\[ \delta_{x_{\text{MM}}} = \text{maximum displacement at Level x, considering torsion, Section 12.8.4.3} \]
\[ \delta_{x_{\text{R}}} = \text{the average of the displacements at the extreme points of the structure at Level x, Section 12.8.4.5} \]
\[ \delta_{x_{c}} = \text{deflection of Level x at the center of the mass and above Level x, Eq. 12.9-15} \]
\[ \delta_{x_{u}} = \text{deflection of Level x at the center of the mass at and above Level x determined by an elastic analysis, Section 12.8.6} \]
\[ \delta_{x_{m}} = \text{modal deflection of Level x at the center of the mass at and above Level x as determined by Section 19.3.2} \]
\[ \delta_{x_{c}}, \delta_{x_{u}} = \text{deflection of Level x at the center of the mass at and above Level x, Exp. 19.2-13 and 19.2-3 (cm. or mm)} \]
\[ \theta = \text{stability coefficient for P- \Delta} \text{ effects as determined in Section 12.8.7} \]
\[ \rho = \text{a redundancy factor based on the extent of structural redundancy present in a building, as defined in Section 12.3.4} \]
\[ \nu_{s} = \text{spiral reinforcement ratio for precast, prestressed piles in Sections 14.2.7.1.6 and 14.2.7.2.6} \]
\[ \lambda = \text{time effect factor} \]
\[ \lambda_{p} = \text{overstrength factor as defined in Table 12.2-1, 15.4-1 and 15.4-2} \]

11.4 Seismic Ground Motion Values

11.4.1 Mapped Acceleration Parameters. The parameters \( S_{x} \) and \( S_{o} \) shall be determined from the 0.2 and 1.0 second spectral response accelerations shown on Figures 12-1 through 22-14 respectively or from the MCE CD-ROM. Where \( S_{x} \) is less than or equal to 0.04 and \( S_{o} \) is less than or equal to 0.15, the structure is permitted to be assigned Seismic Design Category A and is only required to comply with Section 11.7.

11.4.2 Site Class. Based on the site soil properties, the site shall be classified as either Site Class A, B, C, D, E or F in accordance with Section 26. Where the soil properties are not known in sufficient detail to determine the Site Class, Site Class D shall be used unless the authority having jurisdiction or geotechnical data determines Site Class E or F 1996 are present at the site.

11.4.3 Site Coefficients and Adjusted Maximum Considered Earthquake Spectral Response Acceleration Parameters. The maximum considered earthquake spectral response acceleration for short periods \( (S_{a}) \) and at 1 sec \( (S_{o}) \), adjusted for Site Class effects, shall be determined by Eqs. 11.4-1 and 11.4-2, respectively.

\[ S_{a} = F_{S} S_{b} \quad \text{(Eq. 11.4-1)} \]
\[ S_{o} = F_{S} S_{o} \quad \text{(Eq. 11.4-2)} \]

where

\[ S_{b} = \text{the mapped maximum considered earthquake spectral response acceleration at short periods as determined in accordance with Section 11.4.1, and} \]

\[ S_{o} = \text{the mapped maximum considered earthquake spectral response acceleration at a period of 1 sec as determined in accordance with Section 11.4.1} \]

where the coefficients \( F_{S} \) and \( F_{o} \) are defined in Tables 11.4-1 and 11.4-2, respectively. Where the alternate simplified design procedure of Section 12.14 is used, the value of \( F_{S} \) shall be determined in accordance with Section 12.14.1.7.1, and the values for \( F_{o}, S_{a}, \) and \( S_{o}\) need not be determined.

Table 11.4-1 Site Coefficient, \( F_{S} \)

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<table>
<thead>
<tr>
<th>Site Class</th>
<th>Mapped Maximum Considered Earthquake Spectral Response Acceleration Parameter at Short Period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$S_a &lt; 0.25$</td>
</tr>
<tr>
<td>A</td>
<td>0.8</td>
</tr>
<tr>
<td>B</td>
<td>1.0</td>
</tr>
<tr>
<td>C</td>
<td>1.2</td>
</tr>
<tr>
<td>D</td>
<td>1.6</td>
</tr>
<tr>
<td>E</td>
<td>2.5</td>
</tr>
<tr>
<td>F</td>
<td>See Section 11.4.7</td>
</tr>
</tbody>
</table>

Note: Use straight-line interpolation for intermediate values of $S_a$.

<table>
<thead>
<tr>
<th>Site Class</th>
<th>Mapped Maximum Considered Earthquake Spectral Response Acceleration Parameter at 1-Second Period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$S_a &lt; 0.1$</td>
</tr>
<tr>
<td>A</td>
<td>0.8</td>
</tr>
<tr>
<td>B</td>
<td>1.0</td>
</tr>
<tr>
<td>C</td>
<td>1.7</td>
</tr>
<tr>
<td>D</td>
<td>2.4</td>
</tr>
<tr>
<td>E</td>
<td>3.5</td>
</tr>
<tr>
<td>F</td>
<td>See Section 11.4.7</td>
</tr>
</tbody>
</table>

Note: Use straight-line interpolation for intermediate values of $S_a$.

11.4.4 Design Spectral Acceleration Parameters. Design earthquake spectral response acceleration parameters at short period, $S_{ Dia }$, and at 1 sec period, $S_{ Dia }$, shall be determined from Eqs. 11.4.3 and 11.4.4, respectively. Where the alternate simplified design procedure of Section 12.14 is used, the value of $S_{ Dia }$ shall be determined in accordance with Section 12.14.7.1, and the value for $S_{ Dia }$ need not be determined.

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\[ S_{D3} = \frac{2}{3} S_{Ae} \]  \hfill (Eq. 11.4-3)

\[ S_{D3} = \frac{2}{3} S_{Ae} \]  \hfill (Eq. 11.4-4)

11.4.5 Design Response Spectrum Where a design response spectrum is required by this standard and site-specific ground motion procedures are not used, the design response spectrum curve shall be developed as indicated in Figure 11.4-1 and as follows:

1. For periods less than or equal to \( T_s \), the design spectral response acceleration, \( S_s \), shall be taken as given by Eq. 11.4-5:

\[ S_s = S_{D3} \left( 0.4 + 0.6 \frac{T}{T_s} \right) \]  \hfill (Eq. 11.4-5)

2. For periods greater than or equal to \( T_s \) and less than or equal to \( T_u \), the design spectral response acceleration, \( S_s \), shall be taken as equal to \( S_{D3} \).

3. For periods greater than \( T_u \) and less than or equal to \( T_s \), the design spectral response acceleration, \( S_s \), shall be taken as given by Eq. 11.4-6:

\[ S_s = \frac{S_{D3}}{T} \]  \hfill (Eq. 11.4-6)

4. For periods greater than \( T_u \), \( S_s \) shall be taken as given by Eq. 11.4-7:

\[ S_s = \frac{S_{D3} T_s}{T^2} \]  \hfill (Eq. 11.4-7)

where

- \( S_{D3} \) = the design spectral response acceleration parameter at short periods
- \( S_{Ae} \) = the design spectral response acceleration parameter at 1-sec period
- \( T \) = the fundamental period of the structure, sec
- \( T_s \) = 0.2S_{Ae}/S_{D3}
- \( T_u \) = \( S_{D3}/S_{Ae} \) and
- \( T_u \) = long-period transition period (sec) shown in Figure 22-15 (Conterminous United States), Figure 22-16 (Region 1), Figure 22-17 (Alaska), Figure 22-18 (Hawaii), Figure 22-19 (Puerto Rico, Culebra, Vieques, St. Thomas, St. John, and St. Croix), and Figure 22-20 (Guam and Tanan).

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11.4.6 MCE Response Spectrum. Where a MCE response spectrum is required, it shall be determined by multiplying the design response spectrum by 1.5.

11.4.7 Site-Specific Ground Motion Procedures. The site-specific ground motion procedures set forth in Section 21 are permitted to be used to determine ground motions for any structure. A site response analysis shall be performed in accordance with Section 21.1 for structures on Site Class F sites, unless the exception to Section 20.3.1 is applicable. For seismically isolated structures on sites with $S_h$ greater than or equal to 0.6, a ground motion hazard analysis shall be performed in accordance with Section 21.2.

11.5 Importance Factor and Occupancy Category

11.5.1 Importance Factor. An importance factor, $I$, shall be assigned to each structure in accordance with Table 11.5-1 based on the Occupancy Category from Table 1-1.

<table>
<thead>
<tr>
<th>Occupancy Category</th>
<th>$I$</th>
</tr>
</thead>
<tbody>
<tr>
<td>I or II</td>
<td>1.0</td>
</tr>
<tr>
<td>III</td>
<td>1.25</td>
</tr>
<tr>
<td>IV</td>
<td>1.5</td>
</tr>
</tbody>
</table>

11.5.2 Protected Access for Occupancy Category IV. Where operational access to a Occupancy Category IV structure is required through an adjacent structure, the adjacent structure shall conform to the requirements for Occupancy Category IV structures. Where operational access is less than 10 ft from an interior lot line or another structure on the same lot, protection from potential falling debris from adjacent structures shall be provided by the owner of the Occupancy Category IV structure.

11.6 Seismic Design Category

11.6.1 Seismic Design Category Structures shall be assigned a Seismic Design Category in accordance with Section 11.6.1.1.

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17.6.1.4 Determination of Seismic Design Category

Occupancy Category I, II or III structure, located where the mapped spectral response acceleration parameter at 1-second period, $S_a$, is greater than or equal to 0.75 shall be assigned to Seismic Design Category E. Occupancy Category IV structures located where the mapped spectral response acceleration parameter at 1-second period, $S_a$, is greater than or equal to 0.75 shall be assigned to Seismic Design Category F. All other structures shall be assigned to a Seismic Design Category based on their Occupancy Category and the design spectral response acceleration parameters, $S_{S1}$ and $S_{S2}$, determined in accordance with Section 11.4.4. Each building and structure shall be assigned to the most severe Seismic Design Category in accordance with Table 11.6-1 or 11.6-2, irrespective of the fundamental period of vibration of the structure, $T_e$. Where the alternate simplified design procedure of Section 12.14 is used, the Seismic Design Category shall be permitted to be determined from Table 11.6-1 alone, using the value of $S_{S1}$ determined in Section 12.14.7.1.

Exception: The Seismic Design Category is determined from Table 11.6-1 alone when all of the following apply:

1. In each of the two orthogonal directions, the approximate fundamental period of the structure, $T_e$, determined in accordance with Section 12.8.2.1 is less than 0.8 $T_o$, where $T_o$ is determined in accordance with Section 11.4.5 and
2. In each of two orthogonal directions, the fundamental period of the structure used to calculate the story drift is less than $T_o$ and
3. Eq. 12.8.5-3 is used to determine the seismic response coefficient $C_e$, and
4. The diaphragms are rigid as defined in Section 12.3.1 or for diaphragms that are flexible, the distance between vertical elements of the seismic force-resisting system does not exceed 40 feet.

### Table 11.6-1

<table>
<thead>
<tr>
<th>Value of $S_{S1}$</th>
<th>Occupancy Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I or II</td>
</tr>
<tr>
<td>$S_{S1} &lt; 0.167$</td>
<td>A</td>
</tr>
<tr>
<td>$0.167 \leq S_{S1} &lt; 0.33$</td>
<td>B</td>
</tr>
<tr>
<td>$0.33 \leq S_{S1} &lt; 0.50$</td>
<td>C</td>
</tr>
<tr>
<td>$0.50 \leq S_{S1}$</td>
<td>D</td>
</tr>
</tbody>
</table>

### Table 11.6-2

<table>
<thead>
<tr>
<th>Value of $S_{S2}$</th>
<th>Occupancy Category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I or II</td>
</tr>
<tr>
<td>$S_{S2} &lt; 0.167$</td>
<td>A</td>
</tr>
<tr>
<td>$0.167 \leq S_{S2} &lt; 0.33$</td>
<td>B</td>
</tr>
<tr>
<td>$0.33 \leq S_{S2} &lt; 0.50$</td>
<td>C</td>
</tr>
<tr>
<td>$0.50 \leq S_{S2}$</td>
<td>D</td>
</tr>
</tbody>
</table>

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1615.1.1 Site class definitions. The site shall be classified as one of the site classes defined in Table 1615.1.1. Where the soil shear wave velocity, \( V_s \), is not known, site class shall be determined, as permitted in Table 1615.1.1, from standard penetration resistance, \( N \), or from soil undrained shear strength, \( S_u \), calculated per Section 1615.1.5. Where site-specific data are not available to a depth of 100 feet (30 480 mm), appropriate soil properties are permitted to be estimated by the registered design professional preparing the soils report based on known geologic conditions.

When the soil properties are not known in sufficient detail to determine the site class, Site Class D shall be used unless the building official determines that Site Class E or F soil is likely to be present at the site.

1615.1.2 Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters. The maximum considered earthquake spectral response acceleration for short periods, \( S_{ao} \), and at 1-second period, \( S_{mi} \), adjusted for site class effects, shall be determined by Equations 16-16 and 16-17, respectively:

\[
S_{ao} = F_a S_a
\]

(Equation 16-16)

\[
S_{mi} = F_v S_I
\]

(Equation 16-17)

\( F_a = \text{adjustment for soil effect} \) (0.25)

\( F_v = \text{adjustment for soil effect} \) (1.05)

where:

\( F_a = \) Site coefficient defined in Table 1615.1.2(1).

\( F_v = \) Site coefficient defined in Table 1615.1.2(2).

\( S_a = \) The mapped spectral accelerations for short periods as determined in Section 1615.1.

\( S_I = \) The mapped spectral accelerations for a 1-second period as determined in Section 1615.1.

1615.1.3 Design spectral response acceleration parameters. Five-percent damped design spectral response acceleration at short periods, \( S_{ao;d} \), and at 1 second period, \( S_{mi} \), shall be determined from Equations 16-18 and 16-19, respectively:

\[
S_{ao} = \frac{2}{3} S_{ao} \rightarrow \text{Design value}
\]

(Equation 16-18)

\[
S_{mi} = \frac{2}{3} S_{mi} \rightarrow \text{Design value}
\]

(Equation 16-19)

where:

\( S_{ao} = \) The maximum considered earthquake spectral response accelerations for short period as determined in Section 1615.1.2.

\( S_{mi} = \) The maximum considered earthquake spectral response accelerations for 1 second period as determined in Section 1615.1.2.

---

**TABLE 1615.1.1**

**SITE CLASS-DEFINITIONS**

<table>
<thead>
<tr>
<th>SITE CLASS</th>
<th>SOIL PROFILE NAME</th>
<th>AVERAGE PROPERTIES IN TOP 100 FEET (AS PER SECTION 1615.1.5)</th>
<th>Soil shear wave velocity, ( V_s ) (ft/s)</th>
<th>Standard penetration resistance, ( N )</th>
<th>Soil undrained shear strength, ( S_u ) (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Hard rock</td>
<td>( V_s &lt; 5,000 ) Not applicable</td>
<td>( N &gt; 50 ) Not applicable</td>
<td>( S_u &lt; 2,000 ) Not applicable</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Rock</td>
<td>( 2,500 &lt; V_s &lt; 5,000 ) Not applicable</td>
<td>( N &gt; 50 ) Not applicable</td>
<td>( S_u &lt; 2,000 ) Not applicable</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Very dense soil and soft rock</td>
<td>( 1,200 &lt; V_s &lt; 2,500 ) Not applicable</td>
<td>( N &gt; 50 ) Not applicable</td>
<td>( S_u &lt; 2,000 ) Not applicable</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Stiff soil profile</td>
<td>( 600 &lt; V_s &lt; 1,200 ) Not applicable</td>
<td>( 15 &lt; N &lt; 50 )</td>
<td>( 1,000 &lt; S_u &lt; 2,000 ) Not applicable</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Soft soil profile</td>
<td>( V_s &lt; 600 ) Not applicable</td>
<td>( N &lt; 15 )</td>
<td>( S_u &lt; 1,000 ) Not applicable</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Any profile with more than 10 feet of soil having the following characteristics:
1. Plasticity index \( PI > 20 \);
2. Moisture content \( w > 40\% \); and
3. Undrained shear strength \( S_u < 500 \) psi.

Any profile containing soils having one or more of the following characteristics:
1. Soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils
2. Peats and/or highly organic clays (\( H > 10 \) feet of peat and/or highly organic clay where \( H = \text{thickness of soil} \))
3. Very high plasticity clays (\( H > 25 \) feet with plasticity index \( PI > 75 \))
4. Very thick soft/medium stiff clays (\( H > 120 \) ft)

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m², 1 pound per square foot = 0.0479 kPa.

2000 INTERNATIONAL BUILDING CODE®
The input zip-code is 84112.

ZIP CODE                    84112
LOCATION                    40.7608 Lat. -111.8346 Long.
DISTANCE TO NEAREST GRID POINT  5.2441 kms
NEAREST GRID POINT          40.8 Lat. -111.8 Long.
Probabilistic ground motion values, in %g, at the Nearest Grid point are:

  10%PE in 50 yr | 5%PE in 50 yr | 2%PE in 50 yr
PGA      26.688271 | 44.528851 | 70.485046
0.2 sec SA 60.214840 | 106.372200 | 158.947006
0.3 sec SA 55.376450 | 100.342796 | 153.144501
1.0 sec SA 19.473450 | 35.222691 | 65.620247

The input zip-code is .
Zip code is zero and we go to the end and stop.