Bearing capacity of large-diametre bored piles

Capacité portante des pieux forés de grand diamètre

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SYNOPSIS: Initial works on the construction of a public structure in Near East had been performed during 1981 and 1982. The foundation structure is made up of altogether 1040 large - diametre bored piles. Beside the basic exploratory works, totally five additional exploratory boreholes were sunk. In their immediate vicinity CP tests were performed and preliminary test piles with a minimum diametre cf 800 mm and variable depths were placed. Altogether five test and sixteen working piles were tested within the scope of pile testing, using the MLT (maintained load test) method. This work shows results obtained in testing piles of 800 mm diametre and 25 m depth. Also, estimates of ultimate bearing capacities were made on the basis of pile tests, as well as the performed exploratory works. A particular stress was given to the importance of pile-placing technology, i.e. the influence the execution of a pile has upon its bearing capacity. The work shows the qualitative difference between preliminary and working pile test results.

SOIL PROFILE

Table 1 gives a review of static tests on all piles at the site. At the same time, positions and depths of test borings and CP tests are shown. The borings and CP tests were performed at the distance of appr. 2 m from the corresponding test pile.

Table 1. Review of investigations performed

PILES						CPT		BH	
PILE No	NUMBER OF PILES TESTED	Ø (cm)	D (m)	DESIGNED WORKING LOAD Q_{max} (kN)	LOAD APPLIED	CPT No	D (m)	BH No	D (m)
PTP 1 PTP 5	2	80	25	1800	1.5 Q_{max}	CPT 1 CPT 5	[illegible]	BH 1 BH 5	[illegible]
PTP 3 PTP 4	[illegible]	80	22	1800	1.5 Q_{max}	CPT 3 CPT 4	[illegible]	BH 3 BH 4	[illegible]
PTP 2	1	80	30	1800	1.5 Q_{max}	CPT 2	[illegible]	BH 2	[illegible]
TP [illegible] TP 583	10	80	25	1800	1.5 Q_{max}	—	—	—	—
TP 188, TP 825 TP 326, TP 266 TP 357	[illegible]	100	25	2600	2 Q_{max}	—	—	—	—
TP 668 TP 585	[illegible]	120	25	3000	2 Q_{max}	—	—	—	—

Results of the performed exploratory works have been statistically processed and the synthetised model of the characteristic profile can be seen in Fig. 1. The water-bearing layer is made up of sand, being positioned under a surface layer of clay. During the drilling into the water-bearing layer the groundwater level shows a tendency of a sub-artesian pressure.

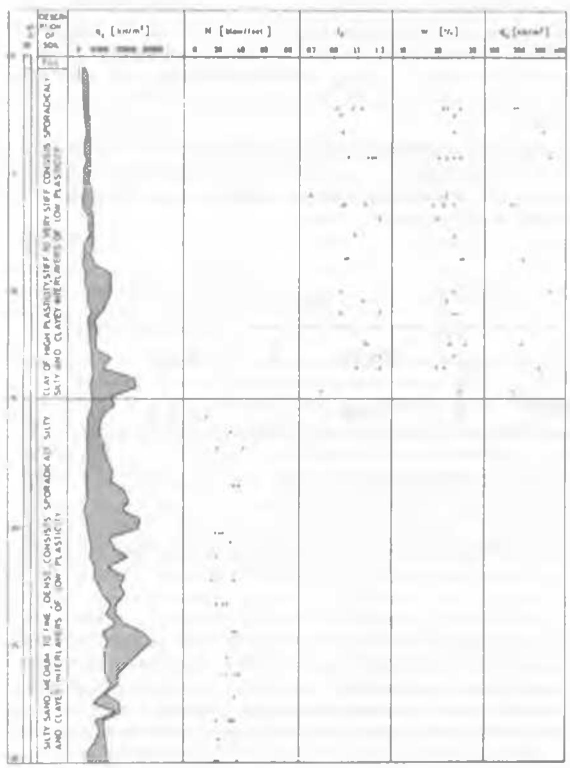

Figure 1. Soil profile

PREDICTIONS OF PILE BEARING CAPACITIES BASED ON RESULTS OF EXPLORATORY WORKS

On the basis of D. Rollberg's works (1976 and 1985) it is possible to estimate the pile failure force from the static probing results, namely from the measured values of CPT's tip resistance, q_c. The correlate parametre α_s is adapted to the material in accordance with the average geotechnical profile. The material of the soil in the relevant zone is sand ($\alpha_s = 3.0$)

Beside the quoted estimate of pile bearing capacity, the comparative analysis was performed, following the work by S.J. Wright and L.C. Reese (1979) - Design criteria for calculating the foundation construction. This reference estimates the failure force of piles on the basis of SPT results, namely the undrained shear strength, if it goes for coherent materials. Results of failure forces for piles in the synthetised soil model give values shown in Table 2.

Table 2. Ultimate bearing capacities for the synthetised soil profile

REFERENCE	Q_{ult} [MN]
D. ROLLBERG	5.26
S.J. WRIGHT L.C. REESE	5.30

CHARACTERISTIC RESULTS OF STATIC PILE TESTING

A satisfactory regularity of the hyperbolic behaviour in the force-settlement diagram had been noticed during the performed static pile tests, conforming to recommendations by a number of authors (e.g. C. Mastrantuono 1973). For this reason, estimates of achieved bearing capacities were based on exactly such interpretations of ultimate pile bearing capacities.

Figure 3. shows representatives of performed pile tests. The curve PTP is the representative of preliminary piles, while TPM is the representative curve for the group of 16 working piles.

Ultimate pile capacities, taking into account of the hyperbolic curve behaviour's interpretation (C. Mastrantuono, 1973), are shown in the Table 3.

Table 3. Ultimate pile capacities

Q_{ult} [MN]		
	PTP	6.57
	TPM	4.63

As it can be seen from Fig. 3 (and confirmed by ultimate bearing capacities of the two groups of tested piles), a qualitative and quantitative difference in the pile behaviour is evident. Reasons for such differences in behaviour have to be sought in soil conditions at the subject site, namely the presence of the artesian pressure. As the lower sand layer is finely grained, a heaving of the excavation bottom had been occuring during the placing of preliminary test piles, being a reason for a cautious work and cleaning of the excavation bottom immediatiely prior to the concreting. TPM piles had been cast in an "assembly-line" manner, which implies a series of routine operations, and these can obviously mean, among other things, a decrease of the nominal bearing capacity in unfavourable soil conditions.

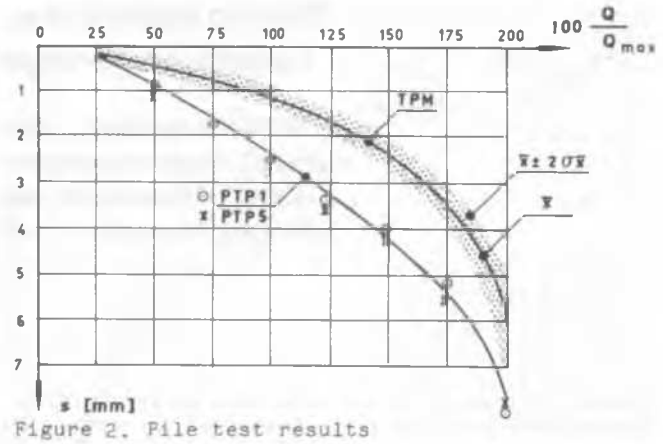

Figure 2. Pile test results

CONCLUSION

The performed exploratory works suggest caution when choosing the technology and manner of pile-placing, particularly considering the noticeable artesian pressure.

The estimated pile capacities resulting from the synthetised soil model are mutually very close and can be taken as dependable. Ultimate bearing capacities of the two groups of tested piles point to the importance of the technology chosen for the pile-placing, as well as to differences which occur due to the routine and hastened work on piles in conditions of the groundwaters' artiesian pressures. The quoted unfavourable soil conditions during the routinized pile-placing induce mutual diferences in the ultimate capacity of even up to 40%. Results suggest a larger portion of conservatism and caution in the phase of designing and defining pile bearing capacities in unfavourable soil conditions (artesian pressures, fine sands, etc.). Also, the particulary important factor is the execution of piles themselves, which affects their final bearing capacity to a great degree.

Bearing in mind all described circumstances, the estimated ultimate bearing capacities of piles tally well with their real behaviour during the static testing. It is particularly emphasized that in the case in question it goes for a specialized and experienced working crew.

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