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INVESTIGATION OF THE DIFFERENCES BETWEEN THE GLASS-FIBER FABRIC BAND AND THE EDGE BANDS IN CASE-TYPE FURNITURE

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ABSTRACT

This study was carried out to compare to the effects of glass-fiber fabric, which might be a new alternative edge band, to PVC and wood veneer edge bands which is used commonly in today's furniture in wood-based materials melamine impregnated paper coated medium-density fiberboard and melamine impregnated paper coated particleboard on strength of corner joints. For this purpose, the 0.4 mm wood veneer, 0.4 mm PVC, 4 mm PVC, and fabric edge band were used as the edge bands. It was prepared 13 different configurations. The prepared test samples were subjected to the tension and compression tests. The data from the experiments was evaluated by means of multiple variance analysis.

This study showed that the joint with the fabric edge band was 34% and 30% higher than 2 mm PVC band, 26% and 23% 0.4 mm PVC band, 22% and 22% 0.4 mm wood veneer band, and 16% and 23% higher than control (for tension and compression, respectively). In addition to, it is to be understood that the fabric may be used like as commercially available edge bands.

KEYWORDS: Case-type furniture, corner joint, glass-fiber fabric, edge band.

INTRODUCTION

Nowadays, the edge bands which are commonly used in the furniture industry are in the form of PVC (polyvinyl chloride) and wood veneer edge bands 0.4, 1, and 2 mm. Several researchers have conducted several studies related to the edge bands. Bal and Akkok (2018) investigated the mechanical performances of three fasteners (minifix, dowel, and confirmat screw) on demountable furniture by adding 0.4 and 0.8 mm thickness of the PVC edge bands onto the hidden side (junction surface of butt and face member) of L-type corner joints of the furniture. They determined that the edge bands which applied to the hidden edge increased the mechanical performance of the furniture joining points. Furthermore, they determined that the thickness of the edge band was no statistically significant effect on the tension and compression test results. Kesik et al. (2017) investigated the effects on the moment capacity of the connection elements in disassembled case-type furniture corner joints coated with PVC edge band on the conjunction surface. They determined that the use of PVC in the corner joint surfaces decreased the strength properties of the LMDF (laminated medium density fiberboard). They said that PVC, which is coated on the joining surfaces, decreased the friction and the moment carrying capacity. Tankut A.N. and Tankut N. (2010) carried out tests to determine the effects of types of the edge banding materials (namely, PVC and wood veneer), thickness of the edge banding material (0.4, 1, and 2 mm), laminated particleboards (LPB) and LMDF on the diagonal tension and compression strength. They determined that the diagonal tension strength was higher than the diagonal compression strength. They determined that the strength of the samples with the edge band was higher than the samples without the edge band (control samples). They concluded that the LMDF corner joints were stronger than the LPB corner joints. Sozen (2008) determined that the effects of edge band thickness (0.4, 1, and 2 mm) and type (PVC, wood, and melamine) used in flat corner joining on the strength of corner joints in case-type furniture. He determined that the tension tests were higher performance than the compression tests. He conducted that the 2 mm thick wood edge band were better performance than the 1 mm thick wood edge band.

Researchers have conducted several studies related to dowel joints. Malkocoglu et al. (2013) and Malkocoglu et al. (2014) determined that MCF moment values were than MCP moment values in the test results. Simek et al. (2010) suggested that with two or more dowels, stresses arising as the joint was loaded into compression were distributed more evenly over the joint length. Nicholls and Crisan (2000) determined that the stiffness values increased by increasing the number of the joint components. Efe (1998) explained that an increase in the number of dowels was a reason for an increase in tension strength, but a decrease in compression strength. And, he explained that fiberboard was higher results than particleboard. And, they determined that higher values were acquired from the dowel joint than the minifix joints. Eren and Eckelman (1998) explained that joint strength and the number of the joint components had a correlation. Rajak and Eckelman (1996) reported that the bending strength of corner joints was directly proportional to the number of fasteners. The bending strength of a two-fastener joint was twice as strong as a single-fastener joint. Cai and Wang (1993) determined that the stiffness of corner joints increased with the use of a greater number of dowels. Bachmann and Hassler (1975) carried out tests with joints constructed with dowels diameter 8 mm. They found that the moment capacities of joints increased regularly when were constructed with 1 to 4 dowels.

Researchers have conducted several studies related to the dowel diameter. The bending strength and tensile strength of dowel joint was increased gradually with the dowel diameter and the embedment depth increasing (Dong and Shao 2007, Norvyadas et al. 2005, Sawata and Yasumura 2002, Zhang and Eckelman 1993a). Chen et al. (2018) conducted to define the influence of dowel diameter (6, 8 and 10 mm) on tensile and bending strength of T-shaped and L-shaped double wood joints. They determined that the values of bending strength of joints reached the peak, when the dowel diameter was 10 mm. They concluded that when dowel diameter was 6 mm, the dowel was broken easily and caused low withdrawal resistance.

Researchers have conducted several studies related to dowel spacing. Yerlikaya (2014) determined that the optimum dowel spacing is 96 mm in LMDF, and 128 mm in LPB. She showed that the joints with 32 and 64 mm dowel spacings had less strength than the joints with 96, and 128 mm dowel spacing. Tankut (2005) examined optimum dowel spacing for corner joints in 32 mm cabinet construction which were prepared from LPB and LMDF materials. He determined that maximum moment is obtained in joints when the spacing between dowels is at least 96 mm. He showed that LMDF corner joints were stronger than LPB corner joints.

Norvydays et al. (2005) figured that the weakest part of cabinet type furniture was the edge components of the its dowel joints, and that the dowel spacing should not be smaller than 96 mm. Ho and Eckelman (1994) determined that the most appropriate screw spacing was approximately 76 mm. Liu and Eckelman (1998) explained that no increase in strength was obtained beyond that point. The bending strength per fastener began to drop as the spacing between fasteners decreased below 57 mm. Zhang and Eckelman (1993b) determined that maximum strength was obtained when the distance between the dowels was at least 76 mm.

Researchers have conducted several studies related to end distances. Malkocoglu et al. (2014) were observed that the strength was increased by decreasing end distances. They determined that LMDF moment values were than LPB moment values in the test results. They were obtained that 50, and 60 mm end distances were highest than 70, and 80 mm. Simek et al. (2010) determined that the cam joints with a 60 mm end distance had significantly higher moment capacity than the joints with 30, and 90 mm edge distances.

Researchers have conducted several studies related to the gluing of the joint area. Tankut (2005) investigated the influence of glue added to the dowel joint surface on the structural properties. And he determined that with glue added to the joint area, joints exhibited a constructed strength that exceeded the bonding strength of the board itself. Liu and Eckelman (1998) were found that because of the adhesive added to the joint area, joints could be constructed that exceeded the bending strength of the board itself.

Researchers have conducted several studies related to the glue types. Tas et al. (2014) examined the strength of case furniture under the effect of external forces such as those experienced during an earthquake. They were produced the test samples from surfaced particleboard with three different joint and glue types. They determined that the highest average diagonal compression and tensile values for the combined joint type were observed in the samples with polyurethane (PU) glue.

Some researchers have conducted a lot of related to the effect of glass fiber fabric on the corner joints of furniture. Yildirim et al. (2018) investigated the effects of the glass fiber reinforced polymer (GFRP) and adhesive type on the diagonal compression and tensile strength in L-type corner joints with a wood biscuit. They determined that the using the GFRP significantly increased the strength of L-type corner joints. They obtained that the epoxy adhesive applied corner joints were higher the bending moment resistance than the PU and polyvinyl acetate (PVAc). Yerlikaya (2013 a,b,c) investigated the failure loads of corner joints, which were reinforced with the fabric in case-type furniture. They observed that the failure loads of joints with the fabric were greater than the failure loads of the joints without the fabric. They determined that the highest failure load was in the dowel + glass fiber composite layer from the outside and inside (DCOI) joints, and the lowest failure load was also the D joints. Yerlikaya and Aktas (2012) and Yerlikaya (2012) investigated the effects of fabric, dowel and cam fastener components on failure loads of corner joints in case-type furniture. They determined that the failure loads of joints with the fabric were greater than the failure loads of the joints without the fabric. They obtained that the lowest failure load was the dowel (D) joints, while the highest failure load was in the dowel + cam + fabric (DMC) joints.

Researchers have conducted several studies related to the glass-fiber. Song et al. (2017) conducted to improve joint performance of cylindrical-LVL (laminated veneer lumber) column, which partly reinforced with glass fiber cloth at the joint, through application to an effective wooden fastener. They observed that reinforced specimen was 95 % higher than non-reinforced specimen. Glisovic et al. (2016) investigated the effectiveness of carbon fiber reinforced polymer (CFRP) plates as flexural reinforcement of glued laminated timber (glulam) beams. Motlagh et al. (2012) investigated that the strengthening the old wood members by CFRP or GFRP.

Ghassan (2011) determined the effect of FRP (fiber reinforced polymers) on the structural properties of a single piece of wood identified as southern pine wood. Heiduschke and Haller (2010) concluded that when compared to unreinforced tubes, the ultimate load of FRP reinforced tubes is increased by about 60%. Cabrero et al. (2010) investigated the outcomes of a parametric study on the performance of reinforced wood tubes submitted to axial compression. Heiduschke et al. (2008) concluded that when compared to the unreinforced columns, the load carrying capacity of the reinforced columns increased by factors of 1.46 and 1.22, respectively. Stevens and Criner (2000) determined that the FRP reinforced beams are stronger than non-reinforced glulam beams because the reinforcement absorbs some of the most damaging tension stresses endured by conventional wooden glulam beams. Windorski et al. (1997) investigated the use of fiberglass reinforcement to enhance the load-carrying capacity of bolted wood connections. Rowlands et al. (1986) evaluated experimentally the technical feasibility of producing internally reinforced laminated wood.

As seen in recent studies, because glass reinforcements have significant effects on resistance, whether the use of the glass fiber cloth as an edge band would be so effective would have been the subject of wonder. Therefore, this study was conducted to investigate this issue.

The aims of this study: 1) The comparing of the effects of fabric, which might be a new alternative edge band, to PVC and wood veneer edge bands in LMDF and LPB, 2) To gain information about whether the fabric can be used instead of various edge bands, 3) Determination of whether the face member or the butt member is more effective on strength, 4) Besides the banding of the face member edges, the investigation of whether there is the effect of the banding with the edge band of the butt member edges, 5) Identifying of the difference between the joints with the glue and without the glue in the corner joints where various edge bands are used.

MATERIALS AND METHODS

Materials

LMDF 18 mm and LPB 18 mm were used in preparing of the test samples. Their density, moisture content, bending strength, and elastic modulus values from which were the physical and mechanical properties of these materials were determined according to TS EN323 (1999), TS EN322 (1999), TS EN310 (1999), and ASTM D1037 (1973) respectively (Tab. 1). Dowels Ø8 x 36 mm, were used as the fastener component. The wood veneer edge band 0.4 mm, the PVC edge band 0.4 mm, and the PVC edge band 2 mm were used as the edge bands. In addition, the fabric 19 mm wide was used as an alternative edge band. Mad Wolf PU glue was used as adhesive in the corner joints as Tas et al. (2017) recommends PU glue joints. As adhesive in the banding of the edge bands, Holt-melt adhesive was used for the PVC and wood veneer edge bands. As Glisovic et al. (2016), the most suitable adhesives for composite materials are based on epoxy resin, because epoxy adhesives have high mechanical properties, superior toughness, good creep and chemical resistance. So, the DTE 1000 epoxy resin and DTS 1105 hardener was preferred for the fabric in this study.

Tab. 1: Some physical and mechanical properties of materials which are used in test samples.

Materials	Specific gravity (g)	Moisture content (%)	Em ($N \cdot mm^{-2}$)	fm ($N \cdot mm^{-2}$)
LMDF	0.759	6.9	3411	25.85
LYL	0.642	8.1	2516	18.59

Em - Modulus of elasticity (MOE), fm - Modulus of rupture (MOR).

Methods

Specimen preparing

As shown in Fig. 1, the test samples were prepared by assembling the face member with the dimensions of 150 x 196 mm and the butt member 132 x 196 mm which were cut from the LMDF and LPB materials 18 mm. Two dowels were used as the fastener component for each test sample in assembling all the test samples. The dowel joining method was chosen because it was the most widely used the method in the market. The test samples were prepared so that the joining surface of the members (a face and a butt member) for each configuration was both the glued and glueless.

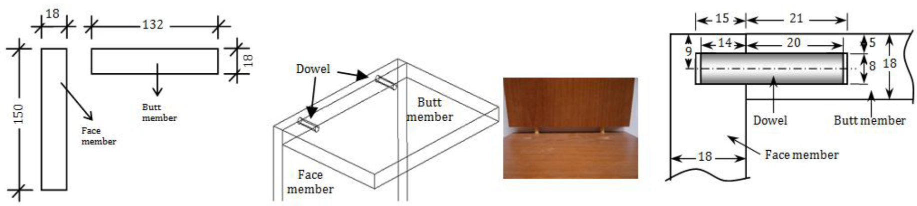

Fig. 1: The configuration of the corner joints. Dimensions in (mm).

As shown in Fig. 2, the configuration of the test samples was prepared as follows:

1. Both members edge without the band (I),
2. The face member edge is the wood veneer band 0.4 mm (II),
3. The face member edge is the PVC band 0.4 mm (III),
4. The face member edge is the PVC band 2 mm (IV),
5. The face member edge is the fabric band (V),
6. The butt member edge is the wood veneer band 0.4 mm (VI),
7. The butt member edge is the PVC band 0.4 mm (VII),
8. The butt member edge is the PVC band 2 mm (VIII),
9. The butt member edge is the fabric band (IX),
10. Both members edges are the wood veneer band 0.4 mm (X),
11. Both the members edges are the PVC band 0.4 mm (XI),
12. Both members edges are the PVC band 2 mm (XII),
13. Both members edges are the fabric band (XIII).

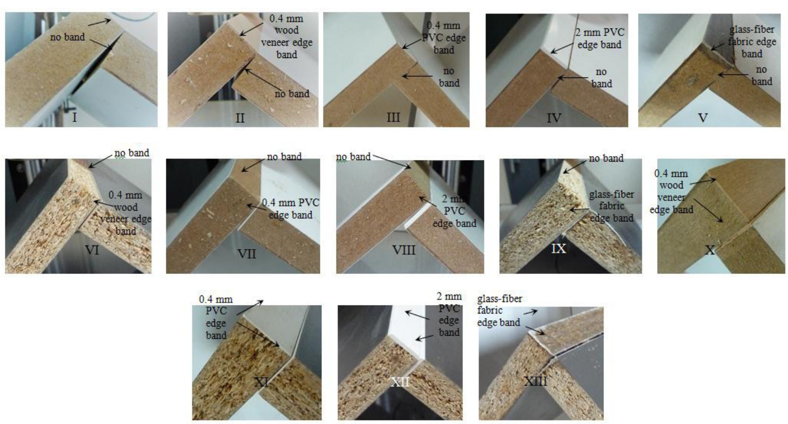

Fig. 2: The configuration of the test samples.

In total 520 samples were prepared for this study (two different materials LMDF and LPB, 13 configurations, 2 joining surfaces - with and without glue, 2 test methods - tension and compression, 5 repeats. LMDF and LPB materials were prepared as follows. From randomly chosen LMDF and LPB boards, were cut the 260 pieces for each member in the dimensions of 150 x 196 mm (face member) and the dimensions of 132 x 196 mm (butt member) with a CNC machine Amount of 40 pieces from both members for each material were banded with four different types of the edge banding (the wood veneer edge band 0.4 mm, the PVC edge band 0.4 mm, the PVC edge band 2 mm, and the fabric edge band). In addition, both members which were 100 pieces were not made any process. So, the member edges were left open. The wood veneer and PVC bands were banded by using Holt-melt adhesive on the edge banding machine. The fabric is applied by hand as follows: The fabrics which were roll shape of the wide of 19 mm were cut the length of 196 mm to be banded on the edges which were the length of 196 mm. The prepared epoxy glue mixture was applied to the place, where the fabric will be applied, by a brush. After the fabric was placed, the epoxy glue mixture was applied on to the fabric again. Then, the nylon was spreaded on the table. And on it, the 10 members were placed intermittently next to it. And, they were connected to each other by molds and were clamped after the table was put on them. And then, they were left to dry 2 days. These clamped members were removed from the molds after 2 days, and they were waited 2 more days. Jutted out fabrics at the member edges were cleaned by cutting on circular saw machine.

The members were drilled according to the drilling plans as shown Fig. 3.

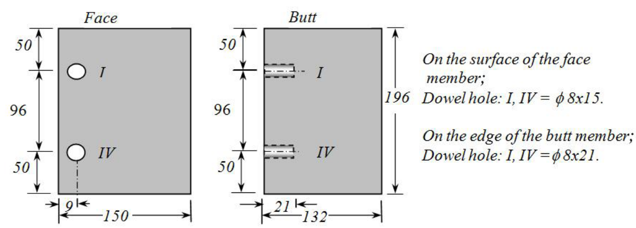

Fig. 3: Drilling plan. Dimensions in (mm).

In this study, end distance was selected as 50 mm. Because Malkocoglu et al. (2014) were obtained that 50, and 60 mm end distances were highest than 70, and 80 mm. In addition to, the distance between the dowel hole centers was selected as 96 mm in this study because Tankut (2005) explained in the study that the spacing between dowels should be at least 96 mm. For the dowel holes according to these plans, 2 holes which were the diameter of 8 mm and the depth of 15 mm were drilled at a distance of 50 mm from the edges and at a distance of 9 mm from the end of the member in the face members. On the joining surfaces in the butt members, 2 holes which were the diameter of 8 mm and the depth of 21 mm were drilled in the center of the joining surface and at a distance of 50 mm from the edges. Then, according to the determined configurations, the face and butt members were assembled together and 260 test specimens were prepared for each material.

Testing procedure

The prepared test samples were subjected to the tension and compression tests at a loading speed of 6 mm·min^{-1} on the Universal testing machine (Zwick/Roell Z020) which having 10 kN loading capacity. Tests were continued until a failure of the samples or over load decreasing occurred. The obtained maximum load and displacement results were recorded by a computer.

After then, the bending moment values were calculated by using the obtained maximum load values (Newton) in M = F . d formula where: M - bending moment (N.m), F - reaction against the applied load (N), d - moment arm (m) that is defined.

Analyses of the data

The data from the experiments was evaluated by means of multiple variance analysis. The multiple variance analysis was carried out on the data at the 0.001 significance level for the individual data to examine the main factors (the material, adhesive, place of edge band and type of edge band) and their interactions on the bending moment of the joints. It was to be determined by the Duncan test. Duncan test carried out to determine the importance of the differences between the groups.

RESULTS AND DISCUSSION

The obtained values in the result of the tests were given in Tab. 2. According to the test results shown, it was seen that the values of the diagonal tension bending moment were higher than the values of the diagonal compression bending moment. Similar results were obtained by Bak and Akkok (2018), Tankut and Tankut (2010) and Sozen (2008). It was concluded that the bending moment values of the LMDF corner joints were greater than those of the LPB corner joints as in study (Bak and Akkok (2018), Tankut and Tankut (2010) and Sozen (2008). It was found that the joints with the glue were greater bending moment values than the joints without the glue. It was determined that the diagonal tension and compression bending moment values of the samples with the edge band were higher than those of the samples without the edge band as in study (Yildirim et al. (2018), Tankut and Tankut (2010).

Tab. 2: The tension and compression bending moment values (N.m).

Name of member	Edge band	Group	Tension test				Compression test			
			LPB		LMDF		LPB		LMDF	
			With glue	Without glue	With glue	Without glue	With glue	Without glue	With glue	Without glue
Face member	0.4 mm wood veneer	II	55.07	24.03	53.20	36.26	36.60	19.74	41.68	27.49
	0.4 mm PVC	III	57.09	26.46	57.40	29.51	33.99	18.76	48.82	26.49
	2 mm PVC	IV	53.20	18.20	58.18	26.09	34.98	17.84	43.56	23.51
	Fabric	V	64.87	27.38	77.47	37.71	44.82	21.50	55.06	33.51
Butt member	0.4 mm wood veneer	VI	43.29	24.43	45.86	38.15	27.08	20.80	29.26	27.68
	0.4 mm PVC	VII	34.51	24.27	34.72	33.16	25.96	19.99	31.90	25.72
	2 mm PVC	VIII	25.65	30.38	27.89	32.20	24.94	17.73	30.82	25.15
	Fabric	IX	61.29	17.13	55.54	36.54	28.15	15.64	43.33	19.710
Both member	Control	I	50.50	25.59	52.97	32.80	24.75	16.13	43.96	25.10
	0.4 mm wood veneer	X	39.09	20.30	48.65	23.20	35.31	15.56	32.00	18.38
	0.4 mm PVC	XI	37.66	20.16	33.37	40.88	25.80	9.43	33.21	27.09
	2 mm PVC	XII	20.21	18.20	32.18	40.00	12.90	13.46	33.70	21.12
	Fabric	XIII	67.91	23.43	66.27	43.82	59.57	13.78	55.42	36.19

It was seen that the samples with the fabric were significantly higher bending moment values than the other samples. Similar results were obtained by Yildirim et al. (2018), Yerlikaya and Aktas (2012), Yerlikaya (2012) and Yerlikaya (2013 a,b,c). When the samples with the fabric edge band are evaluated according to the samples with the other edge bands, the obtained results are as follows. According to the tension tests in the glued LPB materials, it was determined that the samples with the fabric (VI) 64.87 N·m, which were banded to the face member edges, have 29%, 18%, 14%, and 22% higher bending moment than the samples without the edge band (control) (I) 50.5 N·m, the samples with the 0.4 mm wood veneer edge band (II) 55.07 N·m, the samples with the 0.4 mm PVC edge band (III) 57.09 N·m, and the samples with the 2 mm PVC edge band (IV) 53.2 N·m, respectively.

According to the tension tests in the glued LMDF materials, it was determined that the samples with the fabric (VI) 77.47 N·m, which were banded to the face member edges, have 46%, 35%, and 33% higher bending moment than the samples without the edge band (control) (I) 52.97 N·m and the samples with the 0.4 mm wood veneer edge band (II) 53.2 N·m, the samples with the 0.4 mm PVC edge band (III) 57.4 N·m, and the samples with the 2 mm PVC edge band (IV) 58.18 N·m, resp.

For the glueless LPB materials, it was determined that the samples with the fabric (VI) 27.38 N·m, which were banded to the face member edges, have 7%, 14%, 4%, and 50% higher bending moment than the samples without the edge band (control) (I) 25.59 N·m, the samples with the 0.4 mm wood veneer edge band (II) 24.03 N·m, the samples with the 0.4 mm PVC edge band (III) 26.46 N·m, and the samples with the 2 mm PVC edge band (IV) 18.2 N·m, resp.

For the glueless LMDF materials, it was determined that the samples with the fabric (VI) 37.71 N·m, which were banded the face member, have 15%, 4%, 28%, and 45% higher bending moment than the samples without the edge band (control) (I) 32.8 N·m, the samples with the 0.4 mm wood veneer edge band (II) 36.26 N·m, the samples with the 0.4 mm PVC edge band (III) 29.51 N·m, and the samples with the 2 mm PVC edge band (IV) 26.09 N·m, resp.

For the glued LPB materials, it was determined that the samples with the fabric (VI) 44.82 N·m, which were banded to the face member edges, have 81%, 23%, 32%, and 28% higher bending moment than the samples without the edge band (control) (I) 24.75 N·m, the samples with the 0.4 mm wood veneer edge band (II) 36.6 N·m, the samples with the 0.4 mm PVC edge band (III) 33.99 N·m, and the samples with the 2 mm PVC edge band (IV) 34.98 N·m, resp.

For the glued LMDF materials, it was determined that the samples with the fabric (VI) 55.06 N·m, which were banded to the face member edges, have 26%, 32%, 13%, and 26% higher bending moment than the samples without the edge band (control) (I) 43.96 N·m, the samples with the 0.4 mm wood veneer edge band (II) (41.68 N·m), the samples with the 0.4 mm PVC edge band (III) 48.82 N·m, and the samples with the 2 mm PVC edge band (IV) 43.56 N·m, resp.

For the glueless LPB materials, it was determined that the samples with the fabric (VI) 21.5 N·m, which were banded to the face member edges, have 33%, 9%, 15%, and 22% higher bending moment than the samples without the edge band (control) (I) 16.13 N·m, the samples with the 0.4 mm wood veneer edge band (II) 19.74 N·m, the samples with the 0.4 mm PVC edge band (III) 18.76 N·m, and the samples with the 2 mm PVC edge band (IV) 17.84 N·m, resp.

For the glueless LMDF materials, it was determined that the samples with the fabric (VI) 33.51 N·m, which were banded to the face member edges, have 34%, 22%, 27%, and 43% higher bending moment than the samples without the edge band (control) (I) 25.1 N·m, the samples with the 0.4 mm wood veneer edge band (II) 27.49 N·m, the samples with the 0.4 mm PVC edge band (III) 26.49 N·m, and the samples with the 2 mm PVC edge band (IV) 23.51 N·m, resp.

Bending moment was decreased when data obtained were evaluated in terms of the banding of both members edges. Decrease of the bending moment for the 2 mm PVC edge bands was more than the one in the 0.4 mm PVC edge bands while the decrease in the 0.4 mm PVC edge bands was almost equal or slightly higher than the one in the 0.4 mm wood veneer edge bands. The reason of this can be explained (Fig. 4) that, the resistance of the LMDF or LPB material against the dowel decreases naturally because the area, which tried to be failure by the dowel, of the dowel in the 2 mm PVC edge band joints in the face member decreases from 105 mm^2 to 95 mm^2. Because of this reason, the joint resistance decreases.

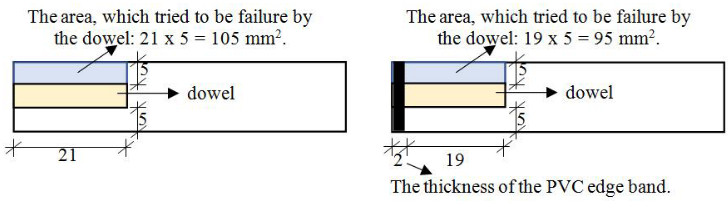

Fig. 4: The area, which tried to be failure by the dowel. Dimensions in (mm).

The results of the multiple variance analysis are given in Tab. 3 and 4. For diagonal tension tests, the results show that there were significant differences in the values of the bending moment in terms of the material, glue, place of edge band, edge band, and interacting effects of these factors. For diagonal compression tests, the results show that there were significant differences at 0.01 % significance level in the values of the bending moment in terms of the material, the glue, the place of the edge band, the edge band, and interacting effects of these factors, except for the interacting effects of the material*glue and the interacting effects of the material*the place of the edge band. There were significant differences at 0.1 % significance level in the values of the bending moment in terms of the interacting effects of the material*the place of the edge band. There were not significant differences in the values of the bending moment in terms of the interacting effects of the material*glue.

Tab. 3: Results of multiple variance analysis (for tension).

Source of variance	**Sum of squares**	**df**	**Mean square**	**F ratio**	**Level of sig.**
Main factors					
Material	3409.404	1	3409.404	493.607	.000 ***
Glue	29474.629	1	29474.629	4267.282	.000 ***
Place of edge band	2901.024	2	1450.512	210.002	.000 ***
Edge band	9067.200	4	2266.800	328.183	.000 ***
Interactions					
Material * Glue	1349.102	1	1349.102	195.321	.000 ***
Material * Place of edge band	200.886	2	100.443	14.542	.000 ***
Material * Edge band	248.261	4	62.065	8.986	.000 ***
Glue * Place of edge band	3646.843	2	1823.422	263.992	.000 ***
Glue * Edge band	5842.294	4	1460.574	211.459	.000 ***
Place of edge band * Edge band	1854.769	8	231.846	33.566	.000 ***
Material * Glue * Place of edge band	158.428	2	79.214	11.468	.000 ***
Material * Glue * Edge band	348.280	4	87.070	12.606	.000 ***
Material * Place of edge band * Edge band	565.952	8	70.744	10.242	.000 ***
Glue * Place of edge band * Edge band	3349.118	8	418.640	60.610	.000 ***
Material * Glue * Place of edge band * Edge band	1096.649	8	137.081	19.846	,000 ***
Error	1657.709	240	6.907		
Corrected Total	65170.549	299			

df - degrees of freedom, *** - Significant at 0.01% significance level.

According to the result of the Duncan it was determined that three groups occurred in the compression tests while two groups determined in tension. In tension, the face member was low, while "the butt member" and "both members" were not statistically different and were high. In compression, the butt member was high, both members were medium, and the face member was low (Tab. 5).

According to results of the Duncan test it was determined that five groups occurred in the tension tests while three groups determined in compression (Tab. 6). In tension, the fabric edge band was the highest, control (without edge band) was higher, 0.4 mm wood veneer edge band, was medium, 0.4 mm PVC edge band was low, and 2 mm PVC edge band was the lowest. In addition, the fabric edge band was 34% higher than 2 mm PVC band, 26% 0.4 mm PVC band, 22% 0.4 mm wood veneer band, and 16% higher than control (without edge band). In compression, the fabric edge band was high, 0.4 mm PVC edge band and control (without edge band) were not statistically different and were medium, 2 mm PVC edge band was low. In addition, the fabric edge band was 30% higher than 2 mm PVC band, 23% 0.4 mm PVC band, 22% 0.4 mm wood veneer band, and 23% higher than control (without edge band).

Tab. 4: Results of multiple variance analysis (for compression).

Source of variance	**Sum of squares**	**df**	**Mean square**	**F ratio**	**Level of sig.**
Main factors					
Material	6579.924	1	6579.924	1376.771	.000 ***
Glue	15771.395	1	15771.395	3299.977	.000 ***
Place of edge band	1771.240	2	885.620	185.306	.000 ***
Edge band	3928.003	4	982.001	205.472	.000 ***
Interactions					
Material * Glue	11.237	1	11.237	2.351	.127 ns
Material * Place of edge band	56.083	2	28.041	5.867	.003 **
Material * Edge band	848.976	4	212.244	44.410	.000 ***
Glue * Place of edge band	923.038	2	461.519	96.567	.000 ***
Glue * Edge band	1901.357	4	475.339	99.459	.000 ***
Place of edge band * Edge band	2728.117	8	341.015	71.353	.000 ***
Material * Glue * Place of edge band	205.122	2	102.561	21.460	.000 ***
Material * Glue * Edge band	673.105	4	168.276	35.210	.000 ***
Material * Place of edge band * Edge band	379.859	8	47.482	9.935	.000 ***
Glue * Place of edge band * Edge band	1042.363	8	130.295	27.263	.000 ***
Material * Glue * Place of edge band * Edge band	1050.322	8	131.290	27.471	.000 ***
Error	1147.018	240	4.779		
Corrected Total	39017.160	299			

df - degrees of freedom, *** - Significant at 0.01% significance level ** - Significant at 0.1% significance level

ns: Not significant.

Tab. 5: Homogeneous groups according to the place of edge banding.

Place of edge banding	Tension (N·m)		Compression (N.m)	
	Average bending moment	Homogeneous groups	Average bending moment	Homogeneous groups
Butt member	36.34	A	26.19	A
Both member	36.90	A	27.64	B
Face member	43.20	B	31.91	C

Tab. 6: Homogeneous groups according to the edge band.

Edge band	Tension (N·m)		Compression (N·m)	
	Average bending moment	Homogeneous groups	Average bending moment	Homogeneous groups
2 mm PVC	31.87	A	24,98	A
0.4 mm PVC	35.77	B	27.26	B
0.4 mm wood veneer	37.70	C	27.63	B
Control	40.46	D	27.49	B
Glass-fiber fabric	48.28	E	35,56	C

CONCLUSIONS

(1) This study showed that the joint with the fabric edge band was significantly higher resistance than the joints with other edge bands. In tension, the fabric edge band was 34% higher than 2 mm PVC band, 26% 0.4 mm PVC band, 22% 0.4 mm wood veneer band, and 16% higher than control (without edge band). In compression, the fabric edge band was 30% higher than 2 mm PVC band, 23% 0.4 mm PVC band, 22% 0.4 mm wood veneer band, and 23% higher than control (without edge band).

(2) It is to be understood that the fabric may be used like as commercially available edge bands. Even the preference of the fabric is recommended.

(3) It was seen that only the banding of the edge of the butt member was 16% and 18% lower resistance than the banding of the edge of the face member and 15% and 13% lower resistance than the banding of the edges of both members (for tension and compression, respectively). As a result, it was understood that the banding of the face members edges were more effective in terms of the effect on the resistance. The banding with 2 mm PVC edge band of the edge of the face member results in lower resistance values because it was decreased the area, which tried to be failure by the dowel. Therefore, it is not recommended to the banding of the edge of the butt member in the joins. As a result, it is proved that the application in the market is correct.

(4) It was determined that the banding of the edges of both the face member and the butt member caused the resistance values to decrease by approximately 15%. For this reason, it is not recommended the banding of the edge of the butt member.

(5) In the furniture which it wanted or needed to have the high joint resistance, the glued corner joints are recommended because the glued joints have higher resistance than the glueless corner joints. It should not be forgotten that the glued joints do not have the feature of disassembling. Therefore, in the produced furniture, it is necessary to decide whether the furniture has the demountable or has high joining resistance. And, according to this, a choice should be made.

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