Effect Of Polydisperse Cementitious Polymer Based Waterproof Coated Steel Fibers And Polypropylene Fibers In Concrete

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Abstract - *Civil engineers are facing much problems regarding the quality of structures and also relating to the age prolongation of the structures with direct affects of natural calamities. To overcome above impacts as well as making the structure more stronger in every points, hybrid fiber addition along with the concrete can be introduced. The combination of hybrid fibers with concrete will provide immense physical and mechanical properties. Furthermore, corrosion resistance against the chemical attack , water seepage problems etc can be subdued by making a cementitious waterproof shield cover over the steel fibres. This experimental study comprises the effect of Hybrid fibres i.e. poly-disperse cementitious polymer based waterproof coated steel fibers and polypropylene fibre on M30 grade concrete. The percentage of hybrid fibre added is limited to 1% of volume of concrete, where variation in percentage of steel and polypropylene fibre is made for the study in this 1% . More over Steel fibres are given Styrene Butadiene Rubber (SBR) coating, which provides a massive protection boosting up the energy absorption capacity of the structure. The mechanical properties such as compressive strength, Split tensile strength and flexural strength are studied to obtain the effects of SBR Coated hybrid fibres on performance of concrete*

Key Words: (Hybrid Fibers, Waterproof coating , Styrene Butadiene Rubber(SBR), Mechanical Properties

1.INTRODUCTION

The development of promising and most efficient concrete mix with improved performance and durability is an important of modern constructions. Modified cement concrete with hybrid fiber reinforcement is increasingly used in all structural works. The quality of concrete in the construction sector decreased due to various factors and civil engineers are facing much problems regarding the quality and age prolongation of the structures with direct affects of natural calamities. Inaddition to boost up the resistance of the infrastructures against bending, stretching and impact shock loads, polydisperse fiber with different specifications and proportions is used in construction practice.

Poly disperse cementitious polymer based waterproof coated steel fibers and polypropylene fibers in concrete have the following advantages :

1. Improve Compressive Strength

2. Better result on split tensile and flexural strengths

Waterproof coated steel fiber reinforcement made of resistance against acid and alkali attacks. When such concrete was used in that type of sensitive portions, mixing waterproof coated steel fiber and polypropylene fiber (polydisperse) with cementitious composites, are capable of self - strengthening before failure under a bending load. The hardened stage of concrete acts as plastic same stage of work in the loaded material. Such concrete, exhibits work hardening with fracture being accompanied by a suspended brittle effects.

The use of Polypropylene fiber (PPF) in practice :

- Portion on continuous wetting
- Storage tanks
- Underground structures with multiscale variational loads and directions
- Where age prolongation is needed

2.MATERIALS

2.1 Fiber reinforced concrete

Fiber - reinforced concrete is usually Portland cement concrete mixed with either metallic or polymer fibers or both. The strength of the fiber reinforced concrete is often determined by the strength of the interfacial transition zone (ITZ). An increase in the strength of the cement paste also causes an increase in the adhesion at the fiber matrix interface.

2.2 Steel fiber (SF) - hooked end

It is made by milling from rolled steel. It is a steel strip of regular round shape in cross section. Due to its high density and easy corrosion, steel fibers (SFs) are not suitable for light weight aggregate concrete and concrete in a high chloride environment.

Fig -1: Steel fiber - hooked end

2.3 Polypropylene fibers (PPF)

The most commonly used microfibers in concrete have been widely used in recent years due to their high strength, high elastic modulus, high corrosion resistance. The propagation of microcracks in concrete will also be blocked or delayed by adding PPF.

Fig -2: Polypropylene fiber

Table -1: Specification of fiber

Types of fiber	Length (L) in mm	Diameter (D)	Aspect Ratio (L/D)	Density in kg/m^3
Steel (Hooked end)	50	1 mm	50	7850
Polypropylene	12	20 microns	600	1000

2.4 Cementitious polymer based waterproof

The polymer used is Styrene - Butadiene Rubber (SBR) as a vehicle for the slurry and cement is acting as the additives and also binding materials. SBR describe families of synthetic rubbers derived from two monomers, styrene and butadiene.

Fig -3: SBR

2.4.1 Properties of SBR

- Good abrasion resistance
- Good ageing stability when protected by additives

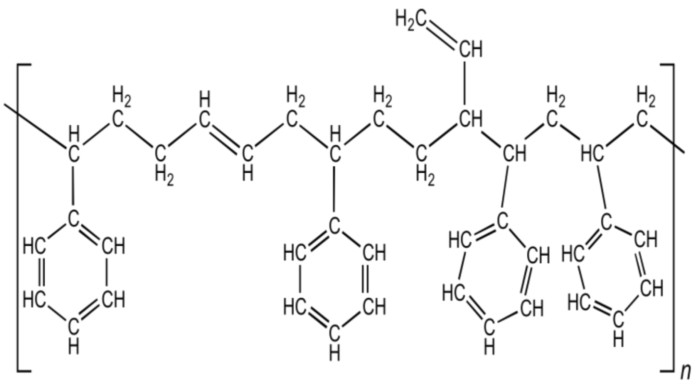

Fig -4: Styrene - Butadiene chemical structure

2.5 Cement

Portland Pozzalana Cement (43 grade) – ULTRATECH CEMENTS confirming to IS 1489 (Part I) : 1991 was used for the experimental programme. Tests were conducted as per IS: 1489 (Part I). Details of the test are given in appendix A. The properties of the cement are tabulated in Table 4.1. The various tests conducted on cement are fineness of cement, standard consistency test, specific gravity, initial and final setting time and compression test on mortar cube.

Fig -5: PPC of 43 grade

Table -2: Properties of cement

Sl. No.	Test Conducted	Result
1	Fineness (%)	6.33
2	Standard Consistency (%)	34.00
3	Specific Gravity	3.12
4	Initial setting time (minutes)	80
5	Mortar cube strength (N/mm²)	25.74

2.6 Fine aggregate

M – Sand was used as fine aggregate. Laboratory test were conducted on fine aggregate to determine the different physical properties as per IS 2386 (Part–III)–1963 and IS 383 (I) - 1970. Details of the test is given in Appendix B. The properties of the fine aggregate are given in Table 4.2. The test conducted on fine aggregate were grain sieve analysis, specific gravity and bulk density.

Table -3: Properties of fine aggregate

Sl. No.	Test Conducted	Result
1	Fineness modulus	2.90
2	Zone of aggregates	II
3	Specific gravity	2.426
4	Bulk density(g/cc)	1.565

2.7 Coarse aggregate

Coarse aggregate is defined as aggregate that passes through a 20 mm IS sieve but is retained on a 4.75 mm IS sieve. Various coarse aggregate tests were carried out in accordance with IS 2386 (Part I) - 1963 and IS:383 – 1970. Details of the tests are given in Appendix C. The properties of coarse aggregate determined as given in Table 4.3. Tests conducted on coarse aggregate were grain sieve analysis, specific gravity and bulk density.

Table -4: Properties of coarse aggregate

Sl. No.	Test Conducted	Result
1	Specific gravity	2.89

2.8 Water

Water is required to wet the surface of aggregate to develop adhesive quality as the cement paste binds quickly and satisfactorily to the wet surface of the aggregates than dry surface. It is widely accepted that any portable water (pH-7) can be used in the production of concrete. It should have inorganic solid less than 1000 ppm and should be free from injurious quantities of alkalis, acids, oils, salts, sugars, organic materials, vegetable growth or other substance that may be deleterious to bricks, stones, concrete or steel.

3. MIX DESIGN

The flow ability and viscosity of cement paste can be controlled by proper proportioning of water/cement ratio and fineness of the cement.

The workability of ordinary concrete can be characterized by the following properties:

- Workability
- Compaction factor

The IS code method was adopted for mix design.

In designing the mix it is useful to consider the relative proportions of the key component by volume rather than by mass.

Table -5: Mix proportion

Material	Cement	Fine Aggregate	Coarse Aggregate	Water
Weight (kg/m^3)	427	600.06	1217.14	192
Mix Ratio	1:1.41:2.85			
W/C Ratio	0.45			

4. EXPERIMENTAL PROGRAM

4.1 Specimen Details

32 numbers of cubes and 24 numbers of cylinders each were casted for determining after 7 days and 28 days curing, compressive strength, split tensile strength and durability test. The cubes are of 150 mm x 150 mm x 150 mm size. The diameter of cylinder was 150 mm and height was 300 mm. 9 numbers of beams were casted for determining flexural strength. The beams are of 500 mm x 100 mm x 100 mm size.

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4.2 Curing of Specimens

After 24 hours from casting, the specimens were removed from the mould, check and confirm the identification marks for each type and immediately submerged in clean fresh water i.e, water cured for 28 days in a water tank. The water used for curing was similar with that used for casting. After 28 days, specimens were taken out and kept ready for testing. Fig. 6 shows the image of specimens immersed in curing tank.

Fig -6: Specimens immersed in curing tank

5. RESULTS AND DISCUSSIONS

5.1 Properties of fresh concrete

5.1.1 Workability

The workability of concrete is measured by slump test in accordance with IS 456 - 2000. Trials are carried out. The results show that as the SF and PPF in different proportions causes variation in workability.

Table -6: Workability of concrete mix

Mix	Control Mix	SF - 0.25 % & PPF - 0.75 % (Proportion no. 1)	SF - 0.50 % & PPF - 0.50 % (Proportion no. 2)	SF - 0.75 % & PPF - 0.25 % (Proportion no. 3)
Slump (mm)	72	72	71	69

5.2 Properties of hardened concrete

5.2.1 Compressive Strength , Split Tensile Strength and Flexural Strength

The average compressive strength, split tensile strength and flexural strength, after 28 days of curing, for different concretemix are shown in Table 7.

Table -7: Average strengths for concrete specimens

Mix	Compressive strength in MPa	Split tensile strength in MPa	Flexural strength in MPa
Control	39.41	2.93	4.3
SF - 0.25 % & PPF - 0.75 % (Proportion no. 1)	40.13	2.76	6.1
SF - 0.50 % & PPF - 0.50 % (Proportion no. 2)	40.33	2.97	10.1
SF - 0.75 % & PPF - 0.25 % (Proportion no. 3)	39.92	3.07	7.9

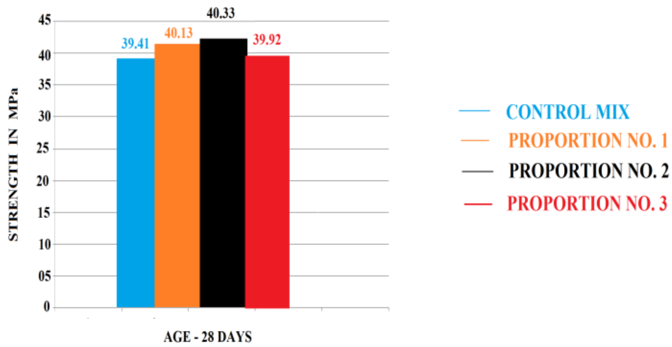

Fig -7: Variation in Compressive Strength with Different Percentage of SF and PPF

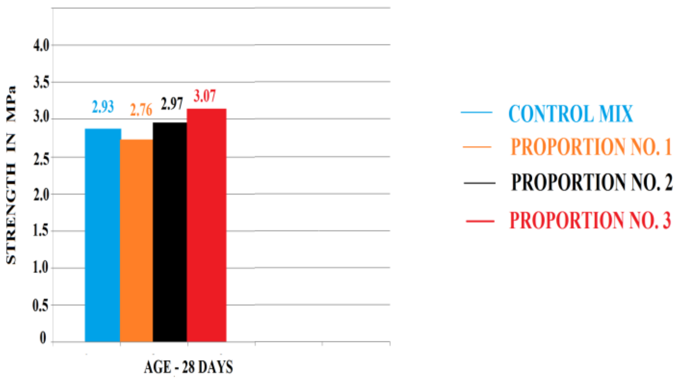

Fig -8: Variation in Split Tensile Strength with Different Percentage of SF and PPF

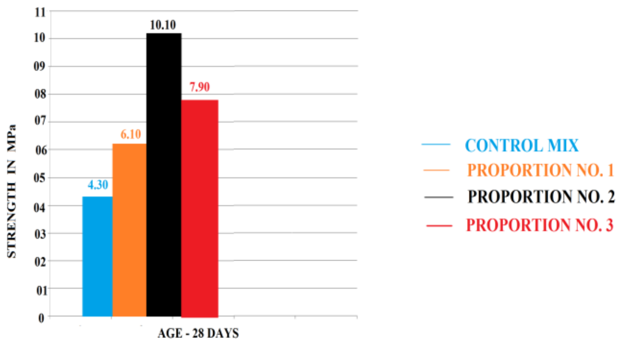

Fig -9: Variation in Flexural Strength with Different Percentage of SF and PPF

6. CONCLUSIONS

The main conclusions derived from this experimental

study may be summarized as follows:

1. As the percentage of Steel fiber (SF) increases or the percentage of Polypropylene fiber (PPF) decreases, it shows the lowering of workability. To improve the workability by increasing water / cement ratio or by the use of some polymer based water reducing admixtures .

2. The experimental results had shown that the compressive strength, split tensile strength and flexural strength of polydisperse (SF and PPF in different proportions) concrete increases in all proportions (except split tensile strength of proportion no. 1) than the control mix.

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