Effect of Fly Ash on Consolidation Characteristics of Compacted Clay

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***Abstract*: One of the most important parameters is to study the geotechnical properties of the soil for the construction of geotechnical structures on the clay. Clayey soil can cause a lot of problems to geotechnical engineers while designing the structures. Consolidation properties are very important for the construction of any structure above the soft clay, so therefore the behavior of the soil is an important parameter for the settlement of clay. The structure may be settling down up to some extent, which may cause settlement problems and damage the structures. Therefore, it is necessary to study and to identify the behavior of the soil which will help to reduce the settlement problems. A laboratory one-dimensional consolidation test was performed to understand the settlement parameters and to strengthen the properties by soil stabilization with fly ash. Fly ash is the byproduct which may modify the geotechnical properties of soil. This study is to carry out to improve the consolidation properties and to reduce the settlement of the clay, by using fly ash at different contents.**

***Keywords*: Geotechnical properties, Consolidation characteristics, Fly ash, Settlement.**

I. INTRODCUTION

Consolidation characteristics are the most important parameter in the field of geotechnical engineering. Consolidation properties are directly proportional to the total settlement of any geotechnical structure. The nonuniform and excess settlement causes a lot of geotechnical problems and damages the dams, highways, roads, buildings, and airports. The excess settlement and inadequate soil causes the failure of the structure. So, to reduce these excess and nonuniform settlements, different geotechnical methods were used, but the most reliable and common method is fly ash stabilization. Fly ash is used as a modifying agent at different percentages such as 0%, 5%, 10%, 15% and 20% to reduce the risk settlement. In this study, A-7-5 soil is used, and the soil is treated with fly ash at different content and tries to find effectively percentage of fly ash, which may modify the consolidation characteristics of the soil.

II. MATERIALS & METHODS

The A-7-5 soil is collected from old boy's hostel MUET Jamshoro, Sindh at depth of 6"-8" below ground level by open excavation method. Fly ash is taken from Lakhra thermal power station district Jamshoro. The basic engineering parameter of the soil are given below in Table 1.

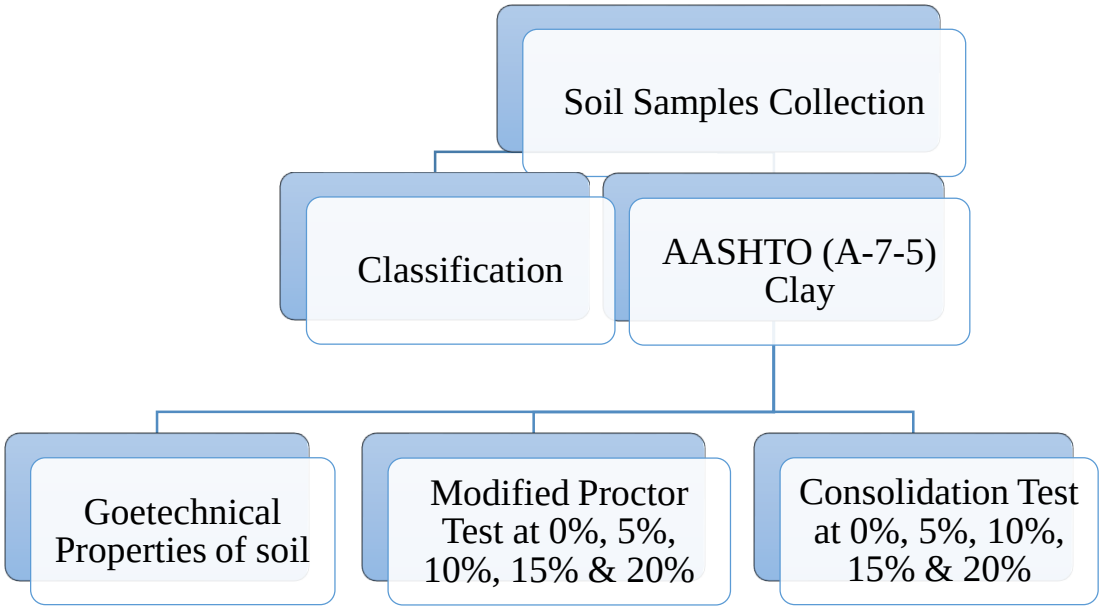
Table 1: Basic properties of the A-7-5 (Clay)

INDEX PROPERTY	INDEX VALUE
NATURAL MOISTURE CONTENT	4.3 %
PLASTIC LIMIT (L.L)	35.0 %
LIQUID LIMIT (P.L)	48.0 %
PLASTICITY INDEX (P.I)	13.0 %
OPTIMUM MOISTURE CONTENT	14.2 %
MAXIMUM DRY DENSITY	1.72 gm/cm^3
SPECIFIC GRAVITY	2.73
CLASSIFICATION	A-7-5 (Clay)

In this study A-7-5 soil is stabilized with fly ash at different contents such as 0%, 5%, 10%, 15%, and 20%. Each sample was taken as 20 days for loading and unloading during the consolidation test. Moisture density test is performed by the help of modified compaction efforts as per ASTM standard D1557-12e1. Then A-7-5 clay and fly ash is thoroughly mixed at different contents such as 0%, 5%, 10%, 15%, and 20%, then compacted on modified efforts during this process maximum dry density and optimum moisture content (OMC) are obtained. Consolidation tests have been performed on A-7-5 specimens as well as four treated soil specimens as per ASTM standard D2435-96. For consolidation sample preparation at different content of fly ash 0%, 05%, 10%, 15%, & 20% were thoroughly blended in the A-7-5 soil and then compacted at optimum moisture content.

Fig. 1: Consolidation Test Process

METHODLOGY CHART



III. RESULTS

A. Proctor Compaction Test:

The proctor compaction tests are carried out for the samples of A-7-5 clay and soil is stabilized with fly ash at different contents such as 0%, 05%, 10%, 15%, and 20% are shown in Fig. 2, it may be analyzed that the addition of fly ash in A-7-5 clay causes an increase in the optimum moisture content and a decrease in the maximum dry density.

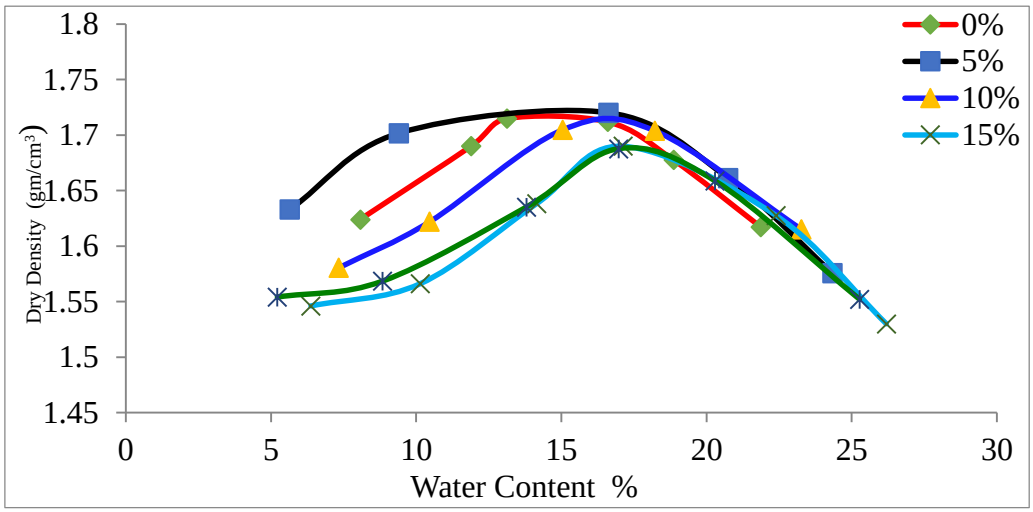


Fig. 2: Proctor compaction curves of A-7-5 clay with percentage of Fly ash

B. Coefficient of Consolidation (C_v):

Consolidation test is carried out to find the consolidation properties of A-7-5 clay and soil is stabilized with fly ash at different contents such as 0%, 05%, 10%, 15%, and 20%. The value of the coefficient of consolidation (C_v) shown in the Fig. 3 is calculated with help of log of time method and depend on the average value of the coefficient of consolidation (C_v) taken for the load range between of (08 kg/cm^2 to 16 kg/cm^2). It is observed that the value of the coefficient of consolidation (C_v) increases as increasing the percentages content of fly ash. Overall the value of coefficient of consolidation increases in relation to A-7-5 clay value. The coefficient of consolidation results of A-7-5 clay with % of fly ash as shown in the Table 2.

Table 2: Coefficient of consolidation A-7-5 clay and stabilized with fly ash

% of Fly Ash	Coefficient of Consolidation (C_v) (mm^2/min)
0%	0.7945
5%	2.355
10%	07
15%	8.305
20%	16.615

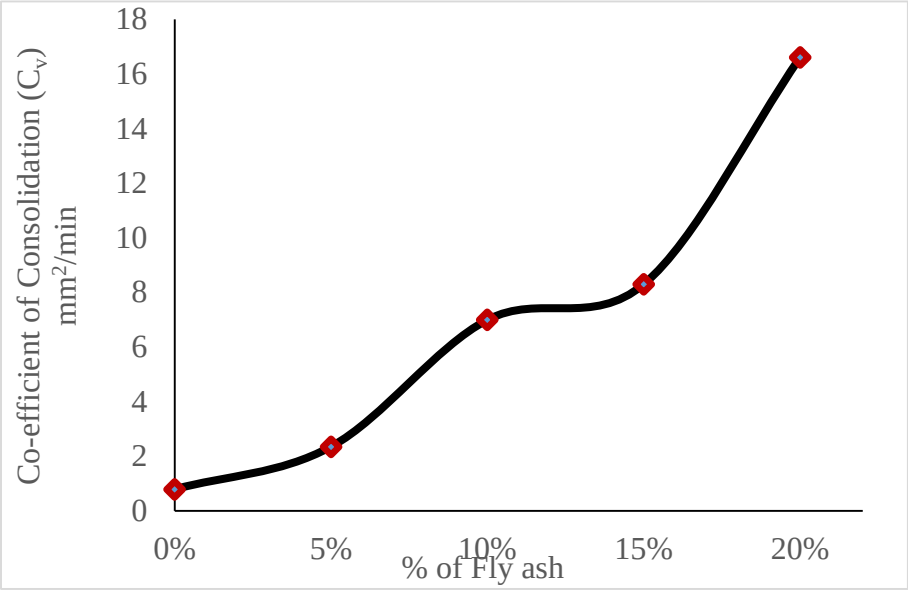


Fig. 3: Coefficient of consolidation (C_v) with % of Fly ash

C. Compression index (Cc):

Compression index of the soil is the most important parameter in the field of geotechnical structures because it is related to the amount of prediction settlement. It is determined by the graphical method with the help of the construction of voids ratio and pressure. The compression index values are shown in Fig. 4, of A-7-5 clay and stabilized with fly ash at different contents such as 0%, 05%, 10%, 15%, and 20%. It is noted that compression index initially reduced up to 10% and remain undefined. The value of the compression index of A-7-5 clay and treated with fly ash is shown in the Table 3.

Table 3: Compression index of A-7-5 clay and stabilized with Fly Ash.

% of Fly Ash	Compression Index (Cc)
0%	0.228
5%	0.19
10%	0.18
15%	0.254
20%	0.219

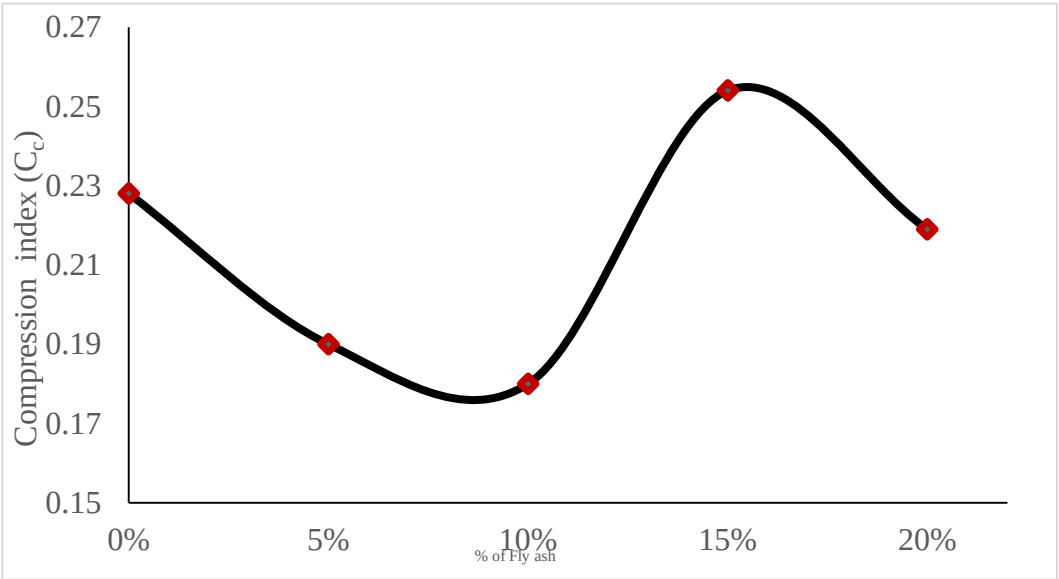


Fig. 4: Compression Index (C_c) with % of Fly ash

D. Coefficient of Volume Compressibility (m_v):

The Coefficient of volume compressibility may be used to find out the primary consolidation. The reduction in volume is shown in the form of specimen thickness. It is noted that the coefficient of volume compressibility (m_v) value decreases up to specific limit then increasing as the percentage of fly ash content increased. The value of the Coefficient of volume compressibility of A-7-5 clay and treated with fly ash is shown in the Table 4.

Table 4: Coefficient of Volume Compressibility (m_v) of A-7-5 clay and stabilized with Fly Ash.

% of Fly Ash	Coefficient of Volume Compressibility (m_v) (cm^2/kg)
0%	0.0335
5%	0.0076
10%	0.0067
15%	0.0356
20%	0.1125

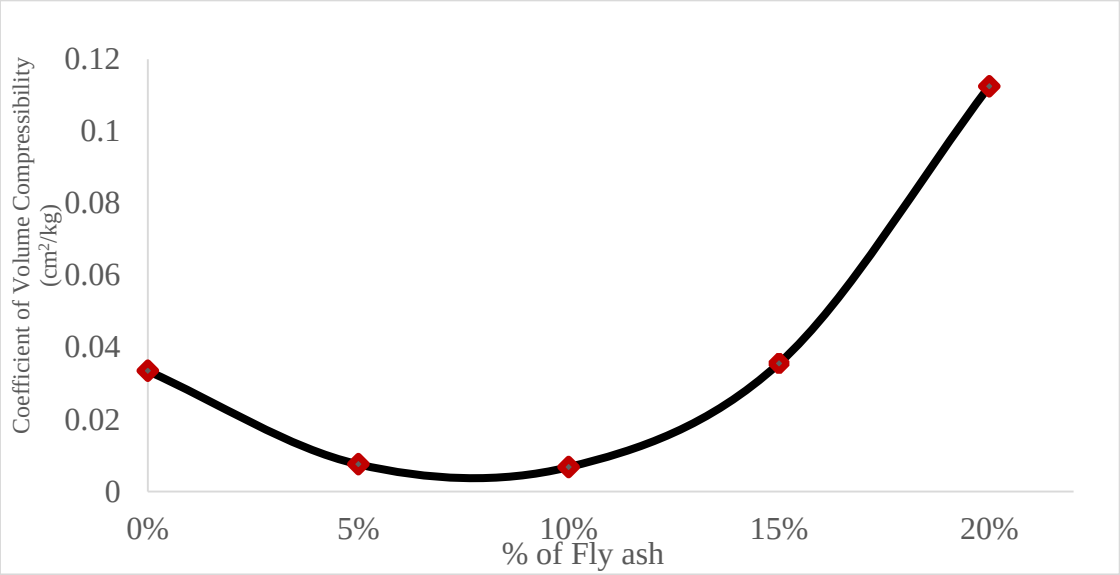


Fig. 5: Coefficient of volume compressibility with % of Fly Ash

IV. CONCLUSION

A laboratory investigation study was conducted to understand the effect of fly ash on the consolidation characteristics of compacted clay. The A-7-5 clay was stabilized with fly ash at different contents such as 0%, 05%, 10%, 15%, and 20%.

- The A-7-5 clay is stabilized with fly ash which causes a decrease in the maximum dry density (MDD), is due to the replacement of A-7-5 clay by the fly ash in the solution, fly ash has relatively lower specific gravity in relation to that of A-7-5 clay and an increase in the optimum moisture content (OMC) because fly ash requires more water during pozzolanic action.
- The value coefficient of consolidation (C_v) increases with the addition of the different content of fly ash in the A-7-5 clay mixture, the addition of the different content of fly ash in the A-7-5 clay became rough or granular & increased the rate of consolidation. Overall the value coefficient of consolidation (C_v) increases in relation to A-7-5 clay value.
- It is find that the compression index (Cc) value decreases upto 10 % of fly ash content and remain undefined by increasing the different content of fly ash.

V. RECOMMENDATIONS

Following are recommendations:

- The effect of chemical stabilizers should be furthermore examination by using different techniques of mixing of soil.
- Fly ash is used in the present study and different chemical stabilizers should also be investigated.

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