



EXPERIMENTAL INVESTIGATION ON STRENGTH OF RC BEAMS RETROFITTED BY DIFFERENT WIREMESH ORIENTATION WITH POLYMER OVERLAY

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Abstract— Abstract-In retrofitting of many historical buildings external plate bonding type is most importantly used. In this type plates of different materials such as CFRP, GFRP, ferrocement sheets, and wire mesh sheets are used to increase its strength. The application of steel wire mesh with polymer overlay (SMPM) is a new promising technique. In this paper six beams (without control beam) were tested by retrofitted with wire mesh orientation such as 0°, 45°, and 60°. The beams are stressed up to 75% of safe load and then retrofitted with wire mesh. Thus the results have been increased 8 to 15% of conventional unretrofitted beams. Among the three orientation 45° gives lesser value of deflection.

Key words: CFRP, GFRP, wire mesh, SMPM, unretrofitted beam

I. INTRODUCTION

A number of historic concrete structures exhibit problems that are related to their date of origin. The working life of the structure may be reduced or extensive maintenance may be required as a result of deterioration of materials, usually steel subject to corrosion attack or concrete subject to aggressive chemicals. Thus repairing or strengthening of such damaged structures need to be studied. The repairing and strengthening processes are aims to improve the performance of the concrete members. Repair is defined as the reinstatement of the original characteristics of a damaged section or member and is confined to dealing with the as-built system. The term strengthening is defined as the number of interventions that may improve one or more seismic response parameters (stiffness, strength and ductility) as a function of the desired structural performance level. Furthermore, strengthening includes the addition of structural elements or the change of the structural system.

Several strengthening techniques have been developed in the past and used with some popularity including steel plate bonding, external prestressing, section enlargement, and reinforced concrete jacketing. Although these techniques can effectively increase the elements load carrying capacity, they are often susceptible to corrosion damage which results in failure of the strengthening system. Consequently, non-corrosive innovative strengthening systems, such as fibre reinforced polymers (FRPs), Steel wire mesh with polymer mortar overlay (SWMPM) that have the potential for extending service lives of RC structures and reducing maintenance costs, are required to replace old strengthening systems. The performance of the polymer as repair materials in concrete construction was determined that the most important properties for durable concrete repairs are modulus of elasticity and bond strength. Polymer mortar is an inorganic material with good resistance to corrosion and fire, and steel wire has the advantage of high strength-to-weight ratio. Similarly, FRP type materials may have all of these advantages. However, the main obstacles to the widespread use of FRP remain its relatively high cost and lack of confidence in its long-term durability. In particular, the cost factor is the more important (Huang *et al.* 2005). This shows steel wire mesh embedded in polymer mortar overlay is less expensive



A. *Retrofitting*

Retrofitting refers to addition of new technology to the existing systems. In construction it is used to increase the life of the structure. Retrofitting of shear concrete elements is traditionally accomplished by externally bonding steel plates to concrete. Although this technique has proved to be effective in increasing strength and stiffness of reinforced concrete elements, it has the disadvantages of being susceptible to corrosion and difficult to install.

In the last decade, the development of strong epoxy glue has led to a technique which has great potential in the field of upgrading structures. Also recent development in the field of composite materials, together with their inherent properties, which include high specific tensile strength good fatigue and corrosion resistance and ease of use, make them an attractive alternative to any other retrofitting technique in the field of repair and strengthening of concrete elements.

Retrofitting of beams with steel wire mesh is a current research development in . Attaching steel plates to certain external surface of the beams is another popular strengthening technique. Anchoring or bonding steel plates to reinforced concrete beams can increase flexural and shear capacity. Furthermore, it can control deflections and cracking of beams. The efficiency of steel plates is influenced by some factors such as the dimension of the steel plate, the arrangement of bolts, and bonding method.

II. MATERIALS AND PROPERTIES

A. *Steel wire mesh*

Wire mesh is the term given to the kind of barrier fencing that is manufactured in square, rectangular shapes. The wire mesh is a metal wire screen that is made up of low carbon steel wire or stainless steel wire. Machines are used to produce the mesh with precise dimensional control. It is widely used in agricultural, industrial, transportation, horticultural and food processing sectors. This can result in considerable savings in time, labour, and money.

B. *Isophthalic Polymer*

Polymer concrete (PC) is a mixture of aggregates with a polymer as the sole binder. PC is a composite material in which the binder consists entirely of a synthetic organic polymer. Depending on the materials employed, PC can develop compressive strengths of the order of 140 MPa (20,000 psi) within hours or even minutes and is therefore suitable for emergency concreting jobs in mines, tunnels, and highways.

The isophthalic polyester resins are one of the most popular resins in the PC production due to their reasonable cost-quality balance. Results shows the properties of the polymer concrete specimens, made using a unsaturated polyester resins, were compared to those of the durable and the normal concrete specimens. On the basis of the results it was found that the polymer concretes made by homemade isophthalic polyester resin show much more mechanical properties than the normal and even the durable concrete. (M. Jamshidi and A.R. Pourkhorshidi)

Reichhold, Inc. has assembled a comprehensive product line to provide an optimal resin selection for each metal industry is given below

Table 1 Selection of polymer resin

Metals	Premium corrosion resins
Carbon steel	Isophthalic polyester
Stainless steel	Teraphthalic polyester
316L stainless steel	Bisphenol epoxy vinyl ester

317L stainless steel	Epoxy novolac vinyl ester
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Figure 1 Isophthalic polymer with initiat



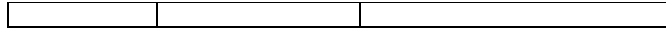
Figure 2 carbon wiremesh

Table 2 Physical properties of wire mesh

SI NO	Diameter of Bars mm	Yield strength (N/mm ²)	Ultimate strength (N/mm ²)	Elongation (%)
1.	2.4	400	511.36	2.52

Table 3 physical properties of steel

SI. No	Diameter mm	Ultimate strength N/mm ²
1.	10	560
2.	6	545



III. EXPERIMENTAL PROGRAMME & PROCEDURE

All seven beams having size of 750×150×150mm. beams were subjected to loading up to failure using a hydraulic machine of 2000 KN state capacity. The load was applied incrementally in 2.0 KN steps. Two concentrated loads at 125mm from mid span were applied to the beam using a stroke control system. RCC Beams were taken after 28 days of curing. Out of one control beam, remaining six beams were retrofitted with carbon steel square wire mesh. Each two beams have different wire mesh orientation such as 0°, 45°, and 60° by using welded connection. After that polymer overlay preparation takes place. The polymer mortars were constructed in a layer 20 mm thickness. Repair materials overlaid on the four sides of concrete beam were used premix type inorganic polymer mortars. Initiate the polymer resin binder and blended thoroughly. Add aggregate to the concrete mix for at least 2 minutes. Place the polymer concrete to the surface of the RCC beam,

1. Immediately after applying the prime coat
2. before gelling
3. within 15 minutes of adding initiator (cobalt)

The resin binder must weigh approximately 12 percent of the weight of the aggregate. It is **must** to know the exact percentage. Polymer concrete must have an initial set time of at least 30 minutes and at most 120 minutes when tested using an initial-setting time Gillmore needle under ASTM C 266.

In this technique, according to the steel stranded wires shares the tension force with a greater tension strength than reinforcing bars. Also, The polymer mortar has the advantages of high degree of density and bonding strength as well as preferable penetrability. Isophthalic polymer resin is also resistible to chloride and some other chemicals. So that, the polymer mortar is able to effectively protect the steel stranded wire mesh and the original reinforcing bars and prevent the inner concrete of the beam from carbonization effect. At the same time, the polymer mortar can bond well the steel stranded wire mesh to the original structure to increase the load-carrying capacity and stiffness of the structural member.



Figure 2 Casting of RCC beams



Figure 3 Mould preparation

IV. TEST RESULTS OF CONTROL BEAMS

A. Test setup & results

The load deflection relationship of the three set of retrofitted beams are plotted in below. It is observed from the curves that with an increase in load there is a considerable increase in deflection for all the beams.



Figure 5 load & failure modes of SMP



Figure 6 Ultimate load crack pattern

B. Load deflection relationship

Table 4 load and deflection results

Specimen	Type	Cracking load (kN)	Yield load (kN)	Displacement (mm)
Specimen 1	Control beam	31.07	70	5.7
Specimen 2	Strengthened with 0 degree	33.67	125	9.25
Specimen 3	Strengthened with 45 degree	36.43	148	8.4
Specimen 4	Strengthened with 0 degree	35	132	9.8

It was also noted the spacing of cracks increases from 0°, 45°, and 60°. This shows the distribution of the stress with wire mesh at zero degree is better. It is observed that the ultimate load increased from 70kN for control beam to 125kN, 148kN, 132kN for 0°, 45°, and 60° retrofitted beams.

Table 5 Failure modes of specimen

Specimen type	Yield, kN	Capacity kN	Failure mode
Control beam	70.74	525.31	Flexural failure
Strengthened beam with 0°	125.836	602.71	Central peeling
Strengthened beam with 45°	148.309	603.73	Regional failure
Strengthened 60°	132.063	556.8	Regional failure

It was also noted the spacing of cracks increases from 0°, 45°, and 60°. This shows the distribution of the stress with wire mesh at zero degree is better. It is observed that the ultimate load increased from 70kN for control beam to 125kN, 148kN, 132kN for 0°, 45°, and 60° retrofitted beams

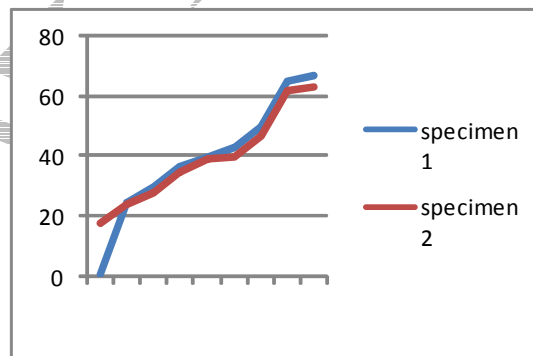


Figure Load curve for control beams

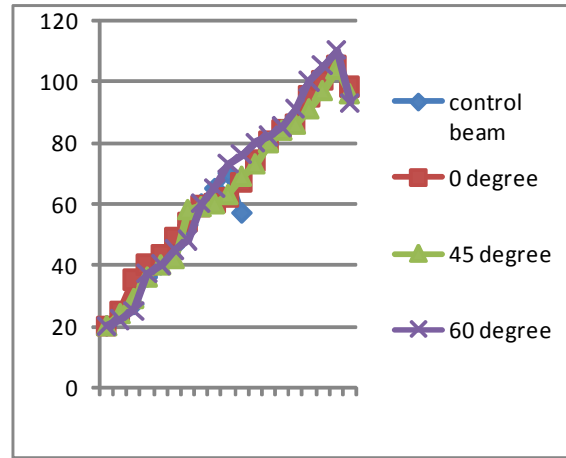


Figure comparison of load curve

Thus the above fig shows that the ultimate load carrying capacity for the beams retrofitted with polymer mortar overlay at 45° have the maximum value. It also shows that the deflection for the beams retrofitted with polymer overlay at 60° has the maximum value and control beam have the least deflection.

C. Comparison results in load and deflection

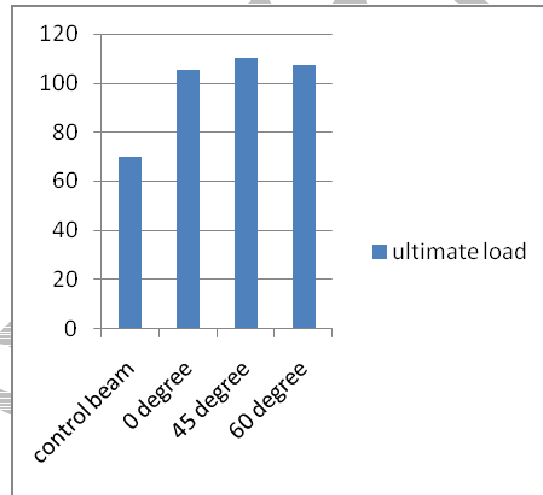


Figure 6 Comparison of load

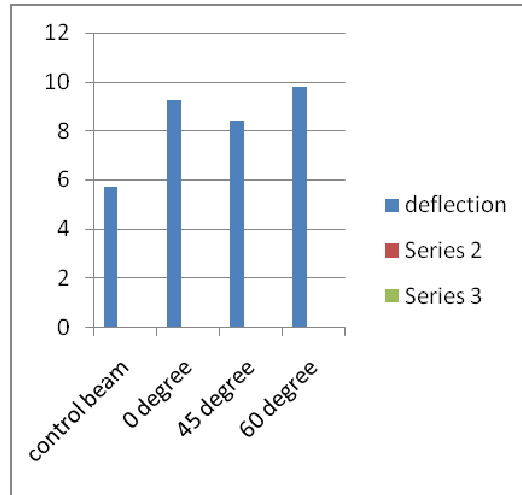


figure 7 comparison of deflection

V. CONCLUSION

A. Conclusions of the results

Based upon the test results of the experimental study undertaken, the following points we can conclude;

The ultimate load carrying capacity of the control beam was obtained as 70.kN and that of retrofitted beams with wire mesh orientation 0°, 45°, and 60 ° was obtained as 125kN, 148kN, 132kN respectively. The deflection of the control beam was obtained as 5.7mm and that of retrofitted beams with wire mesh orientation 0°, 45°, and 60 ° was compared to the control beam. Test specimen shows reduced crack widths, large deflection at ultimate load. The Beams retrofitted with wire mesh at different orientations do not de- bond when loaded to failure. The spacing of cracks was reduced for retrofitted beams indicating better distribution of stress. After retrofitting, all the orientation of 45° stressed beams has the highest load carrying capacity as compared to control beam as well as the other beams retrofitted using different orientation.

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