drift prediction is considered no more reliable than that presented next. In addition, the equation is complex relative to the ability to predict drift accurately. It also requires adjustment factors, such as a nail-slip factor, that can only be determined by testing.

Empirical, Nonlinear Load-Drift Equation

Drift in a wood structural panel shear wall segment may be approximated in accordance with the following equation:

$$\Delta = 2.2\left(\frac{0.5}{G}\right)\sqrt[4]{a}\left(\frac{V_d}{F_{SSW,ULT}}\right)^{2.8}\left[\frac{h}{8}\right] \text{ (in)} \qquad \text{Eq. 6.5-9}$$

where,

Δ = the shear wall drift (in) at load V_d (lb)

G = the specific gravity of framing lumber

a = the shear wall segment aspect ratio (height/width) for aspect ratios from 4 to 1; a value of 1 shall be used for shear wall segments with width (length) greater than height

V_d = the shear load demand (lb) on the wall; the value of V_d is set at any unit shear demand less than or equal to $F_{ssw,ult}$ while the value of V_d should be set to the design load when checking drift at design load conditions

$F_{ssw,ult}$ = the unfactored (ultimate) shear capacity (lb) of the shear wall segment (i.e., F_{ssw} x *SF* or F_{ssw}/ϕ for ASD and LRFD, respectively)

h = the height of wall (ft)

The above equation is based on several tests of shear wall segments with aspect ratios ranging from 4:1 to 1:5.

6.5.2.7 Portal Frames

In situations with little space to include sufficient shear walls to meet required loading conditions, the designer must turn to alternatives. An example is a garage opening supporting a two-story home on a narrow lot such that other wall openings for windows and an entrance door leaves little room for shear walls. One option is to consider torsion and the distribution of lateral loads in accordance with the relative stiffness method. Another possibility is the use of a portal frame.

Portal frames may be simple, specialized framing details that can be assembled on site. They use fastening details, metal connector hardware, and sheathing to form a wooden moment frame and, in many cases, perform adequately. Various configurations of portal frames have undergone testing and provide data and details on which the designer can base a design (NAHBRC, 1998; APA, 1994). The ultimate shear capacity of portal frames ranges from 2,400 to more than 6,000 pounds depending on the complexity and strength of the construction details. A simple detail involves extending a garage header so that it is end-nailed to a full-height corner stud, strapping the header to the jamb studs at the portal opening, attaching sheathing with a standard nailing schedule, and anchoring the portal frame with typical perforated shear wall requirements. The system has an ultimate shear capacity of about 3,400 pounds that, with a safety factor of 2 to 2.5, provides a simple solution for many portal frame applications for residential construction in high-hazard seismic or wind regions. Several manufacturers offer preengineered portal frame and shear wall elements that can be ordered to custom requirements or standard conditions.

6.5.3 Diaphragm Design

6.5.3.1 Diaphragm Design Values

Depending on the location and number of supporting shear wall lines, the shear and moments on a diaphragm are determined by using the analogy of a simply supported or continuous span beam. The designer uses the shear load on the diaphragm per unit width of the diaphragm (i.e., floor or roof) to select a combination of sheathing and fastening from a table of allowable horizontal diaphragm unit shear values found in U.S. building codes. Similar to those for shear walls, unit shear values for diaphragms vary according to sheathing thickness and nailing schedules, among other factors. Table 6.8 presents several of the more common floor and roof constructions used in residential construction as well as their allowable diaphragm resistance values. The values include a safety factor for ASD and therefore require no additional factoring. The aspect ratio of a diaphragm should be no greater than 4 (length/width) in accordance with current building code limits. In addition, the sheathing attachment in floor diaphragms is often supplemented with glue or construction adhesive. The increase in unit shear capacity of vertical diaphragms (i.e. shear walls) was discussed in Section 6.5.2.1 in association with Table 6.1. A similar increase to the unit shear capacity of floor diaphragms can be expected, not to mention increased stiffness when the floor sheathing is glued and nailed.

TABLE 6.8 ***Horizontal Diaphragm ASD Shear Values (plf) for Unblocked Roof and Floor Construction Using Douglas Fir or Southern Pine Framing***[1,2,3,4]

Panel Type and Application	Nominal Panel Thickness (inches)	Common Nail Size	Design Shear Value (plf)
Structural I (Roof)	5/16	6d	165
	3/8	8d	185
	15/32	10d	285
APA Sturd-I-Floor (Floor) and Rated Sheathing	7/16	8d	230
	15/32	8d	240
	19/32	10d	285

Notes:
[1]Minimum framing member thickness is 1-1/2 inches.
[2]Nails spaced at 6 inches on-center at supported panel edges and at the perimeter of the diaphragm. Nails spaced at 12 inches on-center on other framing members spaced a maximum of 24 inches on-center.
[3]"Unblocked" means that sheathing joints perpendicular to framing members are not fastened to blocking.
[4]Apply C_{sp} and C_{ns} adjustment factors to table values as appropriate (see Section 6.5.2.3 for adjustment factor values).