The next question is whether this limitation should be extended to the resulting soil spring stiffness, which is the maximum resistance of the soil divided by the soil's yielding displacement. From the soil yield displacement for horizontal loading (equation 7.13 and equation 7.14) and bearing loading (equation 7.20), it is seen that both are expressed in terms of pipe diameter. In comparing the limiting value from equation 7.13 and equation 7.20, the yielding displacements are essentially the same. Thus, if the horizontal resistance is limited by the maximum bearing resistance of the soil, the resulting soil stiffness will likewise be limited. However, if equation 7.14 is used to determine yielding displacements for medium dense and dense sand, the resulting yielding displacements may be smaller than those estimated for downward direction (equation 7.20) with the result that the horizontal stiffness will be higher than the bearing stiffness, notwithstanding that the soil resistances may be the same. In this case, it is recommended that the pipe stress analysis team consider parametric studies to assess the sensitivity of the pipe strains to the horizontal spring stiffnesses or to carefully consider the horizontal soil properties to justify the use of a stiffer soil spring value.

8.2   Selection of Parameters for Soil Spring Values

Chapter 6 introduced the two types of soil strengths, undrained and drained (effective) strengths, and explained how they related to soil deformation and loading. This section considers two issues: the decision whether to use drained or undrained soil strength to determine the soil spring values (soil resistance, soil yield displacement and soil stiffness) and whether those selected soil strengths are appropriately conservative.

Drained versus Undrained Strengths

Table 8.1 presents a summary of the key points related to drained and undrained strength and their application in soil-pipe interaction modeling. When deciding what parameters to use for soil strength it is important to consider the factors in Table 8.1 and how the pipeline will be affected by interaction with the soil. Effective (drained) strength parameters should always be used with granular soils in both slow