FIELD INVESTIGATION OF HEAVE OF CHEMICALLY-STABILISED EXPANSIVE SOIL SUBGRADES

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ABSTRACT: The stability and performance of a road is reflected by the soil subgrade. Roads constructed on soils which have poor strength and are expansive in their character, are bound to fail resulting in poor pavement performance and increased maintenance costs. Investigations on chemical stabilisation revealed that electrolytes like KCl, CaCl₂, FeCl₃ may be effectively used in place of the conventionally used lime, because of their ready dissolvability in water and supply of adequate cations for ready cation exchange. Moreover, they can be applied to the ground in the form of electrolyte solution. This paper discusses the field studies which were conducted on expansive soil subgrades treated with KCl, CaCl₂ and FeCl₃ and compares the results of heave recorded from the untreated and treated test tracks. It was observed that FeCl₃-treated test track showed the best performance.

INTRODUCTION
Seasonal moisture variations bring about volume changes in expansive soils [1,2]. Continued efforts are being made all over the world to devise ways and means to solve the problems due to expansive soils. Several remedial measures such as application of adequate surcharge load, pre-wetting, moisture control, CNS layer technique [3], under-reamed pile foundation [4] and chemical stabilisation [5,6] were suggested to alleviate the problems posed by expansive soils. However, these and many other techniques are successful only to a partial extent and hence the attempts to devise better techniques are still going on. In addition, majority of these works have been confined to the laboratory under controlled conditions on remoulded samples and hence fail to simulate many of the field conditions.

Chemical modification by adding lime has been practiced for the last two decades [7]. However, due to low solubility (about 1.2g/lit @20°C) of lime and mixing problems involved, use of chemicals like KCl and CaCl₂ were tried by various researchers [8,9,10]. Further, a group of researchers [11,12,13] reported that CaCl₂ could be an effective alternative to conventional lime treatment due to its ready dissolvability to supply adequate calcium ions for exchange reactions.

In this paper an attempt is made to study the effect of KCl, CaCl₂ and FeCl₃ on the heave of the treated expansive soil subgrades.

EXPERIMENTAL STUDY

Materials Used: The following materials are used in this study.
Soil: The soil used for subgrade is black cotton soil collected from Godi Lanka near Amalapuram, in East Godavari District, Andhra Pradesh State, India. The soil properties are w_L=75%, w_P=25%, w_S=12%, IS Classification=CH, DFS=130%, OMC=29%, MDD=16kN/m³.

Murrum Soil: Murrum soil satisfying the MORT&H specifications was used for this study. It is used as a sub-base material in this investigation.

Road Metal: Road aggregates of size between 63-45mm conforming to the MORT&H specifications are used for the base course.

Chemicals Used: Commercial grade KCl, CaCl₂ and FeCl₃ were used for this study. The quantity of the chemical was varied from 0 to 2% by dry weight of soil.

Field Experimentation
Preparation of Test Tracks
Four types of test tracks of size 3m x 1.5m are constructed in JNTU, Kakinada campus. Figure 1 and Figure 2 show the two of the four test tracks constructed (as the test tracks for KCl and CaCl₂ treatments are similar to FeCl₃-treated test track construction). The expansive soil is allowed to dry and the soil is pulverized with the help of hand-operated roller. Test tracks each of size 3m x 1.5m x 0.8m are excavated. Three stretches were used one each for KCl, CaCl₂, FeCl₃ treatments and the other stretch was left untreated with a view to study the relative performance of the treatments.

Then, the expansive soil is mixed with water corresponding to OMC, and spread in the test pit in layers, of 5cm compacted thickness, to a total thickness of 50cm. Each layer is compacted, to get the required density with the help of hand-operated roller.
Further, the treatment for the stretch was done using the optimum percentage of additive obtained from the laboratory. Stabilization was done using the ‘Ponding technique’ in which the required concentration of chemical solution, was applied directly to the subgrade soil without any mixing. A 150mm thick compacted murrum subbase in two layers was laid over the prepared subgrade and then two layers of WBM-II base course of total compacted thickness 150mm were laid on the subbase for the construction of test track.

**Heave Measurements**
Cement concrete panels of size 0.3m x 0.3m x 0.05m were placed centrally in all the stretches for heave measurements. The reduced levels of the top of panels were fixed using levelling instrument with 1mm accuracy and heave measurements were taken during wet and dry seasons for all the stretches.

**DISCUSSION ON TEST RESULTS**
The in situ heave measurements with respect to time were taken on the different test tracks constructed on expansive soil subgrades, and the variation was plotted as shown in Fig 3.

The time taken to attain the maximum heave for FeCl₃-treated test track is nearly one-half, of the time taken by the untreated test track to attain its maximum heave.

**CONCLUSIONS**
i) A reduction in maximum heave by 22%, 30%, 43%, respectively for KCl-treated, CaCl₂-treated, FeCl₃-treated with respect to the untreated test track, was observed.

ii) The time taken to attain the maximum heave for FeCl₃-treated test track is nearly one-half, of the time taken by the untreated test track to attain its maximum heave, better than the other treatments.

iii) The considerable reduction in heave for FeCl₃-treated test track could be attributed to cation exchange with ferric ions and increased electrolyte concentration by addition of FeCl₃ solution, thereby the double layer thickness is suppressed.

iv) From the test results, it is concluded that FeCl₃ is the best treatment alternative, to reduce the heave.

v) A detailed study of the pressure-deformation characteristics due to cyclic loading could be considered as scope for further study.

vi) With reference to the practicability of the technique suggested, the use of ponding technique for large-scale stabilisation works can be carried out with less expenditure with little effort effectively, when compared to the other methods cited above.

**REFERENCES**


**SYMBOLS**

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<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td>CaCl₂</td>
<td>Calcium Chloride</td>
</tr>
<tr>
<td>DFS</td>
<td>Differential Free Swell</td>
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<tr>
<td>FeCl₃</td>
<td>Ferric Chloride</td>
</tr>
<tr>
<td>KCl</td>
<td>Potassium Chloride</td>
</tr>
<tr>
<td>MDD</td>
<td>Maximum Dry Density</td>
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<tr>
<td>MORT&amp;H</td>
<td>Ministry of Road Transport &amp; Highways</td>
</tr>
<tr>
<td>OMC</td>
<td>Optimum Moisture Content</td>
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<tr>
<td>WBM</td>
<td>Water Bound Macadam</td>
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<tr>
<td>w_L</td>
<td>Liquid limit</td>
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<tr>
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<td>w_S</td>
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