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FINGER JOINTED IN GLUED PRODUCTS – MANUFACTURE

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Abstract

Paper is focused on quality requirements upgrade of glued products with finger joints according to STN EN 14 080: 2013. New type of cutter producing l_j = 22 mm long fingers was tested on beech and poplar timber. These lengths of "fingers" are suitable for finger joints in structural products. Finger joints were glued by polyurethane glue XILOBOND T FJ 10 with w = 12 ± 2 % moisture content of wood. Finger tail production knowledge were analysed: sample establishment, manual feeding, height of cutter head adjust, finger allowance and face flatness. Opportunities of finger joint utilization are described (rod systems of trusses, small cross-section chords of light composite beam.

Key words: *finger joint, finger length, milling, gluing, beech, poplar*

INTRODUCTION

Finger joints in glued products represent sophisticated joints, which allows high quality construction elements with shape and dimension diversity. Joint is made by fingers and glue and is recommended for use after testing. Strength and elasticity characteristics of structural elements are influenced by shape and length of finger joints (small, medium, large), type of material (wood species) and glue.

In recent days, structural timber is widely used for various glued products. Requirements for production and evaluation define STN EN 14080:2013. (Canceled: EN 387, EN 390, EN 1194, EN 14080:2005, EN 385, EN 386, EN 391, EN 392). Glued product assortment that use various finger length (l_p ~15 to 30 mm) (Fig.1). Perspective utilization is in lineal and curved hybrid crossection elements (ROHNER 2013), which are connected by large finger joints (l_p › 45 mm).

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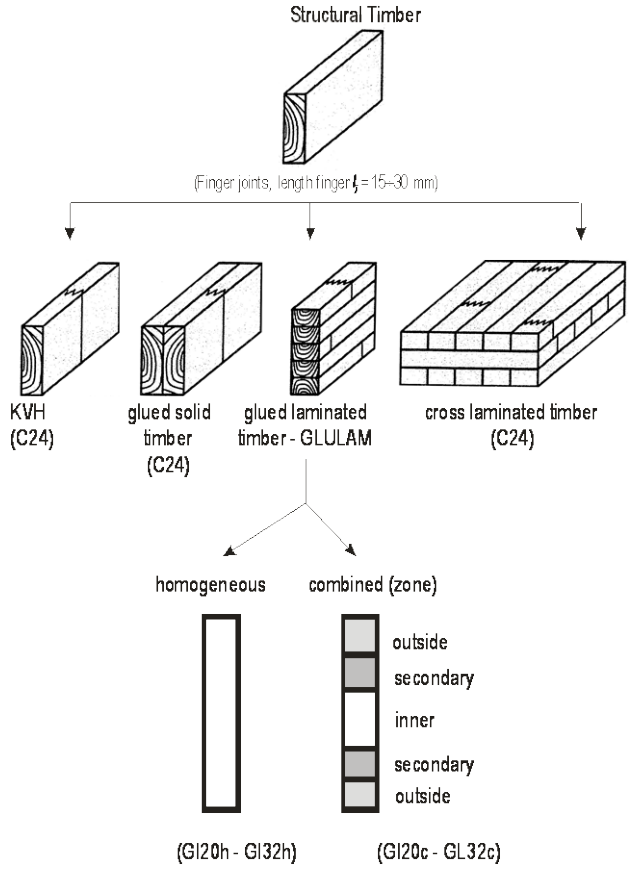

Fig. 1 Various glued products – application finger joints

Finger joint is defined as a self-centering lingitudinal joint created by cutter milling of symetrical fingers row on faces of both sides of elements, which are glued together (BUSTOS *et al* 2001).

Finger joint dimensions (Fig. 2):

$$l_j \geq 4p \times (1 - 2v)$$

$$\alpha \leq 7{,}1^{\circ}$$

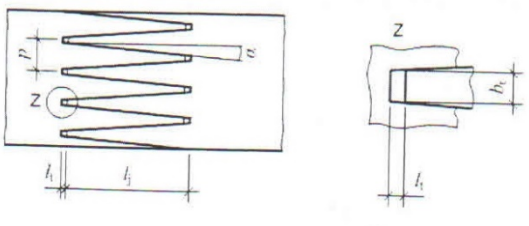

Fig. 2 Profile and geometry of finger joint (EN 14080: 2013)
(l_j - finger length, p – tip spacing, b_t – tip width, v –reduction factor $v = b_t/p$)

Tab. 1 Recommended data of finger joint geometry

Finger length (mm)	Tip spacing, (mm)	Tip width, (mm)	Reduction factor
15	3,8	0,42	0,11
20	5,0	0,5	0,10
20	6,2	1,0	0,16
30	6,2	0,6	0,10

Parameters for various length of finger joints and shape are stated in Tab. 1. Small, medium and large joints are used in production of structural elements e.g. KVH, GLULAM and others.

Knots with diameter up to 6 mm can be neglected, but no knots or deflection of grain direction from longitudal axis are allowed.

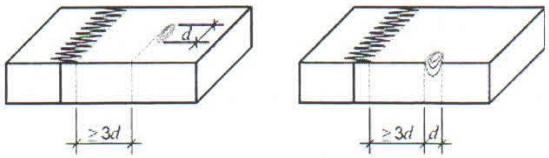

Fig.3 Minimal distance of knot from the base of finger joint

MATERIAL AND METHODS

Fingers on testing samples (beech, poplar) were cutted by horizontal milling cutter. During experiments a new type of cutter head (Φ180x31x50H7 - Benmet Ltd. producing 22 mm long fingers) was tested. This length of fingers is appropriate for finger joints in glued structural elements (STN EN 14 080:2013, tab. 7).

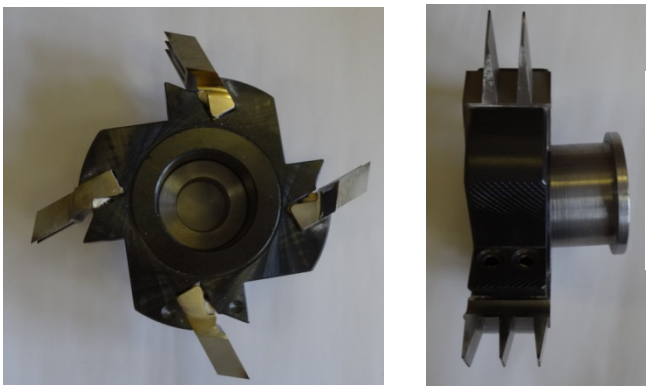

Fig. 4 Cutter head used for joint cutting

RESULTS

Production of finger joints was the most time-consuming part. It was divided into stages:

Stage 1. „Finger“ production, milling cutter setting (fig. 5):

- requires making a tool used for assigning and fixing the samples. They are fixed with an edge and a stops. Samples with obligue cross-section, slight curvature caused low quality fingers from the shape, joint length point of view. Non-steady tip width and crooked fingers were caused becausef of sample indrafting into milling cutter and poor fixing of sample to accessory tool.
- Quality of finger is influenced by feeding speed (manual feeding), non-steady pressure while feeding, causing the coloring of the areas (wood burning, fibres tearing) – requirement: cutter blade sharpening.
- Setting the height of cutting head to secure flatness of surface for both pieces. The milling cutter setting took the longest because accuracy is highly important to reach self-locking effect. Despite that, few joints had low-quality.

Stage 2. - finger joints assembling (dry process). Fig. 6 shows high quality (a) and low quality unsufficient (b) finger joint. Factors influencing on quality of joints, from the „finger“ gap (l_t) and surface flatness point of view, were analysed.

Fig. 5 Joint cutting

a) **b)**

Fig. 6 Finger joint *a)* high quality, *b)* unsufficient

Finger geometry must allows self-locking effect of joint after assemblying and pressing, while a condition should be satisfied (STN EN 14080: 2013):

$$l_j \geq 4p \times (1-2v) \rightarrow \alpha \leq 7{,}1°$$
$$22 \geq 4 \times 6 \times (1-2 \times 0{,}16) \rightarrow 22 \geq 16{,}32, \rightarrow 5 \leq 7{,}1°$$

l_j = 22 mm, p = 6 mm, b_t = 0,96 mm, $v = b_t / p$ = 0,16
while reduction factor v intended to be $v \leq 0{,}18$ and finger length $l_{j>}$ 10 mm.

Joint gluing

One compound glue - XILOBOND T FJ 10 (polyurethane resin) was used. All recommended conditions were kept during gluing process: enviroment temperature, relative humidity and moisture content of wood (temperature 15 C and wood moisture content 12 ± 2 %). Glue was applied manually by brush on both sides of joint. After soaking the glue into wood (approximately 10-15 seconds) joints were assembled. Pressing power was reached with hammer stroke. Testing samples hardened for 72 hours.

Fig. 7 Glued samples hardening with foamed up glue

CONCLUSION

Knowledge gathered from the production of finger joints on the beech and poplar wood are following:

- Experimental testing of new cutter head (l_j =22 mm):

Sample fixing: on small cross-section (26 x 38) is complicated, edges and stops using.
Manual feeding: causes non-steady pressure during feeding, causing the coloring of the areas (wood burning, fibres tearing) – requirement: cutter blade checking and sharpening.
Cutter head height setting: to secure surface flatness of both sides of joint. The milling cutter setting took the longest because accuracy is highly important to reach self-locking effect. Despite that, few joints had low-quality.

- Finger joints assembling (dry process). Factors influencing on quality of joints, from the „finger“ gap (l_t) and surface flatness point of view, were analysed.
- Finger joint utilization in products (rod systems of trusses, small cross-section chords of light composite beam).

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