STRENGTH INCREMENT OF SAND COLUMN BY USING ADMIXTURES

S. M. Farooq, S. Das*, M. Y. Mollah & A. Akter

Dept. of Civil Engineering, Chittagong University of Engineering and Technology, Chittagong-4349, Bangladesh
**Corresponding Author:eequalstomc2_sanjoy@yahoo.com*

ABSTRACT
Fly ash is a coal combustion by-product. It is harmful for environment and can be classified as a hazardous waste. But it has cementious behaviour and may be useful for construction projects, engineering purposes. It is also helpful in solving the problems related to the geotechnical aspects under the process of ground improvement. By unconfined compressive strength test it is observed that the strength of a sand column increases when fly ash is used as one of the admixtures. The unconfined compressive strength test has been done using fly ash, cement and lime as admixtures for sand column considering different curing periods. With various proportions of admixtures the samples were prepared and the experiment was conducted. From the results obtained, it has been found that the percentage of fly ash increases the strength of sand column with respect to other admixtures.

Keywords: Fly ash; unconfined compressive strength; ground improvement

INTRODUCTION
Sustainable development is a vital concept to be considered in substitution of ground improvement methods in conventional construction practices. Inter-dependence of economy and environment factors are significantly important in regards to formulate policies and legislations in global aspect decisions, especially in terms of projects that impose massive impact on environment. It is imperative to study concurrent status of construction site prior to geotechnical design, especially in cases involving larger infrastructures. Most of construction practices use raw materials instead of recycling the waste materials. Waste production and increase of waste become worst as the wastes are harmful to the environment and human health.
Fly ash has been classified as hazardous Coal Combustion by-Product (CCP). This huge value of production is extremely dangerous if not dealt with right methods. As a result, many researchers have started to look into appropriate methods to be used and applied to the fly ash, reported that fly ash can be successfully used to improve the geotechnical parameters such as bearing capacity and shear strength. From research, it has been found that the use of fly ash can increase the potential for implementation as road sub-base for light to medium traffic. Through such research, it is stated that fly ash is a supplement that can be used to increase the strength, improvement of bearing capacity of soil and at the same time to solve the problems of settlement.

METHODOLOGY
Fly ash (FA), cement, lime and sand is used for the experimental investigations. FA is a solid waste from the combustion of coal with a high temperature (about 1000^0C) in coal power stations. For this study, the source of the FA has been taken from Barapukuria coal mine, Dinazpur, Bangladesh. Portland cement has been used based on the availability of this product. This type of cement has an ideal ratio of material properties needed for this study. Sand particles passing through 4.75 mm sieve were used to mixing with other materials. The optimum moisture content of sand is 14.7% with maximum dry density of 1.79 gm/ml. The classification of sand used is Well Graded Sand.

A mould of 4 inch diameter and 4.5 inch height is taken with collar attached to it. The sample prepared by mixing 20% water of its weight is placed in the mould in 3 layers and compacted by

hammer with 25 blows at each layer. The collar is removed and the surface is smoothed by a sharp knife. The mould is placed on a sample ejector and the sample is ejected from it.
The sample is placed in the trimmer to make the size of the sample to the desired shape of 4 inch height and 2 inch diameter. The sample is now covered with plastic membrane and allowed for air curing. The curing is done for the samples maintaining the duration of 7, 14, 21, 28 days according to the contents of admixtures. After curing the sample is placed on the bottom plate of the compression machine and adjusts it with the upper plate for proper contact. Now both the dial gauge and proving ring gauge to zero is adjusted. Compression load is applied to cause an axial strain at rate of 0.5 to 2% per minute. The test is continued until the failure surface is clearly developed.

PROPORTION OF SAMPLE PREPARATION WITH 20% WATER MIXING

1. 40% fly ash, 5% cement, 5% lime and 50% sand mixture.
2. 40% fly ash, 7.5% cement, 7.5% lime and 45% sand mixture.
3. 40% fly ash, 10% cement and 50% sand mixture.
4. 40% fly ash, 15% cement and 45% sand mixture.
5. 50% fly ash, 5% cement, 5% lime and 40% sand mixture.
6. 50% fly ash, 7.5% cement, 7.5% lime and 35% sand mixture.
7. 50% fly ash, 10% cement and 40% sand mixture.
8. 50% fly ash, 15% cement and 35% sand mixture.

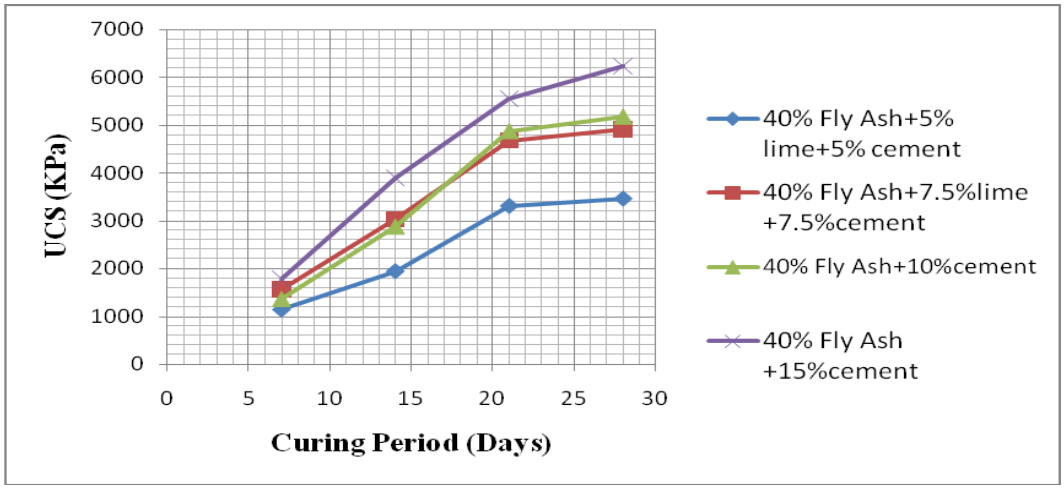

Fig-1: Unconfined Compressive Strength vs. curing time curve for (5, 7.5, 0, 0) % lime and (5, 7.5, 10, 15) % cement with 40% fly ash

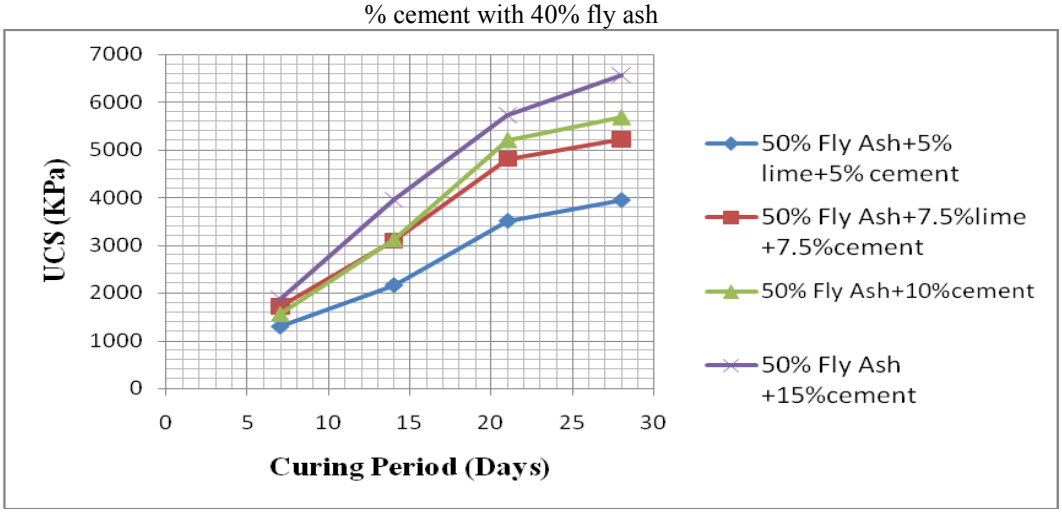

Fig-2: Unconfined Compressive Strength vs. curing time curve for (5, 7.5, 0, 0) % lime and (5, 7.5, 10, 15) % cement with 50% fly ash

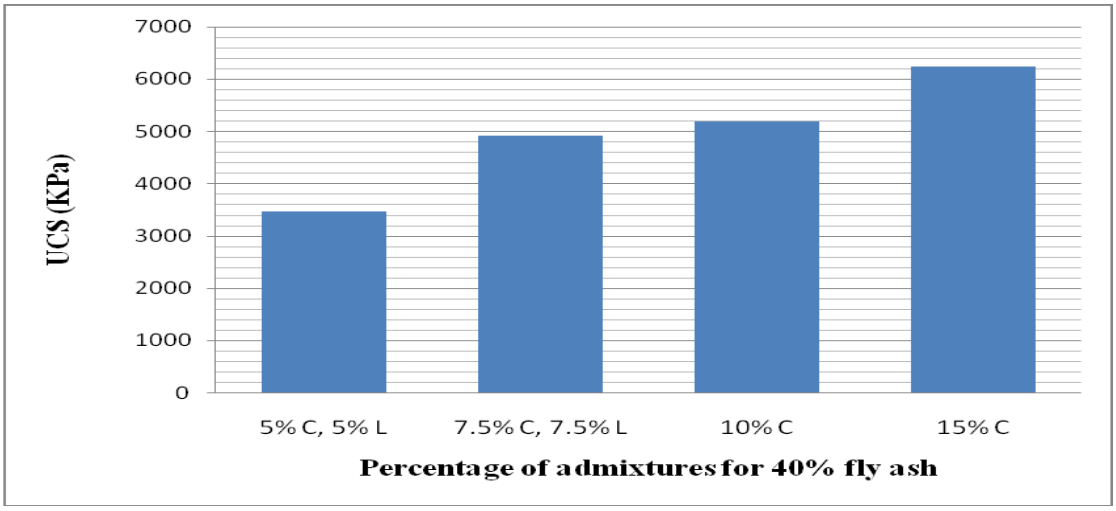

Fig-3: Percentage of admixtures used with 40% fly ash vs. unconfined compressive strength for 28 days

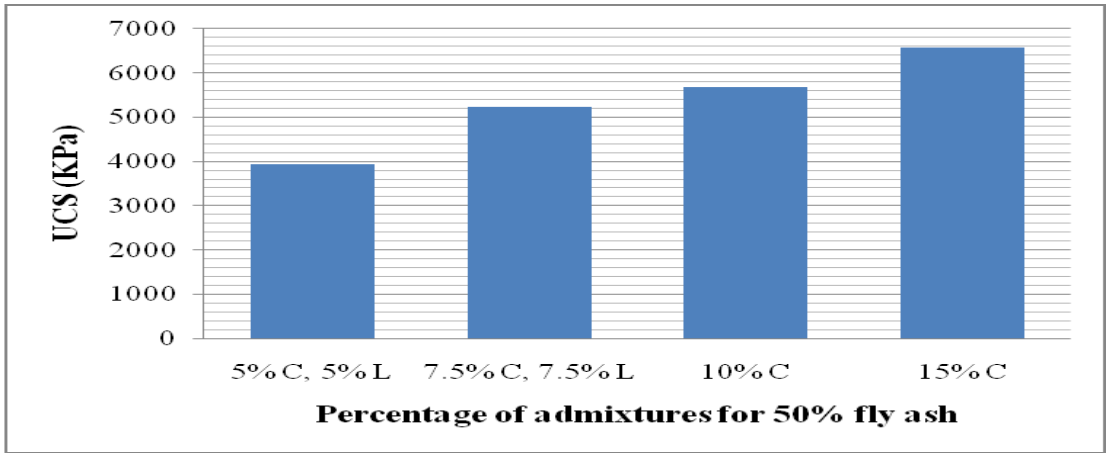

Fig-4: Percentage of admixtures used with 50% fly ash vs. unconfined compressive strength for 28 days.

Table-1: Comparison among unconfined compressive strength of sand column with different proportions of admixtures

Fly Ash (%)	Cement (%)	Sand (%)	Lime (%)	Unconfined Compressive strength (kPa) at different curing periods			
				7 days	14 days	21 days	28 days
40%	5	50	5	1148.00	1950.80	3316.36	3468.09
	7.5	45	7.5	1560.64	3034.58	4681.39	4920.03
	10	50	-	1365.60	2882.00	4877.00	5180.46
	15	45	-	1777.39	3901.60	5548.94	6242.56
50%	5	40	5	1300.53	2167.56	3511.44	3944.96
	7.5	35	7.5	1717.00	3099.61	4811.98	5223.81
	10	40	-	1560.60	3121.28	5202.14	5679.00
	15	35	-	1864.10	3953.63	5722.35	6567.70

RESULTS AND DISCUSSIONS

From the samples made for unconfined compressive strength test, it is observed that the strength gained in 7 days with different admixtures used do not differ much. In fact they are within the range of 1000 kPa to 2000 kPa. But strength increases much at 14 days curing time. The strength gained by 5% cement, 5% lime is less than the others. The strength for 10% cement alone and the combination of cement and lime (7.5%cement+ 7.5% lime) are very close to each other at 14 days curing. The strength gained by 15% cement sample is higher than the other proportions. At 21 days curing, the strength increases almost at the same rate as 14 days curing. From the graph it is seen that the slopes of the curves are almost same. From the Fig.1&2, it is seen that the rate of increment of strength from 21 days curing to 28 days curing is smaller for three proportions except for 15% cement.

Comparing the strength level of the samples of 40% and 50% fly ash admixtures, it is observed that the strength of the sample containing 50% fly ash is higher than that of 40% fly ash. This happens for every proportion of admixtures used for all curing periods (Table 1). For example, the strength of 15% cement sample with 50% fly ash is 4.95% higher than that of 40% fly ash at 28 days curing time (Fig.3 & 4). Hence it can be said that by increasing the amount of fly ash in the sand column the strength of it can be increased.

CONCLUSIONS

Sand column is a method to increase the strength of soft ground. By using fly ash as one of the materials in the sand column, it is useful not only in the geotechnical engineering, but also in the environmental issues. Fly ash and cement are the materials that have cementitous behaviour. This mixture process will continue under the chemical reactions of hydration and pozzolanic. It will harden and the void can be strengthened by unconfined compressive strength (Shakri S.et. al., 2013).

From the present study, it has been observed that by increasing the amount of the fly ash without changing the percentages of other admixtures, the strength of sand column is increased. As fly ash is a waste material and is harmful for environment, its proper use should be made. Use of fly ash in construction purposes increases the strength of the infrastructure and thus save the environment from pollution.

REFERENCES

Arora Dr. K. R., *Soil Mechanics & Foundation Engineering*, Sixth Edition

ASTM D3080. 1998. *Standard Tests Method*, ASTM International, Conshochocken, PA

ASTM C150M. 2001. *Standard specification for Portland cement*.

C. McDowell. 1959. *Stabilization of Soils with Lime, Lime-Fly ash, and Other Lime Reactive Materials*, Highway Research Board Bulletin.

Das Braja M. *Principles of Geotechnical Engineering*, Fifth Edition.

H.Y. Fang. 2006. *Introductory geotechnical engineering: an environmental perspective*, Routledge.

Prabakar, J; Dendorkar, N. et al. (2004), *Influence of fly ash on strength behavior of typical soils*, Construction and Building Materials 18(4), 263-267.

Lambe T. Williams, *Soil Testing For Engineers*, Fifth Edition.

Murthy V.N.S. *Principles of Soil Mechanics & Foundation Engineering*, Fifth Revised Edition.

Shakri, Hafez M.A., Norbaya S ,Journal of a Laboratory Study on *PFA-Cement Mixture to Increase Unconfined Compression Strength of Sand Column*.