iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 Issue: XII Month of publication: December 2022

DOI: https://doi.org/10.22214/ijraset.2022.48235

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue XII Dec 2022- Available at www.ijraset.com

Experimental Study on Steel Fiber Reinforced Concrete

Arivalagan S[1], Dinesh Kumar K S A[2], Paul Makesh A[3]
[1]Professor and Joint Registrar, Dr.M.G.R Educational and Research Institute, Maduravoyal, Chennai,TN, India
[2]Associate Professor, National Institute of Technical Teachers Training and Research ,Taramani, Chennai, TN, India
[3]Assistant Professor of Civil Engineering, Dr.M.G.R Educational and Research Institute, Maduravoyal, Chennai, TN, India

Abstract: As of today, there are no official set of rules for designing fiber reinforced structures, but there are several suggestions for rules which are described in the report. Mechanical properties of concrete and mortar reinforced with randomly distributed smooth steel fibers were investigated to understand the mechanism of fiber reinforcing. Different volumes, lengths, orientations and types of fibers were used. Fibers were compared with conventional reinforcement in flexure, tension and compression. It was observed that the significant reinforcing effect of fibers is derived after the cracks are initiated in the matrix, just as with conventional tensile and stirrup reinforcement. The post-cracking resistance of fibers is considerably influenced by their lengths, orientation, and stress-strain relationship. The spacing of reinforcement appears to have little influence on crack propagation below a certain length. This Project consist of M20 Grade concrete where the compression test and split tensile test are done. The cubes and cylinders are casted for 7,14 and 28 days of curing. Steel fibers are used in this project with three different volume percentage of fibres (0.50%,0.75% and 1.0%). The inclusion of fiber showed improvement of compression strength and tensile strength.

Keywords: Steel Fibre Reinforced Concrete, compressive strength, split tensile strength.

I. INTRODUCTION

The background for this report is that the building industry of today experiences a falling recruitment of skilled labour in addition to requirements of continuous efficiency improvements. This opens for research in more efficient construction methods and has lead to an increased interest in fibre reinforced concrete. The reason for this is that iron fixing is time-consuming activity on a building site and if fibre reinforced concrete may fully or partially replace the traditional reinforcement this work will be smaller. In addition to reducing work time the EHS on the building site may be improved as the iron fixing is a heavy work and may cause work injuries and early retirement for the workers. Another benefit is that the FRC can allow more complex geometry of casting moulds. The report starts with a literature study to illustrate the different properties and behaviours of fibre reinforced concrete. As the use of FRC in carrying structures is at the research stage there are several different propositions for designing methods and some of these are described in this section. Conventional practice usually concentrates welded wire fabric reinforcement within a single plane of a floor slab. Fabric does very little to reinforced the outer zones, which is why spalling is common at the joints and edges. The primary function of welded wire fabric is to hold the floor slab together after the first small hairline cracks have propagate to larger fractures. This serves to maintain some degree of "structural integrity". Conventional wisdom's approach to floor slabs is to maintain "material integrity" through SFRC mix designs. This integrity is accomplished by: Increasing the initial first crack strength. Large numbers of fibres intercepting the micro-cracks and preventing propagation by controlling tensile strength. Unlike rebar and welded wire fabric, fibres are dispersed throughout the slab to reinforce isotropically, so there is no weak plane for a crack to follow. Increases in flexural strength can make it possible to use a thinner slab and eliminate the cumbersome welded wire fabric. Whether it is for lighter duty commercial service or for heavy manufacturing, SFRC slabs are capable of withstanding any load. The only variable is the addition rate of fibre, which could be as low as 12.5kg/m3 to as high as 100 kg/m3.

A. *Effect of Fibers in Concrete*

Fibres are usually used in concrete to control plastic shrinkage cracking and drying shrinkage cracking. They also lower the permeability of concrete and thus reduce bleeding of water. Some types of fibres produce greater impact, abrasion and shatter resistance in concrete. Generally fibres do not increase the flexural strength of concrete, so it can not replace moment resisting or structural steel reinforcement. Some fibres reduce the strength of concrete.

The amount of fibres added to a concrete mix is measured as a percentage of the total volume of the composite (concrete and fibres) termed volume fraction (Vf). Vf typically ranges from 0.1 to 3%. Aspect ratio (l/d) is calculated by dividing fibre length (l) by its diameter (d). Fibres with a non-circular cross section use an equivalent diameter for the calculation of aspect ratio. If the modulus of elasticity of the fibre is higher than the matrix (concrete or mortar binder), they help to carry the load by increasing the tensile strength of the material. Increase in the aspect ratio of the fibre usually segments the flexural strength and toughness of the matrix. However, fibres which are too long tend to “ball” in the mix and create workability problems. Some recent research indicated that using fibres in concrete has limited effect on the impact resistance of concrete materials.This finding is very important since traditionally people think the ductility increases when concrete reinforced with fibres. The results also pointed out that the micro fibres is better in impact resistance compared with the longer fibres.

B. Necessity

It increases the tensile strength of the concrete. It reduce the air voids and water voids the inherent porosity of gel.It increases the durability of the concrete. Fibres such as graphite and glass have excellent resistance to creep, while the same is not true for most resins. Therefore, the orientation and volume of fibres have a significant influence on the creep performance of rebars/tendons.

II. LITERATURE REVIEW

Amit Rai et al (2008) studied in conventional concrete, micro-cracks develop before structure is loaded because of drying shrinkage and other causes of volume change. The fibers help to transfer load to the internal micro cracks.When the structure is loaded, the micro cracks open up and propagate because of development of such micro-cracks, results in inelastic deformation in concrete. Fibre reinforced concrete (FRC) is cementing concrete reinforced mixture with more or less randomly distributed small fibres. Steel fibers can improve the structural strength to reduce in the heavy steel reinforcement requirement. Faisal Fouad Wafa (1992), explain in their book about , Fibre reinforced concrete (FRC) is a new structural material which is gaining increasing importance. Addition of fibre reinforcement in discrete form improves many engineering properties of concrete. Currently, very little research work is being conducted within the Kingdom using this new material. This describes the different types of fibres and the application of FRC in different areas. It also presents the result of research about the mechanical properties of FRC. Arnon Bentur et al.(2010), FRC is known to provide good resistance to plastic shrinkage and has a proven record in the building industry particularly with slab-on-grade application.Adding a fiber to concrete can increase the early age compressive strength by up to 48%.Steel fibers are found to provide residual strength, however they are also prone to deterioration due to corrosion.A fiber with high tensile strength, higher pull out strength and lower flexural strength will be the best candidate to control early age shrinkage cracking. R. D. Neves and J. C. O. and Fernandes de Almeida (1991) conducted an experimental study to investigate the influence of matrix strength, fibre content and diameter on the compressive behaviour of steel fibre reinforced concrete is presented. Two types of matrix and fibres were tested. Test results indicated that the addition of fibres to concrete enhances its toughness and strain at peak stress, but can slightly reduce the Young's modulus. Prafull Vijay et al.(2010) studied , two different types of Light Weight Aggregates, one with Sodium Hydroxide and another without Sodium Hydroxide were manufactured. Their physical properties were inspected and based on that it was found that Aggregates having sodium hydroxide as their constituent were more dense, high water absorption capacity, smooth texture and were well graded than the aggregates without Sodium Hydroxide as their constituent. Based on these tests, aggregates having sodium hydroxide were chosen for the casting of concrete materials as a coarse aggregate ingredient. Three different mix ratios were taken and two different curing methods were adopted as water curing and hot Oven bath curing. Based on that, six different Mix IDs were formed and different no. of cubes and cylinders were made from those mix IDs. The Compressive test, split tensile test were performed on cubes and cylinders respectively. Based on these tests, it was found that the Specimens of mix ratios with hot oven curing yields better strength than the specimens of same mix ratio with water curing. Different results were analyzed and graphs were drawn. Jagan et al .(2017) in their research , study to improve the workability of concrete polycarboxylate ether was used as super plasticizer. Here we present the overview on strength and durability improvement of concrete on addition of 0.25%, 0.5%, 0.75% and 1% of chopped glass fibers in concrete. Various strength tests like compressive strength test, Split tensile strength test and flexural strength test and durability tests like acid attack and fire resistant test were performed. In addition to the above tests, a study on role of polycarboxylate ether on the improvement of workability of concrete was presented. . Arunakanthi et al.(2016) main aim of the study is to study the effect of glass fibre and steel fibers in the concrete. FRC has the high tensile strength and fire resistant properties thus reducing the loss of damage during fire accidents. In the present work the strength studies are carried out to compare the glass and steel fiber concrete.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue XII Dec 2022- Available at www.ijraset.com

The FRC is added 0.5, 1, 2 and 3% are added for M20 grade concrete. Result shows the percentage increase in compressive strength, flexural strength and split tensile strength for 28days. .Musalaiah et al(2017) studied main objective is to be finding out the mechanical behavior of prepared composites from S-2 glass fibre. The specimens were tested tensile and compressive on Universal Testing Machine. The results emphasized the yield strength, ultimate strength as well as young's modulus of tension and compression. Rajesh et al.(2007) studied, this paper will review the newer products and techniques that can improve the properties of bast fibre based composites as well as potential structural and non-structural applications which can increase their market share.

III. EXPERIMENTAL INVESTIGATIONS

The experimental program comprises of casting and testing of cubes of size 150 x 150 x 150mm were tested at 3 days ,7 days and 28 days of curing for compressive strength, cylinders of 150mm diameter and 300mm height for split tensile strength. The mix proportions of high strength concrete with three different percentage of fibres (0.50%,0.75% and 1.0%).

IV. MATERIALS USED

A. Cement

Ordinary Portland cement of 53 grade confirming to IS 12269 was used. The specific gravity of the cement was 3.1. The initial setting and final setting time were found as 30 minutes and 300 minutes respectively.

B. Fine Aggregate

Locally available river sand passing through 4.75mm IS sieve was used. The specific gravity of the sand is found to be 2.65.

C. Coarse Aggregate

Crushed granite aggregate available from local sources has been used. The aggregate passing through 12.5mm and retained on 10mm IS sieve was used in preparation of HS-SFRC and HSC blocks.

D. Fibres

The present investigation aims at producing SFRC with locally available fibres. Hooked Steel wire fibres of 0.5mm diameter and aspect length of 60 were used. The required fibre length of 30mm was cut by using shear cutting equipment. The ultimate tensile strength of fibre was 46kg/cm^2 .

E. Water

Portable fresh water was used for mixing and curing of concrete.

F. Casting of the specimen

Cubes of 150 x150 x150mm were cast to determine the compressive strength, cylinders of 150mm diameter and 300mm depth were cast to evaluate the tensile strength. The specimens were de-moulded after 24 hours and water cured for 7 days, 14days and 28 days.

V. TESTING OF THE SPECIMEN

The testing cubes, cylinders were done in compression testing machine, beams and blocks were tested in universal testing machine. Table 2 shown the test results of compressive strength, split tensile strength.

Table 1: Properties of Steel fibers

Properties of fibers	Steel fiber
Diameter \ equivalent diameter (mm)	0.60
Aspect Ratio	83.3
Specific gravity	5.86
Water Absorption (%)	33.33
Density in kg/m3	6879

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue XII Dec 2022- Available at www.ijraset.com

Table 2: Compressive and Tensile Strength of concrete Specimens.

S .No.	Specimens	Compressive Strength (N\mm^2)			Tensile Strength (N\mm^2)		
		7 days	14 days	28 days	7 days	14 days	28 days
1	Concrete	13.5	16.7	20	2.08	3.15	4.17
2	Steel fibre (0.5%)	31.7	37.1	42.3	2.45	3.47	4.27
3	Steel fibre (0.75%)	33.2	38	44.7	3.05	4.05	4.95
4	Steel fibre (1%)	35	39	46	3.35	4.6	5.3

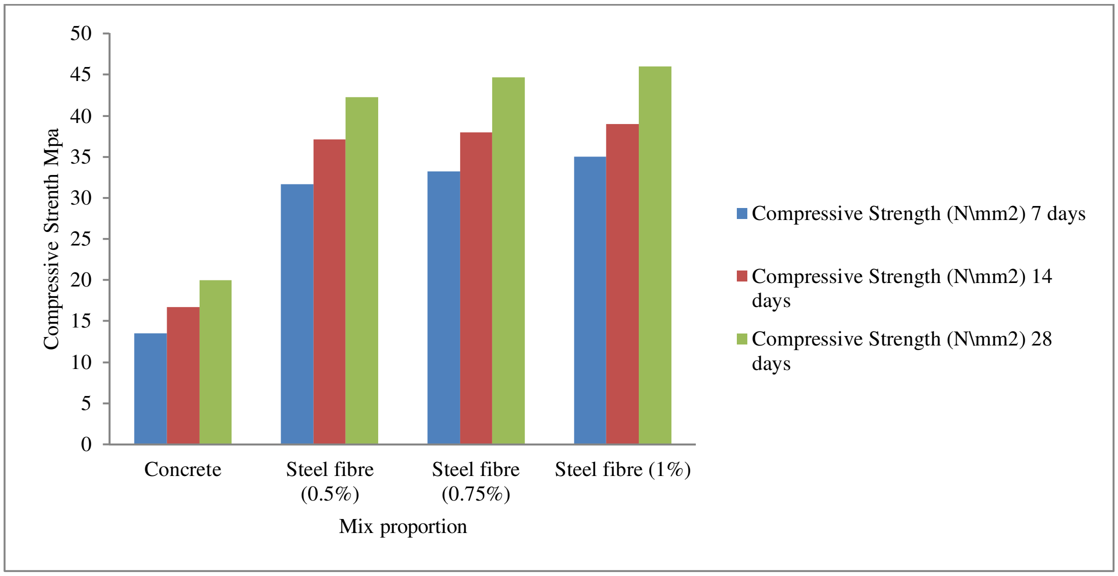


Figure 1: Compression Strength on 7,14 and 28 days

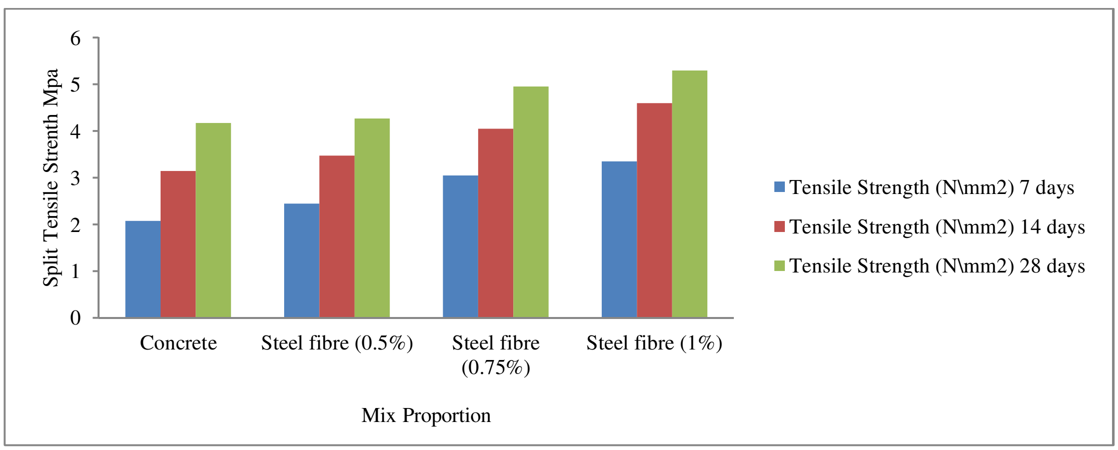


Figure 2: Split Tensile Strength on 7,14 and 28 days

VI. CONCLUSION

The following conclusions could be drawn based on the limited number of variables from the present investigation of steel fiber reinforced concrete.

Compressive strength of SFRC with increasing volume of fiber fraction shows same results with minor increase in value.

Tensile strength of SFRC increases with increase in aspect ratio of fiber

Tensile strength of SFRC increases with increase in volume of fiber fraction

In Addition of steel fibers to the concrete effects , the significant improvement of strength has observed due to the volume of fractions of fibres.

REFERENCES

[1] Amit Rai1, Dr. Y.P Joshi Colin D. Johnston, "Fiber reinforced cements and concretes" Advances in concrete technology volume 3 – Gordon and Breach Science publishes – 2001.

[2] Faisal Fouad Wafa ,Perumalsamy N. Balaguru, Sarendra P. Shah, ''Fiber reinforced cement composites'' , Mc Graw Hill International Editions 1992.

[3] ArnonBentur&SidneyMindess,''Fibrereinforcedcementitiouscomposites''Florida Institute of Technology and Florida International University.

[4] R. D. Neves and J. C. O. Fernandes de Almeida) Standard Test Method for Flexural Toughness and First Crack Strength of Fibre Reinforced Concrete (Using Beam with Third – Point Loading), 1991 Book of ASTM Standards, Part 04.02, American Society for Testing and Materials, Philadelphia, pp.507 – 513.

[5] Prafull Vijay1 , Sandeep Singh2 1,2School of Mechanical and Building Sciences, Vellore Institute of Technology, Vellore-632014.

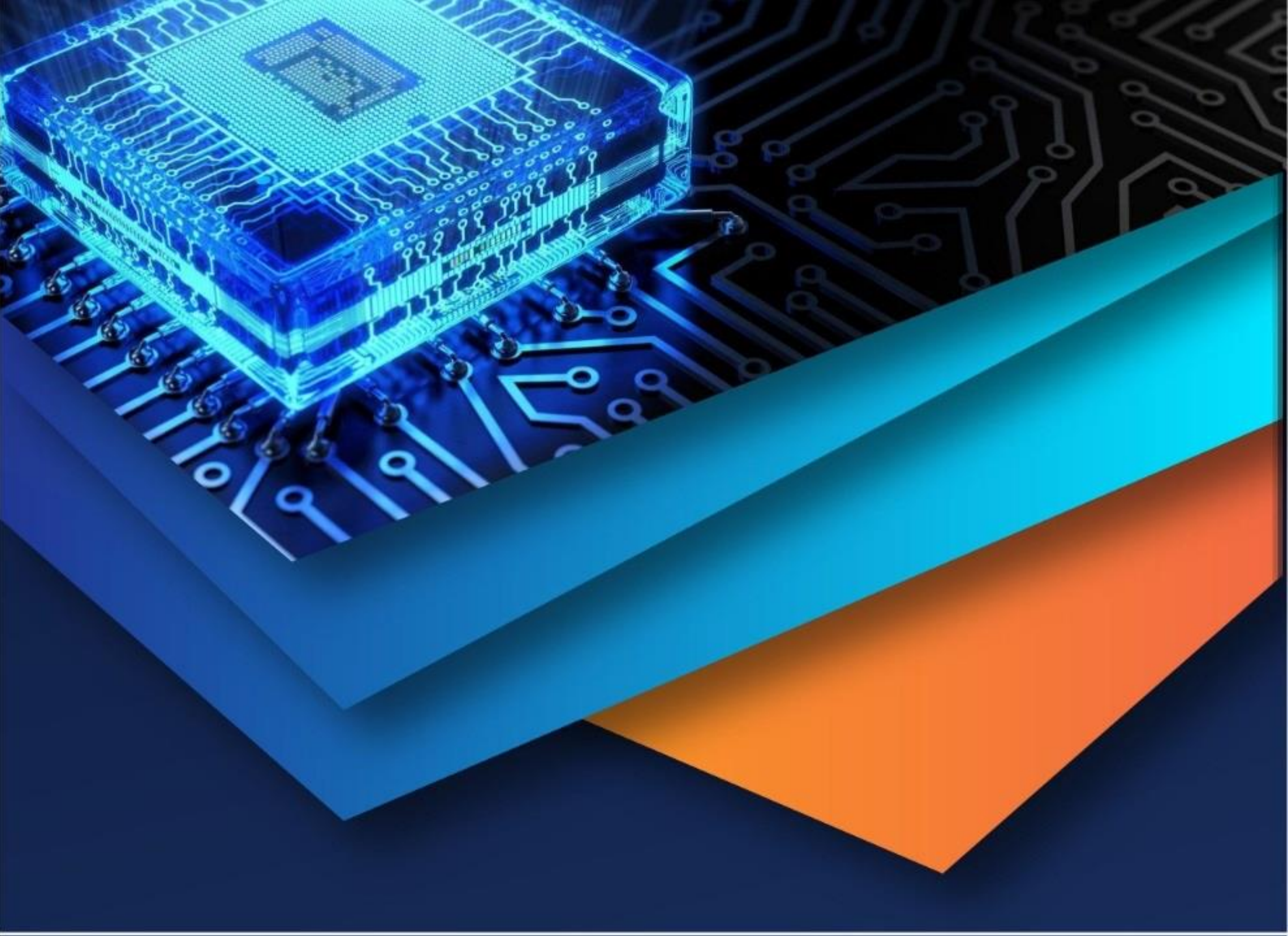
[6] S. Jagan,R. Gokul Kannan,S. Prasanth, Effect of Chopped Glass Fiber on Strength and Durability Of Concrete, International Journal of Civil Engineering and Technology (IJCIET), 2017, 8(11), PP600-608.

[7] E.Arunakanthi,J. D. Chaitanya Kumar, Experimental Studies on Fiber Reinforced Concrete (FRC), International Journal of Civil Engineering and Technology (IJCIET), 2016, 7(5), PP329-336.

[8] G.Musalaiah,BadeVenkataSuresh,MonicaTanniru,P.Ramakrishna Reddy, Development and Mechanical Characterisation of Glass Fibre Reinforced Polymer Composite, International Journal of Mechanical Engineering and Technology (IJMET), 2017, 8(7), PP231-239. .

[9] Rajesh D. Anandjiwala & Sunshine Blouw ,(2007), Composites from Bast Fibres-Prospects and Potential in the Changing Market Environment, Journal of Natural Fibers, 4:2, 91-109, DOI: 10.1300/J395v04n02_07.

[10] ACI committee, "State - of - the art report in fibre reinforced concrete'' ACI 554 IR – 82 Detroit Mechigan 1982.



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY