EXPERIMENTAL INVESTIGATION ON SBR LATEX MODIFIED STEEL FIBER REINFORCED CONCRETE

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Abstract— The experimental study has been made to obtain strength characteristics of compressive strength, split tensile strength and flexural strength. the concrete added with fiber and latex behaved much better with regards to higher first crack load and ultimate load and also lesser deflection. The fibers are capable of carrying a load across the crack. This is due to compactness achieved due to latex and fiber filling in concrete matrix.

The main aim of our project is to increase the strength of concrete structures. When addition of steel fibre and latex. Styrene Butadiene Rubber Latex polymer and hooked end steel fibres have been used for our study. The percentage of steel fibre used were 0%,0.5%,0.75%, at an interval of 0.25%. The fraction of steel fibre which gave the best result was taken and latex was varied in percentage 5%, to obtain maximum strength. In all total cubes (150mm X 150 mm X 150 mm), beam (500mm X 100mm X 100mm) and cylinder specimens (150 mm X 300 mm) were made. The hardened properties of concrete will be tested at 28th days.

Keywords— SBR latex, steel fiber, compressive strength, tensile strength, flexural strength.

I. INTRODUCTION

Concrete is the most widely used building material. It has the distinction of being formed into desired shape most conveniently. It is an artificial material consisting of ingredients such as cement, fine aggregates, coarse aggregates and water. Aggregates are the major ingredients of concrete. Concrete is a composite material composed mainly of water, aggregate, and cement mixed together to form a fluid mass that is easily molded in to various shapes. Over time, the cement forms a hard matrix which binds the rest of the ingredients together into a durable stone-like material with many uses. As times change, there is a need to provide better concrete, in terms of its strength, durability, etc. Special concretes need to be designed which are task specific. Certain fibers, polymers and admixture are used nowadays, to achieve the required concrete mixes.

Any construction activity requires several materials such as concrete, steel bricks, stone, glass clay, mud, wood and so on. For its sustainability and adaptability with respect to the changing environment the concrete must be such that it can converse resources protected environment, economize and lead to proper utilization of energy. The primary role of fibers in hardened concrete is to modify the cracking mechanism. By modifying the cracking mechanism, the macro cracking becomes micro cracking. The cracks are smaller in width\ thus reducing the permeability of concrete and the ultimate cracking strain of the concrete is enhanced. Fiber addition provides increased tensile and compressive strengths, higher toughness, high energy absorption and durability Latex is used as a bonding agent for old and new concrete repair damaged, spalled concrete and filling of cracks suitable for water proofing and laying floor screeds. Hence, many studies have been carried out to explore the mechanical properties and strength characteristics of fiber reinforced concrete.

The greatest benefit of using fiber reinforcement is improved long-term serviceability of the structure. By the use of fibers in concrete, substantial time and cost savings can be attained by reducing the cost intensive labors to prepare, place and control ordinary reinforcement. Hence fiber reinforced concrete has been modern and cost efficient construction material.

In recent years latex modified mortars and concrete have been used widely as construction materials because of their improved properties of high strength, extensibility, adhesion, water proofness and durability. In general latex modified concrete show noticeable increase in tensile strength, adhesion, bond strength, impermeability and durability, etc. Latex modified steel fiber reinforced concrete is made of hydraulic cement, containing fine and coarse aggregate, discontinuous discrete fibers and polymer (SBR-latex). When fibers and polymer are added to conventional concrete they improve mechanical properties of conventional concrete significantly. Recent test on polymer modified steel fiber concrete indicate that they are more durable.

II. LITERATURE REVIEW

Prakhargoeanka and NeerajTiwari studied that the addition of low-cost Steel Fibers, with a combination of Styrene Butadiene Rubber (SBR) Latex Polymer, is an effective way of improving the overall properties of the conventional concrete. The FRPCC (S8) mix with 5% Steel fibers and 20% SBR Latex polymer has shown the best workability, increased compressive strength and high resistance against flexural loads, making it suitable for use in congested spaces under high loads. Parviz Soroushian and Atef investigated the effects of latex modification and steel fiber reinforcement on the impact resistance and flexural strength and toughness of concrete materials. Flexural strength was
also increased in the presence of latex but the flexural tougheness of plain concrete did not receive major benefits from latex modification fibres were effective in increasing the impact resistance and flexural strength and toughness of concrete. Steel fibers enhance the ductility and energy absorption capacity, flexural strength, and impact resistance of concrete. Latex modification, on the other hand, improves the impermeability as well as strength and ductility characteristics of concrete. Dharmender Singh and Praveen Kumar identified that the addition of 15% latex can produce a high strength PMC and when the steel fiber content in concrete is increased shows maximum strength at 1% steel fiber content of total volume of cement. R. D. Neves et al. studied that the addition of fibres to concrete enhances its toughness and strain at peak stress, but can slightly reduce the Young's modulus. K.Ramaraju et al observed that the different latex to cement ratios of styrene butadiene rubber

(SBR) modified mortars and concrete, are found to be having more compressive strength. V.M. Sounthararajan et al. identified that combined addition of steel and polymeric latex additions in concrete leads to increased strength, durability, toughness, resistance to cracking and crack propagation. A major advantage of using fiber reinforced concrete (FRC) besides reducing permeability and increasing fatigue strength is that fiber addition improves the toughness and load carrying ability after the first crack in flexure behavior. From the study it is observe that the concrete added with steel fiber and latex behaved much better with regards to higher first crack load and ultimate load and also lesser deflection .This is due to compactness achieved due to latex and fiber filling in concrete in matrix.

III. MATERIAL PROPERTIES

The cement shall be used and the selected should be appropriate for the intended use. 53 Grade Portland pozzalano Cement confirming to IS: 8112 is used for the study. Crushed angular aggregate of size 20mm is used for the study Styrene based rubber latex was used for improving the hardening properties of concrete with addition of 10 %.Styrene butadiene rubber latex-modified concrete has been widely used in the field of repair work patching, resurfacing works for damaged bridge decks, because of its ease of execution, excellent adhesion to the base concrete, high freeze-thaw resistance and resistance to chloride penetration.

Fig.1 SBR latex

Steel fibers of length 20mm is used for the study. The percentage of fibers in concrete mix is based on volume and is expressed as a percentage of volume of mix. The percentages of fibres commonly used vary from 1%. The main properties of fibre Reinforced Concrete in tension, compression, and shear are influenced by the type of fibre, volume fraction of fibers', aspect ratio and the orientation of fibre in the concrete matrix. The properties of steel fibres with random orientation are the commonly used fibres in the civil engineering applications.

Fig.2 Steel Fibre

Table 1 The Conventional Mix Proportion

Cement	Fine aggregate	Coarse aggregate	water
430 kg/m^3	685 kg/m^3	1151 kg/m^3	186 kg/m^3
1	1.593	2.677	0.43

IV. RESULTS AND DISCUSSION

Slump test is to find out the workability of freshly mixed cement concrete. The strength of cement concrete entirely depends upon the correct percentage of water. This experiment gives the percentage of water and slump. It is the fall vertical height of a freshly prepared concrete with respect to its standard mould height.

Fig.3 Measuring slump of concrete

Table 2 Slump Test Results

Description	Slump test (mm)
Conventional concrete	95
0.75% steel fiber +5%SBR	110
1% steel fiber fiber +5%SBR	115

The hardened concrete testing is used to determine the strength of the concrete. The specimen is tested by compression test machine after 7 days, 14 days and 28 days curing. Load should be applied gradually at the rate of 140kg/cm2 per minute till specimens fails.

Fig .4 Compression Strength Test

Table 3 Compressive Strength

Description	Compressive strength (N/mm²)		
	At 7 days	At 14 days	At 28 days
0% steel fiber +5%SBR	28.5	35.43	46.3
0.5% steel fiber +5%SBR	31.67	37.8	47.11
0.75% steel fiber fiber +5%SBR	34.81	38.2	49.42

The concrete is very weak in tensile due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may cracks.

Fig.5 Split Tensile Test

Description	Split Tensile Strength (N/mm²)		
	7 days	14 days	28 days
0% steel fiber +5%SBR	2.92	2.92	4.67
0.5% steel fiber fiber +5%SBR	3.43	3.43	4.89
0.75% steel fiber fiber +5%SBR	3.87	3.87	5.1

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. It is measured by loading 100mm x 100mm x 500mm concrete beam.

Fig.6 Flexural test

Description	Flextural strength (N/mm²)		
	7 days	14 days	28 days
0% steel fiber +5%SBR	4.14	5.92	6.82
0.5% steel fiber fiber +5%SBR	4.55	6.13	7.2
0.75% steel fiber fiber +5%SBR	5.23	6.76	7.43

V. CONCLUSION

By using the SBR latex with polypropylene fiber in concrete with various proportions, In 28th day compressive strength test results 0.75%steel fiber +5%SBR gives the best compression strength, split tensile strength and flexural strength result. Latex modification of concrete provides the material with higher mechanical strengths. This increase in mechanical strength can be attributed to the microcrack-arresting action of latex in concrete, and also to the bonding they provide between the matrix and aggregates. Improvements of workability through latex modification (which reduces water requirements for achieving similar workability in latex modified concrete is another factor contributing to flexural strength in latex-modified concrete. Latex polymers in the presence of steel fibers provide a better bonding between fibers and the concrete matrix because of the formation of a monolithic polymer film that surrounds the fibers, fills the smaller voids, and links the cementitious environment to the fibers. As a result, the formation of many of the microcracks that tend to take place along the fiber-matrix interface is prevented.

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