Design Example 3
Site-Specific Ground Motion Procedures §11.4.8

Per Section 11.4.7 of ASCE 7-22, a site-specific response spectrum may be derived for any structure based on the procedures set forth in Chapter 21. The site-specific ground motion procedures of Chapter 21 are required for the following case:

- Structures on Site Class F sites, unless the exception to Section 20.3.1 is applicable.

This example illustrates the general procedure for deriving the site-specific design response spectrum based on a given site-specific response spectrum analysis per Sections 21.1 and 21.2.

PROBLEM STATEMENT

For a site in California at 37.875° North (Latitude 37.875°) and 122.258° West (Longitude -122.258°), the following site-specific response spectra have been provided by an official report in accordance with Section 21.1 or Section 21.2. The report classifies the site as Site Class D.

$T_L = 12$ sec

Site-specific response spectra from official report:

Period (sec)	Site-Specific MCE_R Response Spectrum, S_{aM} (g)	DBE Response Spectrum, $S_a = 2/3S_{aM}$ (g)
0.0	0.72	0.48
0.01	0.74	0.49
0.02	0.74	0.49
0.03	0.74	0.49
0.05	0.83	0.55
0.075	1.02	0.68
0.1	1.17	0.78
0.15	1.40	0.93
0.2	1.56	1.04
0.25	1.71	1.14
0.3	1.86	1.24
0.4	1.97	1.31
0.5	1.91	1.27
0.75	1.61	1.07
1.0	1.40	0.93
1.5	1.10	0.73
2.0	0.89	0.59

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Period (sec)	Site-Specific MCE_R Response Spectrum, S_{aM} (g)	DBE Response Spectrum, $S_a = 2/3S_{aM}$ (g)
3.0	0.63	0.42
4.0	0.47	0.31
5.0	0.35	0.23
7.5	0.20	0.13
10.0	0.13	0.09

DETERMINE THE FOLLOWING:

1. Design MPRS per Section 11.4.5.1 (using map-based acceleration parameters from the ASCE Hazard Tool).

2. Scaled site-specific design response spectrum per Section 21.3.

3. Design spectral response acceleration parameters S_{DS}, S_{D1}, S_{MS}, and S_{M1} per Section 21.4.

1. Design MPRS per Section 11.4.5.1 (Using Map-Based Acceleration Parameters from the ASCE Hazard Tool)

Design MPRS per Section 11.4.5.1 (using map-based acceleration parameters from the ASCE Hazard Tool):

Period (sec)	S_a (g)
0.0	0.67
0.01	0.67
0.02	0.67
0.03	0.68
0.05	0.75
0.075	0.91
0.1	1.04
0.15	1.23
0.2	1.37
0.25	1.49
0.3	1.63
0.4	1.77
0.5	1.74
0.75	1.52

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Period (sec)	S_a (g)
1.0	1.34
1.5	0.99
2.0	0.78
3.0	0.51
4.0	0.36
5.0	0.26
7.5	0.14
10.0	0.084

2. Scaled Site-Specific Design Response Spectrum per Section 21.3

In accordance with Section 21.2.3, the design site-specific spectral response acceleration at any period shall not be less than 80 percent of the S_a determined in accordance with Section 11.4.5.1, as done in Part 1. Governing S_a values are shown in bold. Not all periods are shown in the following table. Therefore, the governing period(s) for the structure being designed shall be evaluated in the same way.

Period (sec)	Site-Specific MCER Response Spectrum, S_{aM} (g)	DBE Response Spectrum, $S_a = 2/3S_{aM}$ (g)	S_a per Section 11.4.6	80% of S_a per Section 11.4.6	Governing Site-Specific Design Response Spectrum, S_a (g)	$0.9T \times$ Site-specific S_a (sec × g)
0	0.720	0.480	0.670	0.536	0.536	0.000
0.0l	0.735	0.490	0.670	0.536	0.536	0.004
0.02	0.735	0.490	0.670	0.536	0.536	0.009
0.03	0.735	0.490	0.680	0.544	0.544	0.013
0.05	0.825	0.550	0.750	0.600	0.600	0.025
0.075	1.020	0.680	0.910	0.728	0.728	0.046
0.1	1.170	0.780	1.040	0.832	0.832	0.070
0.15	1.395	0.930	1.230	0.984	0.984	0.126
0.2	1.560	1.040	1.370	1.096	1.096	0.187
0.25	1.710	1.140	1.490	1.192	1.192	0.257
0.3	1.860	1.240	1.630	1.304	1.304	0.335
0.4	1.965	1.310	1.770	1.416	1.416	0.472
0.5	1.905	1.270	1.740	1.392	1.392	0.572

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Period (sec)	Site-Specific MCER Response Spectrum, S_{aM} (g)	DBE Response Spectrum, $S_a = 2/3S_{aM}$ (g)	S_a per Section 11.4.6	80% of S_a per Section 11.4.6	Governing Site-Specific Design Response Spectrum, S_a (g)	$0.9T \times$ Site-specific S_a (sec × g)
0.75	1.605	1.070	1.520	1.216	1.216	0.722
1	1.395	0.930	1.340	1.072	1.072	0.837
1.5	1.095	0.730	0.990	0.792	0.792	0.986
2	0.885	0.590	0.780	0.624	0.624	1.062
3	0.630	0.420	0.510	0.408	0.420	1.134
4	0.465	0.310	0.360	0.288	0.310	1.116
5	0.345	0.230	0.260	0.208	0.230	1.035
7.5	0.195	0.130	0.140	0.112	0.130	0.878
10.000	0.128	0.085	0.084	0.067	0.085	0.765

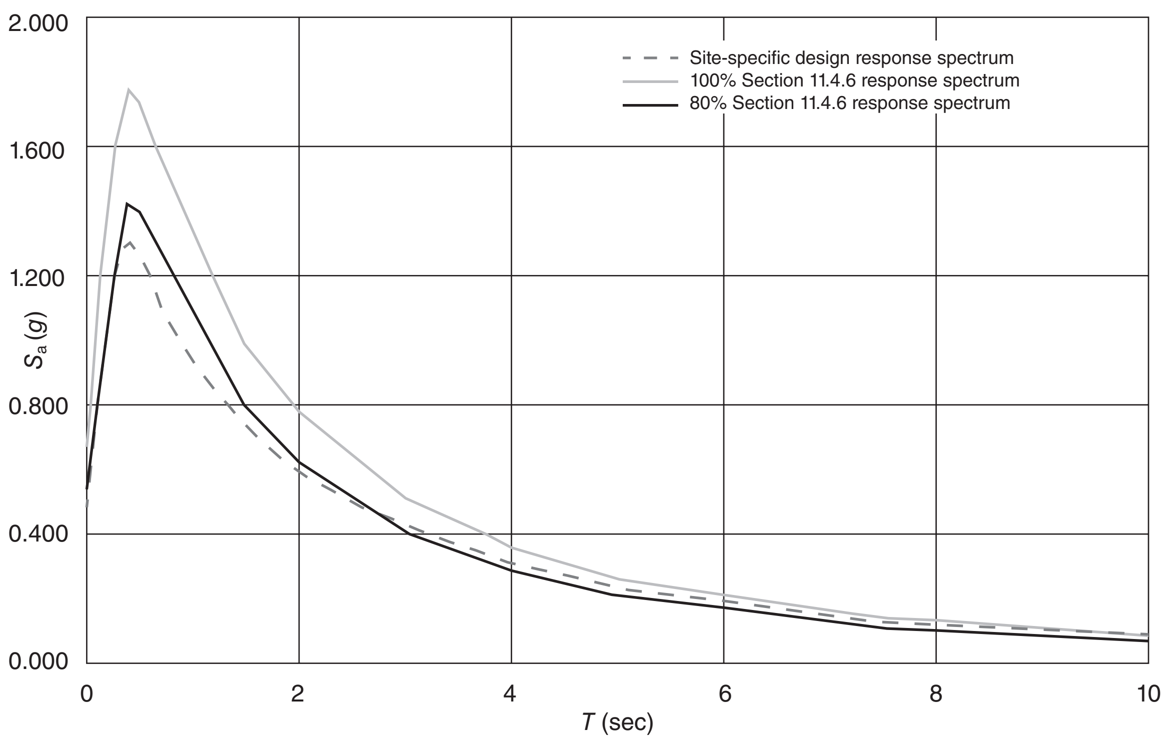

Figure 3-1. Scaling of design site-specific response spectrum

3. Design Spectral Response Acceleration Parameters S_{DS}, S_{D1}, S_{MS}, and S_{M1} per Section 21.4

a. Calculate S_{DS}

S_{DS} = greater of 90 percent of maximum spectral acceleration obtained from the site-specific spectrum, S_a, at any period within the range of 0.2 to 5 seconds, and 80 percent of S_{DS} (per §11.4.4)

80% of S_{DS} (from §11.4.4) = 0.8*1.59g = 1.272g

max S_a between 0.2 sec and 5 sec = 1.31g at 0.4 sec, so S_{DS} (per §21.4) = 0.9*1.31g = 1.179g

S_{DS} = max(1.272g, 1.179g) = 1.272g

b. Calculate S_{D1}

S_{D1} = greater of maximum value of $0.9T \times S_a$ for periods from 1 to 2 seconds, S_a at T = 1 second, and 80 percent of S_{D1} (per §11.4.4) for sites with $\bar{v}_s > 1450$ ft/sec (Site Class A through CD)

S_{D1} = greater of maximum value of $0.9T \times S_a$ for periods from 1 to 5 seconds, S_a at T = 1 second, and 80 percent of S_{D1} (per §11.4.4) for sites with $\bar{v}_s \leq 1450$ ft/sec (Site Class D through F)

80% of S_{D1} (from §11.4.4) = 0.8*1.4g = 1.12g

Since Site Class D max of $0.9T \times S_a$ between 1 sec and 5 sec = 1.134g at 3 sec

S_a at T = 1 sec = 0.93g

S_{DS} = max(1.12g, 1.134g, 0.93g) = 1.134g

c. Calculate S_{MS} and S_{M1}

$S_{MS} = 1.5S_{DS}$ (per §21.4) = 1.5*1.272g = 1.908g

$S_{M1} = 1.5S_{D1}$ (per §21.4) = 1.5*1.134g = 1.701g

Commentary

According to Section 21.4, for use with the equivalent lateral force procedure, the site-specific acceleration, S_a, at T shall be permitted to replace S_{D1}/T in Equation 12.8-4 and $S_{D1}T_L/T^2$ in Equation 12.8-5. Similarly, the parameter S_{DS}, calculated in accordance with Section 21.4 (governing S_a at T = 0.20 seconds from Part 3), may be used in Equations 12.8-3, 12.8-6, 15.4-1, and 15.4-3. However, the mapped value of S_1 shall be used in Equations 12.8-7, 15.4-2, and 15.4-4.

Design Example 4
Importance Factor and Risk Category §11.5
Seismic Design Category §11.6

PROBLEM STATEMENT

Two private high school buildings each have an occupant load greater than 250 and the following design spectral acceleration parameters:

$S_{DS} = 1.17$
$S_{D1} = 0.75$
$S_1 = 0.75$

One building is a traditional classroom wing; the other building is a gymnasium designated as an emergency shelter.

DETERMINE THE FOLLOWING:

1. Risk category and seismic importance factor for each building.

2. Seismic design category (SDC) for each building.

1. Risk Category and Seismic Importance Factor §11.5

From IBC Table 1604.5, "Risk Category of Buildings and Other Structures," a private high school classroom building (Group E Occupancy) with an occupant load greater than 250 is Risk Category III. (The risk category is used to determine the "seismic design category," in accordance with Section 11.6.) A gymnasium that is designated an emergency shelter is Risk Category IV.

The importance factors for earthquake loads are in Table 1.5-2.

Occupancy	Risk Category	Seismic Importance Factor, I_e
Classroom	III	1.25
Gymnasium/Emergency Shelter	IV	1.5

2. Seismic Design Category §11.6

All structures are assigned to a seismic design category (SDC) based on their risk category and the spectral response acceleration coefficients S_{DS} and S_{D1}, irrespective of the structure's fundamental period of vibration, T. Each building or structure is assigned to the most severe SDC in accordance with Table 11.6-1 or 11.6-2 as follows.