$$\overline{v_s}, \bar{N}, \overline{s_u} = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{v_{si}}, \frac{d_i}{N_i}, \frac{d_i}{s_{ui}}} \quad (2\text{-}3)$$

where N_i = SPT blow count in soil layer i;
n = number of layers of similar soil materials for which data are available;
d_i = depth of layer i;
s_{ui} = undrained shear strength in layer i;
v_{si} = shear wave velocity of the soil in layer i; and

$$\sum_{i=1}^{n} d_i = 100\,ft \quad (2\text{-}4)$$

Where v_s data are available for the site, such data shall be used to classify the site. If such data are not available, N data shall be used for cohesionless soil sites (sands, gravels), and s_u data for cohesive soil sites (clays). For rock in profile classes B and C, classification shall be based either on measured or estimated values of v_s. Classification of a site as Class A rock shall be based on measurements of v_s either for material at the site itself or for rock having the same formation adjacent to the site; otherwise, Class B rock shall be assumed. Class A or B profiles shall not be assumed to be present if there is more than 10 ft of soil between the rock surface and the base of the building.

2.4.1.6.2 Default Site Class If there are insufficient data available to classify a soil profile as Class A, B, or C and there is no evidence of soft clay soils characteristic of Class E in the vicinity of the site, the default site class shall be taken as Class D. If there is evidence of Class E soils in the vicinity of the site and no other data supporting selection of Class A, B, C, or D, the default site class shall be taken as Class E.

C2.4.1.6.2 Default Site Class For most sites, the site coefficients for Site Class D provide a sufficiently conservative estimation of the effect of the site amplification on the mapped spectral response parameters. However, in some cases, where very soft soil is encountered, the approximations from assuming Site Class D may not sufficiently account for the site amplification of rock ground motions. In those cases, it is more appropriate to assume a Site Class E, which is why the standard requires the use of Site Class E if there is knowledge of the potential for the site to be classified as Site Class E. It should be noted that the site coefficients for Site Class E are smaller than those for Site Class D in the short period range. This difference is caused by the softer site not amplifying short-period shaking as much. Because of that, an assumption of Site Class E may be unconservative if the building is a short-period dominated building. In addition, the assumption of Site Class E as opposed to Site Class D, though providing a lower short-period response parameter, may cause the building to be classified in a higher level of seismicity. In those cases, the design professional and the authority having jurisdiction should exercise judgment about what site class is appropriate for consideration.

2.4.1.7 General Response Spectrum A general response spectrum shall be developed as specified in Sections 2.4.1.7.1 and 2.4.1.7.2.

2.4.1.7.1 General Horizontal Response Spectrum A general horizontal response spectrum, as shown in Fig. 2-1, shall be developed using Eqs. (2-5), (2-6), (2-7), and (2-8) for spectral response acceleration, S_a, versus structural period, T, in the horizontal direction.

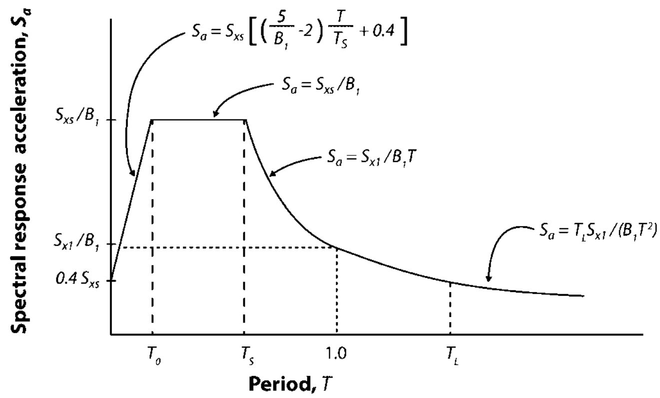

FIG. 2-1. General Horizontal Response Spectrum

$$S_a = \left[\left(\frac{5}{B_1} - 2\right)\frac{T}{T_S} + 0.4\right] \quad (2\text{-}5)$$

for $0 < T < T_0$, and

$$S_a = S_{XS}/B_1 \text{ for } T_0 < T < T_S\text{, and} \quad (2\text{-}6)$$

$$S_a = S_{X1}/(B_1T)\text{, for } T_S < T < T_L \quad (2\text{-}7)$$

$$S_a = T_L S_{X1}/(B_1T^2)\text{, for } T > T_L \quad (2\text{-}8)$$

where T_S and T_0 are given by Eqs. (2-9) and (2-10):

$$T_S = S_{X1}/S_{XS} \quad (2\text{-}9)$$

$$T_0 = 0.2T_S \quad (2\text{-}10)$$

T_L = the long-period transition parameter, shall be obtained from published maps, site-specific response analysis, or any other method approved by the authority having jurisdiction.
and where

$$B_1 = 4/[5.6 - \ln(100\beta)] \quad (2\text{-}11)$$

and β is the effective viscous damping ratio.

Use of spectral response accelerations calculated using Eq. (2-5) in the extreme short-period range ($T < T_0$) shall only be permitted in dynamic analysis procedures and only for modes other than the fundamental mode.

2.4.1.7.2 General Vertical Response Spectrum Where a vertical response spectrum is required for analysis per Chapter 7, it shall be developed by taking two-thirds of the maximum horizontal spectral ordinate, at each period, obtained for the horizontal response spectrum or by alternative rational procedures. Alternatively, it shall be permitted to develop a site-specific vertical response spectrum in accordance with Section 2.4.2.

C2.4.1.7.2 General Vertical Response Spectrum Traditionally, the vertical response spectra are taken as two-thirds of the horizontal spectrum developed for the site. Although this method produces a reasonable approximation for most sites, vertical response spectra at sites located within a few kilometers of the zone of fault rupture can have stronger vertical response spectra than those determined by this approximation. Chapter 23 of FEMA P-750 (2009c) provides additional information on vertical ground motions, including procedures to construct a separate vertical earthquake response spectrum.

Development of site-specific response spectra for such near field sites is recommended where vertical response must be considered for buildings. Kehoe and Attalla (2000) present modeling considerations that should be accounted for where analyzing for vertical effects.