



CHAPTER 7

Connections

7.1 General

The objectives of connection design are

- to transfer loads resisted by structural members and systems to other parts of the structure to form a “continuous load path”;
- to secure nonstructural components and equipment to the building; and
- to fasten members in place during construction to resist temporary loads during installation (i.e., finishes, sheathing, etc.).

Adequate connection of the framing members and structural systems covered in Chapters 4, 5, and 6 is a critical design and construction consideration. Regardless of the type of structure or type of material, structures are only as strong as their connections, and structural systems can behave as a unit only with proper interconnection of the components and assemblies; therefore, this chapter is dedicated to connections. A connection transfers loads from one framing member to another (i.e., a stud to a top or bottom plate) or from one assembly to another (i.e., a roof to a wall, a wall to a floor, and a floor to a foundation). Connections generally consist of two or more framing members and a mechanical connection device such as a fastener or specialty connection hardware. Adhesives are also used to supplement mechanical attachment of wall finishes or floor sheathing to wood.

This chapter focuses on conventional wood connections that typically use nails, bolts, and some specialty hardware. The procedures for designing connections are based on the *National Design Specification for Wood Construction* (NDS) (AF&PA, 1997). The chapter also addresses relevant concrete and masonry connections in accordance with the applicable provisions of *Building Code Requirements for Structural Concrete* (ACI-318) and *Building Code Requirements for Masonry Structures* (ACI-530)(ACI, 1999a; ACI 1999b). When referring to the NDS, ACI-318, or ACI-530, the chapter identifies particular sections as NDS•12.1, ACI-318•22.5, or ACI-530•5.12.



For most connections in typical residential construction, the connection design may be based on prescriptive tables found in the applicable residential building code (ICC, 1998). Table 7.1 depicts a commonly recommended nailing schedule for wood-framed homes.

TABLE 7.1 *Recommended Nailing Schedule for a Wood-Framed Home¹*

Application	Nailing Method	Number of Nails	Size of Nail	Notes
Header to joist	End-nail	3	16d	
Joist to sill or girder	Toenail	2	10d	
	Toenail	3	8d	
Header and stringer (band) joists to sill	Toenail		8d	16 inches on center
Board sheathing	Face-nail	2 or 3	8d	To each joist
Stud to sole plate or top plate	End-nail	2	16d	At each stud
	Toenail	4	8d	
Sole plate to joist or blocking	Face-nail		16d	16 inches on center
Doubled studs	Face-nail, stagger		10d	16 inches on center
End stud of interior wall to exterior wall stud	Face-nail		16d	16 inches on center
Upper top plate to lower top plate	Face-nail		10d	16 inches on center
Double top plate, laps and intersections	Face-nail	4	10d	
Continuous header, two pieces, each edge	Face-nail		10d	12 inches on center
Ceiling joist to top wall plates	Toenail	3	8d	
Ceiling joist laps at partition	Face-nail	4	16d	
Rafter to top plate	Toenail	3	8d	
Rafter to ceiling joist	Face-nail	4	16d	
Rafter to valley or hip rafter	Toenail	4	10d	
Rafter to ridge board	Endnail	3	16d	
	Toenail	4	8d	
Collar beam to rafter, 2-inch member	Face-nail	2	12d	
Collar beam to rafter, 1-inch member	Face-nail	3	8d	
Diagonal let-in brace to each stud and plate, 1-inch member	Face-nail	2	8d	
Intersecting studs at corners	Face-nail		16d	12 inches on center
Built-up girder and beams, three or more members, each edge	Face-nail		10d	12 inches on center each ply
Maximum 1/2-inch-thick (or less) wood structural panel wall sheathing	Face-nail	6d at 6 inches on center at panel edges; 12 inches on center at intermediate framing		
Minimum 1/2-inch-thick (or greater) wood structural panel wall/roof/floor sheathing	Face-nail	8d at 6 inches on center at panel edges; 12 inches on center at intermediate framing		
Wood sill plate to concrete or masonry		1/2-inch-diameter anchor bolt at 6 feet on center and within 1 foot from ends of sill members		

Source: *Based on current industry practice and other sources (ICC, 1998, NAHB, 1994; NAHB, 1982).*

Note:

¹In practice, types of nails include common, sinker, box, or pneumatic; refer to Section 7.2 for descriptions of these fasteners. Some recent codes have specified that common nails are to be used in all cases. However, certain connections may not necessarily require such a nail or may actually be weakened by use of a nail that has too large a diameter (i.e., causing splitting of wood members). Other codes allow box nails to be used in most or all cases. NER-272 guidelines for pneumatic fasteners should be consulted (NES, Inc., 1997). However, the NER-272 guidelines are based on simple, conservative conversions of various code nail schedules, such as above, using the assumption that the required performance is defined by a common nail in all applications. In short, there is a general state of confusion regarding appropriate nailing requirements for the multitude of connections and related purposes in conventional residential construction.