Stress and Stress Path Dependence of the Recompression Index (C_r) for an Over Consolidated Clay Soil

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Abstract: This study focused on the methods of determining the recompression index (C_r) of an over consolidated clay soil in Houston, Texas. Based on the method used to determine the C_r, up to 300% difference in the minimum and maximum C_r values was observed.

1 Introduction

Over estimation of settlement due to heavy structures placed on clays will require ground improvement before construction and will delay and add cost to a project. Although recompression index has been quantified in the literature, its determination is not clearly defined. The recompression index is determined from the unloading-reloading path of a consolidation test which is also non-linear on an e-logσ plot. Since the settlement up to the preconsolidation pressure uses the following relationship (1,2).

$$S_c = \frac{C_r}{1+e_0} H \log\left(\frac{\sigma_o + \Delta\sigma}{\sigma_o}\right) \qquad \text{with} \qquad \sigma_o + \Delta\sigma < \sigma_\pi \qquad (1)$$

Where σ_o is the current in-situ vertical stress, $\Delta\sigma$ the stress increase due to the structure, e_o the in situ void ratio, H the layer thickness and C_r is the recompression index.

2 Objective

The objective of this study was to investigate the different methods used to determine the recompression index and quantify its variation for the Houston over consolidated clay.

3 Test method

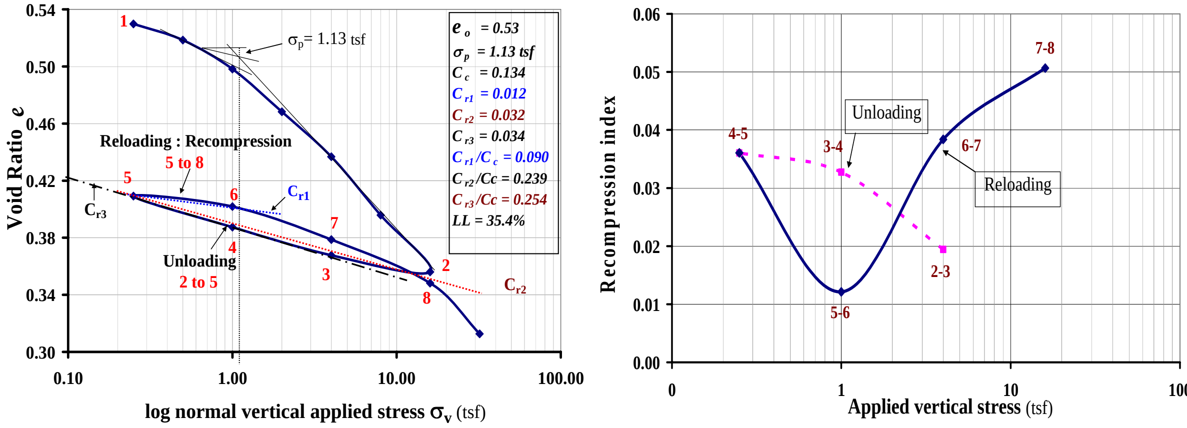
Clay samples were collected using 3 in diameter Shelby tube with an area ratio of 9.5%. The consolidation tests were done according to ASTM D 2435 – 96. The unit weight of the clay sample was 129.7 pcf with a moisture content of 20%. The e-logσ relationship for the clay is shown Fig. 1. a. The preconsolidation pressure (σ_p) was 1.13tsf and the over consolidation ratio (OCR) was1.42.

4 Analysis

As observed in Fig. 1 a., the unloading and reloading paths were non-linear and hence C_r can be determined in many ways as follows:

(1) C_{r1}= 0.012 (stress path 5-6) is the slope of the line joining the end of the unloading part (point 5) and the intersection of the preconsolidation line and the reloading part of the recompression curve;

(2) C_{r2} =0.032 is the average slope as shown in Fig. 1(a) (Holtz 1981);and C_{r3}= 0.034 is the slope of the unloading section of the recompression curve (Das 2006) and was equal to 283% C_{r1} in this case. C_{r3} is almost three times the value of C_{r1}. Fig. 1. b. shows the variation of C_r value with average stress level during the unloading and reloading. C_r varied from 0.019 (16 to 4 tsf) to 0.036 (1 to 0.25 tsf) during unloading and from 0.012 (0.25 to 1 tsf) to 0.038 (1 to 4 tsf) during the reloading stage. The C_r values are summarized in Table1.



a.) b.)

Figure 1. a.) e-log$\sigma_{v'}$ curve of a clay sample from SH146 at 13.5ft showing the three types of recompression indexes C_r ; b.) C_r- log$\sigma_{v'}$

Table 1. Summary of recompression index C_r values

STRESS (tsf -tsf)	PATH	UNLOADING C_r	RELOADING C_r	REMARKS
16 - 4	2 -3	0.019	-	OFF intrest
4 - 1	3 -4	0.033	-	Around the σ_p
1 - 0.25	4 -5	0.036	-	
0.25 -1	5 - 6	-	0.012	
1 - 4	6 - 7	-	0.038	
4 - 16	7 - 8	-	0.051	OFF intrest
RANGE		0.019 to 0.036	0.012 to 0.051	

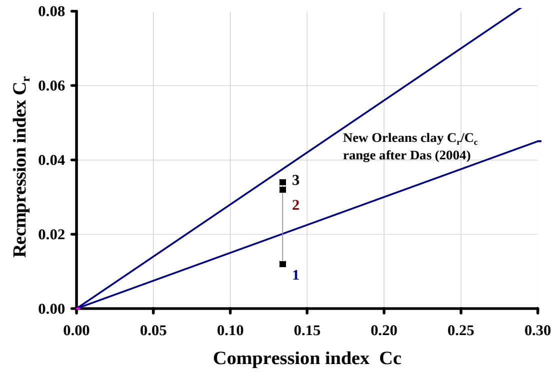


Figure 2. Comparison of C_{ri}/C_c obtained with New Orleans clay ratio range after Das (2006)

5 Comparison

The C_r values obtained from this study are compared to New Orleans clay in Fig. 2. While C_{r2} and C_{r3} were in the range of values specified for New Orleans clay, C_{r1} was outside the range and was much lower.

6 Conclusion

In conclusion, the recompression index C_r is stress path and stress dependent. Based on the stress path and stress level, the C_r varied from 0.012 to 0.038 in the stress range of 0.25 tsf to 4 tsf for unloading-reloading for Houston clay.

7 Acknowledgements

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8 References

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