THE FRENCH TORPEDO CRUISER CONDOR.

AMONG the ships that are at present anchored in the roadstead of Barcelona, the Condor will certainly be one of the most remarked, at least by seafaring men. The public will indeed be struck by the imposing spectacle offered by the French, Italian, and Austrian ironclads that have come to do honor to Spain, but these are of known types whose fighting qualities have in a measure been tested. The attention of naval men is turned at present rather to ships of medium tonnage, designed to do battle with both torpedo boats and ships of heavy tonnage such as ironclads.

In order to fulfill this double mission it required, in fact, manageable vessels having a speed analogous to that of torpedo boats and capable of remaining at sea better than they, in a state to give or refuse battle, maneuvering easily, armed with torpedoes against ironclads, and with rapid-firing guns against torpedo boats, in a word, a sort of ship to do everything, despite its slight displacement.

It was of such an idea that was begotten, first, the Bombe, of 304 tons, and afterward the Condor, which better realizes the object proposed, and which gauges 1,272 tons. We now have four specimens of this type, for the Epervier, which at present forms part of the Channel squadron, the Vautour and the Faucon, which are not yet entirely finished, are absolutely like the Condor, at least in their essential characters.

These ships measure 223 feet in length and 29 in width amidship, and have a draught of 15 feet.

As for defensive power, the hull has an armored deck

THE SUPPORTING POWER OF SOILS.

By RANDELL HUNT, Member of the Civil Engineers' Society of St. Paul.

[Read April 2, 1888.]

It is often necessary for the engineer to prescribe a limit of load, per unit of surface, in designing foundations for structures resting upon soil. In the absence of the time and means to make actual tests of the soil, he must confine himself to an investigation of existing successful structures upon a soil as nearly similar to the one under consideration as he can find. It is the object of this paper, then, to present a few remarks upon the actual supporting power of soils as deduced from an investigation of the matter from our own observations and the recorded examples which have been accessible.

It is probably possible to devise a general mathematical formula which would be applicable to the supporting power of any soil, but such an expression would necessitate our knowing so many particulars as to the character of the soil, such as its weight and natural slope, that we could judge of its actual strength fully as well without applying it. At any rate, we shall confine ourselves to-night simply to the practical side of the matter.

The Supporting Power of Clay.—The supporting power of clay is very variable and depends in a large measure upon the variety and upon its degree of saturation with moisture. In the roadbed of railroads, when the "surfacing" has been done with clay, a

much as a foot. The pressure per square foot of the entire foundation of this bridge is 5 tons.

When the new Westminster Bridge was built the load per pile was reduced to about 12 tons, while the load per square foot of the entire foundation was reduced to 2 tons. I find no record of this bridge having shown any signs of settlement.

Robert Stevenson* attempted to load a stiff hard clay with 5 tons per square foot. He was building some high bridge piers at the time, but before they were completed serious settlements took place, and he decreased the amount per foot by making his foundation of greater area than first determined upon. He also built a large chimney which failed, and then constructed another, at Newcastle-on-Tyne, with only 1½ tons per square foot of foundation, which was successful. Both these chimneys are described as being founded on hard, compact clay.

The subsoil of the vast valley of the Red River of the North is a bed of clay, which varies in depth from 80 to 125 feet—a bed of sand and gravel usually being found underlying it. This clay is generally of a yellowish color, and appears more or less hard and firm in proportion to the amount of moisture contained in it. Chemically considered, it has a large amount of carbonate of lime in it, as can be seen from its action when treated with acids; and when freshly opened up to view in a place where free from much moisture, appears about of the consistency of marl.

In 1881, at Fargo, Dakota, a brick building, of four stories in height, including a basement story, was constructed upon a concrete foundation. The pressure per

THE FRENCH TORPEDO CRUISER CONDOR.

of steel extending from stem to stern. This deck is situated a little beneath the float-water line and protects the vital parts—engines, boilers, rudder apparatus, etc. Besides, the hull is divided into ten watertight compartments by longitudinal and transverse partitions that extend up to the deck.

As for offensive power, the Condor has five four-inch guns, five torpedo tubes, and six revolving guns.

The motive apparatus, which is of 3,200 indicated h. p., consists of two directly connected compound engines.

We must add, for the greatest honor of our engineers, that the plans of the Condor are the first that were made to respond to the programme that we have given above. It is under their inspiration that the Scout type was created in England—a type that made so much stir on the other side of the Channel. Better still, it has been found that our Condor is superior, as regards speed, to the similar torpedo cruisers built by our neighbors. Thus, the English cruiser Cossack makes but 17.7 knots, while the Condor easily makes 18.5—a fact so much the more remarkable in that the first gauges nearly 400 tons more than the second.

To-day, the Condor has been experimented with sufficiently to permit of judging definitely of the services that she is capable of rendering, and it has been found that she can easily keep up a mean speed of 17 knots. This is a splendid result. The vessel is commanded by Captain Lormier.—*L'Illustration.*

GREAT bell at Cologne Cathedral, presented by the German Emperor in 1876, weighs 60,480 pounds, the clapper alone weighing 1,200. It was made of cannon captured in the Franco-German war.

smooth, hard bed, unyielding and with far greater supporting power than would be required, is always found in dry weather. It becomes very compact, so much so that it is impossible to press the point of a walking cane into it. But after a drenching rain, all conditions change, and the roadbed becomes a mass of mud, into which the ties are pressed down and the clay bulges up between them.

We mention this simple example of dry and wet clay because it is familiar to most of us, and shows clearly the effect of too much moisture in such soils.

The clays vary considerably, however, in their chemical constituents, and are affected thereby in the degree to which they absorb moisture. Certain deposits are known to be compact and hard, with a high supporting power, while others are in the condition of a plastic material, easily compressed. But its chief characteristic, which renders all clay more or less unstable, when regarded in the light of a foundation, is its known property of retaining water once admitted to it, and its softening propensities, which gradually take place as the amount of water increases.

The stiff blue clay deposits of London are celebrated as much for the numerous failures of the bridges and other structures founded on it as for any other reason.

Old Westminster Bridge had probably about 5½ tons to the square foot of foundation, and failed.

Blackfriars' Bridge had about 5 tons and appeared to be stable for many years, but ultimately settled very badly.

New London Bridge was built in 1831 and founded upon piles, upon which as much as 80 tons per pile was imposed. Of course, it has settled—in some places as

square foot upon the clay was at no place greater than 2½ tons, and was probably even less than this amount.

The building showed a certain amount of settlement each season until, the third year after being built, one side of it suddenly commenced to crack, and settled a foot or more in a single day, becoming so dangerous that the occupants were compelled to abandon it. The side which had failed was immediately torn down, a new foundation of broader dimension put in, and the wall reconstructed. The load per square foot on the clay of the new wall is about 1½ tons, and, as far as the author knows, has remained intact. All along the side of the wall which failed was an open area, which was very imperfectly drained, and we are inclined to think was the cause of the clay becoming softer than it otherwise would have been, for the three other sides of the building, while showing more or less settlement, yet remained comparatively in good condition.

In the city of Cleveland, Ohio, many heavy structures have been founded upon clay deposits, and one or two notable ones have shown serious settlements. In the new Central Viaduct, now being constructed, and the foundations of which were described in the *Journal of Association of Engineering Societies*, the pressure per square foot of foundation on those piers and abutments which rest directly upon the clay has been limited to from 1 to 1.7 tons. The abutments, which exert the largest load mentioned are described as resting upon "a mixture of blue sand and clay, with some water," while the piers, giving a load of but 1 ton per square foot, rest upon a "plastic blue clay of various degrees of stiffness, mixed with fine sand."

* Trans. Am. Soc. C. E.

EXAMPLES OF FOUNDATIONS ON SOILS.
(IN TONS OF 2,240 POUNDS.)

	Name of structure.	Date.	Engineer.	Kind of soil under foundation.	Pressure per sq. foot (tons).	
1	{ Central viaduct, Cleveland, Ohio }	1887	C. G. Force.....	Blue clay.....	1.0 to 1.7	{ The blue clay of the foundation is mixed with some sand and water. (Jour. of Ass. of Eng. Soc., Vol. VI., No. 6.)
2	{ Bridge on R.R., Busigny to Herson, France..... }	..		Unstable sand.....	1.8	{ Over the Canal de la Sambre. (Debaube.)
3	{ Arches on R.R., Busigny to So-main, France..... }	..		Yellow sandy clay..	2.1 to 2.8	(Debaube.)
4	{ Chimney at New-castle-on-Tyne..... }	..	R. Stevenson ...	Compact clay.....	1½	{ (Trans. Am. Soc. C. E., Vol. II., page 287.)
5	{ Kuilenb'g Bridge, Holland..... }	..		Compact sand.....	2.3 to 2.9	{ A slight mixture of clay with the sand. (Debaube.)
6	{ Chimney N. Y. Steam Co..... }	1882	C. E. Emery	Wet sand.....	4.0	{ Sand was not very compact; some slight settlement. (Tr. Am. So. C.E., Vol. 14, p. 180.)
7	{ Viaduct, Point-du-Jour, France }	..	{ Bassompierre }	Coarse gravel.....	4.4	(Debaube.)
8	{ Brooklyn bridge (anchorage)..... }	1882	Roebling.....	Sand.....	4.0	
9	{ Brooklyn bridge, N. Y. Pier..... }	1882	"	{ Compact stony }	5.5	
10	{ Nantes bridge, France..... }	1863		Sand.....	6.78	{ Some settlement has taken place. (Gaudard.)
11	{ Gorai bridge, Lock Ken Viaduct, Bordeaux bridge..... }	..		{ Compact sand }	7.36 to 8.17	(Gaudard.)
12	{ Washington Mon-ument..... }	1884	U. S. Engineers..	Clay and sand.....	3 to 9	{ Slight settlement during construction. (H. R. Mis. Doc., No. 8, 48th Cong., 2d ses.)

When clay is mixed with other materials, as coarse sand and gravel, its supporting power usually largely increases, being greater in proportion as the other materials are in excess, up to the point of forming a concrete mass, in which the clay is the cementing material, and in just sufficient quantity to bind the materials together. In this condition we often find the clay in an indurated state, and the hardness of the mixture—commonly called “hard pan”—is proverbial. Such soils are safe for heavy loads, approximating that of the softer rocks.

Brennecke, in his book on foundations, mentions a large chimney with a load of 6 tons per square foot on hard clay. This is an extraordinary example, and we are inclined to think, though no further particulars are stated, that it was upon some such hard mixture of clay and gravel as mentioned. At any rate it would be a bad precedent to follow in loading beds of pure clay.

The Washington Monument is founded upon a layer of clay and sand. When the shaft was up 150 feet, an investigation showed that the foundation was entirely inadequate upon which to complete the structure—a committee of United States Army engineers reporting that such a soil should never be loaded above 10,000 pounds per square foot. The foundation was therefore made heavier and larger, and the shaft successfully completed with a height of 555 feet. Colonel Casey, the engineer in charge, reports the pressures upon the soil as nowhere exceeding nine tons per square foot, and less than three tons per square foot near the outer edges.

The settlement of the monument during the repairs to the old foundations was about two inches, and afterward a further settlement gradually occurred during construction of two inches more, making a total of four inches. If the load per square foot on the soil reaches the amount of nine tons, it is the heaviest load upon such a soil which we find any record of, and we think the doubts expressed by different persons as to the ultimate stability of the monument entitled to careful consideration.

Supporting Power of Sand.—Foundations on coarse sand and gravel are usually successful, particularly if free from the action of running water, and structures, proportioned in accordance with any ordinary rules of good construction, are hardly likely to have an area of base which will not be sufficient to limit the load per unit to the safe carrying capacity of the soil. Coarse sand deposited in beds has usually a high supporting power, but the coarseness alone is not proof positive of this, for it also depends somewhat upon how it has been deposited. On beds of sand made artificially, as is often done for foundations, the dry sand loosely thrown down does not form a compact mass such as is desirable, and a certain amount of compressibility will exist.

In some experiments made in France with river sand, it was found that by pounding the sand in thin layers its density could be increased one-fifth, and that there still remained about 20 per cent. of voids which could be notably reduced by simultaneously treating the sand with water while the stamping down took place. The compression was exercised in these experiments by means of hydraulic presses, and the result obtained that river sand treated as above would resist up to pressures of 1,420 lb. per square inch.

Water is the chief agent which makes the particles separate and draws them into the voids of the mass, and is invaluable in all works of embankment in which solidity is required; but it must also be well drained off, because if the original amount should remain, of course the mass of earth would continue in a semi-fluid state.

Mr. McDonald, in constructing the iron ocean pier at Coney Island,* assumed that the safe load per square foot upon the flanges of the iron disks, which were sunk into the sand, was five tons. But many of them really support as much as 6.3 tons continually, and are subject to occasional loads of eight tons per square foot, which they appeared to sustain without settlement.

The foundation of the large chimney of the New York Steam Company† was made of concrete resting directly on the sand of the old beach, which had for-

merly extended to this point. This sand was quite fine, with pockets of gravel, and containing at a few places some stone. The sand was thoroughly saturated with water, and would flow when disturbed or undermined. The load per square foot on this material was to be four tons, but before more than one-third of this amount was placed upon it, slight settlements occurred which were not uniform. After the structure was completed slight cracks appeared, but not sufficient to cause any material damage.

In contrast with the loading of the partly unstable sand of this chimney may be mentioned the loads which were imposed upon a clean, coarse sand in the foundations of the Pacific Mills chimney, at Lawrence, Mass. Here the sand was inclosed by tight sheet piling, and only 1.83 tons per square foot placed upon it.

The anchorage of the Brooklyn Bridge rests upon sand, with a pressure of about 4 tons per square foot. The Nantes Bridge, constructed in 1863, and founded on sand, has a pressure of 6.78 tons per square foot, but has settled somewhat.

The safe loading upon the sandy soil of Berlin is generally taken at about 2.3 tons. Brennecke describes this sand as being comparatively loose, but likewise mentions its having been successfully loaded up to 4.1 tons per square foot.

When sand is mixed with other materials, such as clay or loam, which have the power of retaining water, its supporting power grows less, and proportionally more so as the sand becomes finer and loses its sharpness. Of such a nature is the commonly called “quick” sand, which really occupies a position between pure sand and pure clay, being a mixture of them both. Pure clay is composed of alumina, water, and silica, and in proportion as the silica is absent the more water will it hold. This is the material which, when mixed with the very fine and rounded grains of sand, makes it “quick.” Deposits of such are often found, which through long draining have lost all the water, and which appear dry, and loose, and easy to excavate or handle, and generally of a whitish color.

If we could keep such deposits absolutely free from saturation with water, we could trust it with moderate loads. Its weight is less than either good sand or clay, running from seventy to ninety pounds per cubic foot.

At the foundations of the capitol at Albany, Mr. W. J. McAlpine describes some of the material as being quicksand without the water. Experiments made in the soil of this foundation showed that under a weight of two tons per foot no perceptible displacement occurred; and at about five tons the surrounding soil was forced upward. It was endeavored to place no more than two tons per foot upon the soil with the completed building, and great pains were taken, by means of spreading gravel six inches deep over the whole area, and inclosing it in a puddled wall, to keep the character of the soil from changing. These foundations have partly failed, and serious cracks have appeared in different parts of the structure. We wish here to call your attention to the remarks which we shall make later on, upon judging of the supporting power of soils by limited experiments upon the same. We have not been able to find any complete account of how they were made in this case.

We find recorded by Debaube a case of founding upon a loose, watery sand, partaking somewhat of the nature of quicksand, in which the load per square foot was 1.8 tons. The sand is described as being of a sirupy consistency, and after endeavoring to excavate it without success, further than getting out about three feet in depth, they filled back into this partially excavated hole with dry, coarse sand, placed a bed of beton upon it, and completed the structure, which was a bridge over the canal of the Sambre à l’Oise, for the railroad from Busigny to Herson in France. No after-settlement occurred.

This method of treating quicksands with coarser sands and gravel appears to have been of much service in many cases. Trautwine records an example of its successful use in making a foundation over quicksand for the brick aqueduct for supplying Boston with water.

Supporting Power of Soft Soils.—In speaking of soft soils we generally mean those which are referred to as being compressible, though really this is more or less of

a misnomer, for they are regarded as being the more compressible in proportion to the amount of water they hold, and yet we know water is practically incompressible. Debaube, in his excellent work on foundations, makes this distinction clear, and classes such soils as “mobile,” movable, which in itself is a true definition of their characteristics.

The alluvial mud of many rivers gives us the best example of soils of this kind, and in this country, as in general in most others, the soft soils are usually found at the lower end of rivers flowing through valleys of considerable width, and emptying into the sea or large lakes, where the force of their currents is checked by the larger body of water, causing the detritus held in suspension to be deposited in beds of greater or less thickness; or by overflowing their banks and spreading far and wide throughout the valley the waters lose sufficient velocity to carry the suspended matter further.

An example of the greatest magnitude, of such formation, is seen in the country adjacent to the lower Mississippi, and much of the State of Louisiana has been formed in this way. Here is to be found the “*prairie tremblante*,” or trembling prairie—vast stretches of land composed of a semi-fluid, mud sub-soil, overlaid by a mass of decayed vegetable matter, and which, tied together by rootlets, forms a more solid, but trembling, crust.

It is impossible, of course, to solidly found anything upon such soil; but rather must any such attempt be regarded as a problem of flotation in a muddy liquid. Yet we are often called upon to construct railroads, bridges and buildings in soil but a trifle more solid and homogeneous.

The supporting power of all soils is of course dependent more or less upon the depth at which the foundation is made, and in the alluvial soils such as we are now considering this is of more importance than in other kinds. We have not time at our disposal in this paper to enter into this matter more fully, and in our remarks we have treated upon the supporting power of soils as we generally use them, and not much affected by depth.

The softer clays really belong to and should be treated in the same manner as the soft alluvial soils to which we are now alluding.

The actual supporting power of such soils can hardly be given in figures which can be of much real value. In the city of New Orleans, for instance, almost without exception, we find recorded the serious settlement of all the larger buildings and structures, which have been founded directly upon the alluvial soil, and in many cases the load per square foot is much less than a ton. From some experiments made in India in alluvial soil, the safe load per square foot is given as 1 ton; while Sir Charles Fox* finds it to be only 1,680 pounds for the soil which he tested.

Experiments to determine the weight which can be safely placed upon soft soils have often been made, but are not generally of much value, unless the area of soil tested is of about the same extent as the base of the foundation to be placed upon it. This was very clearly shown in France some years since by a series of experiments made in the soft alluvial soil of the valleys of Vilane and l’Oust.†

A number of small piers of masonry, 6.56 feet square, were built at different points, and made of such a height as to give a load per square centimeter double that of the large embankment which it was the intention to afterward construct. It was supposed that these piers would settle deep into the mud, but they really settled a comparatively small amount, while the embankment, covering a great, broad area of base, but exerting a pressure per square centimeter of only one-half that of the piers, showed in all cases very much greater settlements.

The explanation was simple: if a small pier, with a square base, is pressed down into the soft soil, the frictional resistance against the sides of the compressed ground is proportional to the length of these sides; while a square pier of, say, double the width would experience a frictional resistance just twice that of the first pier. In other words, this resistance is directly proportionate to the length of the perimeters of the bases. But the area of the base of the second pier is four times that of the first, hence we see that, with an equal pressure per square unit of base, a small pier would have much more resistance to overcome than a large one, and that one would be at fault to take as a correct measurement of the supporting power of the soil the results obtained from loading but a limited area. Experiments upon the soil in New Orleans, made in 1851 and 1852, and which are recorded in *Van Nostrand’s Magazine*, Vol. 27, showed analogous results.

Stated then as a proposition: *The supporting power of soft soils is greater in proportion as the loaded area is limited, or, conversely, large areas of soft soil will not support as much weight, per unit of surface, as more limited areas of the same soil.*

This principle is most important, and should not be neglected by engineers designing foundations. It is applicable to the supporting power of bearing piles, and hence any formula for the same which does not make a distinction due to different sectional areas of the piles is incorrect in theory.—*Journal of the Association of Engineering Societies.*

MANUFACTURE OF GLASS BOTTLES IN GERMANY.

By D. J. PARTELLO, U. S. Consul, Dusseldorf.

WITHIN the consular district and about five miles from the city of Dusseldorf, in the valley of the Rhine, at the base of a low range of hills, is located the glass bottle-manufactory of Ferd. Heye, of Gerresheim, claimed to be the largest establishment of the kind in the world owned and operated by one individual. Its convenience for obtaining supplies is second to none; two lines of railroad, both owned by the German government, pass the establishment, one line leading direct into the yard.

The small German town of Gerresheim, containing about 3,000 inhabitants, immediately adjoins the works, the two being inseparable on account of the mutual interests involved, and it is properly said here that

* Trans. Am. Soc. C. E., Vol. 8.
† Trans. Am. Soc. C. E., Vol. 14.

* Clemann’s Railroad Engineer’s Practice.
† Annales des Ponts et Chaussées, 1864.