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INFLUENCE IN CONCRETE PROPERTIES BY UTILIZATION OF FIBERS

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ABSTRACT

In today Construction industries High performance concrete which allowing a reduction in the area of reinforcement needed in certain applications. Due to impose forces by external restraints concrete is significantly bleeds, plastic settlement, thermal and shrinkage strains and stress concentrations even distributed micro-cracks propagate, coalesce and align themselves to produce macro-cracks under an applied load. When loads are further increased, conditions of critical crack growth are attained at the tips of the macro-cracks and unstable and catastrophic failure is precipitated. Under fatigue loads, concrete cracks easily, and cracks create easy access routes for deleterious agents leading to early saturation, freeze-thaw damage, scaling, discoloration and steel corrosion. Evaluating the performance of concrete using different type of fibres is studied in the present paper. Moreover using varying percentage of fibbers which may lead to variation in strength of the concrete hence it has to be assessed. Practical preparation of concrete mixes (M50) for various fibers and also with varying % (0.25%, 0.50%, 0.75%, 1%) of fiber proportions w.r.t volume of concrete is done.

Keywords: Admixtures, Fibre, Polyproylene Fiber, Steel Fiber, Glass Fiber, High Performance Concrete, Permeability.

I. INTRODUCTION

Concrete is acknowledged to be a relatively brittle material when subjected to normal stresses and impact loads, where tensile strength is only approximately one tenth of its compressive strength. As a result for these characteristics, concrete member could not support such loads and stresses that usually take place, majority on concrete beams and slabs. Where good quality concrete cannot be achieved, FRP reinforcement represents valid many possible applications in structures in or near marine environments, in chemical and other industrial plants. Fibre reinforcement concrete is increasingly used on account of the advantages of increased static and dynamic tensile strength, energy absorbing characteristic and better fatigue strength. The uniform dispersion of Fibre throughout the concrete provides isotropic properties not common the conventionally reinforced concrete.

The introduction of fibres was brought in as a solution to develop concrete in view of enhancing its flexural and tensile strength, which are a new form of binder that could combine Portland cement in the bonding with cement matrices. Fibres are most generally discontinuous, randomly distributed throughout the cements matrices.

II. LITERATURE REVIEW

Trottieretet al. (1994) investigated the toughness of fibre reinforced concrete by using different geometry of steel fibres, which include hooked end, crimped circular, crimped crescent and twin cone end steel fibres. One fibre volume fraction (40kg/m^3) was used throughout the research. The test included compressive strength test and flexural strength test, with measurement of deformation of specimen as the load applied. They found out that fibres brought significant improvement in the toughness and energy absorption capacity of concrete. Based on four fibre geometries, fibres with deformations only at end appear more effective than those with deformations over the entire length.

Trottieret. al (1994), by determining the first crack and flexural toughness of steel fibre reinforced with different dimensions. The research used hooked end steel fibre with 30mm long and 0.5mm in diameter. Four groups of dimension were used. First group in width:depth:span ratio of 1:1:3 as the spans beams in 150, 225, 300 and 450mm. The second group used same cross-sectional area (75 x 75mm) with four different spans length of 150, 225, 300 and 450mm. The third group maintained the same width (75mm) and spans (300mm), while the depths are 75, 100 and 150mm. The last group keeps the same depth (100mm) and span (300mm) with five different widths (25, 50, 75, 100 and 150mm). They investigated that all toughness parameter were affected by the width of the beam, even the depth and span were unchanged. Furthermore, the specimen size not only influenced toughness, but also stress and deflection at first crack and ultimate flexural strength.

Wang et al. (2000) applied recycled fibres as reinforcement in concrete. The recycled fibres included tire cords/wires, carpet fibres, feather fibres, steel shavings, wood fibres from paper waste and high-density polyethylene. The research conducted was based on shrinkage, durability and toughness characteristics test. The results of each test showed that recycled fibre effective improving the toughness, shrinkage and durability characteristics of concrete. Wang et. al (2000) recommended and encouraged the use of low cost waste fibre for reinforcement could lead to improved infrastructure with better durability and reliability, as these applications are reduced the solid waste from industrials and consumers.

DragicaJevtić, DimitrijeZakić and AleksandarSavić (2008) The addition of steel fibers in the amount of 60 kg/m3 (0.45% of volume), combined with admixture type superplasticizer, gave higher strength, both flexural and compressive, at all ages. Due to high mechanical strenghtsand presence of silica fume, these composites can be successfully used, both in new constrcution and in repairs and of already existing structures.

Kumar and Srikanth (2008)There was no considerable change in compressive strength with optimum fiber addition but addition of fiber is effective in split tensile and flexural strength, with Glass fiber giving higher strength than Polypropylene fibers. The post peak strains are more for polypropylene based specimens as compared to Glass fiber based specimens, but they carried lower flexural strength.

Zhu and Chung (1997) Carbon fibers decreased the drying shrinkage of mortar. The drying shrinkage from 2 to 24 h is important, though it is usually neglected. Due to the drying shrinkage reduction, brick/brick joint strength was increased by adding carbon fibers to the mortar. The highest joint strength was attained at a fiber content of 0.5% by weight of cement.

III. EXPERIEMENTAL STUDY

The materials used in this research and their sources are summarized.

1. Cement: PPC . Conforming IS 1489 Part 1 (1991)
2. Sand: fine aggregate conforming to zone II of IS 383 -1970
3. Aggregate: coarse aggregate of maximum size 20mm and 10mm.
4. Fibres: Carbon, Steel, Glass and Polypropylene
5. Admixture used: BASF Glenium

Details of Materials & their sources shown in Table 2

Following testing conducted on Concrete

a) Workability – Slump cone
b) Compressive Strength
c) Flexural Strength
d) Split tensile strength
e) Water permeability

Mix design parameters : Mix design for M 50 grade concrete

Proposed Mix Proportions : shown in Table 1 (all weights in kg/cum)

Table 1: Mix Proportions Kg/cum

Concrete Mix				
A/C	3.5	CC =	Density	
W/C	0.35		(1+W/C+A/C)	
FA	40%	CC	2475	
CAI	32%		(1+0.35+3.7)	
CAII	28%	CC =	2475/(1+0.35+3.5)=	
concrete batch	**0.09**	cum	510.31	kg/cum

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CC : Cementitious Content

Table 2: Concrete Materials details

	Wt in Kg				
Mate rial	**kg Per m3**	**Fiber %**			
		0.25	**0.50**	**0.75**	**1**
Cement	510.3	45.93	45.93	45.93	45.93
water	178.6	16.07	16.07	16.07	16.07
FA	714.4	64.30	64.30	64.30	64.30
CAI	571.6	51.44	51.44	51.44	51.44
CAII	500.1	45.01	45.01	45.01	45.01
Carbon		0.07	0.14	0.20	0.27
Glass		0.20	0.41	0.61	0.81
Polypr opylene		0.59	1.17	1.76	2.34
Steel		1.76	3.51	5.27	7.02

IV. RESULTS AND DISCUSSION

Mix Proportions: The mix proportions were made for a control mix of final slump (10min) 100 ± 10 mm for M60 grade of concrete for w/c ratio of 0.25 by using IS-10262-2009 method of mix design.

Test Set-up: The 6 in.(150 mm) cubes with a set of 3 cubes, each were cast for compressive strength .and split strength at 1, 3, 7, 28, days time. Beam moulds of size 6in x 6in x 27.56in i.e. (150x150x700mm) for flexure strength and 6 in.(150 mm) cubes for water permeability test for 28 days time respectively. After the cast, all the test specimens were put into the water tank for curing maintaining temperature of 89.6±35 oF (27±2 ºC) as per IS requirements. The concrete was tested for slump cone test as per the IS-1199 –Methods of sampling and analysis of concrete, for each mix of concrete.

Test results of workability compared with different fiber mix shown in Figure 1

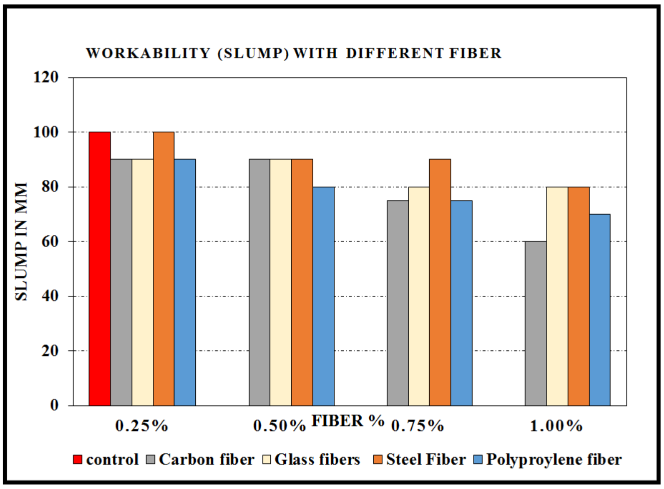

Figure 1: Comparison of Workability in mm

Test results of 1D Compressive strength compared with different fiber mix shown in Figure 2

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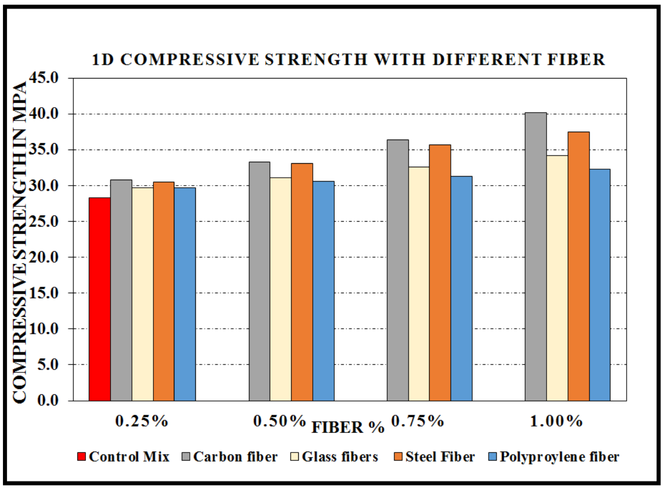

Figure 2: Comparison of 1D Compressive Strength (MPa)

Test results of 28D Compressive strength compared with different fiber mix shown in Figure 3

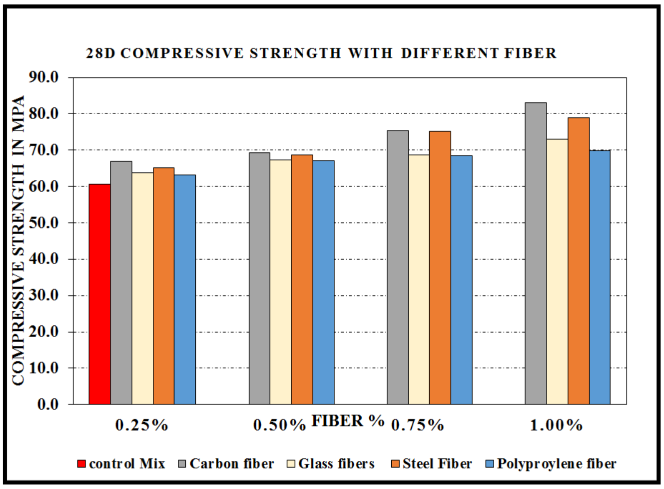

Figure 3: Comparison of 28D Compressive Strength (MPa)

Test results of 28D Flexural strength compared with different fiber mix shown in Figure 4

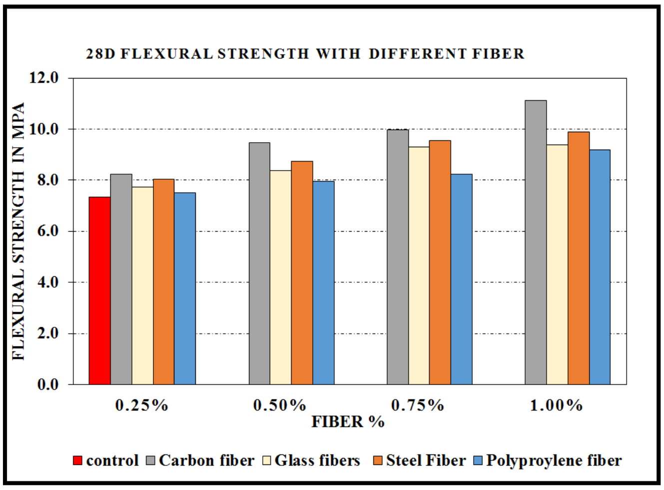

Figure 4: Comparison of 28D Flexural Strength (MPa)

Test results of 28D Split tensile strength compared with different fiber mix shown in Figure 5

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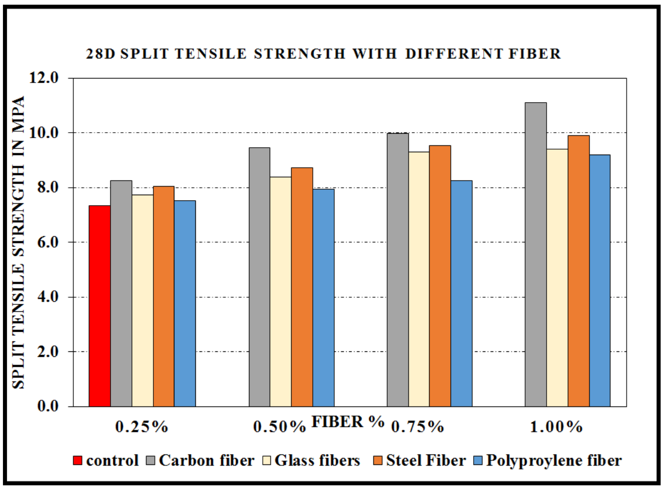

Figure 5: Comparison of 28D Split tensile Strength (MPa)

Test results of 28D Water Permeability test compared with different fiber mix shown in Figure 6

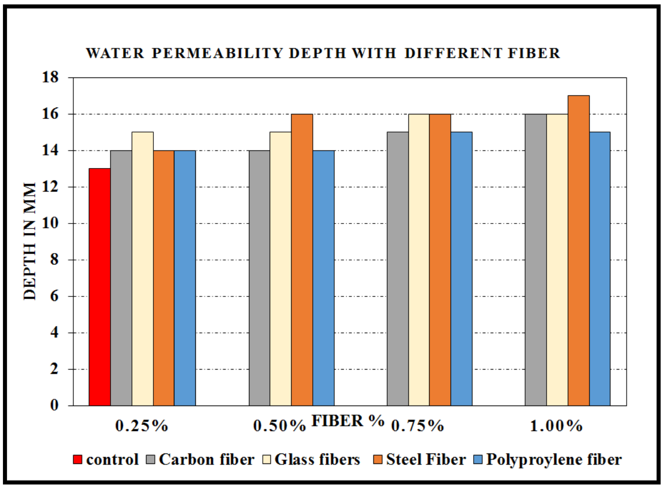

Figure 6: Comparison of Water Permeability test (MPa)

V. CONCLUSION

The primary conclusion expected from this research was to determine if all the mixes researched into, fell into the category of High Performance concrete and thus was either Very early strength (VES), High early strength (HES) or not an Early strength mix. It was finally expected to recommend which mixes based on the strength and durability requirements of High strength concrete were the best.

Based on the results of this investigation, the following conclusions can be drawn.

1) Workability with respect to control mix reduces with the use of increase in fiber dosage. Use of steel fiber show less reduction compared when with other fiber.
2) Durability test of carbon fiber with 1% dosage shows better results compared to other fibers.
3) It is observed that the rate of increase is higher when the volume dosage rate exceeds 0.25%.Maximum compressive strength of 83.1 MPa is observed when carbon fibre volume of 1.00% which indicates an increase of 22.6% MPa (Carbon fiber), 18.4 MPa (Steel fiber), 12.4 MPa (Glass fiber), 9.3MPa (polypropylene)
4) There is an increase of about 8-10% (carbon fiber), 7-8% (Steel fiber), 4-5% (Glass fiber), 3-4% (polypropylene fiber) in compressive strength at 0.25% fibre volume dosage as compared to control mix between 1D & 28D sterngth.
5) Compressive strength at 0.5% fibre volume dosage as compared to control mix between 1D & 28D strength has increase about 14-17% (carbon fiber), 12-16% (Steel fiber), 9-11% (Glass fiber), 8-11% (polypropylene fiber).

6) Percentage growth in between 1D & 28D strength Compressive strength at 0.75% fibre volume dosage as compared to control mix was observed to be 24-28% (carbon fiber), 19-26% (Steel fiber), 13-20% (Glass fiber), 10-13% (polypropylene fiber).
7) The percentage compressive strength gained with respect to the compressive strength gained by control mix at 1 & 28 days .
8) Percentage growth in Flexural strength at 1% fibre volume dosage as compared to control mix was observed to be 51-56% (carbon fiber), 34-39% (Steel fiber), 28-31% (Glass fiber), 24-26% (polypropylene fiber).
9) Percentage growth in 28 days split tensile strength at 1% fibre volume dosage as compared to control mix was observed to be 49% (carbon fiber), 41% (Steel fiber), 30% (Glass fiber), 19% (polypropylene fiber).
10) The use of sustainable materials such as Carbon fibres, has proved beneficial in imparting additional strength to the concrete.
11) The indirect tensile test results have an increasing trend of average tensile strength for fibre reinforced concrete when the fibre volume dosage rate increased. This increase in tensile strength was due to the nature of binding of fibre available in concrete. When the reinforced concrete was force to split apart in the tensile strength test, the load was transferred into the fibres as pull-out behaviour when the concrete matrix began to crack where it exceeded the pre-crack state. The control batch specimens containing no fibres failed suddenly once the concrete cracked, while the fibre reinforced concrete specimens were still intact together.
12) This shows that the fibre reinforced concrete has the ability to absorb energy in the post-cracking state.

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