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A REVIEW OF TERNARY BLENDED HYBRID FIBRE REINFORCED CONCRETE

Peta Purnachandra Sai
Research Scholar, VIT University, Vellore, India

Meena T
Associate Professor, Department of Structural and Geo-Technical Engineering,
VIT University, Vellore, India

ABSTRACT

During the past years, we have seen many types of research on concrete by suitably replacing with many materials to reduce the economy and pollution. The replacement was done with a substance which is pozzolanic, and these substances mostly come from waste materials such as sugarcane bagasse ash, rice husk ash and many other such materials. In this study, we have taken the replacement material GGBS and Silica fume and the addition of polypropylene fibre, steel and glass fibre.

Key words: Hybrid fibres, polypropylene fibre, steel fibre, glass fibre, GGBS, Silica Fume, Ternary blend.

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1. INTRODUCTION

The pozzolanic materials, which are extensively used to replace the concrete, is because of its properties, it enhances the concrete which reduces the cost [2]. Ground granulated blast furnace slag used in concrete at various replacements i.e., 0% to 60% which enhances the overall mechanical properties and durable properties of concretes [3]. The mechanical properties like strength and effectiveness were found to be a mixture of effectiveness factor, depending upon the replacement level of other cementitious materials like sugarcane bagasse ash, fly ash (class-C & class-F) Fig.1 and micro silica reported as earlier. This process makes it easy to design a GGBS concretes to the desired strength of any given percentage replacement of binder [2]

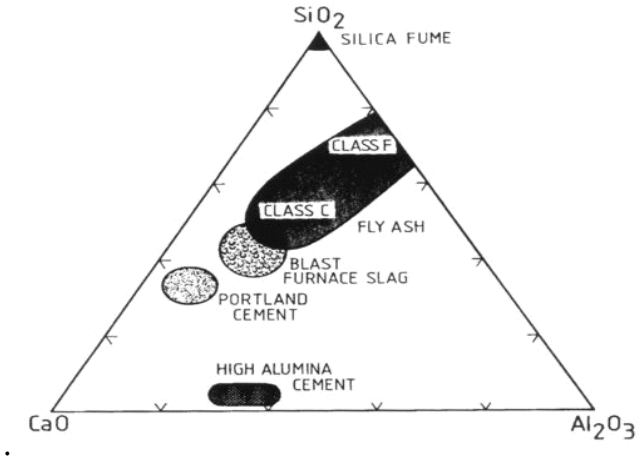

Figure 1

Silica fume is a pozzolanic material, which effectively increases the properties of concrete when replaced with the binder [14]. Usage of silica fume in concrete with superplasticisers, it is easier to achieve compressive strength of 100-150 MPa in the laboratory[3]. Addition of silica fume to concrete improves the durability of concrete which makes it impermeable, reduction of diffused harmful ions due to refined pore structure ultimately reduces the content of $Ca(OH)_2$ present in the concrete, which makes it resistant to sulfate attack. Improvement in the durability of concrete will also enhance the ability of concrete made with silica fume, which enables it to protect the embedded steel reinforcement from corrosion [3].

Concrete inherently develops micro-cracks during curing, which propagates rapidly under applied stresses results in the low tensile strength of concrete. Hence, the addition of fibres in concrete concerning binder ratio improves the concrete strength and reduces the effect of micro-cracks.

2. LITERATURE REVIEW

2.1. Ternary Blended Concrete

R Rathan Raj (2013) This paper articulates procedure for mix design of High Strength Concrete using BIS method and ACI code method along with literature on High strength concrete. M60 mix of TBHSC, i.e., Ternary Blended High Strength Concrete made with redmud(RM), and metakaolin(MK) with different percentage replacement levels are made to test experimentally for workability and strength parameters in the lab [8].

Tahir Kemal Erdem in 2008 studied, 80 varieties of HSC mixes containing pozzolanic materials were produced. Results from the experiments show that ternary blends allow the concrete mix to obtain higher strengths than Portland cement + silica fume binary mixtures. It helps us to understand that performance of slag in the TBC was good when compared to Class F fly ash [9].

D.Audinarayana in 2013 presented experimental investigation to optimise the TBC based on OPC, Fly Ash, Micro Silica for the development of high-performance concrete. Concrete with different blends was tested for compressive Strength for various ages namely 28, 90, 180 days respectively for different replacement levels of FA, i.e., 0, 15 and 20 percentages and SF 0, 5, and 10 percentage mixes with binder are done. Studied three different W/C ratios of 0.55, 0.45 and 0.35 [10].

2.2. Fibres

Vinay Kumar Singh in 2014 reported that fibres in different percentage had been studied to know the strength parameters of concrete using compressive strength test and flexural strength test at 28 days for an M25 grade of concrete. Experimental test results have shown that the performance of polypropylene fibre concrete exhibited good performance than that of plain concrete.[4]

Anthony Nkem Ede in 2104 stated that the concrete properties could be improved by adding micro synthetic polypropylene fibre. It is suggested that an optimal percentage of addition of polypropylene fibre in concrete to improve compressive strength and flexural strength was found to lie within 0.25% and 0.5% [16]

Srikanth in 2014 investigated on property enhancement and improvement of durability of GFRC resistance to alkali environment. GFRC showed an increase of 20% to 25 % in compressive strength, flexural strength and split tensile strength when compared to reinforced concrete. To improve the durability from the view of acid attacks on concrete the usage of AR glass fibres had shown good result. The glass fibre reinforced concrete can be used for blast resisting structures, dams, hydraulic structures [6].

Vijaya Bhaskar in 2016 reported that the addition of steel fibres in concrete which improved the impact resistance concrete. The Ternary concrete showed outstanding performance in resisting impact loads at 90 days curing with the mix combination (MS5%+GGBS30%) over plain concrete and at 28 days and seven days curing the mix does not show much performance comparatively. From this it can be concluded that the MS and GGBS replacement levels could be recommended up to 10% and 30% respectively, after an absolute limit, the GGBS could not enter into the reaction, but behaves like fine aggregate [7].

Vaishali G Ghorpade in 2010 investigated on the behaviour of Glass fibres in HPC. From experimental results, the optimum percentage OF GFHPC was found to be 1.0% fibre volume with 10% SF to achieve the maximum benefits in mechanical properties of GFHPC [14].

3. MATERIALS AND PROPERTIES

3.1. Cement

OPC-53 grade cement used for the trail mix work and special care had taken for cement. Table no.1 shows the physical properties of cement.

Table 1 Properties of Cement

S No	PROPERTY		VALUE
1	Specific Gravity of cement		3.15
2	Fineness of the cement		8.56 %
3	Soundness Test(Le-Chatlier)		3.8 mm
4	Setting Time	Initial	180 min
		Final	240 min

3.2. GGBS

Damage and deterioration in concrete are caused by many factors some of them are water penetration, chemical degradation, erosion and freezing-thawing. Therefore, it is essential that durability of concrete should be enhanced to achieve this adding some additives which improve the properties of both freshly mixed concrete and hardened concrete by the pozzolanic reaction. Benefits of adding cementitious material to the concrete to increase durability should be well established. High-performance concrete contains materials like fly

ash, silica fume, GGBS, natural pozzolana fibres, chemical admixtures and other materials in various combinations which enhance the concrete strength and durability.

3.3. Silica Fume

Silica fume, which is also known as micro silica, is a non-crystalline poly-morph of silicon-di-oxide. It is an ultrafine powder which contains sphere-shaped particles with an average particle diameter of 150 nm. Table no.3 shows physical properties.

Table 3 Physical properties of silica fume

S. No.	Physical Property	Tested Value
1.	Specific Surface Area	18 cm^2/gm
2.	Bulk Density	600 – 630 kg/ m^3
3.	Specific Gravity	2

3.4. Coarse Aggregate

Locally existing stonework, sieved with a 20 mm sieve, was used as coarse aggregate. It was then washed to clear dirt and dust and kept under dry surface conditions. Aggregates tested as per IS: 383-1970. Table no.4 shows the properties of the coarse aggregate used.

Table 4 Properties of Coarse Aggregate

S No	PROPERTY	VALUE
1	Specific gravity	2.8
2	Water absorption	0.2%
3	Fineness modulus	7.3

3.5. Fine Aggregate

Sand which is locally available and conforming to zone-2 of IS 383-1970 used as fine aggregate. Fine aggregate taken was clean, inert and free from organic matter, silt and clay. Table no.5 shows the Properties.

Table 5 Properties of Fine Aggregates

S No	PROPERTY	VALUE
1	Specific gravity	2.65
2	Water absorption	4.16%
3	Fineness modulus	2.69

3.6. Chemical Admixture

Super Plasticizer Conplast SP-430 was used to obtain better workability for the mix of chosen w/c ratio of 0.48. The specific gravity was varying from 1.220 to 1.225 at 30^oC in the lack of chloride. The air entrained in the mix is nearly taken as 1%. The various physical properties of Conplast SP-430 are as listed in Table 6.

Table 6 Properties of Conplast SP-430

S. No.	Description	Property
1	Appearance	Brown liquid
2	Specific Gravity (BSEN 934-2)	1.2 @ 22°C + 2.2°C
3	Water-soluble chloride (BSEN 934-2)	-
4	Alkali content (BSEN 934-2)	Typically less than 53 g. Na_2O equivalent/ litre of admixture

4. RESULTS AND DISCUSSIONS

- Optimum percentage replacement of silica fume to replace with cement is 10% [14]
- Optimum percentage replacement of GGBS with cement is 20% [2]
- Optimum Optimum percentage replacement of polypropylene fibre lies between 0.25% and 0.5% [13]
- Optimum percentage replacement of steel fibre lies between 0.75% and 1% [15]
- Optimum percentage replacement of glass fibre is 1.0% [14]

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