in one half of a millimetre. Instead of the settlement of 33 cm. (13 inches) given by calculations, leaving out of account the Archimedes' principle and the lateral friction on the pier the registered settlement was in the neighbourhood of 3 cm. (1 1/4 inches).

The piezometer placed at the base of the structure showed that the Archimedes' upward thrust was wholly exerted through the clayey layer. Meanwhile the cells made it possible to measure the load transmitted by the pier to the ground. This load was in agreement with the settlement of a few centimetres, as registered. Finally it was possible to compare the load transmitted to the ground by lateral friction (difference between the total load applied and the maximum load transmitted by the base of the pier) with the ultimate resistance to lateral friction given by the conventional formulae; the values arrived at were much lower.

Generally speaking, the results of the different measurements and observations agreed satisfactorily and gave every assurance as to the future behaviour of the structure.

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SUB-SECTION VIc

INFLUENCE OF GROUNDWATER

VIc 4 THE SINKING OF SHAFTS AS A CAUSE OF SETTLEMENT

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It is evident and a well-known fact that the lowering of the piezometric level of underground water causes settlement within the sphere where this process takes place, because the ground layers emerging from the underground water increase in weight owing to the lack of uplift. There are cases, where the lowering of the underground water level takes place unnoticed, so that the settling process is also not noticeable, and its causes are not properly recognized and therefore contested in practise. This is the case particularly with such clay layers, where an actual piezometric underground water level does not exist as capillary rise is considerable, and there is nothing but a surface along which the tension in the pore water are Nil. However, a change of the altitude of this theoretical water level, which might be called "No-Pressure-Surface", also causes locally a lack of lift as is the case when lowering the piezometric level proper, and this takes place immediately and within a wide sphere, because in this case we have to deal merely with an alteration of the tensions in the pore water. The following case, which the author has experienced himself, may serve as an example: In the coal district of Morasvska Ostrava a conveying shaft having a Ø of 8 m was sunk through entirely homogenous and "dry" clay without the necessity of any mine-drainage. Under the clay, and in a depth of about 100 m there was a thin layer of quicksand, which had been prospected with 4 boreholes in the immediate neighbourhood of the shaft. The boreholes had to be telescoped twice so that only the innermost tubing reached as far as the quicksand, thus forming a sort of "depth gauge". Before work in the shaft was begun, pumping tests were carried out in the quicksand for which purpose the inner tubing was somewhat raised and connected with the outer tubing by means of a clamp.
In the course of the work in the shaft the innermost tubing was raised from within the outer

tubing, so that in the course of 6 - 8 months the clamp was 40 to 50 mm above the upper edge (see illustration). This very considerable settlement is caused by the fact that the "No-Pressure-Surface" performs a downward movement together with the bottom of the shaft, which amounts to a lowering of the underground water level, and it causes very considerable axial strain upon the walling of the shaft, which is not taken into consideration. Mine surveying operations carried out within the district showed that cones had formed in the neighbourhood of the already existing shafts, which shows that the shaft walling absorbed the frictional forces of the settling ground layer, thus preventing settlement in the neighbourhood of shafts at least to some extent.
The question relating to the sphere within which the lowering of the "No-Pressure-Surface" is

possible cannot be answered at the present stage of our scientific research and knowledge. However, it is probably of considerable extent as may be seen from the change in the altitude above sea level of buildings situated on the sea coast, where the influence of the tide is felt in areas situated far inland.
The knowledge of this fact provides the possibility of being able very quickly to change the weight of clay layers over long distances. This may be utilised when stemming land-slides and stabilising clay slopes successfully by sinking boreholes in which the water level is kept low. Besides, axial load should be considered in the case of shafts and similar structures, unless it be preferred to eliminate friction between bottom and building structure by lubrication.

REFERENCE

1) Bernatzik: Baugrund und Physik. Zürich 1947.

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SUB-SECTION VI d

VI d 14

SPECIAL PROBLEMS IN FOUNDATION ENGINEERING

THE RESISTANCE TO REVERSING AND THE STABILITY OF THE FOUNDATIONS OF PYLONS

Experimental Study

Research effected at the initiative of the
SOCIETE INTERCOMMUNALE BELGE D'ELECTRICITE

I. OUTLINE OF THE MOTIVES AND ORIGIN OF THE RESEARCH.

The electricians of big lines know the economic importance of the question of the foundations of pylons, foundations of which the cost amounts to about 20% of the fully installed lines.

Besides, the constructors also know the uncertainty of the calculation of foundations in general and of foundations of pylons in particular.

From what precedes may be concluded, that the capitals invested in the foundations of electric pylons are by far not so judiciously used as those, which are consacrated to other parts of the lines.

Very interesting from both economic and technical point of view, the problem of the foundations of pylons is not less interesting from the scientific point of view, because it depends on the mechanism of terreaous pulverulent or coherent soils and because in this part many affirmations or deductions are neither conclusive, nor convincing and consequently ask for an experimental control.

For these three reasons of economic, technical and scientific nature, the SOCIETE INTERCOMMUNALE BELGE D'ELECTRICITE has entered into its programme of research, the experimental study of the stability of the foundations of pylons.

This initiative has first of all been encouraged by the subsidies of the FONDS NATIONAL DE LA RECHERCHE SCIENTIFIQUE allowed by right of Science and Industry ; next by those of the INSTITUT POUR L'ENCOURAGEMENT DES RECHERCHES SCIENTIFIQUES DANS L'INDUSTRIE ET DANS L'AGRICULTURE. (I.R.S.I.A.).

Such is in short the outline of the motives and origin of the research.

II. THE EXPERIMENTAL METHOD AND ITS FUNDAMENTAL PRINCIPLES.

Considering in the first place, that the problem of the foundations of pylons in natural coherent soil can not be solved before the simpler problem of the same foundations in pulverulent soil, without cohesion, the Commission Directrice has fixed the first two essential points of its programme of research, i.e. :

- to study first the stability of the foundations of pylons in a pulverulent soil.
- to study next the stability of the same foundations in natural coherent soils and to deduct from its results the corrections to which the results of the preceding study are liable.

Establishing next the absolute impossibility to carry out sufficient experiments on the foundations of real-sized pylons, the Commission has been compelled to carry out systematically experiments on reduced models only. As a matter of fact the Commission had been preceded in this way by Professor E.H. Lamb who in 1931 made a remarkable communication on this subject at the Conférences Internationales des Grands Réseaux. x)

Besides these systematical experiments on reduced models, the Commission evidently entered into its programme experiments of control also - inevitably less numerous - on the foundations of real-sized pylons.

Moreover, the interpretation of the results obtained on reduced models implies the establishment and the utilisation of the laws of similitude, which constitute the fundamental principle of the experimental method adopted by the Commission.

III. THE EFFECTED EXPERIMENTS, THE OBTAINED RESULTS

The experiments on reduced models which have been made up till now are grouped as fol-

x) Foundations of Pylons by Professor E.H. Lamb, M. Sc. (The British Electrical and Allied Industries Research Association - Londres).