Earthquake resistance and cost-effectiveness of multi-span bridges

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Summary

The design of structural systems depends on a wide range of compliance criteria. More specifically, with respect to earthquake resistant bridges, the issue of economy (cost-effectiveness) is mostly affected by the basic concept of their design, namely the selection of the optimum structural system for specific conditions and requirements. The present study focuses on the cost-effectiveness of four different bridge systems: (a) a fully-integral bridge with an innovative full-height integral abutment, (b) a quasi-integral bridge, which was the "reference" system, (c) a semi-integral bridge, and (d) a "floating deck" bridge, whose deck is supported on piers through bearings. The accommodation of both the in-service and the seismic requirements of bridge systems were studied with the objective of minimizing structural and final costs.

Keywords: bridge; conceptual design; structural cost; integral; semi-integral; "floating deck"; earthquake resistance; serviceability; maintenance.

1. Introduction

The design of bridges is mainly governed by their prevailing function, which is their ability to withstand traffic loads. The selection of the optimum structural system is influenced by site-specific conditions, traffic requirements and structural methods, [1]. However, the seismic response of bridges is also often proven to be decisive for the resisting system and critical for individual members, which are intensely stressed, during earthquake.

It is well known that the design of bridges, as that of structures, should comply with specific serviceability, as well as structural requirements imposed by the implemented structural method. Further to these, the basic design parameters are: (a) safety, including earthquake efficiency, (b) serviceability, (c) economy (of construction and maintenance), and (d) aesthetics.

The criteria referring to safety and serviceability are determined by provisions set out in codes, [2], [3], which constitute the current state-of-practice of bridges. The cost assessment for a particular bridge can be carried out on both the basis of experience and according to the studies of similar design cases. In any case, cost depends on the basic concept of the design, namely the resisting system that has been selected. The basic concept of design not only includes the general idea of the total structure, but also the idea of the structural elements and the configuration of structural details. In the light of this, the basic concept of design is the most important, the most interesting and also the most creative part of the work of the Civil Engineer. An apt basic concept minimizes difficulties in the design study and also in the construction. Considering that it is possible nowadays to calculate and implement almost any concept, there are many people wrongly assume that the more details that are examined, the more complete that design will be, even if the concept is weak.

However, apart from the successful concept, the details should also be considered, since taking them in isolation and comparing them with the overall result gives the impression of insignificance. Nevertheless, dealing correctly with most of the details is not a detail but rather can lead to perfection, according to Michelangelo. The selection of the cross-sections of concrete structural elements according to the economy criterion is also included among the details, on the condition

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