

Calculation note - Ladder fixing kit for cladding

Assumptions :

Rivet centre distance between top and bottom line = 140mm

Distance between vertical axis of ladder and wall = 255mm Steel
cladding thickness = 0.3mm

Ladder secured by at least 3 pairs of brackets Load on upright :

$F_v = 3 \text{ kN}$

In accordance with standard NFE 85-01@, F_v is applied to the fixing lugs.

=> $F_{v1} = 3\text{KN}/3$ (minimum of 3 fixings per upright) = 1 kN

Each interface supports 2 mounting brackets:

Load on interface support: $F_{s1} = F_{v1} \times 2 = 1 \times 2 = 2 \text{ kN}$ **Load**

reduction :

Tensile force R_{h1} :

The point of rotation being commonly accepted on the lower rivet line, the resultant tensile force applied on the upper rivet line is equal:

$255 \times F_{s1} / 140 = 3.4 \text{ kN}$

Number of rivets installed=

3

Resulting force in each rivet: $3.4/3 \Rightarrow R_{h1} = 1.21 \text{ kN}$

Shear force R_{v1} :

In this case, the force F_{s1} of 2 kN will be absorbed by all the fixing rivets installed, both on the lower and upper parts:

Number of rivets installed= 6

Resulting force in each rivet: $2 / 6 \Rightarrow R_{v1} = 0.33 \text{ kN}$

Summary of forces on rivets :

The rivets on the top line are :

- A tensile load $R_{h1} = 1.21 \text{ kN}$;
- A shear load $R_{v1} = 0.33 \text{ kN}$;

The rivets on the bottom line only resume:

- A shear load $R_{v1} = 0.33 \text{ kN}$;

Rivet strength requirements: (see Page 5@ of European technical approval)

The values to be taken into consideration for the "cladding+ rivets" assembly are equal to (for an assembly of part 1, thickness > 1.5mm and part 2 (cladding))

ep. 3/1000ths):

Maximum tensile strength of a rivet

$R_t = 1.48 \text{ kN}$

Maximum rivet shear strength

$R_c = 1.78 \text{ kN}$

Checking the safety coefficient :

The rivets on the top line are :

- *Tensile strength :*
 - $R_t / R_{h1} = 1.48 \text{ kN} / 1.21 = \text{safety coefficient} = 1.22$
- *Shear strength*
 - $R_c / R_{v1} = 1.78 \text{ kN} / 0.33 = \text{safety} = 5.39$

The dimensioning of rivets subjected to combination of forces (*tension + shear*) must comply with the following formula according to Eurocode 3 :

$$(R_{v1}/R_c) + (R_{h1}/(1.4 \times R_t)) \leq 1$$

AN :

$$(0.33/1.78) + (1.21/(1.4 \times 1.48)) = 0.77$$

Satisfactory condition because less than 1

The rivets on the bottom line include :

- *Shear strength*
 - $R_c / R_{v1} = 1.78 \text{ kN} / 0.33 = \text{safety} = 5.39$

Conclusion:

The ladder itself (*including its crinoline and fixing brackets*) complies with standard NFE 85.01@.

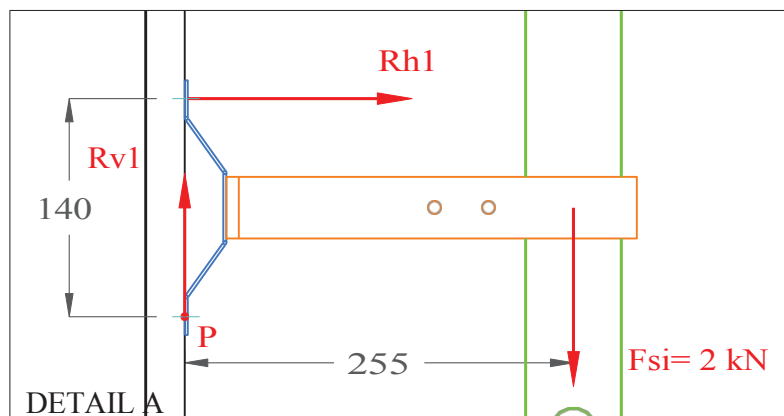
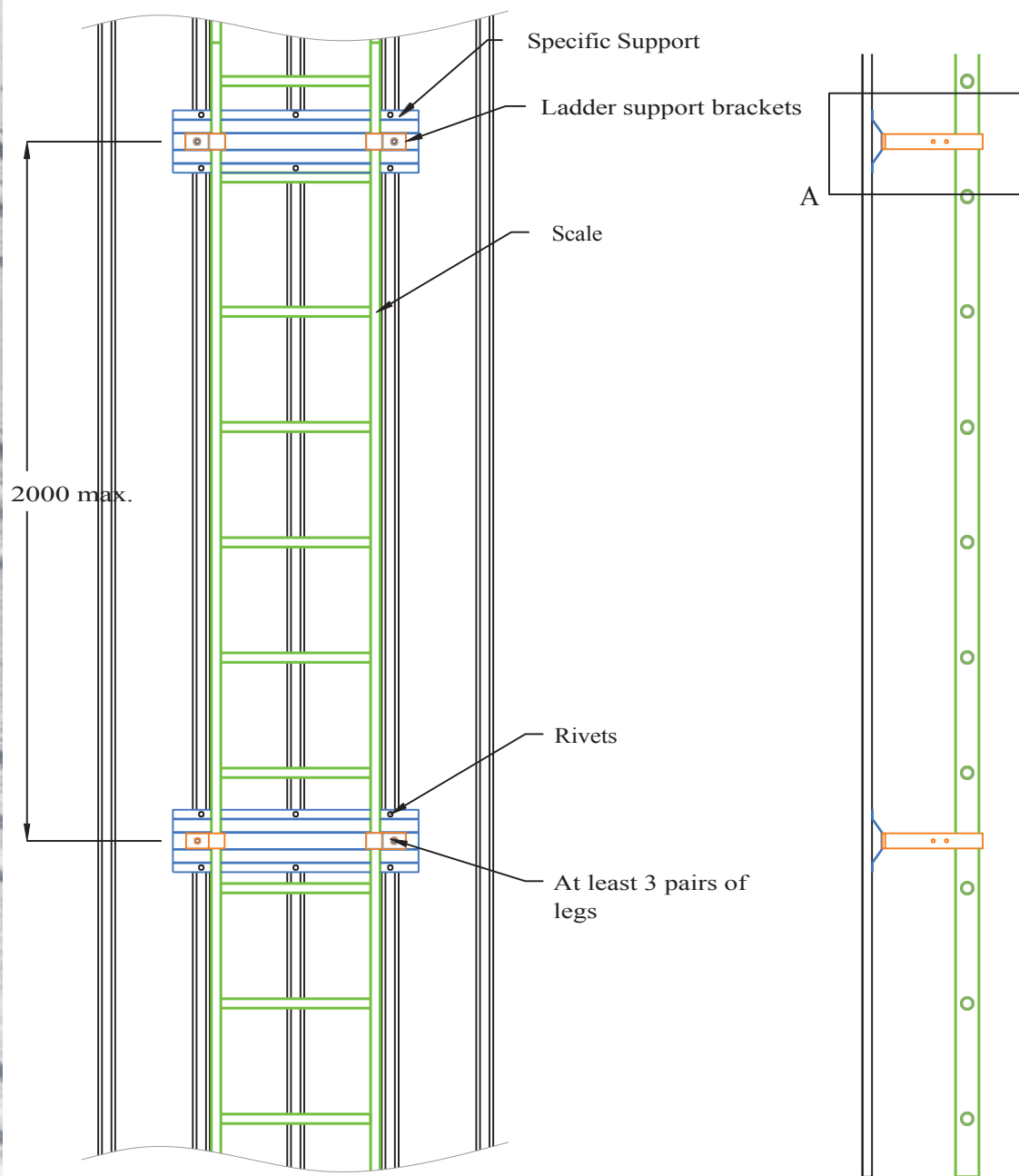
The ladder fixing interface on the cladding is well justified in terms of the 3kN load per upright specified in the standard (*paragraphs 4.3.2 and 7.3*).

__This load does not constitute a normal load but **the minimum vertical tensile load that the ladder must withstand.**

There is no safety coefficient specified in the standard, this condition being considered sufficient.

Consequently, the ladder installed complies with the provisions specified in standard NFE85.01@.

Mr. TALHA (office technician)



4.3 Materials and sizing

4.3.1 Materials

The materials must have sufficient strength and ductility characteristics to ensure that the failure load (breakage or flow) is 25% greater than the ultimate load (a necessary condition to avoid non-ductile failures).

Fasteners must be sized to ensure that the strength and ductility characteristics of the joint components are not degraded.

The materials used must, by their nature or through additional treatment, be able to resist corrosion induced by an ambient atmosphere.

Any part likely come into contact with personnel must be free sharp edges and designed in such a way not to cause a risk of injury due to the user's clothing being caught.

Fixed ladders with or without crinolines must be designed with two uprights. The finish area must comply with NF E 85-014.

4.3.2 Sizing

The ladder components must comply with the requirements of NF EN 131-2. The maximum deformation, as indicated in 5.1 of the aforementioned standard, must not exceed 50 mm.

The permanent deformation of the connecting elements resulting from a horizontal load of 500 N must not exceed 10 mm. The fixing brackets and their fixings must be capable of 3000 N per upright (see check in 7.3).

The permanent deformation of the crinoline resulting from a vertical load of 1000 N must not 10 mm and that resulting from a horizontal load of 500 N must not exceed 10 mm (see 7.2 and Figure 10).

4.4 Rung spacing

4.4.1 Spacing between rungs

The spacing between two successive rungs must be constant and must be between 225 mm and 300 mm.

4.4.2 Spacing between rungs and start/finish area

The vertical distance between the starting platform and the first rung must not exceed the distance between two consecutive rungs.

The top step must be a landing step and must be positioned at the same level as the arrival platform.

4.5 Geometric characteristics of rungs

4.5.1 Length of rungs on fixed ladders with two uprights

The length of the rungs, clearance between the two uprights, must be between 400 and 600 mm.

4.5.2 Step section

The diameter of rungs with a circular cross-section must be at least 20 mm; the width of the bearing surface of rungs with a polygonal and U-shaped cross-section must be at least 20 mm.

The diameter of the circular rung or the largest diameter of a rung with a polygonal cross-section and a U-shaped profile must not be greater than 35 mm, allowing it to be easily grasped by the hand.

7.2.3 For the uprights, a simulated load (F_H) of 500 N must be applied horizontally at the worst point. The simulated load (F_H) can be distributed over three studs (see Figure 12). The permissible permanent deformation measured at the point of application of the load is equal to a maximum of 10 mm. Test crinolines that show permanent deformation must not be put into service.

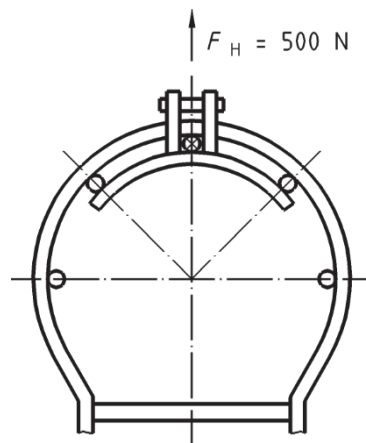
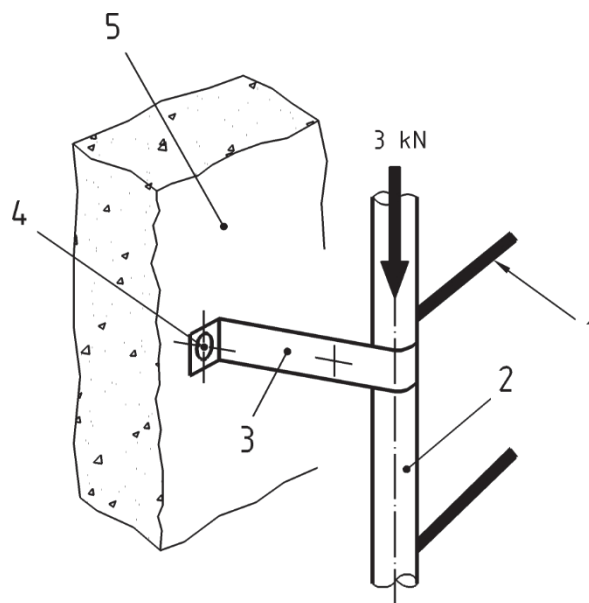


Figure 12 - Testing a crinoline (horizontal)

7.3 Test of anchorage points for fixed ladders with two uprights

On each upright, a maximum of four anchor points must be taken into account, through which the forces are transmitted to the fixed parts of the environment (e.g. wall, machine enclosure, etc.).

The strength of the anchor points for fixed ladders must be calculated taking into account a force of 3 kN for each upright, directed along the centre distance of each upright (see Figure 13).



Legend

- 1 Level
- 2 Amount
- 3 Fixing bracket
- 4 Anchoring point
- 5 Fixed part (e.g. wall)

Figure 13 - Installation for assessing anchor points and fixings for fixed two-post ladders