Numerical prediction of punching behaviour for RC bridge deck slabs using 3D continuum non-linear FE analysis

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Existing infrastructure represents a substantial part of the societal assets and existing bridges represent a huge capital that need to be well administrated. Bridge deck slabs are among the most exposed bridge parts and are often critical for punching failure. Consequently, it is important to examine if the current assessment and analysis methods are appropriate.

Nonlinear finite element analysis (FEA) has been proved to be an enhanced method to evaluate the punching capacity of Reinforced Concrete (RC) slabs with high level of accuracy. However, even though nonlinear FEA has been used increasingly for the assessment of existing structures, building codes do not provide specific guidance on how to perform these analyses. Therefore, the overall aim of this study is to investigate how accurate the response of slabs can be predicted with nonlinear finite element (FE) analysis, and how the modelling choices might influence the analysis results.

The study was conducted by carrying out nonlinear FE analysis for RC slabs subjected to punching failure, using three-dimensional (3D) continuum elements. The load-carrying capacity, load-deflection response, crack pattern and reaction-force distribution of the slabs were compared to experimental data available. The influence of several modelling parameters was investigated, including geometric nonlinearity, element properties, material model of concrete, the model of reinforcement and boundary condition.

The analyses of the tested slabs show possibility to accurately predict the load-carrying capacity and realistically simulate the behaviour of slabs. In the future, existing methodologies for the design and evaluation of RC slabs are to be further developed, especially for structural assessment of existing bridge deck slabs using enhanced evaluation with nonlinear FE analysis. Recommendations for such analyses will be established and parameters for evaluation of safety will be developed.