International Online Conference on Advanced Research in Biology, Ecology, Science and Technology
(ICARBEST'15)
Organized by
International Journal of Advanced Research in Biology, Ecology, Science and Technology (IJARBEST)
19th November 2015

Study on polymer modified Steel Fiber Reinforced Concrete

Dr. S. Suriya[1], S. Sowmiya Sadhana[2], Suman Naaz Shaikh[3]

Assistant professor, Department of Civil Engineering, B.S. Abdur Rahman University, Chennai, India [1]
Student, Department of Civil Engineering, B.S. Abdur Rahman University, Chennai, India [2]
Student, Department of Civil Engineering, B.S. Abdur Rahman University, Chennai, India [3]

Abstract*—Concrete being the most important and widely used material is called upon to possess very high strength and sufficient workability properties. This paper emphasizes on POLYMER MODIFIED STEEL FIBER REINFORCED CONCRETE, a recent advancement in the field of reinforced concrete. It was observed that addition of steel fibers to concrete will improve its flexural strength and compressive strength. Few applications of SFRC are in the field of irrigation structures. Polymer modified steel fiber reinforced concrete is highly resistant to weathering action, so it is extensively used in lying of pavements.

***Keywords* — Concrete, Fiber reinforced concrete, Styrene butadiene rubber.**

I. Introduction

With the advent of technology, new construction materials are being developed in many parts of the world with considerable efforts. It is being recognized that economic progress in construction depends more on an intelligent use of the materials and constant improvement of available materials than on extreme refinements of structural analysis. Researchers all over the world are attempting to develop high performance and light weight concrete by using fibers and other admixtures in concrete.

Concrete is one of the most durable building materials. It provides superior fire resistance, compared with wooden construction and can gain strength over time. Structures made of concrete can have a long service life. Concrete is a composite construction material made primarily with aggregate, cement, and water. Concrete is used more than any other man-made material in the world. There are many formulations of concrete, which provide varied properties, and concrete is the most-used man-made product in the world.

Concrete is usually characterized by its compressive strength. It has been observed that microstructure is very important for the macro performance.

Concrete is widely used for making architectural structures, foundations, brick/block walls, pavements, bridges/overpasses, motorways/roads, runways, parking structures, dams, pools/reservoirs, pipes, footings for gates, fences and poles and even boats.
High performance concrete structures, unlike steel structures, tend to fracture or fail in a relatively brittle fashion, as the ductility or deformation capacity of concrete is limited. In such structures the brittle failure as a result of inelastic deformation can be avoided only if the concrete is made to behave in a ductile manner so that the member can absorb and dissipate large amount of energy.

Fiber reinforced concrete pavements are more efficient than ordinary cement concrete pavement. "FRC is defined as composite material consisting of concrete reinforced with discrete randomly but uniformly dispersed short length fibers."(http://theconstructor.org/concrete/fibre-reinforced-concrete-in-pavements/4781/) The fibers may be of steel, polymer or natural materials. FRC is considered to be a material of improved properties and not as reinforced cement concrete whereas reinforcement is provided for local strengthening of concrete in tension region.

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. The fibers are capable of carrying a load across the crack. 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.

The newly developed "Polymer Concrete" possessing many superior properties over conventional cement concrete, renders itself as one of the most versatile construction materials.

FIBER REINFORCED CONCRETE

Concrete containing a hydraulic cement, water, or fine and coarse aggregates, and discontinuous discrete fibers is called fiber-reinforced concrete (FRC). It may also contain pozzolans and other admixtures commonly used in conventional concrete. Fibers of various shapes and sizes produced from steel, plastic, glass, and natural materials are being used; however, for most structural and non-structural purposes, steel fiber is the most commonly used of all the fibers.

LATEX MODIFIED STEEL REINFORCED CONCRETE

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. Experimental Investigation

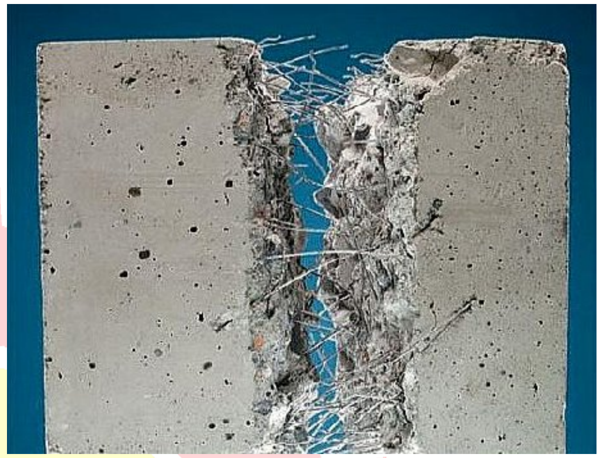
A series of specimens are chosen for the investigation and all are having a unique nominal sectional dimensions for cubes 150 X 150 mm, cylinders 150 mm dia. and 300mm height and prisms 100 X 100 X 500mm respectively.
Plain cement concrete (M25 grade of concrete), Plain cement concrete with Styrene butadiene rubber latex (M25 + SBR-latex), Plain cement concrete with steel fibers (M25 + Steel fibers), Plain cement concrete with steel fibers and Styrene Butadiene Rubber Latex (M25 + steel fibers + SBR-latex).
The details of experimental studies including characterization are presented below.

A. Materials used

Ordinary Portland Cement (OPC) was used for all the test specimens. Silica is added to reduce the dosage of chemical admixtures needed to get required slump. 12 mm nominal maximum aggregate is used as coarse aggregate and fine aggregate is the natural sand free from impurities.
The properties of steel fibers are shown in table 1.

Table 1: Properties of Steel Fibers

Type	Crimped round
Length	36mm
Diameter	0.45mm
Aspect ratio	80



The properties of the SBR Latex are given in the Table 2

Table 2: Properties of the SBR Latex

Polymer Type	Styrene Butadiene 68 ± 3% Styrene 32 ± 3% Butadiene
Average Polymer Particle Size	1500 to 2500 Angstroms
Emulsion Stabilizers	32 ± 3% Butadiene Anionic and non-ionic surfactants 68 ± 3% Styrene
Percent Solids	46.20
Weight per liter, Kg at 25ºC	1.005 to 1.039
Ph	9.5 to 10.50
Color	White

III. CONCRETE MIX DESIGN

A. Mix Proportioning

For SBR+M25 the mix ratio adopted is 1: 1.21: 2.07 with w/b ratio of 0.44., and 10% SBR-latex by weight of binder was added to the mix. For SF+M25, the suitable mix ratio adopted is 1: 1.21: 2.07 with w/b ratio of 0.44, and steel fiber content was 0.75% by volume is incorporated.

For SBR+SF+M25, the suitable mix ratio adopted is 1: 1.21: 2.07 with w/b ratio of 0.44., 15% SBR-latex by weight of binder was added to the mix and steel fiber content was 0.75% by volume is incorporated and in all above mixes 7% of silica fume was added as a partial replacement for cement to mix super plasticizer (Glenium-51) was added in the ratio of 1% of binder.

B. Casting and testing of specimens

Total 108 specimens (cubes, cylinders and prisms) were casted and tested after 3, 7 and 28 days.
The primary variables considered for the study are:

(i) Plain cement concrete (M25 grade of concrete).

(ii) Plain cement concrete with Styrene butadiene rubber latex (M25+SBR-latex).

(iii) Plain cement concrete with Steel fibers (M25 + Steel fibers).

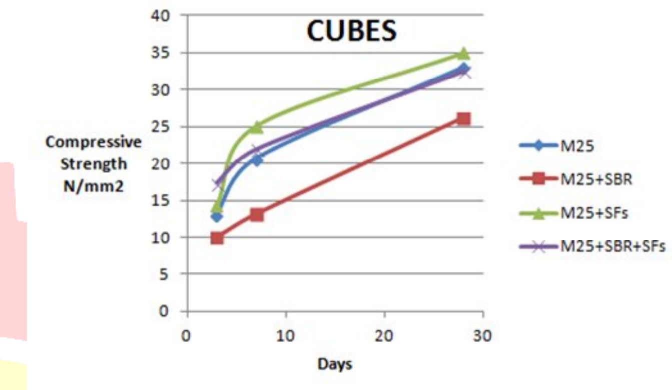
(iv)Plain cement concrete with steel fibers and Styrene Butadiene Rubber Latex (M25 + steel Fibers + SBR-latex).

IV. RESULTS AND DISCUSSIONS

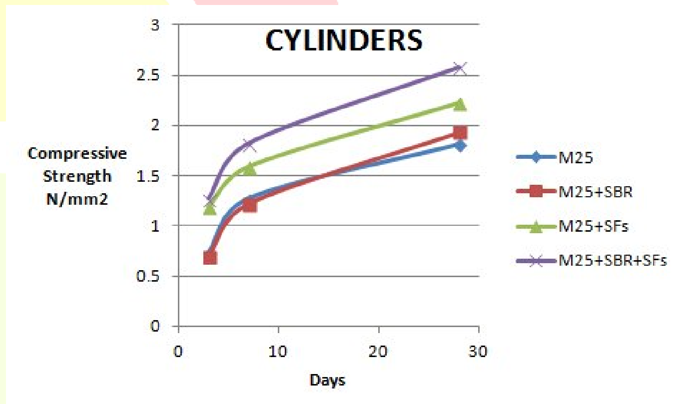
A. Test Readings of specimen

The average test readings of the specimens for 3, 7 and 28 days are shown in table 3.

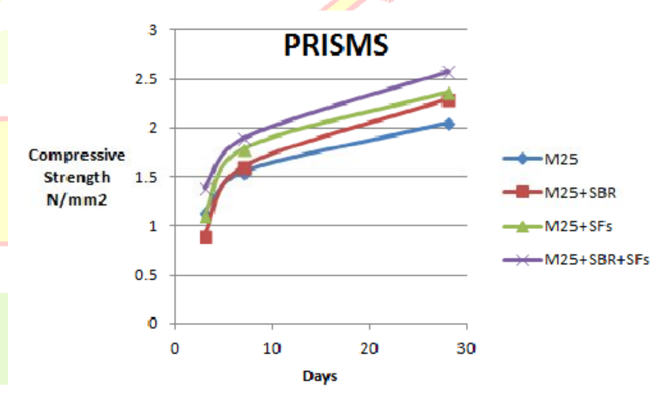
Properties	Age	M25	M25+SBR	M25+SFs	M25+SBR+SFs
Compressive strength (N/mm^2)	3 days	13.13	10	14.33	17.3
	7 days	20.66	13.16	25.1	21.9
	28 days	33	26.16	35	32.5
Split tensile strength (N/mm^2)	3 days	0.73	0.69	1.19	1.27
	7 days	1.27	1.22	1.59	1.82
	28 days	1.81	1.93	2.22	2.58
Flexural strength (N/mm^2)	3 days	1.14	0.9	1.11	1.39
	7 days	1.55	1.6	1.79	1.9
	28 days	2.05	2.29	2.36	2.58



Graph 1: Variation of compressive strength with Age



Graph 2: Variation of split tensile strength with Age



Graph 3: Variation of flexural strength with age

V. CONCLUSIONS

- Among M25, SBR+M25,SF+M25 and SBR+SF+M25, the compressive strength obtained at 28 days are 33Mpa, 26.16Mpa, 35Mpa and 32Mpa respectively. In case of SBR latex modified concrete there is a decrease in compressive strength. This is due to lower density of latex with regard to matrix density. Moreover the combination of SBR

–latex and steel fiber showed an increase in compressive strength.

- Addition of steel fibers to a concrete will improve both its flexural and compressive strength.
- The strengths increase significantly with fiber content.
- Compressive strength values have greater increase than split tensile and flexural strength.
- Due to the compactness that is filling of voids in the matrix achieved due to latex and fiber filling in the concrete matrix, it is observed that the

SBR+SF+M25 has considerable amount of increased in flexural strength as compared to other matrix used.

- Polymer concrete in particular, is highly suitable in case of pre-fabricated building industry, irrigation structures, marine structures, nuclear power production and desalination plants.

VI. REFERENCES

[1] Manjunath V Melkundi *, Prof. Vaijanath Halhalli **, Experimental Investigation of SBR- Latex modified Steel Fiber Reinforced Concrete Journal of Engineering Research & Technology (IJERT), Vol. 2 Issue 11, November – 2013 ISSN: 2278-0181

[2] S.A Kanalli, Ramu Palankar, Bharath Kumar, Praveen Kumar, Prakash S.K, COMPARATIVE STUDY OF POLYMER FIBER REINFORCED CONCRETE WITH CONVENTIONAL CONCRETE PAVEMENT, IJRET: International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308.

[3] G.D.Awchat, N.M.Kanhe, Experimental Studies on Polymer Modified Steel Fiber Reinforced Recycled Aggregate Concrete, *International Journal Application or Innovation in Engineering & Management (IJAIEM).*

[4] www.nbmcw.com/articles/concrete/26929-pfrc.html

[5] courses.washington.edu/cm425/frc.pdf

[6] Prof. Dr. Bayan S. Al-Nu'man and Dr. Abdulkader Ismail Al-Hadithi, Flexural Behaviour of Polymer Modified Reinforced Concrete Beams, Journal of Engineering and Development, Vol. 13, No. 1, March (2009) ISSN 1813-7822.

[7] http://theconstructor.org/concrete/fibre-reinforced-concrete-in-pavements/4781/