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DESIGN OF 10 FOOTBRIDGES IN NEW HIGHWAY "EXPRESS PASS OF CUERNAVACA", MEXICO

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Summary

The Cuernavaca city is located 80 KM, south of Mexico City. The highway Mexico-Acapulco pass through the Cuernavaca city, and traffic jams are very important, particularly during weekends and holydays. For that reason the Ministry of Transports of Mexico started a program to expand the highway from 4 to 10 circulation lanes in the 14.5 KM of the highway zone that crosses the city of Cuernavaca. In that context 10 footbridges, placed over the highway were demolished and replaced with new ones with spans from 37 to 47 m. The bridges are arch type in steel. This type of structure was selected for aesthetic and structural reasons. Due to the high flexibility of the bridges, the dynamic behavior under pedestrian loading was studied and modifications to the original design were made in order to avoid unacceptable vibrations. The bridges are also placed in a high seismic region, and time history calculations considering non-linear behavior of the concrete piers were made in order to evaluate the dynamic response of the bridges under strong earthquakes. This paper presents the main issues of the design process of the bridges, and some important results concerning the dynamic and seismic design of them.

Keywords: aesthetics; dynamics; vertical vibration; seismic design

1. Design of the bridges

The design of the bridges presented several challenges: on one hand, due to the important width of the new highway the spans of the bridges will be relatively important, on the other hand, the city of Cuernavaca is located in an area of high seismicity, and finally a pleasant aesthetic for them was required.

The 10 footbridges have spans comprised between 37 and 47 m, and height comprised between 7 and 11 m. The bridges are steel arches, with reinforced concrete deck. The main arches are composed by two tube arch structures, joined by transverse tube elements. The foundations and piers are both in reinforced concrete.

The Cuernavaca city is located in a high seismic risk zone, 250 Km north of Acapulco, near the area where the "Cocos" plate is subducted into the "North American" plate, originating earthquakes of great magnitude. The maximum seismic coefficient on this zone is 0.75 g.

The methodology for the seismic design of the structures is based on the modeling of the nonlinear behavior of the structures and the realization of FEM time history non-linear calculations.

This allowed the optimization of the design of piers and foundations.

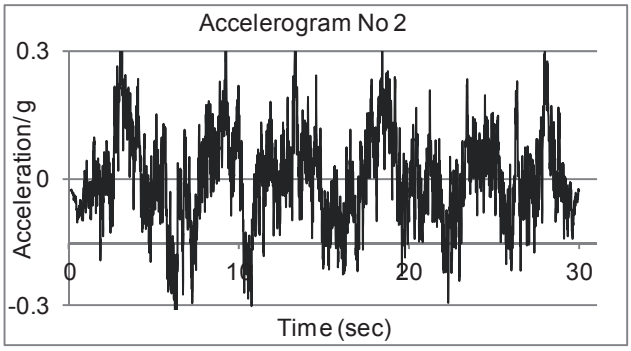

Fig.1. Example of synthetic accelerogram

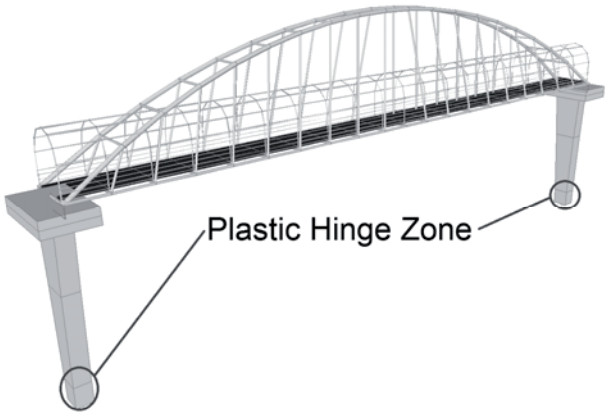

Fig. 2.FEM model of one bridge

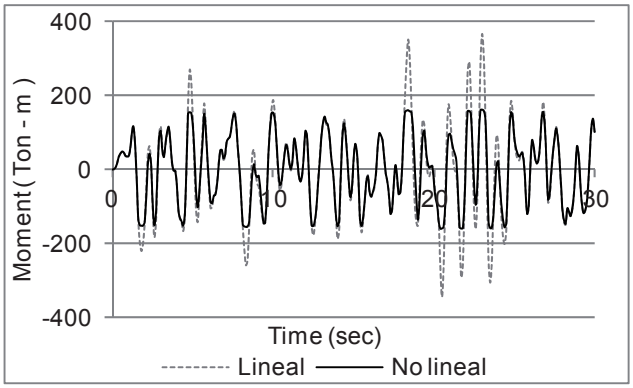

Fig.3. Time history response of longitudinal moments during 1 simulated earthquake

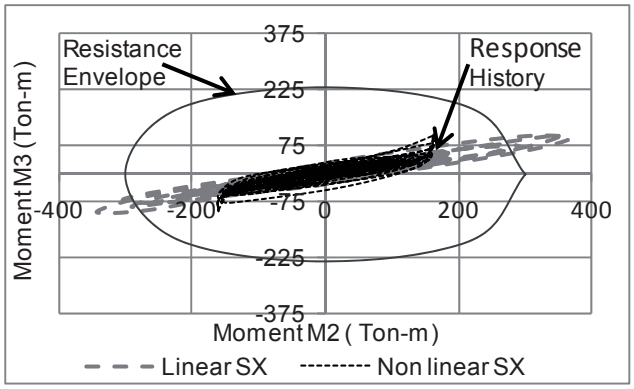

Fig.4. Interaction diagrams of the section at base of piers for transverse a longitudinal seismic load conditions respectively.

As the bridges have important spans, they are sensitive to pedestrian-induced vibrations. Finite element calculations were performed to evaluate the main vibration frequencies (lateral and vertical) of the bridges, and these values were compared with those recommended by some standards, and the risk pathological vibrations was established. These results showed the importance of stiffening the bridges by means of the integration of the structure of the vandalism cage to the main structure.

Fig. 5. Aerial view of the "Express Pass"

Fig.6. General view of one of the bridges during erection