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Task **Statement for nail plate LL13 Combi**

General

This statement based on the testing of the nail plate according to the standards EN 14545:2008 and EN 1075:2014 and on the design standard EN 1995-1-1:2004+A1:2008+A2:2014 (Eurocode 5). The tests have been reported in VTT's research reports no VTT-S-07152-07 and VTT-S-00001-08. The characteristic properties of the LL13 Combi nail plate have been determined according to the compliance criteria presented in EN 14545 for the initial type testing of punched metal plate fasteners. In evaluation of the characteristic strength values EN 14358:2016 standard has been applied according to Annex B of EN 14545.

The structure of the LL13 Combi nail plate is according to Figure 1. LL13 Combi nail plate consists of a punched metal plate fastener part and a nailing plate part both according to EN 14545. The nail plates are manufactured from pre-galvanised steel strips S350GD+Z275 (EN 10346). The yield strength of steel plate is at least 350 N/mm^2 and the tension strength at least 420 N/mm^2. The nominal thickness of the 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.

The punched metal plate part is according to LL13 nail plate defined in the VTT's statement no VTT-S-02367-17. The width of the Combi plate is multiple of 25 mm according to Figure 1. The total length of LL13 Combi nail plate is 240 mm, the length of the punched metal plate part is 84 mm and the diameter of the fastener holes is 5,0 mm.

Annular ringed shank nails (anchorage nails) with nominal diameter of 4,0 mm shall be used on the nailing plate part of LL13 Combi nail plate. The annular ringed shank nails shall fulfil the requirements of threaded nails presented in EN 14592 and they shall have a conical part under the head, the profiled length of at least 24 mm and the characteristic yield moment $M_{y,k} \geq 6500$ Nmm.

On the basis of the above-mentioned research data, VTT Expert Services Ltd regards that LL13 Combi nail plate may be used in connections of load-carrying timber structures in service classes 1 and 2. The LL13 Combi nail plates shall be manufactured under the factory production control presented in EN 14545 and the connections shall be designed

and manufactured according to EN 1995-1-1 and EN 14250 with the additional and substitutive rules given in this statement.

This statement relates to use of the LL13 Combi nail plates in the chord splice connections of solid timber and Kerto-S- and Kerto-T-LVL members so that the Combi plates are fastened from all the holes or as a partial fixing so that two hole rows from both edges are left without fasteners (see Figure 1). The longitudinal direction *y* of the plate shall be parallel to the grain. In Kerto-LVL members the Combi plates are nailed perpendicular to the veneer surfaces.

LL13 Combi nail plates are positioned to the middle line of the timber member on opposite faces of the joint so that the distance between the joint line and the end of the punched metal plate part is 90 mm (see Figure 1). The misplacement tolerance of the Combi nail plates is ± 5 mm. In LL13 Combi connections the thickness of timber members shall be at least 40 mm. The nails may not extend through the timber member. The end and edge distances of fasteners shall fulfil the requirements of Eurocode 5.

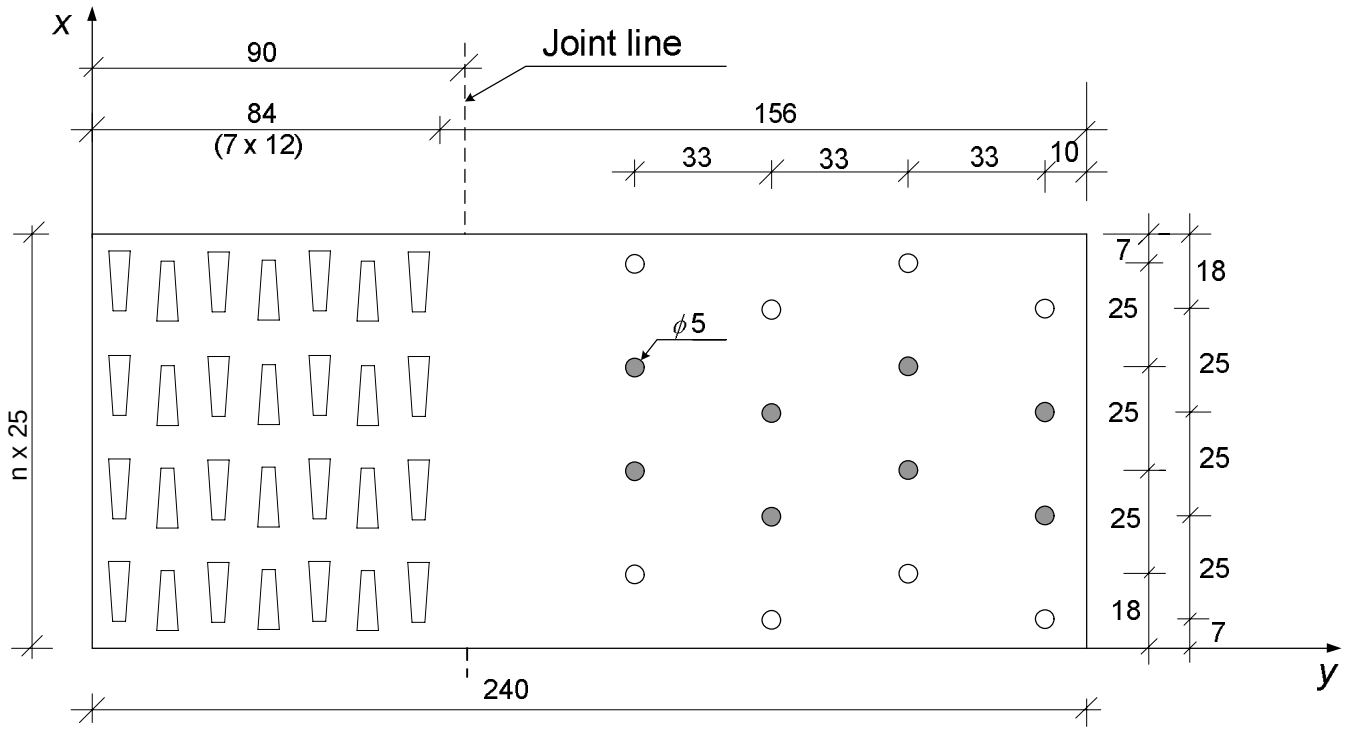

Figure 1. Structure and dimensions of LL13 Combi nail plate in mm. In the partial fixing the plate is fastened from the bold holes, so that altogether 8 holes from the edge rows are left without fasteners.

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 nailed joint capacity,

γ_M is the partial factor for the material property or resistance 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 punching direction of the plate (width direction of the plate),
y-direction perpendicular to the punching direction (length direction of the plate),
α angle between the *x*-direction and the force *F* (= 90° - β),
β angle between the grain direction and the force *F* (= 90° - α),
$f_{c,90}$ compression capacity per unit width of the plate in the *y*-direction (α = 90°).

Design forces and moments of combi plates

For chord splices in tension, the design force and moment per nail plate are as follows

$$F_{A,d} = \sqrt{\left(\frac{N_d}{2}\right)^2 + \left(\frac{V_d}{2}\right)^2} \quad (1)$$

and $$M_{A,d} = \tfrac{1}{2}\left|M_d\right| \quad (2)$$

where N_d is the design tension force of the chord member,
V_d is the design shear force of the chord member and
M_d is the design moment of the joint node.

For chord splices in compression, the contact between timber members may be utilized by using the following reduced values for the design force and moment per nail plate

$$F_{A,d} = \sqrt{\left(\frac{N_d}{4} - \frac{3\left|M_d\right|}{4h}\right)^2 + \left(\frac{V_d}{2}\right)^2} \quad (3)$$

and $$M_{A,d} = \tfrac{1}{4}\left|M_d\right| \quad (4)$$

where h is the depth of the chord and
N_d is the compression force of the chord member.

The expressions (3) and (4) may be used provided, that the height of the Combi plate is at least 2/3 from the depth of the timber member and that the gap between the members has an average value, which is not greater than 1,5 mm, and a maximum value of 3 mm.

Anchorage The anchorage capacity verification of the punched metal plate part of a Combi plate is done according to Eurocode 5 with the declared anchorage strength values of LL 13 nail plate presented in VTT-S-02367-17.

Plate capacity The plate capacity verification of the joint line is done according to the punched metal plate rules of Eurocode 5 with the declared plate capacity parameters of LL 13 nail plate presented in VTT-S-02367-17. However, the characteristic compression capacity of *y*-direction shall be limited to the value

$f_{c,90,k}$ = 85 N/mm.

In case of partial nailing, the width dimension of the plate is reduced by 25 mm from both edges in calculation of the plate capacity (design width = plate width – 50 mm).

Load-carrying capacity of fastener group

For the nailing plate connection part the following expression shall be satisfied

$$q_{\max,d} \leq R_d \tag{5}$$

where

$$q_{\max,d} = \frac{F_{A,d}}{n} + \frac{M_{A,d} r_{\max}}{\sum_1^n r_i^2} \tag{6}$$

R_d is the design value of lateral load-carrying capacity of the nail,
n is the number of fasteners per Combi plate,
r_i is the distance of the fastener i from the centroid of the fastener group and
r_{max} is the distance between the most distant fastener and the centroid of the fastener group.

For anchor nails with a declared length of at least 40 mm, the following characteristic lateral load-carrying capacities may be used:

R_k = 1280 N with solid timber of strength class C40
R_k = 1250 N with solid timber of strength class C35
R_k = 1220 N with solid timber of strength class C30
R_k = 1120 N with solid timber of strength class C24
R_k = 1030 N with solid timber of strength class C18
R_k = 930 N with solid timber of strength class C14
R_k = 1440 N with Kerto-S-LVL
R_k = 1320 N with Kerto-T-LVL.

In tensioned joints, the nails fastened to the nearest hole row from the joint line may not be taken into account in calculation of the connection capacity, because the end distance is too short for structural nails.

Slip modulus

The joint slip of the punched metal plate part is calculated according to Eurocode 5 with the declared slip modulus of LL13 nail plate presented in VTT-S-02367-17.

Under service load, the total spring stiffness of nailing plate parts

$$k_{F,ser} = 2nK_{ser} \tag{7}$$

and the rotational stiffness

$$k_{r,ser} = 2K_{ser}\sum r_i^2 \tag{8}$$

where K_{ser} is the instantaneous slip modulus of the nail,
n is the number of nails per Combi plate and
r_i is the distance of the fastener i from the centroid of the nail group.

For ultimate limit state, the values of expressions (7) and (8) are multiplied by 2/3.

The instantaneous slip modulus of the nail may be taken as

$$K_{ser} = 0{,}2\rho_m^{1{,}5} \quad \text{N/mm} \qquad (9)$$

where ρ_m is the mean density of the timber member in kg/m^3.

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

Espoo, 2nd May 2017

Markku Hentinen
Manager, Business

Ari Kevarinmäki
Leading Expert

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