International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 05 Issue: 07 | July - 2021 ISSN: 2582-3930

STRENGTHENING OF R.C BEAM USING CARBON FIBRE REINFORCED POLYMER STRIPS

Monika Anil Roham[1*], Dr. Sachin Mulay[2*]

[1]*M.tech Student Department of civil engineering, Sandip* University, *Nashik*

[2]*Associate professor, Department of civil engineering, Sandip University, Nashik*

Abstract: The Carbon Fibre Reinforced Polymers composite is utilize in upgrading structural members to increase their capacity. The strengthening of R.C beam using internally reinforcement of carbon fibre reinforced polymer (CFRP) fabric is an effective method to improving shear strength of R.C beam. The CFRP fabric is use to increase load condition and also decrease the deflection and small crack. This project represents experimental data of casting R.C beam. The stirrups are replaced by the 10mm and 20mm of CFRP strips and the experimental readings are obtained. The readings are studied by comparing them with plain simple beam.

Keywords: Shear Strengthening, CFRP Fabric, CFRP strips, FRP, ultimate load, CFRP wrapping patterns.

1. Introduction:

Since decades, steel is being used as reinforcing material in concrete structures to provide strength and ductility. However, steel is susceptible to corrosion in presence of oxygen and moisture [19].Durability concern of steel reinforced concrete structures pushed the researchers to find the remedies for such problem and look for some more durable and reliable materials. In last decades Fibre Reinforced Polymers got considerable attention as substitute material of steel in reinforced concrete structures. Use of Carbon Fibre Reinforce Polymer strips as internal reinforcement is technically sound and practically efficient method of strengthening and upgrading reinforced concrete member. FRP are being used in reinforced concrete structures featuring their light weight, high tensile strength, non-magnetic and corrosion resisting properties, contrasting conventional steel reinforcement [19]. The CFRP fabric use to increase in load condition and also decrease the deflection and small crack. In reinforced structure (RC) structure the corrosion of steel reinforcement is a major cause of deterioration. Since the use of FRP (Fibre Reinforced Polymer) material is improving to solve the major problem for increase the service life of structure [2]. It can be also used for repair and damage structure it is called as retrofitting. There may be reason for deterioration of structure such as error in design and construction, environmental, corrosion in steel, earthquake, accidental event or it may be error caused due to time of construction. It has been shown that the corrosion of the reinforcing bar can significantly affect the strength and ductility of concrete structure [20].So for this purpose the strengthening technique has developed to get strength requirement. There are various FRP materials available in market such as CFRP, GFRP and Aramid etc. The FRP material is widely used but more research is required to be carried out for strengthening. If we consider a normal beam with steel stirrups it has more width of crack and has less avg. ultimate load [6]. So in this paper we exactly solve how to increase a load capacity on it so that it can carry shear. In this project we are going to increase the shear strength with CFRP fabric strips of 10mm and 20mm with various wrapping pattern.

2. Review of Literature:

Beam has always been a subject of interest in structural engineering practice. With the strong growth of construction work in many developing countries, beam design and its behavior prediction is a subject of considerable relevance. The strengthening of R.C beam with various wrapping pattern as different configuration of varying thickness are shown below: Ehab.A.Ahmed et.al. focused on CFRP stirrups on bridge girder. Shraddha.B.Thibe focused on torsional behavior of R.C beam with externally wrapping of CFRP and GFRP fabric.Sandeep Agharal studied on torsional strengthening of R.C. beam with GFRP laminations

3. Experimental Work:

The experimental work carried out contains casting of beams with different stirrup pattern. The beams of size 150mm*300mm*1000mm were casted. Total eleven beams were casted in which one beam was a normal beam and remaining ten beams were wrapped by CFRP strips of 10mm and20mm.

The R.C beams were casted by using M25 grade of concrete 53 grade of ultra tech OPC cement. The size of coarse aggregate was taken as 20mm throughout.

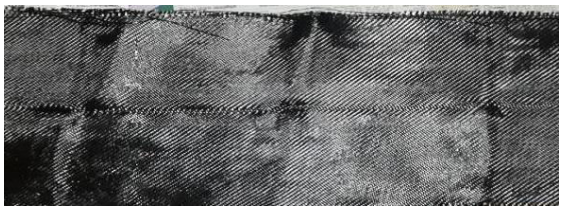


Figure 1.CFRP Fabric

The five beams were casted of 10mm strips stirrups and remaining five were casted of 20mm strips.

Figure 2. 10mmm CFRP strips

Figure 3. 20mm CFRP strips

4. Methodology:

The R.C beams were casted with different wrapping pattern as fallow:

Stirrups at L/3 ,at 0.75d , at L/4, spiral shape stirrups and plus sign stirrups. The R.C beam was casted with top reinforcement 2-10 for M25 grade of concrete 53 grade of ultra tech OPC cement.

Wrapping patterns:

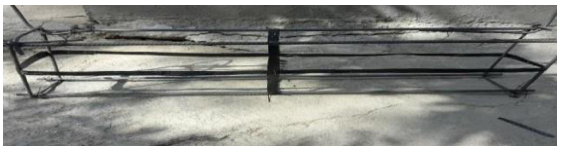


Figure 4. 20mm strips wrapping patterns.

Figure 5. 10mm strips wrapping patterns.

After the casting and curing process the two point load test is carried out on the UTM at 300mm and 700mm.

Figure 6. Two point load test setup

5. Test Result and Discussion:

Below table shows the results for all the wrapping patterns:

1) The first crack load of Normal beam is 20KN which is less in all above wrapping pattern.
2) L/3 ratio and L/4 ratio is for 20mm strips is highest i.e 44.29KN and 46.85KN
3) The percentage increase in shear strength for L/3 ratio and L/4 for 20mm strips is 130 %.

Sr. No	Test Beam	Average Crack Load	Average ultimate load	Percentage increase in load
1	Normal Beam	20 KN	26.500 KN	-
2	L/3 10mm	31.24 KN	39.700 KN	49.81
3	L/3 20mm	44.29 KN	60.950 KN	130
4	0.75d 10mm	20.31 KN	24.350 KN	-8.11
5	0.75d 20mmm	32.65 KN	36.500 KN	37.92
6	Plus sign 10mm	22.19 KN	26.500 KN	0
7	Plus sign 20mm	29.36 KN	36.500 KN	38.30
8	L/4 10mm	32.69 KN	35.850 KN	35.28
9	L/4 20mm	46.85 KN	60.950 KN	130
10	Spiral shape 10mm	32.69 KN	34.350 KN	29.62
11	Spiral shape 20mm	39.72 KN	44.200 KN	66.79

The graphical representation of result obtain is as fallow:

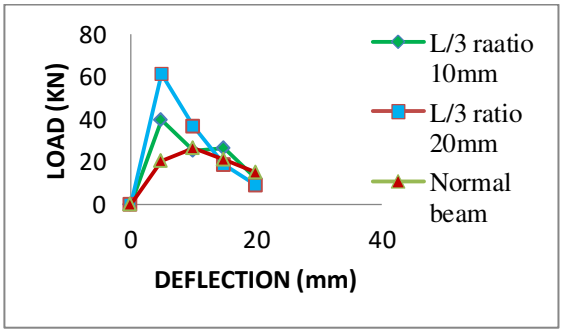


Figure 7. Load vs. deflection for L/3 ratio 10mm and 20mm strips.

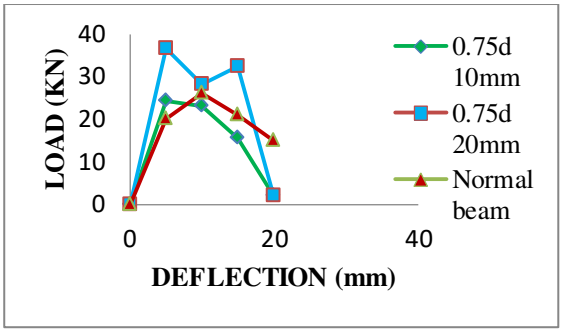


Fig: 8. Load vs. deflection for 0.75d for 10mm and 20mm strips

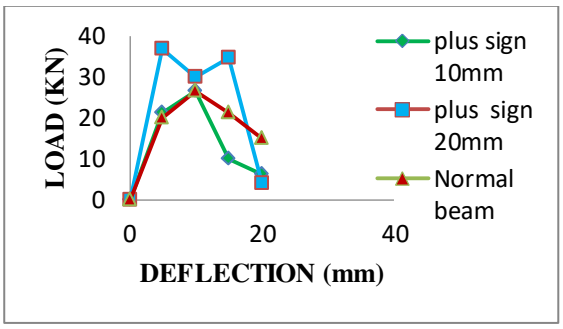


Fig:9. Load vs. deflection for Plus sign 10mm and 20mm strips

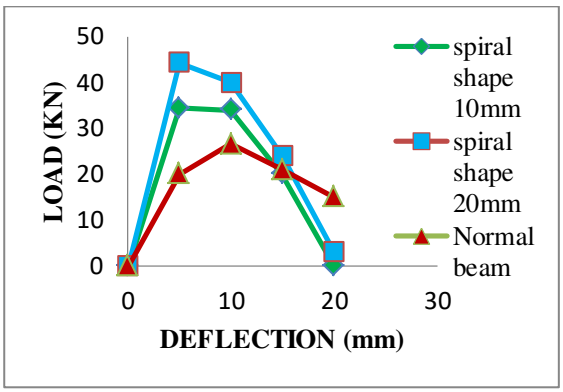
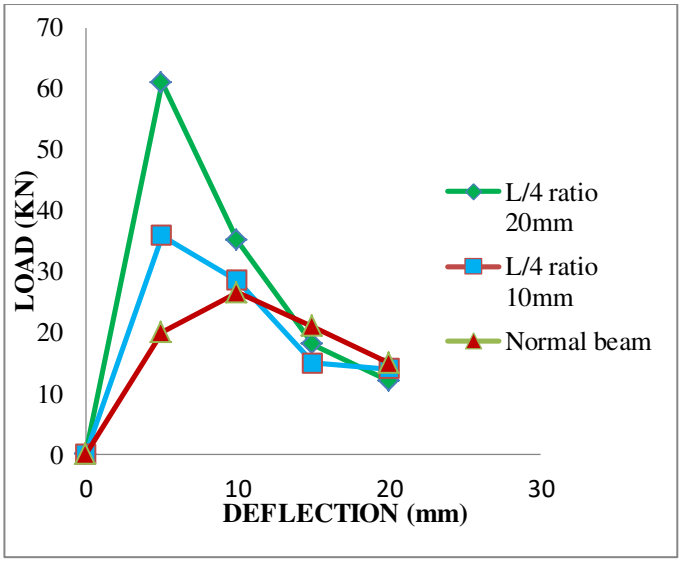


Fig:10. Load vs. deflection for spiral 10mm and 20mm strips



6. Conclusion:

1) It is observed that shear strength taking capacity of L/3 ratio 20mm and L/4 ratio 20mm strips has highest value.
2) The spiral shape 20mm strips and L/3 ratio 10mm strips has increase by 66.79% and 49.81% with respectively to Normal beam.
3) The maximum increase in shear strength is about 130% for both 20mm strips L/3 ratio and L/4 ratio strips.
4) As we compared a normal beam with CFRP strips, it has proved that CFRP strips having maximum shear strength than steel stirrups.
5) We can also say that crack width decrease due to the CFRP fabric strips.
6) Hence, we can conclude that the shear strength has maximum value for CFRP fabric strips than Normal beam.
7) As we consider the wrapping patterns of CFRP fabric 10mm and 20mm strips both are proved to more efficient in shear strength.

7. References:

1) C.Diagana, "Shear Strengthening effectiveness with CFRP strips," Engineering Structures 507-516, 2002.
2) W.Punurai and H. Baian,"Flexural strengthening of reinforced concrete using CFRP strips, "Concrete research– Engineering Sciences, 2003.
3) Khaled Soudki and Ahmed K, "Strengthening of concrete slab column connections using CFRPS," Journal of King Saud University – Engineering Sciences, pp.25-33, 2011
4) C. E. Chalioris & E. F. Sfiri, "Shear Performance of Steel Fibrous Concrete Beams," Procedia Engineering pp. 2064–2068, 2011.
5) M. Nagai.et.al, "Bonding characteristics and flexural stiffening effect of CFRP strand sheets bonded to steel beams," Procedia Engineering 40, pp. 137 – 142, 2012.
6) Asad ur Rehman Khana & Shamsoon Fareeda,"Behaviour of Reinforced Concrete Beams Strengthened by CFRP Wraps with and without End Anchorages," Procedia Engineering 77,pp. 123 – 130,2014.
7) Blkasem Salah Elrawaff and Noridah Binti Mohamad,"Shear Strengthening of Reinforced concrete Beams using CFRP," HBRC Journal, pp 107–114,2014.
8) Omar A. Farghal, "Fatigue behavior of RC T-beams strengthened in shear with CFRP sheets," Ain Shams Engineering Journal 5,pp. 667–680,2014.
9) A.M. Tarabia& H.F. Albakry,"Strengthening of RC columns by steel angles and strips,"Alexandria Engineering Journal, pp 615–626,2014.
10) Franklin F.R Frederick et.al,"Effect of end anchorage in external CFRP confinement on shear damaged RC beams," Procedia Engineering 125, pp. 953 – 958,2015.
11) Ali Chahrour and Khaled Soudki,"Flexural Response of Reinforced Concrete Beams strengthened with end Anchored partially bonded Carbon Fibre Reinforced Polymer strips," Article history:,ppl 1-19,2015.
12) Tara Sena & Ashim Paul,"Confining concrete with sisal and jute FRP as alternatives for CFRP and GFRP," International Journal of Sustainable Built Environment," pp. 248–264,2015.64,2015.
13) Anthony J Lamanna and Lawrence C.Bank,"Flexural strengthening of Reinforced concrete beams by mechanically attaching fibre reinforced polymer strips,," pp 140 – 147,2015.
14) Ahmed M. Khalifa,"Flexural performance of RC beams strengthened with near surface mounted CFRP strips," Alexandria Engineering Journal pp. 1497–1505,2016.
15) Dr.G.S.Suresh1 & Shreesh Kulkarni, "Experimental study on behaviour of RC deep beams," International Research Journal of Engineering and Technology, pp.676-679, 2016.
16) Rasha T.S. Mabrouk, "Effect of flexural and shear reinforcement on the punching behavior of reinforced concrete flat slabs," Alexandria Engineering Journal 56,pp. 591–599,2017.
17) Kazunori Fujikake, "CFRP strengthened RC beams subjected to impact loading," Procedia Engineering 210, pp. 173–181, 2017.
18) Rafid Saeed Atea, "Torsional behaviour of reinforced concrete T-beams strengthened with CFRP strips," Case Studies in Construction Materials 7 pp. 110–127, 2017.
19) Muhammad Tahir and Zhenyu Wang, "Shear Behaviour of concrete beams reinforced with CFRP strip stirrups using wet layout technique," pp-361-368, 2019.
20) Sophia C, "Efficiency of CFRP strip as a substitute for carbon steel stirrups in RC column," pp-2062-2067, 2020.