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THE EFFECT OF PRELOADING DURATION ON THE LEVEL OF SOIL IMPROVEMENT

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Preloading is a wide spread used technique to overcome the problem of settlement by improving the engineering properties of soil. The preloading results in one or more of the primary and secondary consolidation settlement and the increased undrained strength of soil as well. In the present study a series of tests were carried out in order to know the effect of preloading duration on the final level of soil improvement **and the time required.**

EXPERIMENTAL WORK

TESTED MATERIAL

The used clay was passed through 75 μm and its physical properties are, specific gravity G_s = 2.689, LL = 74 % and PI = 36 %. The clay slurry is preconsolidated under pressure of 25 kPa to form the specimen of 150 mm diameter with an average height of about 95 mm and the water content was about 56 %.

TEST PROCEDURE

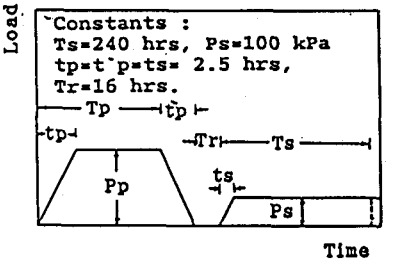

Fig. 1 Key sketch for loading sequence

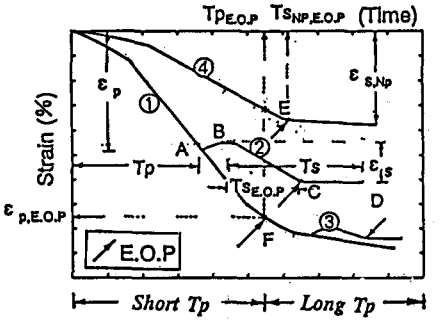

Fig.2 Sketch for strain -Time Curves Under Pp & Ps.

Fig. 1 shows key sketch for loading sequence and its duration. Sketch for test results is shown in Fig. 2. Curve ① shows the behavior under preloading (Pp). Point F indicate the end of primary consolidation (E.O.P) with time $Tp_{E.O.P}$ and strain $\varepsilon_{P,E.O.P}$. From point B on curve ② shows the strain under structure load (Ps) within the tested period Ts . The soil was preloaded until point A for a relatively short period ($Tp < Tp_{E.O.P}$). During and after removing the preload, the soil records heave up to point B where the structure load started to apply. Point C shows E.O.P in a period $Ts_{E.O.P}$, then the secondary consolidation started and continue until the end of the tested period (Ts) at D recording total strain ε_s. Similar loading sequence and corresponding strain is shown in curve ③ for case of relatively long preloading period ($Tp > Tp_{E.O.P}$). Curve ④ shows the strain under structure loading without improvement which record total strain $\varepsilon_{s,NP}$. Primary consolidation was ended at point E in a period $Ts_{NP,E.O.P}$.

The preloading duration were investigated in two stages of preloading intensities. The first is for small preloading (Pp/Ps = 0.75 < 1) and the second for large preloading (Pp/Ps = 2 > 1).

TEST RESULTS AND DISCUSSIONS

The time at the end of primary consolidation (E.O.P) is consider as an important and direct factor which affect and express the residual settlement under Pp and Ps. So, the preloading duration (Tp) as a ratio of the time at E.O.P under Pp ($Tp_{E.O.P}$) is specified to investigate the effect on the behavior under structure load (Ps). This behavior could be discussed through the time at E.O.P and the final level of soil improvement as follows:

PRIMARY CONSOLIDATION PERIOD UNDER STRUCTURE LOADING

Fig. 3 shows $Ts_{E.O.P}$ in a normalized form as ($Ts_{E.O.P}/Ts_{NP,E.O.P}$) for different ($Tp/Tp_{E.O.P}$) ratio. Two cases for short and long preloading period could be discussed as follows :

Short Preloading Period :

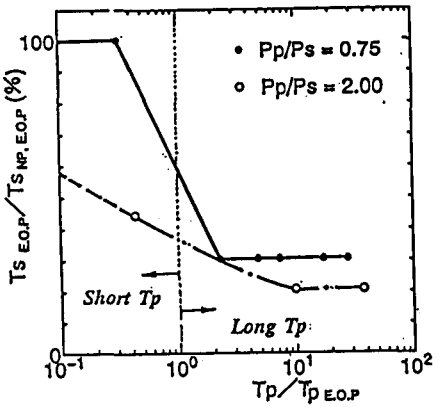

Fig. 3 E.O.P Period under Ps

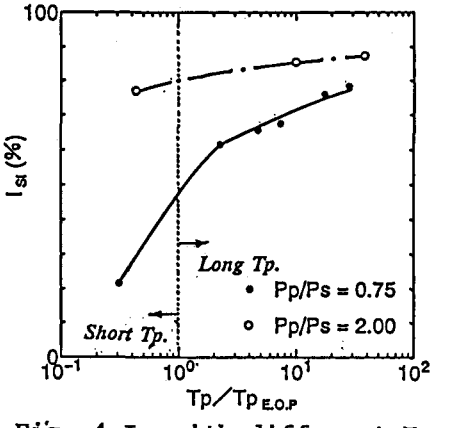

Fig. 4 I_{SI} with different Tp

In case of small preloading intensity, ($Ts_{E.O.P}/Ts_{NP,E.O.P}$) ratio seems to be not affected by ($Tp/Tp_{E.O.P}$) ratio until ($Tp/Tp_{E.O.P}$) of about 0.3 while it decrease in case of large preloading. Then, it decrease in both cases with a higher rate with respect to $Tp/Tp_{E.O.P}$ in case of small preloading until the end of this period ($Tp = Tp_{E.O.P}$).

Long Preloading Period :

In this period, ($Ts_{E.O.P}/Ts_{NP,E.O.P}$) ratio continue to decrease in the same manner until $Tp/Tp_{E.O.P}$ ratio of about 2.3 where both preloading intensities reach the same $Ts_{E.O.P}/Ts_{NP,E.O.P}$ ratio. Then, it become constant in case of small preloading and decrease by the same rate in large preloading until $Tp/Tp_{E.O.P}$ of about 10. For relatively long preloading duration ($Tp/Tp_{E.O.P} > 10$), $Ts_{E.O.P}/Ts_{Np,E.O.P}$ seems to be not affected by preloading duration (Tp).

FINAL LEVEL OF SOIL IMPROVEMENT

The strain under Ps directly express the preloading efficiency. When this strain related to the strain under Ps without improvement, an index of soil improvement (I_{SI}) could be introduced to express the improvement level. This index is defined as $I_{SI} = \{(\varepsilon_{S,NP} - \varepsilon_S)/\varepsilon_{S,NP}\}*100$. Fig. 4 shows I_{SI} for different ($Tp/Tp_{E.O.P}$) ratio. The final level of soil improvement could be discussed for the following two cases :

Short Preloading Period :

Early in this period ($Tp/Tp_{E.O.P} > 0.3$), I_{SI} values generally increased with higher rate with respect to ($Tp/Tp_{E.O.P}$) ratio in both cases of Pp/Ps intensity. For small $Tp/Tp_{E.O.P}$ of about 0.3, I_{SI} is about 22 % in case of small preloading compared with a relatively very high value of about 77 % in case of large preloading. I_{SI} values continue to increase with relatively high rate until the end of this period ($Tp = Tp_{E.O.P}$).

Long Preloading Period :

I_{SI} values generally increased with lower rate in both (Pp/Ps) intensity. This rate still higher in case of small preloading. As Tp is longer, the above rate highly decreased where it could guide to a suitable Tp for both small and large Preloading. Moreover, I_{SI} value for both Pp/Ps becomes more closer.

CONCLUSIONS

1) The time required for primary consolidation under structure load generally decreased in short preloading duration while seems to be not affected for relatively long preloading duration.
2) For short preloading duration, relatively low settlement values is controlled under structure load in case of small preloading intensity compared with a relatively very high vales in case of large preloading.
3) Preloading – structure load ratio (Pp/Ps) is highly affect level of soil improvement in case of short preloading, where this effect becomes small in case of long preloading.

REFERENCES

KASSEM,A.M., PRADHAN,T.B.S and IMAI,G. (1994) "The Effect of Preloading – Structure Load Ratio on The Residual Settlement", Second Geotechnical Engineering Conference, Cairo University, Giza, EGYPT, Vol. I, PP. 169 – 179.