7.2.4 Lag Screws

Lag screws are available in the same diameter range as bolts; the principal difference between the two types of connectors is that a lag screw has screw threads that taper to a point. The threaded portion of the lag screw anchors itself in the main member that receives the tip. Lag screws (often called lag bolts) function as bolts in joints where the main member is too thick to be economically penetrated by regular bolts. They are also used when one face of the member is not accessible for a "through-bolt." Holes for lag screws must be carefully drilled to one diameter and depth for the shank of the lag screw and to a smaller diameter for the threaded portion. Lag screws in residential applications are generally small in diameter and may be used to attach garage door tracks to wood framing, steel angles to wood framing supporting brick veneer over wall openings, various brackets or steel members to wood, and wood ledgers to wall framing.

7.3 Wood Connection Design

7.3.1 General

This section covers the NDS design procedures for nails, bolts, and lag screws. The procedures are intended for allowable stress design (ASD) such that loads should be determined accordingly (see Chapter 3). Other types of fastenings are addressed by the NDS but are rarely used in residential wood construction. The applicable sections of the NDS related to connection design as covered in this chapter include

- NDS•7–Mechanical Connections (General Requirements);
- NDS•8–Bolts;
- NDS•9–Lag Screws; and
- NDS•12–Nails and Spikes.

While wood connections are generally responsible for the complex, non-linear behavior of wood structural systems, the design procedures outlined in the NDS are straightforward. The NDS connection values are generally conservative from a structural safety standpoint. Further, the NDS's basic or tabulated design values are associated with tests of single fasteners in standardized conditions. As a result, the NDS provides several adjustments to account for various factors that alter the performance of a connection; in particular, the performance of wood connections is highly dependent on the species (i.e., density or specific gravity) of wood. Table 7.3 provides the specific gravity values of various wood species typically used in house construction.

TABLE 7.3 Common Framing Lumber Species and Specific Gravity Values

Lumber Species	Specific Gravity, G
Southern Pine (SP)	0.55
Douglas Fir-Larch (DF-L)	0.50
Hem-Fir (HF)	0.43
Spruce-Pine-Fir (SPF)	0.42
Spruce-Pine-Fir (South)	0.36

The moisture condition of the wood is also critical to long-term connection performance, particularly for nails in withdrawal. In some cases, the withdrawal value of fasteners installed in moist lumber can decrease by as much as 50 percent over time as the lumber dries to its equilibrium moisture content. At the same time, a nail may develop a layer of rust that increases withdrawal capacity. In contrast, deformed shank nails tend to hold their withdrawal capacity much more reliably under varying moisture and use conditions. For this and other reasons, the design nail withdrawal capacities in the NDS for smooth shank nails are based on a fairly conservative reduction factor, resulting in about one-fifth of the average ultimate tested withdrawal capacity. The reduction includes a safety factor as well as a load duration adjustment (i.e., decreased by a factor of 1.6 to adjust from short-term tests to normal duration load). Design values for nails and bolts in shear are based on a deformation (i.e., slip) limit state and not their ultimate capacity, resulting in a safety factor that may range from 3 to 5 based on ultimate tested capacities. One argument for retaining a high safety factor in shear connections is that the joint may creep under long-term load. While creep is not a concern for many joints, slip of joints in a trussed assembly (i.e., rafter-ceiling joist roof framing) is critical and, in key joints, can result in a magnified deflection of the assembly over time (i.e., creep).

In view of the above discussion, there are a number of uncertainties in the design of connections that can lead to conservative or unconservative designs relative to the intent of the NDS and practical experience. The designer is advised to follow the NDS procedures carefully, but should be prepared to make practical adjustments as dictated by sound judgment and experience and allowed in the NDS; refer to NDS•7.1.1.4.

Withdrawal design values for nails and lag screws in the NDS are based on the fastener being oriented perpendicular to the grain of the wood. Shear design values in wood connections are also based on the fastener being oriented perpendicular to the grain of wood. However, the lateral (shear) design values are dependent on the direction of loading relative to the wood grain direction in each of the connected members. Refer to Figure 7.4 for an illustration of various connection types and loading conditions.