



Lifelong  
Learning  
Programme



Národní agentura pro evropské vzdělávací programy

# Timber structures

## Case studies

PIETRO CROCE

Department of Civil Engineering and Industrial Engineering –  
Structural division  
University of Pisa

Leonardo da Vinci

Assessment of existing structures

Project number: CZ/08/LLP-LdV/TOI/134005

## Structural reassessment

Inadequate reliability;

Structural modifications;

Changes in category of use and design working life;

Damage or deterioration (environmental, chemical or biological, attack);

Damages due to accidental loads (earthquake, impact or explosion), settlements or other unintentional events

## Preliminary investigations

Acquisition of original information (design and structural conception of the building, reference structural codes, if any);

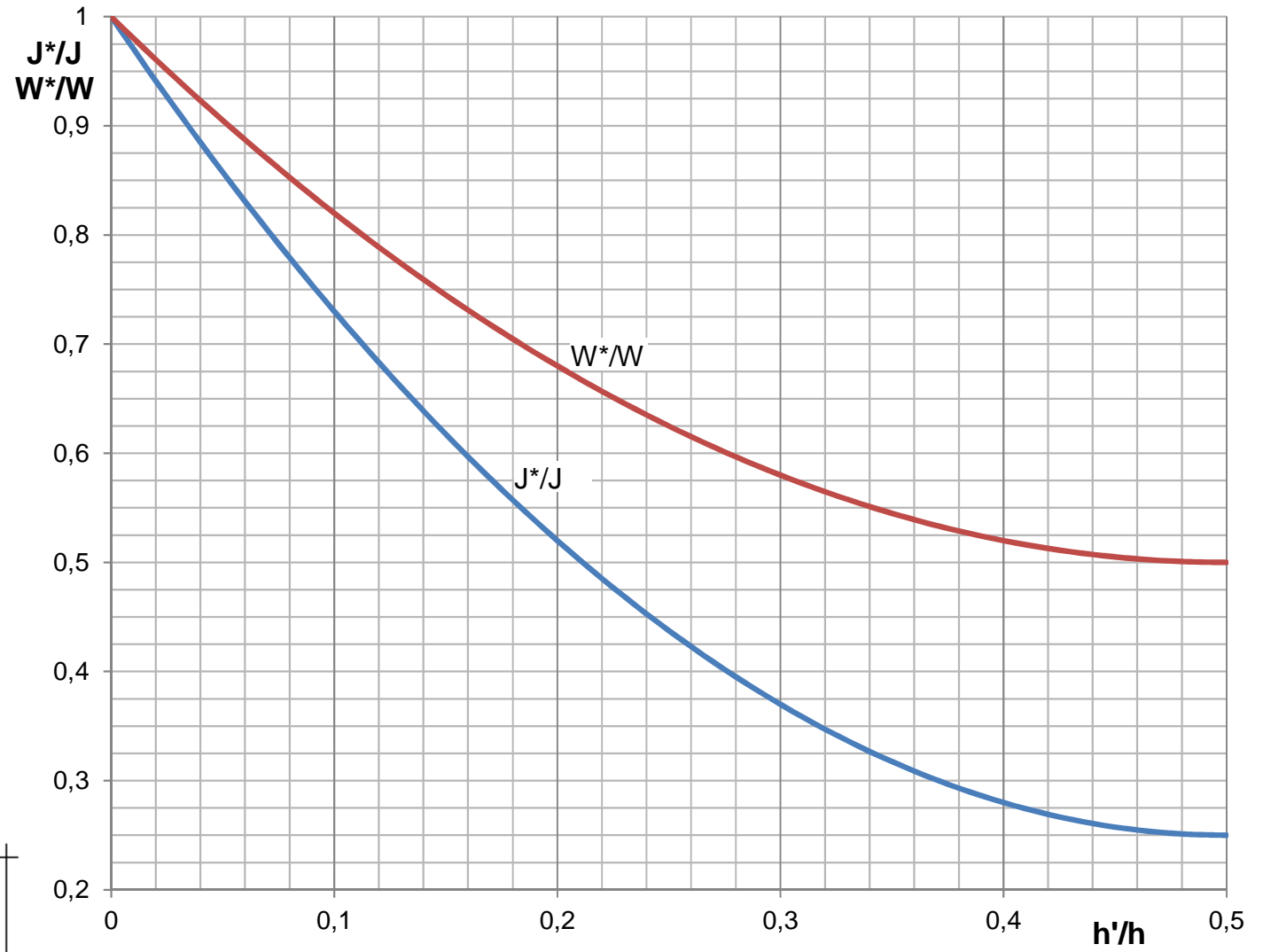
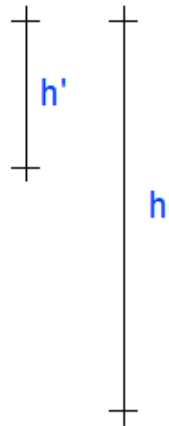
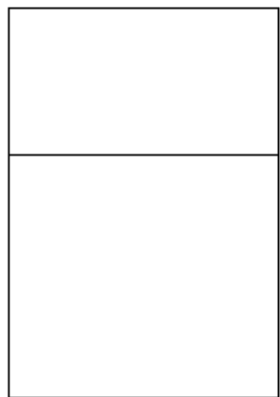
History of structural modifications (addition or demolition, and/or deep maintenance interventions);

actual damage and/or crack patterns;

actual material properties;

required performance level.

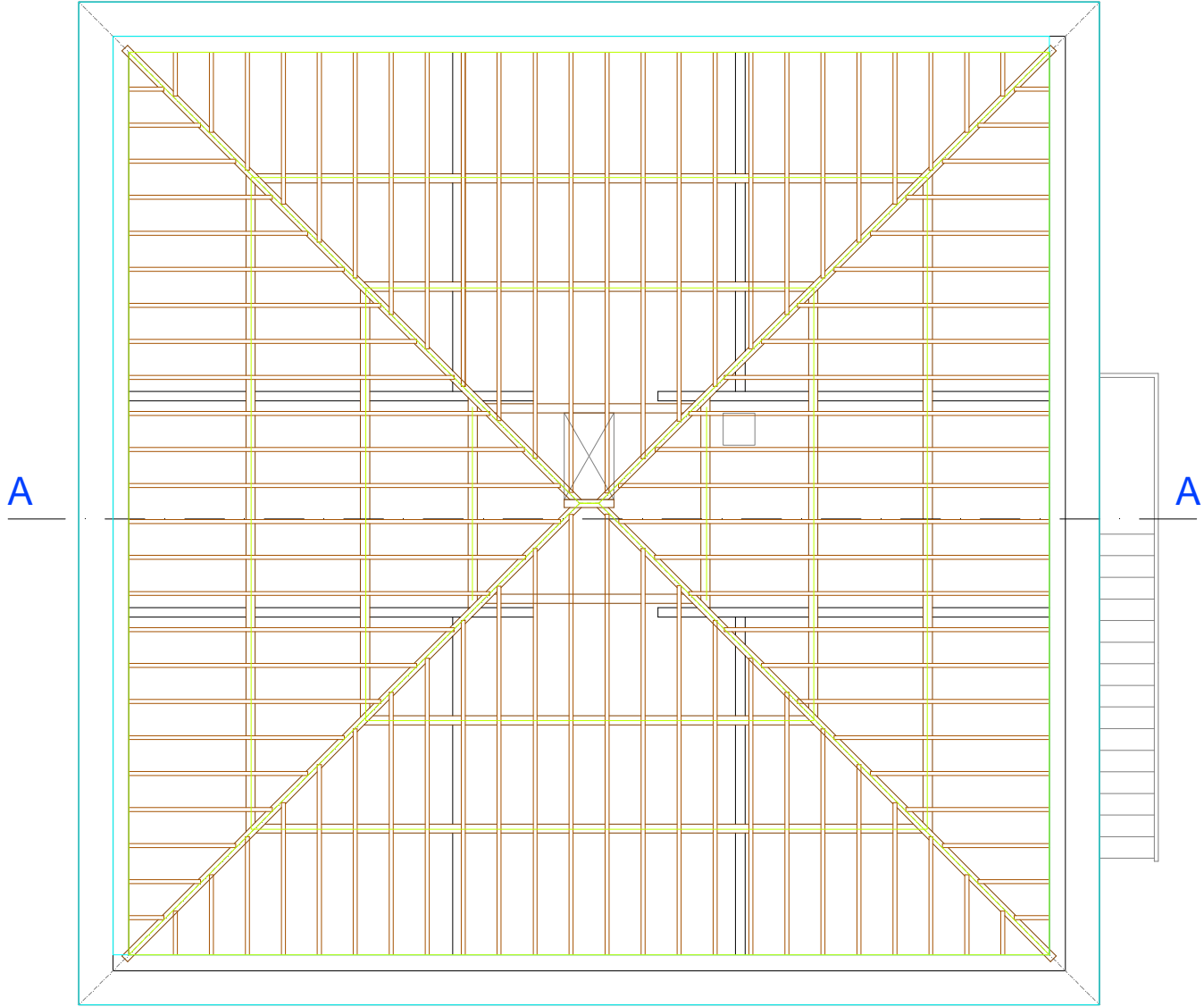
# PRELIMINARY REMARKS



Effect of height of fibre splitting

# CASE STUDY N. 1

## STRENGTHENING OF A TIMBER ROOF





Cracked beam





**Cracked beam**

**Damaged columns**



Damaged columns

Cracked beam

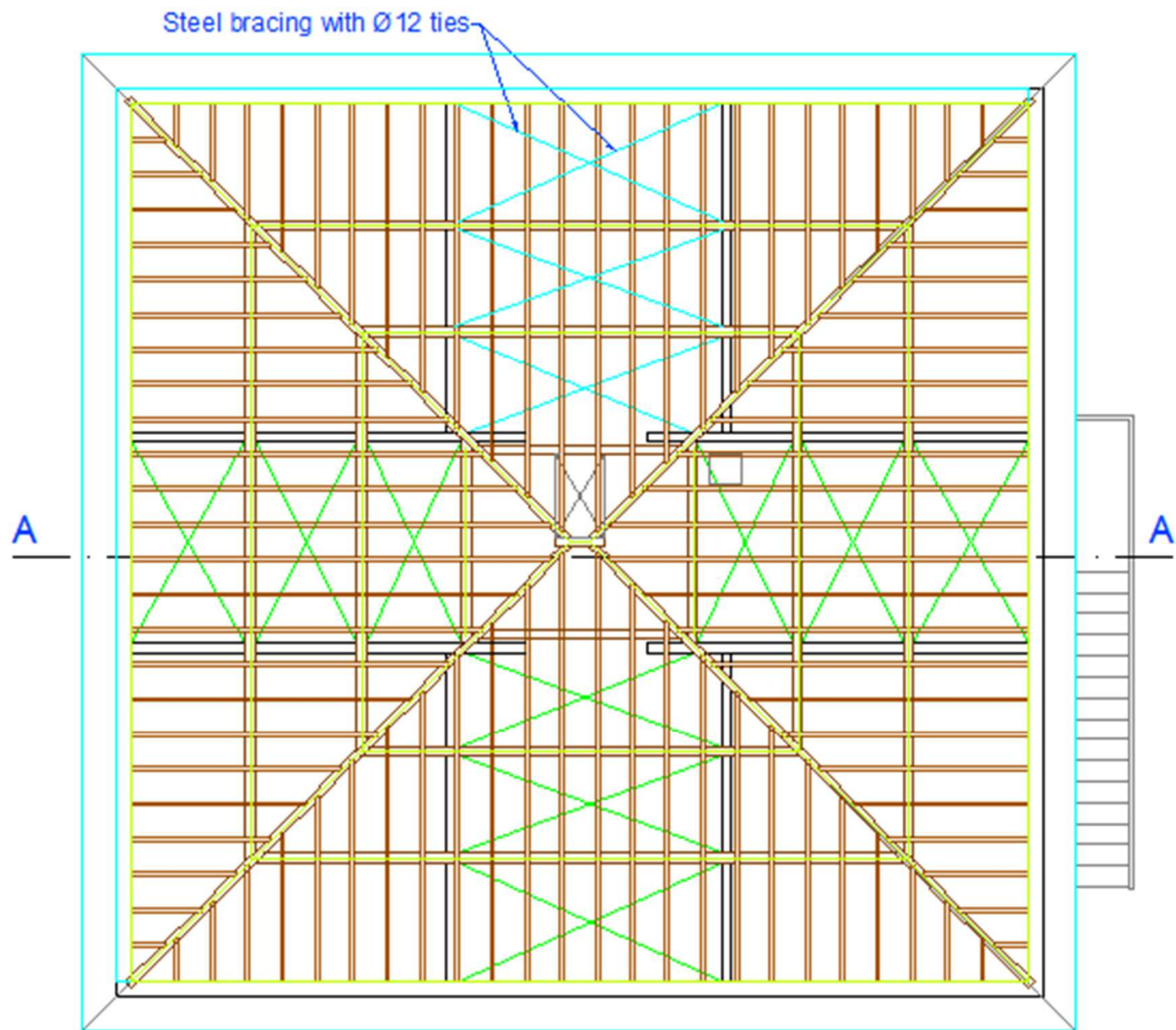




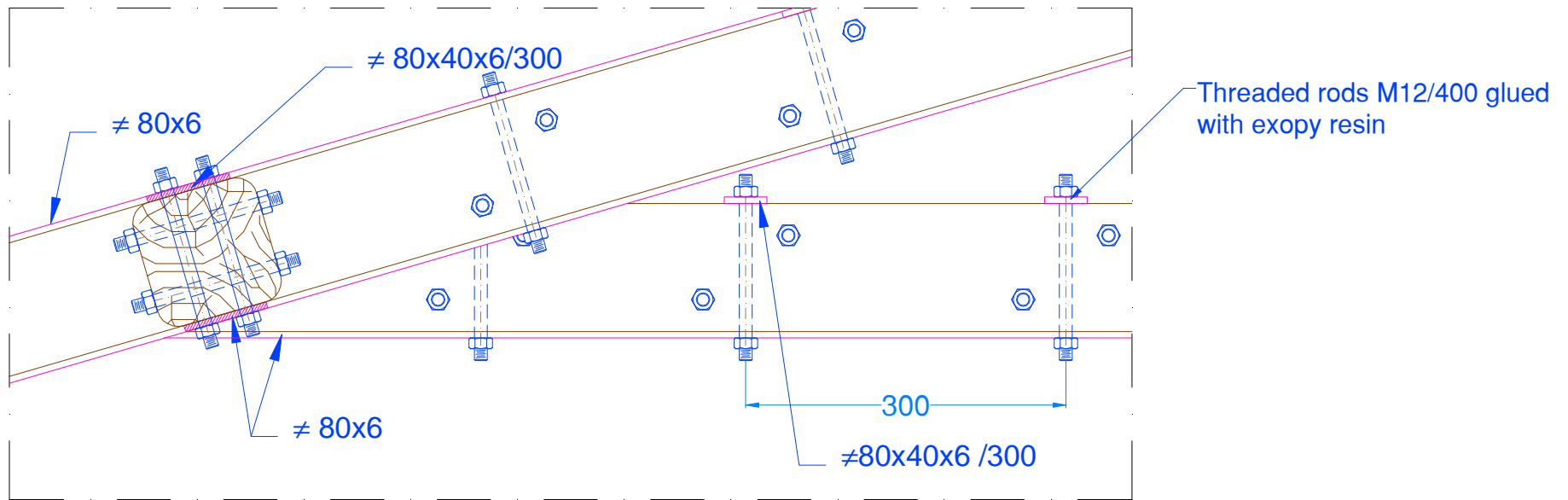
Crack pattern in a beam



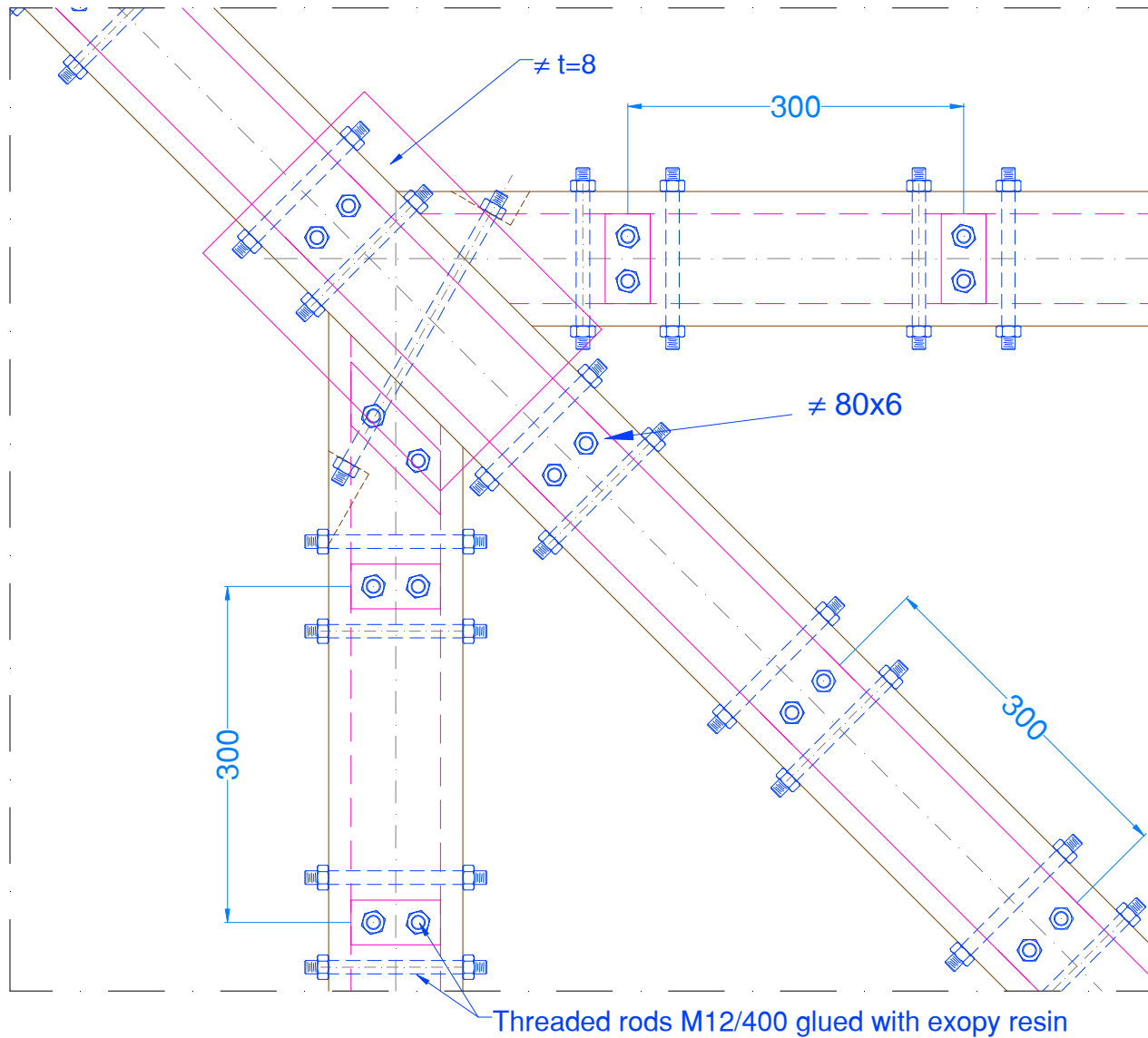
Cracked beam



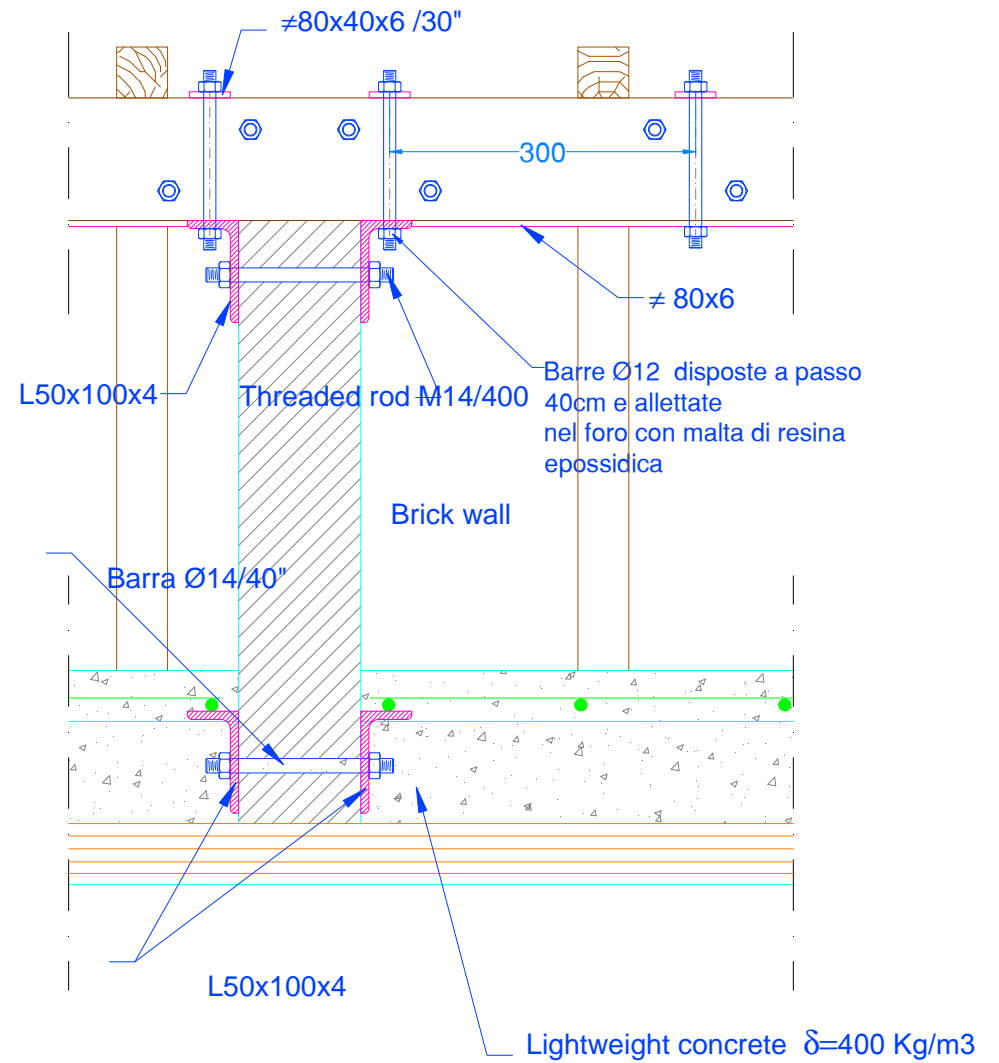
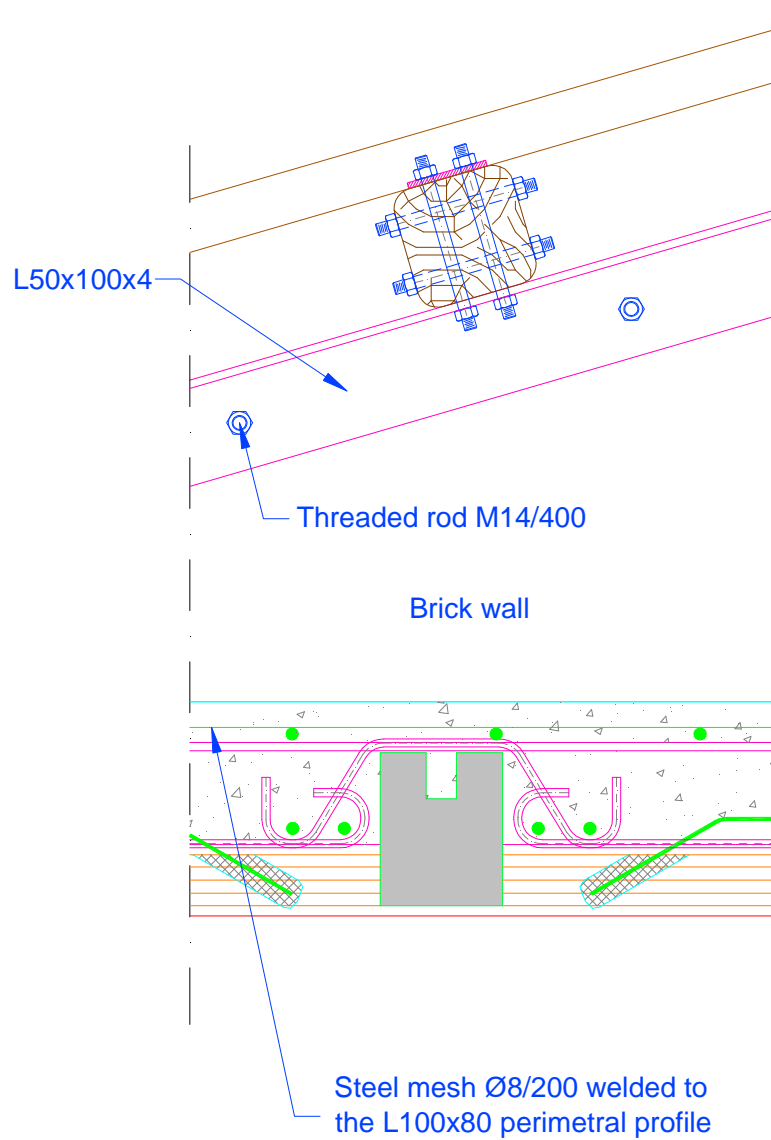
Roof plan



## Strengthening of the beams

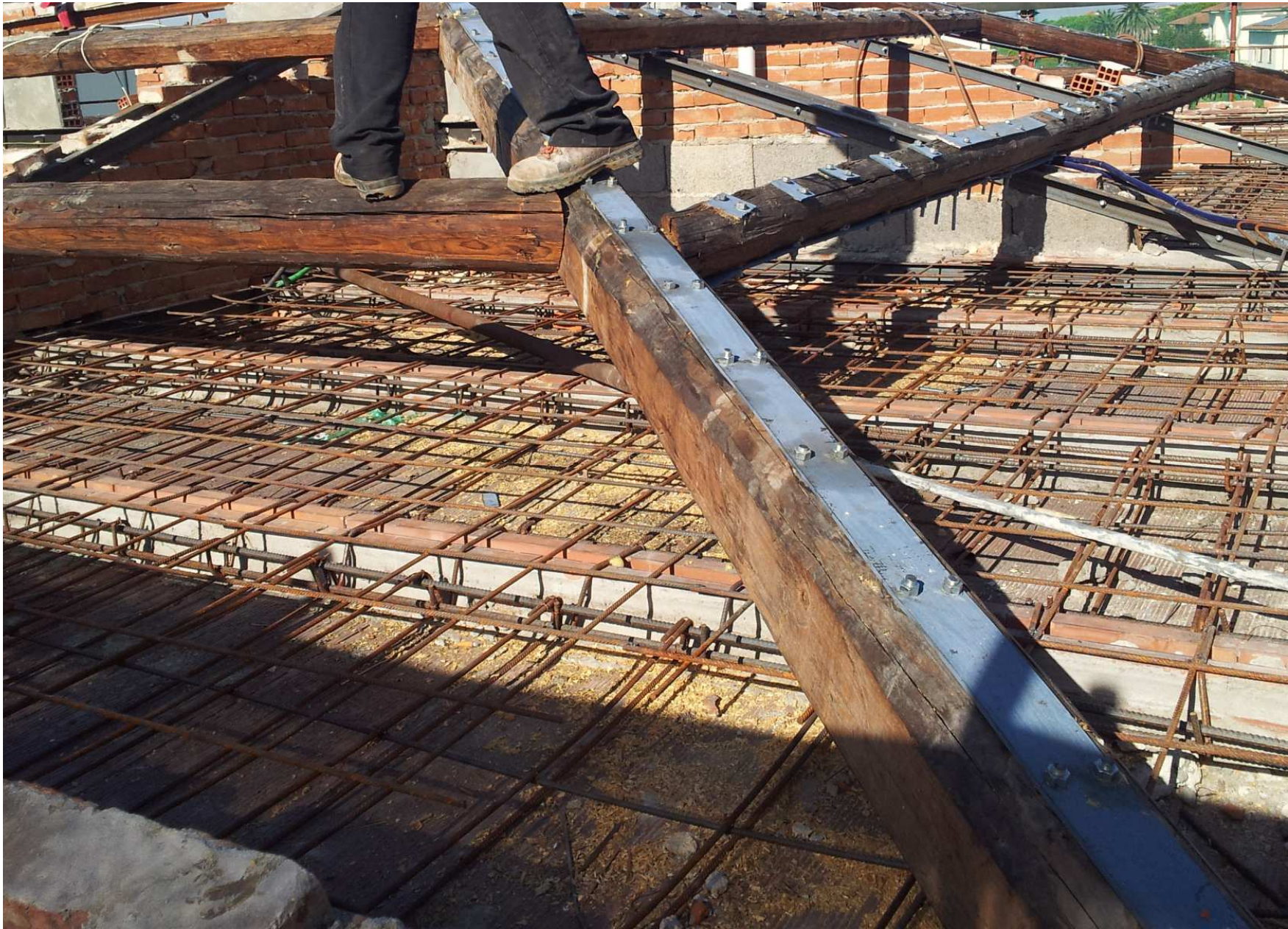


## Strengthening of the connection



Connection with the upper part of the shear walls





**Strengthening of the main beams**



Strengthening of the  
secondary beams



Strengthening of the roof during the works



Strengthening of the roof during the works



Strengthening of the joints



Beams and joint after the strengthening



Strengthening of the beams - Detail



Details of the connections with intermediate brick walls





View of the roof during the work



Strengthening of brick wall

# CASE STUDY N. 2

## ANALYSIS AND REPAIR OF TIMBER BEAMS



**Insufficient cross section – Uncorrect wood fibre pattern**



**Insufficient cross section – Uncorrect wood fibre pattern**



**Insufficient cross section – Uncorrect wood fibre pattern**



Beam supported with a pack prop

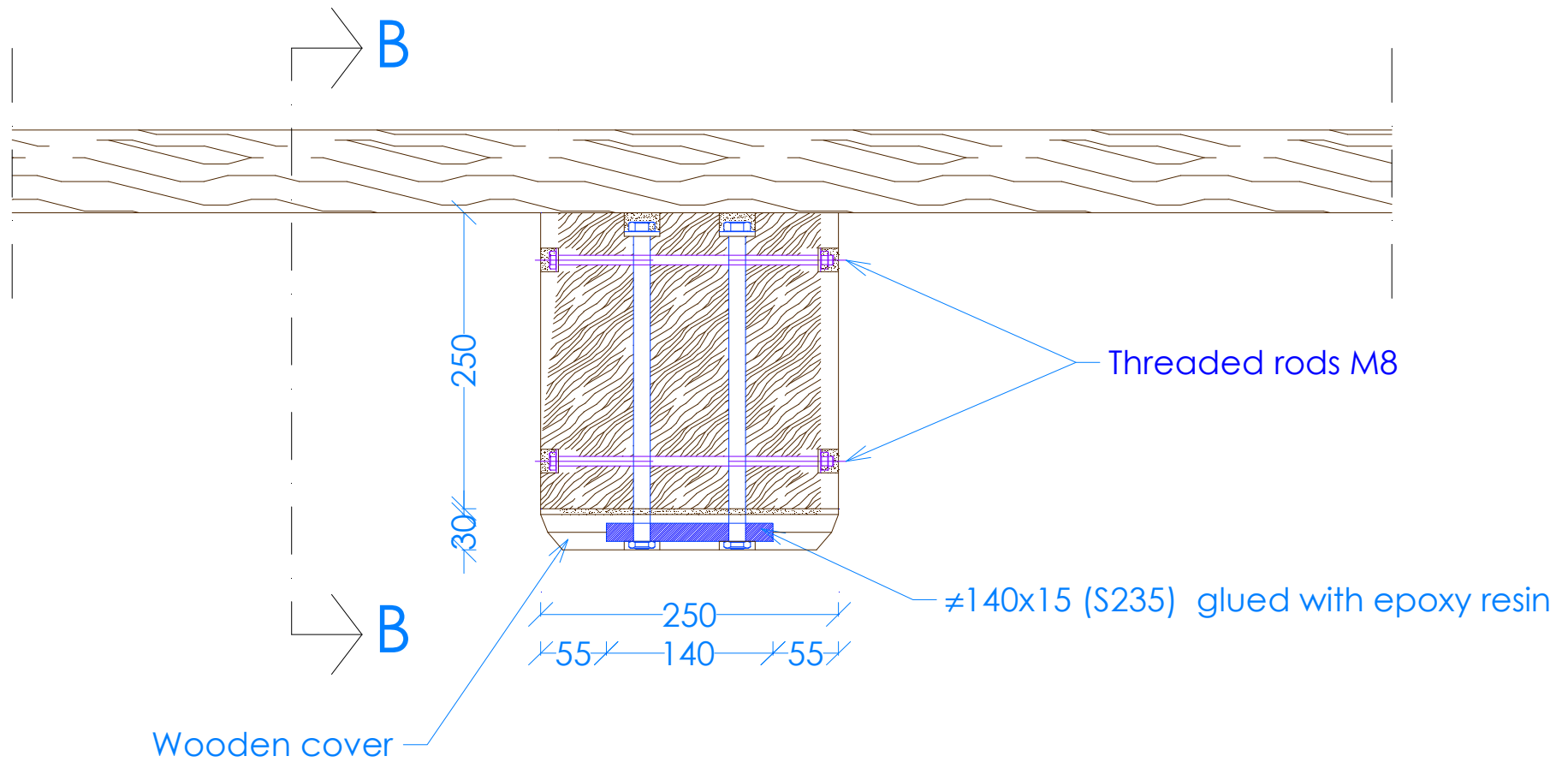


**Beams supported with pack props**

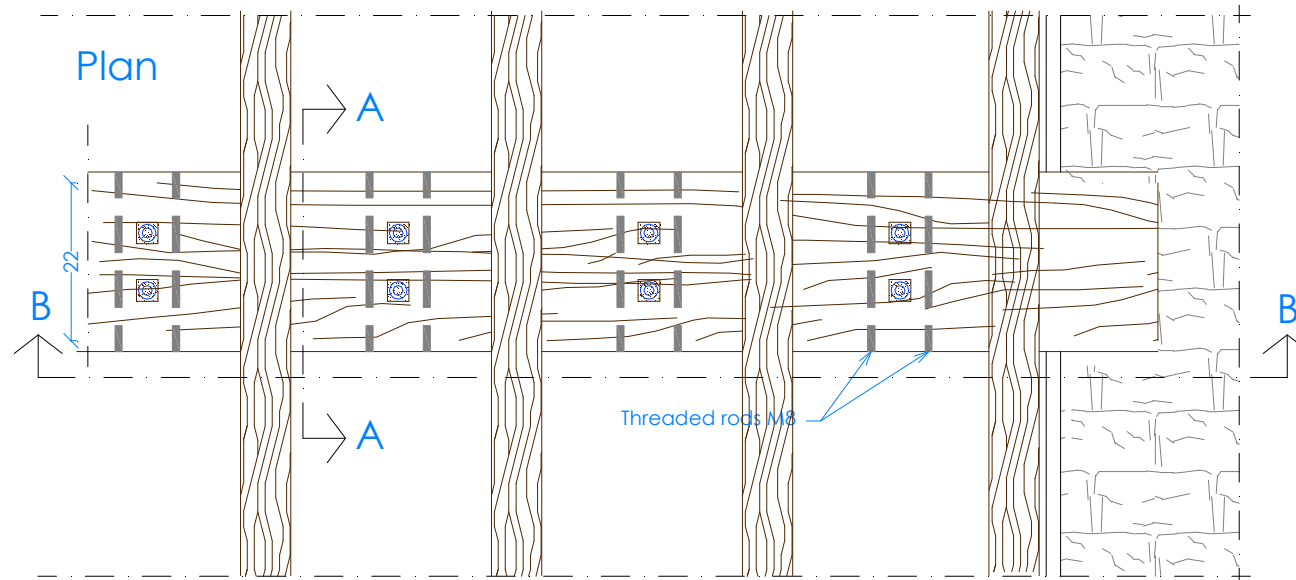
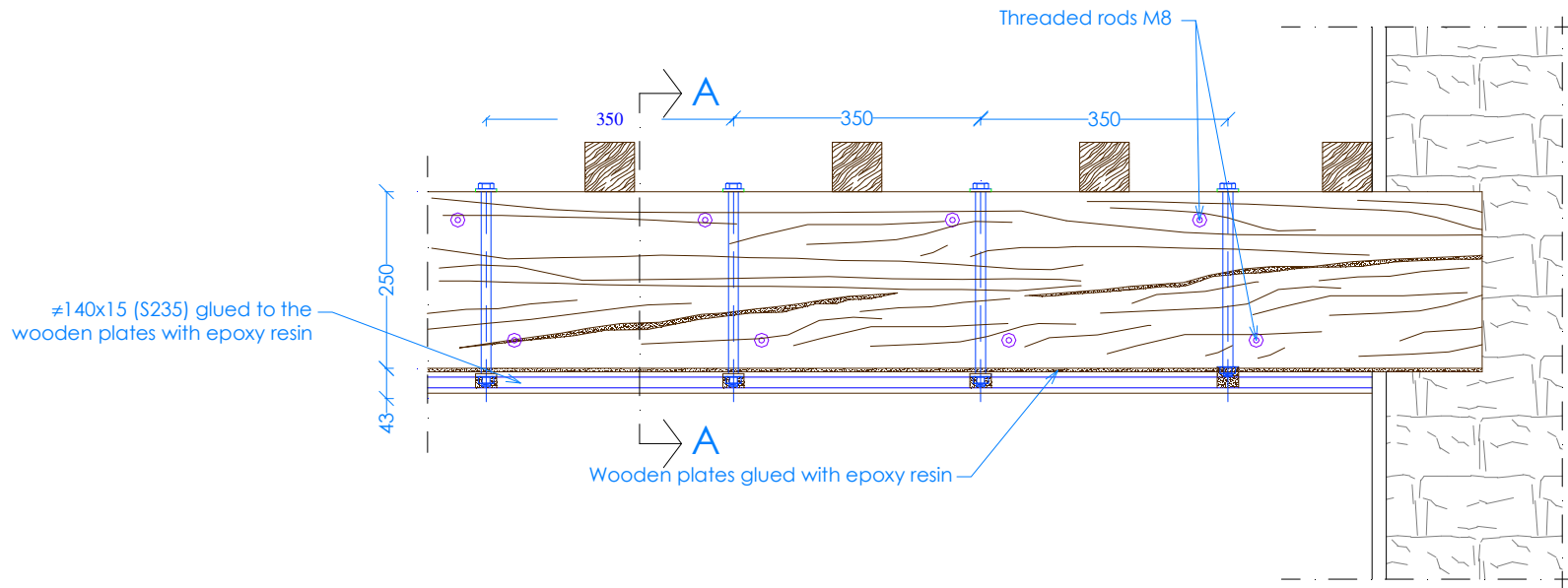




Support and crack



**Strengthening of timber beam preserving the exterior aspect**



**Strengthening of timber beam preserving the exterior aspect**



Crack pattern in a beam



**Beam covered with wood plates**



**General view of the floor**



Detail of the cover



**A surprising arrangement of the cover**





**Detail of the supports**



**Typical crack pattern**



Covered beams



Painted vault

# CASE STUDY N. 3

## SUBSTITUTION OF TIMBER BEAMS

# CASE STUDY N. 3

## SUBSTITUTION OF TIMBER BEAMS



**Substitution of the floor**

# CASE STUDY N. 3

## SUBSTITUTION OF TIMBER BEAMS FROM BELOW





**Removal of the beam supporting the floor**



Insertion of the new beam



**Preparation of the support**



**Beam substitutions completed**



**Arch to be strengthened**



Arch strengthening

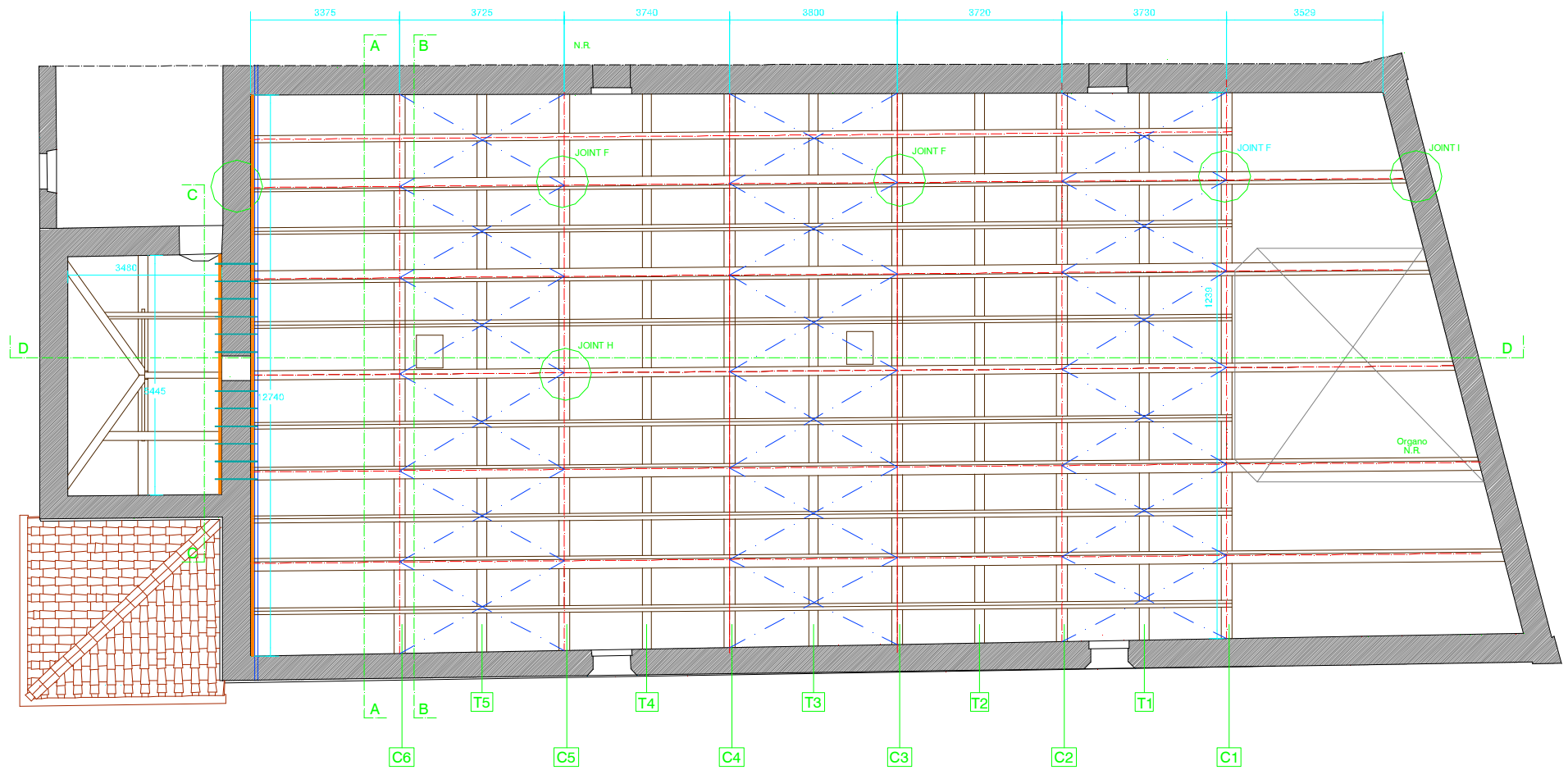
## CASE STUDY N. 4

# STRENGTHENING AND REPAIR OF A WOODEN TRUSS ROOF SUSTAINING A PAINTED CEILING



The interior of the Church





Plan of the roof structure



Typical strut-tie joint



Suspension of the cieling



Connection of the truss tie - Jupiter dart



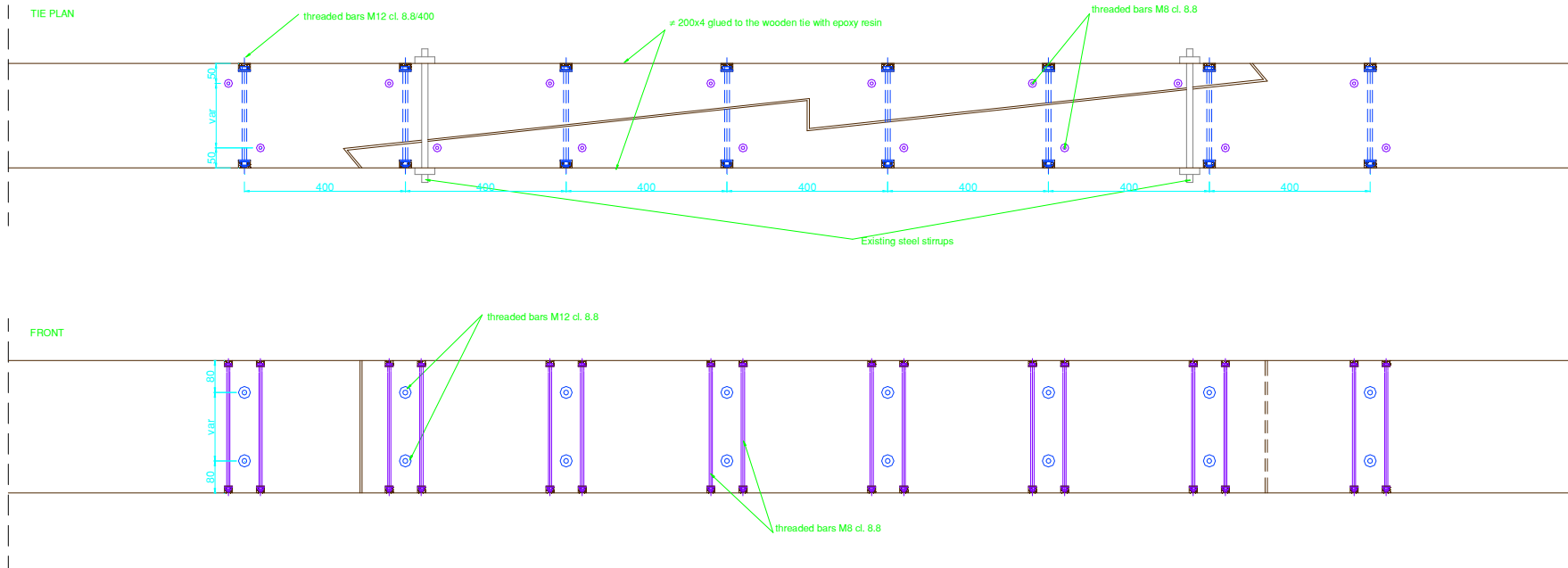
Connection of the truss tie - Jupiter dart



Repair of the strut



Repair of the truss and temporary chain

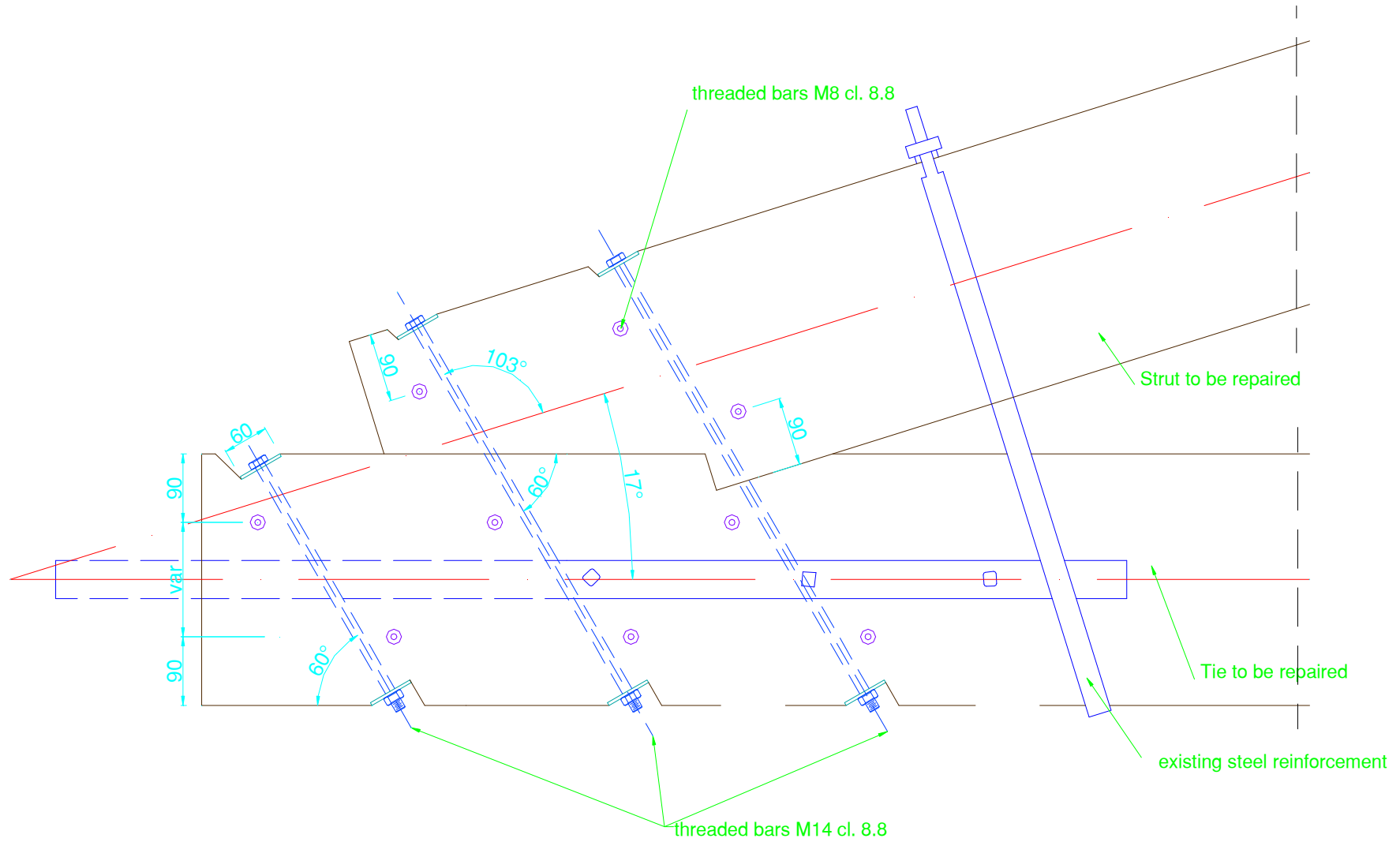


# Repair of the Jupiter dart

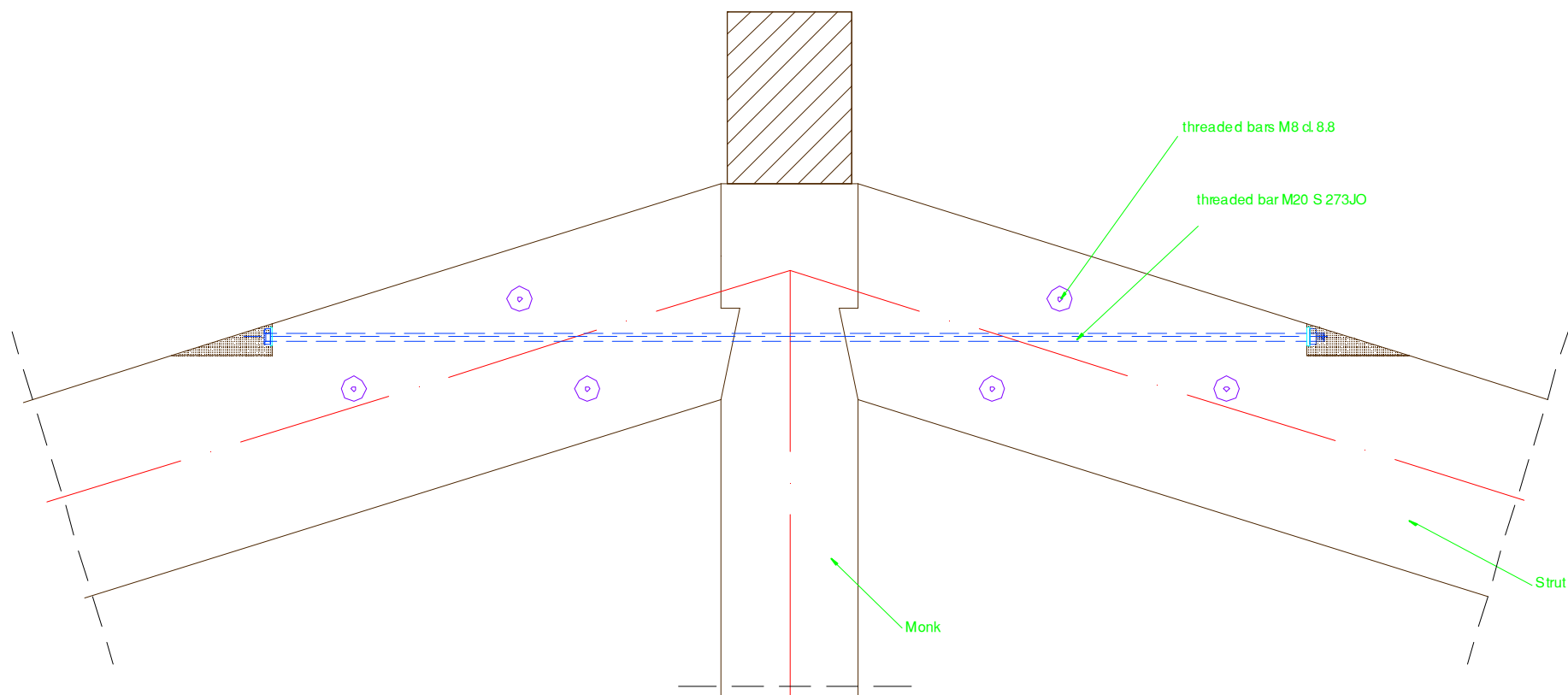




Repair of the Jupiter dart



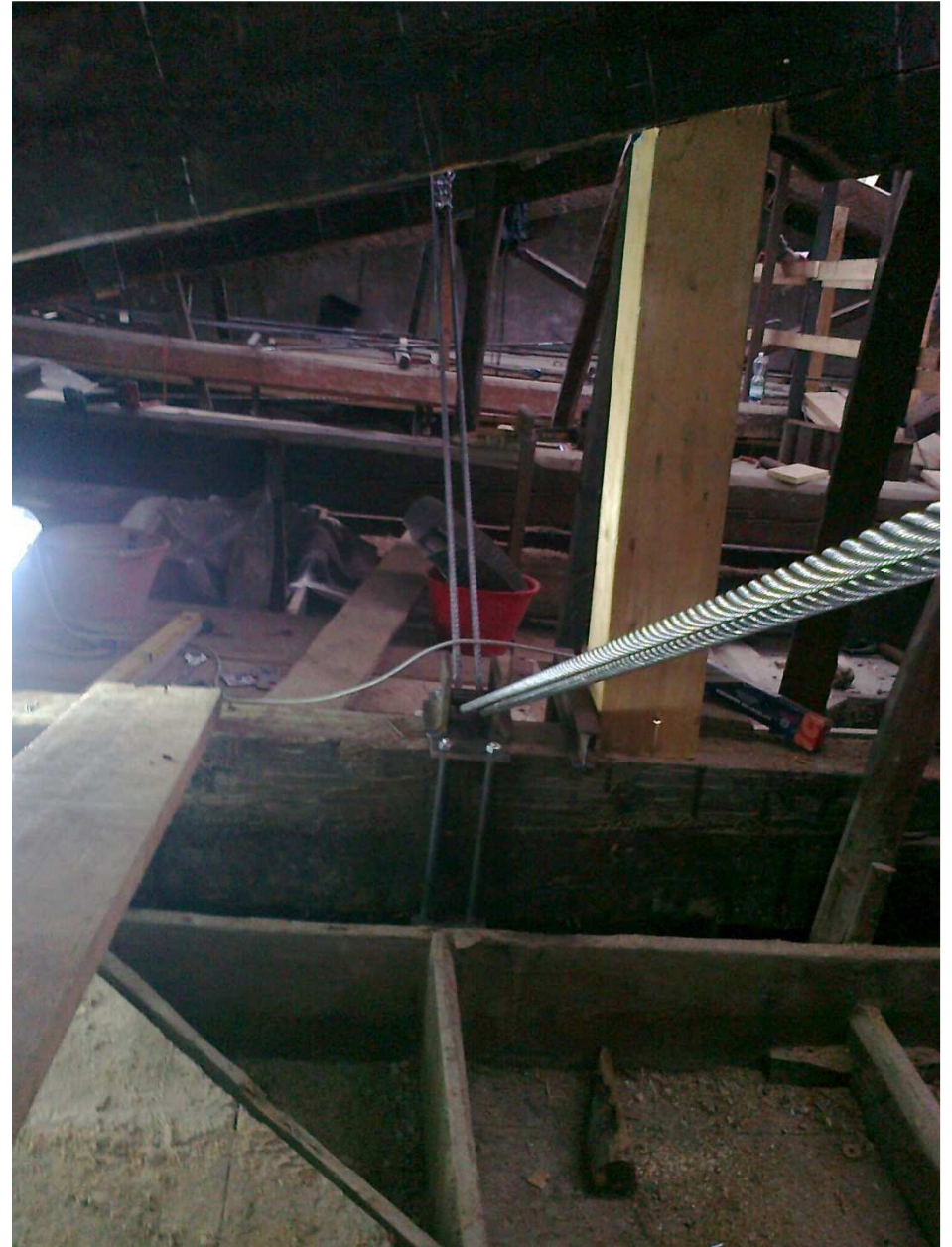
# Repair of the strut-tie connection



Repair of the strut-monk connection



**Repair of the strut-tie connection**



Temporary suspension of  
the truss



Repair of a damaged head



Repair of a damaged head



Steel bracings





Strengthening of the facade wall

**Thank you for your kind attention**