

# Strengthening glue-laminated timber structures



I M P R O V E , P R E S E R V E , S E C U R E



**FREYSSINET**  
SUSTAINABLE TECHNOLOGY

# FOREVA® WOOD

With seventy years of experience in structural reinforcement, specialist contractor Freyssinet puts its knowledge and expertise to good use strengthening its customers' timber structures.

Freyssinet uses its Foreva® Wood solutions to restore damaged elements and strengthen and protect structures, while protecting the integrity of the architectural concept and minimising work that might affect the operation of the structure.

Timber structures can age, be attacked by fungi or be subjected to excessive loads due to a change of use when a building is restored, for example. Defects such as rotting or damaged wood, excessive deformation, cracking or failure of elements can occur as a result.

Freyssinet supports its customers right from the strengthening project preparation phase and designs made-to-measure solutions in conjunction with the architect and design firms in charge of the renovation:

- **Protective measures**
- **Assistance with diagnosis**
- **Assistance with structural analysis and design**
- **Assistance with defining the strengthening strategy**
- **Performance of reinforcement work**

## The Freyssinet Group

Freyssinet brings together **an unrivalled set of skills in the specialist civil engineering sector**. The company implements solutions with high added value in two major fields: construction and repairs.

Freyssinet is involved in numerous major projects on five continents, making it the world leader in its specialist areas of:

- Prestressing;
- Construction methods;
- Cable-stayed structures;
- Structural accessories;
- Repairs;
- Structural reinforcement and maintenance.

Freyssinet is highly involved in sustainable development issues and has set up a number of initiatives to reduce the environmental impact of its projects and enhance its social responsibility policy.

Freyssinet is a subsidiary of the Soletanche Freyssinet Group, a world leader in the soils, structures and nuclear sectors.

*Cover photo: Center Parcs De Huttenheugte  
Netherlands*

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*Timber frame splinting*

# FOREVA® WOOD SOLUTION



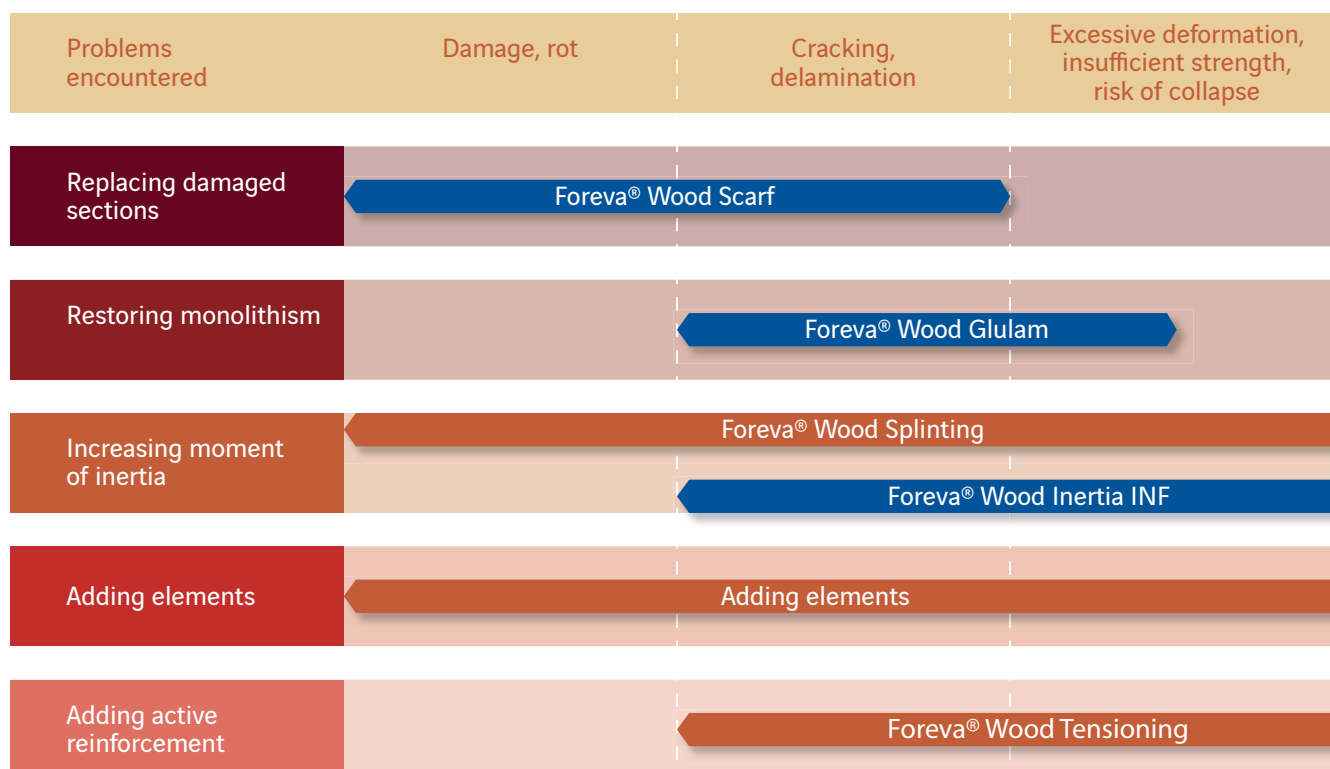
**Foreva® Wood solutions are used to repair and reinforce glue-laminated timber structures regardless of how damaged they are:**

- Damaged, rotten timber;
- Cracked or broken sections;
- Insufficient strength of elements;
- Insufficient stiffness and excessive bending of elements;
- Excessive lateral arch thrust.

**Foreva® Wood solutions are used to repair, reinforce and stiffen timber frameworks:**

- By crack injection, remeshing or restructuring the defective material;
- By replacing damaged material using scarf joints;
- By adding timber or metal reinforcements;
- By adding active reinforcements.

*Increasing arch moment of inertia*



**Foreva® Wood** solutions are frequently used in combination to strengthen different areas of the same structure. Precise monitoring and a diagnosis is required to identify the areas to treat and define their criticality.

Freyssinet can, on request, offer advice in preparing an investigation, diagnosis and recommendation plan.

# REPLACING DAMAGED SECTIONS



## Foreva® Wood Scarf

The **Foreva® Wood Scarf** solution is used for replacing the ends of arches, beams or columns that have been damaged as a result of exposure to inclement weather or attack by insects and/or fungi.

The solution consists of shoring the structure to be preserved, cutting out the damaged sections and replacing them with new timber, glued and connected to the existing timber using reinforcement bars or composite rods anchored with resin.

**Foreva® Wood Scarf** is advantageously used for the bases of outdoor glue-laminated arches or beam ends in contact with damp masonry.

*Installing new timber using scarf joints*

## The stages of replacement



- 1 - Cutting following shoring
- 2 - Removing the damaged part
- 3 - Drilling the recesses

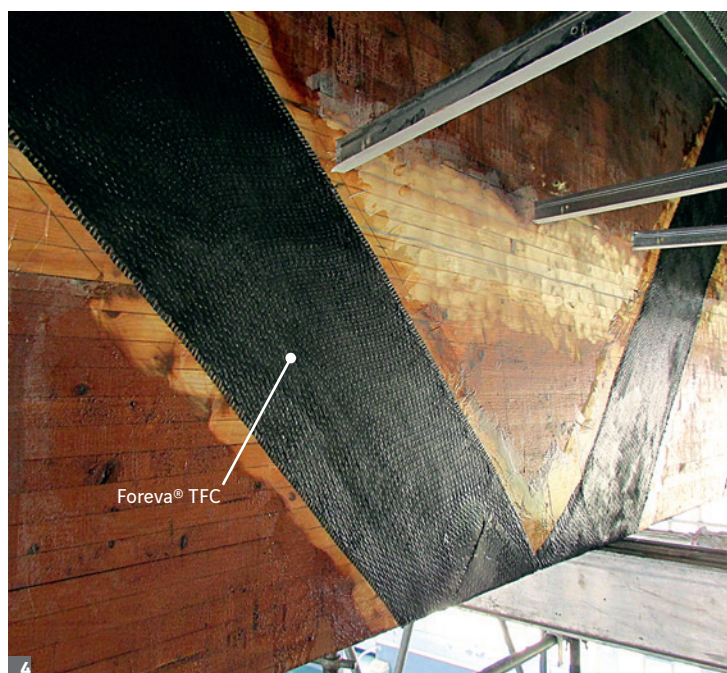
- 4 - Grooving
- 5 - Installing the composite rods
- 6 - Anchoring with resin

# RESTORING MONOLITHISM

## Foreva® Wood Glulam

The **Foreva® Wood Glulam** solution is used to restore the monolithism of glue-laminated timber elements that have undergone delamination or shear failure.

It consists of injecting high-strength epoxy resin into the cracks to provide structural bonding. These "weak planes" can then be connected using reinforcement bars or composite rods anchored with resin.



- 1 - Jacking the beam
- 2 - Delamination before work
- 3 - Resin grouting
- 4 - CFRP reinforcement

# INCREASING MOMENT OF INERTIA



## Foreva® Wood Inertia INF

The **Foreva® Wood Inertia INF** solution consists of increasing the height of an existing glue-laminated beam or arch by adding a new section of timber, glued and connected using reinforcements, underneath.

It is advantageously used for reinforcing glue-laminated timber arches that need to support an over-roofing system or the climatic loads of which have increased due to regulatory changes.



## Foreva® Wood Splinting

The **Foreva® Wood Splinting** solution uses external timber panels connected to the existing element to increase its strength.

This solution can be applied in order to strengthen beams and columns, as well as for repairing structural joints.



1 - Increasing the moment of inertia of a beam by adding an intrados section

2 - Increasing the moment of inertia using carbon fibre fabric strips

3 - Splinting

4 - Splinting of arches

# ADDING ELEMENTS

## Adding elements

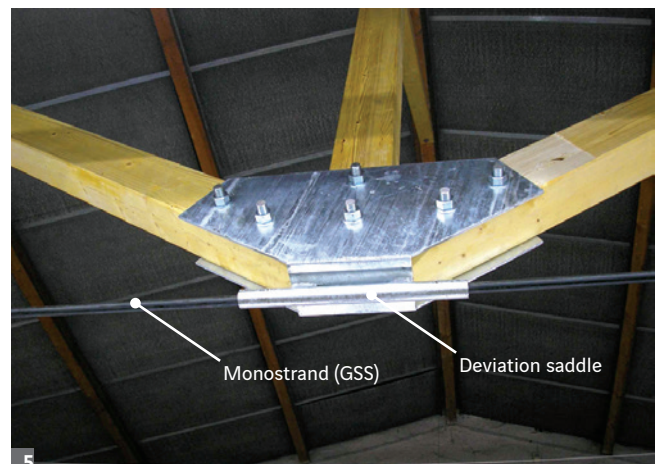
When the structural elements are not strong enough to support the loads to which the structure is subjected, it is preferable to modify the mechanical reinforcement of the structure by adding elements (cross bracing, diagonal reinforcements, etc.).



# ADDING ACTIVE TIE RODS

## Foreva® Wood Tensioning

The bearing capacity of timber beams can be greatly increased by adding active tie rods, advantageously with a deviated path. Freyssinet designs the anchors for connection to the timber elements.



- 1 - Reinforcing beams by reducing their span
- 2 - Reinforcing timberwork by adding diagonals
- 3 - Reinforcement by adding upright and diagonal bracing
- 4 - Adding active tie rods
- 5 - Detail of an active tie rod deviator



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