Annals of Warsaw University of Life Sciences – SGGW
Forestry and Wood Technology No 72, 2010: 170-174
(Ann. WULS-SGGW, For and Wood Technol. 72, 2010)

Rigidity of regenerated screw joints in pine wood

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Abstract: *Rigidity of regenerated screw joints in pine wood.* The study presents results of investigation regarding the rigidity of regenerated screw-pinewood joints. The following two kinds of screws were examined: EURO screws and conical screws mounted in three anatomical wood directions. Damage regeneration was performed using three commercially available epoxy resins and an assembly glue. The obtained results showed that in majority of cases, the regenerated connections were characterised by lower rigidity than the original joints.

Keywords: rigidity, regenerated screw joints, pine wood

INTRODUCTION

The connection of elements in furniture industry and door and window woodwork is commonly achieved by means of couplings with threaded elements. Examples of such coupling elements include: mandrels of screw joints with cam-lever grips, various kinds of screwed in bushes, regulated door hinges as well as screws and bolts. The advantage of these connections is their disassemblability, fully or partially automated way of mounting as well as durability resulting from the material (steel) from which the connectors are made.

The above-mentioned joints with the described connectors are of semirigid character consisting in the occurrence of elastic-plastic deformations as a result of forces acting between the connected elements and the connector. A characteristic feature of a semirigid joint is its rigidity determined empirically. The rigidity of the joint is determined by linear displacement characteristics *s* in the function of the external load change (force F) (Modelowanie... 2004). Characterisation of a semirigid joint is presented in Fig. 1.

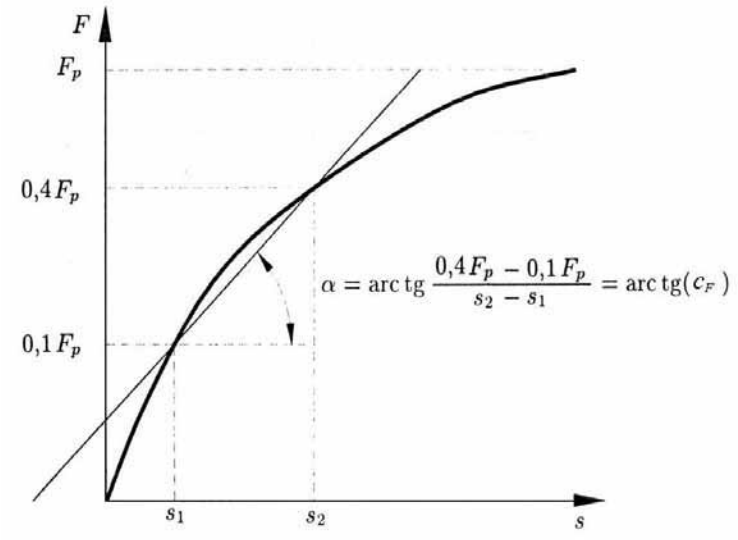

Fig. 1. Characteristics of a semirigid joint and method of determination of its rigidity (Modelowanie... 2004).

Excessively screwed or overloaded connecting elements weaken wood structure. Repeated screwing in and unscrewing of connectors accompanied by a simultaneous cutting in and compressing new coils of thread in wood by the connector thread coils wears out the lead spiral hole in wood and, consequently, reduces the ability of holding of the connector itself.

A damaged joint (torn out connector) can be repaired in many ways. Bearing in mind the fact that the remedial actions should take into account both aesthetic as well as functional aspects, one of possible measures is treatment of the damaged wood element with adhesive material. Conservation work using epoxy composites was initiated in 1960s (Domasłowski, Powidzki 1968). Moreover, the effect of regeneration of screw joints on the capability of holding screws in chipboard was also investigated (Pohl, Wołpiuk 2010).

A number of experimental research results can be found in literature (Modelowanie... 2004; Dzięgielewski and Smardzewski 1995; Eckelman 1971, 1990; Joščák 1999) regarding flexible (semirigid) joints at various states of loads of angle joints. However, there are no research results concerning rigidity of regenerated joints. Therefore, it was decided to investigate the effect of regeneration of screw joints on their rigidity.

REREARCH OBJECTIVE

The aim of investigations was to determine the impact of a screw joint regeneration made in pine wood with the assistance of selected remedial agents on the rigidity of a flexible joint.

RESEARCH METHODOLOGY

Experiments were performed on samples of pine wood of 500 kg/m^3 density and 6.7% moisture content obtained from the same batch of material. Samples in the form of 50x50x50 cubes were cut out in a way which allowed measurements in three wood anatomical directions (radial R, tangential T and longitudinal L). Investigations were carried out in the course of tearing out conical screws 4x40 as well as EURO 6.3x20 screws. The connectors were mounted to the depth of 15 mm with ±0.1 mm accuracy using a screwdriver into earlier prepared holes 16±0.5 mm deep and the diameter equal to the diameter of the plain part of the screw (conical – 2.4 mm, EURO – 3.9 mm). Measurements of the connector holding forces and its displacement during tearing out were taken with the assistance of a testing machine equipped in displacement induction sensors connected to a computer registering and processing data. Employing the formula (Fig. 1), the rigidity of the non-repaired connections pine-conical screw and pine-EURO screw was determined.

Regeneration of damaged screw-wood connections was carried out using Dragon assembly glue as well as three epoxy resins known under the following commercial names: Poxilin, Pattex Repair Express and Poxipol. The performed regeneration involved cleaning the damaged place by removing wood residues and filling it with the above-mentioned agents. After 24 hours, the excess of the applied material was removed and the surface was levelled. Next predrillings were made and the connectors were mounted again. Rigidity measurements of the regenerated joints were carried out in the same way as of the original ones.

RESEARCH RESULTS

Figure 2 presents successive phases of the experiment and the results of trials, which are means of 5 replications, are shown in Figures 3 and 4. Figure 3 shows rigidity values of the EURO screw-pinewood connection before and after regeneration, while rigidity values of the conical screw-pinewood connection before and after regeneration are presented in Figure 4.

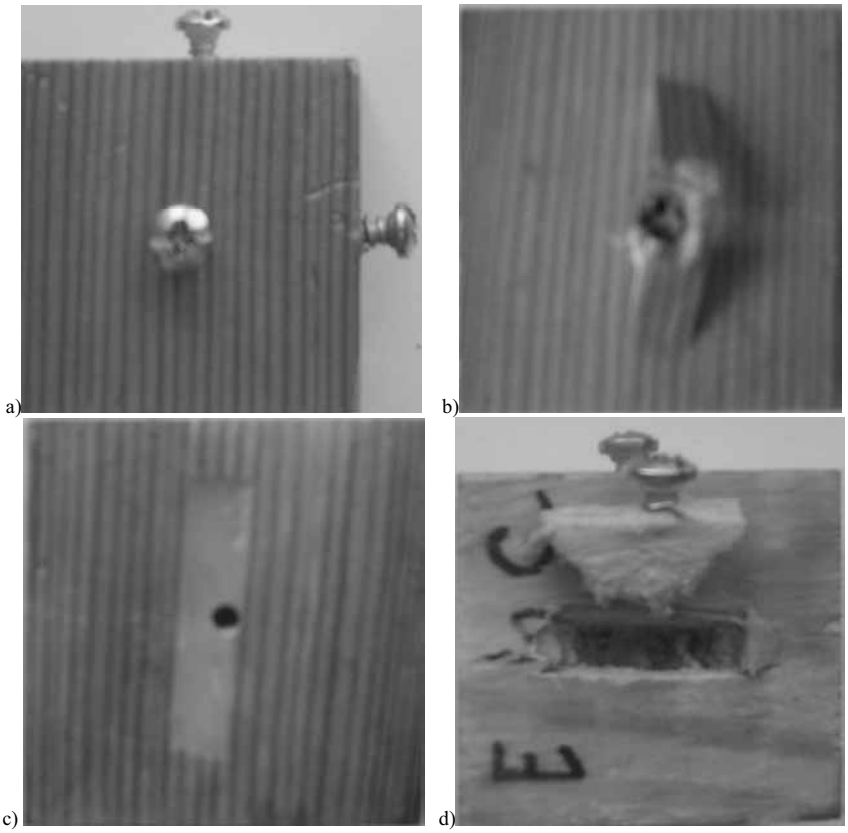

Fig. 2. Example phases of the course of the experiment: a) mounting of connectors in the sample; b) view of damaged sample; c) treatment of the damage; d) tearing out of the connector from regenerated sample.

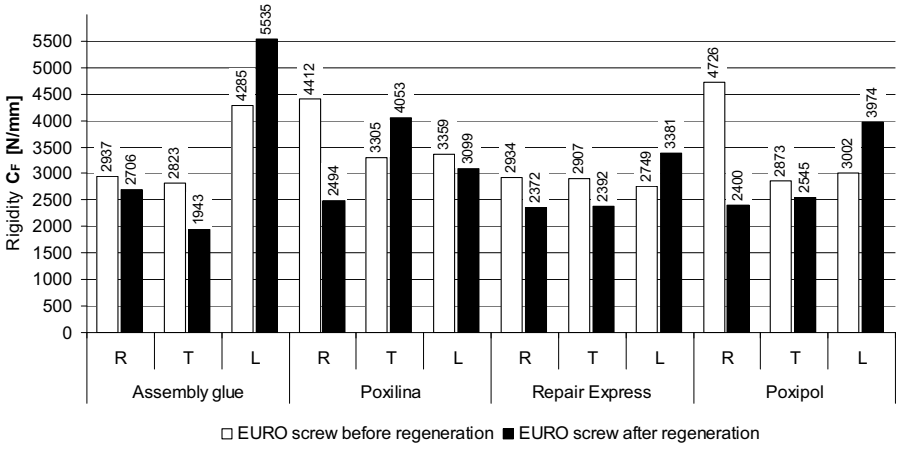

Fig. 3. Values of rigidity of the EURO screw-pinewood connection before and after regeneration using different preparations in three anatomical planes.

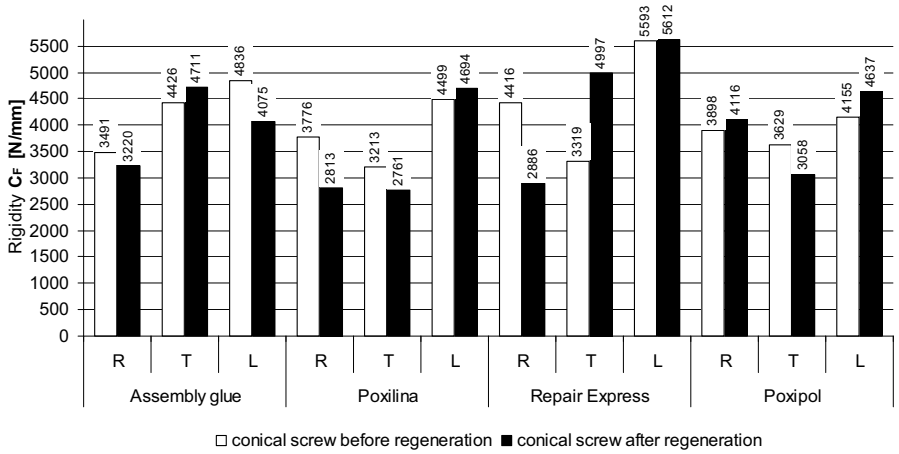

Fig. 4. Values of rigidity of the conical screw-pinewood connection before and after regeneration using different preparations in three anatomical planes.

The obtained research results of the rigidity of screw-pinewood joints showed considerable variability. The tearing out in the regenerated samples occurred at the glue-wood and not at the glue-screw contact which can be attributed to poor adhesion force of the glue to the base – damaged wood. In most cases, a decline in rigidity of the regenerated screw-wood connection was observed. These large inconsistencies could result from differences in pinewood anatomical structure. For the examined EURO screws, repeatability of the rigidity results in the repaired joints regenerated using the assembly glue, RepairExpress and Poxipol could be observed. Every time, a drop in rigidity could be observed in radial and tangential directions, whereas in longitudinal direction, rigidity was found to increase. This could be attributed to pinewood anatomical structure.

CONCLUSIONS

- Rigidity of connections after regeneration with four remedial agents showed considerable variability and, in general, was lower in all anatomical directions of pinewood than before regeneration.
- Regeneration with the applied assembly glue showed increased rigidity in the case of treatment of the damage after the EURO screw mounted in longitudinal direction and after the conical screw in tangential direction.
- Poxilin gave good remedial results in the case of damage repairs after the EURO screws mounted in tangential direction and after the conical screws in longitudinal direction.
- Application of RepairExpress for the regeneration of screw joints in pinewood increased rigidity values for EURO screws mounted in longitudinal direction and for conical screws in tangential and longitudinal directions.
- Regeneration with Poxipol is recommended for the longitudinal direction of mounting of both connectors and for radial direction for conical screws.

LITERATURE

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Streszczenie: *Sztywność regenerowanych połączeń gwintowych w drewnie sosny.* W pracy przedstawiono wyniki badań sztywności regenerowanych połączeń wkrętów z drewnem sosny. Zbadano dwa rodzaje wkrętów, wkręt typu EURO oraz wkręt stożkowy, osadzonych w trzech kierunkach anatomicznych drewna. Regeneracji uszkodzeń dokonano przy użyciu trzech żywic epoksydowych ogólnodostępnych na rynku oraz kleju montażowego. Wyniki wykazały, że w większości przypadków regenerowane połączenia mają niższą sztywność od nienaprawianego połączenia.

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