About the Network Arch Bridge

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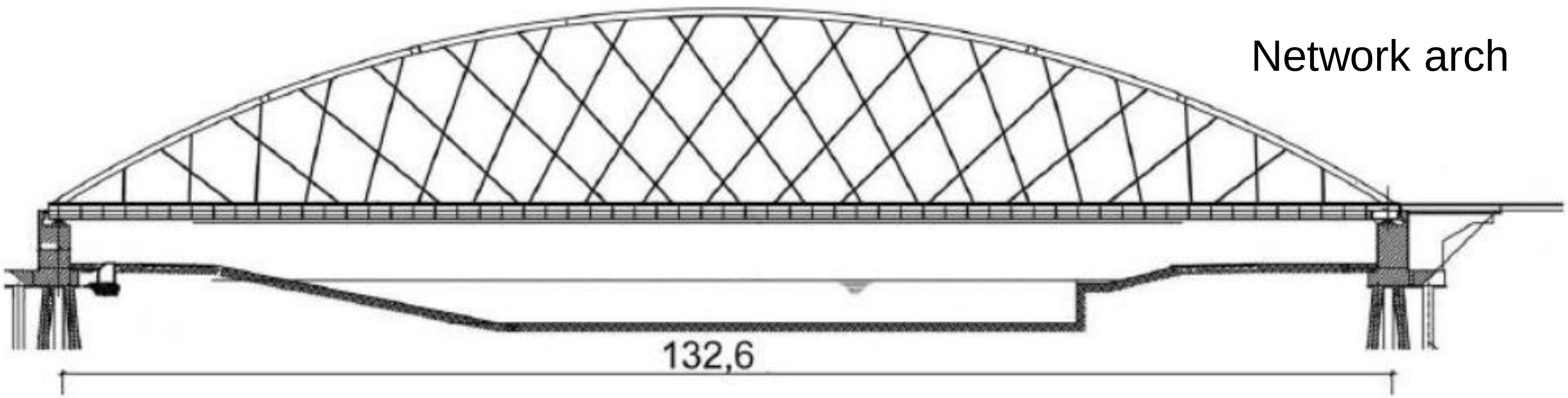
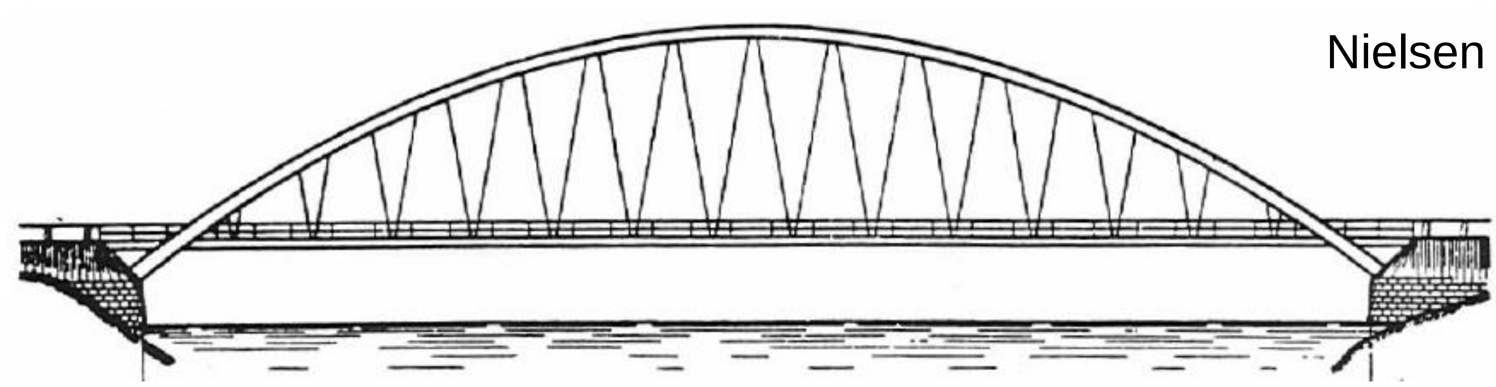
Topics

1. History of Network Arch Bridges
2. Concept
3. Bridges around the world
3. Case study

? Network arches?



Network arch



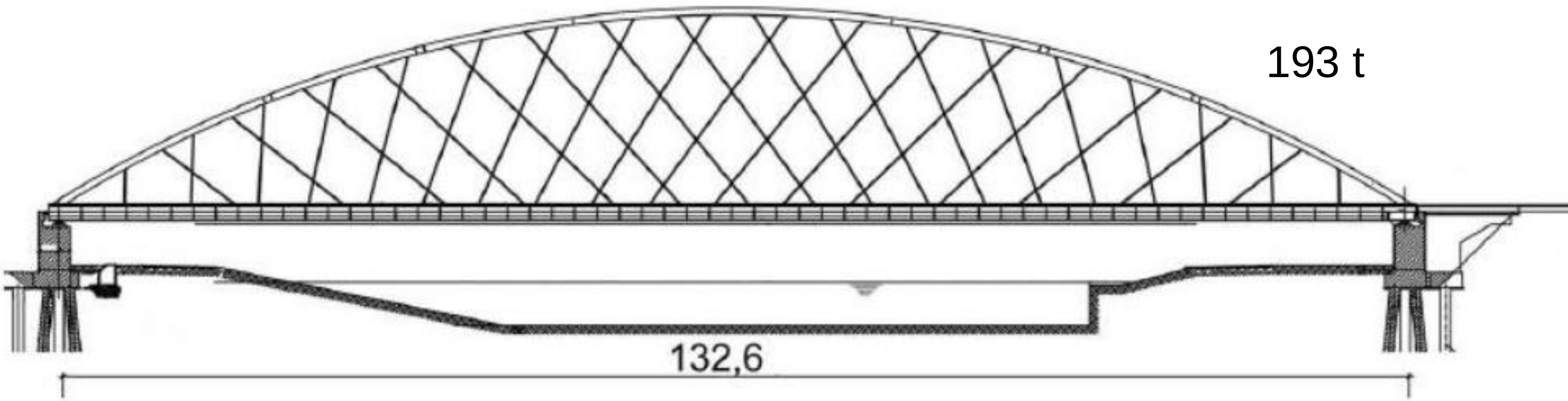
Nielsen bridge

Idea

Per Tveit, dr. Eng, Docent Emeritus, Norway, per.tveit@uia.no

http://home.uia.no/pert/index.php/Home

History of Network Arch Bridges



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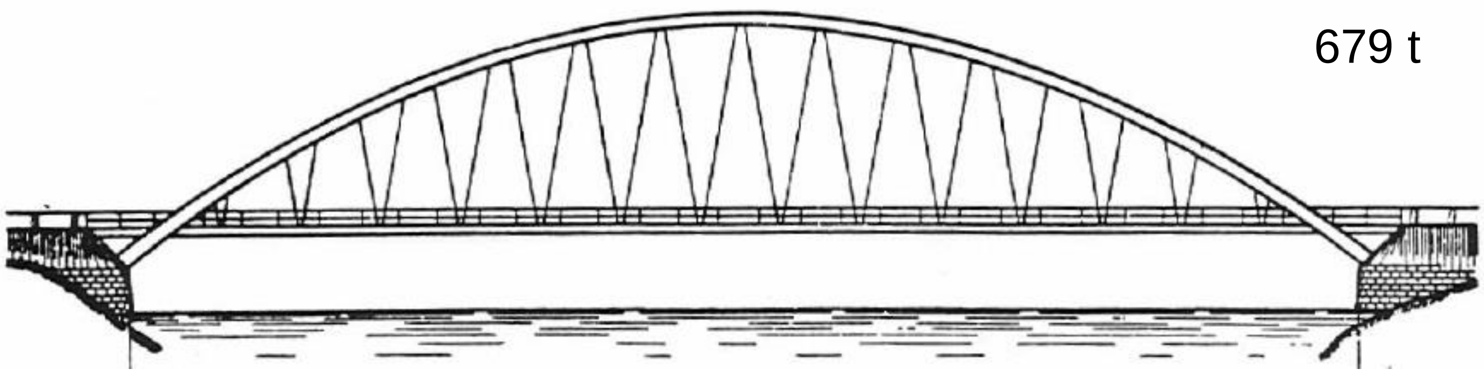


679 t

General recommendations

1. The arch
2. The hangers
3. The lower chord

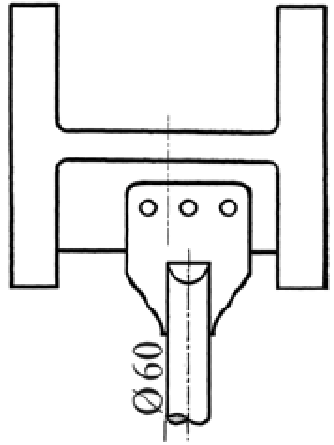
The arch

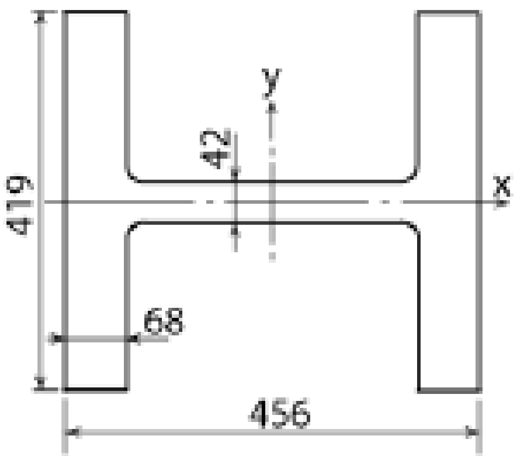
-steel, often circular

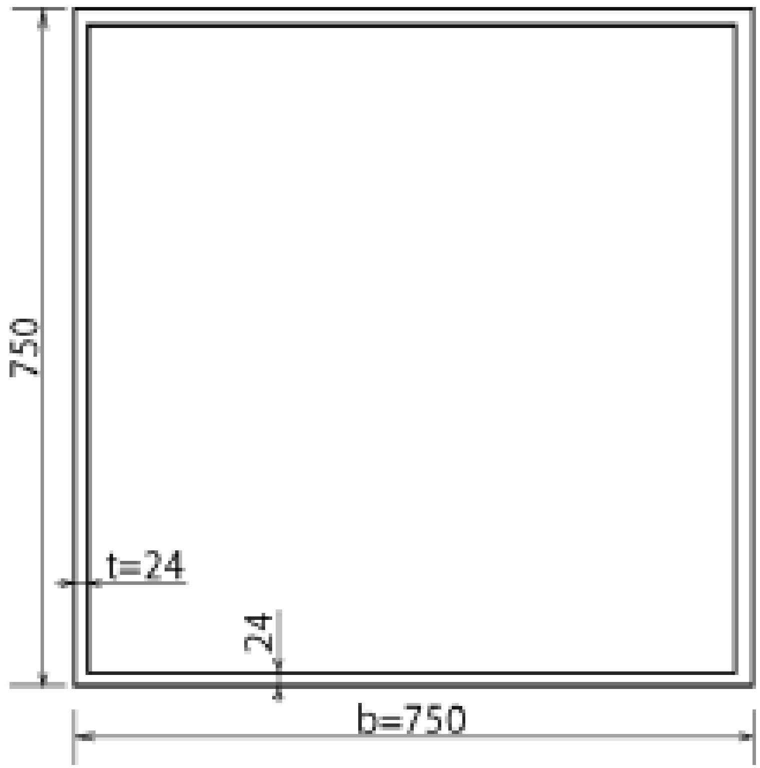
- American wide flange – easy to find

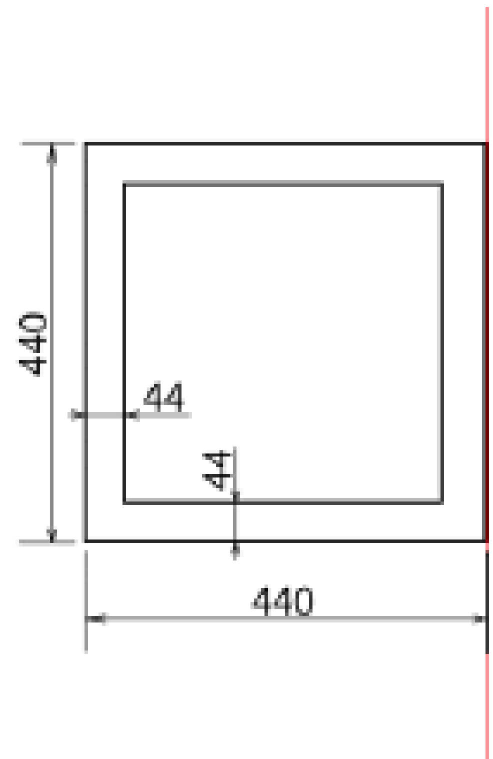
- Longer spans – box section

The arch



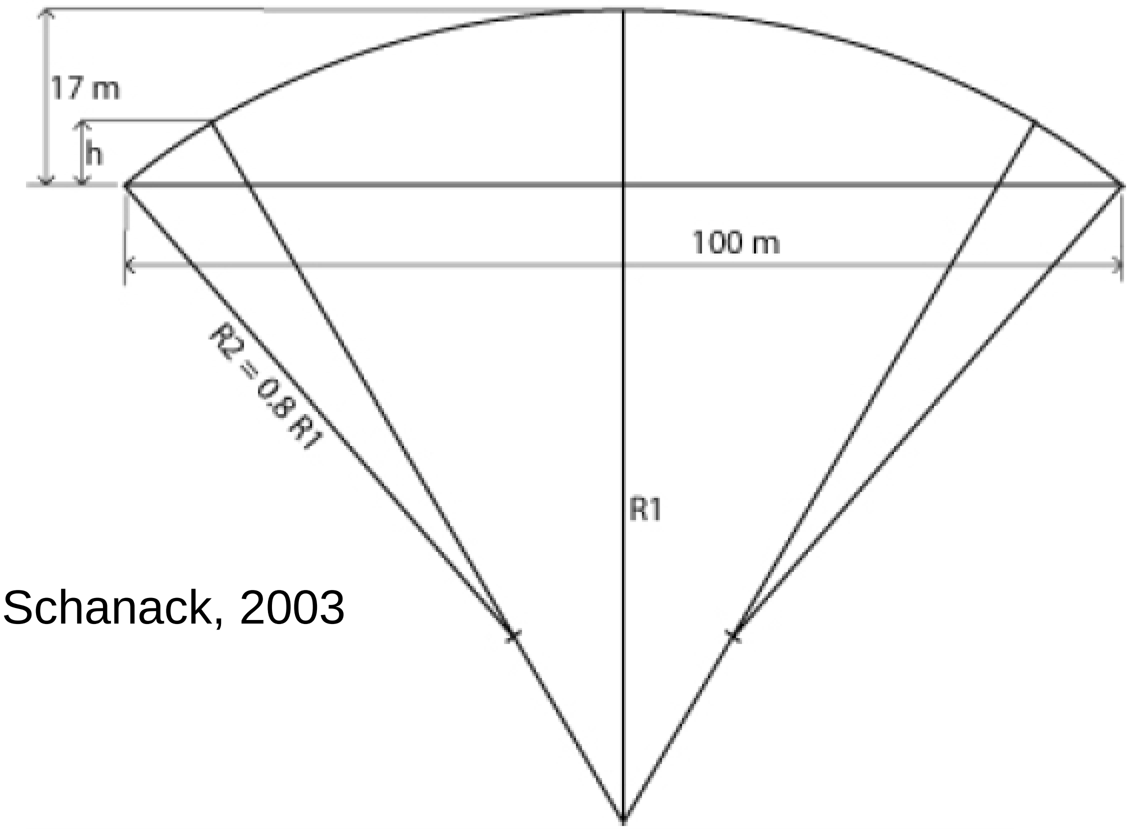






b/t = 31.25, A=69696 mm^2

The arch shape



Brunn and Schanack, 2003

Arch rise

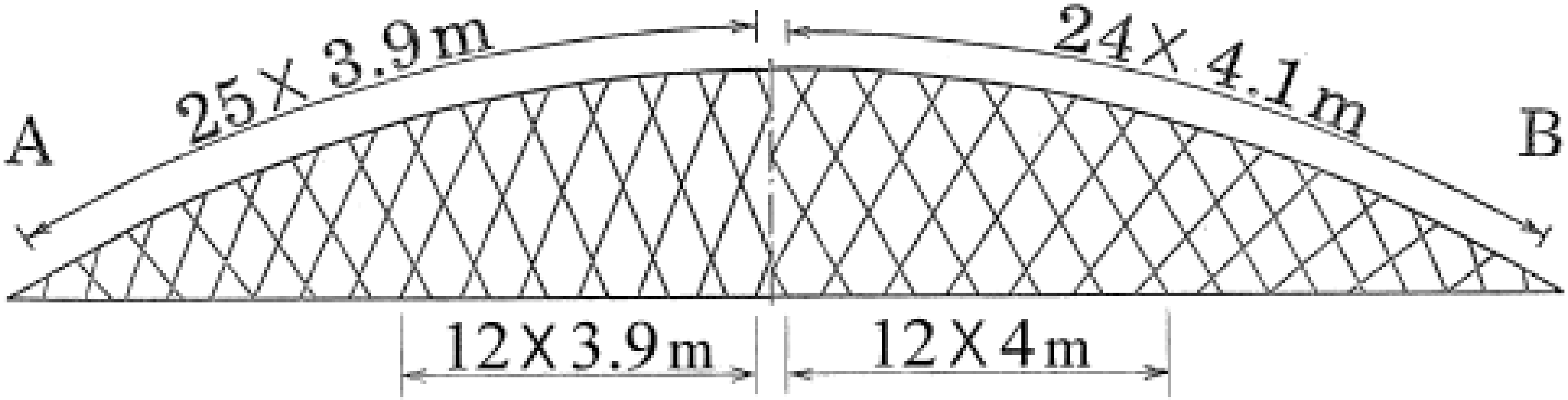
15 – 17 % of the span

The hangers

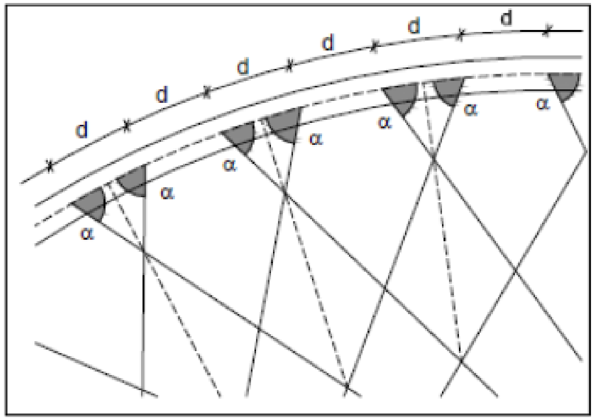
- Wires or rods
- No compression
- Hangers can relax – network ≠ truss

Increase in the bending moments

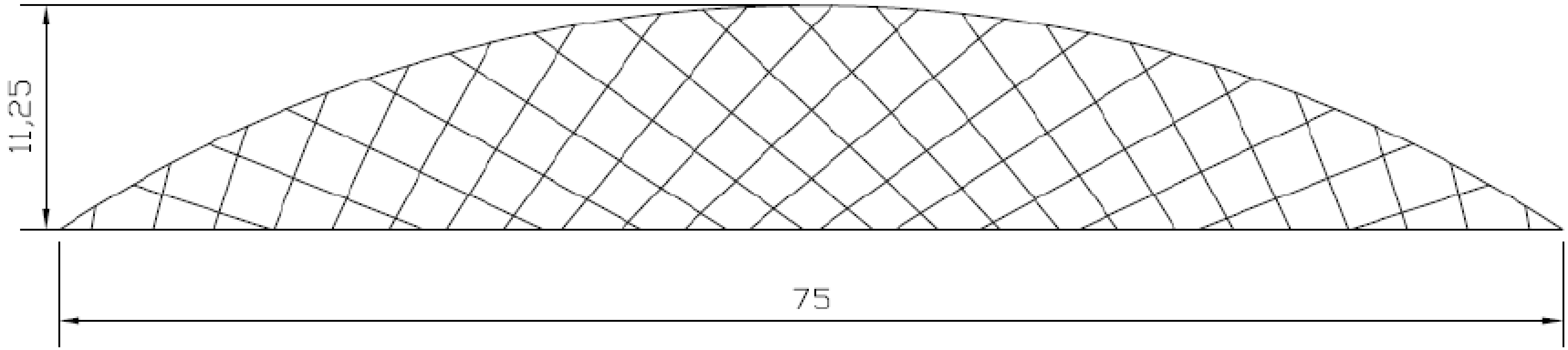
The hangers



The hangers



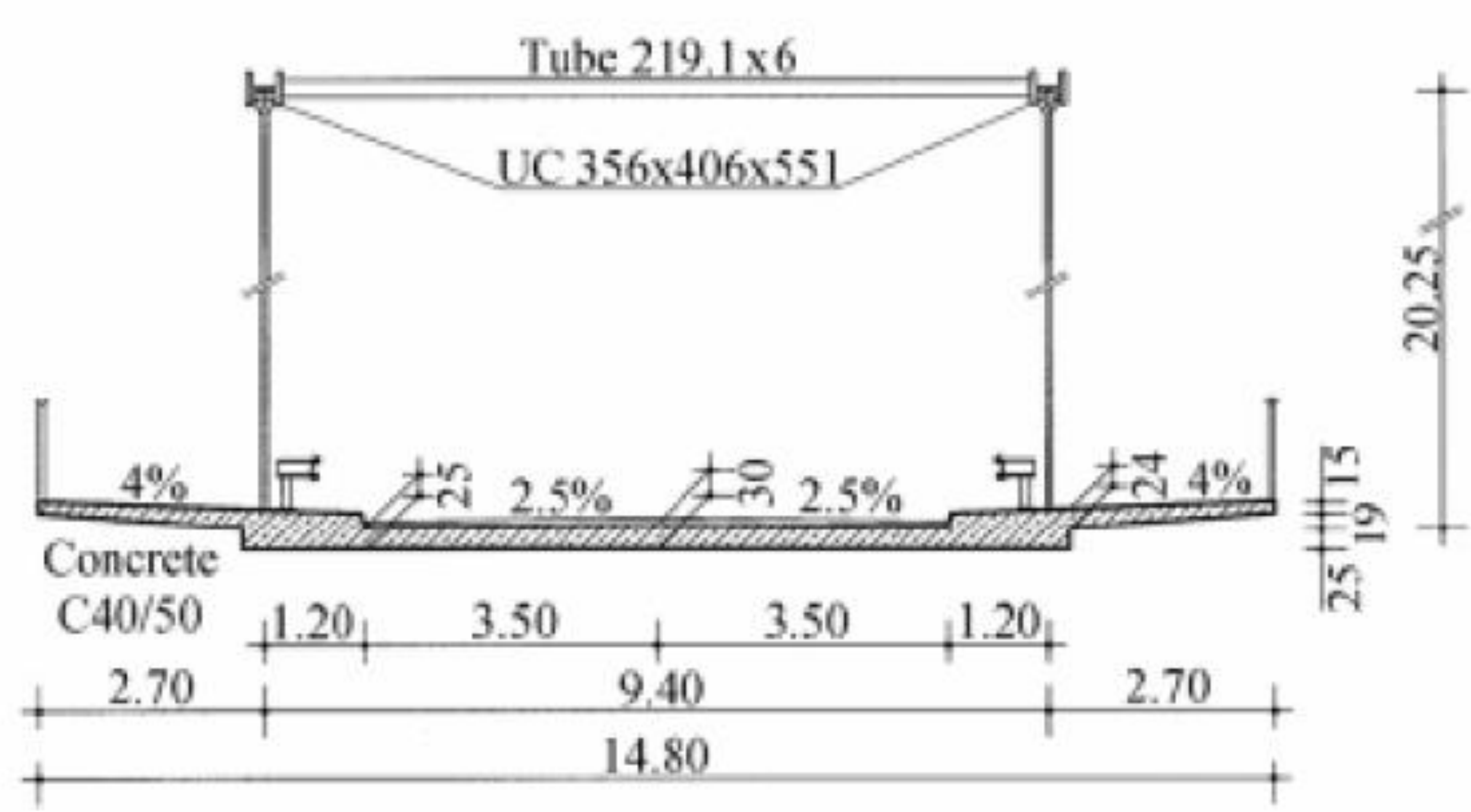
The radial arrangement



The hangers

Φ= 40-60mm
Protection

Lower chord = deck



Lower chord = deck

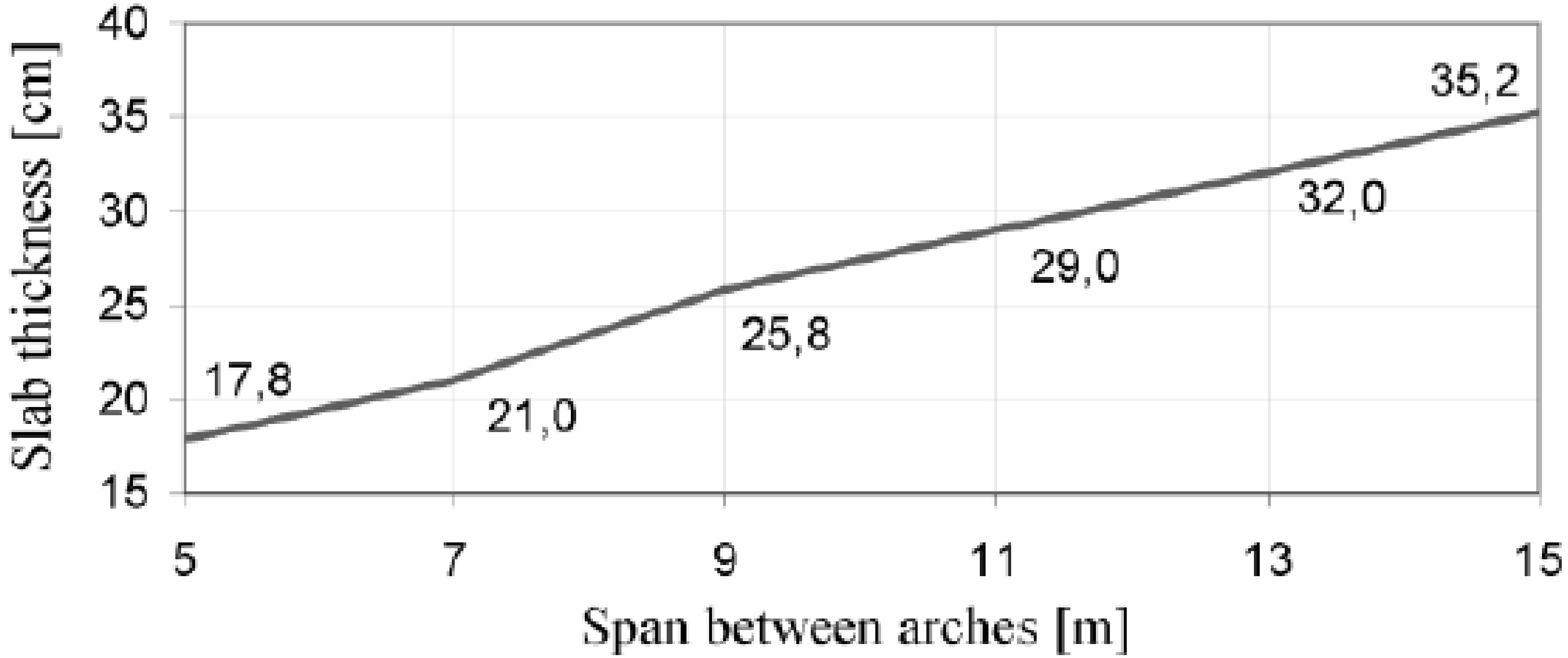


Fig. 3. Slab thickness in network arches. C 40/50

Teich & Wendelin 2001

Why?

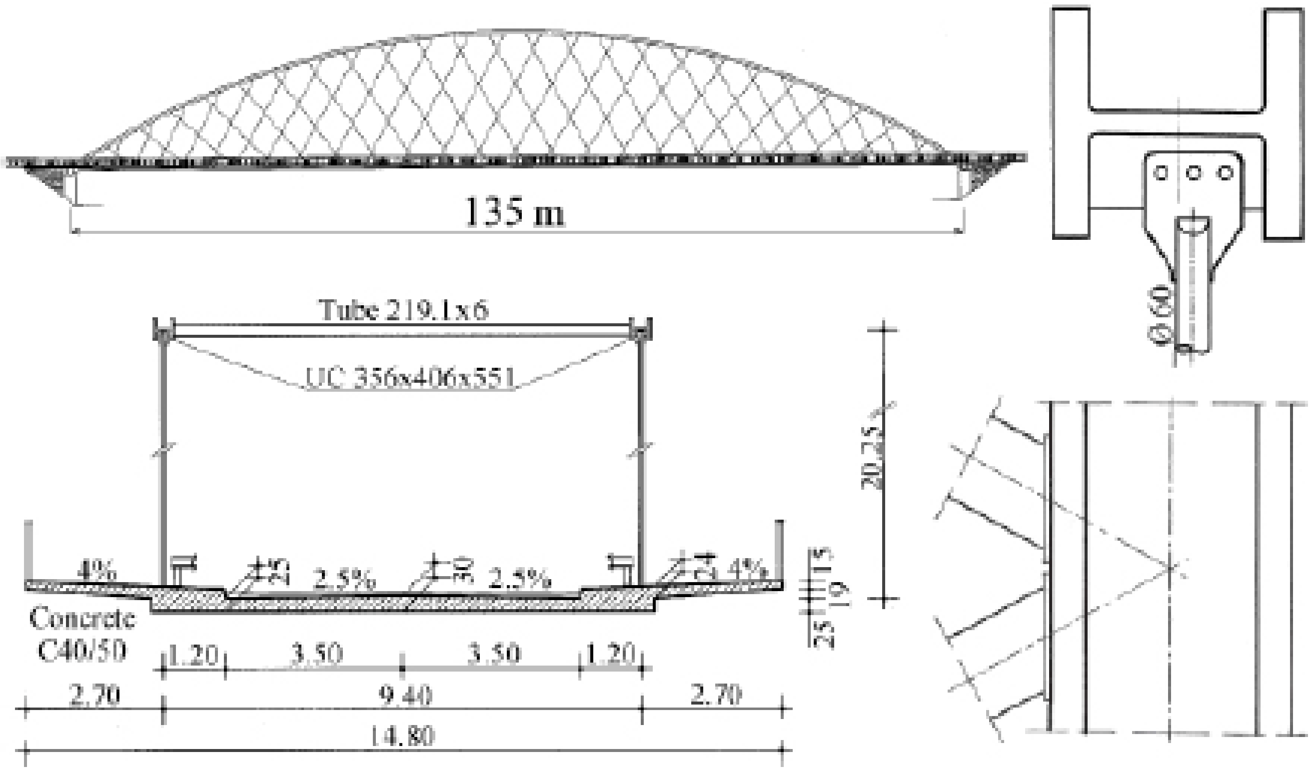


Fig. 28. Åkviksound Bridge. Designed in year 2001.

Why?

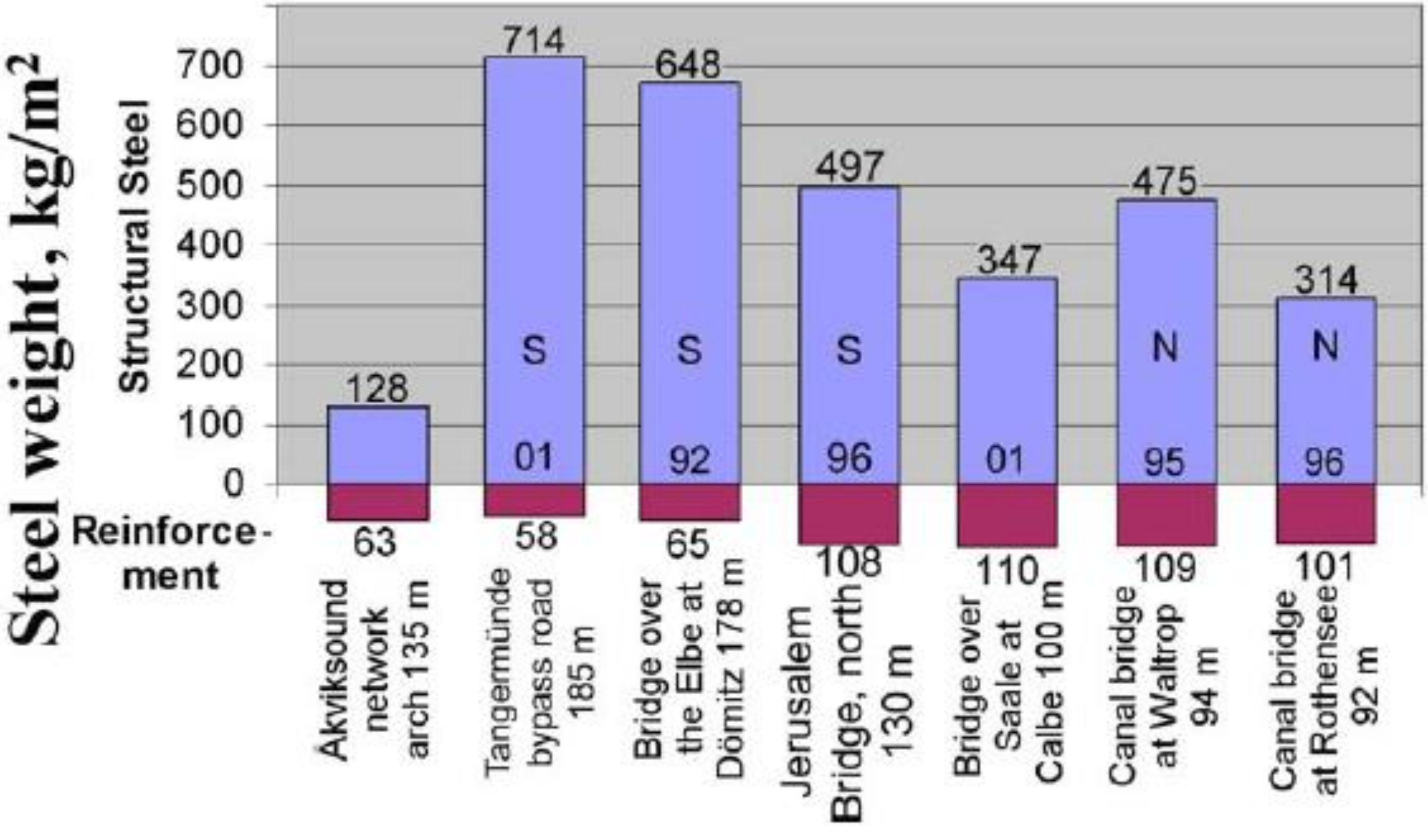
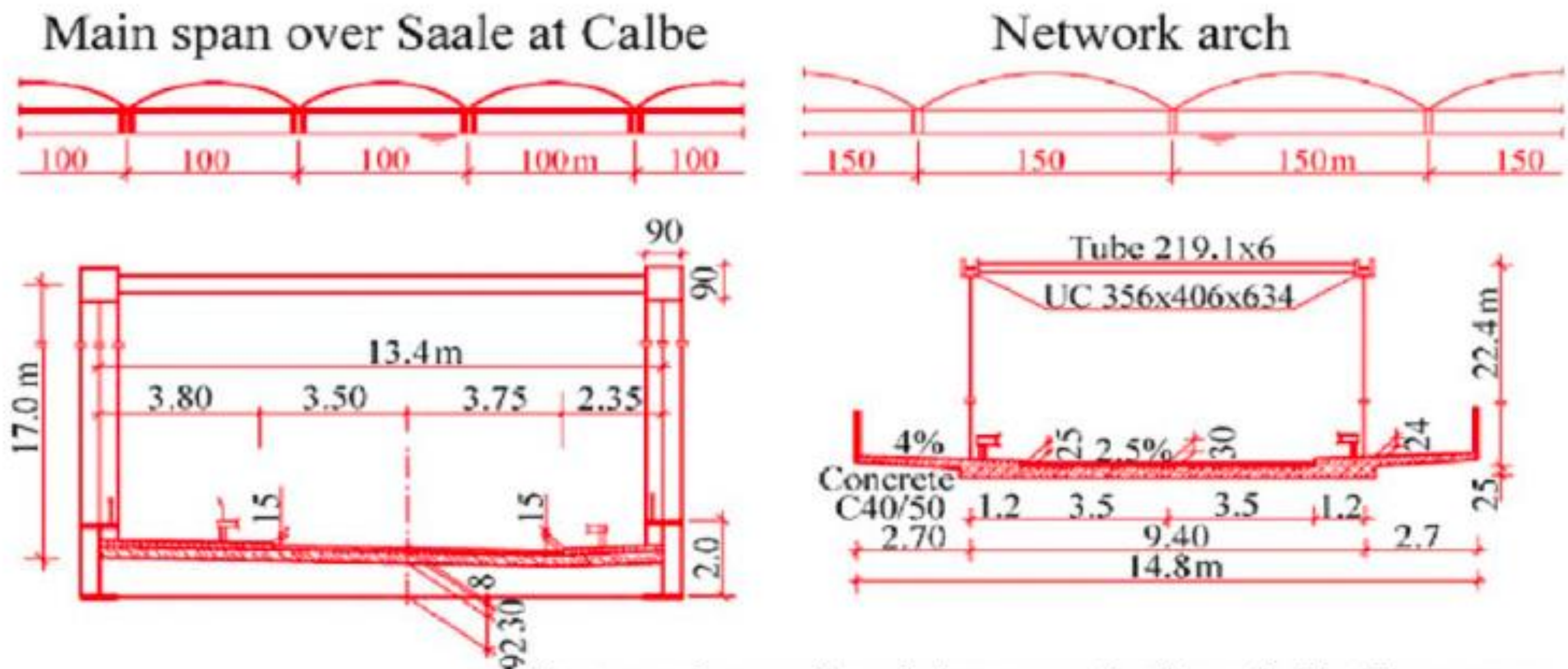


Fig. 29. Steel weight in various arch bridges.

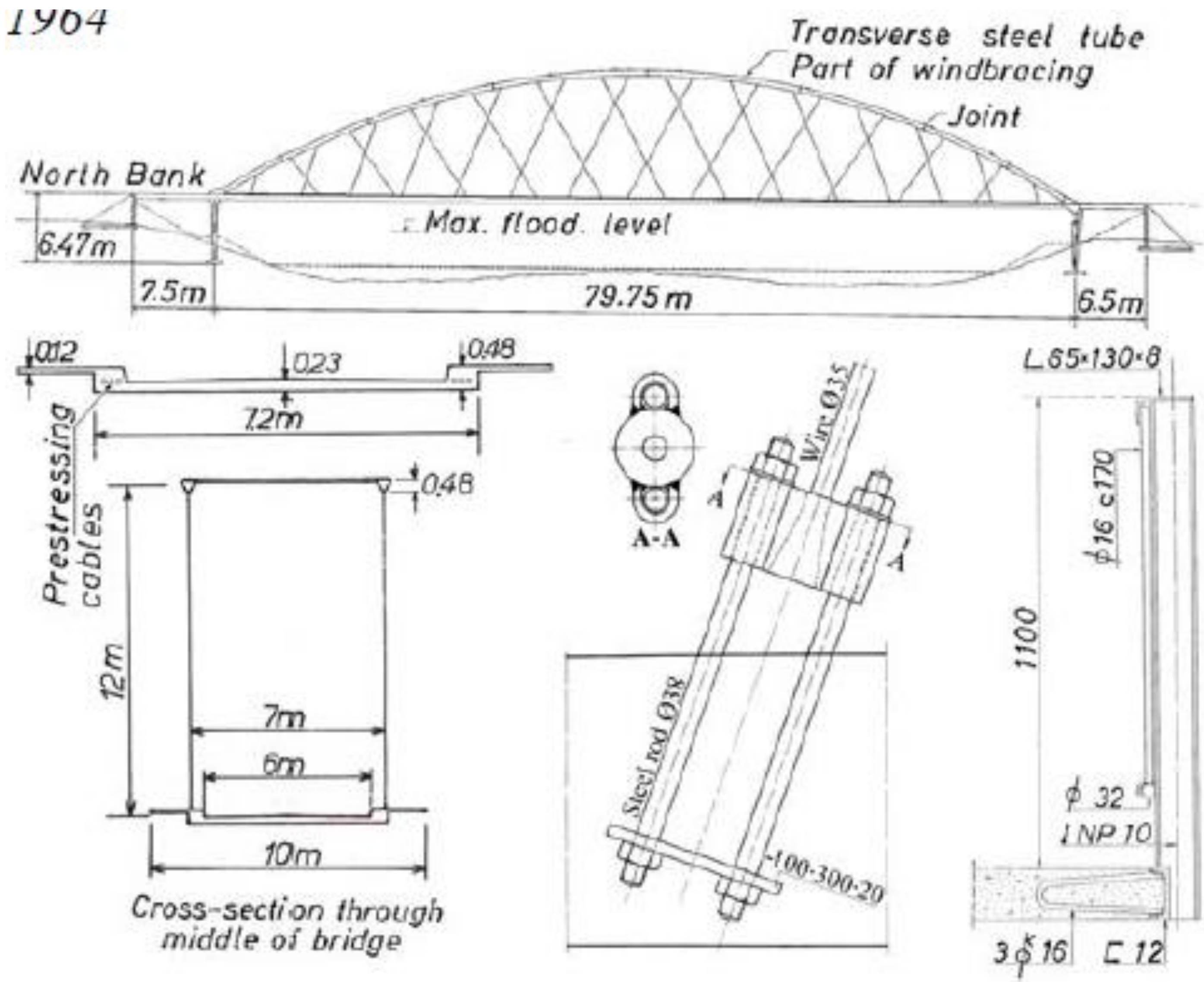


Comparison of weight per m² of useful bridge area

Structural steel incl. prestressing steel	100%	Reduction	58%
Reinforcement	100%	"	34%
Concrete	100%	"	24%
Min. weight to be moved during erection	100%	"	46%
Pillars are the same for both bridges	100%	"	33%

Savings in cost are probably 35 - 45% per m² of useful bridge area.

Fig. 7. Bridge at Steinkjer, Norway, built 1963-1964


1964
Transverse steel tube
Part of windbracing
Joint
North Bank
Max. flood level
6.47m
7.5m
79.75 m
6.5m
0.12
0.23
0.48
7.2m
Prestressing cables
0.48
12m
7m
6m
10m
Cross-section through middle of bridge
A-A
Wire Ø35
Steel rod Ø38
-100-300-20
L 65×130×8
ϕ 16 c170
1100
ϕ 32
I NP 10
3 ϕ 16
⊏ 12

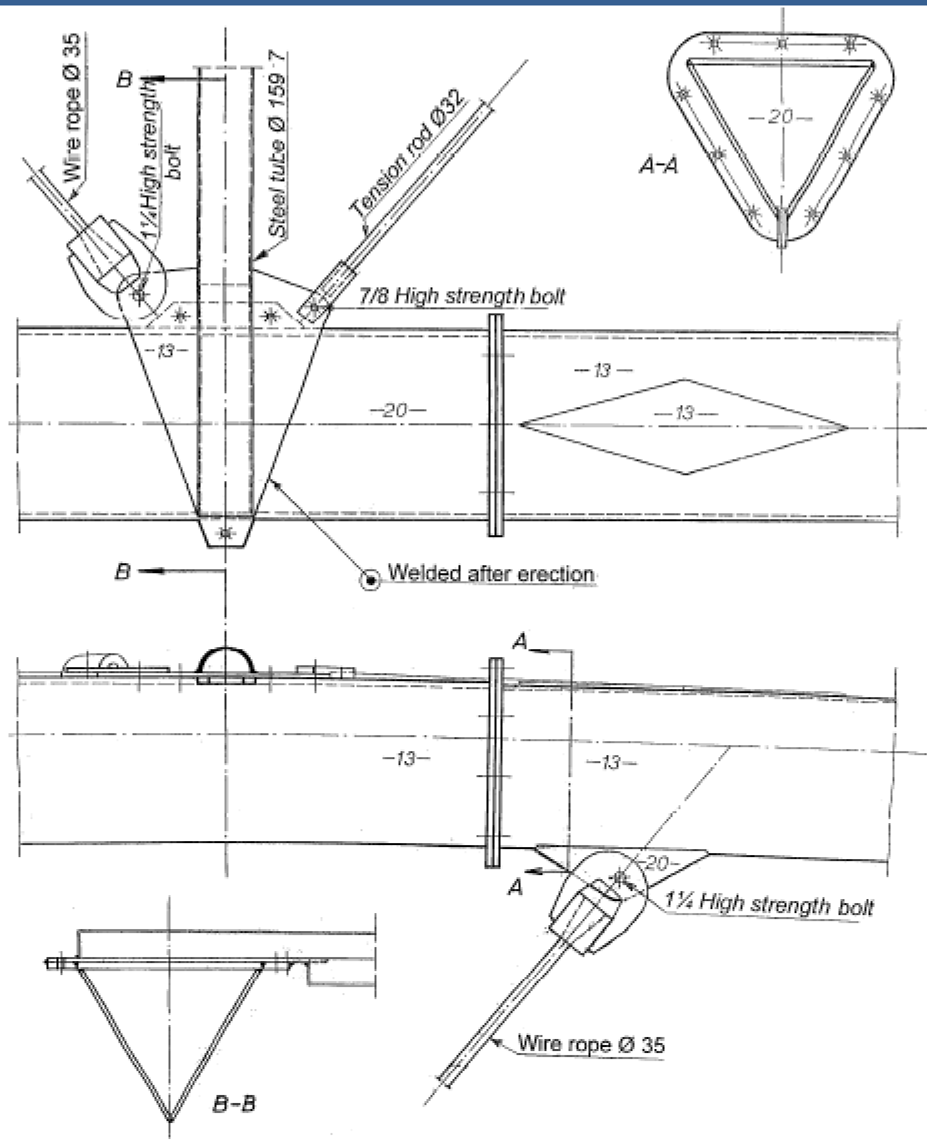


Fig. 13. Details in arch at Steinkjer.

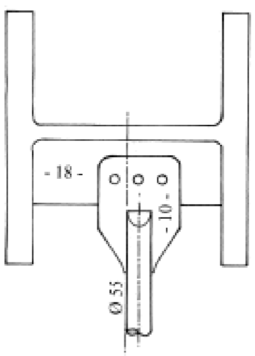


Fig. 15. Fastening of a hanger to the arch.

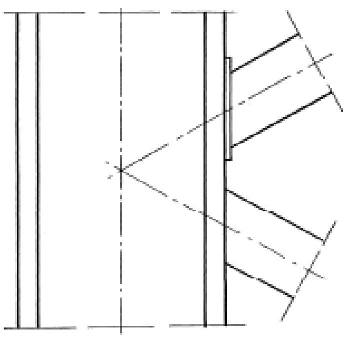


Fig. 16. Joint in wind-bracing.

Fig. H5. The Bolstadstraumen Network Arch seen from the south

Waikato River Network Arch

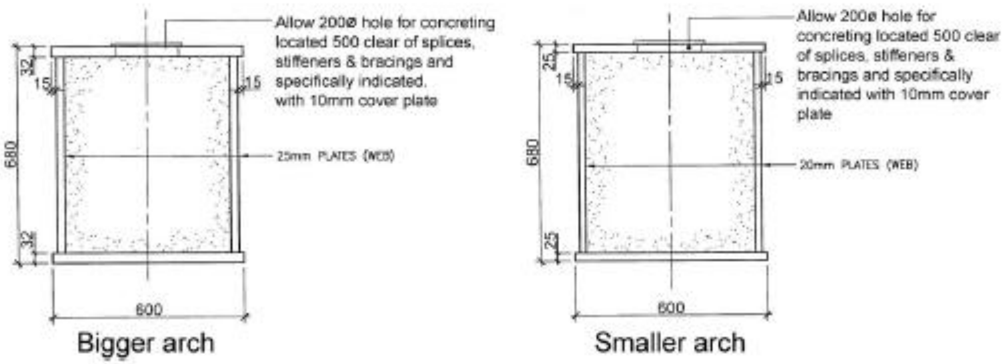
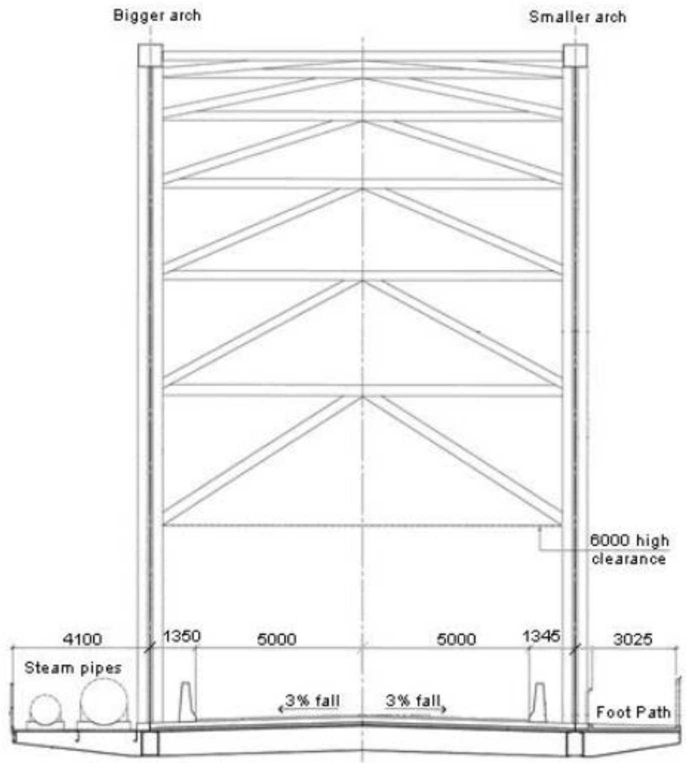


Figure 3. Waikato River Bridge Top Chord Sections



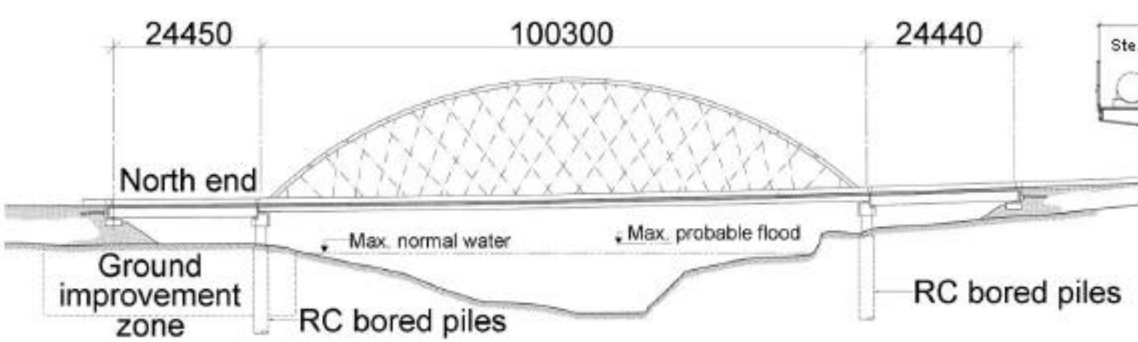


Figure 1. Waikato River Network Arch. Span 100 m. Built 2010. Opened 2011.

Fig. 40e shows a two track railway bridge spanning 100 m designed by Brunn and Shanack

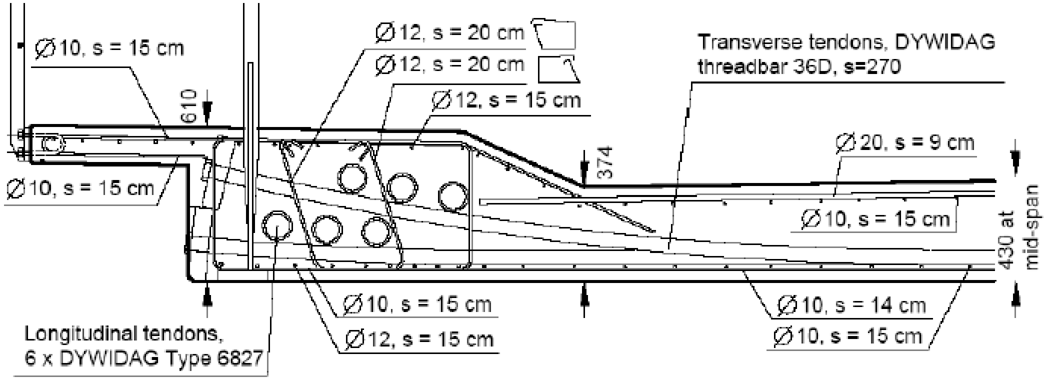
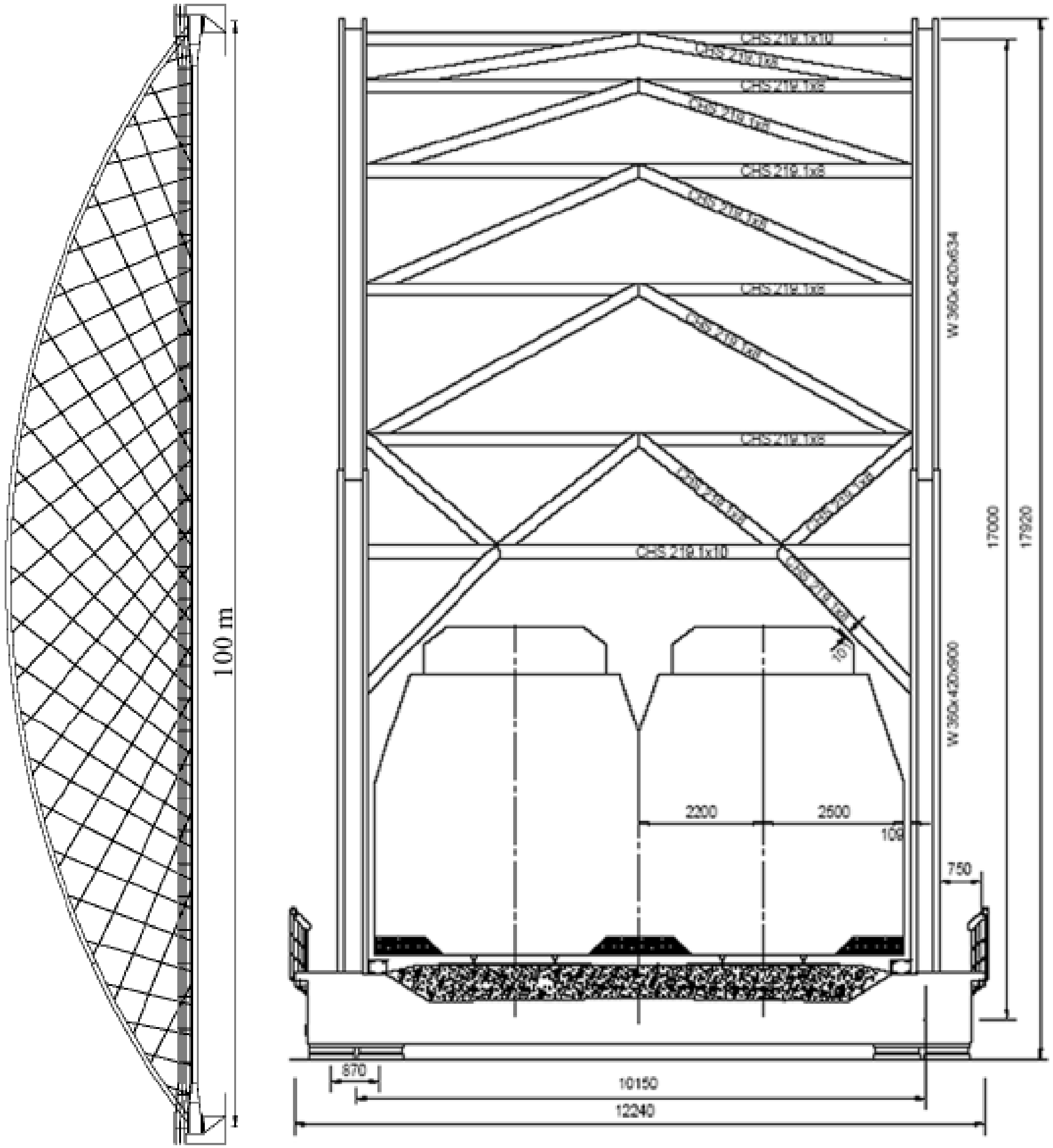
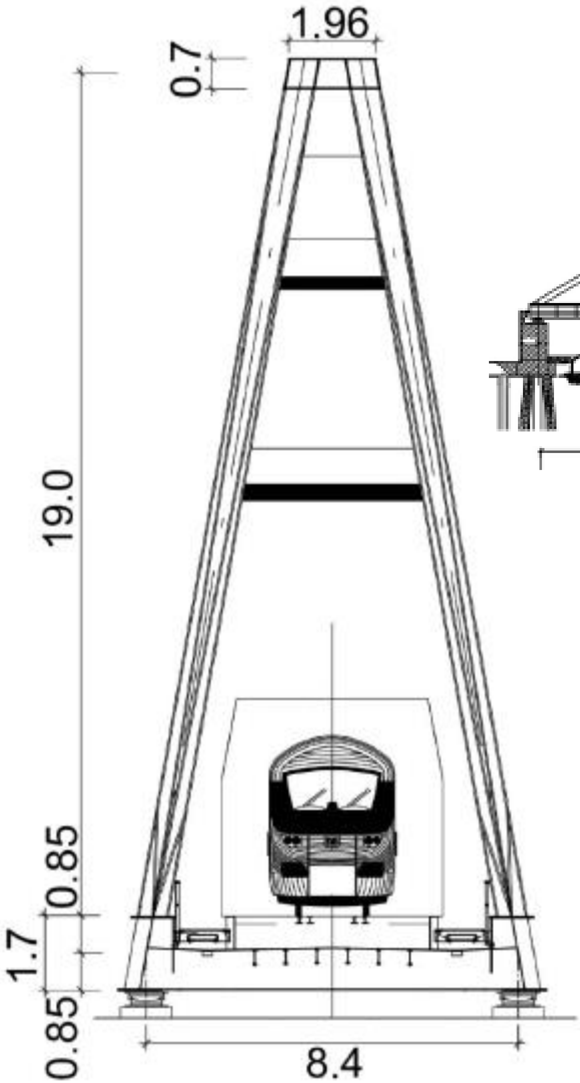
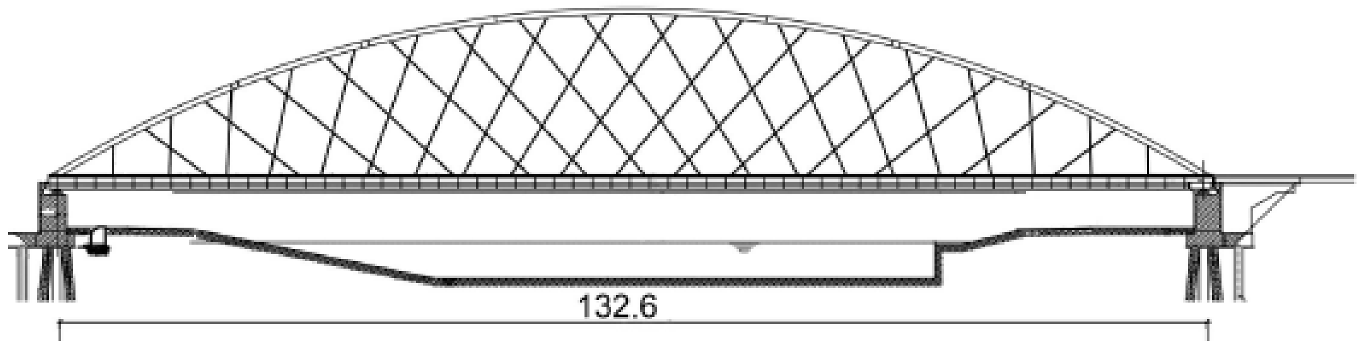


Fig. 40f. Reinforcement for a tie in the railway bridge in fig. 40e


100 m
CHS 219.1x10
CHS 219.1x8
W 360x420x634
W 360x420x900
17000
17920
2200
2600
750
870
10150
12240





Flora Bridge over the Mitteland Canal in Germany

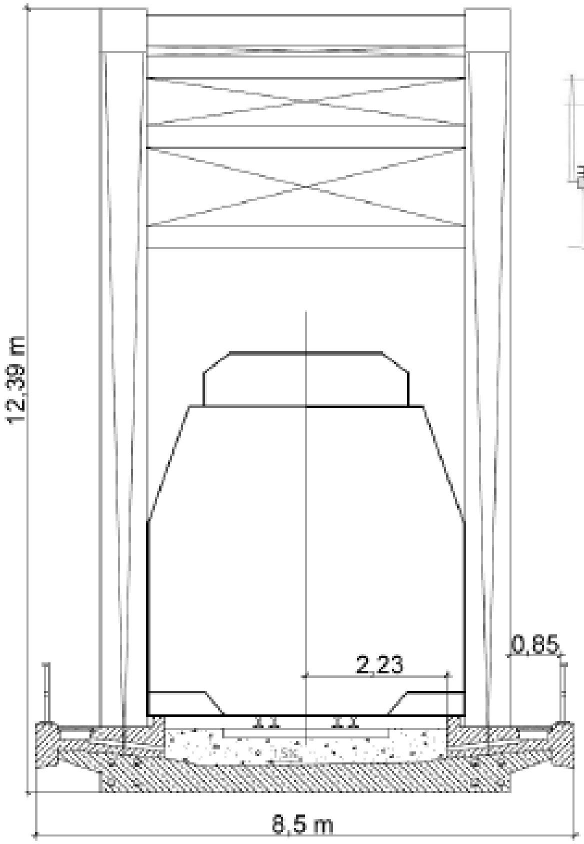
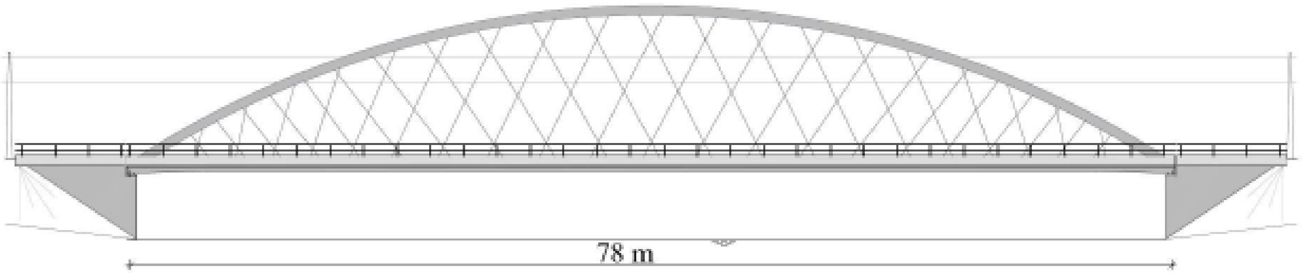


Fig. 40m. Shows an early suggestion by Prof. Marx for a cross-section of the railway bridge over B6 at Halle



Network arch over B6 at Halle

NETWORK ARCH BRIDGE OVER THE RIVER LUZNICE (Czech Republic) Built 2005

Designer: Ladislav Šašek, PhD, Mott MacDonald, Prague

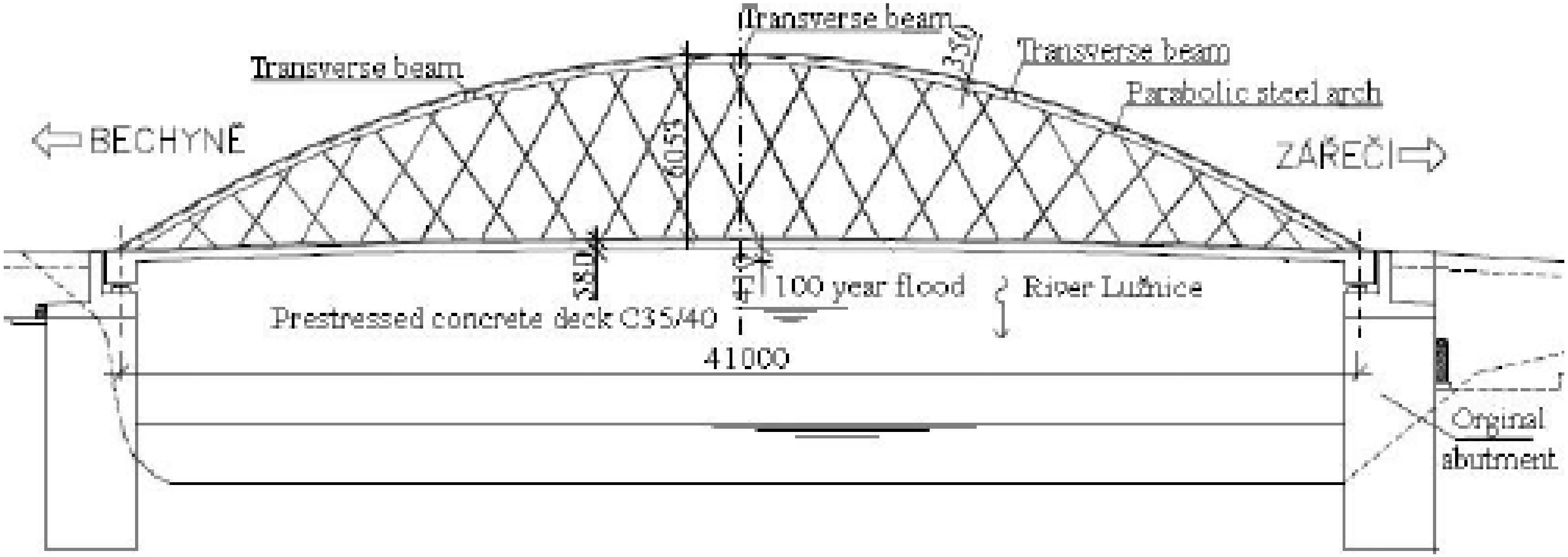


Fig. 96a. Longitudinal section

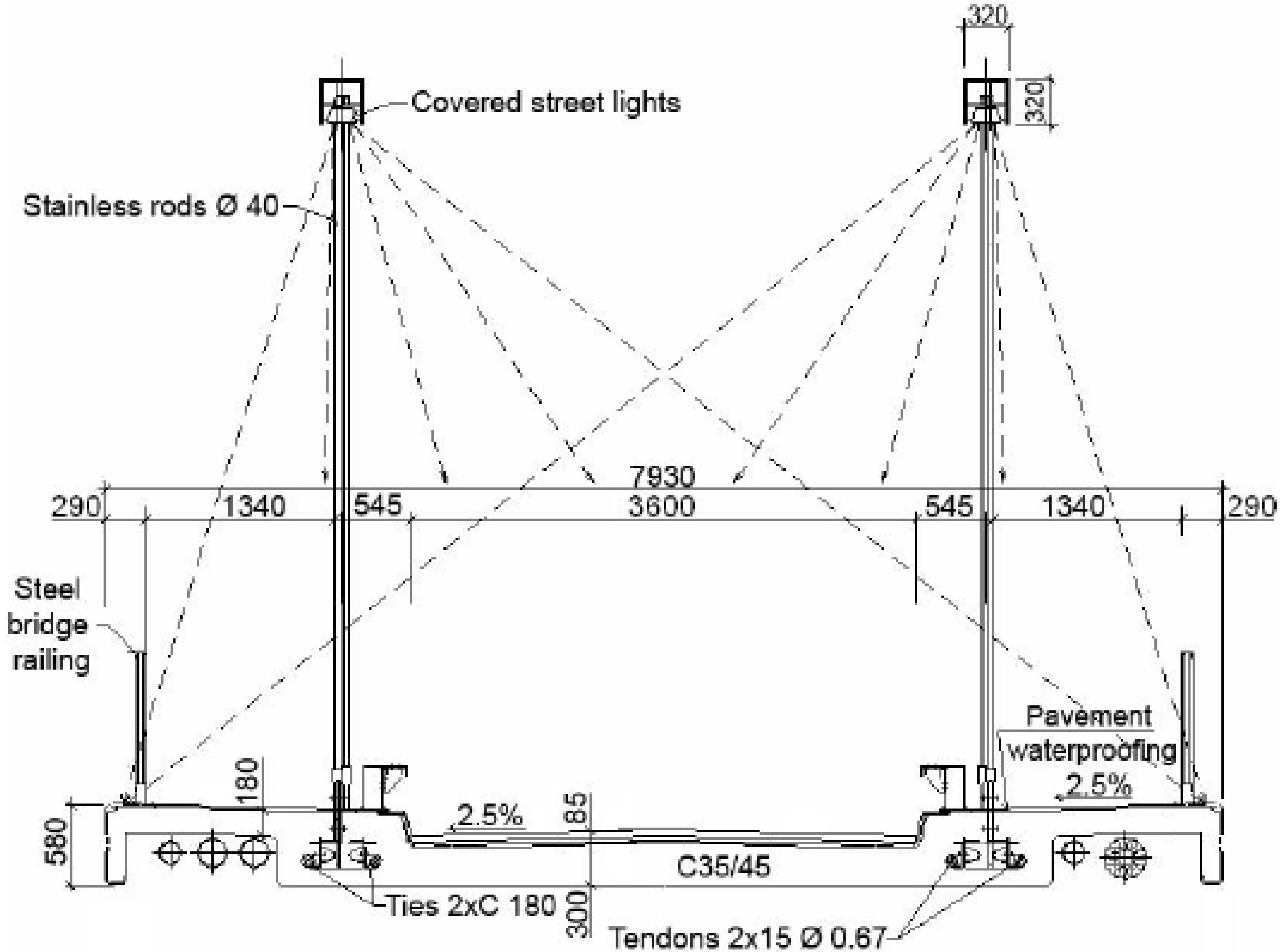


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Fig. 101. The Brandanger Sound Bridge was lifted onto the pillars on the 7th of September 2010

THE BRANDANGER BRIDGE IS THE WORLD'S MOST SLENDER ARCH BRIDGE

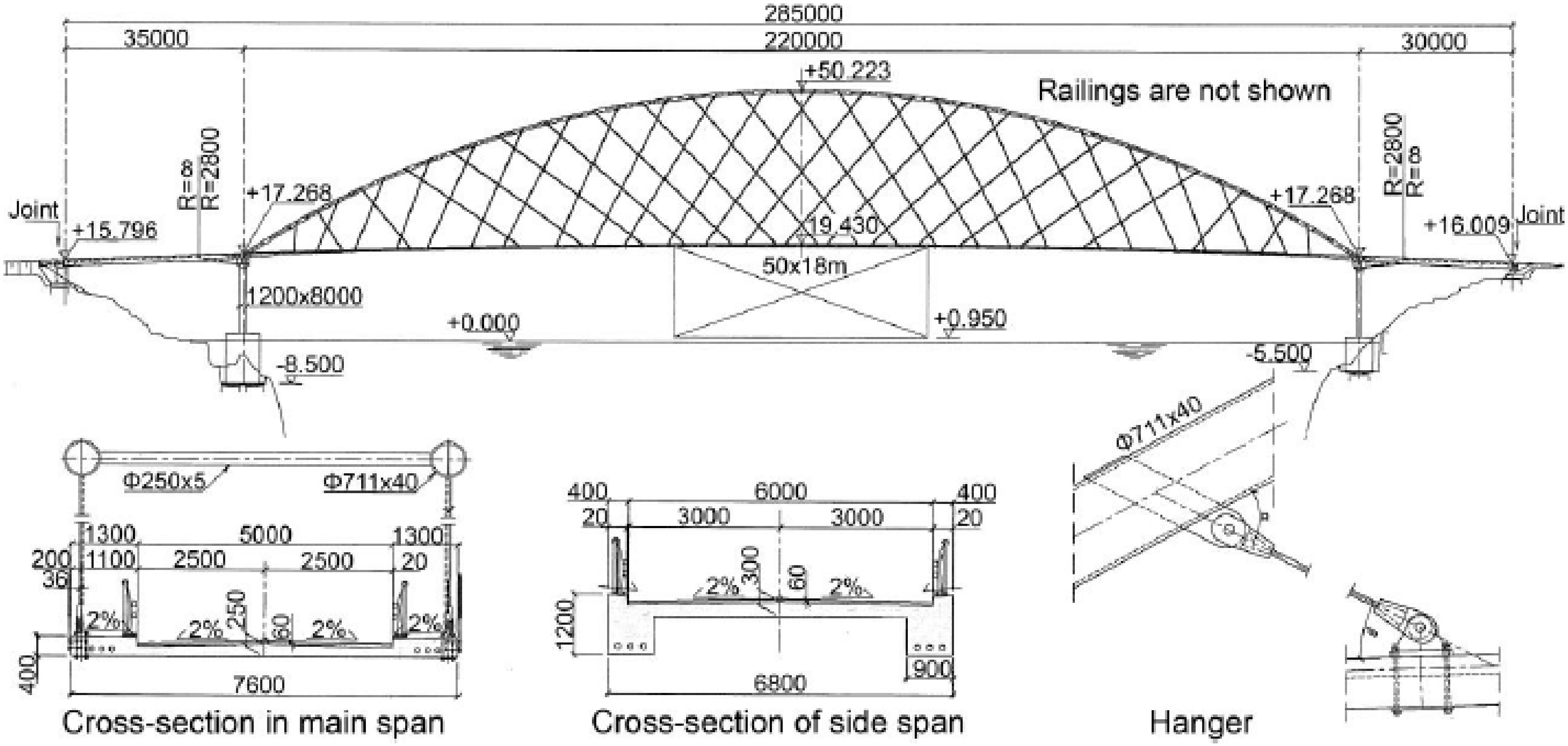
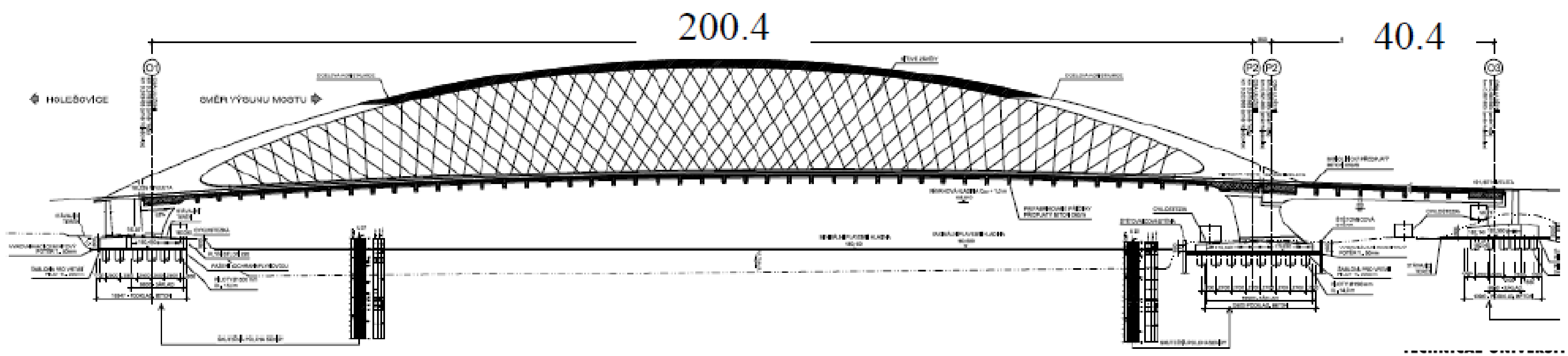


Fig. 100. Final design of the Brandanger Bridge

TROJA BRIDGE IN PRAGUE



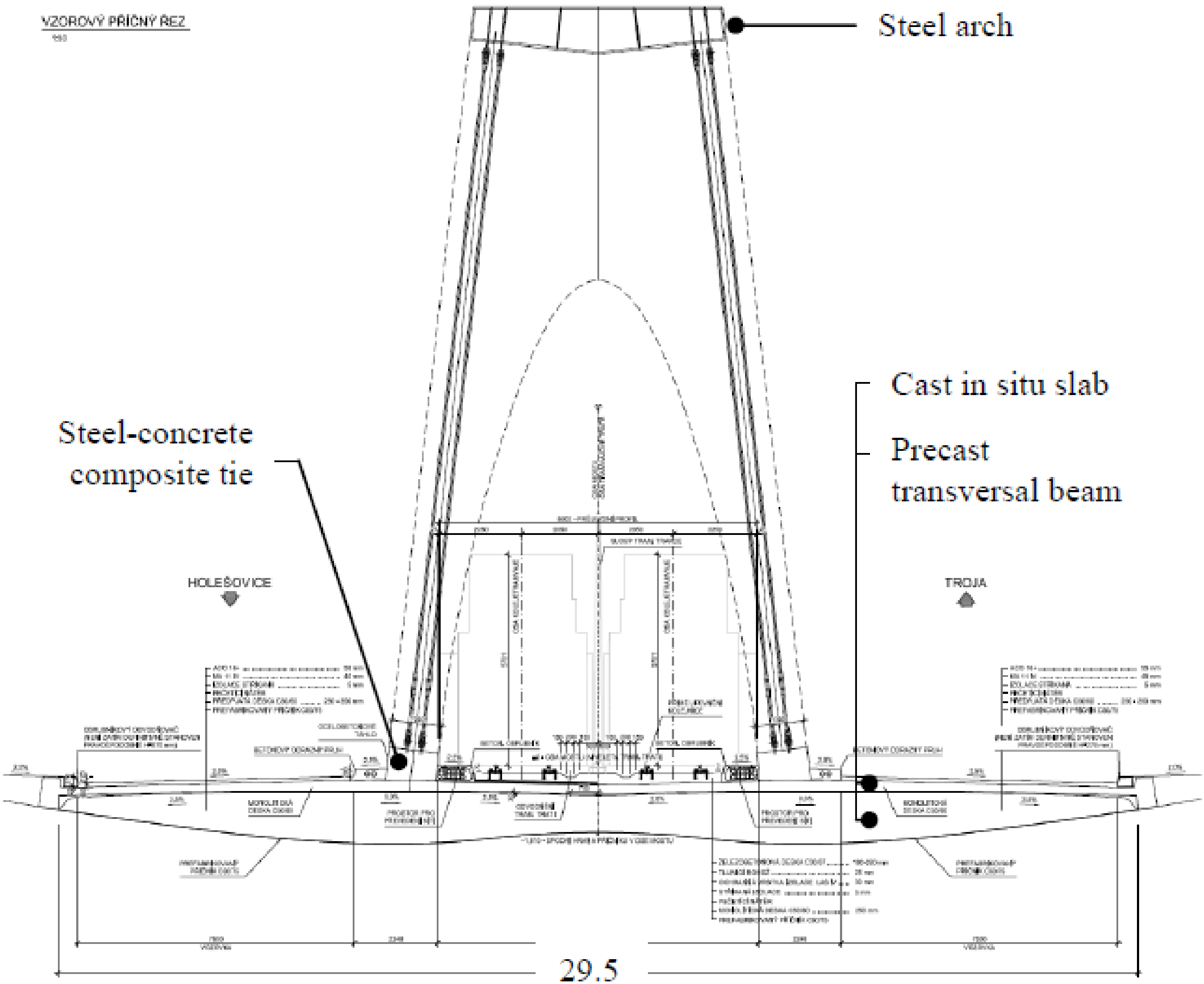
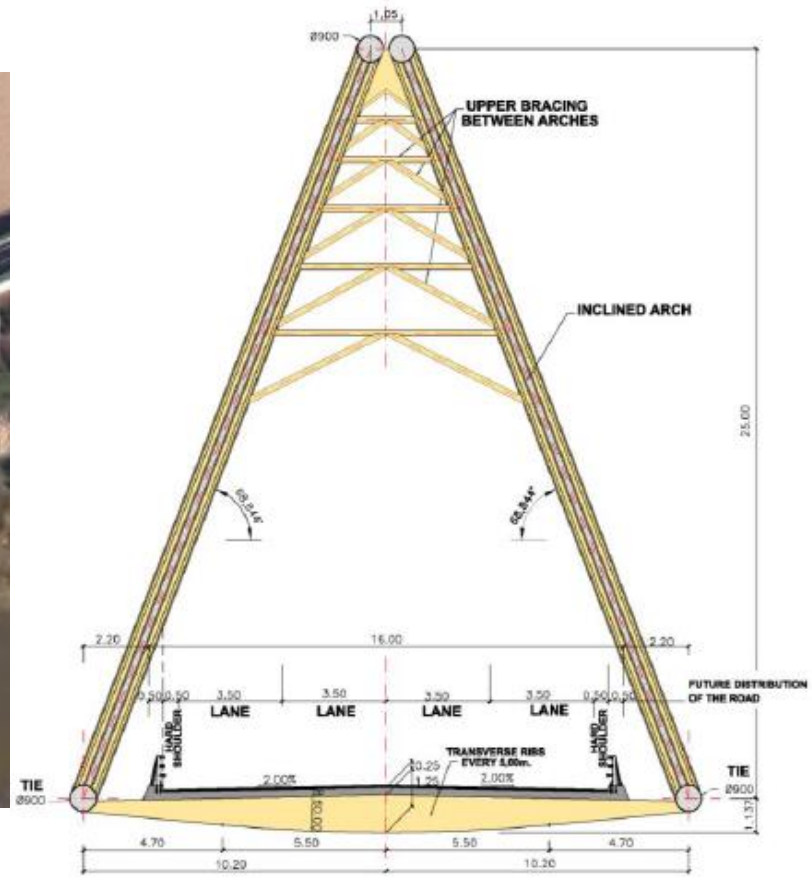
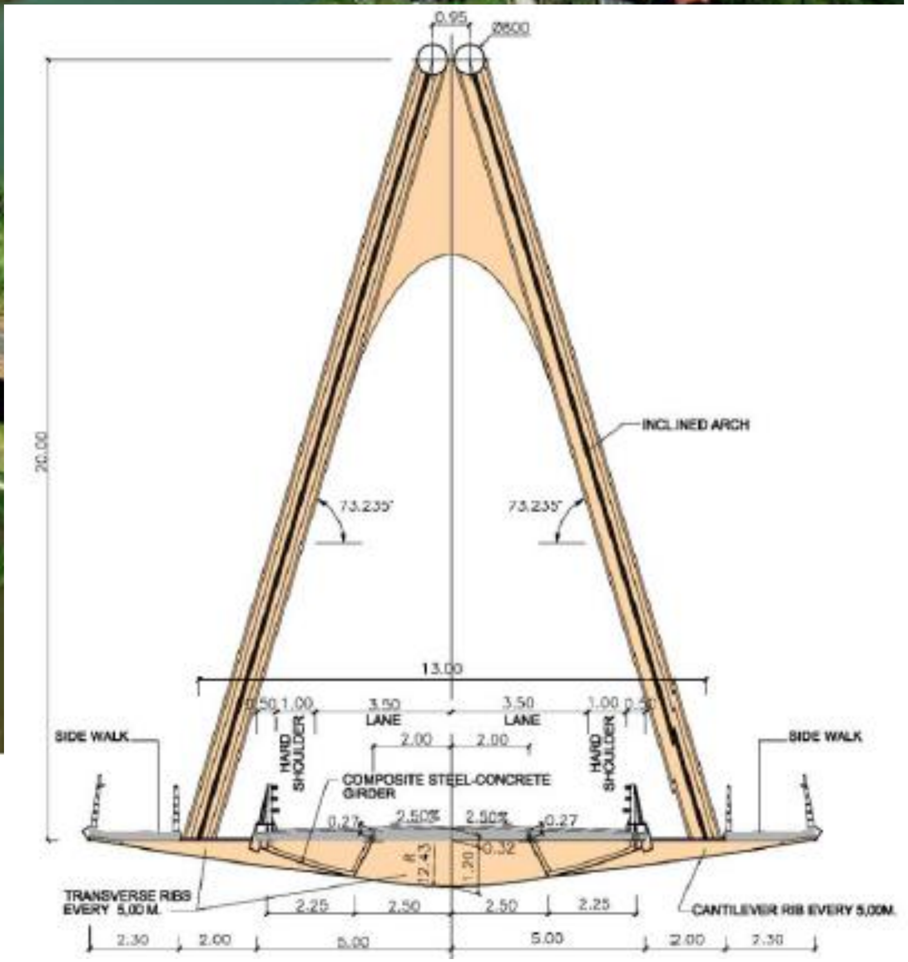

VZOROVÝ PŘÍČNÝ ŘEZ
Steel arch
Cast in situ slab
Precast
transversal beam
Steel-concrete
composite tie
HOLEŠOVICE
TROJA
29.5

Fig. 4 Precast transversal beams stored on the site prior to assembly

“Palma del Río” bowstring arch Bridge. Córdoba. Spain.





“Deba” bowstring arch Bridge.
Guipuzcoa. Spain.

Bridges around the world

Blennerhassett Island Bridge , 268m

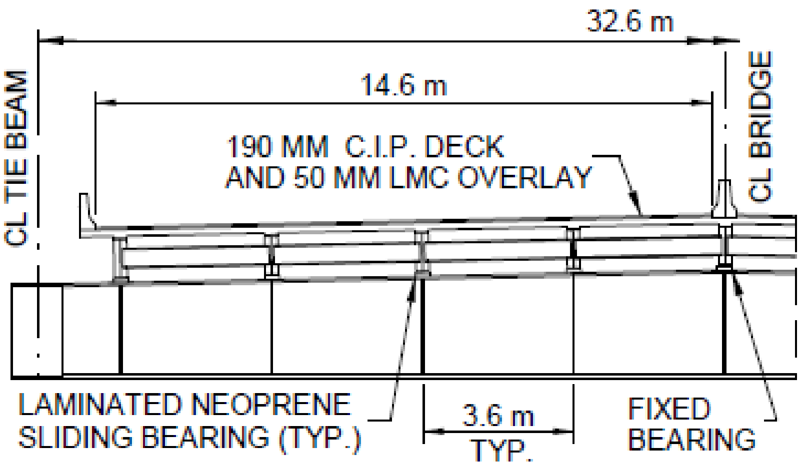


Fig. 3 – Typical Section at Floorbeam

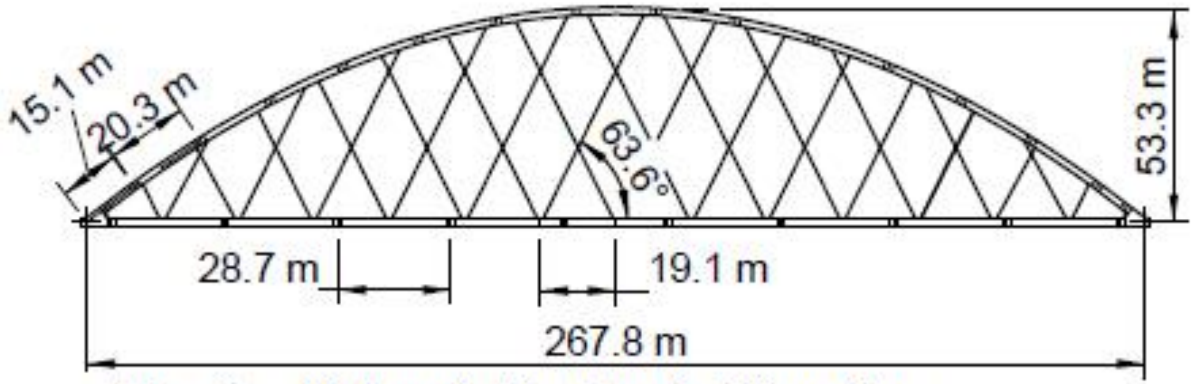
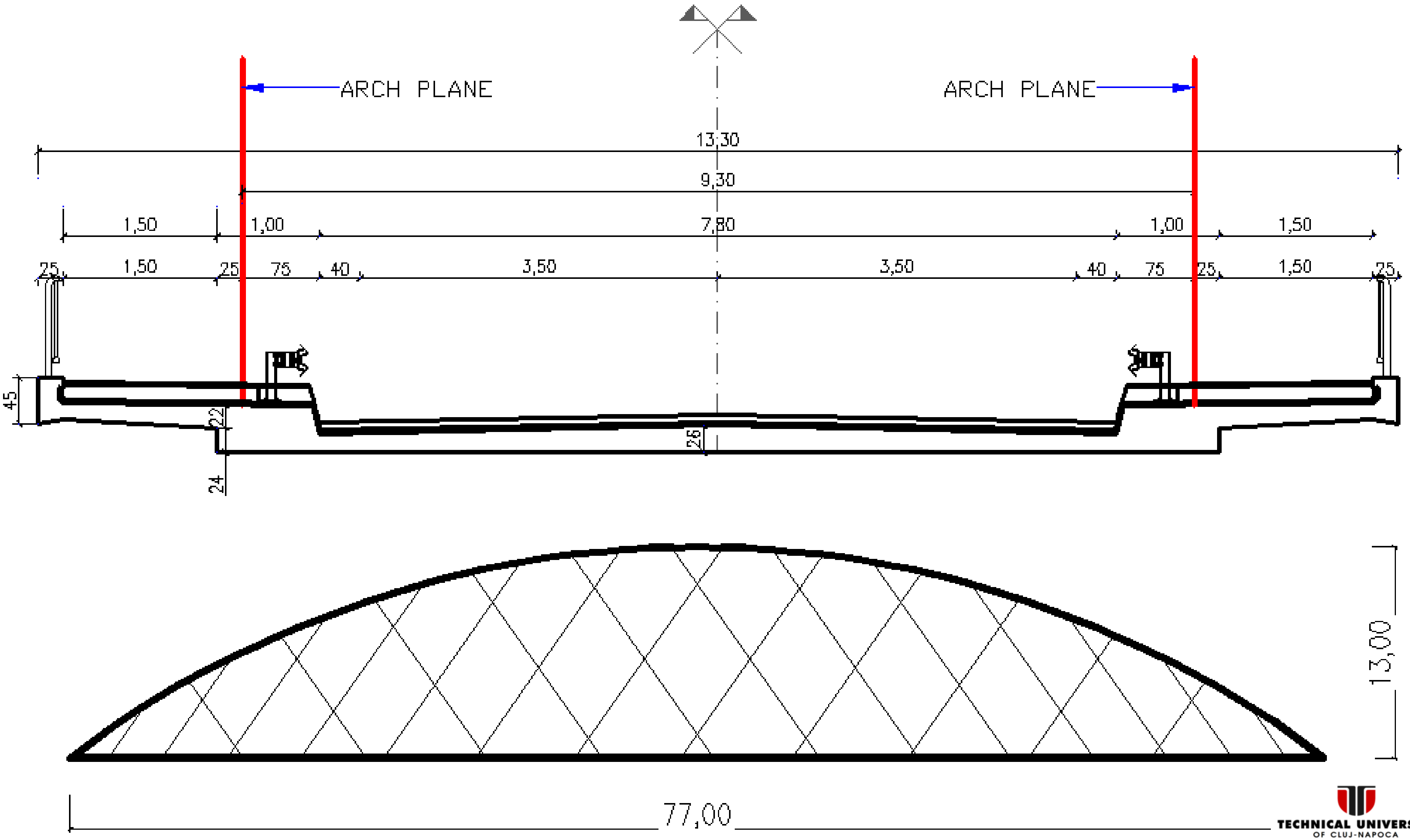


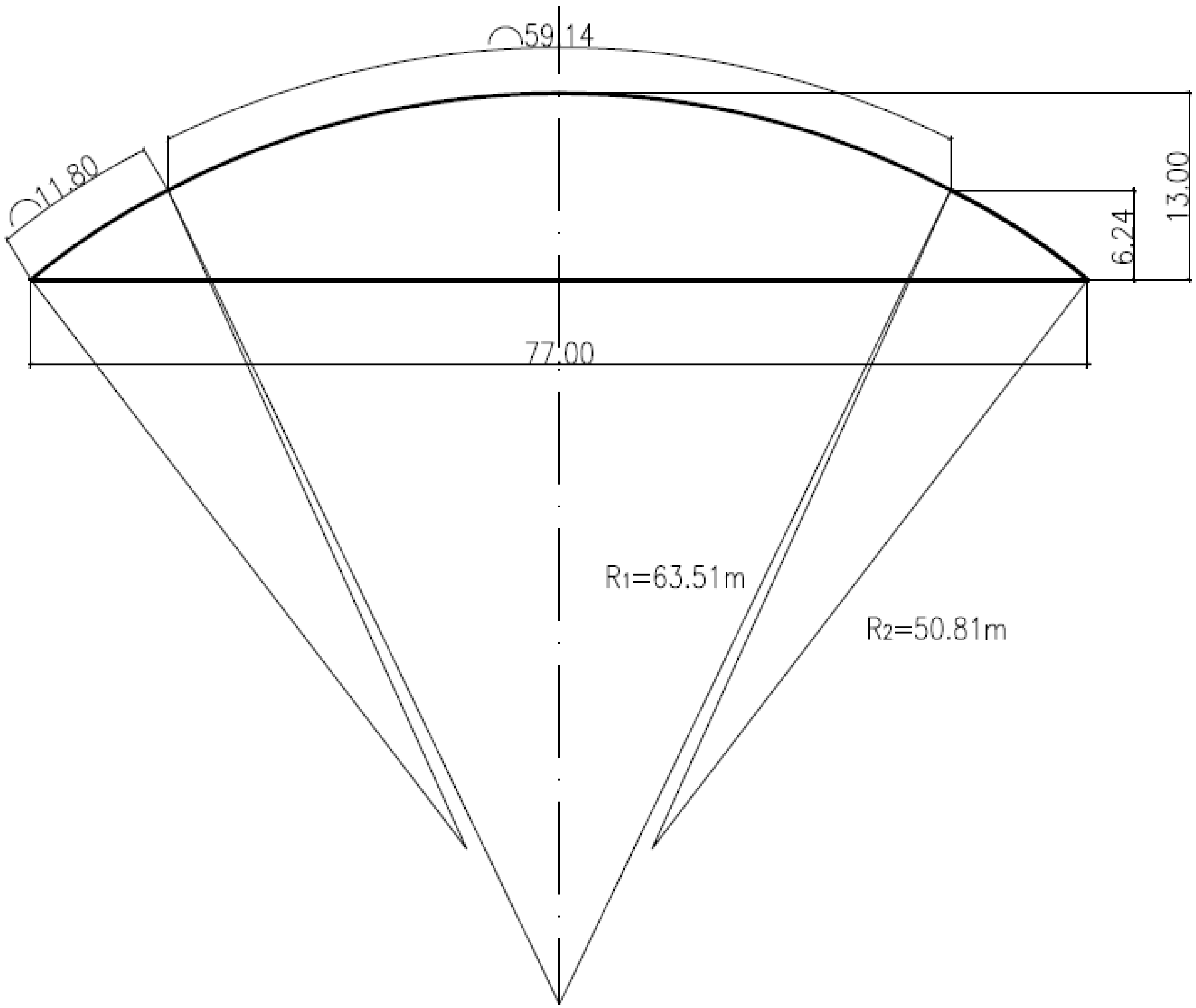
Fig. 4 – Network Tied Arch Elevation

Fig. 5 – Rib Bracing

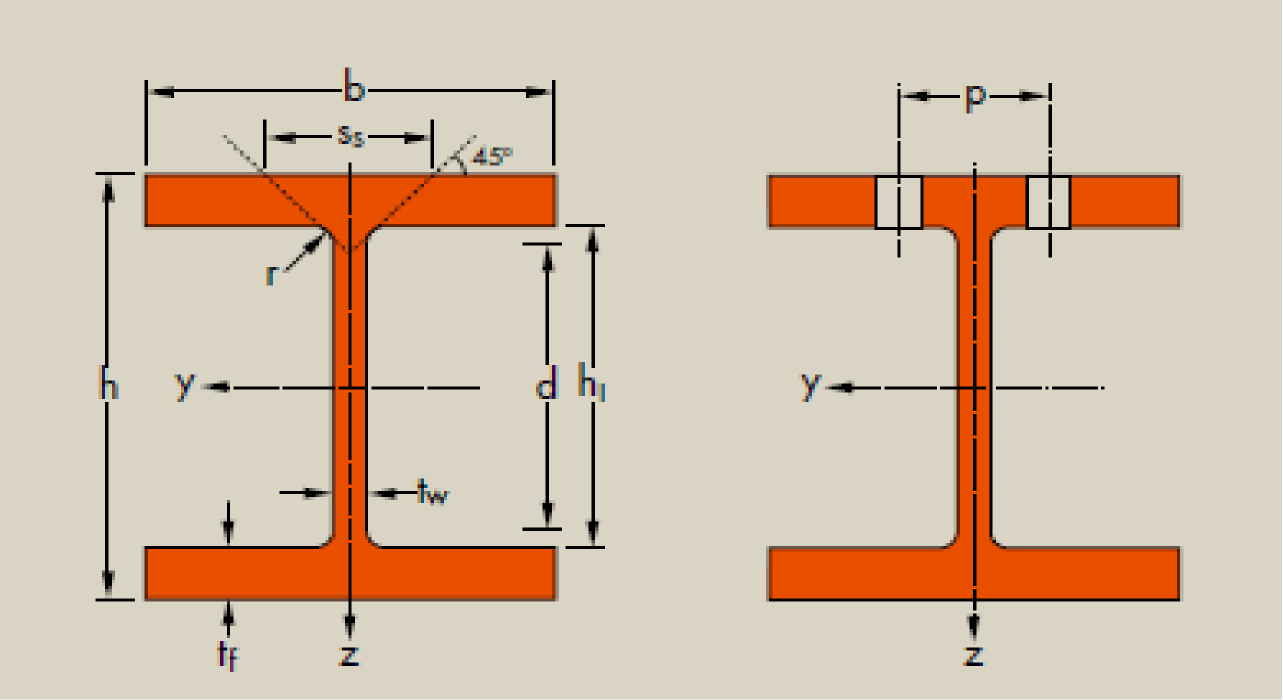
Cross-section



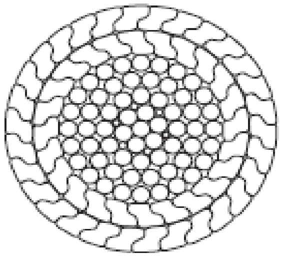
Case study



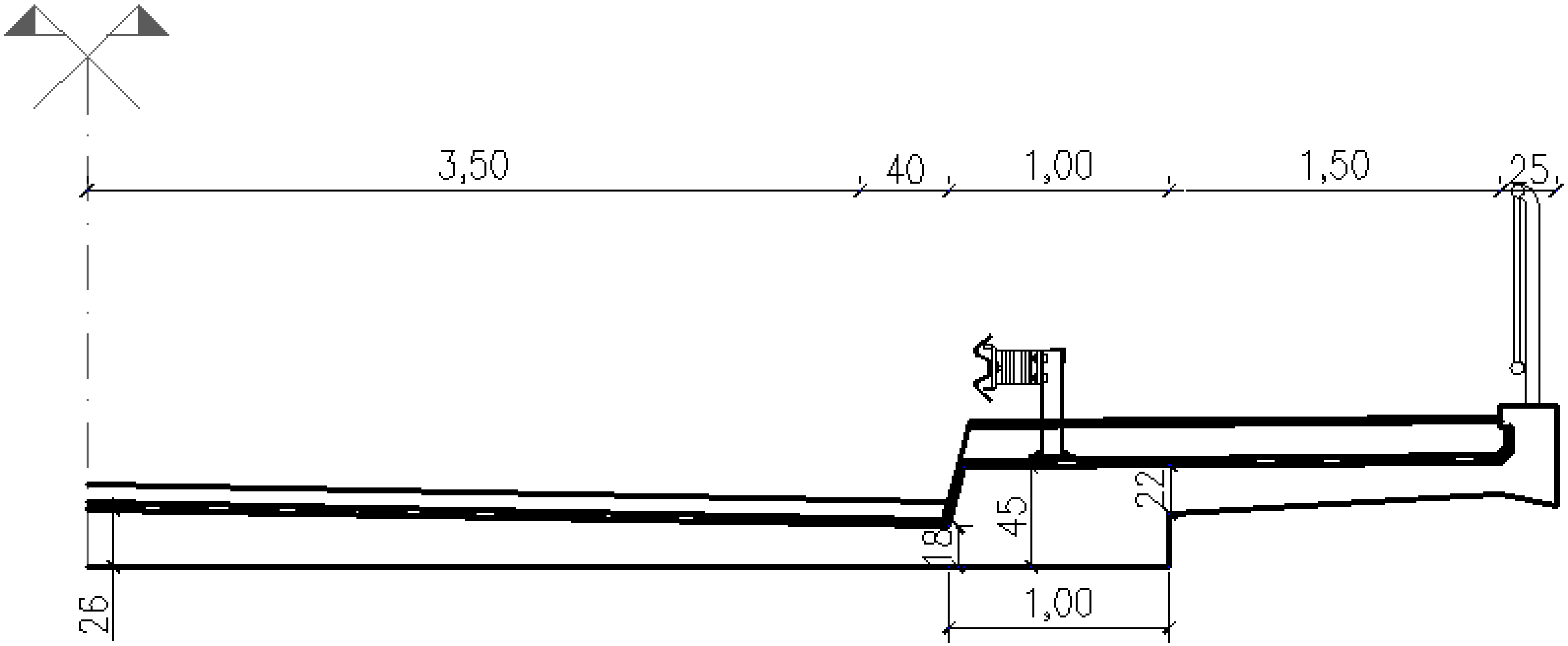
The arch – HD 400x634



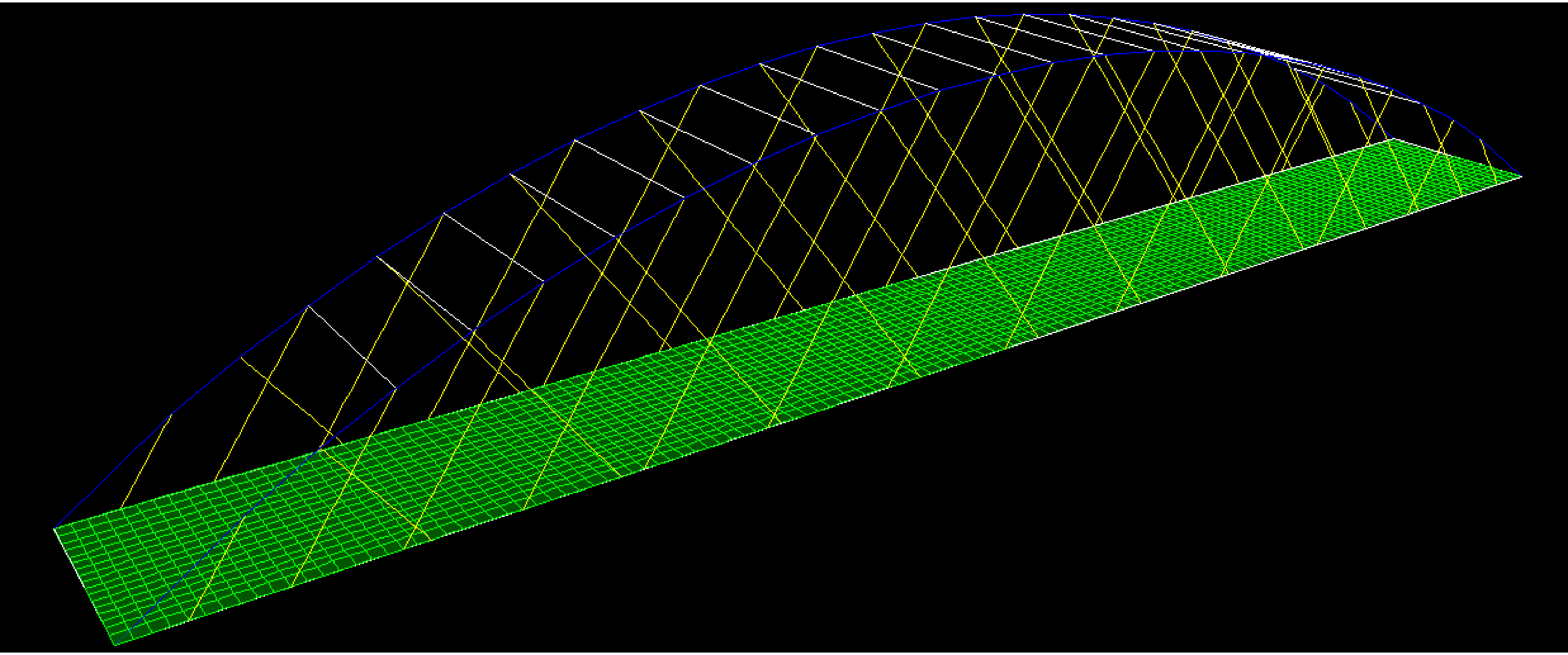
The hangers – Full locked coil strands



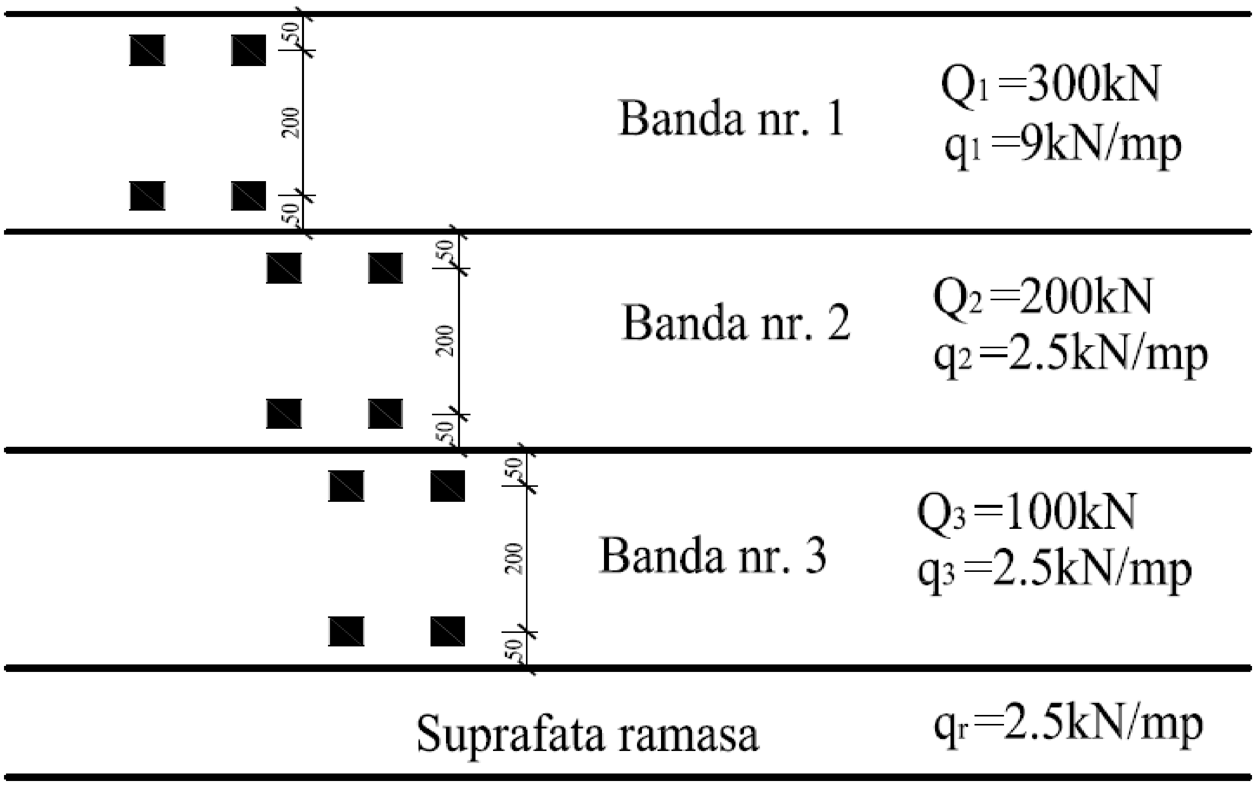
The tie – concrete beam C40/50



The model



Live load: LM1 + pedestrians 3 kN/mp – 1 sidewalk

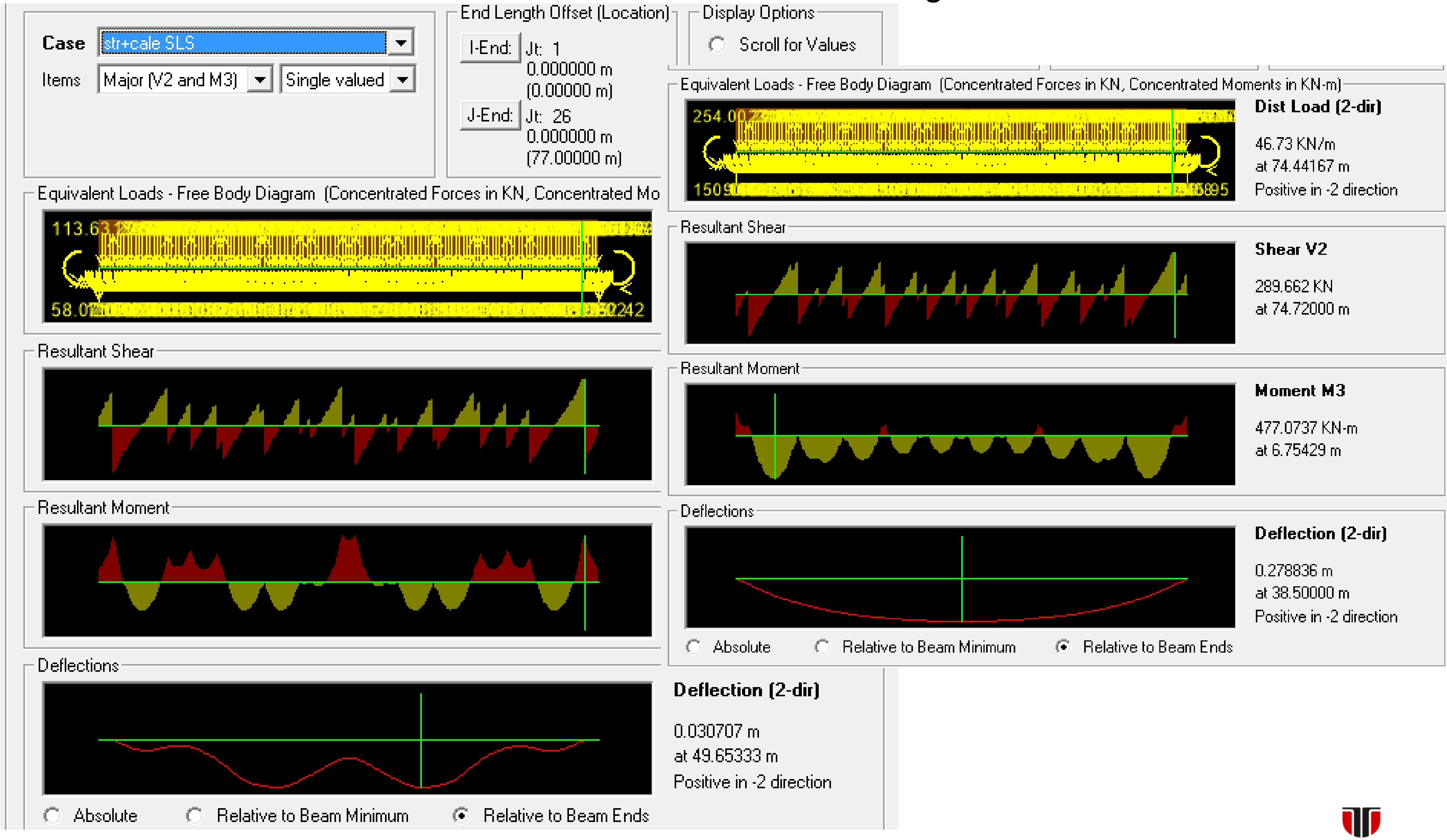


Load cases:
- Dead load
  - Structure
  - Asphalt, railings, etc.
- Live load
  - LM1 – TS + UDL
  - Pedestrians
- Wind
  - Wind x
  - Wind y
  - Wind z

Load combinations:
- Dead load
  - SLS
  - ULS.
- Dead + Live+Wind
  - SLS
  - ULS

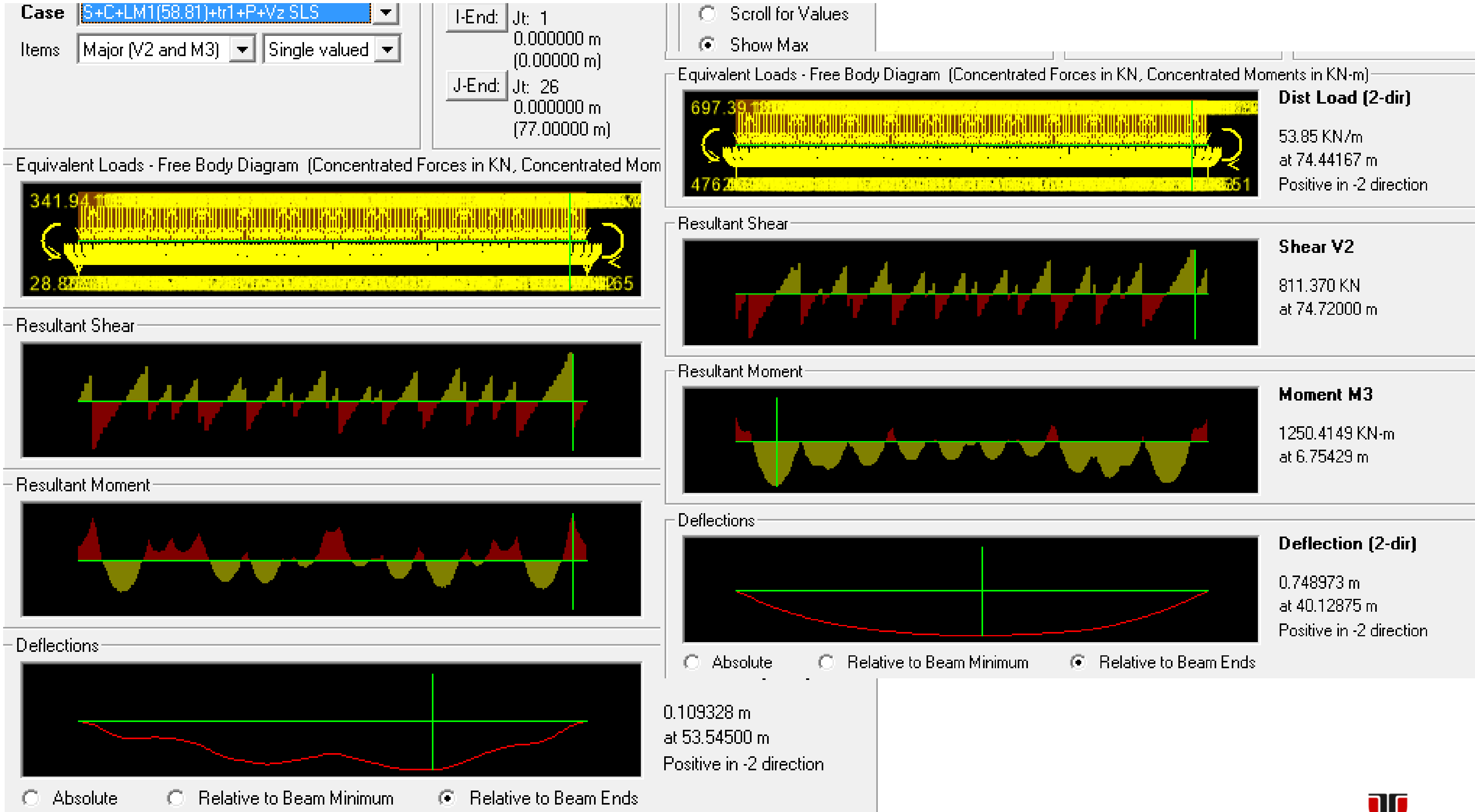
Hangers – tension vs no tension

- deflection - dead weight



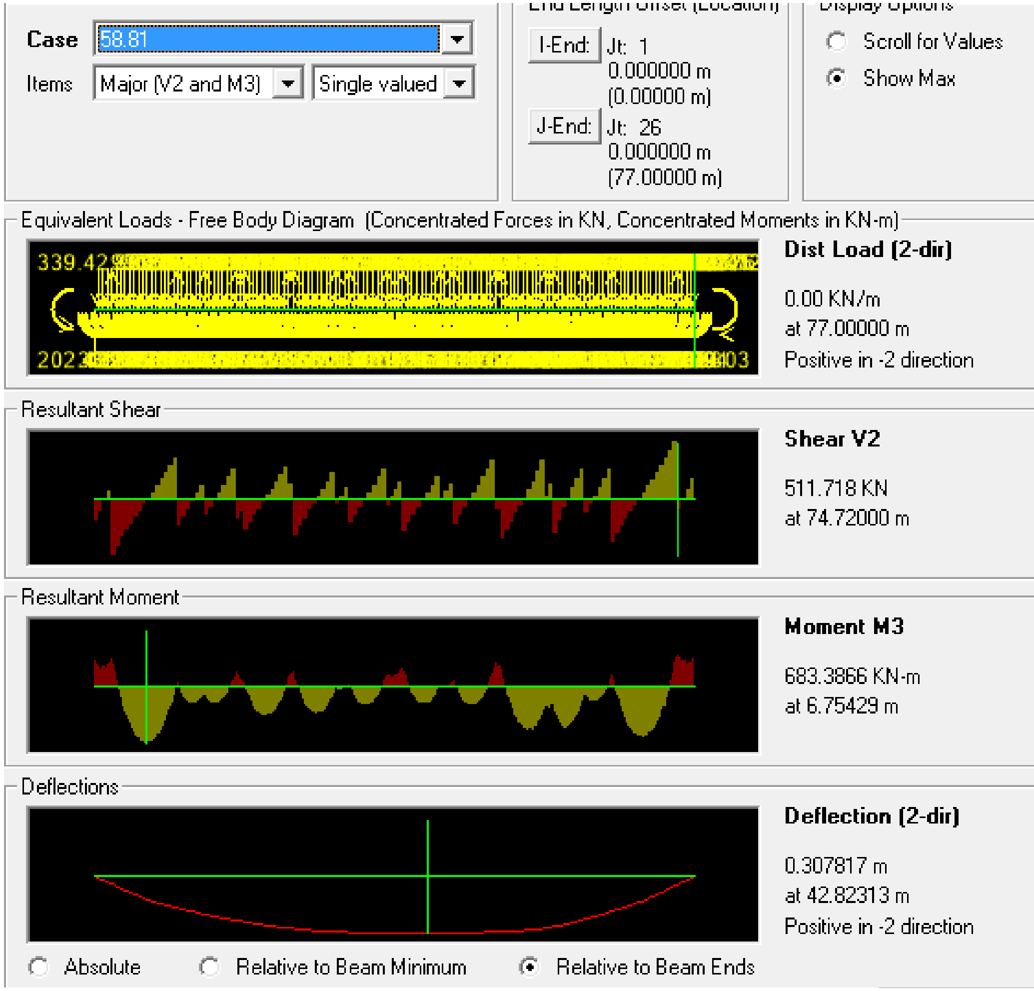
Tension in the hangers vs. no tension

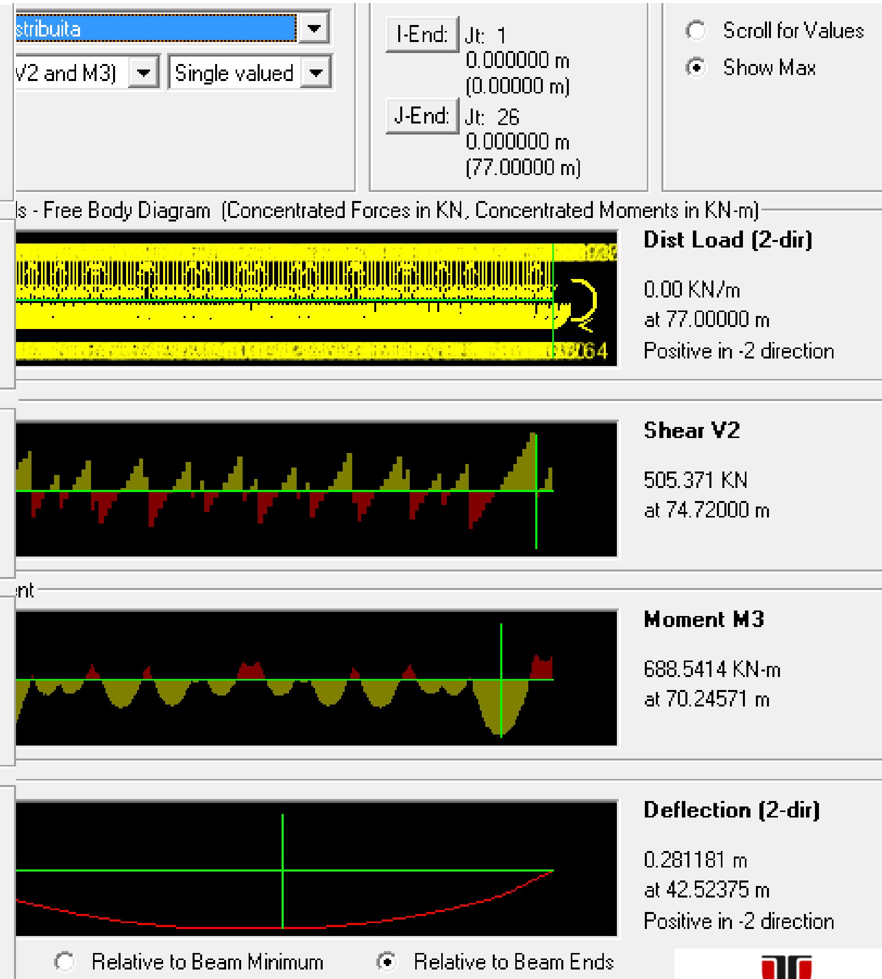
- deflection - dead + live



Tension in the hangers

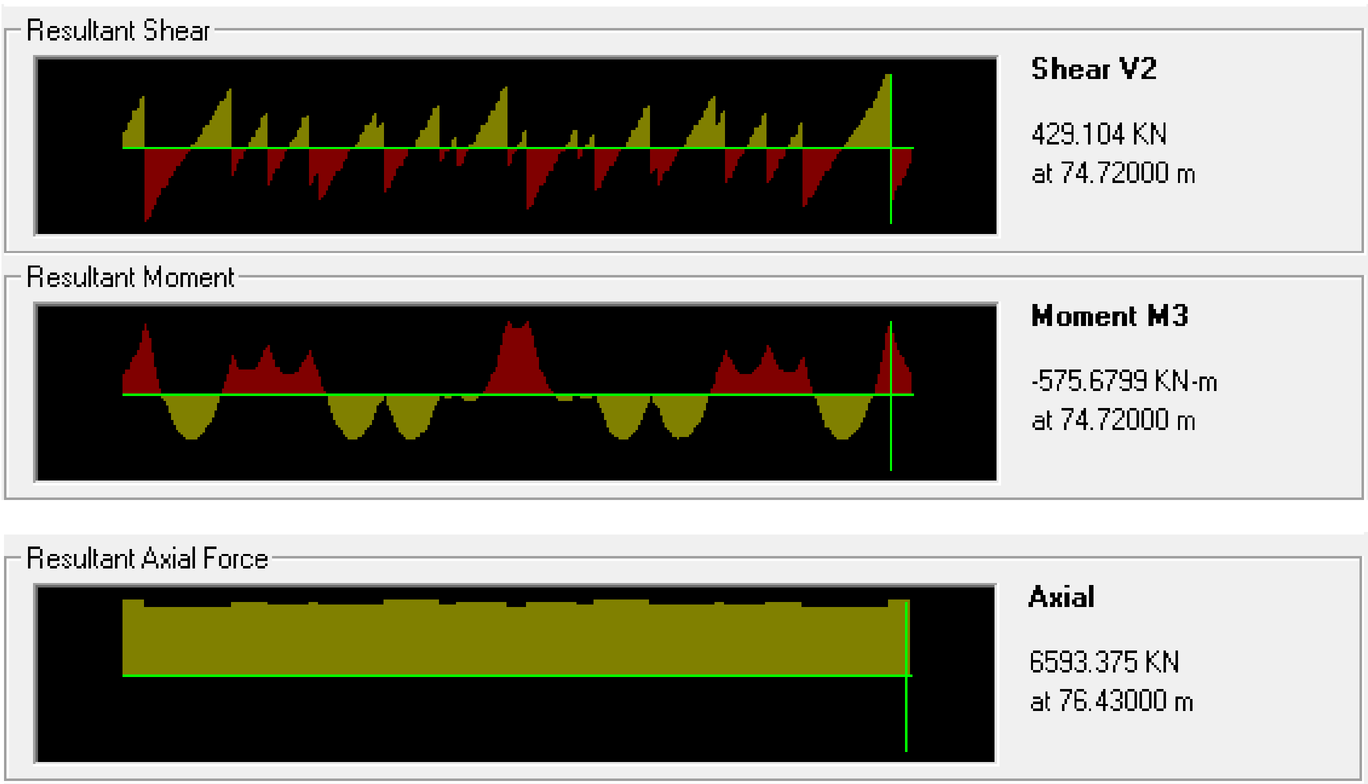
deflection - TS vs UDL





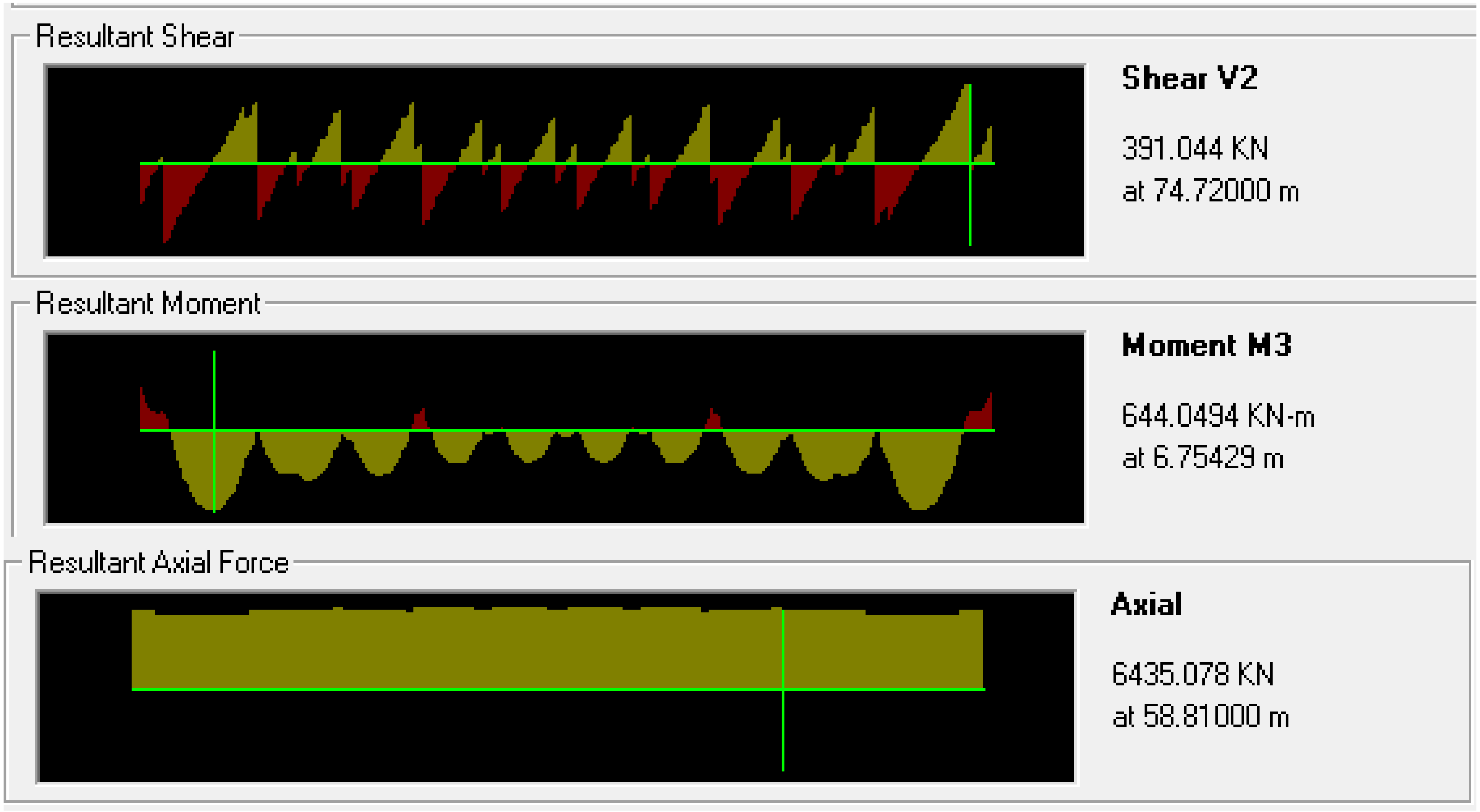
Forces – tension

- Axial force in the **TIE** + bending moment
  - dead load



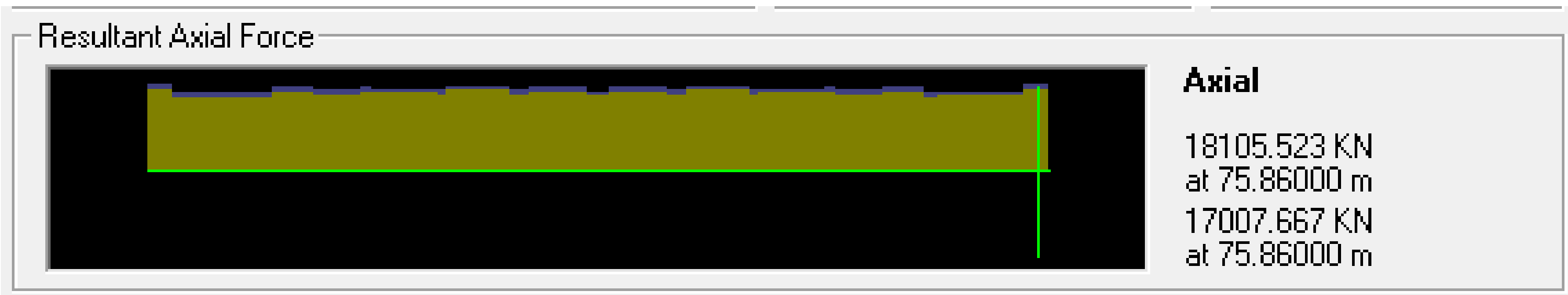
Forces – no tension

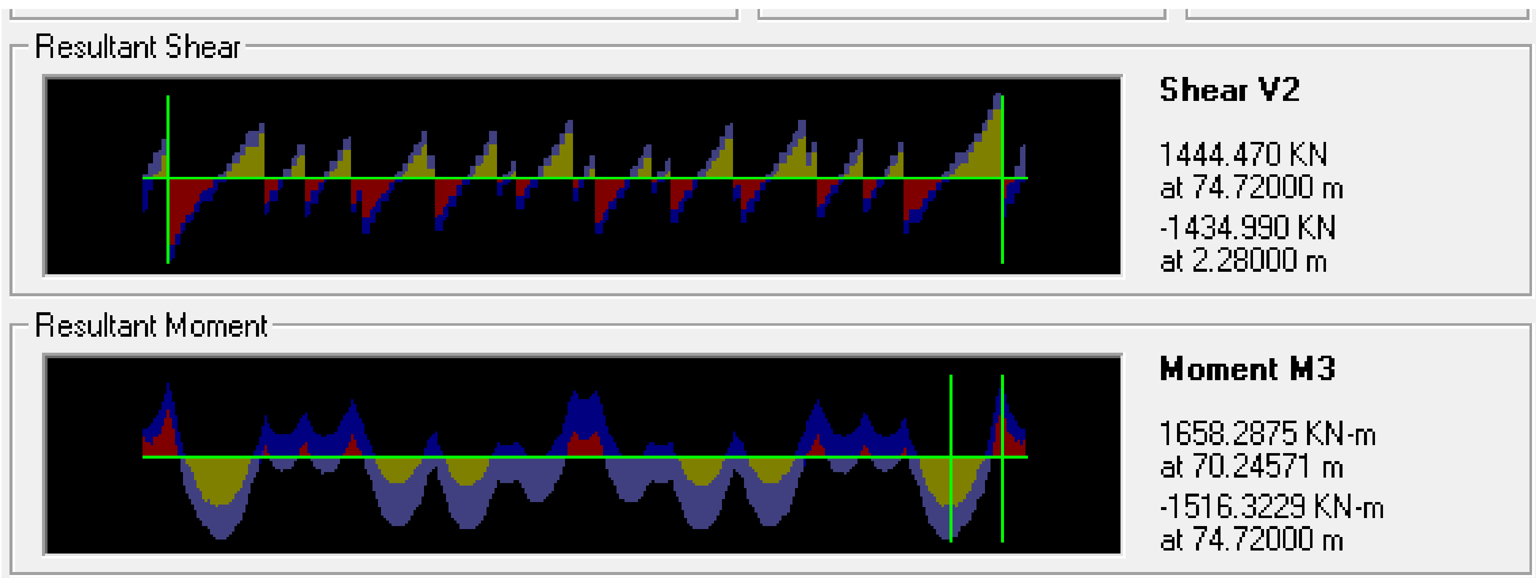
- Axial force in the **TIE** + bending moment
  - dead load



Forces – tension

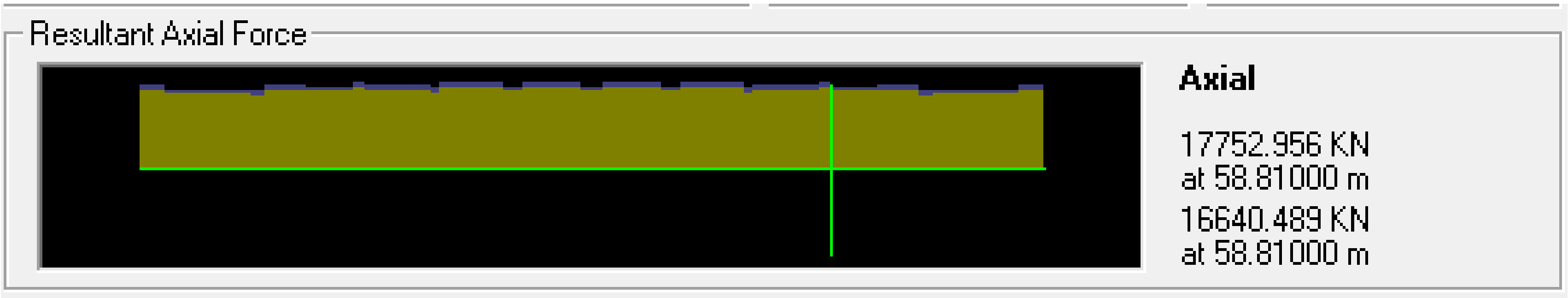
- Axial force in the **TIE** + bending moment
  - DEAD + LIVE

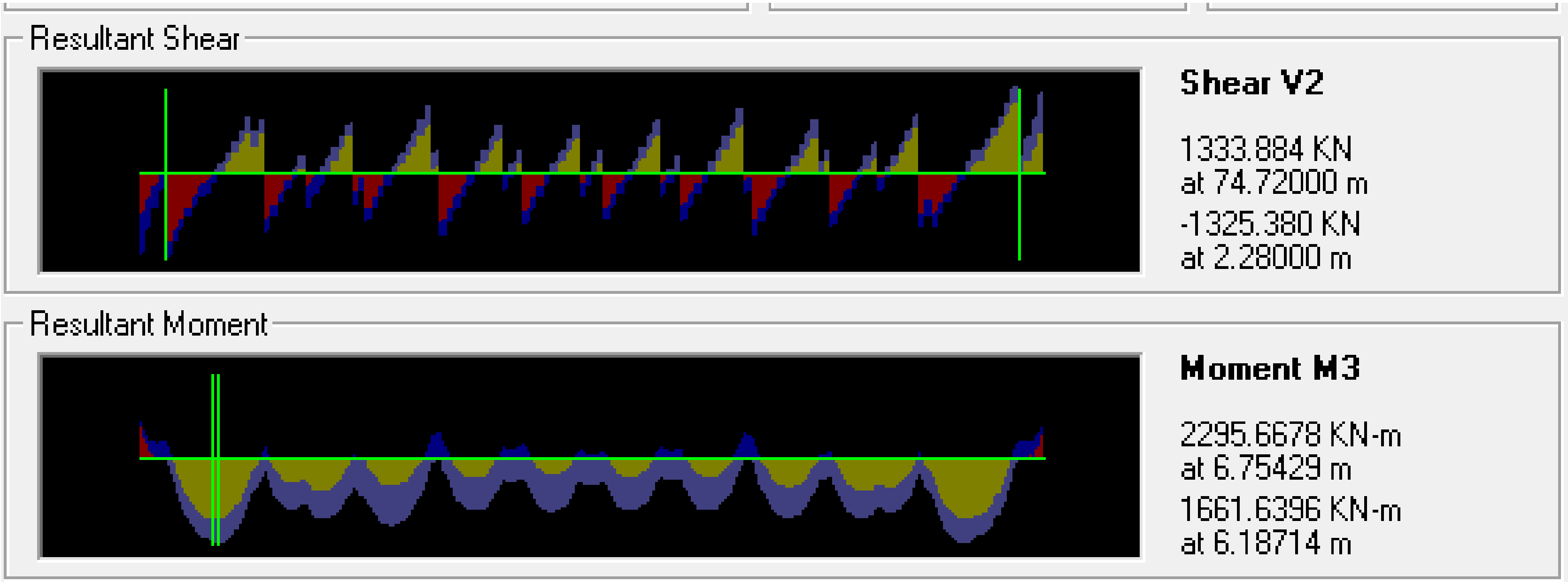




Forces – NO tension

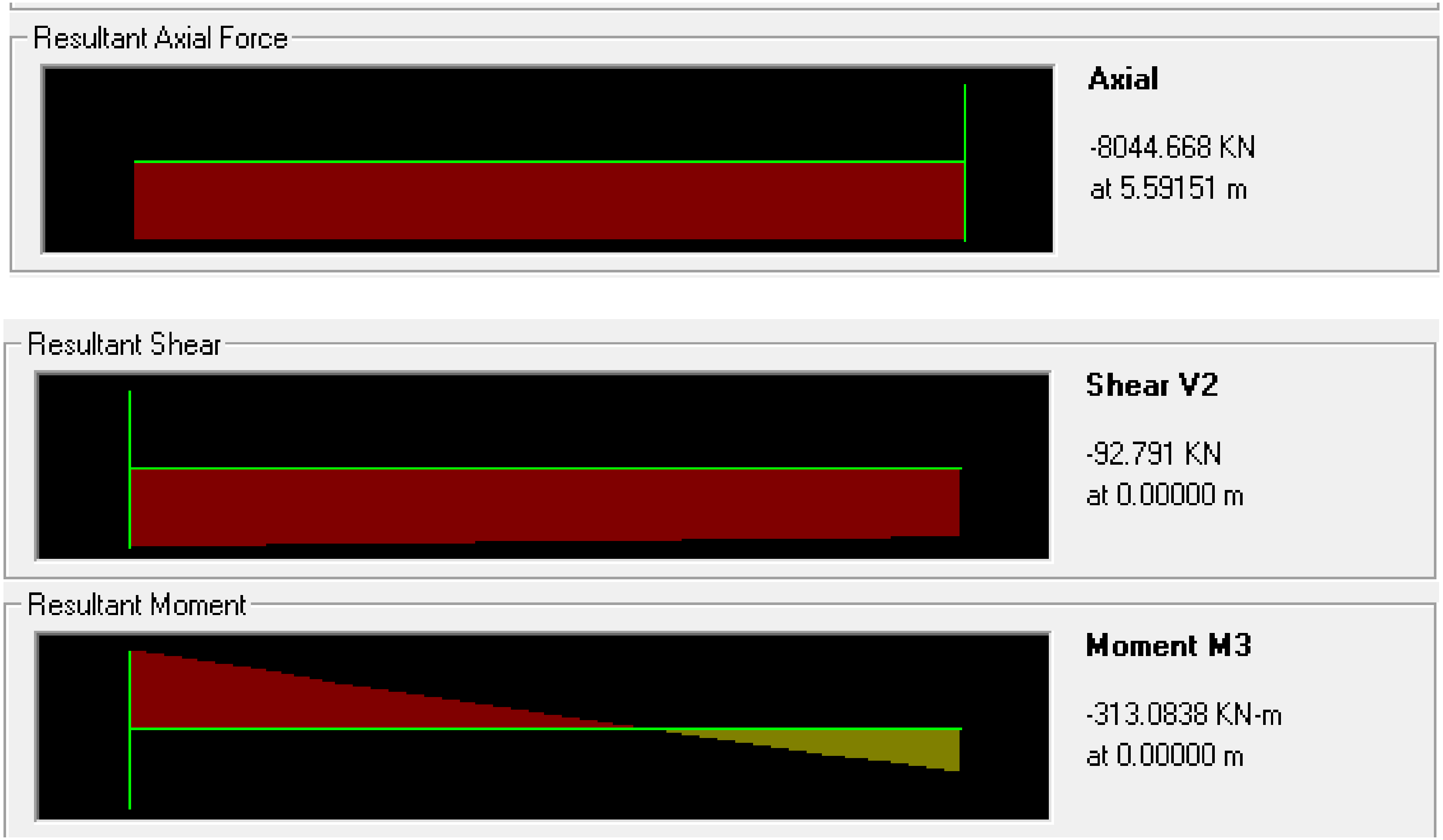
- Axial force in the **TIE** + bending moment
  - DEAD + LIVE





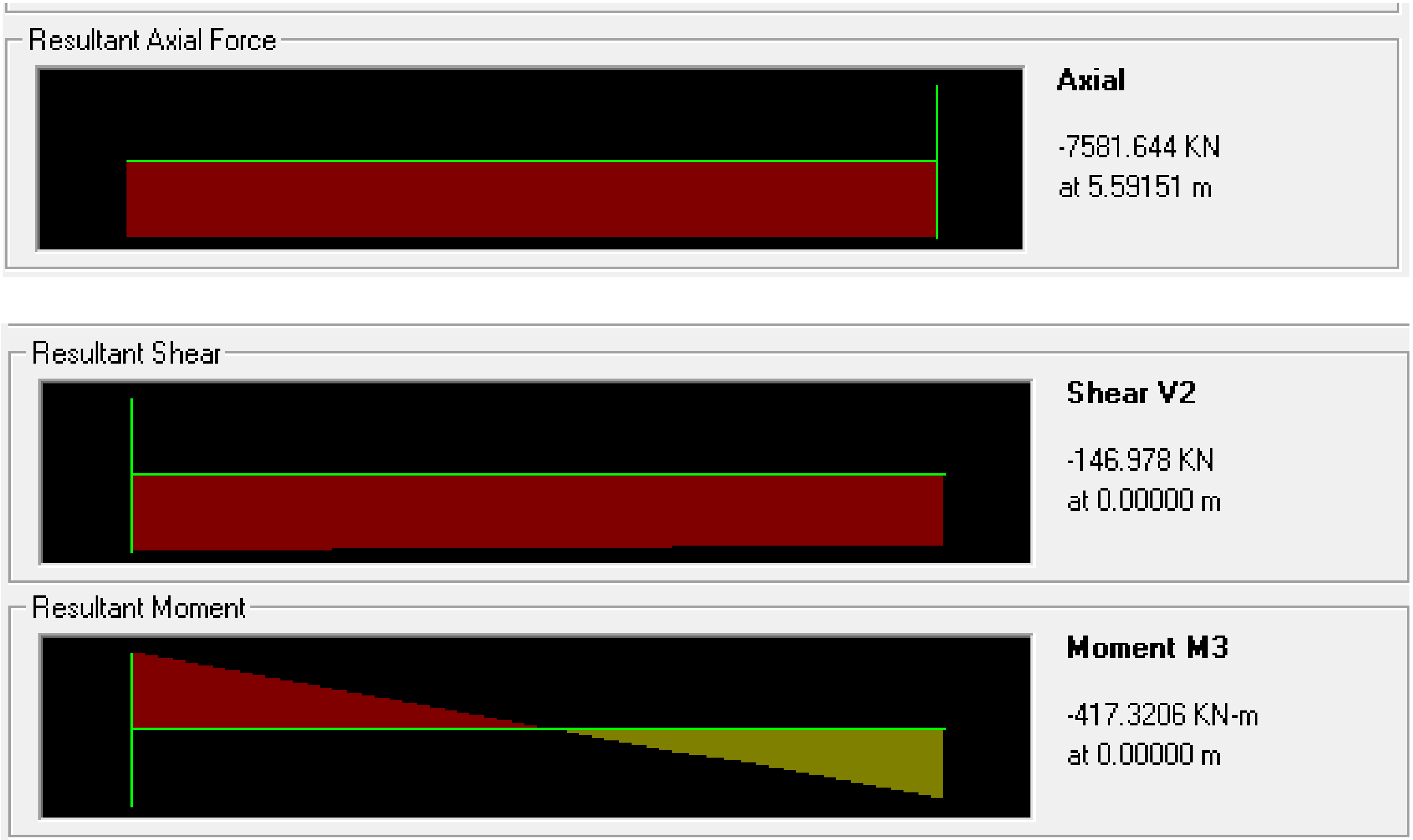
Forces – tension

- Axial force in the **ARCH** + bending moment
  - DEAD



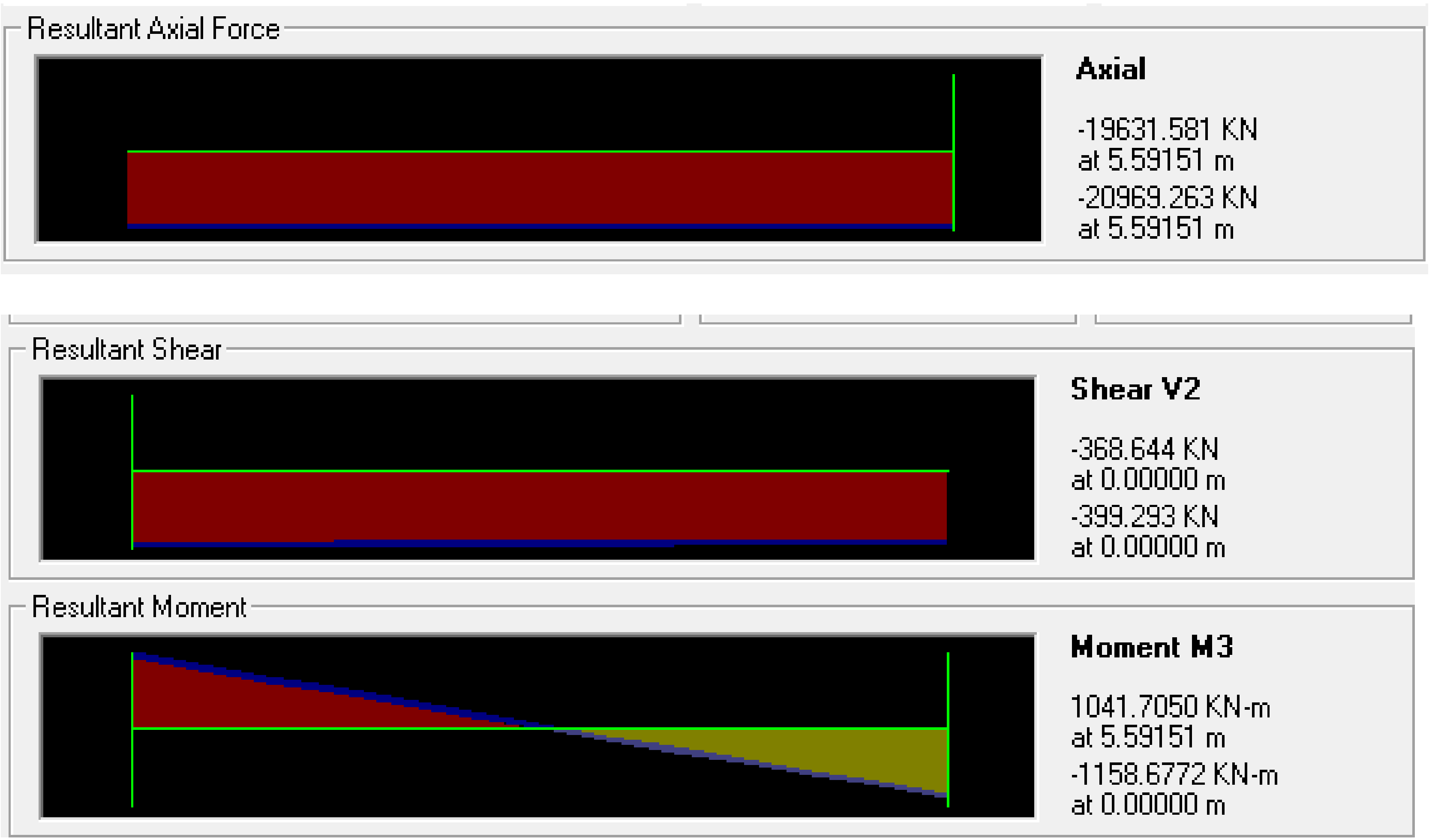
Forces – NO tension

- Axial force in the **ARCH** + bending moment
  - DEAD



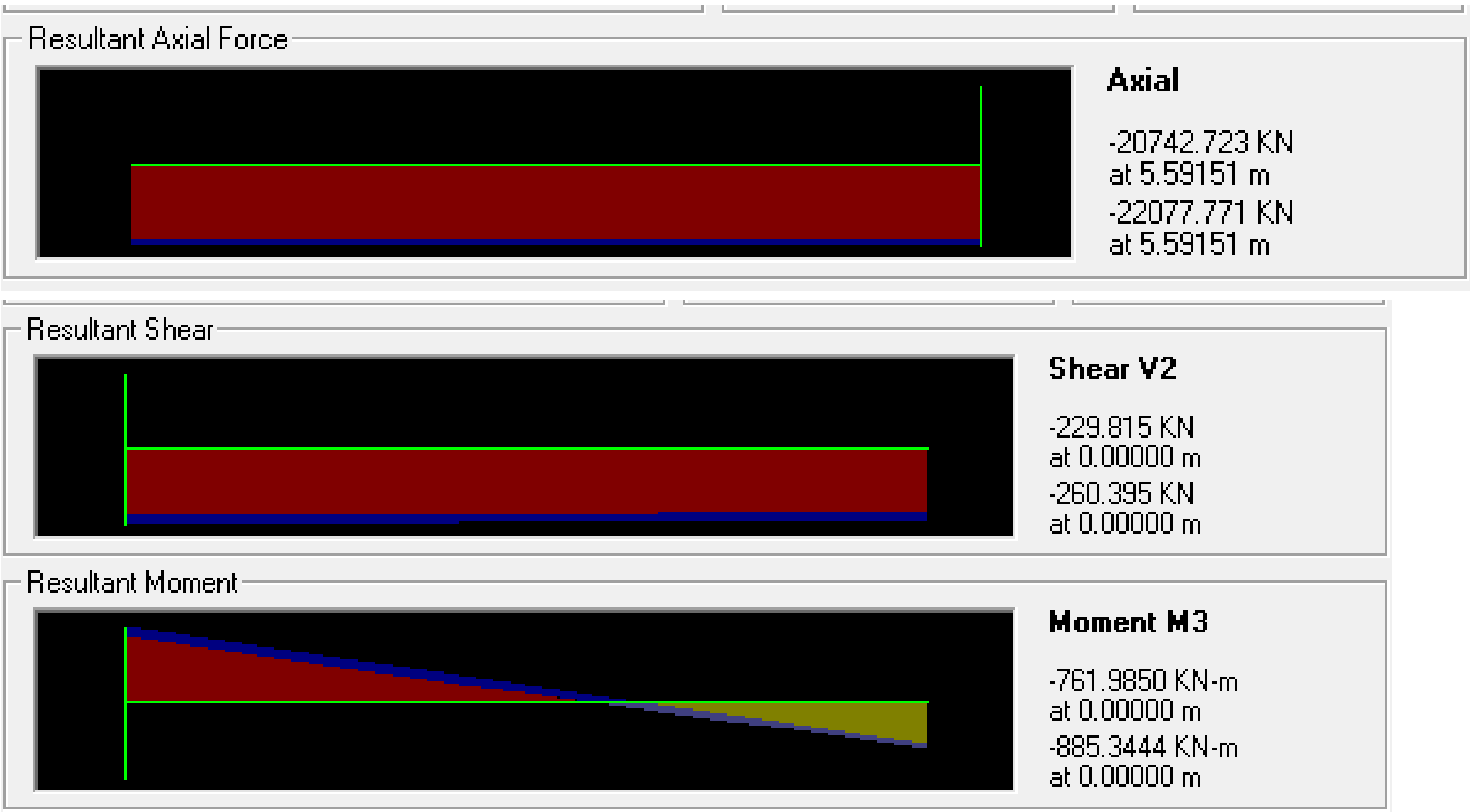
Forces – NO tension

- Axial force in the **ARCH** + bending moment
  - DEAD + LIVE

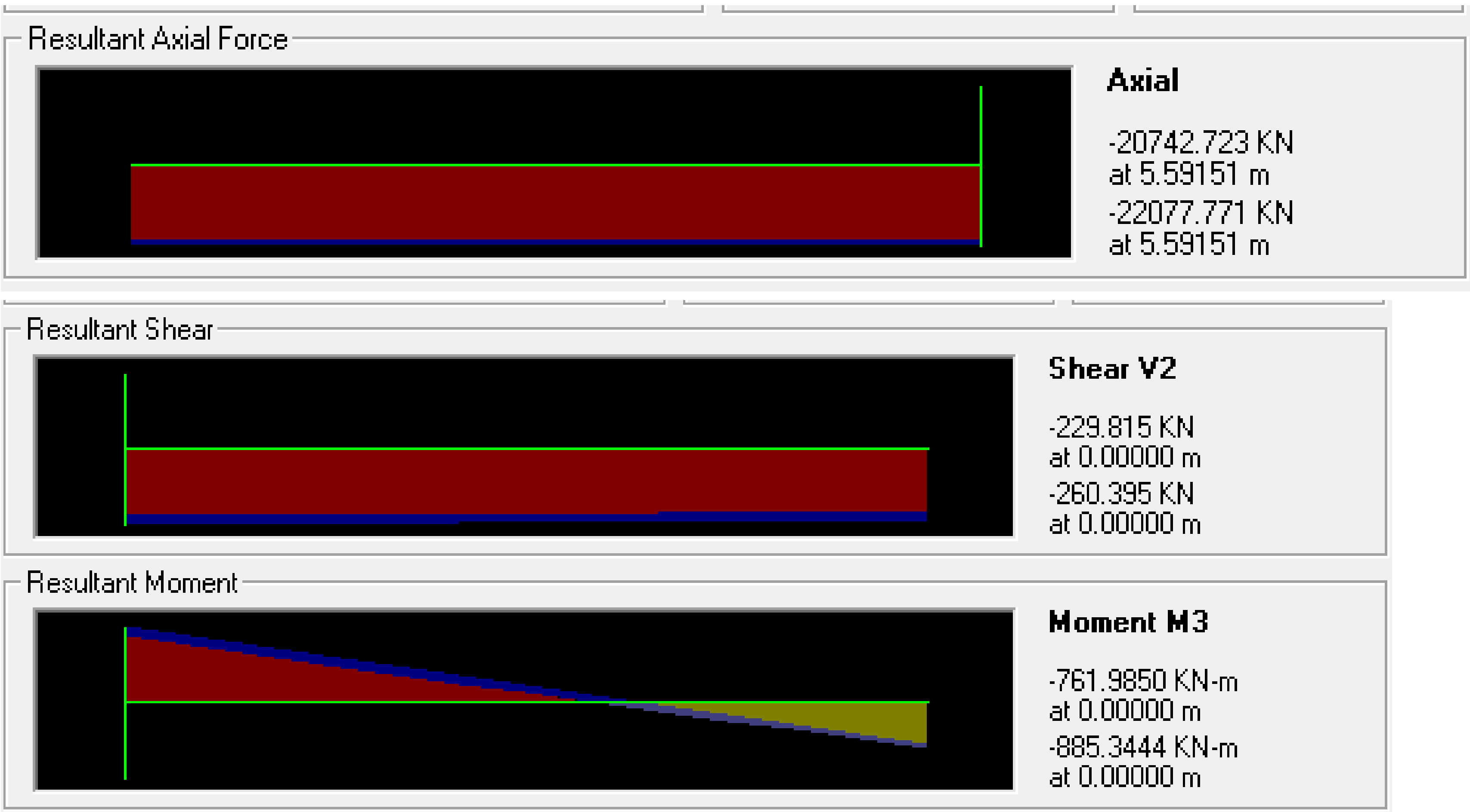


Forces – tension

- Axial force in the **ARCH** + bending moment
  - DEAD + LIVE

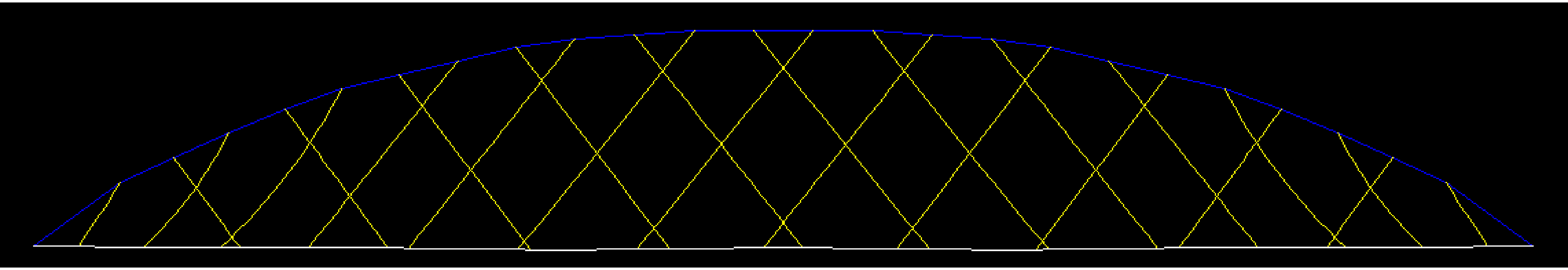


LM1 – static vs moving load

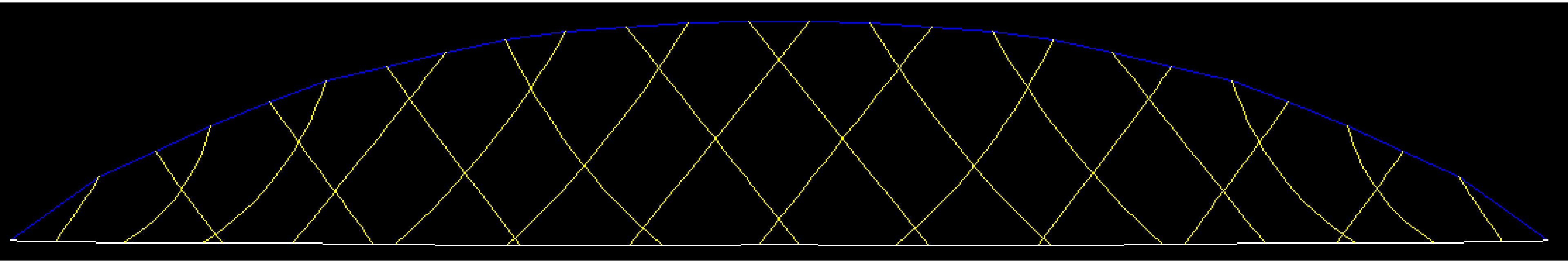


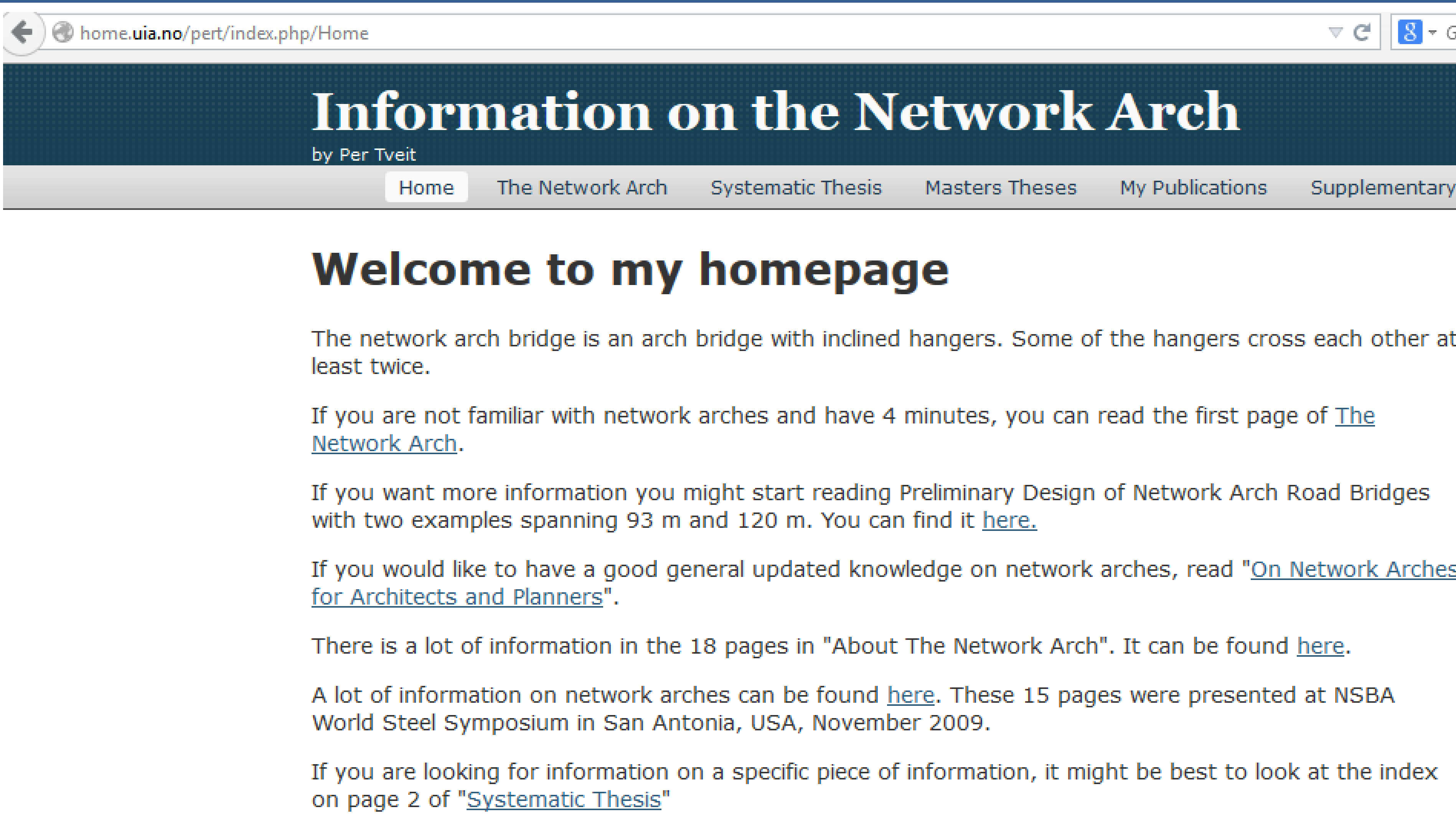
Deformed shape – relaxed hangers

Dead



Dead + live





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Information on the Network Arch

by Per Tveit

Home | The Network Arch | Systematic Thesis | Masters Theses | My Publications | Supplementary

Welcome to my homepage

The network arch bridge is an arch bridge with inclined hangers. Some of the hangers cross each other at least twice.

If you are not familiar with network arches and have 4 minutes, you can read the first page of The Network Arch.

If you want more information you might start reading Preliminary Design of Network Arch Road Bridges with two examples spanning 93 m and 120 m. You can find it here.

If you would like to have a good general updated knowledge on network arches, read "On Network Arches for Architects and Planners".

There is a lot of information in the 18 pages in "About The Network Arch". It can be found here.

A lot of information on network arches can be found here. These 15 pages were presented at NSBA World Steel Symposium in San Antonia, USA, November 2009.

If you are looking for information on a specific piece of information, it might be best to look at the index on page 2 of "Systematic Thesis"

Bibliography

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Thank you for your attention!

Questions?