Study on Compressive Strength of Concrete by the Replacement of Cement with GGBS

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Abstract:
Many works have been done to explore the benefits of using pozzolanic materials in making and enhancing the properties of concrete. Certain investigations carried on the Compressive strength and drying shrinkage of fly ash (FA) - bottom ash (BA) - silica fume (SF) multi blended cement mortars. FA, BA and SF were used to replace part of cement up to 50% by weight. FA were 30%, 40%, 45% 50% while BA were 10% 15%, 20% while SF were 5% 10% by weight of cement. The compressive strength of blended cement with FA and BA was lower than that of Portland cement control at all curing conditions while blended with SF shows higher compressive strength. In addition, compressive strength of specimens cured with water increased with increasing curing temperatures. FA and BA had lower drying shrinkage than that of PC control while drying shrinkage ternary and quaternary containing SF were higher than the PC control and increased with increasing SF level used. In this investigation M30 mix design was used and cement is replaced from 0% to 50% by the use of GGBS. 10% to 30% replaced concrete mixes shows higher compressive strength values and other proportions gives similar values as regular concrete, which is noted as 38.2 N/mm^2 With the replacement of cement by 30%GGBS is gives high compressive strength values compared to conventional mix for 28 days which is 49.3 N/mm^2

Key Words: Cement, Concrete, GGBS, Aggregates and Compressive Strength.

1. Introduction:

As concrete is the most widely used material in the construction of foundations. Concrete is an artificial stone manufactured by mixing together coarse and fine aggregates, cement, water and often other components such as cement replacement materials, e.g., pulverised fuel ash, and chemical admixtures, e.g., superplasticisers. The grading of an aggregate defines the proportions of particles of different size in the aggregate. The size of the aggregate particles normally used in concrete varies from 37.5 mm to 0.15 mm. BS882 places aggregates in three main categories: fine aggregate or sand containing particles the majority of which are smaller than 5 mm, coarse aggregate containing particles the majority of which are larger than 5 mm and all-in aggregate comprising both fine and coarse aggregate. All-in aggregate is not normally allowed in high class concrete work unless specifically authorized by the engineer. The grading of an aggregate has a considerable effect on the workability and stability of a concrete mix and is a most important factor in concrete mix design. In practice, fine and coarse aggregates are batched separately, their proportions being governed largely by their respective grading. The coarse aggregate may be continuous graded or gap graded the latter being where one or more intermediate size fraction is omitted. It is best practice to specify a combination of single sized aggregates for a mix design provided that they are combined in such proportions that the resulting grading falls within the grading requirements of BS882.

2. Materials and Methods:

Concrete is a composite material which is made up of filler and a binder. Typical concrete is a mixture of fine aggregate (sand), coarse aggregate (rock), cement, and water. **Aggregates** are chemically inert, solid bodies held together by the cement. Aggregates come in various shapes, sizes, and materials ranging from fine particles of sand to large, coarse rocks. Because cement is the most expensive ingredient in making

concrete, it is desirable to minimize the amount of cement used. 70 to 80% of the volume of concrete is aggregate in order to keep the cost of the concrete low. The selection of an aggregate is determined, in part, by the desired characteristics of the concrete. **Water** is a transparent and nearly colorless chemical substance that is one of the main constituent of Concrete which available abundantly on Earth's streams, Lake Sand oceans and the fluids of most living organisms. **Cement** is a binder, a substance used for construction that sets, hardens and adheres to other materials, binding them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement is used with fine aggregate to produce mortar for masonry, or with sand and gravel aggregates to produce concrete. Here we replaced cement with **GGBS from 0% to 50%**

2.1. Cement replaced with GGBS:

Ground-granulated blast-furnace slag (**GGBS** or **GGBFS**) is obtained by quenching molten iron slag (a by-product of iron and steel-making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder. Ground-granulated blast furnace slag is highly cementitious and high in CSH (calcium silicate hydrates) which is a strength enhancing compound which increases the strength, durability and appearance of the concrete. GGBS cement can be added to concrete in the concrete manufacturer's batching plant, along with Portland cement, aggregates and water. The normal ratios of aggregates and water to cementitious material in the mix remain unchanged. GGBS is used as a direct replacement for Portland cement, on a one-to-one basis by weight. Replacement levels for GGBS vary from 30% to up to 85%. Typically 40 to 50% is used in most instances.

2.2. Concrete Tests:

Various Concrete mixes was prepared with the help of selected mix proportions of GGBS with cement. Before that various physical properties of cement, Fine Aggregates and Coarse Aggregates are tested and the Sieve analysis of Fine Aggregates and Coarse Aggregates are also estimated. Mix designs for each set having different combinations are carried out by using IS 10262-2009 method. The mix proportions obtained for normal M30 grade concrete is 1: 0.75: 1.5 with a water cement ratio 0.40. The concrete tests are divided into two categories, one is Workability and second one is Compressive Strength analysis. With reference to the above mentioned mix design we prepared specimens (Cubes) to test at an age of 7days, 14days and 28days.

3. Results and Discussions:

With reference to the above chapters, we conducted experiments on compressive strengths with the replacement of various proportions of cement with GGBS. The cubes are casted for the replacements of 0% GGBS, 10% GGBS, 20%GGBS, 305GGBS, 40%GGBS and 50%GGBS to determine the strength of concrete. The slump cone test for all the concrete mixes is determined and the results are tabulated in Table.1. The compressive strengths are determined for each and every specimen casted and cured for 7days, 14days and 28days basis, and are compared to know, the impact of with replacement of GGBS from 10% to 50% and without replacement of GGBS (0%). The obtained Compressive strength results are denoted in Table.2. The obtained compressive strength results are plotted in Figure.1.

Table.1. Slump Test Results

W/C Ratio	M30 Mix Grade	Mix %	Type of Slump
0.4	1: 0.75: 1.5	0%	True
0.4	1: 0.75: 1.5	10%	True
0.4	1: 0.75: 1.5	20%	Shear
0.4	1: 0.75: 1.5	30%	Shear
0.4	1: 0.75: 1.5	40%	Shear
0.4	1: 0.75: 1.5	50%	Shear

Table.2. Compressive Strengths

REPLACEMENT	7 DAYS N/mm^2	14 DAYS N/mm^2	28 DAYS N/mm^2
0% GGBS	16	27.11	38.2
10% GGBS	22.22	28.66	47.11
20% GGBS	28.44	36	48
30% GGBS	28.88	38.2	49.3
40% GGBS	26.6	34.1	39.55
50% GGBS	19.22	30.5	37.72

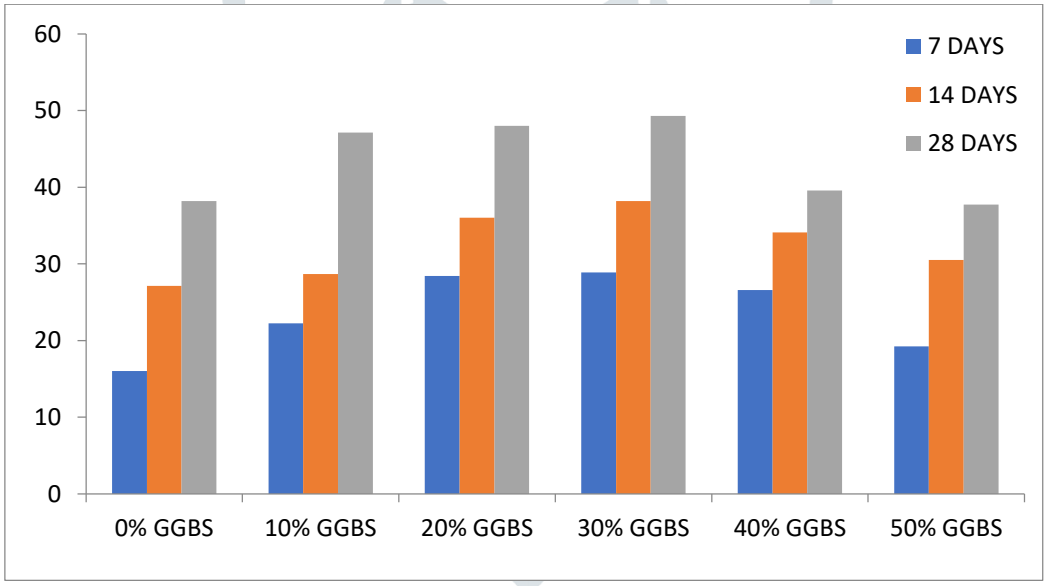

Figure.1. Compressive Strengths

4. Conclusions:

Based on the different mixes and various tests conducted on the cubes, some of the important conclusions were drawn. With the replacement of cement by 30%GGBS is gives high compressive strength values compared to conventional mix for 28 days**.** Among the 20% & 30% replacement of GGBS can use in huge constructions. Like Dams, Reservoirs etc., The 10% replacement of GGBS can use in Apartments constructions, And also use 50%replacement of GGBS can use in small constructions like residential buildings. To compare 0% & 40% replacement of GGBS can be same results. GGBS can also use in soil stabilization.

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