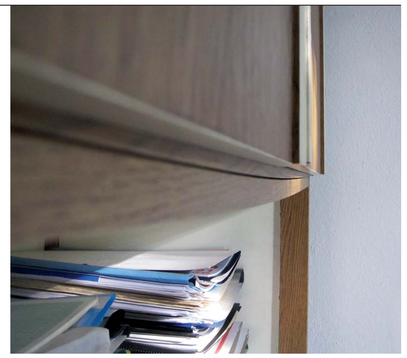
Improving by Reinforcement the Deflection of Shelves Made of Particleboard and MDF

Vassil JIVKOV, Yordan YORDANOV, Assia MARINOVA

UNIVERSITY OF FORESTRY, Department of Interior and Furniture Design

10 Kliment Ohridski blvd, Sofia, BULGARIA

1. INTRODUCTION

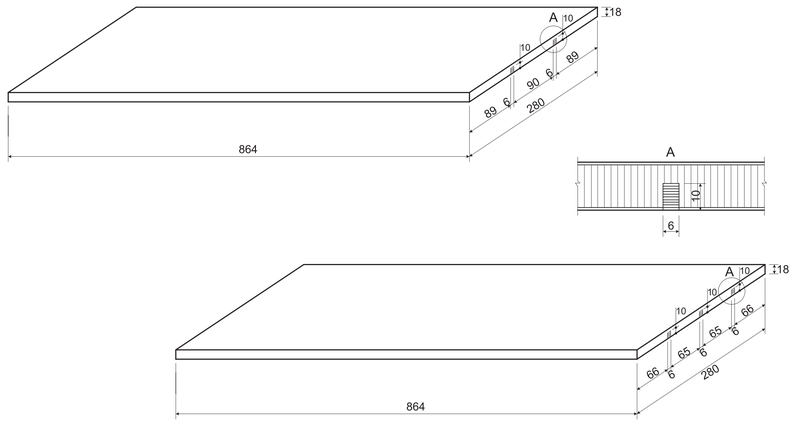


During the last decades wood based panels (WBP) are widely used in furniture constructions. Shelves in case furniture are often loaded with a high weight and this leads to unacceptable deflection. Studies in related areas are done by many authors. Eckelman et al. [3] provides a theoretical analysis for the deflection of shelves and case tops and bottoms. Others like Albin [1], Denizli-Tankut et.al [2] and Nikolaeva [4] investigated experimentally the deflection of wood based panels and did a comparison with the theoretically evaluated deflection. Effect of cyclic humidity on creep behavior was investigated by Ozarska et al. [5] and the effect of rail support was studied by Tankut et al [6]. But no information was found in the literature concerning the possibility to improve the deflection of wood based material by using any kind of reinforcement.

2. MATERIALS AND METHODS

In the present study test specimens were prepared from laminated particleboard with density 673 kg/m^3 and MOE 3464 N/mm^2 and medium density fiberboard with density 736 kg/m^3 and MOE 4632 N/mm^2. The size of the shelves was 864x280x18 mm, most common used for shelves in bookcase. Six series each of 10 samples were made: particleboard (PB) and medium density fiberboard (MDF) without reinforcement and with two (PB 2 and MDF 2) and three reinforcement strips (PB 3 and MDF 3). The strengthening strips were from beech plywood and were vertically inserted in a groove with width of 6 mm and depth of 10 mm and glued by PVAc adhesive.

Shelves were freely supported and loaded for 28 days with distributed static load related to 100 kg/m^2 which correspond to L 50 according to DIN 68874. The elastic deflection was measured immediately after the load was applied and hourly for the first 8 hours and after that the readings were taken daily. Additionally by using FEM software program SAP 2000 the deflection were evaluated theoretically for six different constructions of shelves.



3. RESULTS AND DISCUSSION

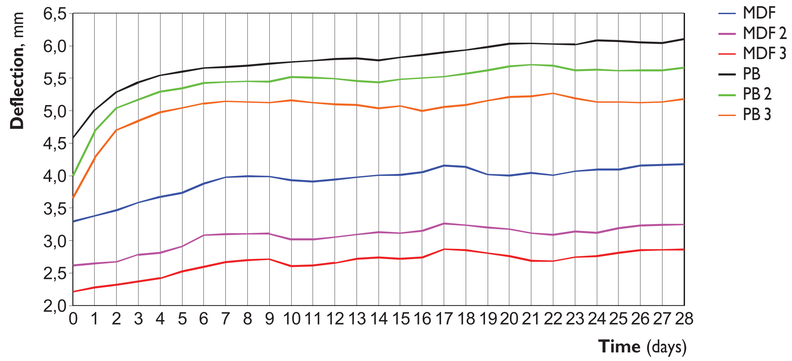
The data of the initial and final deflection as well the theoretically evaluated elastic deflection are given in Table [1]. The greater effect was obtained with MDF and reinforcement with 3 elements of plywood, where the deflection was 32.8% less compare to plain shelve. The significant improvement was found also for shelves with 2 stripes, where the deformation is 20.1% less. Test samples made by laminated particleboard showed that reinforcement decreasing the deflection with 20.3% for 3 stripes and 12.9% for 2, compare to those without any reinforcement. Slightly higher was the difference at the final deflection between panels with reinforcements and without. It is concluded from this study that using FEM is giving a good opportunity for predicting the deflection performance of improved by reinforcement wood based panels, especially in MDF where the difference between calculated and obtained is in a range of 15%.

Table 1. *Actual initial, final and theoretical deflections value of reinforced PB and MDF*

№	Type of WBP	Actual initial elastic deflection, mm	Actual final elastic deflection, mm	Creep deflection, mm	Percent of initial creep deflection, %	Theoretical elastic deflection, mm	Difference initial to theoretical,%
1.	PB	4.58	6.11	1.52	33.2	3.98	15.2
2.	PB 2	3.99	5.67	1.67	41.9	3.50	14.0
3.	PB 3	3.65	5.18	1.53	41.9	2.87	27.2
4.	MDF	3.29	4.17	0.88	26.7	2.95	11.7
5.	MDF 2	2.63	3.25	0.62	23.5	2.70	-2.6
6.	MDF 3	2.21	2.86	0.65	29.5	2.32	-4.7

The curves for creep deflection-time for each type of WBP are plotted in Figure 1. It is clear visible that MDF has better deflection stability compare to particleboard and shows better long term stability.

Figure 1. *Creep deflection of the wood based panels shelves*



4. CONCLUSION

Results from the calculation and from the test clearly indicate the considerable improvements of shelves deflection performance of wood based panel under static loading by reinforcement with plywood strips. For MDF the improvement is between 20 to 30% and for particleboard - between 12 to 20%. MDF shows that has around 30% better deflection stability without reinforcement and up to 40% with 3 strips compare to the particleboards. To develop better utilization of improved wood based panels as structural elements of furniture, additional research is needed for optimizing parameters of the reinforcement strips and some other factors like fit of the joint, glue type and quantity.

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AUTHOR CONTACTS Vassil JIVKOV, UNIVERSITY OF FORESTRY, Department of Interior and Furniture Design, 10 Kliment Ohridski blvd, 1756 Sofia, BULGARIA, vassil.jivkov@prodes.bg, www.ltu.bg