Ground motion spatial variability and cable-stayed bridges: do we need to consider the asynchronous motion?

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Abstract

Cable-stayed bridges are landmark structures and key parts of transportation networks worldwide. It is of vital importance that their integrity is ensured even under very large earthquakes. The spatial variability of the ground motion could be a significant aspect of the seismic behaviour of long-span cable-stayed bridges due to the differential movement of the pylons, which may lead to an amplified seismic response and increased damage in the pylons. The purpose of this paper is to examine the effect of the spatial variability of the ground motion on the seismic response of cable-stayed bridges with H-shaped pylons and various span lengths. Focus is placed on the pylons of the bridges because the constitute key members for the overall stability and structural integrity of the bridge. The study explores how important the spatial variability is in the seismic response of cable-stayed bridges by considering two different orientations of the structures with respect to the seismic fault in an extensive program of non-linear response-history analyses.

Keywords: cable-stayed bridges; spatial variability; pylon, earthquake incidence angle; non-linear analysis.

1 Introduction

The spatial variability of the ground motion (SVGM) is described by the differential movement of the supports of long structures. It becomes important when a structure is long with respect to the wavelength of the input motion in the frequency range of importance to the response of the structure. In such cases, the supports of long structures may be subjected to different excitations [1] and this is known to affect the structural response depending on the amplitude of the ground motion, the geometric characteristics of the structure and the stiffness of the surrounding soil, among others [2-4]. The SVGM is the outcome of the combination of four effects [5]; the wave-passage effect, which refers to the time delay in the arrival of the ground motion at neighbouring supports; the incoherence effect, which refers to the loss of coherency of the ground motion as a result of successive reflections and refractions of the seismic waves in heterogeneous soil media along their path; the site response effect, which comes from the modification of the amplitude and the frequency content of the ground motion as it reaches different supports due to

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