An Experimental Study on Flexural Behaviour of RC Beam Strengthened by Wiremesh and AFRP Sheet

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Abstract- *The use of fiber reinforced polymer (FRP) composites is significantly growing in construction and infrastructure applications where durability under harsh environmental conditions is of great concern. In this study, Experimental work is conducted to evaluate the flexural behaviour of RC beam retrofitted with Wire mesh and Aramid fibre. In this work beams are casted using M20 & M25 grade of concrete, total 54 beam was casted out of them 27 beam are using M20 and other 27 using M25. The beam size is 150 mm x 150 mm and of 700 mm in length, designed as per IS456-2000. Two point loading test has to be conducted on controlled and strengthened beams by varying the wrapping pattern of wire mesh and aramid fibre. The experimental results are compared with the Wire mesh and Aramid fibre.*

Keywords- strengthening, flexure, AFRP Sheet, Wiremesh, retrofitting, concrete.

I. INTRODUCTION

The term retrofitting is defined as modifying existing structure with additional or by using new component. Reinforced concrete is one of the most abundantly used construction material, not only in the developed world, but also in the remotest parts of the developing world. The RCC structures constructed in the developed world are often found to exhibit distress and suffer damage, even before their service period is over due to several causes such as improper design, faulty construction, change of usage of the building, change in codas provisions, overloading, earthquakes, explosion, corrosion, wear and tear, flood, fire etc.

Such unserviceable structures require immediate attention, enquiry into the cause of distress and suitable remedial measures, so as to bring the structure into its functional use again. In the last few decades several attempts have been made in India and abroad to study these problems and to increase the life of the structures by suitable retrofitting and strengthening techniques. Of the various retrofitting techniques available, plate bonding is one of the most effective and convenient methods of retrofitting.

II. MATERIAL PROPERTIES AND MIX PROPORTIONS

A. Materials

Cement

Ordinary Portland Cement of 53 Grade manufactured by siddhi cement company was used in concrete mixes corresponding to IS-8112. The specific gravity of cement is 3.15.

Sand

Natural river sand is used as fine aggregate. As per IS: 2386 (Part III)-1963 , the bulk specific gravity in oven dry condition and water absorption of the sand are 2.65 and 1.70% respectively.

Aggregate

Crushed stones of maximum size 20 mm are used as coarse aggregate. As per IS: 2386 (Part III)-1963 [6], the bulk specific gravity in oven dry condition and water absorption of the coarse aggregate are 2.85 and 0.80% respectively.

Water

Portable water was used to prepare the concrete mix and for the curing.

Aramid fiber

Aramid Fiber is also known as keveler fiber. Aramid fiber is also high strength, tough and highly oriented organic fiber derived from polyamide incorporating into an aromatic ring structure. Aramid is used in bullets resistance jacket. This fiber is quite abrasive and under repeated loading they can abrade against each other by weakening the sheets. Aramid fiber is a family of synthetic products characterized by strength some five times stronger than steel on an equal weight basis and heat-resistance and high tensile strength. Physical properties of Aramid fiber are given in Table 1.

Wiremesh

The Wire mesh is made of metallic or other suitable materials. The fineness of the mortar matrix and its composition should be compatible with the mesh and armature systems it is meant to encapsulate. The matrix may contain discontinuous fibers. A wire mesh is made up of uniformly crossed wires in regular patterns to form a barrier or screen. The patterns can be large or small, square or polygonal depending upon the purpose or application of the end product. From providing perimeter markings to concrete construction applications, this wire mesh is used in a variety of ways today.

Table 1. Physical properties of AFRP Sheet

ITEM	DATA	UNIT
Width	1	m
Thickness	0.4	mm
Breaking strength	2400	N/mm^2
Elongation	3.50	%
Price	1350	INR

Table 2. Physical properties of Wiremesh

ITEM	DATA	UNIT
Diameter	14	mm
Tensile Strength	510	N/mm^2
Yield Strength	275.5	N/mm^2

Admixture

An epoxy resin with hardner was used to glue the AFRP sheet on beam.

Table 2. Properties of coarse aggregate (20 mm)

Test	Result	Unit
Spacific gravity	2.85	-
Water absorption	0.80	Percentage
Impact factor	16.50	Percentage
Flakiness index	28	Percentage
Elongation index	22.80	percentage
Bulk density	1.5	gm/cc

Table 3. Properties of coarse aggregate (10 mm)

Test	Result	Unit
Spacific gravity	2.83	-
Water absorption	0.90	Percentage
Impact value	14.10	Percentage
Flakiness index	27.70	Percentage
Elongation index	19.80	percentage
Bulk density	1.5	gm/cc

Table 4. Properties of Sand

Test	Result
Finesse Modulus	2.52
Conforming Zone	II
Specific Gravity	2.65
Water Absorption	1.70%
Bulk Density	1.20

B. Mix Design

A standard mix M20 and M25 grade was calculated as per Indian Standard (IS 10262-2009). For each binder content, the W/C ratio were 0.45 and 0.50 respectively were determined by trial mixtures. The mix design is given in Table 5.

Table 5. Mix design for M20 and M25 grade of concrete

Grade	M20	M25
Mix Ratio		
Water (Kg)	177	191.6
Cement (Kg)	402.27	383.2
Coarse aggregate (Kg)	1221	1143.18
Fine aggregate (Kg)	695	691.63
W/C ratio	0.44	0.50

C. Casting Procedure

For preparing concrete, a batch mixer was used. Firstly, all the materials are weighted on weighting scale as per quantity of mix design. Then coarse aggregates, fine aggregates, cement, were mixed without water until proper dry mix. Then added water and run batch till proper mix.

Fig 1 Casting of beam.

For Flexural strength, tests were conducted on 150x150x700 mm beam moulds, after 28 days of proper curing. 3 specimens were casted and tested for each combination.

Fig 1 De-moulding of beam.

III. EXPERIMENTAL WORK

A. Beam Reinforcement details

HYSD Fe 500 is use for steel reinforcement work, 10 mm diameter are use as longitudinal steel and 8 mm diameter are used as shear reinforcement @ 150 mm centre to centre.

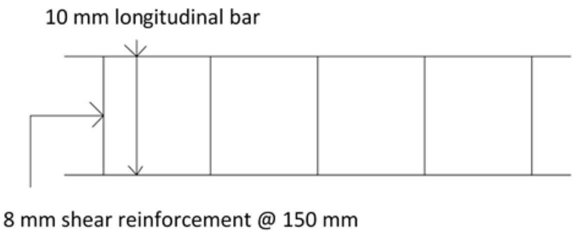

Fig 3 Beam Reinforcement details

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B. Testing of beam

For testing of beam universal testing machine (UTM) is used, load is applied for initially crack load and ultimate load for control specimen. After the cracking the all beams beam are retrofitted with different pattern of wiremesh and AFRP sheet with the help of hardener and resin (1:2) ratio.

Fig 4 Testing setup of UTM

Fig 5 Appling resin and AFRP sheet

Fig 6 Two point load for Flexural test after retrofitting using AFRP Sheet.

Fig 7 Retrofitting of beam using wiremesh.

Fig 8 Strip wrapping using wiremesh

Fig 9 Two point load for Flexural test after Retrofitting using wiremesh

C. Testing Results.

After retrofitting of beam the test is carried out and results are list down below tables.

Table 6. Average Ultimate load on Retrofitted Specimen for AFRP sheet

Sr no	Wrapping Pattern	Average Ultimate load on Retrofitted Specimen in KN	
		M-20	M-25
1	Full- U	102.00	163.70
2	1/2 -U	100.38	158.96
3	Bottom	94.38	151.46
4	Strip	86.38	138.45

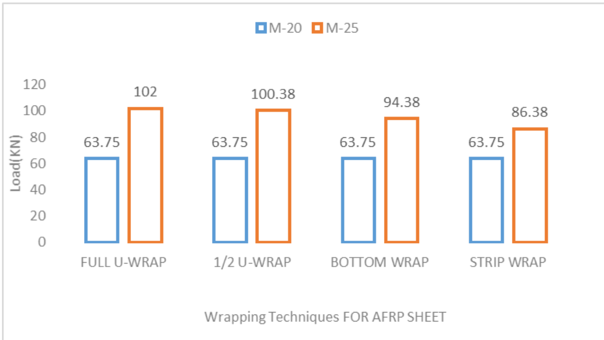

Fig 7 Average Ultimate load on Retrofitted Specimen for AFRP sheet.

Table 7. Average Flexural Strength on Retrofitted Specimen for AFRP sheet.

Sr no	Wrapping Pattern	Average Flexural Strength on Retrofitted Specimen (MPa)	
		M-20	M-25
1	Full- U	21.16	33.95
2	1/2 -U	20.82	32.97
3	Bottom	19.58	31.41
4	Strip	17.92	28.72

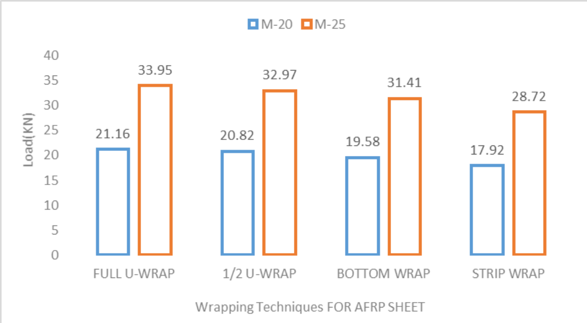

Fig 8 Average Flexural Strength on Retrofitted Specimen for AFRP sheet.

Table 8. Average Ultimate load on Retrofitted Specimen for Wiremesh

Sr no	Wrapping Pattern	Average Ultimate load on Retrofitted Specimen in KN	
		M-20	M-25
1	Full- U	83.32	130.93
2	1/2 -U	82.22	128.24
3	Bottom	77.50	121.26
4	Strip	74.05	115.66

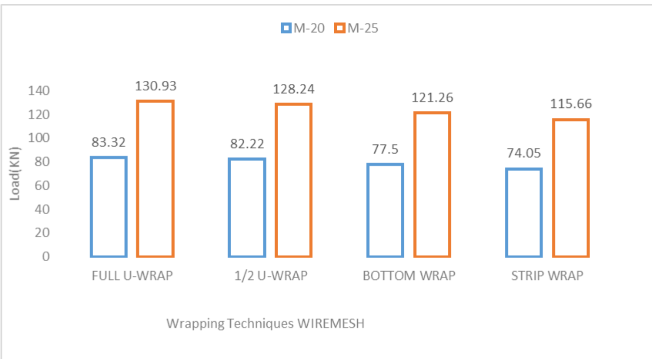

Fig 8. Average Ultimate load on Retrofitted Specimen for Wiremesh

Table 8. Average Flexural Strength on Retrofitted Specimen for Wiremesh.

Sr no	Wrapping Pattern	Average Flexural Strength on Retrofitted Specimen (MPa)	
		M-20	M-25
1	Full- U	17.28	23.3
2	1/2 -U	17.05	22.8
3	Bottom	16.07	21.6
4	Strip	15.36	20.6

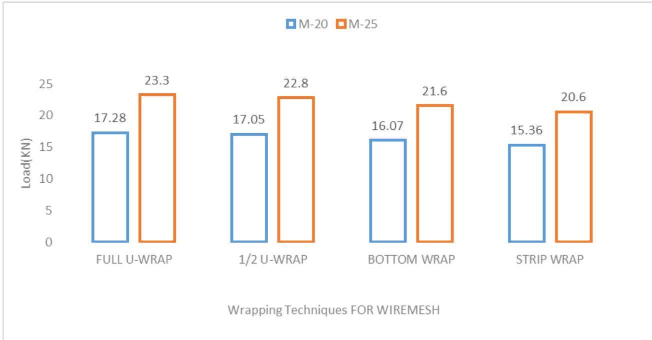

Fig 9 Average Flexural Strength on Retrofitted Specimen for Wiremesh.

IV. CONCLUSION

- After this experiment results show that the wiremesh and AFRP sheet are use as retrofitting material.
- Using AFRP sheet for retrofitting results show that the ultimate load carrying capacity and flexural strength are increasing in U-Wrapping is 60% - 63.70 for M-20, M-25 grade of concrete, compare with control specimen.
- Using wiremesh for retrofitting results show that the ultimate load carrying capacity and flexural strength are increasing in U-Wrapping is 30% - 33.33 for M-20, M-25 grade of concrete, compare with control specimen.
- AFRP sheet give a good result in ultimate load carrying capacity and flexural strength compare to wiremesh.
- U-Wrapping is give a good ultimate load carrying capacity and flexural strength compare to ½ U-shape Wrapping, Bottom Wrapping and Strip Wrapping respectively

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