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# Mechanical properties of confirmat screws corner joints made of native wood and wood-based composites

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**Abstract:** *Mechanical Properties of Confirmat Screws Corner Joints Made of Native Wood and Wood-Based Composites*. The aim of this investigation was to design and determine the mechanical properties of confirmat screws corner joints made of native wood and wood-based composites. The objective of the study was to ascertain the stiffness and load carrying capacity of joints that differed in the diameter and length of confirmat type screw, as well as in the kind of materials. The results include statistical processing of measured and calculated data, and evaluation of the influence of selected factors on mechanical properties. The results are applied to the calculation of the characteristic values of the properties and to the determination of the equations for their calculation for other values of the selected factors. The characteristic values are used for the evaluation of the joints according to the limit state method.

*Key words:* corner joints, load capacity, stiffness, confirmat, characteristic value of property

## INTRODUCTION

The requirements for furniture design are appealing appearance, current fashion, functionality, and structural safety. The structural safety of furniture includes both the strength of a construction member itself and the strength of a joint. Strength properties of joints were investigated by several authors. The most well-known works of Eckelmann C.A., Kamenicky J., Jivkov, V. Kyuchukov, B., Šnyder J., Dziegielewski S., Smardzewski J., Wilczynski A., Kasal et al. was primarily concerned with examining the influence of factors on the load capacity and stiffness of dowel type joints and mortise and tenon joints.

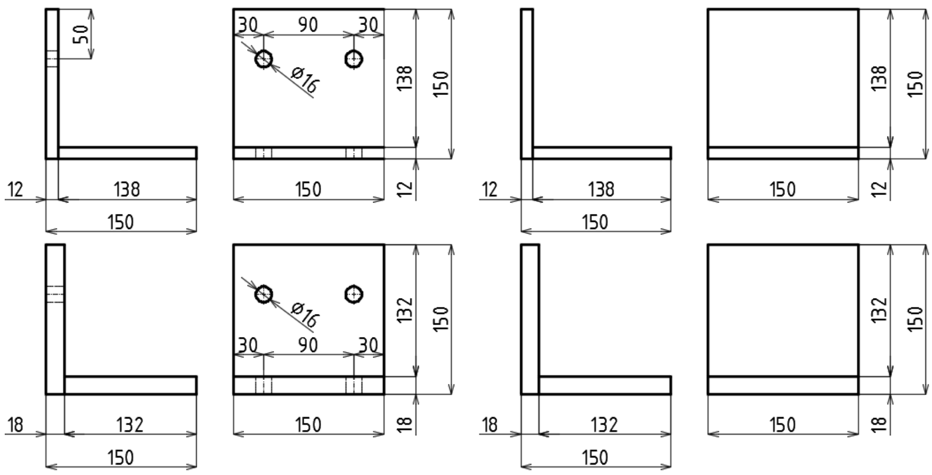
Several scientific works are focused on the determination of load carrying capacity and stiffness of corner joints for the needs of dimensioning of furniture constructions. In particular, dowel-type fasteners (pins, bolts, confirms) and furniture cam lock mounted in solid wood and wood-based materials in these works have been tested. At work Jivkov (2002) tested bending strength and stiffness of end corner joints from 25 mm laminated particleboard. Results of the study indicate that type of joints has a considerable effect on the bending strength and stiffness. With relatively high bending strength are confirmat, dowels and screws, as well Minifix connector.

The influence of the cross-sectional dimension on the mechanical properties of the joints made of sweet chestnut solid wood is described in Kyuchuk et al. (2013). The size of the cross section of the structural elements influences considerably the stiffness coefficient of the joints. An increase of the cross section's thickness from 25 mm to 30 mm increases the stiffness coefficient of the end glued and dismountable corner joints by about 27 % on an average. For the T-shape corner joints the corresponding increases are about 32 % on an average.

The results of the work (Simeonova et. al. 2015) showed, that the highest stiffness is characteristic of joints with universal connector and screw for wood ø 6 x 90 and ø 6 x 80 mm while the lowest stiffness is typical of joints with Minifix with bolt, mounting in metal sleeve and direct mounting. The parameters of the screw joints have considerable impact on the stiffness characteristics of the joints. The results from this study can be used for the strength design of furniture and to be used by constructors as a guideline with respect to the stiffness of the joints. In some papers the mechanical properties of the joints obtained experimentally and influence of some factors are reported (Dudas et al. 1999, Paulenkova et al. 2000). Nevertheless, we still feel the absence of objective basic and calculation methods for designing of structural furniture joints in terms of their strength properties. Their definition and implementation can increase the quality and durability of furniture.

MATERIALS AND METODS

The test samples for determining the mechanical properties of the joint, bending strength and stiffness of end corner joints, were made of spruce (*Picea abies*) and beech (*Fagus silvatica*), especially due to the large difference in wood density and thus the possibility of observing the effect of density on the load bearing capacity. Wood based material particle board (PB) and MDF were tested. The thickness of the test specimens were 12 mm and 18 mm. The type and sizes of the test samples are shown in figure 1.




a) b)

**Figure 1.** Type and sizes of the test samples: a) loaded tensile stress, b) loaded compression stress.

Confirmat screws were used to determine the mechanical properties of screw joints (Fig. 2).

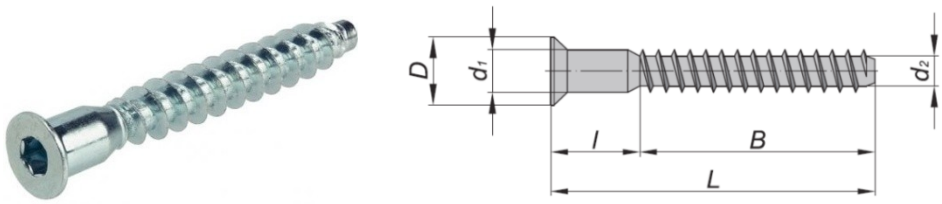



**Figure 2**. Type and sizes confirmat screw (Konfirmát, s.a.).

Confirmat of dimensions $d_2$ x L (mm): 5x40, 5x50, 7x50, 7x70 were used in the test specimens. In preliminary tests, mechanical properties of the experimental joints were determined by compression and tensile bending tests. Preliminary results showed that the load capacity in compressive stress was less than tensile, therefore all other tests were carried out under compression stress. The determination of the strength properties of the joints is based on the scheme in figure 3. Test specimens were air-conditioned at the temperature of 20±2 °C and the air humidity of 65±5%. The moisture content of specimens after air-conditioning was 12±1%.

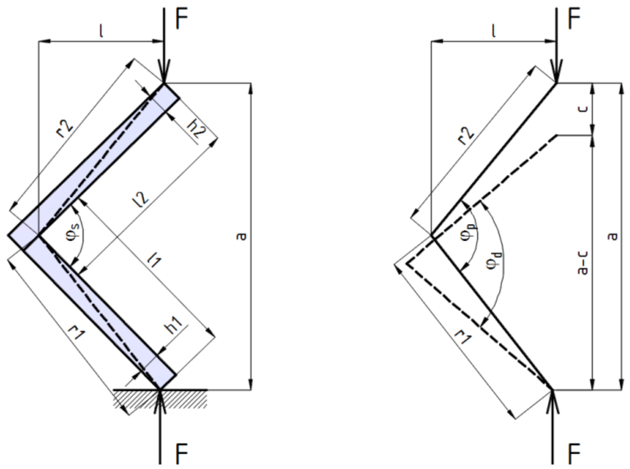



**Figure 3.** Scheme of compression test and geometrical parameter of joint (Joščák et al. 2011).

**Determination of geometric parameters:**

| | |
|---|---|
| Length of arm of joints | $r_1 = \sqrt{h_1^2 + l_1^2}, \quad r_2 = \sqrt{h_2^2 + l_2^2}$ |
| Span length of arm of joints: | $a = \sqrt{r_1^2 + r_2^2 - 2 \cdot r_1 \cdot r_2 \cdot cos\varphi_p}$ |
| Calculation of angular deformation: | $\varphi = \varphi_p - \varphi_d$ |
| The arm angle of the joint before loading: | $\varphi_p = \varphi_s + arccos\frac{l_1}{r_1} + arccos\frac{l_2}{r_2}$ |
| The arm angle of the joint after loading: | $\varphi_d = arccos\frac{r_1^2 + r_2^2 - (a-c)^2}{2 \cdot r_1 \cdot r_2}$ |
| Arm of force: | $l = \frac{r_1 \cdot r_2 \cdot sin\varphi_p}{a}$ |

**Calculation of strength characteristics of joints:**

| | |
|---|---|
| Load carrying capacity | $M_u = F_{max} \cdot l$ |
| Angle deformation of joint: | $\varphi_{max} = \varphi_p - \varphi_{d,max}$, where $\varphi_{d,max} = arccos\frac{r_1^2+r_2^2-(a-c)^2}{2 \cdot r_1 \cdot r_2}$ |
| Stiffness: | $T = \frac{\Delta M}{\Delta \varphi}$ |
| $\Delta M = 0{,}3 \cdot M_{max}$ ; $\Delta\varphi = \varphi_{d10} - \varphi_{d40}$, where $\varphi_{d10} = arccos\frac{r_1^2+r_2^2-(a-c_{10})^2}{2 \cdot r_1 \cdot r_2}$; $\varphi_{d40} = arccos\frac{r_1^2+r_2^2-(a-c_{40})^2}{2 \cdot r_1 \cdot r_2}$; $c_{40}$, $c_{10}$ – are the displacement caused by 40% and 10% loading $F_{max}$, respectively. | |

RESULTS

The average values of calculated mechanical properties for corner joints loaded by compression bending for the tested materials and the dimensions of the confirmat are given in table 1. It confirmed the assumption that the mechanical properties are affected by the type of material, material thickness and confirmat screw size.

**Table 1.** The mean values with coefficients of variation v for mechanical properties.

| Material | Thickness | Confirmat (mm) | $\overline{M_u}$ (N·m) | $v_{Mu}$ (%) | $\overline{\varphi_u}$ (rad) | $v_{\varphi u}$ (%) | $\overline{T_u}$ (N·m/rad) | $v_T$ (%) |
|---|---|---|---|---|---|---|---|---|
| DTD | 12 mm | 5 x 40 | 3,63 | 24,04 | 0,0151 | 22,59 | 77,37 | 42,12 |
| MDF | 12 mm | 5 x 40 | 6,59 | 13,68 | 0,1156 | 21,93 | 108,19 | 23,47 |
| SM | 12 mm | 5 x 40 | 3,95 | 16,09 | 0,16 | 31,73 | 84,56 | 17,05 |
| BK | 12 mm | 5 x 40 | 10,40 | 9,424 | 0,274 | 41,52 | 147,88 | 8,00 |
| DTD | 12 mm | 5 x 50 | 3,60 | 17,19 | 0,0153 | 16,04 | 73,31 | 31,02 |
| MDF | 12 mm | 5 x 50 | 6,59 | 12,41 | 0,1233 | 14,06 | 103,42 | 31,77 |
| SM | 12 mm | 5 x 50 | 4,58 | 21,07 | 0,144 | 21,94 | 93,63 | 23,8 |
| BK | 12 mm | 5 x 50 | 11,09 | 10,81 | 0,2719 | 24,80 | 131,66 | 23,89 |
| DTD | 12 mm | 7 x 50 | 3,77 | 17,21 | 0,0149 | 34,51 | 79,49 | 40,12 |
| MDF | 12 mm | 7 x 50 | 6,99 | 14,35 | 0,1163 | 21,20 | 107,12 | 25,39 |
| SM | 12 mm | 7 x 50 | 3,64 | 24,46 | 0,1595 | 41,51 | 99,89 | 30,64 |
| BK | 12 mm | 7 x 50 | 13,24 | 13,59 | 0,216 | 18,45 | 165,89 | 10,21 |
| DTD | 12 mm | 7 x 70 | 5,17 | 19,22 | 0,0151 | 21,03 | 99,82 | 40,12 |
| MDF | 12 mm | 7 x 70 | 11,31 | 6,66 | 0,103 | 13,29 | 184,92 | 15,27 |
| SM | 12 mm | 7 x 70 | 4,92 | 10,19 | 0,098 | 49,32 | 135,61 | 10,04 |
| BK | 12 mm | 7 x 70 | 14,43 | 6,612 | 0,1599 | 17,82 | 222,93 | 4,77 |
| DTD | 18 mm | 5 x 40 | 7,04 | 14,81 | 0,0146 | 24,13 | 157,81 | 26,01 |
| MDF | 18 mm | 5 x 40 | 14,16 | 7,63 | 0,1264 | 12,12 | 240,99 | 12,65 |
| SM | 18 mm | 5 x 40 | 12,57 | 10,77 | 0,1845 | 22,33 | 157,46 | 11,77 |
| BK | 18 mm | 5 x 40 | 27,08 | 4,56 | 0,2749 | 23,86 | 269,87 | 21,30 |
| DTD | 18 mm | 5 x 50 | 11,98 | 11,05 | 0,0146 | 36,66 | 252,72 | 38,02 |
| MDF | 18 mm | 5 x 50 | 17,33 | 7,21 | 0,1594 | 11,33 | 288,72 | 9,50 |
| SM | 18 mm | 5 x 50 | 10,18 | 20,72 | 0,235 | 17,30 | 159,52 | 20,88 |
| BK | 18 mm | 5 x 50 | 28,67 | 7,47 | 0,285 | 19,92 | 217,87 | 11,02 |
| DTD | 18 mm | 7 x 50 | 13,78 | 7,34 | 0,0103 | 24,96 | 301,88 | 24,13 |
| MDF | 18 mm | 7 x 50 | 19,91 | 4,30 | 0,1252 | 9,64 | 327,21 | 15,36 |
| SM | 18 mm | 7 x 50 | 11,77 | 19,76 | 0,1977 | 24,81 | 210,03 | 18,93 |
| BK | 18 mm | 7 x 50 | 31,53 | 12,13 | 0,271 | 8,83 | 401,27 | 13,39 |
| DTD | 18 mm | 7 x 70 | 21,38 | 4,70 | 0,0146 | 24,50 | 441,97 | 26,21 |
| MDF | 18 mm | 7 x 70 | 24,85 | 4,42 | 0,1465 | 15,99 | 416,06 | 16,21 |
| SM | 18 mm | 7 x 70 | 15,99 | 12,77 | 0,1356 | 20,54 | 186,92 | 12,88 |
| BK | 18 mm | 7 x 70 | 37,43 | 5,60 | 0,257 | 9,11 | 419,90 | 6,75 |

**Load Carrying Capacity:**

For the load carrying capacity, all the factors are statistically significant at the 5% significance level. i. e. screw diameter, type of material, thickness of material and also their interactions, which are evaluated in table 2.

**Table 2.** Summary of the ANOVA Results for the Load Carrying Capacity under the Compression Bending.

| factors / interaction | One-way analysis of variance for $M_u$ (N·m) (ANOVA) Parameterization with sigma-restrictions Decomposition of effective hypotheses | | | | |
|---|---|---|---|---|---|
| | SS | Df | MF | F | p |
| Intercept | 82486.70 | 1 | 82486.70 | 30030.02 | 0.000000 |
| Material | 13775.12 | 3 | 4591.71 | 1671.65 | 0.000000 |
| Thickness (mm) | 17235.07 | 1 | 17235.07 | 6274.58 | 0.000000 |
| Confirmat (mm) | 2687.93 | 3 | 895.98 | 326.19 | 0.000000 |
| Material*Thickness (mm) | 2027.12 | 3 | 675.71 | 246.00 | 0.000000 |
| Material*Confirmat (mm) | 383.72 | 9 | 42.64 | 15.52 | 0.000000 |
| Thickness (mm)*Confirmat (mm) | 791.11 | 3 | 263.70 | 96.00 | 0.000000 |
| Material*Thickness (mm)*Confirmat (mm) | 292.28 | 9 | 32.48 | 11.82 | 0.000000 |
| error | 1230.57 | 448 | 2.75 | | |

SS – sum of the squares of deviations from the average value, Df – number of degrees of discretion, MS – average square of deviations (MS=SS/Df), F – test value, p – probability of error

The mean value of load capacity of corner joints with respect to the thickness of material differs by 61.44% i.e. with thickness of 18mm, the load capacity is 2.59 times higher, compared to a thickness of 12mm. The highest load carrying capacity is obtained for beech (Mu = 14.43 N·m) and for MDF (Mu = 11.31 N·m), both materials thickness 12 mm. Values were achieved for confirmat size 7x70 mm, with a statistically insignificant difference between these materials. The load capacity of beech is approximately 1.2 times higher than MDF. This small difference can be explained by the relatively comparable densities of materials (beech $\rho_0$ = 684 kg/m$^3$, MDF $\rho_0$ = 770 kg/m$^3$).

At a thickness of 12 mm, we compare the same lengths and different diameters of the confirmats 5x50 and 7x50 mm, while the confirmation size is a statistically significant factor. The highest mean values of load capacity is achieved in the beech with confirmat size 5x50 mm $M_u$ = 11.09 N·m and with confirmat size 7x50 mm $M_u$ = 13.24 N·m. For MDF and confirmat size 5x50 $M_u$ = 6.59 N·m, for confirmat size 7x50 $M_u$ = 6.99 N·m. This difference, due to the density of the material and its structure, is justified by the fact that the MDF starts to break at a lower load force.

The lower values of load capacity were achieved with DTD ($M_u$ = 5,17 N·m) and spruce wood ($M_u$ = 4,92 N.m) at a thickness of 12 mm. The difference between these values 4.8% is practically insignificant. Values were obtained with a confirmat size of 7x70 mm. The variability of the load capacity values, expressed by the coefficient of variation $v_{Mu}$ ranged from 4.7% to 24.04% for DTD; from 4.3% to 14.35% for MDF; 10.19% - 24.46% for spruce and from 4.56% to 13.59% for beech (Table 1).

**Angular Deformation:**

When evaluating the deformation of the corner joints, we talk about the angular deformation determined at the limit of load carrying capacity, that is, the change of the angle between the joint arms after the load. For the angular deformation, all the factors are statistically significant at the 5% significance level. i. e. screw diameter, type of material, thickness of material and also their interactions, which are evaluated in table 3.

**Table 3**. Summary of the ANOVA Results for the Angular Deformation under the Compression Bending.

| factors / interaction | One-way analysis of variance for φ (rad) (ANOVA) Parameterization with sigma-restrictions Decomposition of effective hypotheses | | | | |
|---|---|---|---|---|---|
| | SS | Df | MF | F | p |
| Intercept | 9.903321 | 1 | 9.903321 | 4566.061 | 0.000000 |
| Material | 2.982509 | 3 | 0.994170 | 458.376 | 0.000000 |
| Thickness (mm) | 0.043956 | 1 | 0.043956 | 20.266 | 0.000009 |
| Confirmat (mm) | 0.193241 | 3 | 0.064414 | 29.699 | 0.000000 |
| Material*Thickness (mm) | 0.129178 | 3 | 0.043059 | 19.853 | 0.000000 |
| Material*Confirmat (mm) | 0.104843 | 9 | 0.011649 | 5.371 | 0.000001 |
| Thickness (mm)*Confirmat (mm) | 0.031128 | 3 | 0.010376 | 4.784 | 0.002717 |
| Material*Thickness (mm)*Confirmat (mm) | 0.144454 | 9 | 0.016050 | 7.400 | 0.000000 |
| error | 0.971666 | 448 | 0.002169 | | |

SS – sum of the squares of deviations from the average value, Df – number of degrees of discretion, MS – average square of deviations (MS=SS/Df), F – test value, p – probability of error

The change in angular deformation is most influenced by material density and confirmat size. Larger angular deformations occur with smaller screw diameters. According to Duncan's test, differences between the diameters of the confirmats are insignificant at thickness 12 mm and 18 mm in MDF as well as in the DTD. The variability of the angular deformation values, expressed by the coefficient of variation $v_{\varphi u}$ ranged from 16.04% to 36% for DTD; from 9.6% to 21.9% for MDF; 17.3% to 41.5% for spruce and from 8.83% to 41.5% for beech (Table 1).

**Stiffness:**

For the stiffness, all the factors are statistically significant at the 5% significance level. i. e. screw diameter, type of material, thickness of material and also their interactions, which are evaluated in table 4.

**Table 4**. Summary of the ANOVA Results for the Stiffness under the Compression Bending.

| factors / interaction | One-way analysis of variance for T (N·m/rad) (ANOVA) Parameterization with sigma-restrictions Decomposition of effective hypotheses | | | | |
|---|---|---|---|---|---|
| | SS | Df | MF | F | p |
| Intercept | 18990668 | 1 | 18990668 | 19291.68 | 0.00 |
| Material | 768738 | 3 | 256246 | 260.31 | 0.00 |
| Thickness (mm) | 3008948 | 1 | 3008948 | 3056.64 | 0.00 |
| Confirmat (mm) | 882346 | 3 | 294115 | 298.78 | 0.00 |
| Material*Thickness (mm) | 311473 | 3 | 103824 | 105.47 | 0.00 |
| Material*Confirmat (mm) | 205856 | 9 | 22873 | 23.24 | 0.00 |
| Thickness (mm)*Confirmat (mm) | 231930 | 3 | 77310 | 78.54 | 0.00 |
| Material*Thickness (mm)*Confirmat (mm) | 196057 | 9 | 21784 | 22.13 | 0.00 |
| error | 441010 | 448 | 984 | | |

SS – sum of the squares of deviations from the average value, Df – number of degrees of discretion, MS – average square of deviations (MS=SS/Df), F – test value, p – probability of error

The average values of stiffness for corner joint differ by 56.95% with respect to the part thickness. For a material thickness of 18mm, the load capacity is 2.32 times higher than for thickness of 12mm. Stiffness of joints made of beech is approximately 1.20 times higher than MDF. This small difference can be explained by the relatively comparable material densities (beech $\rho_0$ = 684 kg / m3, MDF $\rho_0$ = 770 kg / m3). The lowest values of stiffness were obtained with a material thickness of 12 mm for DTD ($T_u$ = 73.31N·m/ rad) and for confirmat 5x50 mm and spruce ($T_u$ = 84.56 N·m/ rad) for confirmat 5x40 mm. The difference between these materials and the dimension of confirmat is statistically insignificant. Also, at a thickness of 18 mm, the lowest values of stiffness were achieved for DTD ($T_u$ = 157.81 N·m/ rad) and spruce ($T_u$ = 157.46 N·m/ rad) for dimension of confirmat 5x40 mm.

**Characteristics of screw joints for dimensioning purposes**

Based on the experimental tests, the load carrying capacity, deformation and stiffness of the joint can be estimated for different material thicknesses. The estimated values of mechanical properties of corner joints loaded by bending moment in angular plane (compression) for different thicknesses of PB, MDF, spruce and beech for confirmat with dimensions 5x40, 5x50, 6.30 x50, 7x50 and 7x70 mm are given table 5.

**Table 5**. Equations for estimating the mean values of mechanical properties of corner joint for selected thicknesses from interval $h \in \langle 12, 18 \rangle$ material particle board mdf, sprce, beech.

| **Material** | **confirmat (mm)** | $\overline{M_u}$ (N.m) | $\overline{\varphi_u}$ (rad) | $\overline{T_u}$ (N·m/rad) |
|---|---|---|---|---|
| **PB** | Ø 5x40 | $\overline{M_u} = 0,568 \cdot h - 3,19$ | $\overline{\varphi_u}$ = -0,0008.h + 0,0161 | $\overline{T}$ = 13,407.x - 83,51 |
| | Ø 5x50 | $\overline{M_u} = 1,397 \cdot h - 13,16$ | $\overline{\varphi_u}$ = -0,0001.h + 0,0167 | $\overline{T}$ = 29,902.x - 285,51 |
| | Ø 6,3x50 | $\overline{M_u} = 1,250 \cdot h - 11,296$ | $\overline{\varphi_u}$ = -0,0005.h + 0,021 | $\overline{T}$ = 34,901.x - 341,49 |
| | Ø 7x50 | $\overline{M_u} = 1,705 \cdot h - 16,91$ | $\overline{\varphi_u}$ = -0,0008.h + 0,0241 | $\overline{T}$ = 37,065.x - 365,29 |
| | Ø 7x70 | $\overline{M_u} = 2,701 \cdot h - 27,25$ | $\overline{\varphi_u}$ = -0,0002.h + 0,017 | $\overline{T}$ = 57,025.x - 584,48 |
| **MDF** | Ø 5x40 | $\overline{M_u} = 1,262 \cdot h - 8,55$ | $\overline{\varphi_u}$ = 0,0018.h + 0,094 | $\overline{T}$ = 22,133.x - 157,41 |
| | Ø 5x50 | $\overline{M_u} = 7,19 \cdot h - 14,89$ | $\overline{\varphi_u}$ = 0,0108.h - 0,0341 | $\overline{T}$ = 30,883.x - 267,18 |
| | Ø 6,3x50 | $\overline{M_u} = 2,026 \cdot h - 17,464$ | $\overline{\varphi_u}$ = 0,0091.h - 0,0267 | $\overline{T}$ = 34,652.x - 310 |
| | Ø 7x50 | $\overline{M_u} = 2,153 \cdot h - 18,85$ | $\overline{\varphi_u}$ = 0,0082.h - 0,0227 | $\overline{T}$ = 36,682.x - 333,06 |
| | Ø 7x70 | $\overline{M_u} = 2,263 \cdot h - 15,85$ | $\overline{\varphi_u}$ = 0,0073.h + 0,016 | $\overline{T}$ = 38,523.x - 277,36 |
| **Spruce** | Ø 5x40 | $\overline{M_u} = 1,437 \cdot h - 13,29$ | $\overline{\varphi_u}$ = 0,0041.h + 0,111 | $\overline{T}$ = 12,15.x - 61,24 |
| | Ø 5x50 | $\overline{M_u} = 0,933 \cdot h - 6,62$ | $\overline{\varphi_u}$ = 0,0238.h - 0,1934 | $\overline{T}$ = 10,982.x - 38,147 |
| | Ø 6,3x50 | $\overline{M_u} = 1,207 \cdot h - 10,52$ | $\overline{\varphi_u}$ = 0,0242.h - 0,2257 | $\overline{T}$ = 15,775.x - 91,606 |
| | Ø 7x50 | $\overline{M_u} = 1,3553 \cdot h - 12,62$ | $\overline{\varphi_u}$ = 0,0245.h - 0,2427 | $\overline{T}$ = 18,357.x - 120,39 |
| | Ø 7x70 | $\overline{M_u} = 1,845 \cdot h - 17,22$ | $\overline{\varphi_u}$ = 0,0063.h + 0,0228 | $\overline{T}$ = 8,5505.x + 33,011 |
| **Beech** | Ø 5x40 | $\overline{M_u} = 2,78 \cdot h - 22,96$ | $\overline{\varphi_u}$ = 0,0002.h + 0,2722 | $\overline{T}$ = 20,332.x - 96,1 |
| | Ø 5x50 | $\overline{M_u} = 2,93 \cdot h - 24,07$ | $\overline{\varphi_u}$ = 0,0206.h - 0,0861 | $\overline{T}$ = 14,369.x - 40,764 |
| | Ø 6,3x50 | $\overline{M_u} = 3,007 \cdot h - 23,596$ | $\overline{\varphi_u}$ = 0,0202.h - 0,0877 | $\overline{T}$ = 30,529.x - 212,44 |
| | Ø 7x50 | $\overline{M_u} = 3,048 \cdot h - 23,34$ | $\overline{\varphi_u}$ = 0,0201.h - 0,0902 | $\overline{T}$ = 39,23.x - 304,87 |
| | Ø 7x70 | $\overline{M_u} = 3,833 \cdot h - 31,57$ | $\overline{\varphi_u}$ = 0,0162.h - 0,0343 | $\overline{T}$ = 32,829.x - 171,01 |

Taking into account the variability of the files in the individual tests, we can determine the characteristic values $X_k$ of the load carrying capacity and stiffness of the joints. The characteristic value of property is the value, corresponding to the α quantile of the assumed statistical distribution of the evaluated property, for α = 5% the equation (1) is valid:

$$X_k = \overline{X} \cdot (1 - t_{95} \cdot \vartheta_x) \qquad (1)$$

where: $\overline{X}$ – average value of the test property

$X_k$ – characteristic value of property

$t_{95}$ – quantile of Stadent's t-distribution (one-sided estimate), $t_{95}$ = 1,64

$v_x$ – coefficient of variation in absolute terms (not in percent)

The design values of the strength properties are calculated from the characteristic values, taking into account the operating conditions of the joint. These are necessary conditions for the quantification limit state design.

CONCLUSION:

- The parameters of the screw, in particular the diameter of the screw, the thickness of the material and the density of the material, have a significant effect on the stiffness and load carrying capacity of the corner joints.
- Based on the calculated results, and by multiple regression, we have determined the equations to estimate the mechanical properties of the corner joints using the confirmat screws for the individual materials and the thicknesses of these materials at interval 12 to 18 mm.
- The results from the study can be used for the strength design of furniture construction, with respect to the mechanical properties of screw confirmat joints.

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**Streszczenie:** Wytrzymałość połączeń kątowych elementów z drewna litego i tworzyw drewnopochodnych wytworzonych na bazie konfirmatów. Celem badań było zaprojektowanie i określenie właściwości wytrzymałościowych połączeń kątowych wytworzonych na bazie konfiramtów i elementów z drewna litego oraz płyt drewnopochodnych. W ramach badań określono sztywność i nośność złączy wykonanych z różnych materiałów przy zastosowaniu konfirmatów o różnych średnicach i długościach. Uzyskane wyniki zostały poddane analizie statystycznej w tym dokonano oceny wpływu wybranych czynników na właściwości wytrzymałościowe połączeń. Na bazie uzyskanych wyników obliczono wartości charakterystyczne wytrzymałości oraz wyznaczono równania do ich obliczania dla różnych grubości elementów. Wartości charakterystyczne wytrzymałosci zostały wykorzystane do weryfikacji stanu granicznego połączeń.

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