Annals of Warsaw University of Life Sciences – SGGW
Forestry and Wood Technology No 72, 2010: 175-179
(Ann. WULS-SGGW, For and Wood Technol. 72, 2010)

Investigations on holding ability of screws in regenerated pinewood screw joints

PIOTR POHL, MARCIN WOŁPIUK, PIOTR FORMELA
Department of Woodworking Machinery and Basic of Machine Construction,
Poznan University of Life Sciences.

Abstract: *Investigations on holding ability of screw in regenerated pine wood screw joints*. In the course of the performed experiments, screw holding capability in pinewood in repaired and original screw joints in three anatomical directions was examined. The screw joint was made using conical and EURO screws most common in mounting furniture hardware. Three kinds of epoxy resins and assembly glue were employed for regeneration purposes. The performed investigations revealed that the holding capability of EURO and conical screws in pinewood after regeneration was lower in comparison with original joints, on average, by 25% for EURO and by 15% for conical screws.

Keywords: holding capacity, joints, regenerated screw joints, pine wood

INTRODUCTION

One of the major construction issues in furniture industry is the selection of appropriate joints in which the key role is played by connectors or fasteners (Wiśniewski 1971). They should allow rapid assembly and disassembly of joints without negatively affecting aesthetic values of both the connection and the entire piece of furniture.

Appropriately selected joints exert a decisive influence on the construction quality, make relocation of elements in relation to one another impossible and increase strength, rigidity and durability of the entire construction. At the present time, screw fasteners, e.g. screws, are commonly used in furniture production.

Screws are usually employed in situations when joint disassemblability is required. At present, screws replaced nails used for permanent connections. Screws are widely used in furniture production due to their following traits (Durczak 1978): rapid assembly and disassembly of joints, ease of the application of screws as connectors and possibility of automation of mounting,

Disassemblable joints are also burdened with defects such as, for example:

- Weakening of the connection following repeated screwing in and out of fasteners,
- Possibility of damage of the material in which the fastener is mounted,
- Possibility of improper assembly by hammering in the screw,
- Dependence of the strength of joint on the direction of wood grain in relation to mounting of the screw.

One of the measures of the screw holding capability is the force needed to overcome the resistance of wood during the process of screws tearing out in the direction of their longitudinal axis (Biniek 1994). This force depends on the following factors:

- Material in which the screw was set, its density and moisture content,
- Direction of the course of wood fibres,
- Size, shape and depth of mounted screws,
- Diameter of predrilling,
- Kind of the applied loads.

Screw joints are frequently subjected to damage, both in wood-derived materials and in raw wood. Replacement of the damaged element of a piece of furniture is expensive and sometimes impossible. However, there are several ways of allowing regeneration of damaged

joints without the need of replacing the damaged element and changing it to a new one (Pohl, Wołpiuk 2010), for example:

- Replacement of the originally mounted screw by a screw of greater diameter,
- Filling of the damaged hole with steel wool and then setting in the new screw,
- Filling the hole with a mixture of glue and fine wood dust,
- Drilling a new hole using a drill bit of greater diameter and gluing in a mounting peg.

At the present time, damaged joints are repaired using commercially available epoxy resins which do not change their volume during hardening and frequently enhance strength properties of regenerated connections without negatively affecting aesthetic value of a given piece of furniture.

REREARCH OBJECTIVE

The objective of investigations was to ascertain which of the generally available agents for regeneration of screw joints in pinewood was most suitable for this purpose and to compare the strength of repaired and original joints

RESEARCH METHODOLOGY

Bearing in mind widespread application of solid wood in furniture industry, in particular in the manufacture of cabinet and skeleton furniture as construction and finishing elements, a decision was made to conduct investigations on pine wood of 500 kg/m^3 density and 6.7% moisture content.

Experimental samples were obtained from one batch of raw material and were not treated with any finishing materials to eliminate the influence of the finishing layer on the research results.

Recommendations found in the standard PN-77/D-04227 “Investigations on the holding capability of screws” were taken into consideration when selecting the size and shape of experimental samples. In addition, kind and size of damages which can develop in solid wood during tearing out of screws were also taken into account.

Experiments were conducted in the following three wood anatomical directions: radial (R), tangential (T) and longitudinal (L).

Two kinds of screws most common in furniture industry to mount hardware were employed: screws for wood with conical heads 4x40 as well as screws for wood EURO-KOMBI 6.3x20. Predrillings to the depth of 16±0.5 mm were applied in the form of lead holes with diameter equal to the diameter of the plain part of the screw (conical – 2.4 mm, EURO – 3.9 mm). The holes were used to mount fasteners to the depth of 15±0.1 mm using manual screwdrivers.

The screws were torn out in order to determine the capability of holding them in wood and then destroyed wood tissue was removed from damaged samples and the losses were filled using three kinds of agents based on epoxy resins of the following commercial names: Poxilin, Pattex Repair Express and Poxipol as well as Dragon assembly glue. After 24 hours, the excess of the remedial agent was removed using a file and sand paper. Predrilling lead holes were made in the repaired samples and screws were screwed in and next measurements were carried out to determine the capability of their holding in the regenerated joints.

Measurements of the screw holding capability in wood were performed in accordance with the PN-77/D-04227 standard using for this purpose a testing machine (Fig. 2). The machine allowed direct registration and analyses of the obtained results thanks to cooperation with a computer.

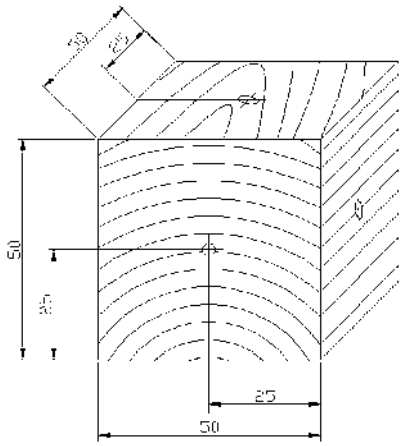

Fig. 1. Sample shape and dimensions.

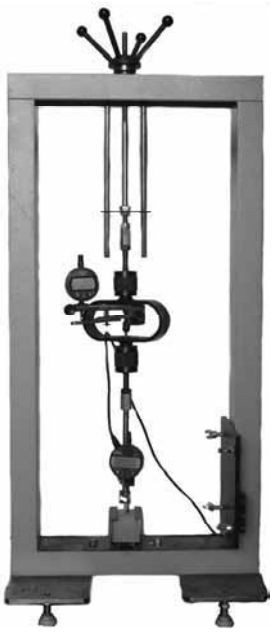
Fig. 2. Testing machine used in investigations.

The pulling out velocity used to determine the breaking force was established at approximately 1 mm/s. The holding capability of screws (Zw) was calculated as a quotient of the tearing out force to the length of screw setting with 1 N/mm accuracy.

RESEARCH RESULTS

Figures 3 and 4 present graphically holding capability of screws (Zw) in original and regenerated screw joints. Figure 3 shows results for the EURO type screws and Figure 4 - for conical screws. The results of screw holding capability are means from five measurement replications.

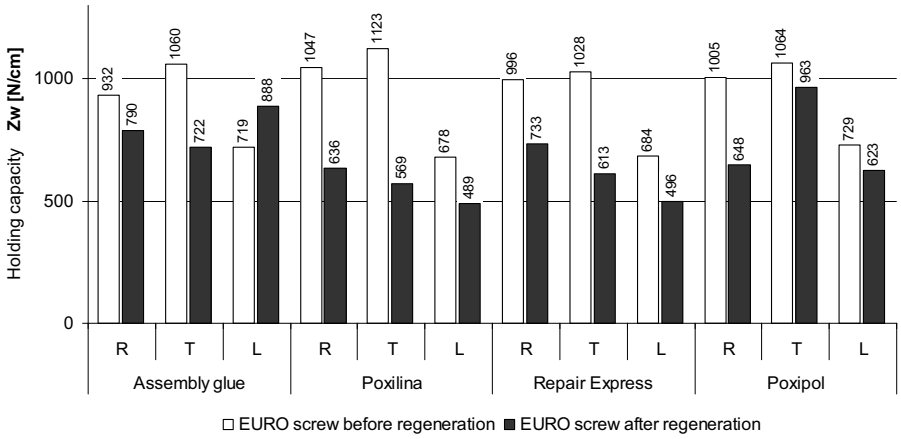

Fig. 3. Holding capacity for the EURO type screws set in pinewood.
R - radial direction, T - tangential direction and L - longitudinal direction

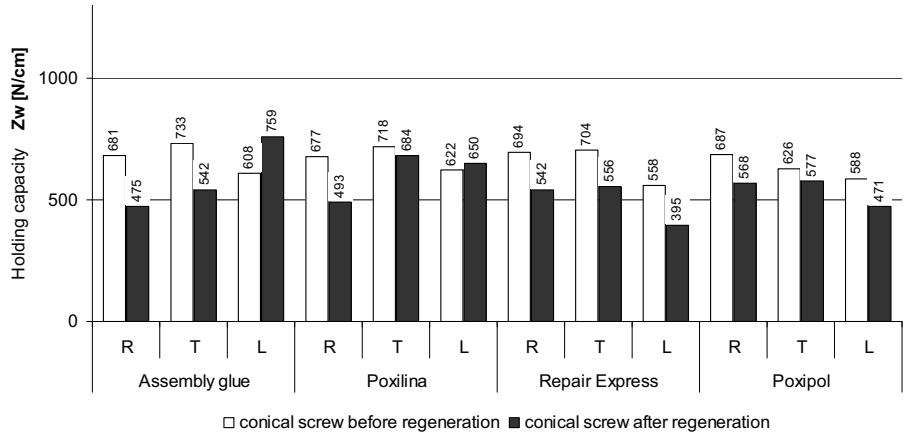

Fig. 4. Holding capacity for the conical screws set in pinewood.
R - radial direction, T - tangential direction and L - longitudinal direction

In the majority of cases, the regenerated screw joints in pinewood exhibited lower values of screw holding capability in comparison with the original joints. Pinewood was characterised by the highest screw holding capability in the case of both EURO and conical screws in tangential direction T. EURO screws were found to have the highest holding capability after regeneration with the assembly glue in longitudinal direction L, with Poxilin and Repair Express – in radial direction R and with Poxipol – in tangential direction T. On the other hand, conical screws were found to have the highest holding capability after regeneration with the assembly glue in longitudinal direction L and with Poxilin, Repair Express and Poxipol – in tangential direction T. The observed decline of screw holding capability in wood can be attributed to the fact that the agents used in experiments are characterised by different structure as well as other physical and mechanical properties than wood. During the tearing out process of screws, the damage did not occur at the contact line of the screw with the regeneration agent but at the contact between the regeneration agent and wood. This resulted in a significant decrease of the screw holding capability in wood after regeneration in comparison with original joints. The results of investigations can be treated as initial. It is necessary to continue experiments on the regeneration of screw joints in wood.

CONCLUSIONS

- EURO screw holding capability in pinewood before regeneration was by about 35% higher in all wood anatomical directions in comparison with conical screws. This was caused by differences in the diameters of the two types of screws. EURO screws had a greater contact surface of the thread coil in wood than conical screws.
- The holding capability of EURO screws in wood after regeneration with epoxy resins Poxilin, Repair Express and Poxipol dropped by about 35% in all wood anatomical directions. In the case of conical screws, their holding capability decreased by about 16% in all wood anatomical directions.
- The holding capability of EURO screws in pinewood after regeneration with the applied assembly glue decreased by about 25% in radial and tangential directions and increased by about 20% in longitudinal direction.
- The holding capability of conical screws in pinewood after regeneration with the applied assembly glue decreased by about 30% in radial and tangential directions and increased by about 20% in longitudinal direction.

LITERATURE

1. Biniek P., (1994): „Badania porównawcze zdolności utrzymania wkrętów o tych samych parametrach wymiarowych mocowanych w drewnie i tworzywach drzewnych", Przemysł Drzewny nr 9, 25-27.
2. Durczak J., (1978): „Wpływ wilgotności płyty wiórowej na zdolność utrzymania wkrętów pod działaniem długotrwałych obciążeń stałych", Typescript AR Poznań.
3. Pohl P., Wołpiuk M. (2010): Investigations on the regeneration of screw joints in chipboards. Annals of Warsaw University of Life Sciences - SGGW. Forestry and Wood Technology No 70
4. Wiśniewski G., (1971): „Próba ustalenia wpływu obciążeń cyklicznych na zdolność utrzymywania wkrętów i gwoździ w płytach wiórowych", Typescript AR Poznań.
5. PN-77/D-04227: „Badania zdolności utrzymania wkrętów".

Streszczenie: *Badanie zdolności utrzymania wkrętów regenerowanych połączeń gwintowych w drewnie sosny.* W pracy badano zdolność utrzymania wkrętów w drewnie sosny przed regeneracją i po regeneracji uszkodzonych połączeń gwintowych w trzech kierunkach anatomicznych. Połączenia gwintowe wykonane były przy użyciu wkrętów stożkowych i wkrętów typu EURO najczęściej używanych do osadzania okuć meblowych. Do regeneracji wykorzystano trzy rodzaje żywic epoksydowych i klej montażowy. Przeprowadzone badania wykazały, że zdolność utrzymania wkrętów Euro i wkrętów stożkowych w drewnie sosny po regeneracji jest niższa niż zdolność utrzymania wkrętów przed regeneracją o średnio 25% dla wkrętów typu EURO i 15% dla wkrętów stożkowych.

Corresponding authors:
Piotr Pohl, Marcin Wołpiuk, Piotr Formela
Department of Woodworking Machinery and Basic of Machine Construction,
Poznan University of Life Sciences,
ul. Wojska Polskiego 28,
60-637 Poznań, Poland.
tel: 0(48) 61 848 74 82, tel/fax: 0(48) 61 848 74 81,
e-mail: ppohl@up.poznan.pl