

## The influence of pitch on the holding power of screws in Scots pine wood

MACIEJ SYDOR, GRZEGORZ ZMYŚLONY, GRZEGORZ PINKOWSKI,  
WALDEMAR SZYMAŃSKI

Faculty of Wood Technology, Poznan University of Life Sciences

**Abstract:** *The influence of pitch on the holding power of screws in Scots pine wood.* The objective of this research was to evaluate the holding power for three types of screws mounted in specimens made from Scots pine (*Pinus sylvestris* L.). Tested screws were fastened perpendicular to the radial and perpendicular to the tangential anatomical planes of wood and were loaded axially. Furniture confirmat screws with three values of pith were used. Based on the results it was found that overall strength properties perpendicular to the tangential plane were 15% higher than perpendicular to the radial plane. Pitch of screws has only a little influence on the holding force for the screws placed perpendicular to the tangential plane. The holding force was decreasing slightly with increasing a pitch for the screws located perpendicular to the radial plane.

**Keywords:** holding power, holding force, withdrawal strength, screw, pith, Scots pine, confirmat

### INTRODUCTION

There are many published contributions towards the experimental assessment of strength of nails and screws driven into solid wood. The results of tests of the holding power of over 10,000 wood screws inserted in the side and end grain of different kinds of engineering wood were published by Fairchild (*Fairchild 1926*). These kinds of studies have been also conducted in Poland. *Rybarczyk and Daroszewski in 1975* studied the relationship holding power depending on the distance of screws. It was found that the mutual distance axis of the screws has a significant impact on the value of this force. Those results were used to calculate the coefficients of the function interaction between groups of screws (*Rybarczyk and Daroszewski 1975*).

Very interesting experiments were conducted by *Kowalik and Nowak in 1979*. They concerned the holding power of different types of screws in the wood and chipboard. Their research were carried out on universal testing machine. In the experiment were determined pull-out force screws with different thread pitch. The research revealed a proportional relationship between holding strength and thread pitch of screw. Increasing the angle of the thread from 8° to 28° for the screw mounted in wood increase the holding power about 30% (*Kowalik and Nowak 1979*).

Another, described in the literature, area of interest was to study the influence of the physical properties of wood materials on the ability to hold up the screws. Kowalik, Nowak and Rochowiak measured the decreasing value of screws holding force for humidity greater than the equilibrium moisture content (*Kowalik, Nowak and Rochowiak 1980*).

Efforts have also been attempts to determine the function of the holding force depending on the geometry of the screws. Researchers have proposed the functional relations between holding force and the diameter of the screw, the embedment depth and chosen material properties of wood. Function coefficients were determined experimentally (*Cassens and Eckelman 1985; Eckelman and Cassens 1984*). Broker and Krause repeated these experiments in 1991 by identification of screw direct withdrawal load resistance on three-layered particleboard, spruce, and beech wood with nine types of screws. They confirmed that

screw direct withdrawal load resistance is directly proportionally dependent on the length and diameter of the screws (**Bröker and Krause 1991**).

Screw and nail withdrawal resistance of important wood species were often compared in literature. A holding power of screw for fir, oak black pine and stone pine wood were determined and were examined (**Ferah 1991; Ayyildiz and Malkocoglu 2001; Aytakin 2008**).

The impact of thermal modification of spruce wood on screw direct withdrawal load resistance is the latest trend research. Experiments were carried out using different types of screws in three anatomical directions. Studies usually includes the comparison of screw direct withdrawal load resistance for native and thermally modified spruce wood (**Kariz, Kuzman, and Sernek 2013; Gašparík, Barčík, Borůvka and Holeček 2015**). However, is no current research on the impact on the value of the thread pitch screws holding force for pine wood. Especially there are few results for furniture confirmat screw.

## MATERIALS AND METHODS

The study was conducted on the samples made of Scots pine (*Pinus sylvestris* L.) wood with a thickness of 18 mm. Three screws type “furniture confirmat screw”<sup>1</sup> with different pith was used: 2.5, 3 and 3.5 mm (fig. 1).

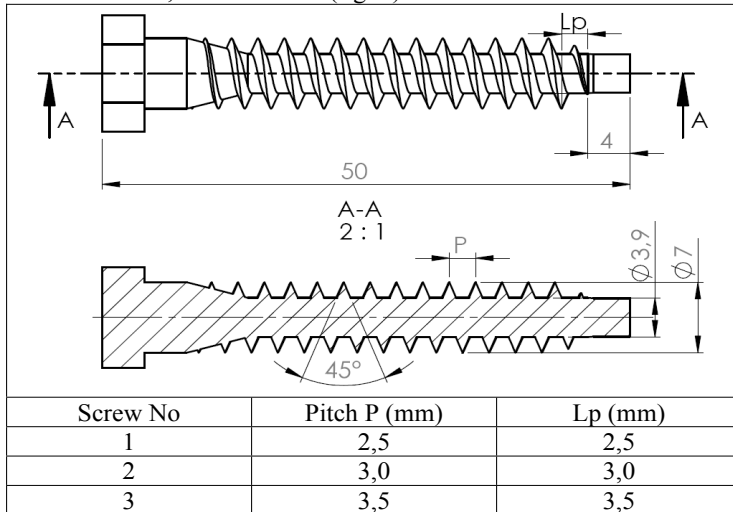


Fig. 1 Three types of screws used in the experiments

Withdrawal testing was carried out according to ISO 9087 (ISO, 1998) Pulling was carried out on a universal testing machine Zwick Z050 using the following parameters:

- initial force: 5 N,
- pulling speed: 2 mm/min.

Screws were deposited in the edge and in the face of the samples (fig. 2). Screws threaded into edge of the samples was perpendicular to the tangential plane of wood, screws located in the face – perpendicular to the radial plane. The diameter of pilot hole was 4 mm, the screw depth was 15 mm.

<sup>1</sup> Confirmat screws are typically offered in two outer diameters (5 and 7 mm), three lengths (40, 50 and 70 mm) and one pitch (3 mm) (“Confirmat,” 2015).

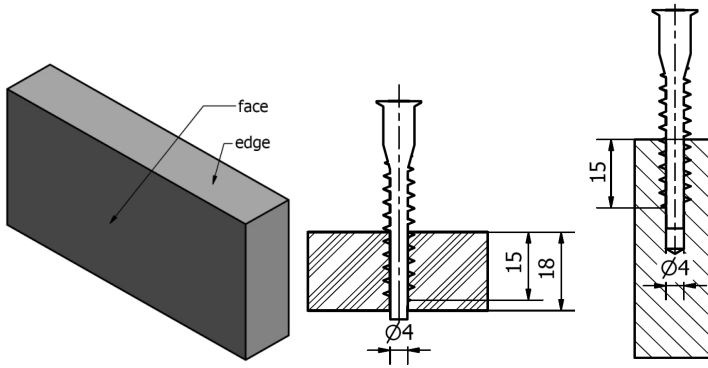


Fig. 2 Two locations of the screws in the samples

For each of two locations and for each of three screws were performed sets of nine samples (total:  $2 \times 3 \times 9 = 54$  samples). For each sets of nine samples the mean value, standard deviation and the mean value error were calculated.

### Results and discussion

Holding strength of screws relative to the insertion depth of the screw were the result of research. Figures 3 and 4 contains measured values two kinds of these specific forces: to the border of proportionality and to the maximum strength.

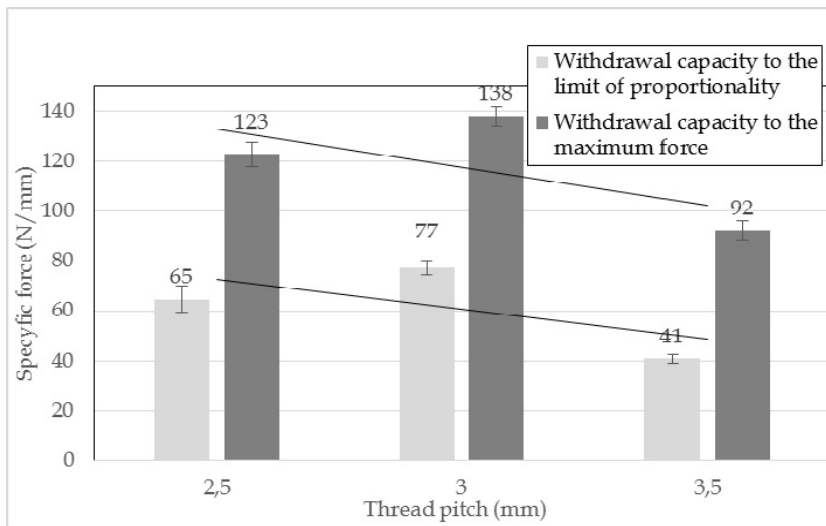


Fig. 2 Specific force in edge of sample (tangential direction)

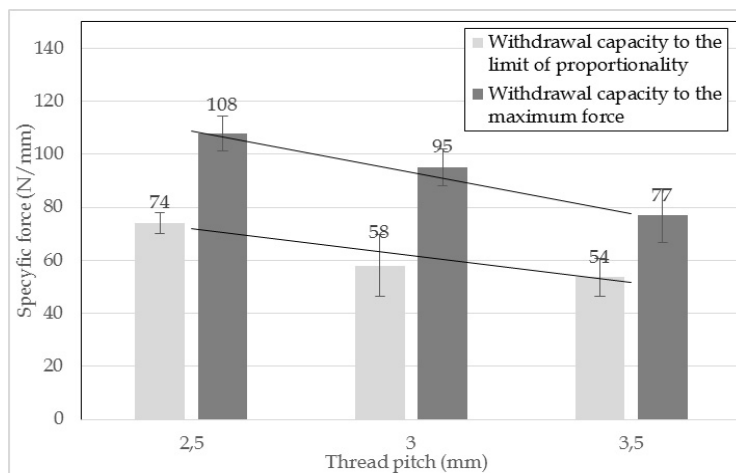


Fig. 4 Specific force in face of sample (radial direction)

## CONCLUSION

We investigated the holding force for three screws placed in samples made of Scots pine wood. Screws are mounted perpendicular to the tangential and to the radial principal anatomical planes of wood. After 9 experiments performed for each of two anatomical planes for three types of screw with differ pitch (2.5, 3.0 and 3.5 mm), it was found that:

1. The holding force for the screws screwed perpendicular to the tangential plane of wood is approx. 15% greater than the holding force of the screws perpendicular to the tangential plane.
2. For the screws placed perpendicular to the tangential plane there was no strong relationship between the thread pitch and screw holding force.
3. For the screws placed perpendicular to the radial plane there was observed decreasing the holding force with increasing a thread pitch.

## REFERENCES

1. AYTEKIN A. 2008): Determination of screw and nail withdrawal resistance of some important wood species. *International Journal of Molecular Sciences*, 9(4), 626–637.
2. AYYILDIZ H., MALKOCOGLU A. 2001: Wood screw withdrawal resistance of some important tree species growing in Eastern Blacksea region. *Journal of Artvin Kafkas Forestry Faculty*, 2(1), 1.
3. BRÖKER F.,W., KRAUSE H. 1991: Orientierende Untersuchungen über das Haltevermögen dynamisch beanspruchter Holzschrauben. *Holz Als Roh-Und Werkstoff*, 49(10), 381–384.
4. CASSENS D. L., ECKELMAN C. A. 1985: Face holding strength of threaded metal inserts in reconstituted wood products. *Forest Products Journal*, 35(3), 18–22.
5. Confirmat. 2015: Häfele America Co. Retrieved from <http://www.hafele.com/us/products/confirmat-screw-connector-hafele.asp>
6. ECKELMAN C., CASSENS D. 1984: Holding strength of metal inserts in wood. *Forest Products Journal*, 34(6), 21–25.
7. ERDIL Y. Z., ZHANG J. 2002: Holding strength of screws in plywood and oriented strand board. *Forest Products Journal*, 52(6), 55.
8. FAIRCHILD I. J. 1926: *Holding power of wood screws*. US Government Printing Office.

9. FERAH O. 1991: *Determination of Nail and Screw Withdrawal Resistance of Some Important Wood Species* (Technical Note). Institute of Forestry Resource, Ankara, Turkey.
10. GAŠPARIK M., BARCÍK Š., BORŮVKA V., HOLEČEK T. 2015: Impact of Thermal Modification of Spruce Wood on Screw Direct Withdrawal Load Resistance. *BioResources*, 10(1), 1790–1802.
11. ISO. 1998: *ISO 9087:1998. Wood – Determination of nail and screw holding power under axial load application*.
12. KARIZ M., KUZMAN M. K., SERNEK M. 2013: The effect of heat treatment on the withdrawal capacity of screws in spruce wood. *BioResources*, 8(3), 4340–4348.
13. KOWALIK R., NOWAK K. 1979: Wpływ ukształtowania wkrętów na zdolność ich utrzymania przez drewno i tworzywa. *Prace Komisji Technologii Drewna*, (8), 53–73.
14. KOWALIK R., NOWAK K., ROCHOWIAK S. 1980: Wpływ wilgotności drewna i płyty wiórowej na długotrwałą zdolność utrzymywania się wkrętów. *Roczniki Akademii Rolniczej W Poznaniu*, 15(125), 59–70.
15. RYBARCZYK W., DAROSZEWSKI J. 1975: Metoda obliczania nośności grup wkrętów przez ustalenie funkcji wzajemnego oddziaływania. *Prace Instytutu Technologii Drewna*, 73-74(XXII), 131–147.

**Streszczenie:** *Wpływ skoku gwintu na siłę utrzymującą wkręty w drewnie sosny zwyczajnej.* Przedmiotem badań była ocena siły utrzymującej trzy rodzaje wkrętów zamontowanych w próbkach wykonanych z drewna sosny zwyczajnej (*Pinus sylvestris* L.). Badano wkręty zamocowane prostopadle do płaszczyzny stycznej oraz promieniowej drewna. Testowano wkręty typu konfirmat o trzech różnych skokach gwintu. Na podstawie wyników badań stwierdzono, że: 1) siła utrzymująca wkręty zamocowane prostopadle do płaszczyzny stycznej jest o 15% większa od analogicznej siły dla wkrętów zamocowanych prostopadle do płaszczyzny promieniowej, 2) skok gwintu ma niewielki wpływ na siłę utrzymującą wkręt wkręcony prostopadle do płaszczyzny stycznej, 3) siła utrzymująca wkręt umieszczony prostopadle do płaszczyzny promieniowej w nieznacznie maleje wraz ze wzrostem skoku gwintu.

Author's addresses:

Maciej Sydor, Grzegorz Zmyślony, Grzegorz Pinkowski, Waldemar Szymański  
Faculty of Wood Technology,  
Poznań University of Life Sciences,  
Ul. Wojska Polskiego 28,  
60-627 Poznań,  
e-mail: [sydor@up.poznan.pl](mailto:sydor@up.poznan.pl).