DEFINITION OF SEISMIC INPUT AT AN INTERCONTINENTAL AIRPORT ACCORDING TO THE CURRENT EUROPEAN SEISMIC HAZARD MODEL

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1. INTRODUCTION

This study focuses on the definition of the seismic input expected at an intercontinental airport according to the current European Seismic Hazard Model delivered in 2020 (ESHM20, [7]). The paper includes four main sections. Section 2 presents the parameters computed at the site under investigation, based on the probabilistic seismic hazard model adopted as reference in this study (i.e. ESHM20). Section 3 deals with the selection of seismo- and spectrum compatible accelerograms for the object site. Section 4 illustrate the preliminary outcomes of the ground response analysis carried out with reference to the airport area. In Section 5, concluding remarks are drafted.

2. PROBABILISTIC SEISMIC HAZARD PARAMETERS AT THE SITE UNDER INVESTIGATION

The uniform hazard spectra for the site under investigation based on ESHM2020 for a return period of 475 years are illustrated in Figure 1. Mean, median and four quantiles (5%, 16%, 84%, 95%) as obtained from the ESHM20 full logic tree are also compared with those obtained from the previous European model, named ESHM13 [8].

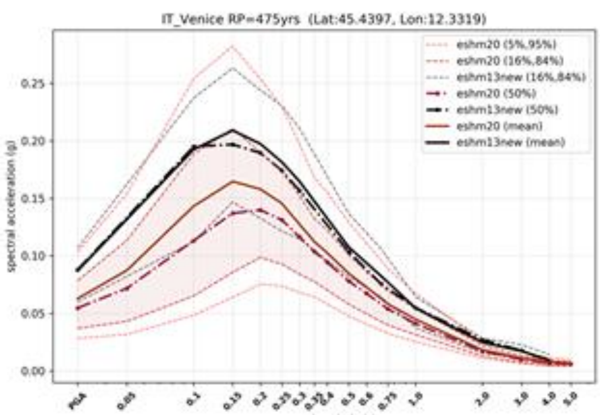
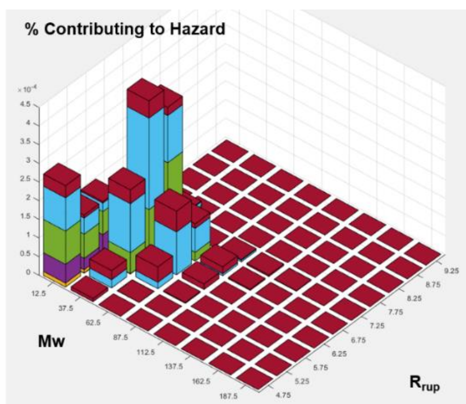


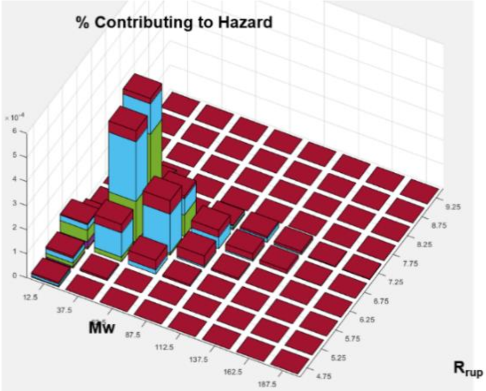
Figure 1. The comparison of mean, median, and uncertainty (16% and 84%) of uniform hazard spectra according to ESHM20 for the site under investigation compared with the ones obtained according to the previous model, i.e. ESHM13

Noteworthy is the reduction of the ESHM20 when compared with ESHM13. It could be quickly observed that the mean spectrum at short periods (less than 0.2 s) for ESHM20 is much lower than the those of ESHM13. However, the uncertainty range (16% to 84%) of both models is remaining the same. These differences can be described by the changes in the earthquake rates, ground motion models, but also on the way the logic tree of the two models have been implemented. For instance, in the ESHM13 only the variability due to ground motion models was explored, as the seismogenic source model was collapsed to a mean branch per model, whereas in ESHM20, the logic tree of both seismogenic source and ground motion models are randomly sampled, resulting in more robust distribution around the central values (mean and median).

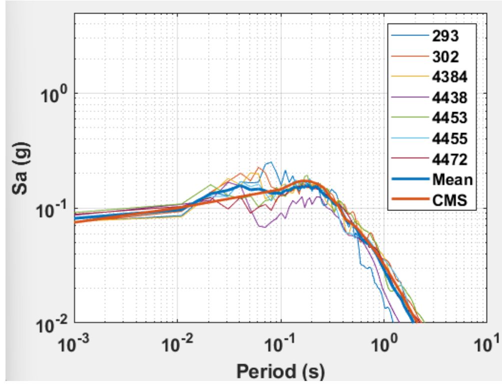
First, the seismic hazard was disaggregated for the peak ground acceleration (PGA) and spectral acceleration at 1 sec. (SA1) at the site of interest (Figure 2).



a)



b)
Figure 2. Disaggregation based on ESHM20 for PGA (a) and SA1 (b)

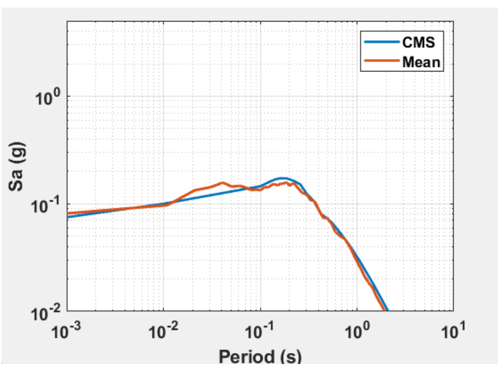


b)
Figure 3. CMS and ground motion set selected at the site under investigation for 475-year return period

3. SELECTION OF SEISMO- AND SPECTRUM-COMPATIBLE ACCELEROGRAMS

This section describes the application of the method for selecting structure-specific ground motions that have a specified spectral acceleration at the structure's fundamental period Figure 3.

In this example, the target response spectrum mean and covariance matrices are obtained using the conditional mean spectrum (CMS) method [10], which provides the mean and variance (and correlations) of the response spectrum conditioned on the specified spectral acceleration. It is to be noted that while this example uses the targets from the CMS method, the proposed algorithm can be used with any arbitrary target mean and covariance (e.g. [11]). The CMS for PGA is defined according to controlling earthquake of 475-year return period from Montello fault and ground motion set were selected according to this controlling earthquake scenario.



a)

4. PRELIMINARY OUTCOMES OF GROUND RESPONSE ANALYSIS

A detailed seismic geotechnical characterization of the airport area under investigation was based on the data from in-situ geotechnical and geophysical investigation campaigns as well as on the geological information. Proper interpretation of the subsoil data led to definition of a ground model to be used as a reference for site response analyses. Figure 4 shows one of the subsoil models built for the airport area. The interested reader can find the details of the subsoil modeling at the airport area in Bozzoni et al. [6].

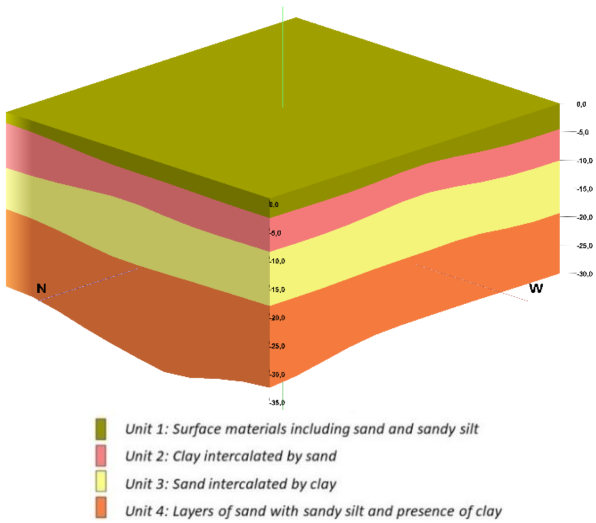
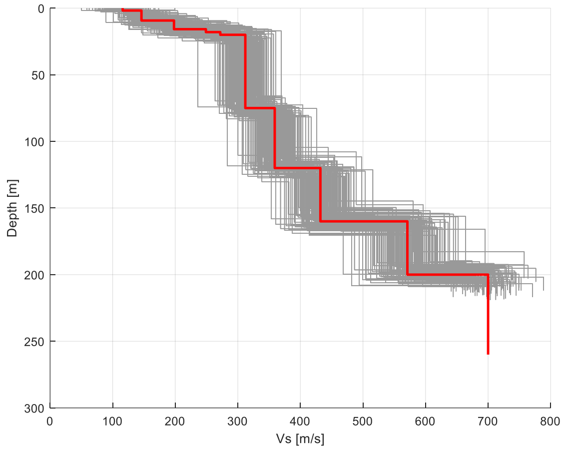


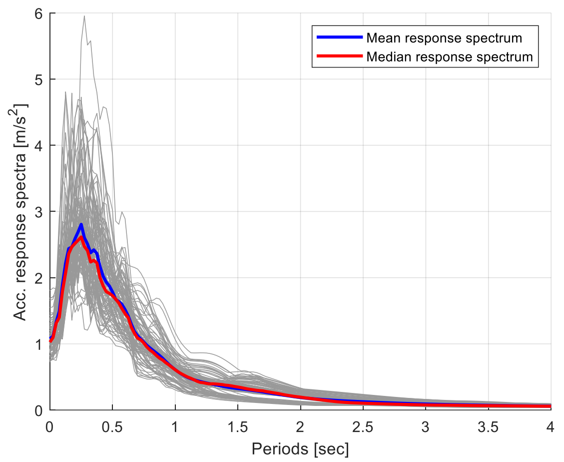
Figure 4. Subsoil model down to about 35m depth from the ground level built with reference to the central part of the airport area [6]

A computer program for performing one-dimension (1D) fully stochastic linear-equivalent ground response analyses of soil deposits, named Stoch-Shake, was set-up at EUCENTRE and tested through the application to several case studies [6]. Through a large number of numerical simulations, the influence of the variability of single parameters and of their combination on the surface ground motion can be assessed. The algorithm is based on adopting the Latin Hypercube sampling technique associated with

Monte Carlo simulations. It consists in iterative runs of a deterministic model, whose input parameters are defined, at each iteration, by a set of random realizations of previously defined probabilistic distributions.



a)



b)

Figure 5. Preliminary outcomes of stochastic ground response analysis at the airport area referred to 475-years return period: a) 100 random Vs profiles (grey lines) generated adopting the Latin Hypercube sampling technique associated with Monte Carlo simulations; the red line represents the mean profile. b) Acceleration response spectra computed out of 100 numerical simulations (grey lines) and also mean (blue line) and median spectra (red line).

5. CONCLUDING REMARKS

The probabilistic seismic hazard model adopted in this study is the current European ESHM20. Disaggregation of the seismic hazard was carried and seismo- and spectrum compatible accelerograms for the site under investigation was carried out for the 475-year return period by adopting the using the conditional mean spectrum method.

Preliminary 1D fully stochastic site response analyses (100 simulations) were carried out by accounting for the uncertainty of soil model parameters as well as the variability of seismic input. Although the seismicity at the site of the airport is moderate, the dynamic response of soils is nonlinear even at low to moderate deformation levels. Thus, these manifestations of soil behaviour have been taken into account using a linear-equivalent constitutive model.

Further ground response analyses are currently ongoing by adopting a larger number of simulations (e.g. 1000) and with reference to a more severe seismic action.

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