Experimental Studies on a Sand Blanket with Contour Reinforcement in Seasonally Frozen Heaving Soils

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Abstract
The paper presents schematic illustration of the test installation to determine the effectiveness of contour reinforcement of a sand blanket. The results given have been obtained under the conditions of seasonally frozen heaving soils. The test installation, being a soil tray with a rigid bottom and walls, is placed in a freezing chamber where the maintained temperature is -4°C. The reinforced sand blanket has made it possible to reduce frost heave more than twofold, as compared to the natural soil bed.

Keywords: frost heave, sand blanket, reinforcement.

INTRODUCTION
Thickness of the active soil layer in Russia is in the range of 0.5 to 3 meters or more. The foundations of low-rise buildings and structures cannot always be constructed below the frost depth. To ensure good performance of foundations constructed on the heaving soils, measures are required to reduce the effect of frost heave on foundations.

One such measure is the use of sand blankets [1]. The authors propose a sand blanket with contour reinforcement in seasonally frozen heaving soils to reduce frost heave. The effectiveness of sand blankets with contour reinforcement in thawed soils is verified by Kraev A.N. [2, 3].

SUBJECTS AND METHOD
The test installation was created in the central research laboratory of frost science at IUT in order to study the effectiveness of sand blankets with contour reinforcement in seasonally frozen soils and reduce frost heave of soil. Schematic illustration of the test installation is shown in Fig. 1.

The scheme illustrates: 1 - heat insulator PPS-10, t=50 mm; 2 - tank shell; 3 - reinforced sand blanket; 4 - clock indicators; 5 - floor of the freezing chamber; 6 - stamp, 7 - water temperature sensor, 8 - heating cable, 9 - polypropylene pipes.

Medium-heaving water-saturated disturbed loam was used as a soil bed; it was embedded in the tray layer by layer. A trapezoidal sand blanket reinforced along the contour by geosynthetics (Geospan TN 80) was placed in the soil bed. The sand blanket in plan (at the top) was 250x650 mm in dimensions and 50 mm in height. A stamp, 150x450 mm in dimensions in plan, which imitated a foundation, was installed on the reinforced sand blanket.

A drainage system incorporating perforated polypropylene pipes and a heating cable inside was placed in the tray to simulate the groundwater level.

The general view of the test installation is shown in Fig. 2.
The test installation was placed in a freezing chamber where the maintained temperature was -4°C. Frost heave and soil temperature were recorded during the experiment. The test temperature was chosen taking into account the technique used to determine the degree of heaving [4].

Soil stamps were introduced into the soil tray in order to record the frost heave; besides, movements of the stamp were recorded during the experiment. Clock indicators with measurement accuracy of 0.01 mm were used to record these movements. Soil temperature was recorded using temperature sensors with measurement accuracy of 0.1°C. The location diagram of soil marks and temperature sensors is shown in Fig. 3.

RESULTS

The results are shown on a comparative graph of stamp movements in soil bed freezing-thawing in time, Fig. 4.

Figure 2: General view of the test installation.

Figure 3: Location diagram of soil marks and temperature sensors.

Figure 4: Stamp movements in soil bed freezing-thawing in time.
It can be seen from the angle of slope in the graph that the intensity of soil heaving and settlement is lower in the bed with reinforced sand blanket than that of the bed with unreinforced sand blanket and natural soil bed.

Vertical movements of the free soil surface during freezing-thawing are given in Table 1.

<table>
<thead>
<tr>
<th>Table 1: Test results</th>
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<tr>
<td>Test #1 (natural bed)</td>
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<td>Maximum soil heave, mm</td>
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<tr>
<td>Shrinkage of soil in the initial period of freezing, mm</td>
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<td>Soil settlement after thawing, mm</td>
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CONCLUSIONS

1) Reinforced sand blanket makes it possible to reduce frost heave more than twofold, as compared to the natural soil bed;

2) Contour reinforcement of the sand blanket makes it possible to reduce frost heave by 10-14%, as compared to the sand blanket without such reinforcement;

3) Reinforcement of the sand blanket makes it possible to eliminate freezing of clay with sand, thus frost heave decreases;

4) Reinforced sand blanket reduces shrinkage of the soil bed in the initial period of freezing; besides, it reduces soil settlement after thawing by 29%, as compared to the sand blanket without such reinforcement.

REFERENCES


