Short Communication

Section modulus of corner joints in furniture frames as engineering design criteria for their efficient construction

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Abstract
Since joints are often the weakest points in furniture construction a detailed analysis of the factors influencing their load bearing capacity and its effectiveness in utilizing the full strength of the wood is reported here.

As a result of this analysis, the value of the ratio of the section modulus of the joint \( W_p \) to the section modulus of the element \( W_e \) has been established as the criterion for determining the correctness of construction based on material strength and production technology. The value of the ratio \( W_p/W_e \) indicates the percent to which utilization of the full strength properties of individual elements in the joints outlined.

The value of the ratio \( W_p/W_e \) is the rational criterion for assessing the correctness of the joint construction and it enables better use of the mechanical properties of the wood used in the joint. Moreover, it makes possibilities to specify the mechanical factors of joints applied in joinery constructions.

1. Introduction

In frame joinery construction the full strength of the construction material is seldom developed. The joints are generally recognized as being the weakest points in the construction since the forming profiles of the joints prevent the development of the full strength of the material. The profiles, in addition to other factors, ultimately determine the load bearing capacity and strength of the joint.

Calculating the load bearing capacity and the strength of the joints is a complex problem depending on many factors. The most significant of these factors are the strength of the construction material, the method of loading, the strength of glue lines appearing in the joint, and the wood cross section as reduced by the joints profile [1–3].

The strength of wood construction materials have been determined by many investigators and are satisfactory for practical purposes [4–7]. There are also many data technical reports on the load bearing capacity and strength of furniture joints [8–10]. It was reported that the first important factor is corner joint–joint type of elements and adhesion strength of corner joint on the furniture strength when tested according to standard forces and loads for furniture resistance [11].

The properties and types of glue lines in joints [12,13] and the factors influencing their mechanical properties [14,15] have also been determined. The mechanical properties and factors affecting the glue lines have been arranged into a group of technological features (accuracy of fit, accuracy of assembling, fastening before gluing, controlled pressure of gluing, capacity current or heating of glued joint, mechanization of machining and assembling joints, saving of material, using the elements of finished surface) [16–18] and a group of strength features (rigidity and load bearing capacity of joints, stresses in main glue lines, size of glued surfaces, anatomic surface of joined members) [19–21]. In general, such procedures require analytical procedures and structural theories to determine the magnitude and distribution of the forces acting within the furniture and the accompanied deflection of the joints and members.

General inadequacies of glued corner joints in furniture frames shown in Figs. 1–4 are lowering of the load carrying cross sections by notching the elements of the joint, (differences in the joints section range 30–70% for mortise and tenon joints as compared to the cross section of the elements), rapid decrease of the section modulus from 100% to 30–40% of the section modulus of the tenon and from 50% to 70% of the section modulus for the mortise, small glue line area and wood grain crossing at 90° in glued wood, quality and thickness of glue lines depends on the tolerance and fit of the joint and not on the press pressure, no possibility of spreading the glue mechanically, great volume of lost wood in machining the mortise or tenon, exposed cross section area are the cause of increased penetration of humidity into the joint resulting in