VTT EXPERT SERVICES LTD

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Task

Statement for nail plate LL13

General

This statement is based on the testing of the nail plate according to the standards EN 14545:2008 and EN 1075:2014. The tests have reported in VTT's research report no VTT-S-07152-07. The characteristic properties have been determined from the test results according to standards EN 14545:2008 and EN 14358:2016.

The structure of the nail plate is according to Figure 1. The width w of the nail plate is multiple of 12 mm and the length l is multiple of 25 mm. The nail plate is manufactured from pre-galvanised steel strips S350GD+ Z275 (EN 10346). The yield strength of the steel plate is at least 350 N/mm^2 and the tension strength at least 420 N/mm^2. The nominal thickness of steel plate is 1,3 mm, the minimum thickness is 1,25 mm and the design core thickness without zinc coatings is at least 1,21 mm.

On the basis of the above-mentioned research data, VTT Expert Services Ltd regards that LL13 nail plate may be used in load carrying joints of softwood timber structures in service class 1 and 2. The nail plate joints shall be designed and manufactured according to EN 1995-1-1 and EN 14250. The thickness of timber shall be at least 39 mm. Timber may be sawn timber, glulam or Kerto-S- or Kerto-T-LVL.

The strength values of the statement are given as the characteristic values X_k of Eurocode 5 (EN 1995-1-1). The design values X_d are calculated by formula

$$X_d = \frac{k_{mod} X_k}{\gamma_M}$$

where k_{mod} is the modification factor for service class and duration of load, that is used in the calculation of anchorage strength and

γ_M is the partial coefficient for material properties according to the actual National Annex of Eurocode 5 (EN 1995-1-1).

Symbols

The symbols used in the statement are defined as follows:

x-direction main direction of plate,

y-direction perpendicular to the main direction,

α angle between the x-direction and the force F (see Figure 2),

β angle between the grain direction and the force F,

$f_{a,0,0}$ the anchorage strength for $\alpha = 0°$ and $\beta = 0°$,

$f_{a,90,90}$ the anchorage strength for $\alpha = 90°$ and $\beta = 90°$,

$f_{t,0}$ the tension capacity per unit width of the plate in the x-direction ($\alpha = 0°$),

$f_{c,0}$ the compression capacity per unit width of the plate in the x-direction,

$f_{v,0}$ the shear capacity per unit width of the plate in the x-direction ($\alpha = 0°$),

$f_{t,90}$ the tension capacity per unit width of the plate in the y-direction ($\alpha = 90°$),

$f_{c,90}$ the compression capacity per unit width of the plate in the y-direction,

$f_{v,90}$ the shear capacity per unit width of the plate in the y-direction ($\alpha = 90°$),

k_1, k_2, k_v, α_0 and γ_0 constants.
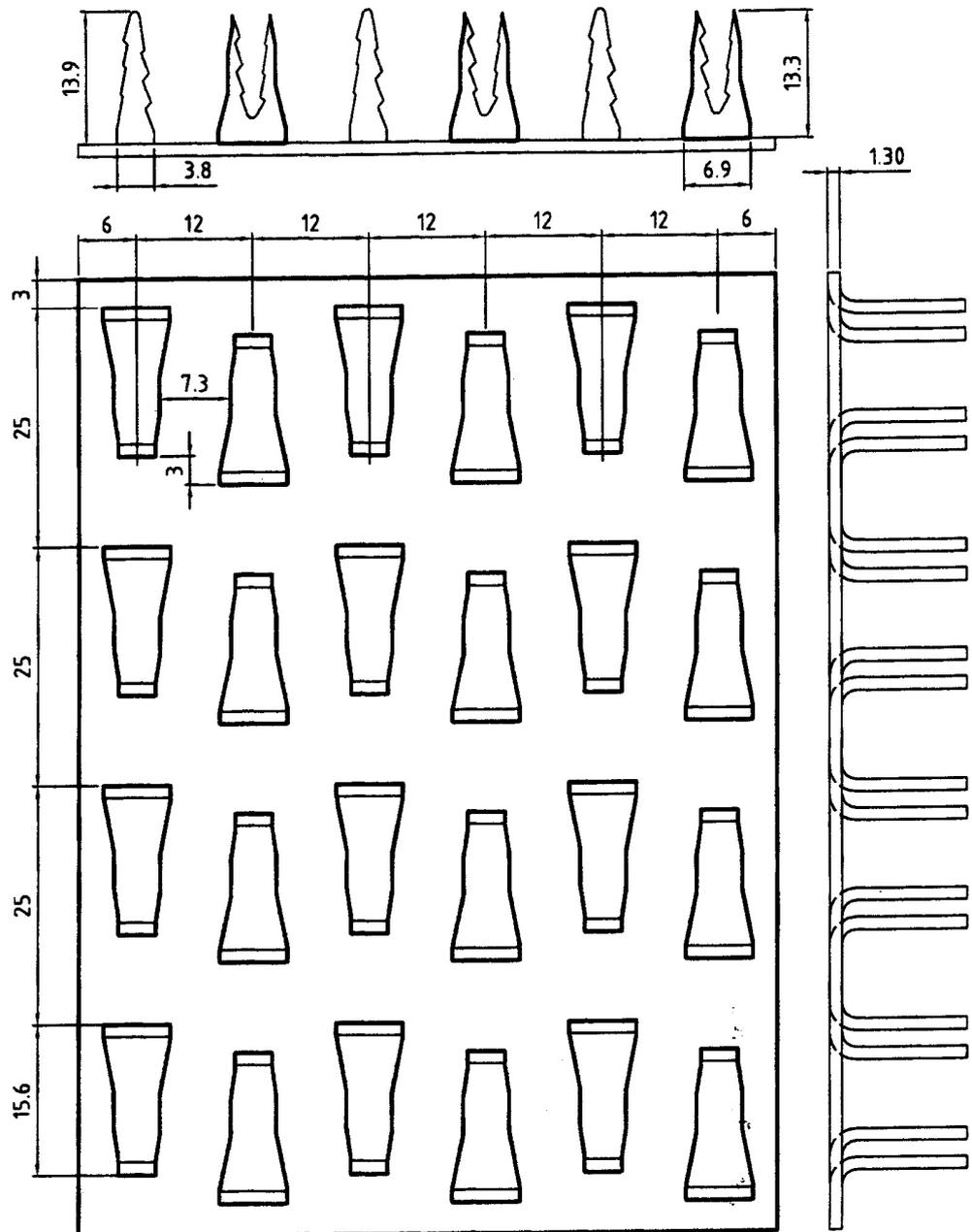

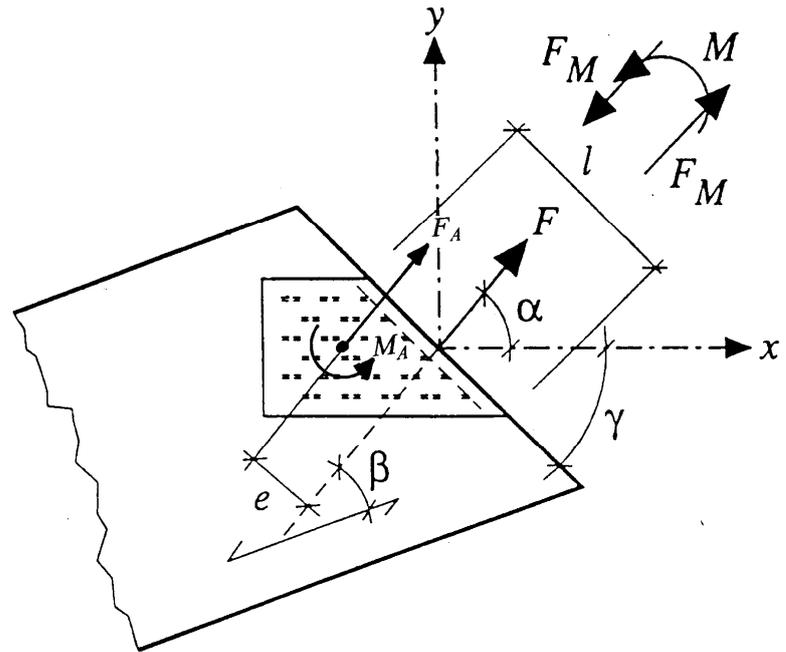**Figure 1.**   Structure of LL13 nail plate.

Figure 2. Geometry of nail plate connection loaded by a force *F* and moment *M*.

Anchorage

The characteristic anchorage strength $f_{a,\alpha,\beta,k}$ is calculated according to Clause 8.8.4 of EN 1995-1-1.

The anchorage parameters of LL13 nail plate are as follows for sawn timber of strength class C24 according to EN 338 and for glued laminated timber of strength class GL30c according to EN 14080:

$$f_{a,0,0,k} = 3,68 \text{ N/mm}^2$$

$$f_{a,90,90,k} = 2,00 \text{ N/mm}^2$$

$$k_1 = -0,003$$

$$k_2 = -0,040$$

$$\alpha_0 = 63°$$

For anchorage strength with other strength class of sawn timber, the characteristic value $f_{a,\alpha,\beta,k}$ should be multiplied by the factor k_ρ given by

$$k_\rho = \sqrt{\frac{\rho_k}{350 \text{ kg/m}^3}}$$

where ρ_k is the characteristic density of sawn timber.

For anchorage strength with other strength class of glued laminated timber, the characteristic value $f_{a,\alpha,\beta,k}$ should be multiplied by the factor k_ρ given by

$$k_\rho = \sqrt{\frac{\rho_k}{390 \text{ kg/m}^3}}$$

where ρ_k is the characteristic density of glulam.

For Kerto-S-LVL according to VTT's certificate no 184/03, the anchorage strength parameters are as follows:

$$f_{a,0,0,k} = 3{,}90 \text{ N/mm}^2$$
$$f_{a,90,90,k} = 2{,}07 \text{ N/mm}^2$$
$$k_1 = 0{,}018$$
$$k_2 = -0{,}030$$
$$\alpha_0 = 45°$$

For Kerto-T-LVL according to Certificate no VTT-C-1781-21, the characteristic anchorage strength is calculated by multiplying the corresponding value $f_{a,\alpha,\beta,k}$ of Kerto-S-LVL by the factor 0,92.

Plate capacity   The plate capacity of the joint line is calculated according to Clause 8.8.5.2 of EN 1995-1-1.

The characteristic values of the plate capacity parameters are as follows:

$$f_{t,0,k} \quad = \quad 264 \text{ N/mm}$$
$$f_{c,0,k} \quad = \quad 111 \text{ N/mm}$$
$$f_{v,0,k} \quad = \quad 123 \text{ N/mm}$$
$$f_{t,90,k} \quad = \quad 192 \text{ N/mm}$$
$$f_{c,90,k} \quad = \quad 111 \text{ N/mm}$$
$$f_{v,90,k} \quad = \quad 97 \text{ N/mm}$$
$$\gamma_0 \quad = \quad 25°$$
$$k_v \quad = \quad 0{,}53$$

Slip modulus   The following value may be used as the general instantaneous slip modulus per unit of the effective nail plate area with mean density of sawn timber $\rho_{mean} = 420 \text{ kg/m}^3$ and with mean density of glued laminated timber $\rho_{mean} = 430 \text{ kg/m}^3$:

$$k_{ser} = 8{,}7 \text{ N/mm}^3$$

For advanced design methods, where the loading direction of the plate α [°] is taken into account, the following values of instantaneous slip modulus per unit of the effective nail plate area may be used:

$$K_{F,\alpha,ser} = 7{,}6 + 0{,}1\alpha \text{ N/mm}^3 \qquad \text{when } \alpha \leq 50°$$

$$K_{F,\alpha,ser} = 20{,}1 - 0{,}15\alpha \text{ N/mm}^3 \qquad \text{when } 50° < \alpha \leq 90°$$

The instantaneous rotational stiffness of the effective nail plate area ($K_r = K_{F,ser}I_p$) may be calculated by using the general value of the instantaneous slip modulus:

$$K_{F,ser} = k_{ser} = 8{,}7 \text{ N/mm}^3$$

For Kerto-S-LVL joints the presented values of slip modulus may be multiplied by the factor 1,06.

This statement shall be valid up until 31.5.2022 at the latest.

Espoo, 2nd May 2017

Markku Hentinen   Ari Kevarinmäki
Manager, Business   Leading Expert

Appendix   Graphically presented characteristic strength values.

Distribution   Ristek Oy   Original, electronically signed
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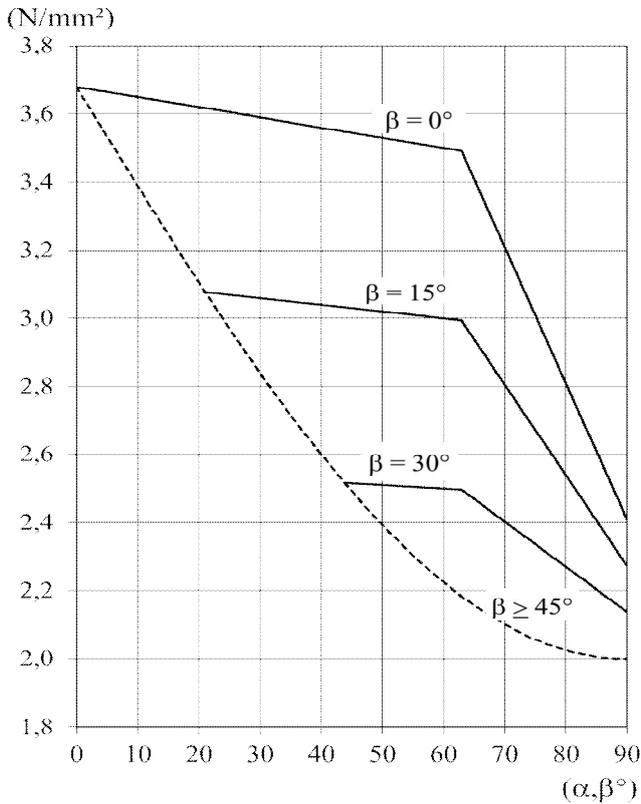Characteristic strength values of LL13 nail plate presented graphically.

Figure A1. Characteristic anchorage strength $f_{a,\alpha,\beta,k}$ for solid timber in strength class C24. The minimum curve (dash line) is used for direction angle max(α,β).
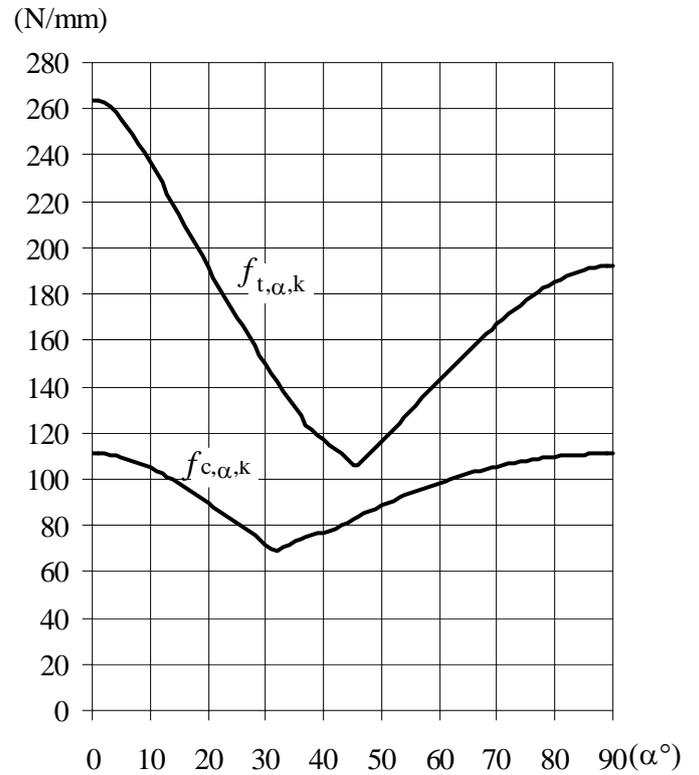

Figure A2. Characteristic plate capacities for tension ($f_{t,\alpha,k}$) and for compression ($f_{c,\alpha,k}$).
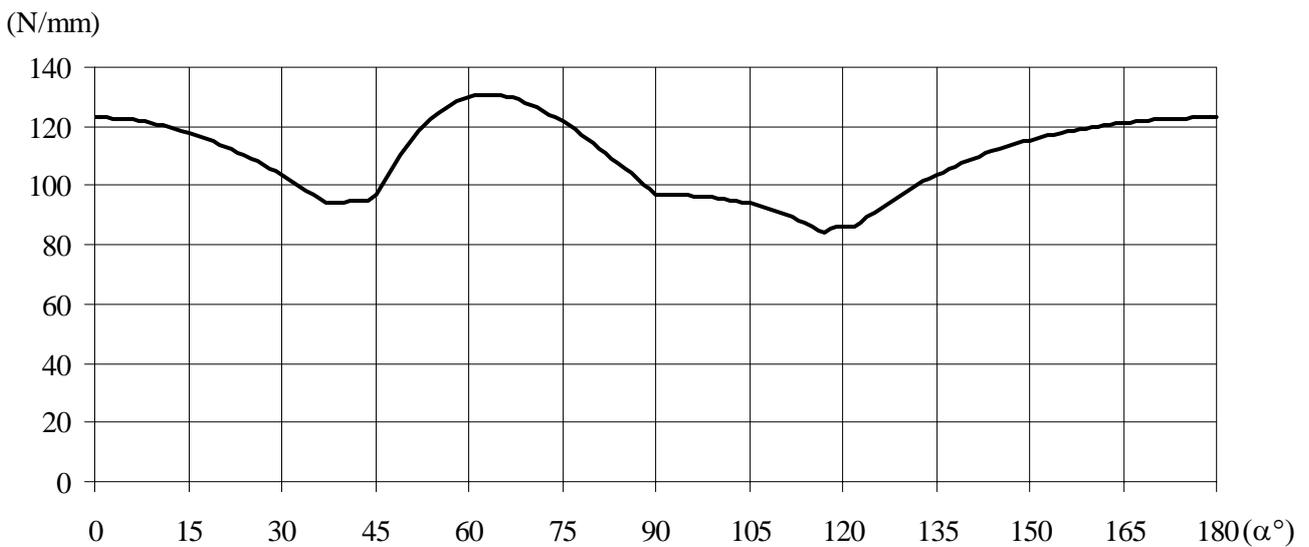

Figure A3. Characteristic plate capacity for shear $f_{v,\alpha,k}$.