INVESTIGATIONS ON THE ROLE OF FINES CONTENT ON CBR VALUE OF SAND-CLAY MIXTURES

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ABSTRACT: In practice, in selection of borrowed earth, importance is paid to the quality of fines only as if quantity of fines is non-influential. It is necessary to understand the effect of quantity of fines on load bearing mechanism. With this objective, from out of a natural soil, the fines are separated and are added to the coarse fraction in the proportion of 0 to 50 percent by weight. The compaction characteristics of each mixture is found and the un-soaked, soaked CBR values of samples prepared at respective OMC are determined. The results clearly indicated the fact that, there is a specific Critical Fines Content (CFC) for the mixture, such that, when FC < CFC the influence of fines on the load bearing mechanism of total soil mass is insignificant. However, when FC = CFC, the load bearing mechanism is transformed in to that of a plastic soil. This phenomena is more pronounced in soaked condition. The CFC for the soil used in the study was found to be 20%. It is there fore necessary to consider PI together with CFC in the suitability criteria for selection of borrowed earth.

1. INTRODUCTION

1.1 General

The Government of India initiatives such as Prime Minister’s Rozegar Yojana (PMGSY), Employment Guarantee Scheme etc., have given boost to construction and up-gradation of pavements. This include laying of embankments, sub-grades using barrowed earth. Selection of borrowed earth is an important activity in construction of pavements.

Several investigations are carried out in understanding the interaction of sand clay mixtures. Georgiannou, V.N. et al. (1990) have studied the un-drained behavior of Clayey Sands in Tri-axial compression and extension. Pitman, T.D. et al. (1994) have studied the influence of plastic fines on collapse of loose sands. The influence of non-plastic fines on residual strength was studied by Zlatovic, S. & Ishihara, K. (1995). Contribution of fines to the compressive strength of mixed soils was studied by Ni, Q. et al. (2004) and concluded that, the equivalent granular void ratio suggested by Tehvanayagam et al. (2002) accounts the differing contributions of fines, while stress history seems to be important.

2. STATEMENT OF THE PROBLEM

2.1 Objective

The primary objective of this study is to investigate, whether the load bearing mechanism of soil with low percentage of plastic fines is identical with that of same soil possessing similar plastic fines in higher proportion. It include exploring the critical percentage of fines, if any, up to which the fines are non-influential on the load bearing mechanism.

2.2 Necessity

In selection of borrowed earth, many a times, emphasis is laid on Plasticity Index alone in isolation with the fines content. Several instances are reported wherein soil mass with highly plastic fines but in very low proportion are rejected even though its soaked CBR values are satisfactory. Hence it is necessary to investigate the interaction between quality and quantity of fines on load bearing mechanism.

2.3 Scope

Scope of this project work is limited to investigations on one type of frictional material and plastic fines only, which are separated from the same natural soil. The scope is limited to exploring the load bearing mechanism in terms of CBR tests only. The sample for consistency limits i.e., particles finer than 0.425 mm are considered as fines. The relative proportion of plastic and non-plastic fines is considered to have been reflected in terms of consistency limits.

3. METHODOLOGY

The methodology includes characterization of the materials used, determination of compaction characteristics as per IS: 2720 (Part-VII)-1980; the CBR values as per IS: 2720 (Part-XVI)-1987. To evaluate the role of fines content, the soil mass used in this project is intentionally separated in to coarse and fine fractions. Then, the fines are added in a
investigations on the role of fines content on cbr value of sand-clay mixtures

systematic manner from 0% to 50% substitution. The compaction and CBR characteristics are determined for these mixtures and analyzed to evaluate the role of fines and their plasticity characteristics.

4. characterisation of materials

4.1 soil

The Clayey Sand is collected from Ranga Reddy district in Andhra Pradesh. The index properties are as given below:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>True specific Gravity (G)</td>
<td>2.64</td>
</tr>
<tr>
<td>2</td>
<td>Particle size distribution</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Gravel Size Particles (%)</td>
<td>9.20</td>
</tr>
<tr>
<td></td>
<td>• Sand Size Particles (%)</td>
<td>81.60</td>
</tr>
<tr>
<td></td>
<td>• Fines (%)</td>
<td>9.20</td>
</tr>
<tr>
<td>3</td>
<td>Plasticity characteristics of fines</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Liquid Limit (%)</td>
<td>36.50</td>
</tr>
<tr>
<td></td>
<td>• Plastic Limit (%)</td>
<td>17.80</td>
</tr>
<tr>
<td></td>
<td>• Plasticity Index (Ip)</td>
<td>18.70</td>
</tr>
<tr>
<td>4</td>
<td>Differential Free Swell index (%)</td>
<td>0.00</td>
</tr>
<tr>
<td>5</td>
<td>Classification as per IS:1498–1970</td>
<td>SP</td>
</tr>
</tbody>
</table>

5. results and observations

Based on the results obtained in this study, the following observations are made:

(a) The Maximum Dry Density is progressively increasing as the % fines are increased from 0% to 30% and reduced marginally between 30% to 50%. Up to 30% substitution, the fines may have contributed to improvement of gradation and hence resulted in increased MDD. However, beyond 30%, the fines content in excess may have altered the gradation to poorly graded and hence may have lead to a marginal reduction in MDD (Fig. 1).

(b) The OMC slightly increase up to 10% substitution and dropped suddenly and again increased gradually as the fines content is increased. In general the OMC of coarse fraction with zero fines is more due to the bulkage effect. This effect may have continued up to 10% of fines. The steep drop in moisture content between 10% to 20% of fines signifies that, the soil is transformed from a cohesion-less medium where bulking is feasible to a c-F medium where it is absent. Beyond 20% of fines, the OMC is progressively increase due to increased specific surface of the mixture (Fig. 2).

(c) The Un-soaked CBR values were almost same up to 10% of fines. From 10% to 30%, there was an increase and from 30% on wards, there is a decrease. Up to 10% fines, the fines were just occupying the void space and were not part of the load bearing mechanism which essentially takes place at particle to particle contact points. From 10% to 30%, the fines continued to occupy the voids thereby contributing to densification. The fines up to 30% were still not in between sand particles in load bearing mechanism. However, as the fines content increased to 50%, the fines were in excess, making the sand particle now get embedded in the clay matrix. Accordingly, in load bearing mechanism, the Sand to Sand contact is replaced by fines to fines contact. Hence the Un-soaked CBR values are lowered (Fig. 3). This phenomena may have continued till 100% fines without much deviation.
(d) The soaked CBR values were almost same up to 10% of fines. This may be due to the fact that, the fines are present in the voids and are non-participatory in load bearing mechanism as the interaction is still between sand to sand. However, beyond 20% of fines, the soaked CBR values are continually lowered as the fines content was increased. This may be essentially due to shift in the interaction from sand-sand to sand-fines (between 20% and 30%) and fines-fines (from 30% onwards). Accordingly, the plasticity of fines contributed to the decrease in soaked CBR values (Fig. 4).

(e) The difference between soaked and un-soaked CBR values showed not much difference up to 10% of fines as the fines are present in side the voids and are non-participatory in load bearing mechanism. However, from 10% onwards, the fines are forming a coating on the sand particles and start embedding the sand particles in the clay matrix. In this state, when the fines are under soaking, their plasticity is brought in and hence the soaked CBR values are much lower than un-soaked CBR values and hence the difference is increased (Fig. 5).

(f) The maximum difference between soaked and un-soaked CBR values was observed at 30% fines content. Hence, 20% fines content at which fines contributed to 34% improvement in un-soaked CBR value and a marginal decrease of 1.10% in soaked CBR value is considered to be critical percentage of fines for the materials used in this study.

6. CONCLUSIONS

Based on the investigations carried out in this project work, the following conclusions are made.

(a) As the fines content is increasing there is gradual shift in interaction from coarse-coarse to coarse-fines and fines-fines which influence the load bearing mechanism. In the present study, the shift took place in stages of up to 20%, 20 to 30% and more than 30% respectively. The influence of plasticity due to soaking was dominant in the last two stages of interaction i.e., coarse-fines & fines-fines.

(b) For the materials used in this project work, the critical fines content (CFC) was found to be 20%, which resulted 34% increase in un-soaked CBR value and mere 1.10% decrease in soaked CBR value.

(c) Presence of fines up to CFC is beneficial.

(d) The concept of “Critical Fines Content (CFC)” need to be incorporated in selection of borrowed earth.

REFERENCES


