Influence of Chicken Wire Mesh Wrapping on Strengthening of RC Beam

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Abstract
Reinforced Concrete (RC) beam is one of the vital structural element in framed structure to carry and transfer the loads from one element to another structural component. Due to strength and durability aspect, the behaviour of RC beam is going to perform down. In this case, the rehabilitation of RC beam is necessary for existing structure in the urban area, because of inconvenience in demolition and new construction activities. Therefore, the objective of this investigation is to perform the rehabilitation and strengthening the flexural behaviour of RC beam with externally bounded chicken wire mesh wrapping. In this research work, two different types of RC beams were prepared in the form of (i) conventional RC beam (ii) RC beam with wire mesh wrapping. Initially, the concrete properties of M25 grade of concrete were observed by using the mix design proportion of concrete and it was used to prepare the controlled specimen. Finally, the test results are such that load-deflection curve, ultimate strength, energy dissipation capacity and stiffness were observed and compared with those specimens. Thus, it concludes that the flexural strength of RC beam with wire mesh is produce high performance than conventional RC beam.

Keywords : Wrapping, stiffness, energy dissipation, flexural strength, ductility

I. INTRODUCTION
Reinforced concrete is made of a combination of traditional cement concrete with reinforcement under design mix concrete proportions. Reinforced concrete structure is one of the most widely used in the construction on high level building with desired quality. Nowadays, strengthening and rehabilitation of structure is most predominant for enhance the life of structure because of scarcity of land, environmental problem and demolition of structures to built new structure for functional use. Many researchers started the rehabilitation and strengthening of RC structures in various structural elements particularly in flexural members were strengthened using of steel plates and fibre reinforced polymer by Balamuralikrishnan and Zeki Karaca. As well as, it impacts in difficult to handling and cost maintenance of the structures also.

Thus, the objective of our research is to impart new material to improve the flexural behaviour of beam in which have cost effective and performance on strength and serviceability basic. In recent research, carbon fibre sheet is used to enhance the performance of RC beams but availability and wrapping also faces somewhat difficult in civil engineering industry.

Utilization of chicken wire mesh in wrapping of RC beam is one of the easy adopted in the field and effectively performed with RC beams. However, it is known that structural failure of RC beam is not catastrophic but required the additional strength at the time of rehabilitation of RC beam. Failures of RC beam predominately happen due flexure and shear failure.

The author Alex et.al[2] and Byong investigated RC beam with CFRP sheets by providing at different weaker zones. This article was discussed the effect of shear failure through the different failure mechanism. Studying on the strengthening of RC beam with chicken wire mesh wrapping is not frequently in rehabilitation.
because of it is not much higher tensile strength than of CFP but it may comfortable perform the strengthening of RC beam.

Using CFRP sheets on flexural strength of beams were presented by Alagusundaramoorthy et.al. and mentioned that CFRP sheets increased in 58% of flexural strength of RC beam. Subhajit Mondal et.al also studied RC beams with glass fiber reinforced polymer. This study focuses the performance of stiffness, failure pattern and ductility of RC beam with strengthened under chicken wire mesh wrapping.

### II SPECIFICATION DETAILS

In this experimental investigation, M25 grade of concrete was used in these specimens and it designed with mix proportions 1:1.88:2.825 and Fe415 steel grade was used. Standard properties of concrete such as compressive strength; flexural split tensile strength cum properties of steel was measured. Concrete cubes of size 150 x 150 x 150 mm were cast and cured with normal water.

After curing, the specimens were tested at 7 days, 14 days and 28 days of compressive strength using compression testing machine of 2000 kN capacity. Similarly, concrete cylinder of size 150 mm diameter and 300 mm length were cast and tested for split tensile strength using compression testing machine, the ultimate load was taken and the average split tensile strength was predicted and tabulated in table 1. Ferrocement is a construction material which was used as strengthening of RC beam in this work and it is consisting of wire meshes and cement mortar.

The mesh was be made of metallic or other suitable materials. Cement mortar consist of cement and sand in 1:3 ratio with 0.6 water-cement ratio. The mortar is acted as a binder between the chicken wire mesh and beam (or) column. The mortar thickness was maintained as 10 mm and the properties of material are tabulated in table 2.

<table>
<thead>
<tr>
<th>Age of Curing</th>
<th>Average Compressive Strength of Concrete In N/mm²</th>
<th>Average Split Tensile Strength of Concrete In N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 Days</td>
<td>22.07</td>
<td>2.92</td>
</tr>
<tr>
<td>14 Days</td>
<td>31.10</td>
<td>3.15</td>
</tr>
<tr>
<td>28 Days</td>
<td>34.66</td>
<td>3.86</td>
</tr>
</tbody>
</table>

### III EXPERIMENTAL INVESTIGATION

To carry out the investigation, four beam specimens were modeled in the size of 700 mm x 150 mm x 150 mm reinforced with two bars of 10 mm diameter in tension zone and two bars of 10 mm diameter in compression zone were cast using the proportioned mix of 1:1.88:2.82.

Out of these four specimens, two specimens were used as conventional beams were tested upto failure and the ultimate load carrying capacity was predicted. The other two beams were retrofitted with 10 mm thick ferrocement jackets made with 1:3 cement mortar under 0.6 w/c ratio.
The jacket was reinforced with single layer of 10mm hexagonal chicken wire mesh. The set of beams (two each) were divided into two categories. Control beams were designated as S-1 and S-2, whereas, beams retrofitted with chicken wire mesh designated as S-3 & S-4 beams respectively. The photographic view of RC beam with chicken wire mesh wrapping is shown in figure 1.

![Fig. 1 Photography of RC beam with chicken wire mesh wrapping](image)

**IV TESTING ARRANGEMENT**

All the four beams were tested under simply supported end conditions. Single point loading is applied for testing and the testing of beams was done with the help of Universal Testing Machine (UTM). The experimental testing setup of the specimen is shown in figure 2. Out of these four beams, two are conventional beams which were tested and remaining two beams were tested after retrofitted with initial application of safe load on specimens.

![Fig. 2 Test setup of specimen](image)

**V RESULT AND DISCUSSION**

Figure 3 shows the load-deflection behaviour of RC beam with strengthened RC beam using chicken wire mesh wrapping. It is observed that the average ultimate load carrying capacity of strengthened RC beam is 71kN higher than when compare with conventional beam. From the figure 3, it is predicted that using wire mess wrapping technique in RC beam enhances the ultimate carrying capacity of beam.
Figure 4 shows the yield load vs. ultimate load of these specimens. Although, the deflection is also much improved in strengthened RC beams when compared to conventional beam. The deflection is increased up to 39.5 mm in RC beam when adding ferrocement wrapping technique. It shows that the distribution of stress with strengthened beam is better than the conventional beam. The load deflection curves are idealized as quadric-linear curves. Also, stiffness is predominant and it means that load required for unit deflection. When comparing the stiffness, the strengthened.

RC beam is provided low initial stiffness than conventional beam. By referring the figure 5, it shows that stiffness of strengthened RC beam is 1.53 times lower than conventional beam because strengthened RC beam much deflection when compared to conventional beam.

Ductility is another important parameter which is required to define the inelastic behaviour of beam without sudden collapse. It states that ratio between ultimate deflection and yield deflection.
When referring the figure 6, the ductility ratio of strengthened beam is higher than conventional beam and states that chicken wire mesh permit much ductility after the yield load attained in the beam.

![Graph showing Ductility](image)

**Fig. 6 Ductility of specimens**

**FAILURE PATTERN OF SPECIMEN**

Conventional RC beam and strengthened RC beam was studied under static loading with help of UTM. Here, the load is applied as point load on the middle of specimen. When referring the figure 7, it shows that tensile crack developed at bottom of the beam and leads into the failure of RC beam.

![Image of Conventional RC beam](image)

**Fig. 7 Conventional RC beam**

At the same time when compare with the strengthened RC beam, tensile cracks and cracks along the periphery of beam developed because the whole beam as act together. Figure 7 and 8 shows the failure of conventional RC beam and strengthened RC beam.
VI. CONCLUSION

Based upon of the experimental investigation, the following conclusions has to be drawn,

- The beam retrofitted with chicken mesh has increased ultimate load carrying capacity of 11% when compared with conventional beam and also increase the flexural strength.
- The failure of the section is characterized by development of flexural cracks over the tension zone. The spacing of cracks is reduced for retrofitted beams indicating better distribution of stress.
- The beam with chicken mesh has the higher load bearing capacity when compared to the conventional beam.
- After retrofitting the specimens has showed the large deflection at the ultimate load, and also a significant increasing in the ductility ratio.
- Beams retrofitted with chicken wire mesh is the most efficient as in cost to strength ratio and it is nearly equal to conventional beam.

REFERENCES

