International Journal of Engineering Research ISSN:2319-6890(online),2347-5013(print)
Volume No.5 Issue: Special 3, pp: 555-557 27-28 Feb. 2016

Effect of Carbon Fibre Reinforcement on Shear Strength of Concrete

V. G. Kulkarni, P. B. Murnal
Department of Applied mechanics, Government College of Engineering, Aurangabad, Maharashtra
E- mail vivekgkulkarni@gmail.com

Abstract: ***In this paper the results obtained by an experimental program are shown. To check the shear strength of concrete here carbon fibres are mixed in concrete. Concrete of grades M-20, M-30 and M-40 were taken. Carbon fibres are mixed in concrete with percentage of carbon fibres 0.5%, 1.00% and 1.50% of cement weight. For testing of shear strength shear cubes are prepared. For same grade of concrete compressive strength and shear failure of beam were taken. The samples were checked after 7days of curing and 28 days of curing. Based on the results it was observed that with the help of carbon fibre the shear strength of concrete increases.***

Keywords: Carbon fibres, compressive strength, shear cubes, shear strength, shear failure

1. Introduction

Concrete made with port land cement has certain characteristics; it is relatively strong in compression but weak in tension & tents to brittle. The weakness in tension can be overcome by the use of conventional rod reinforcement & to some extent by the inclusion of sufficient use of certain fibre(1).The tension problem can be alleviated by addition of short carbon fibres (typically 10 micro meter in diameter), an experiment conducted in Japan showed that the use of carbon fibres of 1.5% of volume of cement increased flexural strength of concrete twice(2-6). Use of fibre also alters the behavior of fibre matrix composite after it has cracked, there by improving itôs toughness(7).

Low toughness characteristics can results in sudden and catastrophic shear failure for concrete with high compressive strength. It is observed that with the help of carbon fibre increase in flexural strength of 85% & flexural toughness by 205% at 28 days of curing can be achieved. The optimum length of carbon fibre is found to be 12 mm (7). In this paper the effect of addition of fibres on shear strength of beam is studied experimentally. It has been shown that there is a significant increase in shear strength using fibres and the effect can be incorporated in design process.

2. EXPERIMENTAL INVESTIGATION

2.1 Experimental program

The material used for making concrete with carbon fibre are carbon fibre , having length 12mm , coarse and fine aggregate, cement (Ultratech), water. The properties of carbon fibre are i) chopped strand type having chop length= 12mm, ii) carbon content= 95% iii) specific heat = 0.17cal/g °C. iv) volume resistivity = 2.0 x 10^-3 Ý cm.v) Elongation= 1.8% vi) tensile strength 4,300 MPA. And vii) Bulk density is 554g/litre. It was bought from ōMuktagiri Industrial Corporation, Borivali East, Mumbai(4). The properties of Coarse aggregates comprising of maximum size 20mm having i) fineness modulus= 5.426,ii) bulk density= 1610 Kg/m^3 and iii)specific gravity= 2.74 were used. The properties of Fine aggregate (sand) are i). Zone= zone 1 as per IS 383-1970.ii) The specific gravity = 2.272 and iii) fineness modulus= 3.169. Both aggregates were in surface dry condition. The cement used for experiment was of Ultratech Company. It is a 53 grade ordinary Portland cement. It has a specific gravity 3.12.Potable water was used for making concrete.

The mix design was made as per IS 10262-1982. For the experimental purpose we have designed the concrete mix of grade M-20, M-30 and M-40.

The specimen used for shear testing is a beam with dimensions 500mm x 100mm x100mm i.e. length = 500 mm, breadth = 100 mm, height = 100 mm. It was tested using a support spacing of 400 mm. Fig.1 shows the typical view of the beam and loading.

In this experiment a beam is designed in such a way that the failure of the beam must be fail in shear. Considering this condition the reinforcement in the beam as explain below.

A beam having reinforcement at bottom with 2 bars of 6mm diameter and two bars in the middle portion of length L/2 leaving behind the length L/4 from both ends was casted. The samples were tested for 28 days of curing having percentage of carbon fibre 0%, 0.5%, 1% and 1.5% .These beams were tested for failure of shear or flexural with two point load. The results obtained are shown in table no 1. The photograph of beam at failure after loading is shown in fig. No.2

The permissible shear stress taken as per hand book for limit state design of R.C.C. Hence beam will fail in shear but safe in flexure. The abstract of above results are given in table No. 1

2.2 Results And discussion

From observation table No.2 it is seen that:-

i)The increase in failure load for M-20 grade of concrete is 14.69%, 25.07% and 49.27% for 0.5%, 1% and 1.5% of carbon fibre content respectively.

ii) The increase in failure load for M-30 grade of concrete is 5.94%, 17.84% and 59.40% for 0.5%, 1% and 1.5% of carbon fibre content respectively.

iii) The increase in failure load for M-40 grade of concrete is 17.24%, 30.60% and 52.15% for 0.5%, 1% and 1.5% of carbon fibre content respectively.

Now in this case - computed Ų value for M-20, M-30 and M-40 grade of concrete containing carbon fibre content 0.5%, 1% and 1.5% as follows:-
Ų = V_v/(b*d),here V_v considered as a failure load, b = 100mm and d = 75mm.

Taking these values - computed values of permissible shear stress(Ų) as mentioned in Table 2
Here it can be observed that permissible shear stress (Ų) increases 0.6584 N/mm^2 to 1.135 N/mm^2 for M20 grade of concrete with 1.5% of carbon fibre content and so on. It is also observed that deflection also increases as percentage of carbon fibre increases.

The graphical representations of Shear strength having percentage of carbon fibre for M-20, M-30 and M-40 grade of concrete and sample load-deflection curves for M20 grade of concrete are as shown in Fig. No.3 and 4.

Figures and Tables

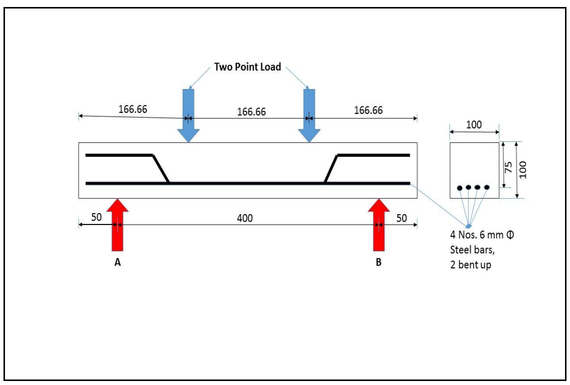
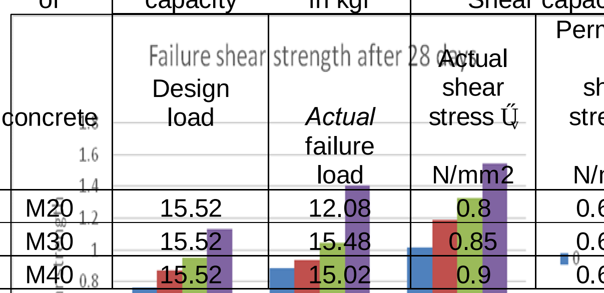


Table No. 1: Flexural capacity & shear capacity of beam

Figure no. 1

Fig.No. 2 Loading & failure of beam

Fig. No.3: Failure Shear Strength of beam



Grade of concrete	Flexural capacity in kgf		Shear capacity	
	Design load	*Actual* failure load	Actual shear stress $Ų_v$ N/mm2	Permissible shear stress Ų N/mm2
M20	15.52	12.08	0.8	0.6584
M30	15.52	15.48	0.85	0.6584
M40	15.52	15.02	0.9	0.6584

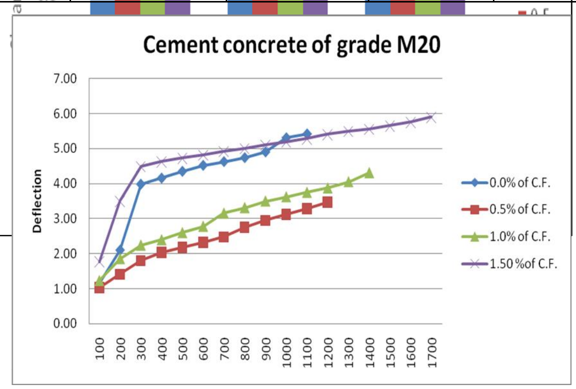


Table no.2 Averages of load, deflection & Shear Strength

Fig. No.4: load-deflection curves for M-20

International Journal of Engineering Research ISSN:2319-6890(online),2347-5013(print)
Volume No.5 Issue: Special 3, pp: 555-557 27-28 Feb. 2016

Conc. Grade	% of Carbon fibre of cement content by weight	Total Load Kgf	Shear load At failure Kgf	Average Shear strength N/mm^2 (τ_c)	Average Deflection in mm
M20	0	1156.6	578.33	0.760	5.56
	0.5	1326.6	663.33	0.872	3.96
	1	1446.6	723.33	0.951	4.58
	1.5	1726.6	863.33	1.135	6
M30	0	1346.6	673.33	0.885	4.82
	0.5	1426.6	713.33	0.938	4.89
	1	1586.6	793.33	1.043	4.95
	1.5	2146.6	1073.3	1.411	5.66
M40	0	1546.6	773.33	1.017	6.13
	0.5	1813.3	906.67	1.192	6.88
	1	2020	1010.0	1.328	6.7
	1.5	2353.3	1176.6	1.547	6.84

3.CONCLUSIONS

In this work, an attempt has been made to experimentally study the behavior of carbon fibre reinforced concrete under shear. The material shear strength and member shear strength are estimated. The experiment has been carried out for a range of concrete mixes and different percentage of carbon fibres. Based on the work, following conclusions are made :-

i)The value of shear strength (τ_c) increased by 171.62% in M20, 214.30% in M30 and 227.82% M40 grade of concrete using carbon fibre 1.5%.

ii)These values can be used in designing beams for shear using carbon fibre.

REFERENCES

i. "Fibre Reinforced Concrete", Cement and Concrete Institute, Midrand, 2010, Source: www.sciencedirect.com/science, 23-February-2013.

ii. Bensaid Boulekbache, Mostefa Hamrat;"Influence of yield stress and compressive strength on direct shear behavior of steel fibre reinforced concrete", Construction and Building Materials Journal, Vol. 27, 2012, Pages 6-14.

iii. Dragos. Marian Bontea, D.D.L Chung, G.C. Lee. "Damage in carbon fibre reinforced concrete, monitored by electrical resistance measurement.", Cement and Concrete Research Journal, Vol. 30, 2000, Pages 651-659.

iv. Muktagiri Industrial Corporation, Mumbai, Raw Material Supplier.

V .H. Saadatmanesh, M. R. Ehsani, and M. W. Li "Strength and Ductility of Concrete Columns Externally Reinforced with Fiber Composite Straps", ACI journal, Title 91-S43, July-Aug 1994.

vi. Amir Z. Fam; "Carbon Fibre Reinforced Plastic Pre stressing and Shear Reinforcement for Concrete Highway Bridges", MS Thesis, Department of Civil and Geological Engineering, University of Manitoba, Winnipeg, 1995.

vii. D.L Chunge, "Carbon Fibre reinforced concrete", Strategic Highway Research Program, National Highway Research Council, SHRP-ID UFR-92-605,1992

viii. H.Hahne, S. Karl and J. Worner, "Fibre Reinforced Concrete Properties and Applications," SP 105, American Concrete Institute, 1997, Pages 211-223.

ix.R. Lankard and K. Newell,"Fibre reinforced concrete", Int. Symp.,p-81, American Concrete Institute, 1984, Pages 287-306.

x.Zeng-Qiang Shi, D.D.L.Chung, "Carbon fiber-reinforced concrete for traffic monitoring and weighing in motion", Cement and Concrete Research Journal, Vol. 29, 1999, Pages 435-439

xi.Abdelhak Bousselham, Omar Chaallal; "Behavior of reinforced concrete T-beams strengthened in shear with CFR, Experimental Study", ACI Structural Journal, Title No. 103-S35, May-June 2006.

xii.V.K.Ghanekar and J.P.Jain ,"Hand book for limit state design of R.C.C

.