Estimation equations for moment resistances of L–type screw corner joints in case goods furniture

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Abstract

The effects of the number of screws and screw sizes on bending moment resistance of L–type furniture corner joints constructed of particleboard (PB) and medium density fiberboard (MDF) with resin surfacing were investigated in this study. Six different sizes of screws which included two diameters (4 and 5 mm) and three lengths (40, 50, and 60 mm) were utilized for constructing the test specimens. Specimens were fastened with only screws. Two, three, and four screws were used in the joints of the specimens that have the same width. Specimens were tested under static compression loads that tended to close the joints and tension loads that tended to open the joints. Results indicated that the ultimate moment resistance was obtained with the MDF specimens when the number of screws was four in the joints. MDF corner joints yielded higher moment resistance than PB corner joints for both compression and tension tests. Test results also showed that a screwed corner joint became stronger as either screw diameter or screw length or number of screws was increased. Screw length was found to have a larger influence on bending moment resistance than screw diameter. Furthermore, the average bending moment resistances of screwed corner joints evaluated in this study in compression and tension could be estimated by means of the developed equations.

In general for furniture products, three essential construction methods were utilized. Furniture was constructed by the case (panel type) or frame (skeleton) method or by a combination of the two, the complex method. The case construction means that the members of furniture were panels. In the frame construction, the members of furniture were rails instead of panels (Kasal et al. 2006). Case goods construction furniture is widely used in homes and offices.

Cabinet manufacturers design and manufacture ready-to-assemble (RTA) furniture with its components connected by mechanical fasteners only to increase their export of case goods to other countries. Furthermore, lacking a rational strength design method for furniture with low-cost fasteners such as screws and dowels, many manufacturers have turned to proprietary RTA fasteners (Tankut 2006).

RTA furniture is specifically designed and manufactured to be sold in a flat package, which allows consumers to take it home or to the office and assemble it themselves. Shipping furniture unassembled lowers costs by eliminating assembly costs and reducing shipping costs. The savings are then passed, in part, to the consumer in the form of lower purchase prices. RTA furniture evolved from knock-down furniture, which has been on the market for many years. As a result of new materials, new manufacturing techniques, new fastening

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*Forest Products Society Member.

Forest Prod. J. 58(9):21–27.

hardware, and updated styling, modern RTA furniture is a dramatic improvement over knock-down furniture. RTA furniture has gained rapid acceptance and is thought to be the fastest growing segment of the world's furniture market (Pepke 1988).

Today, joints without adhesives are common in case goods furniture construction because their use allows furniture to be shipped in knock-down condition and assembled on site, which greatly reduces shipping costs. Screws are widely utilized to connect the corner joints of these types of cases without glue. The rational design of the screw-connected joints requires information about the moment resistances of these joints in particleboard (PB) and medium density fiberboard (MDF).

Important considerations in the furniture engineering of screwed cases are the arrangement of the number of screws and screw sizes that should be used in joining the sides to bottom and top of the case. Limited information is obtainable concerning the moment resistances of screw-type corner joints in case construction. Available information is generally related to the direct withdrawal resistances of glued screw-type joints (Eckelman 1974, 1975, 1978; Rajak and Eckelman 1993).

The relationship between number of fasteners used and joint strength defined by the "zone of influence" or "zone of failure" of the fastener was investigated (Rajak 1989, Ho 1991, Zhang 1991). This term explains that an individual fastener is supported for a finite distance by the material on either side of it. As a result, when a fastener connection such as a screw in the side of a case fails, it causes a portion of the side wall on either side of it to fracture. Rajak (1989) stated "zones of failure" that extended from 40 to 50 mm on either side of the fastener case furniture corner joints constructed with large screws. Ho (1991) obtained a value of a little more than 40 mm on either side. In the case of dowels in similar material, it was found that the "zone of failure" extended about 40 mm on either side of the dowel (Zhang 1991). According to these studies, the minimum fastener spacing will gave maximum fastener strengths.

When cases were connected with multi-dowel corner joints constructed of PB, Zhang and Eckelman (1993) found that a space of 75 mm between two dowels gives the highest moment resistance per dowel. They also emphasized that edge break-out was the normal mode of failure.

Joints with 457 mm in width were constructed with up to 36 fasteners. Screwed and doweled joints were tested in compression for determining the bending moment resistance. According to results of the tests, the bending moment resistances increase rapidly until the "zones of influence" of the fasteners overlap. There was no increase in the moment resistance of the joints beyond that point (Liu and Eckelman 1998). The variability in edge breaking strength obtained for various wood composites were investigated (Eren and Eckelman 1998). Results indicated that the ultimate bending moment resistance can be obtained in corner joints with certain types of mechanical fasteners such as pan head screws and through bolts.

Zhang et al. (2005) investigated the effects of screw sizes, loading, material type, panel surface condition, and gluing on moment resistances of three-screw L-type corner joints for tension and compression tests. Results showed that surfacing PB with synthetic resin and assembling joints with glue applied to the contact surfaces of the face and butt members significantly obtained better moment resistances than joints constructed of only PB. Furthermore, 5-mm diameter by 50- or 60-mm-long screws were suggested for case furniture construction. The bending moment resistances of corner joints for cases constructed of 32-mm-thick laminated PB and MDF under compression and tension loads were investigated (Tankut 2005). The dowel spacing effects on the bending moment resistance of the corner joints were determined. Results indicated that the maximum moment is obtained in joints when spacing between the dowels is at least 96 mm.

The stability of several screw-based fasteners for connecting 15.87-mm-thick furniture grade PB was investigated. Separate statistical tests were performed for the effects of screw shank diameter, screw thread pitch, screw thread design, and fastener type on edge screw withdrawal resistance, bending moment resistance of corner joints, and lateral edge load of butt-jointed shelf units. All three test results showed that screws on their own performed markedly better than either dowels or screws with PVC anchors. The use of thicker screws or screws with anchor was not recommended for butt-jointed shelving applications using PB. Screws with specialized thread configurations such as beveled edges or alternating thread heights performed well, but were not significantly different from plain-threaded screws of the same dimensions in any of the loading configurations (Park et al. 2006).

Although L–type, screw connected corner joints are commonly employed in the construction of the cabinet furniture, limited information is available on the effects of number of screws, screw sizes (diameter and length), loading type, and board material type on the moment resistance of the joints.

The purpose of this study was to obtain practical information concerning the moment resistance of screwed corner joints that the furniture engineers could use in the strength design of case furniture. The objectives were to:

1. Compare bending moment resistance of the screwed corner joints constructed of different panel materials, namely PB and MDF.
2. Determine the effects of number of screws used in the joints on bending moment resistance of screwed corner joints.
3. Determine the effects of screw sizes (diameter and length) utilized for connecting the specimens on bending moment resistance of the screwed corner joints.
4. Estimate the mean bending moment resistances of screwed corner joints evaluated in this study with developed estimation equations.

Materials and methods

Experimental design

The configuration of the screwed L–type corner joint specimens used in the study is shown in **Figure 1**. In this study, Zhang and Eckelman's (1993) work was utilized for the preparation of the samples. Each specimen consisted of two principal structural members, a face and butt member. The members jointed together by 2, 3, or 4 screws along the joint area. Placements of the screws in the joint area for the specimens connected with 2, 3, or 4 screws are given in **Figures 2(a), 2(b),** and **2(c).** The face member measured 350 by 158

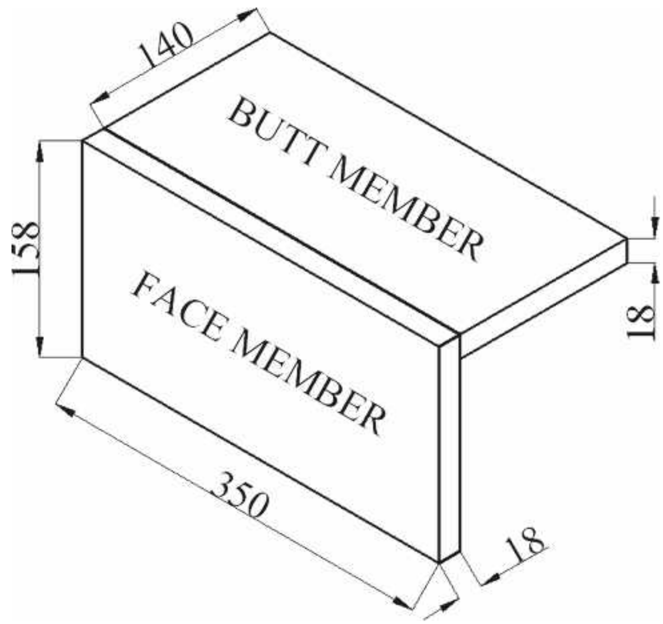

Figure 1. — The L-type corner joint specimens (measurements in mm).

by 18 mm, the butt member measured 350 by 140 by 18 mm. Specimens were assembled using screws only.

A complete 2 × 2 × 3 × 2 × 3 factorial experiment with five replications per cell was conducted to evaluate the factors on the moment resistance of L-type corner joints. The factors were loading type (compression and tension), material type (PB, MDF), number of screws (2, 3, and 4), screw diameter (4 and 5 mm) and screw length (40, 50, and 60 mm).

PB and MDF panels 18 mm in thickness were used as the board materials. The panels were obtained from commercial suppliers. To prepare the specimens, 1880 by 3660-mm full-size sheets were first cut into face and butt member strips. These strips were subsequently cut into the desired member lengths. Some considered necessary physical and mechanical properties of the board materials used in this study were determined in accordance with the procedures described in ASTM D4442 (2001) and ASTM D1037 (2001), respectively.

Steel, Phillips flat-head wood screws with 40±3 degree thread angle were chosen for this study. Screws were drilled into the centerline of the thickness of the butt member. When attaching screws, pilot holes were drilled into the edge of the butt member. The diameters of the pilot holes were equal to approximately 80 percent of the root diameter of the screws, and depths of the pilot holes were equal to approximately 75 percent of the penetration of the screws (Eckelman 1991). The measurements of the screws and diameters, and depths of the drilled pilot holes are listed in **Table 1** with depth of the penetrations according to each screw sizes. Before testing, all of the specimens were stored in a conditioning chamber at 20±2 °C and 65±3 percent relative humidity for a month.

Testing

In everyday use, the corner joints of a case or cabinet are exposed to two main forces: compression and tension. Most of these forces are applied through cantilevers (long sides) and can generate sizable bending moments (Yen et al. 2006). **Figures 3** and **4** show loading diagrams in testing corner joint moment resistances to compression forces that tend to close the corner joints and tension forces that tend to open the corner joints, respectively. In the tension test set up (**Fig. 4**), each of the supports was placed on rollers so that the two joint members were free to move sideways when the joint was loaded (Zhang and Eckelman 1993, A. Tankut and N. Tankut 2004).

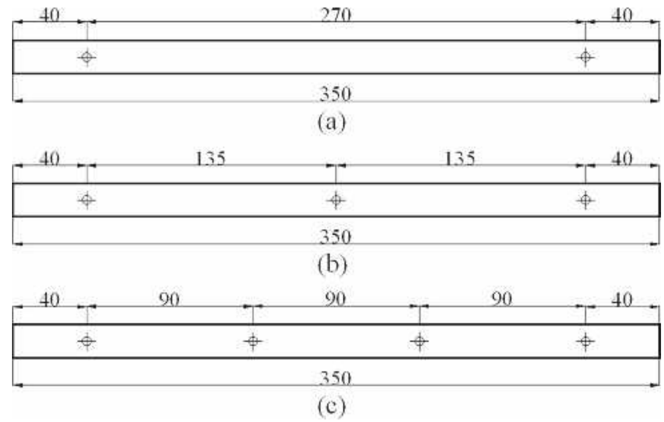

Figure 2. — Placements of the screws in the joints fastened with 2 (a), 3 (b), and 4 (c) screws (measurements in mm).

All tests were carried out on a 30 kN capacity Seidner bending machine. A rate of loading of 6 mm/min was used in all tests. The loading was continued until a failure or full separation occurred in the specimens. Joint failure modes and ultimate failure load values were recorded. Both compression and tension loadings were used to compute the bending moment resistance. The relations between the bending moment resistance and applied ultimate failure loads under compression (F_c) and tension (F_t) were different. The bending moments were calculated by means of the expressions:

$$M_C = F_c \times [\sqrt{(158)^2 - (0.5\,L_c)^2} - 25.456]\ (N\text{-}m) \qquad [1]$$

$$M_T = 0.5\,F_t \times 0.5L_t\ (N\text{-}m) \qquad [2]$$

where:

M_C, M_T = bending moment resistance under compression and tension loadings, respectively (N-m);

F_c, F_t = applied ultimate force of compression and tension (N);

L_c, L_t = moment arms for compression and tension tests (m).

The moment arms were calculated to be 0.08627 and 0.09988 m for compression and tension loadings, respectively, by using right triangle relation. The durability of joint area has been counted as the load carried only by the screws. Frictions on the supports and other forces have been ignored.

Results and discussion

Physical and mechanical properties of the board materials used in this study are given in **Table 2**. Withdrawal resistance of the screws from the PB and MDF used in the tests are presented in **Table 3**.

Failure modes

All joint failures occurred between 90 to 120 seconds. Corner joints opened up slowly, not suddenly. Failures of joints constructed of PB and MDF started with the screw heads crushing into the face member followed by screw withdrawal

Table 1. — Screw sizes, screw penetrations, and diameters and depths of the drilled pilot holes for each screw type.

Screw outside diameter	Screw root diameter	Thread per mm	Screw length	Diameter of the pilot holes	Depth of the pilot holes	Depth of penetration of the screw
(mm)						
4	2.4	1.8	40	2,5	15	22
4	2.4	1.8	50	2,5	24	32
4	2.4	1.8	60	2,5	32	42
5	3	2.2	40	3,0	15	22
5	3	2.2	50	3,0	24	32
5	3	2.2	60	3,0	32	42

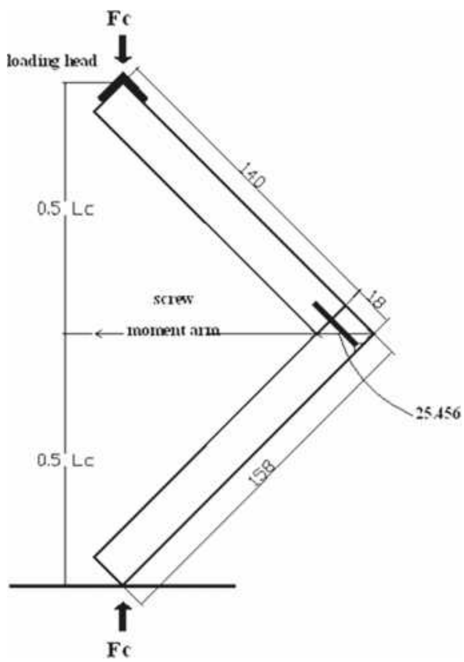

Figure 3. — Loading forms of specimens subjected to compression loads (measurements in mm).

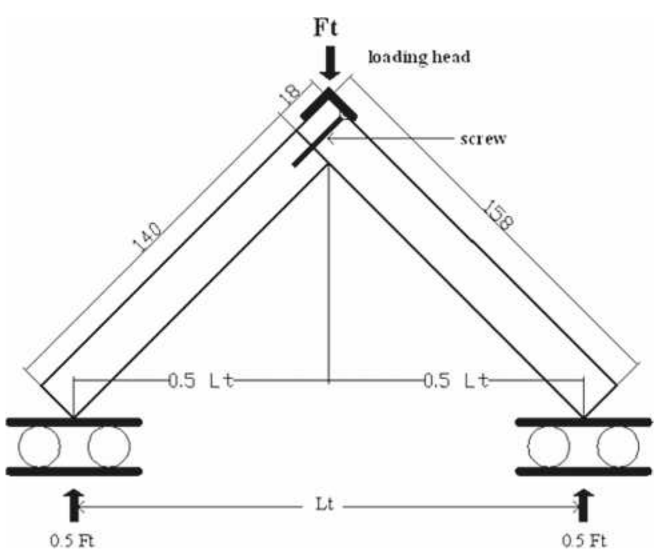

Figure 4. — Loading forms of specimens subjected to tension loads (measurements in mm).

from the butt members along with some core material together, with edge splitting around the screws. PB specimens showed more core material attached on screws than MDF ones. The splitting around the screws of MDF specimens was larger than ones of PB.

Bending moment resistances

Mean ultimate bending moment resistances and their coefficients of variation are summarized in **Table 4** for compression and tension tests, respectively. A five-factor analysis of variance (ANOVA) linear model procedure was carried out for individual data to examine main factors and their interactions on the ultimate bending moment resistances of the joints. The ANOVA results indicated that the five-factor interaction with a p-value of 0.9023 was not significant at the 5 percent significance level. Among five four-factor interactions, four were significant at the 5 percent significance level. These significant interactions were loading type by material type by number of screws by screw diameter, loading type by material type by screw length by screw diameter, loading type by number of screws by screw length by screw diameter, and material type by number of screws by screw length by screw diameter. Therefore, the significant four-factor interactions were further analyzed to explore the factors on the response variable "ultimate moment resistance."

For two of the significant four-factor interactions, loading type by material type by number of screws by screw diameter, loading type by material type by screw length by screw diameter, a one-way classification was created with 24 treatment combinations for each interaction, respectively. The protected least significant difference (LSD) multiple comparison procedure at the 5 percent significance level was performed to determine the mean differences of those treatment combinations. The LSD value of 1.84 N-m was calculated based on the mean square error of the full model.

For the two significant interactions, loading type by number of screws by screw length by screw diameter, and material type by number of screws by screw length by screw diameter, a one-way classification was created with 36 treatment combinations for each interaction, respectively. The protected LSD multiple comparison procedure at the 5 percent significance level was performed to determine the mean differences of those treatment combinations. The LSD value of 2.25 N-m was calculated based on the mean square error of the full model.

Moment comparison

Results of means separations of moment resistances indicated that in general the joints loaded in tension have greater moment resistance than those loaded in compression. According to Zhang and Eckelman (1993), the reason for this phenomenon is that the bending moment resistance of the joints loaded in compression is presumably related to the IB strength of the board, whereas the bending moment resistance of the joints loaded in tension is presumably related to the surface tensile strength parallel to the plane of the board.

But the confounding was found. There was no significant difference in moment resistance between compression and

Table 2. — Physical and mechanical properties of the PB and MDF used in the tests.

Material type	MC (percent)	Density (gr/cm^3)	Bending strength (MOR)	Modulus of elasticity (MOE)	Modulus of rigidity (G)	Internal bond strength (IB)
			---------- (MPa) ----------			
PB	7.2	0.57	14.9	2327	1290	0.52
MDF	6.2	0.75	30.4	3327	1360	0.70

Table 3. — Withdrawal performances of the screws utilized in the joints.

Material type	Screw diameter (mm)	Edge withdrawal performance	Face withdrawal performance
		---------- (N) ----------	
PB	4	58.6	80.3
	5	94.3	122.5
MDF	4	80.4	98.7
	5	170.2	198.2

Table 4. — Average bending moment resistances of the corner joints under compression and tension loads with their coefficients of variation.

Number of screws	Screw diameter	Screw length	Bending moment resistance (*N-m*) Under compression PB	Under compression MDF	Under tension PB	Under tension MDF
	------- (mm) -------					
2	4	40	12.68 (4.8)*	14.55 (4.6)	17.08 (4.3)	22.71 (3.1)
		50	27.56 (2.6)	32.96 (2.6)	36.67 (2.2)	42.11 (1.7)
		60	32.80 (3.8)	40.41 (4.0)	44.62 (5.1)	49.96 (3.1)
	5	40	18.93 (6.7)	22.67 (3.0)	19.89 (5.4)	30.26 (2.4)
		50	37.72 (4.1)	41.58 (5.7)	37.82 (4.5)	55.30 (4.1)
		60	50.05 (3.6)	55.82 (7.7)	47.53 (2.0)	66.94 (2.1)
3	4	40	20.29 (9.3)	27.38 (2.6)	27.26 (3.8)	37.74 (1.8)
		50	45.31 (4.7)	49.02 (5.3)	61.12 (3.5)	69.35 (2.8)
		60	51.55 (8.8)	61.70 (5.6)	73.25 (2.8)	85.35 (2.5)
	5	40	30.26 (6.1)	36.18 (5.1)	32.60 (2.1)	49.96 (5.2)
		50	61.72 (4.8)	71.14 (5.1)	61.12 (3.5)	91.47 (2.2)
		60	87.08 (5.2)	101.5 (3.4)	76.63 (2.2)	108.2 (2.2)
4	4	40	30.28 (2.3)	38.39 (4.7)	42.20 (2.1)	51.52 (4.0)
		50	61.72 (2.8)	73.57 (2.1)	89.73 (1.7)	102.1 (1.9)
		60	71.86 (5.3)	85.39 (8.4)	114.0 (2.5)	121.3 (3.1)
	5	40	40.58 (6.1)	53.94 (3.4)	44.34 (2.7)	74.69 (2.8)
		50	83.18 (4.3)	98.42 (3.7)	93.33 (2.8)	132.4 (1.9)
		60	122.6 (4.1)	147.30 (3.0)	115.4 (2.6)	160.2 (3.5)

* Values in parentheses are coefficients of variation.

tension loadings for the joints connected with 3- to 5-mm-diameter screws of length 60 mm. There was no significant difference in moment resistance between compression and tension loadings for PB joints connected with 2- to 5-mm-diameter screws, and while PB joints connected with 3- to 5-mm-diameter screws showed significantly greater moment resistance to compression load than to tension load. PB joints connected with 5-mm-diameter screws of length 60 mm showed significantly greater moment resistance to compression load than to tension load.

The confounding indicated that the PB joints connected with 5-mm diameter and 60-mm-long screws showed significantly greater moment resistance to compression load than to tension load. For PB joints constructed with 2- to 5-mm diameter screws of lengths 40 and 50 mm as well as joints with 3- to 5-mm-diameter screws of length 50 mm, there were no significant differences in moment resistance between compression and tension loads.

Material effects

The means separations of moment resistances for material type between MDF and PB were performed for each of 12 combinations of loading type by number of screws by screw diameter, and each of 12 combinations of loading type by screw diameter by screw length, and each of 18 combinations of number of screws by screw diameter by screw length, respectively. Means comparisons results indicated that, in general, the joints constructed of MDF showed significantly higher moment resistance the ones constructed of PB. Tests results of the similar previous studies concerning the corner joints of cases (Tankut, A. 2005, Tankut, N. 2006, Zhang et al. 2005, Kasal et al. 2006) agree with this study. This significant difference in moment resistance could be explained by the fact that MDF has higher IB strength and screw withdrawal resistance than PB (**Tables 2** and **3**). In other words, panels with high IB strength and screw withdrawal resistances would likely yield high moment resistance.

Number of screws effects

The means separations of moment resistances for number of screws among 2, 3, and 4 were performed for each of 8 combinations of loading type by material type by screw diameter, and each of 12 combinations of loading type by screw diameter by screw length, and each of 12 combinations of material type by screw diameter by screw length, respectively. Means comparisons results indicated that, in general, moment resistances increased significantly as number of screws increased from 2 to 4 in an increment of 1.

Screw diameter effects

The means separations of moment resistances for screw diameters of 4 and 5 mm were performed for each of 12 combinations of loading type by material type by number of screws, and each of 12 combinations of loading type by material type by screw length, and each of 18 combinations of loading direction by number of screws by screw length, and each of 18 combinations of material type by number of screws by screw length, respectively. Means comparisons results indicated that, in general, moment resistances increased significantly as screw diameter increased from 4 to 5 mm, except one case, the PB joints connected with 50-mm-long screws, of which, the moment resistance to tension load was not significant as screw diameter increased from 4 to 5 mm.

Screw length effects

The means separations of moment resistances for screw length among 40, 50, and 60 mm were performed for each of 8 combinations of loading type by material type by screw diameter, and each of 12 combinations of loading type by number of screws by screw diameter, and each of 12 combinations of material type by number of screws by screw diameter, respectively. Means comparisons results indicated that, in general, moment resistances increased significantly as screw length increased from 40 to 60 mm in increments of 10 mm.

Table 5. — Regression coefficients and associated r^2 for derived equations for estimating mean ultimate moments of screw connected L-type corner joints.

Material type	Loading type	a	b	c	d	r^2
PB	Compression	6.27×10^{-5}	1.741	1.182	2.451	0.96
	Tension	89.44×10^{-5}	0.285	1.277	2.347	0.96
MDF	Compression	13.52×10^{-5}	1.656	1.256	2.312	0.97
	Tension	107.17×10^{-5}	1.272	1.259	1.999	0.97

Estimation equations

To quantify the effects of the significant factors on the moment resistance of screw connected L-type joints, the following power equation was fitted to the individual test data points by means of the least squares method:

$$M = a \times D^b \times N^c \times L^d \quad [3]$$

where:

M = estimated mean ultimate moment (N-m);
D = screw diameter (mm); N = number of screws;
L = screw length (mm),
a, b, c, d = regression constants.

Table 6. — Comparison of observed test results with values obtained with the estimation equations.

				Bending Moment Resistance (N-m)					
				Under compression			Under tension		
Material type	Number of screws	Screw diameter	Screw length	Estimated	Observed	Difference	Estimated	Observed	Difference
		(mm)		------- (N-m) -------		(percent)	--- (N-m) ---		(percent)
PB	2	4	40	13.45	12.68	−6.1	18.55	17.08	−8.6
			50	23.24	27.56	15.7	31.32	36.67	14.6
			60	36.34	32.80	−10.8	48.05	44.62	−7.7
		5	40	19.83	18.92	−4.8	19.77	19.89	0.6
			50	34.27	37.71	9.1	33.38	37.82	11.7
			60	53.59	50.05	−7.1	51.21	47.32	−8.2
	3	4	40	21.72	20.29	−7.0	31.13	27.26	−14.2
			50	37.53	45.30	17.2	52.57	61.12	14.0
			60	58.68	51.55	−13.8	80.65	73.25	−10.1
		5	40	32.03	30.26	−5.8	33.18	32.60	−1.8
			50	55.36	61.71	10.3	56.02	61.12	8.3
			60	86.55	87.08	0.6	85.94	76.63	−12.1
	4	4	40	30.52	30.28	−0.8	44.96	42.20	−6.5
			50	52.74	61.71	14.5	75.91	89.73	15.4
			60	82.46	71.86	−14.8	116.45	114.00	−2.1
		5	40	45.01	40.58	−10.9	47.91	44.34	−8.1
			50	77.78	83.18	6.5	80.89	93.33	13.3
			60	121.61	122.59	0.8	124.10	115.40	−7.5
MDF	2	4	40	16.23	14.54	−11.6	23.82	22.70	−4.9
			50	27.19	32.95	17.5	37.20	42.10	11.6
			60	41.44	40.41	−2.5	53.56	49.96	−7.2
		5	40	23.48	22.67	−3.6	31.64	30.26	−4.6
			50	39.34	41.58	5.4	49.42	55.29	10.6
			60	59.97	55.81	−7.5	71.14	66.93	−6.3
	3	4	40	27.00	27.38	1.4	39.69	37.73	−5.2
			50	45.23	49.01	7.7	61.99	69.35	10.6
			60	68.95	61.70	−11.8	89.24	85.36	−4.5
		5	40	39.07	36.18	−8.0	52.72	49.96	−5.5
			50	65.45	71.17	8.0	82.34	91.46	10.0
			60	99.77	101.45	1.7	118.54	108.16	−9.6
	4	4	40	38.75	38.38	−1.0	57.01	51.52	−10.7
			50	64.91	73.57	11.8	89.05	102.11	12.8
			60	98.95	85.38	−15.9	128.20	121.26	−5.7
		5	40	56.07	53.93	−4.0	75.73	74.68	−1.4
			50	93.92	98.41	4.6	118.29	132.41	10.7
			60	143.18	147.28	2.8	170.29	160.16	−6.3

Table 5 gives the regression coefficients, and coefficients of determination (r^2) of the derived equations for estimating moment resistances of L-type, multiscrew connected corner joints in PB and MDF. High r^2 values suggested that derived power equations could be useful for estimating mean ultimate moments. Higher d values indicate that, in general, screw length affects the moment resistance of L-type, multiscrew corner joints the most of all factors, followed by screw diameter and number of screws. The one exception was the PB joint in tension, where joint moment is less sensitive to screw diameter change compared to other two factors. Also, it seemed that c and d values were less sensitive to material type and number of screws changes compared to the b value.

Differences between estimated and observed values of joint moments were calculated as shown in **Table 6**. The mean differences between estimated and observed values differed by less than 17.5 percent.

Conclusions

This study was carried out to obtain information relating to the bending moment resistance of screwed corner joints constructed of PB and MDF; and also to develop expressions for estimating the bending moment resistance of the joints.

Material type, number of screws, screw diameter, and screw length effects on the bending moment resistance of L-type corner joints were investigated. Test results showed that significant differences occurred in bending moment resistances with respect to above mentioned variables.

The statistical analysis of test results indicated that joints constructed of MDF yielded higher moment resistances than those of PB. Moment resistance comparisons showed that joints connected with four screws tested in this study had significantly higher moment resistances than three-screw connections and two-screw connections under both compression and tension. Results of the tests also indicated that a screw corner joint became stronger as either screw diameter or screw length was increased. Screw length was found to have a greater effect on moment resistance than diameter.

For the case type furniture constructed of PB and MDF evaluated in this study and fastened with screws; a screw diameter of 5 mm and length of 60 mm and four-screw connections are recommended to obtain ultimate moment resistances. However, it should be noted that manufacturers and furniture engineers should take practicalities and economical factors into account in determining the optimum construction parameters. The most important result is that the mean bending moment resistance of screwed corner joints tested in this study could be predicted by the developed estimation equations.

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