



**Annals
of Warsaw
University
of Life
Sciences
– SGGW**

**Forestry and
Wood Technology
No 67
2009**

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Forestry and Wood Technology No 67
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WARSAW UNIVERSITY
OF LIFE SCIENCES PRESS
e-mail: wydawnictwo@sggw.pl

SERIES EDITOR

Ewa Dobrowolska
Marcin Zbieć

ISSN 1898-5912

PRINT: Agencja Reklamowo-Wydawnicza A. Grzegorzcyk

Improvements in the holding strength of cam fittings used in eccentric joints

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Abstract: *Improvements in the holding strength of cam fittings used in eccentric joints.* Many insert fittings are commonly used in furniture production to join particleboard and MDF. Screws either without or with plastic sockets and cam fittings plastic or metal of many manufacturers, are offered for this kind of joints in the market. Previous researchers have studied the holding strength of insert fittings following the manufacturers recommendations with respect to pilot hole size and the insertion of cam fittings. However, use of cam fittings according to manufacturer recommendations resulted in very low holding strength values. Two simple improvements are presented in this work to increase the holding strength of cam fittings: 1) Gluing of cam fittings with PVAc adhesive, and 2) fixing of cam fittings with screws. Holding strength of cam fittings fixed with screws improved by 40.0% to 46.2% in Pbd, and by 53.8% to 92.2% in MDF whereas, the insertion of cam fittings with PVAc adhesive improved their holding strength by 81.3% to 248.2% in Pbd, and by 82.9% to 265.3% in MDF.

Key words: cam fittings, holding strength, eccentric joints, improvements

INTRODUCTION

The resistance to withdrawal of different types of fasteners applied in different panel types, has been studied by many researchers (Cassens and Eckelman 1985, Eckelman and Cassens 1984, Örs, Özen and Doganay 1998, Vassiliou and Barboutis 2004, 2005). The holding strength of most of the insert fittings, used in eccentric joints, has also been studied (Vassiliou and Barboutis 2004, 2005).

On the basis of literature, it can be stated that eccentric joints made with this type of insert fittings, following the manufacturers recommendations, result in very low holding strength values (Vassiliou and Barboutis 2004, 2005), transferring small bending moments (Smardzewski and Prekrad 2002). The most common explanation of their use is the easy way of application even by an unskilled person. Furthermore, it is well known that the holding strength of insert fittings mainly, determines the strength of the corresponding joints.

This investigation was performed to search for improvements of the insert fittings holding strength, used in eccentric joints. In particular, the authors intended to test the influence of: 1) bonding of cam fittings with PVAc adhesive, and 2) fixing of cam fittings with screws, on the holding strength of cam fittings.

MATERIALS AND METHODS

Insert cam fittings of 2 manufacturers (Hettich Germany, and Häfele Germany) were selected for investigation, which were commercially available items (Figure 1). The description of the cam fittings studied is given in the following Table 1.

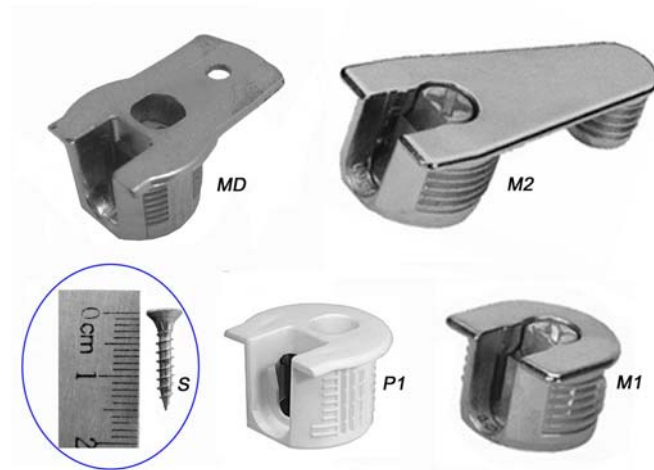


Figure 1. The cam fittings used in the investigation
(P1 is plastic single, M1 is metal single, M2 is metal double, MD is modified metal double and S is the screw inserted)

Table 1. Description of the insert cam fittings used in the study

Characteristic of insert fitting	cam fittings item *		
	P1 Plastic	M1 Metal	M2 Metal
Manufacturer A			
Large diameter (mm)	20	20	20
Large height (mm)	12,5	12,5	12,5
Small diameter (mm)	-	-	10
Small height (mm)	-	-	10,5
Manufacturer B			
Large diameter (mm)	20	20	20
Large height (mm)	12,5	12,5	12,5
Small diameter (mm)	-	-	10
Small height (mm)	-	-	10,5

* Where 1=single cam fitting and 2=double cam fitting (figure 2)

The specimens, measured 5 cm square, 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/mm² and of the MDF were: density 0.680 g/cm³ and internal strength 0.59 N/mm².

Pilot holes were drilled through the side of each specimen by means of a drill, in a direction perpendicular to the face of the sample. Prior to the insertion of cam fittings, all samples were conditioned to constant mass, at a temperature of 20° C and a relative humidity of 65%. The first group of cam fittings was applied following the manufacturers recommendations, by simple insertion (referred to as unglued), the second group of cam fittings was applied also, by simple insertion, plus a prior application of PVAc adhesive (of D3 durability class) in the holes (referred to as glued with PVAc). The third group of cam fittings was applied also, by simple insertion plus the insertion of an additional screw (of 15.4 mm length, 2.9 mm diameter, and 1.35 mm step), fixed in a hole which was predrilled in the center of the double metal cam fitting tale, after the extraction of the small inserting part by cutting (referred to as fixed with screw). Nevertheless to say, that neither the glue application nor the screw fixing affect the dismountable character of the corresponding joints (Figure 2).



Figure 2. Application of cam fittings investigated: A) unglued, B) fixed with screw, and C) glued with PVAc

DISCUSSION OF RESULTS

Values of the holding strength of the tested specimen constructed with the modified cam fittings are presented in Table 2.

Research reported here indicated that holding strength of the cam fittings differed slightly from manufacturer to manufacturer, whereas, their holding strength differed significantly from one treatment to another. Detailed results of the tests for each manufacturer's cam fittings are given in the following Figures.

In the case of manufacturer A (Figure 3) the holding strength of plastic single cam fitting increased with gluing by 99.1% in Pbd and by 82.9% in MDF, and the holding strength of metal single cam fitting increased with gluing by 265.3% in Pbd and by 168.4% in MDF, whereas the additional screw modification increased the holding strength by 40.0% in Pbd and by 53.8% in MDF. It is remarkable, that both modifications surpassed the corresponding holding strength of metal double cam fitting in MDF, and the gluing application in both plastic and metal cam fittings surpassed it in Pbd.

Table 2. Holding strength of the modified cam fittings in particleboard and MDF

Panel type and Insert fitting item	Joint type					
	Manufacturer A			Manufacturer B		
	Unglued	Glued with PVAc	Fixed with Screws	Unglued	Glued with PVAc	Fixed with Screws
Particleboard						
cam fitting plastic single	251.3 (32.3)*	500.3 (36.3)		282.9 (26.2)	512.8 (49.5)	
cam fitting metals single	262.2 (63.0)	957.7 (47.0)	366.8 (32.8)	299.9 (39.6)	1044.3 (67.0)	438.5 (34.5)
cam fitting metal double	417,7 (66,5)			424,7 (63,3)		
Medium Density Fiberboard						
cam fitting plastic single	361.0 (33.9)	660.3 (29.7)		432.6 (21.7)	813.8 (39.1)	
cam fitting metal single	441.3 (55.7)	1184.5 (40.4)	678.5 (31.8)	433.9 (34.7)	1478.5 (54.1)	833.8 (38.0)
cam fitting metal double	519,1 (52,3)			633,6 (24,9)		

* Mean values of 15 samples (Newton), and Standard Deviation in parenthesis

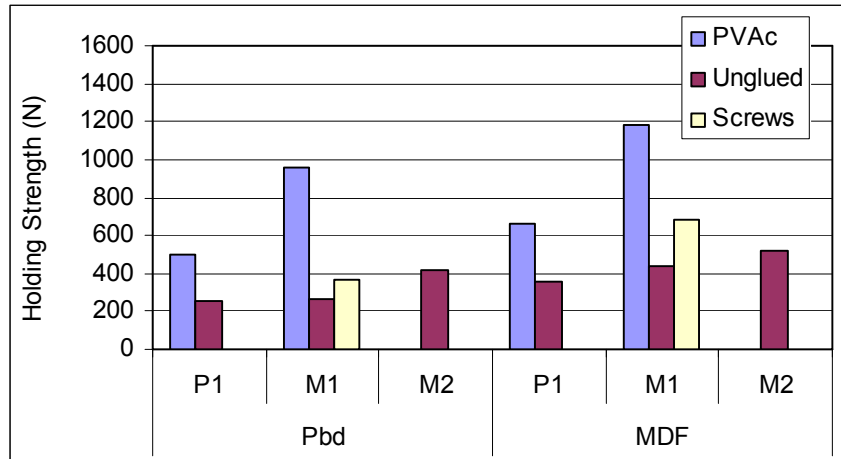


Figure 3. Holding strength of manufacturer A cam fittings

In the case of manufacturer B (Figure 4) the holding strength of plastic single cam fitting increased with gluing by 81.3% in Pbd and by 88.1% in MDF, and the holding strength of metal single cam fitting increased with gluing by 248.2% in Pbd and by 241.0% in MDF, whereas the additional screw modification increased the holding strength by 46.2% in Pbd and by 92.2% in MDF. Furthermore, it is remarkable, that both modifications surpassed the corresponding holding strength of metal double cam fitting in both Pbd and MDF.

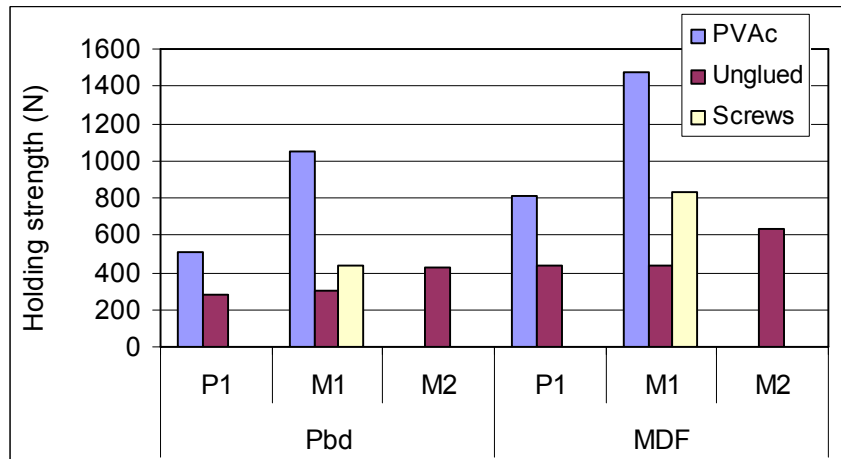


Figure 4. Holding strength of manufacturer B cam fittings

CONCLUSIONS

The following conclusions could be drawn for the tested cam fittings, based on this investigation. In order to improve the holding strength of the cam fittings used in eccentric joints two simple modifications could be followed, without affecting the dismountable character of the corresponding joints.

1. Fixing of cam fittings with screws was found to improve their holding strength by 40.0% to 46.2% in Pbd, and by 53.8% to 92.2% in MDF. The modification of the existing metal double cam fitting is needed before the application of this improvement.
2. Gluing of cam fittings with PVAc adhesive, at the time of their insertion, was found to improve their holding strength by 81.3% to 248.2% in Pbd, and by 82.9% to 265.3% in

MDF. This improvement can be applied without any modification of the existing plastic and metal single cam fittings.

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Streszczenie: *Zwiększanie zdolności utrzymania złączy mimośrodowych przez elementy.* Wiele złączy mimośrodowych jest powszechnie używanych do łączenia płyty wiórowej oraz MDF. Poprzednio prowadzone badania dotyczyły zdolności utrzymania poszczególnych elementów złącza przez płytę, przy zastosowaniu sposobu mocowania zalecanego przez producenta. Jednakże stosowanie złączy mimośrodowych zgodnie z zaleceniami producenta skutkowało bardzo niską zdolnością ich utrzymania przez płytę. W pracy zaprezentowano dwie proste metody zwiększenia tego parametru: 1) przyklejenie elementu złącza klejem PVAc, 2) zamocowanie elementu za pomocą wkręta. Zdolność utrzymania złącza zamocowanego za pomocą wkręta wzrosła o 40-46% w przypadku płyty wiórowej oraz o 53.8-92.2 w przypadku MDF. Z kolei zamocowanie złącza za pomocą kleju PVAc spowodowało wzrost jego zdolności utrzymania o 81.3-248.2% w przypadku płyty wiórowej oraz o 82.9-265.3 w przypadku MDF.

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