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Gliwice, 13.03.2023

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Title of PhD thesis: Analysis of the bond defects influence on the behaviour of RC beams strengthened with CFRP
Analiza wpływu defektów zespolenia na zachowanie się belek żelbetowych wzmocnionych CFRP (in Polish)

Abstract

The use of Carbon Fiber Reinforced Polymer (CFRP) is one of the most popular methods of strengthening existing reinforced concrete structures nowadays. Many civil engineering structures are strengthened this way. After many years of using CFRP strengthening techniques, more and more concerns are dictated by its lifetime durability, gradual deterioration as well as quality assessment of the bond between composite and concrete. Whenever any kind of defect is detected in the bond, there is no simple answer to how it affects the structural member. That is why the fundamental aim of the thesis is to investigate the behaviour of reinforced concrete beams strengthened using CFRP strips with existing defects in the bond.

For the purpose of a better understanding of relevant factors affecting the studied strengthening system and phenomena governing its behaviour, a brief literature review was presented based on available data. Previously conducted studies concerning 'the effect of the defects' were used as a reference to further work.

The experimental part of the thesis consisted of two series of RC beams strengthened with CFRP strips, with a different number of stirrups. As a result, the influence of defects on predicted failure mode was analysed. In each series, three selected defects locations along the beam, on ultimate load also were studied. To observe the influence of the defect size ratio, an additional specimen with a relatively large defect was introduced. Experimental work was preceded by an investigation of materials.

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To verify the predictive possibilities of numerical simulations, an additional part of the study was dedicated to finite element analysis. This part focused on the selected strategy for numerical modelling of strengthened RC beams with the initiated defects. The data obtained from the experimental study allowed for the validation of numerical calculations. For an additional level of verification of FE simulations, an independent numerical tool was developed based on fibre-beam analysis and strain limitation concept. Thanks to the extended numerical study, the relationship between the midspan defect size ratio and the ultimate load was determined for the adopted beam geometry. Additionally, more insightful observations were made on the damage initiation criterion and damage evolution along the beam. Numerical calculations show that the damage is initiated discretely around the defects, in the proximity of the point load and at the ends of the strip in the case of the conducted four-point bending test.

Received conclusions and observations from the study can be useful as a base for further work in the point of view of formulating guidelines and simplified procedures for dealing with defects that are detected during the inspection of passive strengthened structural members in bending with the use of CFRP strips.

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13.03.2023