The model test about silty clay's deformation as water pressure decreasing

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Abstract. The main compression layer of Xi'an is over-consolidated. Based on the property, the physical model is designed as a steel cylinder which is 2.5m diameter,3m high. The soil layers are inter-bedded with silty clay and medium-fine sand. The consolidation pressure and overburden pressure is 295KPa. The process of soil deformation was simulated as the water falling by decreasing the water pressure in the medium-fine sand layer during the silty clay in expansion. Data monitoring test reveal that the silty clay layer continued to expand for 220 hours. After expansion, the silty clay has a larger compression. Based on the study of this test, we could predict that larger land subsidence of Xi'an will occurrence again as the confined water level decline by over pumping of ground - waters.

Introduction

Land subsidence of Xi'an city occurred mainly in urban areas and inner suburban areas. A wide range of level survey suggests that, from 1959 to 2000, the areas which the accumulated subsidence over 200mm reached to 150k㎡. around the center of land subsidence areas, such as Hujiamiao, Nanshapocun, Dayantashizi, Xiaozhai, Dongbalicun, the accumulated subsidence were over 2000mm [1,2].

The previous researches[3,4,5] reveal that the main compression layer of Xi'an is over-consolidated and the excessive exploitation of confined water is the main reason to the city's land subsidence. By the end of last century, the confined water head stop declining and even rising, due to the sharp reduce on exploitation of ground water. Meanwhile, settlement velocity, although is slowing, but the annual velocity of settlement still reached at 18.0mm/a-40.0mm/a. In some areas, such as Dianzicheng, A large amount of groundwater was extracted because of water scarcity. Therefore, the large scale physical model tests was designed to study the relation between the ground water level and over consolidation soil layers' deformation, the ultimate goal of study is to provide theory basis for formulating the reasonable planning of groundwater exploitation. This paper is a continuation based on my previous paper named "The model test about over-consolidated soils' stress and deformation as water pressure increasing" [6].

The Test of over consolidation soil

The purpose of the test

The purpose of the test is to study the stress (such as, earth pressure and pore-water pressure) and deformation of silty clay and medium-fine sand when the water pressure is increasing in medium-fine sand.

The test equipment and method [6]

A closed steel cylinder with 300cm high and 250cm in diameter was used (Fig. 1)in test. The soil in the cylinder is silty clay and medium-fine sand by hydraulic fill. Fig.2 shows the thickness of each layer, and each layer fit with pressure sensors and displacement sensors which horizontal distance to the cylinder centre is 75cm (Fig. 2, Tab 1). The water inlet in the top of cylinder links to

a water tank located on the 9th floor, via a tube to supply the pressure needed for soil layer consolidation.

Fig. 1 Test equipment

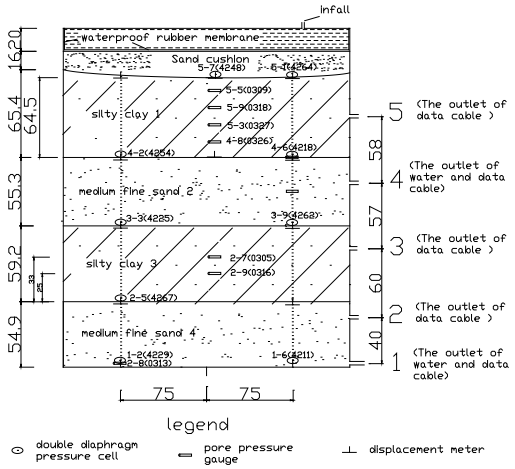

Fig. 2 Schematic diagram of experimental model and thickness of each layer Consolidated for 68 hours (cm)

Table 1. The postion of sensors

Double diaphragm pressure cell		Pore pressure gauge	
Serial Number	Postion	Serial Number	Postion
5-1	Top of silty clay 1	5-9	43.46cm above the bottom silty clay 1
4-2	Top of medium fine sand 2	5-5	50.92cm above the bottom silty clay 1
Displacement meter		3-7	interspace of medium fine sand 2
5-2	Silty caly1	F	Consolidation and overburden pressure

Soil in the test material [6]

The medium-fine sand(Q3) was fetched from the deep foundation pit in the west suburbs of Xi'an city. And silty clay (Q2) is fetched from another deep foundation pit of city's metro line 2 construction site in Xiaozhai district. The initial physical parameters showed in Tab 2, Fig. 3.

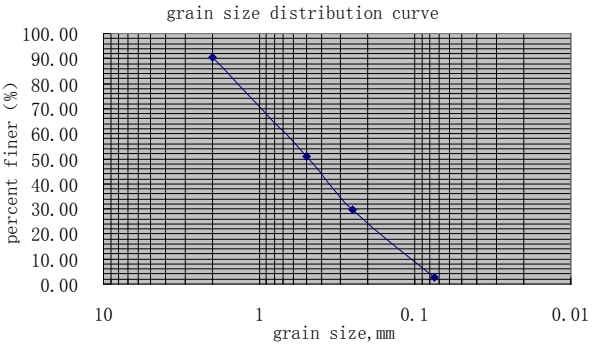

Fig3.Grain size distribution curve of medium-fine sand

Table 2. Initial physical parameter of soil layer

Indicator	Silty clay	Medium-fine sand
Specific gravity of solids	2.7024	2.675
Mass density(g/cm^3)	1.789	1.360
Water content(%)	41.14	
Plastic limit	18.6	
Liquid limit	31.16	
Plasticity index	11.56	

Test preparation

After 68 hours' consolidation under pressure F of 295KPa(Fig.4, F is the consolidation pressure and being hold on as the overburden pressure through the test), each soil layers deformation for two consecutive hours is less than 0.01mm. The soil thickness after consolidation is showed by Fig.2. And the water pressure in medium-sand layer 2 (Gauge 3-7,Fig.4)increased from 50 to 150KPa

gradually. Fig. 2 and Tab. 1 show the location distribution of every sensor. When deformation began to stabilize, the water pressure (F1) was decreased from 150KPa to 70KPa.

Deformation of the silty clay layer

Due to the damage of displacement gauge in this layer (5-2) during the test, only a portion of the data was collected. When decreasing the pore water pressure of the sand layer which under silty clay layer 1 from 150Kpa to 140Kpa, clay layer 1 continue to expand, the expansion was 0.11mm. 220 hours later the silty clay layer stops swelling (or expansion deformation begins to compress). The consolidation deformation was 0.34mm(The Strain rate was 5.44%). Combine with the previous result of curve analysis[6],when the pore water pressure in silty clay 1(Gauge 5-9) higher than 162KPa, silty clay 1 will be in expansion state. otherwise, when the pore water pressure below 162KPa,silty clay 1 will be in compression state.

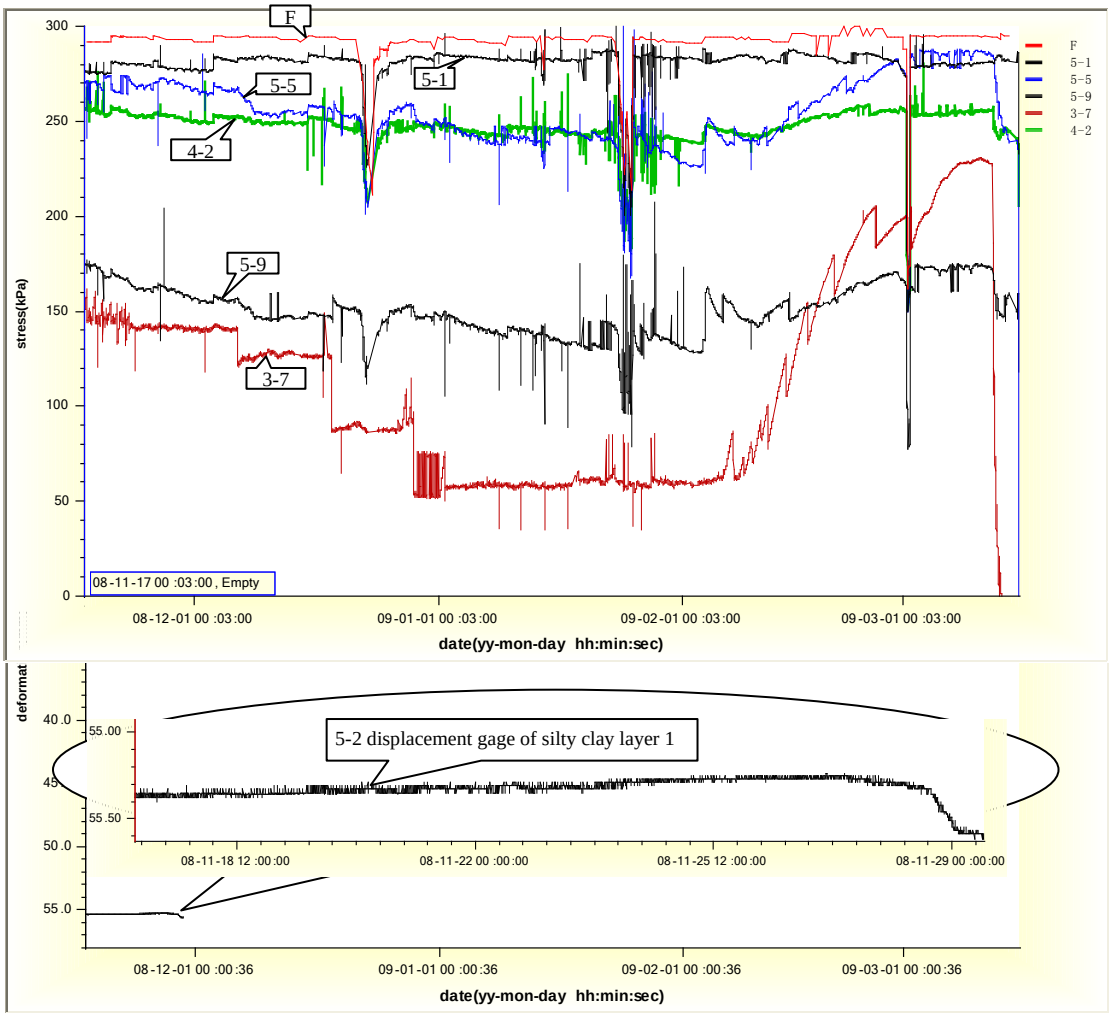

Fig 4. Soil deformation in Clay layer1

Conclusion

Increasing the water pressure of adjacent sand can reduce the compression rate of soil effectively. When the water pressure is more than the pore water pressure of the clay layer, the clay layer will be in the small and slow expansion state. At this time, reducing the water pressure of adjacent sand, the expansion will continue for a period of time. But after this period, expansion deformation will stop and generate large compression deformation. So, during this time, recovering water pressure on time can reduce compression and settlement, or else, it will bring more compression and settlement than the expansion if we pumping underwater largely for a long time.

Acknowledgments

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