PRESSURE ON FOUNDATIONS.

We make the following extracts from an admirable article on this important subject lately published in the *Builder*, in which the principles governing the attainment of safety in building are laid down and classified.

The nature of the soil to be built upon is evidently the first object for consideration; and it is scarcely necessary to say that soils vary in their strength or bearing power as much as in their geological formation. They range from a soft or semi-fluid condition—such as that of marsh, mud or silt,—through all intermediate stages to the condition of the hardest rock. The inherent strength of the soil itself, therefore, and the load to be sustained upon a given unit of its surface (which is usually taken in practice as a square foot) are first to be inquired into.

Where the soil is incapable of sustaining the incumbent load of the structure to be placed upon it, it becomes the duty of the constructor either to increase its bearing power by artificial means, or else, by widening the area of the foundations, to extend and enlarge the bearing surface until it contains within it the resisting power necessary to the requirements of the case. The means by which these results are arrived at will form the second branch of the inquiry.

The materials commonly used for these purposes and the amount of bearing power obtained from them will also be considered.

Every soil is capable of sustaining a certain weight upon each unit of its surface, which varies according to the solidity of the soil. The bearing power of a soil approaching in fluidity to water itself may be assumed at zero, or the lowest point in a scale, and the bearing power of hard rocks may be assumed as the highest; and if these bearing powers be taken at from 0 to 30 tuns per square foot, it will be sufficiently accurate for practical purposes. Between these extremes lie all the intermediate soils of weak rocks, shale, gravel, sand, clay, loam, silt, etc. Supposing the soil to be capable of bearing a pressure of three tuns per square foot, it follows, of course, that either one square foot of foundation must be provided for each three tuns weight in the entire structure, or that the bearing power of the soil must be increased by some means to the required standard.

The weight of the intended structure should first be calculated, and should include all extraneous loading which may be incidental to it. Care must, of course, be taken to ascertain the proportion of weight carried on each part of the foundation, and the area of the part must be proportioned accordingly. The allowance for extraneous loading will vary according to the use of the structure.

Thus in a railway bridge, it is usual to calculate the weight of the trains at from 1 to 1½ tuns per foot run, for each single line. On a road bridge, the usual load assumed is from one half to one cwt. per superficial foot, the load of a crowd of persons standing close together having been ascertained to be a little more than three quarters of a hundred weight per square foot. In ordinary floors, the load may be assumed as similar to that of the road bridge. In a warehouse, the load must be ascertained.

It is then necessary to determine the number of tuns pressure per square foot which the constructor will put on the soil on which the building is to be erected. In this respect, great variety exists in the practice of the most eminent engineers, and pressures varying from 1 to 8 tuns have been allowed on foundations on the London clay. About 4 tuns is recommended in practice as a safe pressure on stiff clay. Loam, indurated clay or shale, as well as soils of similar strength, such as chalk, etc., vary in bearing power in degrees impossible here to indicate. The practical judgment of the constructor must determine in each case. Beds of solid gravel form, when of sufficient thickness and uniformity, one of the most unyielding of the ordinary soils, and they may be safely loaded with double the pressure which can be put on London clay.

The soils of sand vary from a compact close sand, with a clayey bind perfectly impervious to water, through all conceivable varieties of coarseness, looseness and porosity. Porous sand soils are easily removed by running waters, and they require the constructor's extreme care where this is likely to occur. The only course is to lay the foundations so deep that the current shall not lay them bare. Perhaps the most difficult of all engineering work is the foundation of bridge piers in a deep soil of this nature. The usual means employed in these cases up to a comparatively recent date have been the erection of coffer dams round the space to be occupied by the foundation of the pier, the piles forming the dam being driven till they reached solid soil. When a solid bottom could not be attained, long piles were driven all over the foundation surface and the concrete or masonry foundations were laid upon them. In the first case, the natural sustaining power of the lowest soil reached must be the measure of the pressure to be allowed; in the second, this is increased by the friction on the sides of the piles as well as the resistance of their lower ends to sinking. Of late years, these plans have been superseded by sinking, into the bed of the river, upright cylinders. (The construction and mode of operation of such cylinders are already familiar to the readers of the SCIENTIFIC AMERICAN, and need not be dwelt upon here.)

It is generally found that ordinary soils will bear more weight at great depths than nearer to the surface; which is owing to their condensation by the superincumbent pressure, and, also, to the increased difficulty of laterally displacing the soil. This may be understood by considering the action of a pointed pile, which, as it is driven, displaces the original material and renders the soil in its immediate vicinity more condensed.

When sand of good quality is protected from the influence of running water or rains, it forms an excellent foundation, and, when in thick beds, may be loaded with from 6 to 8 tuns per square foot with perfect safety.

There are, however, some practical considerations which modify the question of what constitutes a safe pressure. uppose, for instance, a solid block of masonry, 20 ft. square and 20 ft. high, and a thin wall of the same material, also 20 ft. high, were placed on the same soil. On this supposition, the conditions of both soil and pressure for each square foot of the foundations would be alike in each case; and yet the thin wall, as regards the stability of its foundation, would be far less advantageously situated than the square block. It is customary, therefore, in practice to extend the foundation courses of a wall or column to a considerable width beyond the face of the superstructure.

Rocky soils, which vary from the hardness of granite to that of soft crumbling stone easily worn by exposure to the weather or to running water, may be considered in the same category of bearing power as masonry itself.

The weight of the structure having been calculated, the pressure per square foot on the soil determined, and the area of the foundations deduced therefrom, as above described, the base of the structure must be extended, either by footings, concrete, or otherwise, so as to cover that area and transmit the pressure equally and uniformly over it.

It now remains to consider the pressures which may safely be adopted on the materials themselves which are used in foundations.

Good, ordinary brickwork will crush with a load of about thirty tons, and may be loaded safely up to ten tuns per foot. Brickwork of the best description, set in Portland cement, can be loaded with double this weight; though this should be considered extreme.

The load which can be put upon stonework depends upon the workmanship as well as upon the hardness of the stone itself. Thus, rubble walls with thick and irregular joints of mortar are weaker even than inferior brickwork, while well bedded ashlar masonry will bear loading to an immense extent. In general, from eight to thirty tuns per square foot may be taken as the practical limit.

Concrete will bear from six to twenty tuns per square foot, accordingly to the goodness and proportions of its materials.

The bearing power of timber piles is an important feature in foundations, and varies according to the nature of the soil and the size and length of the pile driven. Where long piles of whole timber are driven through a loose stratum to a firm one underlying it, to the usual extent (a tun hammer with a 15 ft. fall not driving the pile more than a quarter of an inch), they may be trusted with a load of from ten to fifteen tuns. Where their bearing power depends on the friction or adhesion of the soil on their surfaces, it may be easily ascertained by pulling up one of the driven piles by a lever. The measure of the weight required to raise it will be, of course, the friction of the ground on the surface of the pile. When the soil throughout is of a weak and fluid character, it should not be loaded with more than one sixth of the weight which will draw it.

These remarks are, of course, subject to modification in the endless variety of circumstances met with by the practical architect and engineer.

Instruments for Observing Earthquake Shocks.

Owing to the great importance of being able to foresee the eruptions of Vesuvius, the late Government of Naples was led to put up an observatory to watch its signs. The house, built in 1844 on Mount Vesuvius, stands near the hermitage, 2,080 feet above the sea, being placed on a ridge of the mountain, which has turned aside many lava currents without being itself submerged. It is founded on vaulted arches, above which is a large hall for specimens of lava and volcanic minerals. Steps lead up from this hall to the observatory proper. The whole is in charge of Professor Palmieri, of the Royal University of Naples, who, by his ingenuity and zeal, has brought the instruments to a state of great perfection.*

The most important sections of the apparatus are the seismographic or shock recording instruments, which are in a separate room, and are worked by electricity. There are also instruments for observing the electricity of the air, and the pressure of the wind and amount of rainfall, as well as the diurnal variations of the magnetic needle.

All former attempts at measuring and recording earthquakes depended directly on the shocks making their own marks; slight ones thus escaped notice, but by the use of electricity the certainty of record is invariable. The instruments are made to record the horizontal and vertical oscillations, the time of their occurrence, and their duration and direction.

Mercurial columns of ingenious forms are employed in the instruments. The agitation of the mercury, or its change of level, by any shaking of the earth, sets the delicate electrical recording apparatus at work, which instantly shows what has happened.

By means of this apparatus, the astronomical time of the first shock is recorded, as well as the interval between the shocks, and the duration of each; their nature, whether vertical or horizontal, is given, as also the maximum of intensity; and, in the case of horizontal shocks, their direction is indicated. Professor Palmieri has the instruments examined three times a day, and an assistant observer is always at hand, to hear the bell and put back the apparatus to its normal position for fresh observations. It appears that it records all the violent shocks that occur in the Mediterranean basin; thus, on the occasion of the late eruption in the Greek Archipelago, Professor Palmieri was able to announce to the Neapolitans that a great disturbance had taken place long before the news reached Italy. The shocks in connection with Mount Etna are readily observable.

It is recommended that where earthquakes are frequent the observatory should be founded on solid masonry, bedded in the earth, and should consist of a wooden house not liable to be overthrown.

The following signs of an approaching eruption are considered reliable: First, when the crater fills up and the vapor from it diminishes in quantity. Secondly, when the vapor from the crater gives much deposit of iron or sodium. Thirdly, when the water sinks in some of the springs of the neighborhood.

The phenomena more nearly preceding an eruption are the occurrence of earthquakes, increasing in intensity and frequency for some days beforehand, also the irregularity of the diurnal variations of the magnetic needle. One of the remarkable attendants of an eruption (which may be observed to a lesser degree whenever the mountain is steaming much) is the frequency of lightning flashes, attending on the condensation of the vapor of water from the crater; just as, in an ordinary thunderstorm, lightning occurs at the time the vapor is condensing, as is proved by the rain that follows.

In addition to these phenomena of Vesuvius, the volcanic activity of the district is shown by a gradual rising of part of the coast of the bay near Torre dell' Annunziata, where there is already an alteration of several feet; while on the other side of Naples, at Pozzuoli, the pavement at the edge of the harbor is sinking below the level of the water, and the pavement of the temple of Jupiter Serapis had, in the spring of 1869, sunk about 16 inches lower than in 1858.

*The late eruption, which was so extensive and so fatal, was foretold by him as about to take place, and with admirable courage he remained in the observatory at the most dangerous period, when the building ran great risk of being ruined, in order accurately to observe the records of his instruments; a service for which, it is understood, he is to be made a senator of the kingdom of Italy.

Hot July.

In New York, the heat of the first July week has not been paralleled within ten years. On Tuesday, the 2nd inst., the mercury at 3 P. M. stood at 100° in the shade. On the Sunday and Monday previous, it reached 98°, the three days averaging nearly ten degrees hotter than the corresponding days of 1871.

The suffering of both man and brute has been terrible. In the crowded business streets of down town, in the new buildings in process of erection, it was pitiable to see the laborers working unprotected by shade and sweltering in the fierce rays of the sun. Cases of sunstroke were frequent. On the 2nd inst. nearly one hundred and fifty persons were prostrated during the day. Owing to the admirable ambulance system now in working order throughout the city, the sufferers were promptly cared for, but about seventy of their number, it is stated, have died. The horses on the street cars and omnibuses seemed unable to draw their load, dozens succumbing to heat and exhaustion. Among the tenement houses and rookeries in the lower wards of the city, the misery has been appalling.

Railway in Egypt.

The staff of surveyors and assistants, nearly thirty in number, taken out by Mr. John Fowler, C. E., to make a survey for a railway in the valley of the Nile, have returned after having successfully completed their work. The line surveyed is about 600 miles in length, and commences at Wady Kalfah, near the second cataract, and terminates at Khartum, where the Blue and the White Nile unite their waters, above the sixth cataract. For nearly three fourths of its length, the line will be on the edge of the valley of the Nile, about three fourths of a mile from the river, and constructed above the level of the periodical inundations. At the commencement of the great bend, between 18° and 16° north latitude, the railway will leave the valley, and proceed by a direct line across the desert of Bayuda to a point near the sixth cataract, whence it will follow the valley southwards to Khartum, the intended terminus for a time.

THE merchants in Birmingham, Eng., and the surrounding townships who do business on foreign account continue to receive valuable advices from nearly all the markets, as well in Southern as in Northern Europe, from the British antipodean colonies, and from British Canada and the United States. The reduced tariff which will come into operation in America on the 1st of August, by which all metals and their manufactures, except iron wire, watches, and jewelry, are to be admitted at a reduction of 10 per cent, and tin plates at a reduction of 15 per cent, is stimulating not only the demand for iron by American customers, but is also leading to an enlarged business in respect of nearly all the goods contemplated in the reduction. Valuable orders have already been sent across; and enterprising manufacturers and merchants are stimulated to greater energy with a view to the extending of their connection with the different United States markets.

THE velocity of electric waves through the Atlantic cables has been ascertained by Professor Gould to be from 7,000 to 8,000 miles per second. Telegraph wires upon poles in the air conduct the electric waves with a velocity more than double this. It is a curious fact that the rapidity of the transmission increases with the distance between the wire and the earth, or with the hight of the support. The *Journal des Telegraphes* says that wires, placed on poles slightly elevated, transmit signals with a velocity of 12,000 miles a second; and those at a considerable hight give a velocity of 16,000 or 20,000 miles.