EXPERIMENTAL INVESTIGATION ON STRENGTH PROPERTIES OF POLYMER MODIFIED CONCRETE

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Abstract

The polymer modification for cement mortar and concrete is already existing one, since considerable research and improvement of polymer modification have been done for the past 7 decades or more. As a result, various polymer-based admixtures have been developed, and polymer-modified mortar and concrete using them are currently popular construction materials due to their good strength performance and cost effectiveness. This project summarizes the classification of polymer-based admixtures, the principles of polymer modification by the use of polymer latexes, redispersible polymer powders, water-soluble polymers and liquid polymers, the properties and applications of polymer- modified mortar and concrete, recent research and development of workability and strength aspects.

Keywords: **Polymer-based materials and concrete, polymer-cement ratio, properties, applications, research and development, standards, specifications, guides**.

I. Introduction

Cement concrete has been one of the important materials of construction, in spite of its many drawbacks, the newly developed "Polymer Concrete" possessing many superior properties over conventional cement concrete, renders itself as one of the most versatile construction materials. Polymer concrete in particular, is highly suitable in case of pre-fabricated building industry, irrigation structures, marine structures nuclear power production and desalination plants.

The cement mortar and concrete which are made by mixing with the polymer-based admixtures are called polymer-modified mortar (PMM) and concrete (PMC), respectively. In general, the properties of polymer-modified mortar and concrete depend significantly on the polymer content or polymer-cement ratio (defined as the mass ratio of the amount of polymer solids in a polymer-based admixture to the amount of cement in a polymer-modified mortar or concrete) rather than the water-cement ratio compared with ordinary cement mortar and concrete.

1.1 OBJECTIVE

1. To improve the adhesion or bond strength in the concrete.
2. To decrease the pores in the concrete, compare to the conventional concrete.
3. To increase the strength and durability of the concrete.
4. To improve the mechanical properties of repaired concrete.
5. To improve the corrosion resistance to the concrete.

1.2 SCOPE

1. To arrive the mix design of the polymer modified concrete with SBR as a admixture
2. To study the behavior of polymer cement concrete in the hardened state. The variables studied include the grade of concrete and dosage of polymer.
3. To study the various mechanical properties like compressive strength, splitting tensile strength, flexural strength, stress–strain characteristics, and modulus of elasticity and permeability characteristics of concrete
4. To cast the polymer modified concrete.
5. To compare the result between the conventional concrete and polymer modified concrete.

1.3STYRENE BUTADIENE RUBBER POLYMER (SBR)

Styrene butadiene rubber (SBR) is used as polymer modifier in this study. SBR Polymer is the most widely used in concrete. Styrene butadiene, an elastomeric polymer, is the copolymerized product of two monomers, styrene and butadiene. Latex is typically included in concrete in the form of a colloidal suspension polymer in water.

This polymer is usually a milky-white fluid. It has high elasticity, good adhesion, water proofing and high chemical resistance. Co-polymers of Butadiene with Styrene is (Styrene-Butadiene rubber (SBR), are a group of large-volume synthetic rubbers. High adhesion occurs between the polymer films that form and cement hydrates.

Property	Values
Normal consistency (%)	32
Specific gravity	3.15
Initial setting time (min)	30
Final setting time (min)	600
Fineness of cement %	6

Property	Values
Specific gravity	2.62
Fineness modulus	2.70
Grading	Conforming to Zone II
Water absorption (%)	1.64
Bulking of sand(%)	4

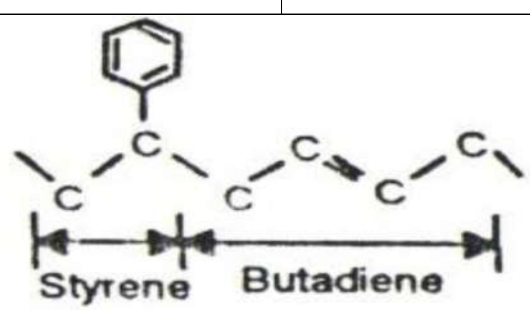

Fig no 1.1 Chemical structures of SBR polymer latexes

Properties	Description
Appearance	White emulsion
Specific Gravity	1.03 ± 0.02@ 25°c
Freeze/Thaw Resistance	Excellent
Chloride Content	Nil
Flammability	Non-flammable
Compatibility	Can be used with all types of Portland cement

Table 1.1 Properties of Styrene Butadiene Rubber (SBR) polymer.

II.EXPERIMENTAL PROGRAME

2.1 Materials

Cement: Ordinary Portland Cement (53 Grade) conforming to IS 12269-1987 was used the properties of cement are given in Table 2.1 Properties of cement.

2.2 Fine and Corse Aggregates: Fine and coarse aggregate conforming to IS 383 – 1970 were used and their properties are

Table 2.2 Properties of Fine Aggregate.

Property	Value
Specific gravity	2.65
Fineness modulus	7.13
Water absorption (%)	20
Impact value (%)	18
Crushing value (%)	20

Table 2.3 Properties of Coarse Aggregate.

2.3 MIX PROPORTION

Cement	W/c	Water	Sand	Aggregate
531.42	0.35	186	803.52	1421.01
1		0.35	1.512	2.674

Table 2.4: Mix proportion

Cement: Sand: Coarse aggregate = 1:1.5:2.6.

III. Results and Discussion

3.1 Compression Strength Result

The150 x 150 x 150 mm cubes were tested at the age of 7and 28 days after curing using Compression Testing Machine (CTM). The ultimate load divided by the cross-sectional area of the specimen is equal to the cube compressive strength.

S. No	Percentage of Polymer	Average compression strength in 28 days (N/mm^2)	Percentage increases in strength
1	0	25.33	
2	5	31.33	19.15
3	10	32.44	21.91
4	15	27.22	6.94

Table 3.1 Compressive Strength of PMC

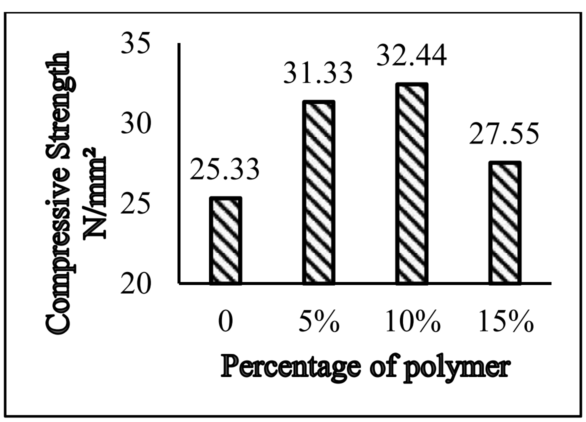

Fig 3.1 Variation of compressive strength in PMC.

3.2 SPLIT TENSILE STRENGTH RESULT

This test is used to determine the tensile strength of concrete. Split tensile strength test was carried out on cylindrical specimens of size 150 mm Dia (D) and 300 mm Long (L) at the age of 7 and 28days after curing using CTM. The split tensile strength of concrete was found using (2P/πLD) where, P is the maximum .load on the cylinder.

S.No.	Percentage of Polymer	Average split tensile strength in 28 days (N/mm^2)	Percentage increases in strength
1	0	2.40	
2	5	3.81`	37
3	10	3.96	39.39
4	15	2.54	5.51

Table 3.2Split Tensile Strength of PMC

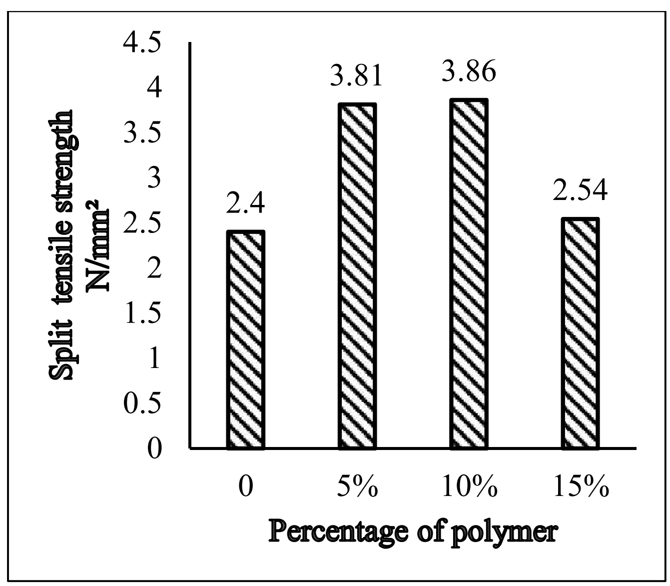

Fig 3.2 Variation of Split tensile strength in PMC

3.3 FLEXURAL STRENGTH RESULT

The flexural strength at 28 days of M20 grade of concrete increased as the percentage of polymer increases. Table 3.3 shows the flexural strength of PMC.There is an increase in flexural strength of M20 concrete by 10.34, 12.5 and 10.2% for 5, 10 and 15% polymer addition respectively compared to plain concrete without polymer.

S.No.	Percentage of Polymer	Average flexural strength in 28 days (N/mm^2)	Percentage increases in strength
1	0	3.9	
2	5	4.35	10.34
3	10	4.46	12.5
4	15	3.56	10.2

Table 3.3 Flexural Strength of PMC

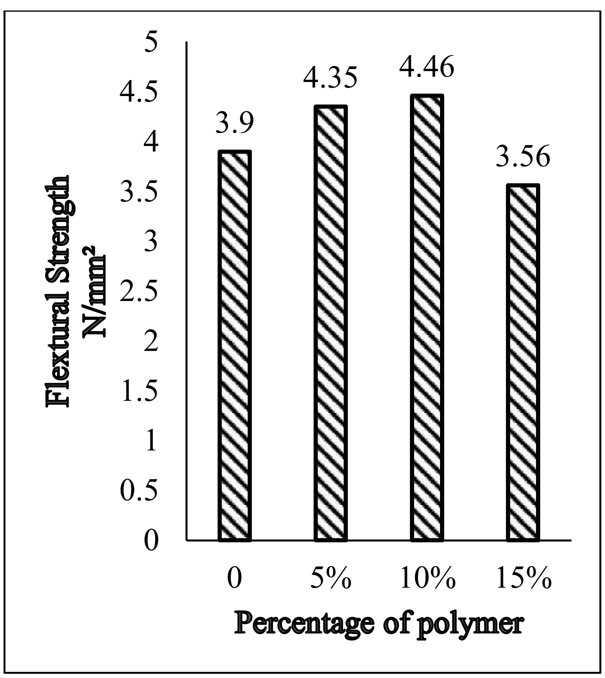

Fig 3.3 Variation of flexural strength in PMC

3.4LOAD DEFLECTION CHARACTERISTICS OF BEAMS

Totally four RC beams were casted .First one was control mix beam, Second one was Polymer modified beam concrete. Beams of size 100mm x 150mm x 1800mm were casted.

The PMRC beam with five percent in volume of the cement, showed an average increase of 19.7 % in ultimate load (Pu) when compared to RC beams.

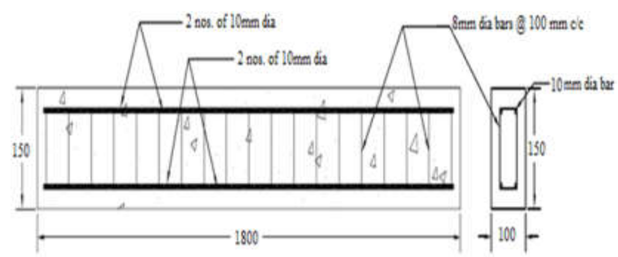

Fig 3.4,5 Beam Specification & Testing.

The average cube strength of control specimens were used to determine the ultimate load of these beams and the theoretical load were compared with average ultimate load of RC beams tested two point loading.

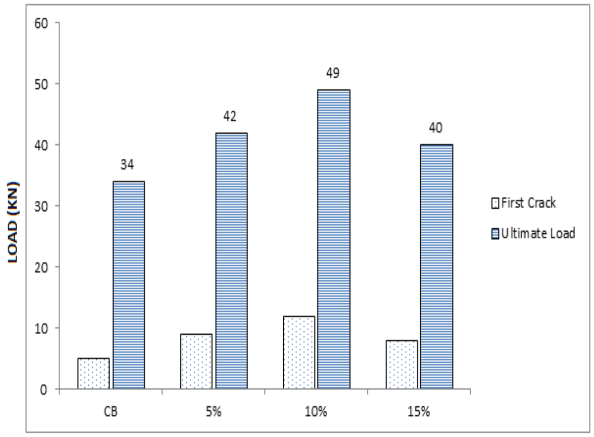

Fig 3.4 Variation between First crack load & Ultimate load.

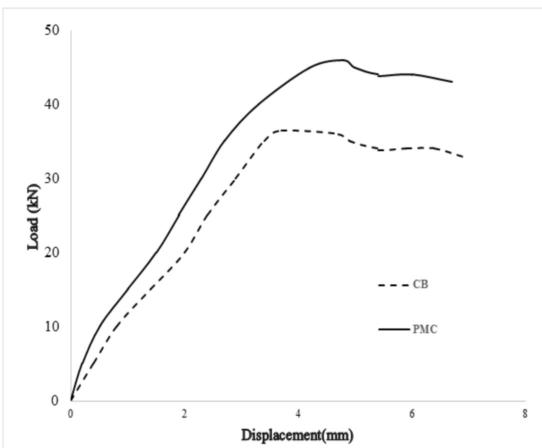

Fig 3.5 Load deflection curve for CB & PMC

IV. Conclusion

- It required 2 to 5 days of full water curing required remaining days are done through moisture curing is enough.
- The performance of all the PMC Reinforced concrete beams is better than the conventional RC beam. The addition of Polymer makes the conventional concrete a more ductile material and improves the post-crack behavior of concrete specimens.
- Percentage of polymer is added 5,10,15% to determined strength of concrete.
- When compare above results 10% of Polymer Modified Concrete gives more strength than 15%.

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