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SEISMIC GEOTECHNICAL CONSIDERATIONS AT SITES OF LONG SPAN BRIDGES [1]

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ABSTRACT

The geotechnical issues pertinent to the seismic evaluation and retrofit of long span bridges will be reviewed and discussed in this Theme Session. These issues include development of site specific earthquake ground motions and consideration of the potential for soil failure at the site.

Site specific earthquake ground motions usually take into account: (i) the source mechanism (e.g., strike slip, thrust); (ii) whether the site is on the hanging wall / foot wall of the seismic source under consideration; (iii) whether directivity is of concern at this site; and (iv) local site conditions at various locations along the bridge alignment. The coherence aspects of these motions as they propagate along the alignment of the bridge site must also be considered for a long span bridge.

Examination of recordings from recent earthquakes, as well as analytical simulations of earthquake ground motions, indicate that the motions generated by a thrust event are about 32% larger (on the average) than those generated by strike slip events. Depending on the location of the site with respect to the source of the earthquake, directivity can result in fault-normal motions that can be up to 1.5 or 2 times the fault-parallel motions; this effect is dependent on the structural period, $T_,$, the magnitude of the earthquake and distance from the source to the site. Typically, this effect is negligible at $T \approx 0.5$ sec and appears to increase to a maximum at $T \approx 4$ sec, increases with magnitude and decreases as the distance to the source increases. Spectral values of motions recorded on the hanging wall appear to be about 45% larger than the average of those recorded on both the hanging and the foot wall (this average is the usual way these recording have been reported in the past). This effect is greatest at short periods ($T \leq 0.6$ sec) and decreases as the period increases and is typically exhibited most strongly at distances of 10 to 20 km from the rupture surface.

Examination of earthquake records, as well as the results of site response studies, indicate that local site conditions can have a profound influence on earthquake ground motions. This effect is minimal for accelerations, but can be quite large for velocities and displacements and hence for spectral ordinates at periods relevant to long span bridges. The presence of soft clay layers, such as those in Mexico City or, to a lesser extent, in the San Francisco Bay Area, can result in a significant increase in spectral values of long periods. Similarly, the occurrence of liquefaction can lead to increases in the long period spectral ordinates, as evidenced by recent recordings in Kobe.

Finally, it is essential that the potential for soil failure (e.g., liquefaction in saturated cohesionless soil layers or over-stressing of soft clay layers) need to be considered at a bridge site, especially if such failure could lead to lateral spreading. Remediations, or counter measures, have been used in many places and are being used or considered for bridge sites at several locations in California and Japan.

These aspects will be discussed at this Theme Session and will be illustrated with examples from recent earthquake and recent evaluations.

KEYWORDS

Bridges, geotechnical, earthquake ground motions, directivity, hanging wall, foot wall, liquefaction, site effects, soil failure, lateral spreading, remediation

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