

# FASTENER LOADS FOR PLYWOOD – SCREWS

Number E830D • August 2005



## 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 load values are based upon tests conducted by APA – *The Engineered Wood Association*.

## TEST RESULTS

### Plywood-and-Metal Connections

Self-drilling, self-tapping screws are commonly used to attach plywood up to 1-1/8 in. thick to steel flanges up to 3/16 in. 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 plywood 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 data apply to wood screws and sheet metal screws.

### Lateral Resistance:

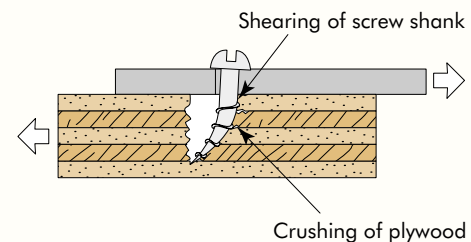
Performance of plywood-and-metal connections is dependent upon the strength properties of all three elements.

a) Plywood-critical joints are characterized by a shearing of the plywood veneers oriented parallel to the direction of the applied force. Veneer plugs, whose width equals the diameter of the screw shank, may shear loose and protrude at the loaded end.

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 to fastener-head embedment into the metal causes the screw to become 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.

FIGURE 1

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



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 away from the metal framing. Failure also occurs when thin metal in a metal-to-plywood joint crushes or tears away from the screw.

Tables 1 and 2 present ultimate lateral loads for wood- and sheet-metal-screw connections in plywood-and-metal joints. Loaded end distance 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-in.-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 (in.)	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 in parentheses are estimates based on other tests.

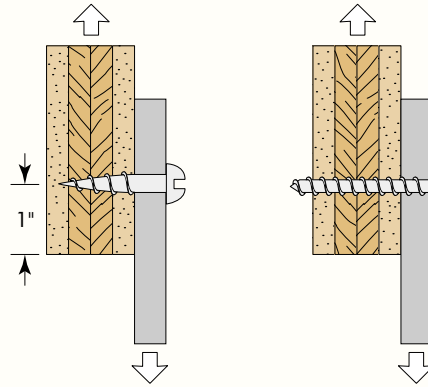


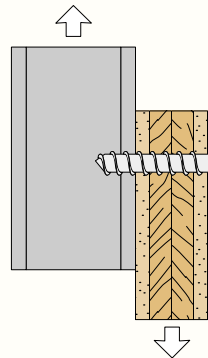
TABLE 2

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

Framing	Plywood Thickness (in.)	Ultimate Lateral Load (lbf) <sup>(b)</sup>				
		Screw Size				1/4"-20 Self Tapping Screw
		#8	#10	#12	#14	
0.080-in. Aluminum	1/4	330	360	390	410	590
	1/2	630	850*	860	920	970
	3/4	910*	930*	1250	1330	1440
0.078-in. 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) 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 have a tapered shank and 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 uniform shank diameter and full-length thread. The difference is not as apparent in the larger gages and lengths because the taper is not as significant.

Values shown in Table 3 for wood screws are based on 1/4-in. 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 shanks.

TABLE 3

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

Depth of Threaded Penetration (in.)	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).

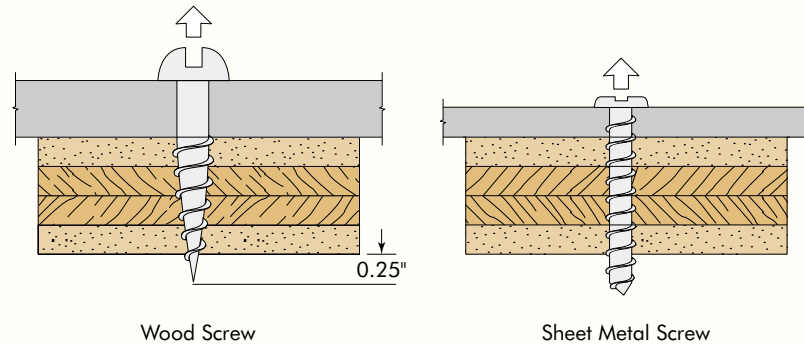


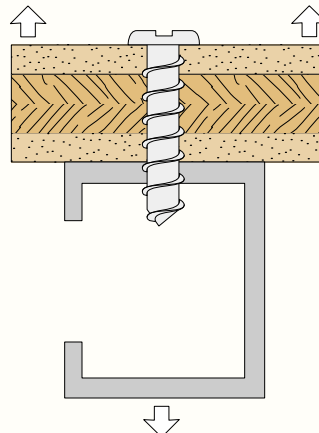
TABLE 4

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

Framing	Plywood Thickness (in.)	Ultimate Withdrawal Load (lbf) <sup>(b)</sup>				
		Screw Size				1/4"-20 Self Tapping Screw
		#8	#10	#12	#14	
0.080-in. Aluminum	1/4	130	150	170	180	220
	1/2	350	470	500	520	500
	3/4	660	680	790	850*	790*
0.078-in. 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) Loads denoted by an asterisk(\*) were limited by screw-to-framing strength; others were limited by plywood strength.



### Adjustment for Species Other Than Group 1:

All the ultimate loads presented in Tables 1 through 4 are based on plywood panels of all-Group 1 construction. For plywood panels of other species groups, the ultimate loads in these tables must be adjusted by correction factors presented in Table 5. Correction factors apply for both lateral and withdrawal loading. The adjustment factor for the highest numbered species group present in any veneer should be used.

### Fastening Into Plywood Panel Edges

Fastening into plywood panel edges is not normally recommended. For some purposes, however, edge fastening may be necessary. Table 6 presents ultimate lateral and withdrawal loads for various sizes of wood screws in this application.

TABLE 5

**LOAD ADJUSTMENT FOR SCREWS INTO PLYWOOD FOR SPECIES GROUPS NOTED<sup>(a)(b)</sup>**

Types of Loading	All-Group 1	All-Group 2	All-Group 3, 4, 5
Lateral	100%	78%	78%
Withdrawal	100%	60%	47%

(a) Adjustments based on the species groups for plywood shown in Voluntary Product Standard PS 1 and the equations in U.S. Agricultural Handbook No. 72.

(b) Face, back, and core veneer must be of the same species group. When species group is unknown, assume all-Group 4.

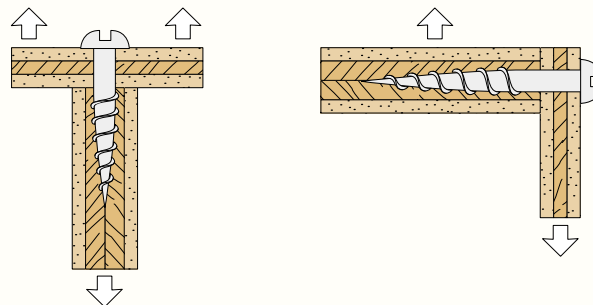
TABLE 6

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

Depth of Threaded Penetration (in.)	Ultimate Lateral Load (lbf) <sup>(b)</sup>			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 3/4"-thick C-D grade with exterior glue (Group 2 inner plies).

(b) Values in parentheses are estimates based on other tests.



## 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, a working load of about one-sixth of the ultimate load has traditionally been used for long-duration loads. For normal load duration, the long-term working load may be increased by 10 percent. Normal load duration contemplates fully stressing the connection for approximately ten years, either continuously or cumulatively.

For laterally loaded screws, a working load of normal duration may be approximated by dividing the tabulated ultimate load by 5 or 6. 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. Adjustments of design values for varying durations of load and combinations of load should be in accordance with the current AF&PA *National Design Specification for Wood Construction*.

We have field representatives in many major U.S. cities and in Canada who can help answer questions involving APA trademarked products. For additional assistance in specifying engineered wood products, contact us:

**APA – THE ENGINEERED WOOD ASSOCIATION**

**HEADQUARTERS**

7011 So. 19th St. ■ Tacoma, Washington 98466 ■ (253) 565-6600 ■ Fax: (253) 565-7265

[www.apawood.org](http://www.apawood.org)



**PRODUCT SUPPORT HELP DESK**

(253) 620-7400 ■ E-mail Address: help@apawood.org

**DISCLAIMER**

*The information contained herein is based on APA – The Engineered Wood Association’s continuing programs of laboratory testing, product research, and comprehensive field experience. Neither APA, nor its members make any warranty, expressed or implied, or assume any legal liability or responsibility for the use, application of, and/or reference to opinions, findings, conclusions, or recommendations included in this publication. Consult your local jurisdiction or design professional to assure compliance with code, construction, and performance requirements. Because APA has no control over quality of workmanship or the conditions under which engineered wood products are used, it cannot accept responsibility for product performance or designs as actually constructed.*

Revised August 2005

