Seismic Design of Elevated Traffic Systems

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Summary

For the seismic design of elevated bridge structures the arrangement of plastic hinges, their design and construction, as well as their ductility requirements in case of an earthquake is of great importance. In this paper the deformation behaviour of plastic hinges will be investigated, using different design and calculation approaches for the deformation behaviour of the confined concrete as well as for the bonding behaviour of the reinforcement steel. The plastic rotation and ductility capacity is determined numerically and compared with the ductility requirements of different international codes. Finally, the investigation results are tested and proved on practical construction examples, such as the Taiwan High Speed Rail Project, where this concept was applied in full, in order to secure a save operation during the intended life time of the system.

Keywords: Seismic design, plastic hinge, ductility, confined concrete, confinement, tension-stiffening, plastic rotation, bridge, column, pile foundation

1. Introduction

The steadily growing world population and the increasing wealth demand for more and better infrastructure, as well as quicker and safer traffic systems. This can be a specific transportation system, such as the Transrapid (Maglev) system, but also high speed train projects, ring roads and other highway developments. In the case of densely populated city areas or due to other reasons, recent infrastructure projects have been planned and constructed with elevated bridge structures. Very often these projects are situated in areas with high seismicity, which means that an efficient seismic design of those bridge structures becomes very important for safety reasons, but also from an economical point of view.

Nowadays, it is state-of-the-art to design elevated bridge structures based on the capacity design principles, using the “weak column – strong girder” principle, which means that in case of an earthquake the plastic hinges are located in the column substructure and the girder superstructure remains in the elastic range, which means that possible repair and retrofit measures after an earthquake will only take place in the columns, and the superstructure, which requires no repair work, keeps its principle function. Hence, the typical failure modes shown in Fig.1 are avoided.

Fig. 1 *Typical failure modes of elevated traffic structures*

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