COMPRESSION ZONE LENGTH OF CEMENT TREATED SANDS

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1. INTRODUCTION

When we design foundation it is important to take into account the foundation soil condition. If foundation soil is not good enough to support the structural load, ground improvement is needed to be carried out. Soil improvement techniques can be classified in various ways: according to the nature of the process involved, the material added, the desired results etc. For example, on the basis of process, we have mechanical stabilization, chemical stabilization, thermal stabilization, and electrical stabilization. Usually the soil at a site to be developed is not ideal from the viewpoint of soil engineering. In some cases, the engineer can avoid potential soil problems by choosing another site or by removing the undesirable soil and replacing it with desirable soil. A second approach to the problem of bad soils is to adapt the design for the conditions at hand. For example, floating foundation and deep foundations can be designed to avoid many of the settlement and stability problems associated with soft foundations. A third approach available to the engineer is to improve the soils.

Cement content does increase the peak strength of the treated soil, it also increases the stiffness thereby reducing the strain at which failure occurs (Lee et al., 2002). Mechanical properties of most cement stabilized soils change over time; therefore the time-related performance of such treated soils is essential in understanding their durability and long-term effectiveness (Porbaha et al., 2002). The viscosity of cement-based material can be improved by decreasing the water/cementitious material ratio or using a viscosity-enhancing agent. It can also be improved by increasing the cohesiveness of the paste through the addition of filler, such as limestone powder.

The use of limestone powder improves the properties of fresh and hardened concrete such as workability and durability (Zhou et al., 2010). For a fixed water content, high powder volume increases interparticle friction due to solid–solid contact. This may affect the ability of the mixture to deform under its own weight and pass through obstacles (Nawa et al., 1998). A method to measure the compression zone length for cement treated sands is presented.

Strain softening of cement treated sand occurs when microcracks which begin before the peak strength coincides to form a zone of damage (Fig. 1a), weakening the cement treated sand, so its load carrying capacity starts diminished, which ultimately leads to complete collapse. Additional deformation of zone of damage weakens it further and continued softening occurs. When specimen is short, damage appears to be concentrated in entire length. Specimen geometry and boundary conditions will also affect the strain softening behavior because they affect the size and shape of failure zone relative to overall specimen; investigating these influences is beyond the scope of experimental work presented here. This paper describes the compression zone length of cement treated sands. Typical stress strain curve for cement treated sand is shown in Fig. 1b.

2. EXPERIMENATL APPARATUS AND PROCEDURE

The size of the test cylindrical specimens were 100x100, 100 x 200, 100 x 300, 100 x 400 mm. Test variables were water to cement ratio (W/C) = 100, 130, 150 %, cement to sand ratio (C/S) = 30%, and Limestone powder to cement ratio, L/C = 130%.

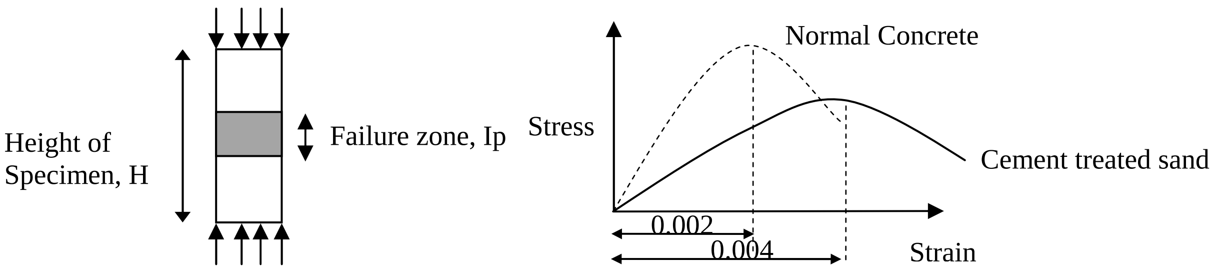

Fig. 1: (a) Failure zone length (b) Typical Stress strain curve

In order to investigate the internal behavior of cement treated sand, strain gauges were attached to a specially made silicone bars, and it has minimum affect on strain gauges attached to it because of having stiffness much less as compared with cement treated sands. Unconfined Compression tests were performed for curing period of 7 and 14 days respectively. Limestone powder is used to increase the viscosity of the paste and make the mix more workable.

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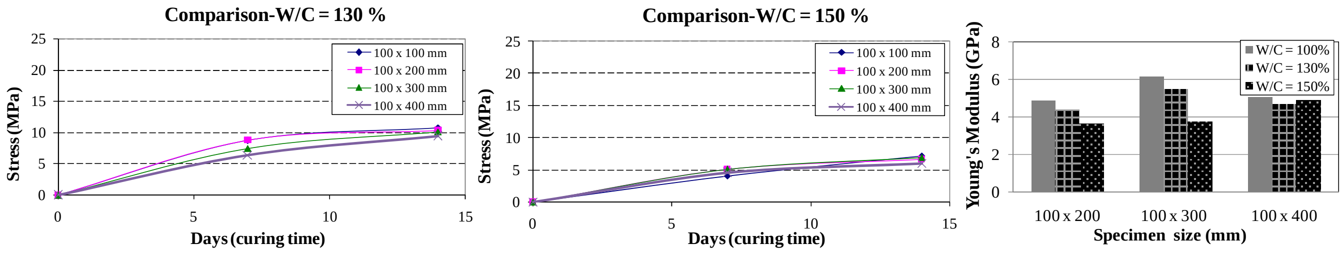
The moisture which is already present in the limestone powder is ignored in the mix design.

3. RESULTS AND DISCUSSIONS

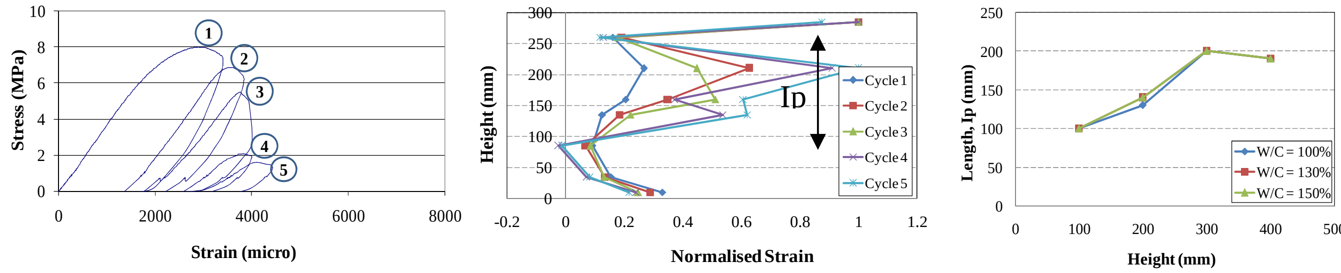
Compression test results are shown in Fig. 3a and b, which indicates that size effect on cement treated sand in term of compression test results is almost negligible. Young's modulus for 14 days curing period using W/C = 100 % is about 5.5 GPa (Fig. 3c). Strain corresponding to peak stress (14days) for such cement treated sand is about 0.004.



(a) (b) (c)

Fig. 3: Comparison of Compression test results for different size specimens and water to cement ratio (a) W/C = 130% (b) W/C = 150% (c) Young's Modulus for different W/C ratio

Cyclic loads were applied while performing compression test (Fig. 4a) Numbers in circle are indicating the loading cycle number. Strain distribution is measured by the strain gauges attached to silicone bar placed at the center of the test specimen. It can be seen in Fig. 4b that compression zone length (Ip, length along which failure is concentrated and can be determined from the strain distribution of the loaded specimen) for the W/C = 150% for specimen size of 100 x 300 mm is extended to a height of about 200 mm. Effect on compression zone length with different H/D ratio is shown in Fig. 4c. It can be seen that compression zone length increases with the height until it reaches to a constant value of about 200 mm.



(a) (b) (c)

Fig. 4: (a) Cyclic loading on a 100 x 300 cm specimen (b) Strain distribution of a 100 x 300 cm specimen (c) Compression zone length variation with different W/C ratio

4. CONCLUSIONS

- Maximum compressive stress is about 20, 10 and 7 MPa for W/C = 100, 130, 150 % respectively.
- Strain corresponding to maximum compressive strength is about 0.004.
- Young's Modulus is about 5.5, 4.5, 3.5 GPa for W/C = 100, 130, 150 % respectively.
- Compression zone length increases with the height of the specimen and then it becomes constant to a height of 200 mm.

5. REFERENCES

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