POLYMER MODIFIED CONCRETE (STEEL FIBRE REINFORCED)

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1. INTRODUCTION

Concrete is produced by incorporating an inorganic material, designated as cement, with water along with some natural sand and stone dust along with natural stones (either crushed or uncrushed). Cement when added with water, it reacts forming artificial stone like structure or a solid hardened mass and that what gives us the cementing property as far as concrete concerned. Since cement is costliest of all the materials constituting concrete, therefore we should restrict its use in concrete beside there are some other associated problem of shrinkage, etc. Bulk of the material in concrete system is formed by the aggregates and cement or other cementing materials of this kind are used as binder materials to bind this skeleton structure.

POLYMER IMBUED CONCRETE

Polymer modified concretes are of three types as stipulated and detailed below:

i) Polymer Concrete (PC)
ii) Polymer Portland cement concrete or polymer modified concrete (PMC)
iii) Polymer Impregnated concrete (PIC)

1. Polymer concrete (PC) – In this type of polymer modified concrete, the conventional Portland cement is completely replaced by polymer to serve as binder in mix.
2. Polymer impregnated concrete (PIC) – This type of concrete is a sort of pre-cast concrete. Monomers, generally having low viscosity, are used to polymerize evenly dried cement. It can also be casted in-situ, by impregnating network of polymer in conventional concrete.
3. Polymer modified concrete or polymer portland cement concrete (PMC or PPCC) In this type of concrete, partial replacement of cement is done by man-made organic polymer. Portland cement is mixed with monomer, discrete-polymer or pre-polymers.

2. SCOPE OF RESEARCH WORK

Present research undertook the exploration of important characteristics of modified concrete by various experimentations. The inferences of experimentations of modified concrete are then compared with those of conventional concrete.

Primarily, an optimum mix of PMC which having the maximum strength is determined and the ratio of polymer and other ingredients of concrete are established.

Secondly, workability and other features of PM-HSC are tested to validate the proportion of polymer for modification of concrete.

3. LITERATURE REVIEW

In this section some of previous work done by researchers on Some of key property of polymer modified steel fiber concrete is reported.

Dr. S. Suriya et al (2015). A series of specimens were chosen for the investigation and all of them were having unique nominal sectional dimensions such as cubes had 150mm edge, prismatic specimen l=100mm, b=100mm and h=500mm and cylindrical specimens with d=150mm, h= 300mm.

Vasudev R and Dr. B G Vishnuram (2013) investigated experimentally the structural strength of fibre-reinforced concrete. Their main focus was on the tensile and compressive strength of composite matrix. Fibers were added in conventional concrete in percentage ranges: 0%, 0.25%, 0.5%, 0.75% and 1%.

Dr. D.L Venkatesh Babu et al (2014) concluded in their investigation that concrete faces many challenges when used as a construction material; it is subjected to many stresses like reverted cycles of load causing fatigue and impact loading, leading to cracks. There are critical issues coming out of plain concrete.

Z.A. Siddhiqi et.al. (2013) in their research stated the effects of the addition of polymer SBR latex to concrete in terms of compressive strength and water absorption. It is also thought that SBR latex improves the internal structure of latex-converted concrete leading to a significant reduction in the absorption rate of water in 28 days.

V. M. Sautaraja et al (2013) present a study to research the properties of concrete which will be further improved by addition of SBR polymer along with steel fiber. This paper states that gain in strength thanks to combined addition of steel fiber and polymer SBR latex in normal concrete results in increase strength, durability, toughness, resistance to cracking and crack propagation.

R. Radhakrishnan (2012) this study described the use of polymer to repair existing concrete structures to repair existing concrete structures. In order to repair the structures that improve the service life, the methods and equipment available, but the success rate of any concrete repair depends largely on the correct choice and method of use of the repair material.

4. EXPERIMENTATIONS

4.1 Materials used

4.1.1 Cement

Ordinary Portland cement of 53 grade Ambuja cement was used for the experimental investigation which conformed to IS: 12269-1987. The cement was tested according to IS: 4031-1988. The properties of cement are shown in table 3.1.

Figure 4.1 OPC -53 cement

Table 4.1: Properties of OPC-53 cement grade

Properties	Value	As per IS 12669-1987
Specific gravity	3.15	3.15
Normal consistency	29%	-
Initial setting time (min.)	115	>30
Final setting time (min.)	165	<600
Fineness (%)	2	<10
Soundness (mm)	2	<10

4.1.2 Fine aggregates

Locally available sand was used in the present experimental investigation. It was sieved through 4.75 mm sieve. The sieve analysis and various properties conform to IS: 383-1970 as given in table 3.2 and 3.3, respectively.

Weight taken = 1 kg.

Table 4.2: Sieve analysis of fine aggregates.

Sieve size (mm)	Retained weight (g)	% weight Retained	Cumulative %weight Retained	Cumulative % passing
10	0	0	0	100
4.75	125	12.5	12.5	88.5
2.36	180	18.0	30.5	69.5
1.18	203	20.3	50.8	49.2
600µ	80	8.0	58.8	41.2
300 µ	201	20.1	78.9	21.1
150 µ	151	15.1	94.0	6.0
Total	940	94	325.5	

Fineness modulus of fine aggregates = **3.25.**

Table 4.3: Physical properties of fine aggregates

Physical tests	Values
Specific gravity	2.63
Fineness modulus	3.25
Water Absorption (%)	1.7
Compacted bulk density (kg/m^3)	1982
Loose bulk density (kg/m^3)	1668

4.1.3 Coarse aggregates

Locally available 10-14 mm coarse aggregates were used in this study conforming to IS: 383-1970, with sieve analysis and physical properties as given in table 3.4 and 3.5, respectively.

Weight taken = 2 kg.

Table 4.4: Sieve analysis of Coarse aggregates

Sieve size (mm)	Retained weight (g)	% weight Retained	Cumulative %weight Retained	Cumulative % passing
20	0	0	0	100
16	0	0	0	100
12.5	20	1	1	99.0
10	236	11.8	12.8	87.2
4.75	1456	72.8	85.6	14.4
2.36	269	13.45	99.05	0.95
Total	1981	99.05	198.45	

Fineness modulus of coarse aggregates = 5.98.

4.4.2.1 Slump Test

Slump test is used in current investigation for workability determination of green concrete (Ref- IS: 1199 – 1959).

Figure 4.3: SLUMP CONE

Slump cone test is simple and popular test extensively used at site to access the workability of the green concrete. The test should be conducted on the commencement of the concreting operations or whenever the workability of concrete changes. The apparatus for slump cone test essentially consists: Metallic mould in the form of a frustum of a cone with a base plate. A steel tamping rod of 16 mm diameter and 60 cm height is to be used for compacting.

4.1.4 Vee-Bee Test

This test is used to determine the mobility and compatibility of green concrete and carried in pursuance of IS: 1199 – 1959

4.2 Properties of Hardened concrete

4.2.1 Compressive strength

It is most important property of hardened concrete as the other strengths as: bond; flexure and resistance to abrasion increases with increase in Compressive strength. Test for this property is performed on compression testing machine at constant loading rate of 5250 N/s as per IS: 516-1959.

4.2.2 Curing:

The moulds were removed subsequently on completion of 24 hours and the samples were kept submerged in a water bath. After curing the specimens in water for a period of 28 days the specimens were removed out and allowed to dry under shade.

4.2.3 Water absorption

Two cubes of size 150×150×150 mm for each mix were casted to determine water absorption values. The water absorption values were taken at an age of 28 days. The cube specimens were taken out from curing tank and surface dried. The weight of surface dried cube specimen was taken on digital weighing machine and kept in oven for 24 hours at 1050 C as shown in fig. After taking out of oven, the dry weight of specimens was noted. The ratio of difference between weight of saturated surface dried specimen and oven dried specimen, to weight of oven dried specimen gave water absorption values as shown below.

Water absorption (%) = [(A-B)/B] × 100.

Where, A is weight of saturated surface dried specimen and B is weight of oven dried specimen.

5. RESULT AND ANALYSIS

The entrained air affects workability. The value of entrained air if optimum it will improve workability and generate resistance in the matrix against freeze and thaw cycles thus improvises strength also. But excess air can harm the mix, polymers, can entrain excessive air, if impregnated in concrete mix. Thus to reduce the probability of reduction of strength of concrete due to excess air bubbles, anti-foamers are introduced to varying percentages. The content of anti-foamer found to give the best results in workability test was 0.45%.

Table 5.1 Effect of antifoamer on workability of PMC

Silicone emulsion/latex ratio (%)	PMC15	Appearance	Slump (mm)	Air content (%)
0	PMC15	Flow able	195	5.5
0.45	PMC15	Flow able	205	3.3
0.70	PMC15	Flow able	200	3.2
1.50	PMC15	Medium	155	2.6
2.00	PMC15	Arid and rough	120	1.8

Workability of PMC

The workability of high strength PMC is much more improvised than that of conventional matrix. Improvement can be seen in terms of surface texture/appearance, viscosity and slump value. A graph is plotted to stipulate the impact of polymer dosage on the workability value. Workability was determined corresponding to various polymer dosage and jotted down and plotted as the curve of Fig shows. All the incorporation of varying polymer dosage is studied on a constant W/C value

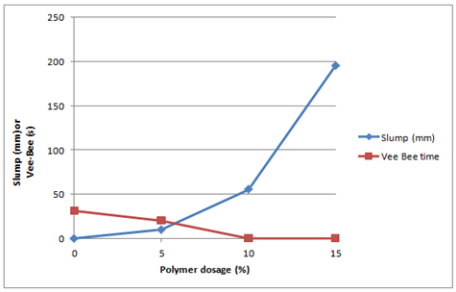

Figure 5.1 : Effects of Polymer dosage on workability of PMC

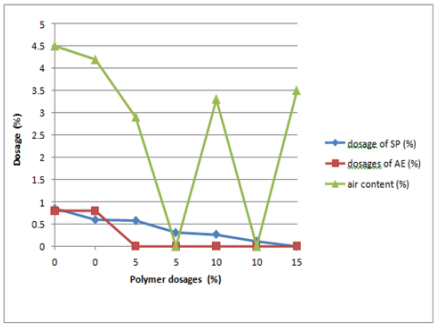

Figure 5.2: Effect of Super-plasticizer on PMC for different polymer dosages

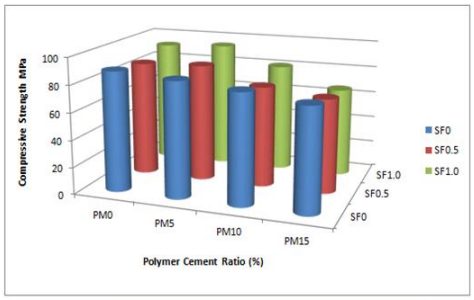

Figure 5.3: Compressive strength of PM-SFRC

6. CONCLUSIONS AND RECOMMENDATIONS

Various conclusions are drawn in this chapter on the basis of results and analysis done in the previous chapter. Scope for future study has been included in this chapter. The aims of this research were to study mechanical properties of four type of concrete namely plain concrete(HSC), polymer modified concrete (PMC), steel fiber reinforced concrete (SFRC) and latex modified steel fiber reinforced concrete (PM-SFRC) has been determined on the basis of various test namely compressive test, flexural test, and workability tests results carried out in laboratory. The prime objective of current work is to explore this important modification (PM-SFRC) of conventional concrete in developing a high strength concrete matrix in term of toughness and durability also. Based on experimental investigation following conclusions may be drawn:

Future Prospect

The current investigation is limited to modification of conventional concrete as PM-SFRC. There are many more aspects which must be unfolded in this regard and other concerned areas to strengthen the construction materials. Following are mere suggestions of future prospect in this regard, but there are many more pages to unfurl:

- Other fiber type like polypropylene nylon (PPN), glass fiber, and plastic fiber can be used in the place of steel fiber.
- As the current work investigated only HSC, the strength of steel fiber and polymer concrete for LSC may be investigated and improvised.
- There are several tests which can be conducted on PM-SFRC such as hardness test, split tensile strength for further study.
- Properties like setting time, consistency, durability, etc are also important from a civil engineer point of view; these may be studied in the further studies.
- Cement content may be further reduced by adding third modifier other than steel fiber and polymer.

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