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EXTENDED ABSTRACT

Strengthening of RC Beams with Prestressed NSM CFRP Laminates

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1. Introduction

In the present paper, results of experimental investigations on the flexural strengthening of reinforced concrete beams using prestressed carbon-fiber-reinforced polymer (CFRP) laminates with near-surface mounted (NSM) method are presented and compared with the results of non-prestressed and non-strengthened specimens. Flexural strength tests of concrete using simple beams with center-point loading are conducted and crack propagation, mid-span load-deflection curves, ductility coefficient, energy absorption capability, and failure modes are discussed.

2. Experimental study

Three beam specimens, according to Fig. 1 are prepared. One of them is not strengthened and is considered the control specimen. The second one is strengthened using two layers of non-prestressed CFRP laminates with dimensions of 20x0.17 mm. The last specimen is also strengthened with CFRP laminates with the same properties of the previous specimen but prestressed up to 40 percent of the ultimate strain of CFRP as Fig. 2. The center-point loading tests are conducted, and the flexural behavior of these specimens is assessed, and the effect of strengthening methods are discussed.

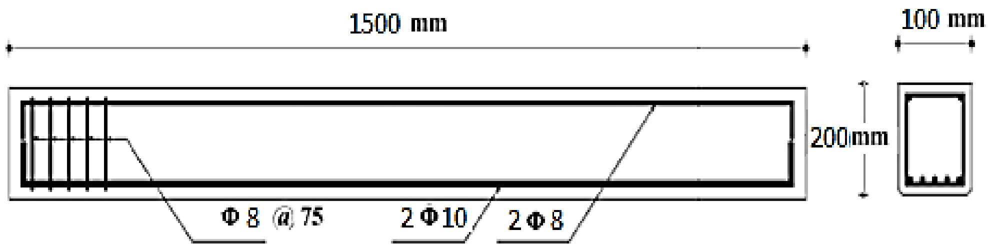

Fig. 1. Dimensions and reinforcement details of beam specimens

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Fig. 2. Prestressing of NSM CFRP

3. Results and discussion

3.1. Crack propagation

The crack propagation under flexural loading until fracture of specimens is shown in Fig. 3 which indicates that prestressing of CFRP laminates restricts the cracks.

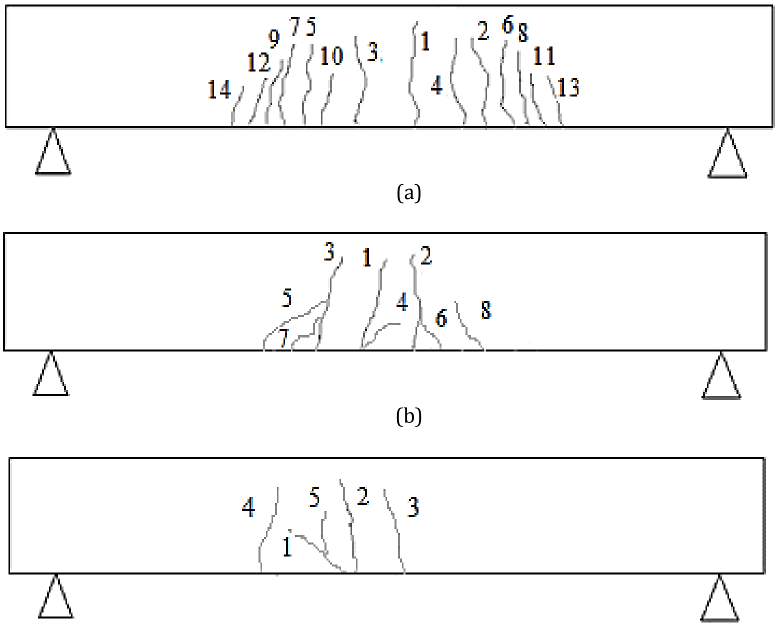

Fig. 3. Crack propagation: a) Control beam specimen, b) Beam specimen strengthened with non-prestressed CFRP laminates, c) Beam specimen strengthened with prestressed CFRP laminates

3.2. Load-deflection curves

Mid-span load-deflection curves under flexural loading of specimens are presented in Fig. 4. As can be seen, the ultimate load capacity of control (NS-NP) and non-prestressed strengthened (S-NP) and prestressed strengthened (S-P40) specimens are 30 kN, 33 kN and 36 kN respectively. Prestressing enhances the flexural strength by utilizing a higher level of tension capacity of FRP materials, while this leads to less ultimate deflection and more brittle behavior.

The displacement ductility coefficient of non-prestressed and prestressed strengthened specimens are decreased by 7.5% and 50% compared to the control specimen, respectively. Furthermore, the energy absorption capabilities of mentioned specimens are 41% and 54% less than the control specimen, respectively. The failure mode of the control specimen was yielding of steel reinforcement, and it was the fracture of CFRP straps in the strengthened specimens.

The observed results are in accordance with studies by (Badawi and Soudki, 2009) and (Xue et al., 2010) and (Yang et al., 2009) and (Deng et al., 2011).

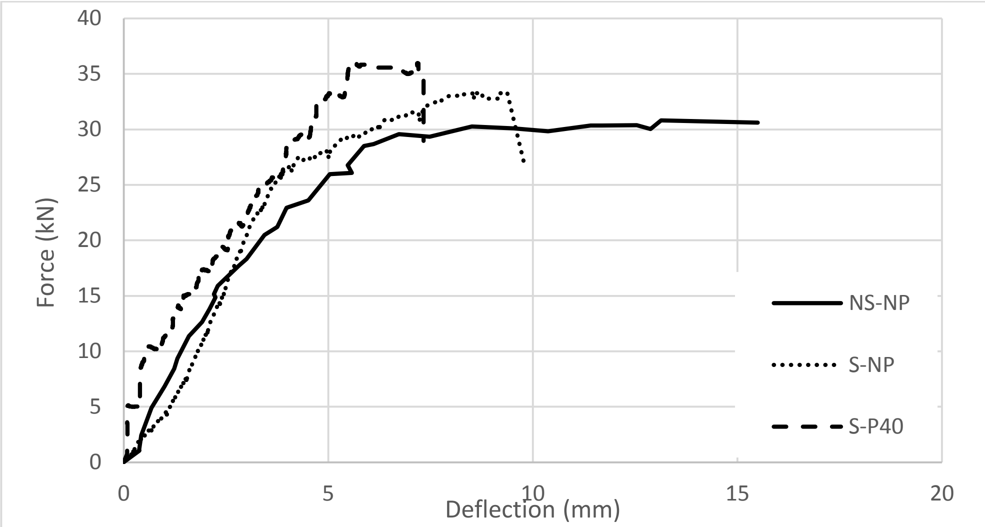

Fig. 4. Mid-span load- deflection curves for specimens under center-point flexural loads

4. Conclusions

The flexural strengthening of RC beams using prestressed CFRP laminates with the NSM method enhances the load-bearing capacity more than non- prestressed CFRP laminates while decreasing ductility because of the deeper neutral axis and less tensile strain in the extreme tension fibers. It is worth mentioning that this method leads to less number of cracks with limited widths.

5. References

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