Comparison of uniaxial composite strength and tensile strength of a composite fly ash material to avoid its dumping and adverse effects on environment

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Abstract— High ash content (30% - 50%) coal contributes to large volumes of fly ash. The country's dependence on coal for power generation is increasing and so the production of fly ash will be more. Fly ash causes air, water and soil pollution when exposed to environment. This project report is an attempt to find a suitable utilization for a particular fly ash sample depending upon its geotechnical properties. The area required for disposing fly ash will be minimised and so damage to the environment will be less. In this project geotechnical experiments were carried out on fly ash samples like Tensile strength study, Unconfined compressive strength study etc. Based on the results obtained from these experiments, a suitable use for the fly ash is ascertained. The main constituents of the composite are:

1. Fly ash
2. Lime

Compressive and tensile strengths were determined from the FCMs after 7, 14, 21 days of curing time. Different samples were taken with different percentages of lime (i.e. 5, 10, and 15 %) with fly ash and their properties were studied. The results from these above experiments helped in determining the potential of the fly ash for use, in manufacture of bricks, in highway embankments, as an aggregate material in Portland cement, filling of low lying and mine void areas etc. Composite material made of fly ash is subject to a variety of different loading conditions, and so different types of stresses develop. Based on the different strength of composites it can be used in various geotechnical applications like construction of roads, Embankment, dams and reservoirs and mine filling.. Thus their toxicity will not be dumped upon the environment.

Keywords- fly ash composite material, comparison of different fly ash composite samples at multiple curing time, fly ash utilization, testing of fly ash composites, selective curing of fly ash composite samples.

INTRODUCTION

Fly ash is chosen for its availability in abundance as well as its low lime content. Different lime proportions (0, 5, 10, and 15) % of fly ash (by weight) was selected. The addition of lime increases the pozzolanic reactivity of fly ash containing insufficient free lime required for pozzolanic reaction with its reactive silica.

Things Required:
1. Fly ash about 25 Kg
2. Lime about 2.5 Kg
3. Digital weight Balance
4. Measuring Cylinder
5. mild steel pipes of designate Length

PREPARATION OF SAMPLE

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1. About 410.4 gm of fly ash was taken and required amount of lime (5, 10, 15 % of weight of sample) and water quantity (20 %) of weight of sample are thoroughly mixed by hand.
2. Then the composite was put inside the pipe. Adequate pressure was applied for proper compaction.
3. Then it was kept inside the steel mould for 24 hours.
4. The samples were cast to size of. 60 mm diameter and 120 mm length for compressive strength tests and 30 mm length and 60 mm diameter for tensile strength test.
5. The samples were taken out of mould and placed inside humidity control chambers for curing where the temperature was maintained at about 30-35°C.

The following mixtures have been used in the investigation:

1. 95 FA+5L
2. 90FA+10L
3. 85 FA+ 15L
4. 100 FA+ 0L

FA-Fly ash, L- Lime

UNIAXIAL COMPRESSION TEST:

AIM: To determine the uniaxial compressive strength of Fly ash composite material

Procedure:

The test procedure is similar to the unconfined compression test for soil. The samples of L/D ratio is taken as 2:1. Place the specimen on the base plate of the load frame. Place a hardened steel ball on the bearing plate. Adjust the centre line of the specimen such that the proving ring and the steel ball are in the same line. Fix a dial gauge to the base plate to measure the vertical compression of the specimen. Adjust the gear position on the load frame to give suitable vertical displacement. Apply the load and record the readings of the proving ring dial and compression dial for every 0.25 mm compression. Continue loading till the sample fails in giving suitable values.

BRAZILLIAN TEST:

AIM : To evaluate the tensile strength of fly ash composite material.

Procedure:

The test procedure is similar to the tensile strength test for soil. Specimens with length-to-diameter ratios (L/D) of 2.5 are placed in a compression loading machine shown in fig- with the load platens situated diametrically across the specimen. Adjust the centre line of the specimen such that the proving ring and the steel ball are in the same line. Fix a dial gauge to the base plate to measure the vertical compression of the specimen. Adjust the gear position on the load frame to give suitable vertical displacement. Apply the load and record the readings of the proving ring dial and compression dial for every 0.10 mm compression. Continue loading till the sample fails in giving suitable values.

OBSERVATION TABLE:

sample	Curing period in days	UCS (MPa)	Brazillian tensile strength (KPa)
100 FA + 0L	7	0.0684	0.0
	14	0.0745	0.0
	21	0.0762	0.0
95 FA + 5L	7	0.160	84.5
	14	0.212	107.0
	21	0.217	110.1
90 FA + 10L	7	0.214	98.7
	14	0.237	111.7
	21	0.245	115.7
85 FA + 15L	7	0.240	109.0
	14	0.305	134.1
	21	0.325	139.3

. RESULTS:

Experiments were conducted to find the relation between the value of stress produced due to given strain for different samples with varying lime content, cured for 7, 14 21 days.

Results are as follows:

UCS TEST:

Table for values of stress at different content of lime against strain provided of 7 days cured UCS sample:

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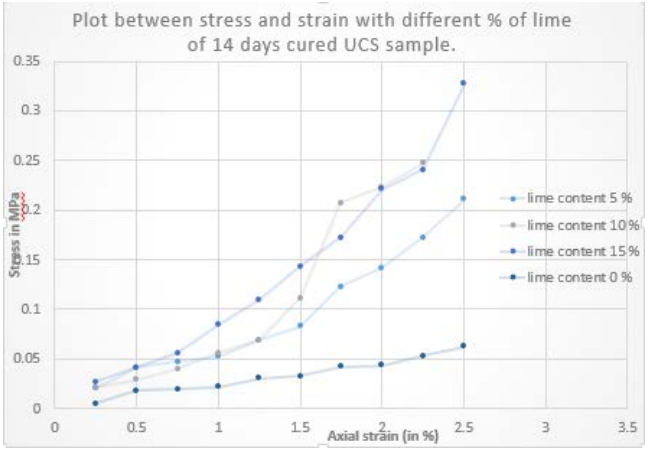
axial strain	lime content 5 %	lime content 10 %	lime content 15 %	lime content 0 %
0.25	0.018	0.021	0.02	0.005
0.5	0.022	0.032	0.027	0.0092
0.75	0.045	0.046	0.042	0.0169
1	0.06	0.063	0.064	0.0278
1.25	0.074	0.092	0.087	0.0372
1.5	0.092	0.134	0.125	0.0495
1.75	0.118	0.152	0.149	0.0674
2	0.128	0.2	0.169	0.0682
2.25	0.162		0.182	0.0691
2.5			0.234	0.071
2.75				
3				



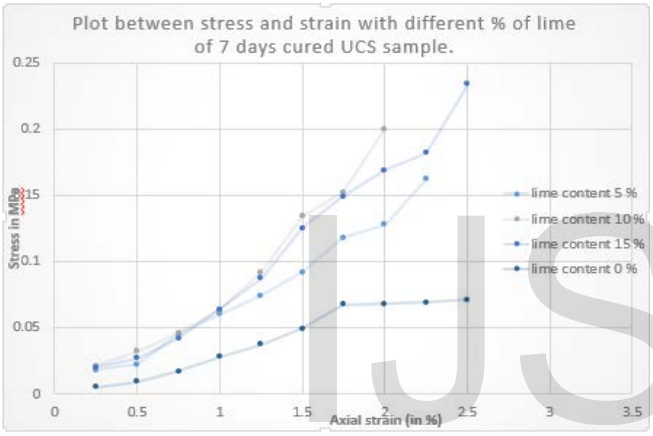
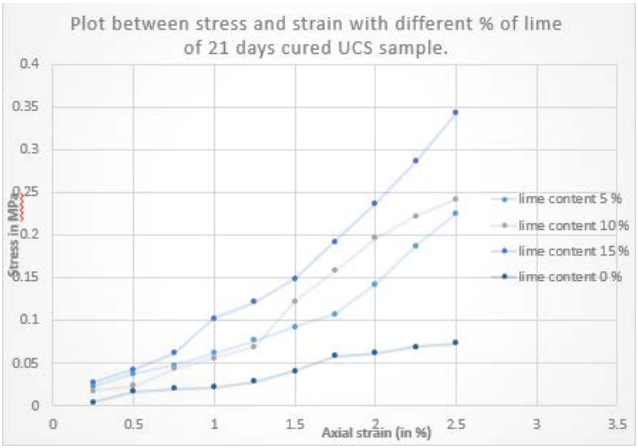


Table for values of stress at different content of lime against strain provided of 14 days cured UCS sample:

axial strain	lime content 5 %	lime content 10 %	lime content 15 %	lime content 0 %
0.25	0.02	0.021	0.027	0.005
0.5	0.041	0.029	0.041	0.018
0.75	0.047	0.04	0.056	0.0192
1	0.052	0.056	0.084	0.022
1.25	0.069	0.069	0.11	0.0301
1.5	0.083	0.111	0.143	0.0323
1.75	0.123	0.207	0.172	0.0421
2	0.142	0.223	0.221	0.0432
2.25	0.172	0.247	0.241	0.0528
2.5	0.211		0.327	0.0621
2.75				
3				

Table for values of stress at different content of lime against strain provided of 21 days cured UCS sample:

axial strain	lime content 5 %	lime content 10 %	lime content 15 %	lime content 0 %
0.25	0.022	0.017	0.027	0.0037
0.5	0.037	0.023	0.042	0.0161
0.75	0.047	0.043	0.061	0.0202
1	0.061	0.056	0.102	0.0218
1.25	0.076	0.069	0.121	0.0285
1.5	0.092	0.122	0.149	0.0409
1.75	0.107	0.158	0.192	0.0581
2	0.142	0.196	0.237	0.0612
2.25	0.187	0.222	0.286	0.0691
2.5	0.225	0.242	0.343	0.0731



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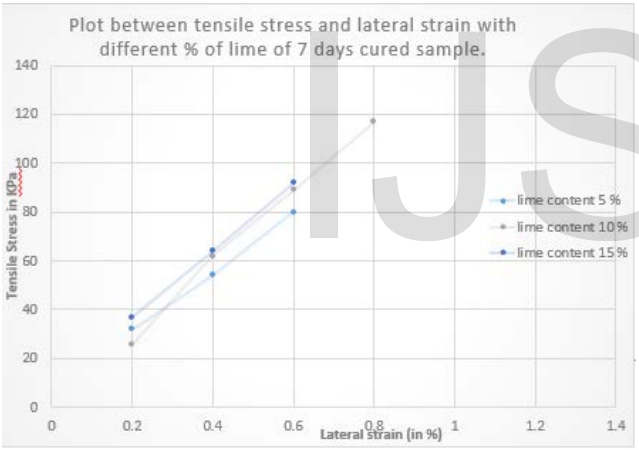
BRAZILLIAN TENSILE STRENGTH TEST:

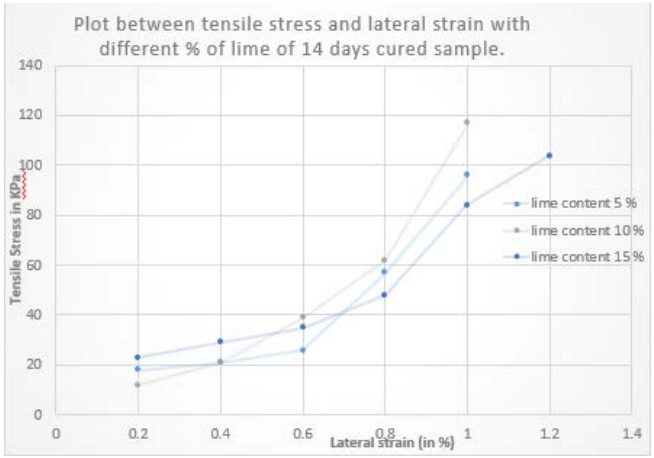
Plot between tensile stress and lateral strain with different % of lime of 7 days cured sample:

Lateral strain applied	lime content 5 %	lime content 10 %	lime content 15 %
0.2	32	26	37
0.4	54	62	64
0.6	80	89	92
0.8		117	
1			
1.2			



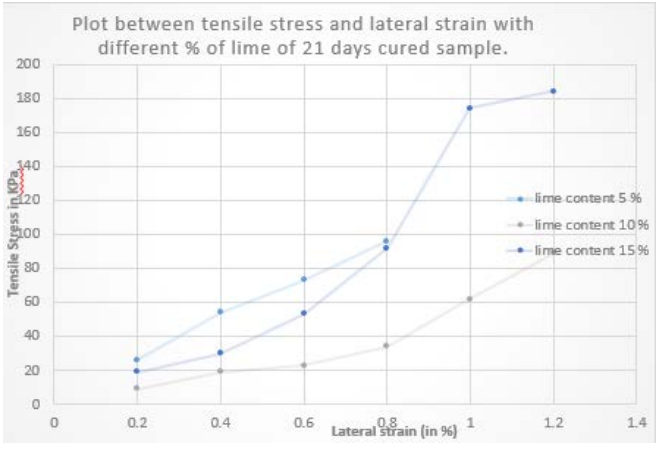
Plot between tensile stress and lateral strain with different % of lime of 14 days cured sample:

Lateral strain applied	lime content 5 %	lime content 10 %	lime content 15 %
0.2	18	12	23
0.4	21	21	29
0.6	26	39	35
0.8	57	62	48
1	96	117	84
1.2			104



Plot between tensile stress and lateral strain with different % of lime of 21 days cured sample:

Lateral strain applied	lime content 5 %	lime content 10 %	lime content 15 %
0.2	26	9	19
0.4	54	19	30
0.6	73	23	53
0.8	96	34	92
1		62	174
1.2		89	184



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THESIS:

Test for compressive strength is a measurement of the resistance of the composites to external loading. UCS tests were conducted on fly ash composite(lime - 5,10,15 %) for 7 , 14 and 21 days curing period at room temperature that was about 30 – 35 o C.The strength of 7 days cured samples of raw fly ash are very low with only 0.0684 Mpa and a very marginal increase for 14 and 21 days cured samples. The strength increases by 2 times by adding 5 % lime for 7 days curing. For 14 days curing the strength nearly doubles of 7 days cured sample but for 21 days curing the increase in strength is marginal. By adding 10 %lime the strength increases by 20 % and for 15% sample the strength increases by 10 % of sample containing 10 % lime.for every sample the strength increment is more from 7 days to 14 days curing period and less for 14 days to 21 days curing period.

Tensile strength is a measure of resistance of the composites to external tensile forces. Brazilian tensile strength tests were carried out to determine the tensile strength of the fly ash composites in the same testing machine used to find the compressive strength. The samples with 5 %, 10 % and 15 % lime have strength of 84.5, 98.7 and 109.0 K pa with 7 days curing. The increase from 5% to 10% lime content increases strength by 14% whereas from 10 % to 15 % it increases by 9 %. For every sample except fly ash with no lime the strength increases more from 7 days to 14 days curing period and less for 14 days to 21 days period.

CONCLUSION:

As the lime content increases the strength also increases but amount of increase in strength from 5 % to 10% is more than from 10 % to 15%. Addition of lime in excess to fly ash may not be beneficial. As the curing period increases the strength is also increased. But increase in strength from 7 days to 14 days curing is more than 14 days to 21 days curing. Up to certain days of curing there will be no further increase in strength.

Based upon the data recorded from this experiment, it can be concluded that such fly ash composite material can be used for many geotechnical, construction and mining processes like stowing and filling. Thus there is lesser need of fly ash disposal and therefore a material which was previously waste can now be converted to something much useful and less harmful for man and environment.

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