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Flexural Strength of GGBS, Metakaolin and Glass Fibers Based High Performance Concrete

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ABSTRACT:*The extent of present exploration is studying and assessing the outcome of replacing of cement with a variety of proportions of each of Metakaoline&GGBS (0%, 5 %, 10 %& 15%) for aggregate binder ratio of 1.75 along withwater-binder ratio of 0.275 within distinctive proportions of glass fibers (0%, 0.5 %, & 0.75 %) along with consistent percent of polypropylene fibers of 0.25 % to generate High performance Concrete. Beams are treated at seven as well as twenty-eight days and then evaluated for Flexural strength.*
KEYWORDS:*Metakaoline, GGBS, Glass Fibres, Polypropylene fibers, High-Performance Concrete, Conplast SP-430, Flexural strength.*

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I. INTRODUCTION

In recent years, improvements in concrete properties have been achieved by the invention of High-Performance-Concrete (HPC). Improvements involving a combination of improved compaction, improved paste characteristics and aggregate-matrix bond, and reduced porosity are achieved through HPC. HPC can be achieved by using admixtures like Flyash, Metakaoline, Silica Fume and GGBS. The ductility of HPC can be improved by altering its composition through the addition of glass fibers in the design mix.High performance concrete (HPC) is a specialized series of concrete designed to provide several benefits in the construction of concrete structures that cannot always be achieved routinely using conventional ingredients, normal mixing and curing practices. In the other words a high performance concrete is a concrete in which certain characteristics are developed for a particular application and environment, so that it will give excellent performance in the structure in which it will be placed, in the environment to which it will be exposed, and with the loads to which it will be subjected during its design life.

II. LITERATURE REVIEW

Vaishali G Ghorpade et al, investigated High performance concrete comprising of Glass fibers. with A/B ratio is taken as 2.0 and the quantity of cement is partially replaced by Silica fume in various combinations as 0%, 10%, 20% and 30%. The glass fibres used are replaced by 0%, 0.5%, 1.0% and 1.5% in concrete to produce Glass fibre reinforced High performance concrete. These are casted, cured and dried. Then these hardened specimens are tested for Compression, Flexural strengths and Split tensile. Hence the obtained results were a bit supportive for High performance concrete made by using Glass fibers

Vishal E, Jai Shankar P et al,used Glass fibres to produce High performance concrete in order to obtain the ductility and tensile strength. In this study M40 grade concrete is taken for investigation and then Glass fibres in various percentages such as 1, 2, 3, 4 and 5% are added. Total 54 specimens comprising of cubes of size 100x100x100mm, beams of size 500x100x100mm and cylinders of 100x200mm size were casted and tested for compression, flexural strength and split tensile. From the obtained results of test it is known that 5% of Glass fibre added to High performance concrete gives more strength compared to normal concrete specimen. Hence by adding Glass fibre strength and ductility got increased.

Ashok Pg, Akmalali Khan aimed to find the workability and mechanical properties of glass fibre reinforced concrete in fresh and hardened state using mineral admixture Ground Granulated Blast Furnace Slag and metakaolin using varying in percentage of glass fibre from about 0 % to 0.5% with about 6mm and 12mm length of glass fibre by weight of concrete with 0.8 % ofsuper plasticiser.In the following work, slump flow, T 50 slump flow, V funnel and L box test were conducted on fresh concrete and compression test, split tensile test, flexural strength test with load deflection characteristics and modulus of elasticity with stress-strain relationship on hardened concrete were tested. Slump flow, V funnel and L box test were conducted to know the workability of fibre reinforced concrete (FRC) and itwas found that slump was 660 to 600mm from 0 to 0.5 % of fibre by weight of concrete respectively , and V funnel was around 7 to 11 seconds of flow for 0 to 0.5% of fibre by weight of concrete respectively and blocking ratio values was 0.98 to 0.82 which is all good as per codal provision for a good concrete mix for a FRC and mechanical properties such as Flexural test, split tensile test and flexural strength test and young's modulus GFRC were determined it's found that there is an increase in Flexural strength up to 125% for 0.2 5 of fiber added to concrete mix as compared to normal conventional concrete and good load deflection characteristics for 0.25 by weight of fiber added to FRC .

III. MATERIALS

The details of the various materials used in this investigation are given in the following sections.

3.1 Cement

Ordinary Portland cement of 43 grade of Ultratech brand conforming to IS: 12269 standards were used in this investigation. The specific gravity of the cement was 3.08. The initial and final setting times were found as 40 minutes and 10 hours 20 minutes respectively.

3.2 Fine Aggregate

M-Sandis collected in an around Ballari conforming IS 383-1970 passing 4.75 mm and with the specific gravity of 2.5..

3.3 Coarse-aggregate

Crushed granite aggregate60%-20mm and 40%-12.5mmavailable from local sources has been used. The specific gravity of coarse aggregate is 2.70.

3.4 Water

Portable fresh water available from local sources was used for mixing and curing of mixes.

3.5Mineral Admixtures

Properties of Mineral Admixtures are as follows

Table 1: SpecificGravity of Mineral Admixtures

SL.NO	Admixtures	Specific Gravity
1	Metakaoline	2.26
2	GGBS	2.8

3.6GlassFibers

Density of glassfibers is 2.56gm/cm^3 and its Specific gravity is 2.7.

3.7Super plasticizer Conplast SP-430

Table 2: Properties of Super Plasticizers

Product name	Conplast SP-430
Appearance	Brown liquid
Chloride content	Nil
Specific gravity	1.14- 1.21
Alkaline content	Less than 55 gms

IV. METHODOLOGY

The present investigation was planned to utilize Metakaoline and GGBS in the production of High-Performance-Concrete with Water Binder Ratio of 0.275 and Aggregate Binder Ratio of 1.75. Cement was partially replaced by Metakaoline and GGBS (0%, 5%, 10% & 15% each) and Natural sand was completely replaced by M-Sand. HPC was produced using locally available Coarse aggregates (60%-20mm and 40%-12.5mm) using Glass fibres which was added in the volume percentages of 0%, 0.5% &0.75% and volume percentage of polypropylene fibreswas kept constant at 0.25% to improve ductility. To improve workability of HPC Super plasticizer Conplast SP-430 was used (0.8%). This investigation examinedFlexural strength of concrete mixtures containing various combinations of Metakaoline and GGBS based multi-fibre reinforced high performance concrete mixes designed by Absolute Volume Method with respect to reference mix. Beams of 100X100X500 mm were cured for 28days before testing. The results are analysed and useful conclusions are drawn.

V. RESULTS AND DISCUSSION

Table 3: 7 days and 28 days Flexural Strength

GF %	METAKOALINE and GGBS %	W/B=0.275	W/B=0.275
		7 Days Flexural Strength (Mpa)	28 Days Flexural Strength (Mpa)
0%	0% (Referance)	6	8
0%	10% (5%+5%)	7	9
	20% (10%+10%)	6	8
	30% (15%+15%)	5	7
0.5%	10% (5%+5%)	8	10
	20% (10%+10%)	7	9
	30% (15%+15%)	6	8
0.75%	10% (5%+5%)	9	11
	20% (10%+10%)	8	10
	30% (15%+15%)	7	9

5.1Effect of Variation of Metakaoline and GGBS percentages for Various percentages of Glass Fibre on Flexural Strength of concrete

Figure 1 shows 7 days Flexural strength for variation of Metakaoline and GGBS percentages, for W/B ratio of 0.275 and for Glass fibre percentages 0%, 0.5%&0.75%.

For 0% of Glass fibre, FlexuralStrength increases by 16.6%, unaltered and decreases by 16.6% with respect to referance mix for 10%, 20% and 30% replacement respectively.

For 0.5% of glass fibre, FlexuralStrength increases by 33.33%, 16.66% and unaltered with respect to referance mix for 10%, 20% and 30% replacement respectively.

For 0.75% of glass fibre, FlexuralStrength increases by 50%, 33.33% and 16.66% with respect to referance mix for 10%, 20% and 30% replacement respectively.

The Flexural strength of concrete increases with increase in addition of glass fibers.

The Flexural strength of concrete increases up to 5% replacement and it decreases by further increase in the percentage of replacement.

The maximum Flexural strength of concrete is obtained for 5% replacement and for 0.75% addition of Glass fibre.

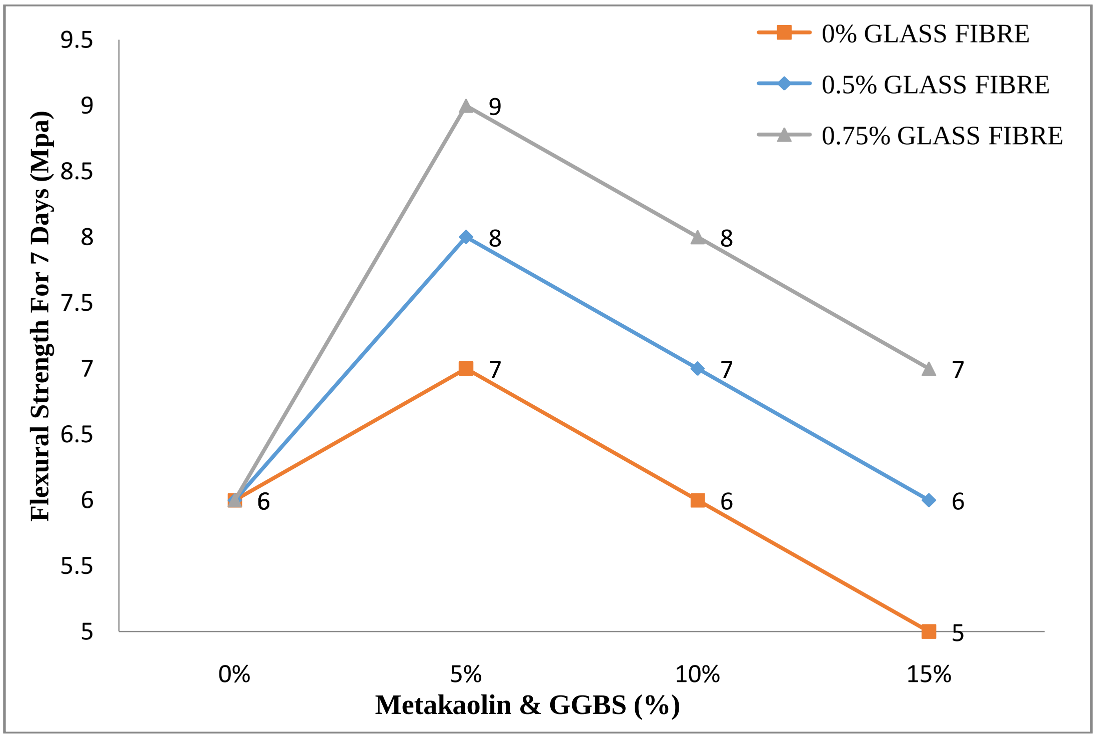

Figure 1: 7 days Flexural Strength forvariation in GGBS% for various Glass Fiber %

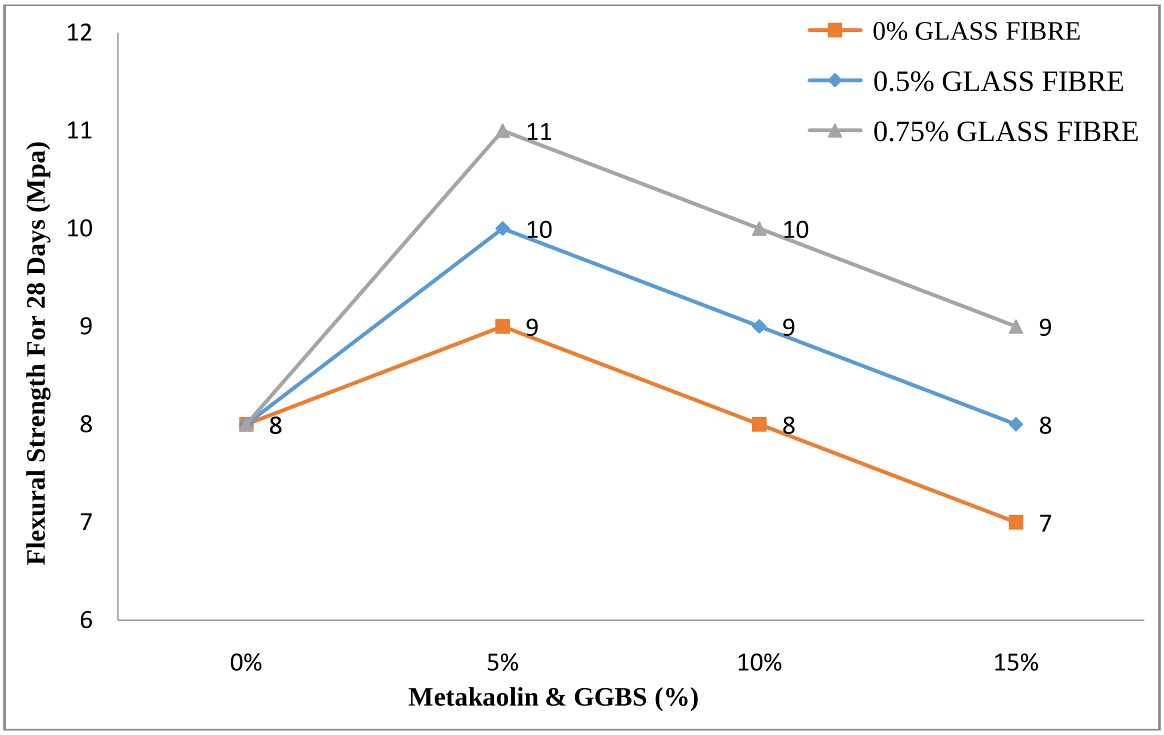

Figure 2: 28 days Flexural Strength forvariation in GGBS% for various Glass Fiber %

Figure 2 shows 28 days Flexural strength for variation of Metakaoline and GGBS percentages, for W/B ratio of 0.275 and for Glass fibre percentages 0%, 0.5%&0.75%.

For 0% of Glass fibre, FlexuralStrength increases by 12.5%, unaltered and decreases by 12.5% with respect to referance mix for 10%, 20% and 30% replacement respectively.

For 0.5% of glass fibre, FlexuralStrength increases by 25%, 12.5% and Unaltered with respect to referance mix for 10%, 20% and 30% replacement respectively.

For 0.75% of glass fibre, FlexuralStrength increases by 37.5%, 25% and 12.5% with respect to referance mix for 10%, 20% and 30% replacement respectively.

The Flexural strength of concrete increases with increase in addition of glass fibers.

The Flexural strength of concrete increases up to 5% replacement and it decreases by further increase in the percentage of replacement.

The maximum Flexural strength of concrete is obtained for 5% replacement and for 0.75% addition of Glass fibre.

VI. CONCLUSIONS

On the basis of the present experimental investigation, the following conclusionsare drawn.

1. The maximum FlexuralStrength obtained for 7 days is 9MPa for 5% replacement of Metakaolin and GGBS each for addition of 0.75% of Glass fibre. Flexural strength is increased by 50% for this mix compared to Reference mix.
2. The maximum FlexuralStrength obtained for 28 days is 11MPa for 5% replacement of Metakaolin and GGBS each for addition of 0.75% of Glass fibre. Flexural strength is increased by 37.5% for this mix compared to Reference mix.
3. The Flexural strength of concrete increases with increase in addition of Glass fibers.
4. The Flexural strength of concrete increases up to 5% replacement of Metakaolin and GGBS each and it decreases by further increase in the percentages of replacement.
5. Thus it can be concluded that 10% replacement of GGBS and Metakaolin and 0.75% of Glass Fiber addition is optimum.

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