Influencing factors analysis of urban land subsidence

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Abstract. The land subsidence is a geological hazard which is a reduction of regional elevation resulted in the compact of soil, caused by the natural and human factors. This paper mainly expounds the influence of water level, soil conditions, and the upper building load on the land subsidence, and provides the necessary theoretical basis for the physical simulation of land subsidence.

Introduction

The land subsidence is an environmental geological phenomena which is a reduction of regional elevation resulted in the compact of soil subjected to the natural and human factors. It is a permanent loss of environment and resource which can not be compensated. The land subsidence has the characteristics of slow growth, wide influence, long development time, complex formation mechanism, and difficult control and is a kind of geological disaster which threatens the resource utilization, environmental protection, economic development, urban construction and people's life. So it is of great significance to study the influence factors of land subsidence.

Effect of groundwater level on land subsidence

Due to the amount imbalance of groundwater pumping in different parts of the country, confined water in the aquifer shows a day, month, or seasonal changes. The period, the range and the characteristics of the confined water level in day, month, or seasonal changes are different. The soils after compaction also have different performances. In order to clarify the relationship between the confined water level and the land subsidence, three typical cases are discussed as follows,

Constant amplitude fluctuation of confined water level. By experiments, it is indicated that the characteristics of the subsidence not only depend on the size of the range, but also have a close relationship with the period of the change. Under the condition of constant amplitude fluctuation of confined water level, the water level fluctuate in different periods, the subsidence increases as time goes by. The water level fluctuate more frequently, the settlement speed more slowly. The constant amplitude fluctuation of water level carries on, but it will not cause the continued development of the settlement.

Confined water level decreased larger than the fluctuation of rebound. According to the data of the water level fluctuation and the pressure density, the water level fluctuation and the expansion rebound quantity data, the consolidation stress line of soil is determined. The water level fluctuations above this line can only cause the elastic deformation of the soil layer because the consolidation has been completed, whereas the water level fluctuations below the line cause a large plastic deformation.

Confined water level fell below the rise of the water level fluctuations. In the area of land subsidence the water level fluctuation which is recharged belongs to this kind.All this is mainly because the compression coefficient of soil is slightly larger than the coefficient of resilience. In order to meet the land no settlement or the demand for a slight rebound, it is necessary to make the rise of the water level after recharged lager than the decline of the water level after pumped in the previous period. In particular, the impacts of water level changes on the land subsidence induced by high-rise buildings are as follows:

(1) When the water level drops, the soil layer does not immediately change in micro , but has a certain reaction time with hysteresis effect; as the time goes by, the soil layer release water slowly, the pores are compressed, resulting in subsidence, but the change rate is very slow, the subsidence curve does not declined directly.

(2) The confined water in silt layer draw down, which has an impact on the silty sand itself , not the biggest, but the second layer of silt closing to the silty clay layer. This is because the confined water reduces, then water pressure decreases, water pressure decrease, water in the soil releases, soil particles rearrange, pore in the soil decrease, finally soil compression produces settlement.

(3) The settlement of land subsidence is different in different location of the land subsidence. Because of the influence of hydraulic gradient, the soil layer releases water to compact earlier in the area where the water level drops faster and the settlement is larger. The location where the water level falls slowly needs a certain time to react, thus slowing down the development of land subsidence.

(4) When confined water level rises, the silt layer does not immediately swell, instead ,essentially unchanged, or even decline. It is because the confined aquifer located in the silt layer and sand in this layer is saturated, water can not easily be free to enter the soil particles to make the soil swell; In the process of water level rises, all soils have different levels of compression settlement trend, mainly because the free pore water entering the soil is an extremely slow process, it may not offset the rheological consolidation caused by additional stress under the effect of load. In the whole, when water level rises, the general trend is that the soil uplift will occur, but can not fully recover the ground level before the water level drops, some land subsidence is unrecoverable, so we can not exploit underground water endlessly, and we should make reasonable arrangements to promptly make the soil water replenished.

Effect of soil stress-strain on the influence of land subsidence

Confined water level of exploitation aquifer in land subsidence areas usually shows a decrease and recovery cycles in a year because of pumping different amounts of groundwater in different seasons. During confined water drop period, the effective stress in the soil increase, thus making soil compaction; but later, confined water in rise period, effective stress of soil layer is reduced, the soil will produce partial rebound. So soil will undergo at least one time of loading-unloading cycle in a year. Land subsidence develops gradually in such repeated loading-unloading cycle, and the performance of soil stress-strain in this process is an important factor influencing land subsidence.

(1) water sand and clay layer all show the phenomenon that soil subsidence lags behind confined water level change, and subsidence retardation time in clay layer is much greater than the sand layer's.

(2) the deformation of the clay layer lags behind the dissipation of pore water pressure, under the same test conditions, the retardation time and creep deformation become larger with the increase of soil thickness.

(3) at the beginning of the confined water levels' falling, excess pore water pressure at the bottom of the clay layer disappear quickly, but excess pore water pressure at the top remain unchanged; As time goes on, the excess pore water pressure at the top of begins to dissipate.

(4) as far as land subsidence caused by releasing water is concerned, the soil subsidence is different in the direction of vertical soil layer, the closer to the pumping aquifer ,the degree of compression is great.

Effect of upper building loads on land subsidence

Settlement of soft soil layer is the main component of construction induced land subsidence. Ground and every point's subsidence variation with time in the region all accord with the exponential function. Subsidence in areas with lots of intensive buildings group exists obvious superposition effects, and shows a trend of increasing along with the increase of volume ratio. For the building volume rate specified in the test, land subsidence superposition effect exists obvious

time effect. Building volume ratio should be controlled in a certain range in order to prevent the land subsidence exceeding the allowable settlement, and give rise to unstable factors of a city's environmental problems.

In another hand, the load and the structure of the building have obvious effects on land subsidence. For small load multi-storey buildings, the settlement of the land subsidence, the influence scope of land subsidence and the duration of subsidence are more limited, and the building volume ratio is low, too. But for high-rise buildings, especially the super high-rise buildings, because of the great load, despite using the pile foundation effectively curbs land subsidence' growth caused by the load increasing, its absolute settlement is still very considerable, and they not only influence large scope, but also works a long time, what is more, the volume ratio is very large.

Conclusions

Soil conditions, hydrogeological conditions and the upper buildings' load conditions in the test field are often complex, and there are many factors which affect the measurement results. By summarizing the three factors on land subsidence mentioned above, new technical data can be accumulated for further recognizing the factors and laws of the land subsidence induced by the high-rise buildings group, verifying the correctness of theoretical analysis, providing basis for establishing mathematical prediction model of land subsidence.

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