

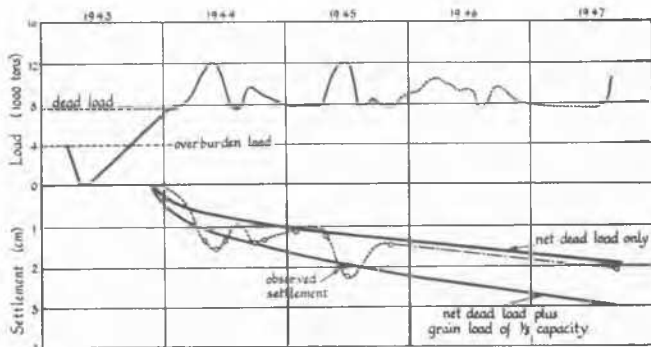
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Comparison between Observed and Computed Settlements Oxford Silo.

FIG.5

basis of past experience they were not likely to be much more than a quarter of an inch. During the course of testing however a series of triaxial compression tests were carried out on Oxford clay samples and it is interesting to see how theoretical values based on these results compare with the actual movements. The tests indicated that the modulus of elasticity was of the order of 150 to 200 tons/sq. ft. From an analysis based on elastic theory the theoretical movement under a grain load of 0.6 tons/sq.ft. would be of the order of 2 in.

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LOADING TESTS ON TANKS IN PERSIA

R.V. ALLIN

The subject of this paper is the method employed and the results achieved in the investigation of the bearing power of two areas consisting chiefly of soft, silty and highly varved soil in Persia, which were proposed for the erection of important plant.

It was known that this plant, which, it was assumed, will be constructed on semi-rigid reinforced concrete slab foundations, would impose on them, during its operation, loads of an intermittent and surging nature which would be somewhat akin to those caused by high structures under wind pressure.

It was also known that any unequal settlement of these foundations which might occur would have extremely serious effects on the operation of this plant.

It was sought to ascertain the working load which, under these circumstances, might be placed with safety on the soil.

Further, it was realised that there did not exist sufficient theoretical equipment for estimating, to any useful degree of accuracy, the amount and type of settlement which might occur on such soil under incremental loading imposed during construction, especially having regard to its heterogeneous nature.

For this reason, and also on account of the large capital loss which might be incurred if a faulty decision was made, it was decided to employ soil investigation and loading tests of a size which, it is believed, have few, if any, precedents.

whereas in actual fact the measured movement was only about 0.3 in.

This result tends to confirm the suggestion put forward by Dr. Terzaghi 1) that, particularly for buildings supported on a raft foundation at a depth of more than about 8 ft. below the ground surface, there exists a great resistance against lateral yield of the stratum which substantially reduces the elastic settlement.

ACKNOWLEDGEMENTS.

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The author wishes to acknowledge the helpful co-operation of the chief structural engineer and his staff in the Ministry of Works in connection with the field work and is indebted to his colleagues, in particular Mr. J. McNamee, for assistance in the laboratory and field work.

REFERENCES.

- 1) K. Terzaghi "Settlement of Structures" Paper F.16 Vol III Proc. 1st. Int. Conference on Soil Mechanics and Foundation Engineering Harvard 1936.

As a preliminary to these loading tests, borings were made on these sites to a depth of about 100 ft. and undisturbed samples were taken and tested.

SOIL INVESTIGATION.

The site borings taken on these two areas disclose the types of soil which have a striking similarity, both in their properties and sequence, in both cases displaying, (a) a surface stratum of laminated light brown clay from 12 to 15 feet in thickness, lying over a soft, silty clay deposit about 50 ft. thick, closely laminated or varved, and containing silty and sandy partings with occasional shelly fragments and also black particles of a peaty nature. Near the base of this latter deposit, erratic inclusions of peat were found.

This deposit, in each case, is followed by a stiff mottled clay, the strength of which rapidly improves with its depth.

SHEAR VALUES.

The samples from the surface stratum of clay had a shear value varying between 1200 and 400 pounds per square foot respectively at its surface, when dry, and at its lower horizon 12 to 15 feet below ground level.

The succeeding silt and clay varved deposit varied in shear strength between about 250 and 450 pounds per square foot, according

The accompanying diagrams show the settlements and tilts which occurred under this incremental loading.

It will be seen that unequal settlements creating tilt commenced in B.T. No. 1 at a net load of 17 cwts. per square foot and in B.T. No. 2 at 17½ cwts. per square foot when their recorded mean settlements had reached 1½ and 2¼ inches respectively.

In the case of B.T. No. 1 the tilt reached a maximum of 1 inch to the west in the full height of the tank when the net loading in the soils had reached 26 cwt. per square foot and had been imposed for about 10 weeks; whereas in the case of B.T. No. 2, this tilt reaches a maximum of 1 3/8 inches when the net loading had reached 26 cwt. per square foot and had been imposed for about 14 weeks.

The direction of tilt of B.T. No. 1 was to the west; whereas, that of Tank No. 2 was to the north, and the periods for their maximum development under the same amount and system of loading were approximately 3 months in the case of B.T. No. 1 and 4 months for B.T. No. 2.

It should be noted that the system of loading by increments until settlement had ceased and the final load was the same in both cases and that stability was reached by B.T. No. 1 in about 7½ months at a final settlement of 9 inches; whereas, with Tank No. 2 this state was reached in about 7 months at a settlement 9 7/8 inches.

The recovery on unloading in the case of No. 1 Tank was 1 5/16 inch and that of No. 2 Tank 1 9/16 inch: in both cases there was a slight reduction of tilt during this operation.

VIBRATION TEST.

A test devised to give an indication of the effects of vibration on this soil when loaded was made on Area No. 1 by driving a 14 by 14 inch concrete pile - 60 feet in length - to a penetration of 54 feet with a 2½ ton hammer with a free fall of 6 feet at a distance of about 13 feet from the outside edge of the raft carrying the test tank No. 2 when its foundation was under a load of 26 cwts. per square foot and all further settlement had ceased.

Although these driving operations produced an appreciable tremor in the ground at the edge of the raft, no further settlement or tilt of the tank occurred as a result of this vibration.

CONCLUSIONS.

The low densities of the soft, silty samples indicated a lightly consolidated condition of the soil consistent with a geologically recent deposit.

Results of the bearing tests are considered to be of great interest owing to the remarkable resemblance which they bear to one another in several respects, particularly the manner of the cessation of settlement of the tanks under steady load.

Again, in spite of the extremely varied nature of the varves of the soils, as previously described, their response to load is very similar, as is also their recovery on its release.

The high loading taken by these weak soils without complete failure is considered to be accounted for by their progressive con-

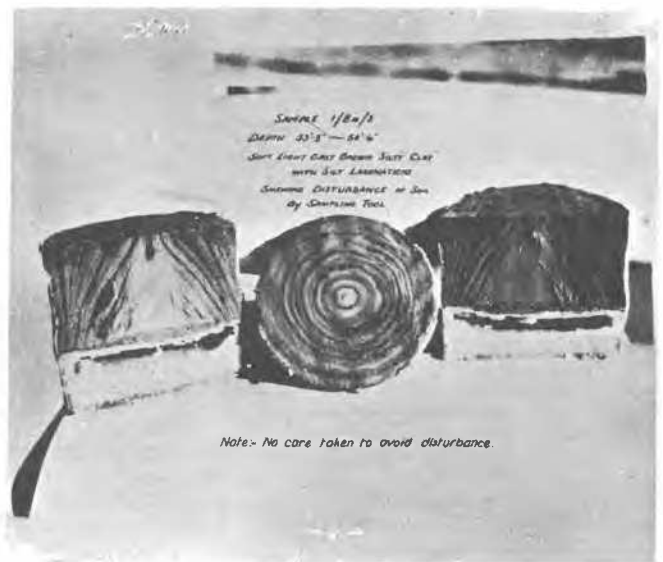


FIG. 3

solidation under load which thus caused a progressive improvement of their bearing resistance under compression.

It will be noted that an endeavour was made to make both tests identical as far as possible, but this was not completely possible for certain practical reasons. It is, however, considered that sufficient uniformity of loading in both tests was achieved to emphasize the great similarity of the response of the soils to load in both tests when due regard is taken of the variations of the periods during which they were loaded.

It is clear that in these lightly consolidated soils considerable advantage can be taken of their progressive consolidation by slow loading which gradually forces the pore water out of them and stabilises them in advance of the load.

It can be said with confidence, therefore, that the tilt which developed would have been considerably greater and probably have occurred earlier in the loading programme if the test loads had been imposed at a more rapid rate. Again, there would have been a greater risk of complete failure by tilting.

With regard to the vibration test, the results appear to emphasize the fact that the soil must have been thoroughly consolidated during the seven months period during which it was test loaded, but would probably have produced considerably increased tilt and settlement if applied before consolidation had taken place.

It would appear that the main lesson to be learnt from these bearing tests is that in water-laden soils of this soft, silty nature, it is extremely important to restrict the speed at which the load is imposed during construction.

ACKNOWLEDGEMENT.

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