# XEPOX®

## TWO COMPONENTS EPOXY ADHESIVE

VIDEO

CALCULATION TOOL

EN 1504-4

### RELIABLE
Proven effectiveness evidenced by 35 years of use in timber construction. Available in 400 ml cartridges for practical and fast use, in 3 litre and 5 litre sizes for larger volume joints.

### HIGH PERFORMANCE
High-performance two-components epoxy adhesive. It allows connections with a stiffness unmatched by mechanical connection systems.

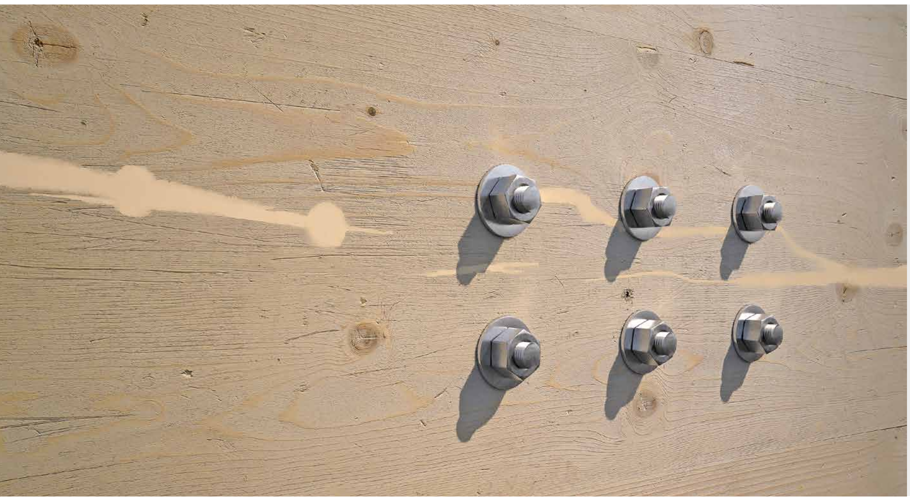
### DAILY USE
Also suitable for everyday use, such as for repairs, filling holes or restoring damaged portions of timber.

USA, Canada and more design values available online.

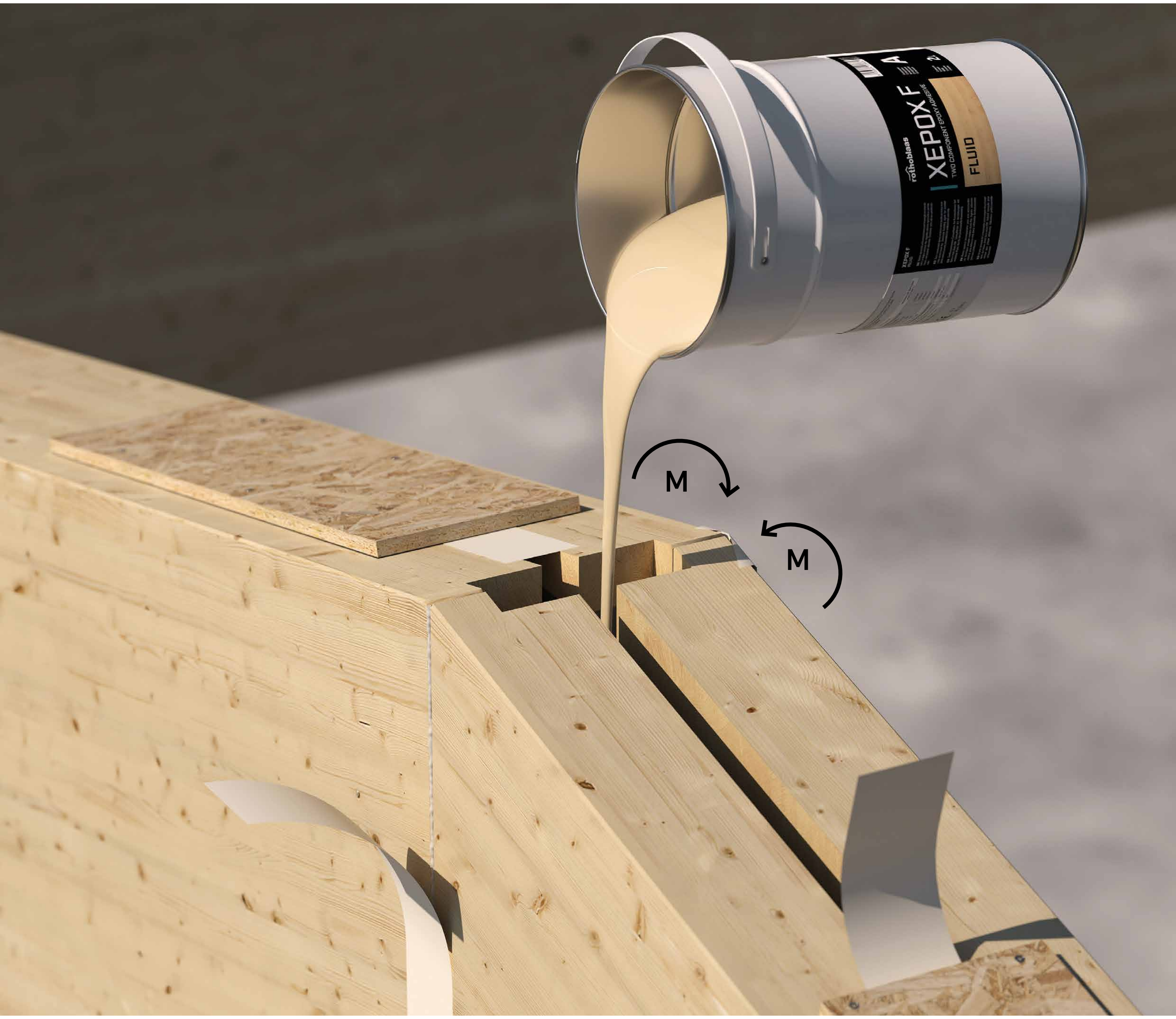
### SIZES
in 3 and 5 litre drums or 400 ml cartridges

### APPLICATION
applicable by spray, brush, percolation or spatula depending on viscosity

### VIDEO
Scan the QR Code and watch the video on our YouTube channel

## FIELDS OF USE
Glued joints for panels, beams, columns, tie rods and studs.
Application with glued rods.
Application with glued plates for rigid shear, moment and axial action joints.
Repair or consolidation of damaged timber elements.




## STRUCTURAL

Excellent for the construction of multi-directional rigid joints, with glued plates or rods.

## STATIC CONSOLIDATION

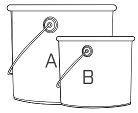
Can be used to rebuild “timber material” in combination with metal rods and other materials.

## CODES AND DIMENSIONS

### XEPOX P - primer

Two-component epoxy adhesive with extremely low viscosity and high wetting properties for carbon or glass fibre structural reinforcements. Useful to protect sanded metal sheets SA2,5/SA3 (ISO 8501) and to realize FRP (Fiber Reinforced Polymers) bits. Applicable by roller, spray and brush.

| CODE | description | content | | package | pcs |
|---|---|---|---|---|---|
| | | [ml] | [US fl oz] | | |
| **XEPOXP3000** | P - primer | A + B = 3000 | *A+B = 101.44* | drums | 1 |

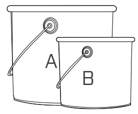



Component A classification: Eye Irrit. 2; Skin Irrit. 2; Skin Sens. 1; Aquatic Chronic 2; Component classification B: Acute Tox. 4; Skin Corr. 1B; Eye Dam. 1; Skin Sens. 1; Aquatic Chronic 3.

### XEPOX L - liquid

Two-components epoxy adhesive for structural usage, very fluid, applicable via pouring into very deep vertical holes and suitable for joints with hidden bits placed in quite extended grooves, also good in case of reduced spacing (1mm or more), provided that the slots are accurately sealed. Pourable and injectable.

| CODE | description | content | | package | pcs |
|---|---|---|---|---|---|
| | | [ml] | [US fl oz] | | |
| **XEPOXL3000** | L - liquid | A + B = 3000 | *A+B = 101.44* | drums | 1 |
| **XEPOXL5000** | L - liquid | A + B = 5000 | *A+B = 169.07* | drums | 1 |

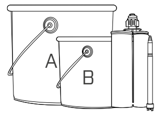



Component A classification: Eye Irrit. 2; Skin Irrit. 2; Skin Sens. 1; Aquatic Chronic 2; Component classification B: Repr. 1B; Acute Tox. 4; STOT RE 2; Skin Corr. 1B; Eye Dam. 1; Skin Sens. 1.

### XEPOX F - fluid

Two-components epoxy adhesive for structural usage, applicable via injection into holes and grooves, provided that the slots are accurately sealed. Ideal for binding timber connectors bent (Turrini-Piazza method) into timber-concrete composite floors, on both new and existing beams; gaps between timber and metal of approximately 2 mm or more. Pourable and injectable with cartridge.

| CODE | description | content | | package | pcs |
|---|---|---|---|---|---|
| | | [ml] | [US fl oz] | | |
| **XEPOXF400**(1) | F - fluid | 400 | *13.53* | cartridge | 1 |
| **XEPOXF3000** | F - fluid | A + B = 3000 | *A+B = 101.44* | drums | 1 |
| **XEPOXF5000** | F - fluid | A + B = 5000 | *A+B = 169.07* | drums | 1 |

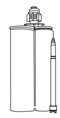



(1) 1 STINGXP mixing nozzle included per XEPOXF400 cartridge
Component A classification: Eye Irrit. 2; Skin Irrit. 2; Skin Sens. 1A; Aquatic Chronic 2; Component classification B: Repr. 1B; Acute Tox. 4; STOT RE 2; Skin Corr. 1B; Eye Dam. 1; Skin Sens. 1A.

### XEPOX D - dense

Two-component epoxy thixotropic (dense) adhesive for structural usage, applicable via injections especially into horizontal or vertical holes in Glulam and solid timber beams, masonry or reinforced concrete walls.
Injectable with cartridge.

| CODE | description | content | | package | pcs |
|---|---|---|---|---|---|
| | | [ml] | [US fl oz] | | |
| **XEPOXD400**(1) | D - dense | 400 | *13.53* | cartridge | 1 |



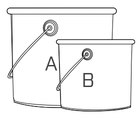
(1) 1 STINGXP mixing nozzle included per XEPOXD400 cartridge

Component A classification: Eye Irrit. 2; Skin Irrit. 2; Skin Sens. 1; Aquatic Chronic 2; Component classification B: Repr. 1B; Acute Tox. 4; Skin Corr. 1B; Eye Dam. 1; Skin Sens. 1; Aquatic Chronic 3.

### XEPOX G - gel

Two-components epoxy gel adhesive for structural usage, applicable via trowel also on vertical surfaces, permits the realization of thick or uneven layers. Suitable for large timber overlaps, for gluing structural reinforcing elements by using glass or carbon fibre and for metal or timber coatings. Spreadable.

| CODE | description | content | | package | pcs |
|---|---|---|---|---|---|
| | | [ml] | [US fl oz] | | |
| **XEPOXG3000** | G-gel | A + B = 3000 | *A+B = 101.44* | drums | 1 |




Component A classification: Eye Irrit. 2; Skin Irrit. 2; Skin Sens. 1; Aquatic Chronic 2; Component classification B: Acute Tox. 4; Skin Corr. 1A; Eye Dam. 1; STOT SE 3; Skin Sens. 1; Aquatic Chronic 4.

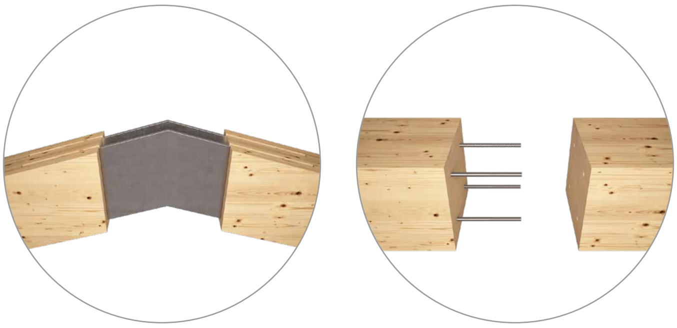
## ADDITIONAL PRODUCTS - ACCESSORIES

| CODE | description | pcs |
|---|---|---|
| MAMDB | special gun for two-component adhesive | 1 |
| STINGXP | spare nozzle for two-component adhesive | 1 |

## FIELD OF USE

The mixture of components A and B causes an exothermic reaction (heat development) and, once hardened, forms a three-dimensional structure with exceptional properties, such as: durability over time, interaction with no humidity, excellent thermal stability, great stiffness and strength.
The different viscosities of XEPOX products guarantee versatile uses for different types of joints, both for new constructions and for structural recoveries. The use in combination with steel, in particular plates, sandblasted or drilled, and rods, allows to provide high strength in limited thickness.

1. MOMENT CONTINUITY JOINT



2. TWO- OR THREE-WAY CONNECTIONS

3. TIMBER JOINT

4. REHABILITATION OF DAMAGED PARTS

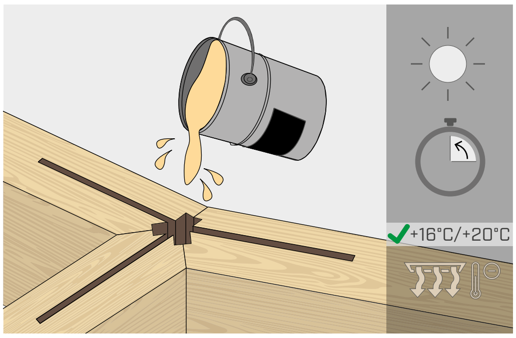
## AESTHETIC IMPROVEMENTS

The cartridge format also allows it to be used for aesthetic adjustments and gluing in small quantities.

## APPLICATION AND CONSERVATION TEMPERATURE

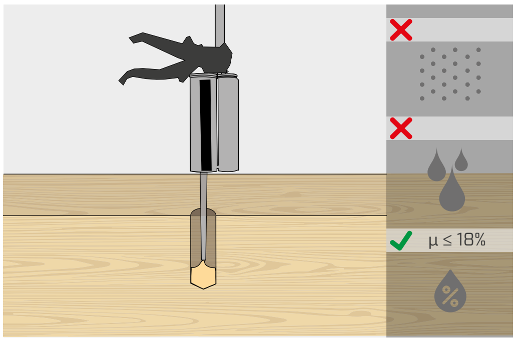

### ADHESIVE CONSERVATION

Epoxy adhesives must be stored and kept until the immediate time of use at a moderate temperature in both winter and summer (ideally around + 16 °C / + 20 °C).
Extreme temperatures facilitate the separation of individual chemical components, increasing the risk of incorrect mixing. Leaving the packages exposed to the sun considerably reduces the product polymerization time.
Storage temperatures below 10 °C increase the viscosity of adhesives, making extrusion or percolation very difficult.




### ADHESIVE APPLICATION

The ambient temperature has a significant influence on curing time. It is recommended to carry out structural glueing at an ambient temperature T>+10 °C, ideally around 20 °C. If the temperature is too cold, it is imperative to heat the packages at least one hour before use and to allow for longer times before applying the load. If temperatures should be too high (> 35 °C), glueing should be carried out in cool places, avoiding the hottest hours of the day, considering a significant reduction in curing time. If the above prescriptions are not followed, there is a risk that the static performance of the joint will not be achieved.




### ROUTING AND HOLE TREATMENTS

Before applying the adhesive, the holes and grooves made in the timber must be protected from meteoric water and humidity, and cleaned with compressed air.
If the parts expecting the potting are wet, it is mandatory to dry them.
XEPOX adhesive is recommended for use with timber with a moisture content lower than 18%.

## TECHNICAL FEATURES

| Properties | Standard | | XEPOX P | XEPOX L | XEPOX F | XEPOX D | XEPOX G |
|---|---|---|---|---|---|---|---|
| Specific weight | ASTM D 792-66 | [kg/dm$^3$] | ≈ 1,10 | ≈ 1,40 | ≈ 1,45 | ≈ 2,00 | ≈ 1,90 |
| Stoichiometric volume ratio (A:B) [(1)] | - | - | 100 : 50 [(2)] | 100 : 50 | 100 : 50 | 100 : 50 | 100 : 50 |
| Viscosity (25 °C) | - | [mPa·s] | A = 1100<br>B = 250 | A = 2300<br>B = 800 | A = 14000<br>B = 11000 | A = 300000<br>B = 300000 | A = 450000<br>B = 13000 |
| Pot life (23 °C ± 2°C)[(3)] | ERL 13-70 | [min] | 50 ÷ 60 | 50 ÷ 60 | 50 ÷ 60 | 50 ÷ 60 | 60 ÷ 70 |
| Application temperature | - | [°C] | 10 ÷ 35 | 10 ÷ 35 | 10 ÷ 35 | 10÷35 | 10÷35 |
| Glass transition temperature | EN ISO 11357-2 | [°C] | 66 | 61 | 59 | 57 | 63 |
| Normal adhesion tension (mean value) $\sigma_0$ | EN 12188 | [N/mm$^2$] | 21 | 27 | 25 | 19 | 23 |
| Compressive oblique shear strength at 50° $\sigma_{0,50°}$ | EN 12188 | [N/mm$^2$] | 94 | 69 | 93 | 55 | 102 |
| Compressive oblique shear strength at 60° $\sigma_{0,60°}$ | EN 12188 | [N/mm$^2$] | 106 | 88 | 101 | 80 | 109 |
| Compressive oblique shear strength at 70° $\sigma_{0,70°}$ | EN 12188 | [N/mm$^2$] | 121 | 103 | 115 | 95 | 116 |
| Compression strength[(4)] | EN 13412 | [N/mm$^2$] | 95 | 88 | 85 | 84 | 94 |
| Elastic modulus in compression | EN 13412 | [N/mm$^2$] | 3438 | 3098 | 3937 | 3824 | 5764 |
| Coefficient of thermal expansion[(5)] | EN 1770 | [m/m°C] | $7{,}0 \times 10^{-5}$ | $7{,}0 \times 10^{-5}$ | $6{,}0 \times 10^{-5}$ | $6{,}0 \times 10^{-5}$ | $5{,}0 \times 10^{-5}$ |
| Tensile strength[(6)] | ASTM D638 | [N/mm$^2$] | 40 | 36 | 30 | 28 | 30 |
| Elastic modulus in tension[(6)] | ASTM D638 | [N/mm$^2$] | 3300 | 4600 | 4600 | 6600 | 7900 |
| Flexural strength[(6)] | ASTM D790 | [N/mm$^2$] | 86 | 64 | 38 | 46 | 46 |
| Elastic modulus in flexure[(6)] | ASTM D790 | [N/mm$^2$] | 2400 | 3700 | 2600 | 5400 | 5400 |
| Unitary shear strength by punch tool[(6)] | ASTM D732 | [N/mm$^2$] | 28 | 29 | 27 | 19 | 25 |

### NOTES

(1) The components are packaged in pre-measured quantities, ready to use. The ratio is by volume (not weight).

(2) It is best not to use more than one litre of mixed XEPOX P at a time. The weight ratio between components A:B is around 100:44,4

(3) Pot-life refers to the time required for the initial viscosity of the mixture to double or quadruple. This is the time during which the resin remains usable after being mixed with the hardener. It differs from the working life, which is the time available for the operator to apply and handle the resin (approximately 25-30 min).

(4) Average value (out of 3 tests performed) at the end of load/unload cycles.

(5) Coefficient of thermal expansion in the range from -20 °C to +40 °C, according to UNI EN 1770.

(6) Average value from tests carried out in the research campaign: "Innovative connections for timber structural elements" - Politecnico di Milano.

- XEPOX is registered as European Union Trade Mark No. 018146096.

# JOINTS WITH GLUED RODS

The indications contained in DIN 1052:2008 and in the Italian standards CNR DT 207:2018 are reported.

## CALCULATION MODE | TENSILE STRENGTH

The tensile strength of a rod of diameter d is equal to:

$$R_{ax,d} = min \begin{cases} f_{y,d} \cdot A_{res} & \text{steel rod failure} \\ \pi \cdot d \cdot l_{ad} \cdot f_{v,d} & \text{timber-to--adhesive interface failure} \\ f_{t,0,d} \cdot A_{eff} & \text{failure on timber side} \end{cases}$$

where:

**$f_{yd}$** is the design yield strength of the steel rod [N/mm$^2$]

**$A_{res}$** is the strength area of the steel rod [mm$^2$]

**d** is the nominal diameter of the steel rod [mm]

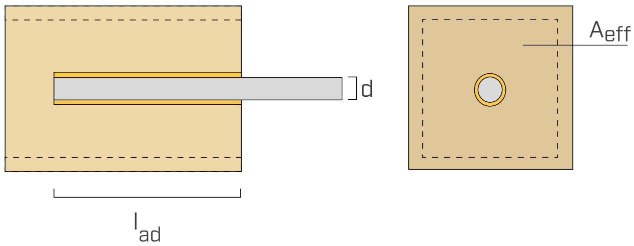
**$l_{ad}$** is the glueing length of the steel rod [mm]

**$f_{v,d}$** is the design shear strength of the glueing [N/mm$^2$]

**$f_{t,0,d}$** is the design tensile strength parallel to the timber grain [N/mm$^2$]

**$A_{eff}$** is the effective failure area of timber [mm$^2$]

The effective area $A_{eff}$ cannot be assumed greater than that corresponding to a timber square of side 6·d and in any case not greater than the effective geometry.




The characteristic shear strength $f_{v,k}$ depends on the glueing length:

| $l_{ad}$ [mm] | $f_{v,k}$ [MPa] |
|---|---|
| **≤ 250** | **4** |
| **250 < $l_{ad}$ ≤ 500** | **5,25 - 0,005 · l** |
| **500 < $l_{ad}$ ≤ 1000** | **3,5 - 0,0015 · l** |

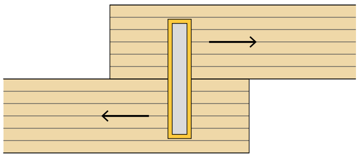
For a glueing angle α with respect to the grain direction:

$$f_{v,\alpha,k} = f_{v,k} \cdot (1,5 \cdot sin^2\alpha + cos^2\alpha)$$

### CALCULATION MODE | SHEAR STRENGTH

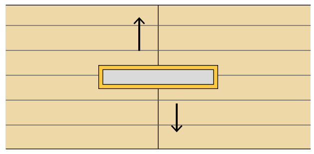
The shear strength of a rod can be calculated using the well-known Johansen's formulas for bolts with the following measures.

$$f_{h,k\perp} = f_{h,k} + 25\%$$



For rods glued **perpendicularly to the fibre**, the bearing stress strength can be increased by up to 25%.

$$f_{h,k,//} = 10\%\ f_{h,k,\perp}$$



For rods glued **parallel to the grain**, thebearing strength is 10% of the value perpendicular to the grain.

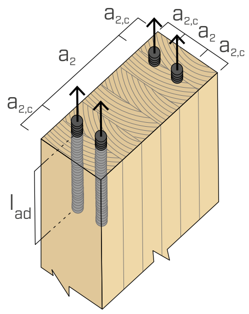
The hollow effect is calculated as the strength given by the timber-adhesive interface. To obtain the strength of a rod glued at an α angle compared to the grain, it is permitted to interpolate linearly between the strength values for α=0° and α=90°.

## INSTALLATION

### MINIMUM DISTANCES FOR TENSILE LOADS

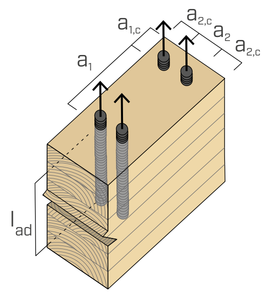
Rods glued // to the fibre

| | |
|---|---|
| $a_2$ | 5·d |
| $a_{2,c}$ | 2,5·d |




Rods glued ⊥ to the grain

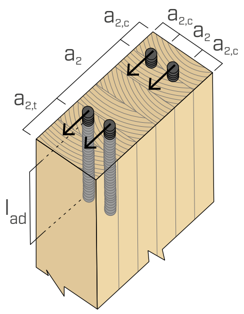
| | |
|---|---|
| $a_1$ | 4·d |
| $a_2$ | 4·d |
| $a_{1,c}$ | 2,5·d |
| $a_{2,c}$ | 2,5·d |




### MINIMUM DISTANCES FOR SHEAR LOADS

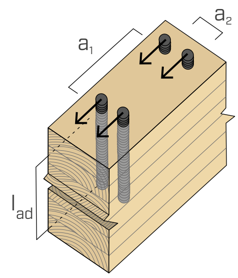
Rods glued // to the fibre

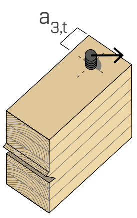
| | |
|---|---|
| $a_2$ | 5·d |
| $a_{2,c}$ | 2,5·d |
| $a_{2,t}$ | 4·d |

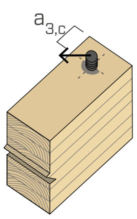


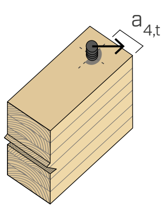

Rods glued ⊥ to the grain

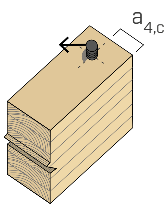
| | |
|---|---|
| $a_1$ | 5·d |
| $a_2$ | 3·d |
| $a_{3,t}$ | 7·d |
| $a_{3,c}$ | 3·d |
| $a_{4,t}$ | 3·d |
| $a_{4,c}$ | 3·d |



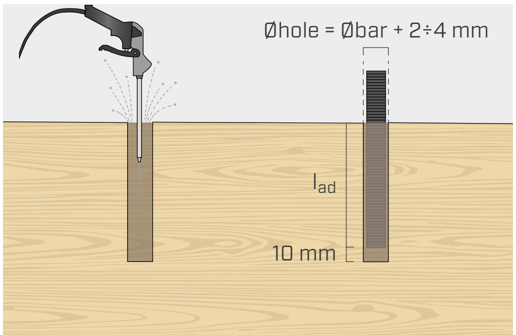



# GLUED RODS - INSTALLATION INSTRUCTIONS

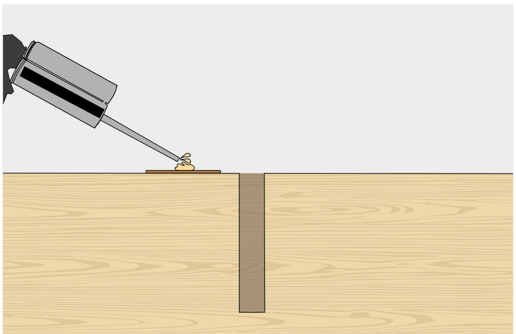
OPTION 1 (only valid for vertical gluing)




## MAKING THE HOLE

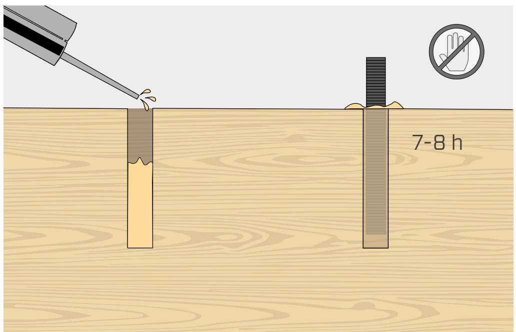
It is advisable to drill a blind hole with a diameter equal to that of the threaded rod increased by 2 to 4 mm. The drill bit must be clean and dry in order to remove any contamination that could affect the polymerization process. Likewise, the rod must be perfectly clean and free of any traces of oil or water on its surface. The hole must be cleaned of swarf or dust using compressed air.

**Consider a hole length equal to the glueing length derived from the calculations, increased by 10 mm .**



## ADHESIVE PREPARATION

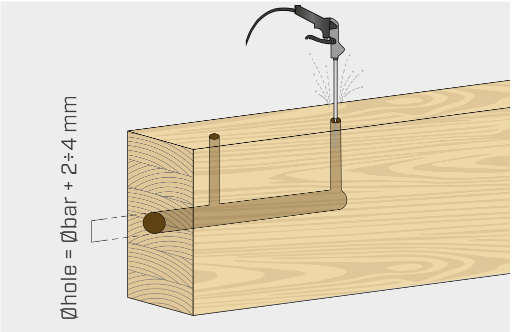
After wearing all the necessary PPE, remove the locking ring and protective cap from the cartridge, install the STINGXP mixing nozzle and fasten it by replacing the locking ring.
It is recommended to use correctly stored cartridges as indicated on the previous pages.
Insert the cartridge into the MAMMOTH DOUBLE gun. Start dispensing the resin, discarding it into a separate container until the mixture is homogeneous and free of streaks. Only when the colour of the resin is homogeneous the mixing of the two components can be considered correct.




## FILLING THE HOLE AND POSITIONING THE ROD

Fill the hole with the required amount of adhesive. It is advisable to exceed the amount of resin a little to be sure that no air bubbles are trapped. A slight lack of resin can be made up after the rod has been inserted.
Slowly insert the rod by turning clockwise and sink it into the hole. It may help to mark the insertion depth on the rod with a felt-tip pen. Ideally, about 1 cm should remain between the end of the rod and the bottom of the hole.
The straightness of the rod can be adjusted up to 15 minutes after insertion. A holding device can be used to keep the rod steady.
For the next 7 to 8 hours, neither the timber nor the rod must be touched or stressed.
It is advisable to leave a small amount of resin overhanging the hole in order to compensate for possible absorption of the timber. Excess adhesive can be wiped off with a cloth or spatula.

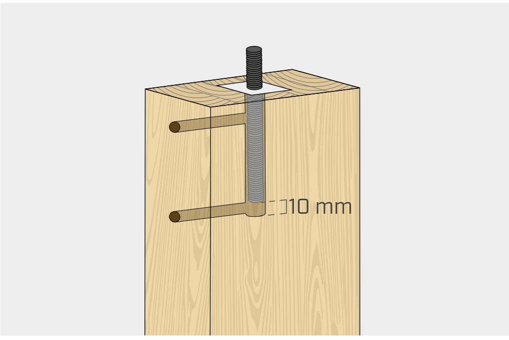
OPTION 2 - RECOMMENDED (valid for vertical or horizontal glueing with sealing)




## MAKING THE HOLE

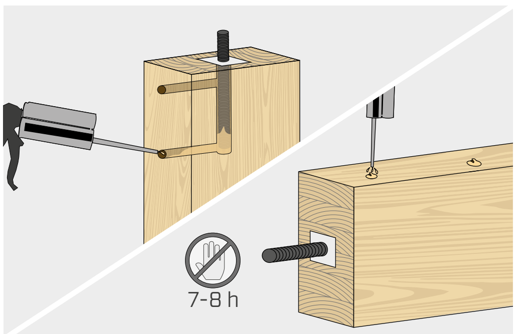
It is advisable to drill a blind hole with a diameter equal to that of the threaded rod increased by 2 to 4 mm. The drill bit must be clean and dry in order to remove any contamination that could affect the polymerization process. Likewise, the rod must be perfectly clean and free of any traces of oil or water on its surface.
Drill two holes perpendicular to each blind hole, one for injection (at the base of the main hole) and one for venting (near the top of the main hole). All 3 holes must be perfectly clean, free of swarf or dust. It is recommended to use air guns to check that they are all connected.

**Consider a main hole length equal to the glueing length derived from the calculations, increased by 10 mm .**



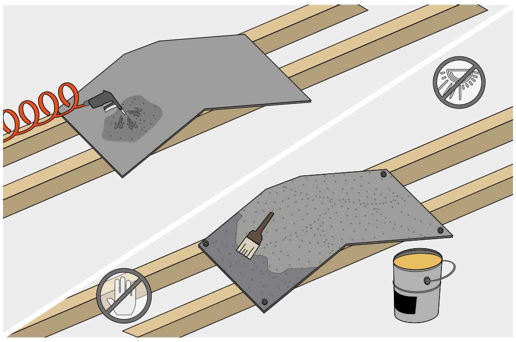

## ROD POSITIONING

Insert the rod into the hole. Ideally, about 1 cm should remain between the end of the rod and the bottom of the hole. It may help to mark the required insertion length with a felt-tip pen on the rod.
A support device can be used to keep the rod perfectly centred.
Seal the entrance of the hole around the threaded rod, taking care not to put sealing material inside the hole.
Pay attention to any cracks in the timber that could cause the resin to leak out before curing. Similarly, the sealant must not leak in such a way that the resin leaks.



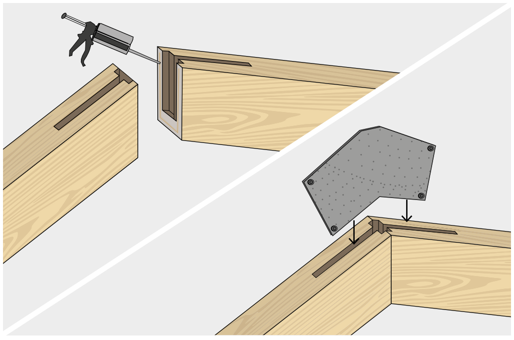

## FILLING THE HOLE

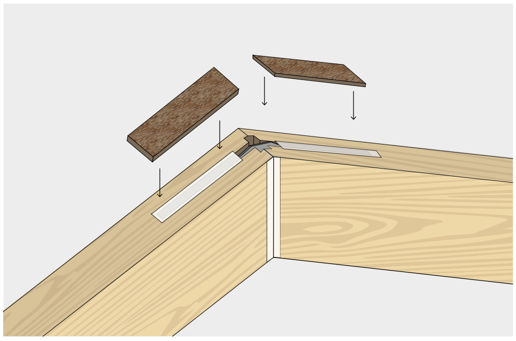
Through the bottom injection hole, inject resin until it flows out of the vent hole. Filling from below allows the hole to be filled free of air bubbles.
If the rod is kept in a horizontal position, filling must be carried out by injecting from the top hole.
Add adhesive if you notice a drop in the adhesive level (due to late air leakage or leaks). Plug the vent and injection holes with timber dowels, cleaning off excess resin.
The straightness of the rod can be adjusted up to 15 minutes after resin injection.
For the next 7 to 8 hours, neither the timber nor the rod must be touched or stressed.



### PREPARATION OF METALLIC SUPPORTS

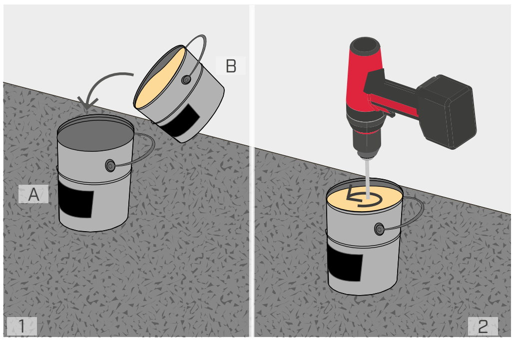
Metal bits must be cleaned and degreased, free of any traces of oil or water on their entire surface.
Smooth sheets must be treated with grade SA2,5/SA3 sanding and then protected through a layer of XEPOX P to avoid their oxidation. To ensure the correct position of the bits within the grooves, it is recommended to place spacer washers on the metal inserts during the protective layer curing phase. Protect metal surfaces from direct sunlight.

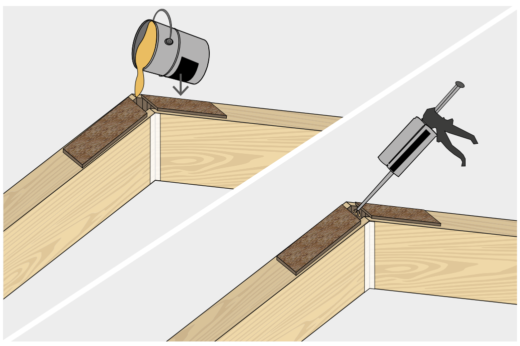




### PREPARATION OF TIMBER SUPPORTS

It is advisable to make a routing cut for each metal support with a thickness equal to that of the plate increased by 4÷6 mm (2÷3 mm of glue per side). The grooved area must be perfectly clean, free of swarf or dust. It is advised to provide also a "useful" bearing of adhesive to be made with a special machine at the top of the timber elements in order to guarantee of the functionality of the contact system.
Close to the vertical edges, apply continuous strips of adhesive paper tape at about 2÷3 mm from the edge. After inserting the plate into the routing, apply a continuous bead of acetic silicone and adhere it to the tape-protected surfaces as well. The outer grooves of sloping elements must be sealed with timber boards before applying resin. Only the end of the routing at the highest point must be left uncovered for gluing.
Any contamination between sealants and resin must be avoided.



### CONSTRUCTION OF THE JOINT

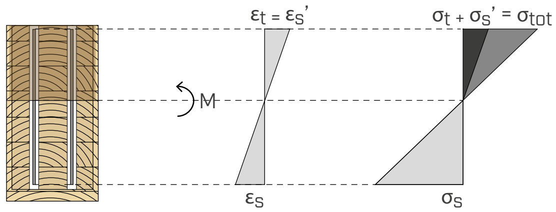
Wear all necessary PPE before starting mixing operations.
**Product in drums:** If necessary, mix the contents of the individual packages in order to amalgamate the solid and liquid parts of the compounds until homogeneous products are obtained. Pour component B into the drum containing component A. Mix with a suitable electrically-mounted double-helix mixer (or metal whisk) until a homogeneously coloured mixture is obtained. No white streaks or different coloured parts should be visible inside the bin. Then pour the resulting mixture into the routing directly from the mixing drum (pouring) or take the product and spread it out with a spatula.

**Product in cartridges:** Insert the cartridge including nozzle into the MAMMOTH DOUBLE gun, taking care to ensure that it is firmly seated in the housing. Start dispensing the resin, discarding it into a separate container until the mixture is homogeneous and free of streaks. Only when the colour of the resin is homogeneous the mixing of the two components can be considered correct.

# MOMENT JOINTS WITH PLATES

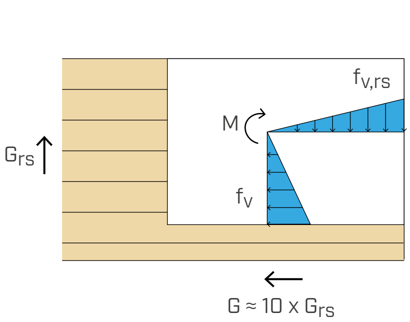
## CALCULATION MODE | HEAD SECTION

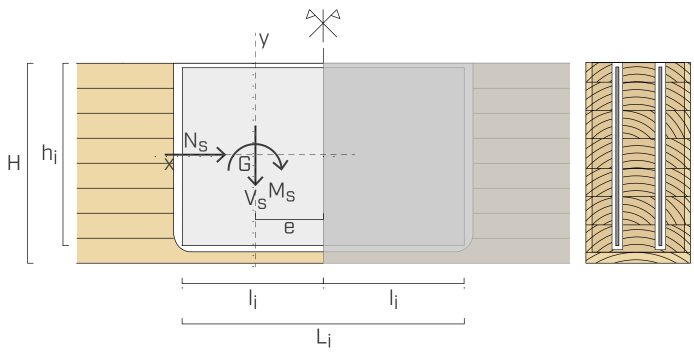
The stresses due to the moment and the axial stress are determined by homogenizing the materials of the section, in the hypothesis of conservation of the flat sections. The shear stress is absorbed only by the plates. It is also necessary to check the stresses acting on the wood section net of the grooved sections.




## CALCULATION METHOD | MOMENT DISTRIBUTION ON THE STEEL-ADHESIVE-TIMBER INTERFACE

The moment is distributed over the number of interfaces (1 plate = 2 interfaces) and then broken down into stresses, considering both the polar inertia around the centre of gravity and the different rigidity of the timber. In this way, the maximum tangential tensions are obtained in the orthogonal and parallel direction to the fibre, to be verified in their interaction.




Polar moment of inertia of half the bit with respect to the centre of gravity, weighed on the wood cutting modules:

$$J_P^* = \frac{l_i \cdot h^3}{12} \cdot G + \frac{l_i{}^3 \cdot h}{12} \cdot G_{rs}$$

Calculation of tangential forces and combined verification:

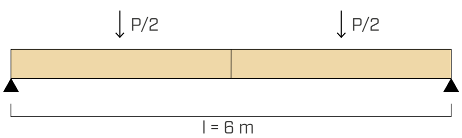
$$\tau_{max,hor} = \frac{(M_d + M_{T,Ed})}{2 \cdot n_i \cdot J_P^*} \cdot \frac{h}{2} \cdot G + \frac{N_d}{2\ n_i\ A_i} \qquad \tau_{max,vert} = \frac{(M_d + M_{T,Ed}) \cdot e}{2 \cdot n_i \cdot J_P^*} \cdot G_{rs} + \frac{V_d}{2\ n_i\ A_i}$$

$$\sqrt{\left(\frac{\tau_{max,hor}}{f_{v,d}}\right)^2 + \left(\frac{\tau_{max,vert}}{f_{v,rs,d}}\right)^2} \leq 1$$

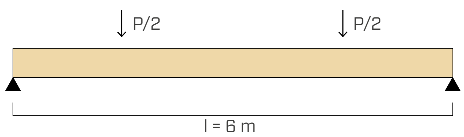
## CONNECTION STIFFNESS

The moment joints made with XEPOX epoxy adhesives guarantee excellent stiffness to the connected elements. In fact, comparing the behaviour of a simply supported beam consisting of two timber elements moment-joined using XEPOX plate and resin with the behaviour of a simply supported continuous beam of equal span and cross-section, stressed by the same load configuration, it is noticed that the moment connection is able to guarantee a stiffness and moment transmission that are close to those of the continuous beam.

EXPERIMENTAL




REFERENCE (whole beam, calculated)




$$\frac{M_{test}}{M_{Rif}} = 0{,}90$$

$$\frac{E_{test}}{E_{Rif}} = 0{,}77$$

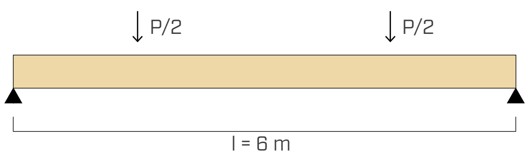
The deflection measured experimentally at the breaking load is approximately 55 mm; the elastic deflection of a whole beam calculated for the same load is 33 mm. The increase in vertical displacement for the jointed beam in the vicinity of the joint failure is therefore l/270. It should be noted that these values are not comparable with the deflection values normally used in design, where the deflection is assessed under operating conditions and not at ultimate limit states.

**Values derived from tests are not characteristic values and are only to be understood as indicative values of the general behaviour of epoxy resin moment unions and plates.**

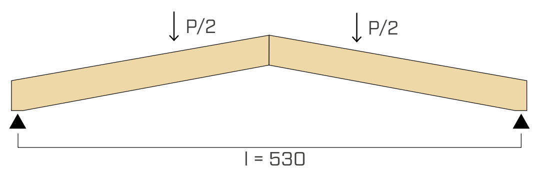
### COMPRESSION-RESPONSIVE TIMBER IN HEAD SECTION

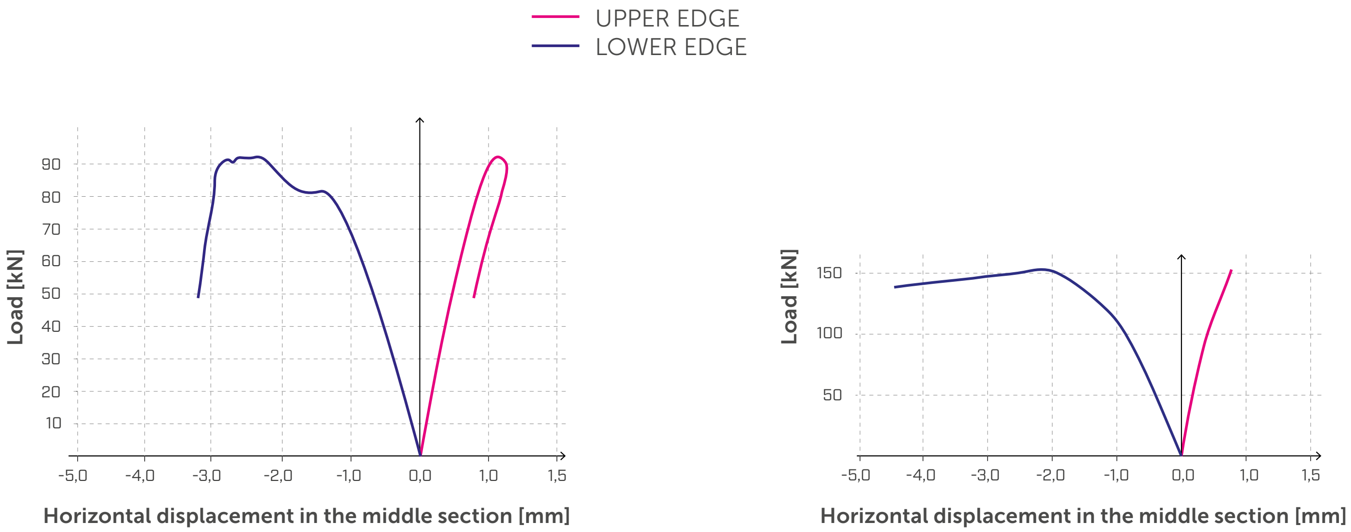
The two graphs below show the horizontal displacements of the tensioned and compressed grains in the head section of the connection, recorded during tests carried out at the Politecnico di Milano.
The two tests involved two moment joints made with XEPOX and metal bits (see example on following pages). The presence of a medium-thick resin pad (5-10 mm) ensured contact between the two head sections. It can be observed in both cases that the greatest displacement occurs in the tensioned grains, validating the computational hypothesis that, if contact between the two sections is guaranteed, the timber also reacts in compression along with the metal bits, shifting the neutral axis upward.

EXAMPLE 1




EXAMPLE 2




## CALCULATION EXAMPLE

The comparison between the results of 4-point bending tests carried out at the laboratories of the Politecnico di Milano and the calculation results of the same moment joint with glued plates is now reported.
As it can be observed from the over-resistance factor f, calculated as the ratio of the resistance moment from testing to the calculated resistance moment, there is a good margin of safety in the calculation of these joints.
The value resulting from the test is not a characteristic value and is not intended to be a use value in the design.

### EXAMPLE 1 | CONTINUITY JOINT

GEOMETRY OF THE NODE: BEAM AND PLATES

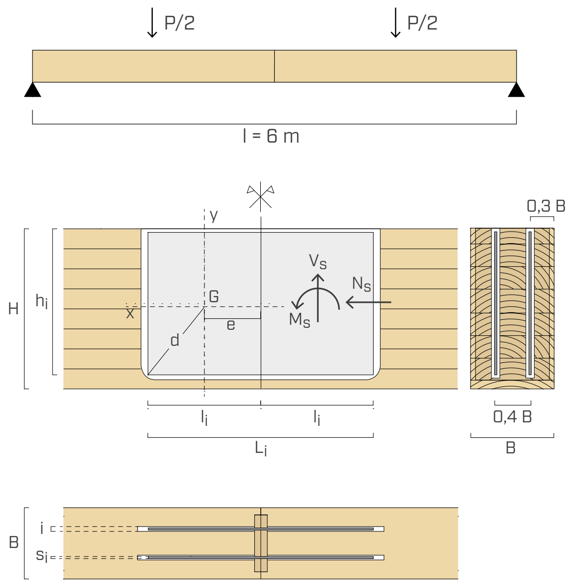
| | | | | | |
|---|---|---|---|---|---|
| **$n_i$** | 2 | mm | **B** | 200 | mm |
| **$S_i$** | 5 | mm | **H** | 360 | mm |
| **$h_i$** | 320 | mm | **$B_n$** | 178 | mm |
| **$l_i$** | 400 | mm | **$\alpha_1$** | 0 | ° |
| **e** | 200 | mm | | | |

PROJECT MATERIAL AND DATA

| **Steel class** | **S275** |
|---|---|
| $\gamma_{M0}$ | 1 |

Metal bits sandblasted to grade SA2.5/SA3 (ISO8501).

| **Wood class** | **GL24h** | |
|---|---|---|
| $f_{c,0,k}$ | 24,0 | MPa |
| $f_{c,90,k}$ | 2,1 | MPa |
| $f_{v,k}$ | 3,5 | MPa |
| $f_{v,rs}$ | 1,2 | MPa |
| $k_{mod}$ | 1,1 | |
| $\gamma_M$ | 1,3 | |



## USE OF XEPOX

Protect the metal bits from oxidation with **XEPOX P**. Use **XEPOX F** or **XEPOX L** adhesive.

### DESIGN LOADS ACTING ON THE CONNECTION

| | | | |
|---|---|---|---|
| $M_d$ | design moment applied | **50,9** | **kNm** |
| $V_d$ | applied design shear | **0** | **kN** |
| $N_d$ | applied axial action | **0** | **kN** |

### CONTROLS

#### HEAD JOINT VERIFICATION [1], [2]

| | | | % verification | |
|---|---|---|---|---|
| $\sigma_t$ | maximum compressive stress on timber side | 10,2 MPa | 50 | % |
| $\sigma_s$ | maximum compressive stress on steel side | 179,4 MPa | 65 | % |
| $\sigma_{s'}$ | maximum tensile stress on steel side | 256,9 MPa | 93 | % |

#### TIMBER NET SECTION VERIFICATION

| | | | % verification | |
|---|---|---|---|---|
| $\sigma_{t,m}$ | maximum bending stress on timber side | 13,2 MPa | 65 | % |
| $F_{t,local}$ | maximum tensile load on timber side | 242,1 kN | 100 | % |

#### VERIFICATION OF INTERFACE SURFACES MAXIMUM TANGENTIAL TENSION [3], [4]

| | | | % verification | |
|---|---|---|---|---|
| $J_P{}^*$ | weighted polar inertia modulus | $8{,}50 \cdot 10^{11}$ $Nmm^2$ | | |
| $\tau_{max,hor}$(3) | maximum tangential stress (shear) | 1,58 MPa | 53 | % |
| $\tau_{max,vert}$(3) | maximum tangential stress (rolling shear) | 0,2 MPa | 19 | % |
| **combined effort verification** | | | **57** | **%** |

#### COMPARISON OF CALCULATED STRENGTH AND TEST STRENGTH

| Connection crisis mode: | % verification | |
|---|---|---|
| Maximum tensile load on timber side | 100 | % |

| | | | |
|---|---|---|---|
| $M_d = M_{Rd}$ | design moment of resistance | **50,9** | **kNm** |
| $M_{TEST}$ | moment of resistance from test (Politecnico Milano) | **94,1** | **kNm** |
| f | **overstrength factor** | **1,8** | |

**LEGEND:**

| | | | |
|---|---|---|---|
| $n_i$ | number of bits | e | eccentricity between the centre of gravity of the plate and the head joint |
| $S_i$ | metal bits thickness | $J_{p^*}$ | weighted half insert polar moment of inertia |
| $h_i$ | metal bits height | $f_{c,o,k}$ | characteristic compressive strength parallel to the grain |
| $l_i$ | metal bits insertion length | $f_{c,90,k}$ | characteristic compressive strength perpendicular to the grain |
| B | beam base | $f_{v,k}$ | characteristic shear resistance |
| H | beam height | $f_{v,rs}$ | characteristic rolling shear resistance |
| $B_n$ | beam width less the routing | $M_{TEST}$ | last moment of resistance from tests carried out at the Politecnico di Milano |
| $\alpha_1$ | beams angle of inclination | f | over-resistance factor ($f = M_{TEST}/M_{Rd}$) |

**NOTES**

The coefficients $k_{mod}$ and $\gamma_M$ should be taken according to the current regulations standard adopted for the design.

It should be noted that the calculations have been made taking into account the values of $k_{mod}$ and $\gamma_M$ according to EN 1995 1-1, and $\gamma_{M0}$ according to EN 1993 1-1.

(1) The calculation of the cross-section has been made considering elastic-line bonds for all materials. It should be noted that in case of axial and shear loads, it is necessary to check the combination of these forces.

(2) In this calculation, it is considered that the resin bearing allows full contact of the interface section, and therefore the wood can react to compression. If the bearing is not made, it is advisable to check the metal bit alone as a reagent, applying the formula with the geometrical parameters of the bit:

$$f_{yd} \leq \frac{M_d}{\frac{B \cdot h^2}{6}}$$

(3) It should be pointed out that XEPOX adhesives are characterised by characteristic shear and tensile strengths that remain unchanged over time and are clearly superior to the strengths offered by the material timber. Due to this reason the interface torsional capacity check can be performed only on the timber element, considering the same check satisfied by the adhesive.

(4) The shear stress "τ" of the timber-adhesive-steel interface, transferred to the timber, is calculated at its maximum value in the case of an inclination parallel or perpendicular to the wood grain. These stresses are compared with shear strength in timber and rolling shear resistance, respectively. The contribution of a transport moment M should also be considered$_{T,ED}$ resulting from shear stress, if present.

- XEPOX is registered as European Union Trade Mark No. 018146096.