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Effect of sand mixing on consolidation characteristics of soils from Kala Shah Kaku campus UET, Lahore, Pakistan

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ABSTRACT: Settlement of subsoil causes damage to the structures that needs costly and cumbersome remedial measures. There are many techniques of stabilization which are used to control the settlement of problematic soils. Among many available techniques, mixing of sand is one of the viable options. This research is performed by stabilizing clayey soil, present near newly built university campus of University of Engineering & Technology, Lahore, commonly known as KSK campus, by mixing sand. For this purpose, undisturbed block samples were taken from the site at depths of 2, 3, 4 and 5ft for testing in the laboratory. Consolidation tests were performed on each undisturbed samples, disturbed/remolded samples and after mixing 5, 10, 15, 20, 25% sand to analyze the effect of mixing sand on consolidation characteristics. It is found that compressibility characteristics, i.e., compression index 'C_c', coefficient of compressibility 'a_v', coefficient of volume compressibility 'm_v', decrease by 12% to 30% as the percentage of sand increases from 5% to 25%. The coefficient of primary consolidation 'C_v' decreases 15% to 38% with sand content varying from 5% to 25%.

1 INTRODUCTION

"Human settlement" has been a problem to be solved since primitive ages. In settlement analysis, almost invariably the consideration of compressible strata as the major contributing factor to the settlement is inevitable. Although in some cases, such as that embankment on soft soils, creep dominates to such an extent that settlement due to consolidation is masked and confused (Leonards and Altschaefel, 1964).

The government is establishing an Education City near Kala Shah Kaku, Lahore where the campus of University of Engineering & Technology, Lahore, commonly known as KSK campus, is being built. The objective of this study is to observe the effect of sand mixing on compressibility characteristics such as compression index 'Cc', Coefficient of compressibility 'a_v', coefficient of volume compressibility 'm_v', the coefficient of primary consolidation 'C_v' and secondary consolidation 'C_α'.

2 METHODOLOGY

Undisturbed block samples were obtained at depths of 2, 3, 4 and 5ft from the location marked on the map as shown in Figure 1. Sand was collected from Kala Shah Kaku area for mixing with the clay. All samples were sealed in sample bags, marked and stored until the time of testing.

The laboratory testing program comprised of following tests;

1. Consolidation test on original samples
2. Consolidation test on remolded samples of original classification.
3. Consolidation test on samples mixed with 5%, 10%, 15%, 20% and 25% local sand by weight.

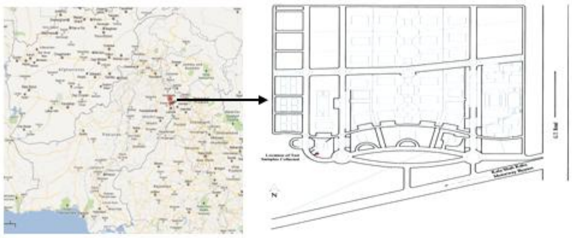

Figure 1: Location map of the study area

3 CONSOLIDATION CHARACHTERISTICS

Conventional consolidation tests have been performed as per ASTM standards on KSK soil samples in undisturbed and disturbed conditions obtained from 2ft to 5ft depth. The same disturbed samples were mixed with varying amount of sand and then tested for consolidation characteristics.

From e-logσ_v curves, the maximum past pressure for each test was determined using Casagrande's technique (1936). The values are tabulated in Table1. The OCR values are ranging between 4.1 to 7.0 and show a decreasing trend with depth indicating that the soil to 5ft depth is over consolidated.

Table 1: Over Consolidation Ratios for the Test Samples

Sample No.	Depth ft (m)	Existing Overburden Pressure "σ_v" (kPa)*	Pre-consolidation Pressure "σ_p" (kPa)	OCR
1	2 (0.6)	8.53	67	7.0
2	3 (0.9)	13.28	78	5.2
3	4 (1.2)	17.91	101	5.0
4	5 (1.5)	22.72	106	4.1

Symbols used for disturbed and undisturbed samples in the following graphs are shown in Figure 2. The effect of sand mixing on compression index is shown in Figures 3, 4, 5 & 6 for 2, 3, 4, and 5ft samples respectively. The value of C_c decreases as the percentage of sand increases. Undisturbed soil samples give more value of C_c but as percentage of sand increases value of C_c decreases. Results obtained in this project were similar by Emad & Osman (2006), Seah & Koslanant (2002) and Nanegrungsunk (1976).

Figures 7, 8, 9 & 10 show the effect of sand mixing on coefficient of compressibility a_v for 2, 3, 4, and 5ft respectively**.** It can be seen that value of a_v decreases with increase in percentage of sand however curves come closer to each other at beyond 500 kPa.

Figures 11, 12, 13 & 14 show the effect of sand mixing on coefficient of volume compressibility for 2, 3, 4, and 5ft respectively,. The discussion of the results is the same as stated for coefficient of compressibility above.

Effect of sand mixing on C_v is shown in Figure 15, 16, 17 & 18 for 2ft, 3ft, 4ft and 5ft samples respectively. From the Figures it can be noted that as percentage of sand increases the value of C_v

decreases. Similar findings were found by Lam Chee Siang (2006), Teves and Moh (1968), Thumaprudti (1974), Towan (1976), Wong Leong Sing et al, 2008-a & b).

The values of C_α for undisturbed and disturbed soil samples are plotted against pressure in Figures 19, 20, 21 & 22 respectively. No definite conclusions can be drawn about the variation of C_α with depth. However, the values of C_α tend to increase and decrease with increase in pressure. The values of C_α range from 0.07 to 0.8 and from 0.06 to 0.38 for undisturbed and disturbed samples respectively. Similar results have been reported by Teves and Moh (1968), Thumapruditi (1974) and Nanegrungsunk (1976).

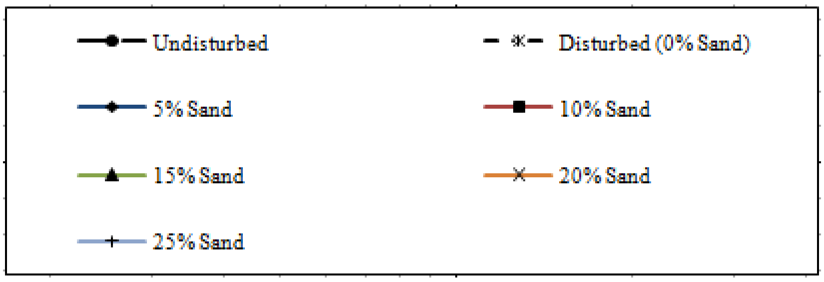

Figure 2: Symbols used for disturbed and undisturbed samples in the graphs

4 CONCLUSIONS

Following conclusions have been drawn from the research work:

1. The soil at the site was classified as silty clay (CL-ML) up to 5ft depth with 3% to 7% sand. The natural moisture content to 4ft depth is very low and becomes 16% at 5ft. The plastic limit of all the samples varies from 20 to 23 and the liquidity index shows that soil is in semisolid or solid state.
2. The over consolidation ratio (OCR) values up to 5ft depth are in the range of 4.1 to 7.0.
3. The values of compression index C_c ,coefficient of compressibility, a_v & coefficient of volume compressibility, m_v decreases 13% to 33% as the %age of increases from 5% to 25%. Coefficient of primary consolidation, decreases15 to 38% as the %age of sand increases. The effect of sand mixing on coefficient of secondary consolidation (0.05 to 0.24) is not significant.

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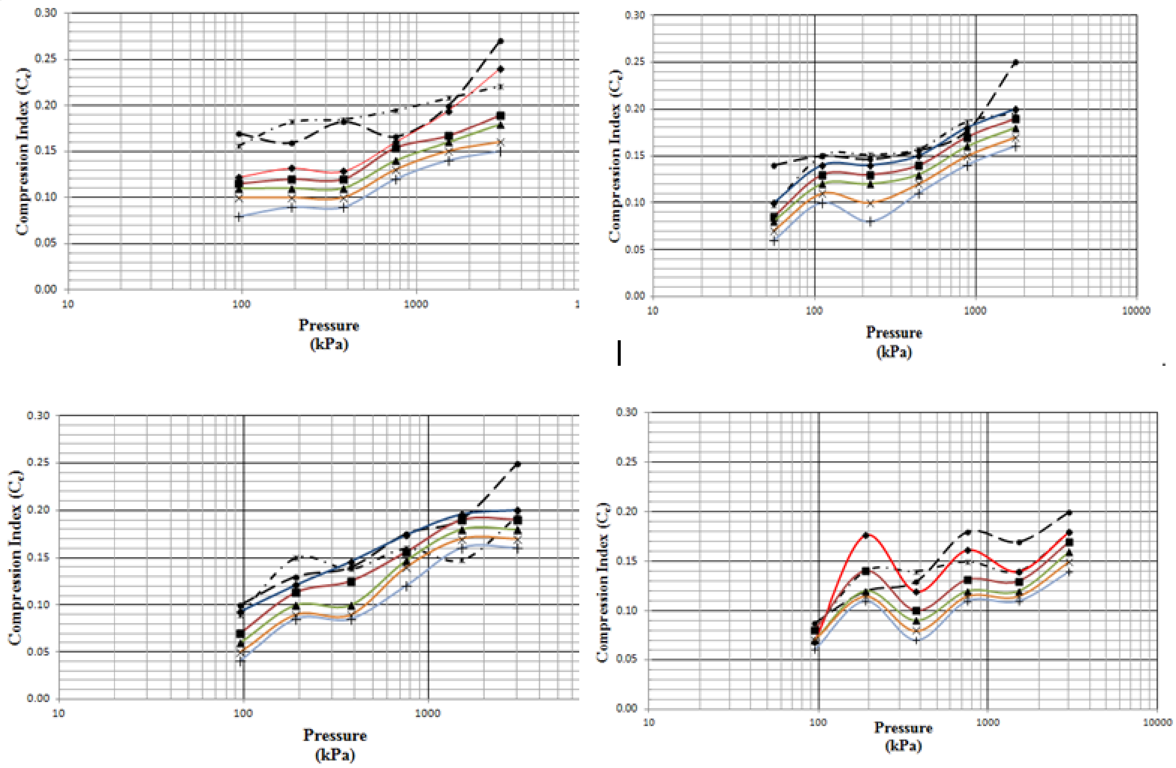
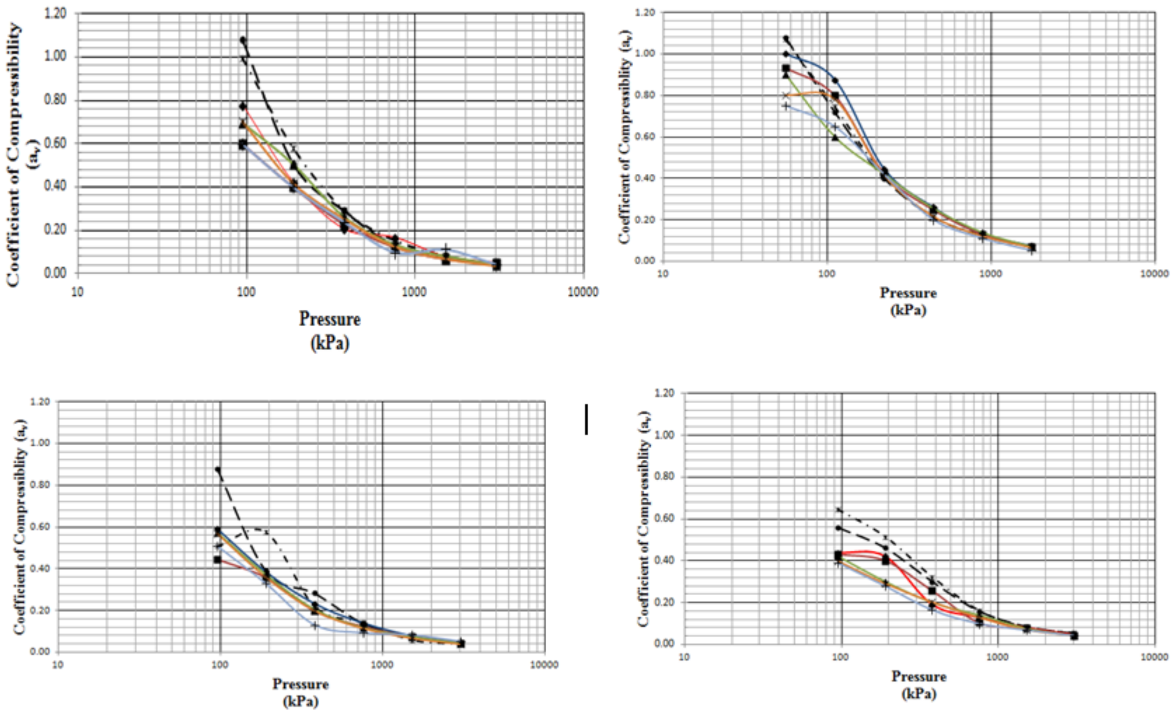
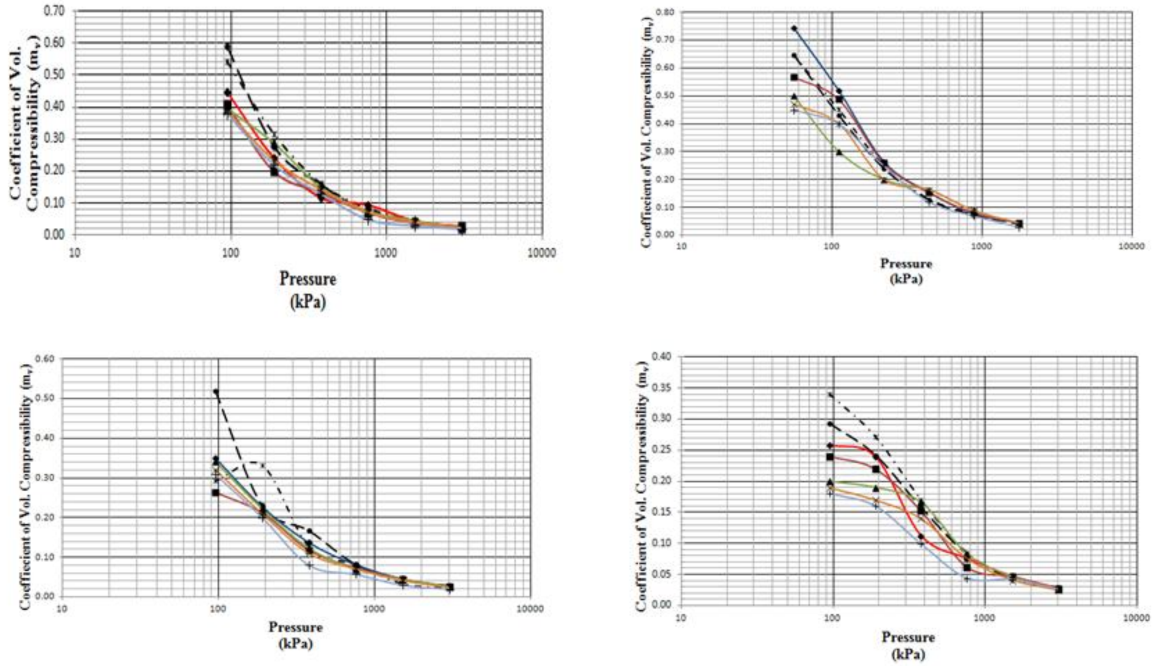


Figures 3, 4, 5, 6: Compression Index-log Pressure Relationship for 2 ,3,4 & 5ft Samples



Figures 7, 8, 9 & 10: a_v-log Pressure Relationship for 2, 3, 4 & 5ft Sample



Figures 11, 12, 13 & 14: Relationship between m_v-logP for 2,3,4 & 5ft Samples

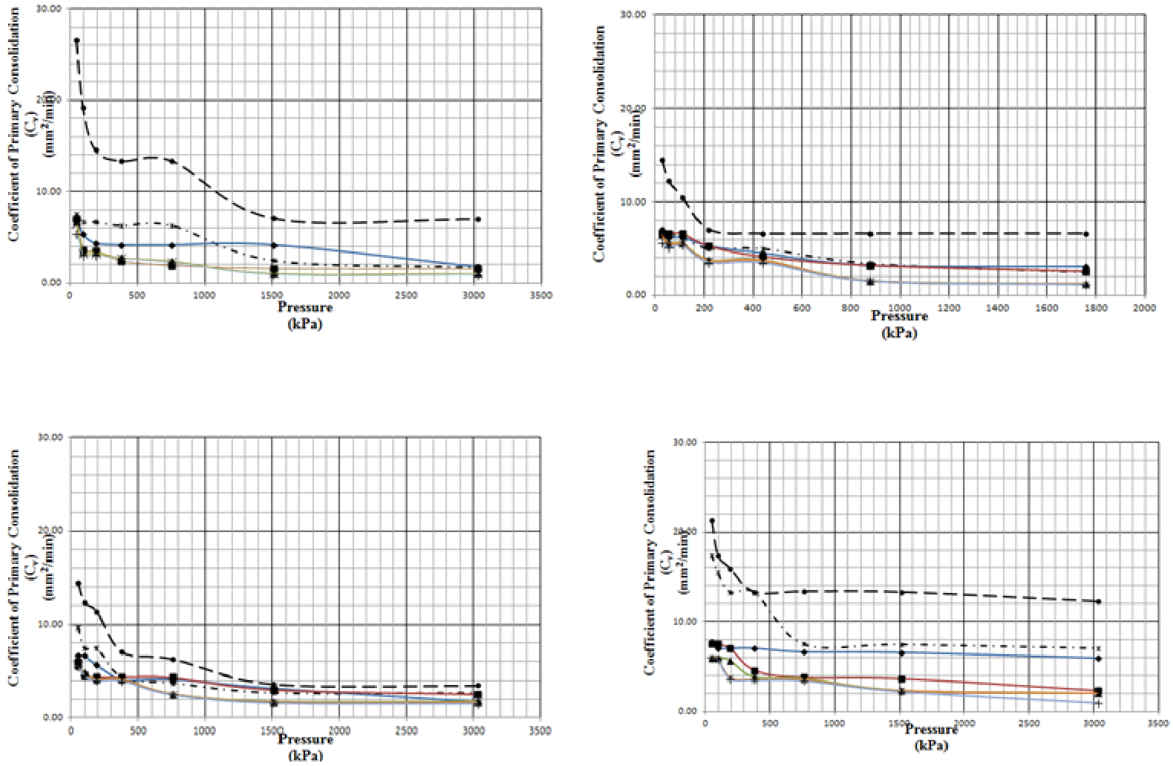
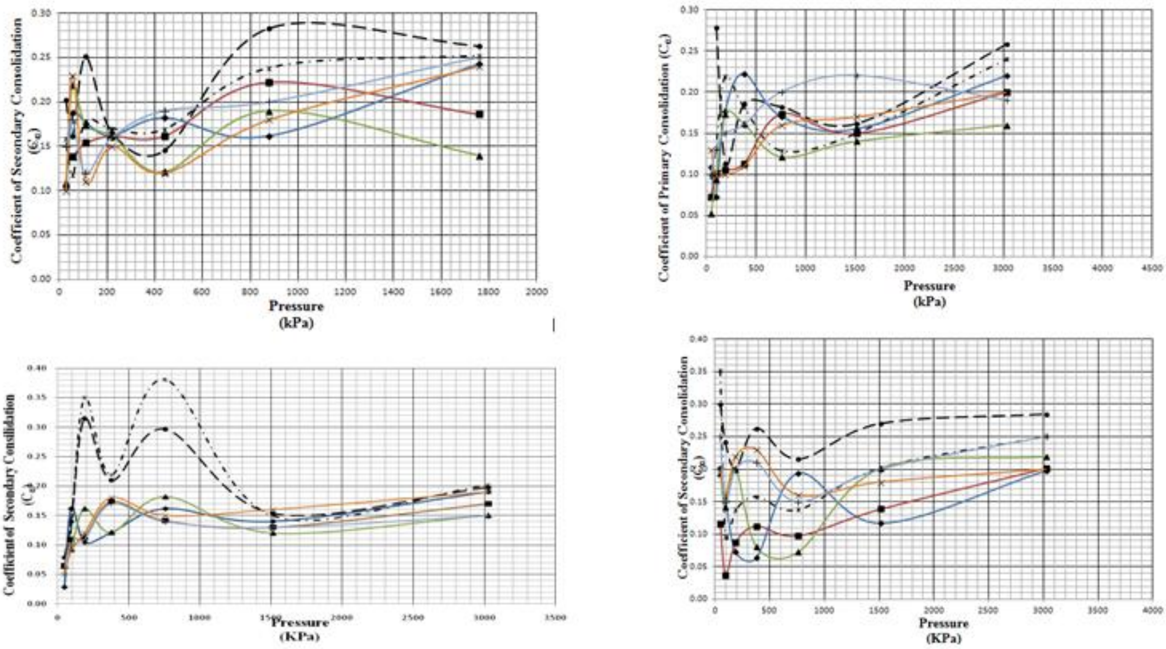


Figure 15, 16, 17 & 18: Variation of C_v with Pressure for 2,3,4,& 5ft Samples.



Figures 19, 20, 21 & 22: C_α-Pressure Relationship for 2,3,4,& 5ft Samples

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