Holding Strength of Staples

Staples are widely used in the furniture industry, both for upholstering purposes and for frame construction. The staples used for upholstering are usually rather small and range in length from perhaps 1/4 to 1/2-inch long. Although such staples are of considerable value to the furniture industry, they will not be considered here because this document is concerned primarily with the larger staples that are used in frame construction.

Staples are used in a variety of ways in frame construction. They are frequently used to hold glue blocks in place until the adhesive dries, for example, as well as to reinforce joints. They are also used to hold joints such as dowel joints together until the glue dries. Staples are also used to bridge members together; that is, to form end-grain to end-grain butt joints. Other uses include attaching plywood gussets to joints to form staple-glued gusset type of joints and also to attach large panels to frames or panels to backs of cases. Power-driven staples are easy to use, and they greatly speed-up production. Unfortunately, they are also easy to misuse, and examples of their misuse are all too easy to find.

Staples used for framing purposes in furniture construction are usually about 1 to 2 inches long, have about a 7/16-inch crown, and a 16 gage shank. Numerous coatings are used on the shanks of staples to improve their holding strength; these coatings include cement, nylon, epoxy, and other materials while other staples are simply etched with acid. Several different points are also used including chisel, divergent-chisel, and divergent point. Although coatings and points both appear to have an effect on the holding strength of staples, it is questionable whether enough is known about their long-time holding characteristics to make specific recommendations. It seems most reasonable, accordingly, to use the holding power of plain galvanized staples as a basis of design.

Withdrawal Strength of Staples

Research carried out by Johnson and Albert (1962) indicates that the withdrawal strength of 16 gage staples from Douglas fir members may be predicted by means of the expression

$$ F = -36 + 196 \times L \quad (6-36) $$

where $F =$ withdrawal strength in pounds; and $L =$ the depth of penetration of the staple into the main member. This equation is of somewhat limited value since it is restricted in use to one gage of staple and one species of wood. Presumably, the withdrawal strength could be predicted by modifying the formulas given by the Wood Handbook (Anon., 1955) for the withdrawal strength of nails to the form given below

$$ F(\text{staple}) = 13,800 \times G_x^{5/2} D \quad (6-37) $$

where $G_x =$ specific gravity of the wood at current moisture content; and $D =$ diameter of the staple leg in inches.
An evaluation of the research carried out by Stearn (1970), however, indicates that shear strength is likely a better indicator of withdrawal strength than is specific gravity. The Wood Handbook formulas also indicates that withdrawal strength varies directly as the diameter of the leg. Incorporating these shear strength and diameter considerations into the previous equation gives

\[ F(\text{staple}) = 16.4 \times D \times (196 \times L - 36) \times S_x / 1130 \]  

(6-38)

where \( S_x \) refers to the shear strength of the wood at current moisture content.

**Example:** To illustrate the use of this expression, let us assume that we wish to find the withdrawal strength of a 16 gage staple embedded 3/4 of an inch in the side grain of a piece of sweetgum which has been conditioned to 12 percent moisture content.

**Solution:** The shear strength of sweetgum at 12 percent moisture content is 1,600 psi, and the diameter of a 16 gage staple, Table 6-20, is .0625 inches so that the estimated withdrawal strength is

\[ F(\text{staples}) = 16.4 \times (0.0625) \times (196 \times 0.75 - 36) \times 1600 / 1130 = 161.1 \text{ lbs}. \]

### Lateral Holding Strength

Research carried out by Johnson and Albert (1962) indicates that the lateral strength of 16 gage staples driven into Douglas fir members as shown in Figure 6-54 can be estimated reasonably well by means of the expression

\[ F(\text{staple, lateral}) = 30 + 180 \times L \]  

(6-39)

where \( F = \) lateral strength of the staple, pounds; and \( L = \) depth of penetration into the main member, inches. Other work carried out by the author (Eckelman, 1970b) indicates that the lateral strength of staples is directly related to the shear strength of the wood parallel to the grain. Assuming the material used by Johnson and Albert was average for the species, the shear strength of wood used in their tests should be 1,130 psi. Applying this correction factor to the above equation gives the predictive expression

\[ F(\text{staple, lateral}) = (30 + 180 \times L) \times S_x / 1,130 \]  

(6-40)

for 16 gage fasteners where \( S_x \) equals the shear strength of the material used for the main member at current moisture content. Values predicted by this expression were found to agree reasonably well with those obtained by Kurtenacker (1962) and Albert and Johnson (1967). It should be noted, however, that values predicted for plain galvanized fasteners were slightly more than 20 percent greater than actual test values.

**Example:** To illustrate the use of equation 6-29, let us consider the following problem: In designing the seat system for a sofa, it was found that each of the sinuous type springs used in the construction of the seat could exert a lateral end-force on the clips to which it was attached of one-hundred pounds. If the clips are attached to the tops of the rails with two-16 gage staples, each of which penetrates the rail to a depth of 7/8-
inches, what safety factor do the clips have, on the average, if the rails are constructed of sweetgum that has a moisture content of 12 percent?

Soln: The shear strength of sweetgum at 12 percent mc is 1,600 psi so that the lateral strength of a clip (that is attached with two staples) would be expected to be

\[ F(\text{staple, lateral}) = 2 \times (30 + 180 \times 0.875) \times 1,600 / 1,130 = 531 \text{ lbs}. \]

The safety factor, SF, for this connection would be, accordingly,

\[ SF = 531 / 100 = 5.31. \]

![Diagram of a clip and staple connection](image.png)

Figure 6-54.

**Additional Information**

Additional information concerning the holding strength of staples in plywood and other wood composites is found in the following publications.


Holding Strength Of Nails

Nails are not normally used in furniture construction as structural load bearing fasteners in areas of high stress, but rather they are most often used to hold other types of joints such as dowel joints together until the glue dries. Many times they are simply used to locate parts in the right position. They are also frequently used to apply clamping pressure as well as to hold the joint together until the glue dries such as in the fabrication of nail-glued plywood gusset-type joints.

On occasion, however, nails are used structurally and are subjected to shear or withdrawal forces, or, both. When the top rail on a sofa is laid in the flat position, nails are often driven through it into the tops of interior uprights. In this case the nails are subjected to both shear and withdrawal forces. Nails often also are driven through side slats into the ends of the center rail. Here, the nails are subjected primarily to lateral shear forces. Often, nails are used to attach stretchers to front and back rails. In this type of construction the nails are driven through the rails into the ends of the members. Here again, the nails are loaded in shear.

Most of the nails used in furniture construction are fairly small—usually 8d or less. Box nails are frequently used, because having a smaller diameter, they are less likely to split the wood. An 8d box nail, for example, has the same diameter as a 6d common nail. Similarly, a 6d box nail, has the same diameter as a 4d box nail. It should be noted that this regular relationship does not hold for all sizes, however. Surface coated nails are often used although bright common wire nails are frequently seen. Annular ring nails could be used to good advantage in furniture construction but are seldom employed.

Withdrawal Strength

Side Grain

The withdrawal strength of bright common wire nails from the side grain of seasoned wood can be calculated by means of the expression

\[ F = 6,900 \times D \times L \times G_o^{5/2} \]  

(6-41)

where \( F \) = withdrawal strength in pounds; \( D \) = diameter of the nail in inches; \( L \) = depth of penetration of the nail into the member holding the point; and \( G_o \) = specific gravity of the wood based on oven dry weight and volume. This equation, it should be noted, is simply a modified form of the expression given in the Wood Handbook. For convenience, commonly used values of \( G_o \) have been calculated and are given in Table 6-17. Also, the diameters of a number of commonly used nails are given in Table 6-21.

As an example problem let us calculate the withdrawal strength of a 6d box nail that is driven one inch into the side grain of a piece of sweetgum. Referring to Appendix 6-1 we see that the specific gravity of sweetgum based on oven dry volume, \( G_o \), is 0.55. From Table 6-17, this
value raised to the 5/2 power, Table 6-17, is 0.22; i.e.,
\[ G_{0}^{\frac{5}{2}} = 0.55^{\frac{5}{2}} = 0.22. \]
Finally, from Table 6-21 we see that the diameter of a 6d box nail is 0.098 inches. Substituting these values into equation (6-41) gives
\[ F_{2} = 6,900 \times (0.098) \times (1) \times (0.22) = 148.8 \text{ lbs}. \]

**End Grain**

The Wood Handbook states that the withdrawal strength of nails from end grain surfaces may be only 50 to 75 percent as great as withdrawal from side grain surfaces in the softer woods. Heavy woods, however, show little difference in withdrawal strength between side grain and end grain surfaces (Brown, Panshin, and Forsaith, 1952). Since nails are often driven into end grain surfaces in furniture construction, it is important to take this reduction into account when designing such joints.

**Lateral Strength of Nails In Wood**

**Side Grain**

The lateral resistance of common wire nails can be predicted by means of the expression
\[ F = K \times (2,632 \cdot G_{0} - 126) \times D^{\frac{3}{2}} \]  
(6-42)
where \( F \) = the lateral strength of the nail in pounds; \( G_{0} \) = the sp. gr. of the wood based on weight and volume when oven dry; \( D \) = the diameter of the nail in inches; and \( K = 6 \) for softwoods, or \( K = 11 \) for hardwoods.

To illustrate the use of this expression, let us calculate the lateral resistance of a 6d box nail driven into the side grain of a piece of American elm. From Appendix 6-1 we see that the specific gravity of American elm based on oven dry volume is 0.55. Similarly from Table 6-21 we see that the diameter of a 6d box nail is 0.098 inches, and that this value raised to the 3/2 power is 0.0307 in\(^3\). Substituting these values into equation 6-42 gives
\[ F = 11 \times (2,632 \times 0.55 - 126) \times 0.0307 = 446.3 \text{ lbs}. \]
Note that if this nail had been driven into a softwood of equal density its predicted lateral holding strength would be
\[ F = \frac{6}{11} \times 446.3 = 243.4 \text{ lbs}. \]

**End Grain**

Equation 6-42 is again a modification of an expression found in the Wood Handbook. The Wood Handbook also states that the lateral holding strength of nails in end grain is less than it is in side grain, and it is
also more erratic. It is recommended, accordingly, that values for end grain be taken as only 60 percent of the strength values calculated for side grain in lightweight woods and slightly higher for the denser species.

Through Bolt with Dowel Nut Construction

Through bolt with dowel nuts, Figure 6-55 are often used to reinforce dowel joints in the side rail to back post connection in chairs. They may, of course, be used alone in such joints, and they are, in fact, used in many other types of furniture joints. One example is the bed rail to bed post joint in beds.

There is perhaps some question how much these bolts add to the strength of a conventional wooden dowel joint because the wooden dowels will likely fail in withdrawal before the bolt can begin to carry an appreciable load. Also, the bolts must be kept tight before they can be effective. The bolt with dowel nut does add considerably to the structural integrity of the joint, however, since the bolt itself can carry the entire load acting on the joint even if the dowels fail.

Numerous manufacturers already recognize that such bolts add to the strength, and in particular, to the durability of a joint and, therefore, incorporate them into their heavy duty chair constructions.

In some cases, long wood screws may be used in place of through bolts to reinforce a dowel joint, Figure 6-56. These screws cannot be expected to be as effective as the through bolts, but they do perhaps at least hold the joint together until the glue dries; they also form a redundant back-up connection if the primary dowel connections fail.

Through bolt with dowel nut construction is also commonly used in table construction to attach steel header plates to the tops of the legs, Figure 6-57. In this type of construction, the steel mounting plate is attached to the top of the leg by means of either one or two machine bolts which pass through the plate and then thread into a steel dowel nut which is embedded crosswise in the leg about 1-3/4 inches below the plate, Figure 6-57. This construction is one of the strongest types tested by the author. Five joints constructed with two 3/8 inch diameter bolts inserted into the ends of 2-1/4 inch square maple legs, for example, were able to resist bending moments of about 10,500 in-lb. To develop the full strength of this joint, it was found necessary to use steel plates 3/8 inch thick.
because 5/16 inch thick plates bent at this load level. Furthermore, 3/8 inch diameter bolts yielded in some tests; the tops of the legs also split out on occasion.

In tests carried out with a single 3/8-inch diameter bolt instead of two bolts, the bolt yielded in each test. This result would be expected from the test results given above in which some yielding occurred even in two-bolt joints.

Research is needed to develop methods of predicting the critical strength parameters of this joint. As an example, it was found that joints constructed with legs 2 inches square developed only 78 percent as much strength as joints constructed with legs 2.4 inches square. Certainly, this result indicates that joint strength is proportional to the cross section of the leg. An important strength parameter that has not been investigated is how far the hole for the dowel nut should be drilled below the top of the leg to prevent the dowel nut from splitting out the end of the leg.

**Withdrawal Strength of Dowel Nuts**

The holding strength of 3/8-inch diameter dowel nuts in solid wood may be estimated by means of the expression

\[
F = 0.14 \times S_x^{0.06} \times (ED)^{0.36} \times (SD)^{0.05}
\]

where \( F \) refers to the withdrawal strength of the d-nuts in tension, lbs; \( S_x \) refers to the compressive strength of the wood parallel to the grain at current moisture content, psi; \( (ED) \) refers to the end embedment distance of the d-nuts, inches; \( (SD) \) refers to the edge (side) embedment distance of the d-nuts, inches (Eckelman, 1989).

These values indicated that withdrawal strength is nearly linearly related to the strength of the wood in compression parallel to the grain. They also indicate that withdrawal strength was only weakly related to end embedment distance, \( (ED) \), and essentially independent of the edge embedment distance, \( (SD) \); i.e., these results indicated that withdrawal strength was not particularly sensitive to d-nut placement. Of particular interest, there was little loss in withdrawal strength when the fasteners were placed as close as 0.5 inches from the edge of the rail. Furthermore, the fasteners maintained a high level of withdrawal strength even when they were placed as close as one inch from the end of the rail. This result is reflected in the regression expression which indicates that withdrawal strength would be expected to decrease by only \( 1 - (1/1.5)^{0.36} \), or, 13.6 percent when end embedment is decreased from 1.5 to 1.0 inches.

In the case of specimens constructed of MDF, edge placement again did not appear to have a major effect. Failure in these specimens occurs owing to crushing of the fibers beneath the nut—not by fracture of the material on the side of the hole. Thus, the withdrawal strength of dowel
nuts appears to be governed primarily by the crushing strength of the base material.

**Bending Moment Resistance of T-Joints Constructed with Dowel Nuts**

The bending moment resistance of T-joints constructed with either one or two 3/8-inch diameter dowel nuts, Figure 6-58, may be estimated by means of the expression

\[ F = 0.192 \times S_x \times J \times (ED)^{0.5} \]  

(6-44)

where \( F \) refers to the bending moment resistance of the joint, in-lb; \( S_x \) refers to the compression strength of the wood parallel to the grain, psi, at current moisture content; \( J \) refers to the internal moment arm of the joint, in (This refers to the distance from the longitudinal axis of the through-bolt loaded in tension to the compressive edge of the rail.); and \( (ED) \) refers to the spacing of the D-nut from the end of the rail, in. In tests carried out by Eckelman (1989), values predicted by this expression varied from actual test results by no more than 14 percent. Furthermore, tests indicated that the dowel nuts could be located as close as 1-inch from the end of a rail with little loss in strength.

To illustrate the use of the above expression consider the joint shown in Figure 6-59, which is constructed of Northern red oak at 7 percent moisture content.

The compressive strength of Northern red oak parallel to the grain is 6,670 psi at 12 percent moisture content. According to the Wood Handbook (1999), the compressive strength of Northern red oak parallel to the grain is 3,440 and 6,760 psi in the green condition and at 12 percent mc, respectively. These values may be converted to 7 percent moisture content by means of the following expression (Wood Handbook, 1999)

\[ s_x = 6,760 \times \left( \frac{6,760}{3,440} \right)^{\frac{12-7}{25-12}} = 9,233 \text{ psi} \]

Substituting the appropriate values into the previous expression and solving gives

\[ F_4 = 0.192 \times 9,233 \times 3 \times (1.5)^{0.5} = 6,514 \text{ in \- lb} \]
Moment Rotation Characteristics of Through Bolt with Dowel Nut Joints

The internal moment-rotation characteristics of a semi-rigid joint may be expressed in functional form as \( \phi = f(F_4) \) where \( \phi \) is the internal joint rotation, radians, and \( F_4 \) is the bending force acting on the joint, lb.-in. When the moment-rotation curve is linear, this expression may be written as \( \phi = Z \times F_4 \) where \( Z \) is defined as a semi-rigid connection factor. This factor is used to render the ordinary exact methods of structural analysis applicable to structures with semi-rigid joints. When the curve is not linear over its entire range, specific \( Z \)-values may still be calculated for the range of moments anticipated.

Moment-rotation characteristics may be expressed in polynomial form as

\[
\phi = b_0 + b_1 F_4 + b_2 F_4^2
\]

where \( \phi \) refers to the internal rotation of the joint, \( b_0 \) and \( b_1 \) are the regression coefficients, and \( F_4 \) is the external bending force acting on the joint. The first derivative of this expression, i.e., the coefficient \( b_1 \), corresponds to the desired \( Z \)-values. With these latter coefficients, a \( Z \)-value may be determined for any range of strength by calculating the rotations at any two bending force levels, and dividing the absolute difference of the two values by the absolute difference of the corresponding bending force values. This procedure is useful when using iterative analytical procedures to treat non-linear, semi-rigid, internal joint rotations.

The coefficients listed in Table 6-22 indicate that these joints are, in fact, flexible compared to adhesive-based joints. A well-made T-joint constructed with dowels (three-inch wide rail and a 2-inch wide dowel spacing), for example, might be expected to have a \( Z \)-value of about 2.5 \( \times 10^{-6} \) radians/lb.-in.

Bending Moment Resistance of Through Bolt with Dowel Nut Leg to Mounting Plate Joints in Table Construction

Several commercially used methods of attaching legs to the undersides of tops have been studied and described by Eckelman (1977). In heavy-duty thin profile tables, the most common method of leg attachment involves the use of an intermediate steel mounting plate. In practice, the top end of each leg is first attached to one of these plates by means of through bolts with dowel nuts. The mounting plate, in turn, is attached to the underside of the top with either three or five bolts which screw into...
threaded metal inserts embedded in the underside of the top. Ordinarily, an 8-mm (5/16-inch) thick by 127-mm (5-inch) square steel mounting plate is used.

The bending moment resistances of various leg to mounting plate joints constructed as shown in Figure 6-60 are given in Table 6-23. As can be seen, leg to mounting plate assembly constructed with two 3/8-inch diameter through bolts and 3/8-inch thick mounting plates were able to withstand an average bending moment of 10,449 in-lbs before failing. In other words, each 30 inch leg on a table equipped with this joint would be able to resist a horizontal floor reaction force of 350 pounds before failing.

This joint derives its strength from the high strength of wood in compression parallel to the grain. Strength of the joint is limited by the bending moment resistance of the mounting plate, the tensile strength of the through bolts, and the ability of the end of the leg to resist splitting as the through bolts apply forces to the dowel nut. In the case of cold rolled steel, a 5/16-inch

![Figure 6-60. Leg to mounting plate joint constructed with two 9.5-mm (3/8-inch) diameter through bolts.](image)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2.5/1</td>
<td>900</td>
<td>-2.881(10⁻³)</td>
<td>1.736(10⁻⁵)</td>
<td>0.778</td>
</tr>
<tr>
<td></td>
<td>1800</td>
<td>-2.508(10⁻²)</td>
<td>4.699(10⁻⁵)</td>
<td>0.813</td>
</tr>
<tr>
<td></td>
<td>2400</td>
<td>-7.503(10⁻³)</td>
<td>1.820(10⁻⁵) 1.196(10⁻⁸)</td>
<td>0.832</td>
</tr>
<tr>
<td>2.5/2</td>
<td>1200</td>
<td>-1.262(10⁻³)</td>
<td>6.923(10⁻⁶)</td>
<td>0.923</td>
</tr>
<tr>
<td></td>
<td>2400</td>
<td>-2.472(10⁻²)</td>
<td>2.933(10⁻⁵)</td>
<td>0.774</td>
</tr>
<tr>
<td></td>
<td>2400</td>
<td>-7.879(10⁻²)</td>
<td>8.230(10⁻⁶) 5.114(10⁻⁹)</td>
<td>0.864</td>
</tr>
<tr>
<td>3/1</td>
<td>1200</td>
<td>-2.969(10⁻³)</td>
<td>1.477(10⁻⁵)</td>
<td>0.771</td>
</tr>
<tr>
<td></td>
<td>2100</td>
<td>-2.106(10⁻²)</td>
<td>4.056(10⁻⁵)</td>
<td>0.781</td>
</tr>
<tr>
<td></td>
<td>2400</td>
<td>-2.477(10⁻²)</td>
<td>4.469(10⁻⁵)</td>
<td>0.824</td>
</tr>
<tr>
<td></td>
<td>2400</td>
<td>6.143(10⁻³)  -1.876(10⁻⁵) 2.425(10⁻⁸)</td>
<td>0.910</td>
<td></td>
</tr>
<tr>
<td>3/2</td>
<td>1800</td>
<td>-1.934(10⁻³)</td>
<td>6.051(10⁻⁶)</td>
<td>0.975</td>
</tr>
<tr>
<td></td>
<td>3600</td>
<td>-1.697(10⁻²)</td>
<td>1.835(10⁻⁵)</td>
<td>0.857</td>
</tr>
<tr>
<td></td>
<td>4200</td>
<td>7.379(10⁻³)  -1.206(10⁻⁵) 7.233(10⁻⁹)</td>
<td>0.972</td>
<td></td>
</tr>
<tr>
<td>3.5/1</td>
<td>1500</td>
<td>-1.551(10⁻³)</td>
<td>5.949(10⁻⁶)</td>
<td>0.896</td>
</tr>
<tr>
<td></td>
<td>3000</td>
<td>-1.801(10⁻²)</td>
<td>2.392(10⁻⁵)</td>
<td>0.821</td>
</tr>
<tr>
<td></td>
<td>3000</td>
<td>7.508(10⁻³)  -1.885(10⁻⁵) 1.293(10⁻⁸)</td>
<td>0.958</td>
<td></td>
</tr>
<tr>
<td>3.5/2</td>
<td>1800</td>
<td>-3.077(10⁻⁴)</td>
<td>2.718(10⁻⁶)</td>
<td>0.936</td>
</tr>
<tr>
<td></td>
<td>3600</td>
<td>-4.462(10⁻³)</td>
<td>5.984(10⁻⁶)</td>
<td>0.787</td>
</tr>
<tr>
<td></td>
<td>6000</td>
<td>-2.420(10⁻²)</td>
<td>1.625(10⁻⁵)</td>
<td>0.853</td>
</tr>
<tr>
<td></td>
<td>6600</td>
<td>7.297(10⁻³)  -9.303(10⁻⁶) 3.757(10⁻⁹)</td>
<td>0.981</td>
<td></td>
</tr>
</tbody>
</table>
to 3/8-inch thick plate is required to obtain this level of strength without bending. Typically, commercially produced plates are 5/16-inch thick which should produce joints with high levels of strength. Tests indicate, however, that 3/8-inch diameter bolts are required to obtain the maximum strength of joints of this configuration.

Strengths of joints constructed with one through bolt are considerably less than for those constructed with two bolts. Since the bolts often fail in these joints, however, it is possible that much higher strengths could be obtained with high strength bolts.

The strength of the joints constructed with anchor bolts is limited by the withdrawal strength of the anchor bolt from the end of the leg and by the tensile strength of the bolt itself. Nonetheless, the stronger of the two constructions listed above produced about half the strength of the joints constructed with two 9.5-mm (3/8-inch) bolts. These results tend to indicate that robust joints could be constructed with anchor bolts provided they were of sufficient length and had sufficient tensile strength.

### Tensile Strength of Common Steel Bolts

Tests carried out on five samples of common 0.375 inch diameter machine bolts gave an average failing strength of 6,602 pounds with a standard deviation of 283.6 pounds (Range 6300 - 6940 pounds).

Similar tests of five 0.25 inch diameter machine bolts yielded an average failing strength of 2,680 pounds with a standard deviation of 126.9 pounds (Range: 2570 - 3890).

<table>
<thead>
<tr>
<th>No. of Spec.</th>
<th>No. of Bolts</th>
<th>Diam.</th>
<th>Diam.</th>
<th>Or DOP</th>
<th>Section</th>
<th>Average Force</th>
<th>Std. Dev.</th>
<th>Z-Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>2-thru</td>
<td>5/16</td>
<td>5/8</td>
<td>1.75</td>
<td>2.29</td>
<td>8858</td>
<td>676</td>
<td>4.0 x 10^4</td>
</tr>
<tr>
<td>5</td>
<td>2-thru</td>
<td>3/8</td>
<td>5/8</td>
<td>1.75</td>
<td>2.29</td>
<td>10449</td>
<td>490</td>
<td>3.7 x 10^4</td>
</tr>
<tr>
<td>5</td>
<td>1-thru</td>
<td>3/8</td>
<td>5/8</td>
<td>1.75</td>
<td>2.4</td>
<td>6900</td>
<td>518</td>
<td>3.9 x 10^4</td>
</tr>
<tr>
<td>5</td>
<td>1-thru</td>
<td>3/8</td>
<td>5/8</td>
<td>1.75</td>
<td>2.0</td>
<td>5326</td>
<td>435</td>
<td>5.1 x 10^4</td>
</tr>
<tr>
<td>5</td>
<td>1-anch</td>
<td>3/8</td>
<td>2.875</td>
<td>2.4</td>
<td>4414</td>
<td>409</td>
<td>4.2 x 10^3</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1-anch</td>
<td>3/8</td>
<td>3.438</td>
<td>2.4</td>
<td>5371</td>
<td>216</td>
<td>4.6 x 10^3</td>
<td></td>
</tr>
</tbody>
</table>

1 This dimension refers to the distance from the diametral axis of the dowel nut in the leg to the end of the leg, or, in the case of anchor bolts, it refers to the depth of penetration of the anchor bolt in the end of the leg.

2 Through bolt; 3 Anchor bolt.