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Recent advances in seismic analysis and design of RC bridges

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ABSTRACT

Paper includes an overview of the research that has been recently performed at the ULJ, Faculty of Civil Engineering, and which is related to the seismic analysis and design of RC bridges. It includes topics such as: 1) pushover based analysis of bridges, 2) modelling and assessment of the shear response of RC bridge columns, 3) seismic strengthening of typical RC bridge columns using different types of jacketing, 4) seismic isolation of RC bridges using new semi-active device – magnetically controlled elastomer.

Nevertheless the inelastic response history analysis has been used for the research purposes for several decades, it is still to complex to be used in the everyday design. To simplify the nonlinear seismic analysis, several nonlinear static, or so-called, pushover methods have been developed. They recently became quite popular analysis tool. However, they are often used without any limitations and even erroneously in some cases. When they are used for the analysis of bridges, it is particularly important to clearly understand their assumptions and limitations. The paper briefly summarizes basic specifics in the application of the pushover methods for the analysis of bridges, and introduces criteria defining the applicability of the N2 method, which is included into Eurocode standards. The analytical research related to simplified seismic analysis of bridges is also evaluated by means of the experimental research.

To perform the nonlinear analysis, adequate numerical models are needed. Basic experiences performed at ULJ FGG in modelling RC bridge columns are summarized. To establish an appropriate numerical model the adequate data about the capacity of columns are needed. While the quantities defining the flexural response are usually well defined, the shear response of columns is much more difficult to predict. The knowledge related to this problem is still incomplete. This is e.g. indicated by quite large differences in the results of different methods proposed for the estimation of the shear strength and stiffness of RC columns. In the paper, this problem is analyzed on the example of columns of a typical existing viaduct, which includes several construction deficiencies. Several methods for estimation of the shear strength are compared and evaluated by means of the experimental results.

There are numerous existing bridges, which were designed before the modern principles of the seismic engineering were established. From the nowadays point of view, they include many substandard construction details which demand adequate strengthening and retrofit. One of such examples is analyzed in the paper. Different retrofitting techniques, including concrete and FRP jacketing are analyzed on the example of a typical viaduct, built in the Central Europe in 1970'ies. The jacketing was performed on the basis of the Eurocode 8/3 standard. In this way it was analyzed when the requirements of the EC8/3, which is primarily intended for the seismic assessment and retrofit of buildings, could be also applied for bridges.

One of the possibilities for the seismic protection of new bridges as well as for the strengthening of the existing structures is the seismic isolation. In the last part of the paper a new semi-active seismic isolation device, magnetically controlled elastomer, developed within the 5th framework EU project VAST-IMAGE, is briefly introduced and the possibilities for its use in bridges are overviewed.