Abstract

Title: *FRP Bond Behaviour during Intermediate Concrete Cover Separation in Flexurally Strengthened RC Beams*

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One of the overlooked premature failure modes of flexurally FRP-strengthened Reinforced Concrete (RC) beams is Intermediate Concrete Cover Separation (ICCS), in which a block of cover concrete breaks off, away from the ends of the beam, triggering general debonding. An experimental investigation is carried out to understand the behaviour of a strengthened RC beam when failure is controlled by ICCS. The cover separation is in the tension zones below the loaded-plates, where internal steel has yielded, and is followed by debonding at the FRP-concrete interface.

Understanding of ICCS requires a realistic knowledge of the bond behaviour between the FRP and concrete between cracks in the presence of steel. The conventional method used to obtain a bond characteristic is to pull a bonded FRP from a concrete block, which effectively simulates the conditions in the anchorage regions of a strengthened beam. The boundary conditions in the anchorage regions differ significantly from those in the regions between the cracks, so a different model must be used.

A new bond test method is proposed and tests are carried out to mimic the FRP-concrete bond behaviour between the cracks and in the anchorage regions when steel is present. The specimens consisted of RC ties strengthened with Near Surface Mounted (NSM) CFRP strips with preformed crack inducers. The boundary conditions between the cracks are similar to the cracked region of a strengthened beam and the regions beyond the cracks simulate the conditions in the anchorage regions. The test results showed that, not only do the local and average bond models differ significantly in the cracked and anchorage regions, but also the steel and its bond stress affect the FRP-concrete bond behaviour. While the debonding propagated in the anchorage regions, in the cracked regions, the presence of cracks reduced the bond stresses due to formation of local herringbone cracks and debonding did not occur.

The experimental beam tests showed that ICCS cannot be predicted with the existing models derived from the conventional bond test. A method is proposed to predict the initiation of ICCS and also the ultimate capacity of a strengthened beam based on the cracked and anchorage-bond models, respectively. The method takes into account the effects of preloading, including self-weight and service load before strengthening of an existing RC beam.