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The Influence of GGBS,Metakaolin and Glass Fibers on Flexural Strength of Concrete Pavement

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ABSTRACT:*The present paper deals with analysis of rigid pavements made by usingM Sand as fine aggregate. Water binder ratio of 0.300 is used where cement is partially replaced by Ground Granulated Blast Furnace Slag& Metakaolin0%, 10%, 20% and 30%. Glass fibre is added by 0.5% and 0.75%. To improve workability of mixes, super plasticizers Conplast SP-430 is used. This study examines Flexural strength of concrete mixtures containing various combinations of Granulated Blast Furnace Slag& Metakaolinbased glass fibre reinforced concrete pavement mixes designed by Absolute volume method. Beams of 100x100x500 mmare cast, cured for 7 & 28 days before testing. The results are analyzed and useful conclusions are drawn.*

KEYWORDS:*, Metakaolin, GGBS, Glass Fibres, Rigid Pavement, Flexural strength, Super plasticizer, Absolute volume method.*

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I. INTRODUCTION

Concrete Pavement is typically the most massive individual material element in the built environment. If the embodied energy of concrete can be reduced without decreasing the performance or increasing the cost, significant environmental and economic benefits may be realized. Concrete is primarily comprised of Portland cement, aggregates, and water. Although Portland cement typically comprises only 12% of the concrete mass, it accounts for approximately 93% of the strength necessary for the design of the structures. Some of the recent studies in various parts of the world have revealed that Ground granulated blast furnace slag concrete can protect the steel reinforcement more efficiently, so that it can resist corrosion, and thus the structure as a whole. GGBS concrete is a type of concrete in which a part of the cement is replaced by ground granulated blast furnace slag, which is an industrial waste. Thus the implementation of GGBS concrete can minimize corrosion in an effective way. Moreover it can lead to much durable structure without considerable increase in cost. Ground granulated blast furnace slag from modern thermal power plants generally does not require processing prior to being incorporated into concrete and is therefore considered to be an environmentally free input material. When used in concrete, ground granulated blast furnace slag is a cementations material that can act as a partial substitution for Portland cement without significantly compromising the Flexural strength.

In the present work an attempt has been made to study the suitability of GGBS and Metakaolin as Mineral admixtures and its effect on the properties of concrete. GGBS and Metakaolin were blended with cement in various proportions to study the effect of strength on concrete. Concrete mixes were made using Ordinary Portland cement alone as Control and also replacing cement by 10%, 20%, and 30% of GGBS and Metakaolin. The physical properties and Flexural strength of concrete were measured.

II. LITERATURE REVIEW

Ashok PG et al, 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 % of super plasticizer.In this 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 it was 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 fibre added to concrete mix as compared to normal conventional concrete and good load deflection characteristics for 0.25 by weight of fibre added to FRC .

Kasu Naveena et al, Due to exponential growing in urbanization and industrialization, by product from industries is becoming an increasing concern for recycling and waste management. Ground granulated blast furnace slag (GGBS) is by product from blast furnace of iron and steel industries. GGBS is very useful in design and development of high quality cement paste. It effects on strength and durability properties. Concrete occupies unique position among the modern construction materials & is widely used in all types of constructions. It consists of a hard, chemically inert particulate substance. Due to increase in demand of concrete more &more new methods &materials are being developed. This paper presents the use of ground granulated blast furnace slag (GGBS) on strength development of concrete and the use of GGBS and mineral admixture metakaolin. Experimental investigation conducted by complete replacement of slag with cement and partial replacement of slag and mineral admixtures by weight in the form of 3cubes by using M30 grade. Results of GGBS with concrete are compared with the results of partial replacement of GGBS and mineral admixtures. A total of cubes were cast and Flexural strength of the concrete specimens were determined at curing age of 3, 7, 28 days. Test results show that strength increases with the increase of slag up to optimum value and also the strength increases by adding of mineral admixture metakaolin.

III. MATERIALS

3.1Cement Used

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 45 minutes and 585 minutes respectively.

Table 1: Properties of Concrete

Material properties	Results
Sp gravity	3.08
Fineness	4%
Normal consistency	28%
Initial setting time	45mins
Final setting time	9hrs 35 mins

3.2 M Sand

M Sand which was collected in an around Bellary conforming IS 383-1970 passing 4.75 mm and with the specific gravity of 2.56.

Table 2: Properties of M Sand

Properties	M sand
Sp gravity	2.56
Bulk density	1.77 kg/m^3
Impurities	Nil
Fineness modulus	3.10

3.3 Coarse-Aggregate Used

Crushed granite aggregate available from local sources has been used. The specific gravity of coarse aggregate is 2.70.

Table 3: Properties of Coarse Aggregate

Properties	Coarse aggregate
Sp gravity	2.70
Bulk density	1.650 kg/m^3
Fineness modulus	7.19

3.4Water Used

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

3.5Mineral Admixtures
Ground Granulated Blast Furnace Slag (GGBS) and Metakaolin (MK) are used as mineral admixture and their specific gravity are 3.12& 2.60 respectively.

3.6Glass Fibres
Glass fibers of length 12mm and a high dispersion capacity of 200 million filaments per kilogram are used in this study.

IV. METHODOLOGY

In the present study, Flexural strengthis analysedfor Concrete pavement. Absolute Volume Method is used for mix design of concrete. Natural River sand is completely replaced by M Sand. Cement is replaced by GGBS and Metakaolin by 0%, 5% 10% and 15% each. Glass Fibres of 0%, 0.5% and 0.75% by Volume of concrete are added to the concrete. To enhance the workability property, Super Plasticizer Conplast SP-430 is used by 0.8% by weight of binder. For every mix 3 beams of 100x100x500mm were cast, cured and tested for 7 and 28 Days Flexural strength.

V. RESULTS AND DISCUSSIONS

5.1 Effect of variation of GGBS& Metakaolin for various percentages of Glass Fibers on Flexural strength of Concrete

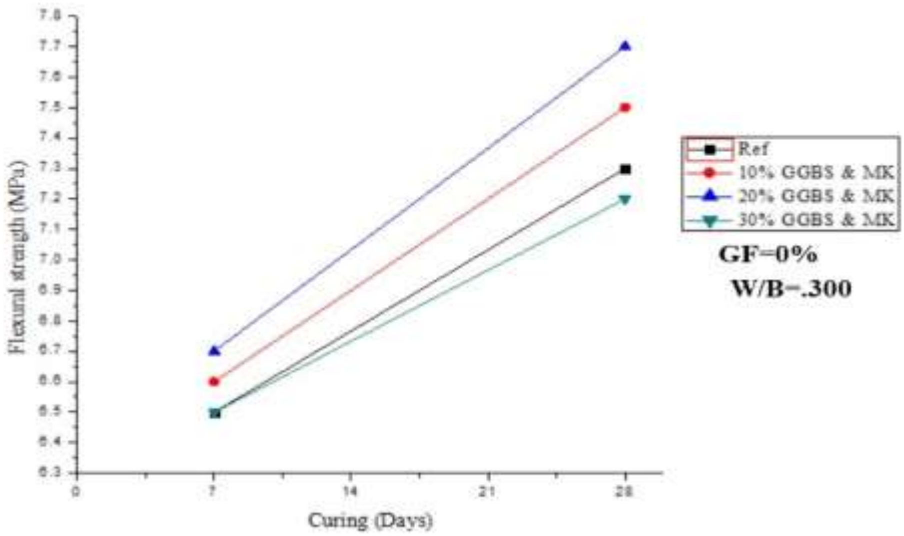

Figure 1:Flexural Strength for various Percentages of GGBS &Metakaolinfor 0%G.F

The above graph shows 7 days and 28 days Flexural Strength for variation in GGBS& Metakaolin for 0% G F. It can be observed that for 20% replacement of GGBS & Metakaolin the Flexural strength is maximum for both 7 and 28 days. TheFlexural strength is increased by 12 %, 12.98 % and 9.72% for 28 days with respect to 7 days strength for 10%, 20% and 30%replacement respectively.

From Figure1 it can be observed that7 Days Flexural strength decreases by 1.51% for 10% replacement, increases by2.98% for 20% replacement and unaltered for 30% replacement compared to reference mix. 28 Days Flexural strength is unaltered for 2.66% replacement, increases by 5.19% for 20% replacementand decreases by 1.38% for 30% replacementcompared to reference mix.

Maximum 28 Days Flexural strength obtained is 7.7 MPa and is for mix with 20% replacementand is increased by 14.63% compared to reference mix.

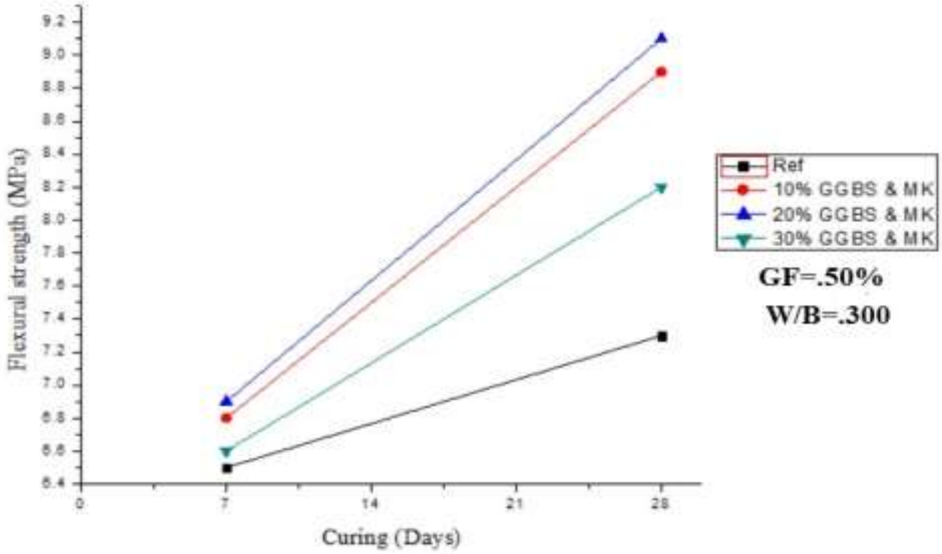

Figure 2: Flexural Strength for various Percentages of GGBS& Metakaolin for 0.5% G.F

The above graph shows 7 days and 28 days Flexural Strength for variation in GGBS& Metakaolin for 0.5% G F. It can be observed that for 20% replacement of GGBS & Metakaolin the Flexural strength is maximum for both 7 and 28 days. TheFlexural strength is increased by 23.59 %, 24.17 % and 19.51% for 28 days with respect to 7 days strength for 10%, 20% and 30%replacement respectively.

From figure 2 it can be observed that 7 Days Flexural strength increases by 4.41% for 10% replacement, increases by 5.79% for 20% replacementand increases by 1.51% for 30% replacementcompared to reference mix. 28 Days Flexural strength is increases by 17.97% for 10% replacement, increases by 19.78% for 20% replacementand increases by 10.97% for 30% replacementcompared to reference mix.

Maximum 28 Days Flexural strength obtained is 9.1 MPa and is for mix with 20% replacementand is increased by 24.17% compared to reference mix.

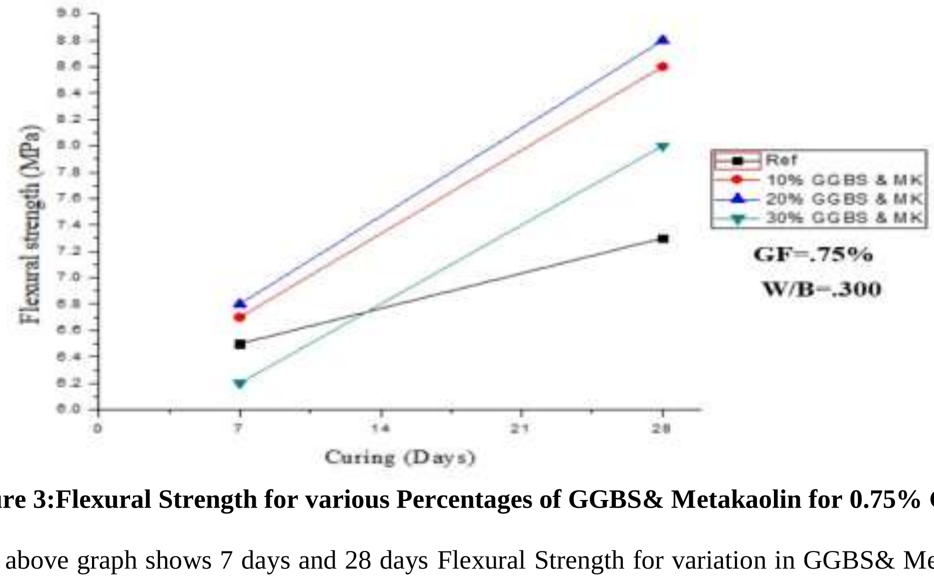

Figure 3:Flexural Strength for various Percentages of GGBS& Metakaolin for 0.75% G.F

The above graph shows 7 days and 28 days Flexural Strength for variation in GGBS& Metakaolin for 0.75% G F. It can be observed that for 20% replacement of GGBS & Metakaolin the Flexural strength is maximum for both 7 and 28 days. TheFlexural strength is increased by 22.09 %, 22.72 % and 22.5% for 28 days with respect to 7 days strength for 10%, 20% and 30% replacement respectively.

From figure 3 it can be observed that 7 Days Flexural strength increases by 2.98 % for 10% replacement, increases by 4.41% for 20% replacement and decreases by 4.83% for 30% replacement compared to reference mix. 28 Days Flexural strength is increased by 15.11% for 10% replacement, increases by 17.04% for 20% replacement and increases by 8.75% for 30% replacement compared to reference mix.

Maximum 28 Days Flexural strength obtained is 8.8 MPa and is for mix with 20% replacement and is increased by 22.72% compared to reference mix.

VI. CONCLUSIONS

On the basis of the present experimental investigation, the following conclusion is drawn.

1. Maximum 28 Days Flexural strength obtained is 7.7 MPa and is for mix with 20% replacement for 0% Glass Fiber and is increased by 14.63% compared to reference mix.
2. Maximum 28 Days Flexural strength obtained is 9.1 MPa and is for mix with 20% replacement for 0.5% Glass Fiber and is increased by 15.55% compared to reference mix.
3. Maximum 28 Days Flexural strength obtained is 8.8 MPa and is for mix with 20% replacement for 0.75% Glass Fiber and is increased by 16.27% compared to reference mix.
4. It can be observed thatFlexural strength increases with increase in GGBS and Metakaolin replacement up to 20% replacement and further decreases with increase in GGBS and Metakaolin replacement. Thus 20% replacement can be considered optimum.
5. It can be observed thatFlexural strength increases with increase in Glass fiber addition up to 0.50% replacement and further decreases with increase in Glass Fiber addition. Thus 0.50% Glass Fiber can be considered optimum.
6. Thus we can conclude that maximum Flexural strength obtained is 9.1 Mpa and is for mix with 20% replacement for 0.5% Glass Fiber

REFERENCES

[1]. Aveline Darquennes, Stephanie Staquet, and Bernard Espion. (2011). "Behaviour of Slag Cement Concrete under Restraint Conditions". European Journal of Environmental and Civil Engineering, 15 (5), 787-798

[2]. Roy, D. M. and Idorn, G.M. (1982) "Hydration, Structure and Properties of Blast Furnace Slag Cements, Mortars and Concrete," ACI Journal, Vol. 79, No.6, Pp.444-457

[3]. Murali. G, Sruthee. P, "Experimental study of concrete with metakaolin as partial Replacement of cement" International journal emerging trends in engineering and Development, Issue 2 volume 4

[4]. Bai, L. et al., 'Strength developments in concrete incorporating PFA and metakaolin',Magazine of concrete research, Vol. 52, No. 3, June 2000

achin Patil" The Influence of GGBS,Metakaolin and Glass Fibers on Flexural Strength of Concrete Pavement" International Journal of Computational Engineering Research (IJCER), vol. 09, no. 6, 2019, pp 35-39