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Enhancing Shear and Flexural Strength of RC Beam Using Aramid Fabric

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ABSTRACT

This paper presents the flexural and shears behaviour of Aramid fabric reinforced polymer (AFRP) strengthened reinforced concrete (RC) beams of M25 grade of concrete. The experimental program was including strengthening and testing. Simply supported rectangular beam of size 150mm x 150mm x 1000 mm as well as various depth of beam such as 150mm,200mm,250mmmm strengthened with Aramid fabric polymer sheets. Total nineteen specimens was tested. It was nine beam tested in flexural and 9 beam was tested in shear strength. which are six beam specimens was tested as control beams and remaining for founded various damage degrees . The results indicate that the load carrying capacity of beams will significantly increased as the number of the layer will be increased.. In order to study the flexural and shear behaviour of the beam, the specimens was only subjected to two point loading mechanism only. The beams was wrapped with AFRP sheets in single layer and double layers along the different strength of the beam. The present work including casting of beam . Thus it is a feasible method for strengthening and retrofitting of RC beams.

Keyword: *Deep beam, AFRP, shear strength, flexural strength, reinforced concrete*

1.INTRODUCTION

As a human body aged in the same way building or any structure also aged. With the aging of building strength of structure decreased gradually. In addition to that structure has to face much harassment from environment. Due to this structural integrity degrades with time. The degradation of structure such as Building, Factory shade, Bridge deck, Jetty structure are mainly due to aggressive environment, chemical surrounding environment, poor maintenance, corrosion etc. This degraded structure cannot take load for which it is designed. Now building is not a mobile that once it dysfunctional than throw it and purchase new. Building must have to retrofit and strengthened. In addition to that older buildings were designed as per older code, which are not fit for current loading condition. In some cases occupancy are changed. Such as some office building are converted into hotel. So in that case some part of structure have to face higher load (such as ball-room, were party or get-to-gather are arranged). In which older structure are not suitable for new uses. They must have to strengthen. Now a days due to increasing space requirement, municipalities have to change F.S.I (Floor space index) every one or two year. Now suppose on building was designed and constructed. After some time F.S.I of those particular area increases, then in many cases it is proposed to increase two or three floor above already build structure.

Now Conventional strengthening and retrofitting technique are concrete-Jacketing and steel jacketing. In jacketing method, structural members cross sectional are increased. So load caring capacity increases. This is the simple logic behind jacketing works. But it has several disadvantages also. Main disadvantage is due to increase in cross section usable floor area (carpet area) decreases. In addition to that is requires additional specialized form work Now new concrete must be such that it bonds with original concrete properly, such that whole section acts as a homogeneous body. But it is difficult to achieve this. Special bonding agent and clamps are available in market, but it leads to increase the cost. Concrete jacketing also increases dead load of structure to the some extent. Steel jacketing proves to be an effective technique to increase strength with very little increase in cross section and dead load. But on the other way it has the same problem of effective bonding and it is prone to be effected by corrosion. The main disadvantage of jacketing is that it must be started from foundation only. It should not be done localize (Means in multi-storey for particular floor only). Localized jacketing will leads to soft story effect. Thus if strengthening has to be done in lower floor than it might be economical but strengthening has to be done on higher story than it will lead to very high cost as jacketing have to be done on all column below that floor. With increase in technology and research there are many new techniques are introduced in the market for the retrofitting. FRP strengthening are one of them.

- FRP has very high fatigue resistance.
- They are available in roll in market. In contrast to this steel plates are available in maximum 5 m long strip.
- From weight point of view steel is comparatively very heavy than FRP.
- Durability compare to steel is very high.
- Applicability is easy, some precautions has to be taken.
- They are easily rolled, which makes their transportation very easy

FRP strengthening works are done generally using the help of Carbon fabric, glass fabric and aramid fabric. These are high strength FRP Fabrics. High strength fabrics are embedded in to appropriate resin and attached to surface. FRP are basically developed for aircraft industries. After 1980 they are introduced into civil engineering industries. Mainly FRP are worked as an additional reinforcing member for the strengthening of structure. The main advantages of Fibre reinforced composite No corrosion, No transportation problem, High ultimate strength, High Young's modulus, Very good fatigue properties, Low weight and Endless tapes available so no joints.

Aramid Fabric:
Aramid Fibre is also known as keveler fibre. Aramid fibre is also high strength, tough and highly oriented organic fibre derived from polyamide incorporating into an aromatic ring structure. Keveler is used in bullets resistance jacket. This fibre is quite abrasive and under repeated loading they can abrade against each other by weakening the sheets. Aramid fibre 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 fibre are given in Table

Properties	**Value**
Tensile Strength (MPa)	3000
Modulus of Elasticity (GPa)	127
Fire resistance	500-600 cel
Weight of the sheet per m_2 (gsm)	300
Alkali attack	Excellent

1.1 LITERATURE SIGNIFICATION:

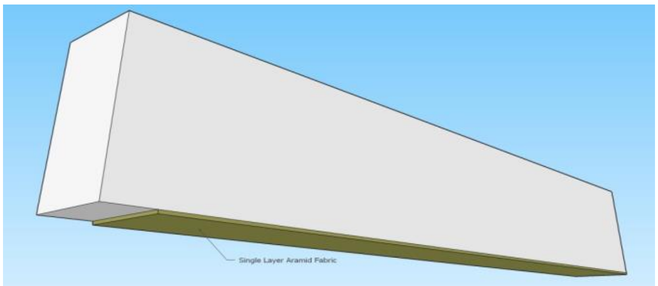
Experimental study conducted of concrete mainly focused on how to increasing strength of RC beam.
The study can be extended by using different wrapping layer for **Various Mechanical Strength Of Aramid Fibres In RC Beam.**

2. EXPERIMENTAL PROGRAM

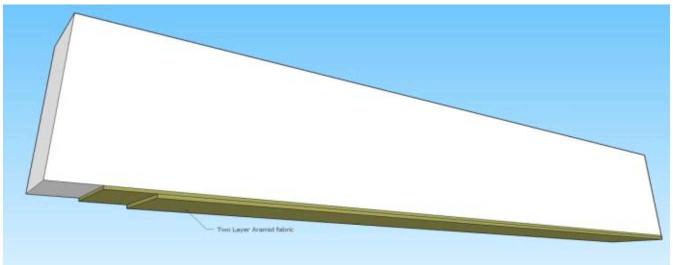
The experimental program consisted of casting reinforced concrete beams, with various depth, number of layer of applying the AFRP sheets and testing them under two point loading on a Universal Testing Machine.

2.1 Details of the Beam Specimen in flexural strength:

SR	Type of beam	No		Size of Beam (mm)		
				150*150 *1000	150*200* 1000	150*250* 1000
1	Control Beam	3	NOTATION	CMF1	CMF2	CMF3
2	Single bottom layer	3		F11	F21	F31
3	Double bottom layer	3		F12	F22	F32



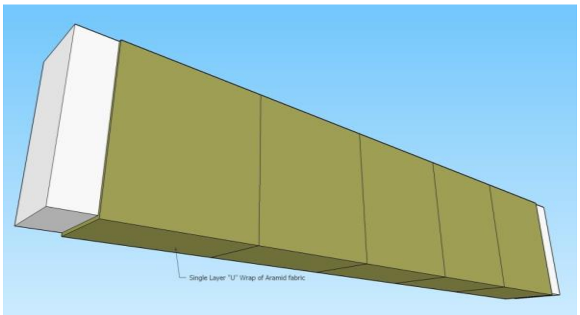
Single Bottom Layer Aramid Fabric



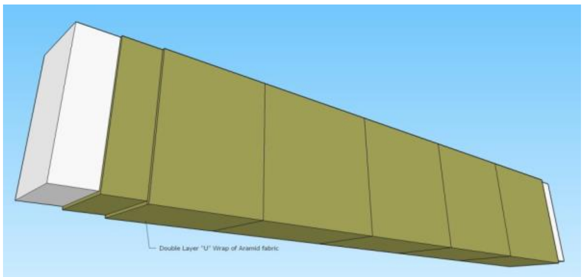
Double Bottom Layer Aramid Fabric

2.2 Details of the Beam Specimen in shear strength:

S R.	Type of beam	No		Size of Beam (mm)		
				150*150 *1000	150*200 *1000	150*250* 1000
1	Control Beam	3	NOTATION	CMS1	CMS2	CMS3
2	Single U Type layer	3		S11	S21	S31
3	Double U Type layer	3		S12	S22	S32



U Type Single Layer Aramid Fabric



U Type Double Layer Aramid Fabric

2.3 Arrangement of reinforcement:

Specimen	No Of Specimen	Size Of Beam	Top Bar	Bottom Bar	Stirrup
weak in flexural	9	150*150 *1000	2-8mm	2-8mm	6mm @c/c160
		150*200 *1000			
		150*250 *1000			

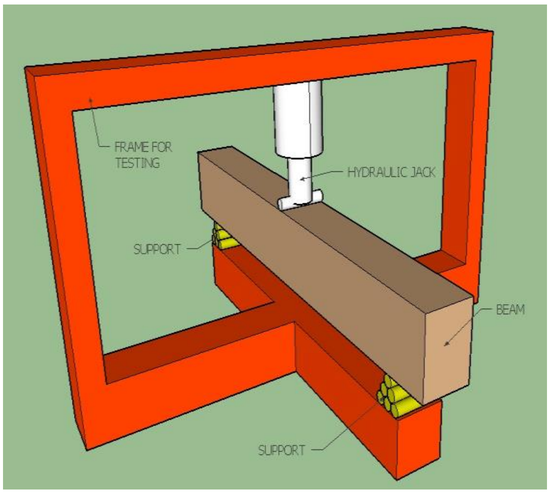
Weak in flexural:
Top bar :2-8mm
Bottom bar : 2-8mm
Stirrups :6mm@c/c 160 mm

Specimen	No Of Specimen	Size Of Beam	Top Bar	Bottom Bar	Stirrup
weak in shear	9	150*150* 1000	2-8mm	2-12mm	6mm @300
		150*200* 1000			
		150*250* 1000			

Weak in shear
Top bar :2-8mm
Bottom bar :2-12mm
Stirrups ;6mm@c/c 300

2.4 Experimental setup for beam Testing:

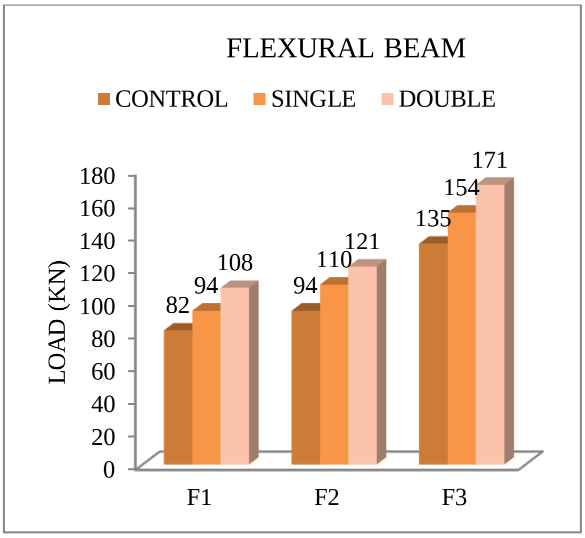
Experimental setup is kept same for both type of beam (Beam in flexure and beam in shear). In this experiment single point are applied at centre. Span of the beam are kept 800 mm c/c. 200 mm of hang kept on both side of the beam. Deflections are measured only at centre.



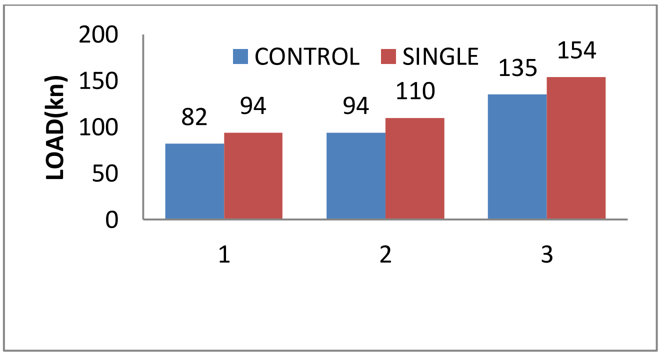
3.RESULTS & DISCUSSIONS:

A) Flexural Beam Results:

- **Over all comparison of Flexural Beam**

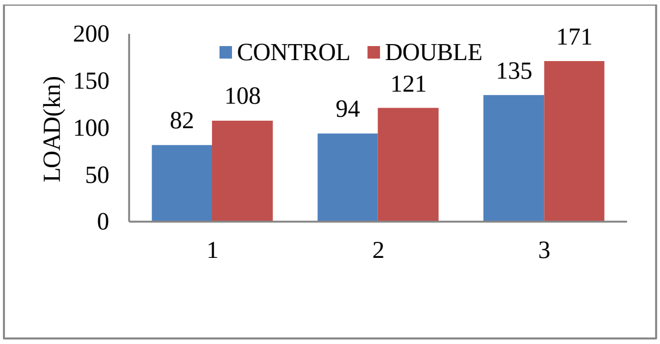


- **Comparison Of Flexural Strength For Control And Single Layer Bottom Beam**



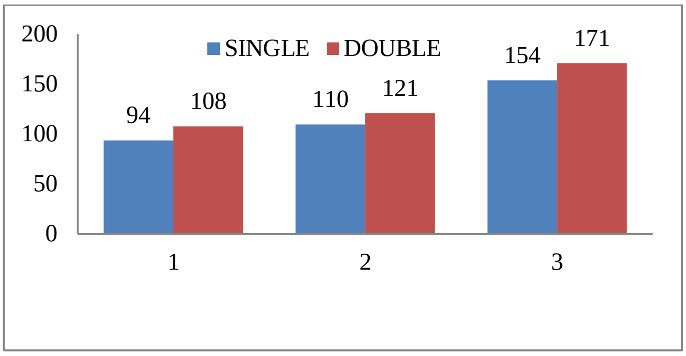
16% Flexural Strength Increasing By Single Layer Bottom Wrapping .

- **Comparison Of Flexural Strength For Control And Double Layer Bottom Beam.**



25%Flexural Strength Increasing By Double Layer Bottom Wrapping.

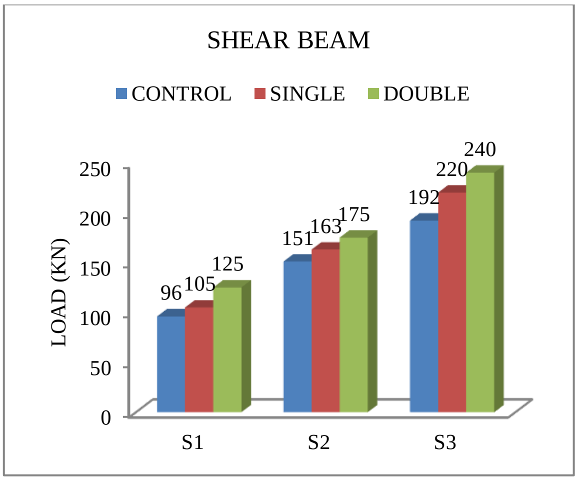
- **Comparison Of Flexural Strength For Single And Double Bottom Layer.**



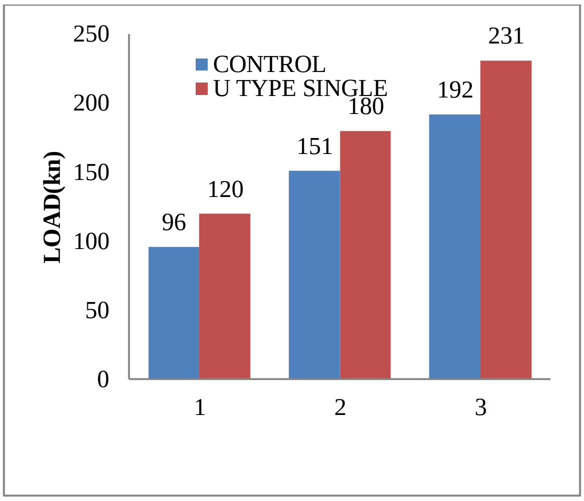
Comparison of single and double bottom layer wrapping ,flexural strength increased by **10%** ,with double layer wrapping .

B) Shear Beam Results:

- **Over All Comparison For Shear Beam**

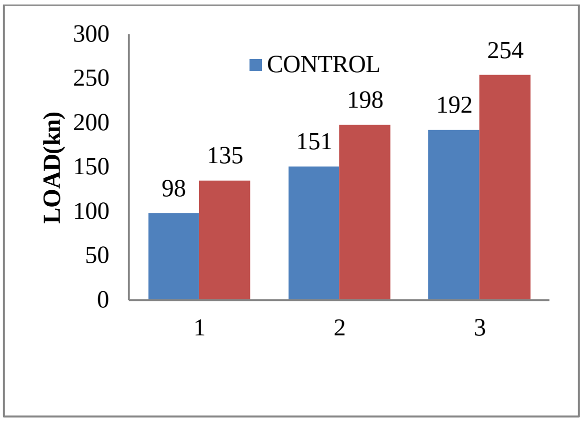


- **Comparison of shear strength for Control and U Type Single Layer beam.**



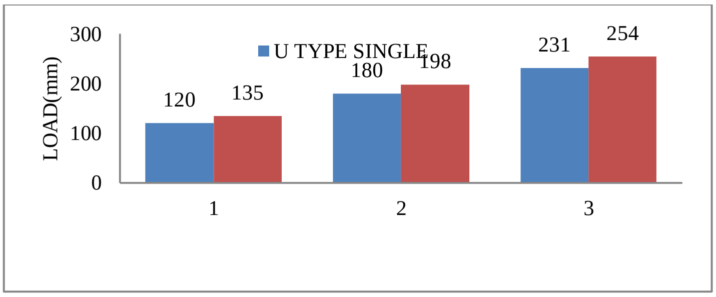
20% shear strength increasing by U type single wrapping of beam .

➢ **Comparison Of Shear Strength For Control And U Type Double Layer Beam**



33% shear strength increasing by U type double wrapping of beam .

➢ **Comparison Of Flexural Strength For Single And Double Bottom Layer.**



Comparison of U Type single and double layer wrapping ,shear strength increased by 11% with Double Layer Wrapping.

4.RESULTS AND DISCUSSION:

Discussion from Flexural Testing result:

1. With the help of external wrapping on bottom flexural load carrying capacity increases decently.
2. External Single Layer Wrapping On Bottom for various depth of beam will increase flexural strength by 16% compare To Control Beam.
3. External Double Layer Wrapping On Bottom for various depth of beam will increase flexural strength by 25% compare To Control Beam.
4. By doing comparison of Single And Double Layer Wrapping , the flexural strength increases by 10% with Double Layer Wrapping.
5. Surface preparation also take a good role in strengthening.
6. With the help of additional wrapping at bottom deflection capacity of beam increases. Also ultimate deflection comes at higher load.
7. As observed and measured from experiments that in case of plain beam deflection at failure is almost double than any of the wrapped beam. This also proves that wrapping increase deformation resistance.

Discussion from shear Testing result:

1. From the above result it was clear that shear capacity is definitely increase by additional wrapping.
2. External U Type Single Layer Wrapping for various depth of beam will increase flexural strength by 20% compare To Control Beam.

3. External U Type Double Layer Wrapping for various depth of beam will increase flexural strength by 32% compare To Control Beam.
4. By doing comparison of U Type Single And Double Layer Wrapping ,shear strength increases by 11% with by double layer wrapping.
5. With the help of wrapping required surfaces are wrapped. This means whole surface of core concrete are isolated from the surrounding atmosphere. So it also protects core concrete to further degrade from surrounding atmosphere.

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