An Experimental Study on Strength of BFRC Concrete Produced using with GGBS and Fly Ash

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Abstract: Cement concrete is the large amount extensively used construction material in the world. The explanation for its extensive use is that it provides good workability and can be turn it to any shape. The development of multi blended mixconcrete has gained attention due to its multiple advantages and environmental friendliness, Normal concrete gives a very low tensile strength, restricted ductility and small amount of resistance to cracking. Internal small cracks lead to brittle failure of concrete. In this new generation civil engineering constructions have their own structural and durability requirements. In this thesis has attempted to examine mechanical properties of M30 grade of concrete of made with basalt fibers. To reduce the deleterious effects of the production of cement on the environment, concrete is being developed by substituting admixtures like GGBS (Ground Granulated Blast-furnace Slag) and Fly Ash in place of cement. Multi blended concrete developed with Fly ash and GGBS showed depletion in the mechanical properties. Basalt fibers were added to this mix additionally to overcome this deficiency. Basalt Fibers used in this experiment. In this experiment 0.25% of total dosage of fiber content was fixed with Supplementary materials Fly ash GGBS in varying percentages i.e. 0% of fly ash and 100% of GGBS, 20% of fly ash and 80% of GGBS, 40% of fly ash and 60% of GGBS,20% of fly ash and 80% of GGBS, 100% of fly ash and 0% of GGBS of total dosage (i.e.40%) by weight of cement. Results are taken as a Beams and Cubes are casted to check the flexural strength and compressive of concrete at 7 days and 28 days.

Keywords: M 30 Grade of cement concrete, Multi blended concrete, Fly ash, GGBS, Basalt fibers, flexural strength, compressive strength, beam and cube.

I. INTRODUCTION

Concrete is a product obtained artificially by hardening of the mixture of cement, Sand, gravel and water in predetermined proportions. When these ingredients are mixed, they form a plastic mass which can be poured in suitable moulds, called forms, and so on standing into hard solid mass. The chemical reaction of cement and water, in the mix is relatively slow and require time and favorable temperature for its completion. The time, known as setting time may be divided into three distinct phases. The first phase designated as time of initial set, requires from 30 minutes to about 60 minutes for completion. During this phase, the mixed concrete decreases its plasticity and develops pronounced resistance to flow. The second phase, known as final set, may vary between 5 to 6 hours after the mixing operation. During this phase, concrete appears to be relatively soft solid without Surface hardness.

Depending on the quality and proportions of the ingredients used in the mix, to properties of concrete vary almost as widely as different kinds of stones. Concrete has enough strength in compression, but has little strength in tension. Due to this concrete as such is weak in bending, shear and torsion. However, to use cement concrete for common structures such as beams, slabs, retaining structure etc, steel bars may be placed at tensile zones of the structure which may then be concrete. The steel bars, known as steel reinforcement, embedded in the concrete, takes the tensile stresses. The concrete so obtained is termed as reinforced cement concrete, commonly abbreviated as R.C.C.

The workable solution to this problem is substituting cement with GGBS and Fly Ash. The fibers are used for concrete to overcome definite insufficiency. The most common fibers are basalt, glass, polypropylene, carbon fibers and steel. The workability of binary mix containing higher percentage substitution with GGBS and fly ash was higher and lower respectively. Improvement of properties can be observed for mixes designed appropriately. Long term compressive strength of both Fly ash and GGBS mixes can be improved. Addition of 0.25% of basalt fibers (by volume of concrete) showed increment in flexural strength. The fly ash and GGBS with 40% as replacement of cement and 3 kg/m3 basalt fibers dosages in concrete developed the better compactness of concrete microstructure, showed Compressive and Flexural tensile strength approximately 10% and 25% higher. In this experiment 0.25% of total dosage of fiber content was fixed with Supplementary materials Fly ash GGBS in varying percentages i.e., 0% of fly ash and 100% of GGBS, 20% of fly ash and 80% of GGBS, 40% of fly ash and 60% of GGBS,20% of fly ash and 80% of GGBS, 100% of fly ash and 0% of GGBS of total dosage (i.e., 40%) by weight of cement. Results are taken as a Beams and Cubes are casted to check the flexural strength and compressive of concrete at 7 days and 28 days. Fibers not only help in withstanding tensile stresses but also enhance strength and durability.

II. MATERIALS USED

A. Fiber reinforced concrete (FRC)

Conventional concrete is modified by random dispersal of short discrete fine fibers of asbestos, steel, sisal, glass, carbon, poly-propylene, nylon, etc. Asbestos cement fibers so far have proved to be commercially successful. Fibers include synthetic fibers and natural fibers each of which lend varying properties to the concrete. The improvement in structural performance depends on the strength characteristics, volume, and spacing. Dispersion and orientation, shape and their aspect ratio (ratio of length to diameter) of fibers. A fiber-reinforced concrete requires a considerably greater amount of fine aggregate than that for conventional concrete for convenient handling. For FRC to be fully effective, each fiber needs to be fully embedded in the matrix, thus the cement paste requirement is more. For FRC the cement paste required ranges between 35 to 45 per cent as against 25 to 35 per cent in conventional concrete the behavior of fiber reinforced concrete (FRC) is shown in Fig. 1.

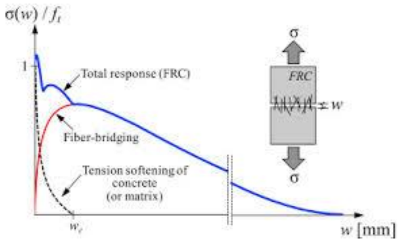


Fig. 1. Concrete the behavior of fiber reinforced concrete (FRC)

B. Fly ash

The fly ash or pulverized fuel ash (PFA) is the residue from the combustion of pulverized coal collected by the mechanical dust collectors or electrostatic precipitors or separators from the fuel gases of thermal power plants. Its composition varies with load on the boiler, the type of fuel burnt and type of separators, etc. like Portland cement, fly ash contains oxide of calcium, aluminum and silicon, but the amount of calcium oxide is considerably less. The carbon content in fly ash should be as low as possible, whereas the silica content should be as high as possible.

C. GGBS (Ground Granulated Blast Furnace Slag)

GGBS comprises mainly of calcium oxide, silicon di-oxide, aluminum oxide, magnesium oxide. It has the same chief chemical elements as ordinary Portland cement but in different proportions and the addition of GGBS in geo-polymer concrete (GPC) increases the strength of the concrete and also curing of Geo-Polymer concrete at room temperature is possible. GGBS was purchased from Laxmi steel Industries Jabalpur.

III. OBJECTIVE OF VIEW

The most important aim of the present work of thesis is to examine mechanical properties of M30 grade of concrete of made with basalt fibers. To reduce the deleterious effects of the production of cement on the environment, concrete is being developed by substituting admixtures like GGBS (Ground Granulated Blast-furnace Slag) and Fly Ash in place of cement. Multi blended concrete developed with Fly ash and GGBS showed depletion in the mechanical properties.

The following are the objectives of this thesis.

1. To find out the effect of Ground-granulated blast-furnace slag (GGBS or GGBFS) on strength when mixed with concrete sample. To study the workability of concrete on variation in different percentage of fly ash when mixed with concrete.
2. Increase the economy of the construction with using the cheaper material as a replacement of the cement.
3. To find out the change in slump value.
4. To check the flexural strength and compressive of concrete at 7days and 28 days.
5. To increase the service life.

Problem Statement

1. The most important problems faced in reinforced concrete construction are the decay of reinforcing steel, which considerably affects the durability and life of concrete structures.
2. Normal concrete gives a very low tensile strength, restricted ductility and small amount of resistance to cracking. Internal small cracks lead to brittle failure of concrete. In this new generation civil engineering constructions have their own structural and durability requirements.
3. In this experiment 0.25% of total dosage of fiber content was fixed with Supplementary materials Fly ash GGBS in varying percentages i.e. 0% of fly ash and 100% of GGBS, 20% of fly ash and 80% of GGBS, 40% of fly ash and 60% of GGBS,20% of fly ash and 80% of GGBS, 100% of fly ash and 0% of GGBS of total dosage (i.e.40%) by weight of cement. Results are taken as a Beams and Cubes are casted to check the flexural strength and compressive of concrete at 7 days and 28 days.

IV. METHODOLOGY AND EXPERIMENTAL VIEW

In this thesis has attempted to examine mechanical properties of M30 grade of concrete as designed by using IS: 10262 (2000) with water binder ratio of 0.45. To reduce the deleterious effects of the production of cement on the environment, concrete is being developed by substituting admixtures like GGBS (Ground Granulated Blast-furnace Slag) and Fly Ash in place of cement. Multi blended concrete developed with Fly ash and GGBS showed depletion in the mechanical properties.

In this experiment 0.25% of total dosage of fiber content was fixed with Supplementary materials Fly ash GGBS in varying percentages i.e. 0% of fly ash and 100% of GGBS, 20% of fly ash and 80% of GGBS, 40% of fly ash and 60% of GGBS, 20% of fly ash and 80% of GGBS, 100% of fly ash and 0% of GGBS of total dosage (i.e.40%) by weight of cement. Results are taken as a Beams and Cubes are casted to check the flexural strength and compressive of concrete at 7 days and 28 days.

Table 1. Mix proportion by (Saturated surface dry) mass

	Cement	**Water**	**Fine aggregate**	**Coarse aggregate**
Quantity (in gm)	414	186	711.21	1079.07
Ratio	1	0.45	1.72	2.61

Table 2 the final trial batches quantities of fly ash, GGBS and Basalt fiber per cubic meter of concrete M30 are

Mix designation	**Cement kg/m3**	**Fly Ash kg/m3**	**GGBS kg/m3**	**Basalt Fiber**	**Fine Aggregate kg/m^3**	**Coarse Aggregate kg/m^3**	**Water kg/m**	**W/ C ratio**
C100	414	-	-	-	725.43	1089.86	161	0.45
C60+(F00+G100)	248.4	0	165.6	3	725.43	1089.86	161	0.45
C60+(F20+G80)	248.4	33.12	132.48	3	725.43	1089.86	161	0.45
C60+(F40+G60)	248.4	66.24	99.36	3	725.43	1089.86	161	0.45
C60+(F60+G40)	248.4	99.36	66.24	3	725.43	1089.86	161	0.45
C60+(F80+G20)	248.4	132.48	33.12	3	725.43	1089.86	161	0.45
C60+(F100+G00)	248.4	165.6	0	3	725.43	1089.86	161	0.45

Table 3: Test matrix for Cube

Mix Design Codes	**Cement (in %)**	**Fly Ash (Total dosage (i.e. 40%) by weight of cement)**	**GGBS (Total dosage (i.e. 40%) by weight of cement)**	**Fiber Quantity (kg/m3)**	**Number of Cubes for 7 day compression test**	**Number of Cubes for 28 day compression test**
MIX-M30	100%	0%	0%	0	1	1
C1-MIX	60%	100%	0%	3	1	1
C2-MIX	60%	80%	20%	3	1	1
C3-MIX	60%	60%	40%	3	1	1
C4-MIX	60%	40%	60%	3	1	1
C5-MIX	60%	20%	80%	3	1	1
C6-MIX	60%	0%	100%	3	1	1

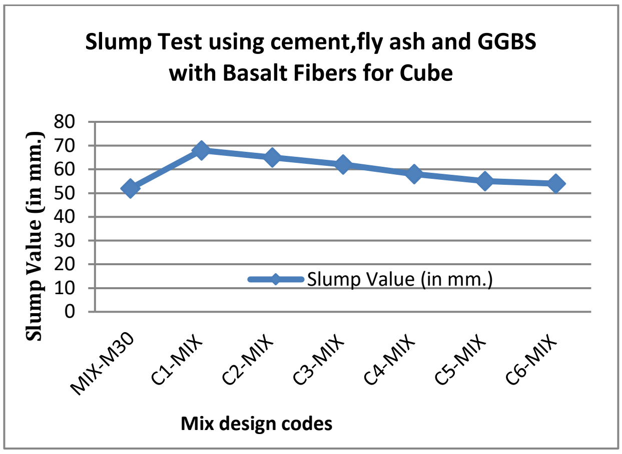
Table 4: Test matrix for Beam

Mix Design Codes	**Cement (in %)**	**Fly Ash (Total dosage (i.e.40%) by weight of cement)**	**GGBS (Total dosage (i.e.40%) by weight of cement)**	**Fiber Quantity (kg/m^3)**	**Number of Beam for 7 day Flexural strength**	**Number of Beam for 28 day Flexural strength**
MIX-M30	100%	0%	0%	0	1	1
B1-MIX	60%	100%	0%	3	1	1
B2-MIX	60%	80%	20%	3	1	1
B3-MIX	60%	60%	40%	3	1	1
B4-MIX	60%	40%	60%	3	1	1
B5-MIX	60%	20%	80%	3	1	1
B6-MIX	60%	0%	100%	3	1	1

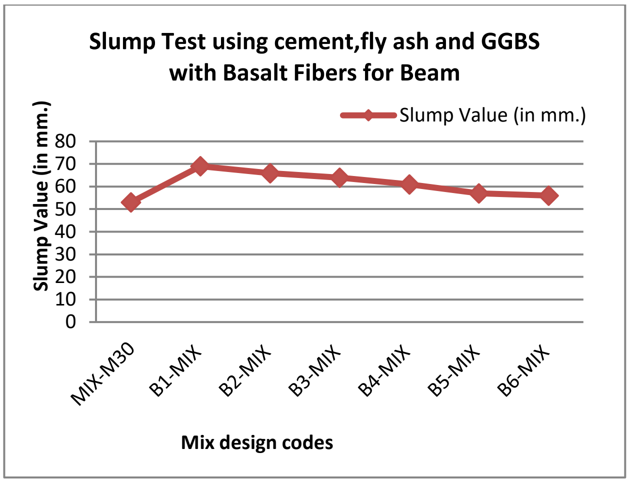
V. RESULT AND OBSERVATIONS

A. Workability Test

Note : (10 mm Basalt fiber dosage 3 kg/m^3)

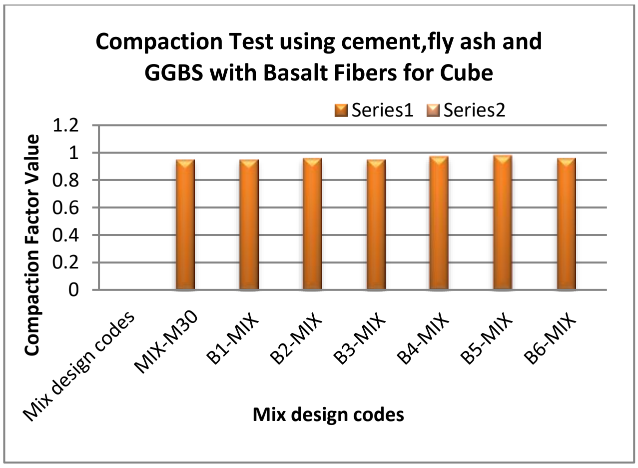


Graph 1: Workability of various concrete mixes design for slump cone test in cube specimen

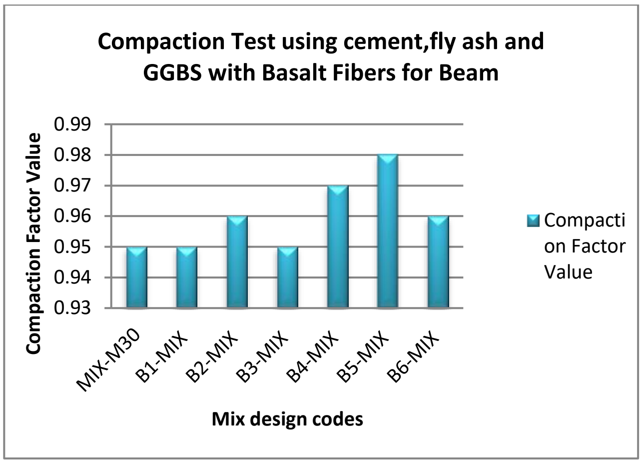


Graph 2: Workability of various concrete mixes design for slump cone test in beam specimen

B. Compaction Factor Test

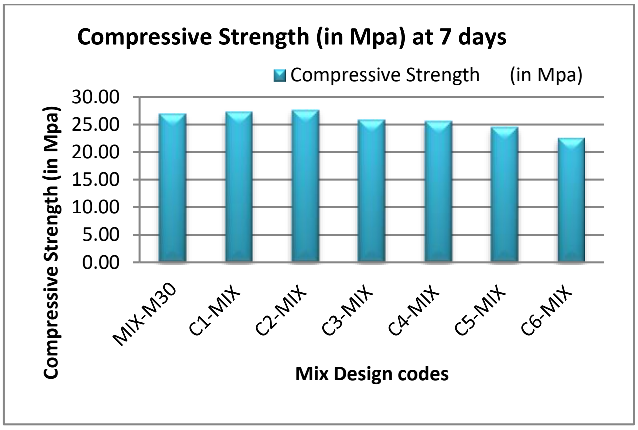


Graph 3: Compaction value of various concrete mixes design for Compaction factor test (Cube specimen)

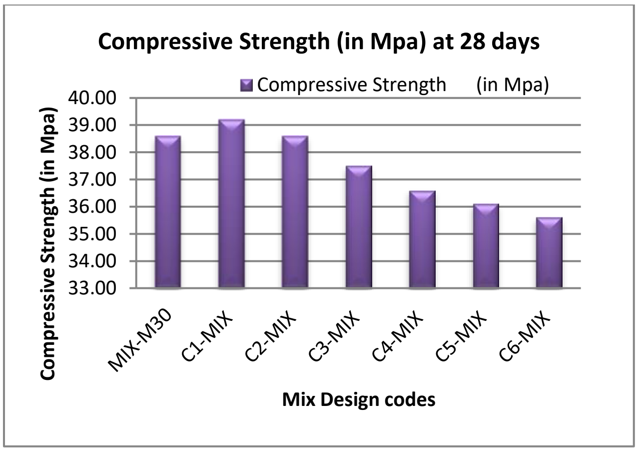


Graph 4: Compaction value of various concrete mixes design for Compaction factor test (Beam specimen)

7.4 Compressive Strength



Graph 5 : Compressive strength for M30 of Fly Ash & GGBS based multi blended concrete mixes with Basalt fibers at 7 days.



Graph 6: Compressive strength for M30 of Fly Ash & GGBS based multi blended concrete mixes with Basalt fibers at 28 days.

To keep the water-cement ratio constant at 0.45 for all the mixes.

Compressive Strength; Fly Ash & GGBS based multi blended concrete mixes with Basalt fibers are compressive strength at 7 & 28 day the results shows in figure 7.5 & 7.6. Compressive strength of Fly ash & GGBS based multi blended concrete mixes with Basalt fibers were reduced with the increase in percentage of fly ash and GGBS at 7day. Conventional concrete compressive strength was 26.95 N/mm2 at 7 days, whereas compressive strength was ranged from 22.19 N/mm2 – 27.60 N/mm2 for multi blended concrete mixes of Fly ash & GGBS with basalt fiber. Multi blended concrete with basalt fiber at 40% of GGBS and fly ash (i.e.40% by weight of cement) show the least reduction in compressive strength compared to conventional concrete.

Compressive strength of Fly ash & GGBS based multi blended concrete mixes with Basalt fibers were reduced with the increase in percentage of fly ash and GGBS at 28 days. Conventional concrete compressive strength was 38.60 N/mm2 at 28 days, whereas compressive strength was ranged from 35.60 N/mm2 -39.60 N/mm2 for multi blended concrete mixes of Fly ash & GGBS with basalt fiber. The multi blended concrete with micro silica & basalt fiber exhibited the target strength of 30 grades at 40% of GGBS and fly ash (i.e.40% by weight of cement).

VI CONCLUSIONS

1. This research aimed to study an experimental study on strength of basalt fiber reinforced concrete produced by partially replacing cement with GGBS and fly ash
2. The flexural & compressive strength of Fly Ash & GGBS based multi blended concrete with basalt fibers were improved when compared with conventional concrete mix design M30.
3. The Basalt Fiber reinforced multi blended concrete almost the same flexural strength as that of conventional concrete at 40% of GGBS and fly ash (i.e.40% by weight of cement).
4. Compressive strength of Fly ash & GGBS based multi blended concrete with basalt fibers increase in percentage of Fly ash & GGBS at 7 days. It followed the similar trend at 28 days except at 40% of GGBS and fly ash (i.e.40% by weight of cement) increase in percentage with basalt fibers.
5. Impact of addition of cementations materials on mechanical properties is significant. Concrete with required grade can be achieved with the judicial use of these materials in suitable proportions. The 30-grade concrete can be developed with the use 0.25% of total dosage of fiber content was fixed with Supplementary materials Fly ash GGBS in varying percentages i.e., 0% of fly ash and 100% of GGBS, 20% of fly ash and 80% of GGBS, 40% of fly ash and 60% of GGBS, 20% of fly ash and 80% of GGBS, 100% of fly ash and 0% of GGBS of total dosage (i.e.40%) by weight of cement.

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