Strength, Modulus and CBR Values for Artificially Cemented Sand

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Abstract: In this study, the mechanical properties of 3% cemented sand cured up to seven days were investigated. The strength of the cemented sand varied from 8 to 40 psi. A linear relationship between modulus-to-strength ratio and CBR value was developed.

1 Introduction

Cemented sand is being used in a variety of geotechnical applications such as subgrades in highway and airport, foundations of nuclear power stations for reducing the liquefaction potential, dam and embankment slopes and backfill around pipes and retaining walls. In almost all the experimental programs reported in the literature, artificially cemented specimens have been used either to establish a fundamental understanding of natural soils behavior or to develop stabilization methods [Saxena and Lastrico (1978), Acar and El-Tahir (1986)]. Artificially cemented soil specimens have been produced by the addition of a range of cementing agents. The cementing agents include Portland cement, lime, fly ash, gypsum, fired kaolin and calcite precipitated at contacts between soil grains with a special technique (Ismail et al. 2000).

The California Bearing Ratio (CBR) is a penetration test for evaluation of the mechanical strength of road subgrades. It was developed by the California Division of Highways around 1930 and subsequently adopted as a standard test method (ASTM D1883-99) by various agencies.

2 Objective

The objective of this study was to investigate the relation between unconfined compression modulus-to-strength ratio and CBR value of 3% cemented sand cured up to 7 days.

3 Test Procedures and Material

In this study, commercially available sand was used and the coefficient of uniformity was less than 2 and was classified as uniformly graded sand. Experiments were conducted using artificially cemented specimens with cement 3% by weight of dry soil. Portland cement Type I was used for obtaining cemented sand. The unconfined compression strength (UCS) was in the range of 8 psi to 40 psi. Samples were compacted with standard compaction hammer (25 blows) and the dry densities varied from 103 to 105 pcf.

The basic CBR test involves applying load to a small penetration piston at a rate of 0.05 in per minute and recording the total load at penetrations ranging from 0.025 in. up to 0.300 in. Generally, the load at 0.1-inch penetration is used to compute the CBR value. The CBR value is defined as the ratio of the stress on piston at 0.1 inch penetration to that of the standard.

4 Results

The compressive stress-strain relationships for cemented sand cured for 1, 3 and 7 days are shown in Fig. 1. A typical CBR test result for 3% cemented sand, cured for 3days, is shown in Fig.2. Based on the laboratory tests the relationship obtained between CBR value and Elastic Modulus to UCS ratio is shown in Fig.3.

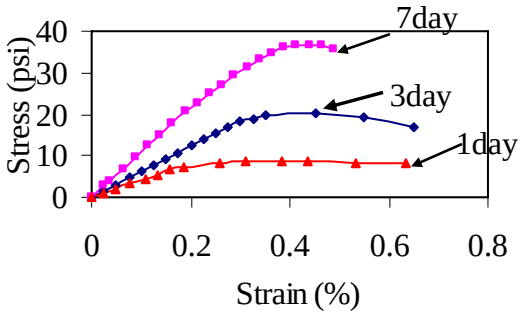

Figure 1. Curing Time Effect on UCS.

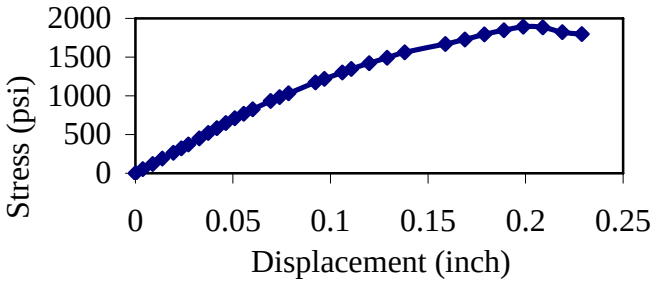

Figure 2. A typical plot of CBR Penetration versus Stress

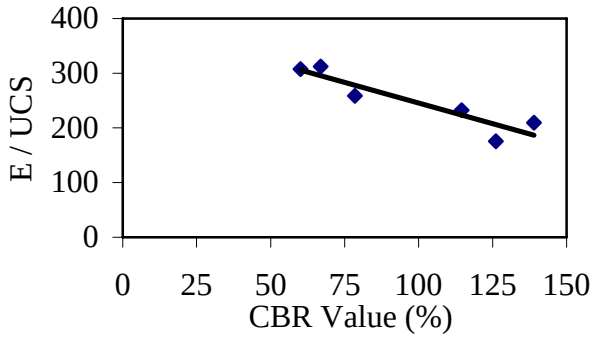

Figure 3. Relation Between strength-to-modulus ratio and CBR value

From the laboratory test following relation (R^2 value of 0.979) was obtained between the CBR values (at 0.1inch displacement) and modulus (E)-to-strength (σ) ratio of cemented sand.

$$E/\sigma \equiv (-5.28 \times CBR) + 544 \quad \textbf{(1)}$$

5 Conclusion

Laboratory tests with 3% cemented sand showed that unconfined compression strength increased up to 40 psi with increasing curing time up to 7 days. A linear relationship between modulus-to-strength ratio and CBR value was observed.

6 Acknowledgements

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7. References

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