HOLDING STRENGTH OF INSERT FITTINGS COMPARED TO BENDING STRENGTH OF THEIR FURNITURE CORNER JOINTS

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ABSTRACT: Different insert fittings (screws, plastic and metallic sockets, plastic and metallic cam fittings single and double) are widely used in ready-to-assemble cabinet furniture joints, connecting particleboard and MDF. The holding strength of insert fittings and the bending strength of the corresponding furniture corner joints constructed with the same fittings were studied. The insert fittings which are offered by four (4) manufacturers (Hettich, Häfele, Lama and one of no name) were studied. Research reported here indicated that bending strength values of furniture corner joints constructed with insert fittings strongly correlated to the face holding strength of the corresponding insert fittings (bending strength is almost equal to holding strength multiplied by 10). Based on these results, it is concluded that the bending strength value of a corner joint constructed with insert fitting could be sufficiently estimated by the measured holding strength value of the corresponding insert fitting.

Key words: insert fitting, holding strength, corner joint, bending strength, furniture

1. INTRODUCTION

Although, eccentric joints represent relatively innovative connectors for use in ready-to-assemble cabinet furniture, they have captured a strong share of furniture market in Europe. The way of fastening furniture insert fittings and the withdrawal resistance during removing these fittings determines to a great extent the strength and stability of ready-to-assemble furniture. The holding strength of most of the insert fittings offered in European market has been studied by Vassiliou and Barboutis (2004, 2005). Furthermore, the stress distribution of eccentric joints constructed with screws and double plastic cam fittings (VB 36M/19) have been investigated extensively, among with trapezoid fastenings, by Smardzewski and Prekrad (2002). On the other hand, the bending strength of furniture corner joints constructed with most of the insert fittings offered in European market has been studied by Vassiliou and Barboutis (2008).

This study was performed to provide information concerning the correlation between the bending strength of corner joints constructed with insert fittings, and the corresponding holding strength of the same insert fittings, used in eccentric fastening of case furniture.

2. MATERIALS AND METHODS

Insert fittings which are offered by 4 manufacturers (Hettich Germany, Häfele Germany, Lama Slovenia, and 1 of unknown manufacturer) were investigated. All of the fittings were commercially available items (Fig. 1).

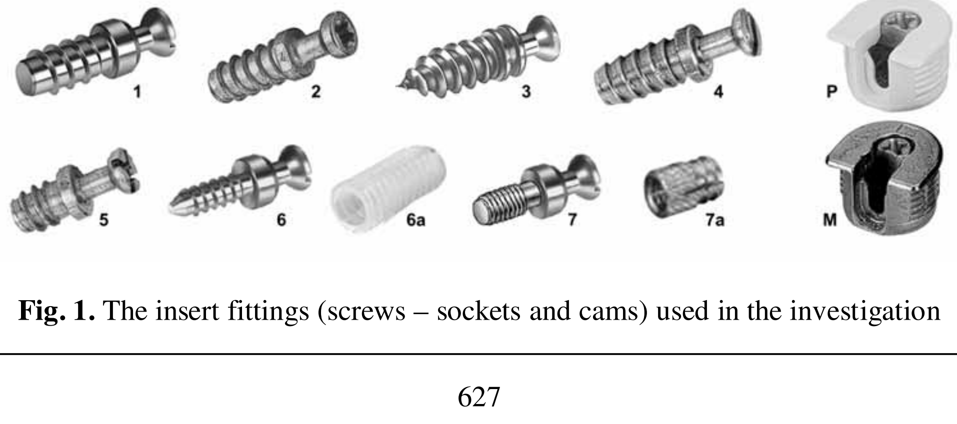

Fig. 1. The insert fittings (screws – sockets and cams) used in the investigation

The description of the fittings studied is given in the following Table 1, for screws and sockets.

Table 1

Description of the insert fittings (screws - sockets) used in the study

Code	**Screw type**	**Hole diameter (mm)**	**Hole length (mm)**	**Screw material**	**Screw diameter (mm)**	**Thread length (mm)**		**Socket use**	**Socket material**	**Socket diameter (mm)**	**Socket length (mm)**
						Total	**Cylindrical**				
MANUFACTURER A											
A	**1**	5	13	Steel	5	11	11	No	-	-	-
B	**2**	5	13	Die-cast zinc	5	12	12	No	-	-	-
C	**5**	5	13	Steel	5	7,8	6.2	No	-	-	-
D	**7**	5	13	Steel	4	7,8	7.8	Yes	Brass	5	7.8
E	6	3	13	Steel	3	11	9	No	-	-	-
F	**6**	5	13	Steel	3	11	9	Yes	Plastic	5	13
	MANUFACTURER B										
A	1	5	13	Steel	5	11	11	No	-	-	-
B	**6**	3	13	Steel	3	11	10.5	No	-	-	-
C	**6**	5	13	Steel	3	11	10.5	Yes	Plastic	5	12
D	**6**	3	13	Steel	3	11	9	No	-	-	-
E	**3**	5	13	Steel	5	12	8.5	No	-	-	-
F	**5**	5	13	Die-cast zinc	5	7.2	7.2	No	-	-	-
MANUFACTURER C											
A	3	5	13	Steel	5	12	8.5	No	-	-	-
B	**3**	5	13	Steel	5	12	9.5	No	-	-	-
MANUFACTURER D											
A	2	5	13	Steel	5	13	10,5	No	-	-	-

* Screw type of Figure 1.

The cam fittings selected for investigation were the single ones (Fig. 1) plastic and metal, with the following dimensions for all manufacturers: diameter 20mm, height 12.5mm. Manufacturers recommendations were followed with respect to pilot hole size and the insertion of screws, screw plastic and metal sockets, and cam fittings (Fig. 2).

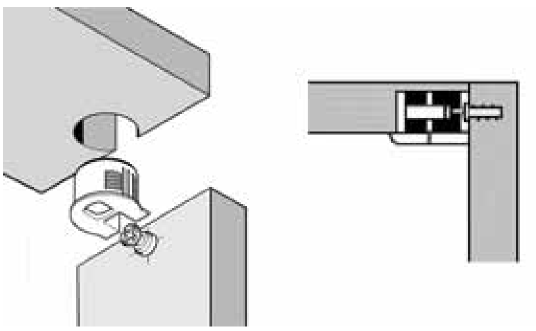

Fig. 2. Application of eccentric joints investigated

The tests of the holding strength measurements were carried out according to the standard EN 13446:2002, and the tests of the compression strength according to the way that most researchers are follow because a European standard is missing. Specimens were constructed with particleboard (Pbd) and medium density fiberboard (MDF) of 16mm thickness. The properties of the Pbd were: density 0.634 g/cm3 and internal strength 0.58 N/mm^2 and of the MDF were: density 0.680 g/cm^3 and internal strength 0.59 N/mm^2. The specimens were allowed to cure for a week before testing in a conditioning room at 20^o C and 65% relative humidity. The configuration of the samples and the method of loading the joints in compression, and the withdrawal capacity, are presented in the next Fig. 3.

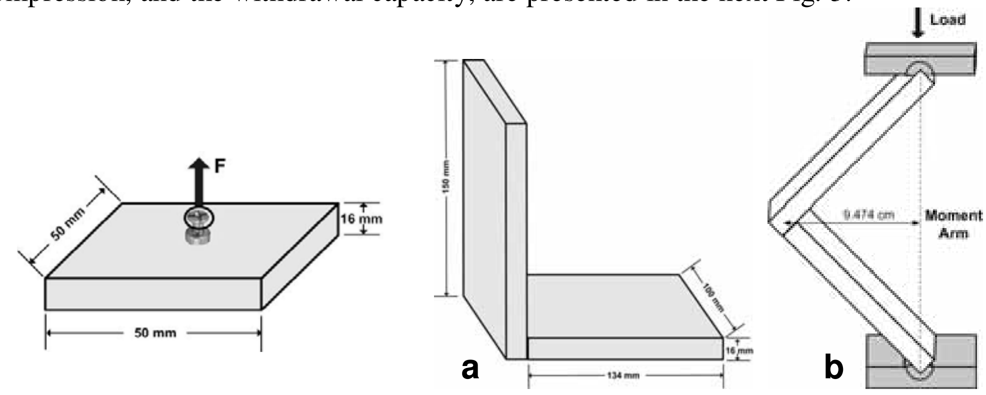

Fig. 3. Configurations of the specimens used: in holding strength test (Left), and in compression strength test of the joints (Right, a - b)

3. RESULTS AND DISCUSSION

Mean values of the bending strength of the tested corner joints measured on both the particleboard and the MDF samples, are shown in the following Table 2.

Table 2

Bending strength of the insert fittings joints in particleboard and MDF

Code*	Cam fitting type	Panel type			
		Particleboard		MDF	
		Strength (N)	S.D.	Strength (N)	S.D.
Manufacturer A					
A	Plastic	66.2**	3.05	78.6	3.41
	Metal	67.6	3.98	89.8	2.74
B	Plastic	67.0	4.92	85.2	3.79
	Metal	68.0	2.83	97.6	3.98
C	Plastic	39.6	4.09	50.2	2.74
	Metal	39.0	4.55	55.2	2.86
D	Plastic	47.2	4.02	60,6	3.78
	Metal	49.6	4.88	70,4	5.15
E	Plastic	48.6	5.50	76.2	5.29
	Metal	53.0	4.92	77.8	7.57
F	Plastic	56.4	5.56	84.2	4.76
	Metal	60.0	4.99	91,4	3.89
Manufacturer B					
A	Plastic	68.0	3.26	87.0	4.03

	Metal	68,6	3.53	88.2	3.05
B	Plastic	63.8	4.66	79.4	8.74
	Metal	63.2	4.44	81,4	4.62
C	Plastic	48.8	4.82	70.8	4.34
	Metal	50.6	3,46	69.6	4.50
D	Plastic	46.8	3.43	67.6	4.60
	Metal	50.4	5.32	69.0	3.16
E	Plastic	55.8	5.20	70.0	6.53
	Metal	54.6	6.19	72.6	5.42
F	Plastic	47.8	5.92	50.4	3.10
	Metal	48.8	5.35	51.2	2.70
Manufacturer C					
A	Plastic	49.0	3.16	69.8	3.05
B	Plastic	56.2	3.58	74.8	2.70
Manufacturer D					
A	Plastic	61.4	4.53	80.4	2.46

The corresponding mean values of the holding strength of the insert fittings tested are presented in Table 3.

Table 3

Holding strength of the insert fittings tested in particleboard and MDF

Code *	Insert fitting item	Panel type			
		Particleboard		MDF	
		Strength (N)	S.D.	Strength (N)	S.D.
MANUFACTURER A					
A	screw	708,4*	82,5	764,3*	31,6
B	#	790,7	87,3	840,8	61,2
C	#	491,7	31,9	518,8	45,0
D	screw + metallic socket	533,5	51,8	427,9	49,9
E	screw	487,2	26,7	610,1	37,6
F	screw + plastic socket	764,9	57,9	792,8	47,9
MANUFACTURER B					
A	screw	736,2	51,2	890,3	55,8
B	#	529,0	30,4	743,1	49,9
C	screw + plastic socket	566,4	27,0	622,0	42,3
D	screw	499,0	55,8	611,9	35,5
E	screw	533,3	60,1	664,8	41,7
F	#	422,3	50,3	505,9	26,8
MANUFACTURER C					
A	screw	603,6	57,3	692,8	43,6
B	#	691,4	52,9	762,2	63,3
MANUFACTURER D					
A	screw	745,8	85,8	844,3	42,8

As we can see, there is an obvious relationship between the two strengths. Generally speaking, the holding strength of each individual insert fitting is almost equal to the bending strength of the corresponding joint of this insert fitting multiplied by ten (10). Statistical analysis of the covariance between the two strengths showed that these two values are strongly correlated each other (see Table 4). That means, the bending strength (Y) could be sufficiently estimated by the corresponding measured holding strength (X) of the same insert fitting.

The corresponding correlation coefficient (r^2) ranged from 0.543 up to 0.768 in particleboard, and from 0.7254 up to 0.9167 in MDF, respectively. The accuracy of the estimation appeared to be higher in MDF panels in comparison to particleboard panels, and this is attributed mainly to the greater homogeneity of the MDF panels. Furthermore, the insert fittings of the manufacturer B showed higher correlation coefficients.

Table 4

Equations of covariance between bending strength (Y) and holding strength (X) in particleboard and MDF

Manufacturer	Insert Fitting	Panel type			
		Particleboard		MDF	
		Equation	Correlation coefficient (r^2)	Equation	Correlation coefficient (r^2)
Mr-A	Plastic	Y=10.92+0.0687X	0.7684	Y=23.545+0.074X	0.7677
Mr-A	Metallic	Y=13.125+0.068X	0.7322	Y=24.952+0.084X	0.7794
Mr-B	Plastic	Y=20.411+0.063X	0.543	Y=10.663+0.089X	0.9063
Mr-B	Metallic	Y=22.538+0.612X	0.6278	Y=10.072+0.092X	0.9167
Mrs-A+B+C+D	Plastic	Y=21.813-0.054X	0.5519	Y=20.98+0.0749X	0.7918
Mrs-A+B	Metallic	Y=21.693+0.058X	0.6196	Y=19.326+0.085X	0.7254

4. SUMMARY

Within the limitations of the present study, it can be concluded that the bending strength of the corner joints constructed with insert fittings could be sufficiently estimated by the corresponding measured holding strength of the insert fittings. The accuracy of the estimation depends on the panel type and the manufacturer of the insert fitting.

The practical benefits of this substitution come mainly of the easier way that the specimens are prepared and the withdrawal capacity can be determined, compared to the compression strength, according to an existed European standard (EN).

LITERATURE

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