Loading Test on a Bridge Pier

Essai de charge d'une pile de pont

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Summary

The author describes a loading test on the pier of a reconstructed bridge, and the results of site investigation. The pier test load was about 3 000 tons, and the settlement in the course of the test attained 19·5 mm. It was found that the settlement of the original bridge had a considerable influence on the settlement of the reconstructed pier.

Sommaire

Cette communication est relative à l'essai de chargement d'une pile de pont à reconstruire, ainsi qu'aux résultats des études du sol. La surcharge d'essai a été de 3 000 t environ, non compris le poids propre de la pile. Le tassement a été de 19,5 mm. On a constaté une nette influence de la charge de l'ancien pont sur l'allure de la courbe de tassement.

In reconstructing a bridge destroyed during the second world war, an alternative design was prepared for a concrete structure much larger than the original steel bridge. It was decided to use the old bridge-piers founded on caissons with the aid of compressed air. The soil pressure under the original bridge piers amounted to about 5·5 kg per sq. cm; in the case of the new concrete structure the pressure ranges from 8·5 to 10 kg per sq. cm.

The original bridge was built in 1875; both geological information and the design of the piers were incomplete. From a contemporary description of caisson work it was revealed that pier *P*8, with a base area of 56·5 sq. m had begun to settle towards the left bank during the sinking of the caisson : under the right edge, very stiff clay was encountered while the left edge was sinking into loose sand. In view of the above, the caisson work was finished at a relatively low depth of about 5·5 m below the river bed. The layer of boulders around pier *P*8, due to many later fillings, was extensive; exploratory borings were possible at a distance of 25 m.

A geological profile of the pier's subsoil was carried out by Prof. S. Rózycki and is shown in Fig. 1.

Underlying pliocene soils have been folded and preconsolidated by glaciers exerting an estimated pressure of 60-100 kg per sq. cm. As a result, pliocene clays and silty loams

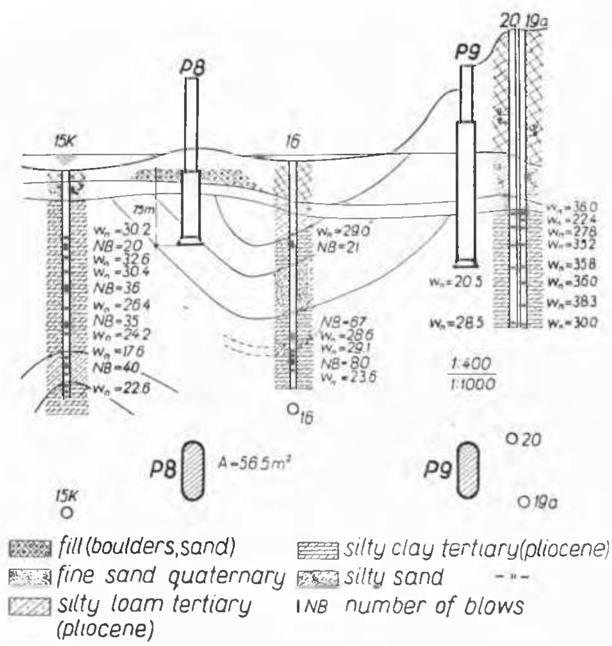

Fig. 1 Geological profile.
Profil géologique.

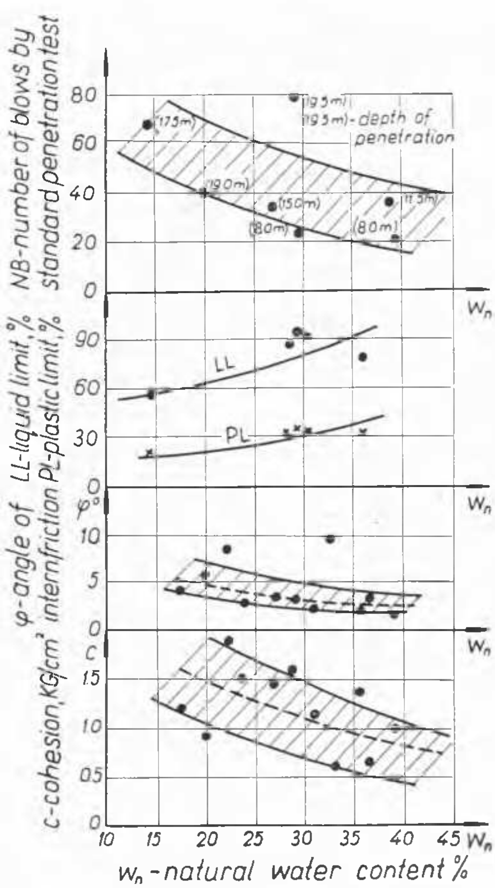

Fig. 2 Soils tests results.
Résultats des essais de sol.

have a moisture content lower than the plastic limit, and are stiff; this is also proved by a large number of blows (20-80) required in the standard penetration test described by TERZAGHI and PECK (1948). The characteristics of pliocene clays are given in Fig. 2, the unit weight of clays was 1·9-2·1 tons per cub. m.

Pliocene sands encountered in clay strata are generally of high density. All tertiary formations reach to a depth exceeding 200 metres.

On the basis of site investigation carried out at pier *P*8 the following characteristics of soils were determined :

pliocene clays $\varphi = 5°$ and $c = 1{\cdot}2$ kg/cm^2;

pliocene sands $\varphi = 30°$.

Bearing capacity of the pier was evaluated in accordance with TERZAGHI and PECK's formulae (1948). With the depth of foundations of about 7·5 m below the bottom of the river and with skin friction at the sides of 10 tons per sq. m, bearing capacity of the pier placed on clay was evaluated to about 5 600 tons, and on sand — to about 15 500 tons.

With the safety factor of $n = 2$, allowable bearing capacity of the pier could be assumed at from 2 800 to 7 700 tons. The lower limit of allowable bearing capacity was the same as for the original bridge, but for the new structure the loading could be nearly double this figure.

Owing to lack of precise data on the subsoil underlying the foundation and in view of the difficulties of defining exactly the allowable bearing capacity, and the values of expected settlement, the chief designer of the bridge, Prof. Z. Wasiutynski, decided to carry out a loading test on the pier.

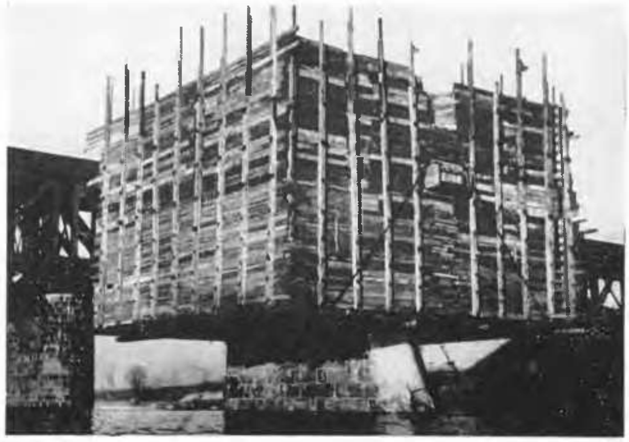

Fig. 3 Photograph of the test.
Photographie de l'essai.

This test was carried out by means of a wooden box of about 2 200 cub. m (Fig. 3). The box was gradually filled

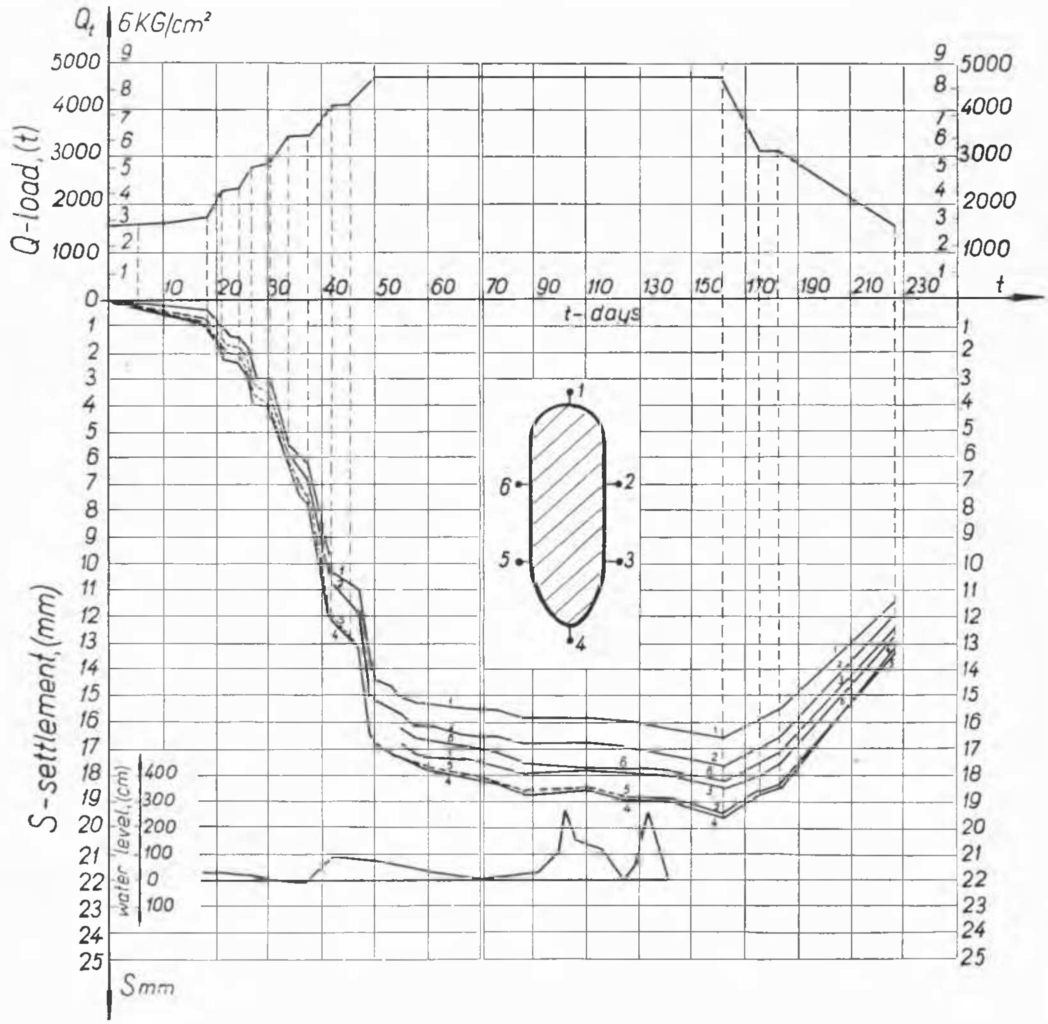

Fig. 4 Load and settlement, vers time.
Variation de la charge et du tassement en fonction du temps.

with river sand having bulk density $\gamma_0 = 1{\cdot}55$ tons per cub. m.

Details of loads, the time of their application and settlement figures are given in Fig. 4.

The settlement-load relationship is shown in Fig. 5.

As a result of the load test it was found that :

1. For loads ranging from 1 600 to 2 870 tons (including the pier's own weight), the settlement increment was considerably lower than for loads from 2 870-4 760 tons (Fig. 5); this was due to the influence of the original bridge.

2. Beyond the range of the former load, however, the growth of settlement is almost linear; this indicates that allowable bearing load was not exceeded; it may be judged by Fig. 5 that after increasing the load to 5 600 tons (10 kg per sq. cm) the settlement should not exceed from 25 to 30 mm.

3. From Fig. 4 we may draw the conclusion that the process of consolidation of precompressed stiff clays is rather rapid. This has been observed by the author on other large structures (WILUN, 1955). It may be assumed, therefore, that the settlement of the pier under a load of 5 600 tons, after the completion of consolidation, should not exceed 35 or 40 mm; with a span between piers of about 65 metres this could be considered as allowable.

4. TERZAGHI and PECK formulae gave satisfactory results, assuming that base of the pier rests on sand. It follows from the test that soil resistance along the sides of the pier may be taken inot account.

5. The variations of water level in the river (Fig. 4) exerted a slight influence on vertical movement of the pier; this movement reveals an appreciable lag in relation to variations in water level.

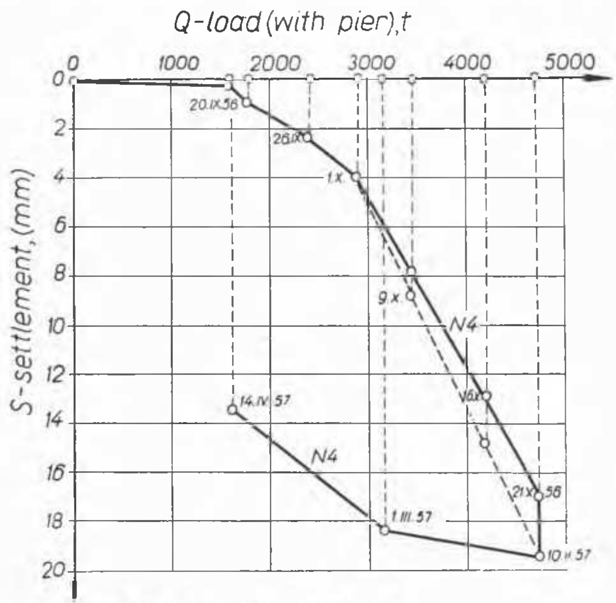

Fig. 5 Settlement versus load.
Tassement en fonction de la charge.

References

[1] TERZAGHI, K. and PECK, R. (1948). Soil mechanics in engineering practice, New-York.

[2] WILUN, Z. (1955). Badania geotechniczne podłoza PKiN w Warszawie. *Inzynieria i Budownictwo*, Nr 6, 1955. Warszawa.