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Study on Frost Heaving Characteristics of Canal Foundation Soil in Hadashan, China Irrigation Area

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Abstract: Frost heaving characteristics of canal foundation soil in HaDashan area are analyzed and studied by indoor frost heave test and field test. The research results show that, under the experimental conditions, the frost heave of the canal soil increases with time and temperature, but after a certain period of time, the amount of frost heave tends to be stable; the frost heaving process is divided into 4 stages: unstable freezing, continuous freezing, stable freezing and thawing. The research results have certain guiding significance for the construction of large channel in HaDashan area.

1. Introduction

In cold regions such as northeast, northwest and high altitude areas in China, cold weather in winter caused freezing of different depths of crustal surface soils, so that many kinds of engineering and structures which are located on the soil base and water are destroyed by ice pushing, frost heaving and freezing thawing, resulting in the destruction of different parts, forms and degrees. The water conveyance channel has the characteristics of long lines, complicated geological conditions, diverse soil quality of filling materials and light quality of channel lining, as well as different winter water conditions and freezing effects. The freezing damage is more likely to occur than other hydraulic structures.

The main water conveyance canal of Hadashan water control project is located in the cold area. and the channel soil is single, basically clay and loess loam, and the preliminary analysis is frost heaving soil.Therefore, it is necessary to carry out indoor and field frost heave observation test to define the frost heave type of foundation soil and provide scientific basis for design and construction.

2. Methodology

2.1 Indoor Frost Heave Test

The indoor frost heaving test was carried out, taking into account the high groundwater level and supplying the frost heaving front, the open system test was used to test the frost heave under the condition of external water supply [1-3]. The frost heave test of the open system is designed with 4 groups, and the test results are shown in Figure 1 and table 1:

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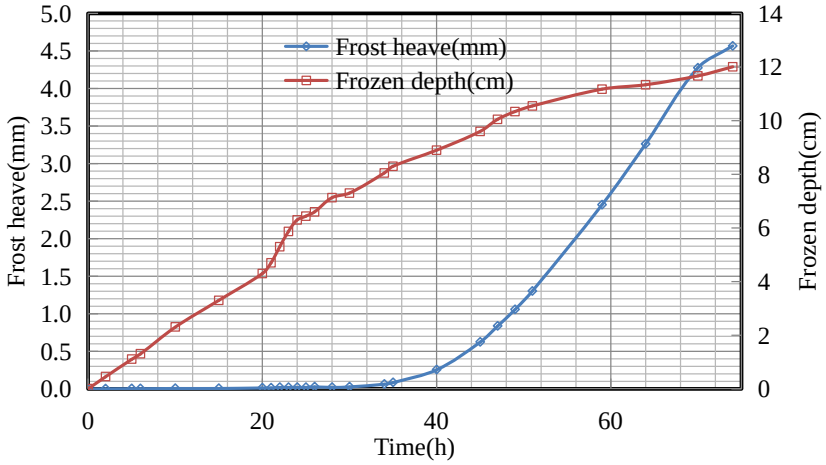


Figure 1. frost heave volume and frozen depth curve

Table 1 HaDaShan drainage base soil frost heave test results table

Number	Water content (%)	Frost heave(mm)	Frost heaving rate(%)
1-1	17.4	4.57	3.95
1-2	18.0	5.23	4.37
1-3	17.2	5.50	4.56
1-4	16.5	4.80	4.03
average value	17.3	5.03	4.23

Test results show that the frost heave of canal foundation soil increases with the freezing depth; under the condition of test, the frost heave of canal foundation soil increases with time and temperature decrease, but reach a certain time after the frost heave stabilized; frost heave of canal foundation soil increases with the increase of water quantity.

2.2 Freezing Process and Freezing Depth of Soil in Site

In the seasonally frozen soil region, the temperature is the upper boundary condition of soil freezing. With the seasonal variation of temperature, the frozen soil melts alternately[4-5]. According to the weather data for many years in the region, the temperature began to be negative in late October to early November, When the soil temperature is lower than the freezing temperature of soil water, soil water particle surface freezes and the soil to form one form of frozen soil, as the temperature decreases, the freezing front also gradually to the lower layer forward until it reaches the maximum frozen depth. After that, the temperature began to thaw, and the frozen layer began to melt in two directions. On the one hand, the temperature rose and the soil on the upper crust melted. On the other hand, under the influence of heat flow in the ground, the upper layer is ablated from the lower layer, and the frozen soil layer is connected between the middle of May and the end of May.

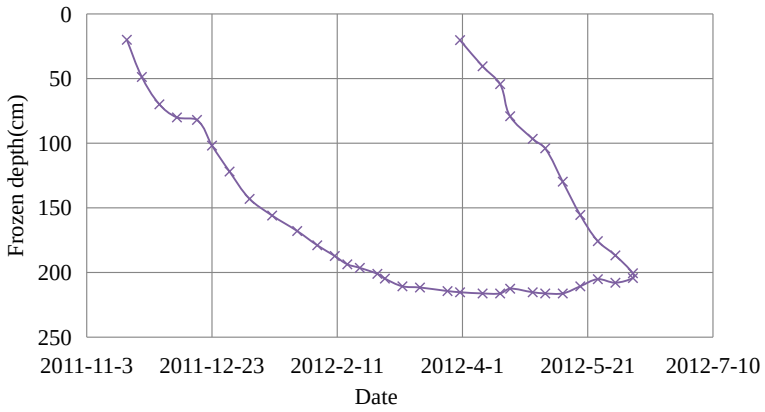


Figure 2. development process of freezing depth

It can be seen from Fig. 2 that the freezing-melting process of winter soil in the test site can go through the following stages:

The first stage is not stable freezing stage: generally occurs in late October to early November, the temperature fluctuate around 0 ° C, the surface soil freezing and thawing day and night, freezing thawing frequently, can not form stable frozen layer.The second stage is the continuous freeze stage: generally occurred in late November, and when the average temperature dropped to a steady negative temperature, the freezing depth began to increase, and reached the maximum freezing depth in late February.In this stage, although the freezing depth fluctuates briefly with the fluctuation of the temperature, but the overall trend is gradually increasing.. The third stage is the stable freezing stage: generally occurs in late February to late March, when the frost depth reach or close to the maximum, there are more than a month of time, due to the freezing interface in the heat balance, the freezing front is relatively stable, that is basically no development or reduced freezing depth.The fourth stage is the thawing stage: when the average temperature in late March reached the positive temperature, the surface began to melt from top to bottom. Thereafter, the bottom of the frozen layer began to melt from bottom to top until the whole layer of the melting layer disappeared. It can be seen that the melting of the frozen layer is carried out in both directions.

3. Results and discussion

The maximum frost heave and frost heave rate of the test ground in each year are shown in table 2. Seen from the table, in the test field, whether it is cold or warm year, surface amount of frost heaving are strong frost, according to the 《freezing resistance design specification》(GB/T50662-2011) in division level are frost heave grade IV~Ⅴ.

Table2 The maximum frost heave of the surface in each year

Year	2008-2009	2011-2012
Maximum frost heave（cm）	16.0	19.3
Frost heaving rate（%）	12.7	10.7

4. Conclusion

(1) Channel soil frost heave increases with the development of the deep freeze; under the condition of test, the frost heave of canal foundation soil increases with time and temperature increased, but reach a certain time after the frost heave stabilized; frost heave channel soil increased with the increase of water supplement.

(2) In the test field, whether it is cold or warm year, surface amount of frost heaving are strong frost, according to the 《freezing resistance design specification》(GB/T50662-2011) in division level are frost heave grade IV~Ⅴ.

(3) The frost heave test results show that the freezing-thawing process in winter can be divided into four stages: unstable freezing, continuous freezing, stable freezing and thawing.

5.References

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