Babtie

Terram Ltd

Geotextile materials to suppress frost heave in soils

Terram Frost Blanket

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1.0 Introduction

Babtie Engineering Laboratories were commissioned by Terram Ltd to verify the ability of their Terram Frost Blanket to suppress frost heave in frost susceptible soils. This material is a composite comprising three layers: Terram 2000 geotextile (hydrophobically enhanced), a plastic drainage sheet, nominal 5mm thickness and Terram 2000 geotextile (see Plate 1).

2.0 Test Protocol

The frost heave test was developed by Road Research Laboratory (RRL) for predicting the frost heave characteristics of soils and road materials during the 1960s, and is fully described in RRL Report LR90[ref 1] and modified to the present test as described in TRRL SR318[ref2]. The modified test was adopted as a British Standard in 1989.

The frost heave test entails making specimens 100mm diameter by 150mm height, compacted to a value of maximum dry density and optimum moisture content as determined by vibratory compaction tests.

The specimens are stood on a porous ceramic disc and supported in a cradle, which is open at the base. The specimens are placed in a frost cabinet so that the ceramic disc is completely immersed in water, which throughout the test is kept at 4°C.

The specimens are allowed to saturate through capillary action for 112 hours and then subjected to freezing at (–17±2)°C for 96 hours and the heave measured. The temperature of the test ensures that the zero degree isotherm occurs at a predetermined height in the sample (approximately 50mm from the base).

An extra requirement to the test required by the Highways Agency in the Specification for Highway Works[ref3], includes a set of reference specimens with known frost heave (13.6±4.0)mm to be included to verify the operation of the equipment and test parameters.

3.0 Testing

A frost heave test, to "British Standard BS 812: Part 124:1989 Testing Aggregates: Method for the determination of frost heave[ref4]", was carried out on a frost susceptible material. The material selected was hassock fines, a locally occurring crushed calcareous sandstone known to give a frost heave greater than 30mm. The particle size distribution of the hassock fines is presented graphically at Figure 2 and tabulated at Table 3.

Two sets of three specimens of hassock fines were prepared, one set incorporated a layer of Terram Frost Blanket material approximately at one third the test specimen height coincidental with the zero degree isotherm during the test. The cut edge of the Frost Blanket was sealed with silicon sealant to ensure that no fines migrated between its layers during compaction.

The other set of specimens were compacted without the addition of the Terram material and tested at the same time as a comparison.

3.0 Results

The frost heave test results are presented at Table 1, the compaction and particle size distribution results for the hassock fines are presented at Tables 2 and 3 respectively.

A mean frost heave of 3.2mm was recorded on the modified specimens, while the unmodified specimens had a mean frost heave of 33.5mm.

A plot of the mean frost heave with time is presented at Figure 1 for the modified and unmodified samples, also included is the same information for the reference specimen.

Table 1 Frost Heave Results

Heave of Sample after 96 hours	Specimen 1	Specimen 2	Specimen 3	Mean	Range
Hassock fines with Terram Frost Blanket	2.5	3.0	4.0	3.2	1.5
Hassock fines	34	32.5	34	33.5	1.5
Reference Sample	13.5	12	13	12.8	1.5

Table 2 Compaction details of test specimen

Property	Determined by Test 14 BS1377	Stable Trial Specimen
Maximum dry density (Mg/m^3)	1.83	1.81
Moisture contents (%)	16	16

Table 3. Particle size distribution for hassock fines

British Standard sieve size (mm)	Percentage passing
20.00	100
10.00	99
5.00	99
2.00	96
0.60	83
0.30	70
0.063	43

4.0 Conclusions

From the tests carried out, Terram Frost Blanket suppressed the frost heave entirely. There was no formation of an ice lens at the zero degree isotherm in the modified specimens.

The minimal heave recorded was noted to have occurred throughout the top of the specimens and was attributed to the water content of the material itself freezing. This is demonstrated at Figure 1, where it can be seen that the frost heave of the modified specimens occurred during the first twenty four hours and therefore can be associated with the initial freezing of the specimens. No further heave occurred during the freezing period; but a subsequent and minimal contraction of the specimens was recorded. Frost heaves below 3mm generally occur in materials with cement stabilisation.

A comparison of the heights of the frozen specimens can be made from Plate 2 showing those with Frost Blanket and Plate 3 showing the unmodified specimens. The difference in height between an unfrozen specimen and the unmodified specimens can clearly be seen, as can the ice lenses located between one third and half way up the specimens. The ice lens forms at this height, which is coincidental with the zero degree isotherm, from water drawn from the base of the specimen by capillary action. The specimens with the Terram Frost Blanket however, display minimal change in height (heave) and no formation of ices lenses, demonstrating an effective break in capillary action

Our laboratory holds UKAS accreditation for all the tests carried out.

5.0 References

1 "RRL Report LR90 The frost susceptibility of soils and Road Materials", Croney and Jacobs, RRL Crowthorne, 1967

2 "TRRL Supplementary Report 318 The "LR90" frost heave test- interim specification for use with granular materials", TRRL Crowthorne 1977

3 "Manual of Contract Documents for Highway Works, Volume 1 - Specification for Highway Works" HMSO, London 2001

4 "British Standard BS 812: Part 124:1989 Testing Aggregates: Method for the determination of frost heave" British Standards Institution, London, 1989

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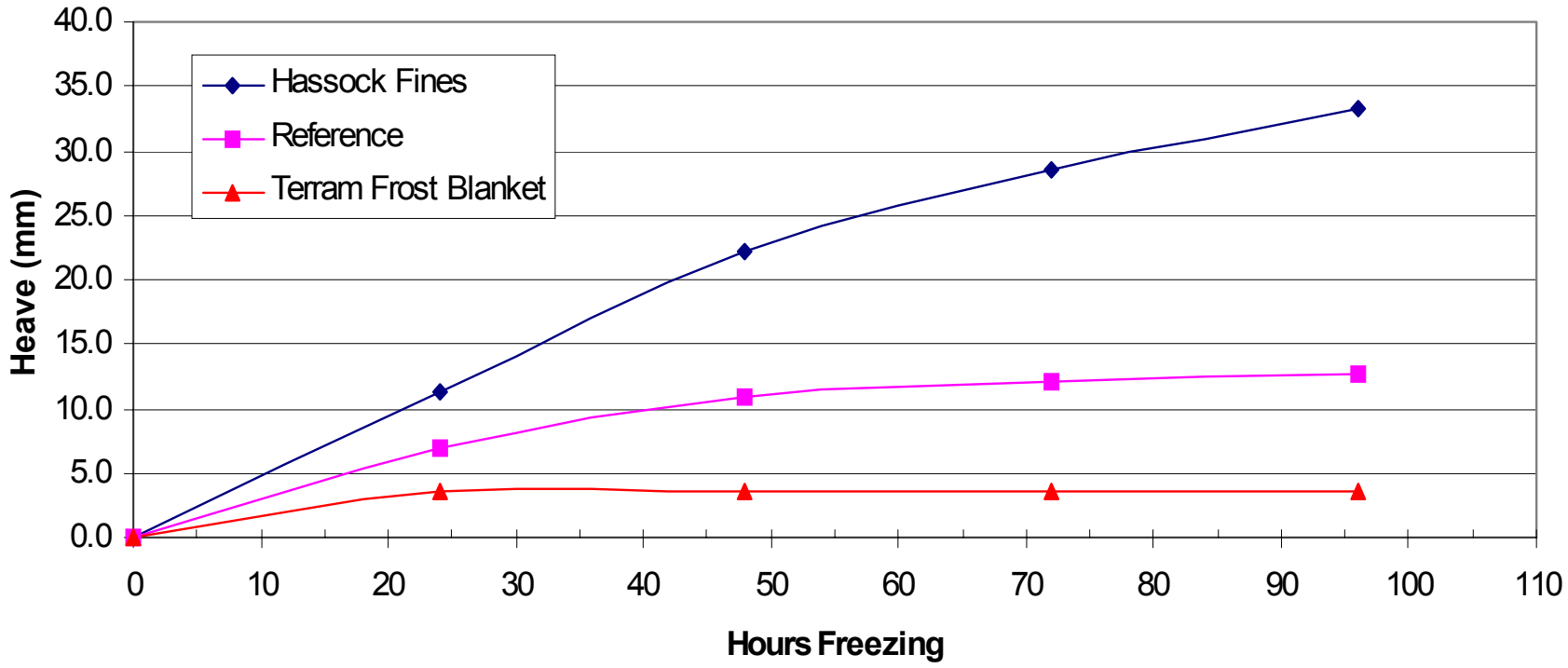
Figure 1. Comparison of frost heave of Hassock fines with and without Terram Frost Blanket



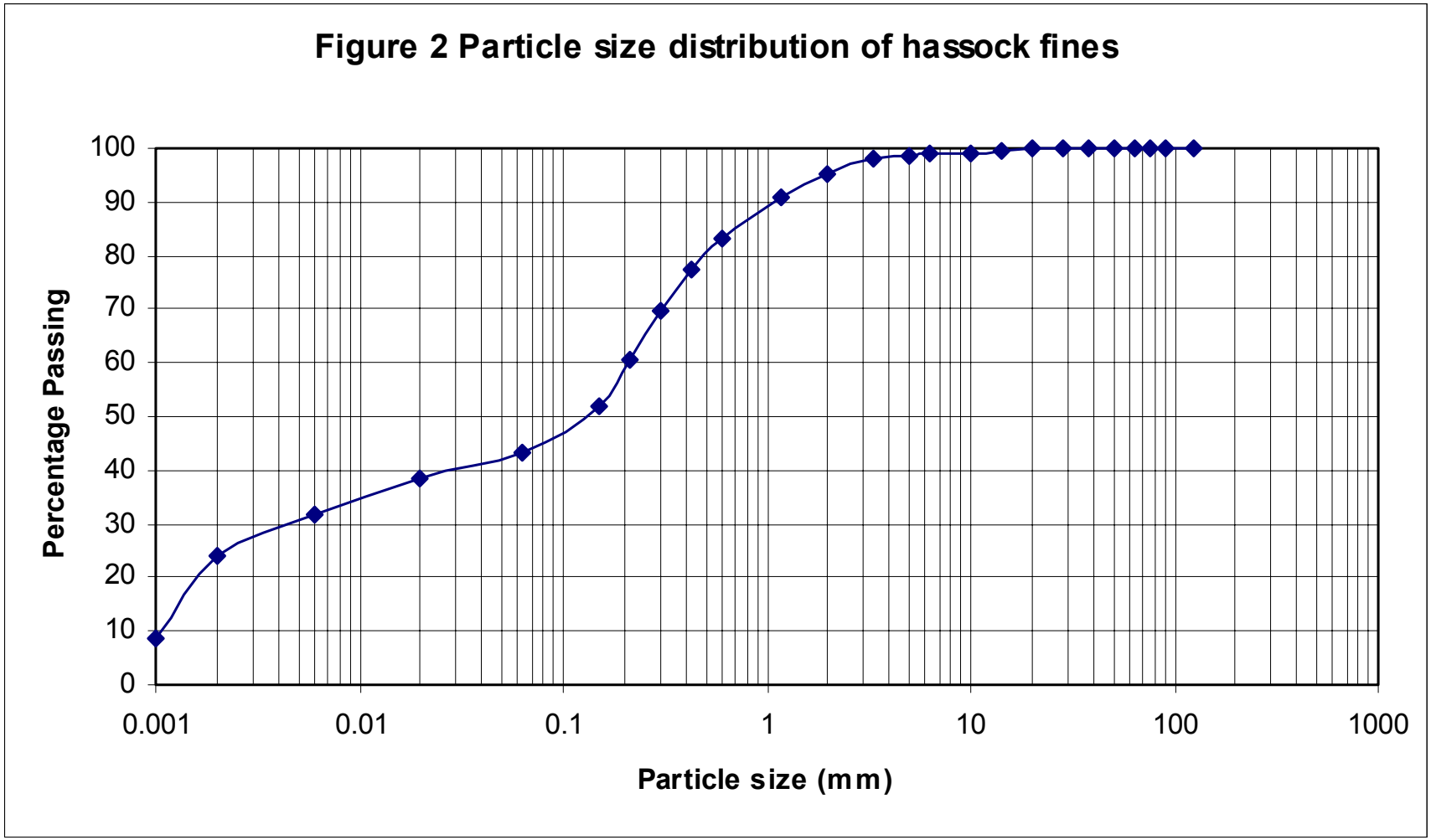


Figure 2 Particle size distribution of hassock fines
Percentage Passing
100
90
80
70
60
50
40
30
20
10
0
0.001
0.01
0.1
1
10
100
1000
Particle size (mm)

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Plate 1

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Plate 2

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Plate 3