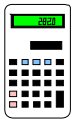
EXAMPLE 7.4 Wall Sole Plate to Floor Connection



Given

- A 2x4 wall bottom (sole) plate of Spruce-Pine-Fir is fastened to a wood floor deck
- Floor framing lumber is Hem-Fir
- A 3/4-inch-thick wood structural panel subfloor is used
- The bottom plate is subject to the following design loads due to wind and/or earthquake lateral loads:
  250 plf shear parallel-to-grain (shear wall slip resistance)
  120 plf shear perpendicular-to-grain (transverse load on wall)
- The uplift load on the wall, if any, is assumed to be resisted by other connections (i.e., uplift straps, shear wall hold-downs, etc.)

Find A suitable nailing schedule for the wall sole plate connection using 16d pneumatic nails (0.131inch diameter by 3.5 inches long).

Solution

It is assumed that the nails will penetrate the sub-flooring and the floor framing members. It will also be conservatively assumed that the density of the sub-floor sheathing and the floor framing is the same as the wall bottom plate (lowest density of the connected materials). These assumptions allow for the use of NDS Table 12.3A. Alternatively, a more accurate nail design lateral capacity may be calculated using the yield equations of NDS•12.3.1.

Using NDS Table 12.3A, it is noted that the closest nail diameters in the table are 0.135 and 0.128 inches. Interpolating between these values, using a side member thickness of 1.5 inches, and assuming Spruce-Pine-Fir for all members, the following Z value is obtained:

$$Z = 79 + [(0.131-0.128)/(0.135-0.128)](88\text{ lb} - 79\text{ lb}) = 83\text{ lb}^*$$

$$Z' = ZC_D = 83\text{ lb}\ (1.6) = 133\text{ lb}$$

*Using the NDS general dowel equations as presented in AF&PA Technical Report 12 (AF&PA, 1999), the calculated value is identical under the same simplifying assumptions. However, a higher design value of 90 pounds may be calculated by using only the subfloor sheathing as a side member with G = 0.5. The ultimate capacity is conservatively predicted as 261 pounds.

Assuming that both of the lateral loads act simultaneously at their full design value (conservative assumption), the resultant design load is determined as follows:

$$\text{Resultant shear load} = \text{sqrt}[(250\text{plf})^2 + (120\text{ plf})^2] = 277\text{ plf}$$

Using the conservative assumptions above, the number of nails per linear foot of wall plate is determined as follows:

$$(277\text{ lb})/(133\text{ lb/nail}) = 2.1\text{ nails per foot}$$

Rounding this number, the design recommendation is 2 nails per foot or 3 nails per 16 inches of wall plate.

Conclusion

The number of 16d pneumatic nails (0.131 inch diameter) required is 2 nails per foot of wall bottom plate for the moderate loading condition evaluated. The number of nails may be reduced by using a larger diameter nail or by evaluating the nail lateral capacity using the yield equations of NDS•12.3.1.

As in Example 7.3, some consideration of extensive experience in conventional residential construction should also be considered in view of the conventional fastening requirements of Table 7.1 for wood sole plate to floor framing connections (i.e., one 16d nail at 16 inches on center); refer to NDS•7.1.1.4. Perhaps 2 nails per 16 inches on center is adequate for the loads assumed in this example problem. Testing has indicated that the ultimate capacity of 2 16d pneumatic nails (0.131 inch diameter) can exceed 600 lb per nail for conditions similar to those assumed in this example problem; refer to Section 7.3.6. The general dowel equations under predict the ultimate capacity by about a factor of two. Using 2 16d pneumatic nails at 16 inches on center may be expected to provide a safety factor of greater than 3 relative to the design lateral load assumed in this problem (i.e., [600 lb/nail] x [2nails/1.33 ft]/277 plf = 3.2).

As noted in Chapter 6, the ultimate capacity of base connections for shear walls should at least exceed the ultimate capacity of the shear wall for seismic design and, for wind design, the connection should at least provide a safety factor of 2 relative to the wind load. For seismic design, the safety factor for shear walls recommended in this guide is 2.5; refer to Chapter 6, Section 6.5.2.3. Therefore, the fastening schedule of 2-16d pneumatic nails at 16 inches on center is not quite adequate for seismic design loads of the magnitude assumed in this problem (i.e., the connection does not provide a safety factor of at least 2.5). The reader is referred to Chapter 3, Section 3.8.4 for additional discussion on seismic design considerations and the concept of “balanced” design.