PROPOSAL 3-120 (2009)

SCOPE: Part 2, Commentary Chapter 20

PROPOSAL FOR CHANGE:

Add Chapter 20 to Part 2, of the 2009 Commentary:

Proposed Chapter is attached. Text is not underlined to allow easier review.

REASON FOR PROPOSAL:

One of the basic tasks of the 2009 NEHRP *Provisions* update is to develop a viable commentary to Part 1. Since Part 1 adopts ASCE 7-05 and lists any exceptions to it, the Commentary is developed in accordance with the format and sections of ASCE 7-05.

TS 3 VOTE:

TS 3 developed this commentary chapter and approved for submission. The chapter was edited and accepted by TS 3 .

Chapter 20

SITE CLASSIFICATION PROCEDURE FOR SEISMIC DESIGN

C20.1 SITE CLASSIFICATION

Site classification procedures are given in Chapter 20 for the purpose of classifying the site and determining site coefficients and site-adjusted maximum considered earthquake ground motions in accordance with Section 11.4.3. Site classification procedures are also used to define the site conditions for which site-specific site response analyses are required to obtain site ground motions in accordance with Section 11.4.7 and Chapter 21.

C20.3 SITE CLASS DEFINITIONS

C20.3.1 Site Class F. Site conditions for which the site coefficients F_a and F_v in Tables 11.4-1 and 11.4-2 may not be applicable and for which site-response analyses are required by Section 11.4.7 are designated Site Class F as defined in Section 20.3.1. For short-period structures it is permissible to determine values of F_a and F_v assuming that liquefaction does not occur, because ground motion data obtained in liquefied soil areas during earthquakes indicate that short-period ground motions generally are attenuated due to liquefaction whereas long-period ground motions may be amplified. This exception does not affect the requirements in Section 11.8 to assess liquefaction potential as a geologic hazard and to develop hazard mitigation measures as required.

~~Sections~~ C20.3.2 through C20.3.5. These sections and Table 20.3-1 provide definitions for Site Classes A through E. Except for the additional definitions for Site Class E in Section 20.3.2, the site classes are defined fundamentally in terms of the average small-strain shear wave velocity in the top 100 feet (30 meters) of the soil or rock profile. If shear wave velocities are available for the site, they should be used to classify the site. However, recognizing that in many cases shear wave velocities are not available for the site, alternative definitions of the site classes also are included. These definitions are based on geotechnical parameters: standard penetration resistance for cohesionless soils and rock, and standard penetration resistance and undrained shear strength for cohesive soils. The alternative definitions are intended to be conservative since the correlation between site coefficients and these geotechnical parameters is more uncertain than the correlation with shear wave velocity. That is, values of F_a and F_v will tend to be smaller if the site class is based on shear wave velocity rather than on the geotechnical parameters. Also, the site class definitions should not be interpreted as implying any specific numerical correlation between shear-wave velocity and standard penetration resistance or undrained shear strength.

Although the site class definitions in Sections 20.3.2 through 20.3.5 are straightforward, there are aspects of these assessments that may require additional judgment and interpretation. Highly variable subsurface conditions beneath a building footprint could result in overly conservative or unconservative site classification. Isolated soft soil layers within an otherwise firm soil site may not affect the overall site response if the predominant soil conditions do not include such strata. Conversely, site response studies have shown that continuous, thin, soft clay strata may affect the site amplification.

The site class should reflect the soil conditions that will affect the ground motion input to the structure or a significant portion of the structure. For structures receiving substantial ground motion input from shallow soils (for example, structures with shallow spread footings, with laterally flexible piles, or with basements where substantial ground motion input to the structure may come through the side walls), it is reasonable to classify the site on the basis of the top ~~100~~ 100 feet (30 meters) of soils below the ground surface. Conversely, for structures with basements supported on firm soils or rock below soft soils, it may be reasonable to classify the site on the basis of the soils or rock below the mat, if it can be justified that the soft soils contribute very little to the response of the structure.

Buildings on sites with sloping bedrock or having highly variable soil deposits across the building area require careful study since the input motion may vary across the building (for example, if a portion of the building is on rock and the rest is over weak soils). Site-specific studies including two- or three-dimensional modeling may be used in such cases to evaluate the subsurface conditions and site and superstructure response. Other conditions that may warrant site-specific evaluation include the presence of low shear wave velocity soils below a depth of 100 feet (~~30~~ 30 meters), location of the site in a sedimentary basin, or subsurface or topographic conditions with strong two- and three-dimensional site-response effects. Individuals with appropriate expertise in seismic ground motions should participate in evaluations of the need for and nature of such site-specific studies.

C20.4 DEFINITION OF SITE CLASS PARAMETERS

Section 20.4 provides formulas for defining Site Classes in accordance with definitions in Section 20.3 and Table 20.3-1. Equation 20.4-1 is for determining the effective average small-strain shear-wave velocity, $\bar{v}_s$, to a depth of 100 feet (30 meters) at a site. This equation defines $\bar{v}_s$ as 100 feet (30 meters) divided by the sum of the times for a shear wave to travel through each layer within the upper 100 feet (30 meters), where travel time for each layer is calculated as the layer thickness divided by the small-strain shear wave velocity for the layer. It is important that this method of averaging be used as it may result in a significantly lower effective average shear wave velocity than the velocity that would be obtained by directly averaging the velocities of the individual layers.

For example, consider a soil profile having four 25-foot-thick layers with shear wave velocities of 500, 1,000, 1,500, and 2,000 ft/s. The arithmetic average of the shear wave velocities is 1250 ft/s (corresponding to Site Class C), but Equation 20.4-1 produces a value of 960 ft/s (corresponding to Site Class D). This latter value is appropriate, as the four layers are being represented by one layer with the same wave passage time.

Equation 20.4.2 is for classifying the site using the average standard penetration resistance blow count, ~~(~~ $\bar{N}$ ~~,)~~ for cohesionless soils, cohesive soils, and rock in the upper 100 feet (30 meters). A method of averaging analogous to the method of Equation 20.4-1 for shear wave velocity is used. The maximum value of *N* that may be used for any depth of measurement in soil or rock is 100 blows/foot.

Equations 20.4-3 and 20.4-4 are for classifying the site using the standard penetration resistance of cohesionless soil layers, N_{ch}, and the undrained shear strength of cohesive soil layers, s_u, within the top 100 feet (30 meters). These equations are provided as an alternative to using Equation 20.4-2 for which *N*-values in all geologic materials in the top 100 feet (30 meters) are used. Where using Equations 20.4-3 and 20.4-4, only the respective thicknesses of cohesionless soils and cohesive soils within the top 100 feet (30 meters) are used.