An Experimental Study on Rehabilitation of Concrete Beam

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Abstract. The theoretical work explains the structural behaviour of a beam reinforced with Aramid warp on repaired structures with its advantages and disadvantages. The final flexural potential of the AFRP is estimated. Experiments were performed to establish the distribution of load-deflection cracks and the width of cracks of the beams. In this work, four numbers of standard beams of the size 1500x150x100 mm are cast with the main rod diameter of 8 mm and a stirrup diameter of 8 mm with a spacing of 150 mm. After curing, the deflection is measured, and the beams under deflected condition are then wrapped in aramid fibre to improve the strength after a deflection by the epoxy resin coated on the surface. It is checked to verify the increased load capacity and is compared to the traditional beam. The result analogy is studied for the reinforcement of the Aramid fibre with the standard beam.

1. Introduction
The use of externally bonded polymer (FRP) sheets and strips was also used as a method for rehabilitating and reinforcing reinforced concrete structures. M40 mix with OPC-53-grade is used in the investigation. The nominal size of fine aggregates below 4.75 mm is mostly used worldwide, according to zone-II. The size of 2.36 mm is used, and river sand passing through a sieve of 1.18 mm is used to prepare Ferro cement. Locally available 20 mm crushed stone is used for concrete. It is used for mixing and healing concrete with a pH value of 7.2. M40 mix is built to cast 1:2.54:3.23 beam.

The effect of the AFRP confined column is studied and investigated under blast and impact load10 and investigated to enchase torsional behaviour of the RC beam using strips of aramid fibre11 and investigated the durability of concrete with aramid fibre subjected to acid attack and temperature rise12. It is observed that there is no enhancement with the increase in several layers of mesh and the betterment of rotation under the state of torsion is noticed on an under reinforced beams with ferrocement “U” wrap compared with others13. Resisting torque capacity is good in completely over reinforced beams than other states of torsion14. It is also observed that in addition to ferrocement, addition of steel angles improves the seismic performance, superior stability for stiffness degradation15. Here, concrete mixes were replaced by 40, 50 and 60% with RCA and GGBS16. It was found that 50% replacement of RCA and 40% replacement of GGBS shows adequate strength than control mix. We carried out on rectangular column Confined with Aramid Composites17. They studied the Behavior of AFRP Confined Concrete Subjected to High Strain Rate Compression18.
2. Material properties

2.1 Aramid fibre
Aramid fibre is high-performance fibre, with molecules connected by strong hydrogen bonds that pass mechanical stress very effectively, and distinguished by rigid polymer chains, allowing it use of low molecular weight chains. Commonly Structures are reinforced by fibre-reinforced polymer wrapping like CFRP & GFRP, whose strength and stiffness are high, is the fragile nature of failure mode. In this 1.45 bulk density, AFRP is used for reinforcement purpose.

Table: 1 Properties of Aramid Fiber

| Sl. No. | Property              | Aramid Fiber       |
|--------|-----------------------|--------------------|
| 1.     | Laminate Strength     | 1430 MPa           |
| 2.     | Fibre Strength G       | 2757MPa            |
| 3.     | Strength-to-Weight     | 993 kNm/kg         |
| 4.     | Young’s Modulus        | 70.5-112.4GPa      |
| 5.     | Specific gravity       | 1.44               |
| 6.     | UV Degradation         | degrade in Sunlight and high UV environment |
| 7.     | Abrasion Resistance    | strong             |
| 8.     | Tensile Modulus        | 131 GPa            |

Table: 2 Properties of Wire Mesh

| Sl.No | Properties                  | Values          |
|-------|-----------------------------|-----------------|
| 1     | Average diameter            | 1.2mm           |
| 2     | The opening size of the mesh| 12.5x12.5mm     |

The Material Properties for various materials like Cement, Fine Aggregate, Coarse Aggregate and Aramid Fiber is shown in table 3 and 4, respectively

Table: 3 Properties of cement

| Specification             | Cement |
|---------------------------|--------|
| Fineness                  | 18%    |
| Initial setting time      | 30 min |
| Soundness                 | 0.233  |
| Standard consistency      | 34%    |
| Specific gravity          | 4.74   |

Table 4: Properties of fine aggregates

| Specification             | Fine aggregate (M Sand) | Coarse aggregate |
|---------------------------|-------------------------|------------------|
| Specific gravity          | 2.61                    | 2.62             |
| Fineness                  | 1.64                    | 5.56             |
| Bulk density              | 1639 kg/m3              | 1653kg/m3        |
| Water absorption          | 7.14%                   | 8.66%            |
3. Experimental investigation

The experimental setup and the beam specifications are shown in Figure: 1 & 2, respectively. After processing the load deflection testing, the beam is ready to be coated with epoxy resin for aramid fibre wrapping and is tested. Ferro cement is deformed in four layers with a ratio of 0.50 w / c.

![Figure 1: Beam Specification](image1)

4. Result and discussion

Aramid Fiber- achieved better cracking performance. It is observed that the beam wrapped with 2 layers of aramid fibre gives 36.8 kN as ultimate load and beam with 1 layer gives 35.5kN. As no much difference is observed between the two, one layer can be adopted, which shows similar strength to carbon fibre. Maximum ultimate load obtained on wrapping is 36.8 kN by AF and on concrete with RCA is 36.7 kN.

![Figure 2: Experimental Setup of beam](image2)

| Sl.No | Layer of Fibre | Ultimate Load (kN) | First cracking load (kN) | Mid Span Deflection (mm) | Stiffness (N/mm) | Flexural Strength (kN) |
|-------|----------------|--------------------|--------------------------|--------------------------|----------------|---------------------|
| 1     | 1              | 35.5               | 6.12                     | 12.68                    | 2.79           | 4.73                |
| 2     | 2              | 36.8               | 7.63                     | 13.42                    | 2.74           | 4.91                |
| 3     | 1              | 33.5               | 7.12                     | 11.62                    | 2.88           | 4.47                |
| 4     | 2              | 34.6               | 8.1                      | 12.75                    | 2.71           | 4.61                |
5. Conclusion
The specimens tested have achieved the strength equal to the control concrete. As the load was constantly increased, the formation of the vertical crack is visible on the surface of the beam, followed by the composition of shear cracks at 45°. Even though the cost of Aramid fibre is high compared to other materials used, the regained strength obtained is higher. Use of more layers of confinement is not beneficial in overall work. Hence it is recommended to use one layer of aramid fibre for the strengthening of deformed beams. The measured crack width is within the allowable limit as prescribed by IS 456-2000.

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