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Description of a Pile Loading Test and of Settlement Observations over a Period of Time on a Completed Building

Description d'un essai de charge et observations de tassement pendant une période donnée sur un bâtiment achevé

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Summary

This paper reviews and discusses the results of a pile loading test carried out on lake marl and of settlement measurements observed over a period of 7 years on the completed building.

Sommaire

Ce rapport présente les résultats obtenus lors d'un essai de chargement de pieux dans un terrain en craie lacustre et discute les tassements observés sur le bâtiment achevé au cours d'une période de sept ans.

Object and Foundation Soil

In 1944, cast in place pile foundations had to be built at Arbon (Switzerland) on the Lake of Constance for a heating system including a factory chimney, boiler house and coal bunker (Figs. 1 and 2).

A test boring, which was made using casings of an outside diameter of 300 mm, went down to the depth of 22.3 m. The results are shown in Fig. 3a.

Test Pile and Loading Test

The test pile and later the pile foundations themselves were constructed according to the "Express" system. This is a system of cast in place concrete piling with a minimum pile-shaft diameter of 0.55 m and a pile bulb with a maximum diameter from 1.10 to 1.30 m. The penetration diagram for the driving of the bore hole casing with lost driving point as well as the driving constants are shown in Fig. 3b.

Fig. 3c shows the quantity of concrete which was placed before retraction of the casing; this enables the shape of the cast in place pile to be approximately determined.

The test pile, which was driven and cast on 7 October 1944, was subjected to a loading test on 5 December. Fig. 4 shows the load-settlement diagram in relation to time. The load of 60 tons, which was left unchanged for 6 days, gave the pattern of the settlement curve for the time between the 2nd and 8th day of the test. The settlement curve of the test load of 80 tons, which was applied on the 9th day, showed a slight flattening

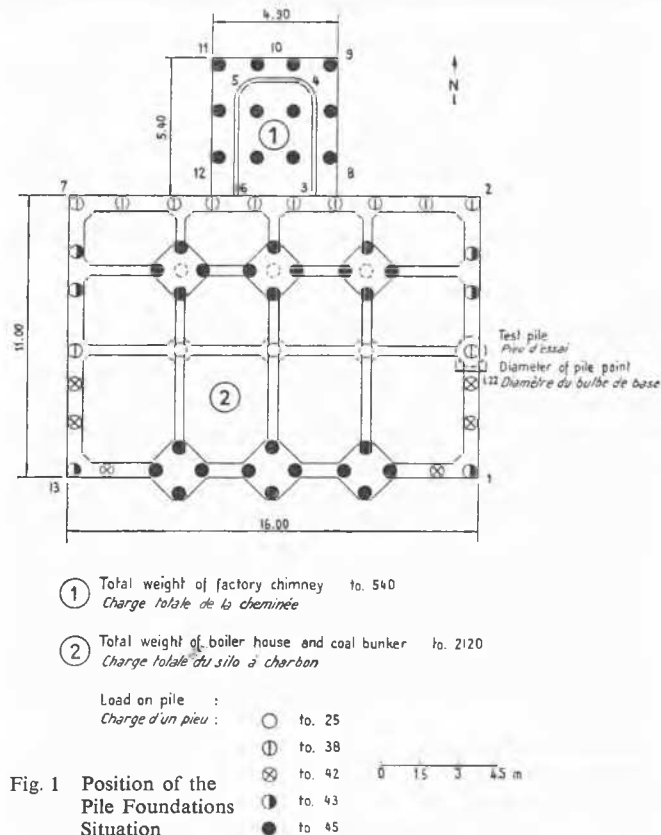


Fig. 1 Position of the Pile Foundations Situation

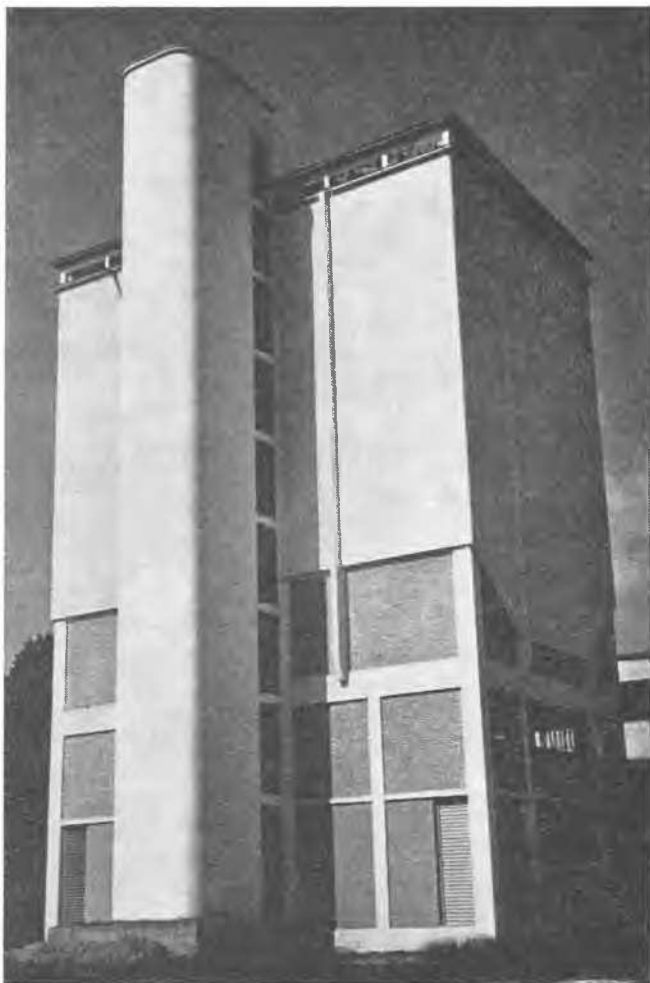


Fig. 2 Completed Building (Photograph)
Bâtiment achevé (photo)

after a few hours. The same occurred with the load movement of 100 tons, the settlement curve of which—between the 12th and 24th hour—showed an additional increase of only one fifth as against the first 12 loading hours. Based upon these test results a permissible safe load of 45 tons was then fixed.

Measurements on the Completed Structure

The pile foundations were completed on the 16 August 1945 and the superstructure, without machinery and installations, in November 1945. Round the building and the chimney, 13 benchmarks were established on the pile framing (see Fig. 1), and these have been periodically levelled since December 1945. Fig. 5 shows the arithmetic average of the settlements observed on the 13 benchmarks in 7 years; the greatest divergence amounted to approximately 10% of the mean value.

By the beginning of 1946 the settlement exceeded 10 mm and up to August 1946, that is approximately one year after completion of the building, the total settlement amounted to 50 mm. The structure remained intact and showed no cracks of any kind.

In September 1946 the coal bunker was filled with coal for the first time, which resulted in a distinct increase in the settlements. It is nevertheless worth noticing, that the settlement curve shows a time lag as against the coal load. As the coal

load diminished again between January and June 1948, a relief of settlement took place, which followed the discharge with a time lag of about four months.

The same phenomenon was repeated again in April 1950. To-day the total settlement has reached an average value of 80 mm and fluctuates within about 5 mm of this value according to the weight of the coal bunker, with a time lag of approximately 4 months.

Conclusions

About 3 years after completion of the building, i.e. approximately 2 years after the first filling of the coal bunker, the settlement ceased; it is now fluctuating around a mean value according to the increasing or decreasing of the load. The period of 6 days, which was decided upon for the loading test of the single test pile, represents a minimum and requires the extrapolation of the measured maximum settlements in relation to time. While the settlement of the test pile under a load of 60 tons over 6 days amounted to approximately 7 mm (Fig. 4), 3 years after completion the settlement of the building showed a value of approximately 80 mm under an average load per pile of approximately 40 tons (including live load) i.e. 11 times greater than for the test pile. A substantial part of this difference is attributed to the considerably greater depth of the building as compared with the single test pile. (A description of the construction of the building and its foundations appeared in "Schweizerische Bauzeitung", 1948, vol. 66, p. 399.)

Time-Settlement and Loading Diagram
Diagrammes du tassement et des charges en fonction du temps

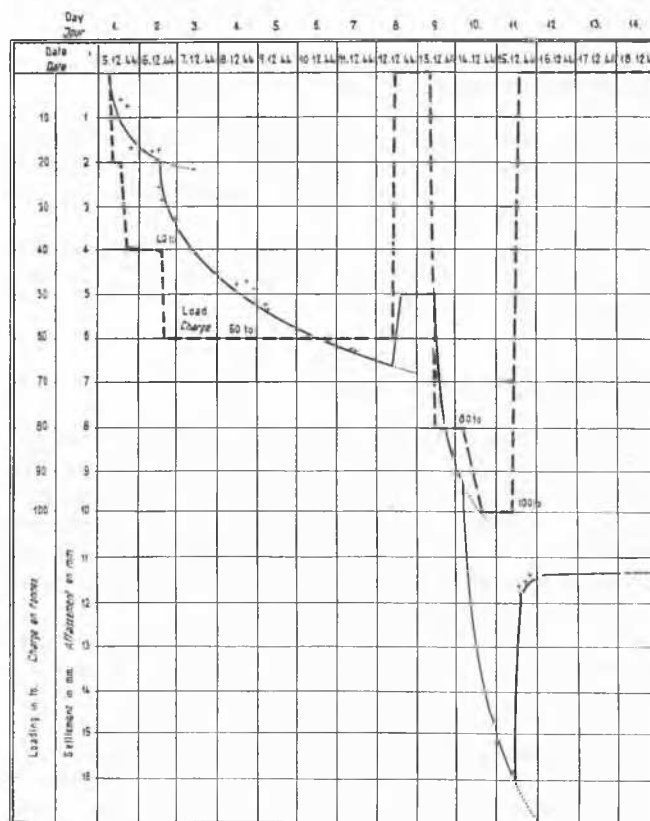


Fig. 4 Time-Settlement and Loading Diagram
Diagrammes du tassement et des charges en fonction du temps

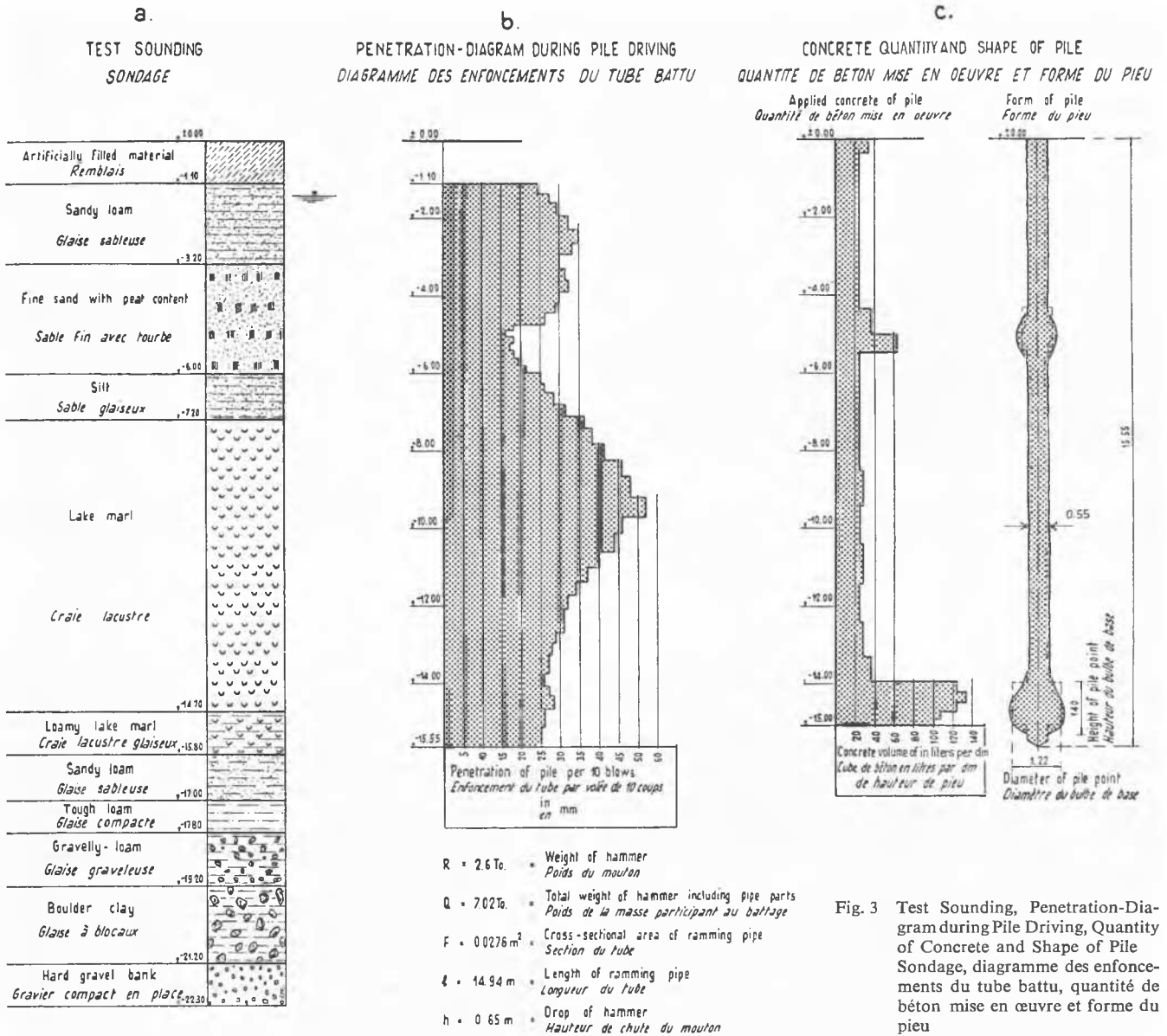


Fig. 3 Test Sounding, Penetration-Diagram during Pile Driving, Quantity of Concrete and Shape of Pile

AVERAGE TIME - SETTLEMENT DIAGRAM OF PILE HEADS / DIAGRAMME DES AFFAISSEMENTS EN FONCTION DU TEMPS

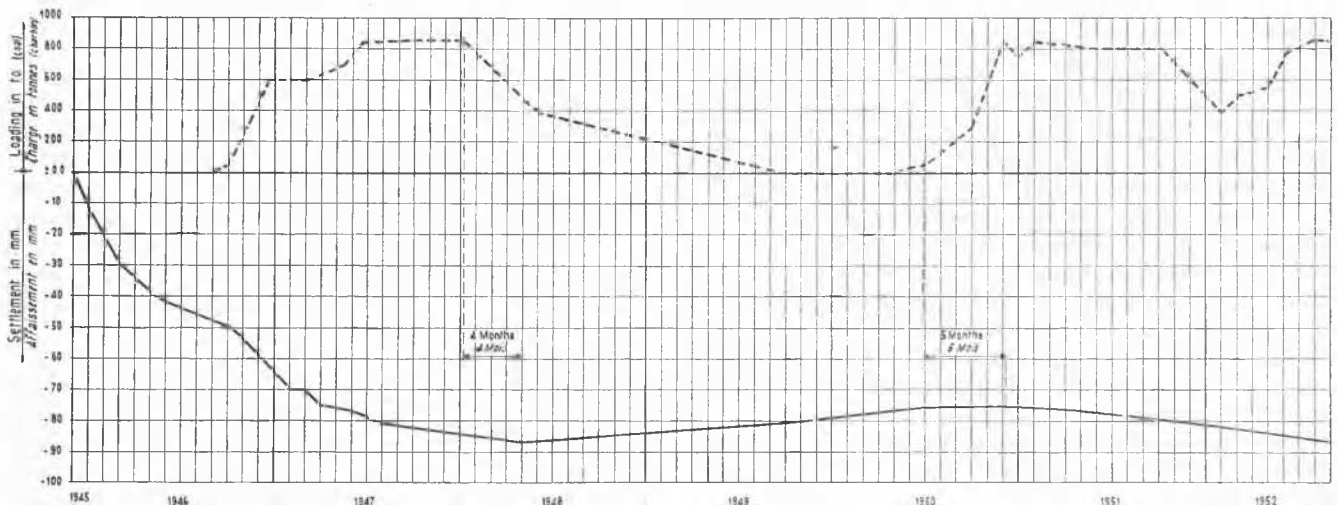


Fig. 5 Average Time-Settlement Diagram of Pile Heads / Diagramme des affaissements en fonction du temps