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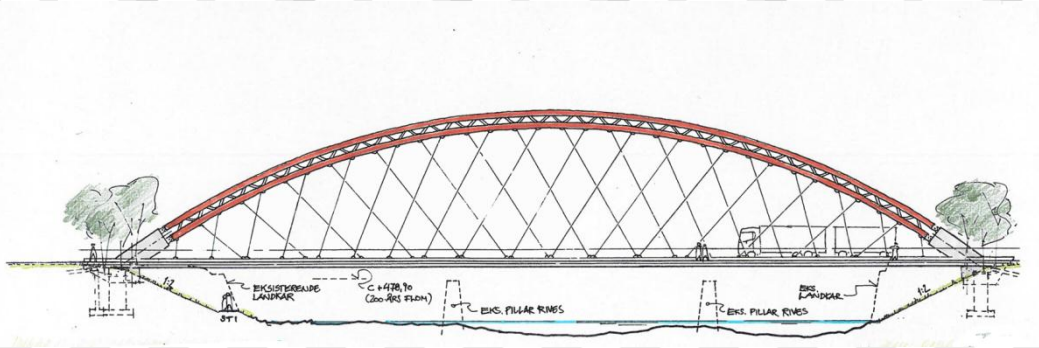
Steien Network Arch Bridge

Johannes Veie
Norwegian Public Road Administration

Rune B Abrahamsen
Sweco

Egil Rønnekleiv
Plan architects



Existing situation

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- Location: Alvdal municipality. Hedmark County, 300 km north of the capital Oslo.
- Existing bridges build in1953 and 1983
- The main bridge is in a bad condition
- High maintenance costs.
- A preliminary study in 2010 concluded that both should be replaced

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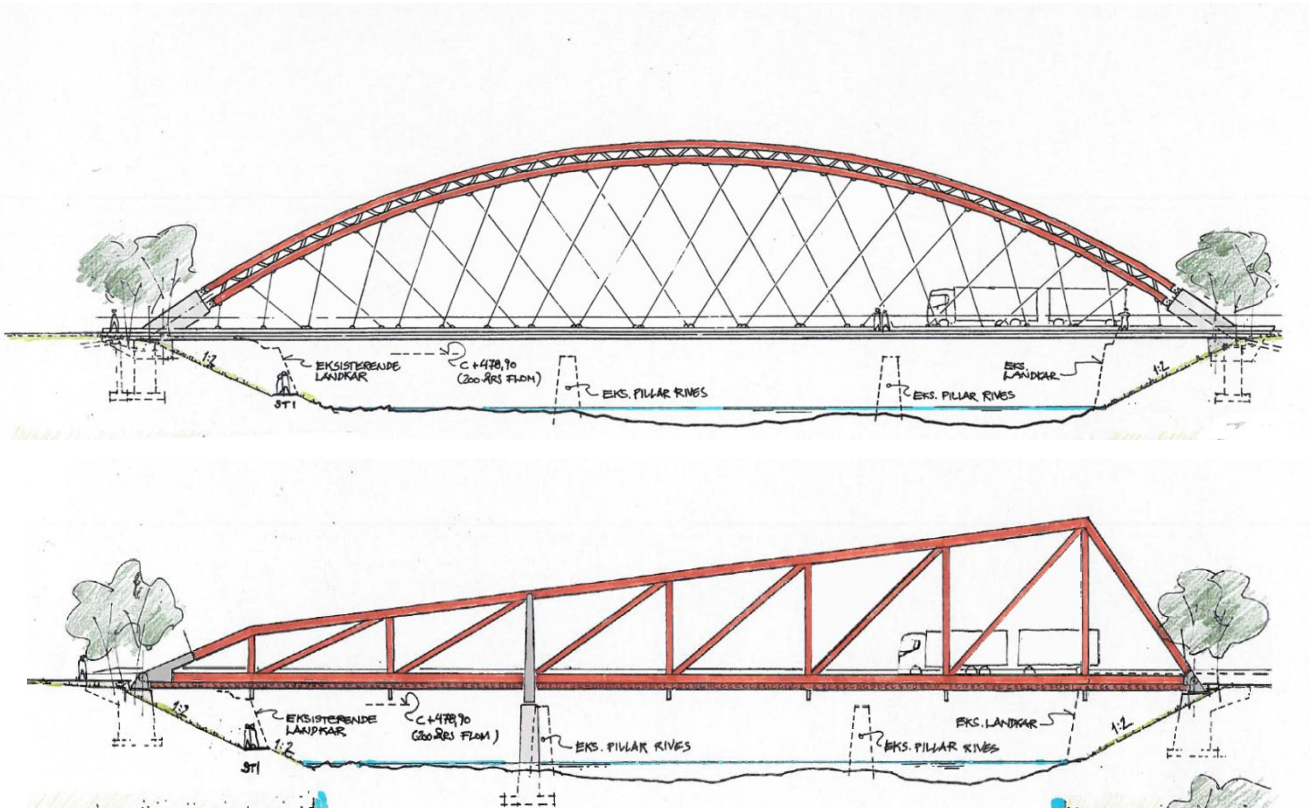
Network arch bridge and a glulam truss bridge

To alternatives was considered in the end of the preliminary study.

The study was performed by: NPRA, Sweco technical consultants and PLAN architects.

The network arch was chosen as the preferred alternative.



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Architectural comments

- Steien network arch bridge in one span over the river Glomma will provide an innovative and elegant design with strong identity and architectural quality.

- Double timber arches connected with diagonals in tension made of plates in stainless steel, along with a slender network, gives a very light and airy superstructure with a good side visibility and transparency. The bridge will appear as a new landmark in Alvdal.

- Walkways on the outside of the network planes provide a good contact with the river scenery.

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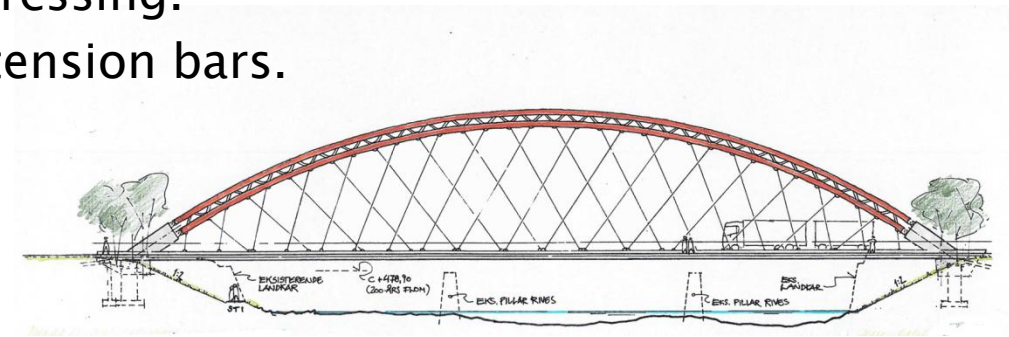
Some general facts

- Span: 88.0 meters
- The bridge carries two traffic lanes, 8 meters wide, and two 3 meters wide pedestrian walkways. Total 19 meters wide.
- Cross section of arches: w x d = 850 x 600 mm
- Height from centre slab to centre lower arch: 14 meters
- Distance between the centrelines of two arches: 1.25 meter
- Spacing of hangers and diagonals along the arches: 2.5 meters
- The slab is made of in situ casted light weight aggregate concrete with prestressing.
- Hangers: ø48 mm tension bars.



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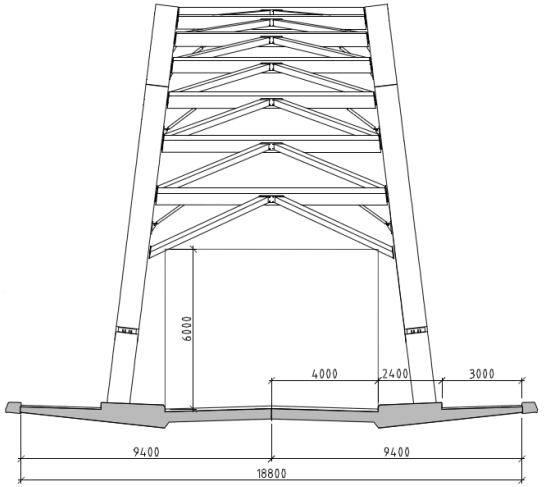
FINAL DESIGN



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Definition of a network arch bridge

Characteristics of an optimal network arch bridge (Tveit 2011):

- Deck made out of concrete
- Ties imbedded in the deck in the form of prestressing cables.
- Arches made as part of a circle
- The upper node of the hangers are evenly spaced along the arch and the hangers not being merged in the nodal points.
- Most hangers crossing at least two other hangers

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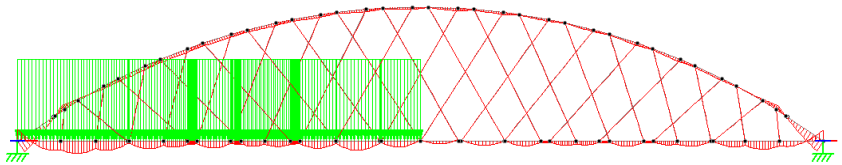
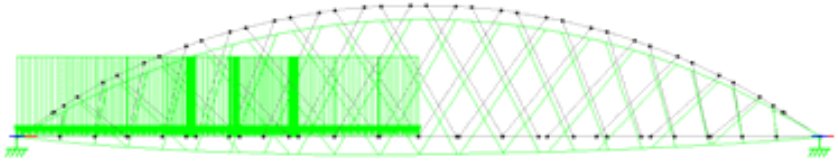
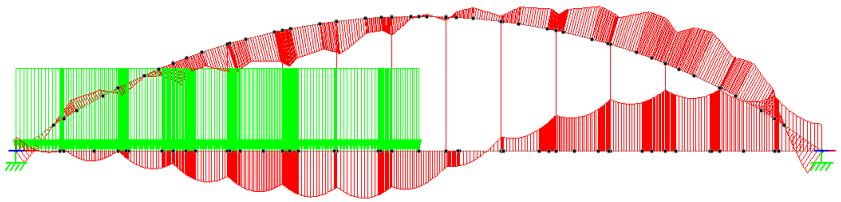
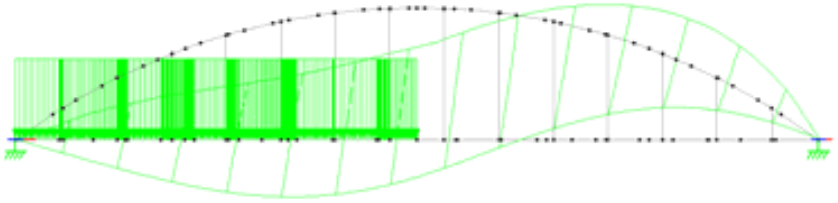
Structural performance compared to a typical tied arch









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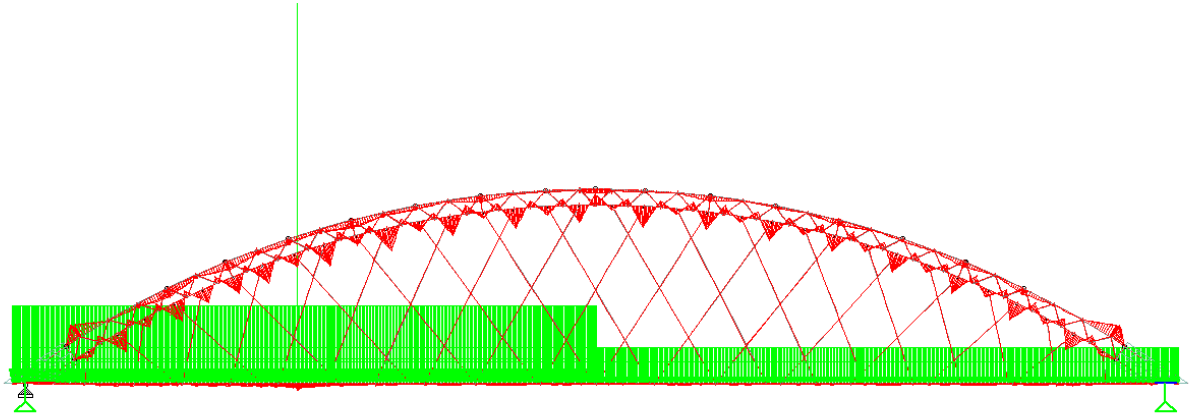
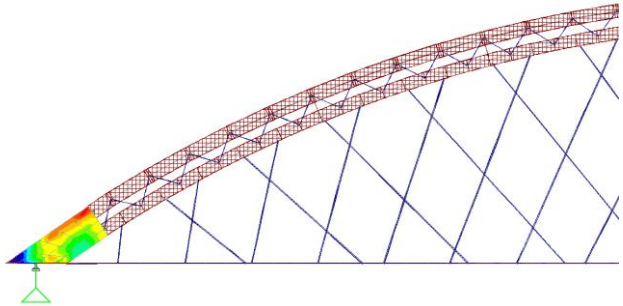
Distribution of moments and compressive forces due to asymmetric loading. Steien arch bridge





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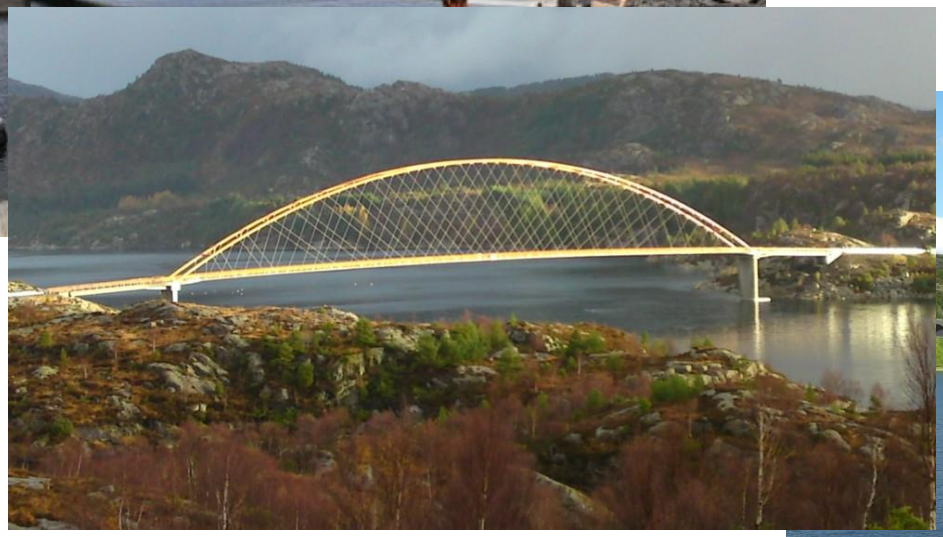
Experience from other network arch bridges



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DETAILS

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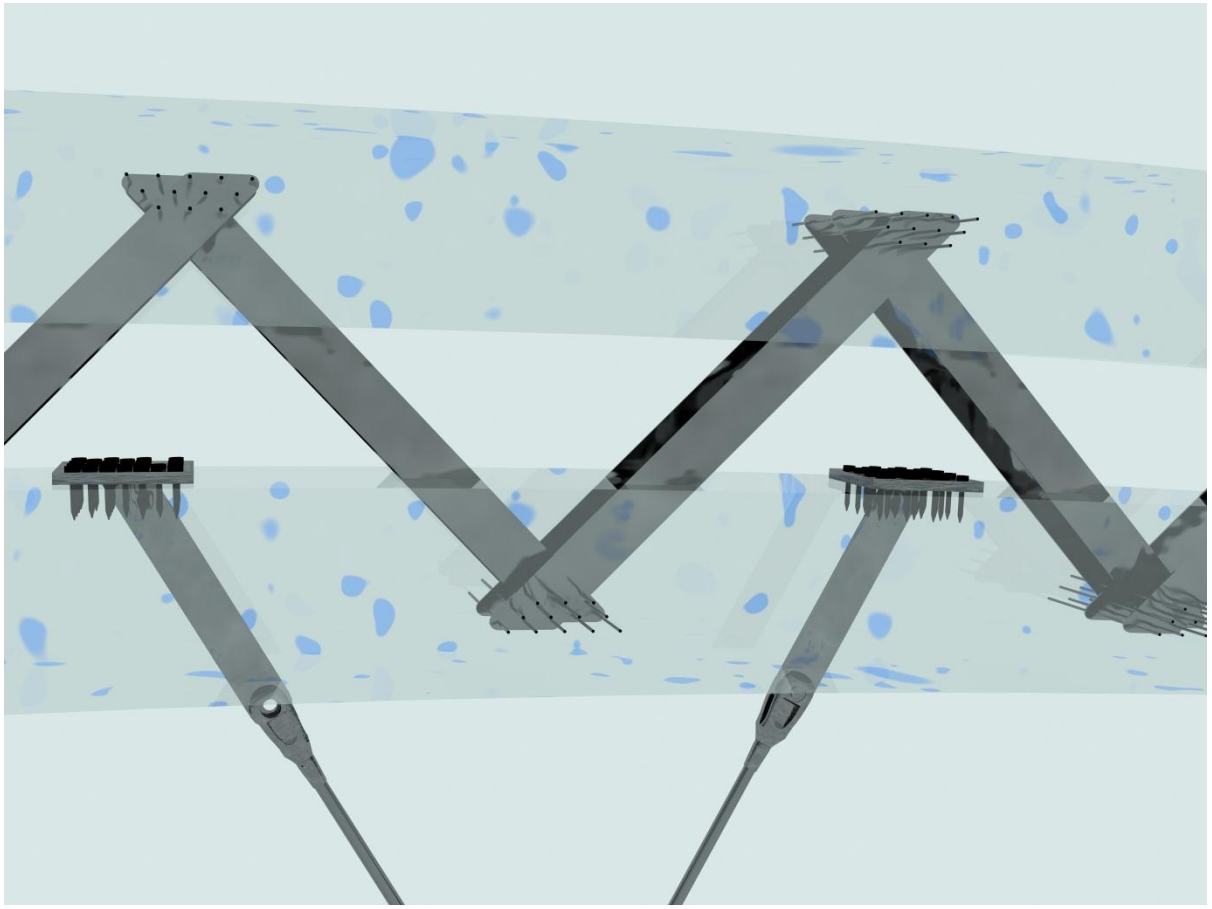

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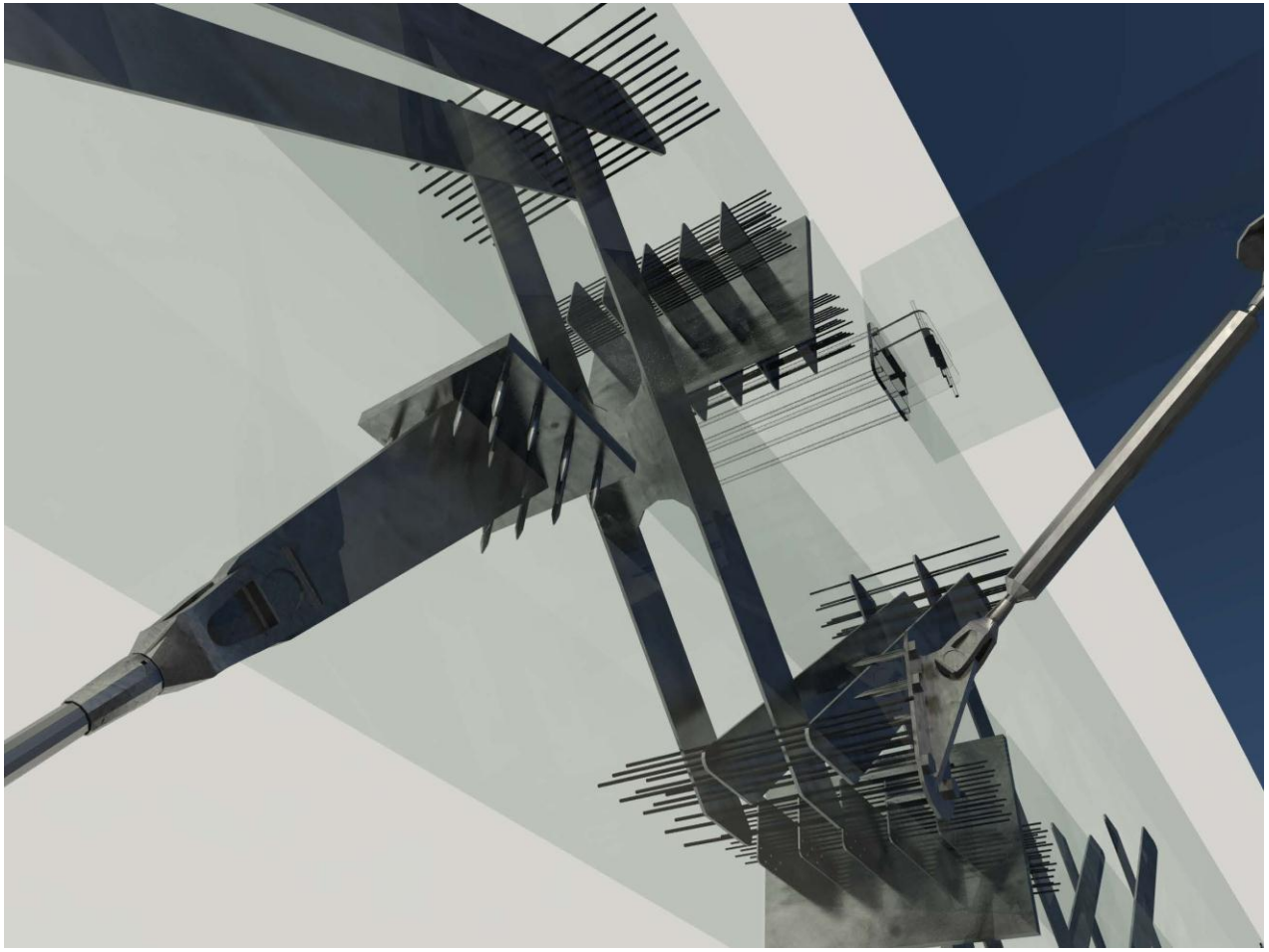

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Construction of the bridge

- When the interim route is established the road bridge and footbridge are demolished.
- Abutments are established prior to or simultaneously with the framework for bridge deck being established.
- Framework established on filling and / or temporary piles, optionally also using existing pillars.
- The slab is casted independent of the arches
- Each arch can be pre-assembled on factory and mounted on site in 4 segments.
- To compensate for the deflection the slab is casted with a camber. After stressing the slab will be jacked with an additional camber in order to ease the mounting of the hangers and reduce the need of hanger adjustments

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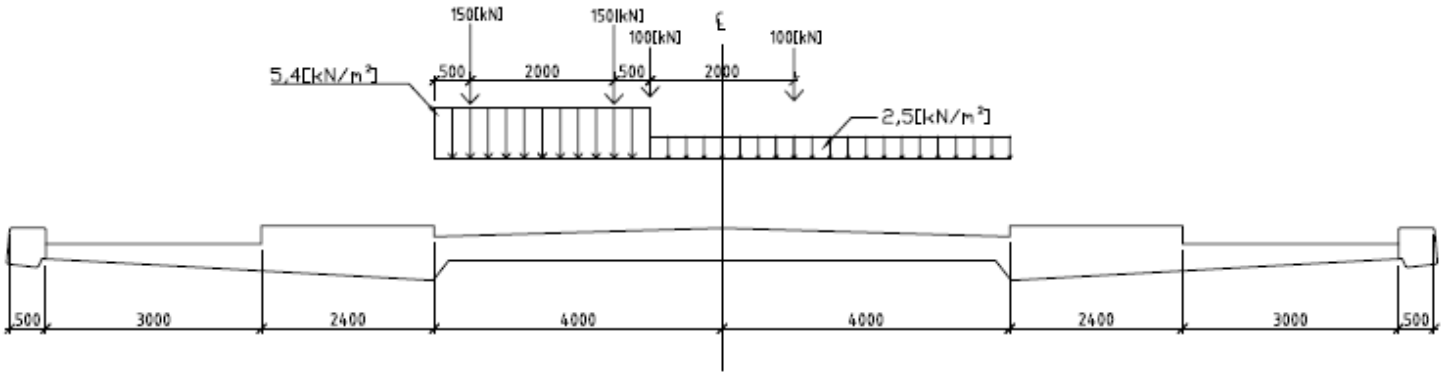
Utilization of the arches

- Total weight of the superstructure: 2264 tons
- Total traffic loading: 495 tons
- Ratio between self-weight of the superstructure + traffic loading and self-weight alone:

  2760 tonns / 2264 tonns = 1.22
- Knowing that the long term modification factor for strength is 0.6, and the same factor for combined loading of self-weight and traffic is 0.9, giving a ratio of 1.5, it is possible to explain why self-weight is governing the design.

Traffic loading



Position	Double axel load (BL)	Equal Distributed load
	Axel load $\alpha_{Qi} \bullet Q_{ik}$ [kN]	$\alpha_{qi} \bullet q_{ik}$ [kN/m²]
Loading area nr 1	1,0 • 300=300	0,6 • 9= 5,4
Loading area nr 2	1,0 • 200=200	1,0 • 2,5 = 2,5

Loadmodel 1 according to NS-EN 1991-2:2003

Equally distributed load on the pedestrian carriageways are

q=5,0 kN/m² without simultaneous traffic loading

q=2,5 kN/m² with simultaneous traffic loading

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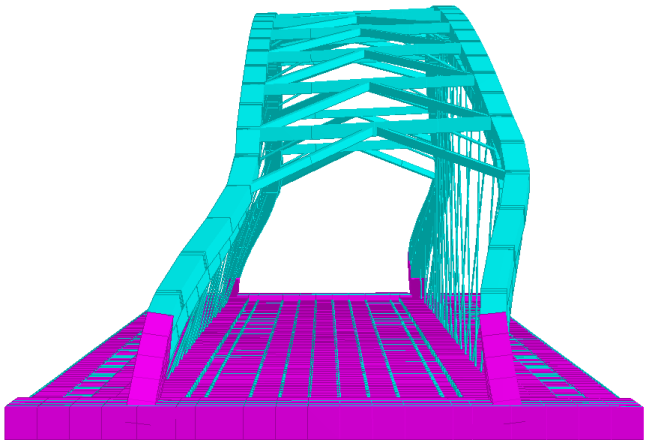
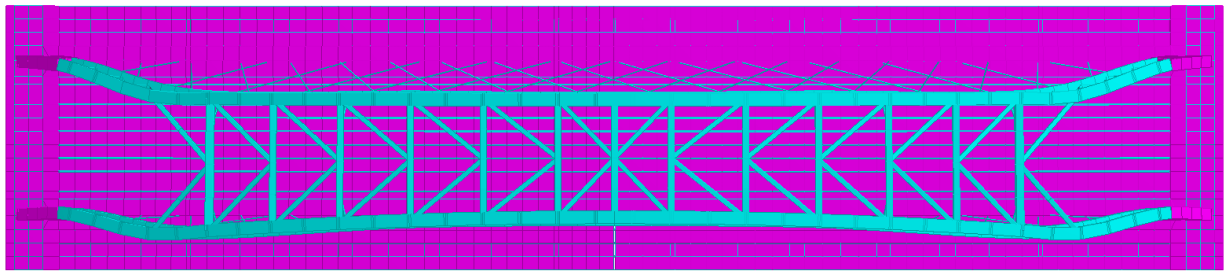
1st buckling mode

Buckling factor = 8
Selfweight alone





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Thank you for your attention