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Investigation of Creep Behavior of the Clay Soil in the Laboratory Condition

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1- Introduction

Clay particles are characterized by the fine particle sizes, less than 2 μm and having negative charges on their surfaces. Due to this nature of clay particles, they are susceptible to physical, mechanical and physico-chemical processes. In dry condition, clay particles adsorb cations and keep them with the help of negatively charged clay surfaces. When clay is exposed to water, the cations diffuse away to balance the concentration through the system (Mitchell and Soga, 2005). The negatively charged clay surfaces and the distributed charges in the adjacent phase are called as diffuse double layer (DDL).

The history of the creep behavior of clay soil extends back to the nineteenth century. The investigations into secondary compression were published about a decade after Terzaghi consolidation theory (Terzaghi, 1925) which described the compression of clay due to dissipation of pore water pressure. Laboratory tests reported on the effect of time on compressibility of clays were indicated by Buisman (1936) and Taylor (1942).The mechanisms involved during the creep behavior of clay due to the sliding of clay particles at particle contacts, deformation of clay particle itself and compression of poresare discussed by several researches.When soil is subjected to a load, effective stress increases with time as a result of dissipation of induced excess pore water pressure, which is known as primary consolidation. Significant amount of settlement occurs during primary consolidation. After the complete dissipation of the excess pore water pressure, if the load is continuously maintained on the soil, deformation can be observed over a long period of time, which is known as the secondary compression or creep. Secondary compression is represented by an index called the coefficient of secondary compression (C_α). Fig 1 shows a typical void ratio-log time relation of saturated soil in the 1D compression test at a sustained total stress. This Figure clearly shows elastic, primary consolidation and secondary compression regions.

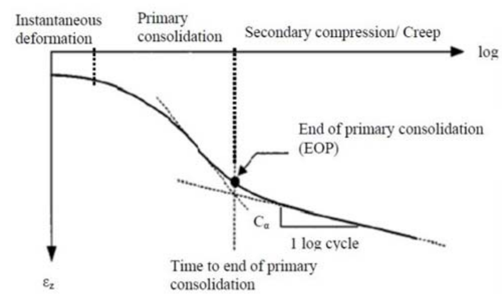

Fig 1. Typical void Ratio-Log Time Relation of Saturated Soil in the 1D Compression Test.

2- Test program

Creep tests are performed on samples in three states as follows: in single stage test, soil sample is loaded to specified stress level and is allowed to creep at this stress level. In stepwise test, the soil sample is loaded at different stress levels and then is allowed to creep. In overloaded-unloaded test, soil sample is loaded to $\sigma_{overload}$, and after the end of primary consolidation, the sample is unloaded to σ_{creep} and is allowed to creep at the same stress level (σ_{creep}).

Single stage tests at the stresses of 200 and 500kPa are carried out on the dried in air and water-saturated clay samples. Stepwise compression creep tests are carried out on dry and water-saturated clay samples, and samples are subjected to stepwise loads at different σ_{creep} of 50, 200, 500 and 800kPa.

Overloaded-unloaded compression creep tests are carried out on water-saturated clay samples to understand the effect of stress history on creep behavior of the clay. The samples are overloaded to 225, and 525kPa, respectively. Then, they are allowed to complete primary consolidation. Immediately after the end of primary consolidation, the samples are unloaded to σ_{creep} of 200 and 500kPa respectively and are allowed to creep. After the creep stage, the samples are again overloaded to 250 and 550kPa, respectively and after the end of primary consolidation at these stress levels, the samples are unloaded to σ_{creep} of 200 and 500 kPa, respectively.

3- Results and Conclusion

In this study, the creep behavior of clay soil is explained and analyzed using the coefficient of secondary compression. Casagrande curve fitting method is used to determine the time (t_{100}) taken to

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completely dissipate the excess pore water pressure at the particular stress level, and the void ratio (e_{EOP}) at the end of primary consolidation.

Test results indicated that with increasing the stress level, Samples became denser and smaller, and so the soil structures become stable and creep rate decreases. The values of C_α in the overloaded-unloaded and single stage tests are approximately equal, but the required time for a specific porous in the overloaded-unloaded test is lower than that single-stage tests, and this test accelerates the creep.