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# PERFORMANCE OF WOOD DOWELS AND SAME SIZE METALLIC CONNECTORS USED FOR FURNITURE JOINTS

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***Abstract:*** *For a circular and sustainable economy, the reuse of wood furniture parts has gathered increasing importance. Disassemblable joints and purposefully developed elements may support this reuse. Despite the relatively high number of structural connectors, newly developed fittings have appeared on the market, combining the advantages of the previous ones or introducing new solutions, like the Domino dowels and connectors developed to make strong hidden joints. In furniture manufacturing, both panel and frame elements are jointed for load bearing, semi-load bearing or non-load bearing connections. Metallic Domino connectors have recently been developed and recommended by the manufacturer only as connecting elements, and not as supporting elements of furniture constructions. In daily practice, the general consideration exists that these metallic connectors are strong enough to perform well also as load bearing elements. The main goal of this research was to examine the strength of corner (L) and T joints made with upper wood dowels and metallic connectors, in order to compare their performance. For the experiments, same sized wood dowels and metallic connectors were used. The tension and compression test results indicate that the type of joint (corner versus T) is a stronger influencing factor of performance than the type of jointing element (wood dowel vs. metallic connector). Domino dowels are manufactured in different sizes. Further research will focus on finding the wood dowel equivalent to a given metallic connector of different size.*

***Key words:*** *Domino dowels, metallic connectors, beech wood, furniture joints, tension, compression.*

## 1. Introduction

By turning our drivers towards a circular and sustainable economy, the prolongation of the lifecycle of furniture has also gathered increasing importance. Structural joints are the discontinuity in the material; thus, they are the critical elements of furniture and need focused attention during furniture design.

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Structural rigidity and strength are known as the most important parts of the design [6]. Wood fasteners are used to join together individual pieces in a perfectly and functionally satisfactory unit, a furniture component or a whole furniture structure. In jointing elements, internal forces are mostly compressive and shear stresses [16, 21]. The areas where the wood dowels are in contact with the wood must be carefully bonded so that the internal forces can be transmitted evenly across the surface [21]. The positioning and size of the joints are often known as limiting factors in the design process [8, 21]. There is a difference between glued (permanent) and non-glued (temporary and removable) joints. Connection and mounting means should be selected according to the connection type. The type of adhesive needs to be chosen accurately depending on the purpose. For wood furniture structural joints, mostly water based polyvinyl acetate (PVAc) adhesives are used [4]. Glued joints reduce vibration in the material compared to other joints, and positively affect the strength of the structure [20]. Papp and Csiha [15] report on the effect of surface quality of wood on the desirable bond strength. Favorable adhesion occurs between 8-12% MC and fine sanded surfaces (120-150 grit size). In the case of drilled side surfaces, adhesive penetration problems, non-wetting conditions may occur. New dowels, like the Domino tenon, are manufactured with grooves for furniture element jointing, taking into consideration the upper aspects [15]. These unique tools are a blend of dowel joiner and biscuit joiner. Round dowels are some of the most important fasteners used in furniture assembly. They are known as one of the preferred connecting elements for frames and carcasses. However, because round dowels do not allow misalignment, exact positioning is required on bench top or semi-stationary machines. Biscuit dowels are usually inserted in components using hand-held machines. Since biscuit dowels are shorter than the guided grooves, a slight misalignment is not a problem because the jointed parts can be sliced while the dowel is inserted, but this requires additional alignment when gluing.

The Domino joint system is a mixture of both: the joint is made by cutting two matching, elongated slots in the wood to be joined, and then inserting the tenon with glue. After the adhesive is applied, the Domino adheres to the sides of the hole more tightly because of the swelling properties of wood, which makes the glued joint even stronger. The grooves on the Domino tenon support even glue distribution [21].

The "Domino" machine is a loose mortise and tenon joining tool, manufactured by the German company Festool. In 2006, the Domino joiner system created strong hidden joints. This is a special type of joint using a loose tenon and mortises into which the Domino tenon is inserted and glued. The Domino wood dowel is a jointing element with rounded edges, oval cross sections, and grooved surfaces. It is supplied in 14 different sizes. The Domino tenon can be purchased in pieces or in the form of a rod that the customer can cut to size as needed. The Domino tenon can be fixed into the mortise by adhesive gluing.

As a detachable interlocutor of the wood Domino tenons, the so-called Domino "connectors" were also developed. These metallic fasteners make flat or corner joints in wood components, providing simple, quick, and disassemblable joints. The same tool is used to form the mortises in both mating work pieces, then depending on the joint type, a custom drilling template fits into the mortise to drill a hole that accepts the mating component of the connector. The Domino connector joints are suitable to connect frames, panels, tops, sides, and other large joints, they assure a robust connection strength and provide a rapid building, moving, and reassembling of furniture components. The simple placement of the Domino tenons and connectors allows for the economical production of individual parts and small batches, for chairs, tables, beds, cabinets, and shelves.

The mechanical performance of the Domino joints was researched in few studies and compared with the similar properties of analogous wood joints. Záborský et al. [21] discusses the effect of selected parameters, such as load direction (tensile and compressive), thickness ratio (one half and one third thickness), wood species like beech (*Fagus sylvatica* L.) and spruce (*Picea abies* L.), and adhesive type (polyvinyl acetate and polyurethane) on joint stiffness. The influence of the annual rings was also monitored. According to this study, the elastic stiffness of the joint was significantly affected by the wood species, the load direction, and thickness ratio between the Domino tenon and the size of the element. Joints made from beech over performed by 90% compared to spruce joints, the joint compression stiffness was 45% higher than the tensile stiffness and the one-third tenon thickness provided 47% higher stiffness than the one half thickness tenons [21]. The effect of the adhesive on joint stiffness has not been proven to be significant. The stiffness values determined in this paper are comparable with the values measured for the mortise and tenon joints made and tested exactly in the same way [20]. However, in the case of the tongue and groove joints, the one half tenon thickness joints showed higher values in every case than the one third thickness joints, which is opposite to the Domino joint values [20].

The pull-out strength of the pegged mortise and tenon connections was analysed by Shanks et al. [17]. The yield load varied between 2237-5760 N, but the values were highly influenced by the edge distance of the pegs. Based on the results, the minimum recommended distance of the pegs from the edge is double that of the peg diameter [17].

Tannert [19] investigated the stiffness of rounded dovetail joints under short-term shear load with different reinforcements (fitting tightness, self-tapping screws, adhesive). All reinforcements increased the joint stiffness, and in the case of the adhesive layer and combination of adhesive layer and the self-tapping screw the increase reached 35 times the non-reinforced values [19].

Kuskun et al. [13] examined experimentally and by numerical analysis the mounting force of newly developed auxetic dowels for furniture joints. The dowels were prepared from polyamide (PA12) using the selective laser sintering 3D printing technology. They found that the necessary mounting forces and contact pressures were lower than of conventional dowels. However, the hole diameter and inclusion size had a significant influence on the results [13].

The stiffness of dovetail joints by numerical and experimental methods was studied by Kamboj et al. [10]. The effect of wood species (spruce and beech), load orientation (compression and tension), adhesive type (PVAc and PUR), and annual ring orientation was considered. Beech specimens performed better than spruce, except when the test specimens were glued with PUR and loaded in tension. The influence of grain orientation was significant, the load applied perpendicular to the rings gave high elastic stiffness values. The numerical calculations confirmed the experimental test results for both wood species loaded in compression; however, the tension results could not validate the measured values, they showed an opposite relationship for grain orientation [10].

Derikvand et al. [5] tested structural connections using wood-based materials. They worked with a furniture manufacturer on a suitable method for testing screw connections and on an improved method for evaluating a structure connected by such a connection. The results showed that the strength of the screw joints depends on the contact surface and the shear forces that form on these surfaces. There were other important parameters such as diameter and pitch of the screw thread. This method provides an objective assessment of the quality of the structure and the selection of the best joint for the designed furniture [5, 18].

Aman et al. [1] compared loose tenon and tenon joints, using test specimens made from cherry, oak, and maple. Experiments have shown that the strength of the joint with a loose tenon and a tenon is within the strength range of a pin joint and a conventional tenon joint. The article states that the loose tenon system is cheaper and more efficient. The usage and primary processing costs of the material are lower.

In this research, T jointed and corner jointed samples were prepared with Domino wood dowels and Domino connectors, using beech wood (*Fagus sylvatica* L.). The main goal of the study was to determine the load bearing capacity of the joints and to compare the strength values of the Domino dowels and connectors in compression and tension tests. The advantage of making joints with Domino dowels and connectors is in the fact that the elements to be jointed can be prepared more easily than the traditional mortises and tenons. Furthermore, the metallic connectors enable the disassembly of the jointed elements, thus easing, for example, the transportation of the furniture.

## 2. Materials and Methods

In this study, beech wood of 10.7% average MC was used for sample preparation. The reason for this choice was that beech wood is widely used in the production of chairs, armchairs, tables, office furniture, and school furniture in places where resistance to load and deformation is required [11]. This wood species is easily accessible today. At the same time, it can be machined and sanded very well [7] and its texture makes it possible to replace expensive, scarce valuable wood by modifying with stains, lacquer or paint. Beech is a preferred wood type on the market due to its resistance, hardness, easy processing, and suitability for bending [12]. The wood material used for the experiments was conditioned prior to manufacturing the joints at 20°C and 65% relative humidity, until a constant mass was obtained, as the moisture content of the wood samples to be glued together needs to be mostly the same [2].

For manufacturing the T joints (Figure 1), elements of 120 x 55 x 55 mm and 195 x 55 x 55 mm were cut. For manufacturing the corner joints (Figure 2), samples of 250 x 55 x 55 mm and 195 x 55 x 55 mm were cut.

In total six T joints and 20 corner joints were prepared both with wood Domino dowels (Table 1) and metallic Domino connectors, as follows: three T-joints were manufactured using metallic Domino connectors, three T-joints were manufactured with wood Domino dowels, 10 corner joints were manufactured using wood Domino dowels, and ten corner joints were manufactured using metallic Domino connectors. The wood dowels were glued into the mortise using TechnobondD3 PVAc water based dispersion adhesive from Szolvegy Kft., and the samples were kept at 20°C and 65% relative humidity until testing. The glue was applied on both surfaces: to the dowels and to the holes drilled by machine too. No glue was used to fix the metallic Domino connectors.

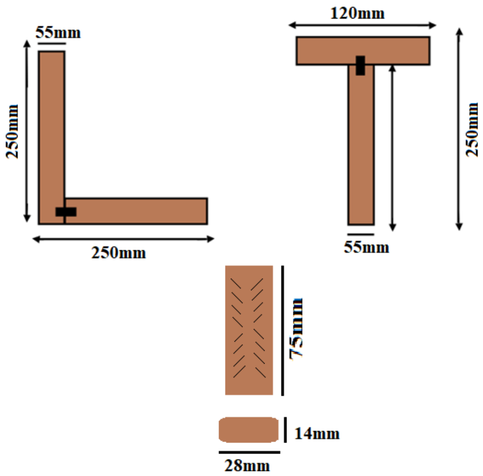


Fig. 1. *Size of samples with T-joints and corner joints*

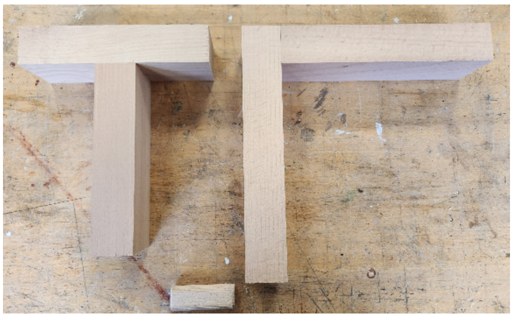

Fig. 2. *T and corner joint made with wood Domino dowels*

*Test samples and joining details* Table 1

| Specimens | T-Joint | Corner Joint | Domino | Connector |
|---|---|---|---|---|
| 3 | 3 | - | + | - |
| 3 | 3 | - | - | + |
| 10 | - | 10 | + | - |
| 10 | - | 10 | - | + |

The specific gravity values of the samples used during the study were calculated by considering ASTM Standard D 2395-93 Method A, the volume measurement method. In addition, the moisture content of the same samples was determined using ASTM Standard D 4442-92 Method A.

We used the Festool Domino XL machine to drill the desired holes in the wood material for the prefabricated wood Domino dowels, and the metallic Domino connectors (Figure 3). The Domino wood dowels, and metallic connectors are available in different sizes. The appropriate height and depth can be set by the milling machine depending on the dimensions of the selected Domino pin [21]. This tool cuts mortises in the manner of a biscuit joiner. A drill-like rotating cutter cuts a round-ended mortise. Each plunge creates a domino loose tenon, creating joints in stock from 22.2 millimeters (0.87 in) wide.

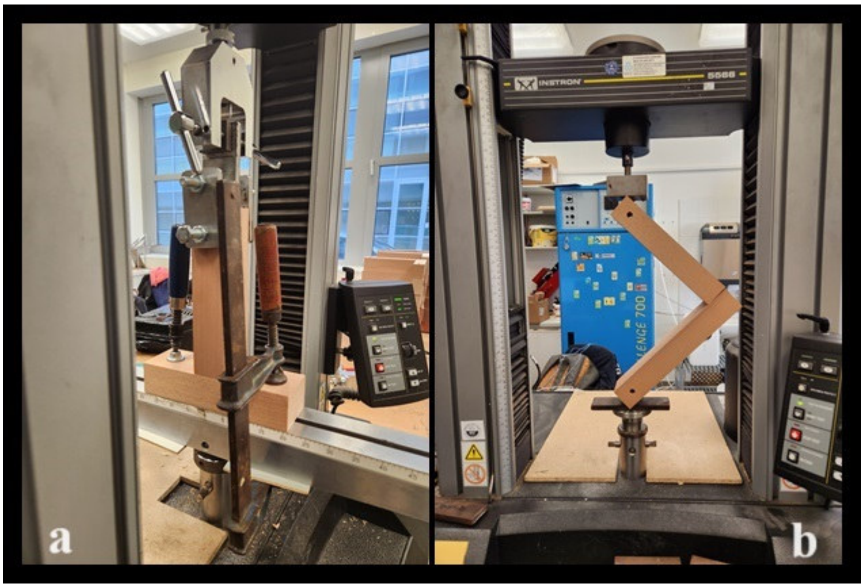


Fig. 3. *Display of test samples on the test machine:*
*a. T joint sample under tensile test; b. L corner joint sample under compression test*

There are five cutter sizes (4, 5, 6, 8, and 10 mm) for six different Domino tenon sizes. Self-referencing pins allow the cutting of rows of evenly spaced mortises. Mortise width is adjustable in three increments with a knob, and cuts can be overlapped for long mortises. The fence tilts from 0-90°, with stop positions at 0, 22.5, 45, 67.5, and 90°. A Domino pin combines the advantages of round and flat pins. It is an improved version that prevents twisting and is firmer. Domino wood dowels and connectors are available in more than six sizes: small, medium, and big. Two pairs of same sized connectors and dowels have already been tested, and testing continues. In this paper, the test results of 82 x 29 x 14 mm and 75 x 28 x 14 mm sized dowels and connectors are reported.

After the adhesive was applied, the Domino dowel adhered to the sides of the hole more tightly. Once the adhesive wets the surface, due to the moisture coming from the adhesive, the surface of the dowel and the side surface of the mortise become rougher and both the dowel and the mortise swell, which makes the dowel get stuck into the mortise. After the adhesive dries out, the swelling reduces, but the adhesive which penetrated the wood grains of the dowel and mortise during the roughening process adheres to a relatively bigger surface than before the roughening process, and makes the joint even stronger [3]. The grooves on the surface of the Domino dowel promote the even distribution of the adhesive [21].

The most relevant factors affecting the durability of a joint are: the type of wood material used, the type of connection, and the resistance of the connecting element. The mechanical stresses that occur inside the joints under loading are forces which try to both close the vertical and horizontal components of the material and separate them outward. Therefore, the compression and tension tests performed as shown in Figures 3a and 3b were chosen as the most appropriate methods causing closing and opening stresses within the joint. The T jointed samples were subjected in higher number to tensile tests, as for them this is the most critical type of load. The samples were put into the testing device as in Figure 3a. The samples' part relaying on the horizontal ground was fixed from the right and left ends with two separate apparatus. Thus, the horizontal part of the sample was fixed to be immovable. The vertical element of the sample was connected to the machine and ready to be subjected to pulling.

In the clamping setup, the corner jointed samples were placed in the test machine as in Figure 3b and then subjected to compression test. A loading rate of 2 mm / min was used in all tests. Maximum load values and joint failure modes were recorded. All tests were carried out in a 10,000 N capacity universal INSTRON testing machine at the Institute of Wood Based Products and Technologies, at University of Sopron. Loading was continued until a sign of separation of elements occurred on the surface of the tested samples. Maximum compressive strength and tensile strength were calculated from the force applied to each test specimen at the time of failure. The results of each sample were recorded by a computer connected to the test device. The T samples were also subjected to compression, and similarly the corner joints were also subjected to tension.

## 3. Results and Discussion

Table 2 presents the maximum displacement and maximum forces of the wood Domino dowel and the metallic connector fastened ***corner*** joints, in the case of the **COMPRESSION tests**.

When testing the corner joints under compression, the same sized wood dowels reached around 37% higher strength values than the metallic connectors. This indicates a deterioration of the metallic connectors. In fact, they did not break, but under compression the whole assemly suffered deformation. Due to the difference in the hadness of solid wood and metal, the parts made from metallic alloy were so hard and strong that they compressed and deformed the wood tissue around them. The tightness of the fit suffered, but the integrity of the joint was maintained. This is also due to the fact that solid wood elements were tested. However, the size of the tested dowels and connectors rather fits the solid wood cross sections than any of the known thicknesses of the wood particle based panels [14].

When evaluating the displacement occurring in the corner joints during compression (Figure 4), a well-differentiated trend can be observed. The wood dowel joints have a smaller deformation compared to the metallic connectors (Figure 5).

Table 2

*Performance of corner joints made with wood Domino dowels and metallic Domino connectors*

| Corner Joint Compression | Connector | | Domino wood dowel | |
|---|---|---|---|---|
| Specimens | Max. displacm. at $F_{max.}$ [mm] | $F_{max}$ [N] | Max. displacm. at $F_{max.}$ [mm] | $F_{max}$ [N] |
| 1 | 10,5 | 664,9 | 13,6 | 844,7 |
| 2 | 8,6 | 676,1 | 8 | 884,3 |
| 3 | 5,7 | 563,7 | 7,98 | 1014,7 |
| 4 | 4,5 | 518,4 | 18,03 | 765 |
| 5 | 5,6 | 563,6 | 6,65 | 980,8 |
| 6 | 8 | 753,9 | 8,75 | 808 |
| 7 | 6,3 | 576 | 11,02 | 944,5 |
| 8 | 6,2 | 471,5 | 10,65 | 1010,9 |
| 9 | 6,8 | 702,4 | 2,43 | 1353,9 |
| 10 | 7,6 | 563,3 | 11,86 | 961,6 |
| Average | 7,0 | 605,3 | 9,90 | 956,84 |
| Standard deviation | 1,7 | 89,2 | 4,2 | 163,8 |

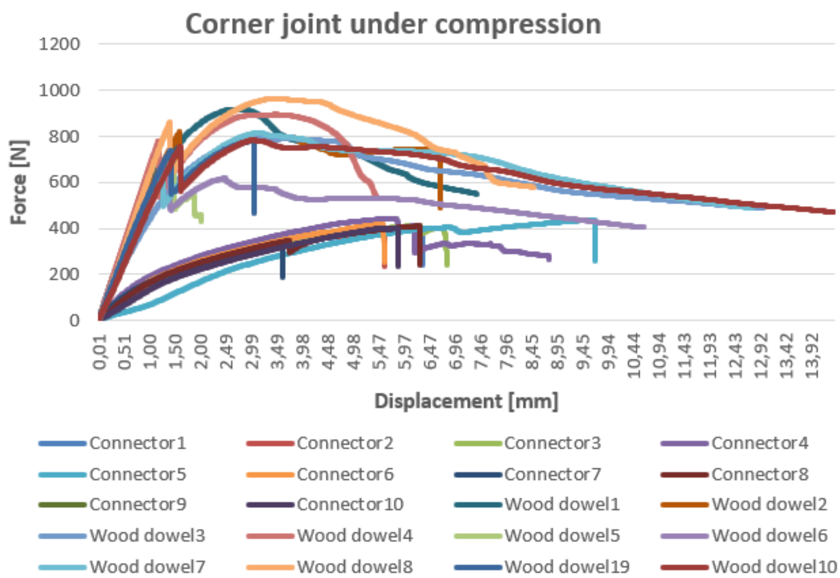


Fig. 4. *Displacement of the corner joints under compression made with Domino wood dowels and metallic connectors*

Their resistance to compression collapses at much higher values of the compressive force. The force-displacement function is linear, following the equation: y=ax+b. The reason for their smaller deformation is that the solid wood samples are made from beech wood and the wood dowels made similarly are made from beech wood, thus they have material of the same hardness. At elevated values of the load, either the wood dowel itself, or the jointed element's hole started to deform according to their local, microstructural specificities (Figure 6).

In the case of the metallic connectors, the force-displacement relation is exponential. The displacement of the samples made with metallic connectors is also continuous, but two zones can be differentiated (Figure 5).

In the first zone, the solid wood resisted better to the pressure of the metal under a compressive force of 200 N, and in the second zone, above a compressive force of 200 N, the metallic connectors increased the measure of the deformation. Considering that after the tests it was possible to pull out the wood dowel from the mortise, whilst this was not the case for the metallic connectors, the metallic connector fastened joint can be considered more reliable as it maintains the integrity of the joint (Figure 7).

Table 3 presents the maximum displacement and maximum forces of the wood Domino dowel and the metallic connector fastened ***T*** joints, in the case of the **COMPRESSION tests**.

Fig. 5. *Deformation caused by metallic connector*

Fig. 6. *Deformation of the wood dowel*

Fig. 7. *Typical deterioration of wood dowel corner joints under compression: the tightness of the fit was loosened*

Table 3

*Performance under compression of T joints made with wood Domino dowels and metallic connectors*

| T-Joint Compression | Connector | | Domino wood dowel | |
|---|---|---|---|---|
| Specimens | Max. displacm. at $F_{max.}$ [mm] | $F_{max}$ [N] | Max. displacm. at $F_{max.}$ [mm] | $F_{max}$ [N] |
| 1 | 10,34 | 1910,5 | 12,618 | 3346,1 |
| 2 | 9,44 | 2449 | 13,5 | 3119,5 |
| 3 | 8,54 | 2623,8 | 13,69 | 2617,7 |
| Average | 9,4 | 2327,8 | 13,6 | 3027,8 |
| Standard deviation | 0,9 | 371,8 | 0,1 | 372,8 |

Based on the data in Table 3, the resistance to compression of the Domino wood dowels was about 26% higher than the resistance of the metallic connectors. Like in the case of the corner joints, the wood dowels performed better. Similarly to the compression test of the corner joints, the T joints also did not break, but under compression the whole assemly suffered deformation. Due to the difference in the hadness of solid wood and metal, the parts made from metallic alloy were so hard and strong that they compressed and deformed the wood tissue around them. The T joints fastened with wood dowels had about three times higher resistance to compression than the simple corner joints. The reason might be that in the case of the T joints, the joint is in the middle of the element, not at the egde, thus the inpingement of the shoulder is stronger than in case of the corner joints. In the case of the T joints tested under compression, the tightness of the fit suffered, but the integrity of the joint was maintained. In some cases, the wood dowel fastened joints disassembled, as the wood grains of the grooves on the surface of the dowel broke up.

Contrary to the corner joints, the displacement of the T joints was rather similar both in the case of the wood dowels and the metallic connectors. When subjected to rotation, the shoulder of the vertical element has a very relevant role of impingement of the horizontal element. This effect is stronger than the distortive effect of the metallic parts. In fact, the impingement of the wood shoulder acts against the pushing of the metallic head of the connector into the wood, thus retarding the deformation procedure. The vertical element's shoulder has a supportive effect against rotation and deformation. This is the main reason why both the wood dowel and the metallic connector have the same even displacement under compression, in the case of the T joints.

Table 4 shows the maximum forces of the wood Domino dowel and the metallic connector fastened ***corner and T*** joints, in the case of the **TENSION tests**.

Under tension, both the wood dowel and the connector fastened corner joints performed mostly the same. In the case of the T joints, it was possible for the connectors to reach about 94% of the resistance of the wood dowel fastened joints.

Table 4

*Performance of corner L and T joints made with wood Domino dowels and metallic Domino connectors*

| T Joint Tension Specimens | Connector, $F_{max}$ [N] | Domino wood dowel, $F_{max}$ [N] | CornerJoint Tension Specimens | Connector, $F_{max}$ [N] | Domino wood dowel, $F_{max}$ [N] |
|---|---|---|---|---|---|
| 1 | 4875,17 | 5163,51 | 1 | 725,63 | 763,68 |
| 2 | 4659,63 | 8548,11 | 2 | 629,44 | 558,09 |
| 3 | 4345,83 | 5322,37 | 3 | 469,11 | 814,93 |
| 4 | 5164,85 | 4315,57 | 4 | 579,52 | 699,93 |
| 5 | 5455,04 | 4752,06 | 5 | 595,33 | 924,02 |
| 6 | 5058,79 | 5237,62 | 6 | 731,89 | 1114,86 |
| 7 | 5303,41 | 5252,62 | 7 | 745,05 | 772,17 |
| 8 | 4979,25 | 5319,65 | 8 | 578,92 | 671,34 |
| 9 | 4971,39 | 4040,67 | 9 | 750,53 | 854,34 |
| 10 | 4818,02 | 4832,85 | 10 | 706,07 | 671,14 |
| Average | 4963,14 | 5278,50 | Average | 651,15 | 784,45 |
| Standard deviation | 317,96 | 1231,29 | Standard deviation | 94,78 | 156,01 |

In the case of the corner joints, the connectors reached about 83% of the resistance to pulling of the wood dowel fastened joints. The reason for the higher resistance of the wood dowels might be that they were glued into the tenon, so the pulling force had to defeat the adhesion forces developed earlier between the dowel and the wall of the tenon. The shear broke the grooves from the side of the Domino wood dowels or in the other cases, the glued dowel was adhering so strongly (more strongly than the cohesion forces perpendicular to the grain of the beech wood), that the layer separation of the wood material occurred.

Without bonding the dowel into the tenon, only frictional adhesion would be the binding force, which would keep the dowel into the hole. Between the connector and the tenon, only the anchoring of the metallic connector is the force of binding, whilst in the case of the wood dowels, the adhesion of the adhesive further increases the frictional adhesion. This theory is supported by the type of deterioration also: the metallic connectors tore out the grains of the wood material, distorted the hole, whilst getting released from the tenon, at elevated values of the pulling force. Some connectors broke during the tension tests, as shown in Figure 8. The weakest points of the metallic connector are the two narrow necks of the metallic claw nut, as marked with green arrows. The failure of the metallic connectors occurred above 4,000 N, which would be equal with 400 kg on a single joint of a multiple jointed assembly, and this is rather unexpected in the case of chairs or furniture.

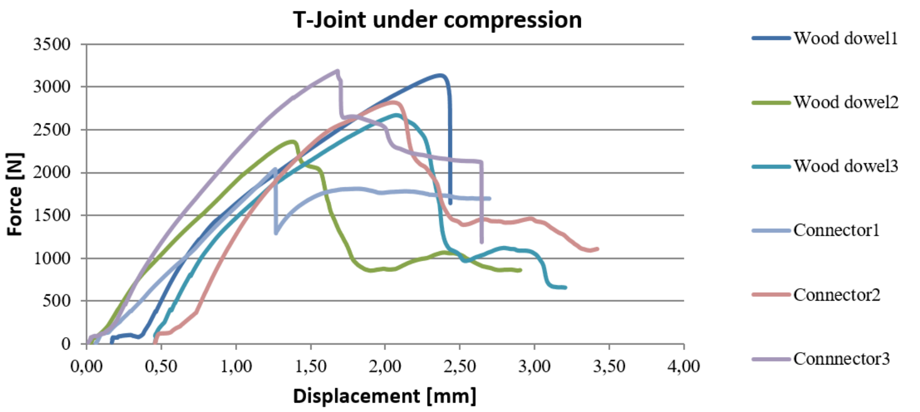


Fig. 8. *Displacement of the T joints under compression made with Domino wood dowels and metallic connectors*

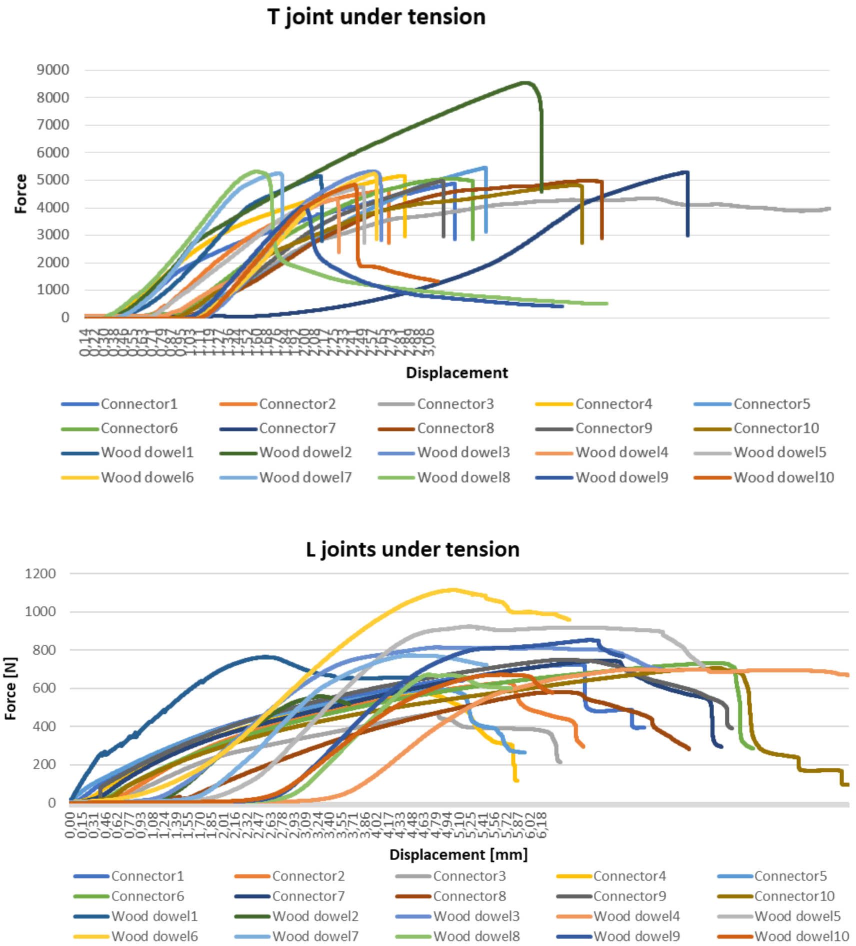


Fig. 9. *Relation of force and displacement in the case of T and L joints under tension*

It is noteworthy, that in the case of the L joints made with wood dowels under tension, there are large horizontal portions of the displacement at low values of forces in Figure 9, which are due to the positioning of the samples, and are not in any case real “elongations” of the samples.

The metallic connectors performed twice as better in the case of tension than in the case of compression, considering the maximal forces. Strengthening the connection of the bottom side of the metallic connectors would result in a stronger resistance of the metallic connectors to pulling, and would act against its breaking.

When evaluating displacement, a characteristic difference between the T joints and the L joints can be identified. Whilst in the case of the T joints, both the wood dowel and the connector fastened joints show similar behavior during pulling, in the case of the corner joints there is a difference between the joints fastened with wood dowels and with metallic connectors. The metallic connectors of the corner joints under tension showed a displacement proportionate to the pulling force (with a slope of the tangent line of $45^{o}$), indicating a continuous deformation. At the same, the time wood dowels show much smaller displacement and steeper graphs of forces, indicating a higher resistance to load. The distortion of the metallic connectors indicated by the graph is due to the fact that the hard and strong metallic claws get pulled out by continuously, consistently deforming and scratching the wood (Figure 10). The corner joints show the same trend of distortion both for compression and for tension. In their case, the torque induced in the joint induces deformations caused by the metallic parts, which do not occur during pulling.

Fig. 10. *Typical type of deterioration of wood dowels during tension tests*

## 4. Conclusions

The tested corner L and T joints made with the tested wood dowels and metallic connectors had higher performance for pulling than for compression. The performance of the tested wood dowels both under tension and compression was higher than the performance of the tested metallic connectors, but based on literature data, they performed better than the traditional wood dowel pins [9].

Furthermore, the connectors under compression were able to maintain the integrity of the joint, whilst the wood dowels got disassembled. The form of deterioration of the metallic connectors and wood dowels in the case of the compression tests was the loosening of the tightness of the fit, no break of jointing elements occurred. In the tension tests, the failure of the metallic connectors occurred above 4,000 N, which would be equal with 400 kg load on a single joint of a multiple jointed assembly, and this is rather an unexpected load in the case of chairs (tested for 150 kg) or beds (tested for 135 kg, double bed 273 kg). During the tension tests, the T joints performed six times better than the corner joints. During the compression tests, the T joints performed about 4-5 times better than the corner joints. As a result, it can be stated that under compression, a T joint fastened with a metallic connector is a structural solution which can be expected to perform better than a corner joint fastened with a same sized wood dowel. The type of joint (corner versus T) is a stronger influencing factor of performance than the type of jointing element (wood dowel vs. metallic connector).

Since the Domino wood dowels and the metallic connectors are available in different sizes, and relatively big connectors and dowels were tested, research continues towards finding a smaller wood domino dowel which has the same performance as the tested Domino connectors.

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