EXPERIMENTAL STUDY OF USE OF BLAST FURNACE SLAG WITH REPLACEMENT OF CEMENT AND SAND IN PAVER BLOCK

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ABSTRACT

The amount of waste is increasing day by day and its disposal has become a serious problem. Industrial slag is one of the by product which are necessary to utilize effectively in the industrial field. The main objective of this study is to investigate the use of by products like blast furnace slag(BFS) and Granulated blast furnace slag(GGBS) in the paver blocks particularly sand with slag (BFS) and cement with Granulated blast furnace slag (GBFS). As it is necessary to move towards sustainable development this experiment will surely help towards it. This experimental study describes the mixing of BFS and GGBS with sand and cement at different mix ratios by weight of BFS and GGBS respectively. The material is prepared with different mix ratios and compression test is performed in each of the sample. The results so obtained are calculated for compression test and the material is used in the paver block.

Keyword: - *Industrial slag, Blast furnace slag ,Granulated blast furnace slag, compression test, Ground granulated blast furnace slag (GGBS), cement, sand, mix ratios, paver blocks.*

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1. Introduction:

In modern society concrete is an important part of building materials and concrete structure is widely used in all kinds of civil engineering projects. Concrete very large industry and having numerous number of consumers which are increasing day by day. It is necessary to find the alternatives of all these materials and due to the sustainable development which is "To meets the need of present without compromising the ability of future generations to meet their own needs. The production of non-conventional materials like ash , blast furnace slag are increasing in a huge amount in industries and degradation of these materials are problematic due to the lack of disposal units and environmental pollution so these the way out solution of this problem i.e. by using them for construction purpose, properties of blast furnace slag have been studied and it is found that blast furnace slag is a material which have the properties which is required for the completion of concrete, which can provide the strength. Blast furnace slag is cheap as compare to other construction materials and is do have the adjacent properties of the same material as well, and it is beneficial as an environmental aspects as well.

1.1 Blast Furnace Slag:

It is the type of metallurgical furnace used for smelting to produce industrial metals like pig iron, lead or copper. Blast refers to the combustion of air being "forced" or supplied above atmospheric pressure, blast furnace slag is a

glass-like-by-product left over after a desired metal has been separated slag is a mixture of metal oxides & silicon. Blast furnace slag is a by-product from blast furnace which is used to produce iron. Blast furnace slag has a successful replacement materials for Portland cement in concrete material to improve durability, produce high strength and also it has been noticed that the per year formation of the slag is 12 billion tones (Indian Mineral year book 2016).

1.2 Properties of Blast Furnace Slag:

Table 1. Physical Properties of Granulated blast furnace slag

Sr No.	Particulars	Values
1	Specific gravity	2.9
2	Bulk density	1200 kg/m^3
3	Fineness	350 m^2/kg

2. Cement:

Cement is a binder, a substance used for construction that sets, hardness, and adheres to other materials to bind them together. In this, ordinary Portland cement of 53 grade conforming to IS: 456-2000 was used. Tests were carried out on various physical properties of cement and the results are shown.

Table 2. Physical Properties of Cement

Sr.No.	Test	Values
1.	Initial Setting Time	65 Min
2	Fineness	98%
3	Std. Consistency	32%
4	Compressive Strength	For 3 Days =11.77N/Mm^2 For 7 Days=14.32N/Mm^2

3. Fine Aggregate:

Sand is a granular material composed of finely divided rock and mineral particles. The properties of sand were determined by conducting test as per IS: 2386 The results indicate that the sand conforms to zone II of IS:383-1970

Table 3. Physical Properties of sand

Sr. No	Test	Values
1	Fineness Modulus	2.923
2	Specific Gravity	1.59
3	Water Content	1.21%

3.1 Particle size distribution of fine aggregate:

Graph 1 Particle size distribution curve

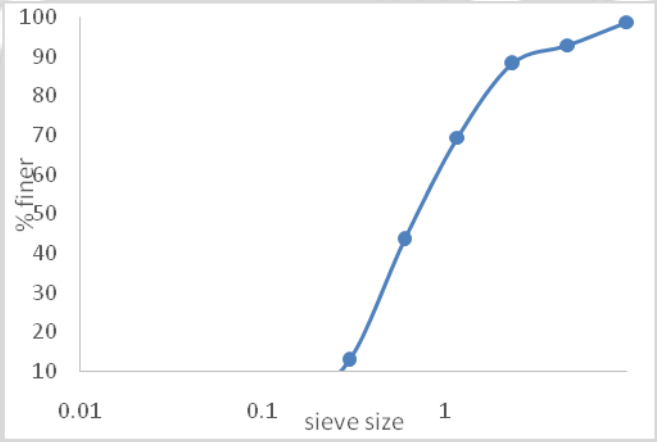

Table 4. Values of Graph 1

Coefficient of uniformity (Cu)	3.185
Coefficient of curvature (Cc)	0.91

4. Coarse Aggregate:

Aggregate are classified in many ways. In this, aggregate of size passing from 6mm and retained on 4mm sieve were sieved and tested as per IS: 383- 1970

Table 5. Physical Properties of coarse aggregate

Sr. No	Test	values
1	Impact Value	36.33%
2	Abrasion value	40%

5. Mix Ratio:

About 14 paver blocks of size 240×120×60 mm for 1**:**2.23**:**2.75 were casted for replacement up to 50%, 75% and100% of cement with GGBS, sand with industrial slag (BFS) and then both cement with GGBS and sand with industrial slag. The ratio represents cement/GGBS: sand/BFS: aggregate

6. Preparation of paver blocks:

The volume of one mould is taken. From this the required amount of cement, sand and aggregate was determined. Replacing the raw materials with GGBF and BFS the percentage was calculated. Accordingly full and partial replacement of the materials was taken and paver blocks were casted. Admixture was added for improved and better results. After casting the moulds were kept in heated placed for nearly about 13-14 hours. After 13 hours of curing the paver blocks were unmolded

7. Tests on paver blocks:

7.1 Compressive strength:

After the casting of paver blocks they were placed to let them dry. Then blocks are transferred to testing. The maximum load at failure reading was taken for three samples of the same ratio. The average compressive strength is calculated by the equation Compressive strength (N/mm²) = load (N) / cross section area of specimen (mm²)

Following table shows various weights of the material based on their percentage

Table 6.Weight for ratio 1:2.23:2.75

	Replacement of materials in gm		
Percentage	50%	75%	100%
Cement/GGBS	750/750	375/1125	0/1500
Sand/BFS	1500/1500	750/2250	0/3000
Cement /GGBS + Sand/BFS	750/750 1500/1500	375/1125 750/2250	0/1500 0/3000

8. Result and discussion:

As per the compression test done on the paver blocks of size (240×120×60mm) it is observed that paver blocks with 50% and 75% replacement of cement and sand had compressive stress 51.63 N/mm^2 i.e. greater from the conventional paver block generally used in market.(28.09 N/mm)

Compression test were performed on the paver blocks casted in which results of 50% replacement of cement, sand and both cement+ sand, 75% replacement of cement, sand and both cement+ sand were obtained successfully. Results for 100% replacement of cement and cement +sand were not obtained. Fully replacement for was successful and results were achieved. Following table shows compressive strength of the paver blocks.

Table 7. Compressive strength results for paver blocks:

Mix ratio	Compressive strength in N/mm^2						
	50%	75%	50%	75%	100 %	50%	75%
1:2.23:2.75	51.63	46.23	36.48	27.02	25.34	28.07	25.56

9. Conclusion:

The paver blocks casted by using GGBS and BFS proved to be more efficient as the strength achieved is higher than the conventional block used in market. As the material used in paver block i.e. GGBS and BFS are light in weight therefore the paver blocks casted of them are light in weight compared to the traditional paver block in market. The cost of GGBS is comparatively less than cement and is a by product of steel or iron slag it is a cost efficient material to be replaced by the raw materials used in traditional blocks. Therefore the project is taking a step towards sustainable development with using waste materials (GGBS and BFS) and avoiding the use of raw materials in market which are towards depletion (Esp. River sand)

9. References:

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