Comparative Study of GBFS & Banana Fibre Reinforced Concrete with Normal Concrete

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Abstract – *Concrete is one of the significant milestone innovations of mankind. It is mostly composed of cement, fine aggregate and coarse aggregate. But recent advancements and discoveries have mainly focused on adding additional materials or replacing the existing material to improve the strength and bearing capacity of the concrete while simultaneously reducing the cost and weight. These days fibres are gaining increasing attention due to the abundant availability of these fibres. Mix design was calculated for M20 concrete and tests for physical properties such as compressive strength, split tensile strength and flexural strength were performed. Banana fibres are added as reinforcement mainly to improve the compressive strength, tensile strength and crack resistance. GBFS has been noted to increase compressive strength and also reduces the cost in concrete preparation due to replacement of cement. The investigations considered GBFS at different proportions with 10% increment at each stage.*

Key Words – banana fibre, compressive strength, flexural strength, GBFS, split tensile strength

1. INTRODUCTION

Agriculture waste alone contributes to about 700 million tonnes per year. Almost 10 million tonnes of waste is produced as scrap metal waste. Disposal of metal is more difficult and improper disposal cause severe land and water pollution. Though agro-wastes are organic wastes they cause strain on the environment due to inefficient disposal methods. So it is necessary to find alternate ways to dispose these wastes. A number of agro waste and scrap metal waste have been in use as a replacement to aggregates in concrete. Due to the availability of efficient treatment techniques fibres can reliably be used without affecting the concrete properties. The fibres also do not adversely affect the workability of the concrete. They have been proved to improve the strength of concrete individually. This paper focuses on using both ground granulated blast furnace slag (GBFS) as partial replacement to cement and banana fibres (BF) as reinforcement in concrete. Banana fibres are made from the waste stalk of banana plant and are treated suitably to serve as an ingredient in the production of concrete. GBFS is manufactured by rapid cooling of the iron slag in water to produce a glassy, granular product. The banana fibres provide with high tensile strength and low extensibility while the GBFS increases compressive and flexural strength.

2. OBJECTIVE

- To experimentally determine the compressive strength, flexural strength and split tensile strength of concrete by reinforcing with banana fibres and by partial replacement of cement with GBFS.
- To compare the values of the strength obtained with that of normal concrete.
- To evaluate the optimum amount of GBFS and BF to be used.

3. MATERIAL PROPERTIES

3.1. Cement

Ordinary Portland cement of grade 53 was used. The observed physical properties of cement are shown in Table-1

Table-1: Physical Properties of Cement

S.No	Physical property	Values obtained	Standard values
1	Initial setting time	127 min	Not less than 30 mins
2	Final setting time	290 min	Not greater than 60 mins
3	Fineness test	6%	Not more than 10%
4	Normal consistency	32 mm	33 to 35 mm
5	Specific gravity	3.14	3.12 to 3.19

3.2 Fine Aggregate

Manufactured sand has been used as an aggregate. It constitutes 60 – 75% of the concrete composition and acts as a filler material to the concrete to provide the required volume. The observed physical properties of fine aggregate are shown in Table-2

Table-2: Physical Properties of Fine Aggregate

S.No	Properties	Value
1	Specific gravity	2.60
2	Water absorption	1.70%
3	Fineness modulus	2.45kg/m3

3.3 Coarse Aggregate

The coarse aggregate used for the tests was of 10mm and 20mm sizes. It was free from silt and other deleterious materials. The observed physical properties of coarse aggregate are shown in Table-3

Table-3 Physical Properties of Coarse Aggregate

S.No	Properties	Value
1	Specific gravity	2.69
2	Water absorption	1.60%
3	Bulk density	1510kg/m^3

3.4 Water

Potable water from laboratory was used for concrete mixing and curing process.

3.5 Banana Fibre

A high quality banana fibre after the necessary pre-treatment, each of size 40mm was used.

4. MIX PROPORTION

The concrete mix was designed to suit M20 grade as per IS 20262-2009

5. TESTS ON HARDENED CONCRETE

5.1 Compressive Strength Test

The compressive strength values are obtained by varying the percentage of GBFS and banana fibres and finding the optimum value. The compressive strength has increased with increase in GBFS up to 30%. The M20+30% GBFS mix proportion was selected and the effect of addition of banana fibre was studied. Addition of banana fibres gives maximum strength at 0.4% addition.

Table-4 Compressive Strength Vs No. of Days

Mix proportion	Compressive strength N/mm2	
	7 days`	28 days
M20	13.72	21.02
M20+10%GBFS	18.35	25.67
M20+20% GBFS	22.46	27.34
M20+30% GBFS	25.26	30.38
M20+40% GBFS	24.64	29.03
M20+50% GBFS	23.25	27.51
M20+30% GBFS+0.1%BF	25.31	29.80
M20+30% GBFS+0.2%BF	24.44	28.63
M20+30% GBFS+0.3%BF	25.82	30.36
M20+30% GBFS+0.4%BF	26.06	30.87
M20+30% GBFS+0.5%BF	23.69	25.97

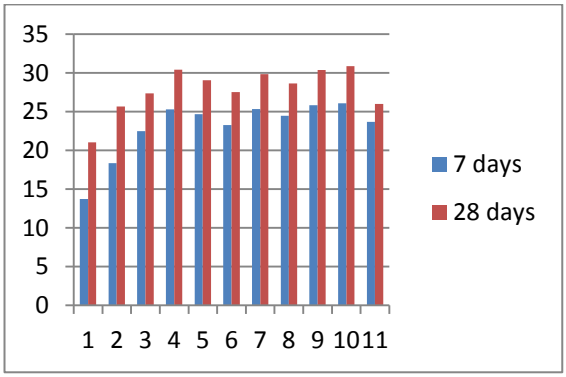

Chart-1 Graph of compressive strength vs no. of days

5.2 Flexural Strength

The specimens were studied with gradual increase in GBFS and maximum strength was obtained at M20+30% GBFS. This mix proportion was selected and the effect of banana fibres with 0.1% addition was studied. It was observed that maximum strength was obtained at 0.4% addition.

Table -5 Flexural Strength Vs No. of Days

Mix proportion	Flexural strength N/mm2	
	7 days	28 days
M20	2.58	3.34

M20+10%GBFS	2.61	3.47
M20+20% GBFS	2.83	3.53
M20+30% GBFS	3.01	3.79
M20+40% GBFS	2.82	3.76
M20+50% GBFS	2.75	3.28
M20+30% GBFS+0.1%BF	2.89	3.82
M20+30% GBFS+0.2%BF	2.94	3.85
M20+30% GBFS+0.3%BF	3.04	3.91
M20+30% GBFS+0.4%BF	3.12	4.11
M20+30% GBFS+0.5%BF	2.97	3.77
M20+40% GBFS+0.1%BF	2.80	3.71
M20+40% GBFS+0.2%BF	2.73	3.63
M20+40% GBFS+0.3%BF	2.69	3.61
M20+40% GBFS+0.4%BF	2.38	3.26
M20+40% GBFS+0.5%BF	2.19	3.08

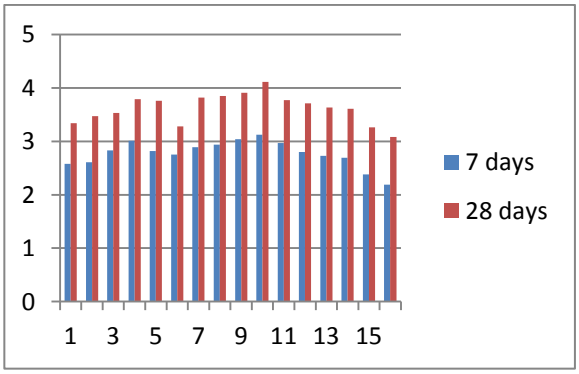

Chart-2 Graph of flexural strength vs no. of days

5.3 Split Tensile Strength

Cylinders were cast for different percentages of GBFS and the 7 days strength and 28 days strength were studied. The maximum strength was obtained at 20%GBFS+0.5%BF. It was found that the addition of GBFS increases the concrete strength by 12.4% while the addition of banana fibres increases the strength further by 50.86%.

Table-6 Split Tensile Strength Vs No. of Days

Mix proportion	Flexural strength N/mm2	
	7 days	28 days
M20	1.73	3.54
M20+10%GBFS	1.82	3.77
M20+20% GBFS	2.43	3.98
M20+30% GBFS	2.01	3.84
M20+40% GBFS	1.95	3.71
M20+50% GBFS	1.74	3.25
M20+20% GBFS+0.1%BF	2.18	4.21
M20+20% GBFS+0.25%BF	4.32	6.04
M20+20% GBFS+0.50%BF	6.59	8.10
M20+20% GBFS+0.75%BF	3.26	6.98
M20+20% GBFS+1.0%BF	1.63	3.23

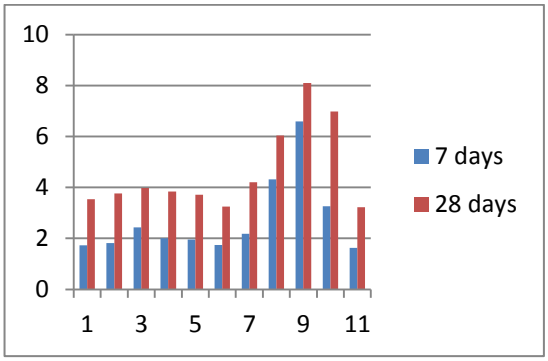

Chart-2 Graph of split tensile strength vs no. of days

6. RESULTS AND DISCUSSIONS

- Maximum compressive strength was observed at 30% GBFS+0.4%BF.
- There was reduction in the compressive strength beyond 30% increase of GBFS and 0.4% increase of banana fibres
- Maximum flexural strength was also observed for the same mix proportion.
- Maximum split tensile strength was observed for M20+20% GBFS+0.50%BF with 56.3% increase in the strength.
- There is reduction in the compressive strength beyond 30% increase of GBFS and 0.4% increase of banana fibres

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