Design Example 1
Design Spectral Response Acceleration Parameters §11.4

OVERVIEW

For a given building site, the risk-targeted maximum considered earthquake spectral response accelerations S_S, at short periods, and S_1, at a 1-second period, are given by the acceleration contour maps in Chapter 22 in Figures 22-1 through 22-6. This example illustrates the general procedure for determining the design spectral response acceleration parameters S_{DS} and S_{D1} from the mapped values of S_S and S_1. The parameters S_{DS} and S_{D1} are used to calculate the design response spectrum in Section 11.4.5 and the design base shear in Section 12.8.

The easiest and most accurate way to obtain the spectral values is to use the "U.S. Seismic Design Maps" application from the USGS website (http://geohazards.usgs.gov/designmaps/us/application.php). The USGS application allows for values of S_S and S_1 to be provided based on the address or the longitude and latitude of the site being entered.

PROBLEM STATEMENT

A building site in California is located at 38.123° North (Latitude 38.123°) and 121.123° West (Longitude -121.123°). The soil profile is Site Class D.

DETERMINE THE FOLLOWING:

1. Mapped risk-targeted maximum considered earthquake (MCE_R) spectral response acceleration parameters S_S and S_1.

2. Site coefficients F_a and F_v and MCE_R spectral response acceleration parameters S_{MS} and S_{M1} adjusted for Site Class effects.

3. Design spectral response acceleration parameters S_{DS} and S_{D1}.

1. Mapped MCE_R Spectral Response Acceleration Parameters S_s and S_1 §11.4.1

For the given site at 38.123° North (Latitude 38.123°) and 121.123° West (Longitude -121.123°), the USGS "U.S. Seismic Design Maps" application provides the values of

$S_S = 0.634g$

$S_1 = 0.272g.$

2. Site Coefficients F_a and F_v and MCE_R Spectral Response Acceleration Parameters S_{MS} and S_{M1} Adjusted for Site Class Effects §11.4.3

For the given Site Class D and the values of S_S and S_1 determined above, the site coefficients are

$F_a = 1.293$ T11.4-1

$F_v = 1.856.$ T11.4-2

The MCE_R spectral response acceleration parameters adjusted for Site Class effects are

$S_{MS} = F_a S_S = 1.292(0.634g) = 0.819g$ Eq 11.4-1

$S_{M1} = F_v S_1 = 1.857(0.272g) = 0.505g$ Eq 11.4-2

3. Design Spectral Response Acceleration Parameters S_{DS} and S_{D1} §11.4.4

$S_{DS} = (2/3)\ S_{MS} = (2/3)(0.819g) = 0.546g$ Eq 11.4-3

$S_{D1} = (2/3)\ S_{M1} = (2/3)(0.505g) = 0.337g$ Eq 11.4-4

Commentary

The USGS application "U.S. Seismic Design Maps" requires the risk category to be specified, even though that category is not necessary for determining S_{DS} and S_{D1}.

Design Example 2
Design Response Spectrum §11.4.5

PROBLEM STATEMENT

A building site in California has the following design spectral response acceleration parameters determined in accordance with Section 11.4.4 and mapped long-period transition period evaluated from Figure 22-12:

$S_{DS} = 0.55g$
$S_{D1} = 0.34g$
$T_L = 8$ sec.

DETERMINE THE FOLLOWING:

1. Design response spectrum.

1. Design Response Spectrum §11.4.5

Section 11.4.5 provides the equations for the 5 percent damped spectral response acceleration, S_a, relative to period, T, in the following ranges:

$0 \leq T < T_0$, $T_0 \leq T \leq T_S$, $T_S < T \leq T_L$, and $T_L < T$

where:

$T_0 = 0.2\ S_{D1} / S_{DS}$,
$T_S = S_{D1} / S_{DS}$, and
T_L = long-period transition period from Figures 22-12 through 22-16.

Given the values above for this example,

$T_0 = 0.2\ S_{D1} / S_{DS} = 0.2(0.34g / 0.55g) = 0.12$ sec
$T_S = S_{D1} / S_{DS} = (0.34g / 0.55g) = 0.62$ sec, and
$T_L = 8$ sec.

The spectral response acceleration, S_a, is calculated as follows:

1. For the interval $0 \le T < T_0$ ($0 \le T < 0.12$ s),

$$S_a = S_{DS}(0.4 + 0.6T/T_0) \qquad \text{Eq 11.4-5}$$
$$S_a = 0.55\text{g}(0.4+0.6T/0.12) = (0.22 + 2.75T)\text{g}.$$

2. For the interval $T_0 \le T \le T_S$ (0.12 s $\le T \le 0.62$ s),

$$S_a = S_{DS} = 0.55\text{g}.$$

3. For the interval $T_S < T \le T_L$ (0.62 s $< T \le 8$ s),

$$S_a = S_{D1}/T \qquad \text{Eq 11.4-6}$$
$$S_a = (0.34/T)\text{g}.$$

4. For the interval $T_L < T$ (8 s $< T$),

$$S_a = S_{D1}T_L/T^2 \qquad \text{Eq 11.4-7}$$
$$S_a = 0.34\text{g}(8)/T^2 = (2.72/T^2)\text{g}.$$

From this information, the elastic design response spectrum for this site can be drawn, as shown below, in accordance with Figure 11.4-1:

T (sec)	S_a (g)
0.00	0.22
0.12	0.55
0.62	0.55
0.75	0.45
1.00	0.34
1.50	0.23
2.00	0.17
4.00	0.09
8.00	0.04
10.00	0.03

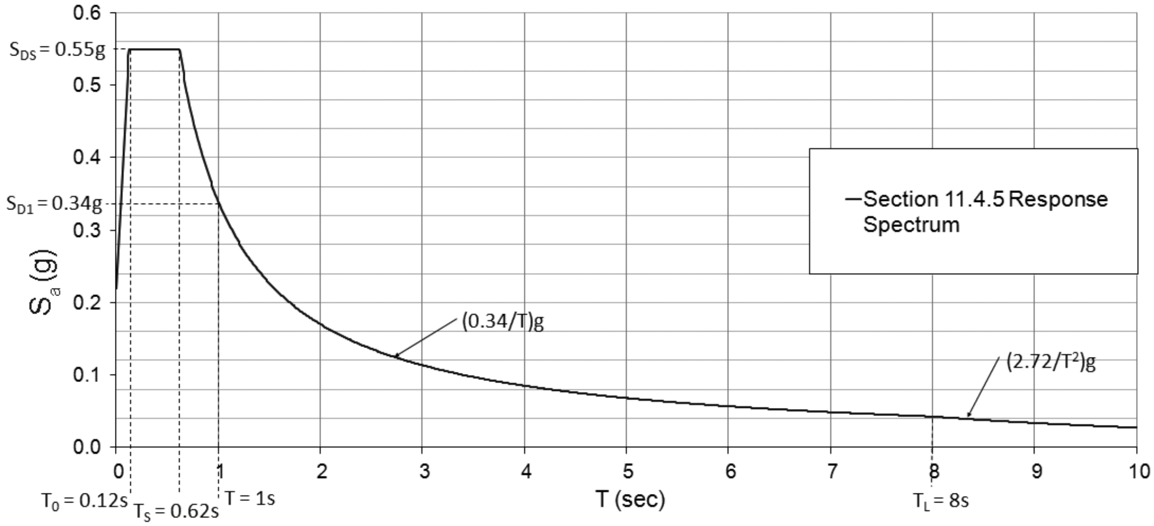

Figure 2-1.
Design response spectrum per Section 11.4.5