

# Influence of Irregularity of the Substructure on Seismic Behavior of Highway Bridges

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## Summary

This article presents the results of elastic analyses performed on three types of bridges, monolithic, continuous, and simple-supported, making changes to the regularity of the substructure. Such variations consist of increasing and reducing the height of the center pier, to determine conditions of vulnerability due to irregularity. The structures were subject to a database of 53 accelerograms recorded on the Mexican Pacific Coast. The maximum responses in displacement and standardized differences between the regular and irregular systems are presented. These data can be applied in preliminary evaluation methodologies and then in maintenance programs.

**Keywords:** substructure irregularity; bridge vulnerability; monolithic, continuous, and simple-supported bridges, seismic analysis.

## 1. Introduction

Bridges are structures of great importance for communication and survival in urban centers, and integrate systems of lifelines. Numerous bridges have presented substantial damage as a result of the aggressive action of natural agents, growth of loads, and the impact of natural events. For these reasons, attention needs to be paid to their preservation and design, to maintain the proper levels of safety and service.

Maintenance programs can be divided in three stages: preliminary evaluation, detailed evaluation, and designing maintenance strategies. The goal of preliminary evaluation is to detect, in a large group of elements, structures that are in vulnerable conditions. On the other hand, detailed evaluation is based on rigorous analyses that show real conditions and the extent of degradation of systems detected in the preliminary evaluation. Then, with the information obtained in the previous stages, decisions are made to design strategies for maintenance, rehabilitation, or rebuilding of structures [1].

There are different methodological approaches used in preliminary evaluation. They are distinguished by the parameters they use, the categories in which those parameters are divided, their relative weights, and the model used to combine them. In general, relative weights are defined subjectively, by means of surveys applied to experts in the field. Also, the choice of parameters and their respective categories are also often subjective. The most common parameters used in preliminary methods include irregularity of piers in terms of height and bearing conditions.

This paper presents parametric analyses of elastic models that consider one of the most common parameters in preliminary evaluation methods, irregularity of substructure. For this purpose, we consider three types of bridges (monolithic, continuous, and simple-supported), six irregularity conditions varying from pier height (+75%, +50%, +25%, -75%, -50%, -25%) and 53 seismic movements recorded in Mexico.