AN EXPERIMENTAL STUDY ON THE AMALGAMATION OF FLYASH AND GROUND GRANULATED BLAST FURNANCE SLAG

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***Abstract*- Flyash is a kind of by-product that is extremely fine and gets emerged from the combustion of coal inside thermal powerplants. The chunk of ash that settles at the surface of boiler is called bottom ash. Almost 80 percent of the total produced waste accounts for fly ash and the leftover 20 percent is bottom ash as per the weight of the substances. Talking about production in India, about 184.14 metric tons was produced only in 2014-15. And in this number, the amount that was used was only about 102.59 metric tons which accounts of about 61 percent of the year 2015-2016, where the generated flyash accounted 176.74 metric tons. In this, only about 107.77 metric tons or about 60.97 percent was used. We can see that the flyash is getting increasingly produced and used but almost 40 percent of the substance comes put as waste. This unused flyash will either go down as a landfill and will cause ecological issues. Based on the landfills, a few heavy metals like boron, mercury and cadmium with finest particles of this substance get fileted into ground water and lead to contamination of ground water. Even air pollution is caused due to he flyash that emerges as a waste. This study tries to make effective and efficient use of flyash that can be used as geo-engineering material. Products utilized in this study were flyash of F-class and emerged out Adhunik Metalics Limited in Sundergarh. Properties relating geo-techniques such as UCS strength, specific gravity, MDD, and OMC were found out for the flyash.**

***Index Terms*: GGBS, Slag, Flyash, Lime, specific gravity, Moisture Content Uniconfined Compression System.**

I. INTRODUCTION

Flyash emerged due to the combustion of coal and is a kind of waste material which has features quite similar to ash emerging from volcanoes. While coal burs in thermal power plants, the highest temperature can be recorded at 2800 degrees F. In the environment, the materials that are not combustible while emerging from burning or coal are flyash & bottom ash. Flyash emerged with the help of flue gasses and contained. Against this, the lighter bottom as is collected from boiler's floor. India's generation of flyash accounts for about 176.74 metric tons or year 2015 and 2016 and in this only about 107.77 metric tons or about 60.97 percent was used. The leftover of this ash was added to ground that led to ecological disbalances and would either pollute the air or could pollute the underground water. Power plants produce a very fine powder known as flyash that emerges out due to burning or coal. You may also call it pulverized fuel ash. The size of its particles can be anywhere between silt and fine sand. Apart from ferrous oxide and alumina, the major element that forms this is silica.

Lime is kind of an alkaline product that resulted due to limestone heating. It is a form of inorganic product that encompasses hydroxides, oxides and carbonates as the main elements. While it gets heated to a substantially high temperature, it results in quicklime. When you add water to this quicklime, slaked lime gets formed and when the slaked lime gets in touch with carbonates, it again results to limestones. Here is the cycle of this formation

Slag or GGBS is a waste product that emerges from iron production. When the melted blast furnace of iron is quenched, it leads to slag formation in water which is formed quickly. The product that forms on the stream is a kind of granular product that is glassy to touch and when dried and ground, a very fine powder is obtained. The GGBS that is obtained from newest vertical mills contains amazing finess and the particle size is quite well distributed with immense activity index and low quantity variation if you match with the old mill of ball slag. The composition of minerals in this slag can vary depending on the raw material properties while the iron production takes place. Slag is a kind f product that has less viscosity and incorporates silicate and aluminate impurities from cokes and ores. GGBS contains products such as MgO, Al2O3, CaO and SiO2 as the major components. In this, if you increase the amount of CaO, the slag will see an enhance n its compressive strength.

II. MATERIALS AND METHODS

Materials

- **Fly ash:-**This study saw the use of flyash of class F. As already stated, it emerged out of Adhunik Metaliks Limited in Sundergarh. Prior to its use, the sample was tested through the 2mm IS sieve to keep away the vegetative materials and foreign samples. The received sample was garnered and mixed well and placed in the oven for a period of a day at temperature ranging between 105 degrees and 110 degrees. The sample was then placed in an airtight jar for future uses.

- **Lime:-**The lime employed in this test was a commercial product that was carried out of Rourkela market and ensured to have cleared 150µ sieve test. Then it was maintained in some container that was airtight for future uses.

- **Slag:-**The granulated blast in a ground form of furnace slag emerged out of Shiva Cement Rourkela. Following this, it was trampled, dried in an oven, cleared a 300u sieve test and preserved in a container for future needs.

Methodology

If flyash underwent some compaction, it could increase in strength a bit but when it turns saturated, it would at once lose all its strength. Therefore, proper stability methods are needed in order to employ this flyash as a material for construction. This project will see flyash being stabilized with the help of lime as the major material. But while it takes some extra cost for lime, we can use GGBS as a stability agent. However, we need to activate GGBS as well and this needed some lime addition. So this study deals in making the flyash a stable material with an increment in chemical and physical properties to employ it like a geo-engineering product by addition of GGBS and lime in regular composition. Distinct mixtures of slag, flyash and lime underwent some light compaction test in order to find strength of product with different mixing and the curing period was also different. This chapter sees quite some detail of used materials, preparation of the sample and procedure for testing.

Initially the physical properties as well as chemical properties are to be determine of the material that were used in the present research work i.e. fly ash. Afterword's engineering properties was determine in which moisture content along with dry density was determined by the help of standard proctor test and various combination were studied in different ratio.

Furthermore unconfined compressive strength was determined for this maximum dry density was calculated on fly ash by finding optimum moisture content by standard proctor test. The cylendrical sample was prepared with hight of 76mm and dia of 38mm. axial strain were also performed for 1.25 mm per minute. To determine the efficacy of curing, these specimen were preserved for 0, 7 days, 14 and 28 days according to the curing period. For every combo of GGBS, flyash and lime with distinct periods of curing, 3 similar test specimens were taken into account and their average value was determined.

III. RESULTS

UCS (MPa) at 0% slag.

Lime %	Unconfined compressive strength in MPa			
	Immediate	7 Days	14 Days	28 Days
0	0.23	0.23	0.23	0.23
2	0.64	0.65	0.71	0.79
4	1.06	2.01	2.92	3.01
8	1.07	2.99	3.02	4.63
12	1.30	3.09	3.61	5.86

UCS (MPa) at 5% slag.

Lime %	Unconfined compressive strength in MPa			
	Immediate	7 Days	14 Days	28 Days
0	0.10	0.20	0.29	0.32
2	0.74	1.42	1.68	1.72
4	0.92	1.9	2.41	2.92
8	0.98	3.08	3.10	4.91
12	1.02	3.62	5.33	5.44

UCS (MPa) at 10% slag.

Lime %	Unconfined compressive strength in MPa			
	Immediate	7 Days	14 Days	28 Days
0	0.21	0.42	0.45	0.59
2	0.35	0.91	1.80	2.97
4	0.45	1.50	3.05	3.40
8	0.58	2.02	3.19	3.81
12	0.61	3.22	3.30	4.89

UCS (MPa) at 15% slag.

Lime %	Unconfined compressive strength in MPa			
	Immediate	7 Days	14 Days	28 Days
0	0.22	0.48	0.62	0.95
2	0.80	1.31	1.89	3.11
4	0.86	2.10	3.49	3.59
8	0.90	2.22	3.69	4.07
12	1.00	3.88	4.32	5.10

UCS (MPa) at 20% slag.

Lime %	Unconfined compressive strength in MPa			
	Immediate	7 Days	14 Days	28 Days
0	0.28	0.62	1.20	1.40
2	0.89	3.00	3.59	3.70
4	0.92	3.27	4.60	5.31
8	0.95	5.41	6.90	7.31
12	1.18	5.80	8.00	8.45

IV. CONCLUSIONS

- Talking about gradation analysis, we found that flyash that passed out of 75μwas about 86 percent and the size of the particles varied between silt size and fine sand. The curvature coefficient and uniformity coefficient were determined and their value was 1.26 & 5.66 that indicated that the materials were well-graded according to the range of the size.
- Standard Proctor test was employed to establish the MDD and OMC values with energy taken as 595kJ per m3. The value of OMC for flyash was 10kN per m3 and the value of MDD was found to be 42.12 percent. It truly states that the virgin flyash contains less MDD with more OMC value.
- Flyash was adulterated with 0 per-cent, 2 per-cent, 4 per-cent, 8 per-cent, and 12 per-cent lime content and the highest value of MDD turned out to be 11.68kN per M3 while the OMC of the products varied from 34.12 per-cent with 12 per-cent of lime. The above results found the conclusion that adding lime in the solution can lessen the value of OMC while the value of MDD was enhanced.
- Flyash was added to 0 per-cent, 5 per-cent, 10 per-cent, 15 per-cent and 20 per-cent slag where the most value of MDD turned out to be 11.66kN per m3 while the OMC being 34.16 percent at about 20 percent of slag. The value of MDD increased while that of OMC lessened.
- A mix of lime and slag using even the flyash was prepared and the value of MDD and OMC were established for each comb. It was found that mix with 20 per-cent of slag and 12 per-cent of lime in association with flyash contains the most MDD at 12.12 kN per m3 and the least OMC at 32.23 per-cent. It can be concluded that adding slag and lime in flyash enhances the MDD value while it lessens the OMC.
- UCS was performed by taking a sample size that was 76mm high and a dia of 38mm, which was compressed to adjacent MDD and OMC that were established with the use of light compaction test. The value of UCS in virgin flyash was about 0.34MPa.

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