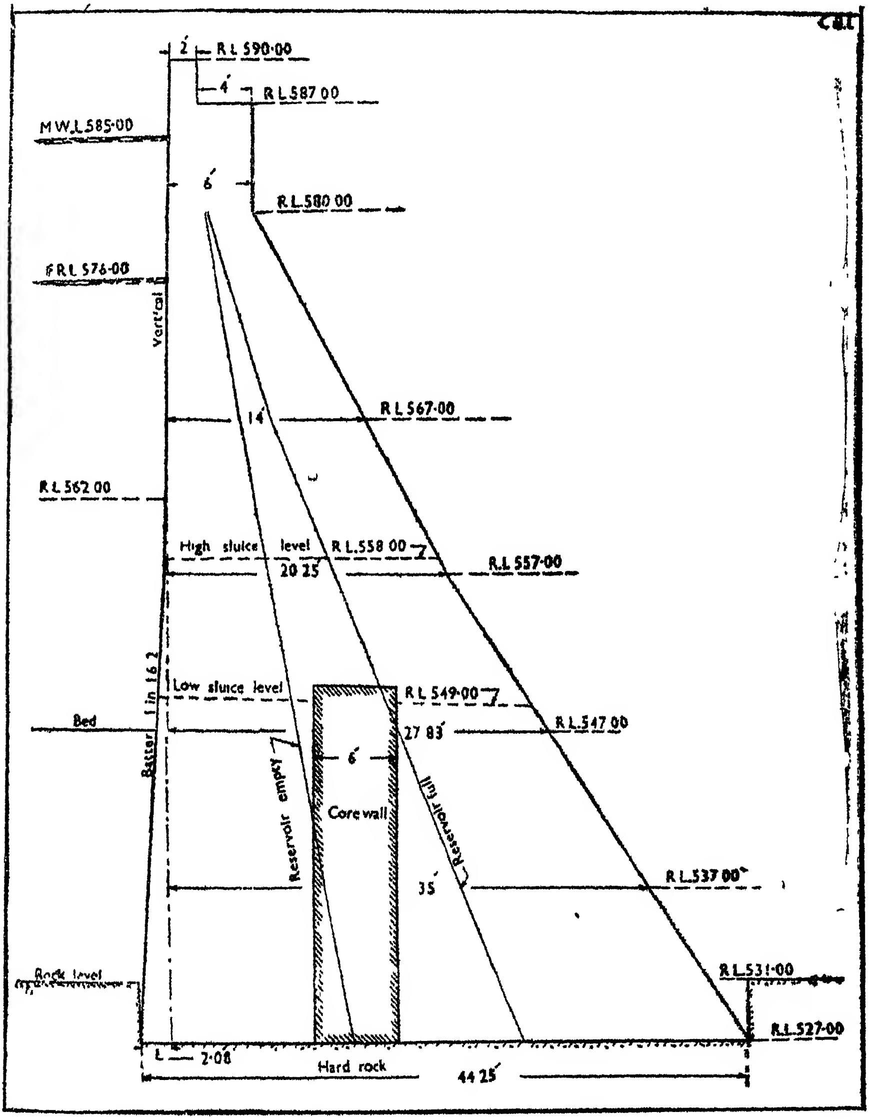
## III. TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (a) M.W.L. | (a) R.L. 585·00 |
| (b) F.R.L. | (b) R.L. 576·00 |
| (c) Area at M.W.L. | (c) 1·68 square miles (approximately) |
| (d) Area at F.R.L. | (d) 0·8 square mile |
| (e) Maximum length | (e) |
| (f) Maximum width | (f) |
| (g) Length of periphery | (g) |
| (2) Capacity of the reservoir | |
| (a) Gross | (a) 11,340 acre feet |
| (b) Live | (b) 4,178 acre feet |

| | |
|---|---|
| (c) Flood storage | (c) 6,926 Acre feet |
| (d) Carry-over | (d) 236 acre feet |

THIPPIYAPALEM DAM (MADRAS)




*Cross Section of Thippayapalem*

(3) Maximum height above the lowest point of foundations — 60 feet

(4) Height above the lowest river bed at dam — 40 feet

| | |
|---|---|
| (5) Height of the top of the dam above the crest of the spillway or weir | 11 feet |
| (6) Maximum width at level of foundations | 44·25 feet |
| (7) Width at top | 6 feet |
| (8) Batter of face-slopes | |
| (a) Upstream<br>(b) Downstream | (a)<br>(b) } As per cross section |
| (9) Length at top of the dam | 424 feet |
| (a) Non-overflow | |
| (i) Main | (i) 312 feet |
| (b) Spillway | (b) 112 feet |
| (10) Cubic volume of the body of the dam | 323,500 cubic feet |

**B. OTHERS**

| | |
|---|---|
| (11) Material of which the dam is constructed | Random rubble masonry in cement mortar upto R.L. 532·00 and in *surkhi* mortar above upto the top of the Dam |
| (12) Specific gravity | |
| (a) Masonry | (a) 2·32 |
| (13) Nature of protection and water-proofing of the upstream and down-stream faces | Cement pointing on the upstream face- |
| (14) Provision for dealing with seepage and drainage water | It has been provided with parallel drains, filled with rough stones and chips at intervals of 30 feet at R.L. 545·00 in the body of the dam |
| (15) Means of securing water tightness of the foundation of the dam | The foundation of dam has been taken down 4 feet below the rock |
| (16) Contraction joints | Contraction joints are provided at 100 feet and 200 feet distance from the left end of the dam. The joints run through the body of the dam from upstream to downstream face of it<br>In order to seal these joints U-shaped copper flexible strip is embedded in the two works of the masonry, where the break in bond occurs |

| | |
|---|---|
| | In front of this copper strip, there is provided a diamond shaped R.C. staunching post standing vertically on gun metal sliding plates and coated over all vertical faces with marine glue, a bituminous compound.<br>Water pressure will press the concrete column against the joint behind it and seal it.<br>Should any water escape past this column it has still to pass the flexible strip, which will reduce the leakage to minimum.<br>At the junction of dam with the old wing walls similar, U-shaped copper strips are provided at the same distance from the face as the strips of the expansion joints. |
| (17) Principal stresses in the masonry with a note of method of calculations employed | |
| (18) Maximum pressure on foundations | 2·9 tons per square foot at rear toe and 1·54 tons per square foot at front by observations and Boriers method. |
| (19) Uplift pressure, calculated or measured. | 1·12 tons per square foot measured |
| (20) Measures adopted for preventing or counteracting uplift pressures | |
| (21) Position and form of the core wall (or other means of securing water tightness) | Masonry core wall, which was built for earthen dam, has been left as it was after the breach of the earthen dam, and has been utilized while building the masonry dam in place of earthen dam. |

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

| | |
|---|---|
| (1) Land submerged : | |
| (a) Crown waste | (a) 794 acres |
| (b) Proprietory | (b) 618 acres |
| (2) Dislocation : | |
| (a) Villages | |
| (b) Families | Below 100 roughly |

| | |
|---|---|
| (*c*) Population | Below 500 roughly |
| (*d*) Roads : | |
| (*i*) Highways | |
| (*ii*) District Roads | |
| (*iii*) Village Roads | |
| (*e*) Railway Lines | |
| (*f*) Temples, mosques, *etc.* | |
| (*g*) Graves, *etc.* | |
| (*h*) Trees, gardens, pastures, houses, wells, *etc.* | One small tank and some wells |
| (*i*) Bridges | |
| (3) Compensation paid under each category of item (2) | Rs. 33,783/- |
| (4) Method of compensating for land of dispossessed landholders | Cash |

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing Works | There are two masonry weirs. (1) Left flank weir is 44 feet in length. (2) Right flank weir is 68 feet in length. Discharging capacity of both the weirs is 9,800 cusecs. |
| (2) Outlet works | There are two sluices one on left, sill R. L. 549·00 and the other on right, sill R.L. 558·00. |
| (3) Scouring works | |
| (4) Inspection facilities | |
| (5) Fish-pass | |
| (6) Means for dissipating energy below the spillway | Flank surplus—aprons provided |

## VIII. SUPPLEMENTARY INFORMATION

| | |
|---|---|
| (1) Constructional features | After the breach of the earthen dam in 1935 it was proposed to replace it by a masonry dam. It was suggested by the Superintending Engineer that to clear the foundations *etc.* work should be carried out by piece work agencies, or otherwise no contractor could be in a position to tender for the excavation of the foundations. The removal of the old earthen *bund* was alone a huge task. So the work was |

started on piece-work by local contractors. At first the earth and stones were removed by head loads. Later when the load became great, conveyance was done by tram line and trucks.

Most of the spoil was thrown in rear between the two surplus courses to form a wide platform for setting the mortar mills, and for forming the sand, *surkhi*, lime and stone jelly dumps. Later on the spoi removed from upstream side was thrown on the same side a little apart to form a ring *bund*. Some of the spoil was thrown into the surplus courses which at the same time served for securing the work against damages by floods.

Foundations were exposed for 50 feet on the downstream side of the core wall, and at some places an extra excavation was done. All these excavations were to be filled up and revetted with cement concrete 1 : 4 : 8. In case of the upstream side of the core wall the proportion of the concrete was changed to 1 : 2½ : 5 while the sanctioned proportion of concrete 1 : 4 : 8 was used elsewhere *i.e.* on downstream of the core wall and at places where extra excavation was done.

During excavation of the founds, on the right and upstream of the core wall, some special features were observed in this portion *i.e.* while excavating below R.L. 529·00, it was observed that a vein of soft whitish clayey stuff passed under the core-wall between 10 feet and 20 feet from the right wing wall. This was removed entirely from the bottom of the corewall down to hard rock and filled up with cement concrete. On the upstream side of the core wall at 11 feet in front of it and 37 feet from the right wing wall, there was a deep pocket wherein hard rock was not met with even at R. L. 521·00. The deep portion was filled with cement concrete 1 : 2½ : 5 reinforced with tram rails. Again on the downstream side of the core wall there were two such pockets one of 10 feet close to the downstream face of the dam and other of 30 feet length and 20 feet width close to the core wall. Special consideration was given to them and after taking out the soft stuff from those suspected pockets they were refilled with cement concrete 1 : 2½ : 5 with grills of tram rails. The supply of materials was arranged through local contractors and conveyance and construction done on nominal muster rolls and job work. The length of the dam was divided into two sections and the construction of each portion was done simultaneously. The dam was constructed in cement mortar upto R.L. 532·00 and above that to the top, it was built in *surkhi* mortar.

As soon as the entire work of masonry in foundations was completed, the further construction of the dam was handed over to the contractors. In January and February 1938, the top of the dam was completed in all respects, *i.e.* the whole work was completed in one year and two months.

Stones were got from the two hills at the ends of the dam and sand from Gundala kamma river. The sand was fairly clean. Lime was manufactured at site and *surkhi* was manufactured from the clay available in the fields in the margins downstream the dam.

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

| | |
|---|---|
| (3) Noteworthy occurrences and accidents | Originally it was constructed as an earthen dam. Two months after its completion, it breached seriously in the central portion in August, 1935. Hence it was reconstructed as masonry dam. |
| (4) Operation of the Dam | |
| (a) Regulation | |
| (b) Silting of the reservoir | |
| (i) Total silt deposited | |
| (ii) Rate of silting | |
| (iii) Density of the silt deposited | |
| (iv) Rate of advancement of delta | |
| (c) Actual yield as against estimated | |
| (d) Various measurements and observations | |
| (i) Evaporation losses | |
| (ii) Sweating below the dam | |
| (iii) Temperature measurements | |
| (iv) Seepage and regeneration | |
| (e) Fish culture | |
| (f) Anti-malaria measures | |
| 5) Recreation facilities | |
| (6) Lessons to be learnt from the construction and utilisation of the dam | On July 14, 1935, there was a rainfall of 1·73″. The reservoir which was then practically empty gradually rose to +559·50 and it continued nearly at that level till 27-7-1935, when, due to a rainfall of 0·59″ on that day, it rose by about another foot. On the morning of August 25, 1935, the level of water was +560·50. There was a sudden rise of water that day of about 10 to 11 feet in the course of 3 hours (between 7 A.M. and 10 A.M.) due to heavy rains in the catchment and water rose to within 6 feet of F. R. L. Slight leaks then appeared along the sides of the wing walls at the flanks of the *bund*. These developed rapidly resulting in the *bund* being breached in two places in the early hours on 26-8-35 for about 30 feet. |

## IX. BIBLIOGRAPHY AND HISTORICAL

| | |
|---|---|
| (1) Historical | In 1907 the people of Thippayapalem locality submitted a petition to the Collector of Kurnool, stating the emergent need for the construction of the tank for irrigating the area.<br>The investigations were thus started in 1908 and a proposal which came into shape was postponed till the decision on the Tunga-Bhadra Project was reached.<br>In 1912 the investigations were started again and, therefore, the then Superintending Engineer submitted the scheme with three alternatives.<br>After reviewing upon the three alternatives the then Chief Engineer decided for the construction of an earthen dam, with a masonry core-wall across the river and two weirs, at either flanks.<br>An estimate amounting to Rs. 3,12,000 was sanctioned initially, but it was revised to Rs. 4,18,000.<br>The construction work was started in 1933 and was completed in May 1935.<br>In August 1935, there was a heavy rainfall in the catchment, thus causing a sudden rise of water level after a prolonged spell of dry weather and it breached the dam seriously.<br>After thoroughly examining all the available information which might throw light as to the probable cause of the failure of the dam, and from a study of the failure of other earthen dams elsewhere, the then Chief Engineer came to the conclusion that the earth in the locality was not suitable for construction and decided to construct a masonry dam in place of the breached earthen dam. |

The construction work for the masonry dam was started in December 1936 and completed in February 1938.

(2) Personnel

(During construction of masonry dam)
Mr. F. M. Woroley, Chief Engineer
Mr. V. Ayyadurai Iyer Superintending Engineer
Mr. P. V. Sri Rama Iyer, Executive Engineer

(3) Bibliography

(1) Public Works Department Madras "Typed noted on the construction of the dam".

(2) Public Works Department Madras, Irrigation Circular Memorandum No. 3075/36 C.E.P. dated 21-9-1936, regarding Thippayapalem reservoir.

# V. 8. Thambraparni Diversion Weir Dam

## (Masonry)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 50 feet |
| (2) Location | Tinnevelly District, Madras State (Thambraparni river) |
| (3) Authority or owner | Madras Government (Electricity Department) |
| (4) Purpose—Main and Subsidiary | Storage required for daily regulation of water for power draft for Papanasam Hydro-electric scheme. |
| (5) Year of commencement | June 1938 |
| (6) Year of completion | June 1941 |
| (7) Capital cost | |
| (a) Estimated | (a) Rs. 11,50,000 |
| (b) Actual | (b) Rs. 7,67,000 |
| (10) Installed hydro-electric capacity | |
| (a) Firm | (a) 21,750 KVA |
| (b) Secondary | |
| (11) Means of access | The dam is situated 9 miles away from Ambasamundram railway station (South Indian Railway) and is accessible by a good metalled road. Tuticorin is the nearest port of landing located 60 miles east of Ambasamundram. |

### II. GEOPHYSICAL

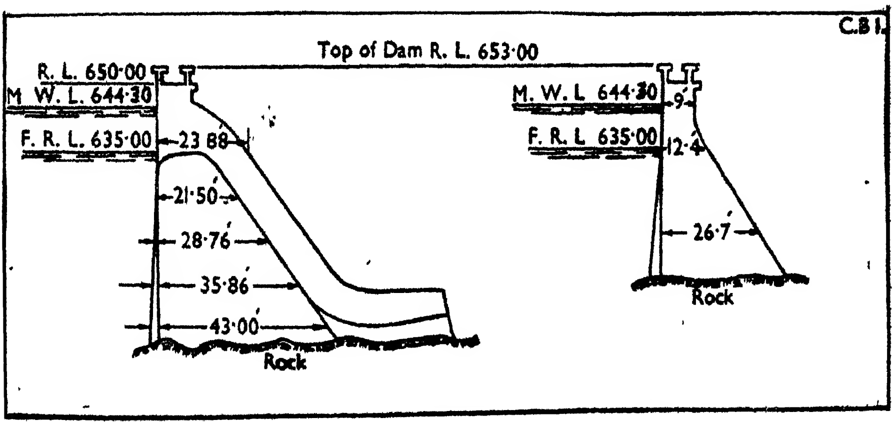
| | |
|---|---|
| (1) Area of catchment | 128 square miles |
| (2) Nature of catchment | Steep, rocky and entirely covered with heavy jungle |
| (3) Mean annual precipitation | |
| (a) Rainfall | (a) 52 inches |

| | |
|---|---|
| (4) Total average annual yield of the catchment | 681,749 acre feet |
| (5) Climate | Being situated at the foot hills of the Western Ghats above Papanasam, it is subject to both West and North East Monsoons (moderate climate). |
| (6) Temperature conditions and variations | Maximum temperature (150°F—in Sun). (110°F—in shade)<br>Minimum temperature 50°F |
| (7) Rate of flow | |
| (a) Maximum | (a) 82,200 cusecs |
| (b) Minimum | |
| (8) Detritus charge of the stream | |
| (9) Character (chemical) of the water stored in the reservoir | Analysis of water<br>Quantitative in parts per 100,000<br>(i) Total solids—4·0<br>(ii) Temporary hardness—0·0<br>(iii) Permanent hardness –1·0<br>(iv) Chlorine—0·4<br>(v) Ammonical nitrogen—trace<br>(vi) Albuminoid—trace<br>(vii) Oxygen absorbed (Tidy's) 0·082<br>(viii) Nitric Nitrogen —<br>(ix) Phosphorous—6·7<br>(x) Alkalinity —<br>Qualitative—<br>(i) Nitrates —<br>(ii) Sulphates—trace.<br>(iii) Phosphates —<br>(iv) Iron poisonous metals —<br>Physical appearance—<br>(i) Colour—Yellow<br>(ii) Turbidity—2·4<br>(iii) Small—none |
| (10) Geological features | |
| (a) of foundations | (a) Deeply fissured and broken rock |
| (b) of catchment area | (b) The country is steep and rocky |

# III. TECHNICAL

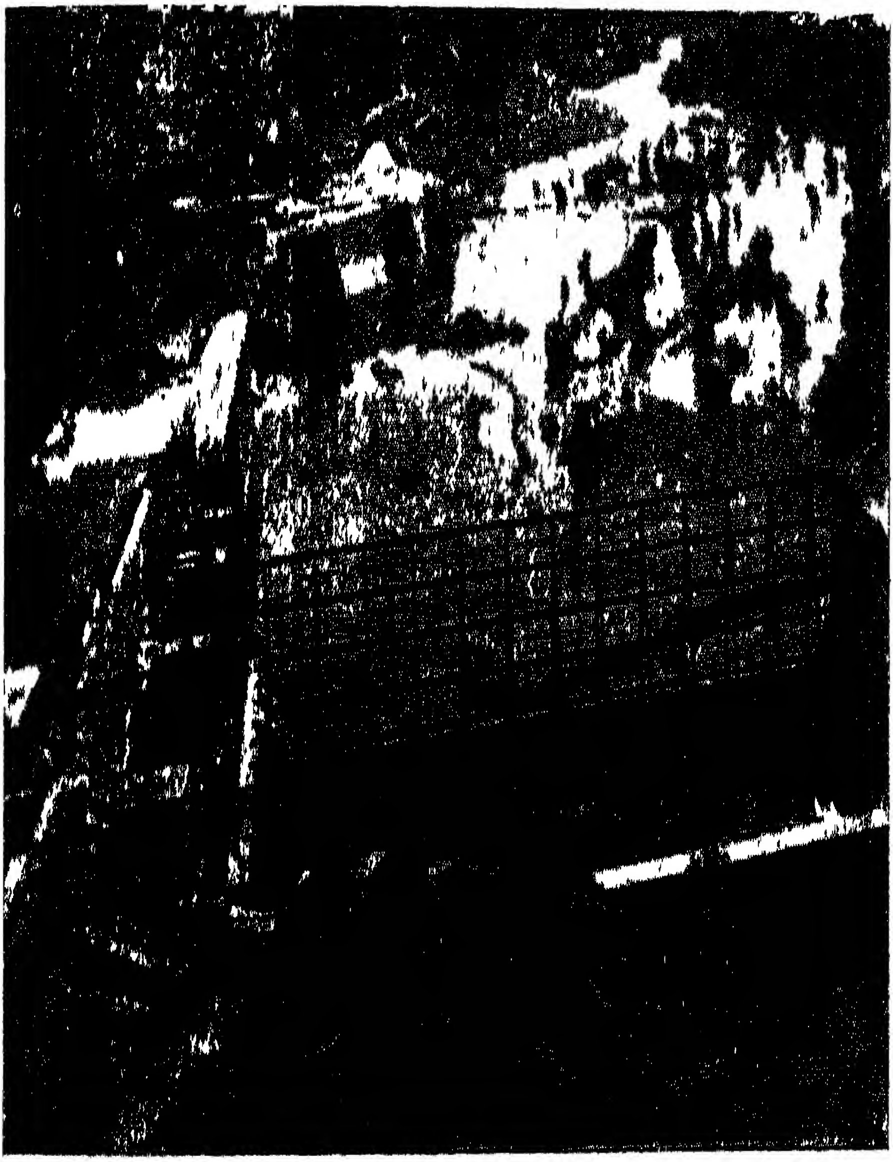
## A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (a) M.W.L. | (a) R.L. 644·30 |
| (b) F.R.L. | (b) R.L. 635·00 |
| (c) Area at M.W.L. | (c) 0·24 square mile |
| (d) Area at F.R.L. | (d) 0·19 square mile |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | |
| (2) Capacity of the reservoir | |
| (a) Gross | |
| (b) Live | (a) 643 acre feet |
| (c) Flood storage | |
| (d) Carry-over | |




*Cross Section of thambraparni Diversion Weir*

| | |
|---|---|
| (3) Maximum height above the lowest point of foundations | 60 feet—non over flow section<br>45 feet—over flow section |
| (4) Height above the lowest river bed at dam | 35-feet—over flow section<br>50 feet—non over flow section |
| (5) Height of the top of the dam above the crest of the spillway or weir | 15 feet |
| (6) Maximum width at level of foundations | 50 feet |
| (7) Width at top | 8 feet—non over flow section<br>7·21 feet—over flow section |
| (8) Batter of face-slopes<br>(*a*) Upstream | Upstream—Overflow section—<br>From R.L.590,00 to R.L. 600·00-1 in 10.<br>Non overflow section—<br>From R.L.590·00 to R.L.600—1 in 10 From R L. 600·0 t0o R.L. 630·00—0·057 in 1.<br>From R.L. 630·00 to R.L. 650·00—Vertical |
| (*b*) Downstream | Downstream—Overflow Section—<br>From R. L. 590·00 to R.L. 600·00—0·85 in 1<br>From R.L. 600·00 to R.L. 620·00—0·71 in 1<br>From R.L. 620·00 to R.L. 628·90 (curve with a radius of 62·96 feet)<br>Above R.L. 620·90 to R.L. 635·00 (Parabola 2 × 25-64y)<br>Non overflow section—<br>From R.L. 600·00 to R.L. 640·00—1 in 1·33<br>From R.L. 640.00 on to top—vertical |
| (9) Length at top of the dam | 1,350 feet |
| (*a*) Non-overflow | |
| (*i*) Main | (*i*) 163·5 feet |
| (*b*) Spillway or waste weir | (*b*) 1186·5 feet |
| (10) Cubic volume of the body of the dam | 1,026,000 cubic feet |



*Diversion weir from left flank showing general view of works in progress.*

## B. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed | Random rubble in cement mortar with coursed rubble facing |
| (12) Specific gravity | |
| (a) Masonry | (a) 2·35 (Masonry for cubic foot weighs 147 lb) |
| (13) Nature of protection and water proofing of the upstream and downstream faces | Upstream face pointed with (1 : 2) cement mortar. |
| (14) Provision for dealing with seepage and drainage water | One longitudinal drain (1′ × 1·5′) formed over the rock surface eight feet from vertical face and connected by six inches diameter vertical holes to the main drain (1′ × 1½′) provided at R.L. 610·00 with a stop of 1 in 100. |
| (15) Means of securing water tightness of the foundations of the dam | The front face to a width of 4 feet into the body of the dam, built with impervious masonry in (1 : 3) cement mortar and pointed with cement mortar (1 : 2). |
| (16) Contraction joints | Contraction joints 10 Nos. at chainages, 200, 300, 400, 500 600, 780, 1,050, 1,150 and 1,250 provided with flexible copper stripes seal and filled with special asphaltum. |
| (17) Principal stresses in the masonry with a note of methods of calculations employed | The stresses described under have been calculated by the direct method of movements, and are within the safe capacity of the foundation rock and masonry mortar, designed and tested to bear the stresses with a factor of safety of 12.<br>Overflow section—<br>(i) Vertical compressive stress at toe with no water on downstream—(Reservoir full)—1·95 tons per square foot<br>(ii) Vertical compressive stress at heel with no water on downstream (Reservoir empty)—3·03 tons per square foot<br>(iii) Maximum inclined stress at heel—3·06 tons per square foot |

(*iv*) Maximum inclined stress at toe—3·35 tons per square foot
(*v*) Maximum inclined stress at foundations—3·35 tons per square foot
(*vi*) Inclination of final resultant at normal 37°—57′

Non over flow section

(*i*) Vertical compressive stress at toe with no water downstream (Reservoir full)—1·81 tons per square foot
(*ii*) Vertical compressive stress at heel with no water downstream (Reservoir full) 3·01 tons per square foot
(*iii*) Maximum inclined stress at toe —2·79 tons per square foot
(*iv*) Maximum inclined stress at heel —2·11 tons per square foot
(*v*) Inclination of final resultant to normal—36°—24′

(18) Maximum pressure on foundations

(19) Uplift pressure, calculated or measured

(20) Measures adopted for preventing or counteracting uplift pressures

(19)–(20): It is so designed that it itself provides for full uplift, besides foundations are pressure grouted through bore holes.

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) Land submerged :
- (*a*) Crown waste
- (*b*) Proprietory

(2) Dislocation :
- (*a*) Villages
- (*b*) Families
- (*c*) Population
- (*d*) Roads :
  - (*i*) Highways
  - (*ii*) District Roads
  - (*iii*) Village Roads
- (*e*) Railway Lines
- (*f*) Temples, mosques, etc.

(g) Graves, etc.

(h) Trees, gardens, pastures, houses, wells, etc.

(i) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY WORKS

| | |
|---|---|
| (1) Surplussing works | Waste weir is 1,186·5 feet long and has a maximum discharging capacity of 120,000 cusecs. |
| (2) Outlet works | Two feet diameter steel pipes fitted with cut off gates and protecting screens to draw water for power requirements |
| (3) Scouring works | Two scouring sluices, one 3′ × 3′ vent way inside the tank chamber and the other 3′ × 3′ between the intake chamber and the weir overflow section, have been provided at the left flank. |
| (4) Inspection facilities | |
| (5) Fish Pass | |
| (6) Means for dissipating energy below the spillway. | |

## VI. POWER HOUSE

## VIII. SUPPLEMENTARY INFORMATION

## IX. BIBLIOGRAPHY AND HISTORICAL

As per Thambraparni Dam (V. 9.)

# V. 9. Thambraparni Dam

## (Masonry)

### I. GENERAL

| | |
|---|---|
| (1) Height above the lowest river bed | 124 feet |
| (2) Location | Tinnevelly District, Madras State (Thambraparni river) |
| (3) Authority or owner | Madras Government (Electricity Department) |
| (4) Purpose-Main and subsidiary | To provide subsidiary storage reservoir to meet dry weather demand for power draft for Papanasam Hydro-Electric Scheme |
| (5) Year of commencement | July 1938 |
| (6) Year of completion | December 1943 |
| (7) Capital cost | |
| (*a*) Estimated | (*a*) Rs. 36,02,000+Rs. 6,75,000 for splilway gates= Rs. 42,77,000 |
| (*b*) Actual | (*b*) Rs. 36,20,000+Rs. 7,41,000 for spillway gates = Rs. 43,61,000 |
| (10) Installed hydro-electric capacity | |
| (*a*) Firm | (*a*) 21,750 KVA (3 of 7,250 each) |
| (*b*) Secondary | |
| (11) Means of access | The dam is situated 14 miles from Ambasamudram railway station (South India Railway) and is accessible by a good metalled road. Tuticorin is the nearest port of landing |

### II. GEOPHYSICAL

| | |
|---|---|
| (1) Area of catchment | 57·54 square miles |
| (2) Nature of catchment | Steep and rocky and entirely covered with heavy *jungle* except for patches of exposed rock |
| (3) Mean annual precipitation | |
| (*a*) Rainfall | (*a*) 90 inches |

| | |
|---|---|
| (4) Total average annual yield of the catchment | 312,006 acre feet |
| (5) Climate | Moderate climates. Area is subjected to both the South West and North East monsoons. |
| (6) Temperature conditions and variations. | Maximum temperature—<br>115°F (in Sun)<br>(110° in shade)<br>Minimum temperature—50°F |
| (7) Rate of flow | |
| (a) Maximum | (a) 47,100 cusecs |
| (b) Minimum | (b) 3 cusecs |
| (8) Detritus charge of the stream<br>(9) Charter (Chemical) of the water stored in the reservoir. | Analysis of water—<br>Quantitative—(in parts per 100,000)<br>Total solid—2·5<br>Temporary hardness—9·5<br>Permanent hardness—1·0<br>Chlorine—0·1<br>Ammoniacal Nitrogen—0·001<br>Albuminoid—0·005<br>Oxygen absorbed—0·161<br>Nitric Nitrogen–<br>Phosphorous—0·67<br>Alkalinity—<br>Qualitative :—<br>Nitrate—<br>Sulphates—Trace<br>Phosphates—<br>Iron, poisonous metals—<br>Colour—Yellow<br>Physical appearance :—<br>Turbidity—3·1<br>Smell— |
| (10) Geological features | |
| (a) of foundations | (a) Gneisses and charnockite |
| (b) of catchment area | (b) The country is steep and rocky |

## III TECHNICAL

### A. STATISTICAL

| | |
|---|---|
| (1) Reservoir Data | |
| (a) M. W. L. | (a) R.L. 868·00 |
| (b) F. R. L. | (b) R. L. 868·00 |
| (c) Area at M. W. L. | (c) 2·24 square miles |
| (d) Area at F. R. L. | (d) 2·24 square miles |
| (e) Maximum length | |
| (f) Maximum width | |
| (g) Length of periphery | |

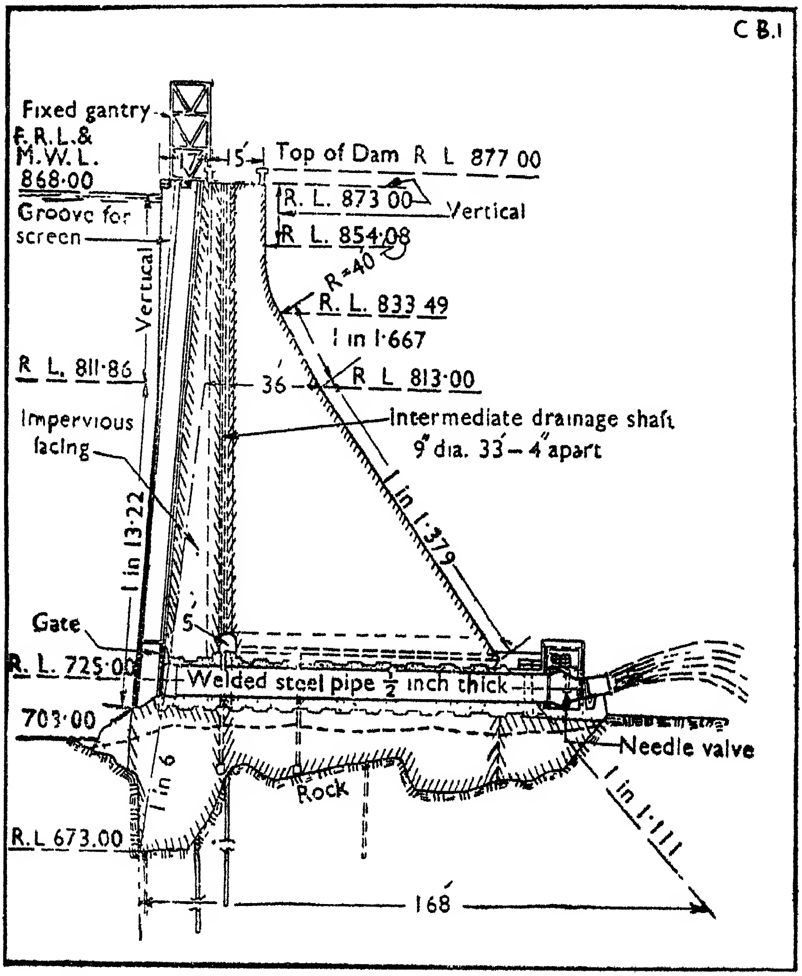
(2) Capacity of the reservoir

(a) Gross — (a) 101,010 acre feet initially and 126,263 acre feet finally after installation of spillway gates

(b) Live

(c) Flood storage

(d) Carry over




*Cross Section of Thambraparni Dam*

(3) Maximum height above the lowest point of foundations. — 215 feet

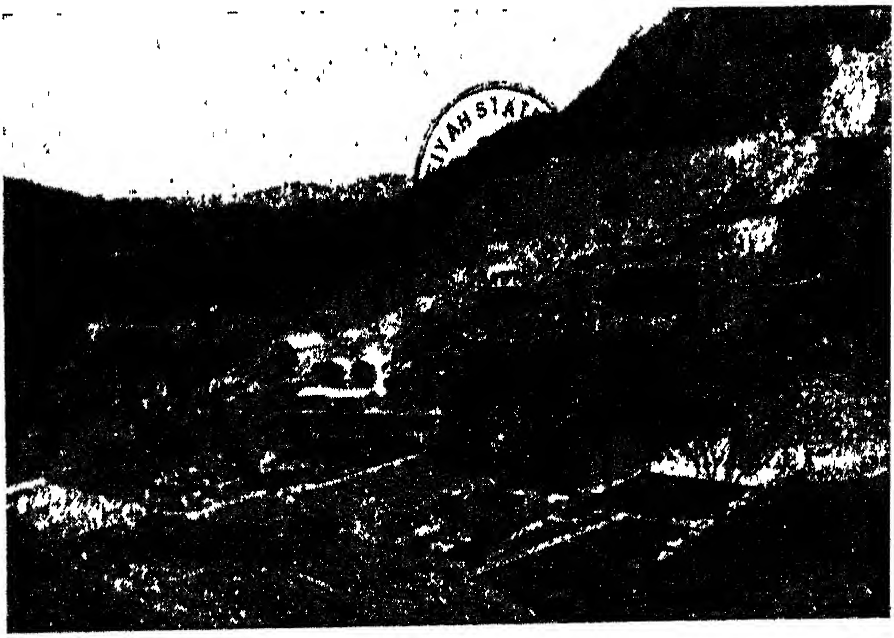
(4) Height above the lowest river bed at dam — 174 feet

| | |
|---|---|
| (5) Height of the top of the dam above the crest of the spillway or weir | 27 feet (including 4 feet height of parapet) |
| (6) Maximum width at level of foundations | 168 feet |
| (7) Width at top | 18 feet |
| (8) Batter of face-slopes | |
| (a) Upstream (a) | As per cross section |
| (b) Downstream (b) | |
| (9) Length at top of the dam | 1,104 feet |
| (a) Non-overflow | |
| (i) Main | 744 feet |
| (b) Spillway or waste weir | 360 feet |
| (10) Cubic volume of the body of the dam | 47,726,000 cubic feet |

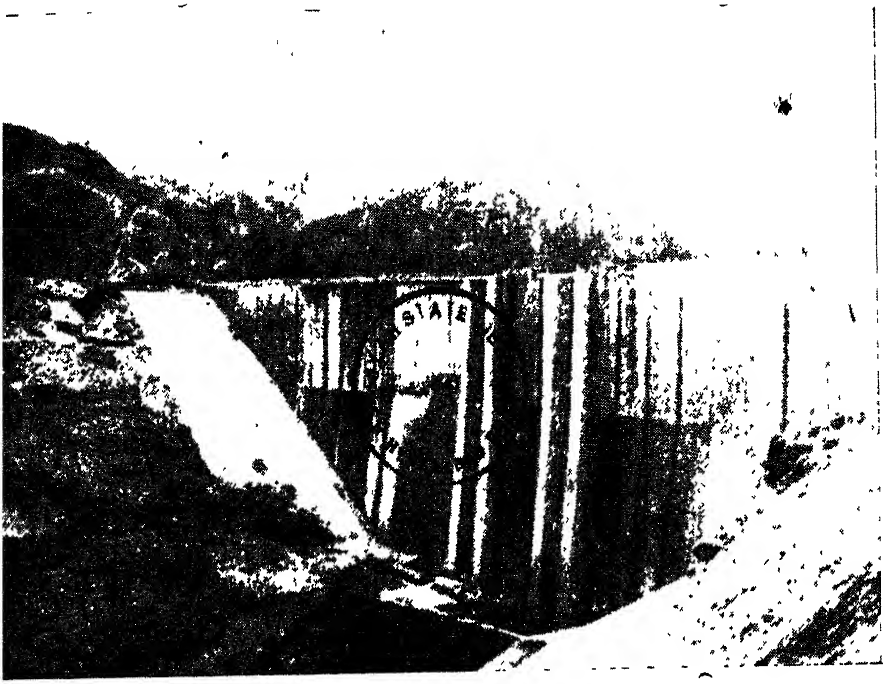
## B. OTHERS

| | |
|---|---|
| (11) Material of which the dam is constructed | Random rubble in cement mortar with coursed rubble facing |
| (12) Specific gravity | |
| (a) Masonry | (a) 2.4 |
| (13) Nature of protection and water-proofing of the upstream and down-stream faces | Upstream face is pointed two inches deep with cement mortar (1 : 2) |
| (14) Provision for dealing with seepage and drainage water | Drainage and inspection gallery of 5 feet by 7 feet with semi-circular arch at roof. Two longitudinal foundation drains $1\frac{1}{2}$ feet by 2 feet connected to gallery by 9 inches diameter shafts |
| (15) Means of securing water tightness of the foundations of the dam | Dam face upto 5 feet depth from the vertical face line, built with impervious mortar (1 cement, 1 river sand and 3 crushed stone) and pointed with cement mortar (1 : 2). |
| (16) Contraction joints | Seven No. joints spaced at 100 feet intervals. The first being at chainage 150 and the last 750 chainage. They have been provided with special asphatum fill, flexible copper strips and seal. |

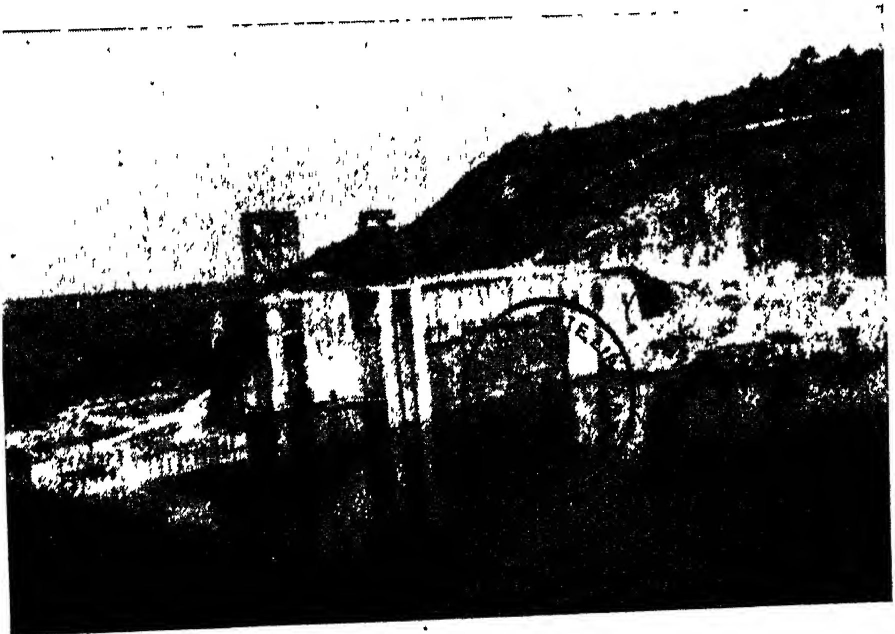
*General view of progress of work from downstream side (Thambraparni Dam)*



*General view from left Flank upstream during progress (Thambparni Dam)*



*View of dam from upstream side showing gates (Thambraparni Dam)*



*View from left Flank upstream showing Dam and surplussing works (Thambraparni Dam)*

(17) Principal stresses in the masonry with a note of methods of calculations employed

(1) Vertical compressive stresses
(a) for reservoir full at toe 7·99 tons per square foot

(18) Maximum pressure on foundations

(b) for reservoir empty at heel 10·76 tons per square foot
(2) Maximum inclined stress at toe 14·46 tons per square foot
(3) Maximum stress on foundation 11·17 tons per square foot
(4) Maximum inclined stress at heel 11·06 tons per square foot

The stresses have been calculated by direct method of moments. The stresses are all within the safe limit of capacity of the foundation rock and the masonry mortar is designed and tested to bear them within the factor of safety of 12.

(19) Uplift pressure, calculated or measured

It is so designed that dam itself provides for 50 per cent uplift as the dam is founded on hard rock. Besides, foundation have been pressure grouted, through bore holes.

(20) Measures adopted for preventing or counteracting uplift pressures

## IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) Land submerged :

(a) Crown waste

(b) Proprietory

(2) Dislocation :

(a) Villages

(b) Families

(c) Population

(d) Roads

(i) Highways
(ii) District Roads
(iii) Village Roads

(*e*) Railway Lines
(*f*) Temples, mosques, *etc.*
(*g*) Graves, *etc.*
(*h*) Trees, gardens, pastures, houses, wells, *etc.*
(*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

## V. AUXILIARY

| | |
|---|---|
| (1) Surplussing works | Spillway is 360 feet long and is provided with 6 gates each 52 feet by 18 feet. The gates are of stoney patent lift shutters. |
| (2) Outlet works | Two outlet pipes each 8·5 feet diameter fitted with screen and cut off gates on the upstream side and are worked upon by regulating valves. |
| (3) Scouring works | |
| (4) Inspection facilities | There is a drainage and inspection gallery five feet by seven feet with a semi circular arched roof at R.L. 372·00. |
| (5) Fish pass | |
| (6) Means for dissipating energy below the spillway | |

## VI. POWER HOUSE

| | |
|---|---|
| (1) Hydraulic head | Gross head 300 feet |
| (2) Name and address of Licensee with managing agents (if any) | The Superintending Engineer, Papanasam Electricity System, Madura. |
| (3) Generating units | |
| (*a*) Type | (*a*) Francis turbine |
| (*b*) Number | (*b*) 3 of which one is spare. |
| (*c*) Capacity | |
| (*i*) Firm | (*i*) 7,250 KVA each or 21,750 KVA |
| (*ii*) Secondary | |

| | |
|---|---|
| (4) Voltage | 11,000 |
| (5) Number of phases and frequency, A.C., or D.C. | 3 phases A. C. 50 cycle |
| (6) Forebay | Two, nine feet steel pipes fitted with cut off gates and protecting screens drew the water for power requirements from the Intake chamber. One of these is blanked off pending the installation of the second pipeline later The fore-bay capacity at spillway level is 28 million cubic feet which provides about one day's effective storage for one machine on full load. |
| (7) A brief description of tunnel and penstocks | The nine feet diameter pipe working at present is 3,586 feet in length. It has a uniform gradient of 1 in 300 and contains seven bends which are anchored by heavy concrete blocks . It is supported at 28 feet intervals on roller bearings to permit movement due to expansion and contraction and there is an expansion joint immediately downstream of each anchor. The velocity at full flow will be 11 feet per second.<br><br>Further at the end of this low pressure pipe, and between it and the head of the penstock is the differential surge pipe. This consists of a vertical riser 9 feet in diameter and 61 feet in height surrounded by a tank 25 feet diameter, water being admitted from one to the other through five ports 1½ feet by 2 feet each. It is designed to take care of the maximum surges that can be expected due to the load fluctuations. On the downstream side of the surge pipe there is a manifold dividing the nine feet diameter outlet into three smaller pipes each of which is connected to a penstock. The nine |

| | |
|---|---|
| | feet diameter pipe and surge are designed to feed two penstocks and power units in the ultimate development and the third which at present acts as a spare is connected in such a way that the junction can be easily dismantled. |
| | Three penstocks take off from the surge pipe as described above, one serving the spare generating unit. A fourth will be added later; and then this and the present third will take their supplies from the second low pressure pipe and surge. |
| (8) Means provided for excluding silt and hash | |
| (9) Tail race | |
| (10) Maximum length of transmission line. | 106 miles |
| (11) Principal towns served | Madura, Virudungar, Koilpatti, Rajapalaiyam, Tuticorin |
| (12) Main and subsidiary purpose of the utilisation of electricity | Light, industries on small scale |
| (13) Any other matter of interest | |

## VIII. SUPPLEMENTARY INFORMATION

(1) Constructional feaures

(2) Changes introduced in the plants of the dam in the method of carrying out the work

(3) Noteworthy occurrences and accidents.

(4) Operation of the dam

(*a*) Regulation

(*b*) Silting of the reservoir

(*i*) Total silt deposited

(*ii*) Rate of silting

(*iii*) Density of the silt deposited

(*iv*) Rate of advancement of delta.

(c) Actual yield as against estimated

(d) Various measurements and observations

(i) Evaporation losses

(ii) Sweating below the dam — (ii) About 71 inches per year

(iii) Temperature measurements

(iv) Seepage and regeneration

(e) Fish culture

(f) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

## IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

The idea of constructing a reservoir on the Thambraparni river in order to regulate and increase the supply of water for irrigation purposes has long been under the consideration of Government but the schemes put forward at different times were dropped as unremunerative. The last one submitted in January 1935, by the Chief Engineer for irrigation in consultation with the Chief Engineer for Electricity provided for a combined irrigation and hydro-electric scheme, the cost to be shared by the Irrigation and Electricity Departments in proportion to the stored water used by each. The Government decided in G.O. No. 1286, Irrigation, dated 29th May 1936, that the scheme could not be sanctioned as part irrigation project, as the increased water rate expected was found to give an inadequate return. They however, sanctioned the detailed investigation of the scheme as a purely hydro-elec-

tric venture as there was a l
lihood of its being remunera
and also stipulated that "the
quirements for irrigation purp
should also be taken into acco
and if it is found that ther
an assured supply from the re
voir for irrigation, resulting in
ditional irrigation revenue
question of affording a credit to
hydro-electric project from ir
gation funds will be considered

(2) Personnel

Chief Engineers—
(1) Sir Henry Howard, C.I.
M.C.,
(2) Col. M. G. Platts, C.I.E., G.
E., M.C.

Superintending Engineers
(1) Mr. Henshaw, G.B.E.,
(2) Shree S. C. Krishnamurthi

Executive Engineers—
(1) Shri N. Krishnamurthy
(2) Shri A. Venkataswaran
(3) Shri P. M. Chengappa
(4) Shri G. Venkataraman

(3) Bibliography