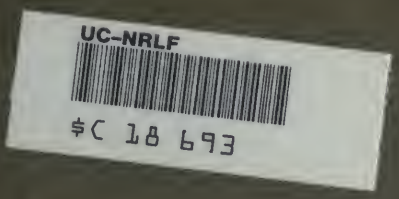

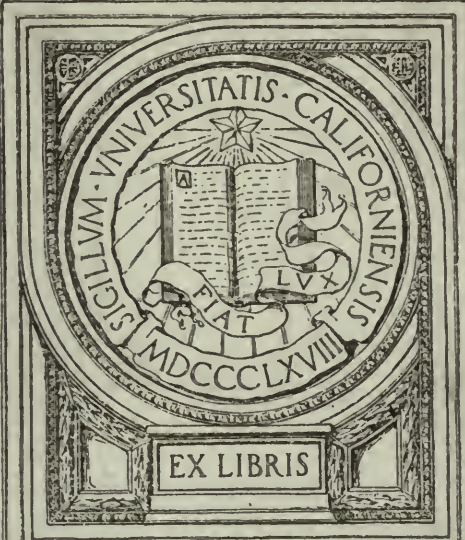

ENGINEER DEPARTMENT, UNITED STATES ARMY.

THE ELEVATION

OF

SITES FOR SEACOAST BATTERIES,

BY

JOHN G. D. KNIGHT,

MAJOR, CORPS OF ENGINEERS, U. S. A.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1896.

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WAR DEPARTMENT

Document No. 23.

OFFICE OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., July 9, 1896.

SIR: I have the honor to submit herewith a paper prepared by Maj. John G. D. Knight, Corps of Engineers, on the influence of the command of a battery on its efficiency.

This paper contains information of great value to officers of the Corps of Engineers concerning the elevation of sites for seacoast batteries, and I recommend that authority be granted to have it printed at the Government Printing Office, and that two hundred copies be obtained for the use of the Engineer Department upon the usual requisition.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

[1st Indorsement.]

WAR DEPARTMENT,
July 17, 1896.

The recommendation of the Chief of Engineers is approved.

By order of the Secretary of War:

JOHN TWEEDALE,
Chief Clerk.

WILLETS POINT, N. Y.,
April 7, 1896.

COLONEL:

The Board of Engineers having now under consideration the subject of the elevation of sites for batteries, and having requested me to elaborate views expressed by me on that subject, I have the honor to submit the following:

What should be the proper elevation of a seacoast battery can not be determined without considering the fire to which it will be exposed and that which it may return; not the weight of projectiles, but more especially the angles at which they will arrive at their targets and certain functions of those angles.

I. This requires at once some assumption as to the ranges at which batteries may expect to be attacked.

During the English naval maneuvers of 1890, the first rule for engaging was "Fire is not to be opened or continued at a greater distance than 4,000 yards."

During those of 1893, when the fleets went into action, "the leaders were then passing in opposite courses, port to port, distant about a mile, fire from main and secondary guns being opened as each vessel came into range of an opponent." Later they engaged when about ¾ mile distant.

In the French maneuvers of 1893, "ships were always to be considered as in action when they were within 3,280 yards of one another." At the close of these maneuvers three vessels, steaming at 10 knots, fired at the summit of Cape Rosso, distant 8,750 yards, with 14 and 16 centimeter guns; and six battle ships, steaming at 8 knots, fired at a range of 3,800 yards with all their guns. Finally the first three fired at a target 8,750 yards distant, while steaming at 10 knots, in the arc of a circle of which the target was the center. "The results are said to have been only moderately satisfactory."

In the English maneuvers of 1894, it was ruled that an enemy's ship coming within 6,000 yards of the entrance to a fortified port was to be out of action for twenty-four hours. One engagement began at 4,000 yards range.

The distances at which the forts of Alexandria were attacked by the English fleet varied at first from 1,000 to 3,800 yards.

At Sfax the French ironclads were stationed at from 7,000 to 4,300 yards, boats being at "a few hundred yards." "After a remarkably deliberate fire of 2,000 projectiles, delivered under peace-practice conditions, the 'defensive power' of the place is reported to have been 'practically uninjured.'"

Sir Andrew Clarke, Inspector General of Fortifications, in this connection stated: "It will need a great deal of shooting from the gun vessels before a shore gun is grazed, and the ironclads will do no harm at all to the defenses."

In the battle of The Yalu, September 17, 1894, the Chinese opened fire at a distance of from 5,500 to 6,500 yards; the Japanese replied at 3,300 yards. The battle was fought in general at ranges of from 2,000 to 3,300 yards.

The cases above cited lead to the conclusion that it is not probable that a naval attack of land batteries will be entered upon at distances exceeding 5,000 yards.

It is not asserted that cities, dockyards, and large harbors densely occupied, may not be bombarded from distances exceeding 5,000 yards; but the probable damage to batteries from attack at the same distances will not justify the expenditure of ammunition.

II. From the ballistic curves computed under the direction of the Board of Engineers in 1885 for the 40-centimeter Krupp breech-loading rifle, and in 1892 for the United States 8 and 10 inch breech-loading rifles, the following table has been prepared:

Range.	Angles of fall.		
	8-inch gun.	10-inch gun.	40-cm. gun.
	Degrees.	*Degrees.*	*Degrees.*
1,000 yards	0.7	0.8	0.6
2,000 yards	1.5	1.8	1.6
3,000 yards	2.6	3.0	2.5
4,000 yards	3.9	4.4	3.7
5,000 yards	5.7	6.1	4.9
	Feet.	*Feet.*	*Feet.*
Initial velocity per second	2,160	1,960	2,035

It is assumed that batteries will not be the targets for projectiles having greater angles of fall than those given for the 10-inch rifle. Should vessels be armed with guns mounted for curved fire, overhead protection may be required for land guns, since increased elevation of site will in itself give no increased protection against such fire.

In batteries where the guns are mounted on Buffington-Crozier carriages and are not to be fired at angles of depression, the gun after recoil lies wholly below a plane which passes through the interior crest and is depressed 7 degrees below a horizontal plane. In other words, the gun after recoil, could not be hit by projectiles clearing the interior crest and having angles of fall of less than 7 degrees. Briefly, the gun may be said to be under a 7-degree plane. This plane passes 5 feet 11 inches above the front edge of the loading platform and 4 feet 4 inches above the extreme rear edge.

When a 10-inch rifle is mounted on a Gordon carriage, it is under a 13-degree plane after recoil and while being loaded at an elevation, and under a 10-degree plane while being loaded in a horizontal position. This 10-degree plane passes 5 feet 10 inches above the front edge of the loading platform and 4 feet 3 inches above the extreme rear edge.

The 12-inch rifle mounted on the lift, when the lift is completely lowered, lies under a 15.5-degree plane, and the rear upper edge of the pit lies under a 9-degree plane. The 15.5-degree plane passes about 8 feet above the floor of the loading passage at the ammunition hoist.

The greatest angle of fall of projectiles for a range of 5,000 yards given in the table above is 6.1 degrees; hence neither guns mounted on the types of carriages mentioned or on lifts, nor the carriages or lifts, will be struck by projectiles passing above interior crests where ranges are 5,000 yards and less, and the fire is direct, *even though the crest of the land battery is at the level of the attacking naval battery.*

As these shot will pass at least 5 feet 6 inches above the rear edge of the loading platform of the 10-inch Buffington-Crozier carriage and about 7 feet above the front edge, the gun detachment will be fairly covered from them. Where guns are mounted en barbette on nondisappearing carriages, both gun and loading detachment are almost wholly above the level of the interior crest. In one case where a 12-inch gun has been so mounted, the loading platform is about 3 inches above the level of the interior crest.

III. To what extent will the protection of guns and gun detachments be increased by selecting elevated sites for batteries?

The following table shows the heights at different ranges, giving corresponding reductions of the angles of fall of arriving projectiles, with corresponding theoretical vertical increase of protection of loading detachment, 45 feet in rear of crest; this distance being approximately the distance of the rear edge of the loading platform from the interior crest:

Angle of fall diminished—	Theoretical vertical increase of protection 45 feet from crest.	Elevation above naval guns at—				
		1,000 yds.	2,000 yds.	3,000 yds.	4,000 yds.	5,000 yds.
	Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1 degree	9	52	105	157	209	262
2 degrees	19	105	210	314	419	524
3 degrees	28	157	314	472	629	786
4 degrees	38	210	420	629	839	1,049
5 degrees	47	262	525	787	1,050	1,312

It is apparent at once that against fire from vessels a mile or more distant, no moderate increase in the elevation of the site of a battery will give much increase in protection. But such slight protection of loading detachment as is given is largely theoretical, for elevations corresponding to the greater reductions in the angle of fall. When this angle of depression is 5 degrees, the platform of the 8-inch gun is 11 inches higher relative to the interior crest than when the gun is to be fired without depression; and that of the 10-inch gun 12.5 inches; the net increase of protection of loading detachment due to elevation of site in these cases is 36 and 35 inches, respectively. This is the increased protection afforded at a distance of 45 feet in rear of the crest 262 feet above the guns of a vessel 1,000 yards distant. If the range be doubled or trebled, the crest elevation must also be doubled or trebled, not to obtain *more* than 36 inches additional protection, but to retain that increase. The explanation of this is that each increase in the elevation of the site requires the loading platform to be raised nearer the level of the interior crest in order that the land gun may be fired at increased angles of depression. Otherwise dead angles would be developed in front of a battery in proportion to the increase in the elevation of its site.

The second table gives what may be called the searching effect of projectiles and the elevation of site that will neutralize this effect. Thus a projectile having an angle of fall of 1 degree just clearing the interior crest will, at a distance of 45 feet to the rear, pass 9 inches below the crest. This is the angle of fall of projectiles fired at a range of about 1,000 yards.

What elevation of the battery site will neutralize this angle of fall, or cause the path of the projectiles on arrival to be horizontal?

The table shows that an elevation of 52 feet is necessary.

For ranges of about 2,000 yards the angle of fall will be about 2 degrees, and the projectile will pass 19 inches below the crest. To neutralize this fall, the elevation of the site must now be 210 feet, and so on, until a projectile fired at a distance of between 4,000 and 5,000 yards having an angle of fall of about 5 degrees will pass 47 inches below the interior crest. To neutralize this the site must have an elevation of over 1,000 feet.

IV. To what extent will the field of fire of the battery be restricted by elevating its site?

These different elevations have reduced the angles of fall of arriving projectiles to 0, and have thus neutralized their searching power.

But what has been the effect upon the land guns, of thus elevating the battery site?

These guns are mounted on carriages allowing the guns but 5 degrees depression; hence they can not be used against vessels at ranges requiring them to be depressed more than 5 degrees.

A 10-inch rifle, firing over a crest 300 feet above the water, will have a dead zone whose radius is about 1,000 yards; one firing over a crest whose elevation is 210 feet will have a dead zone of about 720 yards radius.

V. It has been shown that a gun mounted on either of three disappearing plans will not be directly hit when under direct fire of guns at ranges not exceeding 5,000 yards; that the additional protection arising from the tabulated elevations of site is both unnecessary and slight for guns thus mounted, and is practically nothing for nondisappearing barbette guns; and that moderate elevations of site result in dead zones, which should not be disregarded. Still there seems one reason why sites should be chosen having more elevation than that of naval guns. With nothing but the parapet continuously in an enemy's view, with guns appearing only for brief periods, he must be at a loss how to direct his fire if he can not see the openings into which the gun disappears. Therefore, with the object of depriving an enemy of a definite target for his guns, the battery may well be constructed at sufficient elevation to hide the openings of its emplacements from view from the tops of an enemy's vessel. For this purpose, and for this only, it may be well to give crests of batteries an elevation of about 100 feet above the water.

As the loading platforms of barbette guns on nondisappearing carriages are about on the level of the interior crest, even when the site of the battery is about 300 feet high, it is evident from the table given that the service of these guns without shields demands much exposure of gunners, no matter what reasonable elevation the battery may have.

VI. So far shell and shrapnel have not been considered. With even the low remaining velocity of 1,200 feet, but 0.04 second would be required for a shell to pass from the interior crest to the rear of the emplacement. It is hardly too much to say that the time fuze could not be cut with the accuracy necessary to insure the burst of the shell at some point of its passage over the gun and its gunners. At the Inchkeith experiments, in 1884, firing was carried on against a model gun emplacement and dummy gunners. Thirty rounds of shrapnel, fired from a 10-inch gun at an excellent target and under exceptionally favorable circumstances, resulted in four of the dummies being hit; the target gun was still perfectly capable of being worked. Some years ago French vessels did not carry shrapnel for heavy guns.

If direct hits can be guarded against, and thus the action of percussion fuzes prevented, shell and shrapnel need not be feared where guns are mounted on disappearing devices.

VII. Certain advantages have been attributed to low sites.

(*a*) "They afford no direct fire upon the deck of a ship, which, being her most vulnerable point, should always be attacked."

For equal ranges the angles of fall for the land guns would be increased only as little as those of the naval guns would be decreased for corresponding elevations of site.

Lieut. E. W. Very, U. S. N., asserts that 2-inch steel plates *well supported against flexure*, will give good resistance at angles up to 9 degrees and possibly 10 degrees. The angles of fall of heavy projectiles for ranges up to 3,000 yards do not exceed 3 degrees. Were the elevation of the battery site increased to such an extent as to increase these angles of fall by 5 degrees, a well-supported, flat 2-inch steel deck would still give good resistance at these ranges. The second table given above shows how great are the elevations necessary to give this increase to angles of fall, an increase still insufficient to cause the deck to be penetrated. A slight roll of the vessel may offset the small change in the angle of fall due to increased elevation of battery site; on the other hand, such a roll may unfavorably expose the deck to shot from a low battery.

(*b*) A low site "enables ships to dispense with high angles of fire, for which the mode of mounting their guns, in a measure, disqualifies them."

For neither of the United States guns above mentioned do the angles of elevation corresponding to ranges of 5,000 yards exceed 5 degrees. For the ranges and elevations of site above tabulated, additional elevations of the naval guns do not exceed 5 degrees.

The maximum elevation of the piece then for attacking batteries with the elevations of site and ranges given, will be under 10 degrees.

The maximum practicable elevation for guns on shipboard being from 13 to 15 degrees, it appears that the attack of batteries on sites of the elevations given above does not demand impracticable angles of fire for naval guns at reasonable ranges.

(*c*) "It places the hostile guns on shipboard on an equality with land guns as to energy of impact." As an illustration, attention is called in the text from which this is quoted to the 16-inch rifle firing a 1-ton projectile from a bluff 200 feet high and a ship firing projectiles of like weight at the battery; the ship being thus handicapped 400 foot-tons. Still the land gun has gained only 200 foot-tons by the elevation of the battery site, or about one-half of 1 per cent of its striking energy at a range of 2 miles.

If a 714-pound shot be fired from a ship at 3,000 yards range at a battery elevated 1,270 feet, and another shot of the same weight fired from the battery at the ship, the respective striking velocities would be 1,474 and 1,517 feet per second, and the respective striking energies 10,754 and 11,390 foot-tons; the vessel in this case would be handicapped 636 foot-tons.

But the gun has only gained 3 per cent of energy by reason of its elevated emplacement.

If a blow of 11,100 foot-tons would not damage a steel deck, would one of 11,400 be likely to do so?

The authority urging the above objections concludes the subject with this statement: "Even at Fort Mex, a low work at Alexandria, out of 920 shots fired at 14 guns practically en barbette by five armored ships at ranges from 1,000 to 3,800 yards, two land guns were grazed but none were disabled by direct hits; and only direct hits can place a gun, properly mounted on a bluff, *hors de combat*."

So far as this action throws light on this subject, the only disadvantage entailed upon Fort Mex by its crest being less than 30 feet above sea level was, that two guns out of fourteen were grazed; even though low, its guns escaped direct hits.

CONCLUSION.

Assuming that vessels will not attack batteries at greater ranges than 5,000 yards, barbette guns, mounted according to any of the disappearing methods adopted by the United States, need no additional protection derived from increasing the elevation of battery sites within reasonable limits. Even moderate elevations of batteries, which are armed with guns limited to depression of 5 degrees, entail dead zones of magnitude not to be overlooked where these zones include areas of deep water.

Disappearing guns gain but little additional protection by such increase in the battery elevation, and nondisappearing guns gain therefrom practically no additional protection.

Therefore, unless justified by motives of economy, barbette guns should not be mounted on nondisappearing carriages even on elevated sites. The special advantage of elevated sites for batteries of disappearing guns is, that they put obstacles in the way of an enemy seeking to locate the guns. This advantage will be secured if the battery crest have an elevation of about 100 feet.

Very respectfully,

JOHN G. D. KNIGHT,
Major, Corps of Engineers.

Col. H. M. ROBERT,
Corps of Engineers, U. S. Army,
President Board of Engineers,
New York City.