STRUCTURAL BEHAVIOUR OF RC BEAMS AND BEAM-COLUMN JOINTS STRENGTHENED WITH GEOSYNTHETIC MATERIAL

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ABSTRACT

Shear failure occurs in reinforced concrete (RC) beam when the beam has shear resistance lower than flexural strength, and the shear force exceeds the shear capacity of the RC beam. This type of failure is sudden and occurs without any warning. The shear failure is brittle in nature and very dangerous. The beam-column joint (BCJ) is the most critical and vulnerable part of RC framed structures when subjected to earthquake loading. A research program was conducted experimentally in the laboratory of the National Institute of Technology, Durgapur, Department of Civil Engineering, on strengthening the shear deficient RC beams and BCJs using geosynthetic materials to address concerns about shear failure and seismic vulnerabilities of RC structures.

The aim of the present study is to experimentally and analytically investigate the effectiveness of geosynthetic material, viz. geogrid and geotextile, in strengthening the shear deficient RC beams by external and internal confinement. This study includes the experimental and analytical investigation of cyclic behaviour of shear deficient exterior RC BCJs strengthened using geogrid and geotextile materials by external and internal confinement with two different patterns, where one was the horizontal U-shaped pattern, and the other one was a diagonally X-shaped pattern at 45° orientation in the joint region. The experimental results showed that the brittle shear failure occurred in the shear critical RC beams, which had turned into a flexural failure after strengthening with geogrid and geotextile materials by external and internal confinement. A remarkable enhancement in load-carrying capacity was observed in all the strengthened RC beams by external and internal confinement compared to the un-strengthened conventional specimens. The load-carrying capacity of externally geogrid confined RC beams was maximum, which was increased up to 34.8 % compared to their reference un-strengthened specimen. The test results demonstrated that the ductility factor of the geogrid confined RC beams was increased compared to the geotextile confined beams, and it was maximum in the externally confined specimen. In the case of BCJs too, test results showed that the adopted strengthening schemes with geotextile and geogrid materials by external and internal confinement had successfully altered the failure mode of BCJs from shear to flexural and improved the ductile behaviour of the strengthened specimens. The load-carrying capacity of geotextile and geogrid strengthened RC BCJs by external and internal confinement was increased by 23.7 % to 50 % in comparison with the non-seismic detailed BCJ, where the maximum load-carrying capacity was observed in the diagonally X-shaped geogrid internally

confined specimens. A remarkable improvement was observed in energy dissipation capacity, post-yielding behaviour, pinching width ratio, and damage index in all the strengthened BCJs compared to the non-seismic detailed specimen. Again, it was observed that the geogrid and geotextile confining materials effectively reduced the joint shear strain of BCJ specimens, which made the BCJ stiffer and reduced the joint distortion substantially compared to the non-seismic control specimens. The economy index of all the geogrid & geotextile strengthened RC beams and BCJs was also increased compared to the conventional un-strengthened specimens. Further, the analytical studies are carried out to illustrate the ultimate load-carrying capacity of all the RC beam specimens and the joint shear strength of all the RC BCJs. The analytical predictions are also agreed well with the experimental results, showing high accuracy regarding ultimate load-carrying capacity, modes of failure of RC beams, and joint shear strength of BCJs. Hence, it is confirmed that geogrid and geotextile materials can be a very useful strengthening material for RC beams and BCJs by external or internal confinement at a very low cost. However, these materials can be used as shear reinforcement instead of traditional reinforcing materials for new construction, which will be very cost-effective.