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Experimental Investigation on Structural Behavior of Hybrid Fibres in M25 Grade Concrete with Partial Replacement of Cement using GGBS

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Abstract – *The study is based on an investigation of a hybrid fibre reinforced concrete beam with GGBS. To increase the tensile property of concrete steel fibre and polypropylene were added and to adopt the better compressive strength GGBS were added. As Ordinary Portland Cement emits a large amount of carbon dioxide. By adding GGBS emission of carbon dioxide is reduced. For this study, M25 grade concrete is designed with a water-cement ratio of 0.45. Partial replacement of cement with GGBS will be made for varying percentage 10%, 20% and 30% by weight. Fine aggregate is partial replaced by a hybrid fibre of 2%, 4% and 6% by weight. Beams were cast as mentioned in the above percentage then compressive strength, split tensile strength, flexural strength, crack pattern, ductility and deflection are investigated.*

Key Words: **GGBS, Hybrid fibre, Steel fibre, Polypropylene fibre, Beam, Concrete cube.**

1. INTRODUCTION

Concrete with Portland cement have some characteristics even if cement may be a higher binding material however it emits larger quantity of greenhouse gas. We are able to scale back the greenhouse gas emission in concrete while not poignant the strength of concrete by adding specific amount of GGBS by commutation cement. As concrete is robust in compression weak in tension. To enhance the strength fibres like steel fibre and plastic fibres will be additional.

2. MATERIALS USED AND METHODOLOGY

2.1 HYBRID FIBRE

Hybrid fibre concrete is use of two or quite two fibres in a very single concrete matrix to enhance overall properties of concrete. In well-designed hybrid composites, there's positive interaction between the fibres and also the ensuing hybrid performance exceeds the addition of individual fibre performances. This development is termed "synergy" several fibre combos will give activity.

2.2 STEEL FIBRE

Steel fibres are wide used Applications of steel-fibre-ferroconcrete embrace road pavement, flying field runways, refractory concrete and shotcrete tunnel lining by spraying fibre ferroconcrete. Its potential improvement to extend toughness, minimize cracking because of temperature, resistance to impact, abrasion, blasting and fatigue. moreover steel fibre ferroconcrete greatly reduces the potential for fracture and spalling.

2.3 POLYPROPYLENE FIBRE

Polypropylene could be an artificial organic compound chemical compound. These fibres are particularly built to be used in concrete and mortar as a small reinforcement system. These fibres get uniformly spread within the concrete reduces the plastic shrinkage and settlement cracks. They cut back porosity, increase resistance to impact, abrasion and freeze/thaw. They cut back the segregation, honey hairdressing and corrosion to the reinforcement.

2.4 GGBS

By nature, Ground granular furnace scoria hardens terribly slow and square measure utilized in concrete. GGBS replacement enhances lower heat of association. It has to be activated by combining it with hydraulic cement. GGBS could be a by-product from iron production exploitation furnace. It improves the standard and sturdiness of concrete, and its production is just about carbon dioxide free. GGBS is wide used for its superiority in concrete sturdiness, high resistance to chloride penetration and extend the life time from fifty years to hundred years.

2.5 CEMENT

Cement, in general, adhesive substances of all types, but, during a narrower sense, the binding materials employed in building and technology construction.

2.6 FINE AGGREGATE

M-sand stands for factory-made sand. M-sand is crushed combination created from exhausting granite stone that is cubically formed with ground edges, washed and graded with consistency to be used as a substitute of watercourse sand. It's a fine combination that is created by crushing stone, gravel or scum. This sand is additionally utilized in the dimensions of 2.36mm sieved in our project.

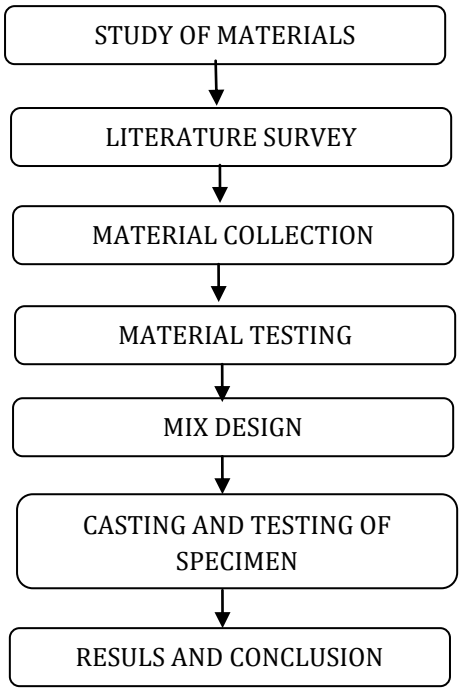
2.7 COARSE AGGREGATE

Aggregate of size additional than 4.75mm, is named as coarse mixture and is one among the foremost necessary ingredient of concrete. It offers strength to the concrete and constituents concerning seventy to 75 % volume of concrete. Crushed stone normally used as coarse mixture that is black in colour, angular and native name called black metal.

2.8 WATER

Although water is a vital constituent of concrete, however it doesn't receive due attention in preparation and internal control of concrete. Strength and different properties of concrete square measure developed as a results of reaction cement and water (hydration) and therefore water plays a crucial role. Quality of blending and action water typically leads to distress and disintegration of concrete reducing the helpful lifetime of the concrete structure.

2.9 METHODOLOGY



3. RESULT AND DISCUSSION

3.1 COMPRESSION TEST

This test is performed on hardened concrete of M25 grade. The compressive strength of the concrete determined employing a compression testing machine. Cube size 150mmx150mmx150mm.

Compressive strength = load / area (N/mm^2)

Table -1: Compressive strength of concrete

S.No.	Mix	Mix ratio		Compressive strength	
		GGBS %	Hybrid fibre %	7 days	28 days
1.	M1	-	-	16.57	28.5
2.	M2	10	2	18.44	28.38
3.	M3	10	4	18.49	28.45
4.	M4	10	6	18.52	28.50
5.	M5	20	2	18.76	28.86
6.	M6	20	4	18.8	28.92
7.	M7	20	6	18.98	29.20
8.	M8	30	2	17.71	27.26
9.	M9	30	4	17.57	27.04
10.	M10	30	6	17.46	26.87

3.2 SPLIT TENSILE STRENGTH

It is one basic important property of concrete. The concrete is incredibly weak in tension thanks to its brittle nature and is not expected to resist the direct tension. Size 150mm diameter and 300mm height.

$$\text{Tensile strength} = 2P/\pi dl$$

Where, P=Failure of load, d= Diameter of cylinder, l=Length of cylinder.

Table -2: Split tensile strength of concrete

S.No.	Mix	Mix ratio		Split tensile strength	
		GGBS %	Hybrid fibre %	7 days	28 days
1.	M1	-	-	2.07	2.55
2.	M2	10	2	2.3	3.52
3.	M3	10	4	2.33	3.55
4.	M4	10	6	2.34	3.57
5.	M5	20	2	2.32	3.6
6.	M6	20	4	2.35	3.61
7.	M7	20	6	2.4	3.65
8.	M8	30	2	2.18	3.40
9.	M9	30	4	2.21	3.38
10.	M10	30	6	2.25	3.35

3.3 Flexural strength

Flexural strength is outlined as a materials ability to resist deformation underneath load. Three beams of size 130mm×200mm×1200mm are casted for various percentages of GGBS by (0%, 30%, 40% and 50%) and hybrid fibre by (2%, 4%, 6%).

Fig-1: Specimen under loading condition

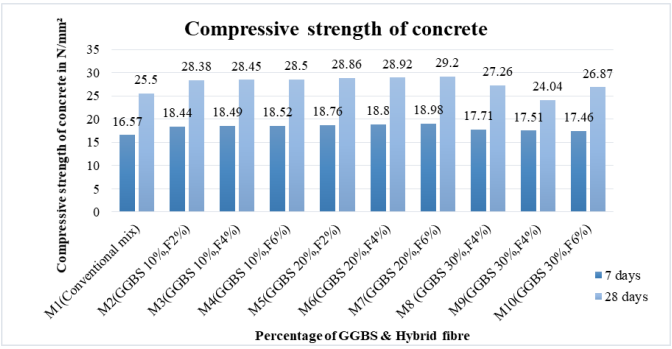


Chart -1: Compressive strength of concrete

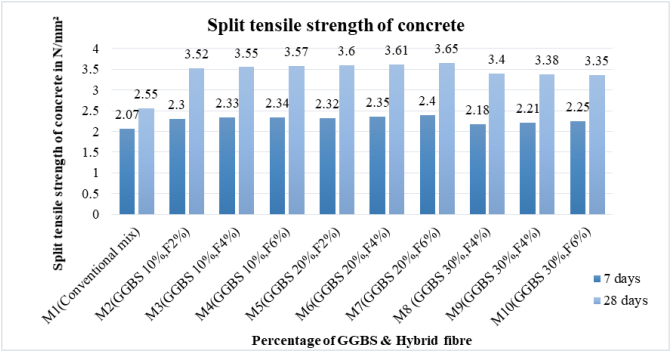


Chart -2: Split tension strength of concrete

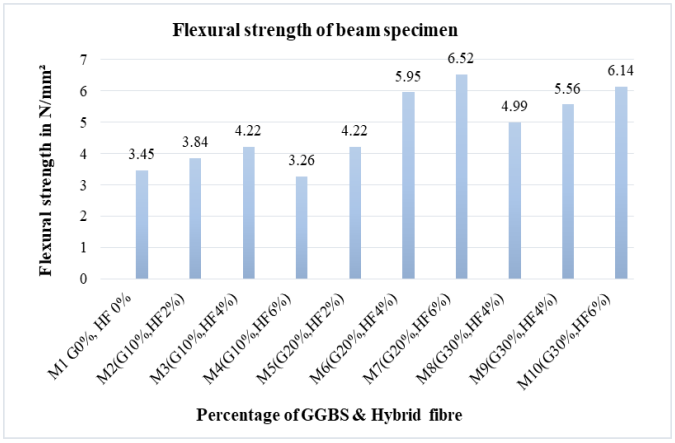


Chart -3: Flexural strength

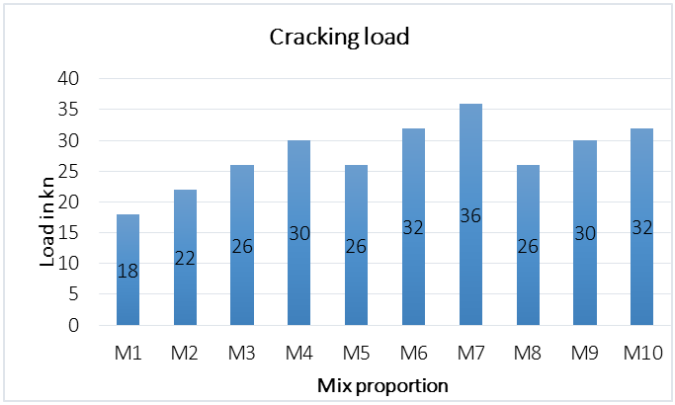


Chart -4: Cracking load of beam specimen

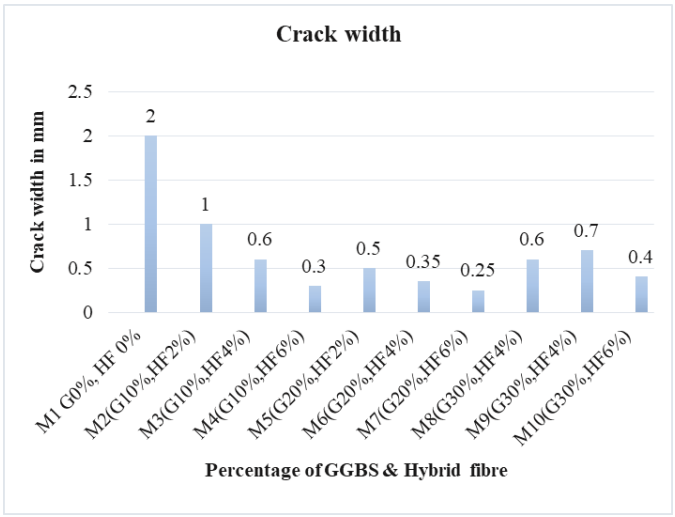


Chart -5: Crack width of beam specimen

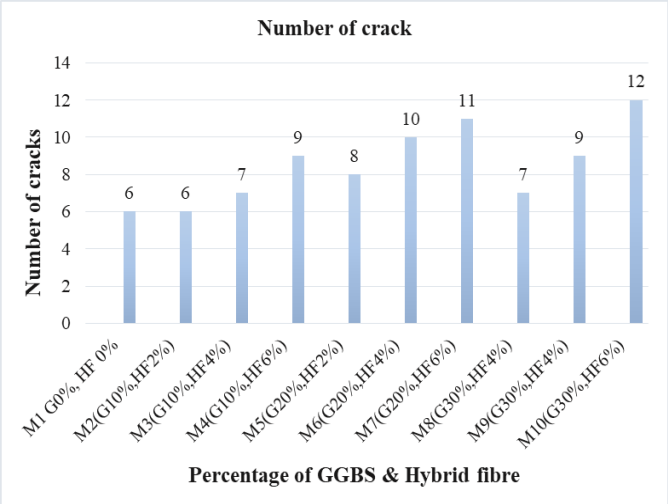


Chart -6: Number of cracks

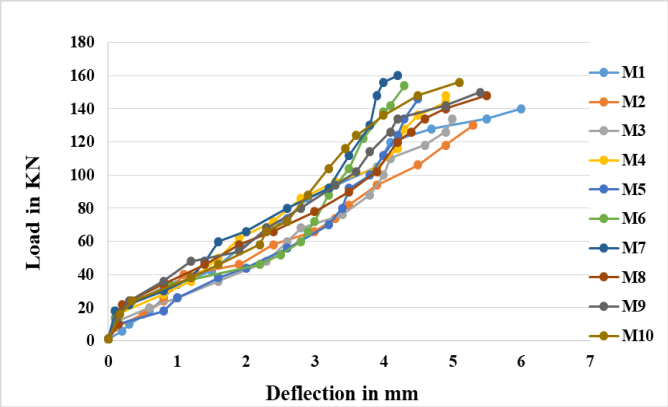


Chart -7: Deflection of beam specimen

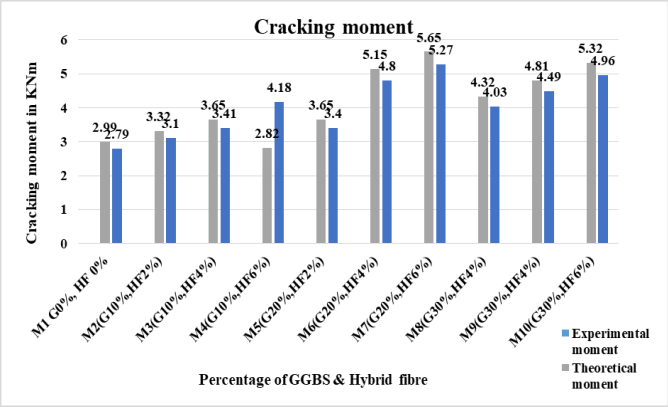


Chart -8: Cracking moment of beam specimen

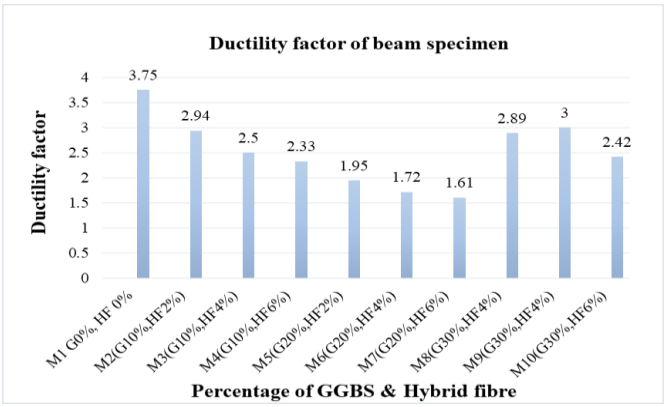


Chart -9: Ductility factor of beam specimen

4. CONCLUSIONS

- Compressive strength doesn't show a larger improvement because of the addition of hybrid fibre, however considerably enhances the ripping lastingness because of addition of fibre. This could be associated with sensational cracks by the addition of hybrid fibre.
- The load at that initial crack developing is higher in 6% hybrid fibre combine (M7) compared to 2% and 4% hybrid fibre. It shows that increase in hybrid will increase the ductility and strength of the beam.
- Maximum crack dimension of hybrid fibre concrete beams is clearly reduced. The addition of 2%, 4% and 6% resulted in regarding 74% in most crack dimension compared to concrete beam while not fibre. The addition of low steel fibre and polypropolene fibre fraction is additionally found to be effective in dominant most crack dimension.
- The number of cracks hyperbolic by 1.5 times once 2.0% hybrid fibre was additional. It's noted that the rise in cracks range followed by redaction in cracks dimension.
- The experimental results show that the addition of hybrid fibre and GGBS decreases the deflection of beam and will increase the load carrying capability of the concrete beam. At quantitative relation of 20% GGBS and 6% hybrid fibre deflection is reduced for 20% compared to conventional concrete.
- The greenhouse emission caused because of heat of association of the OPC is reduced vastly by commutation GGBS as a mineral admixture. Also, the flexural strength is increased more than 50% when 20% GGBS and 6% fibre is replaced.
- The experimental cracking moment is slightly lesser than the theoretical cracking moment. Hence it's clear that addition of GGBS and hybrid fibre reduces the instant created within the beam.
- The ductility factor of M5, M6 and M7 were 52%, 45.8% and 42.9% lesser than the conventional mix (M1). Hence it's finished that addition of 2%, 4% and 6% with 20% GGBS increase the ductile property of the concrete.

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