ALUMINIUM INNOVATIONS FOR TIMBER BUILDINGS

CALCULATION MODE FOR ALUHD28 ®

Traction aluminium plate for Alufoot® system

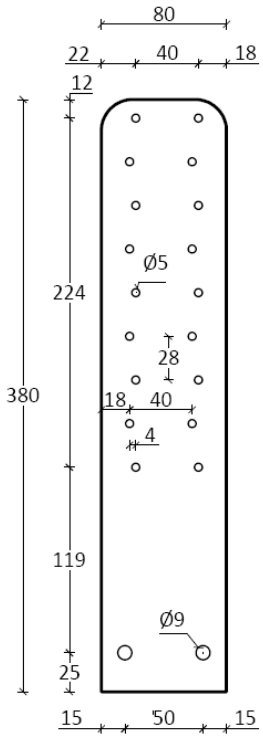
INTRODUCTION

ALUHD28® plate, being part of Alufoot® system, is used in order to connect the CLT wall to the Alufoot® aluminium beam. HD28 geometry has been optimized in order to withstand the traction forces. We suggest to apply them as *hold-down* at the beginning/end of the wall.
Below you can find the report of the strength verification of the plate, following Eurocode 9, using the limit state design, that leads to the definition of the design strength domain compared to the ultimate limit state.
Strength verification is led with the only attention to the failure modes on the metal side (*metal side verification*). Strength verifications of the plate fastening to the timber wall (*timber side verification*) are left to the designer, being subject of many design variables, such as class, wooden type, service class, period of the load, type of fasteners.

SET OF RULES

Eurocode 9 - EN 1999-1-1 (EC9 below)
Eurocode 3 - EN 1993-1-8 (EC3 below)

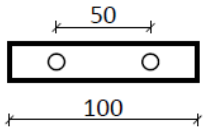
GEOMETRY AND MATERIALS



The system is composed of:

- ALUHD28 plate, using EN AW-5754, aluminium, dimensions 380X80X5 mm;
- EN AW-6082 aluminium guide, L=200 mm, with 4 threaded holes, for M8 bolts;
- 2 self –threading M8 bolts, steel class 8.8, hot galvanizing

The holes (9 mm diameters) for the insertion of the M8 bolts are designed in order to respect the minimum distances as prescribed in EC9 (§8.5.1).



Pic. 1: Geometry of HD28 plate

MATERIAL STRENGTH

According EC9, for EN AW-5754 it is correct to use the characteristic strength values below:

- Yelding: $f_o = 80$ MPa
- Failure: $f_u = 190$ MPa

According to EC3, for steel class 8.8 bolts the characteristic strength values below are assumeable:

- Yelding: $f_{yb} = 640$ MPa
- Failure: $f_{ub} = 800$ MPa

The Eurocodes provides the safety factors below:

- Aluminium ductile failure (EN 1999-1-1 §6.1.3) $\gamma_{M1} = 1.10$
- Aluminium brittle failure (EN 1999-1-1 §6.1.3) $\gamma_{M2} = 1.25$
- Bolts (EN 1993-1-8 §2.2) $\gamma_{M2} = 1.25$

SECTION CLASSIFICATION

The section classification of the plate is calculated according to §6.1.4 of EC9.
For HD28 we have:

- $\beta = 0.4\, b/t = 0.4 \cdot 80/5 = 6.4$
- $\varepsilon = \sqrt{(250/80)} = 1.77$
- $\beta/\varepsilon = 3.62$

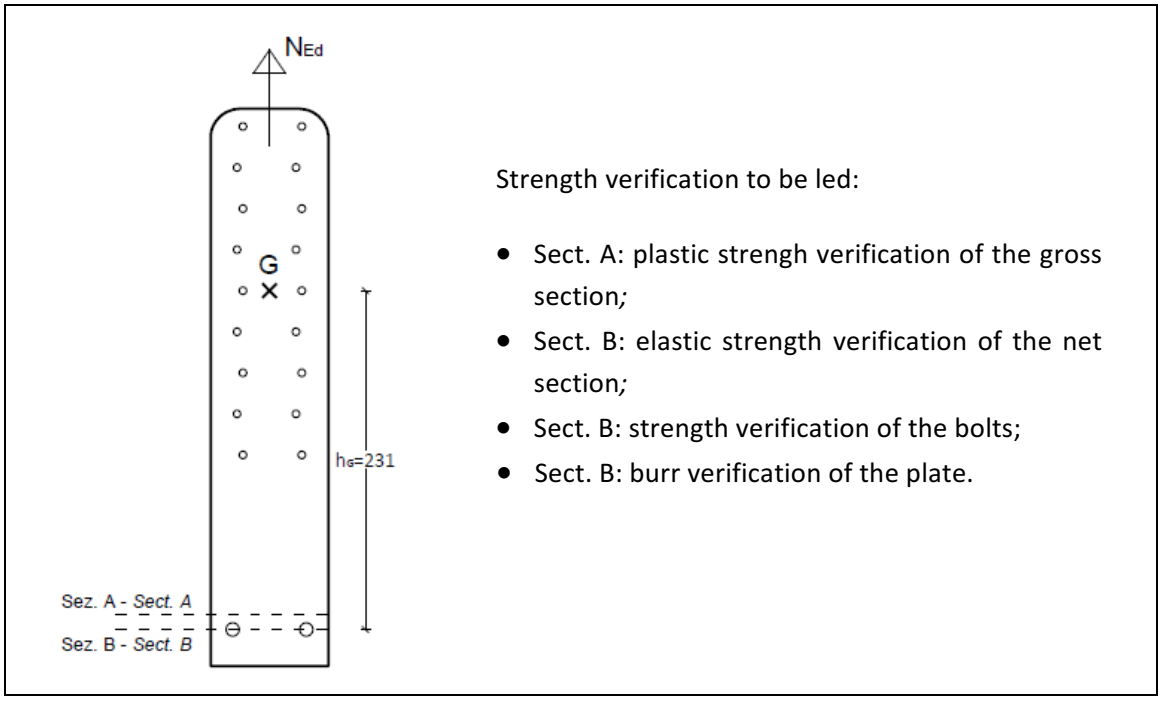
According to table 6.2 of EC9 the section classi s 1. For that class the ultimate strength of the section can be calculated with reference to the ultimate limit state of plastic failure.

DESIGN HYPOTHESIS

The design hypothesis is that the total design force pass through the mass center G of the nailing on the timber wall (see pic. 2).

STRENGTH VERIFICATIONS

The set of strength verifications to be led is illustrated in Pic.2. The strength domain of the plate, in terms of design forces N_{Ed} (traction) and V_{Ed} (shear) will be determined by the weakest strength mechanism



Pic. 2: Verifications to be led

The bolts are fixed to the aluminium profile through an aluminium sliding bar, that is put into the specific pit realized on the profile.
Experimental tests have shown tha the fixing system is over-resistant compared to the bolts, as the failure always comes for the slicing of the bolt on the contact section between plate and aluminium guide.

Section A: verification of the gross section

Because of the geometry of the plate and the aluminium behaviour (defined by EC9), the maximum traction design strength of the plate, gross section level, is equal to:

$$N_{o,Rd} = A_g f_o / \gamma_{M1} = 400 \cdot {}^{80}/_{1.10} = 29.09\ kN$$

Section B: verification of the net area of the plate
Because of the geometry of the plate and the aluminium behaviour (defined by EC9), the maximum traction design strength, on the holes of the bolts, is equal to:

$$N_{u,Rd} = 0.9 A_{net} f_u / \gamma_{M2} = 0.9 \cdot 310 \cdot 190 / 1.25 = 42.41\ kN$$

Section B: verification of bolts strength
The shear strength of the single bolt M8 cl. 8.8 is calculated by the expression:

$$F_{V,Rd} = \alpha_V \cdot \frac{f_{ub} A_s}{\gamma_{M2}} = 0.6 \cdot 800 \cdot \frac{36.6}{1.25} = 14.05\ kN$$

As ALUHD28 uses 2 bolts, the design strength of the bolts is equal to:

$$N_{V,Rd} = 2 \cdot F_{V,Rd} = 2 \cdot 14.05 = 28.1\ kN$$

Section B: burr verification of the plate
The burr verification of the plate for the single M8 hole is calculated by the expression:

$$F_{b,Rd} = k_1 \alpha_b \cdot \frac{f_u d t}{\gamma_{M2}} = 2.5 \cdot 0.926 \cdot \frac{190 \cdot 8 \cdot 5}{1.25} = 14.07\ kN$$

As HD28 has 2 holes, the total burr resistance is equal to:

$$N_{rif,Rd} = 2 \cdot F_{b,Rd} = 2 \cdot 14.07 = 28.14\ kN$$

DESIGN STRENGTH OF THE PLATE (METAL SIDE)
The design traction strength of ALUHD28 is the minor between the ones calculated before:

$$N_{Rd} = \min\{N_{o,Rd}; N_{u,Rd}; N_{V,Rd}; N_{rif,Rd}\} = 28.1\ kN \approx 28\ kN$$

So the verification of HD28 plate will be led according to the following disequation

$$N_{Ed} \leq N_{Rd} = 28\ kN$$

where N_{Ed} is the traction force on the plate, calculated according to USL.