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An Expermental Study For Identification of Granulated Blast Furnace Slag (GBFS) As An Alternative To River Sand And Manufacturing Sand As Fine Aggregate In Concrete

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Abstract

The Cement industry consuming small quantities of slag to produce Portland slag Cement. Further, we can utilize this Granulated Blast Furnace slag (GBFS) as a fine aggregate in concrete as well as in mortar. In this study the comparison of physical properties of GBFS, Natural sand and Manufactured Sand as per IS: 383and IS: 2386 were carried out .The study shows that the GBFS meets the codal provisions and can be used as a fine aggregate in concrete and Mortars. Extraction of natural sand from river beds is banned due to environmental issues. On the other hand the iron and steel industries produce large quantities of Blast furnace slag keeping this in view to proper utilization of Granulated Blast Furnace slag the study has been attempted.

Key Wards: Granulated Blast Furnace slag, River Sand, Manufacturing Sand, Concrete.

Introduction

The natural sand being successfully obtained from river bed thought to be everlasting supply, now the sand resources are getting depleted and exhausted. Due to indiscriminate dredging of river sand, the Honorable High Court imposed a ban on mining of river sand. The crisis triggered by the ban is affecting not only construction activity and also the employment of daily wage workers and staff. There is a strong need for research on river sand substitute for cement mortar and concrete production.

To keep the construction activity intact Granulated Blast Furnace Slag, A byproduct of Steel industry is one of the best viable alternative to river sand.

The Concrete Industry is the largest consumer of natural resources like sand, gravel, crushed rock etc. Sand & crushed stone requirement is about to the tune of 10 billion tonnes per annum. Environmental concerns are being raised against uncontrolled extraction of natural materials particularly River sand in regard to protecting riverbeds against erosion and the importance of having natural sand as a filter for ground water therefore mining of river sand is banned by many State Governments. Blasting of rocks and crushing them to produce sand, has serious environmental implications. Rocks once depleted can never be replenished and do not grow again and hence are not renewable. Sustainable Construction mainly aims at reducing of negative environmental impact by construction Industry.

In addition to environmental issues, there are social issues also. The utility of sand in the construction industry has spawned several criminal syndicates. A crisis situation like this calls for radical solutions. Hence, the construction Industry will have to undergo a major transformation to make it environmental friendly. Further, the steel industry in India has developed and the growth of the steel industry is expected to be healthy. One of the by products of the steel industry is the blast furnace slag. Granulated Blast furnace Slag is considered as environment friendly and its usage will, in the long run, limit the depletion of natural river sand, save rocks, and reduce the amount of energy consumed in their mining.

Granulated Blast Furnace Slag (GBFS):

Granulated Slag is being produced during the process of manufacturing the pig Iron in Blast furnace at around 1400° to 1500°C in the molten form.The granulated slag is obtained by rapidly chilling (Quenching) the molten ash from the furnace by means of water or steam and air and it consisting essentially of glass containing silicates and Alumina Silicates of lime.Fig.1 Samples of GBFS, Natural sand, Manufacturing sand.

Granulated Blast Furnace Slag

Natural Sand

Manuf. Sand

Fine Aggregate:

The fine aggregates used in this study were Natural river sand, manufactured (M. Sand) sand and Granulated Blast Furnace Slag. The physical properties such as sieve analysis, specific gravity, Bulk density etc. for river sand, M. Sand, GBFS were determined as per IS :383(1970) and IS; 2386(1963).

Objective

1. To determine the specific gravity, Bulk density, water absorption, Moisture content of Granulated Blast Furnace Slag, Natural Sand & Manufacture Sand as per IS :383(1970) and IS; 2386(1963).
2. Conducting of Sieve Analysis of River Sand, Manufactured Sand and Granulated Slag
3. Comparison the above parameters as per IS code

Methodology: (Test Procedure)

Specific Gravity

A samples of each GBFS, Natural Sand & Manufacture Sand of about 500 gr. have taken the test was conducted for three samples simultaneously. The sample was placed in a tray and covered with distilled water at a temperature of 30°C. Soon after immersion, air entrapped on the surface of the aggregate is removed by agitation with a rod. The sample was remaining immersed for 24hr.

The water was drained from the sample by decantation through a filter paper. The aggregates including solid matter retained on the filter paper had been exposed to warm air to evaporate surface moisture and stirred at frequent intervals to consume uniform drying until no free surface moisture observed.Both the saturated and surface dry samples were weighed as weight 'A'.The aggregate is them placed in the pycnometer and filled with distilled water. The pycnometer is weighed of weight as B.The pycnometer is emptied in to tray and pycnometer was filled with distilled water to the same level and weighed of weight (C).The water had drained from the sample by decantation through a filter paper and material retained id returned to the sample. Then the sample was placed in the over at a temp. of 100^0C for 2 hr later it was cooled In the air –tight container and weighed as weight 'D'.The specific gravity and water absorption was calculated by using the following

Specific gravity: D/A-(B-C)

Water absorption: 100(A-D)/D

Determination of Bulk Density:

Cylindrical metal measure of 3 lit and filled over flowing by means of scoop. The aggregates are discharged from a height of 5cm above the top of the measure. The surface of the aggregate was leveled with a straight edge the net weight of aggregate in the measure was determined as bulk density in Kg/lit.

The percentage of voids determined by = Specific gravity of aggregate – Bulk Density / Specific gravity of aggregate x 100= Gs-ɣ /Gs x 100

Determination of percentage of Bulking:

A container was filled by the fine aggregate loosely until about two – third full leveled of the top and measured the ht of the aggregate from bottom of the container as 'h' Now, the container was emptied and the aggregates are placed in to another container. The first container was filled with water up to half and pored the half

quantity of fine aggregate and rod it. Again remaining fine aggregate was pore in to the container and rod it measured the depth at the middle with the steel rule as h^I cm.
The percentage of bulking of sand due to moisture is calculated as = $(h/ h^I-1)x\ 100$

Sieve Analysis
Sample of 3 kg of fine aggregate brought to an air dry condition before weighing and sieving by means of heating at a temp. of 100^0C the air- dry sample is weighed and sieved successively on the sieves starting with largest i.e. 4.75mm, 2.36mm, 1.18mm, 600mic, 300mic, 150mic.

Each sieve had been shaken separately over a clean tray on completion of sieving; the material retained on each sieve with the material cleaned from the mesh had been weighed. The cumulative weight passing each sieve had been calculated as a percentage of the total sample weight. The results were compared with the limits given is IS: 383 for different zones such as Zone-I, II, III & IV and accordingly, the results were tabulated as per the limitations.

Result and Discussion

Table 1: Physical Properties of River sand, Manufactured Sand and Granulated Slag

S. No	Description	River Sand	Manufa-ctured Sand	Granulated Slag	Relevant IS code
1	Specific Gravity	2.8	2.6	2.8	IS: 2386, Part-III
2	Bulk Density Kg/m^3	1603	1850	1220	IS: 2386, Part-III
3	Moisture Content (%)	0.8	1.5	1.0	IS: 2386, Part-III
4	Water absorption (%)	0.6	2.6	1.0	IS: 2386, Part-III IS: 2386, Part-IV
5	Fineness Modulus	2.87	2.67	2.86	IS: 2386 Part- I
6	Fines through 75 µ , %	0.65	6.0	0.5	IS: 383

Table 2: Sieve Analysis of River Sand, Manufactured Sand and Granulated Slag

IS Sieve	River sand % Age Passing	Manufactured Sand% Age Passing	Granulated Slag %Age Passing	% Age passing for single sized aggregates of Normal Sand (IS 383 - 1970) Zone II
4.75mm	99.42	100	99.50	90 to 100
2.36mm	94.74	90.70	94.75	75 to 100
1.18mm	68.35	66.20	70.20	55 to 90
600Microns	41.40	39.80	39.70	35 to 59
300 Microns	6.90	25.5	7.00	08 to 30
150 Microns	1.75	9.90	1.95	0 to 10

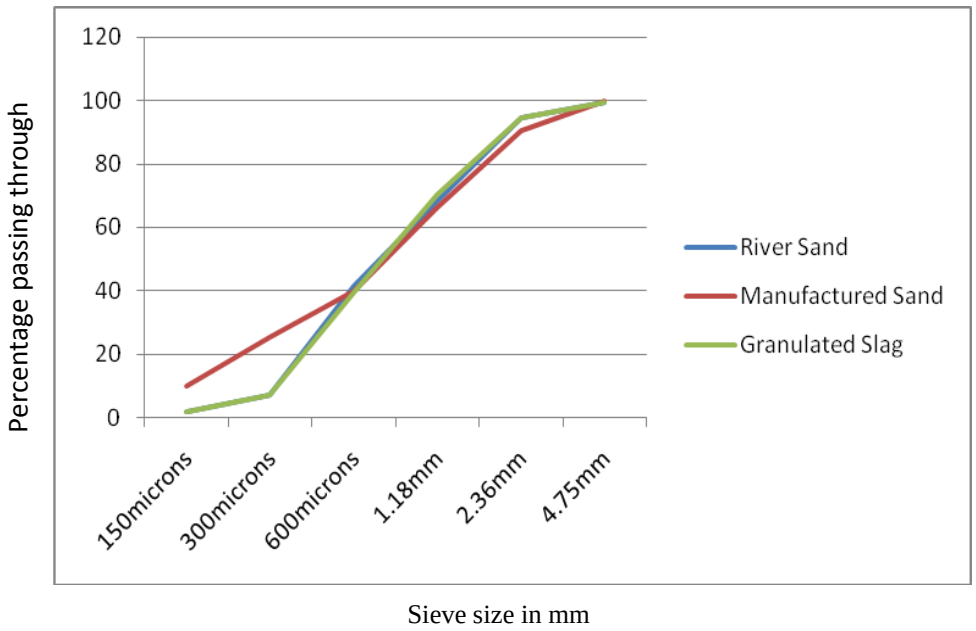

Figure 2: Graphical Representation of Sieve Analysis

As per the above physical analysis, we can utilize granulated blast furnace slag as an alternative to sand in concrete and mortar. Fig2 displays the behavior of manufactured sand, river sand and slag sand in varying sizes. As per the above Physical analysis the GBFS can be used as fine aggregate in concrete and mortar as a replacement of natural sand, since, it meets IS:383-1980 and satisfy Zone :II.

Cost comparison: The cost of river sand is around Rs.1000 (In the states where dredging of sand is banned, the cost of sand River sand is Rs.1400 per ton) per ton, cost of Manufacture Sand is Rs.900 per ton and cost of GBFS is very much nominal around Rs. 400 Per ton. However, the cost may vary from place to place based on the logistic cost.

In view of conserving natural resources like river sand, Rocks and Environmental impacts it is advisable to consider the utilization of Industrial by products such as Granulated blast furnace slag from steel industry by the construction Industry. Scope for further research includes a study to be made on Fresh, Hardened concrete on Durability and environmental aspects.

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