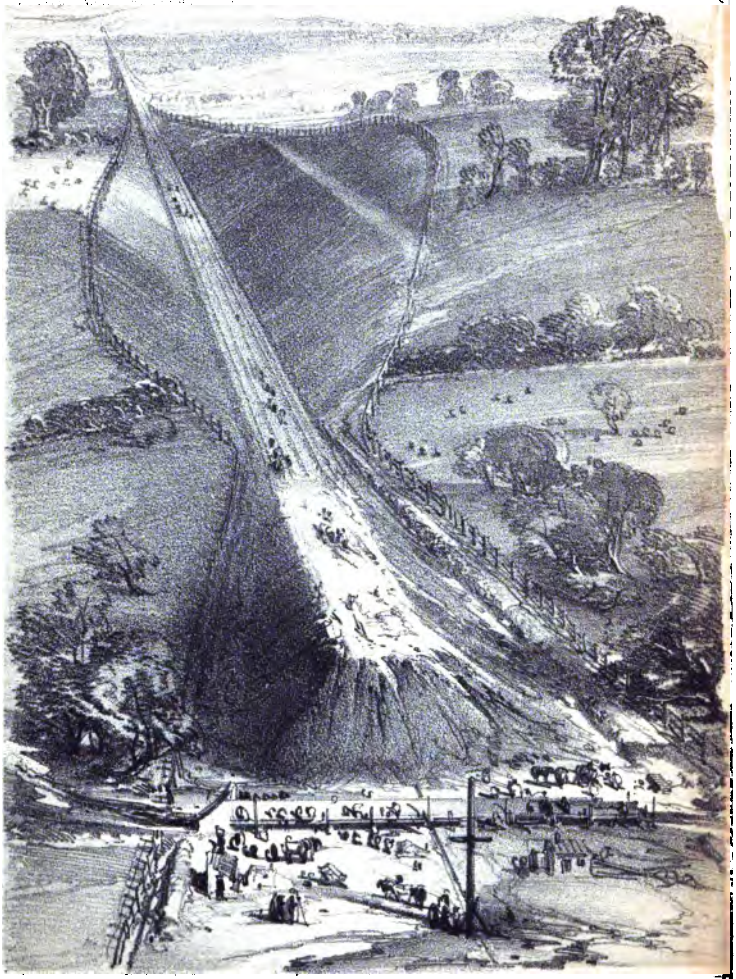

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TABLES AND RULES

FOR FACILITATING THE CALCULATION

OF

EARTHWORK,

LAND, CURVES,

DISTANCES, AND GRADIENTS,

REQUIRED IN THE FORMATION

OF

RAILWAYS,

ROADS, AND CANALS:

ALSO,

ESSAYS

ON THE PRISMOIDAL FORMULA,

AND

ON THE POWER REQUIRED UPON INCLINED PLANES.

BY J. B. HUNTINGTON,

ASSOCIATE OF THE INSTITUTION OF CIVIL ENGINEERS.

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PREFACE.

THE great advancement made of late years in the science of civil engineering, and the increased number of works promoted by public and private interests, in the formation of roads, canals, and railways, call for a more extended view of the theory of the *construction* and *measurement* of such works than has hitherto been given to the world, both for the better instruction of pupils, and for the facilitation of the labours of practical men. With the above object in view I have prepared the following work, especially adapted to the "measurement" of railways, and comprising in its extent a greater compilation of Tables and Essays, on the important features of this subject, than has hitherto been introduced.

During the process of calculating the cubic quantity of earthwork requisite to form a given embankment, or to be taken from a given cutting, I have found the usual methods proposed in various authors and geometric writers more or less tedious in their application; and in the more improved works furnished to the public, the extent of the tables has not been sufficient, in some instances, to enable them to be serviceable.

Calculations of this description are frequently required on a very short notice; and then, on account of the multiplicity of figures employed, an easy and accurate method is an object, not only because time is saved, but amongst so many evolutions of numeration, a ready method would greatly tend to prevent errors to which a lengthened process is liable; and I hope that, on a fair investigation into the merits of my manner of treating this subject, practical men, both engineers and contractors for works, may judge favourably of the utility of my labours.

The portion of the work devoted to the calculation of earthwork contains "Tables for all Bases, between Base 20 and Base 36 inclusive, adapted to ten different Slopes." The tables are followed by an "Essay on the Prismoidal Formula," and a full "Explanation of the use of the Tables," with a digest of all the "Rules derived from the Essay." "Tables for calculating Areas of Land" and "Areas of Slopes" are next given, accompanied by an "Explanation." Then follows a set of "Tables for calculating Offsets to Curves," and an "Explanation" of its use, together with a short "Table to find the Radii of Curves," and "Rules relating to Curves." Next to this comes a "Table of Distances," and then a "Table of Gradients," with the necessary "Explanation and forms of use."

I conclude the work with an "Essay on the Power required on Inclines," in which all the circumstances of Friction, Atmospheric resistance, Gravity, Loss of power round Curves and by the action of the Wind, are all separately considered.

In order to give a general notion of the various conditions which the Earthwork of a Railway exhibit, I have prefixed a Frontispiece, which, in a bird's-eye view, pourtrays a *cutting*, with the effect produced by *siding ground*, and a *bench* formed on the highest side, at a certain height, extending along the cutting, parallel with the base, till it meets the surface of the ground; also an unfinished *embankment*, with the foreground illustrating the fencing off of the requisite *land*, and other minor points of appearance.

The great object I have endeavoured to keep in view has been *utility*, especially to students in Civil Engineering. I have, therefore, avoided all subjects the investigation of which is merely ingenious without practical aim. Entire novelty of matter is hardly to be expected in a work of this nature; but I humbly hope that, in general, the reader will not feel disappointed in this respect.

In choosing the type of this work, especially for the tables, my object was to obtain a bold, clear figure, which should admit of being easily read off; in which important desideratum, I trust, the reader will admit that I have succeeded.

All the calculations will be founded on theories derived from or confirmed by practical observations; and the data, where assumed in illustration of the rules, will be such as may be considered an average, but which, owing to the many complex and inappreciable difficulties which invest discussions such as are contained in this volume, may be varied by the judgment of the reader. The work is so arranged, that the portion relating to the Calculation of Earthwork can be separated, and two volumes can be made up instead of one, to suit the convenience of the reader. I request indulgence for such irregularities and errata as may occur in the composition of the essays; and I will gladly acknowledge any communications and corrections, and insert them in subsequent volumes.

J. B. HUNTINGTON.

Wanstead, Essex,
March 1*st,* 1846.

CONTENTS.

EARTHWORK.

LAND.

CURVES.

DISTANCES.

GRADIENTS.

POWER.

ERRATA:

Page 237—*for* "yards into chains and feet," *read* "feet into chains and yards."

Page 238—*for* "feet into chains and yards," *read* "yards into chains and feet."

ERRATA.

In page v., *after* $1\frac{3}{4}$ to, *insert* 1.

„ 187, *line* 3, *after* H^2 *and* B^2, *instead of* + *read* ×.

„ 193, *line* 24, *instead of* r + s, *read* r ± s.

„ 198, *line* 13, *instead of* r + ²1, *read* $r^2 + 1$.

„ 200, *line* 20, *instead of* L, *read* Z.

„ 202, *line* 3, *instead of* $r^2 + 1$, *read* rs $\sqrt{r^2 + 1}$.

„ 202, rule 12, in the margin, *instead of* s, *read* 3.

„ 208, *line* 13, *instead of* chasm or, *read* chance of.

„ 210, *line* 11, *instead of* was, *read* were.

„ 231, rule 3, in the margin, *instead of* AD^2 AB^2, *read* $AD^2 - AB^2$.

„ 236, *line* 21, *instead of* $2\frac{1}{2}$, *read* $2\frac{3}{4}$.

„ 250, *line* 27, *instead of* rule, *read* rise.

BASE 20—SLOPE ¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	0.3750	31	15.9305	1	.0015	31	1.4830
2	0.7592	32	16.5925	2	.0062	32	1.5802
3	1.1527	33	17.2638	3	.0139	33	1.6805
4	1.5555	34	17.9444	4	.0246	34	1.7839
5	1.9675	35	18.6342	5	.0385	35	1.8904
6	2.3888	36	19.3333	6	.0555	36	2.0000
7	2.8194	37	20.0416	7	.0756	37	2.1126
8	3.2592	38	20.7595	8	.0988	38	2.2284
9	3.7083	39	21.4861	9	.1250	39	2.3472
10	4.1666	40	22.2222	10	.1543	40	2.4691
11	4.6342	41	22.9675	11	.1867	41	2.5941
12	5.1111	42	23.7222	12	.2222	42	2.7222
13	5.5972	43	24.4861	13	.2608	43	2.8545
14	6.0925	44	25.2592	14	.3025	44	2.9876
15	6.5975	45	26.0416	15	.3472	45	3.1250
16	7.1111	46	26.8333	16	.3951	46	3.2654
17	7.6342	47	27.6341	17	.4460	47	3.4089
18	8.1666	48	28.4444	18	.5000	48	3.5555
19	8.7083	49	29.2638	19	.5571	49	3.7052
20	9.2592	50	30.0925	20	.6173	50	3.8580
21	9.8194	51	30.9305	21	.6805	51	4.0139
22	10 3888	52	31.7777	22	.7469	52	4.1728
23	10.9675	53	32.6342	23	.8163	53	4.3349
24	11.5555	54	33.5000	24	.8889	54	4.5000
25	12.1527	55	34.3750	25	.9647	55	4.6682
26	12.7592	56	35.2592	26	1.0432	56	4.8395
27	13.3750	57	36.1527	27	1.1250	57	5.0139
28	14.0000	58	37.0555	28	1.2099	58	5.1913
29	14.6342	59	37.9675	29	1.2978	59	5.3719
30	15.2777	60	38.8888	30	1.3889	60	5.5555

BASE 20—SLOPE ½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.3796	31	20.3796	1	.0031	31	2.9660
2	.7777	32	21.3333	2	.0123	32	3.1605
3	1.1944	33	22.3055	3	.0278	33	3 6111
4	1.6296	34	23.2962	4	.0494	34	3.5679
5	2.0833	35	24.3055	5	.0772	35	3.7808
6	2.5555	36	25.3333	6	.1111	36	4.0000
7	3.0462	37	26.3796	7	.1512	37	4.2253
8	3.5555	38	27.4444	8	.1975	38	4.4568
9	4.0833	39	28.5277	9	.2500	39	4.6944
10	4.6296	40	29.6296	10	.3086	40	4.9383
11	5.1944	41	30.7500	11	.3734	41	5.1883
12	5.7777	42	31.8888	12	.4444	42	5.4444
13	6.3796	43	33.0462	13	.5216	43	5.7067
14	7.0000	44	34.2222	14	.6049	44	5.9753
15	7.6388	45	35.4166	15	.6944	45	6.2500
16	8.2962	46	36.6296	16	.7901	46	6.5308
17	8.9722	47	37.8610	17	.8920	47	6.8179
18	9.6666	48	39.1111	18	1.0000	48	7.1111
19	10.3796	49	40.3796	19	1.1142	49	7.4104
20	11.1111	50	41.6666	20	1.2346	50	7.7160
21	11.8610	51	42.9722	21	1.3611	51	8.0277
22	12.6296	52	44.2962	22	1.4938	52	8.3456
23	13.4166	53	45.6388	23	1.6327	53	8.6697
24	14.2222	54	47.0000	24	1.7778	54	9.0000
25	15.0462	55	48.3796	25	1.9295	55	9.3364
26	15.8888	56	49.7777	26	2.0864	56	9.6790
27	16.7500	57	51.1944	27	2.2500	57	10.0277
28	17.6296	58	52.6296	28	2.4197	58	10.3827
29	18.5277	59	54.0833	29	2.5956	59	10.7438
30	19.4444	60	55.5555	30	2.7778	60	11.1111

BASE 20—SLOPE ¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.3842	31	24.8287	1	.0046	31	4.4490
2	.7962	32	26.0740	2	.0185	32	4.7407
3	1.2361	33	27.3472	3	.0416	33	5.0416
4	1.7037	34	28.6481	4	.0740	34	5.3518
5	2.1990	35	29.9768	5	.1157	35	5 6712
6	2.7222	36	31.3333	6	.1667	36	6.0000
7	3.2731	37	32.7175	7	.2268	37	6 3379
8	3.8518	38	34.1296	8	.2963	38	6.6851
9	4.4583	39	35.5694	9	.3750	39	7.0416
10	5.0925	40	37.0370	10	.4630	40	7.4074
11	5.7546	41	38.5324	11	.5602	41	7.7824
12	6.4444	42	40.0555	12	.6667	42	8.1666
13	7.1620	43	41.6064	13	.7824	43	8.5612
14	7.9074	44	43.1851	14	.9074	44	8 9629
15	8.6805	45	44.7916	15	1.0417	45	9.3750
16	9.4814	46	46.4259	16	1.1852	46	9.7962
17	10.3101	47	48.0879	17	1.3379	47	10.2268
18	11.1666	48	49.7777	18	1.5000	48	10.6666
19	12.0509	49	51.4952	19	1.6713	49	11.1157
20	12.9629	50	53.2407	20	1.8518	50	11.5740
21	13.9033	51	55.0138	21	2.0417	51	12.0416
22	14.8703	52	56.8148	22	2.2407	52	12.5185
23	15.8657	53	58.6435	23	2.4491	53	13.0046
24	16.8888	54	60.5000	24	2.6667	54	13.5000
25	17.9398	55	62.3842	25	2.8935	55	14.0046
26	19.0185	56	64.2962	26	3.1296	56	14.5185
27	20.1250	57	66.2361	27	3.3750	57	15.0416
28	21.2592	58	68.2037	28	3.6296	58	15.5740
29	22.4212	59	70.1990	29	3.8935	59	16.1157
30	23.6111	60	72.2222	30	4.1667	60	16.6666

BASE 20—SLOPE 1 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.3888	31	29.2777	1	.0062	31	5.9321
2	.8148	32	30.8148	2	.0247	32	6.3210
3	1.2777	33	32.3888	3	.0555	33	6.7222
4	1.7777	34	34.0000	4	.0988	34	7.1358
5	2.3148	35	35.6481	5	.1543	35	7.5617
6	2.8888	36	37.3333	6	.2222	36	8.0000
7	3.5000	37	39.0555	7	.3025	37	8.4506
8	4.1481	38	40.8148	8	.3951	38	8.9135
9	4.8333	39	42.6111	9	.5000	39	9.3888
10	5.5555	40	44.4444	10	.6173	40	9.8765
11	6.3148	41	46.3148	11	.7469	41	10.3765
12	7.1111	42	48.2222	12	.8889	42	10.8888
13	7.9444	43	50.1666	13	1.0432	43	11.4135
14	8.8148	44	52.1481	14	1.2099	44	11.9506
15	9.7222	45	54.1666	15	1.3889	45	12.5000
16	10.6666	46	56.2222	16	1.5802	46	13.0617
17	11.6481	47	58.3148	17	1.7839	47	13.6358
18	12.6666	48	60.4444	18	2.0000	48	14.2222
19	13.7222	49	62.6111	19	2.2284	49	14.8209
20	14.8148	50	64.8148	20	2.4691	50	15.4321
21	15.9444	51	67.0555	21	2.7222	51	16.0555
22	17.1111	52	69.3333	22	2.9876	52	16.6913
23	18.3148	53	71.6481	23	3.2654	53	17.3395
24	19.5555	54	74.0000	24	3.5555	54	18.0000
25	20.8333	55	76.3888	25	3.8530	55	18.6728
26	22.1481	56	78.8148	26	4.1728	56	19.3580
27	23.5000	57	81.2777	27	4.5000	57	20.0555
28	24.8888	58	83.7777	28	4.8395	58	20.7654
29	26.3148	59	86.3148	29	5.1913	59	21.4876
30	27.7777	60	88.8888	30	5.5555	60	22.2222

BASE 20—SLOPE $1\frac{1}{4}$ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.3935	31	33.7268	1	.0077	31	7.4151
2	.8333	32	35.5555	2	.0309	32	7.9012
3	1.3194	33	37.4305	3	.0694	33	8.4027
4	1.8518	34	39.3518	4	.1234	34	8.9197
5	2.4305	35	41.3194	5	.1928	35	9.4521
6	3.0555	36	43.3333	6	.2778	36	10.0000
7	3.7268	37	45.3935	7	.3781	37	10.5632
8	4.4444	38	47.5000	8	.4938	38	11.1419
9	5.2083	39	49.6527	9	.6250	39	11.7361
10	6.0185	40	51.8518	10	.7716	40	12.3456
11	6.8750	41	54.0972	11	.9336	41	12.9706
12	7.7777	42	56.3888	12	1.1111	42	13.6111
13	8.7268	43	58.7268	13	1.3040	43	14.2680
14	9.7222	44	61.1111	14	1.5123	44	14.9382
15	10.7638	45	63.5416	15	1.7361	45	15.6250
16	11.8518	46	66.0185	16	1.9753	46	16.3271
17	12.9861	47	68.5416	17	2.2299	47	17.0447
18	14.1666	48	71.1111	18	2.5000	48	17.7777
19	15.3935	49	73.7268	19	2.7855	49	18.5262
20	16.6666	50	76.3888	20	3.0864	50	19.2901
21	17.9861	51	79.0972	21	3.4028	51	20.0694
22	19.3518	52	81.8518	22	3.7346	52	20.8641
23	20.7638	53	84.6527	23	4.0818	53	21.6743
24	22.2222	54	87.5000	24	4.4444	54	22.5000
25	23.7268	55	90.3935	25	4.8228	55	23.3410
26	25.2777	56	93.3333	26	5.2160	56	24.1975
27	26.8750	57	96.3194	27	5.6250	57	25.0694
28	28.5185	58	99.3518	28	6.0494	58	25.9567
29	30.2083	59	102.4305	29	6.4891	59	26.8595
30	31.9444	60	105.5555	30	6.9444	60	27.7777

BASE 20—SLOPE 1 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.3888	31	29.2777	1	.0062	31	5.9321
2	.8148	32	30.8148	2	.0247	32	6.3210
3	1.2777	33	32.3888	3	.0555	33	6.7222
4	1.7777	34	34.0000	4	.0988	34	7.1358
5	2.3148	35	35.6481	5	.1543	35	7.5617
6	2.8888	36	37.3333	6	.2222	36	8.0000
7	3.5000	37	39.0555	7	.3025	37	8.4506
8	4.1481	38	40.8148	8	.3951	38	8.9135
9	4.8333	39	42.6111	9	.5000	39	9.3888
10	5.5555	40	44.4444	10	.6173	40	9.8765
11	6.3148	41	46.3148	11	.7469	41	10.3765
12	7.1111	42	48.2222	12	.8889	42	10.8888
13	7.9444	43	50.1666	13	1.0432	43	11.4135
14	8.8148	44	52.1481	14	1.2099	44	11.9506
15	9.7222	45	54.1666	15	1.3889	45	12.5000
16	10.6666	46	56.2222	16	1.5802	46	13.0617
17	11.6481	47	58.3148	17	1.7839	47	13.6358
18	12.6666	48	60.4444	18	2.0000	48	14.2222
19	13.7222	49	62.6111	19	2.2284	49	14.8209
20	14.8148	50	64.8148	20	2.4691	50	15.4321
21	15.9444	51	67.0555	21	2.7222	51	16.0555
22	17.1111	52	69.3333	22	2.9876	52	16.6913
23	18.3148	53	71.6481	23	3.2654	53	17.3395
24	19.5555	54	74.0000	24	3.5555	54	18.0000
25	20.8333	55	76.3888	25	3.8530	55	18.6728
26	22.1481	56	78.8148	26	4.1728	56	19.3580
27	23.5000	57	81.2777	27	4.5000	57	20.0555
28	24.8888	58	83.7777	28	4.8395	58	20.7654
29	26.3148	59	86.3148	29	5.1913	59	21.4876
30	27.7777	60	88.8888	30	5.5555	60	22.2222

BASE 20—SLOPE $1\frac{1}{4}$ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.3935	31	33.7268	1	.0077	31	7.4151
2	.8333	32	35.5555	2	.0309	32	7.9012
3	1.3194	33	37.4305	3	.0694	33	8.4027
4	1.8518	34	39.3518	4	.1234	34	8.9197
5	2.4305	35	41.3194	5	.1928	35	9.4521
6	3.0555	36	43.3333	6	.2778	36	10.0000
7	3.7268	37	45.3935	7	.3781	37	10.5632
8	4.4444	38	47.5000	8	.4938	38	11.1419
9	5.2083	39	49.6527	9	.6250	39	11.7361
10	6.0185	40	51.8518	10	.7716	40	12.3456
11	6.8750	41	54.0972	11	.9336	41	12.9706
12	7.7777	42	56.3888	12	1.1111	42	13.6111
13	8.7268	43	58.7268	13	1.3040	43	14.2680
14	9.7222	44	61.1111	14	1.5123	44	14.9382
15	10.7638	45	63.5416	15	1.7361	45	15.6250
16	11.8518	46	66.0185	16	1.9753	46	16.3271
17	12.9861	47	68.5416	17	2.2299	47	17.0447
18	14.1666	48	71.1111	18	2.5000	48	17.7777
19	15.3935	49	73.7268	19	2.7855	49	18.5262
20	16.6666	50	76.3888	20	3.0864	50	19.2901
21	17.9861	51	79.0972	21	3.4028	51	20.0694
22	19.3518	52	81.8518	22	3.7346	52	20.8641
23	20.7638	53	84.6527	23	4.0818	53	21.6743
24	22.2222	54	87.5000	24	4.4444	54	22.5000
25	23.7268	55	90.3935	25	4.8228	55	23.3410
26	25.2777	56	93.3333	26	5.2160	56	24.1975
27	26.8750	57	96.3194	27	5.6250	57	25.0694
28	28.5185	58	99.3518	28	6.0494	58	25.9567
29	30.2083	59	102.4305	29	6.4891	59	26.8595
30	31.9444	60	105.5555	30	6.9444	60	27.7777

BASE 20—SLOPE 1½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts	Deduct.
1	.3981	31	38.1759	1	.0092	31	8.8981
2	.8518	32	40.2962	2	.0370	32	9.4815
3	1.3611	33	43.4722	3	.0833	33	10.0833
4	1.9259	34	44.7037	4	.1480	34	10.7037
5	2.5462	35	46.9907	5	.2313	35	11.3425
6	3.2222	36	49.3333	6	.3333	36	12.0000
7	3.9537	37	51.7314	7	.4537	37	12.6759
8	4.7407	38	54.1851	8	.5926	38	13.3703
9	5.5833	39	56.6944	9	.7500	39	14.0833
10	6.4814	40	59.2592	10	.9259	40	14.8148
11	7.4351	41	61.2129	11	1.1203	41	15.5648
12	8.4444	42	64.5555	12	1.3333	42	16.3333
13	9.5092	43	67.2870	13	1.5648	43	17.1202
14	10.6296	44	70.0740	14	1.8148	44	17.9259
15	11.8055	45	72.9166	15	2.0833	45	18.7500
16	13.0370	46	75.8148	16	2.3704	46	19.5925
17	14.3240	47	78.7685	17	2.6759	47	20.4537
18	15.6666	48	81.7777	18	3.0000	48	21.3333
19	17.0648	49	84.8425	19	3.3426	49	22.2314
20	18.5185	50	87.9629	20	3.7037	50	23.1481
21	20.0277	51	91.1388	21	4.0833	51	24.0833
22	21.5925	52	94.3703	22	4.4815	52	25.0370
23	23.2129	53	97.6574	23	4.8981	53	26.0092
24	24.8888	54	101.0000	24	5.3333	54	27.0000
25	26.6203	55	104.3981	25	5.7869	55	28.0092
26	28.4074	56	107.8518	26	6.2592	56	29.0370
27	30.2500	57	111.3611	27	6.7500	57	30.0833
28	32.1481	58	114.9259	28	7.2592	58	31.1481
29	34.1018	59	118.5462	29	7.7869	59	32.2314
30	36.1111	60	122.2222	30	8.3333	60	33.3333

BASE 20—SLOPE 1¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4027	31	42.6250	1	.0108	31	10.3811
2	.8703	32	43.0370	2	.0432	32	11.0609
3	1.4027	33	47.5138	3	.0972	33	11.7638
4	2.0000	34	50.0555	4	.1728	34	12.4876
5	2.6620	35	52.6620	5	.2700	35	13.2330
6	3.3888	36	55.3333	6	.3889	36	14.0000
7	4.1805	37	58.0694	7	.5293	37	14.7885
8	5.0370	38	60.8703	8	.6913	38	15.5987
9	5.9583	39	63.7361	9	.8750	39	16.4305
10	6.9444	40	66.6666	10	1.0802	40	17.2839
11	7.9953	41	69.6620	11	1.3071	41	18.1589
12	9.1111	42	72.7222	12	1.5555	42	19.0555
13	10.2916	43	75.8472	13	1.8256	43	19.9747
14	11.5370	44	79.0370	14	2.1173	44	20.9135
15	12.8472	45	82.2916	15	2.4305	45	21.8750
16	14.2222	46	85.6111	16	2.7654	46	22.8580
17	15.6620	47	88.9953	17	3.1219	47	23.8626
18	17.1666	48	92.4444	18	3.5000	48	24.8888
19	18.7361	49	95.9583	19	3.8997	49	25.9367
20	20.3703	50	99.5370	20	4.3210	50	27.0061
21	22.0694	51	103.1805	21	4.7639	51	28.0972
22	23.8333	52	106.8888	22	5.2284	52	29.2098
23	25.6620	53	110.6620	23	5.7145	53	30.3441
24	27.5555	54	114.5000	24	6.2222	54	31.5000
25	29.5138	55	118.4027	25	6.7516	55	32.6774
26	31.5370	56	122.3703	26	7.3024	56	33.8765
27	33.6250	57	126.4027	27	7.8750	57	35.0972
28	35.7777	58	130.5000	28	8.4691	58	36.3394
29	37.9932	59	134.6620	29	9.0848	59	37.6033
30	40.2777	60	138.8888	30	9.7222	60	38.8888

BASE 20—SLOPE 2 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4074	31	47.0740	1	.0123	31	11.8642
2	.8888	32	49.7777	2	.0494	32	12.6419
3	1.4444	33	52.5555	3	.1111	33	13.4444
4	2.0740	34	55.4074	4	.1975	34	14.2716
5	2.7777	35	58.3333	5	.3086	35	15.1234
6	3.5555	36	61.3333	6	.4444	36	16.0000
7	4.4074	37	64.4074	7	.6049	37	16.9012
8	5.3333	38	67.5555	8	.7901	38	17.8271
9	6.3333	39	70.7777	9	1.0000	39	18.7777
10	7.4074	40	74.0740	10	1.2346	40	19.7530
11	8.5555	41	77.4444	11	1.4938	41	20.7530
12	9.7777	42	80.8888	12	1.7778	42	21.7777
13	11.0740	43	84.4074	13	2.0864	43	22.8271
14	12.4444	44	88.0000	14	2.4197	44	23.9012
15	13.8888	45	91.6666	15	2.7778	45	25.0000
16	15.4074	46	95.4074	16	3.1605	46	26.1234
17	17.0000	47	99.2222	17	3.5679	47	27.2716
18	18.6666	48	103.1111	18	4.0000	48	28.4444
19	20.4074	49	107.0740	19	4.4568	49	29.6420
20	22.2222	50	111.1111	20	4.9382	50	30.8642
21	24.1111	51	115.2222	21	5.4444	51	32.1111
22	26.0740	52	119.4074	22	5.9753	52	33.3827
23	28.1111	53	123.6666	23	6.5309	53	34.6790
24	30.2222	54	128.0000	24	7.1111	54	36.0000
25	32.4074	55	132.4074	25	7.7160	55	37.3456
26	34.6666	56	136.8888	26	8.3457	56	38.7160
27	37.0000	57	141.4444	27	9.0000	57	40.1111
28	39.4074	58	146.0740	28	9.6790	58	41.5308
29	41.8888	59	150.7777	29	10.3827	59	42.9753
30	44.4444	60	155.5555	30	11.1111	60	44.4444

BASE 20—SLOPE 2½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4166	31	55.9722	1	.0154	31	14.8302
2	.9259	32	59.2592	2	.0617	32	15.8015
3	1.5277	33	62.6388	3	.1389	33	16.8055
4	2.2222	34	66.1111	4	.2468	34	17.8395
5	3.0092	35	69.6759	5	.3857	35	18.9043
6	3.8888	36	73.3333	6	.5555	36	20.0000
7	4.8611	37	77.0833	7	.7561	37	21.1265
8	5.9259	38	80.9259	8	.9876	38	22.2839
9	7.0833	39	84.8611	9	1.2500	39	23.4722
10	8.3333	40	88.8888	10	1.5432	40	24.6913
11	9.6759	41	93.0092	11	1.8673	41	25.9413
12	11.1111	42	97.2222	12	2.2222	42	27.2222
13	12.6388	43	101.5277	13	2.6080	43	28.5360
14	14.2592	44	105.9259	14	3.0247	44	29.8765
15	15.9722	45	110.4166	15	3.4722	45	31.2500
16	17.7777	46	115.0000	16	3.9506	46	32.6543
17	19.6759	47	119.6759	17	4.4599	47	34.0895
18	21.6666	48	124.4444	18	5.0000	48	35.5555
19	23.7500	49	129.3055	19	5.5710	49	37.0524
20	25.9259	50	134.2592	20	6.1728	50	38.5802
21	28.1944	51	139.3055	21	6.8055	51	40.1388
22	30.5555	52	144.4444	22	7.4691	52	41.7283
23	33.0092	53	149.6759	23	8.1636	53	43.3487
24	35.5555	54	155.0000	24	8.8889	54	45.0000
25	38.1944	55	160.4166	25	9.6455	55	46.6820
26	40.9259	56	165.9259	26	10.4321	56	48.3950
27	43.7500	57	171.5277	27	11.2500	57	50.1388
28	46.6666	58	177.2222	28	12.0587	58	51.9135
29	49.6759	59	183.0092	29	12.9782	59	53.7191
30	52.7777	60	188.8888	30	13.8889	60	55.5555

BASE 20—SLOPE 3 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4259	31	64.8703	1	.0185	31	17.7963
2	.9629	32	68.7407	2	.0740	32	18.9630
3	1.6111	33	72.7222	3	.1667	33	20.1666
4	2.3703	34	76.8148	4	.2961	34	21.4074
5	3.2407	35	81.0185	5	.4628	35	22.6851
6	4.2222	36	85.3333	6	.6667	36	24.0000
7	5.3148	37	89.7592	7	.9074	37	25.3518
8	6.5185	38	94.2962	8	1.1852	38	26.7407
9	7.8333	39	98.9444	9	1.5000	39	28.1666
10	9.2592	40	103.7037	10	1.8518	40	29.6296
11	10.7962	41	108.5740	11	2.2407	41	31.1296
12	12.4444	42	113.5555	12	2.6667	42	32.6666
13	14.2037	43	118.6481	13	3.1296	43	34.2405
14	16.0740	44	123.8518	14	3.6296	44	35.8518
15	18.0555	45	129.1666	15	4.1667	45	37.5000
16	20.1481	46	134.5925	16	4.7407	46	39.1851
17	22.3518	47	140.1296	17	5.3518	47	40.9074
18	24.6666	48	145.7777	18	6.0000	48	42.6666
19	27.0925	49	151.5370	19	6.6852	49	44.4629
20	29.6296	50	157.4074	20	7.4074	50	46.2963
21	32.2777	51	163.3888	21	8.1667	51	49.1666
22	35.0370	52	169.4814	22	8.9629	52	50.0740
23	37.9074	53	175.6851	23	9.7962	53	52.0185
24	40.8888	54	182.0000	24	10.6667	54	54.0000
25	43.9814	55	188.4259	25	11.5741	55	56.0184
26	47.1851	56	194.9629	26	12.5184	56	58.0640
27	50.5000	57	201.6111	27	13.5000	57	60.1666
28	53.9259	58	206.3703	28	14.5185	58	62.2962
29	57.4629	59	215.2407	29	15.5739	59	64.4629
30	61.1111	60	222.2222	30	16.6667	60	66.6666

BASE 21—SLOPE ¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.3935	31	16.5046	1	.0015	31	1.4830
2	.7962	32	17.1851	2	.0062	32	1.5802
3	1.2083	33	17.8750	3	.0139	33	1.6805
4	1.6296	34	18.5740	4	.0246	34	1.7839
5	2.0601	35	19.2824	5	.0385	35	1.8904
6	2.5000	36	20.0000	6	.0555	36	2.0000
7	2.9490	37	20.7268	7	.0756	37	2.1126
8	3.4074	38	21.4629	8	.0988	38	2.2284
9	3.8750	39	22.2083	9	.1250	39	2.3472
10	4.3518	40	22.9629	10	.1543	40	2.4691
11	4.8379	41	23.7268	11	.1867	41	2.5941
12	5.3333	42	24.5000	12	.2222	42	2.7222
13	5.8379	43	25.2824	13	.2608	43	2.8545
14	6.3518	44	26.0740	14	.3025	44	2.9876
15	6.8750	45	26.8750	15	.3472	45	3.1250
16	7.4074	46	27.6851	16	.3951	46	3.2654
17	7.9490	47	28.5046	17	.4460	47	3.4089
18	8.5000	48	29.3333	18	.5000	48	3.5555
19	9.0601	49	30.1712	19	.5571	49	3.7052
20	9.6296	50	31.0185	20	.6173	50	3.8580
21	10.2083	51	31.8750	21	.6805	51	4.0139
22	10.7962	52	32.7407	22	.7469	52	4.1728
23	11.3935	53	33.6157	23	.8163	53	4.3349
24	12.0000	54	34.5000	24	.8889	54	4.5000
25	12.6157	55	35.3935	25	.9647	55	4.6682
26	13.2407	56	36.2962	26	1.0432	56	4.8395
27	13.8750	57	37.2083	27	1.1250	67	5.0139
28	14.5185	58	38.1296	28	1.2099	58	5.1913
29	15.1712	59	39.0601	29	1.2978	59	5.3719
30	15.8333	60	40.0000	30	1.3889	60	5.5555

BASE 21—SLOPE ⅓ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.3981	31	20.9537	1	.0031	31	2.9660
2	.8148	32	21.9259	2	.0123	32	3.1605
3	1.2500	33	22.9166	3	.0278	33	3.6111
4	1.7037	34	23.9259	4	.0494	34	3.5679
5	2.1759	35	24.9537	5	.0772	35	3.7808
6	2.6666	36	26.0000	6	.1111	36	4.0000
7	3.1759	37	27.0648	7	.1512	37	4.2253
8	3.7037	38	28.1481	8	.1975	38	4.4568
9	4.2500	39	29.2500	9	.2500	39	4.6944
10	4.8148	40	30.3703	10	.3086	40	4.9383
11	5.3981	41	31.5092	11	.3734	41	5.1883
12	6.0000	42	32.6666	12	.4444	42	5.4444
13	6.6203	43	33.8425	13	.5216	43	5.7076
14	7.2592	44	35.0370	14	.6049	44	5.9753
15	7.9166	45	36.2500	15	.6944	45	6.2500
16	8.5925	46	37.4814	16	.7901	46	6.5308
17	9.2870	47	38.7314	17	.8920	47	6.8179
18	10.0000	48	40.0000	18	1.0000	48	7.1111
19	10.7314	49	41.2870	19	1.1142	49	7.4104
20	11.4814	50	42.5925	20	1.2346	50	7.7160
21	12.2500	51	43.9166	21	1.3611	51	8.0277
22	13.0370	52	45.2592	22	1.4938	52	8.3456
23	13.8425	53	46.6203	23	1.6327	53	8.6697
24	14.6666	54	48.0000	24	1.7778	54	9.0000
25	15.5092	55	49.3982	25	1.9295	55	9.3364
26	16.3703	56	50.8148	26	2.0864	56	9.6790
27	17.2500	57	52.2500	27	2.2500	57	10.0277
28	18.1481	58	53.7037	28	2.4197	58	10.3827
29	19.0648	59	55.1759	29	2.5956	59	10.7438
30	20.0000	60	56.6666	30	2.7778	60	11.1111

BASE 21—SLOPE ¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4027	31	25.4027	1	.0046	31	4.4490
2	.8333	32	26.6666	2	.0185	32	4.7407
3	1.2916	33	27.9583	3	.0416	33	5.0416
4	1.7777	34	29.2777	4	.0740	34	5.3518
5	2.2916	35	30.6250	5	.1157	35	5.6712
6	2.8333	36	32.0000	6	.1667	36	6.0000
7	3.4027	37	33.4027	7	.2268	37	6.3379
8	4.0000	38	34.8333	8	.2963	38	6.6851
9	4.6250	39	36.2916	9	.3750	39	7.0416
10	5.3333	40	37.7777	10	.4630	40	7.4074
11	5.9583	41	39.2916	11	.5602	41	7.7824
12	6.6666	42	40.8333	12	.6667	42	8.1666
13	7.4027	43	42.4027	13	.7824	43	8.5612
14	8.1666	44	44.0000	14	.9074	44	8.9629
15	8.9583	45	45.6250	15	1.0417	45	9.3750
16	9.7777	46	47.2777	16	1.1852	46	9.7962
17	10.6250	47	48.9583	17	1.3379	47	10.2268
18	11.5000	48	50.6666	18	1.5000	48	10.6666
19	12.4027	49	52.4027	19	1.6713	49	11.1157
20	13.3333	50	54.1666	20	1.8518	50	11.5740
21	14.2916	51	55.9583	21	2.0417	51	12.0416
22	15.2777	52	57.7777	22	2.2407	52	12.5185
23	16.2916	53	59.6250	23	2.4491	53	13.0046
24	17.3333	54	61.5000	24	2.6667	54	13.5000
25	18.4027	55	63.4027	25	2.8935	55	14.0046
26	19.5000	56	65.3333	26	3.1296	56	14.5185
27	20.6250	57	67.2916	27	3.3750	57	15.0416
28	21.7777	58	69.2777	28	3.6296	58	15.5740
29	22.9583	59	71.2916	29	3.8935	59	16.1157
30	24.1666	60	73.3333	30	4.1667	60	16.6666

BASE 21—SLOPE 1 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4074	31	29.8518	1	.0062	31	5.9321
2	.8518	32	31.4074	2	.0247	32	6.3210
3	1.3333	33	33.0000	3	.0555	33	6.7222
4	1.8518	34	34.6296	4	.0988	34	7.1358
5	2.4074	35	36.2962	5	.1543	35	7.5617
6	3.0000	36	38.0000	6	.2222	36	8.0000
7	3.6296	37	39.7407	7	.3025	37	8.4506
8	4.2962	38	41.5185	8	.3951	38	8.9135
9	5.0000	39	43.3333	9	.5000	39	9.3888
10	5.7407	40	45.1851	10	.6173	40	9.8765
11	6.5185	41	47.0740	11	.7469	41	10.3765
12	7.3333	42	49.0000	12	.8889	42	10.8888
13	8.1851	43	50.9629	13	1.0432	43	11.4135
14	9.0740	44	52.9629	14	1.2099	44	11.9506
15	10.0000	45	55.0000	15	1.3889	45	12.5000
16	10.9629	46	57.0740	16	1.5802	46	13.0617
17	11.9629	47	59.1851	17	1.7839	47	13.6358
18	13.0000	48	61.3333	18	2.0000	48	14.2222
19	14.0740	49	63.5185	19	2.2284	49	14.8209
20	15.1851	50	65.7407	20	2.4691	50	15.4321
21	16.3333	51	68.0000	21	2.7222	51	16.0555
22	17.5185	52	70.2962	22	2.9876	52	16.6913
23	18.7407	53	72.6296	23	3.2654	53	17.3395
24	20.0000	54	75.0000	24	3.5555	54	18.0000
25	21.2962	55	77.4074	25	3.8530	55	18.6728
26	22.6296	56	79.8518	26	4.1728	56	19.3580
27	24.0000	57	82.3333	27	4.5000	57	20.0555
28	25.4074	58	85.8518	28	4.8395	58	20.7654
29	26.8518	59	87.4074	29	5.1913	59	21.4876
30	28.3333	60	90.0000	30	5.5555	60	22.2222

BASE 21—SLOPE 1¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4120	31	34.3009	1	.0077	31	7.4151
2	.8703	32	36.1481	2	.0309	32	7.9012
3	1.3750	33	38.0416	3	.0694	33	8.4027
4	1.9259	34	39.9814	4	.1234	34	8.9197
5	2.5231	35	41.9675	5	.1928	35	9.4521
6	3.1666	36	44.0000	6	.2778	36	10.0000
7	3.8564	37	46.0787	7	.3781	37	10.5632
8	4.5925	38	48.2037	8	.4938	38	11.1419
9	5.3750	39	50.3750	9	.6250	39	11.7361
10	6.2037	40	52.5925	10	.7716	40	12.3456
11	7.0787	41	54.8564	11	.9336	41	12.9706
12	8.0000	42	57.1666	12	1.1111	42	13.6111
13	8.9675	43	59.5231	13	1.3040	43	14.2680
14	9.9814	44	61.9259	14	1.5123	44	14.9382
15	11.0416	45	64.3750	15	1.7361	45	15.6250
16	12.1481	46	66.8703	16	1.9753	46	16.3271
17	13.3009	47	69.4120	17	2.2299	47	17.0447
18	14.5000	48	72.0000	18	2.5000	48	17.7777
19	15.7453	49	74.6342	19	2.7855	49	18.5262
20	17.0370	50	77.3148	20	3.0864	50	19.2901
21	18.3750	51	80.0416	21	3.4028	51	20.0694
22	19.7592	52	82.8148	22	3.7346	52	20.8641
23	21.1898	53	85.6342	23	4.0818	53	21.6743
24	22.6666	54	88.5000	24	4.4444	54	22.5000
25	24.1898	55	91.4120	25	4.8228	55	23.3410
26	25.7592	56	94.3703	26	5.2160	56	24.1975
27	27.3750	57	97.3750	27	5.6250	57	25.0694
28	29.0370	58	100.4259	28	6.0494	58	25.9567
29	30.7453	59	103.5231	29	6.4891	59	26.8595
30	32.5000	60	106.6666	30	6.9444	60	27.7777

BASE 21—SLOPE 1½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4166	31	38.7500	1	.0092	31	8.8981
2	.8888	32	40.8888	2	.0370	32	9.4815
3	1.4166	33	43.0833	3	.0833	33	10.0833
4	2.0000	34	45.3333	4	.1480	34	10.7037
5	2.6388	35	47.6388	5	.2313	35	11.3425
6	3.3333	36	50.0000	6	.3333	36	12.0000
7	4.0833	37	52.4166	7	.4537	37	12.6759
8	4.8888	38	54.8888	8	.5926	38	13.3703
9	5.7500	39	57.4166	9	.7500	39	14.0833
10	6.6666	40	60.0000	10	.9259	40	14.8148
11	7.6388	41	62.6388	11	1.1203	41	15.5648
12	8.6666	42	65.3333	12	1.3333	42	16.3333
13	9.7500	43	68.0833	13	1.5648	43	17.1202
14	10.8888	44	70.8888	14	1.8148	44	17.9259
15	12.0833	45	73.7500	15	2.0833	45	18.7500
16	13.3333	46	76.6666	16	2.3704	46	19.5925
17	14.6388	47	79.6388	17	2.6759	47	20.4537
18	16.0000	48	82.6666	18	3.0000	48	21.3333
19	17.4166	49	85.7500	19	3.3426	49	22.2314
20	18.8888	50	88.8888	20	3.7037	50	23.1481
21	20.4166	51	92.0833	21	4.0833	51	24.0833
22	22.0000	52	95.3333	22	4.4815	52	25.0370
23	23.6388	53	98.6388	23	4.8981	53	26.0092
24	25.3333	54	102.0000	24	5.3333	54	27.0000
25	27.0833	55	105.4166	25	5.7869	55	28.0092
26	28.8888	56	108.8888	26	6.2592	56	29.0370
27	30.7500	57	112.4166	27	6.7500	57	30.0833
28	32.6666	58	116.0000	28	7.2592	58	31.1481
29	34.6388	59	119.6388	29	7.7869	59	32.2314
30	36.6666	60	123.3333	30	8.3333	60	33.3333

BASE 21—SLOPE 1¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4212	31	43.1990	1	.0108	31	10.3811
2	.9074	32	45.6296	2	.0432	32	11.0609
3	1.4583	33	48.1250	3	.0972	33	11.7638
4	2.0740	34	50.6851	4	.1728	34	12.4876
5	2.7546	35	53.3101	5	.2700	35	13.2330
6	3.5000	36	56.0000	6	.3889	36	14.0000
7	4.3101	37	58.7546	7	.5293	37	14.7885
8	5.1851	38	61.5740	8	.6913	38	15.5987
9	6.1250	39	64.4583	9	.8750	39	16.4305
10	7.1296	40	67.4074	10	1.0802	40	17.2839
11	8.1990	41	70.4212	11	1.3071	41	18.1589
12	9.3333	42	73.5000	12	1.5555	42	19.0555
13	10.5324	43	76.6435	13	1.8256	43	19.9747
14	11.7962	44	79.8518	14	2.1173	44	20.9135
15	13.1250	45	83.1250	15	2.4305	45	21.8750
16	14.5185	46	86.4629	16	2.7654	46	22.8580
17	15.9768	47	89.8657	17	3.1219	47	23.8626
18	17.5000	48	93.3333	18	3.5000	48	24.8888
19	19.0879	49	96.8657	19	3.8997	49	25.9367
20	20.7407	50	100.4629	20	4.3210	50	27.0061
21	22.4583	51	104.1250	21	4.7639	51	28.0972
22	24.2407	52	107.8518	22	5.2284	52	29.2098
23	26.0879	53	111.6435	23	5.7145	53	30.3441
24	28.0000	54	115.5000	24	6.2222	54	31.5000
25	29.9768	55	119.4212	25	6.7516	55	32.6774
26	32.0185	56	123.4074	26	7.3024	56	33.8765
27	34.1250	57	127.4583	27	7.8750	57	35.0972
28	36.2962	58	131.5740	28	8.4691	58	36.3394
29	38.5324	59	135.7546	29	9.0848	59	37.6033
30	40.8333	60	140.0000	30	9.7222	60	38.8888

BASE 21—SLOPE 2 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4259	31	47.6481	1	.0123	31	11.8642
2	.9259	32	50.3703	2	.0494	32	12.6419
3	1.5000	33	53.1666	3	.1111	33	13.4444
4	2.1481	34	56.0370	4	.1975	34	14.2716
5	2.8703	35	58.9814	5	.3086	35	15.1234
6	3.6666	36	62.0000	6	.4444	36	16.0000
7	4.5370	37	65.0925	7	.6049	37	16.9012
8	5.4814	38	68.2592	8	.7901	38	17.8271
9	6.5000	39	71.5000	9	1.0000	39	18.7777
10	7.5925	40	74.8148	10	1.2346	40	19.7530
11	8.7592	41	78.2037	11	1.4938	41	20.7530
12	10.0000	42	81.6666	12	1.7778	42	21.7777
13	11.3148	43	85.2037	13	2.0864	43	22.8271
14	12.7037	44	88.8148	14	2.4197	44	23.9012
15	14.1666	45	92.5000	15	2.7778	45	25.0000
16	15.7037	46	96.2592	16	3.1605	46	26.1234
17	17.3148	47	100.0925	17	3.5679	47	27.2716
18	19.0000	48	104.0000	18	4.0000	48	28.4444
19	20.7592	49	107.9814	19	4.4568	49	29.6420
20	22.5928	50	112.0370	20	4.9382	50	30.8642
21	24.5000	51	116.1666	21	5.4444	51	32.1111
22	26.4814	52	120.3703	22	5.9753	52	33.3827
23	28.5370	53	124.6481	23	6.5309	53	34.6790
24	30.6666	54	129.0000	24	7.1111	54	36.0000
25	32.8703	55	133.4259	25	7.7160	55	37.3456
26	35.1481	56	137.9259	26	8.3457	56	38.7160
27	37.5000	57	142.5000	27	9.0000	57	40.1111
28	39.9259	58	147.1481	28	9.6790	58	41.5308
29	42.4259	59	151.8703	29	10.3827	59	42.9753
30	45.0000	60	156.6666	30	11.1111	60	44.4444

BASE 21—SLOPE 2½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4351	31	56.5462	1	.0154	31	14.8302
2	.9629	32	59.8518	2	.0617	32	15.8013
3	1.5833	33	63.2500	3	.1389	33	16.8055
4	2.2962	34	66.7407	4	.2468	34	17.8395
5	3.1018	35	70.3240	5	.3857	35	18.9043
6	4.0000	36	74.0000	6	.5555	36	20.0000
7	4.9907	37	77.7685	7	.7561	37	21.1265
8	6.0740	38	81.6296	8	.9876	38	22.2839
9	7.2500	39	85.5833	9	1.2500	39	23.4722
10	8.5185	40	89.6296	10	1.5432	40	24.6913
11	9.8796	41	93.7685	11	1.8673	41	25.9413
12	11.2962	42	98.0000	12	2.2222	42	27.2222
13	12.8796	43	102.3240	13	2.6080	43	28.5360
14	14.5185	44	106.7407	14	3.0247	44	29.8765
15	16.2500	45	111.2500	15	3.4722	45	31.2500
16	18.0740	46	115.8518	16	3.9506	46	32.6543
17	19.9907	47	120.5462	17	4.4599	47	34.0895
18	22.0000	48	125.3333	18	5.0000	48	35.5555
19	24.1018	49	130.2129	19	5.5710	49	37.0524
20	26.2962	50	135.1851	20	6.1728	50	38.5802
21	28.5833	51	140.2500	21	6.8055	51	40.1388
22	30.9629	52	145.4074	22	7.4691	52	41.7283
23	33.4351	53	150.6574	23	8.1636	53	43.3487
24	36.0000	54	156.0000	24	8.8889	54	45.0000
25	38.6574	55	161.4351	25	9.6455	55	46.6820
26	41.4074	56	166.9629	26	10.4321	56	48.3950
27	44.2500	57	172.5833	27	11.2500	57	50.1388
28	47.1851	58	178.2962	28	12.0587	58	51.9135
29	50.2129	59	184.1018	29	12.9782	59	53.7191
30	53.3333	60	190.0000	30	13.8889	60	55.5555

BASE 21—SLOPE 3 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4444	31	65.4444	1	.0185	31	17.7963
2	1.0000	32	69.3333	2	.0740	32	18.9630
3	1.6666	33	73.3333	3	.1667	33	20.1666
4	2.4444	34	77.4444	4	.2961	34	21.4074
5	3.3333	35	81.6666	5	.4628	35	22.6851
6	4.3333	36	86.0000	6	.6667	36	24.0000
7	5.4444	37	90.4444	7	.9074	37	25.3518
8	6.6666	38	95.0000	8	1.1852	38	26.7407
9	8.0000	39	99.6666	9	1.5000	39	28.1666
10	9.4444	40	104.4444	10	1.8518	40	29.6296
11	11.0000	41	109.3333	11	2.2407	41	31.1296
12	12.6666	42	114.3333	12	2.6667	42	32.6666
13	14.4444	43	119.4444	13	3.1296	43	34.2405
14	16.3333	44	124.6666	14	3.6296	44	35.8518
15	18.3333	45	130.0000	15	4.1667	45	37.5000
16	20.4444	46	135.4444	16	4.7407	46	39.1851
17	22.6666	47	141.0000	17	5.3518	47	40.9074
18	25.0000	48	146.6666	18	6.0000	48	42.6666
19	27.4444	49	130.0000	19	6.6852	49	44.4629
20	30.0000	50	135.4444	20	7.4074	50	46.2963
21	32.6666	51	141.0000	21	8.1667	51	49.1666
22	35.4444	52	146.6666	22	8.9629	52	50.0740
23	38.3333	53	152.4444	23	9.7962	53	52.0185
24	41.3333	54	158.3333	24	10.6667	54	54.0000
25	44.4444	55	164.3333	25	11.5741	55	56.0184
26	47.6666	56	170.4444	26	12.5184	56	58.0640
27	51.0000	57	202.6666	27	13.5000	57	60.1666
28	54.4444	58	209.4444	28	14.5185	58	62.2962
29	58.0000	59	216.3333	29	15.5739	59	64.4629
30	61.6666	60	223.3333	30	16.6667	60	66.6666

BASE 22—SLOPE ¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4120	31	17.0787	1	.0015	31	1.4830
2	.8333	32	17.7777	2	.0062	32	1.5802
3	1.2638	33	18.4861	3	.0139	33	1.6805
4	1.7037	34	19.2037	4	.0246	34	1.7839
5	2.1527	35	19.9305	5	.0385	35	1.8904
6	2.6111	36	20.6666	6	.0555	36	2.0000
7	3.0787	37	21.4120	7	.0756	37	2.1126
8	3.5555	38	22.1666	8	.0988	38	2.2284
9	4.0416	39	22.9305	9	.1250	39	2.3472
10	4.5370	40	23.7037	10	.1543	40	2.4691
11	5.0416	41	24.4861	11	.1867	41	2.5941
12	5.5555	42	25.2777	12	.2222	42	2.7222
13	6.0787	43	26.0787	13	.2608	43	2.8545
14	6.6111	44	26.8888	14	.3025	44	2.9876
15	7.1527	45	27.7083	15	.3472	45	3.1250
16	7.7037	46	28.5370	16	.3951	46	3.2654
17	8.2638	47	29.3750	17	.4460	47	3.4089
18	8.8333	48	30.2222	18	.5000	48	3.5555
19	9.4120	49	31.0787	19	.5571	49	3.7052
20	10.0000	50	31.9444	20	.6173	50	3.8580
21	10.5972	51	32.8194	21	.6805	51	4.0139
22	11.2037	52	33.7037	22	.7469	52	4.1728
23	11.8194	53	34.5972	23	.8163	53	4.3349
24	12.4444	54	35.5000	24	.8889	54	4.5000
25	13.0787	55	36.4120	25	.9647	55	4.6682
26	13.7222	56	37.3333	26	1.0432	56	4.8395
27	14.3750	57	38.2638	27	1.1250	57	5.0139
28	15.0370	58	39.2037	28	1.2099	58	5.1913
29	15.7083	59	40.1527	29	1.2978	59	5.3719
30	16.3888	60	41.1111	30	1.3889	60	5.5555

BASE 22—SLOPE ½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4166	31	21.5277	1	.0031	31	2.9660
2	.8518	32	22.5185	2	.0123	32	3.1605
3	1.3055	33	23.5277	3	.0278	33	3.6111
4	1.7777	34	24.5555	4	.0494	34	3.5679
5	2.2685	35	25.6018	5	.0772	35	3.7808
6	2.7777	36	26.6666	6	.1111	36	4.0000
7	3.3055	37	27.7500	7	.1512	37	4.2253
8	3.8518	38	28.8518	8	.1975	38	4.4568
9	4.4166	39	29.9722	9	.2500	39	4.6944
10	5.0000	40	31.1111	10	.3086	40	4.9383
11	5.6018	41	32.2685	11	.3734	41	5.1883
12	6.2222	42	33.4444	12	.4444	42	5.4444
13	6.8611	43	34.6388	13	.5216	43	5.7067
14	7.5185	44	35.8518	14	.6049	44	5.9753
15	8.1944	45	37.0833	15	.6944	45	6.2500
16	8.8888	46	38.3333	16	.7901	46	6.5308
17	9.6018	47	39.6018	17	.8920	47	6.8179
18	10.3333	48	40.8888	18	1.0000	48	7.1111
19	11.0833	49	42.1944	19	1.1142	49	7.4104
20	11.8518	50	43.5185	20	1.2346	50	7.7160
21	12.6388	51	44.8611	21	1.3611	51	8.0277
22	13.4444	52	46.2222	22	1.4938	52	8.3456
23	14.2685	53	47.6018	23	1.6327	53	8.6697
24	15.1111	54	49.0000	24	1.7778	54	9.0000
25	15.9722	55	50.4166	25	1.9295	55	9.3364
26	16.8518	56	51.8518	26	2.0864	56	9.6790
27	17.7500	57	53.3055	27	2.2500	57	10.0277
28	18.6666	58	54.7777	28	2.4197	58	10.3827
29	19.6018	59	56.2685	29	2.5956	59	10.7438
30	20.5555	60	57.7777	30	2.7778	60	11.1111

BASE 22—SLOPE ¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4212	31	25.9768	1	.0046	31	4.4490
2	.8703	32	27.2592	2	.0185	32	4.7407
3	1.3472	33	28.5694	3	.0416	33	5.0416
4	1.8518	34	29.9074	4	.0740	34	5.3518
5	2.3842	35	31.2731	5	.1157	35	5 6712
6	2.9444	36	32.6666	6	.1667	36	6.0000
7	3.5324	37	34.0879	7	.2268	37	6 3379
8	4.1481	38	35.5370	8	.2963	38	6.6851
9	4.7916	39	37.0138	9	.3750	39	7.0416
10	5.4629	40	38.5185	10	.4630	40	7.4074
11	6.1620	41	40.0509	11	.5602	41	7.7824
12	6.8888	42	41.6111	12	.6667	42	8.1666
13	7.6435	43	43.1990	13	.7824	43	8.5612
14	8.4259	44	44.8148	14	.9074	44	8 9629
15	9.2361	45	46.4583	15	1.0417	45	9.3750
16	10.0740	46	48.1296	16	1.1852	46	9.7962
17	10.9398	47	49.8287	17	1.3379	47	10.2268
18	11.8333	48	51.5555	18	1.5000	48	10.6666
19	12.7509	49	53.3101	19	1.6713	49	11.1157
20	13.7037	50	55.0925	20	1.8518	50	11.5740
21	14.6805	51	56.9027	21	2.0417	51	12.0416
22	15.6851	52	58.7407	22	2.2407	52	12.5185
23	16.7175	53	60.6064	23	2.4491	53	13.0046
24	17.7777	54	62.5000	24	2.6667	54	13.5000
25	18.8657	55	64.4212	25	2.8935	55	14.0046
26	19.9814	56	66.3703	26	3.1296	56	14.5185
27	21.1250	57	68.3472	27	3.3750	57	15.0416
28	22.2962	58	70.3518	28	3.6296	58	15.5740
29	23.4953	59	72.3842	29	3.8935	59	16.1157
30	24.7222	60	74.4444	30	4.1667	60	16.6666

BASE 22—SLOPE 1 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4259	31	30.4259	1	.0062	31	5.9321
2	.8888	32	32.0000	2	.0247	32	6.3210
3	1.3888	33	33.6111	3	.0555	33	6.7222
4	1.9259	34	35.2592	4	.0988	34	7.1358
5	2.5000	35	36.9444	5	.1543	35	7.5617
6	3.1111	36	38.6666	6	.2222	36	8.0000
7	3.7592	37	40.4259	7	.3025	37	8.4506
8	4.4444	38	42.2222	8	.3951	38	8.9135
9	5.1666	39	44.0555	9	.5000	39	9.3888
10	5.9259	40	45.9259	10	.6173	40	9.8765
11	6.7222	41	47.8333	11	.7469	41	10.3765
12	7.5555	42	49.7777	12	.8889	42	10.8888
13	8.4259	43	51.7592	13	1.0432	43	11.4135
14	9.3333	44	53.7777	14	1.2099	44	11.9506
15	10.2777	45	55.8333	15	1.3889	45	12.5000
16	11.2592	46	57.9259	16	1.5802	46	13.0617
17	12.2777	47	60.0555	17	1.7839	47	13.6358
18	13.3333	48	62.2222	18	2.0000	48	14.2222
19	14.4259	49	64.4259	19	2.2284	49	14.8209
20	15.5555	50	66.6666	20	2.4691	50	15.4321
21	16.7222	51	68.9444	21	2.7222	51	16.0555
22	17.9259	52	71.2592	22	2.9876	52	16.6913
23	19.1666	53	73.6111	23	3.2654	53	17.3395
24	20.4444	54	76.0000	24	3.5555	54	18.0000
25	21.7592	55	78.4259	25	3.8530	55	18.6728
26	23.1111	56	80.8888	26	4.1728	56	19.3580
27	24.5000	57	83.3888	27	4.5000	57	20.0555
28	25.9259	58	85.9259	28	4.8395	58	20.7654
29	27.3888	59	88.5000	29	5.1913	59	21.4876
30	28.8888	60	91.1111	30	5.5555	60	22.2222

BASE 22—SLOPE 1¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4305	31	34.8750	1	.0077	31	7.4151
2	.9074	32	36.7407	2	.0309	32	7.9012
3	1.4305	33	38.6527	3	.0694	33	8.4027
4	2.0000	34	40.6111	4	.1234	34	8.9197
5	2.6157	35	42.6157	5	.1928	35	9.4521
6	3.2777	36	44.6666	6	.2778	36	10.0000
7	3.9861	37	46.7638	7	.3781	37	10.5632
8	4.7407	38	48.9074	8	.4938	38	11.1419
9	5.5416	39	51.0972	9	.6250	39	11.7361
10	6.3888	40	53.3333	10	.7716	40	12.3456
11	7.2824	41	55.6157	11	.9336	41	12.9706
12	8.2222	42	57.9444	12	1.1111	42	13.6111
13	9.2083	43	60.3194	13	1.3040	43	14.2680
14	10.2407	44	62.7407	14	1.5123	44	14.9382
15	11.3194	45	65.2083	15	1.7361	45	15.6250
16	12.4444	46	67.7222	16	1.9753	46	16.3271
17	13.6157	47	70.2824	17	2.2299	47	17.0447
18	14.8333	48	72.8888	18	2.5000	48	17.7777
19	16.0972	49	75.5416	19	2.7855	49	18.5262
20	17.4074	50	78.2407	20	3.0864	50	19.2901
21	18.7638	51	80.9861	21	3.4028	51	20.0694
22	20.1666	52	83.7777	22	3.7346	52	20.8641
23	21.6157	53	86.6157	23	4.0818	53	21.6743
24	23.1111	54	89.5000	24	4.4444	54	22.5000
25	24.6527	55	92.4305	25	4.8228	55	23.3410
26	26.2407	56	95.4074	26	5.2160	56	24.1975
27	27.8750	57	98.4305	27	5.6250	57	25.0694
28	29.5555	58	101.5000	28	6.0494	58	25.9567
29	31.2824	59	104.6157	29	6.4891	59	26.8595
30	33.0555	60	107.7777	30	6.9444	60	27.7777

BASE 22—SLOPE 1½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4351	31	39.3240	1	.0092	31	8.8981
2	.9259	32	41.4814	2	.0370	32	9.4815
3	1.4722	33	43.6944	3	.0833	33	10.0833
4	2.0740	34	45.9629	4	.1480	34	10.7037
5	2.7314	35	48.2870	5	.2313	35	11.3425
6	3.4444	36	50.6666	6	.3333	36	12.0000
7	4.2129	37	53.1018	7	.4537	37	12.6759
8	5.0370	38	55.5925	8	.5926	38	13.3703
9	5.9166	39	58.1388	9	.7500	39	14.0833
10	6.8518	40	60.7407	10	.9259	40	14.8148
11	7.8425	41	63.3981	11	1.1203	41	15.5648
12	8.8888	42	66.1111	12	1.3333	42	16.3333
13	9.9907	43	68.8796	13	1.5648	43	17.1202
14	11.1481	44	71.7037	14	1.8148	44	17.9259
15	12.3611	45	74.5833	15	2.0833	45	18.7500
16	13.6296	46	77.5185	16	2.3704	46	19.5925
17	14.9537	47	80.5092	17	2.6759	47	20.4537
18	16.3333	48	83.5555	18	3.0000	48	21.3333
19	17.7685	49	86.6574	19	3.3426	49	22.2314
20	19.2592	50	89.8148	20	3.7037	50	23.1481
21	20.8055	51	93.0277	21	4.0833	51	24.0833
22	22.4074	52	96.2962	22	4.4815	52	25.0370
23	24.0648	53	99.6203	23	4.8981	53	26.0092
24	25.7777	54	103.0000	24	5.3333	54	27.0000
25	27.5462	55	106.4351	25	5.7869	55	28.0092
26	29.3703	56	109.9259	26	6.2592	56	29.0370
27	31.2500	57	113.4722	27	6.7500	57	30.0833
28	33.1851	58	117.0740	28	7.2592	58	31.1481
29	35.1759	59	120.7314	29	7.7869	59	32.2314
30	37.2222	60	124.4444	30	8.3333	60	33.3333

BASE 22—SLOPE 1¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4398	31	43.7731	1	.0108	31	10.3811
2	.9444	32	46.2222	2	.0432	32	11.0609
3	1.5138	33	48.7361	3	.0972	33	11.7638
4	2.1481	34	51.3148	4	.1728	34	12.4876
5	2.8472	35	53.9583	5	.2700	35	13.2330
6	3.6111	36	56.6666	6	.3889	36	14.0000
7	4.4398	37	59.4398	7	.5293	37	14.7885
8	5.3333	38	62.2777	8	.6913	38	15.5987
9	6.2916	39	65.1805	9	.8750	39	16.4305
10	7.3148	40	68.1481	10	1.0802	40	17.2839
11	8.4027	41	71.1805	11	1.3071	41	18.1589
12	9.5555	42	74.2777	12	1.5555	42	19.0555
13	10.7731	43	77.4398	13	1.8256	43	19.9747
14	12.0555	44	80.6666	14	2.1173	44	20.9135
15	13.4027	45	83.9583	15	2.4305	45	21.8750
16	14.8148	46	87.3148	16	2.7654	46	22.8580
17	16.2916	47	90.7361	17	3.1219	47	23.8626
18	17.8333	48	94.2222	18	3.5000	48	24.8888
19	19.4398	49	97.7731	19	3.8997	49	25.9367
20	21.1111	50	101.3888	20	4.3210	50	27.0061
21	22.8472	51	105.0694	21	4.7639	51	28.0972
22	24.6481	52	108.8148	22	5.2284	52	29.2098
23	26.5137	53	112.6250	23	5.7145	53	30.3441
24	28.4444	54	116.5000	24	6.2222	54	31.5000
25	30.4398	55	120.4398	25	6.7516	55	32.6774
26	32.5000	56	124.4444	26	7.3024	56	33.8765
27	34.6250	57	128.5138	27	7.8750	57	35.0972
28	36.8148	58	132.6481	28	8.4691	58	36.3394
29	39.0694	59	136.8472	29	9.0848	59	37.6033
30	41.3888	60	141.1111	30	9.7222	60	38.8888

BASE 22—SLOPE 2 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4444	31	48.2222	1	.0123	31	11.8642
2	.9629	32	50.9629	2	.0494	32	12.6419
3	1.5555	33	53.7777	3	.1111	33	13.4444
4	2.2222	34	56.6666	4	.1975	34	14.2716
5	2.9629	35	59.6296	5	.3086	35	15.1234
6	3.7777	36	62.6666	6	.4444	36	16.0000
7	4.6666	37	65.7777	7	.6049	37	16.9012
8	5.6296	38	68.9629	8	.7901	38	17.8271
9	6.6666	39	72.2222	9	1.0000	39	18.7777
10	7.7777	40	75.5555	10	1.2346	40	19.7530
11	8.9629	41	78.9629	11	1.4938	41	20.7530
12	10.2222	42	82.4444	12	1.7778	42	21.7777
13	11.5555	43	86.0000	13	2.0864	43	22.8271
14	12.9629	44	89.6296	14	2.4197	44	23.9012
15	14.4444	45	93.3333	15	2.7778	45	25.0000
16	16.0000	46	97.1111	16	3.1605	46	26.1234
17	17.6296	47	100.9629	17	3.5679	47	27.2716
18	19.3333	48	104.8888	18	4.0000	48	28.4444
19	21.1111	49	108.8888	19	4.4568	49	29.6420
20	22.9629	50	112.9629	20	4.9382	50	30.8642
21	24.8888	51	117.1111	21	5.4444	51	32.1111
22	26.8888	52	121.3333	22	5.9753	52	33.3827
23	28.9629	53	125.6296	23	6.5309	53	34.6790
24	31.1111	54	130.0000	24	7.1111	54	36.0000
25	33.3333	55	134.4444	25	7.7160	55	37.3456
26	35.6296	56	138.9629	26	8.3457	56	38.7160
27	38.0000	57	143.5555	27	9.0000	57	40.1111
28	40.4444	58	148.2222	28	9.6790	58	41.5308
29	42.9629	59	152.9629	29	10.3827	59	42.9753
30	45.5555	60	157.7777	30	11.1111	60	44.4444

BASE 22—SLOPE 2½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4536	31	57.1203	1	.0154	31	14.8302
2	1.0000	32	60.4444	2	.0617	32	15.8015
3	1.6388	33	63.8611	3	.1389	33	16.8055
4	2.3704	34	67.3703	4	.2468	34	17.8395
5	3.1944	35	70.9722	5	.3857	35	18.9043
6	4.1111	36	74.6666	6	.5555	36	20.0000
7	5.1202	37	78.4537	7	.7561	37	21.1265
8	6.2222	38	82.3333	8	.9876	38	22.2839
9	7.4166	39	86.3055	9	1.2500	39	23.4722
10	8.7036	40	90.3704	10	1.5432	40	24.6913
11	10.0833	41	94.5277	11	1.8673	41	25.9413
12	11.5555	42	98.7777	12	2.2222	42	27.2222
13	13.1203	43	103.1203	13	2.6080	43	28.5360
14	14.7777	44	107.5555	14	3.0247	44	29.8765
15	17.5278	45	112.0833	15	3.4722	45	31.2500
16	18.3704	46	116.7037	16	3.9506	46	32.6543
17	20.3055	47	121.4166	17	4.4599	47	34.0895
18	22.3333	48	126.2222	18	5.0000	48	35.5555
19	24.4537	49	131.1203	19	5.5710	49	37.0524
20	26.6666	50	136.1111	20	6.1728	50	38.5802
21	28.9722	51	141.1944	21	6.8055	51	40.1388
22	31.3703	52	146.3703	22	7.4691	52	41.7283
23	33.8611	53	151.6388	23	8.1636	53	43.3487
24	36.4444	54	157.0000	24	8.8889	54	45.0000
25	39.1203	55	162.4536	25	9.6455	55	46.6820
26	41.8888	56	168.0000	26	10.4321	56	48.3950
27	44.7500	57	174.6389	27	11.2500	57	50.1388
28	47.7036	58	179.3703	28	12.0587	58	51.9135
29	50.7500	59	185.1944	29	12.9782	59	53.7191
30	53.8888	60	191.1111	30	13.8889	60	55.5555

BASE 22—SLOPE 3 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4628	31	66.0185	1	.0185	31	17.7963
2	1.0370	32	69.9259	2	.0740	32	18.9630
3	1.7222	33	73.9444	3	.1667	33	20.1666
4	2.5185	34	78.0740	4	.2961	34	21.4074
5	3.4259	35	82.3148	5	.4628	35	22.6851
6	4.4444	36	86.6666	6	.6667	36	24.0000
7	5.5740	37	91.1296	7	.9074	37	25.3518
8	6.8148	38	95.7037	8	1.1852	38	26.7407
9	8.1666	39	100.3888	9	1.5000	39	28.1666
10	9.6296	40	105.1852	10	1.8518	40	29.6296
11	11.2037	41	110.0925	11	2.2407	41	31.1296
12	12.8888	42	115.1111	12	2.6667	42	32.6666
13	14.6852	43	120.2407	13	3.1296	43	34.2405
14	16.5925	44	125.4813	14	3.6296	44	35.8518
15	19.6111	45	130.8333	15	4.1667	45	37.5000
16	20.7407	46	136.2962	16	4.7407	46	39.1851
17	22.9813	47	141.8702	17	5.3518	47	40.9074
18	25.3333	48	147.5555	18	6.0000	48	42.6666
19	27.7962	49	153.3518	19	6.6852	49	44.4629
20	30.3703	50	159.2593	20	7.4074	50	46.2963
21	33.0555	51	165.2777	21	8.1667	51	49.1666
22	35.8518	52	171.4073	22	8.9629	52	50.0740
23	38.7592	53	177.6480	23	9.7962	53	52.0185
24	41.7777	54	184.0000	24	10.6667	54	54.0000
25	44.9073	55	190.4628	25	11.5741	55	56.0184
26	48.1480	56	197.0370	26	12.5184	56	58.0640
27	51.5000	57	204.7222	27	13.5000	57	60.1666
28	54.9628	58	210.5185	28	14.5185	58	62.2962
29	58.5370	59	217.4258	29	15.5739	59	64.4629
30	62.2222	60	224.4444	30	16.6667	60	66.6666

BASE 23—SLOPE ¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4305	31	17.6527	1	.0015	31	1.4830
2	.8703	32	18.3703	2	.0062	32	1.5802
3	1.3194	33	19.0972	3	.0139	33	1.6805
4	1.7777	34	19.8333	4	.0246	34	1.7839
5	2.2453	35	20.5787	5	.0385	35	1.8904
6	2.7222	36	21.3333	6	.0555	36	2.0000
7	3.2083	37	22.0972	7	.0756	37	2.1126
8	3.7037	38	22.8703	8	.0988	38	2.2284
9	4.2083	39	23.6527	9	.1250	39	2.3472
10	4.7222	40	24.4444	10	.1543	40	2.4691
11	5.2453	41	25.2453	11	.1867	41	2.5941
12	5.7777	42	26.0555	12	.2222	42	2.7222
13	6.3194	43	26.8750	13	.2608	43	2.8545
14	6.8703	44	27.7037	14	.3025	44	2.9876
15	7.4305	45	28.5146	15	.3472	45	3.1250
16	8.0000	46	29.3888	16	.3951	46	3.2654
17	8.5787	47	30.2453	17	.4460	47	3.4089
18	9.1666	48	31.1111	18	.5000	48	3.5555
19	9.7638	49	31.9861	19	.5571	49	3.7052
20	10.3703	50	32.8703	20	.6173	50	3.8580
21	10.9861	51	33.7638	21	.6805	51	4.0139
22	11.6111	52	34.6666	22	.7469	52	4.1728
23	12.2453	53	35.5787	23	.8163	53	4.3349
24	12.8888	54	36.5000	24	.8889	54	4.5000
25	13.5416	55	37.4305	25	.9647	55	4.6682
26	14.2037	56	38.3703	26	1.0432	56	4.8395
27	14.8750	57	39.3194	27	1.1250	67	5.0139
28	15.5555	58	40.2777	28	1.2099	58	5.1913
29	16.2453	59	41.2453	29	1.2978	59	5.3719
30	16.9444	60	42.2222	30	1.3889	60	5.5555

BASE 23—SLOPE ½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4351	31	22.1018	1	.0031	31	2.9660
2	.8888	32	23.1111	2	.0123	32	3.1605
3	1.3611	33	24.1388	3	.0278	33	3.6111
4	1.8518	34	25.1851	4	.0494	34	3.5679
5	2.3610	35	26.2500	5	.0772	35	3.7808
6	2.8888	36	27.3333	6	.1111	36	4.0000
7	3.4351	37	28.4351	7	.1512	37	4.2253
8	4.0000	38	29.5555	8	.1975	38	4.4568
9	4.5833	39	30.6944	9	.2500	39	4.6944
10	5.1851	40	31.8518	10	.3086	40	4.9383
11	5.8055	41	33.0277	11	.3734	41	5.1883
12	6.4444	42	34.2222	12	.4444	42	5.4444
13	7.1018	43	35.4351	13	.5216	43	5.7076
14	7.7777	44	36.6666	14	.6049	44	5.9753
15	8.4720	45	37.9166	15	.6944	45	6.2500
16	9.1851	46	39.1851	16	.7901	46	6.5308
17	9.9166	47	40.4720	17	.8920	47	6.8179
18	10.6666	48	41.7777	18	1.0000	48	7.1111
19	11.4351	49	43.1018	19	1.1142	49	7.4104
20	12.2222	50	44.4444	20	1.2346	50	7.7160
21	13.0278	51	45.8055	21	1.3611	51	8.0277
22	13.8518	52	47.1851	22	1.4938	52	8.3456
23	14.6944	53	48.5833	23	1.6327	53	8.6697
24	15.5555	54	50.0000	24	1.7778	54	9.0000
25	16.4351	55	51.4351	25	1.9295	55	9.3364
26	17.3333	56	52.8888	26	2.0864	56	9.6790
27	18.2500	57	54.3611	27	2.2500	57	10.0277
28	19.1851	58	55.8518	28	2.4197	58	10.3827
29	20.1388	59	57.3611	29	2.5956	59	10.7438
30	21.1111	60	58.8888	30	2.7778	60	11.1111

BASE 23—SLOPE ¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4397	31	26.5509	1	.0046	31	4.4490
2	.9073	32	27.8518	2	.0185	32	4.7407
3	1.4028	33	29.1805	3	.0416	33	5.0416
4	1.9259	34	30.5369	4	.0740	34	5.3518
5	2.4767	35	31.9213	5	.1157	35	5.6712
6	3.0555	36	33.3333	6	.1667	36	6.0000
7	3.6619	37	34.7731	7	.2268	37	6.3379
8	4.2962	38	36.2407	8	.2963	38	6.6851
9	4.9583	39	37.7361	9	.3750	39	7.0416
10	5.6480	40	39.2592	10	.4630	40	7.4074
11	6.3657	41	40.8101	11	.5602	41	7.7824
12	7.1111	42	42.3888	12	.6667	42	8.1666
13	7.8842	43	43.9953	13	.7824	43	8.5612
14	8.6851	44	45.6296	14	.9074	44	8.9629
15	9.5137	45	47.2916	15	1.0417	45	9.3750
16	10.3704	46	48.9815	16	1.1852	46	9.7962
17	11.2545	47	50.6990	17	1.3379	47	10.2268
18	12.1666	48	52.4444	18	1.5000	48	10.6666
19	13.1064	49	54.2175	19	1.6713	49	11.1157
20	14.0740	50	56.0185	20	1.8518	50	11.5740
21	15.0695	51	57.8472	21	2.0417	51	12.0416
22	16.0925	52	59.7037	22	2.2407	52	12.5185
23	17.1435	53	61.5880	23	2.4491	53	13.0046
24	18.2222	54	63.5000	24	2.6667	54	13.5000
25	19.3286	55	65.4397	25	2.8935	55	14.0046
26	20.4629	56	67.4074	26	3.1296	56	14.5185
27	21.6250	57	69.4028	27	3.3750	57	15.0416
28	22.8147	58	71.4259	28	3.6296	58	15.5740
29	24.0323	59	73.4767	29	3.8935	59	16.1157
30	25.2777	60	75.5555	30	4.1667	60	16.6666

BASE 23—SLOPE 1 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4444	31	31.0000	1	.0062	31	5.9321
2	.9258	32	32.5926	2	.0247	32	6.3210
3	1.4444	33	34.2222	3	.0555	33	6.7222
4	2.0000	34	35.8888	4	.0988	34	7.1358
5	2.5926	35	37.5926	5	.1543	35	7.5617
6	3.2222	36	39.3333	6	.2222	36	8.0000
7	3.8888	37	41.1111	7	.3025	37	8.4506
8	4.5926	38	42.9260	8	.3951	38	8.9135
9	5.3333	39	44.7777	9	.5000	39	9.3888
10	6.1111	40	46.6666	10	.6173	40	9.8765
11	6.9258	41	48.5926	11	.7469	41	10.3765
12	7.7777	42	50.5555	12	.8889	42	10.8888
13	8.6666	43	52.5555	13	1.0432	43	11.4135
14	9.5926	44	54.5926	14	1.2099	44	11.9506
15	10.5555	45	56.6666	15	1.3889	45	12.5000
16	11.5555	46	58.7777	16	1.5802	46	13.0617
17	12.5926	47	60.9260	17	1.7839	47	13.6358
18	13.6666	48	63.1111	18	2.0000	48	14.2222
19	14.7777	49	65.3333	19	2.2284	49	14.8209
20	15.9258	50	67.5926	20	2.4691	50	15.4321
21	17.1111	51	69.8888	21	2.7222	51	16.0555
22	18.3333	52	72.2222	22	2.9876	52	16.6913
23	19.5926	53	74.5926	23	3.2654	53	17.3395
24	20.8888	54	77.0000	24	3.5555	54	18.0000
25	22.2222	55	79.4444	25	3.8530	55	18.6728
26	23.5926	56	81.9258	26	4.1728	56	19.3580
27	25.0000	57	84.4444	27	4.5000	57	20.0555
28	26.4444	58	87.0000	28	4.8395	58	20.7654
29	27.9258	59	89.5926	29	5.1913	59	21.4876
30	29.4444	60	92.2222	30	5.5555	60	22.2222

BASE 23—SLOPE 1¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4490	31	35.4490	1	.0077	31	7.4151
2	.9444	32	37.3333	2	.0309	32	7.9012
3	1.4861	33	39.2640	3	.0694	33	8.4027
4	2.0741	34	41.2406	4	.1234	34	8.9197
5	2.7081	35	43.2640	5	.1928	35	9.4521
6	3.8888	36	45.3333	6	.2778	36	10.0000
7	4.1156	37	47.4490	7	.3781	37	10.5632
8	4.8888	38	49.6111	8	.4938	38	11.1419
9	5.7083	39	51.8193	9	.6250	39	11.7361
10	6.5740	40	54.0740	10	.7716	40	12.3456
11	7.4862	41	56.3750	11	.9336	41	12.9706
12	8.4444	42	58.7222	12	1.1111	42	13.6111
13	9.4490	43	61.1157	13	1.3040	43	14.2680
14	10.5000	44	63.5555	14	1.5123	44	14.9382
15	11.5971	45	66.0417	15	1.7361	45	15.6250
16	12.7407	46	68.5740	16	1.9753	46	16.3271
17	13.9303	47	71.1528	17	2.2299	47	17.0447
18	15.1666	48	73.7777	18	2.5000	48	17.7777
19	16.4490	49	76.4490	19	2.7855	49	18.5262
20	17.7777	50	79.1666	20	3.0864	50	19.2901
21	19.1528	51	81.9303	21	3.4028	51	20.0694
22	20.5740	52	84.7407	22	3.7346	52	20.8641
23	22.0417	53	87.5972	23	4.0818	53	21.6743
24	23.5555	54	90.5000	24	4.4444	54	22.5000
25	25.1157	55	93.4490	25	4.8228	55	23.3410
26	26.7222	56	96.4444	26	5.2160	56	24.1975
27	28.3750	57	99.4861	27	5.6250	57	25.0694
28	30.0740	58	102.5740	28	6.0494	58	25.9567
29	31.8193	59	105.7083	29	6.4891	59	26.8595
30	33.6111	60	108.8888	30	6.9444	60	27.7777

BASE 23—SLOPE 1½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4536	31	39.8982	1	.0092	31	8.8981
2	.9629	32	42.0741	2	.0370	32	9.4815
3	1.5278	33	44.3055	3	.0833	33	10.0833
4	2.1481	34	46.5926	4	.1480	34	10.7037
5	2.8238	35	48.9352	5	.2313	35	11.3425
6	3.5555	36	51.3333	6	.3333	36	12.0000
7	4.3426	37	53.7869	7	.4537	37	12.6759
8	5.1851	38	56.2964	8	.5926	38	13.3703
9	6.0833	39	58.8610	9	.7500	39	14.0833
10	7.0370	40	61.4814	10	.9259	40	14.8148
11	8.0464	41	64.1574	11	1.1203	41	15.5648
12	9.1111	42	66.8888	12	1.3333	42	16.3333
13	10.2314	43	69.6759	13	1.5648	43	17.1202
14	11.4074	44	72.5185	14	1.8148	44	17.9259
15	12.6387	45	75.4167	15	2.0833	45	18.7500
16	13.9259	46	78.3703	16	2.3704	46	19.5925
17	15.2682	47	81.3796	17	2.6759	47	20.4537
18	16.6666	48	84.4444	18	3.0000	48	21.3333
19	18.1203	49	87.5647	19	3.3426	49	22.2314
20	19.6296	50	90.7407	20	3.7037	50	23.1481
21	21.1945	51	93.9720	21	4.0833	51	24.0833
22	22.8148	52	97.2592	22	4.4815	52	25.0370
23	24.4968	53	100.6018	23	4.8981	53	26.0092
24	26.2222	54	104.0000	24	5.3333	54	27.0000
25	28.0092	55	107.4536	25	5.7869	55	28.0092
26	29.8518	56	110.9629	26	6.2592	56	29.0370
27	31.7500	57	114.5278	27	6.7500	57	30.0833
28	33.7037	58	118.1481	28	7.2592	58	31.1481
29	35.7128	59	121.8238	29	7.7869	59	32.2314
30	37.7777	60	125.5555	30	8.3333	60	33.3333

BASE 23—SLOPE 1¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4581	31	44.3473	1	.0108	31	10.3811
2	.9815	32	46.8148	2	.0432	32	11.0609
3	1.5695	33	49.3473	3	.0972	33	11.7638
4	2.2222	34	51.9444	4	.1728	34	12.4876
5	2.9395	35	54.6065	5	.2700	35	13.2330
6	3.7222	36	57.3333	6	.3889	36	14.0000
7	4.5696	37	60.1250	7	.5293	37	14.7885
8	5.4814	38	62.9815	8	.6913	38	15.5987
9	6.4583	39	65.9027	9	.8750	39	16.4305
10	7.5000	40	68.8888	10	1.0802	40	17.2839
11	8.6065	41	71.9399	11	1.3071	41	18.1589
12	9.7777	42	75.0555	12	1.5555	42	19.0555
13	11.0138	43	78.2362	13	1.8256	43	19.9747
14	12.3147	44	81.4814	14	2.1173	44	20.9135
15	13.6803	45	84.7916	15	2.4305	45	21.8750
16	15.1111	46	88.1666	16	2.7654	46	22.8580
17	16.6065	47	91.6065	17	3.1219	47	23.8626
18	18.1666	48	95.1111	18	3.5000	48	24.8888
19	19.7916	49	98.6803	19	3.8997	49	25.9367
20	21.4814	50	102.3147	20	4.3210	50	27.0061
21	23.2362	51	106.0138	21	4.7639	51	28.0972
22	25.0555	52	109.7777	22	5.2284	52	29.2098
23	26.9399	53	113.6065	23	5.7145	53	30.3441
24	28.8888	54	117.5000	24	6.2222	54	31.5000
25	30.9027	55	121.4583	25	6.7516	55	32.6774
26	32.9815	56	125.4814	26	7.3024	56	33.8765
27	35.1250	57	129.5696	27	7.8750	57	35.0972
28	37.3333	58	133.7222	28	8.4691	58	36.3394
29	39.6065	59	137.9395	29	9.0848	59	37.6033
30	41.9444	60	142.2222	30	9.7222	60	38.8888

BASE 23—SLOPE 2 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4629	31	48.7962	1	.0123	31	11.8642
2	1.0000	32	51.5555	2	.0494	32	12.6419
3	1.6111	33	54.3888	3	.1111	33	13.4444
4	2.2962	34	57.2962	4	.1975	34	14.2716
5	3.0555	35	60.2777	5	.3086	35	15.1234
6	3.8888	36	63.3333	6	.4444	36	16.0000
7	4.7962	37	66.4629	7	.6049	37	16.9012
8	5.7777	38	69.6666	8	.7901	38	17.8271
9	6.8333	39	72.9444	9	1.0000	39	18.7777
10	7.9629	40	76.2962	10	1.2346	40	19.7530
11	9.1666	41	79.7222	11	1.4938	41	20.7530
12	10.4444	42	83.2222	12	1.7778	42	21.7777
13	11.7962	43	86.7962	13	2.0864	43	22.8271
14	13.2222	44	90.4444	14	2.4197	44	23.9012
15	14.7222	45	94.1666	15	2.7778	45	25.0000
16	16.2962	46	97.9689	16	3.1605	46	26.1234
17	17.9444	47	101.8333	17	3.5679	47	27.2716
18	19.6666	48	105.7777	18	4.0000	48	28.4444
19	21.4629	49	109.7962	19	4.4568	49	29.6420
20	23.3333	50	113.8888	20	4.9382	50	30.8642
21	25.2777	51	118.0555	21	5.4444	51	32.1111
22	27 2962	52	122.2962	22	5.9753	52	33.3827
23	29.3888	53	126.6111	23	6.5309	53	34.6790
24	31.5555	54	131.0000	24	7.1111	54	36.0000
25	33.7962	55	135.4629	25	7.7160	55	37.3456
26	36.1111	56	140.0000	26	8.3457	56	38.7160
27	38.5000	57	144.6111	27	9.0000	57	40.1111
28	40.9629	58	149.2962	28	9.6790	58	41.5308
29	43.5000	59	154.0555	29	10.3827	59	42.9753
30	46.1111	60	158.8888	30	11.1111	60	44.4444

BASE 23—SLOPE 2½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4722	31	57.6946	1	.0154	31	14.8302
2	1.0370	32	61.0370	2	.0617	32	15.8013
3	1.6946	33	64.4722	3	.1389	33	16.8055
4	2.4444	34	68.0000	4	.2468	34	17.8395
5	3.2870	35	71.6203	5	.3857	35	18.9043
6	4.2222	36	75.3333	6	.5555	36	20.0000
7	5.2500	37	79.1387	7	.7561	37	21.1265
8	6.3703	38	83.0370	8	.9876	38	22.2839
9	7.5833	39	87.0275	9	1.2500	39	23.4722
10	8.8888	40	91.1111	10	1.5432	40	24.6913
11	10.2870	41	95.2870	11	1.8673	41	25.9413
12	11.7777	42	99.5555	12	2.2222	42	27.2222
13	13.3611	43	103.9166	13	2.6080	43	28.5360
14	15.0370	44	108.3703	14	3.0247	44	29.8765
15	16.8055	45	112.9166	15	3.4722	45	31.2500
16	18.6666	46	117.5555	16	3.9506	46	32.6543
17	20.6203	47	122.2870	17	4.4599	47	34.0895
18	22.6666	48	127.1111	18	5.0000	48	35.5555
19	24.8055	49	132.0277	19	5.5710	49	37.0524
20	27.0370	50	137.0370	20	6.1728	50	38.5802
21	29.3611	51	142.1388	21	6.8055	51	40.1388
22	31.7777	52	147.3333	22	7.4691	52	41.7283
23	34.2870	53	152.6203	23	8.1636	53	43.3487
24	36.8888	54	158.0000	24	8.8889	54	45.0000
25	39.5833	55	163.4722	25	9.6455	55	46.6820
26	42.3703	56	169.0370	26	10.4321	56	48.3950
27	45.2500	57	174.6946	27	11.2500	57	50.1388
28	48.2222	58	180.4444	28	12.0587	58	51.9135
29	51.2870	59	186.2870	29	12.9782	59	53.7191
30	54.4444	60	192.2222	30	13.8889	60	55.5555

BASE 23—SLOPE 3 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4814	31	66.5926	1	.0185	31	17.7963
2	1.0740	32	70.5185	2	.0740	32	18.9630
3	1.7777	33	74.5555	3	.1667	33	20.1666
4	2.5926	34	78.7037	4	.2961	34	21.4074
5	3.5185	35	82.9629	5	.4628	35	22.6851
6	4.5555	36	87.3333	6	.6667	36	24.0000
7	5.7037	37	91.8147	7	.9074	37	25.3518
8	6.9629	38	96.4074	8	1.1852	38	26.7407
9	8.3333	39	101.1111	9	1.5000	39	28.1666
10	9.8147	40	105.9259	10	1.8518	40	29.6296
11	11.4074	41	110.8518	11	2.2407	41	31.1296
12	13.1111	42	115.8888	12	2.6667	42	32.6666
13	14.9259	43	121.0370	13	3.1296	43	34.2405
14	16.8518	44	126.2962	14	3.6296	44	35.8518
15	18.8888	45	131.6666	15	4.1667	45	37.5000
16	21.0370	46	137.1481	16	4.7407	46	39.1851
17	23.2962	47	142.7407	17	5.3518	47	40.9074
18	25.6666	48	148.4444	18	6.0000	48	42.6666
19	28.1481	49	154.2592	19	6.6852	49	44.4629
20	30.7407	50	160.1852	20	7.4074	50	46.2963
21	33.4444	51	166.2222	21	8.1667	51	49.1666
22	36.2592	52	172.3703	22	8.9629	52	50.0740
23	39.1852	53	178.6296	23	9.7962	53	52.0185
24	42.2222	54	185.0000	24	10.6667	54	54.0000
25	45.3703	55	191.4814	25	11.5741	55	56.0184
26	48.6296	56	198.0740	26	12.5184	56	58.0640
27	52.0000	57	204.7777	27	13.5000	57	60.1666
28	55.4814	58	211.5926	28	14.5185	58	62.2962
29	59.0740	59	218.5185	29	15.5739	59	64.4629
30	62.7777	60	225.5555	30	16.6667	60	66.6666

BASE 24—SLOPE ¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4490	31	18.2268	1	.0015	31	1.4830
2	.9074	32	18.9629	2	.0062	32	1.5802
3	1.3750	33	19.7083	3	.0139	33	1.6805
4	1.8518	34	20.4629	4	.0246	34	1.7839
5	2.3379	35	21.2268	5	.0385	35	1.8904
6	2.8333	36	22.0000	6	.0555	36	2.0000
7	3.3379	37	22.7824	7	.0756	37	2.1126
8	3.8518	38	23.5740	8	.0988	38	2.2284
9	4.3750	39	24.3750	9	.1250	39	2.3472
10	4.9074	40	25.1851	10	.1543	40	2.4691
11	5.4490	41	26.0046	11	.1867	41	2.5941
12	6.0000	42	26.8333	12	.2222	42	2.7222
13	6.5601	43	27.6712	13	.2608	43	2.8545
14	7.1296	44	28.5185	14	.3025	44	2.9876
15	7.7083	45	29.3750	15	.3472	45	3.1250
16	8.2962	46	30.2407	16	.3951	46	3.2654
17	8.8935	47	31.1157	17	.4460	47	3.4089
18	9.5000	48	32.0000	18	.5000	48	3.5555
19	10.1157	49	32.8935	19	.5571	49	3.7052
20	10.7407	50	33.7962	20	.6173	50	3.8580
21	11.3750	51	34 7083	21	.6805	51	4.0139
22	12 0185	52	35.6296	22	.7469	52	4.1728
23	12.6712	53	36.5601	23	.8163	53	4.3349
24	13.3333	54	37.5000	24	.8889	54	4.5000
25	14.0046	55	38.4490	25	.9647	55	4.6682
26	14.6851	56	39.4074	26	1.0432	56	4.8395
27	15.3750	57	40.3750	27	1.1250	57	5.0139
28	16.0740	58	41.3518	28	1.2099	58	5.1913
29	16.7824	59	42.3379	29	1.2978	59	5.3719
30	17.5000	60	43.3333	30	1.3889	60	5.5555

BASE 24—SLOPE ½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4536	31	22.6759	1	.0031	31	2.9660
2	.9259	32	23.7037	2	.0123	32	3.1605
3	1.4167	33	24.7500	3	.0278	33	3.6111
4	1.9259	34	25.8147	4	.0494	34	3.5679
5	2.4536	35	26.8981	5	.0772	35	3.7808
6	3.0000	36	28.0000	6	.1111	36	4.0000
7	3.5647	37	29.1203	7	.1512	37	4.2253
8	4.1481	38	30.2592	8	.1975	38	4.4568
9	4.7500	39	31.4166	9	.2500	39	4.6944
10	5.3703	40	32.5926	10	.3086	40	4.9383
11	6.0092	41	33.7870	11	.3734	41	5.1883
12	6.6666	42	35.0000	12	.4444	42	5.4444
13	7.3425	43	36.2314	13	.5216	43	5.7067
14	8.0370	44	37.4814	14	.6049	44	5.9753
15	8.7500	45	38.7500	15	.6944	45	6.2500
16	9.4814	46	40.0370	16	.7901	46	6.5308
17	10.2314	47	41.3425	17	.8920	47	6.8179
18	11.0000	48	42.6666	18	1.0000	48	7.1111
19	11.7870	49	44.0092	19	1.1142	49	7.4104
20	12.5926	50	45.3703	20	1.2346	50	7.7160
21	13.4167	51	46.7500	21	1.3611	51	8.0277
22	14.2592	52	48.1481	22	1.4938	52	8.3456
23	15.1203	53	49.5647	23	1.6327	53	8.6697
24	16.0000	54	51.0000	24	1.7778	54	9.0000
25	16.8981	55	52.4536	25	1.9295	55	9.3364
26	17.8147	56	53.9259	26	2.0864	56	9.6790
27	18.7500	57	55.4167	27	2.2500	57	10.0277
28	19.7037	58	56.9259	28	2.4197	58	10.3827
29	20.6759	59	58.4536	29	2.5956	59	10.7438
30	21.6666	60	60.0000	30	2.7778	60	11.1111

BASE 24—SLOPE ¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4584	31	27.1250	1	.0046	31	4.4490
2	.9444	32	28.4444	2	.0185	32	4.7407
3	1.4584	33	29.7916	3	.0416	33	5.0416
4	2.0000	34	31.1666	4	.0740	34	5.3518
5	2.5692	35	32.5692	5	.1157	35	5 6712
6	3.1666	36	34.0000	6	.1667	36	6.0000
7	3.7915	37	35.4582	7	.2268	37	6.3379
8	4.4444	38	36.9444	8	.2963	38	6.6851
9	5.1250	39	38.4583	9	.3750	39	7.0416
10	5.8333	40	40.0000	10	.4630	40	7.4074
11	6.5694	41	41.5692	11	.5602	41	7.7824
12	7.3333	42	43.1666	12	.6667	42	8.1666
13	8.1250	43	44.7916	13	.7824	43	8.5612
14	8.9444	44	46.4444	14	.9074	44	8.9629
15	9.7915	45	48.1250	15	1.0417	45	9.3750
16	10.6666	46	49.8333	16	1.1852	46	9.7962
17	11.5692	47	51.5692	17	1.3379	47	10.2268
18	12.5000	48	53.3333	18	1.5000	48	10.6666
19	13.4584	49	55.1250	19	1.6713	49	11.1157
20	14.4444	50	56.9444	20	1.8518	50	11.5740
21	15.4584	51	58.7916	21	2.0417	51	12.0416
22	16.5000	52	60.6666	22	2.2407	52	12.5185
23	17.5692	53	62.5692	23	2.4491	53	13.0046
24	18.6666	54	64.5000	24	2.6667	54	13.5000
25	19.7916	55	66.4584	25	2.8935	55	14.0046
26	20.9444	56	68.4444	26	3.1296	56	14.5185
27	22.1250	57	70.4584	27	3.3750	57	15.0416
28	23.3333	58	72.5000	28	3.6296	58	15.5740
29	24.5692	59	74.5693	29	3.8935	59	16.1157
30	25.8333	60	76.6666	30	4.1667	60	16.6666

BASE 24—SLOPE 1 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4628	31	31.5741	1	.0062	31	5.9321
2	.9629	32	33.1851	2	.0247	32	6.3210
3	1.5000	33	34.3333	3	.0555	33	6.7222
4	2.0740	34	36.5185	4	.0988	34	7.1358
5	2.6850	35	38.2407	5	.1543	35	7.5617
6	3.3333	36	40.0000	6	.2222	36	8.0000
7	4.0185	37	41.7961	7	.3025	37	8.4506
8	4.7407	38	43.6296	8	.3951	38	8.9135
9	5.5000	39	45.5000	9	.5000	39	9.3888
10	6.2962	40	47.4074	10	.6173	40	9.8765
11	7.1296	41	49.3518	11	.7469	41	10.3765
12	8.0000	42	51.3333	12	.8889	42	10.8888
13	8.9074	43	53.3518	13	1.0432	43	11.4135
14	9.8518	44	55.4073	14	1.2099	44	11.9506
15	10.8333	45	57.5000	15	1.3889	45	12.5000
16	11.8518	46	59.6296	16	1.5802	46	13.0617
17	12.9074	47	61.7962	17	1.7839	47	13.6358
18	14.0000	48	64.0000	18	2.0000	48	14.2222
19	15.1296	49	66.2407	19	2.2284	49	14.8209
20	16.2962	50	68.5185	20	2.4691	50	15.4321
21	17.5000	51	70.3333	21	2.7222	51	16.0555
22	18.7407	52	73.1851	22	2.9876	52	16.6913
23	20.0185	53	75.5741	23	3.2654	53	17.3395
24	21.3333	54	78.0000	24	3.5555	54	18.0000
25	22.6850	55	80.4628	25	3.8530	55	18.6728
26	24.0740	56	82.9629	26	4.1728	56	19.3580
27	25.5000	57	85.5000	27	4.5000	57	20.0555
28	26.9629	58	88.0741	28	4.8395	58	20.7654
29	28.4629	59	90.6850	29	5.1913	59	21.4876
30	30.0000	60	93.3333	30	5.5555	60	22.2222

BASE 24—SLOPE $1\frac{1}{4}$ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4674	31	36.0232	1	.0077	31	7.4151
2	.9814	32	37.9259	2	.0309	32	7.9012
3	1.5418	33	39.8750	3	.0694	33	8.4027
4	2.1482	34	41.8703	4	.1234	34	8.9197
5	2.8007	35	43.9120	5	.1928	35	9.4521
6	3.5000	36	46.0000	6	.2778	36	10.0000
7	4.2453	37	48.1340	7	.3781	37	10.5632
8	5.0370	38	50.3148	8	.4938	38	11.1419
9	5.8750	39	52.5416	9	.6250	39	11.7361
10	6.7592	40	54.8148	10	.7716	40	12.3456
11	7.6898	41	57.1342	11	.9336	41	12.9706
12	8.6666	42	59.5000	12	1.1111	42	13.6111
13	9.6898	43	61.9120	13	1.3040	43	14.2680
14	10.7592	44	64.3703	14	1.5123	44	14.9382
15	11.8750	45	66.8750	15	1.7361	45	15.6250
16	13.0370	46	69.4259	16	1.9753	46	16.3271
17	14.2453	47	72.0231	17	2.2299	47	17.0447
18	15.5000	48	74.6666	18	2.5000	48	17.7777
19	16.8007	49	77.3564	19	2.7855	49	18.5262
20	18.1481	50	80.0926	20	3.0864	50	19.2901
21	19.5418	51	82.8750	21	3.4028	51	20.0694
22	20.9814	52	85.7036	22	3.7346	52	20.8641
23	22.4674	53	88.5785	23	4.0818	53	21.6743
24	24.0000	54	91.5000	24	4.4444	54	22.5000
25	25.5785	55	94.4674	25	4.8228	55	23.3410
26	27.2036	56	97.4814	26	5.2160	56	24.1975
27	28.8750	57	100.5418	27	5.6250	57	25.0694
28	30.5925	58	103.6481	28	6.0494	58	25.9567
29	32.3564	59	106.8007	29	6.4891	59	26.8595
30	34.1666	60	110.0000	30	6.9444	60	27.7777

BASE 24—SLOPE 1½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4720	31	40.4722	1	.0092	31	8.8981
2	1.0000	32	42.6666	2	.0370	32	9.4815
3	1.5833	33	44.9166	3	.0833	33	10.0833
4	2.2222	34	47.2222	4	.1480	34	10.7037
5	2.9162	35	49.5833	5	.2313	35	11.3425
6	3.6666	36	52.0000	6	.3333	36	12.0000
7	4.4722	37	54.4719	7	.4537	37	12.6759
8	5.3333	38	57.0000	8	.5926	38	13.3703
9	6.2500	39	59.5833	9	.7500	39	14.0833
10	7.2222	40	62.2222	10	.9259	40	14.8148
11	8.2500	41	64.9166	11	1.1203	41	15.5648
12	9.3333	42	67.6666	12	1.3333	42	16.3333
13	10.4722	43	70.4722	13	1.5648	43	17.1202
14	11.6666	44	73.3333	14	1.8148	44	17.9259
15	12.9162	45	76.2500	15	2.0833	45	18.7500
16	14.2222	46	79.2222	16	2.3704	46	19.5925
17	15.5833	47	82.2500	17	2.6759	47	20.4537
18	17.0000	48	85.3333	18	3.0000	48	21.3333
19	18.4720	49	88.4720	19	3.3426	49	22.2314
20	20.0000	50	92.6666	20	3.7037	50	23.1481
21	21.5833	51	94.9166	21	4.0833	51	24.0833
22	23.2222	52	98.2222	22	4.4815	52	25.0370
23	24.9166	53	101.5833	23	4.8981	53	26.0092
24	26.6666	54	105.0000	24	5.3333	54	27.0000
25	28.4720	55	108.4720	25	5.7869	55	28.0092
26	30.3333	56	112.0000	26	6.2592	56	29.0370
27	32.2500	57	115.5833	27	6.7500	57	30.0833
28	34.2222	58	119.2222	28	7.2592	58	31.1481
29	36.2500	59	122.9162	29	7.7869	59	32.2314
30	38.3333	60	126.6666	30	8.3333	60	33.3333

BASE 24—SLOPE $1\frac{3}{4}$ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4768	31	44.9214	1	.0108	31	10.3811
2	1.0185	32	47.4073	2	.0432	32	11.0609
3	1.6250	33	49.9583	3	.0972	33	11.7638
4	2.2963	34	52.5740	4	.1728	34	12.4876
5	3.0319	35	55.2546	5	.2700	35	13.2330
6	3.8333	36	58.0000	6	.3889	36	14.0000
7	4.6990	37	60.8102	7	.5293	37	14.7885
8	5.6296	38	63.6852	8	.6913	38	15.5987
9	6.6250	39	66.6250	9	.8750	39	16.4305
10	7.6851	40	69.6296	10	1.0802	40	17.2839
11	8.8102	41	72.6990	11	1.3071	41	18.1589
12	10.0000	42	75.8333	12	1.5555	42	19.0555
13	11.2546	43	79.0319	13	1.8256	43	19.9747
14	12.5740	44	82.2962	14	2.1173	44	20.9135
15	13.9583	45	85.6250	15	2.4305	45	21.8750
16	15.4074	46	89.0185	16	2.7654	46	22.8580
17	16.9214	47	92.4768	17	3.1219	47	23.8626
18	18.5000	48	96.0000	18	3.5000	48	24.8888
19	20.1435	49	99.5878	19	3.8997	49	25.9367
20	21.8518	50	104.2407	20	4.3210	50	27.0061
21	23.6250	51	106.9583	21	4.7639	51	28.0972
22	25.4629	52	110.7407	22	5.2284	52	29.2098
23	27.3658	53	114.5878	23	5.7145	53	30.3441
24	29.3333	54	118.5000	24	6.2222	54	31.5000
25	31.3658	55	122.4768	25	6.7516	55	32.6774
26	33.4629	56	126.5185	26	7.3024	56	33.8765
27	35.6250	57	130.6250	27	7.8750	57	35.0972
28	37.8518	58	134.7962	28	8.4691	58	36.3394
29	40.1435	59	139.0319	29	9.0848	59	37.6033
30	42.5000	60	143.3333	30	9.7222	60	38.8888

BASE 24—SLOPE 2 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4814	31	49.3704	1	.0123	31	11.8642
2	1.0370	32	52.1480	2	.0494	32	12.6419
3	1.6666	33	55.0000	3	.1111	33	13.4444
4	2.3704	34	57.9257	4	.1975	34	14.2716
5	3.1480	35	60.9257	5	.3086	35	15.1234
6	4.0000	36	64.0000	6	.4444	36	16.0000
7	4.9257	37	67.1480	7	.6049	37	16.9012
8	5.9257	38	70.3704	8	.7901	38	17.8271
9	7.0000	39	73.6666	9	1.0000	39	18.7777
10	8.1480	40	77.0370	10	1.2346	40	19.7530
11	9.3704	41	80.4814	11	1.4938	41	20.7530
12	10.6666	42	84.0000	12	1.7778	42	21.7777
13	12.0370	43	87.5926	13	2.0864	43	22.8271
14	13.4814	44	91.2590	14	2.4197	44	23.9012
15	15.0000	45	95.0000	15	2.7778	45	25.0000
16	16.5926	46	98.8149	16	3.1605	46	26.1234
17	18.2590	47	102.7036	17	3.5679	47	27.2716
18	20.0000	48	106.6666	18	4.0000	48	28.4444
19	21.8150	49	110.7036	19	4.4568	49	29.6420
20	23.7036	50	115.8149	20	4.9382	50	30.8642
21	25.6666	51	119.0000	21	5.4444	51	32.1111
22	27.7036	52	123.2590	22	5.9753	52	33.3827
23	29.8149	53	127.5926	23	6.5309	53	34.6790
24	32.0000	54	132.0000	24	7.1111	54	36.0000
25	34.2590	55	136.4814	25	7.7160	55	37.3456
26	36.5926	56	141.0370	26	8.3457	56	38.7160
27	39.0000	57	145.6666	27	9.0000	57	40.1111
28	41.4814	58	150.3704	28	9.6790	58	41.5308
29	44.0370	59	155.1480	29	10.3827	59	42.9753
30	46.6666	60	160.0000	30	11.1111	60	44.4444

BASE 24—SLOPE 2½ to 1.

Height.	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4906	31	58.2686	1	.0154	31	14.8302
2	1.0740	32	61.6296	2	.0617	32	15.8015
3	1.7500	33	65.0834	3	.1389	33	16.8055
4	2.5185	34	68.6296	4	.2468	34	17.8395
5	3.3796	35	72.2686	5	.3857	35	18.9043
6	4.3333	36	76.0000	6	.5555	36	20.0000
7	5.3796	37	79.8240	7	.7561	37	21.1265
8	6.5185	38	83.7407	8	.9876	38	22.2839
9	7.7500	39	87.7500	9	1.2500	39	23.4722
10	9.0740	40	91.8518	10	1.5432	40	24.6913
11	10.4906	41	96.0460	11	1.8673	41	25.9413
12	12.0000	42	100.3333	12	2.2222	42	27.2222
13	13.6018	43	104.7131	13	2.6080	43	28.5360
14	15.2962	44	109.1851	14	3.0247	44	29.8765
15	17.0833	45	113.7500	15	3.4722	45	31.2500
16	18.9629	46	118.4074	16	3.9506	46	32.6543
17	20.9349	47	123.1576	17	4.4599	47	34.0895
18	23.0000	48	128.0000	18	5.0000	48	35.5555
19	25.1576	49	132.9349	19	5.5710	49	37.0524
20	27.4074	50	138.9629	20	6.1728	50	38.5802
21	29.7500	51	143.0833	21	6.8055	51	40.1388
22	32.1851	52	148.2962	22	7.4691	52	41.7283
23	34.7131	53	153.6018	23	8.1636	53	43.3487
24	37.3333	54	159.0000	24	8.8889	54	45.0000
25	40.0460	55	164.4908	25	9.6455	55	46.6820
26	42.8518	56	170.0740	26	10.4321	56	48.3950
27	45.7500	57	175.7500	27	11.2500	57	50.1388
28	48.7407	58	181.5185	28	12.0587	58	51.9135
29	51.8240	59	187.3796	29	12.9782	59	53.7191
30	55.0000	60	193.3333	30	13.8889	60	55.5555

(1.)

BASE 24—SLOPE 3 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5000	31	67.1666	1	.0185	31	17.7963
2	1.1111	32	71.1111	2	.0740	32	18.9630
3	1.8333	33	75.1666	3	.1667	33	20.1666
4	2.6666	34	79.3333	4	.2961	34	21.4074
5	3.6111	35	83.6111	5	.4628	35	22.6851
6	4.6666	36	88.0000	6	.6667	36	24.0000
7	5.8333	37	92.5000	7	.9074	37	25.3518
8	7.1111	38	97.1111	8	1.1852	38	26.7407
9	8.5000	39	101.8333	9	1.5000	39	28.1666
10	10.0000	40	106.6666	10	1.8518	40	29.6296
11	11.6111	41	111.6111	11	2.2407	41	31.1296
12	13.3333	42	116.6666	12	2.6667	42	32.6666
13	15.1666	43	121.8333	13	3.1296	43	34.2405
14	17.1111	44	127.1111	14	3.6296	44	35.8518
15	19.1666	45	132.5000	15	4.1667	45	37.5000
16	21.3333	46	138.0000	16	4.7407	46	39.1851
17	23.6111	47	143.6111	17	5.3518	47	40.9074
18	26.0000	48	149.3333	18	6.0000	48	42.6666
19	28.5000	49	155.1666	19	6.6852	49	44.4629
20	31.1111	50	162.1111	20	7.4074	50	46.2963
21	33.8333	51	167.1666	21	8.1667	51	49.1666
22	36.6666	52	173.3333	22	8.9629	52	50.0740
23	39.6111	53	179.6111	23	9.7962	53	52.0185
24	42.6666	54	186.0000	24	10.6667	54	54.0000
25	45.8333	55	192.5000	25	11.5741	55	56.0184
26	49.1111	56	199.1111	26	12.5184	56	58.0640
27	52.5000	57	205.8333	27	13.5000	57	60.1666
28	56.0000	58	212.6666	28	14.5185	58	62.2962
29	59.6111	59	219.6111	29	15.5739	59	64.4629
30	63.3333	60	226.6666	30	16.6667	60	66.6666

BASE 25—SLOPE ¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4676	31	18.8009	1	.0015	31	1.4830
2	.9444	32	19.5555	2	.0062	32	1.5802
3	1.4305	33	20.3194	3	.0139	33	1.6805
4	1.9259	34	21.0925	4	.0246	34	1.7839
5	2.4305	35	21.8750	5	.0385	35	1.8904
6	2.9444	36	22.6666	6	.0555	36	2.0000
7	3.4676	37	23.4676	7	.0756	37	2.1126
8	4.0000	38	24.2777	8	.0988	38	2.2284
9	4.5416	39	25.0972	9	.1250	39	2.3472
10	5.0926	40	25.9259	10	.1543	40	2.4691
11	5.6528	41	26.7639	11	.1867	41	2.5941
12	6.2222	42	27.6111	12	.2222	42	2.7222
13	6.8009	43	28.4676	13	.2608	43	2.8545
14	7.3888	44	29.3333	14	.3025	44	2.9876
15	7.9861	45	30.2083	15	.3472	45	3.1250
16	8.5925	46	31.0925	16	.3951	46	3.2654
17	9.2083	47	31.9861	17	.4460	47	3.4089
18	9.8333	48	32.8888	18	.5000	48	3.5555
19	10.4675	49	33.8009	19	.5571	49	3.7052
20	11.1111	50	34.7222	20	.6173	50	3.8580
21	11.7639	51	35.6528	21	.6805	51	4.0139
22	12.4259	52	36.5926	22	.7469	52	4.1728
23	13.0972	53	37.5416	23	.8163	53	4.3349
24	13.7777	54	38.5000	24	.8889	54	4.5000
25	14.4676	55	39.4676	25	.9647	55	4.6682
26	15.1666	56	40.4444	26	1.0432	56	4.8395
27	15.8750	57	41.4305	27	1.1250	67	5.0139
28	16.5925	58	42.4259	28	1.2099	58	5.1913
29	17.3194	59	43.4305	29	1.2978	59	5.3719
30	18.0555	60	44.4444	30	1.3889	60	5.5555

BASE 25—SLOPE ½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4722	31	23.2500	1	.0031	31	2.9660
2	.9629	32	24.2962	2	.0123	32	3.1605
3	1.4722	33	25.3611	3	.0278	33	3.6111
4	2.0000	34	26.4444	4	.0494	34	3.5679
5	2.5462	35	27.5463	5	.0772	35	3.7808
6	3.1111	36	28.6666	6	.1111	36	4.0000
7	3.6944	37	29.8055	7	.1512	37	4.2253
8	4.2963	38	30.9629	8	.1975	38	4.4568
9	4.9166	39	32.1388	9	.2500	39	4.6944
10	5.5555	40	33.3333	10	.3086	40	4.9383
11	6.2130	41	34.5463	11	.3734	41	5.1883
12	6.8888	42	35.7777	12	.4444	42	5.4444
13	7.5833	43	37.0277	13	.5216	43	5.7076
14	8.2962	44	38.2962	14	.6049	44	5.9753
15	9.0277	45	39.5833	15	.6944	45	6.2500
16	9.7777	46	40.8888	16	.7901	46	6.5308
17	10.5462	47	42.2129	17	.8920	47	6.8179
18	11.3333	48	43.5555	18	1.0000	48	7.1111
19	12.1388	49	44.9166	19	1.1142	49	7.4104
20	12.9629	50	46.2963	20	1.2346	50	7.7160
21	13.8055	51	47.6944	21	1.3611	51	8.0277
22	14.6666	52	49.1111	22	1.4938	52	8.3456
23	15.5462	53	50.5462	23	1.6327	53	8.6697
24	16.4444	54	52.0000	24	1.7778	54	9.0000
25	17.3611	55	53.4722	25	1.9295	55	9.3364
26	18.2962	56	54.9629	26	2.0864	56	9.6790
27	19.2500	57	56.4722	27	2.2500	57	10.0277
28	20.2222	58	58.0000	28	2.4197	58	10.3827
29	21.2129	59	59.5462	29	2.5956	59	10.7438
30	22.2222	60	61.1111	30	2.7778	60	11.1111

BASE 25—SLOPE ¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4768	31	27.6991	1	.0046	31	4.4490
2	.9815	32	29.0370	2	.0185	32	4.7407
3	1.5139	33	30.4028	3	.0416	33	5.0416
4	2.0741	34	31.7962	4	.0740	34	5.3518
5	2.6619	35	33.2176	5	.1157	35	5.6712
6	3.2777	36	34.6666	6	.1667	36	6.0000
7	3.9212	37	36.1434	7	.2268	37	6.3379
8	4.5926	38	37.6481	8	.2963	38	6.6851
9	5.2916	39	39.1805	9	.3750	39	7.0416
10	6.0184	40	40.7407	10	.4630	40	7.4074
11	6.7732	41	42.3288	11	.5602	41	7.7824
12	7.5555	42	43.9444	12	.6667	42	8.1666
13	8.3657	43	45.5879	13	.7824	43	8.5612
14	9.2036	44	47.2592	14	.9074	44	8.9629
15	10.0693	45	48.9583	15	1.0417	45	9.3750
16	10.9629	46	50.6851	16	1.1852	46	9.7962
17	11.8842	47	52.4397	17	1.3379	47	10.2268
18	12.8333	48	54.2222	18	1.5000	48	10.6666
19	13.8101	49	56.0323	19	1.6713	49	11.1157
20	14.8147	50	57.8704	20	1.8518	50	11.5740
21	15.8472	51	59.7361	21	2.0417	51	12.0416
22	16.9074	52	61.6296	22	2.2407	52	12.5185
23	17.9953	53	63.5508	23	2.4491	53	13.0046
24	19.1111	54	65.5000	24	2.6667	54	13.5000
25	20.2546	55	67.4768	25	2.8935	55	14.0046
26	21.4258	56	69.4814	26	3.1296	56	14.5185
27	22.6250	57	71.5139	27	3.3750	57	15.0416
28	23.8518	58	73.5741	28	3.6296	58	15.5740
29	25.1064	59	75.6619	29	3.8935	59	16.1157
30	26.3888	60	77.7777	30	4.1667	60	16.6666

BASE 25—SLOPE 1 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4814	31	32.1481	1	.0062	31	5.9321
2	1.0000	32	33.7777	2	.0247	32	6.3210
3	1.5555	33	35.4444	3	.0555	33	6.7222
4	2.1481	34	37.1481	4	.0988	34	7.1358
5	2.7777	35	38.8888	5	.1543	35	7.5617
6	3.4444	36	40.6666	6	.2222	36	8.0000
7	4.1481	37	42.4814	7	.3025	37	8.4506
8	4.8888	38	44.3333	8	.3951	38	8.9135
9	5.6666	39	46.2222	9	.5000	39	9.3888
10	6.4814	40	48.1481	10	.6173	40	9.8765
11	7.3333	41	50.1111	11	.7469	41	10.3765
12	8.2222	42	52.1111	12	.8889	42	10.8888
13	9.1481	43	54.1481	13	1.0432	43	11.4135
14	10.1111	44	56.2222	14	1.2099	44	11.9506
15	11.1111	45	58.3333	15	1.3889	45	12.5000
16	12.1481	46	60.4814	16	1.5802	46	13.0617
17	13.2222	47	62.6666	17	1.7839	47	13.6358
18	14.3333	48	64.8888	18	2.0000	48	14.2222
19	15.4814	49	67.1481	19	2.2284	49	14.8209
20	16.6666	50	69.4444	20	2.4691	50	15.4321
21	17.8888	51	71.7777	21	2.7222	51	16.0555
22	19.1481	52	74.1481	22	2.9876	52	16.6913
23	20.4444	53	76.5555	23	3.2654	53	17.3395
24	21.7777	54	79.0000	24	3.5555	54	18.0000
25	23.1481	55	81.4814	25	3.8530	55	18.6728
26	24.5555	56	84.0000	26	4.1728	56	19.3580
27	26.0000	57	86.5555	27	4.5000	57	20.0555
28	27.4814	58	89.1481	28	4.8395	58	20.7654
29	29.0000	59	91.7777	29	5.1913	59	21.4876
30	30.5555	60	94.4444	30	5.5555	60	22.2222

BASE 25—SLOPE $1\frac{1}{4}$ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4860	31	36.5973	1	.0077	31	7.4151
2	1.0185	32	38.5185	2	.0309	32	7.9012
3	1.5972	33	40.4861	3	.0694	33	8.4027
4	2.2222	34	42.5000	4	.1234	34	8.9197
5	2.8934	35	44.5601	5	.1928	35	9.4521
6	3.6111	36	46.6666	6	.2778	36	10.0000
7	4.3750	37	48.8192	7	.3781	37	10.5632
8	5.1851	38	51.0185	8	.4938	38	11.1419
9	6.0416	39	53.2368	9	.6250	39	11.7361
10	6.9444	40	55.5555	10	.7716	40	12.3456
11	7.8936	41	57.8935	11	.9336	41	12.9706
12	8.8888	42	60.2777	12	1.1111	42	13.6111
13	9.9305	43	62.7083	13	1.3040	43	14.2680
14	11.0185	44	65.1852	14	1.5123	44	14.9382
15	12.1527	45	67.7083	15	1.7361	45	15.6250
16	13.3333	46	70.2777	16	1.9753	46	16.3271
17	14.5601	47	72.8935	17	2.2299	47	17.0447
18	15.8333	48	75.5555	18	2.5000	48	17.7777
19	17.1527	49	78.2638	19	2.7855	49	18.5262
20	18.5184	50	81.0185	20	3.0864	50	19.2901
21	19.9305	51	83.8192	21	3.4028	51	20.0694
22	21.3888	52	86.6666	22	3.7346	52	20.8641
23	22.8935	53	89.5601	23	4.0818	53	21.6743
24	24.4444	54	92.5000	24	4.4444	54	22.5000
25	26.0416	55	95.4861	25	4.8228	55	23.3410
26	27.6851	56	98.5185	26	5.2160	56	24.1975
27	29.3750	57	101.5973	27	5.6250	57	25.0694
28	31.1111	58	104.7222	28	6.0494	58	25.9567
29	32.8935	59	107.8935	29	6.4891	59	26.8595
30	34.7222	60	111.1111	30	6.9444	60	27.7777

BASE 25—SLOPE 1½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4906	31	41.0464	1	.0092	31	8.8981
2	1.0370	32	43.2592	2	.0370	32	9.4815
3	1.6389	33	45.5278	3	.0833	33	10.0833
4	2.2964	34	47.8518	4	.1480	34	10.7037
5	3.0092	35	50.2314	5	.2313	35	11.3425
6	3.7777	36	52.6666	6	.3333	36	12.0000
7	4.6016	37	55.1572	7	.4537	37	12.6759
8	5.4814	38	57.7037	8	.5926	38	13.3703
9	6.4166	39	60.3055	9	.7500	39	14.0833
10	7.4073	40	62.9629	10	.9259	40	14.8148
11	8.4538	41	65.6759	11	1.1203	41	15.5648
12	9.5555	42	69.4444	12	1.3333	42	16.3333
13	10.7129	43	71.2685	13	1.5648	43	17.1202
14	11.9259	44	74.1481	14	1.8148	44	17.9259
15	13.1944	45	77.0833	15	2.0833	45	18.7500
16	14.5185	46	80.0740	16	2.3704	46	19.5925
17	15.8981	47	83.1202	17	2.6759	47	20.4537
18	17.3333	48	86.2222	18	3.0000	48	21.3333
19	18.8240	49	89.3794	19	3.3426	49	22.2314
20	20.3703	50	92.5926	20	3.7037	50	23.1481
21	21.9722	51	95.8611	21	4.0833	51	24.0833
22	23.6296	52	99.1851	22	4.4815	52	25.0370
23	25.3426	53	102.5647	23	4.8981	53	26.0092
24	27.1111	54	106.0000	24	5.3333	54	27.0000
25	28.9350	55	109.4906	25	5.7869	55	28.0092
26	30.8147	56	113.0370	26	6.2592	56	29.0370
27	32.7500	57	116.6389	27	6.7500	57	30.0833
28	34.7407	58	120.2962	28	7.2592	58	31.1481
29	36.7870	59	124.0092	29	7.7869	59	32.2314
30	38.8888	60	127.7777	30	8.3333	60	33.3333

BASE 25—SLOPE 1¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4952	31	45.4952	1	.0108	31	10.3811
2	1.0555	32	48.0000	2	.0432	32	11.0617
3	1.6806	33	50.5695	3	.0972	33	11.7638
4	2.3704	34	53.2037	4	.1728	34	12.4876
5	3.1250	35	55.9027	5	.2700	35	13.2380
6	3.9444	36	58.6666	6	.3889	36	14.0000
7	4.8284	37	61.4952	7	.5293	37	14.7885
8	5.7777	38	64.3888	8	.6913	38	15.5987
9	6.7916	39	67.3471	9	.8750	39	16.4305
10	7.8702	40	70.3703	10	1.0802	40	17.2839
11	9.0140	41	73.4583	11	1.3071	41	18.1589
12	10.2222	42	77.6111	12	1.5555	42	19.0555
13	11.4952	43	79.8286	13	1.8256	43	19.9747
14	12.8333	44	83.1111	14	2.1173	44	20.9135
15	14.2361	45	86.4583	15	2.4305	45	21.8750
16	15.7037	46	89.8703	16	2.7654	46	22.8580
17	17.2361	47	93.3471	17	3.1219	47	23.8626
18	18.8333	48	96.8888	18	3.5000	48	24.8888
19	20.4952	49	100.4952	19	3.8997	49	25.9367
20	22.2222	50	104.1666	20	4.3210	50	27.0061
21	24.0140	51	107.9027	21	4.7639	51	28.0972
22	25.8702	52	111.7037	22	5.2284	52	29.2098
23	27.7916	53	115.5695	23	5.7145	53	30.3441
24	29.7777	54	119.5000	24	6.2222	54	31.5000
25	31.8284	55	123.4952	25	6.7516	55	32.6774
26	33.9444	56	127.5555	26	7.3024	56	33.8765
27	36.1250	57	131.6806	27	7.8750	57	35.0972
28	38.3704	58	135.8703	28	8.4691	58	36.3394
29	40.6806	59	140.1250	29	9.0848	59	37.6033
30	43.0555	60	144.4444	30	9.7222	60	38.8888

BASE 25—SLOPE 2 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5000	31	49.9444	1	.0123	31	11.8642
2	1.0740	32	52.7407	2	.0494	32	12.6419
3	1.7222	33	55.6111	3	.1111	33	13.4444
4	2.4444	34	58.5555	4	.1975	34	14.2716
5	3.2407	35	61.5740	5	.3086	35	15.1234
6	4.1111	36	64.6666	6	.4444	36	16.0000
7	5.0555	37	67.8333	7	.6049	37	16.9012
8	6.0740	38	71.0740	8	.7901	38	17.8271
9	7.1666	39	74.3888	9	1.0000	39	18.7777
10	8.3333	40	77.7777	10	1.2346	40	19.7530
11	9.5741	41	81.2407	11	1.4938	41	20.7530
12	10.8888	42	85.7777	12	1.7778	42	21.7777
13	12.2777	43	88.3888	13	2.0864	43	22.8271
14	13.7407	44	92.0740	14	2.4197	44	23.9012
15	14.2777	45	95.8333	15	2.7778	45	25.0000
16	16.8888	46	99.6666	16	3.1605	46	26.1234
17	18.5741	47	103.5740	17	3.5679	47	27.2716
18	20.3333	48	107.5555	18	4.0000	48	28.4444
19	22.1666	49	111.6111	19	4.4568	49	29.6420
20	24.0740	50	115.7407	20	4.9382	50	30.8642
21	26.0555	51	119.9444	21	5.4444	51	32.1111
22	28.1111	52	124.2222	22	5.9753	52	33.3827
23	30.2407	53	128.5740	23	6.5309	53	34.6790
24	32.4444	54	133.0000	24	7.1111	54	36.0000
25	34.7222	55	137.5000	25	7.7160	55	37.3456
26	37.0740	56	142.0740	26	8.3457	56	38.7160
27	39.5000	57	146.7222	27	9.0000	57	40.1111
28	42.0000	58	151.4444	28	9.6790	58	41.5308
29	44.5740	59	156.2407	29	10.3827	59	42.9753
30	47.2222	60	161.1111	30	11.1111	60	44.4444

BASE 25—SLOPE 2½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5092	31	58.8425	1	.0154	31	14.8302
2	1.1111	32	62.2222	2	.0617	32	15.8013
3	1.8055	33	65.6944	3	.1389	33	16.8055
4	2.5926	34	69.2592	4	.2468	34	17.8395
5	3.4722	35	72.9166	5	.3857	35	18.9043
6	4.4444	36	76.6666	6	.5555	36	20.0000
7	5.5092	37	80.5092	7	.7561	37	21.1265
8	6.6666	38	84.4444	8	.9876	38	22.2839
9	7.9166	39	88.4722	9	1.2500	39	23.4722
10	9.2592	40	92.5926	10	1.5432	40	24.6913
11	10.6944	41	96.8055	11	1.8673	41	25.9413
12	12.2222	42	101.1111	12	2.2222	42	27.2222
13	13.8425	43	105.5092	13	2.6080	43	28.5360
14	15.5555	44	110.0000	14	3.0247	44	29.8765
15	17.3611	45	114.5833	15	3.4722	45	31.2500
16	19.2592	46	119.2592	16	3.9506	46	32.6543
17	21.2500	47	124.0277	17	4.4599	47	34.0895
18	23.3333	48	128.8888	18	5.0000	48	35.5555
19	25.5092	49	133.8425	19	5.5710	49	37.0524
20	27.7777	50	138.8888	20	6.1728	50	38.5802
21	30.1388	51	144.0277	21	6.8055	51	40.1388
22	32.5926	52	149.2592	22	7.4691	52	41.7283
23	35.1388	53	154.5833	23	8.1636	53	43.3487
24	37.7777	54	160.0000	24	8.8889	54	45.0000
25	40.5092	55	165.5092	25	9.6455	55	46.6820
26	43.3333	56	171.1111	26	10.4321	56	48.3950
27	46.2500	57	176.8055	27	11.2500	57	50.1388
28	49.2592	58	182.5926	28	12.0587	58	51.9135
29	52.3611	59	188.4722	29	12.9782	59	53.7191
30	55.5555	60	194.4444	30	13.8889	60	55.5555

BASE 25—SLOPE 3 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5185	31	67.7407	1	.0185	31	17.7963
2	1.1482	32	71.7037	2	.0740	32	18.9630
3	1.8888	33	75.7777	3	.1667	33	20.1666
4	2.7407	34	79.9629	4	.2963	34	21.4074
5	3.7037	35	84.2592	5	.4628	35	22.6851
6	4.7777	36	88.6666	6	.6667	36	24.0000
7	5.9629	37	93.1850	7	.9074	37	25.3518
8	7.2592	38	97.8148	8	1.1852	38	26.7407
9	8.6666	39	102.5555	9	1.5000	39	28.1666
10	10.1851	40	107.4074	10	1.8518	40	29.6296
11	11.8148	41	112.3703	11	2.2407	41	31.1296
12	13.5555	42	117.4444	12	2.6667	42	32.6666
13	15.4074	43	122.6296	13	3.1296	43	34.2407
14	17.3703	44	127.9258	14	3.6296	44	35.8518
15	19.4444	45	133.3333	15	4.1667	45	37.5000
16	21.6296	46	138.8518	16	4.7407	46	39.1851
17	23.9259	47	144.4814	17	5.3518	47	40.9074
18	26.3333	48	150.2222	18	6.0000	48	42.6666
19	28.8518	49	156.0740	19	6.6852	49	44.4629
20	31.4815	50	162.0370	20	7.4074	50	46.2963
21	34.2222	51	168.1111	21	8.1667	51	49.1666
22	37.0740	52	174.2962	22	8.9629	52	50.0740
23	40.0370	53	180.5926	23	9.7962	53	52.0185
24	43.1111	54	187.0000	24	10.6667	54	54.0000
25	46.2962	55	193.5185	25	11.5741	55	56.0184
26	49.5926	56	200.1481	26	12.5184	56	58.0740
27	53.0000	57	206.8888	27	13.5000	57	60.1666
28	56.5185	58	213.7407	28	14.5185	58	62.2962
29	60.1482	59	220.7037	29	15.5741	59	64.4629
30	63.8888	60	227.7777	30	16.6667	60	66.6666

BASE 26—SLOPE ¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4861	31	19.3750	1	.0015	31	1.4830
2	.9814	32	20.1481	2	.0062	32	1.5802
3	1.4861	33	20.9305	3	.0139	33	1.6805
4	2.0000	34	21.7222	4	.0246	34	1.7839
5	2.5231	35	22.5231	5	.0385	35	1.8904
6	3.0555	36	23.3333	6	.0555	36	2.0000
7	3.5972	37	24.1527	7	.0756	37	2.1126
8	4.1481	38	24.9814	8	.0988	38	2.2284
9	4.7083	39	25.8194	9	.1250	39	2.3472
10	5.2777	40	26.6666	10	.1543	40	2.4691
11	5.8564	41	27.5231	11	.1867	41	2.5941
12	6.4444	42	28.3888	12	.2222	42	2.7222
13	7.0416	43	29.2638	13	.2608	43	2.8545
14	7.6481	44	30.1481	14	.3025	44	2.9876
15	8.2638	45	31.0416	15	.3472	45	3.1250
16	8.8888	46	31.9444	16	.3951	46	3.2654
17	9.5231	47	32.8564	17	.4460	47	3.4089
18	10.1666	48	33.7777	18	.5000	48	3.5555
19	10.8194	49	34.7083	19	.5571	49	3.7052
20	11.4814	50	35.6481	20	.6173	50	3.8580
21	12.1527	51	36.5972	21	.6805	51	4.0139
22	12.8333	52	37.5555	22	.7469	52	4.1728
23	13.5231	53	38.5231	23	.8163	53	4.3349
24	14.2222	54	39.5000	24	.8889	54	4.5000
25	14.9305	55	40.4861	25	.9647	55	4.6682
26	15.6481	56	41.4814	26	1.0432	56	4.8395
27	16.3750	57	42.4861	27	1.1250	57	5.0139
28	17.1111	58	43.5000	28	1.2099	58	5.1913
29	17.8564	59	44.5231	29	1.2978	59	5.3719
30	18.6111	60	45.5555	30	1.3889	60	5.5555

BASE 26—SLOPE ½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4907	31	23.8241	1	.0031	31	2.9660
2	1.0000	32	24.8888	2	.0123	32	3.1605
3	1.5277	33	25.9722	3	.0278	33	3.3611
4	2.0741	34	27.0740	4	.0494	34	3.5679
5	2.6388	35	28.1944	5	.0772	35	3.7808
6	3.2222	36	29.3333	6	.1111	36	4.0000
7	3.8240	37	30.4908	7	.1512	37	4.2253
8	4.4444	38	31.6666	8	.1975	38	4.4568
9	5.0833	39	32.8611	9	.2500	39	4.6944
10	5.7407	40	34.0740	10	.3086	40	4.9383
11	6.4166	41	35.3055	11	.3734	41	5.1883
12	7.1111	42	36.5555	12	.4444	42	5.4444
13	7.8240	43	37.8240	13	.5216	43	5.7067
14	8.5555	44	39.1111	14	.6049	44	5.9753
15	9.3054	45	40.4166	15	.6944	45	6.2500
16	10.0740	46	41.7407	16	.7901	46	6.5308
17	10.8611	47	43.0833	17	.8920	47	6.8179
18	11.6666	48	44.4444	18	1.0000	48	7.1111
19	12.4907	49	45.8240	19	1.1142	49	7.4105
20	13.3333	50	47.2222	20	1.2346	50	7.7160
21	14.1944	51	48.6388	21	1.3611	51	8.0277
22	15.0740	52	50.0740	22	1.4938	52	8.3456
23	15.9722	53	51.5277	23	1.6327	53	8.6697
24	16.8888	54	53.0000	24	1.7778	54	9.0000
25	17.8240	55	54.4907	25	1.9295	55	9.3364
26	18.7777	56	56.0000	26	2.0864	56	9.6790
27	19.7500	57	57.5277	27	2.2500	57	10.0277
28	20.7407	58	59.0740	28	2.4197	58	10.3827
29	21.7500	59	60.6388	29	2.5956	59	10.7438
30	22.7777	60	62.2222	30	2.7778	60	11.1111

BASE 26—SLOPE ¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.4953	31	28.2732	1	.0046	31	4.4490
2	1.0185	32	29.6296	2	.0185	32	4.7407
3	1.5694	33	31.0139	3	.0416	33	5.0416
4	2.1481	34	32.4258	4	.0740	34	5.3518
5	2.7545	35	33.8657	5	.1157	35	5.6712
6	3.3888	36	35.3333	6	.1667	36	6.0000
7	4.0508	37	36.8287	7	.2268	37	6.3379
8	4.7407	38	38.3518	8	.2963	38	6.6851
9	5.4583	39	39.9027	9	.3750	39	7.0416
10	6.2036	40	41.4814	10	.4630	40	7.4074
11	6.9768	41	43.0880	11	.5602	41	7.7824
12	7.7777	42	44.7222	12	.6667	42	8.1666
13	8.6064	43	46.3842	13	.7824	43	8.5602
14	9.4629	44	48.0740	14	.9074	44	8.9629
15	10.3470	45	49.7916	15	1.0417	45	9.3750
16	11.2592	46	51.5370	16	1.1852	46	9.7962
17	12.1990	47	53.3101	17	1.3379	47	10.2268
18	13.1666	48	55.1111	18	1.5000	48	10.6666
19	14.1620	49	56.9397	19	1.6713	49	11.1157
20	15.1851	50	58.7962	20	1.8518	50	11.5740
21	16.2360	51	60.6805	21	2.0417	51	12.0416
22	17.3147	52	62.5926	22	2.2407	52	12.5185
23	18.4213	53	64.5322	23	2.4491	53	13.0046
24	19.5555	54	66.5000	24	2.6667	54	13.5000
25	20.7175	55	68.4952	25	2.8935	55	14.0046
26	21.9073	56	70.5185	26	3.1296	56	14.5185
27	23.1250	57	72.5694	27	3.3750	57	15.0416
28	24.3703	58	74.6481	28	3.6296	58	15.5740
29	25.6435	59	76.7545	29	3.8935	59	16.1157
30	26.9444	60	78.8888	30	4.1667	60	16.6666

BASE 26—SLOPE 1 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5000	31	32.7222	1	.0062	31	5.9321
2	1.0370	32	34.3703	2	.0247	32	6.3210
3	1.6111	33	36.0555	3	.0555	33	6.7222
4	2.2222	34	37.7777	4	.0988	34	7.1358
5	2.8704	35	39.5370	5	.1543	35	7.5617
6	3.5555	36	41.3333	6	.2222	36	8.0000
7	4.2777	37	43.1666	7	.3025	37	8.4506
8	5.0370	38	45.0370	8	.3951	38	8.9135
9	5.8333	39	46.9444	9	.5000	39	9.3888
10	6.6666	40	48.8888	10	.6173	40	9.8765
11	7.5370	41	50.8704	11	.7469	41	10.3765
12	8.4444	42	52.8888	12	.8889	42	10.8888
13	9.3888	43	54.9444	13	1.0432	43	11.4135
14	10.3703	44	57.0370	14	1.2099	44	11.9506
15	11.3888	45	59.1666	15	1.3889	45	12.5000
16	12.4444	46	61.3333	16	1.5802	46	13.0617
17	13.5370	47	63.5370	17	1.7839	47	13.6358
18	14.6666	48	65.7777	18	2.0000	48	14.2222
19	15.8333	49	68.0555	19	2.2284	49	14.8209
20	17.0370	50	70.3703	20	2.4691	50	15.4321
21	18.2777	51	72.7222	21	2.7222	51	16.0555
22	19.5555	52	75.1111	22	2.9876	52	16.6913
23	20.8704	53	77.5370	23	3.2654	53	17.3395
24	22.2222	54	80.0000	24	3.5555	54	18.0000
25	23.6111	55	82.5000	25	3.8580	55	18.6728
26	25.0370	56	85.0370	26	4.1728	56	19.3580
27	26.5000	57	87.6111	27	4.5000	57	20.0555
28	28.0000	58	90.2222	28	4.8395	58	20.7654
29	29.5370	59	92.8704	29	5.1913	59	21.4876
30	31.1111	60	95.5555	30	5.5555	60	22.2222

BASE 26—SLOPE 1¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5046	31	37.1713	1	.0077	31	7.4151
2	1.0555	32	39.1111	2	.0309	32	7.9012
3	1.6528	33	41.0972	3	.0694	33	8.4027
4	2.2963	34	43.1296	4	.1234	34	8.9197
5	2.9859	35	45.2083	5	.1928	35	9.4521
6	3.7222	36	47.3333	6	.2778	36	10.0000
7	4.5045	37	49.5046	7	.3781	37	10.5632
8	5.3333	38	51.7222	8	.4938	38	11.1419
9	6.2083	39	53.9860	9	.6250	39	11.7361
10	7.1296	40	56.2962	10	.7716	40	12.3456
11	8.0972	41	58.6528	11	.9336	41	12.9706
12	9.1111	42	61.0555	12	1.1111	42	13.6111
13	10.1712	43	63.5046	13	1.3040	43	14.2680
14	11.2777	44	66.0000	14	1.5123	44	14.9382
15	12.4304	45	68.5416	15	1.7361	45	15.6250
16	13.6296	46	71.1296	16	1.9753	46	16.3271
17	14.8750	47	73.7639	17	2.2299	47	17.0447
18	16.1666	48	76.4444	18	2.5000	48	17.7777
19	17.5046	49	79.1712	19	2.7855	49	18.5262
20	18.8888	50	81.9444	20	3.0864	50	19.2901
21	20.3195	51	84.7639	21	3.4028	51	20.0694
22	21.7962	52	87.6296	22	3.7346	52	20.8641
23	23.3195	53	90.5416	23	4.0818	53	21.6743
24	24.8888	54	93.5000	24	4.4444	54	22.5000
25	26.5046	55	96.5046	25	4.8228	55	23.3410
26	28.1666	56	99.5555	26	5.2160	56	24.1975
27	29.8750	57	102.6528	27	5.6250	57	25.0694
28	31.6296	58	105.7962	28	6.0494	58	25.9567
29	33.4305	59	108.9860	29	6.4891	59	26.8595
30	35.2777	60	112.2222	30	6.9444	60	27.7777

BASE 26—SLOPE 1½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5092	31	41.6204	1	.0092	31	8.8981
2	1.0740	32	43.8518	2	.0370	32	9.4815
3	1.6944	33	46.1389	3	.0833	33	10.0833
4	2.3704	34	48.4815	4	.1480	34	10.7037
5	3.1016	35	50.8796	5	.2313	35	11.3425
6	3.8888	36	53.3333	6	.3333	36	12.0000
7	4.7314	37	55.8424	7	.4537	37	12.6759
8	5.6296	38	58.4074	8	.5926	38	13.3703
9	6.5833	39	61.0277	9	.7500	39	14.0833
10	7.5926	40	63.7037	10	.9259	40	14.8148
11	8.6574	41	66.4352	11	1.1203	41	15.5648
12	9.7777	42	70.2222	12	1.3333	42	16.3333
13	10.9536	43	72.0648	13	1.5648	43	17.1202
14	12.1851	44	74.9629	14	1.8148	44	17.9259
15	13.4720	45	77.9166	15	2.0833	45	18.7500
16	14.8148	46	80.9260	16	2.3704	46	19.5925
17	16.2129	47	83.9907	17	2.6759	47	20.4537
18	17.6666	48	87.1111	18	3.0000	48	21.3333
19	19.1759	49	90.2870	19	3.3426	49	22.2314
20	20.7407	50	93.5185	20	3.7037	50	23.1481
21	22.3611	51	96.8055	21	4.0833	51	24.0833
22	24.0370	52	100.1481	22	4.4815	52	25.0370
23	25.7686	53	103.5462	23	4.8981	53	26.0092
24	27.5555	54	107.0000	24	5.3333	54	27.0000
25	29.3981	55	110.5092	25	5.7869	55	28.0092
26	31.2962	56	114.0740	26	6.2592	56	29.0370
27	33.2500	57	117.6945	27	6.7500	57	30.0833
28	35.2592	58	121.3704	28	7.2592	58	31.1481
29	37.3240	59	125.1017	29	7.7869	59	32.2314
30	39.4444	60	128.8888	30	8.3333	60	33.3333

BASE 26—SLOPE 1¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5138	31	46.0694	1	.0108	31	10.3811
2	1.0926	32	48.5926	2	.0432	32	11.0617
3	1.7361	33	51.1805	3	.0972	33	11.7638
4	2.4444	34	53.8333	4	.1728	34	12.4876
5	3.2175	35	56.5509	5	.2700	35	13.2330
6	4.0555	36	59.3333	6	.3889	36	14.0000
7	4.9582	37	62.1805	7	.5293	37	14.7885
8	5.9259	38	65.0926	8	.6913	38	15.5987
9	6.9582	39	68.0694	9	.8750	39	16.4305
10	8.0555	40	71.1111	10	1.0802	40	17.2839
11	9.2175	41	74.2176	11	1.3071	41	18.1589
12	10.4444	42	78.3888	12	1.5555	42	19.0555
13	11.7361	43	80.6250	13	1.8256	43	19.9747
14	13.0926	44	83.9258	14	2.1173	44	20.9135
15	14.5138	45	87.2916	15	2.4305	45	21.8750
16	16.0000	46	90.7222	16	2.7654	46	22.8580
17	17.5508	47	94.2177	17	3.1219	47	23.8626
18	19.1666	48	97.7777	18	3.5000	48	24.8888
19	20.8472	49	101.4026	19	3.8997	49	25.9367
20	22.5926	50	105.0926	20	4.3210	50	27.0061
21	24.4026	51	108.8472	21	4.7639	51	28.0972
22	26.2777	52	112.6666	22	5.2284	52	29.2098
23	28.2177	53	116.5508	23	5.7145	53	30.3441
24	30.2222	54	120.5000	24	6.2222	54	31.5000
25	32.2916	55	124.5138	25	6.7516	55	32.6774
26	34.4258	56	128.5926	26	7.3024	56	33.8765
27	36.6250	57	132.7361	27	7.8750	57	35.0972
28	38.8888	58	136.9444	28	8.4691	58	36.3394
29	41.2176	59	141.2174	29	9.0848	59	37.6033
30	43.6111	60	145.5555	30	9.7222	60	38.8888

BASE 26—SLOPE 2 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5185	31	50.5185	1	.0123	31	11.8642
2	1.1111	32	53.3333	2	.0494	32	12.6419
3	1.7777	33	56.2222	3	.1111	33	13.4444
4	2.5185	34	59.1851	4	.1975	34	14.2716
5	3.3333	35	62.2222	5	.3086	35	15.1234
6	4.2222	36	65.3333	6	.4444	36	16.0000
7	5.1851	37	68.5185	7	.6049	37	16.9012
8	6.2222	38	71.7777	8	.7901	38	17.8271
9	7.3333	39	75.1111	9	1.0000	39	18.7777
10	8.5185	40	78.5185	10	1.2346	40	19.7530
11	9.7777	41	82.0000	11	1.4938	41	20.7530
12	11.1111	42	86.5555	12	1.7778	42	21.7777
13	12.5185	43	89.1851	13	2.0864	43	22.8271
14	14.0000	44	92.8888	14	2.4197	44	23.9012
15	15.5555	45	96.6666	15	2.7778	45	25.0000
16	17.1851	46	100.5185	16	3.1605	46	26.1234
17	18.8888	47	104.4444	17	3.5679	47	27.2716
18	20.6666	48	108.4444	18	4.0000	48	28.4444
19	22.5185	49	112.5185	19	4.4568	49	29.6420
20	24.4444	50	116.6666	20	4.9382	50	30.8642
21	26.4444	51	120.8888	21	5.4444	51	32.1111
22	28.5185	52	125.1851	22	5.9753	52	33.3827
23	30.6666	53	129.5555	23	6.5309	53	34.6790
24	32.8888	54	134.0000	24	7.1111	54	36.0000
25	35.1851	55	138.5185	25	7.7160	55	37.3456
26	37.5555	56	143.1111	26	8.3457	56	38.7160
27	40.0000	57	147.7777	27	9.0000	57	40.1111
28	42.5185	58	152.5185	28	9.6790	58	41.5308
29	45.1111	59	157.3333	29	10.3827	59	42.9753
30	47.7777	60	162.2222	30	11.1111	60	44.4444

BASE 26—SLOPE 2½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5277	31	59.4166	1	.0154	31	14.8302
2	1.1482	32	62.8148	2	.0617	32	15.8015
3	1.8611	33	66.3055	3	.1389	33	16.8055
4	2.6666	34	69.8888	4	.2468	34	17.8395
5	3.5648	35	73.5648	5	.3857	35	18.9043
6	4.5555	36	77.3333	6	.5555	36	20.0000
7	5.6388	37	81.1944	7	.7561	37	21.1265
8	6.8148	38	85.1482	8	.9876	38	22.2839
9	8.0833	39	89.1944	9	1.2500	39	23.4722
10	9.4444	40	93.3333	10	1.5432	40	24.6913
11	10.8981	41	97.5648	11	1.8673	41	25.9413
12	12.4444	42	101.8888	12	2.2222	42	27.2222
13	14.0833	43	106.3055	13	2.6080	43	28.5360
14	15.8148	44	110.8148	14	3.0247	44	29.8765
15	17.6388	45	115.4166	15	3.4722	45	31.2500
16	19.5555	46	120.1111	16	3.9506	46	32.6543
17	21.5648	47	124.8981	17	4.4599	47	34.0895
18	23.6666	48	129.7777	18	5.0000	48	35.5555
19	25.8611	49	134.7500	19	5.5710	49	37.0524
20	28.1482	50	139.8148	20	6.1728	50	38.5802
21	30.5277	51	144.9722	21	6.8055	51	40.1388
22	33.0000	52	150.2222	22	7.4691	52	41.7283
23	35.5648	53	155.5648	23	8.1636	53	43.3487
24	38.2222	54	161.0000	24	8.8889	54	45.0000
25	40.9722	55	166.5277	25	9.6455	55	46.6820
26	43.8148	56	172.1482	26	10.4321	56	48.3950
27	46.7500	57	177.8611	27	11.2500	57	50.1388
28	49.7777	58	183.6666	28	12.0587	58	51.9135
29	52.8981	59	189.5648	29	12.9782	59	53.7191
30	56.1111	60	195.5555	30	13.8889	60	55.5555

BASE 26—SLOPE 3 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5370	31	68.3148	1	.0185	31	17.7963
2	1.1852	32	72.2962	2	.0740	32	18.9630
3	1.9444	33	76.3888	3	.1667	33	20.1666
4	2.8148	34	80.5926	4	.2963	34	21.4074
5	3.7962	35	84.9074	5	.4628	35	22.6851
6	4.8888	36	89.3333	6	.6667	36	24.0000
7	6.0926	37	93.8703	7	.9074	37	25.3518
8	7.4074	38	98.5186	8	1.1852	38	26.7407
9	8.8333	39	103.2777	9	1.5000	39	28.1666
10	10.3703	40	108.1481	10	1.8518	40	29.6296
11	12.0185	41	113.1296	11	2.2407	41	31.1296
12	13.7777	42	118.2222	12	2.6667	42	32.6666
13	15.6482	43	123.4259	13	3.1296	43	34.2407
14	17.6296	44	128.7407	14	3.6296	44	35.8518
15	19.7222	45	134.1666	15	4.1667	45	37.5000
16	21.9259	46	139.7037	16	4.7407	46	39.1851
17	24.2407	47	145.3517	17	5.3518	47	40.9078
18	26.6666	48	151.1111	18	6.0000	48	42.6666
19	29.2037	49	156.9814	19	6.6852	49	44.4629
20	31.8518	50	162.9630	20	7.4074	50	46.2963
21	34.6111	51	169.0555	21	8.1667	51	49.1666
22	37.4815	52	175.2592	22	8.9629	52	50.0740
23	40.4630	53	181.5740	23	9.7962	53	52.0185
24	43.5555	54	188.0000	24	10.6667	54	54.0000
25	46.7592	55	194.5370	25	11.5741	55	56.0184
26	50.0740	56	201.1851	26	12.5184	56	58.0740
27	53.5000	57	207.9444	27	13.5000	57	60.1666
28	57.0370	58	214.8148	28	14.5185	58	62.2962
29	60.6851	59	221.7962	29	15.5741	59	64.4629
30	64.4444	60	228.8888	30	16.6667	60	66.6666

BASE 27—SLOPE ¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5046	31	19.9490	1	.0015	31	1.4830
2	1.0185	32	20.7407	2	.0062	32	1.5802
3	1.5416	33	21.5416	3	.0139	33	1.6805
4	2.0740	34	22.3518	4	.0246	34	1.7839
5	2.6157	35	23.1712	5	.0385	35	1.8904
6	3.1666	36	24.0000	6	.0555	36	2.0000
7	3.7268	37	24.8379	7	.0756	37	2.1126
8	4.2962	38	25.6851	8	.0988	38	2.2284
9	4.8750	39	26.5416	9	.1250	39	2.3472
10	5.4629	40	27.4074	10	.1543	40	2.4691
11	6.0601	41	28.2824	11	.1867	41	2.5941
12	6.6666	42	29.1666	12	.2222	42	2.7222
13	7.2824	43	30.0601	13	.2608	43	2.8545
14	7.9074	44	30.9629	14	.3025	44	2.9876
15	8.5416	45	31.8750	15	.3472	45	3.1250
16	9.1851	46	32.7962	16	.3951	46	3.2654
17	9.8379	47	33.7268	17	.4460	47	3.4089
18	10.5000	48	34.6666	18	.5000	48	3.5555
19	11.1712	49	35.6157	19	.5571	49	3.7052
20	11.8518	50	36.5740	20	.6173	50	3.8580
21	12.5416	51	37.5416	21	.6805	51	4.0139
22	13.2407	52	38.5185	22	.7469	52	4.1728
23	13.9490	53	39.5046	23	.8163	53	4.3349
24	14.6666	54	40.5000	24	.8889	54	4.5000
25	15.3935	55	41.5046	25	.9647	55	4.6682
26	16.1296	56	42.5185	26	1.0432	56	4.8395
27	16.8750	57	43.5416	27	1.1250	67	5.0139
28	17.6296	58	44.5740	28	1.2099	58	5.1913
29	18.3935	59	45.6157	29	1.2978	59	5.3719
30	19.1666	60	46.6666	30	1.3889	60	5.5555

BASE 27—SLOPE ½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5092	31	24.3981	1	.0031	31	2.9660
2	1.0370	32	25.4814	2	.0123	32	3.3611
3	1.5833	33	26.5833	3	.0278	33	3.6111
4	2.1481	34	27.7037	4	.0494	34	3.5679
5	2.7314	35	28.8425	5	.0772	35	3.7808
6	3.3333	36	30.0000	6	.1111	36	4.0000
7	3.9536	37	31.1758	7	.1512	37	4.2253
8	4.5926	38	32.3703	8	.1975	38	4.4568
9	5.2500	39	33.5833	9	.2500	39	4.6944
10	5.9258	40	34.8148	10	.3086	40	4.9383
11	6.6203	41	36.0648	11	.3734	41	5.1883
12	7.3333	42	37.3333	12	.4444	42	5.4444
13	8.0648	43	38.6203	13	.5216	43	5.7076
14	8.8148	44	39.9258	14	.6049	44	5.9753
15	9.5833	45	41.2500	15	.6944	45	6.2500
16	10.3703	46	42.5926	16	.7901	46	6.5308
17	11.1758	47	43.9536	17	.8920	47	6.8179
18	12.0000	48	45.3333	18	1.0000	48	7.1111
19	12.8425	49	46.7314	19	1.1142	49	7.4105
20	13.7037	50	48.1481	20	1.2346	50	7.7160
21	14.5833	51	49.5833	21	1.3611	51	8.0277
22	15.4814	52	51.0370	22	1.4938	52	8.3456
23	16.3981	53	52.5092	23	1.6327	53	8.6697
24	17.3333	54	54.0000	24	1.7778	54	9.0000
25	18.2870	55	55.5092	25	1.9295	55	9.3364
26	19.2592	56	57.0370	26	2.0864	56	9.6790
27	20.2500	57	58.5833	27	2.2500	57	10.0277
28	21.2592	58	60.1481	28	2.4197	58	10.3827
29	22.2870	59	61.7314	29	2.5956	59	10.7438
30	23.3333	60	63.3333	30	2.7778	60	11.1111

BASE 27—SLOPE ¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5138	31	28.8470	1	.0046	31	4.4490
2	1.0555	32	30.2222	2	.0185	32	4.7407
3	1.6250	33	31.6250	3	.0416	33	5.0416
4	2.2222	34	33.0555	4	.0740	34	5.3518
5	2.8472	35	34.5138	5	.1157	35	5.6712
6	3.5000	36	36.0000	6	.1667	36	6.0000
7	4.1804	37	37.5138	7	.2268	37	6.3379
8	4.8888	38	39.0555	8	.2963	38	6.6851
9	5.6250	39	40.6250	9	.3750	39	7.0416
10	6.3888	40	42.2222	10	.4630	40	7.4074
11	7.1805	41	43.8472	11	.5602	41	7.7824
12	8.0000	42	45.5000	12	.6667	42	8.1666
13	8.8472	43	47.1805	13	.7824	43	8.5612
14	9.7222	44	48.8888	14	.9074	44	8.9629
15	10.6250	45	50.6250	15	1.0417	45	9.3750
16	11.5555	46	52.3888	16	1.1852	46	9.7962
17	12.5138	47	54.1805	17	1.3379	47	10.2268
18	13.5000	48	56.0000	18	1.5000	48	10.6666
19	14.5138	49	57.8472	19	1.6713	49	11.1157
20	15.5555	50	59.7222	20	1.8518	50	11.5740
21	16.6250	51	61.6250	21	2.0417	51	12.0416
22	17.7222	52	63.5555	22	2.2407	52	12.5185
23	18.8472	53	65.5138	23	2.4491	53	13.0046
24	20.0000	54	67.5000	24	2.6667	54	13.5000
25	21.1805	55	69.5138	25	2.8935	55	14.0046
26	22.3888	56	71.5555	26	3.1296	56	14.5185
27	23.6250	57	73.6250	27	3.3750	57	15.0416
28	24.8888	58	75.7222	28	3.6296	58	15.5740
29	26.1804	59	77.8472	29	3.8935	59	16.1157
30	27.5000	60	80.0000	30	4.1667	60	16.6666

BASE 27—SLOPE 1 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5184	31	33.2962	1	.0062	31	5.9321
2	1.0740	32	34.9629	2	.0247	32	6.3210
3	1.6666	33	36.6666	3	.0555	33	6.7222
4	2.2962	34	38.4074	4	.0988	34	7.1358
5	2.9629	35	40.1851	5	.1543	35	7.5617
6	3.6666	36	42.0000	6	.2222	36	8.0000
7	4.4074	37	43.8518	7	.3025	37	8.4506
8	5.1851	38	45.7407	8	.3951	38	8.9135
9	6.0000	39	47.6666	9	.5000	39	9.3888
10	6.8518	40	49.6296	10	.6173	40	9.8765
11	7.7407	41	51.6296	11	.7469	41	10.3765
12	8.6666	42	53.6666	12	.8889	42	10.8888
13	9.6296	43	55.7407	13	1.0432	43	11.4135
14	10.6296	44	57.8518	14	1.2099	44	11.9506
15	11.6666	45	60.0000	15	1.3889	45	12.5000
16	12.7407	46	62.1851	16	1.5802	46	13.0617
17	13.8518	47	64.4074	17	1.7839	47	13.6358
18	15.0000	48	66.6666	18	2.0000	48	14.2222
19	16.1851	49	68.9629	19	2.2284	49	14.8209
20	17.4074	50	71.2962	20	2.4691	50	15.4321
21	18.6666	51	73.6666	21	2.7222	51	16.0555
22	19.9629	52	76.0740	22	2.9876	52	16.6913
23	21.2962	53	78.5184	23	3.2654	53	17.3395
24	22.6666	54	81.0000	24	3.5555	54	18.0000
25	24.0740	55	83.5184	25	3.8530	55	18.6728
26	25.5184	56	86.0740	26	4.1728	56	19.3580
27	27.0000	57	88.6666	27	4.5000	57	20.0555
28	28.5184	58	91.2962	28	4.8395	58	20.7654
29	30.0740	59	93.9629	29	5.1913	59	21.4876
30	31.6666	60	96.6666	30	5.5555	60	22.2222

BASE 27—SLOPE 1¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5230	31	37.7453	1	.0077	31	7.4151
2	1.0926	32	39.7036	2	.0309	32	7.9012
3	1.7083	33	41.7083	3	.0694	33	8.4027
4	2.3703	34	43.7592	4	.1234	34	8.9197
5	3.0788	35	45.8564	5	.1928	35	9.4521
6	3.8333	36	48.0000	6	.2778	36	10.0000
7	4.6342	37	50.1897	7	.3781	37	10.5632
8	5.4814	38	52.4259	8	.4938	38	11.1419
9	6.3750	39	54.7083	9	.6250	39	11.7361
10	7.3148	40	57.0370	10	.7716	40	12.3456
11	8.3009	41	59.4120	11	.9336	41	12.9706
12	9.3333	42	61.8333	12	1.1111	42	13.6111
13	10.4120	43	64.3009	13	1.3040	43	14.2680
14	11.5370	44	66.8147	14	1.5123	44	14.9382
15	12.7082	45	69.3750	15	1.7361	45	15.6250
16	13.9259	46	71.9814	16	1.9753	46	16.3271
17	15.1897	47	74.6342	17	2.2299	47	17.0447
18	16.5000	48	77.3333	18	2.5000	48	17.7777
19	17.8564	49	80.0788	19	2.7855	49	18.5262
20	19.2592	50	82.8703	20	3.0864	50	19.2901
21	20.7083	51	85.7083	21	3.4028	51	20.0694
22	22.2036	52	88.5926	22	3.7346	52	20.8641
23	23.7453	53	91.5230	23	4.0818	53	21.6743
24	25.3333	54	94.5000	24	4.4444	54	22.5000
25	26.9675	55	97.5230	25	4.8228	55	23.3410
26	28.6480	56	100.5926	26	5.2160	56	24.1975
27	30.3750	57	103.7083	27	5.6250	57	25.0694
28	32.1481	58	106.8703	28	6.0494	58	25.9567
29	33.9675	59	110.0788	29	6.4891	59	26.8595
30	35.8333	60	113.3333	30	6.9444	60	27.7777

BASE 27—SLOPE 1½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5277	31	42.1944	1	.0092	31	8.8981
2	1.1111	32	44.4444	2	.0370	32	9.4815
3	1.7500	33	46.7500	3	.0833	33	10.0833
4	2.4444	34	49.1111	4	.1480	34	10.7037
5	3.1944	35	51.5277	5	.2313	35	11.3425
6	4.0000	36	54.0000	6	.3333	36	12.0000
7	4.8610	37	56.5277	7	.4537	37	12.6759
8	5.7777	38	59.1111	8	.5926	38	13.3703
9	6.7500	39	61.7500	9	.7500	39	14.0833
10	7.7777	40	64.4444	10	.9259	40	14.8148
11	8.8610	41	67.1944	11	1.1203	41	15.5648
12	10.0000	42	70.0000	12	1.3333	42	16.3333
13	11.1944	43	72.8610	13	1.5648	43	17.1202
14	12.4444	44	75.7777	14	1.8148	44	17.9259
15	13.7500	45	78.7500	15	2.0833	45	18.7500
16	15.1111	46	81.7777	16	2.3704	46	19.5925
17	16.5277	47	84.8610	17	2.6759	47	20.4537
18	18.0000	48	88.0000	18	3.0000	48	21.3333
19	19.5277	49	91.1944	19	3.3426	49	22.2314
20	21.1111	50	94.4444	20	3.7037	50	23.1481
21	22.7500	51	97.7500	21	4.0833	51	24.0833
22	24.4444	52	101.1111	22	4.4815	52	25.0370
23	26.1944	53	104.5277	23	4.8981	53	26.0092
24	28.0000	54	108.0000	24	5.3333	54	27.0000
25	29.8610	55	111.5277	25	5.7869	55	28.0092
26	31.7777	56	115.1111	26	6.2592	56	29.0370
27	33.7500	57	118.7500	27	6.7500	57	30.0833
28	35.7777	58	122.4444	28	7.2592	58	31.1481
29	37.8610	59	126.1944	29	7.7869	59	32.2314
30	40.0000	60	130.0000	30	8.3333	60	33.3333

BASE 27—SLOPE 1¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5323	31	46.6435	1	.0108	31	10.3811
2	1.1296	32	49.1851	2	.0432	32	11.0617
3	1.7916	33	51.7916	3	.0972	33	11.7638
4	2.5185	34	54.4629	4	.1728	34	12.4876
5	3.3101	35	57.1990	5	.2700	35	13.2330
6	4.1666	36	60.0000	6	.3889	36	14.0000
7	5.0878	37	62.8656	7	.5293	37	14.7885
8	6.0740	38	65.7962	8	.6913	38	15.5987
9	7.1250	39	68.7916	9	.8750	39	16.4305
10	8.2406	40	71.8518	10	1.0802	40	17.2839
11	9.4213	41	74.9768	11	1.3071	41	18.1589
12	10.6666	42	78.1666	12	1.5555	42	19.0555
13	11.9768	43	81.4212	13	1.8256	43	19.9747
14	13.3518	44	84.7407	14	2.1173	44	20.9135
15	14.7916	45	88.1250	15	2.4305	45	21.8750
16	16.2962	46	91.5740	16	2.7654	46	22.8580
17	17.8656	47	95.0878	17	3.1219	47	23.8626
18	19.5000	48	98.6666	18	3.5000	48	24.8888
19	21.1990	49	102.3101	19	3.8997	49	25.9367
20	22.9629	50	106.0185	20	4.3210	50	27.0061
21	24.7916	51	109.7916	21	4.7639	51	28.0972
22	26.6851	52	113.6296	22	5.2284	52	29.2098
23	28.6435	53	117.5323	23	5.7145	53	30.3441
24	30.6666	54	121.5000	24	6.2222	54	31.5000
25	32.7545	55	125.5323	25	6.7516	55	32.6774
26	34.9073	56	129.6296	26	7.3024	56	33.8765
27	37.1250	57	133.7916	27	7.8750	57	35.0972
28	39.4073	58	138.0185	28	8.4691	58	36.3394
29	41.7545	59	142.3101	29	9.0848	59	37.6033
30	44.1666	60	146.6666	30	9.7222	60	38.8888

BASE 27—SLOPE 2 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5370	31	51.0926	1	.0123	31	11.8642
2	1.1481	32	53.9258	2	.0494	32	12.6419
3	1.8333	33	56.8333	3	.1111	33	13.4444
4	2.5926	34	59.8147	4	.1975	34	14.2716
5	3.4258	35	62.8703	5	.3086	35	15.1234
6	4.3333	36	66.0000	6	.4444	36	16.0000
7	5.3148	37	69.2037	7	.6049	37	16.9012
8	6.3703	38	72.4814	8	.7901	38	17.8271
9	7.5000	39	75.8333	9	1.0000	39	18.7777
10	8.7037	40	79.2592	10	1.2346	40	19.7530
11	9.9815	41	82.7592	11	1.4938	41	20.7530
12	11.3333	42	86.3333	12	1.7778	42	21.7777
13	12.7592	43	89.9814	13	2.0864	43	22.8271
14	14.2592	44	93.7037	14	2.4197	44	23.9012
15	15.8333	45	97.5000	15	2.7778	45	25.0000
16	17.4815	46	101.3703	16	3.1605	46	26.1234
17	19.2037	47	105.3147	17	3.5679	47	27.2716
18	21.0000	48	109.3333	18	4.0000	48	28.4444
19	22.8703	49	113.4258	19	4.4568	49	29.6420
20	24.8148	50	117.5926	20	4.9382	50	30.8642
21	26.8333	51	121.8333	21	5.4444	51	32.1111
22	28 9258	52	126.1480	22	5.9753	52	33.3827
23	31.0926	53	130.5370	23	6.5309	53	34.6790
24	33.3333	54	135.0000	24	7.1111	54	36.0000
25	36.6480	55	139.5370	25	7.7160	55	37.3456
26	38.0370	56	144.1480	26	8.3457	56	38.7160
27	40.5000	57	148.8333	27	9.0000	57	40.1111
28	43.0370	58	153.5926	28	9.6790	58	41.5308
29	45.6480	59	158.4258	29	10.3827	59	42.9753
30	48.3333	60	163.3333	30	11.1111	60	44.4444

BASE 27—SLOPE 2½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5462	31	59.9908	1	.0154	31	14.8302
2	1.1851	32	63.4073	2	.0617	32	15.8013
3	1.9166	33	66.9166	3	.1389	33	16.8055
4	2.7408	34	70.5185	4	.2468	34	17.8395
5	3.6573	35	74.2129	5	.3857	35	18.9043
6	4.6666	36	78.0000	6	.5555	36	20.0000
7	5.7686	37	81.8796	7	.7561	37	21.1265
8	6.9629	38	85.8519	8	.9876	38	22.2839
9	8.2500	39	89.9167	9	1.2500	39	23.4722
10	9.6296	40	94.0740	10	1.5432	40	24.6913
11	11.1018	41	98.3240	11	1.8673	41	25.9413
12	12.6666	42	102.6666	12	2.2222	42	27.2222
13	14.3240	43	107.1018	13	2.6080	43	28.5360
14	16.0740	44	111.6296	14	3.0247	44	29.8765
15	17.9167	45	116.2500	15	3.4722	45	31.2500
16	19.8519	46	120.9629	16	3.9506	46	32.6543
17	21.8796	47	125.7686	17	4.4599	47	34.0895
18	24.0000	48	130.6666	18	5.0000	48	35.5555
19	26.2129	49	135.6573	19	5.5710	49	37.0524
20	28.5185	50	140.7408	20	6.1728	50	38.5802
21	30.9166	51	145.9166	21	6.8055	51	40.1388
22	33.4073	52	151.1851	22	7.4691	52	41.7283
23	35.9908	53	156.5462	23	8.1636	53	43.3487
24	38.6666	54	162.0000	24	8.8889	54	45.0000
25	42.4352	55	167.5462	25	9.6455	55	46.6820
26	44.2962	56	173.1851	26	10.4321	56	48.3950
27	47.2500	57	178.9166	27	11.2500	57	50.1388
28	50.2962	58	184.7408	28	12.0587	58	51.9135
29	53.4352	59	190.6573	29	12.9782	59	53.7191
30	56.6666	60	196.6666	30	13.8889	60	55.5555

BASE 27—SLOPE 3 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5555	31	68.8888	1	.0185	31	17.7963
2	1.2222	32	72.8888	2	.0740	32	18.9630
3	2.0000	33	77.0000	3	.1667	33	20.1666
4	2.8888	34	81.2222	4	.2963	34	21.4074
5	3.8888	35	85.5555	5	.4628	35	22.6851
6	5.0000	36	90.0000	6	.6667	36	24.0000
7	6.2222	37	94.5555	7	.9074	37	25.3518
8	7.5555	38	99.2222	8	1.1852	38	26.7407
9	9.0000	39	104.0000	9	1.5000	39	28.1666
10	10.5555	40	108.8888	10	1.8518	40	29.6296
11	12.2222	41	113.8888	11	2.2407	41	31.1296
12	14.0000	42	119.0000	12	2.6667	42	32.6666
13	15.8888	43	124.2222	13	3.1296	43	34.2407
14	17.8888	44	129.5555	14	3.6296	44	35.8518
15	20.0000	45	135.0000	15	4.1667	45	37.5000
16	22.2222	46	140.5555	16	4.7407	46	39.1851
17	24.5555	47	146.2222	17	5.3518	47	40.9074
18	27.0000	48	152.0000	18	6.0000	48	42.6666
19	29.5555	49	157.8888	19	6.6852	49	44.4629
20	32.2222	50	163.8888	20	7.4074	50	46.2963
21	35.0000	51	170.0000	21	8.1667	51	49.1666
22	37.8888	52	176.2222	22	8.9629	52	50.0740
23	40.8888	53	182.5555	23	9.7962	53	52.0185
24	44.0000	54	189.0000	24	10.6667	54	54.0000
25	48.2222	55	195.5555	25	11.5741	55	56.0184
26	50.5555	56	202.2222	26	12.5184	56	58.0740
27	54.0000	57	209.0000	27	13.5000	57	60.1666
28	57.5555	58	215.8888	28	14.5185	58	62.2962
29	61.2222	59	222.8888	29	15.5741	59	64.4629
30	65.0000	60	230.0000	30	16.6667	60	66.6666

BASE 28—SLOPE ¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5231	31	20.5231	1	.0015	31	1.4830
2	1.0555	32	21.3333	2	.0062	32	1.5802
3	1.5972	33	22.1527	3	.0139	33	1.6805
4	2.1481	34	22.9814	4	.0246	34	1.7839
5	2.7083	35	23.8194	5	.0385	35	1.8904
6	3.2777	36	24.6666	6	.0555	36	2.0000
7	3.8564	37	25.5231	7	.0756	37	2.1126
8	4.4444	38	26.3888	8	.0988	38	2.2284
9	5.0416	39	27.2639	9	.1250	39	2.3472
10	5.6481	40	28.1481	10	.1543	40	2.4691
11	6.2639	41	29.0416	11	.1867	41	2.5941
12	6.8888	42	29.9444	12	.2222	42	2.7222
13	7.5231	43	30.8564	13	.2608	43	2.8545
14	8.1666	44	31.7777	14	.3025	44	2.9876
15	8.8194	45	32.7083	15	.3472	45	3.1250
16	9.4814	46	33.6481	16	.3951	46	3.2654
17	10.1527	47	34.5972	17	.4460	47	3.4089
18	10.8333	48	35.5555	18	.5000	48	3.5555
19	11.5231	49	36.5231	19	.5571	49	3.7052
20	12.2222	50	37.5000	20	.6173	50	3.8580
21	12.9305	51	38.4861	21	.6805	51	4.0139
22	13.6481	52	39.4814	22	.7469	52	4.1728
23	14.3750	53	40.4861	23	.8163	53	4.3349
24	15.1111	54	41.5000	24	.8889	54	4.5000
25	15.8564	55	42.5231	25	.9647	55	4.6682
26	16.6111	56	43.5555	26	1.0432	56	4.8395
27	17.3750	57	44.5972	27	1.1250	57	5.0139
28	18.1481	58	45.6481	28	1.2099	58	5.1913
29	18.9305	59	46.7083	29	1.2978	59	5.3719
30	19.7222	60	47.7777	30	1.3889	60	5.5555

BASE 28—SLOPE ½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5277	31	24.9722	1	.0031	31	2.9660
2	1.0740	32	26.0740	2	.0123	32	3.1605
3	1.6388	33	27.1944	3	.0278	33	3.3611
4	2.2222	34	28.3333	4	.0494	34	3.5679
5	2.8240	35	29.4907	5	.0772	35	3.7808
6	3.4444	36	30.6666	6	.1111	36	4.0000
7	4.0833	37	31.8611	7	.1512	37	4.2253
8	4.7407	38	33.0740	8	.1975	38	4.4568
9	5.4166	39	34.3055	9	.2500	39	4.6944
10	6.1111	40	35.5555	10	.3086	40	4.9383
11	6.8240	41	36.8240	11	.3734	41	5.1883
12	7.5555	42	38.1111	12	.4444	42	5.4444
13	8.3055	43	39.4166	13	.5216	43	5.7067
14	9.0740	44	40.7407	14	.6049	44	5.9753
15	9.8611	45	42.0833	15	.6944	45	6.2500
16	10.6666	46	43.4444	16	.7901	46	6.5308
17	11.4906	47	44.8240	17	.8920	47	6.8179
18	12.3333	48	46.2222	18	1.0000	48	7.1111
19	13.1944	49	47.6389	19	1.1142	49	7.4105
20	14.0740	50	49.0740	20	1.2346	50	7.7160
21	14.9722	51	50.5277	21	1.3611	51	8.0277
22	15.8888	52	52.0000	22	1.4938	52	8.3456
23	16.8240	53	53.4907	23	1.6327	53	8.6697
24	17.7777	54	55.0000	24	1.7778	54	9.0000
25	18.7500	55	56.5277	25	1.9295	55	9.3364
26	19.7407	56	58.0740	26	2.0864	56	9.6790
27	20.7500	57	59.6389	27	2.2500	57	10.0277
28	21.7777	58	61.2222	28	2.4197	58	10.3827
29	22.8240	59	62.8240	29	2.5956	59	10.7438
30	23.8888	60	64.4444	30	2.7778	60	11.1111

BASE 28—SLOPE ¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5323	31	29.4213	1	.0046	31	4.4490
2	1.0925	32	30.8148	2	.0185	32	4.7407
3	1.6805	33	32.2361	3	.0416	33	5.0416
4	2.2962	34	33.6851	4	.0740	34	5.3518
5	2.9397	35	35.1620	5	.1157	35	5.6712
6	3.6111	36	36.6666	6	.1667	36	6.0000
7	4.3101	37	38.1990	7	.2268	37	6.3379
8	5.0370	38	39.7592	8	.2963	38	6.6851
9	5.7916	39	41.3470	9	.3750	39	7.0416
10	6.5740	40	42.9629	10	.4630	40	7.4074
11	7.3842	41	44.6064	11	.5602	41	7.7824
12	8.2222	42	46.2777	12	.6667	42	8.1666
13	9.0879	43	47.9768	13	.7824	43	8.5602
14	9.9815	44	49.7037	14	.9074	44	8.9629
15	10.9027	45	51.4583	15	1.0417	45	9.3750
16	11.8518	46	53.2407	16	1.1852	46	9.7962
17	12.8286	47	55.0508	17	1.3379	47	10.2268
18	13.8333	48	56.8888	18	1.5000	48	10.6666
19	14.8657	49	58.7547	19	1.6713	49	11.1157
20	15.9258	50	60.6481	20	1.8518	50	11.5740
21	17.0138	51	62.5694	21	2.0417	51	12.0416
22	18.1296	52	64.5185	22	2.2407	52	12.5185
23	19.2731	53	66.4953	23	2.4491	53	13.0046
24	20.4444	54	68.5000	24	2.6667	54	13.5000
25	21.6435	55	70.5323	25	2.8935	55	14.0046
26	22.8703	56	72.5926	26	3.1296	56	14.5185
27	24.1250	57	74.6806	27	3.3750	57	15.0416
28	25.4074	58	76.7962	28	3.6296	58	15.5740
29	26.7175	59	78.9397	29	3.8935	59	16.1157
30	28.0555	60	81.1111	30	4.1667	60	16.6666

BASE 28—SLOPE 1 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5370	31	33.8704	1	.0062	31	5.9321
2	1.1111	32	35.5555	2	.0247	32	6.3210
3	1.7222	33	37.2777	3	.0555	33	6.7222
4	2.3703	34	39.0370	4	.0988	34	7.1358
5	3.0555	35	40.8333	5	.1543	35	7.5617
6	3.7777	36	42.6666	6	.2222	36	8.0000
7	4.5370	37	44.5370	7	.3025	37	8.4506
8	5.3333	38	46.4444	8	.3951	38	8.9135
9	6.1666	39	48.3888	9	.5000	39	9.3888
10	7.0370	40	50.3703	10	.6173	40	9.8765
11	7.9444	41	52.3888	11	.7469	41	10.3765
12	8.8888	42	54.4444	12	.8889	42	10.8888
13	9.8703	43	56.5370	13	1.0432	43	11.4135
14	10.8888	44	58.6666	14	1.2099	44	11.9506
15	11.9444	45	60.8333	15	1.3889	45	12.5000
16	13.0370	46	63.0370	16	1.5802	46	13.0617
17	14.1666	47	65.2777	17	1.7839	47	13.6358
18	15.3333	48	67.5555	18	2.0000	48	14.2222
19	16.5370	49	69.8704	19	2.2284	49	14.8209
20	17.7777	50	72.2222	20	2.4691	50	15.4321
21	19.0555	51	74.6111	21	2.7222	51	16.0555
22	20.3703	52	77.0370	22	2.9876	52	16.6913
23	21.7222	53	79.5000	23	3.2654	53	17.3395
24	23.1111	54	82.0000	24	3.5555	54	18.0000
25	24.5370	55	84.5370	25	3.8580	55	18.6728
26	26.0000	56	86.1111	26	4.1728	56	19.3580
27	27.5000	57	89.7222	27	4.5000	57	20.0555
28	29.0370	58	92.3703	28	4.8395	58	20.7654
29	30.6111	59	95.0555	29	5.1913	59	21.4876
30	32.2222	60	97.7777	30	5.5555	60	22.2222

BASE 28—SLOPE 1¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5416	31	38.3194	1	.0077	31	7.4151
2	1.1296	32	40.2962	2	.0309	32	7.9012
3	1.7638	33	42.3194	3	.0694	33	8.4027
4	2.4444	34	44.3888	4	.1234	34	8.9197
5	3.1712	35	46.5046	5	.1928	35	9.4521
6	3.9444	36	48.6666	6	.2778	36	10.0000
7	4.7638	37	50.8750	7	.3781	37	10.5632
8	5.6296	38	53.1296	8	.4938	38	11.1419
9	6.5416	39	55.4305	9	.6250	39	11.7361
10	7.5000	40	57.7777	10	.7716	40	12.3456
11	8.5046	41	60.1712	11	.9336	41	12.9706
12	9.5555	42	62.6111	12	1.1111	42	13.6111
13	10.6527	43	65.0972	13	1.3040	43	14.2680
14	11.7962	44	67.6296	14	1.5123	44	14.9382
15	12.9860	45	70.2083	15	1.7361	45	15.6250
16	14.2222	46	72.8333	16	1.9753	46	16.3271
17	15.5046	47	75.5046	17	2.2299	47	17.0447
18	16.8333	48	78.2222	18	2.5000	48	17.7777
19	18.2083	49	80.9860	19	2.7855	49	18.5262
20	19.6296	50	83.7962	20	3.0864	50	19.2901
21	21.0972	51	86.6527	21	3.4028	51	20.0694
22	22.6111	52	89.5555	22	3.7346	52	20.8641
23	24.1712	53	92.5046	23	4.0818	53	21.6743
24	25.7777	54	95.5000	24	4.4444	54	22.5000
25	27.4305	55	98.5416	25	4.8228	55	23.3410
26	29.1296	56	100.6296	26	5.2160	56	24.1975
27	30.8750	57	104.7638	27	5.6250	57	25.0694
28	32.6666	58	107.9444	28	6.0494	58	25.9567
29	34.5046	59	111.1712	29	6.4891	59	26.8595
30	36.3888	60	114.4444	30	6.9444	60	27.7777

BASE 28—SLOPE 1½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5462	31	42.7686	1	.0092	31	8.8981
2	1.1481	32	45.0370	2	.0370	32	9.4815
3	1.8055	33	47.3611	3	.0833	33	10.0833
4	2.5185	34	49.7407	4	.1480	34	10.7037
5	3.2869	35	52.1759	5	.2313	35	11.3425
6	4.1111	36	54.6666	6	.3333	36	12.0000
7	4.9906	37	57.2129	7	.4537	37	12.6759
8	5.9260	38	59.8148	8	.5926	38	13.3703
9	6.9166	39	62.4722	9	.7500	39	14.0833
10	7.9629	40	65.1851	10	.9259	40	14.8148
11	9.0648	41	67.9536	11	1.1203	41	15.5648
12	10.2222	42	70.7777	12	1.3333	42	16.3333
13	11.4351	43	73.6574	13	1.5648	43	17.1202
14	12.7037	44	76.5926	14	1.8148	44	17.9259
15	14.0277	45	79.5833	15	2.0833	45	18.7500
16	15.4074	46	82.6296	16	2.3704	46	19.5925
17	16.8426	47	85.7314	17	2.6759	47	20.4537
18	18.3333	48	88.8888	18	3.0000	48	21.3333
19	19.8796	49	92.1017	19	3.3426	49	22.2314
20	21.4815	50	95.3703	20	3.7037	50	23.1481
21	23.1388	51	98.6944	21	4.0833	51	24.0833
22	24.8518	52	102.0740	22	4.4815	52	25.0370
23	26.6203	53	105.5092	23	4.8981	53	26.0092
24	28.4444	54	109.0000	24	5.3333	54	27.0000
25	30.3240	55	112.5462	25	5.7869	55	28.0092
26	32.2592	56	115.1481	26	6.2592	56	29.0370
27	34.2500	57	119.8055	27	6.7500	57	30.0833
28	36.2962	58	123.5185	28	7.2592	58	31.1481
29	38.3981	59	127.2870	29	7.7869	59	32.2314
30	40.5555	60	131.1111	30	8.3333	60	33.3333

BASE 28—SLOPE 1¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5508	31	47.2177	1	.0108	31	10.3811
2	1.1666	32	49.7777	2	.0432	32	11.0617
3	1.8472	33	52.4028	3	.0972	33	11.7638
4	2.5926	34	55.0926	4	.1728	34	12.4876
5	3.4027	35	57.8472	5	.2700	35	13.2330
6	4.2777	36	60.6666	6	.3889	36	14.0000
7	5.2177	37	63.5508	7	.5293	37	14.7885
8	6.2222	38	66.5000	8	.6913	38	15.5987
9	7.2916	39	69.5138	9	.8750	39	16.4305
10	8.4258	40	72.5926	10	1.0802	40	17.2839
11	9.6250	41	75.7360	11	1.3071	41	18.1589
12	10.8888	42	78.9444	12	1.5555	42	19.0555
13	12.2175	43	82.2176	13	1.8256	43	19.9747
14	13.6111	44	85.5555	14	2.1173	44	20.9135
15	15.0693	45	88.9583	15	2.4305	45	21.8750
16	16.5926	46	92.4259	16	2.7654	46	22.8580
17	18.1805	47	95.9583	17	3.1219	47	23.8626
18	19.8333	48	99.5555	18	3.5000	48	24.8888
19	21.5509	49	103.2176	19	3.8997	49	25.9367
20	23.3333	50	106.9444	20	4.3210	50	27.0061
21	25.1805	51	110.7360	21	4.7639	51	28.0972
22	27.0926	52	114.5926	22	5.2284	52	29.2098
23	29.0693	53	118.5138	23	5.7145	53	30.3441
24	31.1111	54	122.5000	24	6.2222	54	31.5000
25	33.2175	55	126.5508	25	6.7516	55	32.6774
26	35.3888	56	129.6666	26	7.3024	56	33.8765
27	37.6250	57	134.8472	27	7.8750	57	35.0972
28	39.9258	58	139.0926	28	8.4691	58	36.3394
29	42.2916	59	143.4028	29	9.0848	59	37.6033
30	44.7222	60	147.7777	30	9.7222	60	38.8888

BASE 28—SLOPE 2 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5555	31	51.6666	1	.0123	31	11.8642
2	1.1851	32	54.5185	2	.0494	32	12.6419
3	1.8888	33	57.4444	3	.1111	33	13.4444
4	2.6666	34	60.4444	4	.1975	34	14.2716
5	3.5185	35	63.5185	5	.3086	35	15.1234
6	4.4444	36	66.6666	6	.4444	36	16.0000
7	5.4444	37	69.8888	7	.6049	37	16.9012
8	6.5185	38	73.1851	8	.7901	38	17.8271
9	7.6666	39	76.5555	9	1.0000	39	18.7777
10	8.8888	40	80.0000	10	1.2346	40	19.7530
11	10.1852	41	83.5185	11	1.4938	41	20.7530
12	11.5555	42	87.1111	12	1.7778	42	21.7777
13	13.0000	43	90.7777	13	2.0864	43	22.8271
14	14.5185	44	94.5185	14	2.4197	44	23.9012
15	16.1111	45	98.3333	15	2.7778	45	25.0000
16	17.7777	46	102.2222	16	3.1605	46	26.1234
17	19.5185	47	106.1851	17	3.5679	47	27.2716
18	21.3333	48	110.2222	18	4.0000	48	28.4444
19	23.2222	49	113.3333	19	4.4568	49	29.6420
20	25.1851	50	118.5185	20	4.9382	50	30.8642
21	27.2222	51	122.7777	21	5.4444	51	32.1111
22	29.3333	52	127.1111	22	5.9753	52	33.3827
23	31.5185	53	131.5185	23	6.5309	53	34.6790
24	33.7777	54	136.0000	24	7.1111	54	36.0000
25	36.1111	55	140.5555	25	7.7160	55	37.3456
26	38.5185	56	144.1851	26	8.3457	56	38.7160
27	41.0000	57	149.8888	27	9.0000	57	40.1111
28	43.5555	58	154.6666	28	9.6790	58	41.5308
29	46.1851	59	159.5185	29	10.3827	59	42.9753
30	48.8888	60	164.4444	30	11.1111	60	44.4444

BASE 28—SLOPE 2½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5647	31	60.5647	1	.0154	31	14.8302
2	1.2222	32	64.0000	2	.0617	32	15.8015
3	1.9722	33	67.5277	3	.1389	33	16.8055
4	2.8148	34	71.1481	4	.2468	34	17.8395
5	3.7500	35	74.8611	5	.3857	35	18.9043
6	4.7777	36	78.6666	6	.5555	36	20.0000
7	5.8980	37	82.5646	7	.7561	37	21.1265
8	7.1111	38	86.5555	8	.9876	38	22.2839
9	8.4166	39	90.6389	9	1.2500	39	23.4722
10	9.8148	40	94.8148	10	1.5432	40	24.6913
11	11.3055	41	99.0833	11	1.8673	41	25.9413
12	12.8888	42	103.4444	12	2.2222	42	27.2222
13	14.5648	43	107.8981	13	2.6080	43	28.5360
14	16.3333	44	112.4444	14	3.0247	44	29.8765
15	18.1944	45	117.0833	15	3.4722	45	31.2500
16	20.1481	46	121.8148	16	3.9506	46	32.6543
17	22.1944	47	126.6389	17	4.4599	47	34.0895
18	24.3333	48	131.5555	18	5.0000	48	35.5555
19	26.5648	49	135.5646	19	5.5710	49	37.0524
20	28.8888	50	141.6666	20	6.1728	50	38.5802
21	31.3055	51	146.8611	21	6.8055	51	40.1388
22	33.8148	52	152.1481	22	7.4691	52	41.7283
23	36.4166	53	157.5277	23	8.1636	53	43.3487
24	39.1111	54	163.0000	24	8.8889	54	45.0000
25	41.8980	55	168.5647	25	9.6455	55	46.6820
26	44.7777	56	173.2222	26	10.4321	56	48.3950
27	47.7500	57	179.9722	27	11.2500	57	50.1388
28	50.8148	58	185.8148	28	12.0587	58	51.9135
29	53.9722	59	191.7500	29	12.9782	59	53.7191
30	57.2222	60	197.7777	30	13.8889	60	55.5555

BASE 28—SLOPE 3 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5740	31	69.4630	1	.0185	31	17.7963
2	1.2592	32	73.4815	2	.0740	32	18.9630
3	2.0555	33	77.6111	3	.1667	33	20.1666
4	2.9630	34	81.8518	4	.2963	34	21.4074
5	3.9815	35	86.2037	5	.4628	35	22.6851
6	5.1111	36	90.6666	6	.6667	36	24.0000
7	6.3518	37	95.2404	7	.9074	37	25.3518
8	7.7037	38	99.9259	8	1.1852	38	26.7407
9	9.1666	39	104.7222	9	1.5000	39	28.1666
10	10.7407	40	109.6296	10	1.8518	40	29.6296
11	12.4260	41	114.6481	11	2.2407	41	31.1296
12	14.2222	42	119.7777	12	2.6667	42	32.6666
13	16.1296	43	125.0185	13	3.1296	43	34.2407
14	18.1481	44	130.3703	14	3.6296	44	35.8518
15	20.2777	45	135.8333	15	4.1667	45	37.5000
16	22.5185	46	141.4074	16	4.7407	46	39.1851
17	24.8703	47	147.0926	17	5.3518	47	40.9078
18	27.3333	48	152.8888	18	6.0000	48	42.6666
19	29.9074	49	157.7962	19	6.6852	49	44.4629
20	32.5926	50	164.8148	20	7.4074	50	46.2963
21	35.3888	51	170.9444	21	8.1667	51	49.1666
22	38.2962	52	177.1851	22	8.9629	52	50.0740
23	41.3148	53	183.5370	23	9.7962	53	52.0185
24	44.4444	54	190.0000	24	10.6667	54	54.0000
25	47.6850	55	196.5470	25	11.5741	55	56.0184
26	51.0370	56	202.2592	26	12.5184	56	58.0740
27	54.5000	57	210.0555	27	13.5000	57	60.1666
28	58.0740	58	216.9630	28	14.5185	58	62.2962
29	61.7592	59	222.9814	29	15.5741	59	64.4629
30	65.5555	60	231.1111	30	16.6667	60	66.6666

BASE 29—SLOPE ¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5416	31	21.0972	1	.0015	31	1.4830
2	1.0926	32	21.9259	2	.0062	32	1.5802
3	1.6527	33	22.7639	3	.0139	33	1.6805
4	2.2222	34	23.6111	4	.0246	34	1.7839
5	2.8009	35	24.4676	5	.0385	35	1.8904
6	3.3888	36	25.3333	6	.0555	36	2.0000
7	3.9861	37	26.2083	7	.0756	37	2.1126
8	4.5926	38	27.0926	8	.0988	38	2.2284
9	5.2083	39	27.9861	9	.1250	39	2.3472
10	5.8333	40	28.8888	10	.1543	40	2.4691
11	6.4676	41	29.8009	11	.1867	41	2.5941
12	7.1111	42	30.7222	12	.2222	42	2.7222
13	7.7639	43	31.6527	13	.2608	43	2.8545
14	8.4259	44	32.5926	14	.3025	44	2.9876
15	9.0972	45	33.5416	15	.3472	45	3.1250
16	9.7777	46	34.5000	16	.3951	46	3.2654
17	10.4676	47	35.4676	17	.4460	47	3.4089
18	11.1666	48	36.4444	18	.5000	48	3.5555
19	11.8750	49	37.4305	19	.5571	49	3.7052
20	12.5926	50	38.4259	20	.6173	50	3.8580
21	13.3194	51	39.4305	21	.6805	51	4.0139
22	14.0555	52	40.4444	22	.7469	52	4.1728
23	14.8009	53	41.4676	23	.8163	53	4.3349
24	15.5555	54	42.5000	24	.8889	54	4.5000
25	16.3194	55	43.5416	25	.9647	55	4.6682
26	17.0926	56	44.5926	26	1.0432	56	4.8395
27	17.8750	57	45.6527	27	1.1250	67	5.0139
28	18.6666	58	46.7222	28	1.2099	58	5.1913
29	19.4676	59	47.8009	29	1.2978	59	5.3719
30	20.2777	60	48.8888	30	1.3889	60	5.5555

BASE 29—SLOPE ½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5462	31	25.5463	1	.0031	31	2.9660
2	1.1111	32	26.6666	2	.0123	32	3.3611
3	1.6944	33	27.8055	3	.0278	33	3.6111
4	2.2962	34	28.9629	4	.0494	34	3.5679
5	2.9166	35	30.1388	5	.0772	35	3.7808
6	3.5555	36	31.3333	6	.1111	36	4.0000
7	4.2129	37	32.5463	7	.1512	37	4.2253
8	4.8888	38	33.7777	8	.1975	38	4.4568
9	5.5833	39	35.0277	9	.2500	39	4.6944
10	6.2962	40	36.2962	10	.3086	40	4.9383
11	7.0278	41	37.5833	11	.3734	41	5.1883
12	7.7777	42	38.8888	12	.4444	42	5.4444
13	8.5463	43	40.2129	13	.5216	43	5.7076
14	9.3333	44	41.5555	14	.6049	44	5.9753
15	10.1388	45	42.9166	15	.6944	45	6.2500
16	10.9629	46	44.2962	16	.7901	46	6.5308
17	11.8055	47	45.6944	17	.8920	47	6.8179
18	12.6666	48	47.1111	18	1.0000	48	7.1111
19	13.5463	49	48.5462	19	1.1142	49	7.4105
20	14.4444	50	50.0000	20	1.2346	50	7.7160
21	15.3611	51	51.4722	21	1.3611	51	8.0277
22	16.2962	52	52.9629	22	1.4938	52	8.3456
23	17.2500	53	54.4722	23	1.6327	53	8.6697
24	18.2222	54	56.0000	24	1.7778	54	9.0000
25	19.2129	55	57.5462	25	1.9295	55	9.3364
26	20.2222	56	59.1111	26	2.0864	56	9.6790
27	21.2500	57	60.6944	27	2.2500	57	10.0277
28	22.2962	58	62.2962	28	2.4197	58	10.3827
29	23.3611	59	63.9166	29	2.5956	59	10.7438
30	24.4444	60	65.5555	30	2.7778	60	11.1111

BASE 29—SLOPE ¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5508	31	29.9954	1	.0046	31	4.4490
2	1.1296	32	31.4074	2	.0185	32	4.7407
3	1.7361	33	32.8472	3	.0416	33	5.0416
4	2.3703	34	34.3147	4	.0740	34	5.3518
5	3.0323	35	35.8101	5	.1157	35	5.6712
6	3.7222	36	37.3333	6	.1667	36	6.0000
7	4.4397	37	38.8842	7	.2268	37	6.3379
8	5.1851	38	40.4629	8	.2963	38	6.6851
9	5.9583	39	42.0695	9	.3750	39	7.0416
10	6.7592	40	43.7037	10	.4630	40	7.4074
11	7.5880	41	45.3657	11	.5602	41	7.7824
12	8.4444	42	47.0555	12	.6667	42	8.1666
13	9.3287	43	48.7731	13	.7824	43	8.5612
14	10.2407	44	50.5185	14	.9074	44	8.9629
15	11.1806	45	52.2916	15	1.0417	45	9.3750
16	12.1481	46	54.0926	16	1.1852	46	9.7962
17	13.1434	47	55.9212	17	1.3379	47	10.2268
18	14.1666	48	57.7777	18	1.5000	48	10.6666
19	15.2176	49	59.6620	19	1.6713	49	11.1157
20	16.2962	50	61.5740	20	1.8518	50	11.5740
21	17.4027	51	63.5140	21	2.0417	51	12.0416
22	18.5370	52	65.4814	22	2.2407	52	12.5185
23	19.6991	53	67.4768	23	2.4491	53	13.0046
24	20.8888	54	69.5000	24	2.6667	54	13.5000
25	22.1064	55	71.5508	25	2.8935	55	14.0046
26	23.3518	56	73.6296	26	3.1296	56	14.5185
27	24.6250	57	75.7361	27	3.3750	57	15.0416
28	25.9258	58	77.8703	28	3.6296	58	15.5740
29	27.2546	59	80.0323	29	3.8935	59	16.1157
30	28.6111	60	82.2222	30	4.1667	60	16.6666

BASE 29—SLOPE 1 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5555	31	34.4444	1	.0062	31	5.9321
2	1.1481	32	36.1481	2	.0247	32	6.3210
3	1.7777	33	37.8888	3	.0555	33	6.7222
4	2.4444	34	39.6666	4	.0988	34	7.1358
5	3.1481	35	41.4814	5	.1543	35	7.5617
6	3.8888	36	43.3333	6	.2222	36	8.0000
7	4.6666	37	45.2222	7	.3025	37	8.4506
8	5.4814	38	47.1481	8	.3951	38	8.9135
9	6.3333	39	49.1111	9	.5000	39	9.3888
10	7.2222	40	51.1111	10	.6173	40	9.8765
11	8.1481	41	53.1481	11	.7469	41	10.3765
12	9.1111	42	55.2222	12	.8889	42	10.8888
13	10.1111	43	57.3333	13	1.0432	43	11.4135
14	11.1481	44	59.4814	14	1.2099	44	11.9506
15	12.2222	45	61.6666	15	1.3889	45	12.5000
16	13.3333	46	64.8888	16	1.5802	46	13.0617
17	14.4814	47	66.1481	17	1.7839	47	13.6358
18	15.6666	48	68.4444	18	2.0000	48	14.2222
19	16.8888	49	70.7777	19	2.2284	49	14.8209
20	18.1481	50	73.1481	20	2.4691	50	15.4321
21	19.4444	51	75.5555	21	2.7222	51	16.0555
22	20.7777	52	78.0000	22	2.9876	52	16.6913
23	22.1481	53	80.4814	23	3.2654	53	17.3395
24	23.5555	54	82.0000	24	3.5555	54	18.0000
25	25.0000	55	85.5555	25	3.8530	55	18.6728
26	26.4815	56	88.1481	26	4.1728	56	19.3580
27	28.0000	57	90.7777	27	4.5000	57	20.0555
28	29.5555	58	93.4444	28	4.8395	58	20.7654
29	31.1481	59	96.1481	29	5.1913	59	21.4876
30	32.7777	60	98.8888	30	5.5555	60	22.2222

BASE 29—SLOPE $1\frac{1}{4}$ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5601	31	38.8935	1	.0077	31	7.4151
2	1.1666	32	40.8888	2	.0309	32	7.9012
3	1.8194	33	42.9305	3	.0694	33	8.4027
4	2.5185	34	45.0185	4	.1234	34	8.9197
5	3.2638	35	47.1527	5	.1928	35	9.4521
6	4.0555	36	49.3333	6	.2778	36	10.0000
7	4.8934	37	51.5601	7	.3781	37	10.5632
8	5.7777	38	53.8333	8	.4938	38	11.1419
9	6.7083	39	56.1527	9	.6250	39	11.7361
10	7.6851	40	58.5185	10	.7716	40	12.3456
11	8.7083	41	60.9305	11	.9336	41	12.9706
12	9.7777	42	63.3888	12	1.1111	42	13.6111
13	10.8934	43	65.8935	13	1.3040	43	14.2686
14	12.0555	44	68.4444	14	1.5123	44	14.9382
15	13.2638	45	71.0416	15	1.7361	45	15.6250
16	14.5185	46	74.6851	16	1.9753	46	16.3271
17	15.8194	47	76.3750	17	2.2299	47	17.0447
18	17.1666	48	79.1111	18	2.5000	48	17.7777
19	18.5601	49	81.8935	19	2.7855	49	18.5262
20	20.0000	50	84.7222	20	3.0864	50	19.2901
21	21.4861	51	87.5972	21	3.4028	51	20.0694
22	23.0185	52	90.5185	22	3.7346	52	20.8641
23	24.5972	53	93.4860	23	4.0818	53	21.6743
24	26.2222	54	95.5000	24	4.4444	54	22.5000
25	27.8935	55	99.5601	25	4.8228	55	23.3410
26	29.6111	56	102.6666	26	5.2160	56	24.1975
27	31.3750	57	105.8194	27	5.6250	57	25.0694
28	33.1851	58	109.0185	28	6.0494	58	25.9567
29	35.0416	59	112.2638	29	6.4891	59	26.8595
30	36.9444	60	115.5555	30	6.9444	60	27.7777

BASE 29—SLOPE 1½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5647	31	43.3426	1	.0092	31	8.8981
2	1.1851	32	45.6296	2	.0370	32	9.4815
3	1.8611	33	47.9722	3	.0833	33	10.0833
4	2.5926	34	50.3703	4	.1480	34	10.7037
5	3.3795	35	52.8240	5	.2313	35	11.3425
6	4.2222	36	55.3333	6	.3333	36	12.0000
7	5.1202	37	57.8980	7	.4537	37	12.6759
8	6.0740	38	60.5185	8	.5926	38	13.3703
9	7.0833	39	63.1944	9	.7500	39	14.0833
10	8.1481	40	65.9259	10	.9259	40	14.8148
11	9.2685	41	68.7129	11	1.1203	41	15.5648
12	10.4444	42	71.5555	12	1.3333	42	16.3333
13	11.6758	43	74.4537	13	1.5648	43	17.1202
14	12.9629	44	77.4074	14	1.8148	44	17.9259
15	14.3055	45	80.4166	15	2.0833	45	18.7500
16	15.7037	46	84.4814	16	2.3704	46	19.5925
17	17.1573	47	86.6018	17	2.6759	47	20.4537
18	18.6666	48	89.7777	18	3.0000	48	21.3333
19	20.2314	49	93.0092	19	3.3426	49	22.2314
20	21.8518	50	96.2962	20	3.7037	50	23.1481
21	23.5277	51	99.6388	21	4.0833	51	24.0833
22	25.2592	52	103.0370	22	4.4815	52	25.0370
23	27.0462	53	106.4906	23	4.8981	53	26.0092
24	28.8888	54	109.0000	24	5.3333	54	27.0000
25	30.7870	55	113.5647	25	5.7869	55	28.0092
26	32.7407	56	117.1852	26	6.2592	56	29.0370
27	34.7500	57	120.8611	27	6.7500	57	30.0833
28	36.8147	58	124.5926	28	7.2592	58	31.1481
29	38.9351	59	128.3795	29	7.7869	59	32.2314
30	41.1111	60	132.2222	30	8.3333	60	33.3333

BASE 29—SLOPE 1¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5692	31	47.7917	1	.0108	31	10.3811
2	1.2037	32	50.3703	2	.0432	32	11.0617
3	1.9028	33	53.0140	3	.0972	33	11.7638
4	2.6666	34	55.7222	4	.1728	34	12.4876
5	3.4952	35	58.4953	5	.2700	35	13.2330
6	4.3888	36	61.3333	6	.3889	36	14.0000
7	5.3470	37	64.2360	7	.5293	37	14.7885
8	6.3703	38	67.2037	8	.6913	38	15.5987
9	7.4583	39	70.2360	9	.8750	39	16.4305
10	8.6111	40	73.3333	10	1.0802	40	17.2839
11	9.8286	41	76.4953	11	1.3071	41	18.1589
12	11.1111	42	79.7222	12	1.5555	42	19.0555
13	12.4582	43	83.0140	13	1.8256	43	19.9747
14	13.8703	44	86.3703	14	2.1173	44	20.9135
15	15.3470	45	89.7917	15	2.4305	45	21.8750
16	16.8888	46	94.2777	16	2.7654	46	22.8580
17	18.4952	47	96.8286	17	3.1219	47	23.8626
18	20.1666	48	100.4444	18	3.5000	48	24.8888
19	21.9027	49	104.1250	19	3.8997	49	25.9367
20	23.7037	50	107.8703	20	4.3210	50	27.0061
21	25.5694	51	111.6805	21	4.7639	51	28.0972
22	27.5000	52	115.5555	22	5.2284	52	29.2098
23	29.4952	53	119.4952	23	5.7145	53	30.3441
24	31.5555	54	122.5000	24	6.2222	54	31.5000
25	33.6805	55	127.5694	25	6.7516	55	32.6774
26	35.8703	56	131.7037	26	7.3024	56	33.8765
27	38.1250	57	135.9027	27	7.8750	57	35.0972
28	40.4444	58	140.1666	28	8.4691	58	36.3394
29	42.8286	59	144.4952	29	9.0848	59	37.6033
30	45.2777	60	148.8888	30	9.7222	60	38.8888

BASE 29—SLOPE 2 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5740	31	52.2407	1	.0123	31	11.8642
2	1.2222	32	55.1111	2	.0494	32	12.6419
3	1.9444	33	58.0555	3	.1111	33	13.4444
4	2.7407	34	61.0740	4	.1975	34	14.2716
5	3.6111	35	64.1666	5	.3086	35	15.1234
6	4.5555	36	67.3333	6	.4444	36	16.0000
7	5.5740	37	70.5740	7	.6049	37	16.9012
8	6.6666	38	73.8888	8	.7901	38	17.8271
9	7.8333	39	77.2777	9	1.0000	39	18.7777
10	9.0740	40	80.7407	10	1.2346	40	19.7530
11	10.3888	41	84.2777	11	1.4938	41	20.7530
12	11.7777	42	87.8888	12	1.7778	42	21.7777
13	13.1406	43	91.5740	13	2.0864	43	22.8271
14	14.7777	44	95.3333	14	2.4197	44	23.9012
15	16.3888	45	99.1666	15	2.7778	45	25.0000
16	18.0740	46	104.0740	16	3.1605	46	26.1234
17	19.8333	47	107.0555	17	3.5679	47	27.2716
18	21.6666	48	111.1111	18	4.0000	48	28.4444
19	23.5740	49	115.2407	19	4.4568	49	29.6420
20	25.5555	50	119.4444	20	4.9382	50	30.8642
21	27.6111	51	123.7222	21	5.4444	51	32.1111
22	29.7407	52	128.0740	22	5.9753	52	33.3827
23	31.9444	53	132.5000	23	6.5309	53	34.6790
24	34.2222	54	136.0000	24	7.1111	54	36.0000
25	36.5740	55	141.5740	25	7.7160	55	37.3456
26	39.0000	56	146.2222	26	8.3457	56	38.7160
27	41.5000	57	150.9444	27	9.0000	57	40.1111
28	44.0740	58	155.7407	28	9.6790	58	41.5308
29	46.7222	59	160.6111	29	10.3827	59	42.9753
30	49.4444	60	165.5555	30	11.1111	60	44.4444

BASE 29—SLOPE 2½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5833	31	61.1388	1	.0154	31	14.8302
2	1.2592	32	64.5926	2	.0617	32	15.8013
3	2.0277	33	68.1389	3	.1389	33	16.8055
4	2.8888	34	71.7777	4	.2468	34	17.8395
5	3.8426	35	75.5092	5	.3857	35	18.9043
6	4.8888	36	79.3333	6	.5555	36	20.0000
7	6.0277	37	83.2500	7	.7561	37	21.1265
8	7.2592	38	87.2592	8	.9876	38	22.2839
9	8.5833	39	91.3611	9	1.2500	39	23.4722
10	10.0000	40	95.5555	10	1.5432	40	24.6913
11	11.5092	41	99.8425	11	1.8673	41	25.9413
12	13.1111	42	104.2222	12	2.2222	42	27.2222
13	14.8054	43	108.6944	13	2.6080	43	28.5360
14	16.5926	44	113.2592	14	3.0247	44	29.8765
15	18.4722	45	117.9166	15	3.4722	45	31.2500
16	20.4444	46	123.6666	16	3.9506	46	32.6543
17	22.5092	47	127.5092	17	4.4599	47	34.0895
18	24.6666	48	132.4444	18	5.0000	48	35.5555
19	26.9166	49	137.4722	19	5.5710	49	37.0524
20	29.2592	50	142.5926	20	6.1728	50	38.5802
21	31.6944	51	147.8055	21	6.8055	51	40.1388
22	34.2222	52	153.1111	22	7.4691	52	41.7283
23	36.8426	53	158.5092	23	8.1636	53	43.3487
24	39.5555	54	163.0000	24	8.8889	54	45.0000
25	42.3610	55	169.5833	25	9.6455	55	46.6820
26	45.2592	56	175.2592	26	10.4321	56	48.3950
27	48.2500	57	181.0277	27	11.2500	57	50.1388
28	51.3333	58	186.8888	28	12.0587	58	51.9135
29	54.5092	59	192.8425	29	12.9782	59	53.7191
30	57.7777	60	198.8888	30	13.8889	60	55.5555

(c.)

BASE 29—SLOPE 3 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5926	31	70.0370	1	.0185	31	17.7963
2	1.2962	32	74.0740	2	.0740	32	18.9630
3	2.1111	33	78.2222	3	.1667	33	20.1666
4	3.0370	34	82.4814	4	.2963	34	21.4074
5	4.0740	35	86.8518	5	.4628	35	22.6851
6	5.2222	36	91.3333	6	.6667	36	24.0000
7	6.4813	37	95.9258	7	.9074	37	25.3518
8	7.8518	38	100.6296	8	1.1852	38	26.7407
9	9.3333	39	105.4444	9	1.5000	39	28.1666
10	10.9259	40	110.3703	10	1.8518	40	29.6296
11	12.6296	41	115.4074	11	2.2407	41	31.1296
12	14.4444	42	120.5555	12	2.6667	42	32.6666
13	16.3703	43	125.8148	13	3.1296	43	34.2407
14	18.4074	44	131.1851	14	3.6296	44	35.8518
15	20.5555	45	136.6666	15	4.1667	45	37.5000
16	22.8148	46	143.2592	16	4.7407	46	39.1851
17	25.1851	47	147.9628	17	5.3518	47	40.9074
18	27.6666	48	153.7777	18	6.0000	48	42.6666
19	30.2592	49	159.7037	19	6.6852	49	44.4629
20	32.9629	50	165.7407	20	7.4074	50	46.2963
21	35.7777	51	171.8888	21	8.1667	51	49.1666
22	38.7037	52	178.1481	22	8.9629	52	50.0740
23	41.7407	53	184.5185	23	9.7962	53	52.0185
24	44.8888	54	190.0000	24	10.6667	54	54.0000
25	48.1480	55	197.5926	25	11.5741	55	56.0184
26	51.5184	56	204.2962	26	12.5184	56	58.0740
27	55.0000	57	211.1111	27	13.5000	57	60.1666
28	58.5926	58	218.0370	28	14.5185	58	62.2962
29	62.2962	59	225.0740	29	15.5741	59	64.4629
30	66.1111	60	232.2222	30	16.6667	60	66.6666

BASE 30—SLOPE ¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5602	31	21.6713	1	.0015	31	1.4830
2	1.1296	32	22.5185	2	.0062	32	1.5802
3	1.7083	33	23.3750	3	.0139	33	1.6805
4	2.2962	34	24.2407	4	.0246	34	1.7839
5	2.8935	35	25.1157	5	.0385	35	1.8904
6	3.5000	36	26.0000	6	.0555	36	2.0000
7	4.1157	37	26.8935	7	.0756	37	2.1126
8	4.7407	38	27.7963	8	.0988	38	2.2284
9	5.3750	39	28.7083	9	.1250	39	2.3472
10	6.0185	40	29.6296	10	.1543	40	2.4691
11	6.6713	41	30.5602	11	.1867	41	2.5941
12	7.3333	42	31.5000	12	.2222	42	2.7222
13	8.0046	43	32.4490	13	.2608	43	2.8545
14	8.6851	44	33.4073	14	.3025	44	2.9876
15	9.3750	45	34.3750	15	.3472	45	3.1250
16	10.0740	46	35.3518	16	.3951	46	3.2654
17	10.7824	47	36.3379	17	.4460	47	3.4089
18	11.5000	48	37.3333	18	.5000	48	3.5555
19	12.2268	49	38.3379	19	.5571	49	3.7052
20	12.9629	50	39.3518	20	.6173	50	3.8580
21	13.7083	51	40.3750	21	.6805	51	4.0139
22	14.4629	52	41.4073	22	.7469	52	4.1728
23	15.2268	53	42.4490	23	.8163	53	4.3349
24	16.0000	54	43.5000	24	.8889	54	4.5000
25	16.7824	55	44.5602	25	.9647	55	4.6682
26	17.5740	56	45.6296	26	1.0432	56	4.8395
27	18.3750	57	46.7083	27	1.1250	57	5.0139
28	19.1851	58	47.7963	28	1.2099	58	5.1913
29	20.0046	59	48.8935	29	1.2978	59	5.3719
30	20.8333	60	50.0000	30	1.3889	60	5.5555

BASE 30—SLOPE ½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5648	31	26.1203	1	.0031	31	2.9660
2	1.1481	32	27.2592	2	.0123	32	3.1605
3	1.7500	33	28.4166	3	.0278	33	3.3611
4	2.3704	34	29.5926	4	.0494	34	3.5679
5	3.0092	35	30.7870	5	.0772	35	3.7808
6	3.6666	36	32.0000	6	.1111	36	4.0000
7	4.3425	37	33.2315	7	.1512	37	4.2253
8	5.0370	38	34.4815	8	.1975	38	4.4568
9	5.7500	39	35.7500	9	.2500	39	4.6944
10	6.4815	40	37.0370	10	.3086	40	4.9383
11	7.2315	41	38.3425	11	.3734	41	5.1883
12	8.0000	42	39.6666	12	.4444	42	5.4444
13	8.7870	43	41.0092	13	.5216	43	5.7067
14	9.5926	44	42.3704	14	.6049	44	5.9753
15	10.4166	45	43.7500	15	.6944	45	6.2500
16	11.2592	46	45.1481	16	.7901	46	6.5308
17	12.1203	47	46.5648	17	.8920	47	6.8179
18	13.0000	48	48.0000	18	1.0000	48	7.1111
19	13.8981	49	49.4537	19	1.1142	49	7.4105
20	14.8147	50	50.9260	20	1.2346	50	7.7160
21	15.7500	51	52.4166	21	1.3611	51	8.0277
22	16.7037	52	53.9260	22	1.4938	52	8.3456
23	17.6759	53	55.4537	23	1.6327	53	8.6697
24	18.6666	54	57.0000	24	1.7778	54	9.0000
25	19.6759	55	58.5648	25	1.9295	55	9.3364
26	20.7037	56	60.1481	26	2.0864	56	9.6790
27	21.7500	57	61.7500	27	2.2500	57	10.0277
28	22.8147	58	63.3704	28	2.4197	58	10.3827
29	23.8981	59	65.0092	29	2.5956	59	10.7438
30	25.0000	60	66.6666	30	2.7778	60	11.1111

BASE 30—SLOPE ¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5694	31	30.5694	1	.0046	31	4.4490
2	1.1666	32	32.0000	2	.0185	32	4.7407
3	1.7917	33	33.4583	3	.0416	33	5.0416
4	2.4444	34	34.9444	4	.0740	34	5.3518
5	3.1250	35	36.4583	5	.1157	35	5 6712
6	3.8333	36	38.0000	6	.1667	36	6.0000
7	4.5692	37	39.5694	7	.2268	37	6.3379
8	5.3333	38	41.1666	8	.2963	38	6.6851
9	6.1250	39	42.7917	9	.3750	39	7.0416
10	6.9444	40	44.4444	10	.4630	40	7.4074
11	7.7917	41	46.1250	11	.5602	41	7.7824
12	8.6666	42	47.8333	12	.6667	42	8.1666
13	9.5694	43	49.5692	13	.7824	43	8.5602
14	10.5000	44	51.3333	14	.9074	44	8.9629
15	11.4583	45	53.1250	15	1.0417	45	9.3750
16	12.4444	46	54.9444	16	1.1852	46	9.7962
17	13.4583	47	56.7917	17	1.3379	47	10.2268
18	14.5000	48	58.6666	18	1.5000	48	10.6666
19	15.5694	49	60.5694	19	1.6713	49	11.1157
20	16.6666	50	62.5000	20	1.8518	50	11.5740
21	17.7917	51	64.4583	21	2.0417	51	12.0416
22	18.9444	52	66.4444	22	2.2407	52	12.5185
23	20.1250	53	68.4583	23	2.4491	53	13.0046
24	21.3333	54	70.5000	24	2.6667	54	13.5000
25	22.5692	55	72.5694	25	2.8935	55	14.0046
26	23.8333	56	74.6666	26	3.1296	56	14.5185
27	25.1250	57	76.7917	27	3.3750	57	15.0416
28	26.4444	58	78.9444	28	3.6296	58	15.5740
29	27.7917	59	81.1250	29	3.8935	59	16.1157
30	29.1666	60	83.3333	30	4.1667	60	16.6666

BASE 30—SLOPE 1 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5740	31	35.0185	1	.0062	31	5.9321
2	1.1851	32	36.7407	2	.0247	32	6.3210
3	1.8333	33	38.5000	3	.0555	33	6.7222
4	2.5185	34	40.2962	4	.0988	34	7.1358
5	3.2407	35	42.1296	5	.1543	35	7.5617
6	4.0000	36	44.0000	6	.2222	36	8.0000
7	4.7962	37	45.9074	7	.3025	37	8.4506
8	5.6296	38	47.8518	8	.3951	38	8.9135
9	6.5000	39	49.8333	9	.5000	39	9.3888
10	7.4074	40	51.8518	10	.6173	40	9.8765
11	8.3518	41	53.9074	11	.7469	41	10.3765
12	9.3333	42	56.0000	12	.8889	42	10.8888
13	10.3518	43	58.1296	13	1.0432	43	11.4135
14	11.4074	44	60.2962	14	1.2099	44	11.9506
15	12.5000	45	62.5000	15	1.3889	45	12.5000
16	13.6296	46	64.7407	16	1.5802	46	13.0617
17	14.7962	47	67.0185	17	1.7839	47	13.6358
18	16.0000	48	69.3333	18	2.0000	48	14.2222
19	17.2407	49	71.6851	19	2.2284	49	14.8209
20	18.5185	50	74.0740	20	2.4691	50	15.4321
21	19.8333	51	76.5000	21	2.7222	51	16.0555
22	21.1851	52	78.9629	22	2.9876	52	16.6913
23	22.5740	53	81.4629	23	3.2654	53	17.3395
24	24.0000	54	84.0000	24	3.5555	54	18.0000
25	25.4629	55	86.5740	25	3.8580	55	18.6728
26	26.9629	56	89.1851	26	4.1728	56	19.3580
27	28.5000	57	91.8333	27	4.5000	57	20.0555
28	30.0740	58	94.5185	28	4.8395	58	20.7654
29	31.6851	59	97.2407	29	5.1913	59	21.4876
30	33.3333	60	100.0000	30	5.5555	60	22.2222

BASE 30—SLOPE 1¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5786	31	39.4676	1	.0077	31	7.4151
2	1.2037	32	41.4815	2	.0309	32	7.9012
3	1.8750	33	43.5417	3	.0694	33	8.4027
4	2.5926	34	45.6481	4	.1234	34	8.9197
5	3.3564	35	47.8009	5	.1928	35	9.4521
6	4.1666	36	50.0000	6	.2778	36	10.0000
7	5.0230	37	52.2453	7	.3781	37	10.5632
8	5.9259	38	54.5370	8	.4938	38	11.1419
9	6.8750	39	56.8750	9	.6250	39	11.7361
10	7.8703	40	59.2592	10	.7716	40	12.3456
11	8.9120	41	61.6898	11	.9336	41	12.9706
12	10.0000	42	64.1666	12	1.1111	42	13.6111
13	11.1344	43	66.6898	13	1.3040	43	14.2680
14	12.3148	44	69.2592	14	1.5123	44	14.9382
15	13.5416	45	71.8750	15	1.7361	45	15.6250
16	14.8148	46	74.5370	16	1.9753	46	16.3271
17	16.1344	47	77.2453	17	2.2299	47	17.0447
18	17.5000	48	80.0000	18	2.5000	48	17.7777
19	19.9120	49	82.8009	19	2.7855	49	18.5262
20	20.3703	50	85.6481	20	3.0864	50	19.2901
21	21.8750	51	88.5417	21	3.4028	51	20.0694
22	23.4259	52	91.4815	22	3.7346	52	20.8641
23	25.0230	53	94.4676	23	4.0818	53	21.6743
24	26.6666	54	97.5000	24	4.4444	54	22.5000
25	28.3564	55	100.5786	25	4.8228	55	23.3410
26	30.0926	56	103.7037	26	5.2160	56	24.1975
27	31.8750	57	106.8750	27	5.6250	57	25.0694
28	33.7037	58	110.0926	28	6.0494	58	25.9567
29	35.5786	59	113.3564	29	6.4891	59	26.8595
30	37.5000	60	116.6666	30	6.9444	60	27.7777

BASE 30—SLOPE 1½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5833	31	43.9166	1	.0092	31	8.8981
2	1.2222	32	46.2222	2	.0370	32	9.4815
3	1.9166	33	48.5833	3	.0833	33	10.0833
4	2.6666	34	51.0000	4	.1480	34	10.7037
5	3.4722	35	53.4722	5	.2313	35	11.3425
6	4.3333	36	56.0000	6	.3333	36	12.0000
7	5.2500	37	58.5833	7	.4537	37	12.6759
8	6.2222	38	61.2222	8	.5926	38	13.3703
9	7.2500	39	63.9166	9	.7500	39	14.0833
10	8.3333	40	66.6666	10	.9259	40	14.8148
11	9.4722	41	69.4722	11	1.1203	41	15.5648
12	10.6666	42	72.3333	12	1.3333	42	16.3333
13	11.9166	43	75.2500	13	1.5648	43	17.1202
14	13.2222	44	78.2222	14	1.8148	44	17.9259
15	14.5833	45	81.2500	15	2.0833	45	18.7500
16	16.0000	46	84.3333	16	2.3704	46	19.5925
17	17.4722	47	87.4722	17	2.6759	47	20.4537
18	19.0000	48	90.6666	18	3.0000	48	21.3333
19	21.5833	49	93.9166	19	3.3426	49	22.2314
20	22.2222	50	97.2222	20	3.7037	50	23.1481
21	23.9166	51	100.5833	21	4.0833	51	24.0833
22	25.6666	52	104.0000	22	4.4815	52	25.0370
23	27.4722	53	107.4722	23	4.8981	53	26.0092
24	29.3333	54	111.0000	24	5.3333	54	27.0000
25	31.2500	55	114.5833	25	5.7869	55	28.0092
26	33.2222	56	118.2222	26	6.2592	56	29.0370
27	35.2500	57	121.9166	27	6.7500	57	30.0833
28	37.3333	58	125.6666	28	7.2592	58	31.1481
29	39.4722	59	129.4722	29	7.7869	59	32.2314
30	41.6666	60	133.3333	30	8.3333	60	33.3333

BASE 30—SLOPE 1¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5879	31	48.3657	1	.0108	31	10.3811
2	1.2407	32	50.9629	2	.0432	32	11.0617
3	1.9583	33	53.6250	3	.0972	33	11.7638
4	2.7407	34	56.3518	4	.1728	34	12.4876
5	3.5879	35	59.1435	5	.2700	35	13.2330
6	4.5000	36	62.0000	6	.3889	36	14.0000
7	5.4768	37	64.9213	7	.5293	37	14.7885
8	6.5185	38	67.9073	8	.6913	38	15.5987
9	7.6250	39	70.9583	9	.8750	39	16.4305
10	8.7962	40	74.0740	10	1.0802	40	17.2839
11	10.0324	41	77.2456	11	1.3071	41	18.1589
12	11.3333	42	80.5000	12	1.5555	42	19.0555
13	12.6990	43	83.8101	13	1.8256	43	19.9747
14	14.1296	44	87.1852	14	2.1173	44	20.9135
15	15.6250	45	90.6250	15	2.4305	45	21.8750
16	17.1852	46	94.1296	16	2.7654	46	22.8580
17	18.8101	47	97.6990	17	3.1219	47	23.8626
18	20.5000	48	101.3333	18	3.5000	48	24.8888
19	23.2546	49	105.0324	19	3.8997	49	25.9367
20	24.0740	50	108.7962	20	4.3210	50	27.0061
21	25.9583	51	112.6250	21	4.7639	51	28.0972
22	27.9073	52	116.5185	22	5.2284	52	29.2098
23	29.9213	53	120.4768	23	5.7145	53	30.3441
24	32.0000	54	124.5000	24	6.2222	54	31.5000
25	34.1435	55	128.5879	25	6.7516	55	32.6774
26	36.3518	56	132.7407	26	7.3024	56	33.8765
27	38.6250	57	136.9583	27	7.8750	57	35.0972
28	40.9629	58	141.2407	28	8.4691	58	36.3394
29	43.3657	59	145.5879	29	9.0848	59	37.6033
30	45.8333	60	150.0000	30	9.7222	60	38.8888

BASE 30—SLOPE 2 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5926	31	52.8148	1	.0123	31	11.8642
2	1.2592	32	55.7037	2	.0494	32	12.6419
3	2.0000	33	58.6666	3	.1111	33	13.4444
4	2.8148	34	61.7037	4	.1975	34	14.2716
5	3.7037	35	64.8148	5	.3086	35	15.1234
6	4.6666	36	68.0000	6	.4444	36	16.0000
7	5.7037	37	71.2592	7	.6049	37	16.9012
8	6.8148	38	74.5926	8	.7901	38	17.8271
9	8.0000	39	78.0000	9	1.0000	39	18.7777
10	9.2592	40	81.4814	10	1.2346	40	19.7530
11	10.5926	41	85.0370	11	1.4938	41	20.7530
12	12.0000	42	88.6666	12	1.7778	42	21.7777
13	13.4814	43	92.3074	13	2.0864	43	22.8271
14	15.0370	44	96.1480	14	2.4197	44	23.9012
15	16.6666	45	100.0000	15	2.7778	45	25.0000
16	18.3704	46	103.9259	16	3.1605	46	26.1234
17	20.1480	47	107.9259	17	3.5679	47	27.2716
18	22.0000	48	112.0000	18	4.0000	48	28.4444
19	24.9259	49	116.1480	19	4.4568	49	29.6420
20	25.9259	50	120.3704	20	4.9382	50	30.8642
21	28.0000	51	124.6666	21	5.4444	51	32.1111
22	30.1480	52	129.0370	22	5.9753	52	33.3827
23	32.3704	53	133.4814	23	6.5309	53	34.6790
24	34.6666	54	138.0000	24	7.1111	54	36.0000
25	37.0370	55	142.5926	25	7.7160	55	37.3456
26	39.4814	56	147.2592	26	8.3457	56	38.7160
27	42.0000	57	152.0000	27	9.0000	57	40.1111
28	44.5926	58	156.8148	28	9.6790	58	41.5308
29	47.2592	59	161.7037	29	10.3827	59	42.9753
30	50.0000	60	166.6666	30	11.1111	60	44.4444

BASE 30—SLOPE 2¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6018	31	61.7130	1	.0154	31	14.8302
2	1.2962	32	65.1851	2	.0617	32	15.8015
3	2.0833	33	68.7500	3	.1389	33	16.8055
4	2.9630	34	72.4074	4	.2468	34	17.8395
5	3.9352	35	76.1573	5	.3857	35	18.9043
6	5.0000	36	80.0000	6	.5555	36	20.0000
7	6.1573	37	83.9352	7	.7561	37	21.1265
8	7.4074	38	87.9630	8	.9876	38	22.2839
9	8.7500	39	92.0833	9	1.2500	39	23.4722
10	10.1851	40	96.2962	10	1.5432	40	24.6913
11	11.7130	41	100.6018	11	1.8673	41	25.9413
12	13.3333	42	105.0000	12	2.2222	42	27.2222
13	15.0462	43	109.4908	13	2.6080	43	28.5360
14	16.8518	44	114.0740	14	3.0247	44	29.8765
15	18.7500	45	118.7500	15	3.4722	45	31.2500
16	20.7407	46	123.5185	16	3.9506	46	32.6543
17	22.8240	47	128.3797	17	4.4590	47	34.0895
18	25.0000	48	133.3333	18	5.0000	48	35.5555
19	28.2685	49	138.3797	19	5.5710	49	37.0524
20	29.6296	50	144.5185	20	6.1728	50	38.5802
21	32.0833	51	148.7500	21	6.8055	51	40.1388
22	34.6296	52	154.0740	22	7.4691	52	41.7283
23	37.2685	53	159.4908	23	8.1636	53	43.3487
24	40.0000	54	165.0000	24	8.8889	54	45.0000
25	42.8240	55	170.6018	25	9.6455	55	46.6820
26	45.7407	56	176.2962	26	10.4321	56	48.3950
27	48.7500	57	182.0833	27	11.2500	57	50.1388
28	51.8518	58	187.9630	28	12.0587	58	51.9135
29	55.0462	59	193.9352	29	12.9782	59	53.7191
30	58.3333	60	200.0000	30	13.8889	60	55.5555

BASE 30—SLOPE 3 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6111	31	70.6111	1	.0185	31	17.7963
2	1.3333	32	74.6666	2	.0740	32	18.9630
3	2.1666	33	78.8333	3	.1667	33	20.1666
4	3.1111	34	83.1111	4	.2963	34	21.4074
5	4.1666	35	87.5000	5	.4628	35	22.6851
6	5.3333	36	92.0000	6	.6667	36	24.0000
7	6.6111	37	96.6111	7	.9074	37	25.3518
8	8.0000	38	101.3333	8	1.1852	38	26.7407
9	9.5000	39	106.1666	9	1.5000	39	28.1666
10	11.1111	40	111.1111	10	1.8518	40	29.6296
11	12.8333	41	116.1666	11	2.2407	41	31.1296
12	14.6666	42	121.3333	12	2.6667	42	32.6666
13	16.6111	43	126.6111	13	3.1296	43	34.2407
14	18.6666	44	132.0000	14	3.6296	44	35.8518
15	20.8333	45	137.5000	15	4.1667	45	37.5000
16	23.1111	46	143.1111	16	4.7407	46	39.1851
17	25.5000	47	149.8333	17	5.3518	47	40.9078
18	28.0000	48	154.6666	18	6.0000	48	42.6666
19	31.6111	49	160.6111	19	6.6852	49	44.4629
20	33.3333	50	167.6666	20	7.4074	50	46.2963
21	36.1666	51	172.8333	21	8.1667	51	49.1666
22	39.1111	52	179.1111	22	8.9629	52	50.0740
23	42.1666	53	185.5000	23	9.7962	53	52.0185
24	45.3333	54	192.0000	24	10.6667	54	54.0000
25	48.6111	55	198.6111	25	11.5741	55	56.0184
26	52.0000	56	205.3333	26	12.5184	56	58.0740
27	55.5000	57	212.1666	27	13.5000	57	60.1666
28	59.1111	58	219.1111	28	14.5185	58	62.2962
29	62.8333	59	226.1666	29	15.5741	59	64.4629
30	66.6666	60	233.3333	30	16.6667	60	66.6666

BASE 31—SLOPE ¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5787	31	22.2453	1	.0015	31	1.4830
2	1.1666	32	23.1111	2	.0062	32	1.5802
3	1.7639	33	23.9861	3	.0139	33	1.6805
4	2.3703	34	24.8703	4	.0246	34	1.7839
5	2.9861	35	25.7639	5	.0385	35	1.8904
6	3.6111	36	26.6666	6	.0555	36	2.0000
7	4.2453	37	27.5787	7	.0756	37	2.1126
8	4.8888	38	28.5000	8	.0988	38	2.2284
9	5.5416	39	29.4305	9	.1250	39	2.3472
10	6.2037	40	30.3703	10	.1543	40	2.4691
11	6.8750	41	31.3194	11	.1867	41	2.5941
12	7.5555	42	32.2777	12	.2222	42	2.7222
13	8.2453	43	33.2453	13	.2608	43	2.8545
14	8.9444	44	34.2222	14	.3025	44	2.9876
15	9.6527	45	35.2083	15	.3472	45	3.1250
16	10.3703	46	36.2037	16	.3951	46	3.2654
17	11.0972	47	37.2083	17	.4460	47	3.4089
18	11.8333	48	38.2222	18	.5000	48	3.5555
19	12.5787	49	39.2453	19	.5571	49	3.7052
20	13.3333	50	40.2777	20	.6173	50	3.8580
21	14.0972	51	41.3194	21	.6805	51	4.0139
22	14.8703	52	42.3703	22	.7469	52	4.1728
23	15.6527	53	43.4305	23	.8163	53	4.3349
24	16.4444	54	44.5000	24	.8889	54	4.5000
25	17.2453	55	45.5787	25	.9647	55	4.6682
26	18.0555	56	46.6666	26	1.0432	56	4.8395
27	18.8750	57	47.7639	27	1.1250	67	5.0139
28	19.7037	58	48.8703	28	1.2099	58	5.1913
29	20.5416	59	49.9861	29	1.2978	59	5.3719
30	21.3888	60	51.1111	30	1.3889	60	5.5555

BASE 31—SLOPE ½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5833	31	26.6944	1	.0031	31	2.9660
2	1.1851	32	27.8518	2	.0123	32	3.3611
3	1.8055	33	29.0277	3	.0278	33	3.6111
4	2.4444	34	30.2222	4	.0494	34	3.5679
5	3.1018	35	31.4352	5	.0772	35	3.7808
6	3.7777	36	32.6666	6	.1111	36	4.0000
7	4.4722	37	33.9166	7	.1512	37	4.2253
8	5.1851	38	35.1851	8	.1975	38	4.4568
9	5.9166	39	36.4722	9	.2500	39	4.6944
10	6.6666	40	37.7777	10	.3086	40	4.9383
11	7.4352	41	39.1018	11	.3734	41	5.1883
12	8.2222	42	40.4444	12	.4444	42	5.4444
13	9.0277	43	41.8055	13	.5216	43	5.7076
14	9.8518	44	43.1851	14	.6049	44	5.9753
15	10.6944	45	44.5833	15	.6944	45	6.2500
16	11.5555	46	46.0000	16	.7901	46	6.5308
17	12.4352	47	47.4351	17	.8920	47	6.8179
18	13.3333	48	48.8888	18	1.0000	48	7.1111
19	14.2500	49	50.3611	19	1.1142	49	7.4105
20	15.1851	50	51.8518	20	1.2346	50	7.7160
21	16.1388	51	53.3611	21	1.3611	51	8.0277
22	17.1111	52	54.8888	22	1.4938	52	8.3456
23	18.1018	53	56.4351	23	1.6327	53	8.6697
24	19.1111	54	58.0000	24	1.7778	54	9.0000
25	20.1388	55	59.5833	25	1.9295	55	9.3364
26	21.1851	56	61.1851	26	2.0864	56	9.6790
27	22.2500	57	62.8055	27	2.2500	57	10.0277
28	23.3333	58	64.4444	28	2.4197	58	10.3827
29	24.4352	59	66.1018	29	2.5956	59	10.7438
30	25.5555	60	67.7777	30	2.7778	60	11.1111

BASE 31—SLOPE ¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5880	31	31.1435	1	.0046	31	4.4490
2	1.2037	32	32.5926	2	.0185	32	4.7407
3	1.8472	33	34.0694	3	.0416	33	5.0416
4	2.5185	34	35.5740	4	.0740	34	5.3518
5	3.2175	35	37.1065	5	.1157	35	5.6712
6	3.9444	36	38.6666	6	.1667	36	6.0000
7	4.6990	37	40.2546	7	.2268	37	6.3379
8	5.4814	38	41.8703	8	.2963	38	6.6851
9	6.2916	39	43.5140	9	.3750	39	7.0416
10	7.1296	40	45.1852	10	.4630	40	7.4074
11	7.9954	41	46.8842	11	.5602	41	7.7824
12	8.8888	42	48.6111	12	.6667	42	8.1666
13	9.8102	43	50.3657	13	.7824	43	8.5612
14	10.7592	44	52.1481	14	.9074	44	8.9629
15	11.7360	45	53.9583	15	1.0417	45	9.3750
16	12.7407	46	55.7963	16	1.1852	46	9.7962
17	13.7732	47	57.6620	17	1.3379	47	10.2268
18	14.8333	48	59.5555	18	1.5000	48	10.6666
19	15.9213	49	61.4768	19	1.6713	49	11.1157
20	17.0370	50	63.4260	20	1.8518	50	11.5740
21	18.1805	51	65.4028	21	2.0417	51	12.0416
22	19.3518	52	67.4074	22	2.2407	52	12.5185
23	20.5509	53	69.4397	23	2.4491	53	13.0046
24	21.7777	54	71.5000	24	2.6667	54	13.5000
25	23.0323	55	73.5879	25	2.8935	55	14.0046
26	24.3147	56	75.7037	26	3.1296	56	14.5185
27	25.6250	57	77.8472	27	3.3750	57	15.0416
28	26.9629	58	80.0185	28	3.6296	58	15.5740
29	28.3288	59	82.2175	29	3.8935	59	16.1157
30	29.7222	60	84.4444	30	4.1667	60	16.6666

BASE 31—SLOPE 1 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5926	31	35.5926	1	.0062	31	5.9321
2	1.2222	32	37.3333	2	.0247	32	6.3210
3	1.8888	33	39.1111	3	.0555	33	6.7222
4	2.5926	34	40.9260	4	.0988	34	7.1358
5	3.3333	35	42.7777	5	.1543	35	7.5617
6	4.1111	36	44.6666	6	.2222	36	8.0000
7	4.9260	37	46.5926	7	.3025	37	8.4506
8	5.7777	38	48.5555	8	.3951	38	8.9135
9	6.6666	39	50.5555	9	.5000	39	9.3888
10	7.5926	40	52.5926	10	.6173	40	9.8765
11	8.5555	41	54.6666	11	.7469	41	10.3765
12	9.5555	42	56.7777	12	.8889	42	10.8888
13	10.5926	43	58.9260	13	1.0432	43	11.4135
14	11.6666	44	61.1111	14	1.2099	44	11.9506
15	12.7777	45	63.3333	15	1.3889	45	12.5000
16	13.9260	46	65.5926	16	1.5802	46	13.0617
17	15.1111	47	67.8888	17	1.7839	47	13.6358
18	16.3333	48	70.2222	18	2.0000	48	14.2222
19	17.5926	49	72.5926	19	2.2284	49	14.8209
20	18.8888	50	75.0000	20	2.4691	50	15.4321
21	20.2222	51	77.4444	21	2.7222	51	16.0555
22	21.5926	52	79.9260	22	2.9876	52	16.6918
23	23.0000	53	82.4444	23	3.2654	53	17.3395
24	24.4444	54	85.0000	24	3.5555	54	18.0000
25	25.9260	55	87.5926	25	3.8530	55	18.6728
26	27.4444	56	90.2222	26	4.1728	56	19.3580
27	29.0000	57	92.8888	27	4.5000	57	20.0555
28	30.5926	58	95.5926	28	4.8395	58	20.7654
29	32.2222	59	98.3333	29	5.1913	59	21.4876
30	33.8888	60	101.1111	30	5.5555	60	22.2222

BASE 31—SLOPE 1¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5972	31	40.0416	1	.0077	31	7.4151
2	1.2407	32	42.0740	2	.0309	32	7.9012
3	1.9305	33	44.1528	3	.0694	33	8.4027
4	2.6666	34	46.2777	4	.1234	34	8.9197
5	3.4490	35	48.4490	5	.1928	35	9.4521
6	4.2777	36	50.6666	6	.2778	36	10.0000
7	5.1528	37	52.9305	7	.3781	37	10.5632
8	6.0740	38	55.2407	8	.4938	38	11.1419
9	7.0416	39	57.5972	9	.6250	39	11.7361
10	8.0555	40	60.0000	10	.7716	40	12.3456
11	9.1157	41	62.4490	11	.9336	41	12.9706
12	10.2222	42	64.9444	12	1.1111	42	13.6111
13	11.3750	43	67.4862	13	1.3040	43	14.2680
14	12.5740	44	70.0740	14	1.5123	44	14.9382
15	13.8193	45	72.7083	15	1.7361	45	15.6250
16	15.1111	46	75.3888	16	1.9753	46	16.3271
17	16.4490	47	78.1156	17	2.2299	47	17.0447
18	17.8333	48	80.8888	18	2.5000	48	17.7777
19	19.2640	49	83.7083	19	2.7855	49	18.5262
20	20.7407	50	86.5740	20	3.0864	50	19.2901
21	22.2640	51	89.4862	21	3.4028	51	20.0694
22	23.8333	52	92.4444	22	3.7346	52	20.8641
23	25.4490	53	95.4490	23	4.0818	53	21.6743
24	27.1111	54	98.5000	24	4.4444	54	22.5000
25	28.8193	55	101.5972	25	4.8228	55	23.3410
26	30.5740	56	104.7407	26	5.2160	56	24.1975
27	32.3750	57	107.9305	27	5.6250	57	25.0694
28	34.2222	58	111.1666	28	6.0494	58	25.9567
29	36.1157	59	114.4490	29	6.4891	59	26.8595
30	38.0555	60	117.7777	30	6.9444	60	27.7777

BASE 31—SLOPE 1½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6018	31	44.4907	1	.0092	31	8.8981
2	1.2592	32	46.8148	2	.0370	32	9.4815
3	1.9722	33	49.1944	3	.0833	33	10.0833
4	2.7407	34	51.6296	4	.1480	34	10.7037
5	3.5647	35	54.1203	5	.2313	35	11.3425
6	4.4444	36	56.6666	6	.3333	36	12.0000
7	5.3796	37	59.2684	7	.4537	37	12.6759
8	6.3703	38	61.9259	8	.5926	38	13.3703
9	7.4166	39	64.6388	9	.7500	39	14.0833
10	8.5185	40	67.4074	10	.9259	40	14.8148
11	9.6759	41	70.2314	11	1.1203	41	15.5648
12	10.8888	42	73.1111	12	1.3333	42	16.3333
13	12.1574	43	76.0462	13	1.5648	43	17.1202
14	13.4815	44	79.0370	14	1.8148	44	17.9259
15	14.8611	45	82.0833	15	2.0833	45	18.7500
16	16.2962	46	85.1851	16	2.3704	46	19.5925
17	17.7870	47	88.3424	17	2.6759	47	20.4537
18	19.3333	48	91.5555	18	3.0000	48	21.3333
19	20.9350	49	94.8240	19	3.3426	49	22.2314
20	22.5926	50	98.1482	20	3.7037	50	23.1481
21	24.3055	51	101.5277	21	4.0833	51	24.0833
22	26.0740	52	104.9629	22	4.4815	52	25.0370
23	27.8982	53	108.4536	23	4.8981	53	26.0092
24	29.7777	54	112.0000	24	5.3333	54	27.0000
25	31.7130	55	115.6018	25	5.7869	55	28.0092
26	33.7037	56	119.2592	26	6.2592	56	29.0370
27	35.7500	57	122.9722	27	6.7500	57	30.0833
28	37.8518	58	126.7407	28	7.2592	58	31.1481
29	40.0092	59	130.5647	29	7.7869	59	32.2314
30	42.2222	60	134.4444	30	8.3333	60	33.3333

BASE 31—SLOPE 1¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6064	31	48.9398	1	.0108	31	10.3811
2	1.2777	32	51.5555	2	.0432	32	11.0617
3	2.0139	33	54.2360	3	.0972	33	11.7638
4	2.8148	34	56.9815	4	.1728	34	12.4876
5	3.6804	35	59.7916	5	.2700	35	13.2330
6	4.6111	36	62.6666	6	.3889	36	14.0000
7	5.6064	37	65.6064	7	.5293	37	14.7885
8	6.6666	38	68.6111	8	.6913	38	15.5987
9	7.7916	39	71.6804	9	.8750	39	16.4305
10	8.9815	40	74.8148	10	1.0802	40	17.2839
11	10.2360	41	78.0139	11	1.3071	41	18.1589
12	11.5555	42	81.2777	12	1.5555	42	19.0555
13	12.9398	43	84.6064	13	1.8256	43	19.9747
14	14.3888	44	88.0000	14	2.1173	44	20.9135
15	15.9027	45	91.4583	15	2.4305	45	21.8750
16	17.4815	46	94.9814	16	2.7654	46	22.8580
17	19.1250	47	98.5694	17	3.1219	47	23.8626
18	20.8333	48	102.2222	18	3.5000	48	24.8888
19	22.6064	49	105.9397	19	3.8997	49	25.9367
20	24.4444	50	109.7222	20	4.3210	50	27.0061
21	26.3470	51	113.5694	21	4.7639	51	28.0972
22	28.3147	52	117.4814	22	5.2284	52	29.2098
23	30.3470	53	121.4583	23	5.7145	53	30.3441
24	32.4444	54	125.5000	24	6.2222	54	31.5000
25	34.6064	55	129.6064	25	6.7516	55	32.6774
26	36.8333	56	133.7777	26	7.3024	56	33.8765
27	39.1250	57	138.0140	27	7.8750	57	35.0972
28	41.4815	58	142.3148	28	8.4691	58	36.3394
29	43.9027	59	146.6804	29	9.0848	59	37.6033
30	46.3888	60	151.1111	30	9.7222	60	38.8888

BASE 31—SLOPE 2 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6111	31	53.3888	1	.0123	31	11.8642
2	1.2962	32	56.2962	2	.0494	32	12.6419
3	2.0555	33	59.2777	3	.1111	33	13.4444
4	2.8888	34	62.3333	4	.1975	34	14.2716
5	3.7962	35	65.4629	5	.3086	35	15.1234
6	4.7777	36	68.6666	6	.4444	36	16.0000
7	5.8333	37	71.9444	7	.6049	37	16.9012
8	6.9629	38	75.2962	8	.7901	38	17.8271
9	8.1666	39	78.7222	9	1.0000	39	18.7777
10	9.4444	40	82.2222	10	1.2346	40	19.7530
11	10.7962	41	85.7962	11	1.4938	41	20.7530
12	12.2222	42	89.4444	12	1.7778	42	21.7777
13	13.7222	43	93.1666	13	2.0864	43	22.8271
14	15.2962	44	96.9629	14	2.4197	44	23.9012
15	16.9444	45	100.8333	15	2.7778	45	25.0000
16	18.6666	46	104.7777	16	3.1605	46	26.1234
17	20.4629	47	108.7962	17	3.5679	47	27.2716
18	22.3333	48	112.8888	18	4.0000	48	28.4444
19	24.2777	49	117.0555	19	4.4568	49	29.6420
20	26.2962	50	121.2962	20	4.9382	50	30.8642
21	28.3888	51	125.6111	21	5.4444	51	32.1111
22	30.5555	52	130.0000	22	5.9753	52	33.3827
23	32.7962	53	134.4629	23	6.5309	53	34.6790
24	35.1111	54	139.0000	24	7.1111	54	36.0000
25	37.5000	55	143.6111	25	7.7160	55	37.3456
26	39.9629	56	148.2962	26	8.3457	56	38.7160
27	42.5000	57	153.0555	27	9.0000	57	40.1111
28	45.1111	58	157.8888	28	9.6790	58	41.5308
29	47.7962	59	162.7962	29	10.3827	59	42.9753
30	50.5555	60	167.7777	30	11.1111	60	44.4444

BASE 31—SLOPE 2½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6203	31	62.2870	1	.0154	31	14.8302
2	1.3333	32	65.7777	2	.0617	32	15.8013
3	2.1388	33	69.3611	3	.1389	33	16.8055
4	3.0370	34	73.0370	4	.2468	34	17.8395
5	4.0277	35	76.8055	5	.3857	35	18.9043
6	5.1111	36	80.6666	6	.5555	36	20.0000
7	6.2870	37	84.6202	7	.7561	37	21.1265
8	7.5555	38	88.6666	8	.9876	38	22.2839
9	8.9166	39	92.8055	9	1.2500	39	23.4722
10	10.3703	40	97.0370	10	1.5432	40	24.6913
11	11.9166	41	101.3611	11	1.8673	41	25.9413
12	13.5555	42	105.7777	12	2.2222	42	27.2222
13	15.2870	43	110.2870	13	2.6080	43	28.5360
14	17.1111	44	114.8888	14	3.0247	44	29.8765
15	19.0277	45	119.5833	15	3.4722	45	31.2500
16	21.0370	46	124.3703	16	3.9506	46	32.6543
17	23.1388	47	129.2500	17	4.4599	47	34.0895
18	25.3333	48	134.2222	18	5.0000	48	35.5555
19	27.6203	49	139.2870	19	5.5710	49	37.0524
20	30.0000	50	144.4444	20	6.1728	50	38.5802
21	34.4722	51	149.6944	21	6.8055	51	40.1388
22	35.0370	52	155.0370	22	7.4691	52	41.7283
23	37.6944	53	160.4722	23	8.1636	53	43.3487
24	40.4444	54	166.0000	24	8.8889	54	45.0000
25	43.2870	55	171.6203	25	9.6455	55	46.6820
26	46.2222	56	177.3333	26	10.4321	56	48.3950
27	49.2500	57	183.1388	27	11.2500	57	50.1388
28	52.3703	58	189.0370	28	12.0587	58	51.9135
29	55.5833	59	195.0277	29	12.9782	59	53.7191
30	58.8888	60	201.1111	30	13.8889	60	55.5555

BASE 31—SLOPE 3 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6296	31	71.1851	1	.0185	31	17.7963
2	1.3704	32	75.2592	2	.0740	32	18.9630
3	2.2222	33	79.4444	3	.1667	33	20.1666
4	3.1851	34	83.7407	4	.2963	34	21.4074
5	4.2592	35	88.1481	5	.4628	35	22.6851
6	5.4444	36	92.6666	6	.6667	36	24.0000
7	6.7407	37	97.2962	7	.9074	37	25.3518
8	8.1481	38	102.0370	8	1.1852	38	26.7407
9	9.6666	39	106.8888	9	1.5000	39	28.1666
10	11.2962	40	111.8518	10	1.8518	40	29.6296
11	13.0370	41	116.9260	11	2.2407	41	31.1296
12	14.8888	42	122.1111	12	2.6667	42	32.6666
13	16.8518	43	127.4074	13	3.1296	43	34.2407
14	18.9260	44	132.8146	14	3.6296	44	35.8518
15	21.1111	45	138.3333	15	4.1667	45	37.5000
16	23.4074	46	143.9629	16	4.7407	46	39.1851
17	25.8147	47	149.7037	17	5.3518	47	40.9074
18	28.3333	48	155.5555	18	6.0000	48	42.6666
19	30.9629	49	161.5185	19	6.6852	49	44.4629
20	33.7037	50	167.5926	20	7.4074	50	46.2963
21	36.5555	51	173.7777	21	8.1667	51	49.1666
22	39.5185	52	180.0740	22	8.9629	52	50.0740
23	42.5926	53	186.4814	23	9.7962	53	52.0185
24	45.7777	54	193.0000	24	10.6667	54	54.0000
25	49.0740	55	199.6296	25	11.5741	55	56.0184
26	52.4814	56	206.3703	26	12.5184	56	58.0740
27	56.0000	57	213.2222	27	13.5000	57	60.1666
28	59.6296	58	220.1852	28	14.5185	58	62.2962
29	63.3703	59	227.2592	29	15.5741	59	64.4629
30	67.2222	60	234.4444	30	16.6667	60	66.6666

BASE 32—SLOPE ¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.5972	31	22.8194	1	.0015	31	1.4830
2	1.2037	32	23.7037	2	.0062	32	1.5802
3	1.8194	33	24.5972	3	.0139	33	1.6805
4	2.4444	34	25.5000	4	.0246	34	1.7839
5	3.0787	35	26.4120	5	.0385	35	1.8904
6	3.7222	36	27.3333	6	.0555	36	2.0000
7	4.3750	37	28.2639	7	.0756	37	2.1126
8	5.0370	38	29.2037	8	.0988	38	2.2284
9	5.7083	39	30.1527	9	.1250	39	2.3472
10	6.3888	40	31.1111	10	.1543	40	2.4691
11	7.0787	41	32.0787	11	.1867	41	2.5941
12	7.7777	42	33.0555	12	.2222	42	2.7222
13	8.4861	43	34.0416	13	.2608	43	2.8545
14	9.2037	44	35.0370	14	.3025	44	2.9876
15	9.9305	45	36.0416	15	.3472	45	3.1250
16	10.6666	46	37.0555	16	.3951	46	3.2654
17	11.4120	47	38.0787	17	.4460	47	3.4089
18	12.1666	48	39.1111	18	.5000	48	3.5555
19	12.9305	49	40.1527	19	.5571	49	3.7052
20	13.7037	50	41.2037	20	.6173	50	3.8580
21	14.4861	51	42.2639	21	.6805	51	4.0139
22	15.2777	52	43.3333	22	.7469	52	4.1728
23	16.0787	53	44.4120	23	.8163	53	4.3349
24	16.8888	54	45.5000	24	.8889	54	4.5000
25	17.7083	55	46.5972	25	.9647	55	4.6682
26	18.5370	56	47.7037	26	1.0432	56	4.8395
27	19.3750	57	48.8194	27	1.1250	57	5.0139
28	20.2222	58	49.9444	28	1.2099	58	5.1913
29	21.0787	59	51.0787	29	1.2978	59	5.3719
30	21.9444	60	52.2222	30	1.3889	60	5.5555

BASE 32—SLOPE ½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6018	31	27.2685	1	.0031	31	2.9660
2	1.2222	32	28.4444	2	.0123	32	3.1605
3	1.8611	33	29.6389	3	.0278	33	3.3611
4	2.5185	34	30.8518	4	.0494	34	3.5679
5	3.1944	35	32.0833	5	.0772	35	3.7808
6	3.8888	36	33.3333	6	.1111	36	4.0000
7	4.6018	37	34.6018	7	.1512	37	4.2253
8	5.3333	38	35.8888	8	.1975	38	4.4568
9	6.0833	39	37.1944	9	.2500	39	4.6944
10	6.8518	40	38.5185	10	.3086	40	4.9383
11	7.6389	41	39.8611	11	.3734	41	5.1883
12	8.4444	42	41.2222	12	.4444	42	5.4444
13	9.2685	43	42.6018	13	.5216	43	5.7067
14	10.1111	44	44.0000	14	.6049	44	5.9753
15	10.9722	45	45.4166	15	.6944	45	6.2500
16	11.8518	46	46.8518	16	.7901	46	6.5308
17	12.7500	47	48.3055	17	.8920	47	6.8179
18	13.6666	48	49.7777	18	1.0000	48	7.1111
19	14.6018	49	51.2684	19	1.1142	49	7.4105
20	15.5555	50	52.7777	20	1.2346	50	7.7160
21	16.5277	51	54.3055	21	1.3611	51	8.0277
22	17.5185	52	55.8518	22	1.4938	52	8.3456
23	18.5277	53	57.4166	23	1.6327	53	8.6697
24	19.5555	54	59.0000	24	1.7778	54	9.0000
25	20.6018	55	60.6018	25	1.9295	55	9.3364
26	21.6666	56	62.2222	26	2.0864	56	9.6790
27	22.7500	57	63.8611	27	2.2500	57	10.0277
28	23.8518	58	65.5185	28	2.4197	58	10.3827
29	24.9722	59	67.1944	29	2.5956	59	10.7438
30	26.1111	60	68.8888	30	2.7778	60	11.1111

BASE 32—SLOPE ¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6064	31	31.7176	1	.0046	31	4.4490
2	1.2407	32	33.1851	2	.0185	32	4.7407
3	1.9028	33	34.6805	3	.0416	33	5.0416
4	2.5926	34	36.2037	4	.0740	34	5.3518
5	3.3101	35	37.7546	5	.1157	35	5.6712
6	4.0555	36	39.3333	6	.1667	36	6.0000
7	4.8286	37	40.9397	7	.2268	37	6.3379
8	5.6296	38	42.5740	8	.2963	38	6.6851
9	6.4583	39	44.2360	9	.3750	39	7.0416
10	7.3148	40	45.9259	10	.4630	40	7.4074
11	8.1991	41	47.6435	11	.5602	41	7.7824
12	9.1111	42	49.3888	12	.6667	42	8.1666
13	10.0509	43	51.1620	13	.7824	43	8.5602
14	11.0185	44	52.9629	14	.9074	44	8.9629
15	12.0138	45	54.7916	15	1.0417	45	9.3750
16	13.0370	46	56.6481	16	1.1852	46	9.7962
17	14.0879	47	58.5323	17	1.3379	47	10.2268
18	15.1666	48	60.4444	18	1.5000	48	10.6666
19	16.2731	49	62.3842	19	1.6713	49	11.1157
20	17.4074	50	64.3518	20	1.8518	50	11.5740
21	18.5694	51	66.3472	21	2.0417	51	12.0416
22	19.7592	52	68.3703	22	2.2407	52	12.5185
23	20.9768	53	70.4212	23	2.4491	53	13.0046
24	22.2222	54	72.5000	24	2.6667	54	13.5000
25	23.4953	55	74.6064	25	2.8935	55	14.0046
26	24.7962	56	76.7407	26	3.1296	56	14.5185
27	26.1250	57	78.9028	27	3.3750	57	15.0416
28	27.4814	58	81.0926	28	3.6296	58	15.5740
29	28.8657	59	83.3101	29	3.8935	59	16.1157
30	30.2777	60	85.5555	30	4.1667	60	16.6666

BASE 32—SLOPE 1 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6111	31	36.1666	1	.0062	31	5.9321
2	1.2592	32	37.9259	2	.0247	32	6.3210
3	1.9444	33	39.7222	3	.0555	33	6.7222
4	2.6666	34	41.5555	4	.0988	34	7.1358
5	3.4259	35	43.4259	5	.1543	35	7.5617
6	4.2222	36	45.3333	6	.2222	36	8.0000
7	5.0555	37	47.2777	7	.3025	37	8.4506
8	5.9259	38	49.2592	8	.3951	38	8.9135
9	6.8333	39	51.2777	9	.5000	39	9.3888
10	7.7777	40	53.3333	10	.6173	40	9.8765
11	8.7592	41	55.4259	11	.7469	41	10.3765
12	9.7777	42	57.5555	12	.8889	42	10.8888
13	10.8333	43	59.7222	13	1.0432	43	11.4135
14	11.9259	44	61.9259	14	1.2099	44	11.9506
15	13.0555	45	64.1666	15	1.3889	45	12.5000
16	14.2222	46	66.4444	16	1.5802	46	13.0617
17	15.4259	47	68.7592	17	1.7839	47	13.6358
18	16.6666	48	71.1111	18	2.0000	48	14.2222
19	17.9444	49	73.5000	19	2.2284	49	14.8209
20	19.2592	50	75.9259	20	2.4691	50	15.4321
21	20.6111	51	78.3888	21	2.7222	51	16.0555
22	22.0000	52	80.8888	22	2.9876	52	16.6913
23	23.4259	53	83.4259	23	3.2654	53	17.3395
24	24.8888	54	86.0000	24	3.5555	54	18.0000
25	26.3888	55	88.6111	25	3.8580	55	18.6728
26	27.9259	56	91.2592	26	4.1728	56	19.3580
27	29.5000	57	93.9444	27	4.5000	57	20.0555
28	31.1111	58	96.6666	28	4.8395	58	20.7654
29	32.7592	59	99.4259	29	5.1913	59	21.4876
30	34.4444	60	102.2222	30	5.5555	60	22.2222

BASE 32—SLOPE 1¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6157	31	40.6157	1	.0077	31	7.4151
2	1.2777	32	42.6666	2	.0309	32	7.9012
3	1.9861	33	44.7639	3	.0694	33	8.4027
4	2.7407	34	46.9074	4	.1234	34	8.9197
5	3.5416	35	49.0971	5	.1928	35	9.4521
6	4.3888	36	51.3333	6	.2778	36	10.0000
7	5.2823	37	53.6157	7	.3781	37	10.5632
8	6.2222	38	55.9444	8	.4938	38	11.1419
9	7.2083	39	58.3195	9	.6250	39	11.7361
10	8.2407	40	60.7407	10	.7716	40	12.3456
11	9.3195	41	63.2083	11	.9336	41	12.9706
12	10.4444	42	65.7222	12	1.1111	42	13.6111
13	11.6157	43	68.2823	13	1.3040	43	14.2680
14	12.8333	44	70.8888	14	1.5123	44	14.9382
15	14.0971	45	73.5416	15	1.7361	45	15.6250
16	15.4074	46	76.2407	16	1.9753	46	16.3271
17	16.7639	47	78.9861	17	2.2299	47	17.0447
18	18.1666	48	81.7777	18	2.5000	48	17.7777
19	19.6157	49	84.6157	19	2.7855	49	18.5262
20	21.1111	50	87.5000	20	3.0864	50	19.2901
21	22.6528	51	90.4305	21	3.4028	51	20.0694
22	24.2407	52	93.4074	22	3.7346	52	20.8641
23	25.8750	53	96.4305	23	4.0818	53	21.6743
24	27.5555	54	99.5000	24	4.4444	54	22.5000
25	29.2823	55	102.6157	25	4.8228	55	23.3410
26	31.0555	56	105.7777	26	5.2160	56	24.1975
27	32.8750	57	108.9861	27	5.6250	57	25.0694
28	34.7407	58	112.2407	28	6.0494	58	25.9567
29	36.6528	59	115.5416	29	6.4891	59	26.8595
30	38.6111	60	118.8888	30	6.9444	60	27.7777

BASE 32—SLOPE 1½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6203	31	45.0648	1	.0092	31	8.8981
2	1.2962	32	47.4074	2	.0370	32	9.4815
3	2.0277	33	49.8055	3	.0833	33	10.0833
4	2.8148	34	52.2592	4	.1480	34	10.7037
5	3.6574	35	54.7685	5	.2313	35	11.3425
6	4.5555	36	57.3333	6	.3333	36	12.0000
7	5.5092	37	59.9536	7	.4537	37	12.6759
8	6.5185	38	62.6296	8	.5926	38	13.3703
9	7.5833	39	65.3611	9	.7500	39	14.0833
10	8.7037	40	68.1481	10	.9259	40	14.8148
11	9.8797	41	70.9907	11	1.1203	41	15.5648
12	11.1111	42	73.8888	12	1.3333	42	16.3333
13	12.3981	43	76.8425	13	1.5648	43	17.1202
14	13.7407	44	79.8519	14	1.8148	44	17.9259
15	15.1388	45	82.9166	15	2.0833	45	18.7500
16	16.5926	46	86.0370	16	2.3704	46	19.5925
17	18.1018	47	89.2129	17	2.6759	47	20.4537
18	19.6666	48	92.4444	18	3.0000	48	21.3333
19	21.2870	49	95.7314	19	3.3426	49	22.2314
20	22.9629	50	99.0740	20	3.7037	50	23.1481
21	24.6944	51	102.4722	21	4.0833	51	24.0833
22	26.4814	52	105.9259	22	4.4815	52	25.0370
23	28.3241	53	109.4351	23	4.8981	53	26.0092
24	30.2222	54	113.0000	24	5.3333	54	27.0000
25	32.1758	55	116.6203	25	5.7869	55	28.0092
26	34.1851	56	120.2962	26	6.2592	56	29.0370
27	36.2500	57	124.0277	27	6.7500	57	30.0833
28	38.3703	58	127.8148	28	7.2592	58	31.1481
29	40.5462	59	131.6574	29	7.7869	59	32.2314
30	42.7777	60	135.5555	30	8.3333	60	33.3333

BASE 32—SLOPE 1¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6250	31	49.5139	1	.0108	31	10.3811
2	1.3147	32	52.1481	2	.0432	32	11.0617
3	2.0694	33	54.8472	3	.0972	33	11.7638
4	2.8888	34	57.6111	4	.1728	34	12.4876
5	3.7731	35	60.4397	5	.2700	35	13.2330
6	4.7222	36	63.3333	6	.3889	36	14.0000
7	5.7360	37	66.2916	7	.5293	37	14.7885
8	6.8148	38	69.3148	8	.6913	38	15.5987
9	7.9583	39	72.4027	9	.8750	39	16.4305
10	9.1666	40	75.5555	10	1.0802	40	17.2839
11	10.4399	41	78.7731	11	1.3071	41	18.1589
12	11.7777	42	82.0555	12	1.5555	42	19.0555
13	13.1805	43	85.4027	13	1.8256	43	19.9747
14	14.6481	44	88.8148	14	2.1173	44	20.9135
15	16.1805	45	92.2916	15	2.4305	45	21.8750
16	17.7777	46	95.8333	16	2.7654	46	22.8580
17	19.4399	47	99.4397	17	3.1219	47	23.8626
18	21.1666	48	103.1111	18	3.5000	48	24.8888
19	22.9583	49	106.8472	19	3.8997	49	25.9367
20	24.8148	50	110.6481	20	4.3210	50	27.0061
21	26.7360	51	114.5139	21	4.7639	51	28.0972
22	28.7222	52	118.4444	22	5.2284	52	29.2098
23	30.7731	53	122.4399	23	5.7145	53	30.3441
24	32.8888	54	126.5000	24	6.2222	54	31.5000
25	35.0694	55	130.6250	25	6.7516	55	32.6774
26	37.3147	56	134.8147	26	7.3024	56	33.8765
27	39.6250	57	139.0694	27	7.8750	57	35.0972
28	42.0000	58	143.3888	28	8.4691	58	36.3394
29	44.4399	59	147.7731	29	9.0848	59	37.6033
30	46.9444	60	152.2222	30	9.7222	60	38.8888

BASE 32—SLOPE 2 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6296	31	53.9629	1	.0123	31	11.8642
2	1.3333	32	56.8888	2	.0494	32	12.6419
3	2.1111	33	59.8888	3	.1111	33	13.4444
4	2.9629	34	62.9629	4	.1975	34	14.2716
5	3.8888	35	66.1111	5	.3086	35	15.1234
6	4.8888	36	69.3333	6	.4444	36	16.0000
7	5.9629	37	72.6296	7	.6049	37	16.9012
8	7.1111	38	76.0000	8	.7901	38	17.8271
9	8.3333	39	79.4444	9	1.0000	39	18.7777
10	9.6296	40	82.9629	10	1.2346	40	19.7530
11	11.0000	41	86.5555	11	1.4938	41	20.7530
12	12.4444	42	90.2222	12	1.7778	42	21.7777
13	13.9629	43	93.9629	13	2.0864	43	22.8271
14	15.5555	44	97.7777	14	2.4197	44	23.9012
15	17.2222	45	101.6666	15	2.7778	45	25.0000
16	18.9629	46	105.6296	16	3.1605	46	26.1234
17	20.7777	47	109.6666	17	3.5679	47	27.2716
18	22.6666	48	113.7777	18	4.0000	48	28.4444
19	24.6296	49	117.9629	19	4.4568	49	29.6420
20	26.6666	50	122.2222	20	4.9382	50	30.8642
21	28.7777	51	126.5555	21	5.4444	51	32.1111
22	30.9629	52	130.9629	22	5.9753	52	33.3827
23	33.2222	53	135.4444	23	6.5309	53	34.6790
24	35.5555	54	140.0000	24	7.1111	54	36.0000
25	37.9629	55	144.6296	25	7.7160	55	37.3456
26	40.4444	56	149.3333	26	8.3457	56	38.7160
27	43.0000	57	154.1111	27	9.0000	57	40.1111
28	45.6296	58	158.9629	28	9.6790	58	41.5308
29	48.3333	59	163.8888	29	10.3827	59	42.9753
30	51.1111	60	168.8888	30	11.1111	60	44.4444

BASE 32—SLOPE 2½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6388	31	62.8611	1	.0154	31	14.8302
2	1.3703	32	66.3703	2	.0617	32	15.8015
3	2.1944	33	69.9722	3	.1389	33	16.8055
4	3.1111	34	73.6666	4	.2468	34	17.8395
5	4.1203	35	77.4537	5	.3857	35	18.9043
6	5.2222	36	81.3333	6	.5555	36	20.0000
7	6.4166	37	85.3055	7	.7561	37	21.1265
8	7.7037	38	89.3703	8	.9876	38	22.2839
9	9.0833	39	93.5277	9	1.2500	39	23.4722
10	10.5555	40	97.7777	10	1.5432	40	24.6913
11	12.1203	41	102.1203	11	1.8673	41	25.9413
12	13.7777	42	106.5555	12	2.2222	42	27.2222
13	15.5277	43	111.0833	13	2.6080	43	28.5360
14	17.3703	44	115.7037	14	3.0247	44	29.8765
15	19.3055	45	120.4166	15	3.4722	45	31.2500
16	21.3333	46	125.2222	16	3.9506	46	32.6543
17	23.4537	47	130.1203	17	4.4599	47	34.0895
18	25.6666	48	135.1111	18	5.0000	48	35.5555
19	27.9722	49	140.1944	19	5.5710	49	37.0524
20	30.3703	50	145.3703	20	6.1728	50	38.5802
21	32.8611	51	150.6388	21	6.8055	51	40.1388
22	35.4444	52	156.0000	22	7.4691	52	41.7283
23	38.1203	53	161.4537	23	8.1636	53	43.3487
24	40.8888	54	167.0000	24	8.8889	54	45.0000
25	43.7500	55	172.6388	25	9.6455	55	46.6820
26	46.7037	56	178.3703	26	10.4321	56	48.3950
27	49.7500	57	184.1944	27	11.2500	57	50.1388
28	52.8888	58	190.1111	28	12.0587	58	51.9135
29	56.1203	59	196.1203	29	12.9782	59	53.7191
30	59.4444	60	202.2222	30	13.8889	60	55.5555

BASE 32—SLOPE 3 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6480	31	71.7592	1	.0185	31	17.7963
2	1.4074	32	75.8518	2	.0740	32	18.9630
3	2.2777	33	80.0555	3	.1667	33	20.1666
4	3.2592	34	84.3703	4	.2963	34	21.4074
5	4.3518	35	88.7962	5	.4628	35	22.6851
6	5.5555	36	93.3333	6	.6667	36	24.0000
7	6.8703	37	97.9814	7	.9074	37	25.3518
8	8.2962	38	102.7407	8	1.1852	38	26.7407
9	9.8333	39	107.6111	9	1.5000	39	28.1666
10	11.4814	40	112.5926	10	1.8518	40	29.6296
11	13.2407	41	117.6851	11	2.2407	41	31.1296
12	15.1111	42	122.8888	12	2.6667	42	32.6666
13	17.0926	43	128.2037	13	3.1296	43	34.2407
14	19.1851	44	133.6296	14	3.6296	44	35.8518
15	21.3888	45	139.1666	15	4.1667	45	37.5000
16	23.7037	46	144.8148	16	4.7407	46	39.1851
17	26.1296	47	150.5740	17	5.3518	47	40.9078
18	28.6666	48	156.4444	18	6.0000	48	42.6666
19	31.3148	49	162.4259	19	6.6852	49	44.4629
20	34.0740	50	168.5185	20	7.4074	50	46.2963
21	36.9444	51	174.7222	21	8.1667	51	49.1666
22	39.9259	52	181.0370	22	8.9629	52	50.0740
23	43.0185	53	187.4629	23	9.7962	53	52.0185
24	46.2222	54	194.0000	24	10.6667	54	54.0000
25	49.5370	55	200.6480	25	11.5741	55	56.0184
26	52.9629	56	207.4074	26	12.5184	56	58.0740
27	56.5000	57	214.2777	27	13.5000	57	60.1666
28	58.1480	58	221.2592	28	14.5185	58	62.2962
29	63.9074	59	228.3518	29	15.5741	59	64.4629
30	67.7777	60	235.5555	30	16.6667	60	66.6666

BASE 33—SLOPE ¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6157	31	23.3935	1	.0015	31	1.4830
2	1.2407	32	24.2963	2	.0062	32	1.5802
3	1.8750	33	25.2083	3	.0139	33	1.6805
4	2.5185	34	26.1296	4	.0246	34	1.7839
5	3.1713	35	27.0601	5	.0385	35	1.8904
6	3.8333	36	28.0000	6	.0555	36	2.0000
7	4.5046	37	28.9490	7	.0756	37	2.1126
8	5.1852	38	29.9074	8	.0988	38	2.2284
9	5.8750	39	30.8750	9	.1250	39	2.3472
10	6.5740	40	31.8519	10	.1543	40	2.4691
11	7.2824	41	32.8379	11	.1867	41	2.5941
12	8.0000	42	33.8333	12	.2222	42	2.7222
13	8.7268	43	34.8379	13	.2608	43	2.8545
14	9.4629	44	35.8519	14	.3025	44	2.9876
15	10.2083	45	36.8750	15	.3472	45	3.1250
16	10.9629	46	37.9074	16	.3951	46	3.2654
17	11.7268	47	38.9940	17	.4460	47	3.4089
18	12.5000	48	40.0000	18	.5000	48	3.5555
19	13.2824	49	41.0601	19	.5571	49	3.7052
20	14.0740	50	42.1296	20	.6173	50	3.8580
21	14.8750	51	43.2083	21	.6805	51	4.0139
22	15.6852	52	44.2963	22	.7469	52	4.1728
23	16.5046	53	45.3935	23	.8163	53	4.3349
24	17.3333	54	46.5000	24	.8889	54	4.5000
25	18.1713	55	47.6157	25	.9647	55	4.6682
26	19.0185	56	48.7407	26	1.0432	56	4.8395
27	19.8750	57	49.8750	27	1.1250	67	5.0139
28	20.7407	58	51.0185	28	1.2099	58	5.1913
29	21.6157	59	52.1713	29	1.2978	59	5.3719
30	22.5000	60	53.3333	30	1,3889	60	5.5555

BASE 33—SLOPE ½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6203	31	27.8426	1	.0031	31	2.9660
2	1.2592	32	29.0370	2	.0123	32	3.1605
3	1.9166	33	30.2500	3	.0278	33	3.3611
4	2.5926	34	31.4815	4	.0494	34	3.5679
5	3.2870	35	32.7314	5	.0772	35	3.7808
6	4.0000	36	34.0000	6	.1111	36	4.0000
7	4.7314	37	35.2870	7	.1512	37	4.2253
8	5.4815	38	36.5926	8	.1975	38	4.4568
9	6.2500	39	37.9166	9	.2500	39	4.6944
10	7.0370	40	39.2592	10	.3086	40	4.9383
11	7.8426	41	40.6203	11	.3734	41	5.1883
12	8.6666	42	42.0000	12	.4444	42	5.4444
13	9.5092	43	43.3981	13	.5216	43	5.7076
14	10.3703	44	44.8148	14	.6049	44	5.9753
15	12.2500	45	46.2500	15	.6944	45	6.2500
16	12.1481	46	47.7037	16	.7901	46	6.5308
17	13.0647	47	49.1758	17	.8920	47	6.8179
18	14.0000	48	50.6666	18	1.0000	48	7.1111
19	14.9537	49	52.1758	19	1.1142	49	7.4105
20	15.9259	50	53.7037	20	1.2346	50	7.7160
21	16.9166	51	55.2500	21	1.3611	51	8.0277
22	17.9259	52	56.8148	22	1.4938	52	8.3456
23	18.9537	53	58.3981	23	1.6327	53	8.6697
24	20.0000	54	60.0000	24	1.7778	54	9.0000
25	21.0647	55	61.6203	25	1.9295	55	9.3364
26	22.1481	56	63.2592	26	2.0864	56	9.6790
27	23.2500	57	64.9166	27	2.2500	57	10.0277
28	24.3703	58	66.5926	28	2.4197	58	10.3827
29	25.5092	59	68.2870	29	2.5956	59	10.7438
30	26.6666	60	70.0000	30	2.7778	60	11.1111

BASE 33—SLOPE ¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6250	31	32.2916	1	.0046	31	4.4490
2	1.2777	32	33.7777	2	.0185	32	4.7407
3	1.9583	33	35.2916	3	.0416	33	5.0416
4	2.6666	34	36.8333	4	.0740	34	5.3518
5	3.4027	35	38.4027	5	.1157	35	5.6712
6	4.1666	36	40.0000	6	.1667	36	6.0000
7	4.9583	37	41.6250	7	.2268	37	6.3379
8	5.7777	38	43.2777	8	.2963	38	6.6851
9	6.6250	39	44.9583	9	.3750	39	7.0416
10	7.5000	40	46.6666	10	.4630	40	7.4074
11	8.4027	41	48.4027	11	.5602	41	7.7824
12	9.3333	42	50.1666	12	.6667	42	8.1666
13	10.2916	43	51.9583	13	.7824	43	8.5602
14	11.2777	44	53.7777	14	.9074	44	8.9629
15	12.2916	45	55.6250	15	1.0417	45	9.3750
16	13.3333	46	57.5000	16	1.1852	46	9.7962
17	14.4027	47	59.4027	17	1.3379	47	10.2268
18	15.5000	48	61.3333	18	1.5000	48	10.6666
19	16.6250	49	63.2916	19	1.6713	49	11.1157
20	17.7777	50	65.2777	20	1.8518	50	11.5740
21	18.9583	51	67.2916	21	2.0417	51	12.0416
22	20.1666	52	69.3333	22	2.2407	52	12.5185
23	21.4027	53	71.4027	23	2.4491	53	13.0046
24	22.6666	54	73.5000	24	2.6667	54	13.5000
25	23.9583	55	75.6250	25	2.8935	55	14.0046
26	25.2777	56	77.7777	26	3.1296	56	14.5185
27	26.6250	57	79.9583	27	3.3750	57	15.0416
28	28.0000	58	82.1666	28	3.6296	58	15.5740
29	29.4027	59	84.4027	29	3.8935	59	16.1157
30	30.8333	60	86.6666	30	4.1667	60	16.6666

BASE 33—SLOPE 1 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6296	31	36.7407	1	.0062	31	5.9321
2	1.2962	32	38.5185	2	.0247	32	6.3210
3	2.0000	33	40.3333	3	.0555	33	6.7222
4	2.7407	34	42.1851	4	.0988	34	7.1358
5	3.5185	35	44.0740	5	.1543	35	7.5617
6	4.3333	36	46.0000	6	.2222	36	8.0000
7	5.1851	37	47.9629	7	.3025	37	8.4506
8	6.0740	38	49.9629	8	.3951	38	8.9135
9	7.0000	39	52.0000	9	.5000	39	9.3888
10	7.9629	40	54.0740	10	.6173	40	9.8765
11	8.9629	41	56.1851	11	.7469	41	10.3765
12	10.0000	42	58.3333	12	.8889	42	10.8888
13	11.0740	43	60.5185	13	1.0432	43	11.4135
14	12.1851	44	62.7407	14	1.2099	44	11.9506
15	13.3333	45	65.0000	15	1.3889	45	12.5000
16	14.5185	46	67.2962	16	1.5802	46	13.0617
17	15.7407	47	69.6296	17	1.7839	47	13.6358
18	17.0000	48	72.0000	18	2.0000	48	14.2222
19	18.2962	49	74.4074	19	2.2284	49	14.8209
20	19.6296	50	76.8518	20	2.4691	50	15.4321
21	21.0000	51	79.3333	21	2.7222	51	16.0555
22	22.4074	52	81.8518	22	2.9876	52	16.6913
23	23.8518	53	84.4074	23	3.2654	53	17.3395
24	25.3333	54	87.0000	24	3.5555	54	18.0000
25	26.8518	55	89.6296	25	3.8530	55	18.6728
26	28.4074	56	92.2962	26	4.1728	56	19.3580
27	30.0000	57	95.0000	27	4.5000	57	20.0555
28	31.6296	58	97.7407	28	4.8395	58	20.7654
29	33.2962	59	100.5185	29	5.1913	59	21.4876
30	35.0000	60	103.3333	30	5.5555	60	22.2222

BASE 33—SLOPE 1¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6342	31	41.1898	1	.0077	31	7.4151
2	1.3148	32	43.2592	2	.0309	32	7.9012
3	2.0417	33	45.3750	3	.0694	33	8.4027
4	2.8148	34	47.5370	4	.1234	34	8.9197
5	3.6342	35	49.7453	5	.1928	35	9.4521
6	4.5000	36	52.0000	6	.2778	36	10.0000
7	5.4120	37	54.3009	7	.3781	37	10.5632
8	6.3703	38	56.6481	8	.4938	38	11.1419
9	7.3750	39	59.0417	9	.6250	39	11.7361
10	8.4258	40	61.4814	10	.7716	40	12.3456
11	9.5231	41	63.9675	11	.9336	41	12.9706
12	10.6666	42	66.5000	12	1.1111	42	13.6111
13	11.8564	43	69.0786	13	1.3040	43	14.2686
14	13.0926	44	71.7037	14	1.5123	44	14.9382
15	14.3750	45	74.3750	15	1.7361	45	15.6250
16	15.7037	46	77.0926	16	1.9753	46	16.3271
17	17.0786	47	79.8564	17	2.2299	47	17.0447
18	18.5000	48	82.6666	18	2.5000	48	17.7777
19	19.9675	49	85.5231	19	2.7855	49	18.5262
20	21.4814	50	88.4258	20	3.0864	50	19.2901
21	23.0417	51	91.3750	21	3.4028	51	20.0694
22	24.6481	52	94.3703	22	3.7346	52	20.8641
23	26.3009	53	97.4120	23	4.0818	53	21.6743
24	28.0000	54	100.5000	24	4.4444	54	22.5000
25	29.7453	55	103.6342	25	4.8228	55	23.3410
26	31.5370	56	106.8148	26	5.2160	56	24.1975
27	33.3750	57	110.0417	27	5.6250	57	25.0694
28	35.2592	58	113.3148	28	6.0494	58	25.9567
29	37.1898	59	116.6342	29	6.4891	59	26.8595
30	39.1666	60	120.0000	30	6.9444	60	27.7777

BASE 33—SLOPE 1½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6388	31	45.6388	1	.0092	31	8.8981
2	1.3333	32	48.0000	2	.0370	32	9.4815
3	2.0833	33	50.4166	3	.0833	33	10.0833
4	2.8888	34	52.8888	4	.1480	34	10.7037
5	3.7500	35	55.4166	5	.2313	35	11.3425
6	4.6666	36	58.0000	6	.3333	36	12.0000
7	5.6388	37	60.6388	7	.4537	37	12.6759
8	6.6666	38	63.3333	8	.5926	38	13.3703
9	7.7500	39	66.0833	9	.7500	39	14.0833
10	8.8888	40	68.8888	10	.9259	40	14.8148
11	10.0833	41	71.7500	11	1.1203	41	15.5648
12	11.3333	42	74.6666	12	1.3333	42	16.3333
13	12.6388	43	77.6388	13	1.5648	43	17.1202
14	14.0000	44	80.6666	14	1.8148	44	17.9259
15	15.4166	45	83.7500	15	2.0833	45	18.7500
16	16.8888	46	86.8888	16	2.3704	46	19.5925
17	18.4166	47	90.0833	17	2.6759	47	20.4537
18	20.0000	48	93.3333	18	3.0000	48	21.3333
19	21.6388	49	96.6388	19	3.3426	49	22.2314
20	23.3333	50	100.0000	20	3.7037	50	23.1481
21	25.0833	51	103.4166	21	4.0833	51	24.0833
22	26.8888	52	106.8888	22	4.4815	52	25.0370
23	28.7500	53	110.4166	23	4.8981	53	26.0092
24	30.6666	54	114.0000	24	5.3333	54	27.0000
25	32.6388	55	117.6388	25	5.7869	55	28.0092
26	34.6666	56	121.3333	26	6.2592	56	29.0370
27	36.7500	57	125.0833	27	6.7500	57	30.0833
28	38.8888	58	128.8888	28	7.2592	58	31.1481
29	41.0833	59	132.7500	29	7.7869	59	32.2314
30	43.3333	60	136.6666	30	8.3333	60	33.3333

BASE 33—SLOPE 1¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6435	31	50.0879	1	.0108	31	10.3811
2	1.3518	32	52.7407	2	.0432	32	11.0617
3	2.1250	33	55.4583	3	.0972	33	11.7638
4	2.9629	34	58.2407	4	.1728	34	12.4876
5	3.8657	35	61.0879	5	.2700	35	13.2330
6	4.8333	36	64.0000	6	.3889	36	14.0000
7	5.8657	37	66.9768	7	.5293	37	14.7885
8	6.9629	38	70.0185	8	.6913	38	15.5987
9	8.1250	39	73.1250	9	.8750	39	16.4305
10	9.3518	40	76.2962	10	1.0802	40	17.2839
11	10.6435	41	79.5324	11	1.3071	41	18.1589
12	12.0000	42	82.8333	12	1.5555	42	19.0555
13	13.4214	43	86.1991	13	1.8256	43	19.9747
14	14.9074	44	89.6296	14	2.1173	44	20.9135
15	16.4583	45	93.1250	15	2.4305	45	21.8750
16	18.0740	46	96.6851	16	2.7654	46	22.8580
17	19.7546	47	100.3101	17	3.1219	47	23.8626
18	21.5000	48	104.0000	18	3.5000	48	24.8888
19	23.3101	49	107.7546	19	3.8997	49	25.9367
20	25.1851	50	111.5740	20	4.3210	50	27.0061
21	27.1250	51	115.4583	21	4.7639	51	28.0972
22	29.1296	52	119.4074	22	5.2284	52	29.2098
23	31.1991	53	123.4214	23	5.7145	53	30.3441
24	33.3333	54	127.5000	24	6.2222	54	31.5000
25	35.5324	55	131.6435	25	6.7516	55	32.6774
26	37.7962	56	135.8518	26	7.3024	56	33.8765
27	40.1250	57	140.1250	27	7.8750	57	35.0972
28	42.5185	58	144.4629	28	8.4691	58	36.3394
29	44.9768	59	148.8657	29	9.0848	59	37.6033
30	47.5000	60	153.3333	30	9.7222	60	38.8888

BASE 33—SLOPE 2 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6481	31	54.5370	1	.0123	31	11.8642
2	1.3703	32	57.4814	2	.0494	32	12.6419
3	2.1666	33	60.5000	3	.1111	33	13.4444
4	3.0370	34	63.5926	4	.1975	34	14.2716
5	3.9814	35	66.7592	5	.3086	35	15.1234
6	5.0000	36	70.0000	6	.4444	36	16.0000
7	6.0926	37	73.3148	7	.6049	37	16.9012
8	7.2592	38	76.7037	8	.7901	38	17.8271
9	8.5000	39	80.1666	9	1.0000	39	18.7777
10	9.8148	40	83.7037	10	1.2346	40	19.7530
11	11.2037	41	87.3148	11	1.4938	41	20.7530
12	12.6666	42	91.0000	12	1.7778	42	21.7777
13	14.2037	43	94.7592	13	2.0864	43	22.8271
14	15.8148	44	98.5926	14	2.4197	44	23.9012
15	17.5000	45	102.5000	15	2.7778	45	25.0000
16	19.2592	46	106.4814	16	3.1605	46	26.1234
17	21.0926	47	110.5370	17	3.5679	47	27.2716
18	23.0000	48	114.6666	18	4.0000	48	28.4444
19	24.9814	49	118.9703	19	4.4568	49	29.6420
20	27.0370	50	123.1481	20	4.9382	50	30.8642
21	29.1666	51	127.5000	21	5.4444	51	32.1111
22	31.3703	52	131.9259	22	5.9753	52	33.3827
23	33.6481	53	136.4259	23	6.5309	53	34.6790
24	36.0000	54	141.0000	24	7.1111	54	36.0000
25	38.4259	55	145.6481	25	7.7160	55	37.3456
26	40.9259	56	150.3703	26	8.3457	56	38.7160
27	43.5000	57	155.1666	27	9.0000	57	40.1111
28	46.1481	58	160.0370	28	9.6790	58	41.5308
29	48.8703	59	164.9814	29	10.3827	59	42.9753
30	51.6666	60	170.0000	30	11.1111	60	44.4444

BASE 33—SLOPE 2½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6574	31	63.4352	1	.0154	31	14.8302
2	1.4074	32	66.9629	2	.0617	32	15.8013
3	2.2500	33	70.5833	3	.1389	33	16.8055
4	3.1852	34	74.2963	4	.2468	34	17.8395
5	4.2129	35	78.1018	5	.3857	35	18.9043
6	5.3333	36	82.0000	6	.5555	36	20.0000
7	6.5463	37	85.9907	7	.7561	37	21.1265
8	7.8518	38	90.0740	8	.9876	38	22.2839
9	9.2500	39	94.2500	9	1.2500	39	23.4722
10	10.7407	40	98.5185	10	1.5432	40	24.6913
11	12.3241	41	102.8796	11	1.8673	41	25.9413
12	14.0000	42	107.3333	12	2.2222	42	27.2222
13	15.7685	43	111.8796	13	2.6080	43	28.5360
14	17.6296	44	116.5185	14	3.0247	44	29.8765
15	19.5833	45	121.2500	15	3.4722	45	31.2500
16	21.6296	46	126.0740	16	3.9506	46	32.6543
17	24.7685	47	130.9907	17	4.4599	47	34.0895
18	26.0000	48	136.0000	18	5.0000	48	35.5555
19	28.3241	49	141.1018	19	5.5710	49	37.0524
20	30.7407	50	146.2963	20	6.1728	50	38.5802
21	33.2500	51	151.5833	21	6.8055	51	40.1388
22	35.8518	52	156.9629	22	7.4691	52	41.7283
23	38.5463	53	162.4352	23	8.1636	53	43.3487
24	41.3333	54	168.0000	24	8.8889	54	45.0000
25	44.2129	55	173.6574	25	9.6455	55	46.6820
26	47.1852	56	179.4074	26	10.4321	56	48.3950
27	50.2500	57	185.2500	27	11.2500	57	50.1388
28	53.4074	58	191.1852	28	12.0587	58	51.9135
29	56.6574	59	197.2129	29	12.9782	59	53.7191
30	60.0000	60	203.3333	30	13.8889	60	55.5555

BASE 33—SLOPE 3 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6666	31	72.3333	1	.0185	31	17.7963
2	1.4444	32	76.4444	2	.0740	32	18.9630
3	2.3333	33	80.6666	3	.1667	33	20.1666
4	3.3333	34	85.0000	4	.2963	34	21.4074
5	4.4444	35	89.4444	5	.4628	35	22.6851
6	5.6666	36	94.0000	6	.6667	36	24.0000
7	7.0000	37	98.6666	7	.9074	37	25.3518
8	8.4444	38	103.4444	8	1.1852	38	26.7407
9	10.0000	39	108.3333	9	1.5000	39	28.1666
10	11.6666	40	113.3333	10	1.8518	40	29.6296
11	13.4444	41	118.4444	11	2.2407	41	31.1296
12	15.3333	42	123.6666	12	2.6667	42	32.6666
13	17.3333	43	129.0000	13	3.1296	43	34.2407
14	19.4444	44	134.4444	14	3.6296	44	35.8518
15	21.6666	45	140.0000	15	4.1667	45	37.5000
16	24.0000	46	145.6666	16	4.7407	46	39.1851
17	27.4444	47	151.4444	17	5.3518	47	40.9074
18	29.0000	48	157.3333	18	6.0000	48	42.6666
19	31.6666	49	163.3333	19	6.6852	49	44.4629
20	34.4444	50	169.4444	20	7.4074	50	46.2963
21	37.3333	51	175.6666	21	8.1667	51	49.1666
22	40.3333	52	182.0000	22	8.9629	52	50.0740
23	43.4444	53	188.4444	23	9.7962	53	52.0185
24	46.6666	54	195.0000	24	10.6667	54	54.0000
25	50.0000	55	201.6666	25	11.5741	55	56.0184
26	53.4444	56	208.4444	26	12.5184	56	58.0740
27	57.0000	57	215.3333	27	13.5000	57	60.1666
28	60.6666	58	222.3333	28	14.5185	58	62.2962
29	64.4444	59	229.4444	29	15.5741	59	64.4629
30	68.3333	60	236.6666	30	16.6667	60	66.6666

BASE 34—SLOPE ¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6342	31	23.9676	1	.0015	31	1.4830
2	1.2777	32	24.8888	2	.0062	32	1.5802
3	1.9305	33	25.8194	3	.0139	33	1.6805
4	2.5926	34	26.7592	4	.0246	34	1.7839
5	3.2638	35	27.7083	5	.0385	35	1.8904
6	3.9444	36	28.6666	6	.0555	36	2.0000
7	4.6342	37	29.6342	7	.0756	37	2.1126
8	5.3333	38	30.6111	8	.0988	38	2.2284
9	6.0416	39	31.5972	9	.1250	39	2.3472
10	6.7592	40	32.5926	10	.1543	40	2.4691
11	7.4861	41	33.5972	11	.1867	41	2.5941
12	8.2222	42	34.6111	12	.2222	42	2.7222
13	8.9676	43	35.6342	13	.2608	43	2.8545
14	9.7222	44	36.6666	14	.3025	44	2.9876
15	10.4861	45	37.7083	15	.3472	45	3.1250
16	11.2592	46	38.7592	16	.3951	46	3.2654
17	12.0416	47	39.8194	17	.4460	47	3.4089
18	12.8333	48	40.8888	18	.5000	48	3.5555
19	13.6342	49	41.9676	19	.5571	49	3.7052
20	14.4444	50	43.0555	20	.6173	50	3.8580
21	15.2638	51	44.1527	21	.6805	51	4.0139
22	16 0926	52	45.2592	22	.7469	52	4.1728
23	16.9305	53	46.3750	23	.8163	53	4.3349
24	17.7777	54	47.5000	24	.8889	54	4.5000
25	18.6342	55	48.6342	25	.9647	55	4.6682
26	19.5000	56	49.7777	26	1.0432	56	4.8395
27	20.3750	57	50.9305	27	1.1250	57	5.0139
28	21.2592	58	52.0926	28	1.2099	58	5.1913
29	22.1527	59	53.2638	29	1.2978	59	5.3719
30	23.0555	60	54.4444	30	1.3889	60	5.5555

BASE 34—SLOPE ½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6388	31	28.4166	1	.0031	31	2.9660
2	1.2962	32	29.6296	2	.0123	32	3.1605
3	1.9722	33	30.8611	3	.0278	33	3.3611
4	2.6666	34	32.1111	4	.0494	34	3.5679
5	3.3796	35	33.3796	5	.0772	35	3.7808
6	4.1111	36	34.6666	6	.1111	36	4.0000
7	4.8611	37	35.9722	7	.1512	37	4.2253
8	5.6296	38	37.2962	8	.1975	38	4.4568
9	6.4166	39	38.6388	9	.2500	39	4.6944
10	7.2222	40	40.0000	10	.3086	40	4.9383
11	8.0462	41	41.3796	11	.3734	41	5.1883
12	8.8888	42	42.7777	12	.4444	42	5.4444
13	9.7500	43	44.1944	13	.5216	43	5.7067
14	10.6296	44	45.6296	14	.6049	44	5.9753
15	11.5277	45	47.0833	15	.6944	45	6.2500
16	12.4444	46	48.5555	16	.7901	46	6.5308
17	13.3796	47	50.0462	17	.8920	47	6.8179
18	14.3333	48	51.5555	18	1.0000	48	7.1111
19	15.3055	49	53.0833	19	1.1142	49	7.4105
20	16.2962	50	54.6296	20	1.2346	50	7.7160
21	17.3055	51	56.1944	21	1.3611	51	8.0277
22	18.3333	52	57.7777	22	1.4938	52	8.3456
23	19.3796	53	59.3796	23	1.6327	53	8.6697
24	20.4444	54	61.0000	24	1.7778	54	9.0000
25	21.5277	55	62.6388	25	1.9295	55	9.3364
26	22.6296	56	64.2962	26	2.0864	56	9.6790
27	23.7500	57	65.9722	27	2.2500	57	10.0277
28	24.8888	58	67.6666	28	2.4197	58	10.3827
29	26.0462	59	69.3796	29	2.5956	59	10.7438
30	27.2222	60	71.1111	30	2.7778	60	11.1111

BASE 34—SLOPE ¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6435	31	32.8657	1	.0046	31	4.4490
2	1.3148	32	34.3703	2	.0185	32	4.7407
3	2.0138	33	35.9027	3	.0416	33	5.0416
4	2.7407	34	37.4629	4	.0740	34	5.3518
5	3.4953	35	39.0509	5	.1157	35	5.6712
6	4.2777	36	40.6666	6	.1667	36	6.0000
7	5.0879	37	42.3101	7	.2268	37	6.3379
8	5.9259	38	43.9814	8	.2963	38	6.6851
9	6.7916	39	45.6805	9	.3750	39	7.0416
10	7.6851	40	47.4074	10	.4630	40	7.4074
11	8.6044	41	49.1620	11	.5602	41	7.7824
12	9.5555	42	50.9444	12	.6667	42	8.1666
13	10.5324	43	52.7546	13	.7824	43	8.5602
14	11.5370	44	54.5925	14	.9074	44	8.9629
15	12.5694	45	56.4583	15	1.0417	45	9.3750
16	13.6296	46	58.3518	16	1.1852	46	9.7962
17	14.7175	47	60.2731	17	1.3379	47	10.2268
18	15.8333	48	62.2222	18	1.5000	48	10.6666
19	16.9768	49	64.1990	19	1.6713	49	11.1157
20	18.1481	50	66.2037	20	1.8518	50	11.5740
21	19.5694	51	68.2361	21	2.0417	51	12.0416
22	20.5740	52	70.2962	22	2.2407	52	12.5185
23	21.8287	53	72.3842	23	2.4491	53	13.0046
24	23.1111	54	74.5000	24	2.6667	54	13.5000
25	24.4214	55	76.6435	25	2 8935	55	14.0046
26	25.7037	56	78.8148	26	3.1296	56	14.5185
27	27.1250	57	81.0138	27	3.3750	57	15.0416
28	28.5185	58	83.2407	28	3.6296	58	15.5740
29	29.9398	59	85.4953	29	3.8935	59	16.1157
30	31.3888	60	87.7777	30	4.1667	60	16.6666

BASE 34—SLOPE 1 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6481	31	37.3148	1	.0062	31	5.9321
2	1.3333	32	39.1111	2	.0247	32	6.3210
3	2.0555	33	40.9444	3	.0555	33	6.7222
4	2.8148	34	42.8148	4	.0988	34	7.1358
5	3.6111	35	44.7222	5	.1543	35	7.5617
6	4.4444	36	46.6666	6	.2222	36	8.0000
7	5.3148	37	48.6481	7	.3025	37	8.4506
8	6.2222	38	50.6666	8	.3951	38	8.9135
9	7.1666	39	52.7222	9	.5000	39	9.3888
10	8.1481	40	54.8148	10	.6173	40	9.8765
11	9.1666	41	56.9444	11	.7469	41	10.3765
12	10.2222	42	59.1111	12	.8889	42	10.8888
13	11.3148	43	61.3148	13	1.0432	43	11.4135
14	12.4444	44	63.5555	14	1.2099	44	11.9506
15	13.6111	45	65.8333	15	1.3889	45	12.5000
16	14.8148	46	68.1481	16	1.5802	46	13.0617
17	16.0555	47	70.5000	17	1.7839	47	13.6358
18	17.3333	48	72.8888	18	2.0000	48	14.2222
19	18.6481	49	75.3148	19	2.2284	49	14.8209
20	20.0000	50	77.7777	20	2.4691	50	15.4321
21	21.3888	51	80.2777	21	2.7222	51	16.0555
22	22.8148	52	82.8148	22	2.9876	52	16.6913
23	24.2777	53	85.3888	23	3.2654	53	17.3395
24	25.7777	54	88.0000	24	3.5555	54	18.0000
25	27.3148	55	90.6481	25	3.8580	55	18.6728
26	28.8888	56	93.3333	26	4.1728	56	19.3580
27	30.5000	57	96.0555	27	4.5000	57	20.0555
28	32.1481	58	98.8148	28	4.8395	58	20.7654
29	33.8333	59	101.6111	29	5.1913	59	21.4876
30	35.5555	60	104.4444	30	5.5555	60	22.2222

BASE 34—SLOPE 1¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6527	31	41.7639	1	.0077	31	7.4151
2	1.3518	32	43.8518	2	.0309	32	7.9012
3	2.0972	33	45.9861	3	.0694	33	8.4027
4	2.8888	34	48.1666	4	.1234	34	8.9197
5	3.7268	35	50.3935	5	.1928	35	9.4521
6	4.6111	36	52.6666	6	.2778	36	10.0000
7	5.5416	37	54.9861	7	.3781	37	10.5632
8	6.5185	38	57.3518	8	.4938	38	11.1419
9	7.5416	39	59.7639	9	.6250	39	11.7361
10	8.6111	40	62.2222	10	.7716	40	12.3456
11	9.7268	41	64.7268	11	.9336	41	12.9706
12	10.8888	42	67.2777	12	1.1111	42	13.6111
13	12.0972	43	69.8750	13	1.3040	43	14.2680
14	13.3518	44	72.5185	14	1.5123	44	14.9382
15	14.6527	45	75.2083	15	1.7361	45	15.6250
16	16.0000	46	77.9444	16	1.9753	46	16.3271
17	17.3935	47	80.7268	17	2.2299	47	17.0447
18	18.8333	48	83.5555	18	2.5000	48	17.7777
19	20.3194	49	86.4305	19	2.7855	49	18.5262
20	21.8518	50	89.3518	20	3.0864	50	19.2901
21	23.4305	51	92.3194	21	3.4028	51	20.0694
22	25.0555	52	95.3333	22	3.7346	52	20.8641
23	26.7268	53	98.3935	23	4.0818	53	21.6743
24	28.4444	54	101.5000	24	4.4444	54	22.5000
25	30.2083	55	104.6527	25	4.8228	55	23.3410
26	32.0185	56	107.8518	26	5.2160	56	24.1975
27	33.8750	57	111.0972	27	5.6250	57	25.0694
28	35.7777	58	114.3888	28	6.0494	58	25.9567
29	37.7268	59	117.7268	29	6.4891	59	26.8595
30	39.7222	60	121.1111	30	6.9444	60	27.7777

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BASE 32—SLOPE 1½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6574	31	46.2129	1	.0092	31	8.8981
2	1.3703	32	48.5926	2	.0370	32	9.4815
3	2.1388	33	51.0277	3	.0833	33	10.0833
4	2.9629	34	53.5185	4	.1480	34	10.7037
5	3.8426	35	56.0648	5	.2313	35	11.3425
6	4.7777	36	58.6666	6	.3333	36	12.0000
7	5.7685	37	61.3240	7	.4537	37	12.6759
8	6.8148	38	64.0370	8	.5926	38	13.3703
9	7.9166	39	66.8055	9	.7500	39	14.0833
10	9.0740	40	69.6296	10	.9259	40	14.8148
11	10.2870	41	72.5092	11	1.1203	41	15.5648
12	11.5555	42	75.4444	12	1.3333	42	16.3333
13	12.8796	43	78.4351	13	1.5648	43	17.1202
14	14.2592	44	81.4816	14	1.8148	44	17.9259
15	15.6944	45	84.5833	15	2.0833	45	18.7500
16	17.1851	46	87.7407	16	2.3704	46	19.5925
17	18.7316	47	90.9537	17	2.6759	47	20.4537
18	20.3333	48	94.2222	18	3.0000	48	21.3333
19	21.9907	49	97.5463	19	3.3426	49	22.2314
20	23.7037	50	100.9259	20	3.7037	50	23.1481
21	25.4722	51	104.3611	21	4.0833	51	24.0833
22	27.2963	52	107.8518	22	4.4815	52	25.0370
23	29.1759	53	111.3981	23	4.8981	53	26.0092
24	31.1111	54	115.0000	24	5.3333	54	27.0000
25	33.1018	55	118.6574	25	5.7869	55	28.0092
26	35.1481	56	122.3703	26	6.2592	56	29.0370
27	37.2500	57	126.1388	27	6.7500	57	30.0833
28	39.4074	58	129.9629	28	7.2592	58	31.1481
29	41.6203	59	133.8426	29	7.7869	59	32.2314
30	43.8888	60	137.7777	30	8.3333	60	3.33333

BASE 34—SLOPE 1¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6620	31	50.6620	1	.0108	31	10.3811
2	1.3888	32	53.3333	2	.0432	32	11.0617
3	2.1805	33	56.0694	3	.0972	33	11.7638
4	3.0370	34	58.8703	4	.1728	34	12.4876
5	3.9583	35	61.7361	5	.2700	35	13.2330
6	4.9444	36	64.6666	6	.3889	36	14.0000
7	5.9953	37	67.6620	7	.5293	37	14.7885
8	7.1111	38	70.7222	8	.6913	38	15.5987
9	8.2916	39	73.8472	9	.8750	39	16.4305
10	9.5370	40	77.0370	10	1.0802	40	17.2839
11	10.8472	41	80.2916	11	1.3071	41	18.1589
12	12.2222	42	83.6111	12	1.5555	42	19.0555
13	13.6620	43	86.9953	13	1.8256	43	19.9747
14	15.1666	44	90.4444	14	2.1173	44	20.9135
15	16.7361	45	93.9583	15	2.4305	45	21.8750
16	18.3703	46	97.5370	16	2.7654	46	22.8580
17	20.0694	47	101.1805	17	3.1219	47	23.8626
18	21.8333	48	104.8888	18	3.5000	48	24.8888
19	23.6620	49	108.6620	19	3.8997	49	25.9367
20	25.5555	50	112.5000	20	4.3210	50	27.0061
21	27.5138	51	116.4027	21	4.7639	51	28.0972
22	29.5370	52	120.3703	22	5.2284	52	29.2098
23	31.6250	53	124.4027	23	5.7145	53	30.3441
24	33.7777	54	128.5000	24	6.2222	54	31.5000
25	35.9953	55	132.6620	25	6.7516	55	32.6774
26	38.2777	56	136.8888	26	7.3024	56	33.8765
27	40.6250	57	141.1805	27	7.8750	57	35.0972
28	43.0370	58	145.5370	28	8.4691	58	36.3394
29	45.5138	59	149.9583	29	9.0848	59	37.6033
30	48.0555	60	154.4444	30	9.7222	60	38.8888

BASE 34—SLOPE 2 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6666	31	55.1111	1	.0123	31	11.8642
2	1.4074	32	58.0740	2	.0494	32	12.6419
3	2.2222	33	61.1111	3	.1111	33	13.4444
4	3.1111	34	64.2222	4	.1975	34	14.2716
5	4.0740	35	67.4074	5	.3086	35	15.1234
6	5.1111	36	70.6666	6	.4444	36	16.0000
7	6.2222	37	74.0000	7	.6049	37	16.9012
8	7.4074	38	77.4074	8	.7901	38	17.8271
9	8.6666	39	80.8888	9	1.0000	39	18.7777
10	10.0000	40	84.4444	10	1.2346	40	19.7530
11	11.4074	41	88.0740	11	1.4938	41	20.7530
12	12.8888	42	91.7777	12	1.7778	42	21.7777
13	14.4444	43	95.5555	13	2.0864	43	22.8271
14	16.0740	44	99.4074	14	2.4197	44	23.9012
15	17.7777	45	103.3333	15	2.7778	45	25.0000
16	19.5555	46	107.3333	16	3.1605	46	26.1234
17	21.4074	47	111.4074	17	3.5679	47	27.2716
18	23.3333	48	115.5555	18	4.0000	48	28.4444
19	25.3333	49	119.7777	19	4.4568	49	29.6420
20	27.4074	50	124.0740	20	4.9382	50	30.8642
21	29.5555	51	129.4444	21	5.4444	51	32.1111
22	31.7777	52	132.8888	22	5.9753	52	33.3827
23	34.0740	53	137.4074	23	6.5309	53	34.6790
24	36.4444	54	142.0000	24	7.1111	54	36.0000
25	38.8888	55	146.6666	25	7.7160	55	37.3456
26	41.4074	56	151.4074	26	8.3457	56	38.7160
27	44.0000	57	156.2222	27	9.0000	57	40.1111
28	46.6666	58	161.1111	28	9.6790	58	41.5308
29	49.4074	59	166.0740	29	10.3827	59	42.9753
30	52.2222	60	171.1111	30	11.1111	60	44.4444

BASE 34—SLOPE 2½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6759	31	64.0092	1	.0154	31	14.8302
2	1.4444	32	67.5555	2	.0617	32	15.8015
3	2.3055	33	71.1944	3	.1389	33	16.8055
4	3.2592	34	74.9259	4	.2468	34	17.8395
5	4.3055	35	78.7500	5	.3857	35	18.9043
6	5.4444	36	82.6666	6	.5555	36	20.0000
7	6.6759	37	86.6759	7	.7561	37	21.1265
8	8.0000	38	90.7777	8	.9876	38	22.2839
9	9.4166	39	94.9722	9	1.2500	39	23.4722
10	10.9259	40	99.2592	10	1.5432	40	24.6913
11	12.5277	41	103.6388	11	1.8673	41	25.9413
12	14.2222	42	108.1111	12	2.2222	42	27.2222
13	16.0092	43	112.6759	13	2.6080	43	28.5360
14	17.8888	44	117.3333	14	3.0247	44	29.8765
15	19.8611	45	122.0833	15	3.4722	45	31.2500
16	21.9259	46	126.9259	16	3.9506	46	32.6543
17	24.0833	47	131.8611	17	4.4599	47	34.0895
18	26.3333	48	136.8888	18	5.0000	48	35.5555
19	28.6759	49	142.0092	19	5.5710	49	37.0524
20	31.1111	50	147.2222	20	6.1728	50	38.5802
21	34.6388	51	152.5277	21	6.8055	51	40.1388
22	36.2592	52	157.9259	22	7.4691	52	41.7283
23	38.9722	53	163.4166	23	8.1636	53	43.3487
24	41.7777	54	169.0000	24	8.8889	54	45.0000
25	45.6759	55	174.6759	25	9.6455	55	46.6820
26	47.6666	56	180.4444	26	10.4321	56	48.3950
27	50.7500	57	186.3055	27	11.2500	57	50.1388
28	53.9259	58	192.2592	28	12.0587	58	51.9135
29	57.1944	59	198.3055	29	12.9782	59	53.7191
30	60.5555	60	204.4444	30	13.8889	60	55.5555

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BASE 34—SLOPE 3 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6851	31	72.9074	1	.0185	31	17.7963
2	1.4814	32	77.0370	2	.0740	32	18.9630
3	2.3888	33	81.2777	3	.1667	33	20.1666
4	3.4074	34	85.6296	4	.2963	34	21.4074
5	4.5370	35	90.0925	5	.4628	35	22.6851
6	5.7777	36	94.6666	6	.6667	36	24.0000
7	7.1296	37	99.3518	7	.9074	37	25.3518
8	8.5925	38	104.1481	8	1.1852	38	26.7407
9	10.1666	39	109.0555	9	1.5000	39	28.1666
10	11.8518	40	114.0740	10	1.8518	40	29.6296
11	13.6481	41	119.2037	11	2.2407	41	31.1296
12	15.5555	42	124.4444	12	2.6667	42	32.6666
13	17.5740	43	129.7962	13	3.1296	43	34.2407
14	19.7037	44	135.2592	14	3.6296	44	35.8518
15	21.9444	45	140.8333	15	4.1667	45	37.5000
16	24.2962	46	146.5185	16	4.7407	46	39.1851
17	26.7592	47	152.3148	17	5.3518	47	40.9078
18	29.3333	48	158.2222	18	6.0000	48	42.6666
19	32.0185	49	164.2407	19	6.6852	49	44.4629
20	34.8148	50	170.3703	20	7.4074	50	46.2963
21	37.7222	51	176.6111	21	8.1667	51	49.1666
22	40.7407	52	182.9629	22	8.9629	52	50.0740
23	43.8703	53	189.4259	23	9.7962	53	52.0185
24	47.1111	54	196.0000	24	10.6667	54	54.0000
25	50.4629	55	202.6851	25	11.5741	55	56.0184
26	53.9259	56	209.4814	26	12.5184	56	58.0740
27	57.5000	57	216.3888	27	13.5000	57	60.1666
28	61.1851	58	223.4074	28	14.5185	58	62.2962
29	64.9814	59	230.5370	29	15.5741	59	64.4629
30	68.8888	60	237.7777	30	16.6667	60	66.6666

BASE 35—SLOPE ¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6527	31	24.5416	1	.0015	31	1.4830
2	1.3148	32	25.4814	2	.0062	32	1.5802
3	1.9861	33	26.4305	3	.0139	33	1.6805
4	2.6666	34	27.3888	4	.0246	34	1.7839
5	3.3564	35	28.3564	5	.0385	35	1.8904
6	4.0555	36	29.3333	6	.0555	36	2.0000
7	4.7638	37	30.3194	7	.0756	37	2.1126
8	5.4814	38	31.3148	8	.0988	38	2.2284
9	6.2083	39	32.3194	9	.1250	39	2.3472
10	6.9444	40	33.3333	10	.1543	40	2.4691
11	7.6898	41	34.3564	11	.1867	41	2.5941
12	8.4444	42	35.3888	12	.2222	42	2.7222
13	9.2083	43	36.4305	13	.2608	43	2.8545
14	9.9814	44	37.4814	14	.3025	44	2.9876
15	10.7638	45	38.5416	15	.3472	45	3.1250
16	11.5555	46	39.6111	16	.3951	46	3.2654
17	12.3564	47	40.6898	17	.4460	47	3.4089
18	13.1666	48	41.7777	18	.5000	48	3.5555
19	13.9861	49	42.8750	19	.5571	49	3.7052
20	14.8148	50	43.9814	20	.6173	50	3.8580
21	15.6527	51	45.0972	21	.6805	51	4.0139
22	16.5000	52	46.2222	22	.7469	52	4.1728
23	17.3564	53	47.3564	23	.8163	53	4.3349
24	18.2222	54	48.5000	24	.8889	54	4.5000
25	19.0972	55	49.6527	25	.9647	55	4.6682
26	19.9814	56	50.8148	26	1.0432	56	4.8395
27	20.8750	57	51.9861	27	1.1250	67	5.0139
28	21.7777	58	53.1666	28	1.2099	58	5.1913
29	22.6898	59	54.3564	29	1.2978	59	5.3719
30	23.6111	60	55.5555	30	1.3889	60	5.5555

BASE 35—SLOPE ½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6574	31	28.9907	1	.0031	31	2.9660
2	1.3333	32	30.2222	2	.0123	32	3.1605
3	2.0277	33	31.4722	3	.0278	33	3.3611
4	2.7407	34	32.7407	4	.0494	34	3.5679
5	3.4722	35	34.0277	5	.0772	35	3.7808
6	4.2222	36	35.3333	6	.1111	36	4.0000
7	4.9907	37	36.6574	7	.1512	37	4.2253
8	5.7777	38	38.0000	8	.1975	38	4.4568
9	6.5833	39	39.3611	9	.2500	39	4.6944
10	7.4074	40	40.7407	10	.3086	40	4.9383
11	8.2500	41	42.1388	11	.3734	41	5.1883
12	9.1111	42	43.5555	12	.4444	42	5.4444
13	9.9907	43	44.9907	13	.5216	43	5.7076
14	10.8888	44	46.4444	14	.6049	44	5.9753
15	11.8055	45	47.9166	15	.6944	45	6.2500
16	12.7407	46	49.4074	16	.7901	46	6.5308
17	13.6944	47	50.9166	17	.8920	47	6.8179
18	14.6666	48	52.4444	18	1.0000	48	7.1111
19	15.6574	49	53.9907	19	1.1142	49	7.4105
20	16.6666	50	55.5555	20	1.2346	50	7.7160
21	17.6944	51	57.1388	21	1.3611	51	8.0277
22	18.7407	52	58.7407	22	1.4938	52	8.3456
23	19.8055	53	60.3611	23	1.6327	53	8.6697
24	20.8888	54	62.0000	24	1.7778	54	9.0000
25	21.9907	55	63.6574	25	1.9295	55	9.3364
26	23.1111	56	65.3333	26	2.0864	56	9.6790
27	24.2500	57	67.0277	27	2.2500	57	10.0277
28	25.4074	58	68.7407	28	2.4197	58	10.3827
29	26.5833	59	70.4722	29	2.5956	59	10.7438
30	27.7777	60	72.2222	30	2.7778	60	11.1111

BASE 35—SLOPE ¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6620	31	33.4398	1	.0046	31	4.4490
2	1.3518	32	34.8518	2	.0185	32	4.7407
3	2.0694	33	36.5139	3	.0416	33	5.0416
4	2.8148	34	38.0926	4	.0740	34	5.3518
5	3.5879	35	39.6990	5	.1157	35	5.6712
6	4.3888	36	41.3333	6	.1667	36	6.0000
7	5.2176	37	42.9953	7	.2268	37	6.3379
8	6.0740	38	44.6851	8	.2963	38	6.6851
9	6.9583	39	46.4027	9	.3750	39	7.0416
10	7.8703	40	48.1481	10	.4630	40	7.4074
11	8.8102	41	49.9214	11	.5602	41	7.7824
12	9.7777	42	51.7222	12	.6667	42	8.1666
13	10.7731	43	53.5509	13	.7824	43	8.5602
14	11.7963	44	55.4074	14	.9074	44	8.9629
15	12.8472	45	57.2916	15	1.0417	45	9.3750
16	13.9259	46	59.2037	16	1.1852	46	9.7962
17	15.0324	47	61.1435	17	1.3379	47	10.2268
18	16.1666	48	63.1111	18	1.5000	48	10.6666
19	17.3287	49	65.1065	19	1.6713	49	11.1157
20	18.5185	50	67.1296	20	1.8518	50	11.5740
21	19.7361	51	69.1805	21	2.0417	51	12.0416
22	20.9815	52	71.2592	22	2.2407	52	12.5185
23	22.2546	53	73.3657	23	2.4491	53	13.0046
24	23.5555	54	75.5000	24	2.6667	54	13.5000
25	24.8842	55	77.6620	25	2.8935	55	14.0046
26	26.2407	56	79.8518	26	3.1296	56	14.5185
27	27.6250	57	82.0694	27	3.3750	57	15.0416
28	29.0370	58	84.3148	28	3.6296	58	15.5740
29	30.4768	59	86.5879	29	3.8935	59	16.1157
30	31.9444	60	88.8888	30	4.1667	60	16.6666

BASE 35—SLOPE 1 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6666	31	37.8888	1	.0062	31	5.9321
2	1.3703	32	39.7037	2	.0247	32	6.3210
3	2.1111	33	41.5555	3	.0555	33	6.7222
4	2.8888	34	43.4444	4	.0988	34	7.1358
5	3.7037	35	45.3703	5	.1543	35	7.5617
6	4.5555	36	47.3333	6	.2222	36	8.0000
7	5.4444	37	49.3333	7	.3025	37	8.4506
8	6.3703	38	51.3703	8	.3951	38	8.9135
9	7.3333	39	53.4444	9	.5000	39	9.3888
10	8.3333	40	55.5555	10	.6173	40	9.8765
11	9.3703	41	57.7037	11	.7469	41	10.3765
12	10.4444	42	59.8888	12	.8889	42	10.8888
13	11.5555	43	62.1111	13	1.0432	43	11.4135
14	12.7037	44	64.3703	14	1.2099	44	11.9506
15	13.8888	45	66.6666	15	1.3889	45	12.5000
16	15.1111	46	69.0000	16	1.5802	46	13.0617
17	16.3703	47	71.3703	17	1.7839	47	13.6358
18	17.6666	48	73.7777	18	2.0000	48	14.2222
19	19.0000	49	76.2222	19	2.2284	49	14.8209
20	20.3703	50	78.7037	20	2.4691	50	15.4321
21	21.7777	51	81.2222	21	2.7222	51	16.0555
22	23.2222	52	83.7777	22	2.9876	52	16.6913
23	24.7037	53	86.3703	23	3.2654	53	17.3395
24	26.2222	54	89.0000	24	3.5555	54	18.0000
25	27.7777	55	91.6666	25	3.8530	55	18.6728
26	29.3703	56	94.3703	26	4.1728	56	19.3580
27	31.0000	57	97.1111	27	4.5000	57	20.0555
28	32.6666	58	99.8888	28	4.8395	58	20.7654
29	34.3703	59	102.7037	29	5.1913	59	21.4876
30	36.1111	60	105.5555	30	5.5555	60	22.2222

BASE 35—SLOPE 1¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6712	31	42.3379	1	.0077	31	7.4151
2	1.3888	32	44.4444	2	.0309	32	7.9012
3	2.1527	33	46.5972	3	.0694	33	8.4027
4	2.9629	34	48.7962	4	.1234	34	8.9197
5	3.8194	35	51.0416	5	.1928	35	9.4521
6	4.7222	36	53.3333	6	.2778	36	10.0000
7	5.6712	37	55.6712	7	.3781	37	10.5632
8	6.6666	38	58.0555	8	.4938	38	11.1419
9	7.7083	39	60.4861	9	.6250	39	11.7361
10	8.7962	40	62.9629	10	.7716	40	12.3456
11	9.9305	41	65.4861	11	.9336	41	12.9706
12	11.1111	42	68.0555	12	1.1111	42	13.6111
13	12.3379	43	70.6712	13	1.3040	43	14.2686
14	13.6111	44	73.3333	14	1.5123	44	14.9382
15	14.9305	45	76.0416	15	1.7361	45	15.6250
16	16.2962	46	78.7962	16	1.9753	46	16.3271
17	17.7083	47	81.5972	17	2.2299	47	17.0447
18	19.1666	48	84.4444	18	2.5000	48	17.7777
19	20.6712	49	87.3379	19	2.7855	49	18.5262
20	22.2222	50	90.2777	20	3.0864	50	19.2901
21	23.8194	51	93.2638	21	3.4028	51	20.0694
22	25.4629	52	96.2962	22	3.7346	52	20.8641
23	27.1527	53	99.3750	23	4.0818	53	21.6743
24	28.8888	54	102.5000	24	4.4444	54	22.5000
25	30.6712	55	105.6712	25	4.8228	55	23.3410
26	32.5000	56	108.8888	26	5.2160	56	24.1975
27	34.3750	57	112.1527	27	5.6250	57	25.0694
28	36.2962	58	115.4629	28	6.0494	58	25.9567
29	38.2638	59	118.8194	29	6.4891	59	26.8595
30	40.2777	60	122.2222	30	6.9444	60	27.7777

BASE 35—SLOPE 1½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6759	31	46.2870	1	.0092	31	8.8981
2	1.4074	32	49.1851	2	.0370	32	9.4815
3	2.1944	33	51.6388	3	.0833	33	10.0833
4	3.0370	34	54.1481	4	.1480	34	10.7037
5	3.9351	35	56.7129	5	.2313	35	11.3425
6	4.8888	36	59.3333	6	.3333	36	12.0000
7	5.8981	37	62.0092	7	.4537	37	12.6759
8	6.9629	38	64.7407	8	.5926	38	13.3703
9	8.0833	39	67.5277	9	.7500	39	14.0833
10	9.2592	40	70.3703	10	.9259	40	14.8148
11	10.4907	41	73.2685	11	1.1203	41	15.5648
12	11.7777	42	76.2222	12	1.3333	42	16.3333
13	13.1203	43	79.2314	13	1.5648	43	17.1202
14	14.5185	44	82.2962	14	1.8148	44	17.9259
15	15.9722	45	85.4166	15	2.0833	45	18.7500
16	17.4814	46	88.5925	16	2.3704	46	19.5925
17	19.0462	47	91.8240	17	2.6759	47	20.4537
18	20.6666	48	95.1111	18	3.0000	48	21.3333
19	22.3425	49	98.4537	19	3.3426	49	22.2314
20	24.0740	50	101.8518	20	3.7037	50	23.1481
21	25.8611	51	105.3055	21	4.0833	51	24.0833
22	27.7037	52	108.8148	22	4.4815	52	25.0370
23	29.6018	53	112.3796	23	4.8981	53	26.0092
24	31.5555	54	116.0000	24	5.3333	54	27.0000
25	33.5648	55	119.6759	25	5.7869	55	28.0092
26	35.6296	56	123.4074	26	6.2592	56	29.0370
27	37.7500	57	127.1944	27	6.7500	57	30.0833
28	39.9259	58	131.0370	28	7.2592	58	31.1481
29	42.1574	59	134.9351	29	7.7869	59	32.2314
30	44.4444	60	138.8888	30	8.3333	60	33.3333

BASE 35—SLOPE 1¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6805	31	51.2361	1	.0108	31	10.3811
2	1.4259	32	53.9259	2	.0432	32	11.0617
3	2.2361	33	56.6805	3	.0972	33	11.7638
4	3.1111	34	59.5000	4	.1728	34	12.4876
5	4.0509	35	62.3842	5	.2700	35	13.2330
6	5.0555	36	65.3333	6	.3889	36	14.0000
7	6.1250	37	68.3472	7	.5293	37	14.7885
8	7.2592	38	71.4259	8	.6913	38	15.5987
9	8.4583	39	74.5694	9	.8750	39	16.4305
10	9.7222	40	77.7777	10	1.0802	40	17.2839
11	11.0509	41	81.0509	11	1.3071	41	18.1589
12	12.4444	42	84.3888	12	1.5555	42	19.0555
13	13.9028	43	87.7916	13	1.8256	43	19.9747
14	15.4259	44	91.2592	14	2.1173	44	20.9135
15	17.0138	45	94.7916	15	2.4305	45	21.8750
16	18.6666	46	98.3888	16	2.7654	46	22.8580
17	20.0509	47	102.0509	17	3.1219	47	23.8626
18	22.1666	48	105.7777	18	3.5000	48	24.8888
19	24.0138	49	109.5694	19	3.8997	49	25.9367
20	25.9259	50	113.4259	20	4.3210	50	27.0061
21	27.9028	51	117.3472	21	4.7639	51	28.0972
22	29.9444	52	121.3333	22	5.2284	52	29.2098
23	32.0509	53	125.3842	23	5.7145	53	30.3441
24	34.2222	54	129.5000	24	6.2222	54	31.5000
25	36.4583	55	133.6805	25	6.7516	55	32.6774
26	38.7592	56	137.9259	26	7.3024	56	33.8765
27	41.1250	57	142.2361	27	7.8750	57	35.0972
28	43.5555	58	146.6111	28	8.4691	58	36.3394
29	46.0509	59	151.0509	29	9.0848	59	37.6033
30	48.6111	60	155.5555	30	9.7222	60	38.8888

BASE 35—SLOPE 2 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6851	31	55 6851	1	.0123	31	11.8642
2	1.4444	32	58.6666	2	.0494	32	12.6419
3	2.2777	33	61.7222	3	.1111	33	13.4444
4	3.1851	34	64.8518	4	.1975	34	14.2716
5	4.1666	35	68.0555	5	.3086	35	15.1234
6	5.2222	36	71.3333	6	.4444	36	16.0000
7	6.3518	37	74.6851	7	.6049	37	16.9012
8	7.5555	38	78.1111	8	.7901	38	17.8271
9	8.8333	39	81.6111	9	1.0000	39	18.7777
10	10.1851	40	85.1851	10	1.2346	40	19.7530
11	11.6111	41	88.8333	11	1.4938	41	20.7530
12	13.1111	42	92.5555	12	1.7778	42	21.7777
13	14.6851	43	96.3518	13	2.0864	43	22.8271
14	16.3333	44	100.2222	14	2.4197	44	23.9012
15	18.0555	45	104.1666	15	2.7778	45	25.0000
16	19.8518	46	108.1851	16	3.1605	46	26.1234
17	21.7222	47	112.2777	17	3.5679	47	27.2716
18	23.6666	48	116.4444	18	4.0000	48	28.4444
19	25.6851	49	120.6851	19	4.4568	49	29.6420
20	27.7777	50	125.0000	20	4.9382	50	30.8642
21	29.9444	51	129.3888	21	5.4444	51	32.1111
22	32.1851	52	133.8518	22	5.9753	52	33.3827
23	34.5000	53	138.3888	23	6.5309	53	34.6790
24	36.8888	54	143.0000	24	7.1111	54	36.0000
25	38.2407	55	147.6851	25	7.7160	55	37.3456
26	41.8888	56	152.4444	26	8.3457	56	38.7160
27	44.5000	57	157.3888	27	9.0000	57	40.1111
28	47.1851	58	162.1851	28	9.6790	58	41.5308
29	49.9444	59	167.1666	29	10.3827	59	42.9753
30	52.7777	60	172.2222	30	11.1111	60	44.4444

BASE 35—SLOPE 2¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6944	31	64.5833	1	.0154	31	14.8302
2	1.4814	32	68.1481	2	.0617	32	15.8013
3	2.3611	33	71.8055	3	.1389	33	16.8055
4	3.3333	34	75.5555	4	.2468	34	17.8395
5	4.3981	35	79.3981	5	.3857	35	18.9043
6	5.5555	36	83.3333	6	.5555	36	20.0000
7	6.8055	37	87.3611	7	.7561	37	21.1265
8	8.1481	38	91.4814	8	.9876	38	22.2839
9	9.5833	39	95.6944	9	1.2500	39	23.4722
10	11.1111	40	100.0000	10	1.5432	40	24.6913
11	12.7316	41	104.3981	11	1.8673	41	25.9413
12	14.4444	42	108.8888	12	2.2222	42	27.2222
13	16.2500	43	113.4722	13	2.6080	43	28.5360
14	18.1481	44	118.1481	14	3.0247	44	29.8765
15	20.1388	45	122.9166	15	3.4722	45	31.2500
16	22.2222	46	127.7777	16	3.9506	46	32.6543
17	24.3981	47	132.7316	17	4.4599	47	34.0895
18	26.6666	48	137.7777	18	5.0000	48	35.5555
19	29.0277	49	142.9166	19	5.5710	49	37.0524
20	31.4814	50	148.1481	20	6.1728	50	38.5802
21	34.0277	51	153.4722	21	6.8055	51	40.1388
22	36.6666	52	158.8888	22	7.4691	52	41.7283
23	39.3981	53	164.3981	23	8.1636	53	43.3487
24	42.2222	54	170.0000	24	8.8889	54	45.0000
25	45.1388	55	175.6944	25	9.6455	55	46.6820
26	48.1481	56	181.4814	26	10.4321	56	48.3950
27	51.2500	57	187.3611	27	11.2500	57	50.1388
28	54.4444	58	193.3333	28	12.0587	58	51.9135
29	57.7316	59	199.3981	29	12.9782	59	53.7191
30	61.1111	60	205.5555	30	13.8889	60	55.5555

BASE 35—SLOPE 3 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.7037	31	73.4814	1	.0185	31	17.7963
2	1.5185	32	77.6296	2	.0740	32	18.9630
3	2.4444	33	81.8888	3	.1667	33	20.1666
4	3.4814	34	86.2592	4	.2963	34	21.4074
5	4.6296	35	90.7407	5	.4628	35	22.6851
6	5.8888	36	95.3333	6	.6667	36	24.0000
7	7.2592	37	100.0370	7	.9074	37	25.3518
8	8.7407	38	104.8518	8	1.1852	38	26.7407
9	10.3333	39	109.7777	9	1.5000	39	28.1666
10	12.0370	40	114.8148	10	1.8518	40	29.6296
11	13.8518	41	119.9629	11	2.2407	41	31.1296
12	15.7777	42	125.2222	12	2.6667	42	32.6666
13	17.8148	43	130.5925	13	3.1296	43	34.2407
14	19.9629	44	136.0740	14	3.6296	44	35.8518
15	22.2222	45	141.6666	15	4.1667	45	37.5000
16	24.5925	46	147.3703	16	4.7407	46	39.1851
17	27.0740	47	153.1851	17	5.3518	47	40.9074
18	29.6666	48	159.1111	18	6.0000	48	42.6666
19	32.3703	49	165.1481	19	6.6852	49	44.4629
20	35.1851	50	171.2962	20	7.4074	50	46.2963
21	38.1111	51	177.5555	21	8.1667	51	49.1666
22	41.1481	52	183.9259	22	8.9629	52	50.0740
23	44.2962	53	190.4074	23	9.7962	53	52.0185
24	47.5555	54	197.0000	24	10.6667	54	54.0000
25	50.9259	55	203.7037	25	11.5741	55	56.0184
26	54.4074	56	210.5185	26	12.5184	56	58.0740
27	58.0000	57	217.4444	27	13.5000	57	60.1666
28	61.7037	58	224.4814	28	14.5185	58	62.2962
29	65.5185	59	231.6296	29	15.5741	59	64.4629
30	69.4444	60	238.8888	30	16.6667	60	66.6666

BASE 36—SLOPE ¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6712	31	25.1157	1	.0015	31	1.4830
2	1.3518	32	26.0740	2	.0062	32	1.5802
3	2.0416	33	27.0416	3	.0139	33	1.6805
4	2.7407	34	28.0185	4	.0246	34	1.7839
5	3.4490	35	29.0046	5	.0385	35	1.8904
6	4.1666	36	30.0000	6	.0555	36	2.0000
7	4.8935	37	31.0046	7	.0756	37	2.1126
8	5.6296	38	32.0185	8	.0988	38	2.2284
9	6.3750	39	33.0416	9	.1250	39	2.3472
10	7.1296	40	34.0740	10	.1543	40	2.4691
11	7.8935	41	35.1157	11	.1867	41	2.5941
12	8.6666	42	36.1666	12	.2222	42	2.7222
13	9.4490	43	37.2268	13	.2608	43	2.8545
14	10.2407	44	38.2962	14	.3025	44	2.9876
15	11.0416	45	39.3750	15	.3472	45	3.1250
16	11.8518	46	40.4629	16	.3951	46	3.2654
17	12.6712	47	41.5601	17	.4460	47	3.4089
18	13.5000	48	42.6666	18	.5000	48	3.5555
19	14.3379	49	43.7824	19	.5571	49	3.7052
20	15.1851	50	44.9074	20	.6173	50	3.8580
21	16.0416	51	46.0416	21	.6805	51	4.0139
22	16.9074	52	47.1851	22	.7469	52	4.1728
23	17.7824	53	48.3379	23	.8163	53	4.3349
24	18.6666	54	49.5000	24	.8889	54	4.5000
25	19.5601	55	50.6712	25	.9647	55	4.6682
26	20.4629	56	51.8518	26	1.0432	56	4.8395
27	21.3750	57	53.0416	27	1.1250	57	5.0139
28	22.2962	58	54.2407	28	1.2099	58	5.1913
29	23.2268	59	55.4490	29	1.2978	59	5.3719
30	24.1666	60	56.6666	30	1.3889	60	5.5555

BASE 36—SLOPE ½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6759	31	29.5648	1	.0031	31	2.9660
2	1.3703	32	30.8148	2	.0123	32	3.1605
3	2.0833	33	32.0833	3	.0278	33	3.3611
4	2.8148	34	33.3703	4	.0494	34	3.5679
5	3.5648	35	34.6759	5	.0772	35	3.7808
6	4.3333	36	36.0000	6	.1111	36	4.0000
7	5.1203	37	37.3425	7	.1512	37	4.2253
8	5.9259	38	38.7037	8	.1975	38	4.4568
9	6.7500	39	40.0833	9	.2500	39	4.6944
10	7.5925	40	41.4814	10	.3086	40	4.9383
11	8.4537	41	42.8981	11	.3734	41	5.1883
12	9.3333	42	44.3333	12	.4444	42	5.4444
13	10.2316	43	45.7870	13	.5216	43	5.7067
14	11.1481	44	47.2592	14	.6049	44	5.9753
15	12.0833	45	48.7500	15	.6944	45	6.2500
16	13.0370	46	50.2592	16	.7901	46	6.5308
17	14.0092	47	51.7870	17	.8920	47	6.8179
18	15.0000	48	53.3333	18	1.0000	48	7.1111
19	16.0092	49	54.8981	19	1.1142	49	7.4105
20	17.0370	50	56.4814	20	1.2346	50	7.7160
21	18.0833	51	58.0833	21	1.3611	51	8.0277
22	19.1481	52	59.7037	22	1.4938	52	8.3456
23	20.2316	53	61.3425	23	1.6327	53	8.6697
24	21.3333	54	63.0000	24	1.7778	54	9.0000
25	22.4537	55	64.6759	25	1.9295	55	9.3364
26	23.5925	56	66.3703	26	2.0864	56	9.6790
27	24.7500	57	68.0833	27	2.2500	57	10.0277
28	25.9259	58	69.8148	28	2.4197	58	10.3827
29	27.1203	59	71.5648	29	2.5956	59	10.7438
30	28.3333	60	73.3333	30	2.7778	60	11.1111

BASE 36—SLOPE ¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6805	31	34.0138	1	.0046	31	4.4490
2	1.3888	32	35.5555	2	.0185	32	4.7407
3	2.1250	33	37.1250	3	.0416	33	5.0416
4	2.8888	34	38.7222	4	.0740	34	5.3518
5	3.6805	35	40.3472	5	.1157	35	5.6712
6	4.5000	36	42.0000	6	.1667	36	6.0000
7	5.3472	37	43.6805	7	.2268	37	6.3379
8	6.2222	38	45.3888	8	.2963	38	6.6851
9	7.1250	39	47.1250	9	.3750	39	7.0416
10	8.0555	40	48.8888	10	.4630	40	7.4074
11	9.0138	41	50.6805	11	.5602	41	7.7824
12	10.0000	42	52.5000	12	.6667	42	8.1666
13	11.0138	43	54.3472	13	.7824	43	8.5602
14	12.0555	44	56.2222	14	.9074	44	8.9629
15	13.1250	45	58.1250	15	1.0417	45	9.3750
16	14.2222	46	60.0555	16	1.1852	46	9.7962
17	15.3472	47	62.0138	17	1.3379	47	10.2268
18	16.5000	48	64.0000	18	1.5000	48	10.6666
19	17.6805	49	66.0138	19	1.6713	49	11.1157
20	18.8888	50	68.0555	20	1.8518	50	11.5740
21	20.1250	51	70.1250	21	2.0417	51	12.0416
22	21.3888	52	72.2222	22	2.2407	52	12.5185
23	22.6805	53	74.3472	23	2.4491	53	13.0046
24	24.0000	54	76.5000	24	2.6667	54	13.5000
25	25.3472	55	78.6805	25	2 8935	55	14.0046
26	26.7222	56	80.8888	26	3.1296	56	14.5185
27	28.1250	57	83.1250	27	3.3750	57	15.0416
28	29.5555	58	85.3888	28	3.6296	58	15.5740
29	31.0138	59	87.6805	29	3.8935	59	16.1157
30	32.5000	60	90.0000	30	4.1667	60	16.6666

BASE 36—SLOPE 1 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6851	31	38.4629	1	.0062	31	5.9321
2	1.4074	32	40.2962	2	.0247	32	6.3210
3	2.1666	33	42.1666	3	.0555	33	6.7222
4	2.9629	34	44.0740	4	.0988	34	7.1358
5	3.7962	35	46.0185	5	.1543	35	7.5617
6	4.6666	36	48.0000	6	.2222	36	8.0000
7	5.5740	37	50.0185	7	.3025	37	8.4506
8	6.5185	38	52.0740	8	.3951	38	8.9135
9	7.5000	39	54.1666	9	.5000	39	9.3888
10	8.5185	40	56.2962	10	.6173	40	9.8765
11	9.5740	41	58.4629	11	.7469	41	10.3765
12	10.6666	42	60.6666	12	.8889	42	10.8888
13	11.7962	43	62.9074	13	1.0432	43	11.4135
14	12.9629	44	65.1851	14	1.2099	44	11.9506
15	14.1666	45	67.5000	15	1.3889	45	12.5000
16	15.4074	46	69.8518	16	1.5802	46	13.0617
17	16.6851	47	72.2407	17	1.7839	47	13.6358
18	18.0000	48	74.6666	18	2.0000	48	14.2222
19	19.3518	49	77.1296	19	2.2284	49	14.8209
20	20.7407	50	79.6296	20	2.4691	50	15.4321
21	22.1666	51	82.1666	21	2.7222	51	16.0555
22	23.6296	52	84.7407	22	2.9876	52	16.6913
23	25.1296	53	87.3518	23	3.2654	53	17.3395
24	26.6666	54	90.0000	24	3.5555	54	18.0000
25	28.2407	55	92.6851	25	3.8580	55	18.6728
26	29.8518	56	95.4074	26	4.1728	56	19.3580
27	31.5000	57	98.1666	27	4.5000	57	20.0555
28	33.1851	58	100.9629	28	4.8395	58	20.7654
29	34.9074	59	103.7962	29	5.1913	59	21.4876
30	36.6666	60	106.6666	30	5.5555	60	22.2222

BASE 36—SLOPE 1¼ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6898	31	42.9120	1	.0077	31	7.4151
2	1.4259	32	45.0370	2	.0309	32	7.9012
3	2.2083	33	47.2083	3	.0694	33	8.4027
4	3.0370	34	49.4259	4	.1234	34	8.9197
5	3.9120	35	51.6898	5	.1928	35	9.4521
6	4.8333	36	54.0000	6	.2778	36	10.0000
7	5.8009	37	56.3564	7	.3781	37	10.5632
8	6.8148	38	58.7592	8	.4938	38	11.1419
9	7.8750	39	61.2083	9	.6250	39	11.7361
10	8.9814	40	63.7037	10	.7716	40	12.3456
11	10.1342	41	66.2453	11	.9336	41	12.9706
12	11.3333	42	68.8333	12	1.1111	42	13.6111
13	12.5787	43	71.4675	13	1.3040	43	14.2680
14	13.8703	44	74.1481	14	1.5123	44	14.9382
15	15.2083	45	76.8750	15	1.7361	45	15.6250
16	16.5925	46	79.6481	16	1.9753	46	16.3271
17	18.0231	47	82.4675	17	2.2299	47	17.0447
18	19.5000	48	85.3333	18	2.5000	48	17.7777
19	21.0231	49	88.2453	19	2.7855	49	18.5262
20	22.5925	50	91.2037	20	3.0864	50	19.2901
21	24.2083	51	94.2083	21	3.4028	51	20.0694
22	25.8703	52	97.2592	22	3.7346	52	20.8641
23	27.5787	53	100.3564	23	4.0818	53	21.6743
24	29.3333	54	103.5000	24	4.4444	54	22.5000
25	31.1342	55	106.6898	25	4.8228	55	23.3410
26	32.9814	56	109.9259	26	5.2160	56	24.1975
27	34.8750	57	113.2083	27	5.6250	57	25.0694
28	36.8148	58	116.5370	28	6.0494	58	25.9567
29	38.8009	59	119.9120	29	6.4891	59	26.8595
30	40.8333	60	123.3333	30	6.9444	60	27.7777

BASE 36—SLOPE 1½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts	Deduct.
1	.6944	31	47.3611	1	.0092	31	8.8981
2	1.4444	32	49.7777	2	.0370	32	9.4815
3	2.2500	33	52.2500	3	.0833	33	10.0833
4	3.1111	34	54.7777	4	.1480	34	10.7037
5	4.0277	35	57.3611	5	.2313	35	11.3425
6	5.0000	36	60.0000	6	.3333	36	12.0000
7	6.0277	37	62.6944	7	.4537	37	12.6759
8	7.1111	38	65.4444	8	.5926	38	13.3703
9	8.2500	39	68.2500	9	.7500	39	14.0833
10	9.4444	40	71.1111	10	.9259	40	14.8148
11	10.6944	41	74.0277	11	1.1203	41	15.5648
12	12.0000	42	77.0000	12	1.3333	42	16.3333
13	13.3611	43	80.0277	13	1.5648	43	17.1202
14	14.7777	44	83.1111	14	1.8148	44	17.9259
15	16.2500	45	86.2500	15	2.0833	45	18.7500
16	17.7777	46	89.4444	16	2.3704	46	19.5925
17	19.3611	47	92.6944	17	2.6759	47	20.4537
18	21.0000	48	96.0000	18	3.0000	48	21.3333
19	22.6944	49	99.3611	19	3.3426	49	22.2314
20	24.4444	50	102.7777	20	3.7037	50	23.1481
21	26.2500	51	106.2500	21	4.0833	51	24.0833
22	28.1111	52	109.7777	22	4.4815	52	25.0370
23	30.0277	53	113.3611	23	4.8981	53	26.0092
24	32.0000	54	117.0000	24	5.3333	54	27.0000
25	34.0277	55	120.6944	25	5.7869	55	28.0092
26	36.1111	56	124.4444	26	6.2592	56	29.0370
27	38.2500	57	128.2500	27	6.7500	57	30.0833
28	40.4444	58	132.1111	28	7.2592	58	31.1481
29	42.6944	59	136.0277	29	7.7869	59	32.2314
30	45.0000	60	140.0000	30	8.3333	60	3.33333

BASE 36—SLOPE 1¾ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.6990	31	51.8101	1	.0108	31	10.3811
2	1.4629	32	54.5185	2	.0432	32	11.0617
3	2.2916	33	57.2916	3	.0972	33	11.7638
4	3.1852	34	60.1296	4	.1728	34	12.4876
5	4.1435	35	63.0825	5	.2700	35	13.2330
6	5.1666	36	66.0000	6	.3889	36	14.0000
7	6.2456	37	69.0825	7	.5293	37	14.7885
8	7.4074	38	72.1296	8	.6913	38	15.5987
9	8.6250	39	75.2916	9	.8750	39	16.4305
10	9.9074	40	78.5185	10	1.0802	40	17.2839
11	11.2456	41	81.8101	11	1.3071	41	18.1589
12	12.6666	42	85.1666	12	1.5555	42	19.0555
13	14.1435	43	88.5879	13	1.8256	43	19.9747
14	15.6852	44	92.0740	14	2.1173	44	20.9135
15	17.2916	45	95.6250	15	2.4305	45	21.8750
16	18.9629	46	99.2407	16	2.7654	46	22.8580
17	20.6990	47	102.9212	17	3.1219	47	23.8626
18	22.5000	48	106.6666	18	3.5000	48	24.8888
19	24.3657	49	110.4768	19	3.8997	49	25.9367
20	26.2962	50	114.3518	20	4.3210	50	27.0061
21	28.2916	51	118.2916	21	4.7639	51	28.0972
22	30.3518	52	122.2962	22	5.2284	52	29.2098
23	32.4768	53	126.3657	23	5.7145	53	30.3441
24	34.6666	54	130.5000	24	6.2222	54	31.5000
25	36.9212	55	134.6990	25	6.7516	55	32.6774
26	39.2407	56	138.9629	26	7.3024	56	33.8765
27	41.6250	57	143.2916	27	7.8750	57	35.0972
28	44.0740	58	147.6852	28	8.4691	58	36.3394
29	46.5879	59	152.1435	29	9.0848	59	37.6033
30	49.1666	60	156.6666	30	9.7222	60	38.8888

BASE 36—SLOPE 2 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.7037	31	56.2592	1	.0123	31	11.8642
2	1.4814	32	59.2592	2	.0494	32	12.6419
3	2.3333	33	62.3333	3	.1111	33	13.4444
4	3.2592	34	65.4814	4	.1975	34	14.2716
5	4.2592	35	68.7037	5	.3086	35	15.1234
6	5.3333	36	72.0000	6	.4444	36	16.0000
7	6.4814	37	75.3703	7	.6049	37	16.9012
8	7.7037	38	78.8148	8	.7901	38	17.8271
9	9.0000	39	82.3333	9	1.0000	39	18.7777
10	10.3703	40	85.9259	10	1.2346	40	19.7530
11	11.8148	41	89.5925	11	1.4938	41	20.7530
12	13.3333	42	93.3333	12	1.7778	42	21.7777
13	14.9259	43	97.1481	13	2.0864	43	22.8271
14	16.5925	44	101.0370	14	2.4197	44	23.9012
15	18.3333	45	105.0000	15	2.7778	45	25.0000
16	20.1481	46	109.0370	16	3.1605	46	26.1234
17	22.0370	47	113.1481	17	3.5679	47	27.2716
18	24.0000	48	117.3333	18	4.0000	48	28.4444
19	26.0370	49	121.5925	19	4.4568	49	29.6420
20	28.1481	50	125.9259	20	4.9382	50	30.8642
21	30.3333	51	130.3333	21	5.4444	51	32.1111
22	32.5925	52	134.8148	22	5.9753	52	33.3827
23	34.9259	53	139.3703	23	6.5309	53	34.6790
24	37.3333	54	144.0000	24	7.1111	54	36.0000
25	39.8148	55	148.7037	25	7.7160	55	37.3456
26	42.3703	56	153.4814	26	8.3457	56	38.7160
27	45.0000	57	158.3333	27	9.0000	57	40.1111
28	47.7037	58	163.2592	28	9.6790	58	41.5308
29	50.4814	59	168.2592	29	10.3827	59	42.9753
30	53.3333	60	173.3333	30	11.1111	60	44.4444

BASE 36—SLOPE 2½ to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.7129	31	65.1574	1	.0154	31	14.8302
2	1.5185	32	68.7407	2	.0617	32	15.8015
3	2.4166	33	72.4166	3	.1389	33	16.8055
4	3.4074	34	76.1851	4	.2468	34	17.8395
5	4.4907	35	80.0462	5	.3857	35	18.9043
6	5.6666	36	84.0000	6	.5555	36	20.0000
7	6.9351	37	88.0462	7	.7561	37	21.1265
8	8.2962	38	92.1851	8	.9876	38	22.2839
9	9.7500	39	96.4166	9	1.2500	39	23.4722
10	11.2962	40	100.7407	10	1.5432	40	24.6913
11	12.9351	41	105.1574	11	1.8673	41	25.9413
12	14.6666	42	109.6666	12	2.2222	42	27.2222
13	16.4907	43	114.2685	13	2.6080	43	28.5360
14	18.4074	44	118.9629	14	3.0247	44	29.8765
15	20.4166	45	123.7500	15	3.4722	45	31.2500
16	22.5185	46	128.6296	16	3.9506	46	32.6543
17	24.7129	47	133.6018	17	4.4599	47	34.0895
18	27.0000	48	138.6666	18	5.0000	48	35.5555
19	29.3796	49	143.8240	19	5.5710	49	37.0524
20	31.8518	50	149.0740	20	6.1728	50	38.5802
21	34.4166	51	154.4166	21	6.8055	51	40.1388
22	37.0740	52	159.8518	22	7.4691	52	41.7283
23	39.8240	53	165.3796	23	8.1636	53	43.3487
24	42.6666	54	171.0000	24	8.8889	54	45.0000
25	45.6018	55	176.7129	25	9.6455	55	46.6820
26	48.6296	56	182.5185	26	10.4321	56	48.3950
27	51.7500	57	188.4166	27	11.2500	57	50.1388
28	54.9629	58	194.4074	28	12.0587	58	51.9135
29	58.2685	59	200.4907	29	12.9782	59	53.7191
30	61.6666	60	206.6666	30	13.8889	60	55.5555

BASE 36—SLOPE 3 to 1.

Height	Add.	Height	Add.	Dif. of Hts.	Deduct.	Dif. of Hts.	Deduct.
1	.7222	31	74.0555	1	.0185	31	17.7963
2	1.5555	32	78.2222	2	.0740	32	18.9630
3	2.5000	33	82.5000	3	.1667	33	20.1666
4	3.5555	34	86.8888	4	.2963	34	21.4074
5	4.7222	35	91.3888	5	.4628	35	22.6851
6	6.0000	36	96.0000	6	.6667	36	24.0000
7	7.3888	37	100.7222	7	.9074	37	25.3518
8	8.8888	38	105.5555	8	1.1852	38	26.7407
9	10.5000	39	110.5000	9	1.5000	39	28.1666
10	12.2222	40	115.5555	10	1.8518	40	29.6296
11	14.0555	41	120.7222	11	2.2407	41	31.1296
12	16.0000	42	126.0000	12	2.6667	42	32.6666
13	18.0555	43	131.3888	13	3.1296	43	34.2407
14	20.2222	44	136.8888	14	3.6296	44	35.8518
15	22.5000	45	142.5000	15	4.1667	45	37.5000
16	24.8888	46	148.2222	16	4.7407	46	39.1851
17	27.3888	47	154.0555	17	5.3518	47	40.9078
18	30.0000	48	160.0000	18	6.0000	48	42.6666
19	32.7222	49	166.0555	19	6.6852	49	44.4629
20	35.5555	50	172.2222	20	7.4074	50	46.2963
21	38.5000	51	178.5000	21	8.1667	51	49.1666
22	41.5555	52	184.8888	22	8.9629	52	50.0740
23	44.7222	53	191.3888	23	9.7962	53	52.0185
24	48.0000	54	198.0000	24	10.6667	54	54.0000
25	51.3888	55	204.7222	25	11.5741	55	56.0184
26	54.8888	56	211.5555	26	12.5184	56	58.0740
27	58.5000	57	218.5000	27	13.5000	57	60.1666
28	62.2222	58	225.5555	28	14.5185	58	62.2962
29	66.0555	59	232.7222	29	15.5741	59	64.4629
30	70.0000	60	240.0000	30	16.6667	60	66.6666

TABLE OF BASES.

	1	2	3	4	5
1	.0185	.0370	.0556	.0741	.0926
2	.0370	.0741	.1111	.1481	.1852
3	.0556	.1111	.1667	.2222	.2778
4	.0741	.1481	.2222	.2963	.3704
5	.0926	.1852	.2778	.3704	.4630
6	.1111	.2222	.3333	.4444	.5556
7	.1296	.2593	.3889	.5185	.6481
8	.1481	.2963	.4444	.5926	.7407
9	.1667	.3333	.5000	.6667	.8333
10	.1852	.3704	.5556	.7407	.9259
11	.2047	.4074	.6111	.8148	1.0185
12	.2222	.4444	.6667	.8889	1.1111
13	.2407	.4815	.7222	.9630	1.2037
14	.2593	.5185	.7778	1.0370	1.2963
15	.2778	.5556	.8333	1.1111	1.3889
16	.2963	.5926	.8889	1.1852	1.4815
17	.3148	.6296	.9444	1.2592	1.5741
18	.3333	.6667	1.0000	1.3334	1.6667
19	.3519	.7037	1.0556	1.4074	1.7592
20	.3704	.7407	1.1111	1.4814	1.8518
21	.3889	.7777	1.1667	1.5555	1.9444
22	.4074	.8148	1.2222	1.6296	2.0370
23	.4259	.8519	1.2778	1.7037	2.1297
24	.4444	.8889	1.3333	1.7778	2.2222
25	.4630	.9259	1.3889	1.8519	2.3148
26	.4815	.9630	1.4444	1.9260	2.4074
27	.5000	1.0000	1.5000	2.0000	2.5000
28	.5185	1.0370	1.5556	2.0740	2.5926
29	.5370	1.0741	1.6111	2.1481	2.6852
30	.5556	1.1111	1.6667	2.2222	2.7777

TABLE OF BASES.

	1	2	3	4	5
31	.5741	1.1481	1.7222	2.2963	2.8704
32	.5926	1.1852	1.7778	2.3704	2.9630
33	.6111	1.2222	1.8333	2.4444	3.0556
34	.6296	1.2593	1.8889	2.5185	3.1481
35	.6481	1.2963	1.9444	2.5926	3.2407
36	.6667	1.3333	2.0000	2.6667	3.3333
37	.6852	1.3704	2.0556	2.7407	3.4259
38	.7037	1.4074	2.1111	2.8148	3.5185
39	.7222	1.4444	2.1667	2.8889	3.6111
40	.7407	1.4815	2.2222	2.9630	3.7037
41	.7593	1.5185	2.2778	3.0370	3.7963
42	.7778	1.5556	2.3333	3.1111	3.8889
43	.7963	1.5926	2.3889	3.1852	3.9815
44	.8148	1.6296	2.4444	3.2592	4.0741
45	.8333	1.6667	2.5000	3.3334	4.1667
46	.8519	1.7037	2.5556	3.4074	4.2592
47	.8704	1.7407	2.6111	3.4814	4.3518
48	.8889	1.7777	2.6667	3.5555	4.4444
49	.9074	1.8148	2.7222	3.6296	4.5370
50	.9259	1.8519	2.7778	3.7037	4.6297
51	.9444	1.8889	2.8333	3.7778	4.7222
52	.9630	1.9259	2.8889	3.8519	4.8148
53	.9815	1.9630	2.9444	3.9260	4.9074
54	1.0000	2.0000	3.0000	4.0000	5.0000
55	1.0185	2.0370	3.0556	4.0741	5.0926
56	1.0370	2.0741	3.1111	4.1481	5.1852
57	1.0556	2.1111	3.1667	4.2222	5.2777
58	1.0741	2.1481	3.2222	4.2963	5.3704
59	1.0926	2.1852	3.2778	4.3704	5.4630
60	1.1111	2.2222	3.3333	4.4444	5.5555

AN ESSAY

ON THE

PRISMOIDAL FORMULA,

FOR THE PURPOSE OF CALCULATING THE

EARTHWORK OF RAILWAYS AND CANALS.

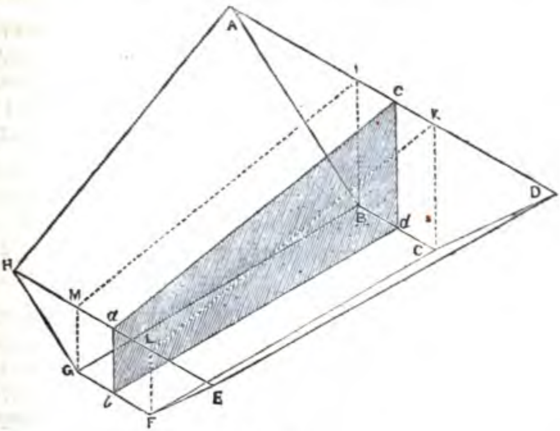


Fig. 1.

Let the above diagram represent an isometric view of a prismoid.

Let ab = height at one end.

" cd = height at the other.

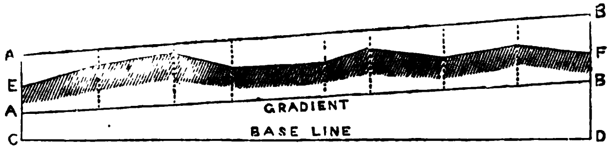
" bd = length of prismoid.

" $abcd$ = the vertical section through the centre in the direction of its length.

This figure is that view commonly represented on sections, and by reference to which all the calculations are made.

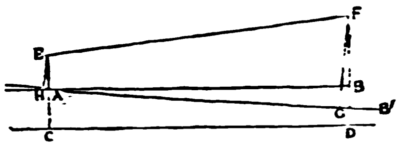
A *section* is a plot of a succession of levels taken along a given line of country (see Fig. 2), shewing the comparative levels of any two points, and also the distance between them.

Fig. 2.



The line C D represents the datum line on a horizontal plane, assumed according to circumstances, for the purpose of shewing the comparative levels of any given places; the line AB is the gradient determined to be worked on by the engineer, which likewise has its comparative levels in reference to the datum line C D; the line E F is the surface of the country, consisting of hills and valleys on the site of the line of the proposed work. According as the gradient AB is below or above the surface of the country E F, as shewn on the Fig. 2, the whole quantity of earthwork is required to be taken from the space E A B F, if the former case; or it is necessary to fill up with earth, imposed on the surface E F, a quantity sufficient to form the embankment indicated on the section by the space A E B F. To render the computation as simple as possible, and to reduce it within the known rules of geometry, at every variation of level there are perpendiculars let fall (or raised, as the case may be) to the gradient A B, thereby making the section a series of simple figures, and similar to that shewn as Fig. 1, which is the prismoid. The ordinary way of dividing the section is by squaring up lines with the datum C D; but if the gradient is not a level, but takes a direction AB^1, then the figure is no longer a rectangular prismoid ABFE, (see Fig. 3); but a prismoid AB^1 FE where neither the angles EAB^1 or AB^1 F are right angles.

Fig. 3.



The prismoid due to the surface EF is greater in that case than in the rectangular case: I will shew the difference further on, and merely remark here, that in practice, supposing such difference existed in the prismoids, FG represents the height due to a rectangular prismoid, while FB^1 is the actual height measured; the error is due to the difference of the heights FB^1 and FG. Yet the steepest gradient rarely exceeds 1 in 100; so that when the perpendicular height FG with the gradient is 1, the distance $GB^1 = \frac{1}{100}$, then the height FB^1 due to the perpendicular to the base line is $\sqrt{1 + \frac{1}{10000}}$; the error is so trifling that it need never be regarded in calculations of this kind for practical purposes.

When the sections are prepared, the slope of the sides is determined upon according to the local and contingent circumstances, and the base of the work is also given. These are the only other quantities involved which are not represented on the *section;* for on inspection of Fig. 1, it is seen that the area ABCD of the transverse section consists of a parallelogram of the *base* BC, and height BI, and two triangles of the height BI, and a base AI due to the *slope*. Therefore, by knowing the heights on the section, and the lengths, the cubic contents can be determined.

The rule given in books on geometry and other practical works is as follows:—

To the area of the two ends add four times the middle section, and divide the sum by one-sixth of the length = prismoid; or (algebraically expressed)

Let H = height of one end.
" h = height of the other end.
" L = length.
" B = given base.
" S = given slope.

Then $\left(HB + H^2S + hB + h^2S + 4\left[\left(\frac{H+h}{2}\right) B + \frac{(H+h)^2}{4}\right)S\right] \times \frac{L}{6}$

is the cubic content of the prismoid.

When developed, this equation becomes

$$[HB + H^2S + hB + h^2S + 2BH + 2Bh + H^2\,S^2\;2Hh + h^2\,S] + \frac{L}{6};$$

and when reduced, it becomes

$$\left[\frac{(H+h)\,B}{2} + \frac{(H^2 + Hh + h^2)\,S}{3}\right] L = \text{cubic contents.}$$

Now, this rule being given, in order to establish its accuracy I will prove it by the method of fluxions, and take it in the most simple form, when H $= o$, or the surface of the ground at one end intersects the base (see Fig. 4).

Fig. 4.

Let AB be the gradient,* and AC the surface, and the expressions in algebra be the same as before.†

Let any variable area at DE be equal to y, and AD, a variable length, be equal to x. Now $y\dot{x}$ = fluxion of cube,

* In all cases where the gradient is mentioned, the formation level is intended, which is generally 2 feet 6 inches lower than the level of the rails. The word "gradient" signifies a certain rise above, or fall below, the horizontal line in some given length.

† These expressions will always be used throughout the whole essay; and, occcasionally, b, h, s, l are used, instead of B, H, S, L.

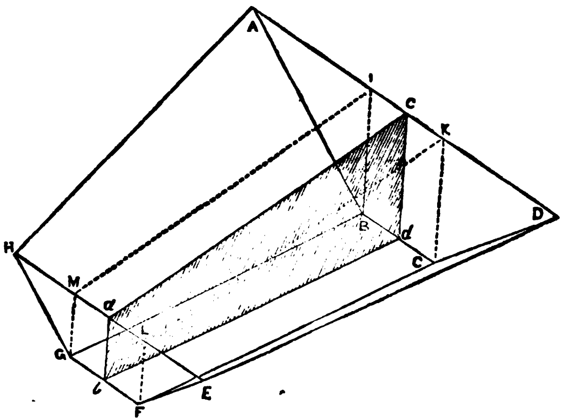
and as AB : AD :: BC : DE, or DE $= \frac{h\,x}{l}$; and the area then is $\left(\frac{b\,h\,x}{l} + \frac{h^2\,x^2\,s}{l^2}\right) = y$; therefore $\frac{b\,h\,x\,\dot{x}}{l} + \frac{s h^2\,x^2\,\dot{x}}{l^2} =$ fluxion of cube: the fluent of this is $\frac{b\,h\,x^2}{2\,l} + \frac{s\,h^2\,x^3}{3\,l^2} =$ cube; and when $x = l$, cube $= \frac{b\,h\,l}{2} + \frac{s\,h^2\,l}{3} =$ ABC. Now, by deducting the prism ADE from ABC, we can find the prismoid EDBC. Introducing the other height H, EDBC $= l\left(\frac{b\,H}{2} + \frac{s\,H^2}{3}\right) - \left(\frac{b\,h}{2} - \frac{s\,h^2}{3}\right) x$. But DB being given$=$L, $x = l - L$; so, as $x : h :: L : (H - h)$; therefore $x = \frac{h\,L}{H - h} = l - L$, and $l = L\left(\frac{H}{H - h}\right)$. Substitute this value of L and x in the former equation, $\left(\frac{bH}{2} + \frac{s\,H^2}{3}\right) L\,\frac{H}{H - h} - \left(\frac{bh}{2} + \frac{s\,h^2}{3}\right) L\,\frac{h}{H - h} = c.$

Reduce this, $L\left(\frac{B\,H^2}{2} + \frac{s\,H^3}{3} - \frac{bh^2}{2} - \frac{s\,h^3}{3}\right) \times \frac{1}{H - h} = c$; therefore $L\left(\frac{b}{2}\,\frac{(H^2 - h^2)}{H - h} + \frac{s}{3}\,\frac{(H^3 - h^3)}{H - h}\right) = c$. But $H^2 - h^2 = (H + h) \times (H - h)$; hence $\frac{H^2 - h^2}{H - h} = H + h$. And $H^3 - h^3 = (H^2 + Hh + h^2)\,(H - h)$; therefore $\frac{H^3 - h^3}{H - h} = H^2 + Hh + h^2$. Consequently $\left[\frac{(H + h)\,B}{2} + \frac{(H^2 + H\,h + h^2)\,s}{3}\right] \times L =$ cube, which is the same as the ordinary rule *Q, E. D.*

For the benefit of those who do not understand the fluxional process, I subjoin a geometric method of proof

Let fig. 5 be a prismoid in geometric perspective, and the slopes of the sides be assumed of equal ratio.

Fig. 5.



The solid figure is ABCDEFGH. The base of the work being BC, draw perpendiculars to BC through B and C, and complete the solid IBCKLMGF by the intersecting vertical planes on BG and CF. The prismoid is then divided into three figures, namely, the two equal solids AIBGMH, and DKCFLE, which are frustra of pyramids; and the middle solid IBCKLMGF, which is a frustrum of a rectangular wedge. If the analysis is carried on in the same manner as the former, by assuming the surface and the base to meet, as in fig. 4, the results will be obtained in a more simple form.

Using the same notation as before, we have—

h = height.

l = length.

s = ratio of slope.

b = base.

Fig. 6.

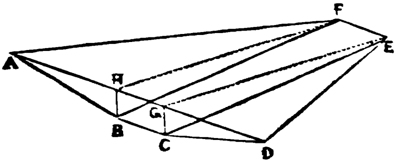


Figure 6 represents the isometric perspective of such solid, where all the planes meet at F E.

First, the wedge H B C G E F is $= \frac{b\,h\,l}{2}$

Secondly, the pyramids A H B F and D G C E are $= \frac{h^2\,s\,l}{3}$

Therefore the sum is $\frac{b\,h\,l}{2} + \frac{h^2\,s\,l}{3} =$ cube. This equation being the same as produced by the fluent in the fluxional method, of course, must bring out the same results, which, when determined for a prismoid, becomes $\left[\frac{b\,(H+h)}{2} + \frac{s}{3}\,(H^2 + Hh + h^2)\right] \times l.$ Mr. Macneil, in his tables, has also proved the rule in a different manner to that followed here, though not in so concise a form of investigation, and produces at once the rule ordinarily given.

Having now shewn the principle of the prismoidal formula, I shall proceed to compare it with the ordinary method of measuring work by contractors. There are two ways in use. One is to take the mean height of a section (supposed to be subdivided), and, finding the area, then to multiply by the length for the cube, or algebraically, $\frac{H+h}{2} =$ mean height; $\left[\frac{B\,(H+h)}{2} + \left(\frac{H^2 + 2\,Hh + h^2}{4}\right)s\right] \times l =$ cube.

Compare this with the prismoid, and we find that the quantities that differ are those due to the sides, therefore $\frac{H^2 + 2\,Hh + h^2}{4} \pm x = \frac{H^2 + Hh + h^2}{3}$ therefore $3H^2 + 6Hh + 3\,h^2 \pm 12x = 4H^2 + 4\,Hh + 4\,h^2$ consequently $\pm\,12\,x = H^2 - 2\,Hh + h^2 = (H - h)^2$. But as $(H - h)^2$ is always a positive quantity, the sign of the other term of the equation will be positive; so that

$x = \frac{(H-h)^2 s}{12}$ = the quantity required to be added to the area of the mean height, shewing that that process gives the quantity less than the true one. The second method used by contractors is to find the areas of the ends of a section, and take the mean area, and multiply by the length as before for the cube, or algebraically expressed,

$$\left[\frac{BH + H^2S + Bh + h^2S}{2}\right] \times l = \text{cube} = \left[\frac{B}{2}(H+h) + \frac{S}{2}(H^2+h^2)\right]l.$$

Comparing this with the prismoid, it is the side quantities that differ again; hence $\frac{H^2+h^2}{2} \pm x = \frac{H^2 + Hh + h^2}{3}$; therefore $3H^2 + 3h^2 \pm 6x = 2H^2 + 2Hh + 2h^2$; consequently $H^2 - 2Hh + h^2 = \mp 6x = (H-h)^2$; and $(H-h)^2$ being always positive, x is always negative by transposition; so that $\frac{(H-h)^2 s}{6}$ = quantity to be deducted from the mean area found, proving that this method is always in excess, and, comparing the two methods together, the latter is twice as much in excess as the former is in deficiency. As a numerical illustration may shew the comparative results more clearly, I will suppose two heights, 50 feet and 30 feet, and a length 500 feet, on a base 35 feet, with a slope of 2 to 1.

By the prismoidal formula,

30×50	=	1500	=	Hh
30×30	=	900	=	h^2
50×50	=	2500	=	H^2
$2)80 = H + h$		$3)4900$		
40		$1633\frac{1}{3}$	=	$\frac{H^2 + Hh + h^2}{3}$
$35 = B$		2	=	s
$1400 = B\frac{(H+h)}{2}$		$3266\frac{2}{3}$		

$$
\begin{array}{r}
3266\frac{2}{3} \\
1400 \\
\hline
4666\frac{2}{3} = B\,\dfrac{(H+h)}{2} + \dfrac{(H^2 + Hh+h^2)}{3} \\
500 \quad = \quad L \\
\hline
2333000 \\
333 \\
\hline
3)2333333 \\
\hline
9)\ 777777.7 \\
\hline
86419.7
\end{array}
$$

$27 \times \left\{ \right.$ 3)2333333, 9) 777777.7

86419.7 cubic yards.

By mean heights—

$$
\begin{array}{r}
50 \\
30 \\
\hline
2)80 \\
\hline
40
\end{array}
$$

$$40 \times 35 = \qquad 1400 = \frac{(H+h)\,B}{2}$$

$$40 \times 40 = 1600 \times 2 = 3200 = \frac{(H+h)^2\,s}{4}$$

$$4600 = \frac{(H + h)\,B}{2} + \frac{(H + h)^2\,s}{4}$$

$$
\begin{array}{r}
500 \\
\hline
3)2300000 \\
\hline
9)\ 766666\frac{2}{3} \\
\hline
85185.1
\end{array}
$$

$27 \left\{ \right.$ 3)2300000, 9) $766666\frac{2}{3}$

85185.1 cubic yards.

Mean Heights	=	85185.1	cubic yards.
Prismoid	=	86419.7	"
Deficiency	=	1234.6	cubic yar[ds.]

By mean areas—

$$
\begin{array}{l}
50 \times 35 = 1750 \qquad\qquad 1750 = BH \\
50 \times 50 = 2500 \times 2 = 5000 = H^2 s \\
50 \times 35 = 1050 \qquad\qquad 1050 = Bh \\
30 \times 30 = 900 \times 2 = 1800 = h^2 s
\end{array}
$$

$$
\begin{array}{r}
\underline{\qquad\qquad} \\
2)9600 \\
\underline{\qquad\qquad}
\end{array}
$$

$$4800 = \frac{B(H+h)}{2} + \frac{(H^2+h^2)\,s}{2}$$

$$
\begin{array}{r}
500 \\
\underline{\qquad\qquad\quad} \\
27 \left\{ \begin{array}{r} 3)2400000 \\ \underline{\qquad\qquad} \\ 9)\ \ 800000 \end{array} \right. \\
\underline{\qquad\qquad\quad}
\end{array}
$$

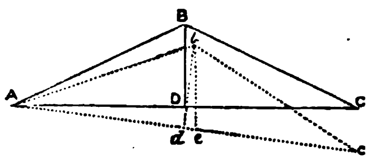
88888.8 cubic yards.

Mean areas	=	88888.8	cubic yards.
Prismoid	=	86419.7	"
Excess	=	2469.1	cubic yards.

This single calculation shews that the error is very great for such an ordinary length as 500 feet. A contractor who uses these methods may, therefore, tender for a greater quantity than is true by the method of mean areas; and by the method of mean heights, he may tender for a less quantity than true: so that he incurs the danger of two extremes—in the first case being liable to be refused, because his figures exceed the estimate of the engineer, based on the prismoidal formula; and of being disadvantageously met by other contractors, who may have availed themselves of the true method; or otherwise, if he should tender according to the results derived in the second case, and he should be accepted, he would find that, on his work being measured, he would have to perform more than he contracted for, at his own cost; besides the general effect the error in either case would have upon the schedule of prices. On the other hand, it is necessary that the resident engineer should be careful not to allow the use of the method of mean areas, as the contractor would thereby receive more money than his work performed would warrant, the contractor's interest evidently preventing him from using the other way. The consideration of the above I therefore earnestly recommend to both parties, that they may do justice to each other as well as to themselves.

I have hitherto assumed that all the prismoidal sections are rectangular, although in page 175, I alluded to cases where they are otherwise, owing to the inclination of the gradient. Though at first sight the two cases may appear to be alike, yet the following demonstration will explain the difference. For simplicity, I will assume the section as in Fig. 7, which represents an ordinary small cutting, commencing at the surface of the ground at A, the summit being at B, and the termination at C. Here AC is the gradient; and ABC is the surface of the ground; BD is a height which is common to both prismoids ABD and DBC. When AC is horizontal, then BD is perpendicular to it; but if the gradient takes another direction A *c*, being the same length, and the surface ABC being equal to A*bc*, then *b d*, the perpendicular to A *c*, is equal to B D; and *b e*, a vertical line through the point *b*, meeting A *c* in *e*, is greater than *b d*; for the angle *b d e* being a right angle, *b e* is the hypothenuse of the triangle *b d e*, and *b e* is also common to the prismoids A *b e* and *e b c*; but the lengths A *c* and A C are equal, and B D and *b e* being given, the mean areas can be found, which multiplied by the length, will give the cubic contents. Therefore, because *b e* is greater than B D, the solid A *b c* is greater

Fig. 7.

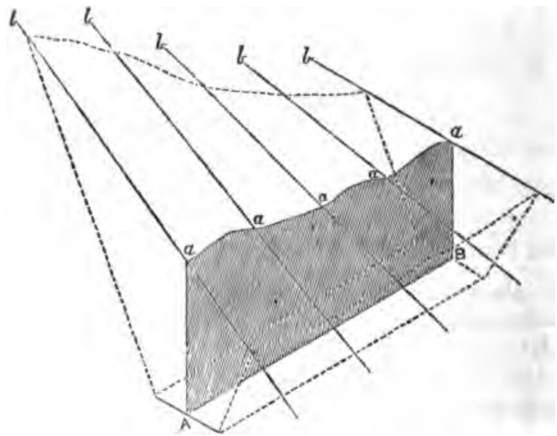


than the solid A B C. This result shews that the method of squaring the divisions from the base line is not perfectly accurate, though, for the reasons previously given, sufficiently so for practice.

It not unfrequently happens that, in an irregular country, the ground not only varies considerably in the direction of the line of works, but also transversely, so as to affect the quantity to be measured in a very sensible manner. In cases of this description, it is necessary to take cross sections of the country at every sub-division of the ordinary section, and sometimes oftener; on which occasion the section must be further sub-divided to intersect the cross sections.

In the subjoined Fig. 8, the line AB is the gradient

Fig. 8.

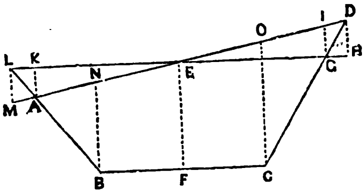


depressed below the surface of the country, and the section is sub-divided at various points *a, a, a,* into simple figures; and the lines *ba, ba, ba,* represent the cross sections at the points *a, a, a,* having reference to perpendiculars at those places, or to a horizontal datum line like an ordinary section.

The most simple case of the prismoid with a cross section is, when two cross levels, some measured distance from each other, produce the same inclination, for then it is sufficient to find the areas in the same manner as for the common prismoid; but when two levels vary, then it becomes necessary to determine the law of the variation, and find the solid by the fluxional process, which is the most ready method.

In Fig. 9, let the area ABCD represent a transverse section, where AD is the natural slope of the ground. Draw the horizontal line LH, passing through the centre (E) of the section, EF is the height of the section at the centre of the base.

Fig. 9.



Let r be the ratio of the natural slope, when the vertical height is $= 1$. The area ABCD consists of the triangle ABN, the trapezium NBCO, and the triangle OCD. Because EF is the mean between NB and OC, EF $\times$ BC $=$ area of NBCO. The triangle OCD $= (\text{EH}-\text{FC.}) \times \frac{\text{OC}}{2}$; and the triangle ABN $= (\text{EK}-\text{BF}) \times \frac{\text{BN}}{2}$.

The slopes of the railway being assumed equal on both sides, therefore EL $=$ EG.

As EG : GI :: r : 1 :: EH : HD.

As GH $=$ EH—EG : HD :: s : 1.

Hence EH $=$ HD $\times$ r; therefore HD $= \frac{\text{EH}}{r}$.

Also EH—EG $=$ HD $\times$ s; therefore, HD $= \frac{\text{EH}-\text{EG}}{s}$.

And EHs $=$ EHr—EGr

EH $(r-s) =$ EGr; therefore, EH $=$ EG $\frac{r}{r-s}$, being the width on one side of the centre.

As EL : LM :: r : 1 :: EK : KA.
As KL = EL—EK : KA :: s : 1.
Hence EK = KA × r; therefore $KA = \frac{EK}{r}$

Also EL—EK = KA × s; therefore, $KA = \frac{EL-EK}{s}$

And $EKs = EL \times r - EK \times r$

$EK\,(r+s) = ELr$; therefore, $EK = EL\frac{r}{r+s}$, or

$EK = EG\frac{r}{r+s}$, being the width on the other side of the centre.

Now since $EG = \frac{b}{2} + hs$,

We have $EH = \frac{b+2hs}{2}\left(\frac{r}{r-s}\right)$

And $EK = \frac{b+2hs}{2}\left(\frac{r}{r+s}\right)$

Also $OC = EF + \frac{FC}{r} = h + \frac{b}{2r} = \frac{2hr+b}{2r}$

And $BN = EF - \frac{BF}{2} = h - \frac{b}{2r} = \frac{2hr-b}{2r}$.

From the above equations we derive the whole area ABCD as follows—

The triangle $OCD = \left(\frac{b+2hs}{2}\right)\left(\frac{2hr+b}{4}\right)\frac{1}{r-s} - \frac{b}{2}\left(\frac{2hr+b}{4r}\right)$.

The triangle $ABN = \left(\frac{b+2hs}{2}\right)\left(\frac{2hr-b}{4}\right)\frac{1}{r+s} - \frac{b}{2}\left(\frac{2hr-b}{4r}\right)$.

Trapezium $NBCO = bh$,

Consequently, the whole area ABCD is—

$$\left(\frac{2hs+b}{2}\right)\left(\frac{2hr-b}{4}\right) \times \frac{1}{r+s} + bh + \left(\frac{2hs+b}{2}\right)\left(\frac{2hr+b}{4}\right) \times \frac{1}{r-s}.$$

When the slopes of the sides and the natural slope of the ground are given, the area may be found speedily, if they can be referred to the accompanying table. The formula being simplified first into—

$\frac{bh}{2} + \frac{2hs \times b}{2}\left(\frac{2hr-b}{4(r+s)}\right) + \left(\frac{2hr+b}{4(r-s)}\right)$; which, again reduced, is $\frac{b\,h}{2} + \frac{2\,h\,s + b}{2}\left[\frac{2\,h\,r^2 + b\,s}{2\,(r^2 - s^2)}\right]$; and, by expounding this form, we have $\frac{b\,h}{2} + \frac{4\,r^2\,s\,h^2 + 2\,(r^2 + s^2)\;b\,h + s\,b^2}{4\,r^2 - s^2}$; and finally, the area is $H^2 + \frac{r^2\,s}{r^2 - s^3} + B\,H\,\left(\frac{1}{2} + \frac{r^2 + s^2}{2(r^2 - s^2)}\right) + B^2 + \frac{s}{4\,(r^2 - s^2)})$; and making $\frac{r^2\,s}{r^2 - s^2} = X$; $\frac{1}{2} + \frac{r^2 + s^2}{2\,(r^2 - s^2)} = Y$; $\frac{s}{4\,(r^2 - s^2)} = Z$;

$$H^2\,X + B\,H\,Y + B^2\,Z = \text{area.}$$

Slope 1 to 1.				Slope 1½ to 1.				Slope 2 to 1.			
R	X	Y	Z	R	X	Y	Z	R	X	Y	Z
5	1.0416	1.0416	.01083	5	1.6666	1.1111	.01673	5	2.3810	1.0905	.02381
10	1.0101	1.0101	.00252	10	1.5345	1.0230	.00384	10	2.0833	1·0416	.00521
15	1.0044	1.0044	.00111	15	1.5151	1.0101	.00168	15	2.0363	1.0181	.00226
20	1.0025	1.0025	.00062	20	1.5085	1.0056	.00094	20	2.0202	1.0101	.00126
25	1.0016	1.0016	.00040	25	1.5054	1.0036	.00060	25	2.0129	1.0064	.00080
30	1.0011	1.0011	.00028	30	1.5037	1.0025	.00042	30	2.0090	1.0045	.00056
35	1.0008	1.0008	.00020	35	1.5027	1.0018	.00030	35	2.0065	1.0032	.00041
40	1.0006	1.0006	.00015	40	1.5021	1.0013	.00023	40	2.0050	1.0025	.00031
45	1.0005	1.0005	.00012	45	1.5017	1.0011	.00018	45	2.0040	1.0020	.00024
50	1.0004	1.0004	.00010	50	1.5013	1.0008	.00015	50	2.0032	1.0016	.00020

To render this table more comprehensible, let us assume a numerical example—

Let the height be 30 feet
" base 34 feet
" slope 2 to 1
Natural slope 25 to 1

And by referring to the table, slope 2 to 1, and opposite the value of R, we find the respective coefficients X, Y, Z.

$X \times H^2 = 900 \times 2.0202 = 1818.18$
$Y \times BH = 1020 \times 1.0101 = 1030.30$
$Z \times B^2 = 1156 \times .00126 = 1.45$

9)2849.93=area in feet.

316.66=square yards area.

If the area had been computed, supposing the ground to be level, then—

$$\begin{array}{llll} BH & = & 30 \times 34 & = 1020 \\ H^2 \times s & = & 30 \times 30 \times 2 & = 1800 \\ & & & \overline{9)2820} \\ & & & \overline{313.33} \text{ square yards.} \end{array}$$

Therefore, this example shews, that if the natural slope of the ground had not been considered, 3.33 square yards would have been lost in the area. As the solid figure is not altered in regard to its principles, by the consideration of the natural ground slope, the cubic contents can be found by modifying the formula for the simple prismoid. For, using the same notation as before, and introducing the second height, the solid is

$$= L \times \left[B^2 Z + \frac{B(H+h)Y}{2} + \frac{(H^2 + Hh + h^2)X}{3}\right];$$

and if the mean areas of the ends be found, assuming them to be calculated by the express formula for sloping ground, the correct rule is $\left[\frac{A + a}{2} - \frac{(H - h)^2 X}{6}\right] \times L =$ the solid, when A and a are the areas of the ends.

Let this be illustrated numerically:

$H = 30$ feet
$h = 20$ feet
$B = 34$ feet
$S = 2$ to 1
$R = 25$ to 1
$L = 400$ feet

In the table we find—
$X = 2.0129$
$Y = 1.0064$
$Z = .0008$

$$\begin{array}{rcrcl} H^2 X & = & 900 \times 2.0129 & = & 1811.61 \\ h^2 X & = & 400 \times 2.0129 & = & 805.16 \\ B(H+h)Y & = & 50 \times 34 \times 1.0064 & = & 1710.88 \\ 2B^2 Z & = & 1156 \times 2 \times .0008 & = & 1.85 \\ & & & & \overline{2)4329.50} \\ & & \text{Mean area} & = & \overline{2164.75} \end{array}$$

$$\frac{(H-h)^2 X}{6} = \frac{X\,(30-20)^2}{6} = \frac{100 \times 2.0129}{6} = 33.54$$

2164.75	=	mean area of the two ends.
33.54	=	correction.
2131.21	=	true mean area of prismoid.
400	=	length.
27 { 9)852484.00	=	contents in cubic feet.
3) 94720.44		
31573.48	=	cubic yards in solid.

Comparing this with the simple prismoid—

$S\,H^2 = 900 \times 2 = 1800$

$s\,h^2 = 400 \times 2 = 800$

$B\,(H+h) = 50 \times 34 = 1700$

2)4300

2150 = mean area of the two ends.

$$\frac{(H-h)^2 s}{6} = \text{correction} = \frac{100 \times 2}{6} = 33.33$$

2150	=	mean area.
33.33	=	correction.
2116.66	=	true mean area of the prismoid.
400	=	length.
27 { 9)846664.00	=	contents in cubic feet.
3) 94073.77		
31357.92	=	cubic yards in solid.

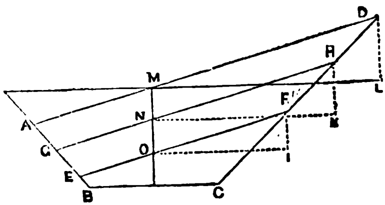
By prismoid with sloping ground = 31573.48
By " level do. = 31357.92

Therefore, by this example, it appears that 215.56 cubic yards would be lost by neglecting to estimate for the natural slope of the ground.

When the natural slope of the ground continually varies, in order to determine the cube accurately, it is necessary to ascertain the law of the variation of the slope; which process, if it were possible in practice, would involve so many calculations, as to render it tedious and inapplicable for practical men; but it is a very near approximation to the real value, if the natural slope of the ground is supposed to increase directly in proportion to the distances.

Let Fig. 10 represent a transverse section of an uniform rising section. If we suppose the base B C to intersect a horizontal ground surface transversely, but as the section advances, the cross sections assume the figures EBCF, GBCH, ABCD, whose natural ground slopes vary in proportion to the distance from the intersecting point, through which BC passes; that is, if the section EBCF is at half the distance at which ABCD is situated, the ratio of OI to IF is half the ratio of ML to LD; and also if the ratio of NK to KH of the section GBCH (whose centre point N is midway between M and O) is half the sum, or the mean between the ratio ML to LD, and OI to IF. Then if these ratios are given, it is easy to determine the cube very nearly. For this solid may be considered as only another modification of the prismoid; and whereas the increments of the heights and slopes are uniformly proportional, we shall find that the same relation exists between the prismoid and the rules for mean heights or areas, as has been shown in former examples. Therefore, making use of the former notation and example, and adding a new ratio of slope r = 15 to 1 due to one of the ends, we have, by using the tables, the following method to find the mean area:—

Fig. 10.



$H = 30 \quad R = 25 \quad B = 34$

$h = 20 \quad r = 15 \quad S = 2 \qquad L = 400$ feet.

$$\frac{H + h}{2} = \frac{30 + 20}{2} = 25 = h = \text{mean height.}$$

$$\frac{R + r}{2} = \frac{25 + 15}{2} = 20 = r = \text{mean slope.}$$

In the table we find the following coefficients :—

Due to R = 25.		Due to r = 15.		Due to r = 20.	
X =	2.0129	x =	2.0362	x =	2.0202
Y =	1.0064	y =	1.0181	y =	1.0101
Z =	.0008	z =	.00226	z =	.00126

$H^2 X = 900 \times 2.0129 = 1811.61$

$BHY = 34 \times 30 \times 1.0064 = 1026.53$

$B^2 Z = 1156 \times .0008 = .92$

(A) 2839.06 { Area of greater end.

$h^2 x = 400 \times 2.0362 = 814.48$

$Bhy = 34 \times 20 \times 1.0181 = 692.31$

$B z = 1156 \times .00226 = 2.61$

(B) 1509.40 { Area of lesser end.

$h^2 x = 625 \times 2.0202 = 1262.62$

$B h y = 34 \times 25 \times 1.0101 = 858.58$

$B^2 z = 1156 \times .00126 = 1.45$

(C) 2122.65 × 4 = 8490.60 { Area of mid. sec.

6)12839.06

Mean area 2139.84

Calculation carried forward

2139.84
400

27 { 3)855936.00
9)285312.00

31701.33 cube yards = true contents of solid.

Compare this with the mean height method, we have

	2122.65 Area (C)		
	400		cube yds.
		By prismoid	31701.33
27	3)849060.00	By mean heights	31446.66
	9)283020.00	Deficiency	254.66
	31446.66 cube yards.		

And comparing it with the method of mean areas, we have—

2839.06 = greater end (A)
1509.40 = lesser end (B)

2)4348.46

2174.23 = mean area of the two ends.

	400		cube yds.
	3)869692.00	By prismoid	31701.33
27		By mean areas	32210.81
	9)289897.33		
		Excess	509.48
	32210.81 cube yards.		

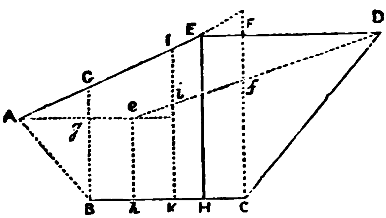
Difference between mean heights and mean areas 764.15 cubic yards.

These results shew that, though not exactly correct, the method by the prismoidal formula is nearer the truth than either of the other two, and the method is nearer and nearer the usual result, as the given variable ratios of the slopes approach to equality.

In case the formation of the surface assumes a curve, the nearest method that can be used in practice is by laying down such a straight line as will give the same area, and determine the mean slope of the particular cross section: this being repeated as often as may be necessary, the remaining process is the same as before to find the cube.

If in a given cross section there may be found two slopes (reduced from a curve or otherwise) whose intersection can be conveniently determined, within two vertical lines falling on the extremities of the base; then the base being subdivided by a line perpendicular to it, from the intersection of the slopes, two separate calculations may be made of the respective areas, whose sum is equal to the whole transverse section. Thus, in fig. 11, ABCD is a cross section, whose surface AED is composed of two slopes AE, ED meeting at E. The base BC is divided into two lengths, BH, HC; and the area ABCD can be computed by finding the sum of ABHE and EHCD.

Fig. 11.



Now, as the mean height EH, at the intersection of the slopes = H; and BH, the part of the base cut off, can be measured = *b*; then substituting this height for the usual height, and *b* for $\frac{B}{2}$, the general expression for each figure becomes $\left(\frac{(b^2 + \bar{h} s) r}{r \pm s} - b\right) \times \left(\frac{\bar{h} r \mp b}{2r}\right) + \left(\frac{2 \bar{h} r \mp b}{2 r}\right) b.$

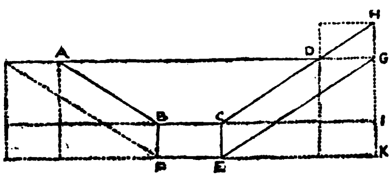
This equation reduced to its simplest terms is $\frac{r}{r + s} \times$ $\left(b \bar{h} + \bar{h}^2 \frac{s}{2} \mp \frac{B^2}{2 r}\right)$. The sign plus being used in the coefficient $\frac{r}{r \pm s}$, and the sign minus in the term $\mp \frac{b^2}{2r}$ when the ground *falls* towards the centre, and contrariwise when the ground rises.

When the nature of the ground is such that it becomes necessary to use two different slopes on opposite sides of an embankment or cutting, it is sometimes convenient to compute the contents by taking half the sum of the cubes produced, supposing the section to be calculated with each slope separately. But, if the tables used admit of it, the simplest way is to take the mean between the two given slopes, and work out the cubes as usual. For as $\frac{H^2 s}{2}$ is the area of the one side, $H^2 \frac{(S + s)}{2}$ is the area of the two sides. But in the case of inclining ground, the slopes must be separated, as the equation of each side has a coefficient depending on the particular slope; therefore, the rule given for the last case applies here, making $b = \frac{B}{2}$ or half the base, if the inclination of the ground is uniform.

It sometimes happens, after the estimates are completed, that, owing to the insufficiency or improper disposal of materials, according to the existing gradients and other causes, the engineer alters the gradient, and thereby renders it necessary to undertake another series of calculations. The easiest way is to make use of the prismoidal tables with the amended heights; but as it may be sometimes useful to know the area due to the difference of the heights, I will subjoin a solution of this problem.

Let Fig. 12 represent a transverse section. ABCD is the original area; and BF is an increase in depth, the base and slopes remaining the same. It is obvious that the additional area is the figure BFEC, and twice CEGD. If the parallelogram CEGH be completed, and HK drawn perpendicular, and BC FE be produced to meet HK, then the rectangular parallelogram CEKI is equal to

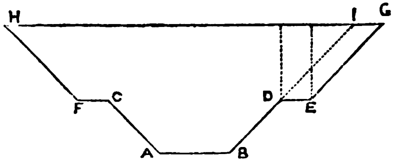
Fig. 12.



CEGH; CEGD is equal to CEGH — the right-angled triangle GHD. But DG is to GH as the ratio of the slope; and CI is equal to the sum of the side base due to the height + DG, or CI is the base due to the increased height. Therefore, in notation, making d = increase of depth, we have $BE = bd$ and $^2 \times CEKI = 2d\ (h + d)\ s - d^2 s$; therefore the increase of area is $d\ [b + (2h + d)\ s]$; or, if d represented the reduction of depth, the area to be deducted is $d\ [b + (2h - d)\ s]$.

The next case which comes under our notice is, when in any given section the slopes do not continue uniformly from the gradient to the surface of the ground, but are interrupted by a bench being introduced at a given point of the height. Let fig. 13 represent such a cutting. AB is the base; HG the surface; FC DE benches introduced. Here, by producing the slope BD to meet the surface in I, the parallelogram IGED is the additional area to each side of the original section. Therefore, if the height of DE from AB be given $= h^1$, and the breadth $DF = b$, then $2\ (H - h^1)\ b$ = area to be added to the original section. If these benches extend in parallel planes with the gradient, then the additional solid is $\frac{(H + h - 2h^1)\ b\,L}{2}$.

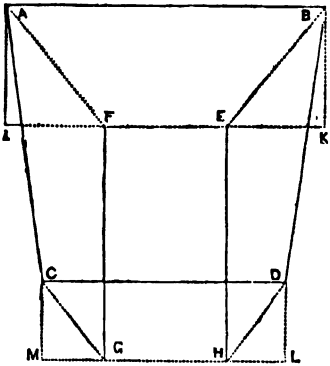
Fig. 13.



The last case but one I shall observe is, when the widths in a plan are given, to find the cubic contents.

In the diagram Fig. 14, let ABCD represent a plan of a prismoid; and let the dotted lines represent the respective sections at the ends. That is, let ABEF be the section at AB; and CDHG be the section at CD. Produce FE HG both ways, and let fall on them the perpendiculars, completing the rectangles AIKB, CMLD. Insert W for AB, and w for CD, and use in other respects the previous notation.

Fig. 14.



It appears by the construction that

$WH - H^2 S$ = area of ABEF or AIKB—2 AIF;

$wh - h^2 s$ = area of CDHG or CMLD—2 CMG.

But $W = 2Hs + B$, therefore $H = \frac{W - B}{2s}$.

$$WH \doteq \frac{W^2 - WB}{2s} \quad H^2 S = \frac{W^2 - 2WB + B^2}{4s}.$$

Therefore, the area AEBF $= \frac{W^2 - B^2}{4s}$, and substituting half the width and half the base for their respective wholes, we have $\frac{W^2 - B^2}{s}$ = area ABEF.

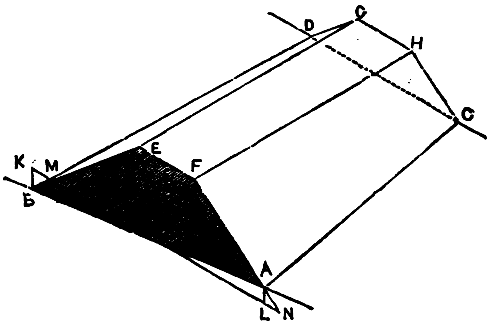
Treating the other area in a similar manner, we find CDGH $= \frac{w^2 - B^2}{s}$; therefore, the solid contents of ABEFGHDC is $\left[\frac{W^2 - B^2}{s} + \frac{w^2 - B^2}{s} + \frac{W^2 + 2Ww + w^2 - 4B^2}{s}\right] \times \frac{L}{6}$.

This equation reduced becomes $\left[\frac{(W^2 + Ww + w^2)}{3s} - \frac{B^2}{s}\right] \times L$.

It is to be observed that this equation is simpler than that given in the terms of heights; for as s and B are known, there is only one unknown term, from which a constant quantity is deducted, to find the mean area.

It only remains now to find the cubic contents of a prismoid with sloping ground, when the extreme widths are given. Let us assume a case where the slope is uniform throughout.

Fig. 15.



Let Fig. 15 represent the proposed prismoid whose cube is required. Let NK be a line parallel to the base EF, intersecting the surface AB in I, the vertical centre of the base, and cutting the slopes in M and N; and let fall the perpendiculars AE, BK, through A and B on the line NK. By a former case we know that $IL = IN\left(\frac{r}{r+s}\right)$, and $IK = IN\left(\frac{r}{r-s}\right)$; therefore $LK = IN\left(\frac{2r^2}{r^2-s^2}\right)$. Also $AB = W$ is the hypothenuse of a triangle whose base and perpendicular are in the ratio of r to 1; therefore $AB = W = LK\left(\frac{\sqrt{r^2+1}}{r}.\right)$

Let $cLK = W$, when c is the coefficient $\frac{\sqrt{r^2+1}}{r}$. Now $IN = \frac{B+2HS}{2}$; therefore $W = \frac{B+2HS}{2} \times \frac{2r^2c}{r^2-s^2}$.

$B + 2Hs = \frac{2W(r^2-s^2)}{2r^2c}$; therefore $H = \frac{W(r^2-s^2)}{2r^2cs} - \frac{B}{2s}$.

By the former case the area was found to be

$$A = H^2 \left(\frac{r^2 s}{r^2 - s^2}\right) + BH \frac{r^2}{r^2 - s^2} + B^2 \left(\frac{s}{4 (r^2 - s^2)}\right).$$

If half the base and half the width be given, instead of the whole base and width, and the value of H be substituted, we have area A =

$$H^2 \left(\frac{r^2 s}{r^2 - s^2}\right) + 2BH \left(\frac{r^2}{r^2 - s^2}\right) + B^2 \left(\frac{s}{r^2 - s^2}\right) = W^2 \left(\frac{r^2 - s^2}{c^2 r^2 s}\right) - \frac{B^2}{s};$$

and inserting the value of c in the equation—

$$A = W^2 \left(\frac{r^2 - s^2}{s (r^2 + 1)}\right) - \frac{B^2}{s}.$$

Now as $H = W \left(\frac{r^2 - s^2}{s r \sqrt{r^2 + 1}}\right) - \frac{B}{s}$, and it may be sometimes desirable to know the height in the middle, the subjoined table is constructed in order to facilitate the calculations.

The column X is computed by the formula $\left(\frac{r^2 - s^2}{s (r + {}^2 1)}\right)$; and the column C by the formula $= \left(\frac{r^2 - s^2}{r s \sqrt{r^2 + 1}}\right)$.

Slope 1 to 1.			Slope 1½ to 1.			Slope 2 to 1.		
R	X	C	R	X	C	R	X	C
5	.92308	.94137	5	.58334	.59490	5	.40385	.41185
10	.98022	.98487	10	.64523	.63368	10	.47524	.47762
15	.99115	.99337	15	.65708	.65855	15	.48893	.49002
20	.99502	.99625	20	.66195	.66278	20	.49377	.49439
25	.99680	.99760	25	.66379	.66423	25	.49601	.49641
30	.99780	.99835	30	.66461	.66498	30	.49723	.49751
35	.99838	.99877	35	.66490	.66518	35	.49796	.49817
40	.99875	.99907	40	,66531	.66553	40	.49843	.49860
45	.99900	.99926	45	.66560	.66576	45	.49876	.49890
50	.99922	.99942	50	.66581	.66595	50	.49900	.49910

I will illustrate this table by a numerical example :

Given, The natural slope R = 15 to 1.

Half the base = 17 feet.

Half the width = 108 feet.

The slope being = 2 to 1.

$$\text{Here } X = 0.48893\text{; therefore,}$$

$$\begin{array}{lcr} + 108 \times 108 \times 0.48893 & = & 5702.88 \\ - 17 \times 17 \times \frac{1}{2} & = & 144.50 \\ \hline & \text{Feet} & 5558.38 \text{ mean area.} \end{array}$$

$$\text{Now } C = 0.49002\text{; therefore,}$$

$$\begin{array}{lcr} + 108 \times 0.49002 & = & 52.92 \\ - 17 \times \frac{1}{2} & = & 8.50 \\ \hline & \text{Feet} & 44.42 \text{ height in the middle.} \end{array}$$

Having found the height, let us prove the preceding calculation of the area by the table given in page 187, in the terms of the heights and base.

Here $X = 2.0362$; $Y = 1.0181$; $Z = .00226$; therefore,

$$\begin{array}{lcr} 44.42 \times 44.42 \times 2.0362 & = & 4017.70 \\ 44.42 \times 34 \times 1.0181 & = & 1537.62 \\ 34 \times 34 \times 0.00226 & = & 2.61 \\ \hline & \text{Feet} & 5557.93 \text{ mean area;} \end{array}$$

the difference being only such as may be due to a trifling error in the last place of decimals in the table. The only difference in finding the solid in this case and the last will be by affixing to the term in which W^2 and w^2 are found, the coefficients X due to the sloping ground, instead of the coefficient $\frac{1}{s}$; the solid then becomes

$$L \times \left[x \left(\frac{W^2 + Ww + w^2}{3} \right) - \frac{B^2}{s} \right].$$

RULES RELATING TO THE PRISMOIDAL FORMULA.

To avoid the necessity of referring to the essay to calculate cubic contents, I subjoin the following—

RULES FOR PRACTICAL CASES.

1.—*To find the contents of a prismoid (when the cross section is horizontal).*

$\frac{BH + H^2 S}{2}$ From the mean area of the two ends deduct

$+\frac{Bh + h^2 S}{2}$ one-sixth of the product of the slope, multiplied by the square of the difference of the heights. This difference multiplied by the length will give the contents.

$-\frac{(H-h)^2 S}{6}$

2.—*To find the area of a transverse section of a railway (when the cross section is horizontal).*

$B H + H^2 S$ Multiply the base by the height, and add to the product the product of the slope and the square of the height.

3.—*To find the area of a transverse section (when the cross section is sloping).*

Let 1 to r be the ratio of the sloping ground, r being the horizontal length; and let 1 to s be the ratio of the slope of the cutting; then making $X = \frac{r^2 s}{r^2 - s^2}$, $Y = \frac{1}{2} + \frac{r^2 + s^2}{2(r^2 - s^2)}$,

$Z = \frac{s}{4(r^2 - s^2)}$. The area will be found by

$H^2 X + HBY + B^2 Z$ adding together the product of the square of the height by X, the product of the base by the height by Y, and the product of the square of the base by L.

4.—*To find the cubic contents of a prismoid (the cross section being sloping).*

$\frac{A + a}{2} - \frac{(H - h)^2 x}{6} \times L$ From the mean area of the two ends deduct one-sixth of the product of the coefficient x (found by rule 3), and the square of the difference of the heights. The difference multiplied by the length gives the contents.

5.—*To find the area due to an alteration in the level of a base or formation line.*

First Case.—If the depth is increased: Multiply the sum of twice the original height, $d[B+(2H+d)s]$ and the increase of depth, by the slope; to this add the base, and multiply the sum by the increase of depth for the increase of area.

Second Case.—If the depth is diminished: Multiply the difference of twice the original height, and the diminution of depth, by the slope; to this add the base, and multiply the sum by the diminution of depth; the result gives the area to be deducted.

$d[B+(2h-d)s]$

6.—*To find the additional solid by having benches on each side (parallel with the base line).*

$\frac{(H+h-2h^1)bL}{2}$

From the sum of the heights deduct twice the height of the bench above the base; multiply the difference by half the width of the bench, and by the length; the product is the contents.

7—*When the half-widths of the cuttings or embankments at the edge of the slopes against the surface are given, to find the area.*

$\frac{W^2-B^2}{s}$

Divide the difference of the squares of half the width and half the base by the slope; the result is the area of the section.

8.—*When the widths are given (as above), to find the cubic contents.*

$\frac{W^2+Ww+w^2}{3\,s} - \frac{B^2}{s}$

Add together the square of half the greater width, the square of half the lesser width, and the product of both half widths; divide this sum by 3, and from the quotient deduct the square of half the base. This difference divided by the slope, and multiplied by the length, will give the cubic contents.

9.—*When the widths are given, to find the area (when the cross section is sloping).*

Let 1 to r be the ratio of the sloping ground; and 1 to s be the ratio of the slopes of the cutting; make $x = \frac{r^2 - s^2}{s\,(r^2 + 1)}$. Then the product of the square of half the width, by the coefficient x, less by the quotient of the square of half the base divided by the slope, is the area.

$W^2\,x - \frac{B^2}{s}$

10.—*To find the height, given the width (when the cross section between is sloping).*

$Wc - \frac{B}{s}$ Make $C = \frac{r^2 - s^2}{\sqrt{r^2 + 1}}$; when the ground is level, the coefficient C becomes $= \frac{1}{s}$; then, by dividing half the base by the slope, and deducting the quotient from the product of half the width, and the coefficient C, the result is the height in the middle.

11.—*To find the width when the height is given (the cross section of the ground being sloping).*

$\frac{H + \frac{B}{s}}{C}$ To the height add the quotient of half the base divided by the slope, and divide the sum by the coefficient C as before found; the result is the width.

12.—*When the widths are given, to find the cubic contents (the cross section being sloping ground).*

$\frac{x(W^2+Ww+w^2)}{s} - \frac{B^2}{s}$ Proceed the same as in rule 8, substituting for coefficient $\frac{1}{3}$ the coefficient $\frac{x}{3}$; when x is found by the formula in rule 9. The result is the cubic contents.

EXPLANATION

OF THE USE OF

TABLES OF EARTHWORK.

In preparing these tables, the object I had in view was to do away with the necessity of turning over many pages and of referring to the intersection of two columns of given heights to find the tabular number, and also to serve other useful purposes; and I thought that if I could reduce the table required for any given slope and base to one page, I should materially simplify the operations, though apparently at the expense of a few extra figures. The tables of Mr. Mac Neill are constructed partly for given bases and slopes, and partly for a base 1, with a series of slopes. The former tables, by reference to the intersection of the given heights, at once produce the mean area of the prismoid; but these tables are very limited in extent of base and slope. The latter tables, by a similar reference, give a number in one column to be multiplied by the given base, and this is added to a number found in the same line of intersection in a second column. The sum is the mean area required. I here subjoin an example; the two heights being 18 and 38, and the slope being 1 to 1, and the base 32 feet :—

By Second Series of Tables.

In base 1, slope 1 to 1, opposite 18 and under 38 we find—

Tabular number	. .	1.037
Multiply by base	. .	32
		2·074
		31.11
		33.184
Add tabular number	. .	30.272
Mean area	. .	63.456

In using either series of tables it is necessary to turn over a few pages constantly, which renders the application tedious, though very far preferable to calculating by the formula. These tables, moreover, do not admit of any application of them except for the purpose of *cubing* the prismoid.

Other tables have been published for computing the quantities for any given base, but they are not more advantageous than Mac Neill's, but are more economical in cost, and have been serviceable, owing to the present scarcity of Mac Neill's work.

Mac Neill's tables are computed by the formula $\left(\frac{H + h}{2}\right) B + \left(\frac{H^2 + Hh + h^2}{3}\right) s$, which will give the mean area in feet, and divided by 27 gives his tabular number in his first series of tables at each intersection of given heights. In his second series, he has divided the tabular numbers into two columns at each intersection of the heights, the first being computed by the term $\frac{H + h}{54}$ and the second by the term $\left(\frac{H^2 + Hh + h}{81}\right) s$. All his dimensions are measured in feet.

As I wish to save as much as possible the intersecting method, which, in a work of the extent I have brought out, would have been almost impracticable on account of the labour and expense attending it, and being desirous of applying the same tables to other purposes, I sought and found the formula $\frac{BH + H^2 S}{2} + \frac{Bh + h^2 S}{2} - \frac{(H - h)^2 S}{6}$ well adapted for the purpose. This is obviously the mean area of the two ends, with the correction applied to render the prismoid true, the particular investigation of which will be found at page 180. By the use of this formula I keep the heights independent of each other, except in the third term, when their difference is required. Therefore in determining the values of the terms for any series of bases, slopes, and heights, the two first terms are exactly similar, and can be classed in one table; and the third term, depending upon the difference of heights, can be classed in a second table; and this term is also common in all the given bases for the same slope. But in the tables I have reprinted it in every base, so as to save the trouble of turning to another page. Therefore the tables are computed for the first two columns by the term $\frac{BH + H^2 S}{54}$, and the table of differences by the term $\frac{H^2 S}{162.}$ In order to use the tables the following rules are given:—

To Calculate the Cube.

Look in the table of the given base and slope opposite the two given heights, for the numbers under the columns headed "add," and add these together: this corresponds with the mean area of the two ends. Then look in the columns headed "deduct," for the number opposite the difference of the heights: by deducting this from the sum previously obtained, the mean area of the cube will be found, which, multiplied by the length, will give the cubic contents in yards. All the dimensions must be given in feet. Take, for an example, the dimensions before given in illustration of Mac Neill's tables—

Base 32, Slope 1 to 1.

Col. Add.

Opposite 18 we find	16.6666
Ditto 38 ditto	49.2592
	65.9258

Col. Deduct.

Difference of heights being 20, opposite 20 we find	2.4691
Mean area . . .	63.4567

It is obvious, in comparing this method with Mr. Mac Neill's, that the operation of *adding and subtracting*, required by the former method, is much less liable to error than the operation of *multiplying and adding* required by the latter. Besides, the two added numbers at once give an approximate result, which may frequently suffice for a rough estimate, without subtracting at all.

I now give a form which will illustrate the calculation of a cutting or embankment complete. I used these tables for some years on the Eastern Counties Railway; and for the convenience of preserving the calculations, I had a number of books ruled in this form, in the manner of a levelling book. And the whole process admits of being checked in a similar manner, except the multiplication: for the sum of the columns of addition in columns 1 and 2 should equal the sum of the various sums column 3; and the sum of the deductions, column 4, deducted from the sum in column 3, should correspond with the sum of the differences in column 5. The lengths are written in column 6; and the product of columns 5 and 6 are written in column 7: the sum of these products will give the quantity in the cutting or embankment. In columns 8 and 9 are written the respective heights at either end; and column 10 gives the difference of the heights.

Base 32, Slope 1 to 1.

No.	1 Add together.	2	3 Sum.	4 Deduct.	5 Difference mean area	6 Length. in feet.	7 Prodct. cu. yds.	8 Heights in feet.	9	10 Dif. of heights.
	0.0000	2.6666	2.6666	.0988	2.5678	120	308	0	4	4
	2.6666	5.9259	8.5925	.0988	8.4937	260	2208	4	8	4
	5.9529	14.2222	20.1481	.3951	19.7530	340	6716	8	16	8
	14.2222	24.8888	39.1110	.3951	38.7159	280	10840	16	24	8
	24.8888	37.9259	62.8147	.3951	61.4196	670	41151	24	32	8
	14.2222	11.5259	25.7481	2.0000	23.7481	870	20661	16	14	18
	11.5259	5.0555	16.5814	.5000	16.0814	460	7397	14	7	9
	5.0555	1.9444	6.9999	.0988	6.9011	330	2277	7	3	4
	1.9444	0.0000	1.9444	.0555	1.8889	130	246	3	0	3
			Total cubic yards—				91804			

In the above form there is no necessity to repeat so many of the figures, for it is obvious that the same height is common to both adjoining prismoids, and the same tabular number will apply, except in such cases where a jump or sudden break in the ground occurs at the same place as illustrated in line six of the calculation; except in such a case, it would be sufficient merely to write the numbers in columns 2 and 9, omitting those in columns 1 and 8. Therefore for each prismoid two tabular numbers are required to be abstracted, both found in the same page; the one for the *last height* of the prismoid, and the other for *the difference of the heights*. The number due to the *first height* of the prismoid is the same as that due to the last height of the prismoid immediately preceding, so that it will have been already entered in the form. The quickest way, having first transferred all the measurements to the form, is to extract the tabular numbers at once seriatim, and then proceed to the addition, subtraction, and multiplication of the whole. After a little practice the reader will soon become habituated to the tables. In general, three places of decimals are amply accurate. The use of the tables, and of the above form, will be found very simple, if, instead of the lengths of each prismoid being unequal, the given cutting or embankment was divided into any number of *equal* parts; let the heights be measured as usual, and the tabular numbers entered in the form; for then, in order to find the cube, sum up column 3, from which deduct the sum of column 4, and multiply by the whole length of the cutting or embankment, and divide the product by the number of prismoids of equal length: the quotient is the required cube. This last method will probably reduce the calculation of a long cutting or embankment to *one* operation of multiplication only, instead of *several*, thereby considerably reducing the ~~chasm~~ of error, and enabling the whole of the work to be *easily* checked.

To Calculate the Area of the Section.

Multiply the tabular number in the columns headed "add," opposite any given height in feet, by 6; and the product is the area in square yards. Hence in the preceding form any of the numbers in columns 1 and 2 may be taken to find the area of the section; for instance, 24.8888 × 6 = 149.3328 = area in yards, corresponding with 24 feet height in column 8. The numbers in columns 1 and 2 themselves are half the cubic contents, in yards, due to the section of a prism 1 foot long.

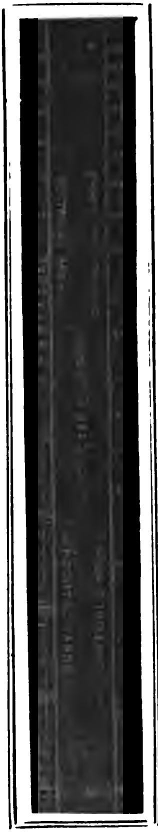
To Calculate the Area of the Sides.

Multiply the tabular number in the columns headed "deduct," opposite any given height in feet, by 6; and the product is the cubic contents, in yards, due to 1 foot of length: this again multiplied by 3 will give the area of the sides in yards.

The preceding form, therefore, enables us to take a memorandum of the *section*, the base and slope and situation on the section being indicated at the head of the form, the lengths and heights being given in columns 6, 8, 9 of the form; also, to produce the *sectional area* at any given place, or the *area of the sides*, or the *cube*.

As it may be required to know the area of any section, supposing that the base is made accidentally narrower or broader, or to compute the cubic contents consequent upon such alteration, I subjoin a table of bases, 1, 2, 3, 4, 5. By the use of this table, suppose that it were required to compute *the cubic contents* of a cutting with base 18, which is not in the table; then compute as if for base 20, and deduct from each calculation of the mean area the sum of the two numbers due to the difference of the bases (20 — 18 = 2) opposite the given heights in the tables of bases: the difference is the true mean area. To *find the area* of any given section for an altered base, deduct or add the number opposite the given height in the column of bases which represents the decrease or increase, from the tabular number of the given height in the original base; six times the result is the true area. To find the *area of the middle piece,* multiply the number opposite the given height in base 1 by the given base; six times the result is the area. And to find the *cubic contents of the middle piece* add together the corresponding numbers in base 1 due to the given heights, and multiply by the length, and by the given base: the result is the cube.

Having thus explained the use of the tables, I now proceed to give an explanation of a scale for measuring



earthwork, which I have successfully used on the Eastern Counties Railway. The vertical and horizontal scales, and also the base and slope, must be previously determined for each scale, and then a set can be formed embracing the required slopes of the railway. My scales were made four in number, for base 34; slopes, 1, 1¼, 1½, and 2 to 1; and on the back of each was properly described the slope, base, and vertical and horizontal scales to which they were applicable. All the dimensions were taken in yards lineal, superficial, or cubical, as required; the application being precisely the same as the use of the tables, and the rules being the same to find the *area*, using 2 as a coefficient instead of 6. The annexed diagram shews one of the scales for slope 1 to 1, reduced to one-half of its real size, being calculated for 20 feet to 1 inch vertical scale, and 2½ chains to one inch horizontal scale. This diagram is, therefore, applicable to 40 feet to 1 inch vertical scale, and 5 chains to 1 inch horizontal scale. But, owing to the fineness of the graduations, I would not advise, to insure accuracy, that the vertical scale be made less than 40 feet to 1 inch, and, generally, the larger the better. 20 feet to 1 inch vertical is a good working scale. The lengths can be made to suit convenience.

There is no necessity to measure the heights or lengths previously, and the same form must be used as before described.

To Measure a Cutting by the Scale.

Apply the zero of the scale of sectional areas vertically to the gradient or formation line, and read off where the surface line intersects; put this in column 1 or 2, as the case requires: then, at the smaller end of the prismoid, upon the scale of vertical yards, with zero on the surface line, observe where the gradient intersects, then place the same point of intersection on the gradient at the other end, and read off above the zero on the scale of differential areas, where the surface line intersects; put this in column 4, and then, having measured all the lengths by the scale of horizontal yards, proceed as in the use of the tables. To save time, it is desirable to take a pair of dividers, and mark off at each division the difference of the heights in succession, and then the differential scale above zero need only be applied.

This method of computing cubic contents of cuttings and embankments is very expeditious with a little practice, and is quite as accurate, and generally more so, than the calculating by feet and the tables; because, in a working section, the points of intersection of the scale and surface line can be estimated readily by the eye; but, in using an ordinary scale of equal parts, we are compelled to neglect the fractional parts of a foot. Should any of my readers wish to obtain these scales, they can easily be made, by giving a reasonable notice to Mr. Elliott, High Holborn. The rule for forming them is as follows:—

To Calculate the Sectional Areas.

The formula is area $= \frac{BH + H^2 S}{2} = A$; therefore, when the area is graduated 10, 20, 30, 40, &c., in even progression, we have $H^2 + \frac{B}{S} H = 2 A$; and the corresponding height is $H = \sqrt{2 A + \frac{B^2}{4S^2}} - \frac{B}{2S}$; when $B = 34$ feet $= \frac{34}{3}$

in yards, and $s = 2$ to 1, the rule becomes $H = \sqrt{2A + \frac{34^2}{3^2 \times 4 \times 4}} - \frac{34}{3 \times 2 \times 2} = \sqrt{A + \left(\frac{17}{6}\right)^2} - \frac{17}{6}$. To find the limit of the graduation, (a) the greatest height the scale may be wanted for must be determined. The scale of differential areas is computed from the formula $D = \frac{H^2 S}{6}$; therefore the differences being graduated 1, 2, 3, 4, &c., 10, 20, 30, &c. seriatim, we have the corresponding height, $H = \sqrt{\frac{6D}{S}}$. If required for slope 2 to 1, the rule becomes $1.723 \sqrt{D}$.

From the preceding explanation it is evident that the particular vertical scale being determined, a set of scales for *any number* of bases can be easily made, as the only variable portion is that of the sectional areas. These scales are very convenient and portable, and can be frequently employed in the absence of tables, by being carried in the pocket, enclosed in a case.

AREAS OF LAND FOR CUTTINGS AND EMBANKMENTS.

SLOPE ¼ to 1.				SLOPE ½ to 1.			
Ht.	Sides.	Ht.	Sides.	Ht.	Sides.	Ht.	Sides.
1	0000057	31	0001779	1	0000115	31	0003538
2	0000115	32	0001837	2	0000230	32	0003673
3	0000173	33	0001894	3	0000345	33	0003688
4	0000230	34	0001951	4	0000459	34	0003903
5	0000287	35	0002009	5	0000574	35	0004017
6	0000345	36	0002066	6	0000688	36	0004132
7	0000402	37	0002124	7	0000803	37	0004247
8	0000459	38	0002181	8	0000918	38	0004362
9	0000517	39	0002238	9	0001033	39	0004476
10	0000574	40	0002296	10	0001148	40	0004591
11	0000631	41	0002353	11	0001262	41	0004706
12	0000688	42	0002410	12	0001377	42	0004821
13	0000746	43	0002468	13	0001492	43	0004935
14	0000803	44	0002525	14	0001607	44	0005050
15	0000861	45	0002583	15	0001722	45	0005165
16	0000918	46	0002640	16	0001837	46	0005280
17	0000976	47	0002698	17	0001951	47	0005395
18	0001033	48	0002755	18	0002066	48	0005510
19	0001091	49	0002812	19	0002181	49	0005624
20	0001148	50	0002869	20	0002296	50	0005739
21	0001205	51	0002927	21	0002410	51	0005854
22	0001262	52	0002984	22	0002525	52	0005969
23	0001320	53	0003042	23	0002640	53	0006083
24	0001377	54	0003099	24	0002755	54	0006198
25	0001435	55	0003156	25	0002869	55	0006313
26	0001492	56	0003214	26	0002984	56	0006428
27	0001550	57	0003271	27	0003099	57	0006542
28	0001607	58	0003328	28	0003214	58	0006657
29	0001664	59	0003386	29	0003328	59	0006772
30	0001722	60	0003444	30	0003444	60	0006887

AREAS OF LAND FOR CUTTINGS AND EMBANKMENTS.

SLOPE ¾ to 1.				SLOPE 1 to 1.			
Ht.	**Sides.**	**Ht.**	**Sides.**	**Ht.**	**Sides.**	**Ht.**	**Sides.**
1	0000172	31	0005337	1	0000229	31	0007116
2	0000345	32	0005510	2	0000459	32	0007346
3	0000518	33	0005682	3	0000689	33	0007576
4	0000689	34	0005854	4	0000918	34	0007805
5	0000861	35	0006026	5	0001148	35	0008035
6	0001033	36	0006198	6	0001377	36	0008264
7	0001205	37	0006371	7	0001607	37	0008494
8	0001377	38	0006542	8	0001836	38	0008723
9	0001550	39	0006714	9	0002066	39	0008953
10	0001722	40	0006887	10	0002295	40	0009182
11	0001893	41	0007059	11	0002524	41	0009411
12	0002066	42	0007231	12	0002754	42	0009641
13	0002238	43	0007403	13	0002984	43	0009871
14	0002410	44	0007575	14	0003213	44	0010100
15	0002585	45	0007748	15	0003443	45	0010330
16	0002755	46	0007920	16	0003673	46	0010559
17	0002927	47	0008093	17	0003902	47	0010789
18	0003099	48	0008265	18	0004132	48	0011018
19	0003272	49	0008436	19	0004361	49	0011248
20	0003444	50	0008608	20	0004591	50	0011478
21	0003615	51	0008781	21	0004820	51	0011707
22	0003788	52	0008953	22	0005050	52	0011937
23	0003960	53	0009125	23	0005280	53	0012167
24	0004132	54	0009297	24	0005509	54	0012396
25	0004304	55	0009469	25	0005739	55	0012626
26	0004476	56	0009642	26	0005968	56	0012855
27	0004649	57	0009813	27	0006198	57	0013085
28	0004821	58	0009985	28	0006427	58	0013314
29	0004992	59	0010158	29	0006657	59	0013544
30	0005165	60	0010331	30	0006887	60	0013774

AREAS OF LAND FOR CUTTINGS AND EMBANKMENTS.

SLOPE 1¼ to 1.				SLOPE 1½ to 1.			
Ht.	Sides.	Ht.	Sides.	Ht.	Sides.	Ht.	Sides.
1	0000287	31	0008895	1	0000345	31	0010674
2	0000574	32	0009182	2	0000689	32	0011019
3	0000861	33	0009469	3	0001033	33	0011363
4	0001148	34	0009756	4	0001377	34	0011707
5	0001435	35	0010043	5	0001722	35	0012052
6	0001722	36	0010330	6	0002066	36	0012396
7	0002009	37	0010617	7	0002410	37	0012740
8	0002296	38	0010904	8	0002775	38	0013085
9	0002583	39	0011191	9	0003099	39	0013429
10	0002869	40	0011478	10	0003445	40	0013774
11	0003156	41	0011765	11	0003788	41	0014118
12	0003443	42	0012052	12	0004132	42	0014463
13	0003733	43	0012339	13	0004476	43	0014807
14	0004017	44	0012626	14	0004821	44	0015151
15	0004304	45	0012913	15	0005165	45	0015496
16	0004591	46	0013200	16	0005510	46	0015840
17	0004878	47	0013487	17	0005854	47	0016184
18	0005165	48	0013774	18	0006198	48	0016529
19	0005452	49	0014061	19	0006542	49	0016873
20	0005739	50	0014348	20	0006887	50	0017217
21	0006026	51	0014635	21	0007231	51	0017561
22	0006313	52	0014922	22	0007575	52	0017906
23	0006600	53	0015209	23	0007920	53	0018250
24	0006887	54	0015496	24	0008265	54	0018594
25	0007174	55	0015783	25	0008608	55	0018939
26	0007461	56	0016070	26	0008953	56	0019283
27	0007748	57	0016357	27	0009297	57	0019627
28	0008035	58	0016644	28	0009642	58	0019972
29	0008322	59	0016931	29	0009985	59	0020316
30	0008608	60	0017217	30	0000330	60	0020661

ACRES OF LAND FOR CUTTINGS AND EMBANKMENTS.

SLOPE 1½ to 1.				SLOPE 2 to 1.			
Ht.	Sides.	Ht.	Sides.	Ht.	Sides.	Ht.	Sides.
1	0000401	31	0012453	1	0000459	31	0014233
2	0000804	32	0012856	2	0000918	32	0014692
3	0001207	33	0013258	3	0001377	33	0015151
4	0001607	34	0013659	4	0001836	34	0015610
5	0002009	35	0014061	5	0002295	35	0016070
6	0002410	36	0014462	6	0002755	36	0016529
7	0002812	37	0014865	7	0003214	37	0016988
8	0003213	38	0015265	8	0003673	38	0017447
9	0003616	39	0015667	9	0004132	39	0017906
10	0004017	40	0016069	10	0004591	40	0018365
11	0004417	41	0016470	11	0005050	41	0018824
12	0004820	42	0016872	12	0005509	42	0019283
13	0005222	43	0017274	13	0005968	43	0019742
14	0005623	44	0017675	14	0006427	44	0020201
15	0006026	45	0018078	15	0006887	45	0020661
16	0006428	46	0018479	16	0007346	46	0021120
17	0006829	47	0018882	17	0007805	47	0021579
18	0007231	48	0019283	18	0008264	48	0022038
19	0007633	49	0019684	19	0008723	49	0022497
20	0008035	50	0020086	20	0009183	50	0022956
21	0008435	51	0020488	21	0009641	51	0023415
22	0008838	52	0020890	22	0010100	52	0023874
23	0009240	53	0021292	23	0010559	53	0024333
24	0009641	54	0021693	24	0011018	54	0024792
25	0010043	55	0022095	25	0011478	55	0025252
26	0010444	56	0022497	26	0011937	56	0025711
27	0010847	57	0022898	27	0012396	57	0026170
28	0011248	58	0023299	28	0012855	58	0026629
29	0011649	59	0023702	29	0013314	59	0027088
30	0012052	60	0024105	30	0013774	60	0027548

AREAS OF LAND FOR CUTTINGS AND EMBANKMENTS.

SLOPE 2½ to 1.				SLOPE 3 to 1.			
Ht.	Sides.	Ht.	Sides.	Ht.	Sides.	Ht.	Sides.
1	0000574	31	0017790	1	0000690	31	0021348
2	0001148	32	0018364	2	0001378	32	0022038
3	0001722	33	0018938	3	0002066	33	0022726
4	0002296	34	0019512	4	0002754	34	0023414
5	0002870	35	0020086	5	0003444	35	0024104
6	0003444	36	0020660	6	0004132	36	0024792
7	0004018	37	0021234	7	0004820	37	0025480
8	0004592	38	0021808	8	0005511	38	0026170
9	0005166	39	0022382	9	0006200	39	0026858
10	0005738	40	0022956	10	0006890	40	0027548
11	0006312	41	0023530	11	0007576	41	0028236
12	0006886	42	0024104	12	0008264	42	0028926
13	0007460	43	0024678	13	0008952	43	0029614
14	0008034	44	0025252	14	0009642	44	0030302
15	0008608	45	0025826	15	0010330	45	0030992
16	0009182	46	0026400	16	0011020	46	0031680
17	0009756	47	0026974	17	0011708	47	0032368
18	0010330	48	0027548	18	0012396	48	0033058
19	0010904	49	0028122	19	0013084	49	0033746
20	0011478	50	0028696	20	0013774	50	0034434
21	0012052	51	0029270	21	0014462	51	0035122
22	0012626	52	0029844	22	0015150	52	0035812
23	0013200	53	0030418	23	0015840	53	0036500
24	0013774	54	0030992	24	0016530	54	0037188
25	0014348	55	0031566	25	0017216	55	0037878
26	0014922	56	0032140	26	0017906	56	0038566
27	0015496	57	0032714	27	0018594	57	0039254
28	0016070	58	0033288	28	0019284	58	0039944
29	0016644	59	0033862	29	0019970	59	0040632
30	0017216	60	0034434	30	0020660	60	0041322

Table for Estimating the Superficial Quantity of Slopes of Cuttings and Embankments in Rods.

SLOPE ¼ to 1.				SLOPE ⅓ to 1.			
Ht.	Contents in Rods.	Ht.	Contents in Rods.	Ht.	Contents in Rods.	Ht.	Contents in Rods.
1	003786	31	117370	1	004106	31	127305
2	007572	32	121156	2	008213	32	131412
3	011358	33	124942	3	012320	33	135519
4	015144	34	128728	4	016426	34	139625
5	018931	35	132515	5	020533	35	143732
6	022717	36	136301	6	024640	36	147839
7	026503	37	140087	7	028746	37	151945
8	030289	38	143873	8	032853	38	156052
9	034075	39	147659	9	036960	39	160159
10	037861	40	151445	10	041066	40	164266
11	041647	41	155231	11	045172	41	168372
12	045433	42	159017	12	049279	42	172479
13	049219	43	162803	13	053386	43	176586
14	053005	44	166589	14	057492	44	180692
15	056792	45	170376	15	061599	45	184799
16	060578	46	174162	16	065706	46	188906
17	064364	47	177948	17	069812	47	193012
18	068150	48	181734	18	073919	48	197119
19	071936	49	185520	19	078026	49	201226
20	075723	50	189307	20	082133	50	205332
21	079509	51	193093	21	086239	51	209438
22	083295	52	196879	22	090346	52	213545
23	087081	53	200665	23	094453	53	217652
24	090867	54	204451	24	098559	54	221758
25	094654	55	208238	25	102666	55	225865
26	098440	56	212024	26	106773	56	229972
27	102226	57	215810	27	110879	57	234078
28	106012	58	219596	28	114986	58	238185
29	109798	59	223382	29	119063	59	242292
30	113584	60	227168	30	123199	60	246399

Table for Estimating the Superficial Quantity of Slopes of Cuttings and Embankments in Rods.

SLOPE ¾ to 1.				SLOPE 1 to 1.			
Ht.	Contents in Rods.	Ht.	Contents in Rods.	Ht.	Contents in Rods.	Ht.	Contents in Rods.
1	004591	31	142332	1	005194	31	161030
2	009183	32	146924	2	010389	32	166225
3	013774	33	151515	3	015584	33	171420
4	018365	34	156106	4	020778	34	176614
5	022957	35	160698	5	025973	35	181809
6	027548	36	165289	6	031167	36	187003
7	032139	37	169880	7	036362	37	192198
8	036731	38	174472	8	041556	38	197392
9	041322	39	179063	9	046751	39	202587
10	045914	40	183665	10	051945	40	207782
11	050505	41	188246	11	057139	41	212976
12	055097	42	192838	12	062334	42	218171
13	059688	43	197429	13	067529	43	223366
14	064279	44	202020	14	072723	44	228560
15	068871	45	206612	15	077918	45	233755
16	073462	46	211203	16	083112	46	238949
17	078053	47	215794	17	088307	47	244144
18	082645	48	220386	18	093501	48	249338
19	087236	49	224977	19	098696	49	254533
20	091827	50	229568	20	103891	50	259727
21	096418	51	234159	21	109085	51	264921
22	101010	52	238751	22	114280	52	270116
23	105601	53	243342	23	119475	53	275311
24	110192	54	247933	24	124669	54	280505
25	114784	55	252525	25	129864	55	285700
26	119375	56	257116	26	135058	56	290894
27	123966	57	261707	27	140253	57	296089
28	128558	58	266299	28	145447	58	301283
29	133149	59	270890	29	150642	59	306478
30	137741	60	275482	30	155836	60	311672

Table for Estimating the Superficial Quantity of Slopes of Cuttings and Embankments in Rods.

SLOPE $1\frac{1}{4}$ to 1.				SLOPE $1\frac{1}{2}$ to 1.			
Ht.	**Contents in Rods.**	**Ht.**	**Contents in Rods.**	**Ht.**	**Contents in Rods.**	**Ht.**	**Contents in Rods.**
1	005880	31	182275	1	006622	31	205275
2	011760	32	188155	2	013243	32	211896
3	017639	33	194034	3	919865	33	218518
4	023519	34	199914	4	026487	34	225140
5	029399	35	205794	5	033109	35	231762
6	035279	36	211674	6	039731	36	238384
7	041139	37	217534	7	046352	37	245005
8	047039	38	223434	8	052974	38	251627
9	052918	39	229313	9	059596	39	258249
10	058798	40	235193	10	066218	40	264871
11	064678	41	241073	11	072840	41	271493
12	070558	42	246953	12	079461	42	278114
13	076437	43	252832	13	086083	43	284736
14	082317	44	258712	14	092705	44	291358
15	088197	45	264592	15	099327	45	297980
16	094077	46	270472	16	105949	46	304602
17	099937	47	276332	17	112570	47	311223
18	105837	48	282232	18	119192	48	317845
19	111716	49	287111	19	125814	49	324467
20	117596	50	293991	20	132435	50	331088
21	123476	51	299871	21	139057	51	337710
22	129356	52	305751	22	145678	52	344331
23	135235	53	311630	23	152300	53	350953
24	141115	54	317510	24	158922	54	357575
25	146995	55	323390	25	165544	55	364197
26	152875	56	329270	26	172166	56	370819
27	158735	57	335130	27	178787	57	377440
28	164635	58	341030	28	185409	58	384062
29	170515	59	346909	29	192031	59	390684
30	176395	60	352789	30	198653	60	397306

Table for Estimating the Superficial Quantity of Slopes of Cuttings and Embankments in Rods.

SLOPE $1\frac{3}{4}$ to 1.				SLOPE 2 to 1.			
Ht.	Contents in Rods.	Ht.	Contents in Rods.	Ht.	Contents in Rods.	Ht.	Contents in Rods.
1	007403	31	229504	1	008213	31	254612
2	014807	32	236908	2	016427	32	262825
3	022210	33	244311	3	024640	33	271039
4	029613	34	251714	4	032853	34	279252
5	037017	35	259118	5	041066	35	287465
6	044420	36	266521	6	049280	36	295679
7	051824	37	273925	7	057493	37	303892
8	059227	38	281328	8	065706	38	312105
9	066630	39	288731	9	073920	39	320319
10	074034	40	296134	10	082133	40	328532
11	081437	41	303537	11	090346	41	336745
12	088841	42	310941	12	098560	42	344959
13	096244	43	318344	13	106773	43	353172
14	103647	44	325747	14	114986	44	361385
15	111051	45	333151	15	123199	45	369598
16	118454	46	340554	16	131413	46	377812
17	125858	47	347958	17	139626	47	386025
18	133261	48	355361	18	147839	48	394238
19	140664	49	362764	19	156053	49	402452
20	148067	50	370168	20	164266	50	410664
21	155470	51	377571	21	172479	51	418877
22	162874	52	384975	22	180693	52	427091
23	170277	53	392378	23	188906	53	435304
24	177680	54	399781	24	197119	54	443517
25	185084	55	407185	25	205332	55	451730
26	192487	56	414588	26	213546	56	459944
27	199891	57	421992	27	221759	57	468157
28	207294	58	429395	28	229972	58	476370
29	214697	59	436798	29	238186	59	484584
30	222101	60	444201	30	246399	60	492797

Table for Estimating the Superficial Quantity of Slopes of Cuttings and Embankments in Rods.

SLOPE 2½ to 1.				SLOPE 3 to 1.			
Ht.	Contents in Rods.	Ht.	Contents in Rods.	Ht.	Contents in Rods.	Ht.	Contents in Rods.
1	009890	31	306593	1	011615	31	360075
2	019780	32	316483	2	023232	32	371691
3	029670	33	326373	3	034846	33	383306
4	039560	34	336263	4	046464	34	394921
5	049450	35	346153	5	058077	35	406537
6	059341	36	356044	6	069696	36	418152
7	069231	37	365934	7	081307	37	429767
8	079121	38	375824	8	092929	38	441383
9	089011	39	385714	9	104538	39	453000
10	098901	40	395604	10	116153	40	464614
11	108791	41	405494	11	127768	41	476229
12	118681	42	415384	12	139384	42	487845
13	128571	43	425274	13	151000	43	499460
14	138461	44	435164	14	162614	44	511075
15	148351	45	445054	15	174230	45	522691
16	158242	46	454945	16	185845	46	534306
17	168132	47	464835	17	197460	47	545921
18	178022	48	474725	18	209076	48	557537
19	187912	49	484615	19	220691	49	569152
20	197802	50	494505	20	232307	50	580767
21	207692	51	504395	21	243922	51	592382
22	217582	52	514285	22	255538	52	604000
23	227472	53	524175	23	267153	53	615613
24	237362	54	534065	24	278768	54	627228
25	247252	55	543955	25	290384	55	638844
26	257143	56	553846	26	292000	56	650459
27	267033	57	563736	27	313614	57	662074
28	276923	58	573626	28	325230	58	673690
29	286813	59	583516	29	336845	59	685305
30	296703	60	593406	30	348460	60	696921

EXPLANATION OF TABLES

For Calculating the Areas of Land required for a Railway.

Having prepared a form similar to that required for the earthwork, look in the tables for the given slope, opposite the given heights at each end of the prismoid, in the columns headed "sides;" and also look in the columns headed "bases," which corresponds with slope 1 to 1 of the sides, for a number corresponding with the given base added to the two widths on each side between the edge of the slope at the surface of the ground, and the boundary or fence line. These three numbers added together and multiplied by the length will give the area in acres and decimals: all dimensions are given in feet.

Example:
Slope 1 to 1; base 32 feet.
Side widths, 12 feet each.
Heights, 18 and 38 feet; length, 560 feet.

Col. Sides.	Opposite 18 we find - -	.0004132
	Opposite 38 we find - -	.0008723
Col. Bases.	Opposite 32 + 12 + 12 = 56 we find	.0012855
		.0025710
	Multiply by length =	560
		1.4397600

	A.	R.	P.
Answer	1	1	30

It is obvious that in any given railway, whose base and side widths are determined, the third number (in this case .0012855) is common to all the additions; therefore, this may be multiplied by the entire length at once, and the sides computed and added to the result afterwards. Moreover, the same as in the earthwork, one tabular number is common to two adjoining plots. Much time may be saved also, by adding mentally the two heights together, and seeking, if the tables admit of it, the corresponding tabular number; for

Opposite 18 we find		.0004132
Opposite 38	"	.0008723
Their sum is 56		.0012855

and opposite 56 we find .0012855.

Table to find the Superficial Quantity of Slopes.

Add together the numbers opposite the given heights, and multiply the sum by the length; the product in the area is rods and decimals.

Example: the heights and slopes as before:

Opposite 18 we find		.093501
Opposite 38	"	.197392
56		.290893
Multiply by length		560

	RODS.	YDS.	
Answer	162	27	162.900080

Here again, the sum of the heights being taken = 56, the corresponding number is .290893.

TABLE OF OFFSETS TO CURVES,

Calculated for Radius = 1000.

Tan.	Offsett.	Tan.	Offsett.	Tan.	Offsett.	Tan.	Offsett.
1	.0005	31	.4806	61	1.8623	91	4.1492
2	.0020	32	.5121	62	1.9239	92	4.2411
3	.0045	33	.5446	63	1.9865	93	4.3340
4	.0080	34	.5781	64	2.0501	94	4.4279
5	.0125	35	.6127	65	2.1148	95	4.5228
6	.0180	36	.6482	66	2.1804	96	4.6187
7	.0245	37	.6847	67	2.2471	97	4.7157
8	.0320	38	.7222	68	2.3147	98	4.8136
9	.0406	39	.7607	69	2.3833	99	4.9216
10	.0501	40	.8003	70	2.4530	100	5.0126
11	.0606	41	.8408	71	2.5237	101	5.1136
12	.0721	42	.8824	72	2.5954	102	5.2157
13	.0846	43	.9249	73	2.6681	103	5.3187
14	.0981	44	.9685	74	2.7418	104	5.4228
15	.1126	45	1.0131	75	2.8165	105	5.5278
16	.1281	46	1.0586	76	2.8922	106	5.6339
17	.1446	47	1.1052	77	2.9689	107	5.7411
18	.1621	48	1.1528	78	3.0466	108	5.8492
19	.1806	49	1.2013	79	3.1253	109	5.9584
20	.2001	50	1.2508	80	3.2052	110	6.0685
21	.2206	51	1.3013	81	3.2859	111	6.1796
22	.2421	52	1.3529	82	3.3677	112	6.2918
23	.2646	53	1.4054	83	3.4505	113	6.4051
24	.2881	54	1.4590	84	3.5343	114	6.5193
25	.3126	55	1.5137	85	3.6191	115	6.6346
26	.3381	56	1.5693	86	3.7049	116	6.7508
27	.3646	57	1.6259	87	3.7917	117	6.8681
28	.3921	58	1.6835	88	3.8795	118	6.9865
29	.4206	59	1.7421	89	3.9684	119	7.1058
30	.4501	60	1.8017	90	4.0538	120	7.2262

TABLE OF OFFSETS TO CURVES,

Calculated for Radius = 1000.

Tan.	Offsett.	Tan.	Offsett.	Tan.	Offsett.	Tan.	Offsett.
121	7.3474	151	11.4661	181	16.5168	211	22.5139
122	7.4797	152	11.6193	182	16.7013	212	22.7303
123	7.5931	153	11.7736	183	16.8869	213	22.9479
124	7.7176	154	11.9290	184	17.0736	214	23.1665
125	7.8433	155	12.0856	185	17.2615	215	23.3860
126	7.9696	156	12.2428	186	17.4502	216	23.6066
127	8.0971	157	12.4013	187	17.6400	217	23.8283
128	8.2276	158	12.5609	188	17.8310	218	24.0511
129	8.3572	159	12.7213	189	18.0229	219	24.2751
130	8.4861	160	12.8830	190	18.2160	220	24.5002
131	8.6175	161	13.0455	191	18.4099	221	24.7262
132	8.7501	162	13.2091	192	18.6050	222	24.9533
133	8.8837	163	13.3739	193	18.8012	223	25.1815
134	9.0185	164	13.5396	194	18.9985	224	25.4108
135	9.1544	165	13.7065	195	19.1968	225	25.6413
136	9.2910	166	13.8742	196	19.3960	226	25.8727
137	9.4287	167	14.0430	197	19.5964	227	26.1052
138	9.5675	168	14.2130	198	19.7978	228	26.3388
139	9.7074	169	14.3839	199	20.0004	229	26.5735
140	9.8485	170	14.5560	200	20.2041	230	26.8094
141	9.9903	171	14.7290	201	20.4087	231	27.0463
142	10.1332	172	14.9030	202	20.6144	232	27.2842
143	10.2772	173	15.0782	203	20.8212	233	27.5233
144	10.4223	174	15.2545	204	21.0291	234	27.7634
145	10.5685	175	15.4318	205	21.2381	235	28.0047
146	10.7154	176	15.6099	206	21.4480	236	28.2470
147	10.8634	177	15.7891	207	21.6590	237	28.4904
148	11·0125	178	15.9694	208	21.8711	238	28.7349
149	11.1627	179	16.1508	209	22.0843	239	28.9805
150	11.3140	180	16.3334	210	22.2987	240	29.2271

TABLE OF OFFSETS TO CURVES,

Calculated for Radius = 1000.

Tan.	Offsett.	Tan.	Offsett.	Tan.	Offsett.	Tan.	Offsett.
241	29.4746	271	37.4205	301	46.3757	331	56.3692
242	29.7234	272	37.7025	302	46.6919	332	56.7206
243	29.9734	273	37.9857	303	47.0093	333	57.0732
244	30.2246	274	38.2701	304	47.3279	334	57.4270
245	30.4770	275	38.5558	305	47.6477	335	57.7819
246	30.7300	276	38.8422	306	47.9684	336	58.1380
247	30.9842	277	39.1298	307	48.2903	337	58.4954
248	31.2396	278	39.4186	308	48.6135	338	58.8539
249	31.4963	279	39.7086	309	48.9379	339	59.2137
250	31.7542	280	40.0000	310	49.2635	340	59.5746
251	32.0126	281	40.2921	311	49.5900	341	59.9367
252	32.2722	282	40.5854	312	49.9178	342	60.3001
253	32.5331	283	40.8799	313	50.2468	343	60.6646
254	32.7952	284	41.1756	314	50.5770	344	61.0304
255	33.0585	285	41.4725	315	50.9084	345	61.3973
256	33.3226	286	41.7702	316	51.2408	346	61.7655
257	33.5880	287	42.0692	317	51.5744	347	62.1349
258	33.8546	288	42.3694	318	51.9092	348	62.5055
259	34.1225	289	42.6708	319	52.2453	349	62.8773
260	34.3914	290	42.9734	320	52.5825	350	63.2503
261	34.6610	291	43.2768	321	52.9208	351	63.6246
262	34.9319	292	43.5815	322	53.2603	352	64.0000
263	35.2039	293	43.8874	323	53.6010	353	64.3767
264	35.4772	294	44.1945	324	53.9429	354	64.7546
265	35.7516	295	44.5028	325	54.2860	355	65.1337
266	36.0268	296	44.8120	326	54.6302	356	65.5141
267	36.3032	297	45.1224	327	54.9756	357	65.8957
268	36.5809	298	45.4340	328	55.3223	358	66.2785
269	36.8597	299	45.7468	329	55.6701	358	66.6625
270	37.1397	300	46.0608	330	56.0191	360	67.0477

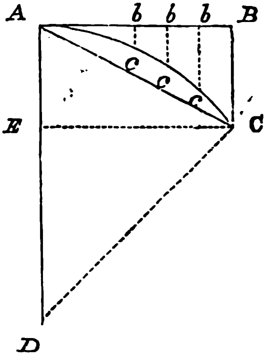
EXPLANATION

OF THE

TABLES OF OFFSETS TO CURVES.

In setting out the curves of a railway in the fields, the usual practice is to lay out a tangent line, and from certain points along this line to set off at right angles such distances as will give points in the curve: each distance is called "an offset." It has generally been considered sufficient, in setting out these curves, to calculate the offsets for every chain of tangent, to the extreme length of 10 chains; and the ordinary rule for this purpose (which is sufficiently near when the radius is not less than two miles) is to compute the extreme or last offset correctly, and then all the others are derived from it, by making the offsets vary *as the square* of the tangent. But as the radius must be determined for every set, and therefore the application of a table so constructed would be limited to a *few* given cases only, I thought it better to provide such a table as would be applicable to *all* cases, whether the radius were long or short; and the tangent might bear such a proportion to the radius as would admit of the tables being used in very sharp curves. For instance, in a curve of 10 chains radius, the tables will extend to 3.6 chains of tangent.

I now proceed to shew how these tables were formed, and then to explain their use.



Let A*c*C (in the accompanying diagram) be the arc of a circle required to be laid down; AD is the radius, AB the tangent, and BC the offset. Also *bc bc* are intermediate offsets. AC is the chord. By the well known equation of a circle we have this rule to find BC. $BC = AD - \sqrt{AD^2 - AB^2}$.

Suppose that AD were 1000, and that tangents were given in the series 1, 2, 3, 4, &c., corresponding to A*b*, A*b*, &c., then the offsets .0005, .0020, .0045, .0080, &c., are the true distances *bc bc*, &c.

In the tables, every consecutive fifth number was calculated according to the above rule; and the intermediate numbers were interpolated. The error (if any) is in the 4th place of decimals only, and then not exceeding any where .0003; and this discrepancy, with a radius of 1000 chains, or 12½ miles, will not equal ¼ of an inch. Therefore, the tables may be considered as practically accurate.

RULE FOR THE TABLES.

Given radius and tangent, to find the offset. Divide 1,000 times the tangent by radius, and look in column of tangents for the quotient; then multiply the corresponding opposite offset by 1,000 times the radius: the result is the true offset.

Example:

Radius, 2,940; tangent, 147. Here $\frac{147 \times 1000}{2940} = 50.$

In the column of tangents in the tables we look for 50; and opposite to this, in the column of offsets, we find 1.2508: this number multiplied by the radius 2940, and divided by 1000, will give the true offset sought $= \frac{1.2508 \times 2940}{1000} = 3.677.$

It is very easy to assume such a tangent as will give, when divided, some number to be found in the table; which number should again admit of being sub-divided into equal parts by some convenient divisor. For instance, the above example (147) is easily divided by 2,940, and the quotient 50 is found in the table. Also 50 can be divided easily by 5 or 10, and will admit of 10 offsets 14.7 apart, or 5 offsets 29.4 apart. In the first case, the numbers opposite 5, 10, 15, &c., must be chosen to find the offsets; and in the latter case, we should extract the numbers opposite 10, 20, 30, &c.; and computing these offsets as before, we can fill up so many points in the curve.

The use of these tables affords equal facility, whether the calculations are made in feet, chains, yards, or any other measure. Besides the use of computing the offsets to curves, for small divisions on a tangent line, it is sometimes very desirable to know some remote point in a long curve, for the purpose of checking the work, or when the instruments for delineating curves are not long enough to reach the whole extent of the required sweep. For instance, in a working plan, plotted to 2½ chains to 1 inch, or 32 inches to 1 mile, suppose a curve of 4 miles' radius to extend over 2 miles of line, this will be 5 feet 4 inches long; and as the radius is 10 feet 8 inches, unless some points were computed, it would not be safe to depend upon the line which could be drawn by a sweep only 18 or 24 inches long. But, to make some of the points through which the curve should pass, calculate them by the tables; thus:

Given radius 4 miles = 320 chains; tangents, 16, 32, 48, 64, 80 chains; here, $\frac{80 \times 1000}{320} = 250$; and as 250 divides easily by 5, we can extract the numbers opposite.

						CHAINS.
250	=	31.7542	then each	Offset for tangent		80
200	=	20.2041	number	"	"	64
150	=	11.3140	multiplied	"	"	48
100	=	5.0126	by	"	"	32
50	=	1.2508	320÷1000	"	"	16

It is now easy (having plotted these offsets) to join the points by a proper sweep. To facilitate various calculations relating to curves, I subjoin the following rules:—

$AD = \frac{AB^2 + BC^2}{2\ BC}$

1.—*Given tangent* AB *and offset* BC; *to find radius* AD:

Add together the squares of the tangent and offset, and divide by twice the offset; the quotient is the radius.

$AD = \frac{AC^2}{2\ BC}$

2.—*Given chord* AC, *and offset* BC; *to find radius* AD:

Divide the square of the chord by twice the offset; the quotient is the radius.

$BC = AD - \sqrt{AD^2\ AB^2}$

3.—*Given radius and tangent; to find the offset:*

From the radius deduct the square root of the difference of the squares of the radius and tangent; the result is the offset.

$BC = \frac{AC^2}{2\ AD}$

4.—*Given the radius and chord; to find the offset:*

Divide the square of the chord by twice the radius; the quotient is the offset.

$AB = \sqrt{AC^2 - BC^2}$

5.—*Given the chord and offset; to find the tangent.*

Take the square root of the difference of the squares of the chord and offset; the result is the tangent.

$AB = \sqrt{2\ AD \times BC - BC^2}$

6.—*Given the radius and offset; to find the tangent:*

Multiply the difference of twice the radius and the offset by the offset; and the square root of the product is the tangent.

$AC = \sqrt{AB^2 + BC^2}$

7.—*Given the tangent and offset; to find the chord:*

Add together the squares of the tangent and offset; the square root of the sum is the chord.

$AC = \sqrt{2\ BC \times AD}$

8.—*Given the radius and offset; to find the chord:*

Multiply twice the offset by the radius; the square root of the product is the chord.

Table for finding the Radius, when the Tangent is known, and the Angle subtending the arc is given (contained between the two tangents to the extreme points of the arc).

Rule—*To find the radius.*

Multiply the tangent by the coefficient opposite the given angle; the product is the radius.

Angle.	Coefficient.	Angle.	Coefficient.
179½	229.18	164½	7.415
179	114.60	164	7.185
178½	76.40	163½	6.969
178	57.30	163	6.765
177½	45.84	162½	6.573
177	38.20	162	6.392
176½	32.74	161½	6.221
176	28.65	161	6.059
175½	25.47	160½	5.905
175	22.92	160	5.758
174½	20.84	159½	5.619
174	19.10	159	5.487
173½	17.64	158½	5.361
173	16.38	158	5.241
172½	15.29	157½	5.125
172	14.33	157	5.015
171½	13.49	156½	4.910
171	12.74	156	4.809
170½	12.07	155½	4.713
170	11.47	155	4.620
169½	10.92	154½	4.531
169	10.43	154	4.445
168½	9.981	153½	4,363
168	9.567	153	4.283
167½	91.85	152½	4.207
167	8.833	152	4.133
166½	8.507	151½	4.062
166	8.205	151	3.994
165½	7.924	150½	3.927
165	7.661	150	3.863

Given radius and angle; to find corresponding tangent.

Rule—Divide radius by coefficient due to the angle; the quotient is the required tangent.

EXPLANATION OF THE TABLE OF DISTANCES.

For the convenience of those who wish to transfer chains into feet or yards, or the reverse, I have supplied tables, giving the comparative values of any desired distances at once; and by multiplying or dividing the numbers given in the table by 10, it is easy to obtain any extension of the tables required in practice.

TABLE OF DISTANCES.

Chains into Yards and Feet.

Miles	Chains.	Yards.	Feet.	Miles	Chains.	Yards.	Feet.
	.01	.22	.66		11	242	726
	.02	.44	1.32		12	264	792
	.03	.66	1.98		13	286	858
	.04	.88	2.64		14	308	924
	.05	1.10	3.30	$\frac{3}{16}$	15	330	990
	.06	1.32	3.96		16	352	1056
	.07	1.54	4.62		17	374	1122
	.08	1.76	5.28		18	396	1188
	.09	1.98	5.94		19	418	1254
	.10	2.20	6.60	$\frac{1}{4}$	20	440	1320
	.20	4.40	13.20		21	462	1386
	.30	6.60	19.80		22	484	1452
	.40	8.80	26.40		23	506	1518
	.50	11.00	33.00		24	528	1584
	.60	13.20	39.60	$\frac{5}{16}$	25	550	1650
	.70	15.40	46.20		26	572	1716
	.80	17.60	52.80		27	594	1782
	.90	19.80	59.40		28	616	1848
	1.00	22.00	66.00		29	638	1914
	2.00	44.00	132.00	$\frac{3}{8}$	30	660	1980
	3.00	66.00	198.00		31	682	2046
	4.00	88.00	264.00		32	704	2112
	5.00	110.00	330.00		33	726	2178
$\frac{1}{16}$	6.00	132.00	396.00		34	748	2244
	7.00	154.00	462.00	$\frac{7}{16}$	35	770	2310
	8.00	176.00	528.00		36	792	2376
	9.00	198.00	594.00		37	814	2442
$\frac{1}{8}$	10.00	220.00	660.00		38	836	2508
					39	858	2574
				$\frac{1}{2}$	40	880	2640

TABLE OF DISTANCES.

Chains into Yards and Feet.

Miles	Chains.	Yards.	Feet.	Miles	Chains.	Yards.	Feet.
	41	902	2704		71	1562	4686
	42	924	2772		72	1584	4752
	43	946	2838		73	1606	4818
	44	968	2904		74	1628	4884
$\frac{9}{16}$	45	990	2970	$\frac{15}{16}$	75	1650	4950
	46	1012	3036		76	1672	5016
	47	1034	3102		77	1694	5082
	48	1056	3168		78	1716	5148
	49	1078	3234		79	1738	5214
$\frac{5}{8}$	50	1100	3300	1	80	1760	5280
	51	1122	3366		81	1782	5346
	52	1144	3432		82	1804	5412
	53	1166	3498		83	1826	5478
	54	1188	3564		84	1848	5544
$\frac{11}{16}$	55	1210	3630	$1\frac{1}{16}$	85	1870	5610
	56	1232	3696		86	1892	5676
	57	1254	3762		87	1914	5742
	58	1276	3828		88	1936	5808
	59	1298	3894		89	1958	5874
$\frac{3}{4}$	60	1320	3960	$1\frac{1}{8}$	90	1980	5940
	61	1342	4026		91	2002	6006
	62	1364	4092		92	2024	6072
	63	1386	4158		93	2046	6138
	64	1408	4224		94	2068	6204
$\frac{13}{16}$	65	1430	4290	$1\frac{3}{16}$	95	2090	6270
	66	1452	4356		96	2112	6336
	67	1474	4422		97	2134	6402
	68	1496	4488		98	2156	6468
	69	1518	4554		99	2178	6534
$\frac{7}{8}$	70	1540	4620	$1\frac{1}{4}$	100	2200	6600

TABLE OF DISTANCES.

Chains into Yards and Feet.

Miles	Chains.	Yards.	Feet.	Miles	Chains.	Yards.	Feet.
$1\frac{5}{16}$	105	2310	6930	$4\frac{3}{8}$	350	7700	23100
$1\frac{3}{8}$	110	2420	7260	$4\frac{1}{2}$	360	7920	23760
$1\frac{7}{16}$	115	2530	7590	$4\frac{5}{8}$	370	8140	24420
$1\frac{1}{2}$	120	2640	7920	$4\frac{3}{4}$	380	8360	25080
$1\frac{9}{16}$	125	2750	8250	$4\frac{7}{8}$	390	8580	25740
$1\frac{5}{8}$	130	2860	8580	5	400	8800	26400
$1\frac{11}{16}$	135	2970	8910	$5\frac{1}{8}$	410	9020	27060
$1\frac{3}{4}$	140	3080	9240	$5\frac{1}{4}$	420	9240	27720
$1\frac{13}{16}$	145	3190	9570	$5\frac{3}{8}$	430	9460	28380
$1\frac{7}{8}$	150	3300	9900	$5\frac{1}{2}$	440	9680	29040
$1\frac{15}{16}$	155	3410	10230	$5\frac{5}{8}$	450	9900	29700
2	160	3520	10560	$4\frac{3}{4}$	460	10120	30360
$2\frac{1}{8}$	170	3740	11220	$5\frac{7}{8}$	470	10340	31020
$2\frac{1}{4}$	180	3960	11880	6	480	10560	31680
$2\frac{3}{8}$	190	4180	12540	$6\frac{1}{8}$	490	10780	32340
$2\frac{1}{2}$	200	4400	13200	$6\frac{1}{4}$	500	11000	33000
$2\frac{5}{8}$	210	4620	13860	$6\frac{3}{8}$	510	11220	33660
$2\frac{1}{2}$	220	4840	14520	$6\frac{1}{2}$	520	11440	34320
$2\frac{7}{8}$	230	5060	15180	$6\frac{5}{8}$	530	11660	34980
3	240	5280	15840	$6\frac{3}{4}$	540	11880	35640
$3\frac{1}{8}$	250	5500	16500	$6\frac{7}{8}$	550	12100	36300
$3\frac{1}{4}$	260	5720	17160	7	560	12320	36960
$3\frac{3}{8}$	270	5940	17820	$7\frac{1}{8}$	570	12540	37620
$3\frac{1}{2}$	280	6160	18480	$7\frac{1}{4}$	580	12760	38280
$3\frac{5}{8}$	290	6380	19140	$7\frac{3}{8}$	590	12980	38940
$3\frac{3}{4}$	300	6600	19800	$7\frac{1}{2}$	600	13200	39600
$3\frac{7}{8}$	310	6820	20460	$7\frac{5}{8}$	610	13420	40260
4	320	7040	21120	$7\frac{3}{4}$	620	13640	40920
$4\frac{1}{8}$	330	7260	21780	$7\frac{7}{8}$	630	13860	41580
$4\frac{1}{4}$	340	7480	22440	8	640	14080	42240

TABLE OF DISTANCES.

Yards into Chains and Feet.

Feet.	Yards.	Chains.	Feet.	Yards.	Chains.
.1	.033	.0015	21	7.000	.3181
.2	.066	.0030	22	7.333	.3333
.3	.100	.0045	23	7.666	.3484
.4	.133	.0060	24	8.000	.3636
.5	.166	.0075	25	8.333	.3787
.6	.200	.0090	26	8.666	.3939
.7	.233	.0106	27	9.000	.4090
.8	.266	.0121	28	9.333	.4242
.9	.300	.0136	29	9.666	.4393
1.0	.333	.0151	30	10.000	.4545
2.0	.666	.0303	31	10.333	.4696
3.0	1.000	.0454	32	10.666	.4848
4.0	1.333	.0606	33	11.000	.5000
5.0	1.666	.0757	34	11.333	.5151
6.0	2.000	.0909	35	11.666	.5303
7.0	2.333	.1060	36	12.000	.5454
8.0	2.666	.1212	37	12.333	.5606
9.0	3.000	.1363	38	12.666	.5757
10.0	3.333	.1515	39	13.000	.5909
11.0	3.666	.1666	40	13.333	.6060
12.0	4.000	.1818	41	13.666	.6212
13.0	4.333	.1969	42	14.000	.6363
14.0	4.666	.2121	43	14.333	.6515
15.0	5.000	.2272	44	14.666	.6666
16.0	5.333	.2424	45	15.000	.6818
17.0	5.666	.2575	46	15.333	.6969
18.0	6.000	.2727	47	15.666	.7121
19.0	6.330	.2878	48	16.000	.7272
20.0	6.666	.3030	49	16.333	.7424
			50	16.666	.7575

TABLE OF DISTANCES.

Feet into Chains and Yards.

Yards.	Feet.	Chains.	Yards.	Feet.	Chains.
.1	.3	.0045	21	63	.9545
.2	.6	.0090	22	66	1.0000
.3	.9	.0136	23	69	1.0454
.4	1.2	.0181	24	72	1.0909
.5	1.5	.0227	25	75	1.1363
.6	1.8	.0272	26	78	1.1818
.7	2.1	.0318	27	81	1.2272
.8	2.4	.0363	28	84	1.2727
.9	2.7	.0409	29	87	1.3181
1.0	3.0	.0454	30	90	1.3636
2.0	6.0	.0909	31	93	1.4090
3.0	9.0	.1363	32	96	1.4545
4.0	12.0	.1818	33	99	1.5000
5.0	15.0	.2272	34	102	1.5454
6.0	18.0	.2727	35	105	1.5909
7.0	21.0	.3181	36	108	1.6363
8.0	24.0	.3636	37	111	1.6818
9.0	27.0	.4090	38	114	1.7272
10.0	30.0	.4545	39	117	1.7727
11.0	33.0	.5000	40	120	1.8181
12.0	36.0	.5454	41	123	1.8636
13.0	39.0	.5909	42	126	1.9090
14.0	42.0	.6363	43	129	1.9545
15.0	45.0	.6818	44	132	2.0000
16.0	48.0	.7272	45	135	2.0454
17.0	51.0	.7727	46	138	2.0909
18.0	54.0	.8181	47	141	2.1363
19.0	57.0	.8636	48	144	2.1818
20.0	60.0	.9090	49	147	2.2272
			50	150	2.2727

TABLE OF GRADIENTS.

Ratio, one in	Vert. alt. in feet per mile.	Vert. alt. in feet per chain	Gravity in lbs. due to 1 ton.	Ratio, one in	Vert. alt. in feet per mile.	Vert. alt. in feet per chain	Gra. in lbs. due to 1 ton.
22	240.00	3.0000	101.816	52	101.53	1.2692	43.076
23	229.56	2.8696	97.368	53	99.62	1.2452	42.264
24	220.00	2.7500	93.336	54	97.77	1.2222	41.480
25	211·20	2.6400	89.600	55	96.00	1.2000	40.726
26	203.06	2.5384	86.152	56	94.28	1.1786	40.000
27	195·55	2.4444	82.960	57	92.63	1.1578	39.298
28	188.56	2.3572	80.000	58	91.03	1.1377	38.620
29	182.06	2.2758	77.240	59	89.49	1.1186	37.966
30	176.00	2.2000	74.666	60	88.00	1.1000	37.333
31	170.32	2.1290	72.216	61	86.55	1.0818	36.720
32	165.00	2.0625	70.000	62	85.16	1.0645	36.108
33	160.00	2.0000	67.880	63	83.81	1.0477	35.555
34	155.30	1.9413	65.880	64	82.50	1.0312	35.000
35	150.84	1.8856	64.000	65	81.23	1.0152	34.460
36	146.66	1.8333	62.222	66	80.00	1.0000	33.940
37	142.70	1.7839	60.540	67	78.81	.9851	33.432
38	138.95	1.7368	58.944	68	77.64	.9706	32.940
39	135.38	1.6923	57.436	69	76.49	.9563	32.464
40	132.00	1.6500	56.000	70	75.43	.9429	32.000
41	128.78	1.6098	54.634	71	74.36	.9296	31.550
42	125.71	1.5714	53.333	72	73.33	.9166	31.111
43	122.78	1.5348	52.092	73	72.32	.9041	30.685
44	120.00	1.5000	50.908	74	71.35	.8919	30.270
45	117.33	1.4666	49.777	75	70.40	.8800	29.867
46	115.04	1.4380	48.684	76	69.47	.8684	29.472
47	112.34	1.4042	47.660	77	68.57	.8570	29.090
48	110.00	1.3750	46.688	78	67.69	.8461	28.718
49	107.75	1.3470	45.716	79	66.83	.8355	28.355
50	105.60	1.3200	44.800	80	66.00	.8250	28.000
51	103.52	1.2941	43.920	81	65.20	.8140	27.718

TABLE OF GRADIENTS.

Ratio. One in	Ver. al. in feet per m.	Ver. al. in feet per ch.	Gra. in lbs. due to 1 ton.	Ratio. One in	Ver. al. in feet per m.	Ver. al. in feet per ch.	Gra. in lbs. due to 1 ton.
82	64.39	.8048	27.317	110	48.00	.6000	20.363
83	63.61	.7952	26.988	111	47.57	.5940	20.180
84	62.86	.7857	26.666	112	47.14	.5893	20.000
85	62.12	.7764	26.353	113	46.72	.5840	19.823
85.16	62.00	.7750	26.303	114	46.31	.5789	19.649
86	61.39	.7674	26.046	115	45.93	.5739	19.478
87	60.69	.7586	25.746	116	45.52	.5688	19.310
88	60.00	.7500	25.454	117	45.13	.5641	19.145
89	59.33	.7416	25.168	118	44.75	.5593	18.983
90	58.66	.7333	24.888	119	44.37	.5545	18.820
91	58.02	.7252	24.614	120	44.00	.5500	18.666
92	57.52	.7190	24.342	121	43.64	.5454	18.512
93	56.77	.7096	24.086	122	43.28	.5409	18.360
94	56.17	.7021	23.830	123	42.92	.5364	18.210
95	55.60	.6900	23.579	124	42.58	.5322	18.054
96	55.00	.6875	23.334	125	42.24	.5280	17.920
97	54.43	.6804	23.092	126	41.90	.5238	17.777
98	53.88	.6735	22.858	127	41.57	.5196	17.638
99	53.33	.6666	22.626	128	41.25	.5157	17.500
100	52.80	.6600	22.400	128.78	41.00	.5125	17.394
101	52.27	.6535	22.180	129	40.93	.5016	17.364
102	51.76	.6470	21.960	130	40.61	.5076	17.230
103	51.26	.6408	21.747	131	40.08	.5009	17.099
104	50.77	.6346	21.538	132	40.00	.5000	16.970
105	50.28	.6285	21.333	133	39.70	.4962	16.842
105.6	50.00	.6250	21.212	134	39.40	.4925	16.716
106	49.81	.6226	21.132	135	39.11	.4888	16.592
107	49.34	.6168	20.934	136	38.82	.4853	16.470
108	48.89	.6111	20.740	137	38.54	.4816	16.350
109	48.44	.6055	20.555	138	38.24	.4782	16.232

TABLE OF GRADIENTS.

Ratio. One in	Ver. al. in feet per m.	Ver. al. in feet per ch.	Gra. in lbs. due to 1 ton.	Ratio. One in	Ver. al. in feet per m.	Ver. al. in feet per ch.	Gra. in lbs. due to 1 ton.
139	38.00	.4750	16.114	168	31.43	.3929	13.333
140	37.71	.4713	16.000	169	31.24	.3904	13.254
141	37.44	.4680	15.886	170	31.06	.3883	13.176
142	37.18	.4648	15.775	171	30.88	.3859	13.099
143	36.92	.4614	15.666	172	30.69	.3837	13.023
144	36.66	.4583	15.555	173	30.57	.3821	12.942
145	36.41	.4551	15.448	174	30.34	.3793	12.873
146	36.16	.4520	15.342	175	30.17	.3771	12.800
147	35.92	.4489	15.238	176	30.00	.3750	12.727
148	35.67	.4459	15.135	177	29.83	.3729	12.655
149	35.44	.4426	15.033	178	29.66	.3708	12.584
150	35.20	.4400	14.933	179	29.50	.3687	12.514
150.85	35.00	.4375	14.849	180	29.33	.3666	12.444
151	34.97	.4371	14.834	181	29.17	.3646	12.376
152	34.74	.4341	14.736	182	29.01	.3626	12.307
153	34.44	.4305	14.640	182.07	29.00	.3625	12.305
154	34.28	.4285	14.545	183	28.85	.3606	12.240
155	34.06	.4257	14.452	184	28.76	.3595	12.171
156	33.84	.4230	14.359	185	28.54	.3567	12.108
157	33.62	.4203	14.268	186	28.39	.3548	12.043
158	33.42	.4177	14.177	187	28.24	.3529	11.980
159	33.21	.4150	14.088	188	28.08	.3511	11.915
160	33.00	.4125	14.000	188.5	28.00	.3500	11.883
161	32.80	.4088	13.912	189	27.93	.3429	11.852
162	32.60	.4070	13.859	190	27.80	.3466	11.789
163	32.39	.4048	13.741	191	27.65	.3456	11.727
164	32.19	.4024	13.658	192	27.50	.3437	11.667
165	32.00	.4000	13.576	193	27.36	.3420	11.606
166	31.81	.3976	13.494	194	27.22	.3402	11.546
167	31.62	.3952	13.412	195	27.07	.3384	11.487

TABLE OF GRADIENTS.

Ratio. One in	Ver. alt. in feet per mile.	Ver. alt in feet per ch.	Gra. in lbs. due to 1 ton.	Ratio. One in	Ver. alt. in feet per mile.	Vr.alt. in feet per ch.	Gra. in lbs. due to 1 ton
196	26.938	.3367	11.429	254	20.787	.2598	8.819
198	26.666	.3333	11.313	256	20.625	.2578	8.750
199.25	26.50	.3312	11.242	260	20.30	.2537	8.615
200	26.40	.3300	11.200	264	20.00	.2500	8.485
203	26.00	.3250	11.034	266	19.85	.2481	8.421
204	25.882	.3235	10.980	268	19.701	.2462	8.358
205	25.756	.3219	10.927	270	19.55	.2444	8.296
206	25.631	.3204	10.873	270.77	19.50	.2437	8.273
207	25.507	.3188	10.821	272	19.411	.2426	8.235
208	25.38	.3173	10.769	274	19.270	.2408	8.175
210	25.14	.3142	10.666	275	19.20	.2400	8.146
211.2	25.00	.3125	10.606	276	19.17	.2396	8.116
212	24.905	.3113	10.566	278	19.00	.2375	8.057
216	24.44	.3055	10.370	280	18.85	.2356	8.000
220	24.00	.3000	10.181	282	18.72	.2340	7.943
224	23.571	.2946	10.000	285.4	18.50	.2312	7.849
225	23.47	.2934	9.955	286	18.461	.2307	7.832
226	23.362	.2920	9.911	288	18.33	.2291	7.777
228	23.158	.2895	9.824	290	18.20	.2275	7.724
229.5	23.00	.2875	9.760	292	18.08	.2260	7.671
230	22.95	.2868	9.739	293.3	18.00	.2250	7.637
232	22.758	.2844	9.655	296	17.838	.2229	7.567
236	22.373	.2796	9.491	300	17.60	.2200	7.466
240	22.00	.2750	9.333	301.71	17.50	.2187	7.424
242	21.82	.2727	9.256	306	17.22	.2152	7.320
245	21.55	.2693	9.143	310	17.03	.2128	7.226
246	21.46	.2682	9.105	310.6	17.00	.2125	7.212
250	21.12	.2640	8.960	314	16.812	.2101	7.134
251.4	21.00	.2625	8.910	315	16.76	.2095	7.111
252	20.952	.2619	8.888	318	16.603	.2075	7.044

TABLE OF GRADIENTS.

Ratio. One in	Ver. alt. in feet per mile.	Ver. al. in feet per ch.	Gra. in lbs. due to 1 ton	Ratio. One in	Ver. alt. in feet per mile.	Ver. al. in feet per ch.	Gra. in lbs. due to 1 ton
320	16.50	.2062	7.000	406.1	13.00	.1625	5.517
322	16.398	.2044	6.956	410	12.878	.1609	5.463
326	16.196	.2024	6.871	415	12.722	.1590	5.397
330	16.00	.2000	6.787	420	12·57	.1571	5.333
334	15.809	.1976	6.706	422.4	12.50	.1562	5.303
338	15.621	.1952	6.627	425	12.42	.1553	5.230
340	15.53	.1941	6.588	430	12.28	.1535	5.209
344	15.34	.1917	6.511	435	12.13	.1517	5.149
348	15.122	.1896	6.436	440	12.00	.1500	5.090
350	15.08	.1885	6.400	445	11.865	.1483	5.033
352	15.00	.1875	6.363	449	11.76	.1470	4.989
356	14.831	.1854	6.292	450	11.73	.1466	4.977
360	14.666	.1833	6.222	455	11.626	.1453	4.923
362	14.589	.1823	6.188	459.13	11.50	.1437	4.879
364.13	14.50	.1812	6.152	460	11.47	.1434	4.869
366	14.426	.1803	6.120	465	11.35	.1419	4.817
370	14.27	.1783	6.054	470	11.23	.1404	4.766
372	14.192	.1774	6.018	475	11.12	.1380	4.716
375	14.08	.1760	5.973	480	11.00	.1375	4.666
376	14.04	.1755	5.957	484	10.909	.1363	4.628
377.1	14.00	.1750	5.941	485.	10.886	.1361	4.616
380	13.90	.1737	5.894	490	10.77	.1346	4.571
384	13.75	.1718	5.833	495	10.666	.1333	4.525
388	13.608	.1701	5.773	500	10.56	.1320	4.480
390	13.54	.1692	5.743	502.85	10.50	.1312	4.455
391.11	13.50	.1687	5.727	505	10.455	.1307	4.436
392	13.469	.1683	5.714	507	10.414	.1302	4.418
396	13.333	.1666	5.657	510	10.35	.1294	4.392
400	13.20	.1650	5.600	512	10.312	.1289	4.375
405	13.037	.1629	5.531	515	10.252	.1281	4.349

TABLE OF GRADIENTS.

Ratio. One in	Ver. Alt. in feet per mile.	Vr. Al. in feet per ch.	Gra. in lbs. due to 1 ton	Ratio. One in	Ver. Alt. in feet per mile.	Ver. Al. in feet per ch.	Gra. in lbs. due to 1 ton
520	10.15	.1268	4.307	690	7.65	.0956	3.246
525	10.057	.1257	4.266	700	7.54	.0942	3.200
528	10.00	.1250	4.242	704	7.50	.0937	3.182
530	9.962	.1245	4.226	710	7.436	.0929	3.155
535	9.86	.1233	4.187	720	7.33	.0916	3.111
540	9.77	.1222	4.148	730	7.23	.0905	3.068
545	9.689	.1211	4.110	740	7.13	.0891	3.027
550	9.60	.1200	4.072	750	7.04	.0880	2.986
555	9.513	.1189	4.036	754.3	7.00	.0875	2.970
555.68	9.50	.1187	4.031	760	6.947	.0868	2.947
560	9.42	.1178	4.000	763	6.92	.0865	2.935
565	9.345	.1168	3.964	770	6.857	.0857	2.909
570	9.266	.1150	3.929	780	6.77	.0846	2.871
575	9.182	.1145	3.895	790	6.685	.0835	2.835
580	9.103	.1138	3.862	800	6.60	.0825	2.800
585	9.02	.1128	3.829	810	6.518	.0814	2.765
586.6	9.00	.1125	3.818	812.3	6.50	.0812	2.758
590	8.949	.1118	3.796	820	6.439	.0805	2.731
595	8.874	.1109	3.764	830	6.36	.0795	2.698
600	8.800	.1100	3.733	840	6.285	.0785	2.666
610	8.655	.1082	3.672	850	6.21	.0776	2.635
620	8.516	.1064	3.611	860	6.139	.0767	2.604
621.17	8.50	.1062	3.606	870	6.06	.0758	2.574
625	8.48	.1056	3.584	880	6.00	.0750	2.545
630	8.38	.1047	3.555	890	5.932	.0741	2.516
640	8.25	.1031	3.500	900	5.86	.0733	2.488
650	8.123	.1015	3.446	910	5.802	.0725	2.461
660	8.00	.1000	3.393	920	5.739	.0717	2.434
670	7.880	.0985	3.343	930	5.67	.0709	2.408
680	7.76	.0970	3.294	940	5.617	.0702	2.383

TABLE OF GRADIENTS.

Ratio. One in	Ver. Al. in feet per mile	Ver. Al. in feet per ch.	Gra. in lbs. due to 1 ton	Ratio. One in	Vr. Al in fee per m	Vr. Al. in feet per ch.	Gra. in lbs. due to 1 ton
950	5.55	.0694	2.357	1760	3.00	.0375	1.272
960	5.50	.0687	2.333	1800	2.933	.0366	1.244
970	5.443	.0680	2.309	1850	2.854	.0356	1.211
980	5.38	.0673	2.285	1900	2.780	.0345	1.178
990	5.333	.0666	2.262	1950	2.707	.0338	1.148
1000	5.280	.0660	2.240	2000	2.64	.0330	1.120
1050	5.028	.0628	2.133	2100	2.514	.0314	1.066
1056	5.00	.0625	2.121	2112	2.50	.0312	1.060
1100	4.80	.0600	2.036	2200	2.40	.0300	1.018
1150	4.591	.0574	1.947	2300	2.295	.0286	0.973
1173.33	4.50	.0562	1.909	2400	2.200	.0275	.933
1200	4.40	.0550	1.866	2500	2.112	.0264	.896
1234	4.2787	.0535	1.815	2600	2.030	.0253	.861
1250	4.224	.0528	1.792	2640	2.00	.0250	.848
1300	4.061	.0507	1.723	2700	1.955	.0244	.829
1320	4.00	.0500	1.697	2800	1.885	.0235	.800
1350	3.911	.0488	1.659	2870	1.84	.0230	.780
1400	3.77	.0471	1.600	2900	1.820	.0227	.772
1440	3.66	.0458	1.555	3000	1.760	.0220	.746
1450	3.641	.0455	1.544	3200	1.650	.0206	.700
1500	3.52	.0440	1.493	3400	1.553	.0194	.658
1508.57	3.50	.0437	1.485	3520	1.500	.0187	.636
1520	3.47	.0433	1.473	3600	1.466	.0183	.622
1550	3.406	.0425	1.445	3800	1.390	.0173	.589
1600	3.30	.0412	1.400	4000	1.320	.0165	.560
1620	3.26	.0407	1.382	4285	1.232	.0154	.522
1650	3.20	.0400	1.357	4500	1.173	.0146	.497
1700	3.106	.0388	1.317	5000	1.056	.0132	.448
1730	3.052	.0381	1.294	5280	1.000	.0125	.424
1750	3.017	.0377	1.280				

EXPLANATION

OF THE

USE OF THE TABLES OF GRADIENTS.

The first column gives the ratio of the horizontal length to an unit of vertical height, as when in column 1 we find 160, it signifies that the gradient indicated has one foot vertical rise to 160 feet horizontal length, commonly written "inclination 1 in 160." The second column gives the number of feet of vertical rise per mile due to the inclination indicated in column 1. The third column gives the number of feet of vertical rise per chain due to the same inclination. The fourth column gives the number of pounds avoirdupois required to be exerted by an engine to overcome the gravitation of one ton weight, to be moved upwards along the same inclination.

To calculate the rise or fall of gradients, multiply the tabular number corresponding to the required character opposite to the given inclination by the length, and the product will give the total rise in feet. Example—Gradient 1 in 160, length 125 chains. Opposite 160 we find .4125; and $.4125 \times 125 = 51.56$ feet vertical rise.

It is hardly necessary to observe that these tables admit of being applicable to gradients not contained therein, by applying any required multiple—as 2, 3, 4, 5, &c., or $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, &c.—to some gradients included in the table. For instance, the rise due to 1 in 19 may be found by doubling that of 1 in 38, and the rise due to 1 in 4650 may be found by dividing that due to 465 by 10, or that of 155 by 30, &c.

While plotting a series of gradients, I should suggest the following form of arranging them, as rendering the calculations easier to be checked and to be referred to:—

LIST OF GRADIENTS,

commencing at a point elevated (50) feet above the datum line:—

Inclination.	Describe whether rise or fall	Length.		Total length from terminus.		Vert. rise	Vert. fall.	Reduced level above datum.
		ms.	chns.	miles.	chns.	feet.	feet.	feet.
1 in 160	rise		40		40	16.50	——	66.50
252	fall		32		72	——	8.38	58.12
490	fall		70	1	62	——	9.42	48.70
Level	level		45	2	27	——	——	48.70
132	rise		62	3	9	31.00	——	79.70
464	rise		18	3	27	2.56	——	82.26
920	fall	1	11	4	38	——	6.52	75.74
100	fall		28	4	66	——	1.85	73.89
264	rise		46	5	32	11.50	——	85.39
Proof of Length		5	32			61.56	26.17	
						26.17		
Effective rise - -						35.39		
Add terminus above datum—						50.00		
Proof of Height - -						85.39		

By computing the gradients from the total lengths, they will be made to agree with the mileage. I recommend that the gradients be estimated in feet and decimals, and not in feet and inches, the decimal method being more accurate.

The use of the fourth column in the table may be thus described—

Suppose that it were required to know the gravitating influence of any incline on a railway—for example, on an incline of 1 in 160; then in column four, opposite 160, we find 14lbs. per ton; and if the load to be drawn (including the engine and tender) be 100 tons, then $100 \times 14 = 1400$lbs. would represent the resistance to motion upwards, and also it would represent the force assisting the train to *descend* the same gradient. It is manifest that the forces up and down are in equilibrium; therefore any given incline will not, by itself, be a sufficient datum to find the preponderating influence of the whole series of inclines. By the term *preponderance* I wish to express "the excess of force due to gravity alone, with which the load drawn resists the tractive power, in one direction, over that force which is similarly exerted in the opposite direction." As the *resistance*, due to gravity, on an *ascending* gradient, is measured by the height through which the load is raised; and as the *propelling force*, due to gravity, on a *descending* gradient, is measured by the height through which the load is lowered; it follows, that part of the force *expended* to raise the load will be *restored* by the self-propelling influence of gravity, when the load shall begin to descend. If the descent is *greater* than the ascent, there will be a surplus of gravitating power, or the "preponderance" will be active in the *opposite direction* to the given motion; but if the descent is *less* than the ascent, there will remain a portion of the tractive force unbalanced, or the "preponderance" will be active in the *given direction*; and, in either case, its retarding action is always due to the *difference* of the ascent and descent. Therefore, in a series of inclines, some rising and some falling, the effect in any given direction will be proportional to the difference of the sum of all the ascents and the sum of all the descents in that direction; therefore if it were required to know the preponderance of the series of gradients given in the preceding form, it will be necessary to multiply the corresponding tabular number found in the fourth column by the length, and setting the ascents in one result, and the descents in another, and dividing their difference by the total length, the result will give the preponderance in pounds per ton in favour of that series of gradients whose sum is greatest. The following form is adapted for the purpose:—

Inclination.	Describe whether rise or fall.	Length. chains.	Gravity of one ton in lbs.	Product of rises.	Product of falls.
1 in 160	rise	40	14.00	560.	——
252	fall	32	8.89	——	284.48
490	fall	70	4.57	——	319.90
Level	level	45	——	——	——
132	rise	62	16.97	1052.14	——
464	rise	18	4.83	86.94	——
920	fall	91	2.43	——	221.13
100	fall	28	22.40	——	62.72
264	rise	46	8.48	390.08	——
		432		2089.16	888.23
				888.23	

Divide by the Length - 432)1200.93

Preponderance due to the rises in pounds=2.78.

The same result may be obtained in a less complex manner, but the above form gives the ratios each separate length of gradient bear, when compared with the whole length; for instance, $\frac{560}{432} = 1.296$ is the preponderance in pounds per ton due to the rise of 1 in 160; that is, if 1 in 160 were the only gradient, and the rest of the line were a level, then 1.296lbs. per ton represents the excess of power required over the whole line, though for the length of the gradient only = 40 chains, the actual gravitation is 14lbs. per ton; and the sum of all these individual preponderances due to the rises, *less* the sum of those due to the falls, will give a total of 2.78lbs. per ton required in the given direction to overcome the general influence of gravitation. When the train returns along the same series of gradients, the preponderance is in favour of the motion—that is, assists it; because the rises become falls and the falls rises. Hence the excess of power required in *the one* direction, *compared* with that required in *the other,* will be $2.78 \times 2 = 5.56$lbs. per ton. In order to compute the total excess at once *without reference* to the intermediate gradients, it is sufficient to know the effective rise between one terminus and the other, and the total length. Let H be the effective rise in feet, and let L be the total length in *chains;* then the rule for the excess is $\frac{67.86 \text{ H}}{\text{L}}$; and taking, for example, the preceding data, we have $\text{H} = 35.39$ and $\text{L} = 432$. The excess in this case, therefore, is $\frac{35.39 \times 67.86}{432} = 5.55$lbs. per ton, the same as above. If the length is given in *miles,* the rule for the excess becomes $\frac{.848 \text{ H}}{\text{L}}$, and the above example will work out $\frac{.848 \times 35.39}{5.4} = 5.55$lbs. per ton.

For the convenience of those who prefer a literal, instead of an algebraical rule, I subjoin the following:—

Rule, *to find the excess of power required per ton in one direction, compared with that required in the other*—

1st. When the "effective rise" in feet, and the "total length" in *chains* are given—

Multiply the rise by 67.86, and divide the product by the length: the quotient is the required "excess" in pounds per ton.

2nd. When the "effective rise" in feet, and the "total length" in *miles* are given—

Multiply the rule by 0.848, and divide the product by the length: the quotient is the required "excess" in pounds per ton.

ESSAY

ON THE POWER REQUIRED TO OVERCOME THE RESISTANCE ON INCLINED PLANES.

As the Table of Gradients above described is not sufficient to enable an estimate to be formed of the total power required to put in motion a given weight of train with a given velocity, it is to approximate this object that the following few pages are devoted.

The ordinary resistance to which a train is subjected during motion may be separated into three kinds:

1stly. The resistance due to the friction of the carriages and of their load.

2ndly. The resistance due to the air acting on the surfaces of the carriages.

3rdly. The resistance due to the gradient.

I.—*Of the Friction.*

Experience has determined that, for all carriages constructed on the same principle and with the same dimensions of bearings, gauge of rails, and general construction of parts, the friction is a constant quantity for all velocities, and is expressed by a certain proportion of the weight drawn. Therefore, if the symbol f denote this constant proportion, and W the weight drawn, we have fW expressing the total friction of the train. For example—If one carriage with its load weighs 6 tons, and there are 10 carriages, and if the proportion which has been ascertained by experiment is taken at 7lbs. per ton, then $(f=7) \times (W=6\times10) = 420$ lbs., which indicates the resistance due to friction. But, in estimating the frictiobe overcome, besides the carriages, the engine in front, being of a different construction, should be taken into consideration. Some experiments have shewn that the friction of an 11-inch cylinder engine whose weight is about 8 tons, when running on 4 wheels, is about 13 lbs. per ton; and a 14-inch cylinder engine on 6 wheels, the weight being about 11 tons, offers a resistance by friction of 16 lbs. per ton. Supposing that an engine of the first description were used, it would be proper to add to the preceding calculation $8 \times 13 = 104$ lbs., making a total of $420 + 104 = 524$ lbs.; and if a 6-wheel engine were used, as above described, $11 \times 16 = 176$ lbs. must be added, making a total of $420 + 176 = 596$ lbs.: the engine tender is here supposed to be one of the carriages. But the above allowance for engines must necessarily vary with their construction and weight.

In general, for approximation, 4 carriages may be added for a 4-wheeled engine and tender, and 6 carriages for a 6-wheeled engine and tender, and the gross weight of each carriage (of the passenger class) may be taken at 5 tons; but this approximation must be understood to refer only to a railway laid down with a 4 feet $8\frac{1}{2}$ inches, or 5 feet gauge.

Hence, if n expresses the number of carriages actually containing passengers or goods, the total resisting load for a 4-wheeled engine is $5\ (n + 4)$ tons, and the friction will be $(f = 7) \times (W = 5\ n + 20)$ in pounds.

II.—*Of the Resistance of the Air.*

The resistance due to the medium through which the train passes is divided into two parts—one being that due to the direct or perpendicular surface exposed to the medium in the direction of the motion; and the other is due to the lateral action of the particles of air on the sides, top, and bottom of the carriages.

First—To treat of the direct surface.

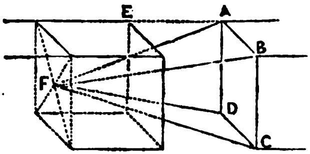
This is measured by the actual transverse area of the railway carriages, with their wheels, springs, and framework, such as would be represented on a geometric plane, which is commonly called by draughtsmen a "transverse elevation" of the object. This area, then, is part of the direct surface exposed. Another portion is computed by supposing that the extreme mobility of the air enables it to intersect and oppose itself to all the various openings, corners, and parts not represented by the "transverse elevation," but which by their situation would be so if a section were made so as to expose them in front; instead of which, the air has access to them by tortuous and indirect channels. With these parts must be included the front surface of every succeeding carriage to the first, as there is a large space between two carriages which very freely permits the air to act on each carriage in succession. From the immense variety of the dimensions and position of the parts, it is quite impossible to arrive at any thing more than an approximate measure of the surface; but if this be chosen with discretion, the error will not materially affect the accuracy of the estimate.

Having ascertained the surface, the nature of the resistance is next to be considered. The motion of trains through the air is so very variously influenced by the state of the medium, in regard to its barometric and thermometric condition, and also in regard to the direction and force of the wind at the time, which again is varied by the winding course of the railway, that it is also on this account impracticable to give a true solution to this problem. Therefore, in order to fix a standard to which these calculations shall refer, let it be assumed that the air has a constant barometric pressure of 30 inches, or 14.706 lbs. per square inch nearly. The temperature is to be 60° Fahrenheit, and the air to be quite calm or at rest. Then the resistance of the air will be measured by the same force which the air itself would exert against a given surface if moving against it with the given velocity. Moreover, since both theory and practice have established that the resistance of air in motion varies as the square of the velocity directly, we derive the resistance offered to the carriages when we know the resistance due to some given velocity. Thus, if F is a given velocity, and A is the resistance due to it for a square foot of surface, and V is any other velocity, then, as $F^2 : A : : V^2 : \frac{AV^2}{F^2} = a\,V^2 =$ the resistance for any velocity when $a = \frac{A}{F^2}$.

With regard to the total surface of the train in direct opposition to the air; let S represent the transverse area, and include in this some allowance for the surfaces of various parts indirectly exposed to the air. Also let Z represent the front surface of each succeeding carriage besides the first. This expression Z will be less than the transverse area (S) by a quantity due to the obliquity of direction of the impinging particles on the plane of the carriage. This obliquity will depend on the variation of distance between the carriages, and of their breadth according to their construction. The following investigation is suggested as a means of arriving at some definite proportion of the whole to the effective surface.

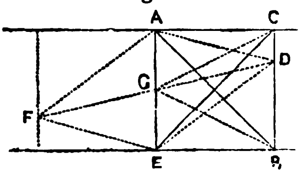
In Fig. 1, let ABCD be the surface of the back, and let there be another in front of it of equal transverse; and also let AE be the distance between them.

Fig. 1.



By first considering the action upon a simple plane only in the direction of the motion. In Fig. 2, the line AB shews the extreme limit of the action of the uninterrupted column of air rushing in from the opening AC; and the line A C shews the other limit for the same opening: also each of these lines may respectively represent the full force of the

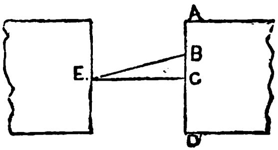
Fig 2.



air. Any intermediate line (AD) represents the force of the air from one side at the point D. In like manner EC ED EB represent the force of the air upon the points C, D, B, from the other side EB; therefore, the full action on any point (D) is the joint action of the forces AD ED, and by completing the parallelogram AFED the line FD represents the force acting on the point D. But because AFED is a parallelogram, AE is bisected in G by the diagonal FD, therefore the force on D is twice GD, and also GC, GB, represent half the forces on C and B, and generally the whole effect of the air on the surface CB will be twice the sum of all the forces GD. Hence, in Fig. 1, if f is a centre point in the body of a carriage adjoining the surface ABCD, the bundle of forces directed against ABCD will be contained in the pyramid FABCD, whose vertical axis is 2 AE.

In Fig 3, let $\frac{1}{2}$ AD = AC = b, let EC = a, and BC = x, the force EB is $f = \sqrt{a^2 + x^2}$. But by reducing any force (EB) to its respective horizontal and vertical forces, the intensity of this force is diminished in the ratio of the 4th power of the

Fig. 3.



cosine of the impinging angle; therefore, at any point (B), the radius being EB = $\sqrt{a^2 + x^2}$, and the cosine EC = a, the force $\sqrt{a^2 + x^2}$ becomes $\frac{a^4}{(\sqrt{a^2 + x^2})^{\frac{3}{2}}}$.

The mean radius is EB $= \frac{a + 2\sqrt{a^2 + b^2}}{3}$ nearly, therefore the effective mean force becomes for the whole surface $\frac{20.784\, a^4}{(a + 2\sqrt{a^2 + b^2})^3}$ and by putting $b = na$, and calling $a = 1$, the whole effect will be for each foot of surface $\frac{20{,}784}{(1 + 2\sqrt{1 + n^2})^3}$

The rule I have adopted in computing the effective surface is $\frac{20}{(1 + 2\sqrt{1+n^2})}\, s$ when n is equal to the full breadth divided by twice the intermediate space; and computing the proportions due to the above rule, we have—

$$\text{When } n = \left\{\begin{array}{lcc} 1 & \text{the effective surface is} & \frac{6}{10} \\ \frac{7}{8} & \text{''} & \frac{5}{9} \\ \frac{3}{4} & \text{''} & \frac{5}{10} \\ \frac{5}{8} & \text{''} & \frac{4}{9} \\ \frac{1}{2} & \text{''} & \frac{7}{20} \end{array}\right\} \text{of the whole.}$$

Assuming the third proportion to be nearest to the practice in construction, and adopting this figure in the estimate, the expression Z becomes $S \times \frac{1}{2}$, and for all the carriages less the first $\frac{s(n-1)}{2}$ expresses their resisting surface; and adding the engine and tender, which also receive a share of the direct action of the air, the total resistance is found in the formula $\frac{s(n+3)}{2} \times a V^2$.

It now remains to give some expression for the lateral resistance of the air. Let K represent the actual measurement of a railway carriage, such as would be represented on a drawing denominated a "longitudinal elevation" of the object, and to this surface add some allowance for those parts which are likewise indirectly exposed to lateral action. For all trains in motion there must necessarily be a current of air directed against the sides of the carriages, caused by the eddying motion given to the air displaced in front by the forward motion, which then acts along the sides of the carriages in its endeavours to reinstate itself. This action of the air cannot be accurately appreciated; yet some account should be taken of it, as, however trifling it may appear, the surface exposed to it is very great, varying, in trains of 10 or 15 carriages, from 5,000 to 10,000 square feet. Then let l represent the resistance due to one square foot. l K $(n + 2)$ is the whole lateral resistance; and the whole resistance lateral and direct is expressed by $\left[\frac{s\,(n + 3)\,a}{2} + \mathrm{K}\,l\,(n + 2)\right] \times \mathrm{V}^2$, and making

$$\mathrm{Q} = \frac{s\,(n + 3)\,a}{2} + \mathrm{K}\,l\,(n + 2) \text{ it becomes } \mathrm{QV}^2.$$

It will be proper now to give some value to the coefficients a and l. The first is found by the well known laws of pneumatics. The height of the uniform atmosphere which surrounds the earth is computed to be, on an average, 26,400 feet. Eight times the square root of this height will give the velocity with which the air will rush into a vacuum, therefore $8\ \sqrt{26400} = 1300$ feet per second. This velocity is due to a pressure of 14.71 lbs. per square inch, or 2118 lbs. per square foot of surface. Hence the pressure on a square foot with any other velocity may be found, because the pressures vary as the squares of the velocities. $\frac{1300 \times 15}{22}$ = velocity of airin vacuo in miles per hour. Now as $\frac{1300^2 \times 15^2}{22^2} : 2118 :: \mathrm{V}^2 : \frac{\mathrm{V}^2}{370}$ = resistance due to any velocity V. Hence $a = \frac{1}{370}$

By some observations I made in a train moving at the rate of 30 miles per hour, the air being quite calm at the time, I found that the current against the carriages was acting at an angle of 9 or 9½ degrees nearly, and computing the force (which varies as the square of the sine of the angle) we have this proportion—

As $\frac{\mathrm{V}^2}{370} : 1 :: x : \left\{ \begin{matrix} \text{sine}^2 9 \\ \text{sine}^2 9\frac{1}{2} \end{matrix} \right\}$ or $x = \frac{\mathrm{V}^2}{14400}$, hence $l = \frac{1}{14400}$.

Moreover, this quantity l will vary with the velocity; for the disturbing force producing the current varies with the velocity, and therefore the angle varies. Therefore, since the cause which produces this angle varies as the square of the velocity, we have this proportion to find the true value of l. Since the angle given is known to be due to thirty miles per hour velocity, then as $30^2 = 900 : \frac{1}{14400} :: V^2 : \frac{V^2}{12,960,000} = l$. The lateral current of air does not act on the entire lateral surface of the train, because the air, after acting on the front surfaces of the carriages, is repelled therefrom, and, escaping laterally, passes along the carriages in continuous eddies, thereby neutralising part of the effect of the currents directed against them. No accurate measure can be given of the effect produced; it depends partly on the proportion between the lengths of the carriages and the intermediate spaces. If we assume that the current begins to act upon the carriages after the train has traversed a space equal to twice the intermediate distance, and if the length of the carriages are taken at a medium to be three times this distance, then the side surface effectively exposed to the lateral current will not be more than one-third of the whole. I therefore, in default of better data, assume this proportion; and, by substituting these values of a and l, in the equation of Q, we have $Q = \frac{s\,(n+3)}{2} \times \frac{1}{370} + \frac{K(n+2)}{3} \times \frac{V^2}{12,960,000}$.

For convenience of calculation, the values of S, K, n, should be determined, so that every thing relating to an estimate of power may refer to a standard. According to the existing practice in the construction of carriages, I estimate the value of S to be 80 square feet, including the allowances for indirect action. The value of K also I take at 600 square feet, with similar allowances. With regard to n, I assume as a standard 100 tons weight drawn, including engine and tender; and supposing these last together weigh 20 tons, the remaining 80 tons divided by five (the average tonnage per carriage) will give 16 carriages, or $n = 16$.

Substituting these values in the equation of Q, we have $Q = \frac{80\,(16+3)}{2 \times 370} + \frac{600 \times (16+2)\,V^2}{38,880,000} = 2.054 + \frac{V^2}{3600}$. Hence the second item of the resistance to motion is

$$QV^2 = 2.054\,V^2 + \frac{V^4}{3600}.$$

To facilitate the application of the preceding rules to practical cases, I subjoin a table which will embrace all the different values of S, K, and V, and the variable proportion (indicated by the symbol x) of distance between the back carriages. The general rule for the resistance of the air is $QV^2 = \frac{SV^2}{370}\,[(n+1)\,x + 1] + \frac{KV^4}{38,880,000}\,(n+2)$ in pounds avoirdupois.

(S) TABLE OF FRONT SURFACES. (S)

Velocity	30 Sqr. ft.	40 Sqr. ft	50 Sqr. ft.	60 Sqr. ft	70 Sqr. ft.	80 Sqr. ft.	90 Sqr. ft.	100 Sqr. ft.
10	8.11	10.81	13.51	16.22	18.92	21.62	24.32	27.03
12	11.67	153.57	19.46	23.35	27.24	31.13	35.03	38.92
14	15.62	21.19	26.49	31.24	37.08	42.38	47.67	52.97
16	20.76	27.67	34.59	41.51	48.43	55.35	62.27	69.19
18	26.27	35.03	43.78	52.54	61.30	70.05	78.81	87.57
20	32.43	43.24	54.05	64.86	75.67	86.48	97.30	108.11
22	39.24	52.32	65.40	78.49	91.57	104.65	117.73	130.81
24	46.70	62.27	77.84	93.40	108.97	124.54	140.11	155.68
26	54.81	73.08	91.35	109.62	127.89	146.16	164.43	182.70
28	62.48	84.75	105.94	124.97	148.32	169.51	190.70	211.89
30	72.97	97.30	121.62	145.94	170.26	194.59	218.91	243.24
32	83.02	110.70	138.37	166.05	193.73	221.40	249.08	276.75
34	93.73	124.97	156.21	187.45	218.70	249.94	281.18	312.43
36	105.08	140.11	175.13	210.16	245.19	280.22	315.24	350.31
38	117.08	156.11	195.13	234.16	273.19	312.22	351.24	390.26
40	129.73	172.97	216.21	259.45	302.70	345.94	389.18	432.43

(K) TABLE OF SIDE SURFACES. (K)

Velocity.	350 Sqr.ft.	400 Sq. ft.	450 Sq. ft.	500 Sq. ft.	550 Sq. ft.	600 Sq. ft.	650 Sq. ft.	700 Sq. ft.	750 Sq. ft.	800 Sq. ft.
10	.09	.10	.12	.13	.14	.15	.16	.18	.19	.21
12	.18	.21	.24	·27	.29	.32	.34	.37	.40	.42
14	.35	.39	.44	.49	.54	.59	.64	.69	.74	.79
16	.59	.67	.75	.84	.92	1.01	1.09	1.18	1.26	1.34
18	.95	1.08	1.22	1.35	1.48	1.62	1.75	1.89	2.02	2.16
20	1.44	1.64	1.85	2.05	2.26	2.46	2.67	2.88	3.08	3.29
22	2.11	2.41	2.71	3.01	3.31	3.61	3.91	4.22	4.52	4.82
24	2.99	3.41	3.84	4.27	4.69	5.12	5.54	5.97	6.40	6.82
26	4.11	4.70	5.29	5.87	6.46	7.05	7.64	8.22	8.82	9.40
28	5.53	6.32	7.11	7.90	8.69	9.48	10.27	11.06	11.86	12.64
30	7.29	8.33	9.37	10.41	11.46	12.50	13.56	14.60	15.62	16.66
32	9.44	10.75	12.13	13.48	14.83	16.18	17.53	18.87	20.22	21.57
34	12.02	13.75	15.47	17.18	18.90	20.62	22.34	24.06	25.44	27.49
36	15.12	17.28	19.44	21.60	23.76	25.92	28.08	30.24	32.40	34.56
38	18.77	21.45	24.13	26.82	29.49	32.17	34.86	37.54	40.22	42.90
40	23.06	26.35	29.65	32.94	36.24	39.53	42.83	46.13	49.42	52.71

(N) Table of Number of Carriages (exclusive of Engine and Tender). (N)

Ratio of brdth. to in.space.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Ratio of brdth. to in.space.
1	2.2	2.8	3.4	4.0	4.6	5.2	5.8	6.4	7.0	7.6	8.2	8.8	9.4	10.0	10.6	11.2	11.8	12.4	13.0	13.6	1
7/8	2.1	2.6	3.2	3.8	4.3	4.9	5.4	6.0	6.5	7.1	7.6	8.2	8.8	9.3	9.9	10.4	11.0	11.5	12.1	12.6	7/8
3/4	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	3/4
5/8	1.9	2.3	2.8	3.2	3.6	4.1	4.5	5.0	5.4	5.9	6.3	6.8	7.2	7.6	8.1	8.5	9.0	9.4	9.9	10.3	5/8
1/2	1.7	2.0	2.4	2.7	3.1	3.4	3.8	4.1	4.5	4.8	5.2	5.5	5.9	6.2	6.6	6.9	7.3	7.6	8.0	8.3	1/2

To estimate the resistance of the air by the tables, when the number of carriages (n) is given, exclusive of engine and tender, let the formula become $QV^2 = SN + K(n+2)$. Look in table S for the number corresponding to the given velocity and front surface, and in table N for the number corresponding to the number of carriages (n), and to the given proportion of the intermediate space to the breadth of the carriage (x), and multiply the tabular numbers found together; and to this product add the product of $n + 2$, and of the tabular number in Table K corresponding to the given velocity, and the side surface of each carriage. This sum will give the resistance required. To illustrate this by an example—

Let $v = 24$ miles per hour.
" $s = 70$ feet front surface.
" $n = 12$ carriages.
" $k = 600$ feet side surface.
" x = half the breadth = intermediate space.

In Table S,	
Opposite 24, and under 70, we find - -	108.97
In Table N,	
Opposite $\frac{1}{2}$, and under 12, we find - -	5.5
The product of these numbers is - -	599.33
In Table K,	
Opposite 24 and under 600, we find - -	5.12
and $n + 2 = 12 + 2 =$ - - - -	14
The product of these numbers is -	71.68
And the sum of $599.33 + 71.68 =$ - -	671.01

is the resistance sought in pounds.

III.—*Of the Gradient.*

The force exerted by a body on an inclined plane is to the weight of the body as the height of the plane is to its length; and this force tends to cause the body to descend the plane. But if the motion of the train is up the incline, then the force acts in resistance to this motion; and if the motion is down the incline, then it acts as an assistant to the propelling force applied to overcome friction and atmospheric resistance. Therefore, this term of the equation of total resistance is expressed $+ \frac{W}{g}$ or $- \frac{W}{g}$ when g is the ratio of the length of the incline to its height, the term + being used on ascending, and the term — on descending inclines.

Summary of the Resistance.

From the foregoing investigation, it appears that the total resistance to be overcome, to move 100 tons along with some velocity (V), along any gradient (g) is expressed by the formula, in pounds $= 700 + 2.054\ V^2 + \frac{V^4}{3600} \pm \frac{224,000}{g}$. And the general rule is $(5\,n + 20)\,f + \frac{s\,(n+3)\,V^2}{740} + \frac{K\,(n+2)\,V^4}{38,880,000} \pm \frac{2240\ W}{g}$ in pounds. Also, the equivalent for n in the terms of W, may be inserted. Let g express the number found in the 4th column of the table of gradients, instead of $\frac{2240}{g}$, and inserting the previous values of (s) and (K), it becomes $Wf \pm Wg + \frac{(W-5)\,V^2}{46.25} + \frac{(W-10)\,V^4}{324,000}$, or $W(f \pm g + \frac{V^2}{46.25} + \frac{V^4}{324,000}) - \frac{V^2}{9.25} - \frac{V^4}{32,400}$; and if the velocity were assumed to be at an average of 30 miles per hour, and the friction at 7lbs. per ton, the rule becomes W $(29 \pm g)$ — 122. If the weight were 100 tons, the resistance in pounds becomes $2900 \pm 100g$. Therefore, the number 2900 expresses the resistance in pounds of 100 tons moving along a level plane at the velocity of 30 miles per hour, which gives 29 lbs. per ton, or is equivalent to the gravity of an incline of one in $77\frac{1}{4}$. Any incline, therefore, whose descent is not in a less ratio than this, will not cause the train to accelerate its velocity (being already 30 miles per hour) by gravitation.

Relation of the Power required to the Resistance.

I will conclude this essay by shewing briefly the relation existing between the resistance of the load and the power of the engines required to draw it along. I resume the data upon which the resistance was formerly computed, and which are recapitulated as follows:—

Friction of each carriage, 7lbs. per ton.

Carriages weigh each, 5 tons.

Engine and tender computed as 4 carriages.

Weight drawn (including engine and tender weighing 20 tons) 100 tons.

Front surface of each carriage (with allowance for concealed surface) 80 square feet.

Side surface of each carriage (with allowance for concealed surfaces), 600 square feet.

Space between carriages, three-quarters the breadth of a carriage.

Velocity of motion, 30 miles per hour.

The rule for resistance due to the above data is $2900 \pm 100\,g$ in lbs.

To draw a train along a railway, the power of traction depends upon the adhesion of the driving wheels to the rails. This adhesion, therefore, independently of the inclines, must equal 2900lbs.

But in estimating the power, it is necessary to take the most extreme cases which may occur on the railway, that the engine may surmount with its load the steepest inclines. In the more recent practice of engineers, the inclination 1 in 200 is not unfrequently adopted as the standard gradient, and to this I will confine myself, as, when inclines are much steeper, the speed is practically considerably reduced below 30 miles per hour. On referring to the table of gradients, opposite 1 in 200, column 4th, we find 11.20 lbs. per ton, which gives $11.2 \times 100 = 1120$ lbs. for the resistance due to the gradient. Therefore, adding together $2900 + 1120 = 4020$ lbs. adhesion required to enable the engine to draw the load at the given speed. The adhesion varies very much, owing partly to the liability of the wheels to slip or skid on greasy rails, partly to casual imperfections in the rails or machinery, and partly to inappreciable obstructions, oscillations, and irregularities of motion. It will also vary owing to the different manner in which the weight of the engine is supported on the wheels, either by the driving wheels being coupled or uncoupled, or by there being six wheels to carry the weight; also, the diameters of the wheels being different cause great variation in the adhesion; and also, by varying the construction of the engine, the weight imposed on the driving wheels may vary from $\frac{1}{4}$ to $\frac{3}{4}$ of the whole. A combination of the above causes produces great uncertainty, to avoid which I have fixed as a standard, that the adhesion, under the least favourable circumstances, of an engine weighing 12 tons, whose weight on the driving wheels is 8 tons (being two-thirds of the whole) is one-sixteenth part of the weight of the engine when the driving wheel is 5 feet 6 inches in diameter, and this proportion will vary inversely as the diameter of the wheel. Supposing that such engines are used, then the adhesion of *one engine* is $\frac{12 \times 2240}{16} = 1680$ lbs.; and in order to enable a train opposing a resistance of 4020 lbs. to be moved at 30 miles per hour along an incline of 1 in 200, three engines would be required at least.

Pursuing the investigation to ascertain the commercial expenditure resulting from the use of the engines to draw the load as before given, I have considered that the best measure of the effect would be the cubic feet of water vaporized under a given pressure in an hour, in preference to computing the horses-power, or the lbs. raised 1 foot high. By knowing the performance of the boiler as to the supply of steam, we can find the real effect produced by an engine, when the resistance due to the given uniform *maximum* velocity is determined.

The quantity of fuel which will cause the vaporization of a cubic foot of water, multiplied by the total vaporization will give the required commercial effect. I will suppose the case of an engine with a 12-inch diameter of cylinder (whose area is a inches); stroke of the piston 1 foot 6 inches (the length being l in feet); the driving wheel being 5 feet 6 inches (indicated by the symbol D in feet); the speed as before being 30 miles per hour (or V miles). Then the general expression for the quantity of steam used by the two cylinders in one hour, allowing for the waste in the passages, &c., $\frac{4.4\,la}{144} \times \frac{5280 \times 7\,V}{22\,D} = \frac{51.33\,la\,V}{D}$

The relative volume of steam at 60 lbs. per square inch, compared with the water generating it, is 380 : 1; therefore $\frac{51.33}{380} \times \frac{la\,V}{D} = .135\,\frac{la\,V}{D}$ = cubic feet of water vaporized per hour. Then substituting the values of laV and D, we have 124.8 cubic feet of water required per hour for one engine, supposing it was fully employed. The actual power transferred from the cylinder to the circumference of the wheel at the point of contact with the rail is measured by the pressure on the piston, reduced in the ratio of the length of the stroke to the diameter of the wheel.

Let (p) represent the pressure (60 lbs. on the inch), and let the previous notation be used, then the general expression of the power is $\frac{pal}{D}$ for one cylinder only. The ratio between the greatest effect of one crank, and the mean effect of two acting simultaneously at right angles to each other, is nearly as 10 to 16; and adopting this proportion, we have $1.6 \times \frac{pal}{D}$ = power of two cylinders. Hence, substituting the values of $p\,a\,l$ and D, we have 2960 lbs. nearly for the power of one engine; and the power of the three engines necessary for adhesion will be 2960 × 3 = 8880 lbs., being 4860 lbs. in excess of the resistance. This excess will be partly taken away by the additional friction of two extra engines and tenders, and the corresponding indirect front and lateral atmospheric resistance, and the gravity of 40 tons extra on an incline of 1 in 200. This extra resistance will not exceed 800 lbs., and the whole resistance will be 4020 + 800 = 4820 lbs; therefore, the power which can be obtained is more than that which is required in the proportion of 8880 : 4820 :: 1.84 : 1.

To reduce this supply to the demand, we may reduce the vaporization of 124.8 cubic feet in each boiler by 1.84, and then we have $\frac{124.8 \times 3}{1.84} = 203.4$ cubic feet to be actually converted into high pressure steam.

The above computation refers only to the case of an ascending gradient; but, of course, it is proper to estimate the case of a descending gradient, to obtain a true mean value of the effect. Therefore, supposing that the same weight is returned along the railway, we have 2900 — 1120 = 1780 lbs. for the resistance. One engine alone is nearly equal to the duty as regards adhesion, which is 1680 lbs.; but it is better to use two to be certain of the duty required, owing to the variation to which the adhesion is liable. The power of one engine being 2960 lbs., two engines would exert 5920 lbs., from which suppose 400 lbs. to be deducted for the resistance to the extra engine, 5520 is the effective power which can be exerted, bearing a proportion to the resistance of 3 to 1 nearly. Hence, if the steam is generated at the full pressure of 60 lbs., and is allowed to expand to 19.3 lbs. pressure in the cylinders, only $\frac{1}{3.1}$ of the full complement of water is necessary; that is, instead of requiring 124.8 × 2 = 249.6 cubic feet, $\frac{249.6}{3.1} = 80.5$ cubic feet are sufficient. Therefore, to go and return a journey of 30 miles in one hour, 203.4 + 80.5 = 283.9 cubic feet of water are required; and reducing this quantity to simple terms, we have an average of $\frac{283.9}{30} = 9.46$ cubic feet of water required per mile for 100 tons load, when travelling 30 miles per hour, on gradients whose constant ascent and descent are 1 in 200. This estimate is not exactly applicable to a level line, though the aggregate resistance in both cases is nearly the same, the difference in favour of the level being due to the resistance of the extra engine. For on the inclined railway we have the resistance $4020 + 800 + 1780 + 400 = 7000$; on the level we have the resistance $2900 + 400 + 2900 + 400 = 6600$, being 400 in favour of the level, equal to the resistance of one extra engine. On a level, the resistance being 2900, two engines are necessary; and the effective power being 5520, the proportion of power to the resistance is 1.9 to 1 nearly. Hence, the steam can be allowed to expand from 60 lbs. to 31.6 lbs. in the cylinder, and quantity of water required to be vaporized is $\frac{124.8 \times 2}{1.9} =$ 262.8 cubic feet, that is 8.76 cubic feet per mile, shewing .7 of a cubic foot in favour of the level.

It now only remains to shew what duty one engine may be put to; the gradient, velocity, and other proportions being the same as before.

As the adhesion is the limit of the power, and consequently is the measure of the resistance the engine is capable of, it follows that 1680 lbs. is all that is required to be exerted by the cylinders. Hence, the resistance will bear a proportion to the whole power the engine can exert (= 2960 lbs.) of $1 : 1.76$ nearly; therefore, expanding the steam from 60 to 34 lbs. in the cylinders, the vaporization of $\frac{124.8}{1.76} = 70.9$ cubic feet of water is the limit of effect required. Also we have this equation of the power required given in terms of the number of carriages drawn $(f = 7) \times (5n + 20) + \left(\frac{s\,V^2}{370} = 194.59\right) \times \left(\frac{n+3}{2}\right)$

$$+\left(\frac{K\,V^4}{38{,}880{,}000}=12.5\right)\times(n+2)\pm(g=11.2)\times(5n+20)$$

$= 1680$, and reducing this equation $n = \dfrac{1223.12 \mp 224}{144.79 \mp 56}$. This will give 16 carriages, equal to $16 \times 5 + 20 = 100$ tons descending, and 5 carriages, equal to $5 \times 5 + 20 = 45$ tons ascending; also, we deduce that the engine can draw eight carriages $= 8 \times 5 + 20 = 60$ tons on a level.

For the convenience of those who wish to calculate the vaporization required with pressures in the boiler different from the assumed standard of 60 lbs., I subjoin the following table of relative volumes of the steam compared with the water generating it:—

Pressure per square inch above atmosphere.	Relative Volume of Steam, that of water being 1.	Water vaporized per hour at maximum. power of Engine.	Maximum power of one engine, at the point of contact with the rail.
		cubic feet.	lbs.
70	340	139.6	3453
65	359	132.2	3206
60	381	124.5	2960
55	406	116.9	2713
50	434	109.3	2466
45	467	101.6	2220
40	506	93.8	1973
35	552	86.0	1727

From the above table it is easy to determine any modification of the preceding calculations the reader may think fit to make.

It is necessary to state here, in concluding this portion of the essay, that so much does the capability of an engine to draw a load depend upon the state of the rails, that the preceding estimate of adhesion = 1680 lbs. may be considered as very low; indeed, experiments and observations have been made, showing that the adhesion varies from $\frac{1}{5}$th to $\frac{1}{24}$th of the weight on the driving wheels; this great variation being consequent upon the temporary circumstances of weather, cleanliness, and state of repair of the metals; so that, since the preceding calculations are founded upon the *lowest datum*, the capability of an engine may possibly be increased two or three times that which is indicated by the results I have given. It appears that the cylinders are capable of exerting a power equal to 2960 lbs. with steam of 60 lbs. pressure; therefore, in ordinary circumstances, the adhesion may be estimated as equal to this power. This will give an increase of effect produced much above the calculated effect; for, by estimating the term 1223.12, in the equation of n, to be increased by adding to it (2960—1680 =) 1280, and therefore making this term = 2503.12, we shall find that

A descending train may be = 150 tons.
An ascending train may be = 85 tons.
A train on a level may be = 105 tons.

The boiler, in this case, must vaporize its maximum quantity of steam. It is also obvious that, under very favourable circumstances, the adhesion may be much greater than even this estimate; so that by increasing the pressure of the steam a greater velocity can be obtained, or by enlarging the diameter and stroke of the cylinders much greater loads may be drawn. Further, if instead of employing one pair of driving wheels, the two pair of a four-wheeled engine are coupled, then the whole of the engine is exerting its weight to produce adhesion. In the case which I have assumed, the engine weighs 12 tons, with 8 tons resting on one pair of wheels; but if the machinery is so constructed that 6 tons may rest on each pair of wheels, then the adhesion will be increased one-half more; or the tractive force, instead of 2960 lbs., may be estimated at 2960 + 1480 = 4440 lbs. Therefore, the term 2503.12, in the equation of n as last determined, may be increased by 1480, which makes it = 3983.12. Hence we shall find, that, in ordinary cases, a four-wheeled coupled engine is capable of drawing

A descending train	= 230	tons.
Or an ascending train	= 125	tons.
Or a train along a level	= 155	tons.

The reader is requested to bear in mind, that the numbers here given are only comparative, and that they depend entirely upon the data assumed in the foregoing pages. In consequence of the many varying circumstances of construction and other conditions, I am compelled to give a general illustration only. It is not within the scope of this essay to enter into further particulars, which more properly belong to a treatise on locomotive engines; and therefore, such readers as desire to obtain a knowledge of the details which govern the mechanical action of an engine, will find the subject amply discussed in works ably written by the Comte de Pambour, Mr. Wood, and others.

ACCIDENTAL CAUSES OF RESISTANCE.

The resistance of a train as brought forward in detail in the course of this essay is all that can be taken into account when forming a general estimate; but there remain two important accidental causes of resistance, which it is not improper now to mention. The first cause which I shall draw attention to is the resistance opposed by the wind. The second cause is the resistance opposed by the journey of a train along curves on the line.

The Resistance of the Wind.

I have hitherto considered that the air through which the train passes is quite calm, or at rest. But this is very seldom the case; and though, when gentle winds are blowing, the effect on the surface of the train is not very remarkable, yet strong winds will produce a sensible retardation of velocity; or an additional tractive force is necessary to overcome the resistance of the wind, and maintain the required velocity unimpaired. As the wind may arise from any point of the compass, but the direction of the railway is fixed, the wind will impinge, generally, in an oblique direction upon the surface of the train. It is, therefore, necessary to determine such a general rule as shall meet any given circumstances of direction.

Suppose that the wind acts upon the train at some given angle contained between the directions of the wind and train respectively. The force which the wind will exert in its true direction is $\frac{Y^2}{371}$, when Y is the wind's velocity in miles per hour. This diagonal force can be resolved into two forces; one acting perpendicularly and the other parallel to the direction of the train. That which is perpendicular is proportional to the square of the sine of the given angle, and the force is represented by the expression $\text{sine}^2 \times \frac{Y^2}{371}$. This force, whichever way the train is moving, is constantly soliciting it to act against the side of the opposite rail, and tends to produce friction. The force which acts parallel with the train's direction is proportional to the square of the cosine of the given angle, and is represented by the expression $\cos.^2 \times \frac{Y^2}{371}$. This force, according as its resolved direction and velocity is opposed to, or composed with, the direction and velocity of the train, requires an increase of the tractive force, or becomes itself a propeller. The symbol Y expresses the absolute velocity of the wind; but since trains in motion are now under discussion, the expression above given will indicate only the effect produced on a train at rest. The real effect of the wind is due to its relative velocity. If the wind and train are moving in the same direction, the wind can produce no effect unless $Y = V$ = velocity of the train. Therefore, in this case, $V - Y = Z$ is the effective velocity which aids in propelling the train when V is less than Y; and $V + Y = Z$ is the effective velocity which opposes the train when the wind and train move in opposite directions. Also, when V is greater than Y, and the wind moves with the train, the effective velocity is $V - Y = Z$, which will oppose the train. But in the former part of this essay we have already estimated the effect due to V^2 (corresponding with the velocity of the train); therefore, the expression which will correspond with the velocity of the wind only, is $Y^2 \pm 2VY = Z^2$. The sign — being used when the wind and train move together, and the sign + when in contrary directions; in both cases acting in opposition to the train's motion. Also, the sign —, is used when the wind and train move together; and the term Y being greater than V, the wind assists in propelling the train. Therefore, the general expression, $\cos.^2 \times \frac{Y^2}{371}$ will now become $\cos.^2 \times \frac{Y^2 \pm 2VY}{371} = \cos.^2 \frac{Z^2}{371}$. All winds may be considered as blowing in a horizontal direction; therefore in estimating the amount of surface exposed to the force expressed by $\text{sine}^2 \frac{Y^2}{371}$, it is not necessary to estimate the tops, bottoms, and the reverse sides of the carriages; and the opposed surface will be sufficiently taken, if the expression K, which represents the side surface, be made $\frac{K}{4}$: then the resistance due to the wind acting on the sides of the carriages of the whole train will be indicated by the expression $\text{sine}^2 \times \frac{K(n+2)}{4} \times \frac{Y^2}{371}$.

The surface exposed to the force expressed by $\cos.^2 \times \frac{Z^2}{371}$ varies according to the angle of direction of the wind, and to the intermediate distances between the carriages. When the angle does not exceed a certain number of degrees, the whole front surface of the carriage is not exposed to its action, part of it being sheltered by the adjoining carriage. On calculating these limits due to the different intermediate spaces, I find that when the intermediate distance

Is equal to the breadth,		The angle is	45 deg.	0 min.
Is 7-eighths	do.		48 "	48 "
Is 3-fourths	do.		53 "	7 "
Is 5-eighths	do.		57 "	59 "
Is 1-half	do.		63 "	26 "

Hence, any angle which is less than the angle due to the given intermediate distance will not permit the whole front surface to be acted upon by the wind. If the front surface be expressed by S as used in a former part of this essay, and X express the fraction of the intermediate space when the breadth of a carriage is = 1, the actual surface exposed will be SX $\times \frac{\text{sin.}}{\text{cos.}}$, and the resistance will be expressed by $\frac{SXZ^2 \times \text{cos.} \times \text{sin.}}{371}$, and for the whole train it becomes $SZ^2 \; (\frac{1}{371} + \frac{x\,(n+1)\,\text{cos.} \times \text{sin.}}{371})$. To facilitate the computation of these two forces I subjoin a table. The first column shews the impinging angle for every five degrees of the quadrant. The second column gives a divisor (L) due to the coefficient of the perpendicular force $= \text{sin.}^2 \times \frac{1}{4 \times 371}$. The remaining columns give the divisors (F) due to the coefficient of the parallel force $= \frac{X\,(\text{cos.} \times \text{sin.})}{371}$.

Degree of angle of incidence.	L Divisor due to lateral surface.	F DIVISORS DUE TO THE FRONT SURFACE. Inter. space. = 1	Inter. space. = $\frac{7}{8}$	Inter. space. = $\frac{3}{4}$	Inter. space = $\frac{5}{8}$	Inter. space. = $\frac{1}{2}$
0	inf.	inf.	inf.	inf.	inf.	inf.
5	195348	4273	4883	5697	6837	8546
10	49212	2169	2479	2892	3470	4338
15	22152	1484	1696	1978	2373	2968
20	12684	1154	1319	1538	1846	2308
25	8308	968	1106	1291	1549	1936
30	5936	856	978	1141	1371	1714
35	4508	789	902	1052	1352	1690
40	3591	753	860	1004	1205	1506
45	2968	742	848	989	1187	1484
50	2529	898	898	1004	1205	1506
55	2211	1127	1127	1127	1352	1610
60	1978	1484	1484	1484	1484	1714
65	1806	2077	2077	2077	2077	2077
70	1680	3171	3171	3171	3171	3171
75	1590	5538	5538	5538	5538	5538
80	1530	12303	12303	12303	12303	12303
85	1493	48837	48837	48837	48837	48837
90	1484	inf.	inf.	inf.	inf.	inf.

The use of this table is as follows:

To find the resistance against the sides of the train: Multiply together the square of the wind's velocity $= Y^2$, and the total lateral surface $= K(n + 2)$, and divide this product by the number in column L due to the impinging angle; the quotient is the resistance in pounds.

To find the resistance against the front of the train: Multiply together the square of the wind's effective velocity $= Y^2 \pm 2VY$, and the front surface $= S$; also divide the number of carriages plus one by the number in column F, corresponding to the impinging angle and the intermediate space, and to the quotient add .002692; then multiply the first product and this sum together: the result is the resistance in pounds, which becomes positive or negative dependent on the direction and the velocity of the train as already pointed out.

The Resistance of Curves.

As long as the train proceeds over those portions of a railway which are straight, the progressive motion is not disturbed by lateral forcible contact with the rails, because there is no disturbing force which urges the wheels to leave the rectilinear course in which they move in accordance to the laws of dynamics. But when the train arrives at such portions of a railway as are laid down in a curvilinear direction, then the flanges of the wheels, by reason of the dynamical law of progression, come into contact with the rail whose radius is greatest, so that during the train's progress along the curve they are constantly urged to impinge on the rail, which diverts the wheels from their tendency to continue motion in a right line. This continual contact between the flange and the rail is a source of resistance which I propose to investigate. It is well known that when a body is made to revolve round a centre, it is acted upon by two forces; one urges the body forward in the direction of the tangent to the circular path of the body, and the other urges the body towards the centre of revolution: the combined action of these two forces keep the body in rotation. The latter force is equal and opposite to another which urges the body to fly from the centre and to seek a rectilineal path, and which is called the centrifugal force of the body. This force may be easily appreciated by observing the effect of a common sling which a man puts into rapid revolution. As long as the man holds the strings together the sling revolves; but when he lets one of them slip, the stone or weight in the sling is liberated and goes forward in a straight line. The force urging the body towards the centre is measured by the tension on the string, and this tension is equal and opposite to the centrifugal force. In like manner when a train moves along a curve the tractive power would urge the carriages in a straight line were they not confined by the rail; the pressure against the rail is the measure and effect of the centrifugal force, and the friction consequent on the pressure is the measure of the resistance to progression. The rule given in all works on mechanics for ascertaining the centrifugal force is $\frac{V^2 \times W}{32 \times R} = P$ when V is the velocity in feet per second, R is the radius in feet, W is the weight of the body. But in this work we shall require that

V = velocity in miles per hour.
r = radius in miles.
W = weight of the train in tons $= 5\ (n + 4)$.
P = centrifugal force in pounds.

The above expression becomes $P = \frac{V^2 W}{35\, r} = \frac{V^2 (n + 4)}{7\, r}$.

Engineers have generally attempted to balance this centrifugal force by making the exterior rail of the curve of such an elevation above the interior one, so that the gravity of the carriages will cause them to descend a transverse inclined plane, whose length is to its height as the whole weight of carriages is to such a portion of it as will balance the centrifugal force. In order to estimate this inclined plane, let g be the gauge of the rails in feet; and h the elevation of the exterior above the interior rail, in inches.

Then as $g : \frac{h}{12} :: 5\ (n + 4) \times 2240 : \frac{V^2 (n+4)}{7\, r}$.

Hence $h = \frac{g\, V^2}{6533\, r}$ in inches.

It is necessary to fix some velocity by which the value of h may be determined, and, of course, the maximum velocity should be assumed, as then any less velocity cannot produce sufficient centrifugal force to surmount the incline. It is, moreover, worthy of observation, that the elevation of the exterior rail is altogether independent of the weight drawn. The following is a small table adapted to a velocity of 30 miles per hour as a maximum, and a gauge of rails = 5 feet. The elevations corresponding to any other gauge may be found by multiplying the tabular number by the assumed gauge, and dividing by five.

Radius of curves, in miles.	Height of exterior rail above inte. rail, in inches.	Radius of curve, in miles.	Height of exterior rail above inte. rail, in inches.
¼	2.7564	2	.3445
½	1.3782	2½	.2756
¾	.9188	3	.2297
1	.6891	3½	.1969
1¼	.5513	4	.1722
1½	.4593	5	.1378
1¾	.3938	6	.1148

It may, therefore, be assumed that the centrifugal force is balanced by the elevation of the outward rail, and that resistance will not ensue from this cause. The principal remaining cause of resistance is the tendency of the wheels to impinge against the rails, causing the carriages to oscillate from side to side. This takes place in the following manner:—When the train leaves the straight line, and comes into the curve, it continues its direct motion till the wheels strike the rail very obliquely. The carriages then recede from this rail at an angle of recoil equal to that of the impingence, and continue motion in this oblique direction till the other wheels strike the other rail, when they again recede, and the same degree of oscillation is continually repeated. This obliquity is measured by the small angle contained between the rail and the wheel; and the angle, when greatest, is due to the arc of a circle whose chord is in the direction of the wheels, and which contains, in a portion of its length, the distance between the extreme points of intersection of the outer circumferences of the two sets of carriage wheels, and the upper surface of the rail, being also the extreme points of contact; and, at the end of this distance, the versed sine is the difference between the gauge of the rails and the gauge of the flanges.

I have been particular in describing these measures, because from them only we can obtain the measure of the chord of impingence, as will presently be seen.

The difference of the gauges varies from ¾ of an inch to 1¼ inches with different engineers and builders. I will assume a mean difference of 1 inch, which gives half an inch on each side between the flange and the rail when the train does not oscillate. It is needless to take any less dimension for the versed sine, because, during the repeated oscillations that ensue, the flange must be in contact with the rail on one side of the line, leaving a space = 1 inch between the flange and the rail on the other side. Also, in consequence of these oscillations, one of the front wheels will be in contact with the rail on one side, while the opposite back wheel is in contact with the other rail, and so on; therefore, the distance of the wheels measures a proportion of the chord only, which depends for its ratio on the radius of the curve.

It is required to find the length of the chord. Let the distance of the wheels measure from the point of contact $= a$, and the versed sine at this distance $= b$; let the length of the half chord $= c$, and the versed sine of the half chord $= x$: the radius of the curve, as before, $= r$. Then, a, b, and r are given to find c and x. Since the arc in this case is very inconsiderable when compared with the whole circle, we will suppose that the versed sines vary as the squares of the chords with which they are found. Therefore $c - a$ is the length of the half chord with which the versed sine $x - b$ is found. Now, as $c^2 : (c-a)^2 :: x : x - b$, or $x = \frac{b\,c^2}{2ac - a^2}$. By the properties of the circle x is also $= r - \sqrt{r^2 - c^2} = \frac{c^2}{2r}$ very nearly; hence $\frac{b\,c^2}{2ac - a^2} = \frac{c^2}{2r}$, or $2rb = 2ac - a^2$, and $c = \frac{2rb + a^2}{2a}$; then if $\frac{a}{b} = m$, $c = \frac{a}{2} + \frac{r}{m}$, and $x = \frac{(am + 2r)^2}{8m^2\,r}$. But the sine of the angle which the wheel makes with the rail is measured by $2x$, or $\frac{(am + 2r)^2}{4m^2\,r}$, when the radius is c.

Also, when the length of c is known, the number of oscillations due to the impingence on the curve in a second will be $= \frac{22V}{15c}$, when $V =$ velocity in miles per hour.

Before we proceed to estimate the force which produces resistance on the curve, it is necessary to explain another cause of the oscillations not yet noticed.

All the engine and carriage wheels are made of a conical form, tapering outwards. The object of this form is purposely to correct the tendency, we are now discussing, of the wheels to strike the rails while going round a curve; for the instant the wheels move laterally on the rail, those on one side, in consequence of their tapering form, enlarge their diameters; while those on the other side are equally diminished; therefore, the velocity of the wheels on the outer rail of the curve is greater than that of the inner ones; and if the velocities of both are in proportion to the inner and outer radii of the curve respectively, it is evident that there would be no tendency of the wheels to strike the rails, but they would always continue motion in the direction of the tangent to the curve. All that theory requires is, that the carriage wheels should have such a taper, that the increase of velocity in moving laterally one inch shall be to the whole velocity as the gauge of the rails is to the inner radius of the curve. If d represents the diameter of the wheel in inches, and t the taper of the tire for an inch of the breadth thereof, it is evident that d will be proportional to the whole velocity when $2t$ is the increase, therefore $d : 2t :: r : g$ or $t = \frac{dg}{2r}$. If the diameter of the wheel is 42 inches, the gauge of the rails 5 feet, and the radius half a mile, we shall find $t = \frac{1}{25}$th of inch nearly, for each inch in breadth of the tire. But, practically, this conical form does not generally secure the object it is designed for. The taper having been once determined upon, can never be varied as the circumstances require; for, *cæteris paribus*, the taper ought to vary inversely as the radius of the curve, which it cannot, and hence arises that cause of oscillation which I have alluded to: but, as regards the increase of resistance from this cause, it will ultimately appear to be very insignificant, and need only be considered in extreme cases.

I will suppose, for the sake of argument, that the taper is calculated for the worst, that is, the sharpest curves of the railway. When the wheels have enlarged their diameters by the lateral motion, the increase of velocity is expressed by $\frac{2tr}{d}$. The increase of velocity proportional to the radius of the curve should be $= \frac{g}{r}$; therefore, as the taper which is proper for the worst curves will give too great an accession of velocity to any other curve, we have $v\ (\frac{2t}{d} - \frac{g}{r})$ for the relative velocity which will cause the wheels to rotate round a centre whose radius is $\frac{dg}{2t}$. But this rotation produces a centrifugal force which impels the wheels already oscillating into a still more rapid state of oscillation. The measure of this centrifugal force is expressed by the equation $\phi = 1505.8\ t\ V^2 \times \frac{(2tr - dg)^2}{d^3\ gr^2}$. This force in conjunction with that due to the angle of impingence, increases the number of oscillations computed by the chord c, in the proportion of the latter force to the sum of the two: and the chord c will be shortened in the same ratio. The force p, due to the angle of impingence, is to the whole force which propels the weight of the carriage, as the sine of the angle $= \frac{(am + 2r)^2}{4m^2\ r}$ to the radius $= \frac{am + 2r}{2m}$; and $p = 5600 \times \frac{am+2r}{mr}$. The sum of the two forces becomes $= 5600\ [\frac{am + 2r}{mr} + .2689\ t\ V^2 \times \frac{(2tr - dg)^2}{d^3\ gr^2}]$, consequently the number of oscillations will be

$$o = V \times \frac{2.933m}{am + 2r} + .7887\ V^3 \times \frac{m^2\ t}{d^3\ gr} \times \frac{(2tr - dg)^2}{(am + 2r)^2};$$ and

when o is known, the length of the chord of impingence is $\frac{22\text{V}}{15,o}$.

In order to enable the reader to apply these rules practically, I will assume such general dimensions as will simplify the formula, and then give a practical example in illustration.

Let the distance of the wheels, as specified in a former page, be $a = 8\frac{1}{3}$ feet, and the lateral play of the wheels be $b = 1$ inch, then $\frac{a}{b} = m = 100$. Let the diameter of the carriage wheels be $d = 42$ inches, and the taper of the tire be $t = .05$ inches; let the gauge of the rails be $g = 5$ feet, also let $v = 30$ miles per hour, and let r be given in miles; so in that r in the formula becomes $5280r$. With these data we shall find that the sum of the impinging forces is $f = \left[\frac{8.8384 + 112r}{r} + \frac{(2.5142r - 1)^2}{3456r^2}\right]$. The number of oscillations is represented by $o = \frac{10.56}{(12.6723r + 1)} + \frac{1.9361}{r} \times \frac{(2.5142r - 1)^2}{12.6723r + 1)^2}$

If we take, for an example, the radius to be 1 mile, then the force acting at the point of contact is $= (120.8384 + .0006634)$ $= 120.839$ lbs. per carriage.

As it is evident that the second term of both the above equations due to the taper of the wheels is scarcely appreciable except at very great velocities and round very sharp curves, it is better to omit it altogether in the estimate; and then we have the following practical rules adapted to the data already given:

Rule—*To find the force of impingence on the curve:* Add together 112 and the quotient of 8.838 divided by the radius in miles: the sum is the resistance due to the impinging force in pounds common to all velocities.

Rule—*To find the number of oscillations in a second of time:* Divide the number 10.56 by the sum of 1+12.67 times the radius: the quotient is the number required. If the number for any other velocity is wanted, multiply this result by the given velocity, and divide by 30.

The oscillations of the wheels computed by the foregoing rule must not be confounded with the actual oscillations observed by a passenger travelling in a carriage, which are produced by the lateral play of the springs and bearings, and are much more frequent. It may be easily shown that the engine is more liable to oscillation than the carriages, from its greater weight and the inequality of the diameters of the wheels and conical tires, also because the centre of gravity of the machine is higher, and there is an unequal action produced by the successive reciprocating motion of the two cranks. But this oscillation is not communicated to the carriages, and since my intention has been to offer a general rule only, I shall not take any account of it.

Since the resistance computed by the foregoing rule is not uniform but chronic, it is now proper to determine the mean tractive force required to overcome it. Because the expression $5600\ (\frac{am + 2r}{mr})$ represents the force of impingence of one carriage, and $v \times \frac{2.933\,m}{am + 2r}$ represents the oscillations in a second of time, then $5600\ (n + 4) \times \frac{2.933\,v}{r} =$ the whole force of impingence acting during this time. But the lateral velocity with which this force moves is to the forward velocity as the sine of the length to the radius, or $v : \mathrm{V} :: \frac{(am + 2r)^2}{4m^2r} : \frac{am + 2r}{2m}$, therefore $v = \mathrm{V} \times \frac{am + 2r}{2mr}$; consequently the force with which the whole train resists uniformly is $5600\ (n + 4)\ \mathrm{V} \times \frac{1.4666\ (am + 2r)}{mr^2}$; and when this expression is simplified to suit the data already assumed, the rule becomes $\frac{n + 4}{13.576} \times \frac{12.672r + 1}{r^2} =$ uniform maximum resistance.

It must be borne in mind that this resistance is the greatest which can ever occur, because, by hypothesis, the extreme lateral play of the wheels was assumed. But the carriages will oscillate though the lateral motion be not extreme, and it is required to know what the resistance will be in any given case. This may be easily accomplished by observing the number of oscillations made in a second of time. The resistance will vary as the squares of the sines of the angles of impingence. But the angle of impingence depends upon the ratio of the chord to the radius of the curve, and this ratio will be obtained by supposing that the radius varies inversely as the number of oscillations, for then it is evident that the length of the chord being the same, the radius for a less number of oscillations will be greater, and consequently the angle of impingence less, and the effect produced will be the same as if the space travelled over were greater before the wheels came in contact with the rail; so that we have the following method to determine the actual resistance:

Let O be the observed number of oscillations: when the radius $= 1$, the sine $= \frac{O}{o} \times \frac{am + 2r}{2mr}$ due to O; consequently the resistance will vary as $\frac{O^2}{o^2}$; hence the expression for the resistance with any observed number of oscillations is $954.54 \frac{O^2}{Vr^2} \times (n+4) \times \frac{(am + 2r)^3}{m^3}$, and using the data as before, $(n+4) \times \frac{O^2}{r^2} \times \frac{(12.672r + 1)^3}{1514} =$ general expression of resistance in pounds.

Rule—*To find the resistance of a curve* (*acting uniformly to retard motion*) *:* Multiply the number of carriages plus 4 by the square of the oscillations observed in a second, and by the cube of the sum of 1 + 12.67 times the radius, and divide this product by 1514 times the square of the radius: the quotient is the resistance of the train in pounds at a velocity of 30 miles per hour. For any other velocity divide this result by the given velocity, and multiply the quotient by 30, the product is the resistance sought.

Example:

Given $n = 10$ carriages.

$O = 1$ oscillation per second.

$r = 1$ mile radius.

Then $\frac{(10+4=14) \times 1^2 \times (12.67+1)^3}{1514} = 23.62$ lbs. resistance.

In treating of this subject, I am aware that the information we possess is by no means satisfactory, and is very scanty; and indeed, the foregoing estimate of the resistance I wish the reader to accept as suggestive only. But, were there a few good experiments made, the calculation might be reduced to almost a certainty, by the use of the foregoing investigation. For, if the actual resistance were ascertained with given dimensions, then a practical rule can be formed by making the resistance vary *directly as the square of the number of oscillations, the radius, and the number of carriages; and inversely as the velocity.* When the resistance is determined for any of the set of wheels, whose distances are respectively 90, 100, 110, 120, 130 inches, then the resistance due to any other set will vary *inversely* as the numbers 2077, 1514, 1137, 876, 689, respectively, the velocity, radius of curve, number of carriages, and number of oscillations per second, remaining the same in all cases. Also, we derive that the resistance due to curves is not great, except in extreme cases, and it need not be generally regarded when the centrifugal force is properly balanced.

As it may be convenient to know what difference a variation of the distance between the wheels makes in the estimate, I subjoin the requisite alterations of the coefficients employed in the foregoing rules.

Instead of the coefficient.		When the distance is a =			
		Inches. 90	Inches. 110	Inches. 120	Inches. 130
8.838	substitute.	7.95	9.72	10.60	11.49
12.576	do.	15.08	12.34	11.31	8.29
12.672	do.	15.63	10.47	8.80	7.50
10.560	do.	11.73	9.60	8.80	8.12
1514.000	do.	2077,00	1137.00	876.16	689.13

If it is required to know the resistance caused by oscillation on a *straight line,* the following form will give it:

$$\text{Resistance is} = \frac{106\,(n + 4)\,O^2}{V} \text{ in pounds.}$$

The literal expression of the above form may be more convenient, therefore I herewith subjoin it.

To find the resistance on a straight line due to the oscillation of the carriages:

Multiply together, the coefficient 106, the number of carriages plus 4, and the square of the number of oscillations per second; divide the product by the velocity in miles per hour: the quotient is the resistance required in pounds.

The *friction* consequent upon the resistance may be assumed to be $\frac{1}{10}$th of the result derived from the rules whether for a curve or for a straight line.

I shall now conclude this essay; and I beg the reader to consider that I do not put forth the data I have adopted as invariable, but have singled them out from the many practical cases that occur, rather for the sake of argument. Should the reader be desirous of adopting his own, or any other practical data, I shall be happy, if in the preceding pages I have been instrumental as a guide in leading his inquiries to an approximate, if not an accurate result. Though the consideration of the acceleration or retardation of trains is a subject which may be properly