strain-hardening effects. When calculating the capacity of elements for this purpose, material strengths should not be reduced by capacity or resistance factors.

C12.6 ANALYSIS PROCEDURE SELECTION

Table 12.6-1 provides the permitted analysis procedures for all seismic design categories. The table is applicable only to buildings without seismic isolation (Chapter 17) or passive energy devices (Chapter 18).

The four basic procedures provided in Table 12.6-1 are Equivalent Lateral Force (ELF) analysis (Section 12.8), modal response spectrum (MRS) analysis (Section 12.9), and linear response history (LRH) analysis and nonlinear response history (NRH) analysis. Requirements for performing response history analysis are provided in Chapter 16 of the standard. Nonlinear static pushover analysis is not provided as an “approved” analysis procedure in ASCE 7-05.

The ELF method is allowed for all SDC B and C buildings, and for all SDC D, E, and F buildings, with the following two exceptions:

Regular structures with height > 160 ft (48.8 m) and $T > 3.5T_s$

Structures with height < 160 ft (48.8 m) and with one or more of the following irregularities: torsion, extreme torsion, soft story, extreme soft story, weight (mass), or vertical geometric.

$T_s = S_{D1}/S_{DS}$ is the period at which the horizontal and descending parts of the response spectrum intersect (Figure 11.4-1). The value of T_s will depend on the Site Class because S_{DS} and S_{D1} include such effects. When ELF is not allowed, the analysis must be performed using modal response spectrum or response history analysis.

ELF is not allowed for buildings with the listed irregularities because the procedure is based on an assumption of a gradually varying distribution of mass and stiffness along the height and negligible torsional response. The basis for the $3.5T_s$ limitation is that the higher modes become more dominant in taller buildings (Lopez and Cruz 1996, Chopra 2007), and as a result, the ELF method may underestimate the design base shear and may not correctly predict the vertical distribution of seismic forces in taller buildings.

C12.7.1 Foundation Modeling

This section provides direction as to how to treat the interface between the structure and soils. Foundation flexibility may be included as part of the model of the structure, but doing so is not required. Where foundation flexibility is not considered, the foundation elements and the base of the structure may be rigidly restrained. The rigid restraints should be consistent with the design of the structure. As an example, consider a moment frame building without a basement and with moment-frame columns supported on footings designed to support shear and axial loads, i.e., pinned column bases. For such a building, the base is the level at the top of the footings. If foundation flexibility is not considered, the columns should be restrained horizontally and vertically, but not rotationally. Consider a moment-frame building with a basement and the base defined as the level closest to grade. For this building, horizontal restraint may be provided at the level closest to grade, as long as the diaphragm is designed to transfer the shear out of the moment frame. Because the columns extend through the basement, they may also be restrained rotationally and vertically at this level. However, many times it is better to extend the model through the basement and provide the vertical and rotational restraints at the foundation elements, which is more consistent with the actual building geometry.

C12.8.4.1 Inherent Torsion

Where earthquake forces are applied concurrently in two orthogonal directions the 5 percent displacement of the center of mass should be applied along a single orthogonal axis chosen to produce the greatest effect, but need not be applied simultaneously along two axes (i.e., in a diagonal direction).

Most diaphragms of light-frame construction are somewhere between rigid and flexible for analysis purposes, that is, semirigid. Such diaphragm behavior is difficult to analyze when considering torsion of the structure. As a result, it is believed that consideration of the amplification of the torsional moment is a refinement that is not warranted for light-frame construction.

Historically, the intent of the A_x term was not to amplify the natural torsion component, only the accidental torsion component. There does not appear reason to further increase design forces by amplifying both components together.

C12.11.2 Anchorage of Structural Walls and Transfer of Design Forces into Diaphragms

There are numerous instances in U.S. earthquakes of tall, single-story, and heavy walls becoming detached from supporting roofs, resulting in collapse of walls and supported bays of roof framing