Civil Engineering for Sustainability and Resilience International Conference, **CESARE '14**
Amman, Jordan, 24-27 April 2014

SENSITIVITY OF A STEEL ARCH ROAD BRIDGE TO IMPOSED FOUNDATION DISPLACEMENTS AND ROTATIONS

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Keywords: steel arch bridge, imposed foundation settlements, liquefaction, nonlinear analysis

ABSTRACT

It is common practice to prohibit the use of shallow foundation for bridges in areas prone to seismic liquefaction. Hence, deep foundations (piles) are exclusively used, transferring loads to deeper, non-liquefiable soil layers. Nevertheless, recent studies regarding the seismic response of shallow foundations on liquefiable soils suggest that the aforementioned conventional design philosophy may be drastically changed in order to reduce the overall cost, while maintaining acceptable performance and safety levels. Namely, the existence of a surface "crust" of non-liquefiable soil with sufficient thickness and shear strength may mitigate the consequences of liquefaction in the subsoil, so that the use of shallow foundations becomes permissible. Moreover, this new design concept has the additional advantage of reducing the inertia forces acting on the superstructure, as the part of the subsoil, which will be intentionally allowed to liquefy, will lose its shear resistance and may consequently act as a "natural" system of seismic isolation.

However, there are also some potentially detrimental effects from this new design concept. One of them is that shallow foundations are admittedly more sensitive to differential settlements, which are likely to create additional actions to the bridge superstructure. This issue is investigated in the present paper for the case of a steel arch road bridge consisting of two simply supported spans with composite deck. Each span of the bridge under consideration is 42m long and the deck's width is 15m. The effect of large displacements and rotations induced at the level of the foundation of the intermediate pier on the structural efficiency of the superstructure is investigated by means of nonlinear analyses. The results show that the bridge under consideration can sustain large displacements at the base of the pier without significant damage. However, the superstructure is quite vulnerable to imposed rotations of the foundation, especially about the longitudinal axis of the bridge.