"Effect On Concrete Properties By Addition Of Carbon Fibres with Varying Aspect Ratio"

Ms. Jyoti J Gaikwad[1],
[1]*PG Scholar, Department of Civil Engineering,*
Dr.V.V.P. College of Engineering,
Ahmednagar, Maharashtra.
[1]*jjgaikwad20@gmail.com*

Prof. U.R.Kawade[2]
Project Guide &HOD of Civil Engineering,
Dr.V.V.P.College of Engineering,
Ahmednagar, Maharashtra.
[2]*urmilaanagar@gmail.com*

ABSTRACT -

Fibres are generally used as resistance of cracking and to improve strength of concrete. According to various research papers, it has bund that steel fibres give the maximum strength in comparison to other fibres. Fibre reinforced concrete has been successfully used in slab, beam, shotcrete, footing, hydraulic structure, structures in seismic regions and many other applications. The main objective of this research work is to study the effect on concrete properties while adding carbon fibre with 1% by volume of M-35 grade of concrete with varying aspect ratio-30,35,40,50,60 etc. Also adding fly ash 10% by weight of cement to make concrete.

KEY WORDS —Carbon fibre, Aspect Ratio, compressive strength, split tensile strength, Flexural strength,FRC

I. INTRODUCTION

Concrete is mostly used as a construction material in world wide.The basic ingredients of concrete mix are sand, gravel (aggregate), cement (binder) and water. Concrete is strong in compression but weak in tension.The weakness in tension of concrete can be reducing by the use of conventional reinforcement bars and to some extent by the addition of a sufficient volume of certain fibers. Through time, different materials have been added toconcrete in order to improve or alter its properties. The addition of fibres, such as steel, glass, polymeric materials,carbon to fresh concrete in order to improve properties of concrete. Carbon fibres are usually combined with other materials to form a composite. When they are combined with a plastic resin and wound or molded it forms carbon fiber reinforced polymer often referred to as carbon fibre which has a very high strength to weight ratio and it is rigid although somewhat brittile.

FRC has been successfully used in construction due to its excellent flexural-tensile strength, resistance to spitting, impact resistance and excellent permeability and frost resistance. Using fibres in concrete is an effective way to increase toughness, shock resistance and resistance to plastic shrinkage cracking. The most commonly used fibres are Steel fibre, Carbon-steel fibre, Glass fibre, Carbon fibre, Natural fibre, Synthetic fibre.These fibers increase structural properties such as compressive, tensile and flexural strengths, flexural toughness and impact resistance . Carbon fibers also increase durability and dry shrinkage. However, the addition of carbon fibers decreases the electrical resistance. Carbon fibers have low density, high thermal conductivity, good chemical stability and excellent abrasion resistance, and can be used to reduce or eliminate cracking and shrinkage

Fig 1 .carbon fiber.

II LITERATURE REVIEW

Peter Stynoski *et al.*(2015) Early age fracture surfaces of cement concrete containing carbon fibers were observed using a scanning electron microscope Further optimization of dosage, size, and interface strength is required to fully utilize carbon nanotubes in cementitious composites. carbon fibers to characterize changes in fracture properties. The early age hydration kinetics of cement pastes containing carbon nanotubes were compared using isothermal calorimetry.

Prashant Muley *et al.*(2015)The purpose of this research is based on the investigation of the use of short fibres in structural concrete to enhance the mechanical properties of concrete. The

objective of the study was to determine and compare the differences in properties of concrete containing no fibres and concrete with fibres, as well as the comparison on the effects of different volume of fibers to the concrete. This investigation was carried out using several tests, which included workability test, compressive test, split tensile test and flexural test. A total of five mix batches of concrete containing 0%, 0.25%, 0.5%, 0.75% and 1.0% fiber volume dosage rate on carbon fibers were tested to determine the enhancement of mechanical properties of concrete. The workability of concrete significantly reduced as the fibre dosage rate increases. In flexural and split tensile test showed specimens with fibres that drastic increase in strength from specimens without fibres.

Rishita A. et al.(2015)Fibres are generally used as resistance of cracking and strengthening of concrete. According to various research papers, it has been found that steel fibres give the maximum strength in comparison to other fibres. Fibre reinforced concrete has been successfully used in slab, beam, shotcrete, footing, hydraulic structure, structures in seismic regions and many other applications. The main objective of this research work is to study the effect of carbon steel fibre reinforcement with different percentage of fibre 0 %, 0.5%, 1%, 1.5% and 2% by volume for M-25 grade of concrete with aspect ratio-50. The carbon steel fibre reinforced concrete will be tested for compressive strength, flexural strength and split tensile strength. The percentage increase through utilization of carbon steel fibres will be reported.

S. M. Kinayekar*et al.*(2014)In this they concludes that carbon fibers can be effectively used as a reinforcing material in HSC cement content for HSC mix is replaced with fixed percentages of fly ash (10%) and carbon fiber are added in volume fraction (0 to 0.60%), also the Carbon Fiber Reinforced Polymer (CFRP) strip are placed in different layer (single, double and triple layer) with varying width of CFRP strip (0 to 80 mm). The hardened concrete properties of HSC were studied and the regression analysis was carried out on the experimental investigation.

III.OBJECTIVES OF INVESTIGATION

a) To find compressive strength of concrete by addition of carbon fibre with varying aspect ratio.

b) To check the split tensile strength of concrete by addition of carbon fibre with varying aspect ratio.

c)To check the Flexural strengthtest of concrete by addition of carbon fibre with varying aspect ratio.

IV.MATERIAL

The present research work is experimental and requires preliminary investigations in a methodological manner.

A. Cement

The cement used in this experimental work is Ordinary Portland cement- 53 grade according to IS 12269-1987.

Table 1 specification of grade 53 OPC Cement

Specific Gravity	3.15
Standard Consistency	32 %
initial Settng time	92 min
final Setting Time	376 min

B. Fine aggregate

Natural sand confirming to IS 383-1970 is used. Various test such as specific gravity, water absorption, impact strength, sieve analysis etc. have been conducted on fine aggregate to know their quality and strength.

Table 2.Specification for fine aggregate as per IS 383-1970

Sr. No.	Property	Specification
1	Particle shape size	4.75mm down
2	Fineness Modulus	2.6
3	Silt content	7%
4	Specific Gravity	2.6
5	Bulking of sand	4.2%
6	Water absorption	0.2%

C.Coarse Aggregate:

The nominal maximum size of coarse aggregate should as large as possible within the specified limits but in no case greater than one fourth of the minimum thickness of the aggregate. The aggregate of size 20mm were used confirming to IS 383-1970.

Table.3.Specification for coarse aggregate as per IS 383-1970

Sr. No.	Property	Specification
1	Particle shape size	20mm down
2	Fineness Modulus	4.95
4	Specific Gravity	2.69
6	Water absorption	0.23%

D.water

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. it is necessary that the water used in mixing shall be portable water.

E.Fly ash

Fly ash is used as a supplementary cementitious material (SCM) in the production of portland cement concrete.In this present study Fly ash is used 10% by weight of cement.

F.Carbonfibre :

Nature; Mineral Fiber
Fibretype : straight

Aspect ratio(l/d) varies 30,35,40,50,60 etc. Here diameter of carbon fibre is constant 0.5mm only length varies as 15, 17.5 ,20 ,25 ,30 etc.

V.Methodology:

For this test concrete mix design prepared by is method to find proportion of ingredients. Design proportion for M_{35} grade of concrete = 1: 1.35 : 2.39 .Adding 10% fly ash by weight of cement and also carbon fibreadded1 % by volume of concrete varying aspect ratio of 30,35,40,50,60etc to find compressive strength, split tensile strength and flexural strength etc.

Table 4Summary of Concrete Mix Design Observation and Calculation

1	Characteristic Compressive Strength	35 N/mm2
2	Degree of quality control	Good
3	Standard deviation(S)	5.0
4	Target mean compressive strength, Ft $=F_{ck} + 1.65\times S$	43.25 N/mm2
5	W/C ratio	0.41
6	Type of cement	OPC 53
7	Nominal size of coarse aggregate	20mm
8	Specific gravity of cement, Sc	3.15
9	Specific gravity of fine aggregate, S_{fa}	2.6
10	Specific gravity of coarse aggregate, S_{ca}	2.69
11	Water content per m3 of concrete	192 lit.
13	Cement content for W/C = 0.41	467Kg/m3
14	Total fine aggregate per m3 of concrete, Fa	635 Kg/m3
15	Total coarse aggregate per m3 of concrete, Ca	1118Kg/m3

Testing Program

1.Compressive strength test:

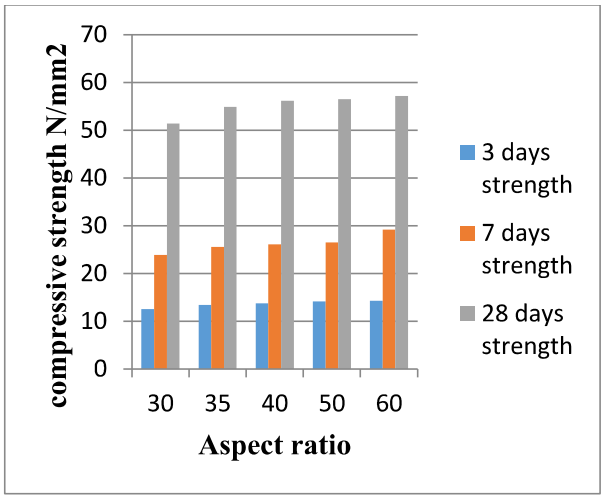
Compression test on the 150 mm x 150 mm x 150 mm cube specimens were conduct on the 1000 KN compressive testing machine. The specimens were cured in water for 28-days. The cube compressive strength is calculated as crushing load per unit area

F= P /A
F=Crushing Load (N or KN)
A=Area Of Cube (mm2)

Fig 2Compressive Strength Test

Table 5 compressivestrength test result

Sr. No	Aspect ratio	3 days Strength	7 days Strength	28 days Strength	Remark
1	30	12.52	23.89	51.36	As per clause No. 3.2, Page no.1 of IS: 10262-2009 compressive strength at 28 days for M35 concrete is **43.25MPa**
2	35	13.38	25.52	54.85	
3	40	13.74	26.09	56.12	
4	50	14.15	26.50	56.50	
5	60	14.27	29.19	57.15	



Graph 1 Compressive Strength after 3, 7 & 28 Days of Curing by adding carbon fiber.

2.Split Strength Test :

The split tensile strength test are carried on cylinderdiameter 150 mm and length 300 mm were casted and cured for 28 days. The split tensile strength of cylinder is calculated by the following formula:

$f = 2P / \pi D L$

Where, f=split Tensile strength, Mpa

P=Load at failure, N

L = Length of cylinder, mm

D = Dia. Of cylinder, mm

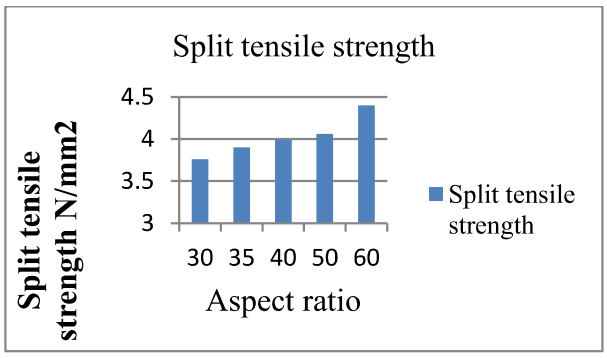
L = Length of cylinder, mm

D = Dia. Of cylinder, mm

Table 6 Split tensile strength result

Sr. No.	Aspect ratio	Split tensile strength	Remark
1	30	3.76	clause no.6.2.2 page no. 16 of IS: 456-2000 Split Tensile Strength of M35 grade conventional concrete is **4.14 MPa.**
2	35	3.9	
3	40	3.99	
4	50	4.06	
5	60	4.4	

Fig.3 Split tensile strength Test specimen



Graph No2. Split tensile Strength after 28 Days of Curing.

3. Flexural Strength :

Flexural strength test on the150x150x700mm were casted and cured for 28 days. The flexural strength is determined by the

$$fcr = P_f L / bd^2$$

Where,

fcr = Flexural strength, MPa

P_f = Central load through two point loading

L = Span of beam, mm

b = Width of beam, mm

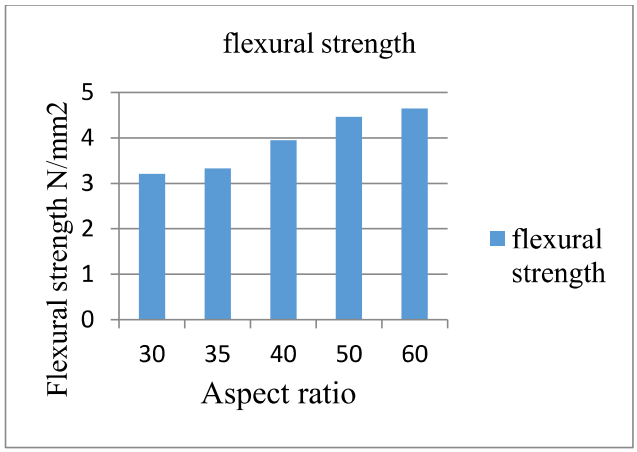
d = Depth of beam, mm

Fig.4 Flexural Strength of Concrete.

Three cubes of conventional concrete using carbon fiber were casted and their 28 days Flexural strength was estimated. The results for 28 day flexural strength test for concrete specimen are shown below

Table 7.Flexural Strength after 28 Days of Curing.

Sr. No.	Aspect ratio	Flexural strength	Remark
1	30	3.31	As per clause no.6.2.2 page no. 16 of IS: 456-2000 Flexural Strength of M35 grade concrete is **4.14MPa**
2	35	3.33	
3	40	3.95	
4	50	4.46	
5	60	4.65	



Graph 3Flexural Strength after 28 Days of Curing.

.

VI.CONCLUSION

The present experimental research work was carried out to evaluate the suitability of carbon fibre as a 1 % by volume Based on the analysis of test results we can conclude

- When aspect ratio of carbon fiber is increased then strength of concrete get increased.
- While adding carbon fiber in concrete showed increases in the compressive strength when the fibre aspect ratio get increased.
- While adding carbon fiber in concrete showed increases in the split tensile strength when the fibre aspect ratio get increased.
- Flexural strength of concrete increases as aspect ratio of carbon fiber aspect ratio is increased.

Experimental work was carried out using the facilities in Civil Engineering Department laboratory of D.V.V.P.COE, Ahmednagar. I wish to thank Prof. U.R. Kawade, my guide, HOD, Dr. S. L. Hake, ME Co-ordinatorfor their valuable Suggestions kind support. I also wish to thank the laboratory staff for their help and support during experimental work.

REFRENCES

1. Balaguru, P. (1994). Contribution of fibers to crack reduction of cement composites during the initial and final setting period. ACI Materials Journal. V. 91, No. 3, May-June, 280-288.
2. D.D.L. Chung," Cement reinforced with short carbon fibers: a multifunctional material" Composite Materials Research Laboratory, State University of New York at, Buffalo, NY 14260-4400, USA
3. IS 10262: 2009, "Indian Standard, recommended guidelines for concrete mix designs", Bureau of Indian Standard, New Delhi.
4. IS 2386 (Part I) -1963,"Methods of test for aggregates for concrete- Particle size and shape", Bureau of Indian Standards, New Delhi.
5. IS 456:2000, "Code of Practice for Plain and Reinforced Concrete," Bureau of Indian Standards, New Delhi, India.
6. IS 516:1959, "Method of tests for strength of concrete", Bureau of Indian Standards, New Delhi.
7. IS 516:1959, "Method of Tests for Strength of concrete", Bureau of Indian Standard, New Delhi.
8. IS 5816:1999,"Splitting tensile strength of concrete", Bureau of Indian Standards, New Delhi.
9. IS.383-1970,"Specifications for Coarse and Fine Aggregates from Natural sources for Concrete", Bureau of Indian Standards, New Delhi.
10. Johnston C. D. and Skarendahl A., 1992, Comparative flexural performance evaluation of steel fiber-reinforced concretes according to ASTM C1018 shows importance of fiber parameters, Materials and Structures, Volume 25, Number 148, May 1992, p.191-200
11. Johnston C. D., 1982, Steel Fiber Reinforced and Plain Concrete: Factors influencing Flexural Strength Measurement, ACI Journal, Volume 79, Number 14, March-April 1982, p.131-138.
12. M. Yakhlaf, Md. Safiuddin, K.A. Soudki," Properties of freshly mixed carbon fibre reinforced self-consolidating concrete"
13. M.Tech Scholar *Damyanti G. Badagha*, Professor *Dr. C. D. Modhera* , "Studies on harden properties of mortar using carbon fibres" International Journal of Advancements in Research & Technology, Volume 2, Issue 5, M ay-2013 249 ISSN 2278-7763
14. Nanni A., and ACSE, 1992, Properties of Aramid-Fiber Reinforced Concrete and SIFCON, Journal of Materials in Civil Engineering, Volume 4, Number 1, February 1992, p.1-13.
15. Peter Stynoski , ParamitaMondal , Charles Marsh,"Effects of silica additives on fracture properties of carbon nanotube and carbon fiber reinforced Portland cement mortar" University of Illinois at Urbana-Champaign, Department of Civil and Environmental Engineering, 205 N Mathews Avenue, Urbana, IL 61801, USA, Noyes Publications, New Jersey, United State of America.
16. RatanKharatmol , PankajSananse ,RohitTambe, Ms.RakshaJ.Khare" Strengthening of Beams Using Carbon Fibre Reinforced Polymer" International

Journal of Emerging Engineering Research and Technology Volume 2, Issue 3, June 2014, PP 119-125

17. S. M. Kinayekar, Dr. V. D. Gundakalle, KishorKulkarni,"The Effect of Addition of Carbon Fibers on Mechanical Properties of High Strength Concrete"IJIRSETVol. 3, Issue 1, January 2014
18. Toutanji, H. A. and Saafi, M., "Flexural Behavior of Concrete Beams Reinforced with Glaass Fiber-Reinforced Polymer (GFRP) Bars," ACI Structural Journal, Vol. 97, No. 5, September-October 2000, pp. 712-719.