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# SEISMIC RESPONSE CONTROL OF A CANTILEVERED HIGHWAY SIGN SUPPORT USING A TMD

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## ABSTRACT

This work contributes to a better understanding of the seismic response of cantilevered sign support structures used in highways. For such, the present paper presents a comparative study of the seismic response of a cantilever sign support when subjected to earthquakes with and without a tuned mass damper (TMD). The paper starts with a brief summary of different methodologies to assess seismic input on structures. Some guidelines on the considered procedure for the selection of appropriate suites of accelerograms complying with Eurocode 8 prescription for Portugal (Faro) are presented. To mitigate earthquakes dynamic effects, the sign support structure can be equipped with a TMD with proven efficiency and ease of application and modelling, for the out-of-plane vibration control of the sign support in terms of displacements and accelerations reductions when the structure is subjected to series of real accelerograms compatible with the earthquake scenario of Eurocode 8-1.

***Keywords:*** seismic response, Eurocode 8-1, cantilevered sign support structure, TMD.

## INTRODUCTION

Highway sign support structures have been studied previously by the authors, in the viewpoints of stability and design under the Eurocode 3-1 and equivalent international regulations; moreover some significant aspects of the wind response (fatigue considerations implication) have also been addressed in other studies by the authors. This work also presents a comparative study of the seismic response of a cantilever sign support when subjected to a series of real accelerograms compatible with the earthquake scenario of Eurocode 8-1.

There are two basic methods for identification of earthquake scenarios. The deterministic seismic hazard analysis approach (DSHA) and the probabilistic seismic hazard analysis (PSHA). Frequently, a probability of exceedance deemed socially acceptable is specified by a building code - typically 10%, 5% or 2% in a period of 50 years, depending on the type of structure. For a particular site the PSHA must estimate the level of shaking associated with that probability (in our study 10% in a period of 50 years, with a return period of 475 years).

## RESULTS AND CONCLUSIONS

Fig. 1 shows 14 scaled records (7x, 7y) compatible with EC8-1 target spectrum for Faro. REXEL computer software selects the records according with a parameter, which measures how much the spectrum of an individual record deviates from the target spectrum of the code.

The Fig. 2 represents a cantilevered sign support, constituted by a square hollow cross-section 250*250*8 mm (uniform member) in S355 strength steel. The column and the beam have a

length of 6.5 m and 6.0 m, respectively. The signboard dimensions can also be seen in Fig. 2. Fig. 3 shows the first four modes of vibration of the cantilevered model used in the analysis.

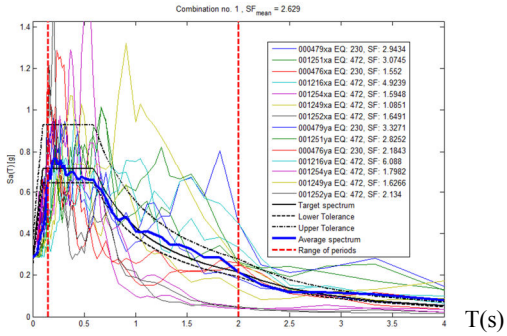


Fig. 1 - Results of the 14 selected records, scaled response spectra and target spectrum

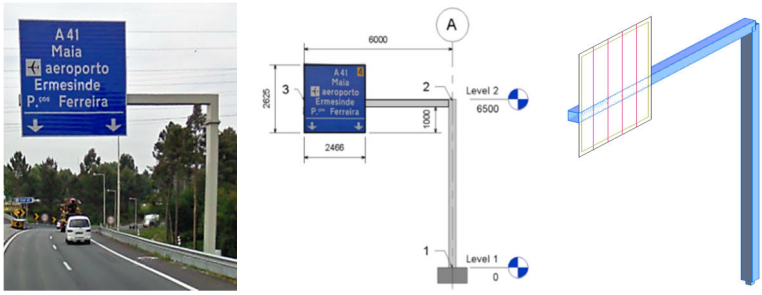


Fig. 2 - Example of a cantilevered sign support structure (left) geometry of the design example (dimensions in mm, center) and numerical model of the cantilever sign support (right)

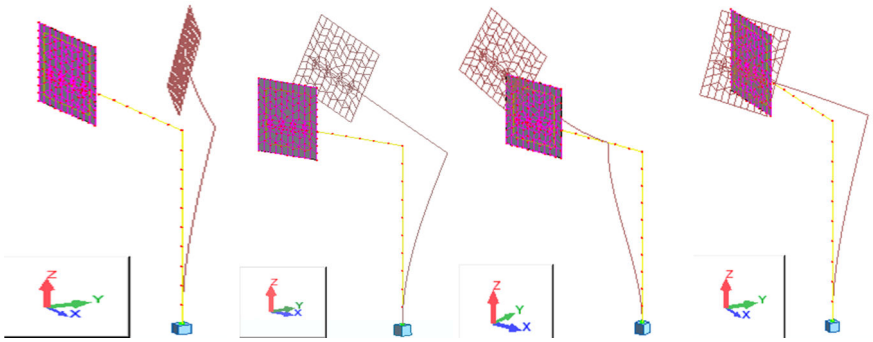

Fig. 3 - First, second, third and fourth modes of vibration (from left to right) for the numerical model

Using a TMD in the highway sign, modeled with optimal parameters associated with a 1% mass ratio, it was concluded that in terms of maximum accelerations (mean values) reductions of the order of 28% can be achieved. For the maximum displacements (mean values) it was concluded that the structural reference system is less effective, achieving reductions of 14%.

## ACKNOWLEDGMENTS

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