APPENDIX B - ARS CURVES

The procedure for developing seismic loading is based on the deterministic ARS approach as specified in the Caltrans Guidelines for Structures Foundation Reports (http://onramp.dot.ca.gov/hq/esc/geotech/requests/guidelines.pdf).

A: Peak Rock Acceleration. The deterministic **A** values are obtained from the current Caltrans Seismic Hazard Map [1996]. The peak acceleration values on this map correspond to the estimated median acceleration values using 1996 Caltrans attenuation relationship.

R: Rock Spectra. The rock spectra **R** are magnitude and distance dependent. The spectral shapes for acceleration values between 0.1 and 0.7g (in 0.1g increments) for three magnitude groups (6.5 ± 0.25, 7.25 ± 0.25, and 8.0 ± 0.25) are shown in Figures B1 through B12. These spectra are for California-type rock and correspond to NEHRP Soil Profile Type B. These curves are a reasonable upper bound of the spectral values obtained using various spectral relationship.

S: Site Modification Factors. **S** factors have been developed using the soil profile types and soil amplification factors developed at a workshop on how site response should reflect in seismic code provisions [9], [10]. Table B.1 summarizes the soil profile types, which are the same as those adopted in the 1994 NEHRP Provisions [11].

Recommendations for classifying a site according to soil profile type are contained in the ATC 32 Report [2].

Table B.1 Soil Profile Types

Soil Profile Type	Soil Profile Description[a]
A	Hard rock with measured shear wave velocity ν_s > 5000 ft/s (1,500 m/s)
B	Rock with shear wave velocity 2,500 < ν_s < 5000 ft/s (760m/s < ν_s < 1,500 m/s)
C	Very dense soil and soft rock with shear wave velocity 1,200 < ν_s < 2,500 ft/s (360m/s < ν_s < 760 m/s) or with either standard penetration resistance N > 50 or undrained shear strength $s_u \geq$ 2,000 psf (100 kPa)
D	Stiff soil with shear wave velocity 600 < ν_s < 1,200 ft/s (180 m/s < ν_s < 360 m/s) or with either standard penetration resistance 15 ≤ N ≤ 50 or undrained shear strength 1000 psf ≤ s_u ≤ 2000 psf (50 kPa ≤ s_u ≤ 100 kPa)
E	A soil profile with shear wave velocity ν_s < 600 ft/s (180 m/s) or any profile with more than 10 ft (3 m) of soft clay, defined as soil with plasticity index *PI* > 20, water content $w \geq$ 40 percent, and undrained shear strength s_u < 500 psf (25 kPa)
F	Soil requiring site-specific evaluation: 1. Soils vulnerable to potential failure or collapse under seismic loading; i.e. liquefiable soils, quick and highly sensitive clays, collapsible weakly-cemented soils 2. Peat and/or highly organic clay layers more than 10 ft (3 m) thick 3. Very high-plasticity clay (*PI* > 75) layers more than 25 ft (8 m) thick 4. Soft-to-medium clay layers more than 120 ft (36 m) thick

[a] The soil profile types shall be established through properly substantiated geotechnical data.

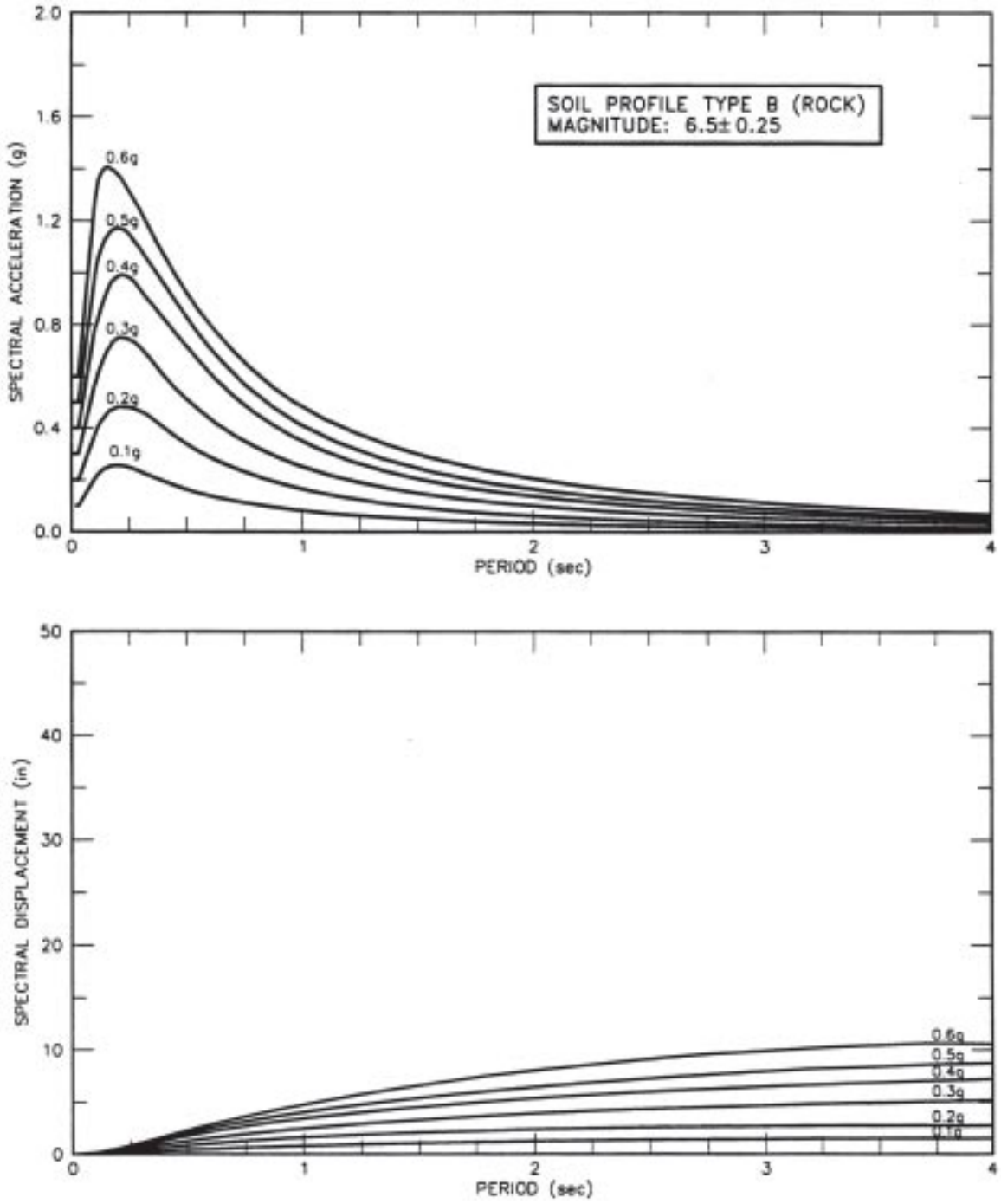


Figure B.1 Elastic Response Spectra Curves (5% Damping) for Soil Profile Type B (Rock) (M = 6.5 ± 0.25)

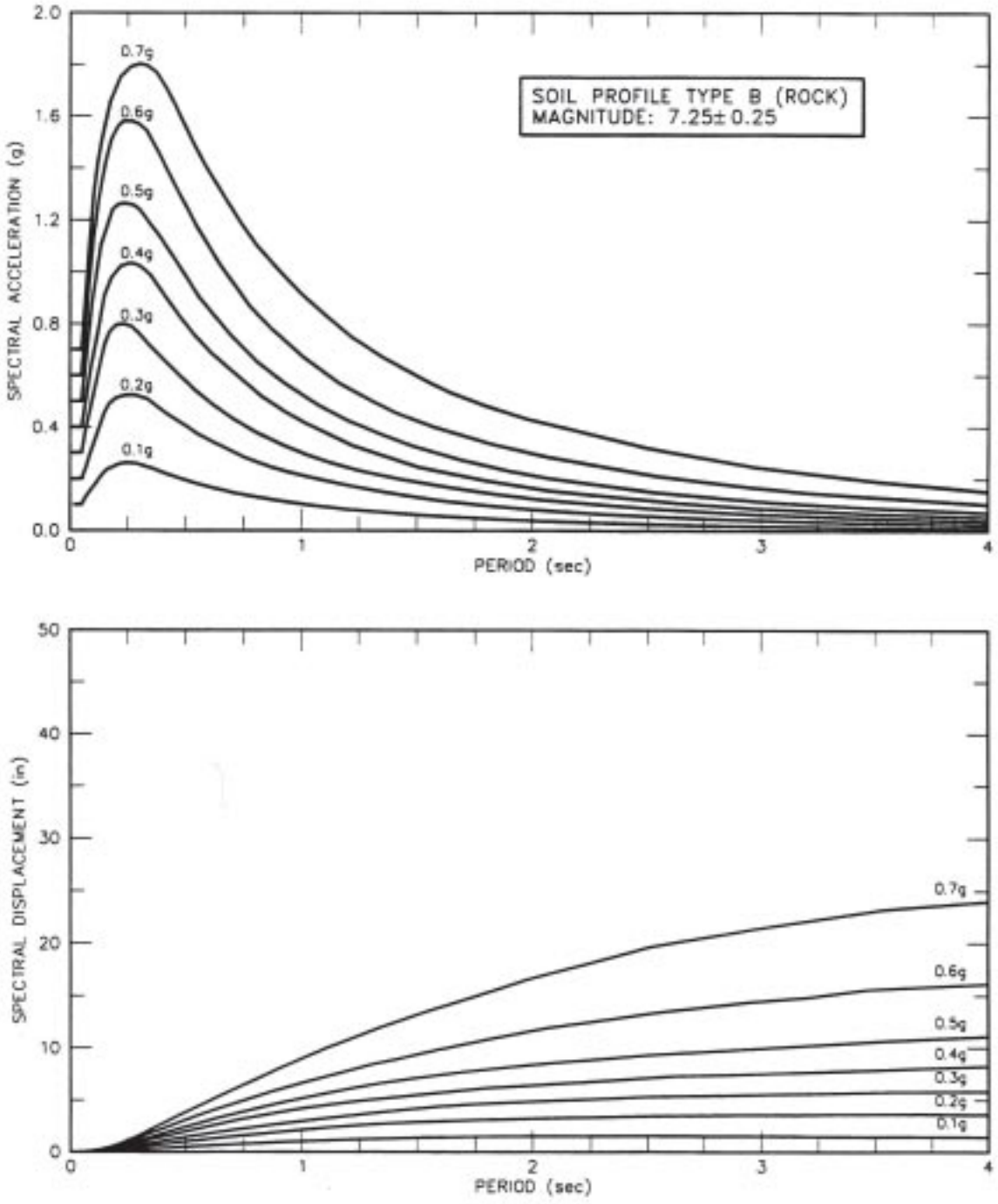


Figure B.2 Elastic Response Spectra Curves (5% Damping) for Soil Profile Type B (Rock) (M = 7.25 ± 0.25)

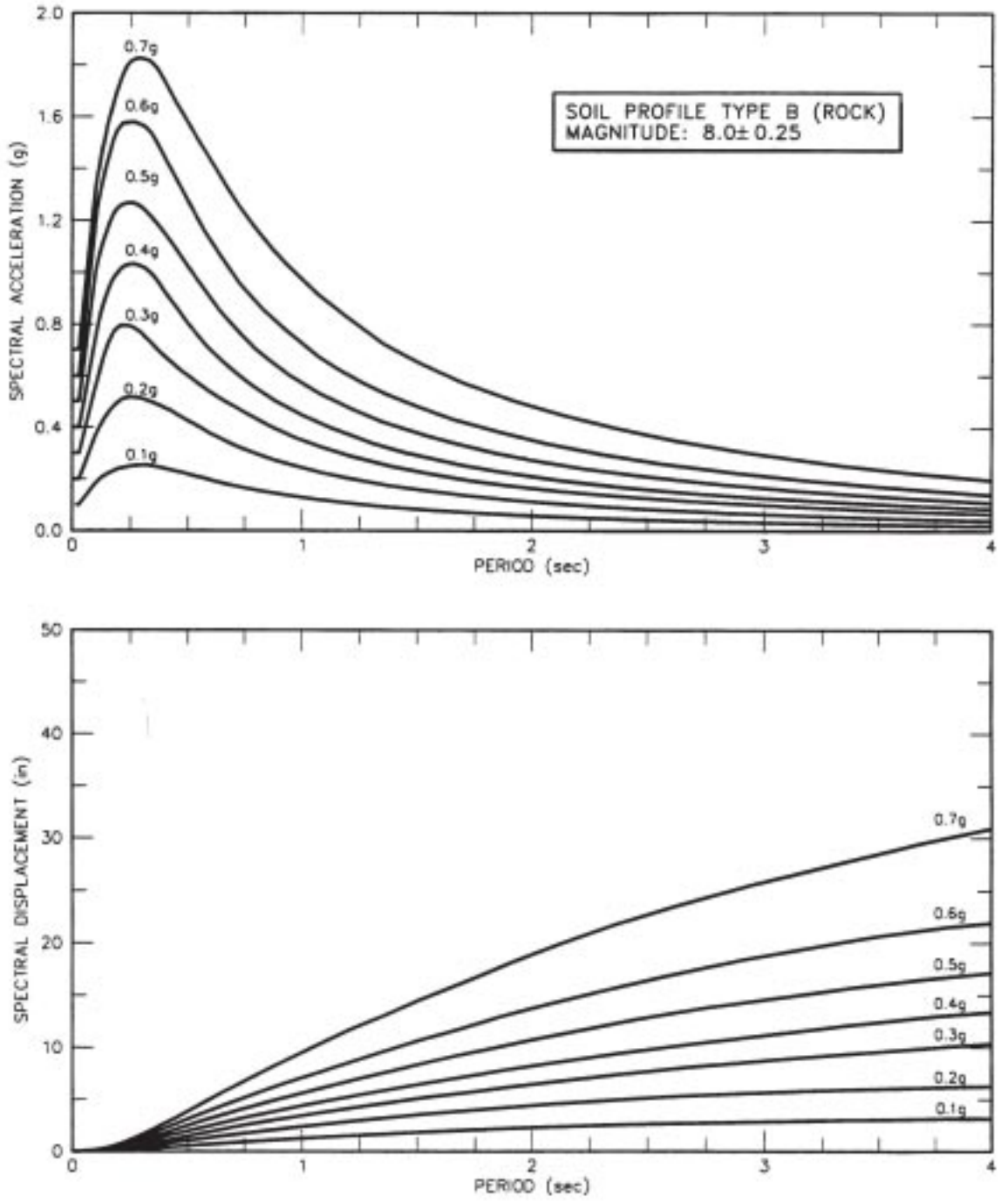
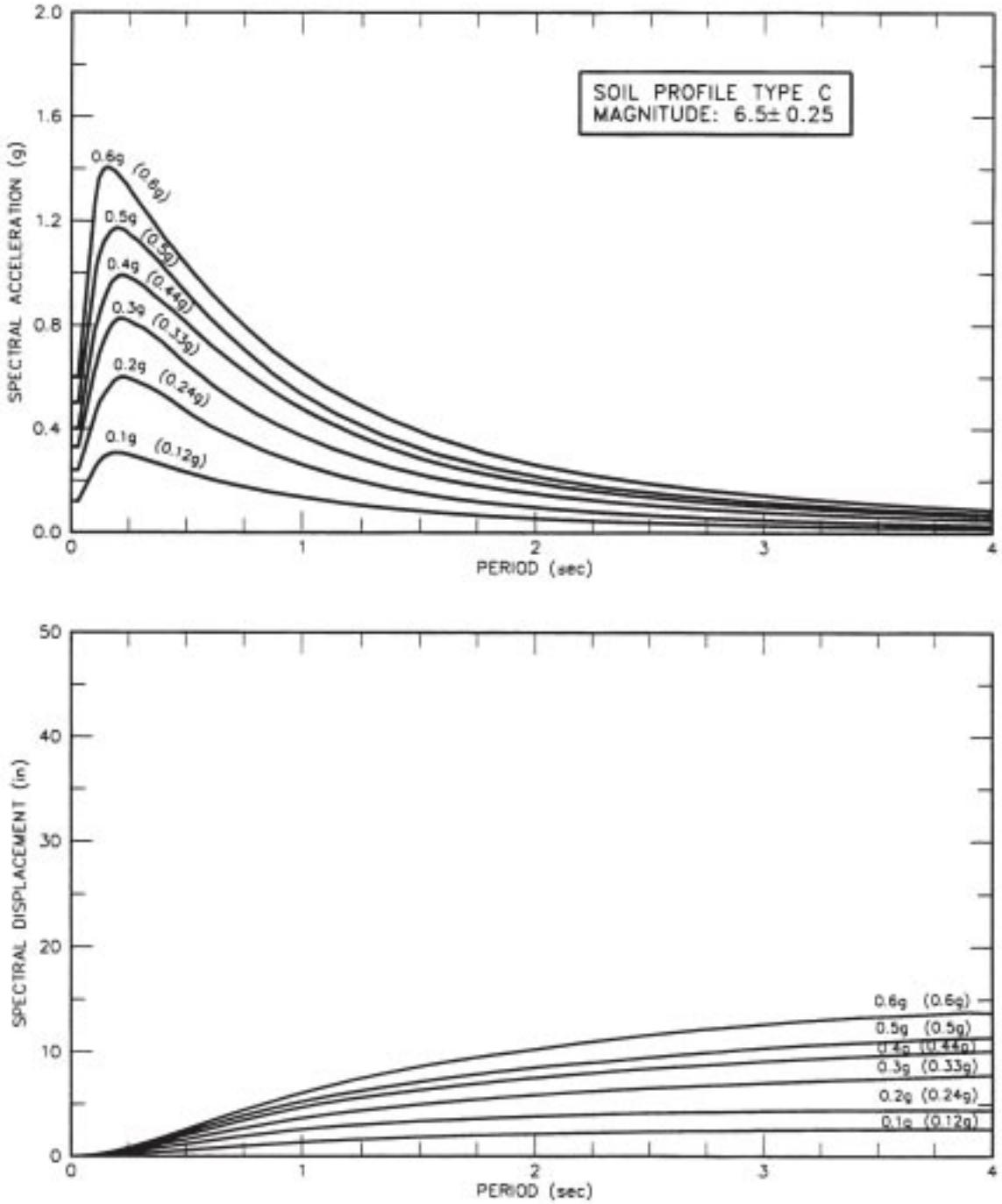
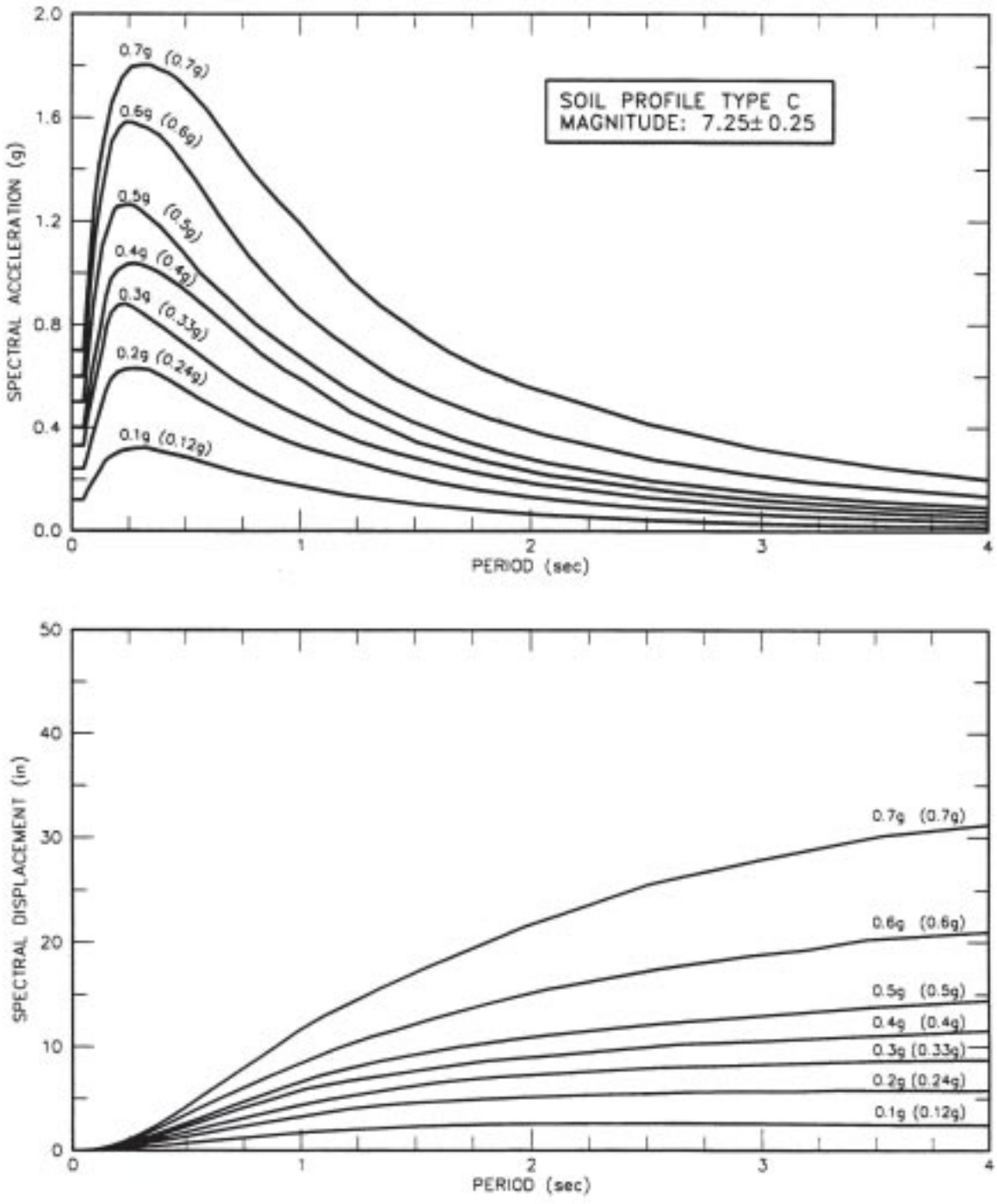


Figure B.3 Elastic Response Spectra Curves (5% Damping) for Soil Profile Type B (Rock) (M = 8.0 ± 0.25)



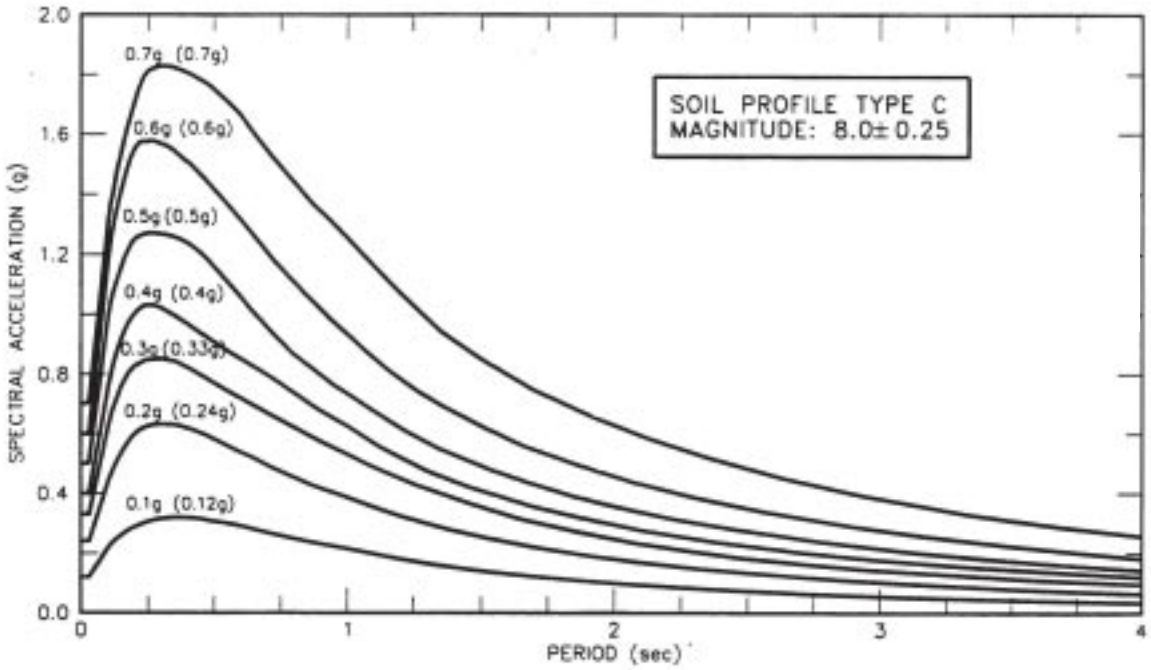
Note: Peak ground acceleration values not in parentheses are for rock (Soil Profile Type B) and peak ground acceleration values in parentheses are for Soil Profile Type C.

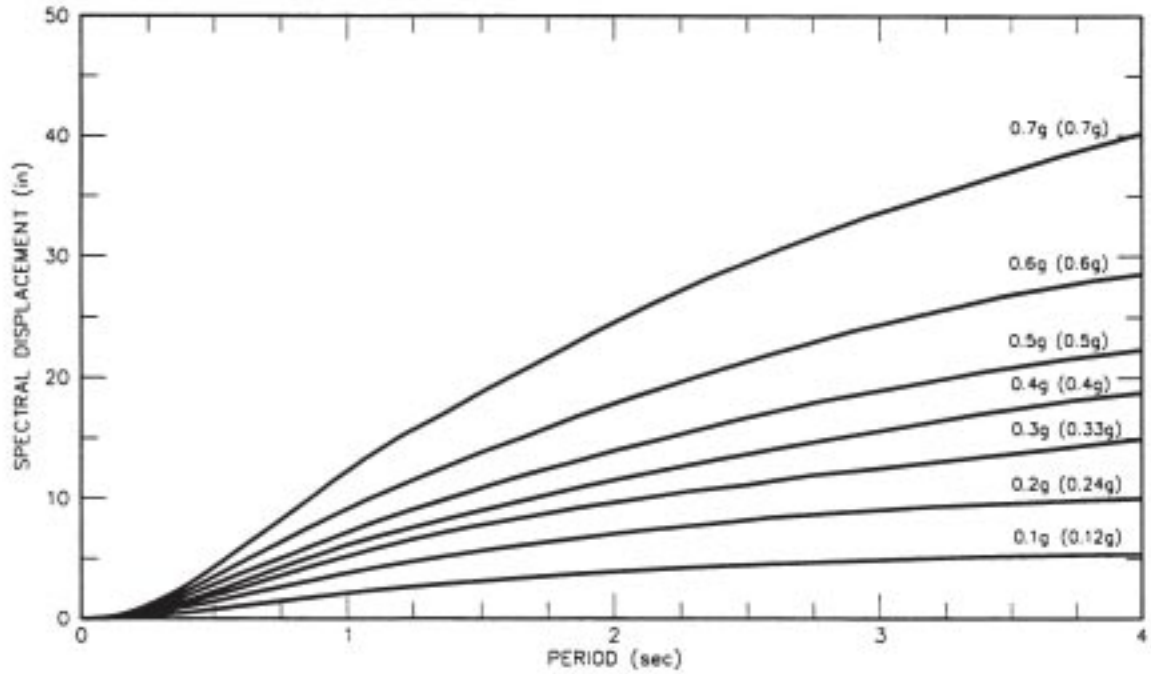
Figure B.4 Elastic Response Spectra Curves (5% Damping) for Soil Profile Type C (M = 6.5 ± 0.25)



Note: Peak ground acceleration values not in parentheses are for rock (Soil Profile Type B) and peak ground acceleration values in parentheses are for Soil Profile Type C.

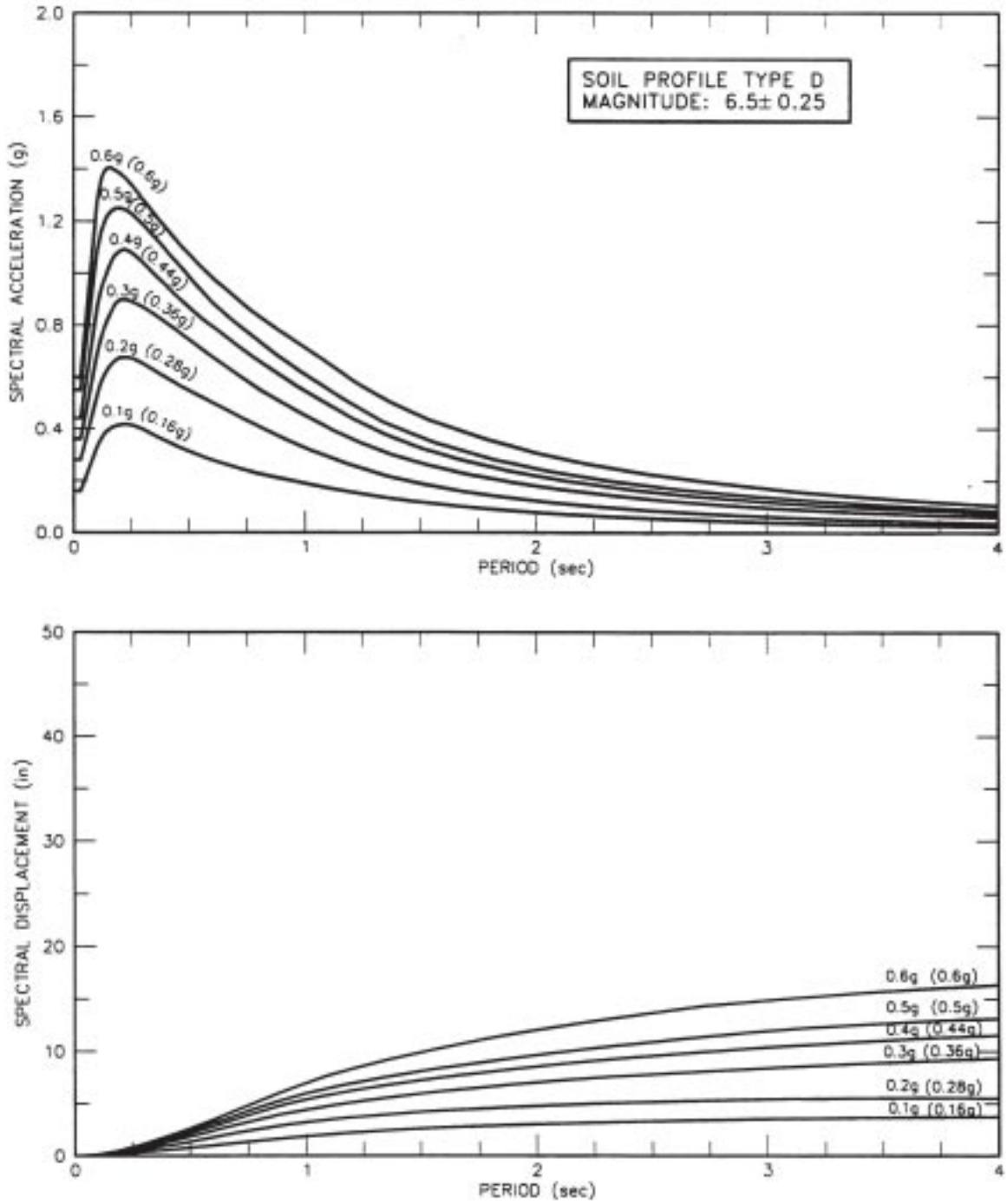
Figure B.5 Elastic Response Spectra Curves (5% Damping) for Soil Profile Type C (M = 7.25 ± 0.25)





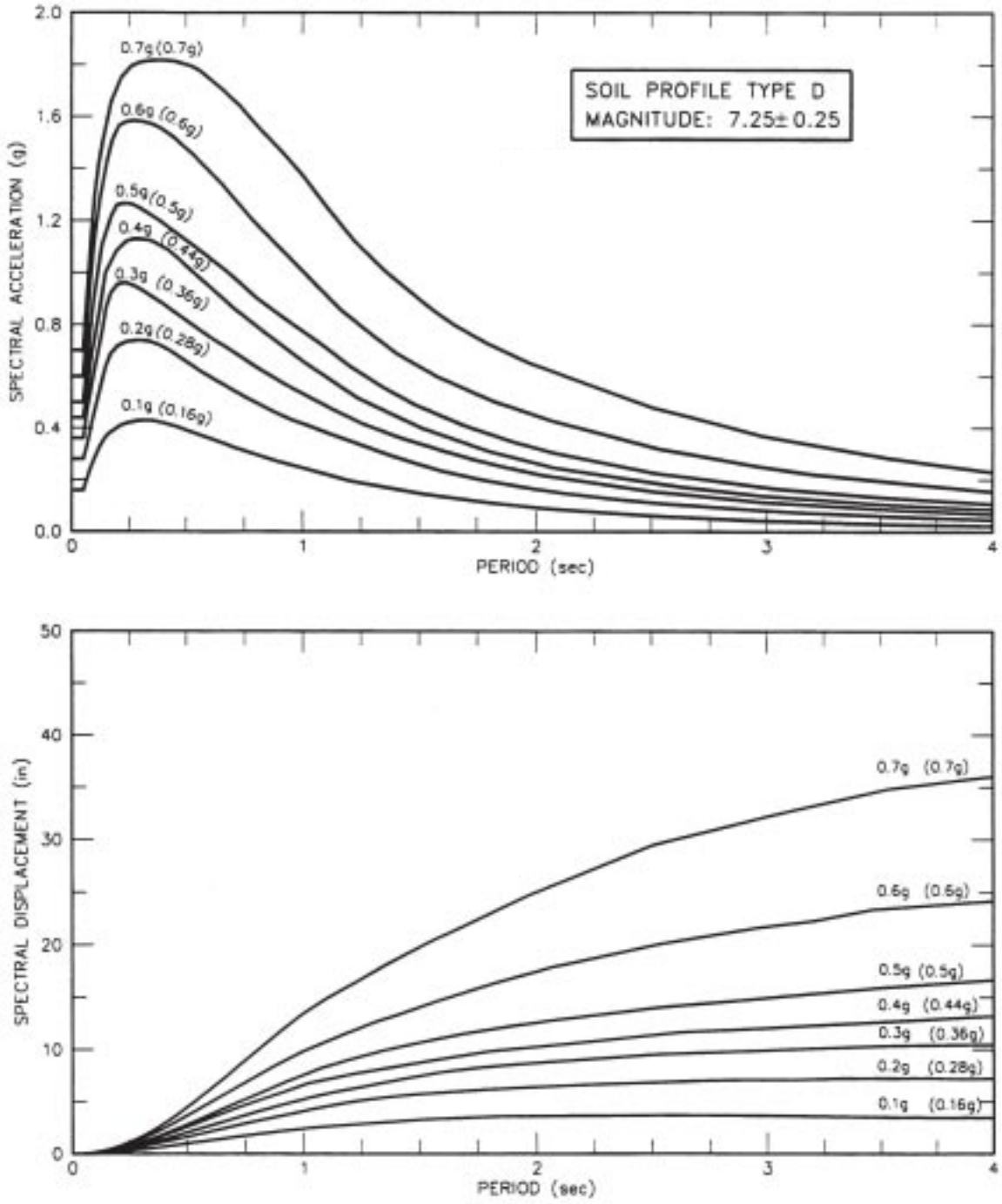
Note: Peak ground acceleration values not in parentheses are for rock (Soil Profile Type B) and peak ground acceleration values in parentheses are for Soil Profile Type C.

Figure B.6 Elastic Response Spectra Curves (5% Damping) for Soil Profile Type C (M = 8.0 ± 0.25)



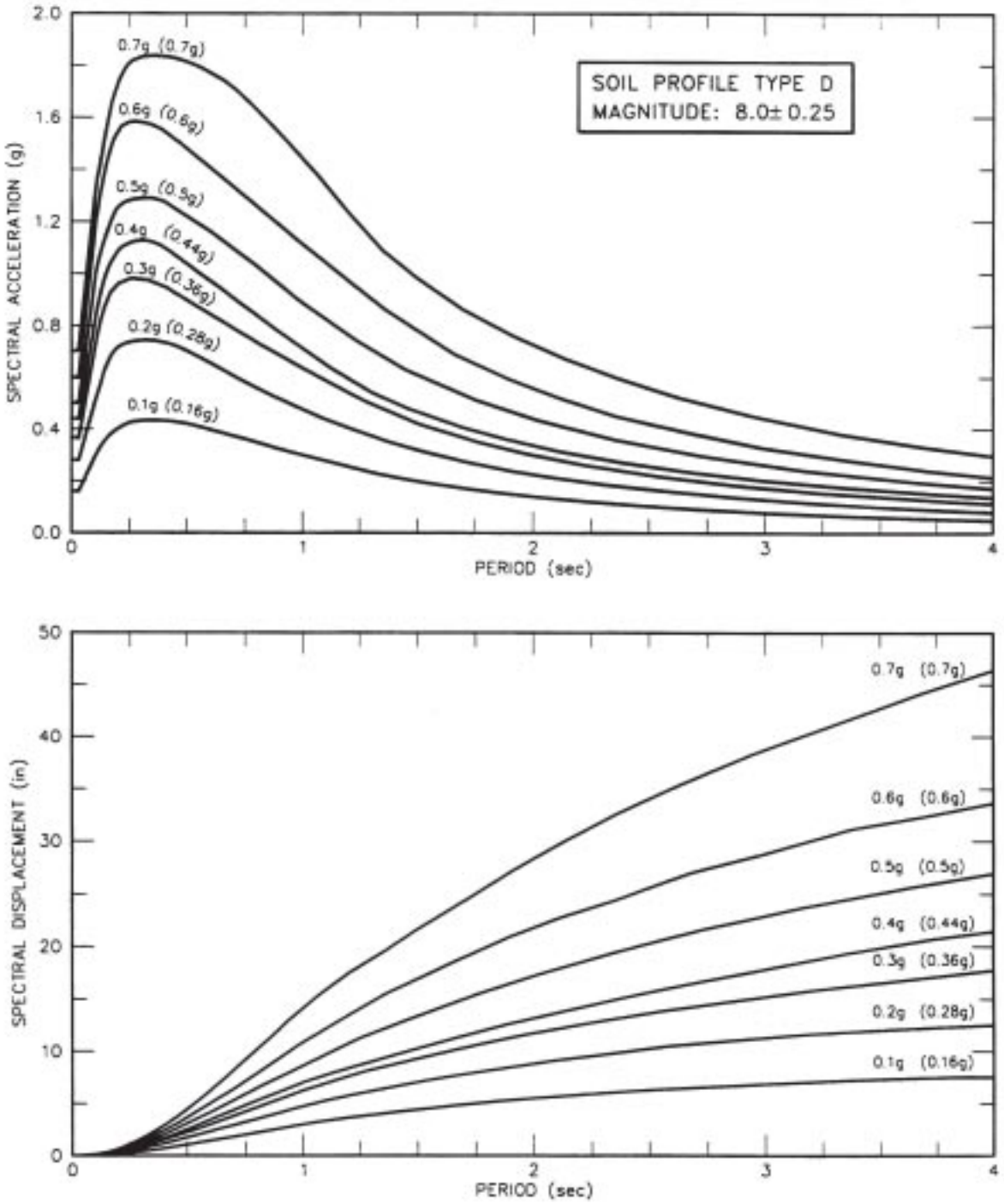
Note: Peak ground acceleration values not in parentheses are for rock (Soil Profile Type B) and peak ground acceleration values in parentheses are for Soil Profile Type D.

Figure B.7 Elastic Response Spectra Curves (5% Damping) for Soil Profile Type D (M = 6.5 ± 0.25)



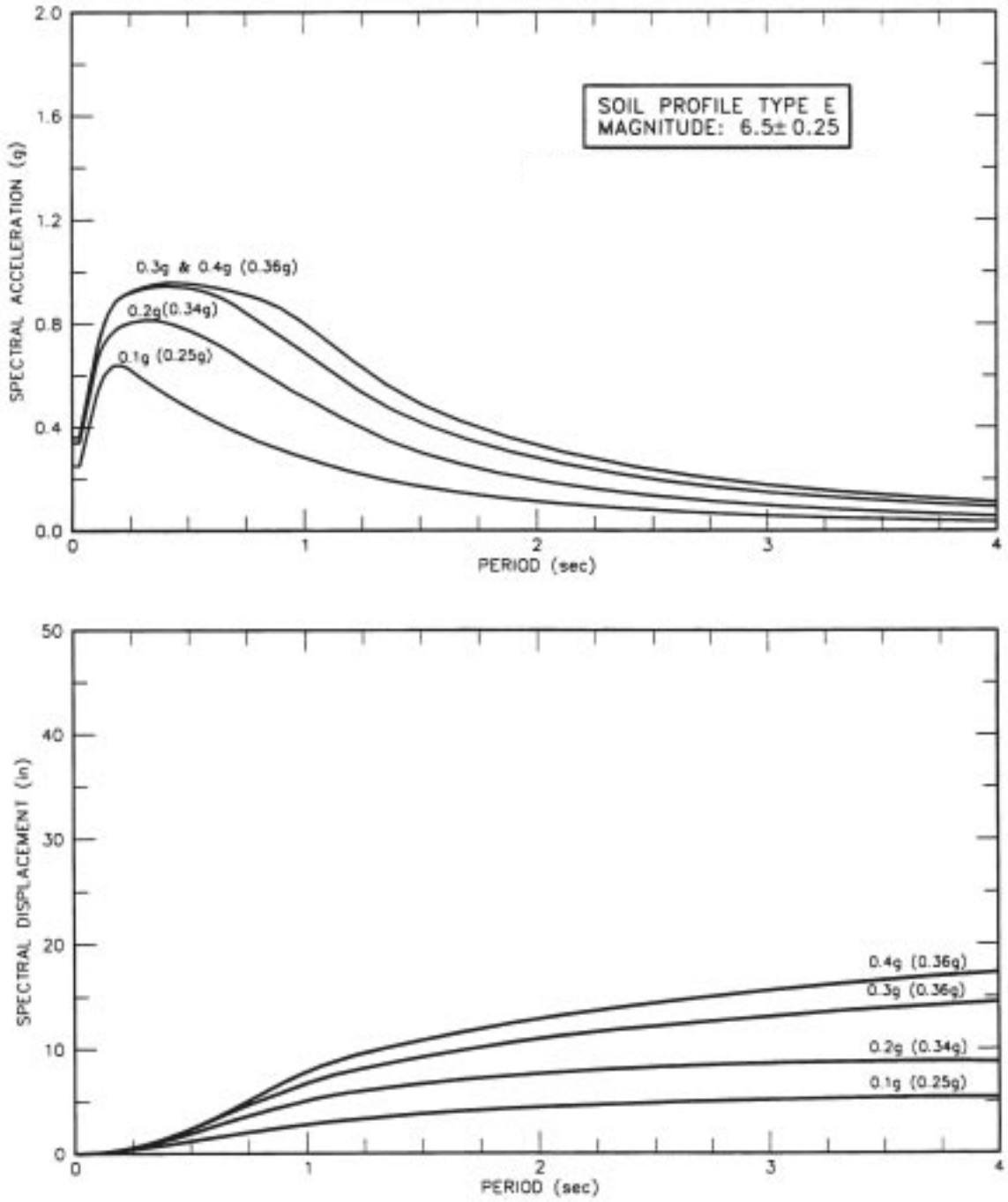
Note: Peak ground acceleration values not in parentheses are for rock (Soil Profile Type B) and peak ground acceleration values in parentheses are for Soil Profile Type D.

Figure B.8 Elastic Response Spectra Curves (5% Damping) for Soil Profile Type D (M = 7.25 ± 0.25)



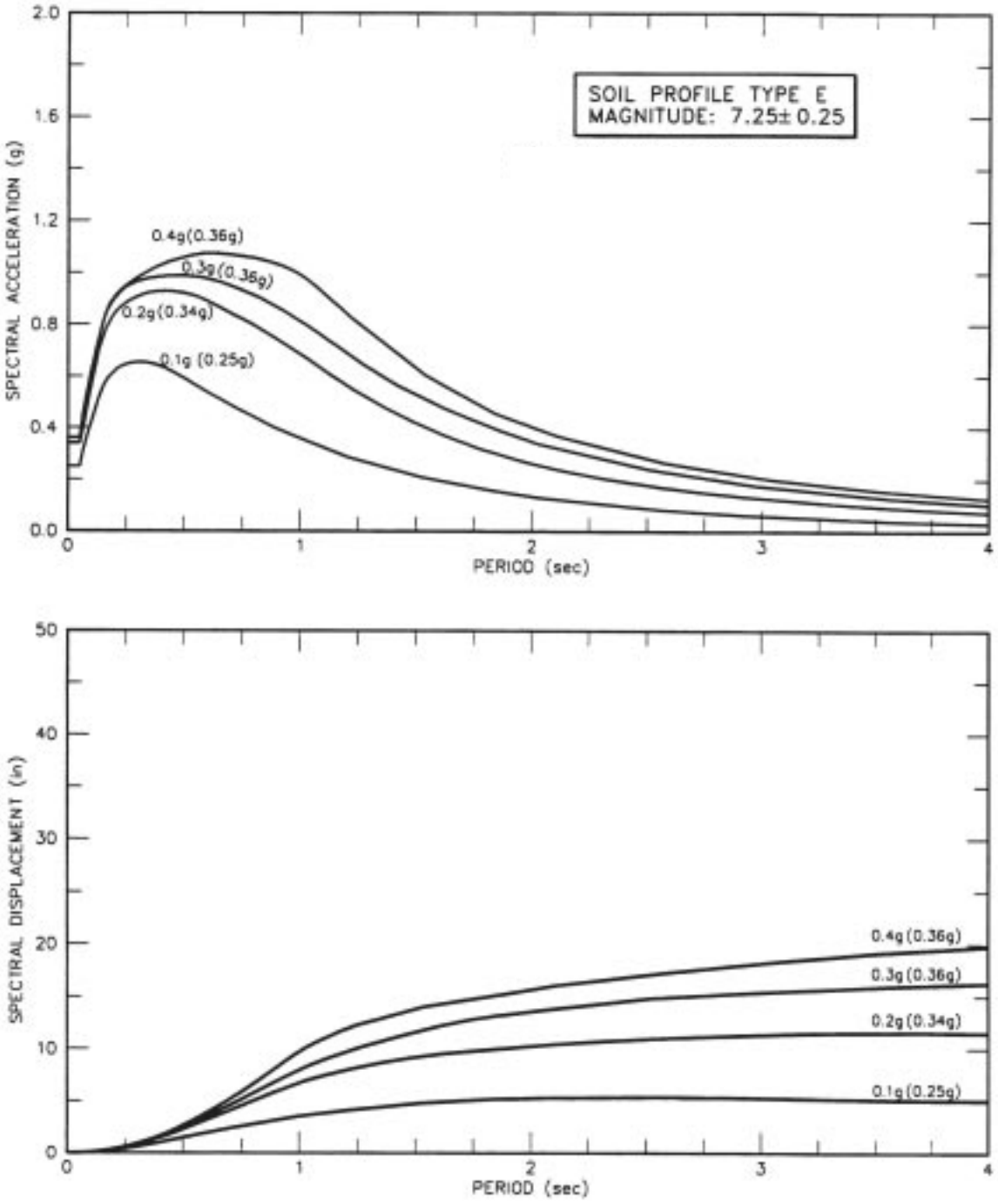
Note: Peak ground acceleration values not in parentheses are for rock (Soil Profile Type B) and peak ground acceleration values in parentheses are for Soil Profile Type D.

Figure B.9 Elastic Response Spectra Curves (5% Damping) for Soil Profile Type D (M = 8.0 ± 0.25)



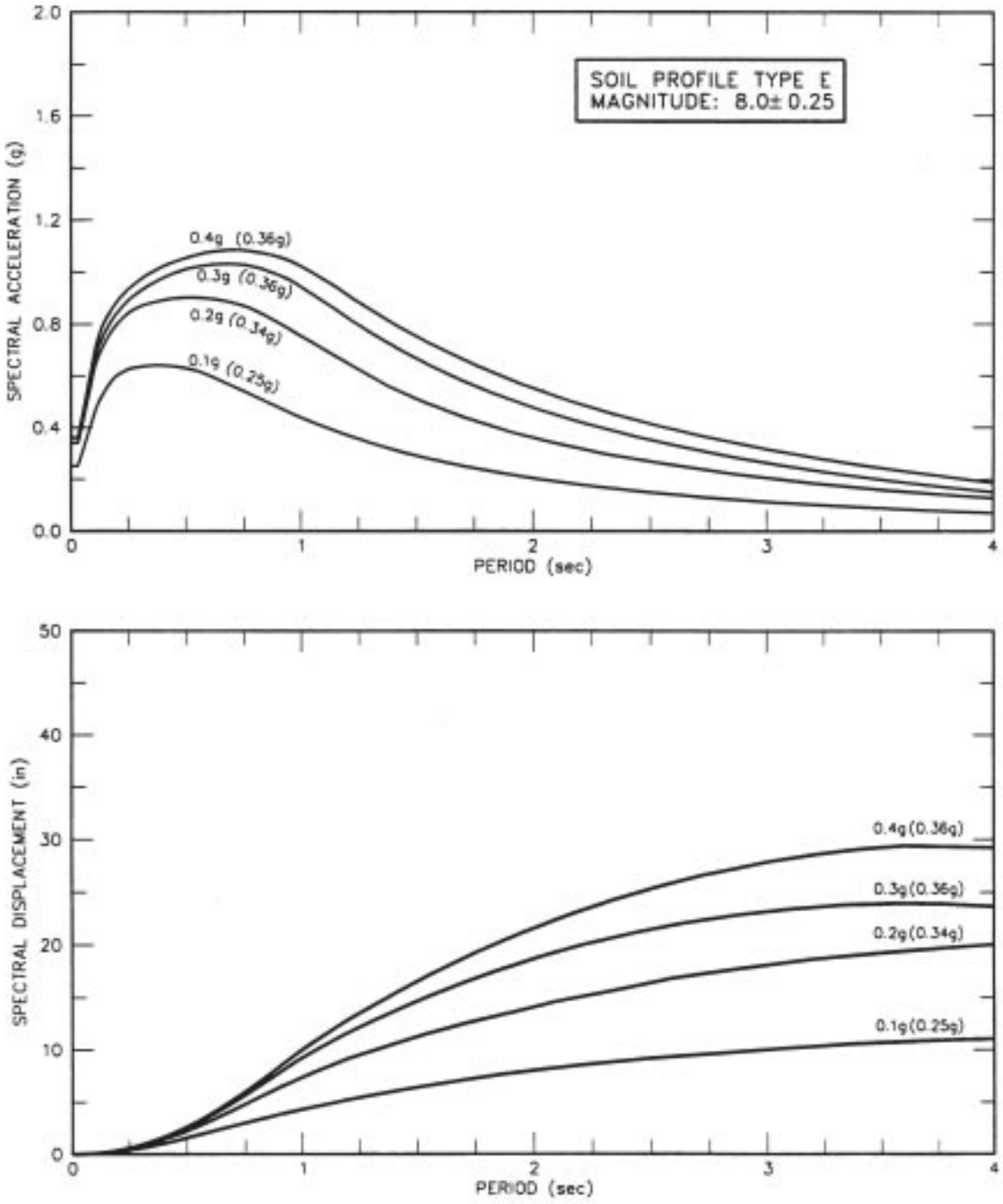
Note: Peak ground acceleration values not in parentheses are for rock (Soil Profile Type B) and peak ground acceleration values in parentheses are for Soil Profile Type E.

Figure B.10 Elastic Response Spectra Curves (5% Damping) for Soil Profile Type E (M = 6.5 ± 0.25)



Note: Peak ground acceleration values not in parentheses are for rock (Soil Profile Type B) and peak ground acceleration values in parentheses are for Soil Profile Type E.

Figure B.11 Elastic Response Spectra Curves (5% Damping) for Soil Profile Type E (M = 7.25 ± 0.25)



Note: Peak ground acceleration values not in parentheses are for rock (Soil Profile Type B) and peak ground acceleration values in parentheses are for Soil Profile Type E.

Figure B.12 Elastic Response Spectra Curves (5% Damping) for Soil Profile Type E (M = 8.0 ± 0.25)