Flexural Strengthening of RC Beams Using Near Surface Mounted (NSM) Fiber Reinforced Polymers (FRPs)

Ahmed Mahmood AL-Lawati

Abstract

This research study presents an experimental investigation of the behaviour of Reinforced Concrete (RC) beams strengthened in flexure by near surface mounted (NSM)technique using Glass and Carbon Fiber Reinforced Polymers (GFRP/CFRP). An experimental program consisting of 10 full scale reinforced concrete beams of 200×300×2760 mm (width × depth × length) were constructed and strengthened in flexure with different types of FRPs. The experimental investigation included four parameters; technique used (NSM or Hybrid), type of FRP used (Carbon or Glass), amount of FRP (one or two bars), and steel reinforcement ratio (two ratios). Out of the 10 constructed beams, two beams were reference beams.

Four beams were strengthened with NSM FRP using CFRP and GFRP with two different ratios. Two were strengthened using hybrid system (NSM + EB) with different amount of CFRP. The last two beams were strengthened with NSM CFRP in different ratios and using double amount of tension steel reinforcement. All beams were tested under four point bending set-up. The measurements used included the ultimate load capacity, deflection, cracking, reinforcement and concrete strains, and mode of failure.

All strengthened beams strengthened showed an increase in the ultimate load capacity of about 31 to 133% compared with the reference beams. In this study, most of the strengthened beams had deboned under sudden failure except the NSM-GFRP beams. The NSM-CFRP strengthened beams carried higher loads in terms of ultimate capacity than the NSM-GFRP strengthened beams but they showed less ductile behavior.

The NSM-GFRP strengthened beam showed a good ductile behavior with high deflection values at ultimate load which were almost similar or even higher those recorded in the reference beams. This gave an ample warning before failure and can be considered an important advantage of strengthening RC beams with NSM-GFRP system. The load carrying capacities of the tested specimens were also calculated using the ACI 440.2R-08 guidelines and compared to the measure values.