APPENDIX

In this appendix section we provide more details on the models of the buildings, the infills, the soil, and the free-field response spectra that we obtain from the analyses of the soil columns.

BUILDINGS

We used fiber elements in our models instead of using the plastic hinges approach, as in Kappos et al. (2006), using the materials described in the main text. Some indicative characteristics are shown in Table 1. Most buildings in the South of Europe built around the 1960s are characterized by sparse (>200 mm), improperly constructed, transverse reinforcement, thus, this reinforcement is neglected in our analyses. Figure 10 shows the geometry and reinforcement for the selected 2-story building. Further description of the buildings examined in our study can be found in Kappos et al. (2003).

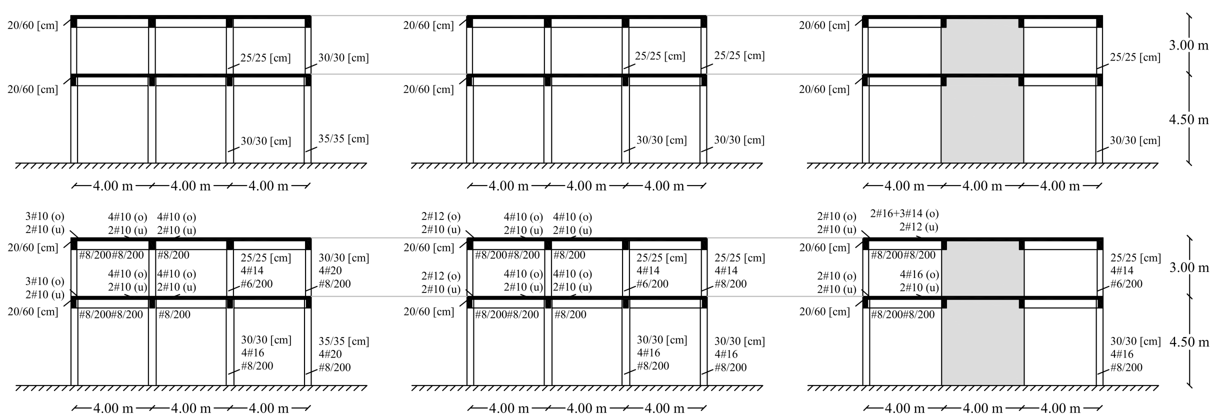

Figure 10. Geometry and reinforcement of the 2-story building.

INFILLS

Following the procedure described in Kappos et al. (2003), we model the unreinforced masonry infill walls as equivalent strut models. In particular, we use the "truss"element provided in OpenSees to model the equivalent strut, as well as the corresponding skeleton curve of the hysteresis model, as shown in Figure 11.

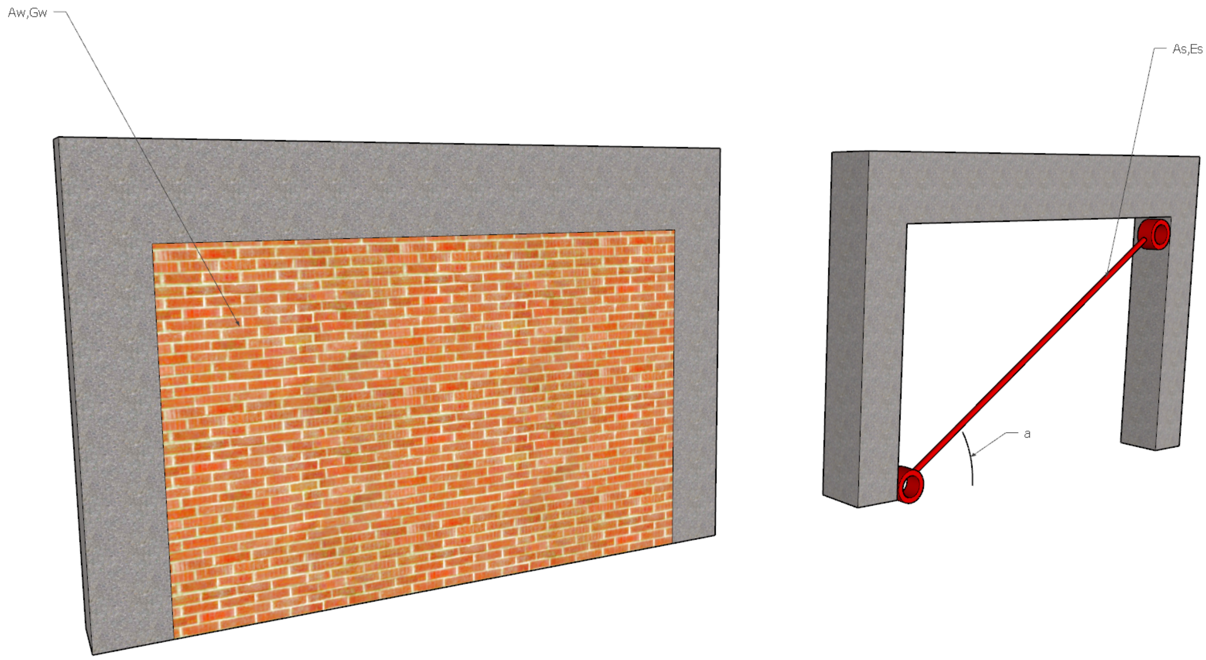

Figure 11. Sketch representing the RC frame and unreinforced masonry infill (left). Equivalent strut model (right).

The axial stiffness coefficient of the equivalent strut is estimated as a function of the shear stiffness of the infill wall and the inclination of the strut, as shown in Equation 3.

$$E_S \cdot A_S = \frac{G_w \cdot A_w}{cos^2 a \cdot sina} \tag{3}$$

SOIL

Table 5 shows the suggested parameter values, as found in OpenSees wiki. In our work, we implement the soil models described in the main text adapting these values for the parameters involved. In particular, upon selecting a specific value for the shear wave velocity characterizing the soil profile, we use Equation 4 to estimate the corresponding soil shear modulus. To adapt the values proposed in Table 5, we use linear interpolation between the values, with respect to the shear moduli estimated.

$$G = V_s^2 \cdot \rho \tag{4}$$

Table 5. Suggested soil parameter values in OpenSees, as reported in the software wiki adapted from the USCD soil models. These values are initially reported in Das (1983); Holtz and Kovacs (1981); Das (1981), and should be used with caution and engineering judgement.

Parameters	Soft Clay	Medium Clay	Stiff Clay
Soil mass density	1.3 ton/m^3	1.5 ton/m^3	1.8 ton/m^3
Low-strain shear modulus	1.3x10^4 kPa	6.0x10^4 kPa	1.5x10^5 kPa
Bulk modulus	6.5x10^4 kPa	3.0x10^5 kPa	7.5x10^5 kPa
Cohesion	18 kPa	37 kPa	75 kPa
Shear strain at max shear	0.1	0.1	0.1
Friction angle	0.0	0.0	0.0

RESPONSE SPECTRA

Indicatively, we present in Figures 12, 13 and 14 the normalized response spectra at the free field, for the soil profiles 2 ($V_{s,30} = 450m/s$), 3 ($V_{s,30} = 360m/s$), 5 ($V_{s,30} = 250m/s$) and 6 ($V_{s,30} = 180m/s$) according to Table 2, for PGA at bedrock level equal to 1 m/s^2, 3 m/s^2 and 7 m/s^2, respectively. Thick lines are the mean spectra, while light grey lines are the clouds of the free-field responses. In the same figures, we plot in colored lines the normalized EC8 response spectra referring to soil types B, C and D. We observe that, indeed, soil amplification is generally higher for lower PGA at bedrock.

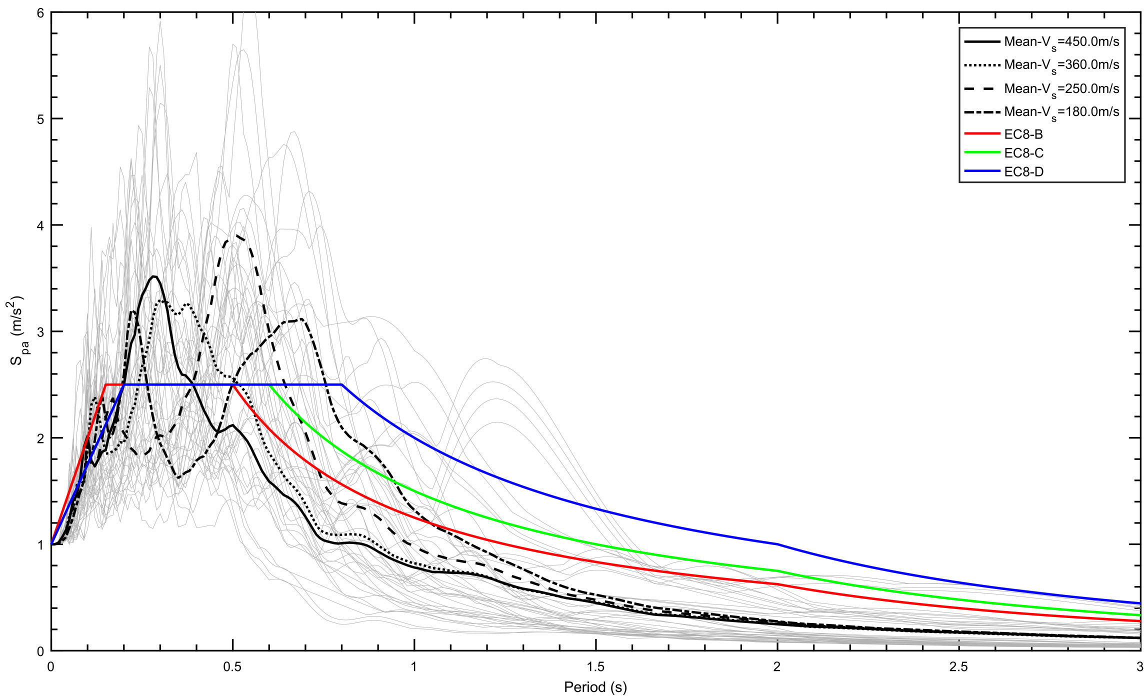

Figure 12. Normalized response spectra at the free field for the soil profiles 2, 3, 5 and 6 according to Table 2, for PGA at bedrock level equal to 1 m/s^2, and the corresponding mean spectra and normalized EC8 response spectra referring to soil types B, C and D.

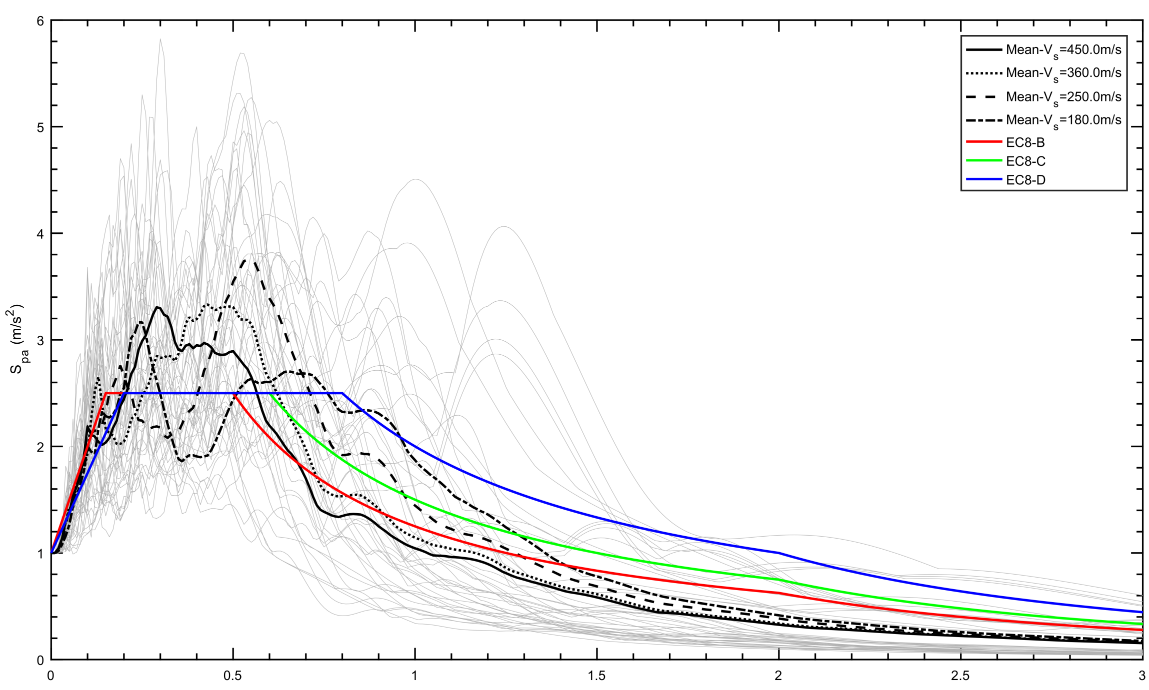

Figure 13. Normalized response spectra at the free field for the soil profiles 2, 3, 5 and 6 according to Table 2, for PGA at bedrock level equal to 3 m/s^2, and the corresponding mean spectra and normalized EC8 response spectra referring to soil types B, C and D.

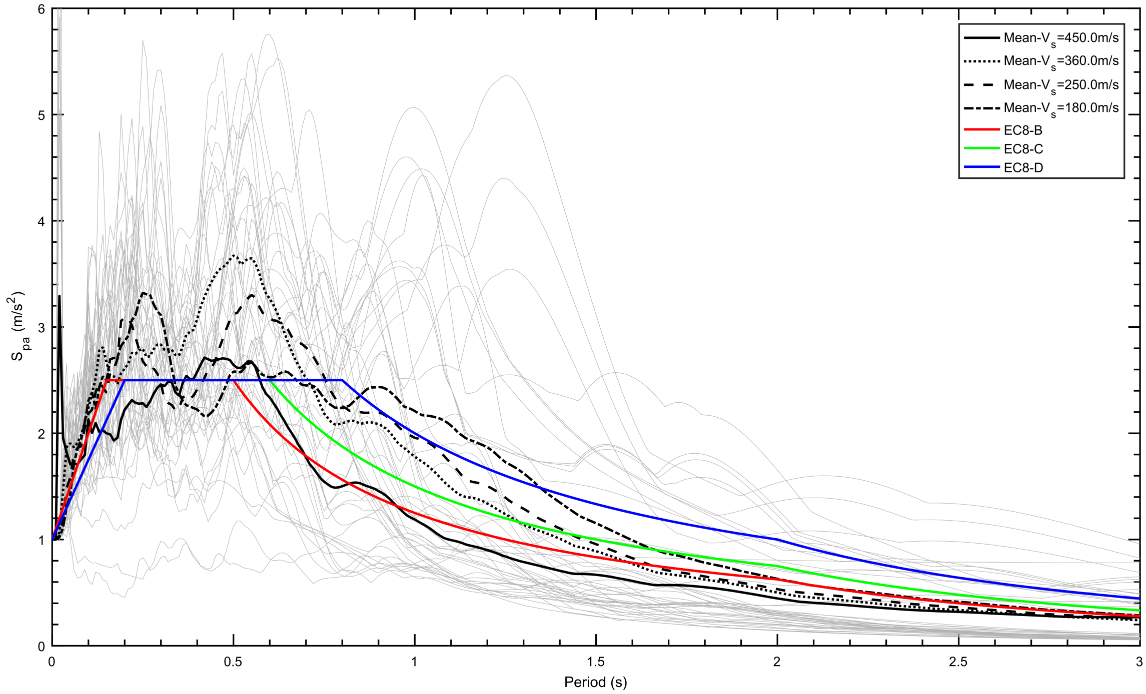

Figure 14. Normalized response spectra at the free field for the soil profiles 2, 3, 5 and 6 according to Table 2, for PGA at bedrock level equal to 7 m/s^2, and the corresponding mean spectra and normalized EC8 response spectra referring to soil types B, C and D.