BEHAVIOUR OF POLYMER MODIFIED FIBER RIENFORCED CONCRETE WITH HIGH VOLUME FIBRE FRACTION

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ABSTRACT

The present work aims to study 1)To study the stress strain behavior of polymer modified fiber reinforced concrete under bond, flexure, compression, single shear and double shear, states of stress 2)Calculation toughness indices, shear transfer law. 3)Calculation of elastic constants and dynamic modulus of PMFRC 4)Mathematical modelling of various strengths in terms of volume fraction V_{faw} and compression f_{cu}.5)Matrial modelling. Crimped Shaped steel fiber and SBR polymer were used in this investigation. Fiber content varies from 1% to 10% by weight of cement considering polymer percentage constant as 10% by weight of cement .polymer in the form of emulsified styrene butadiene rubber latex was used. The M-40 grade of concrete is used to investigation. 36 Cubes of Size 150mmX150mmX150mm for compressive and bond strengths test, 36 beams of size 150mmX150mmX700mm for flexural strength test will be cast,36 push off specimens of size 150mmx150mmx450mm were cast for single shear test. and double shear test will conduct on one of the parts of broken piece of beam under flexure. All specimens incorporating 1% to 10% crimped shaped steel fibersat an interval of 1% by weight of cement. Also 10% of latex polymers styrene butadiene rubber will be added. All specimens were air cured up to 90 days to form proper bond between polymer layer and concrete ingredients. All the beam specimens for flexural strength were test under two point loading up to failure, and all push off specimens were test by direct shear. workability of wet mix was found to be increased due to polymer initially and found to be reduce with increases in fiber content.

Keywords: polymer (SBR latex), aspect ratio of fiber, volume fraction of fibers, PMFRC workability, strength of concrete, toughness, toughness indices, elastic constants.

I.INTRODUCTION

Concrete the most widely used construction material has several desirable properties like high compressive strength, stiffness, durability under usual environmental factors. At the same time concrete is brittle and weak in tension plain concrete has two deficiencies, low tensile strength and a low strain at fracture .These shortcomings are generally overcome by reinforcing concrete. Normally reinforcement consists of continuous deformed steel bars or pre-stressing tendons. The advantage of reinforcing and pre-stressing technology utilizing steel reinforcement as high tensile steel wires have helped in overcoming the incapacity of concrete in tension but not the ductility magnitude of compressive strength. Many of the current applications of fiber reinforced concrete involve the use of fibers ranging around 1.0-10 percent by volume of concrete. Recent attempts made it possible to incorporate relatively large volumes of steel or synthetic fibers in concrete for substantial enhancement of the tensile load carrying capacity of the matrix.

1 Steel fiber reinforced concretes are structural materials that are gaining importance quite rapidly due to the increasing demand of superior structural properties. These composites exhibit attractive tensile and compressive strengths, low drying shrinkage, high toughness, high energy absorption and durability. This is due to the tendency of propagating micro-cracks in cementitious matrices to be arrested or deflected by fibers, which is guaranteed by the local bond between fibers and matrix. Thus fiber reinforced concrete has superior resistance to cracks and crack propagation. The net result of all these is to impart to the fiber composite pronounced post-cracking ductility which is unheard of in ordinary concrete. These properties of steel fiber reinforced concrete can be enhanced by the addition of a suitable polymer into it.

2 Polymer cement concretes have high tensile strength, good ductile behavior and high impact resistance capability due to the formation of a three dimensional polymer network through the hardened cementitious matrices. Because of the void-filling effect of this network and its bridging across cracks, the porosity decreases and pore radius are refined. In the present experimental investigation latex polymers in form of styrene butadiene rubber emulsion is incorporated to improve the ductile behavior and flexural strength of steel fiber reinforced cement concretes (SFC).

3 Polymer-modified concrete (PMC), or polymer Portland cement concrete (PPCC), is normal Portland cement concrete with a polymer admixture. The polymer and the cement hydration products comingle and create two interpenetrating matrices, which work together, resulting in an improvement in the material properties of PPCC alone. PMC is the term for such concrete with lower dosages of polymers, typically 5% or less, and PPCC generally is the term for composites with more than 5% polymer by weight of concrete.

4 Polymer modification affects the workability of fresh PMC. The dispersed polymer particles act as "ball bearings" to ease the relative movement of cement and hydration particles. Also, the polymers themselves in the latexes to reduce segregation of the suspension, act like water reducing admixtures and significantly increase slump and reduce water demand. Due to the improved particle packing, air entrainment, and enhanced cement particle dispersion of PMC, there is less bleeding and segregation, and a more homogeneous microstructure. This contributes to higher strength and lower permeability of the concrete. The water-retention properties of fresh .PMC, due to the hydrophobic and colloidal properties of the latexes, reduce the need for long wet-curing of PMC. Adhesion of PMC to substrates is much better than that of normal concrete, because of the bonding of the polymers with the base material. The modulus of elasticity *(E)* of PMC is typically lower than unmodified concrete since polymers have lowervalues of E. Properly cured PMC undergoes less drying shrinkage than unmodified concrete probably because of its higher water-retention ability. In combination with the increase in tensile strength of PMC, thischaracteristic results in improved extensibility, which reduces drying shrinkage cracking.

5 Current applications of PMC are primarily for resurfacing, flooring, and patching applications. Overlays on roadways and bridges, both as new construction and as repairs of existing deteriorated structures. PMC is also being used in flooring, water tanks, swimming pools, septic tanks, silos, drains, pipes, and ship decks. Two very promising, relatively new applications of PMC are its use in combination with fiber reinforcing and its use as a pneumatically applied material or shot Crete. In present experimental investigation the polymer modified fiber reinforced concrete has been used to find out workability of concrete, compressive strength, toughness index as well as dynamic modulus of concrete for M40 grade of concrete with varying percentage of fibers.

II.LITERATURE REVIEW

Polymers have been used in construction as long ago as the fourth millennium B.C., when the clay brick walls of Babylonia were built using the natural polymer asphalt in the mortar. The temple of Ur-Nina (King of Lagash), in the city of Kish, had masonry foundations built with mortar made from 25 to 35% bitumen (a natural polymer), loam, and chopped straw or reeds. The walls of Jericho were built using bituminous earth in about 2500-2100 B.C. Other historic applications of bituminous mortars in construction have been identified in the ancient Indus Valley cities of Mohenjo-Daro and Harappa around 3000 B.C., and near the Tigris River in 1300 B.C, Many natural polymers have been used in ancient mortar, including albumen, blood, rice paste, and others polymers. The earliest indication of the use of polymers in PCC was apparently in 1909, in the United States, when a patent for such use was granted to L. H. Backland; and in 1922, in France, when a patent was granted to Varegyas[1].

1)The concept of polymer –hydraulic cement system was firstly developed in 1923 by Creson[2]. He developed a paving materials with natural rubber latexes and used cement as filler material. While Lefbure mentioned the concept of the polymer latex modified systems in 1924. He also worked on polymer latex modified mortar and concrete but used natural rubber latexes by mix proportioning method. Kirkpatrick in 1925 follow the same method mentioned by Lefbure[3]

2)1930's were a turning point in the use of latexes as a cement modifiers (from the natural rubber latexes to synthetic rubber or resins latexes. In 1932 Bond suggested the use of synthetic rubber latexes for the polymer modified systems and Rodwell's[4] in 1920 claimed to apply synthetic resins latexes including polyvinyl acetate latexes to the modified systems.

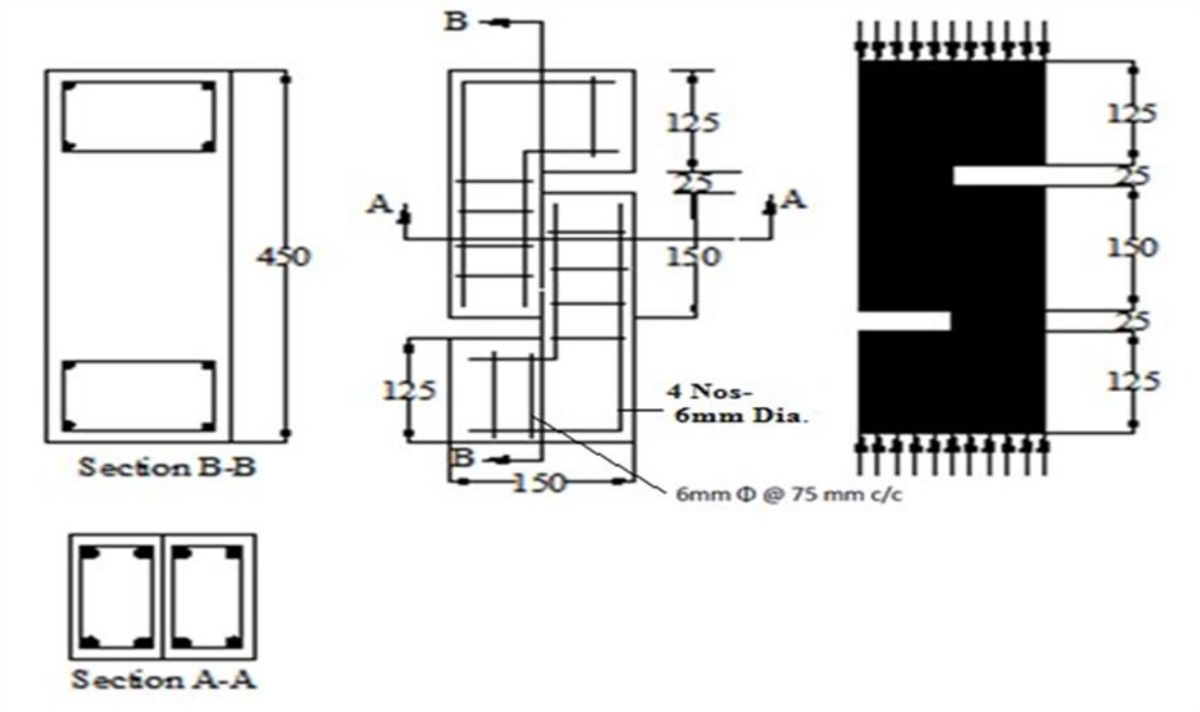
3)In 1940 the polymer modified systems with synthetic latexes such as chloroprene rubber (neoprene) latexes and polyacrylic latexes where used. This polymer mortar and concrete have been used in various applications such as deck covering for ships and bridges, paving, flooring, anti corrosives and adhesives. In the UK, feasibility studies on the applications of natural-rubber-modified systems were conducted Griffiths and Stevens. Meanwhile, a strong interest focused on the use of the synthetic latexes in polymer modified systems. In 1953, Geist et al. [5] reported a detailed fundamental study on the polyvinyl- acetate- modified mortar and provided a number of valuable suggestions for the later research and development of the polymer modified systems.

4)In 1960's styrene-butadine rubber, polyacrylic-ester and poly(vinylidene chloride-vinyl chloride)[6] modified mortars and concretes became increasingly used in practical applications. Since the 1960's the practical research and development of polymer modified mortar and concrete has been considerably advanced in various countries, particularly in U.S.A., U.S.S.R., West Germany, Japan and U.K. In 1971 Dikeou [7], Steinberg et al. also studied other systems of modified systems. Donnelly and Duff patented systems based on epoxy resins in 1965 and 1973 respectively in 1959 a system modified with urethane pre polymer was patented. Shibazaki[8] showed that other polymers, such as hydroxyl ethyl cellulose and polyvinyl alcohol (poval) are effective for the water soluble polymer modified mortar. A considerably research and development of polymer modified mortar and concrete where conducted in the world in 1970's. in 1980's the polymer modified mortars and concrete became the dominant material in the construction industry.

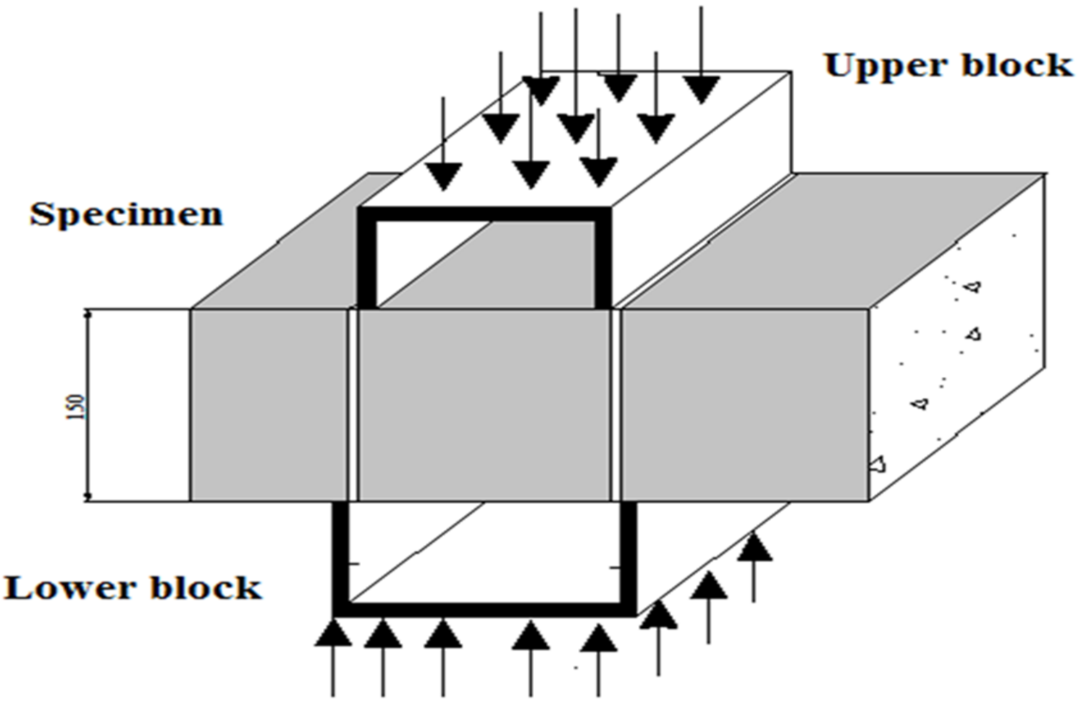
5)Agrawal[9] (2007) studied Properties of polymer-modified mortars using epoxy and acrylic emulsions. In this study it is observed that synthetic fiber may remulsify in humid alkaline condition. To overcome this problem and epoxy emulsion based polymer system has been developed. The results showed that the mortar have superior strength property and better resistance to penetration of chloride ions and carbon dioxide.

6)SedatKurugo et.al [10]. studied Young's modulus of fiber-reinforced and polymer-modified lightweight concrete composites. This study represents the effect of steel fiber reinforcement and polymer modification on the Young's modulus of lightweight concrete aggregates observed through experimental measurements and volume fractions of their constituents. Dept. of Civil and Environmental Engineering, The University of Tennessee, Knoxville studied the balance between permeability and strength properties of polymer-modified pervious concrete (PMPC) in 2010. Department of Civil Engineering, Shantou University, Shantou, China studied Microstructures of the composites by using scanning electron microscope and mercury intrusion porosimetre. Results show that the addition of steel fibers increases both flexural and compressive strength of the composites. The flexural strength increases significantly when containing 3–10 % SBR by wt of cement. However, the compressive strength may decrease with the addition of SBR. When the addition arrives 10% by wt of cement, a 16% reduction in compressive strength is observed.

7) Genying Li et. al[11] carried the experimental study to observe the effect of steel fibers along with polymers . Microstructures of PSFC were analyzed by using scanning electron microscope and mercury intrusion porosimetry. By the comparison of properties of SFC and PSFC a significant increase in flexural strength when 3-10% SBR is added was observe. But the compressive strength may decrease with the addition of SBR. TarannumMerajet. al[12] has carried the experimental study to determine flexural behavior of PMFRC. In this study various parameters such as stress strain variation, first crack load, ultimate load, deflection, ductility and strain variation along the depth of the beam have been carried out and quantitative comparison is observed at each stage of loading. It is also observed that due to the presence of steel fibers the ductility of PMFRC is increased by 50.27% in comparison with plain concrete.



Reinforcement in Push-off for shear Specimen



Double Shear Test

III.CONCLUSIONS

1.In polymer modified mixes, workability of concrete mix increases with the addition of polymer, while inclusion of steel fibers leads in reduction of slump.

2.slump loss calculated for variable fiber percentage shows increases in slump loss as the percentage of fiber dosage increases.

3.Wet Density of normal concrete was observed to be higher than polymer modified composites.

4.But with the increment in percentage of fiber in polymer modified concrete density marginally increases and observed to be less than density of normal concrete.

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