Deflections and Cracks Pattern of RC Beams Strengthened By CFRP

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Abstract. Carbon Fiber Reinforced Polymers (CFRP) widely used for strengthening and retrofitting which repairing of a structural building. This experiment is discussing deflections and cracks pattern to RC Beam strengthening with CFRP (BS 0%) and retrofitting with CFRP (BS 30% and BS 60%) compared with RC Beam (BN). The behavior of BS 30% and BS 60% loaded with initially loading 30% and 60% of ultimate loads and placement CFRP when loading remains. The experiment study about flexural testing to RC Beam. Loading used centered load point. The experimental results explain that CFRP can increase strength. Cracks width BS 0%, BS 30% and BS 60% more larger than BN. The Strength of BS 0% is the highest, and it investigated that strengthening more effective than retrofitting.

Keywords: RC Beam, strengthening, retrofitting, flexural tested, deflections, cracks pattern, CFRP.

1 Introduction

Building structural rehabilitation has developed in some decades recently, materials like Carbon Fiber Reinforced Polymer (CFRP) are components of strengthening and retrofitting for repairing structural. The advantages of CFRP sheets are easy to use and can increase the strength of concrete especially tensile strength. The tensile strength of CFRP can reach 3450 MPa [1]. But CFRP not resistance to high temperature. Concrete is brittleness need added tensile strength. Therefore CFRP is useful for increasing tensile strength of reinforced concrete beside steel strengthen [2]. CFRP is used to improve the flexural capacity of RC Beam.

2 Objective of study

This research is discussing aimed RC Beam Specimens strengthening and retrofitting with CFRP. This experiment observed about flexural tested to RC Beam enhancing and retrofitting which have been connected by CFRP bonded to the beams by the epoxy adhesive. Specify studies about deflections, failure load, failure mode and crack pattern. The failure of RC Beams expected started by yielding of steel reinforcement followed by CFRP which the last rupture. The inability of RC Beams due to peeling of CFRP has avoided.

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3 Literature review

On Reseach of the flexural Beam with Carbon fiber wraps (CFW) can increase the strength of RC Beam, the results can reach 114,2857 % customarily compared RC Beam [2][1]. The failure of strengthened beams started by yielding of steel reinforcement followed by partial rupture of CFRP sheets or strips [3]. Concrete inside DSTCs with circular inner steel tubes demonstrates almost monotonically ascending stress-strain curves, indicating that it is confined effectively by FRP and Steel tubes [4]. Concrete in hollow DSTCs with circular inner steel tubes and HCFFTs with circular inner voids exhibits larger ultimate axial stresses (fcu) and strains (ecu) than those in their companions with square steel tubes or inner voids. On the other hand, the behavior of DSTCs with square inner steel tubes improves significantly through concrete-filling of their inner steel tubes. It is observed that filled DSTCs with square inner tubes exhibit similar performance levels to those of companion DSTCs with circular inner steel tubes [5].

4 Methodology

4.1 Materials

This research using concrete as the structural material with an average of the tensile strength of 5 cylinders concrete is 22,06 MPa. The Tensile strength of Steel reinforcing for diameter 6 mm is the average from 3 bars is 414,35 MPa; 3 bars of diameter 8 mm is 372,28 MPa; 3 bars of diameter 12 mm is 393,42 MPa. Gravel and sand used from local material from Yogyakarta region. CFRP type used is Sika Wrap Hex-230C-Dry Application, and epoxy type is Adhesives-330-Dry Application as gluing between RC Beam and CFRP.

4.2 Specimen

Total of four beams tested and specimen RC Beam, i.e.:

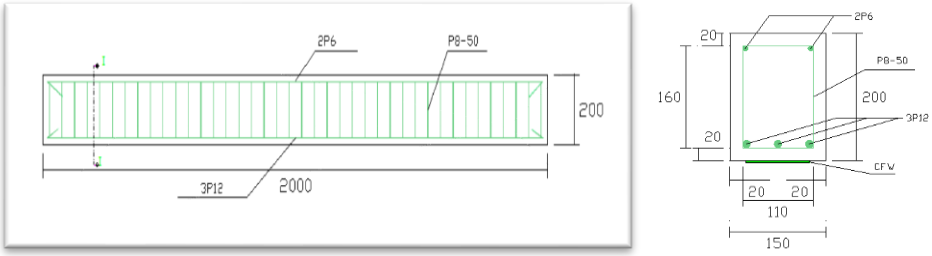

Fig. 1. cross-section of RC beams strengthened of CFRP.

Fig 1. Shows RC Beam specimen has 2200 mm length, 150 mm width, and 200 height. There is four type of RC Beams consists of Normally RC Beam (BN); RC Beam Strengthened CFRP (BS 0%); RC Beam strengthened with initially 30 % ultimate load (BS 30%), and RC Beam

strengthened with initially 60 % ultimate load (BS 60%). Fig 2. Is behavior RC Beam Specimen when giving initially loaded 30% and 60% using plate-resistance. The plate resistance is useful for resistance loading when CFRP was placing mid-span RC Beam Specimens.

Fig. 2. Plate-resistance loading modification.

CFRP placement on the flexural area of RC Beam specimen in the surface area. CFRP placement on the midst of surface area underneath steel reinforced with 50 mm width and 2100 length (Exclude of RC Beam Supporting).

4.3 Experimental setting up

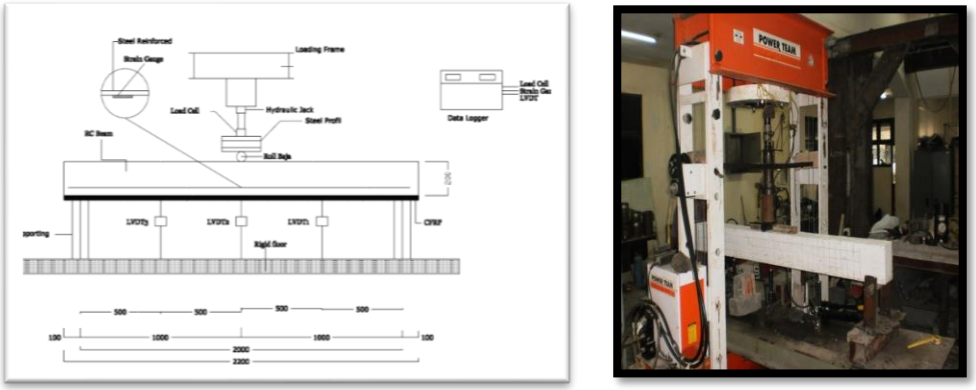

Fig. 3. Experimental setting up.

Fig. 3 shows RC Beam tested as flexural testing with one point load on midst top of the specimen with two supporting in the both of RC Beam. Results of deflection RC Beam can obtain with Linear Variable Differential Transformer (LVDT). There are 3 LVDT on position looks like on figure experimental set up. And results width of cracks can obtain with calipers.

5 Result and experimental investigation

5.1 Deflections BN; BS 0%; BS 30%; and BS 60%

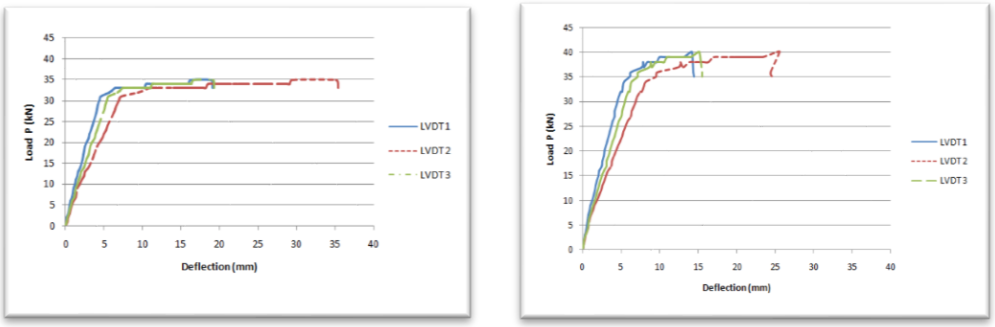

Fig. 4. Load Deflection relations Diagram BN and BS 0%.

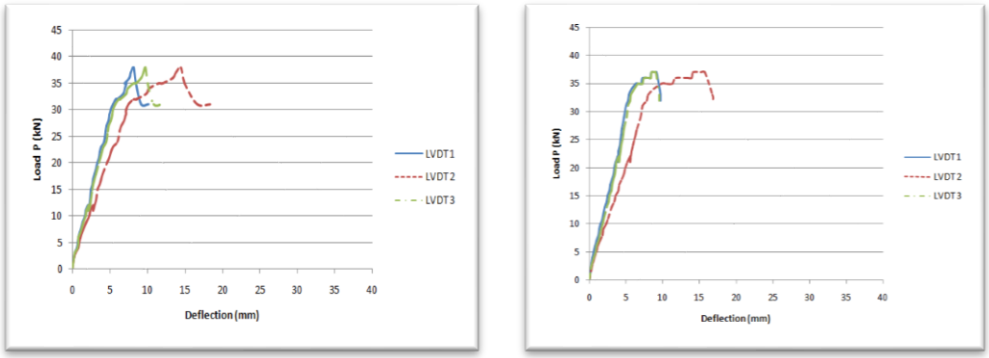

Fig. 5. Load Deflection relations Diagram BS 30% and BS 60%.

From fig. 4 and 5 explaining deflections on point 1 and 3 showing similar pattern because of placement LVDT on 1/3 length of RC Beam. Different with point 2 because of placement at 1/2 distance of RC Beam. Deflections at point 2 more larger than other points**.**

5.2 Cracks Pattern of BN; BS 0%; BS 30%; dan BS 60%

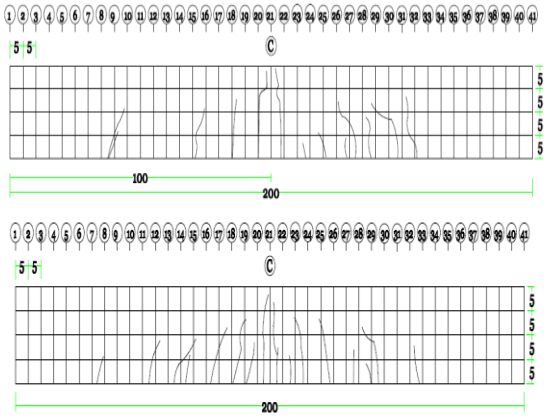

Fig. 6. Cracks Pattern at BN and BS 0%.

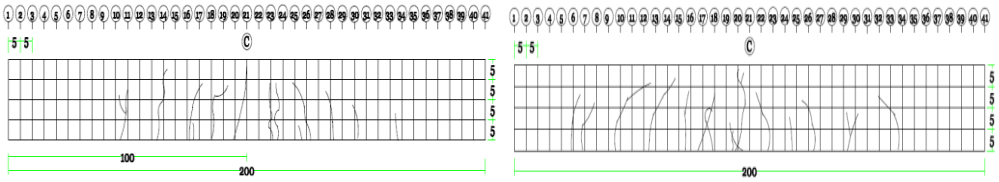

Fig. 7. Cracks Pattern at BS 30% and BS 60%.

From Fig. 6 and Fig. 7 are cracks pattern of BN, BS 0%, BS 30%, BS 60% shows the flexural behavior failure mode.

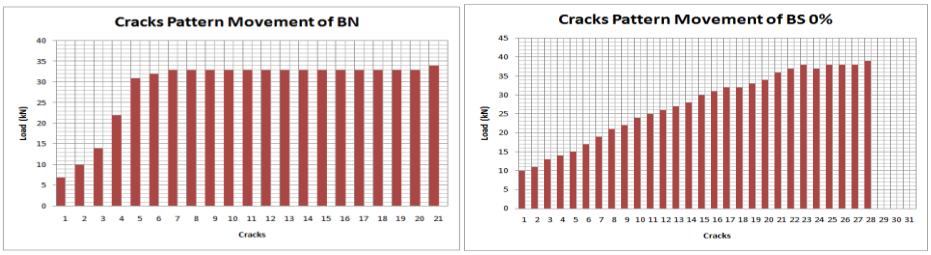

Fig. 8. Cracks Pattern movement of BN and BS 0%

Cracks pattern movement of BN started the first crack at load 7 kN with crack width 0,02 mm and the last break at point twenty-eight with load capacity at 34 kN and cracked width 11,1 mm. Different with BS 0% started the first crack at load 7 kN with crack width 0,02 mm and the last break at point twenty one with load capacity at 40 kN and cracked width 17,60 mm (Fig.8)

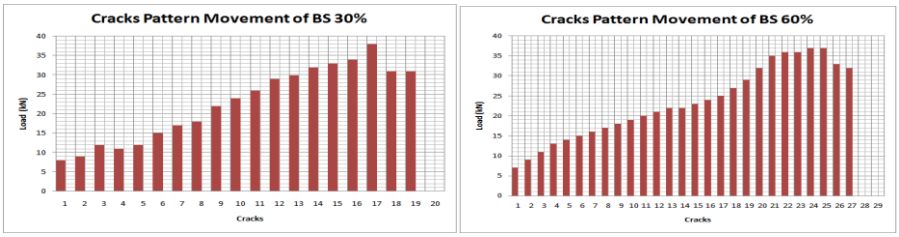

Fig. 9. Cracks Pattern movement of BS 30% and BS 60%

Cracks pattern movement of BS 30% started the first crack at load 7 kN with crack width 0,02 mm and the last break at point nineteen with load capacity at 38 kN and cracked width 35 mm. Different with BS 0% started the first crack at load 7 kN with crack width 0,02 mm and the last break at point twenty-seven with load capacity at 37 kN and cracked width 18,90 mm

6 Conclusion

The conclusion of this experiment is: CFRP can provide enhancement strength of RC Beams; Cracks width at RC Beam strengthening with CFRP larger than BN; RC Beam strengthening is more effective than retrofitting to increasing resistance of RC Beam.

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