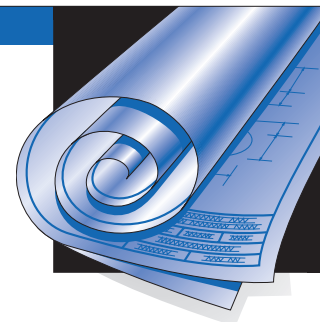


# Fastener Loads for Plywood – Screws

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## INTRODUCTION

The integrity of a structure is frequently dependent upon the connections between its component elements. For maximum strength and stability, each joint requires a design adapted to the fastener type and to the strength properties of the individual structural members. Included in the following tables are ultimate withdrawal and lateral loads for plywood joints fastened with wood and sheet metal screws. These values are based upon tests conducted on plywood by APA – The Engineered Wood Association.

To calculate design withdrawal and lateral capacities for various sizes of wood screws, see Table 11.3.1A of AF&PA NDS-2005, and APA Technical Topic TT-051 and Section 4.4.7 of *Panel Design Specification*, APA Form D510. See also [www.awc.org/calculators/index.html](http://www.awc.org/calculators/index.html) for online fastener calculators.

## TEST RESULTS

### Panel-and-Metal Connections

Self-drilling, self-tapping screws are commonly used to attach panels up to 1-1/8 inches thick to steel flanges up to 3/16 inch thick. However, since threads are usually provided on only a portion of the fastener shank, it is important to specify the appropriate fastener length for a given panel thickness. This precaution ensures that the threaded portion of the shank will engage in the steel framing. Several lengths and styles are available. Additional details for these types of screws may be obtained from specific fastener manufacturers. The following test data apply to wood screws and sheet metal screws. Little design data is available on sheet metal screws, but the primary difference between wood and sheet metal screws is that sheet metal screws are generally threaded their full length and wood screws are only threaded about two-thirds of their length.

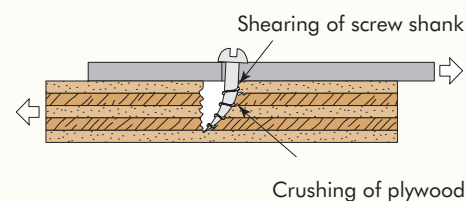
### Lateral Resistance:

Performance of panel-and-metal connections is dependent upon the strength properties of all three elements.

- a) Panel-critical joints are characterized by a shearing of the wood fibers oriented parallel to the direction of the applied force.
- b) Fastener-critical joints are characterized by a shear failure of the screw shank. As shown in Figure 1, once localized crushing of the wood has occurred, resistance of the metal to fastener-head embedment causes the screw to become

FIGURE 1

### FAILURE OF LATERALLY LOADED, SINGLE-SHEAR METAL-TO-PLYWOOD CONNECTION



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a shear specimen and joint behavior is dependent upon the shear strength of the fastener. Shear failure of the screw shank occurs at the wood-metal interface.

- c) The metal-critical joint may fail in one of two ways. Failure occurs when the resistance of the screw head to embedment is greater than the resistance of the metal to lateral and/or withdrawal load, and the screw tears through or away from the metal. Failure also occurs when thin metal in a metal-to-panel joint crushes or tears away from the screw.

The following test data are presented for **plywood** only.

Tables 1 and 2 present average ultimate lateral loads for wood- and sheet-metal-screw connections in plywood-and-metal joints. The end distance of the loaded-edge in these tests was one inch. Plywood face grain was parallel to the load since this direction yields the lowest lateral loads when the joint is plywood-critical. All wood-screw specimens were tested with a 3/16-inch-thick steel side plate, and values should be modified if thinner steel is used.

TABLE 1

**SCREWS: METAL-TO-PLYWOOD CONNECTIONS<sup>(a)</sup>**

Depth of Threaded Penetration (inch)	Average Ultimate Lateral Load (lbf) <sup>(b)</sup>					
	Wood Screws			Sheet Metal Screws		
	#8	#10	#12	#8	#10	#12
1/2	415	(500)	590	465	(565)	670
5/8	—	—	—	500	(600)	705
3/4	—	—	—	590	(655)	715

(a) Plywood was C-D grade with exterior glue (all plies Group 1), face grain parallel to load. Side plate was 3/16"-thick steel.

(b) Values are **not** design values. Values in parentheses are estimates based on other tests.

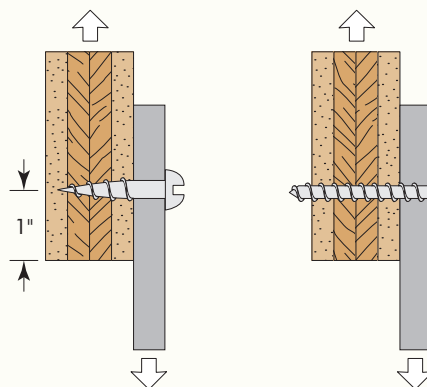


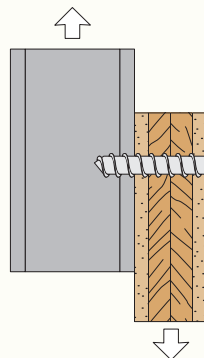
TABLE 2

**SHEET METAL SCREWS: PLYWOOD-TO-METAL CONNECTIONS<sup>(a)</sup>**

Framing	Plywood Performance Category	Average Ultimate Lateral Load (lbf) <sup>(b)</sup>				
		Screw Size				1/4"-20 Self Tapping Screw
		#8	#10	#12	#14	
0.080-inch Aluminum	1/4	330	360	390	410	590
	1/2	630	850*	860	920	970
	3/4	910*	930*	1250	1330	1440
0.078-inch Galvanized Steel (14 gage)	1/4	360	380	400	410	650
	1/2	700*	890*	900	920	970
	3/4	700*	950*	1300*	1390*	1500

(a) Plywood was A-C EXT (all plies Group 1), face grain parallel to load.

(b) Values are **not** design values. Loads denoted by an asterisk(\*) were limited by screw-to-framing strength; others were limited by plywood strength.



**Withdrawal:**

Tables 3 and 4 present average ultimate withdrawal loads for wood and sheet metal screws in plywood-and-metal joints, based on analysis of test results. Wood screws are threaded for only 2/3 of their length. Sheet metal screws typically have higher ultimate load than wood screws in the smaller gages because of their full-length thread.

Values shown in Table 3 for wood screws are based on 1/4-inch protrusion of the wood screw from the back of the panel. This was to assure measurable length of thread embedment in the wood, since the tip of the tapered wood screw may be smaller than the pilot hole. This was not a factor for sheet metal screws due to their uniform shank diameters.

TABLE 3

**WOOD AND SHEET METAL SCREWS: METAL-TO-PLYWOOD CONNECTIONS<sup>(a,b)</sup>**

Depth of Threaded Penetration (inch)	Average Ultimate Withdrawal Load (lbf)					
	Screw Size					
	#6	#8	#10	#12	#14	#16
3/8	150	180	205	–	–	–
1/2	200	240	275	315	350	–
5/8	250	295	345	390	440	–
3/4	300	355	415	470	525	–
1	–	–	–	625	700	775
1-1/8	–	–	–	705	790	875
2-1/4	–	–	–	–	1580	–

(a) Plywood was C-D grade with exterior glue (all plies Group 1).

(b) Values are **not** design values.

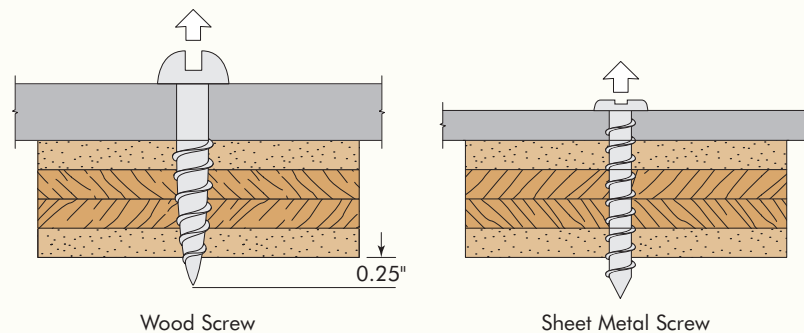


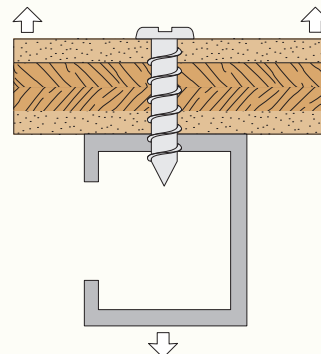
TABLE 4

**SHEET METAL SCREWS: PLYWOOD-TO-METAL CONNECTIONS<sup>(a)</sup>**

Framing	Plywood Performance Category	Average Ultimate Withdrawal Load (lbf) <sup>(b)</sup>				
		Screw Size				1/4"-20 Self Tapping Screw
		#8	#10	#12	#14	
0.080-inch Aluminum	1/4	130	150	170	180	220
	1/2	350	470	500	520	500
	3/4	660	680	790	850*	790*
0.078-inch Galvanized Steel (14 gage)	1/4	130	150	170	180	220
	1/2	350	470	500	520	500
	3/4	660	680	800	900	850

(a) Plywood was A-C EXT (all plies Group 1).

(b) Values are **not** design values. Loads denoted by an asterisk(\*) were limited by screw-to-metal-framing strength; others were limited by plywood strength.



### Fastening Into Plywood Panel Edges

Fastening into plywood panel edges is not normally recommended. For some purposes, however, edge fastening may be necessary. Table 5 presents average ultimate lateral and withdrawal loads for various sizes of wood screws in this application.

### ESTIMATING ALLOWABLE DESIGN LOADS

It is the responsibility of the designer to select a working load suitable for the particular application. A high degree of variability is inherent in individual fastener test results. Therefore, for screws in withdrawal or laterally loaded, a working load of about one-fifth of the ultimate load has traditionally been used for normal duration of load which contemplates fully stressing the connection for approximately ten years, either continuously or cumulatively. For practically all laterally loaded screw connections shown, the normal-duration working load will correspond to a joint slip of less than 0.01 inch.

Adjustments for shorter or longer duration of load apply to design values for mechanical fasteners where the strength of the wood (i.e., not the strength of the metal fastener) determines the load capacity. Calculations and adjustments of design values for varying combinations of materials and durations of load should be in accordance with the current AF&PA *National Design Specification for Wood Construction*.

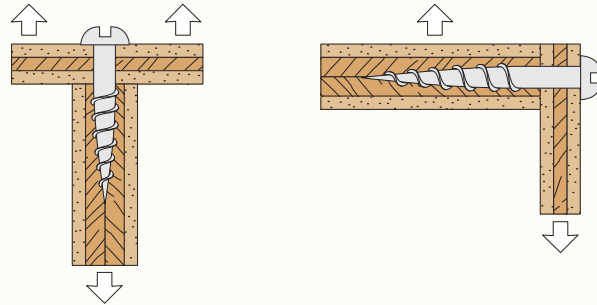
TABLE 5

WOOD SCREWS: PLYWOOD-TO-PLYWOOD EDGE CONNECTIONS<sup>(a)</sup>

Depth of Threaded Penetration (inch)	Average Ultimate Lateral Load (lbf) <sup>(b)</sup>			Average Ultimate Withdrawal Load (lbf) <sup>(b)</sup>		
	#8	#10	#12	#8	#10	#12
1	180	(185)	195	360	(405)	450
1-1/2	180	(185)	195	410	(455)	500

(a) Plywood receiving screw thread was Performance Category 3/4 C-D grade with exterior glue (Group 2 inner plies).

(b) Values are **not** design values. Values in parentheses are estimates based on other tests.



## Fastener Loads For Plywood – Screws

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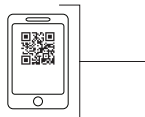
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