186 m footbridge in Kalmar, Sweden

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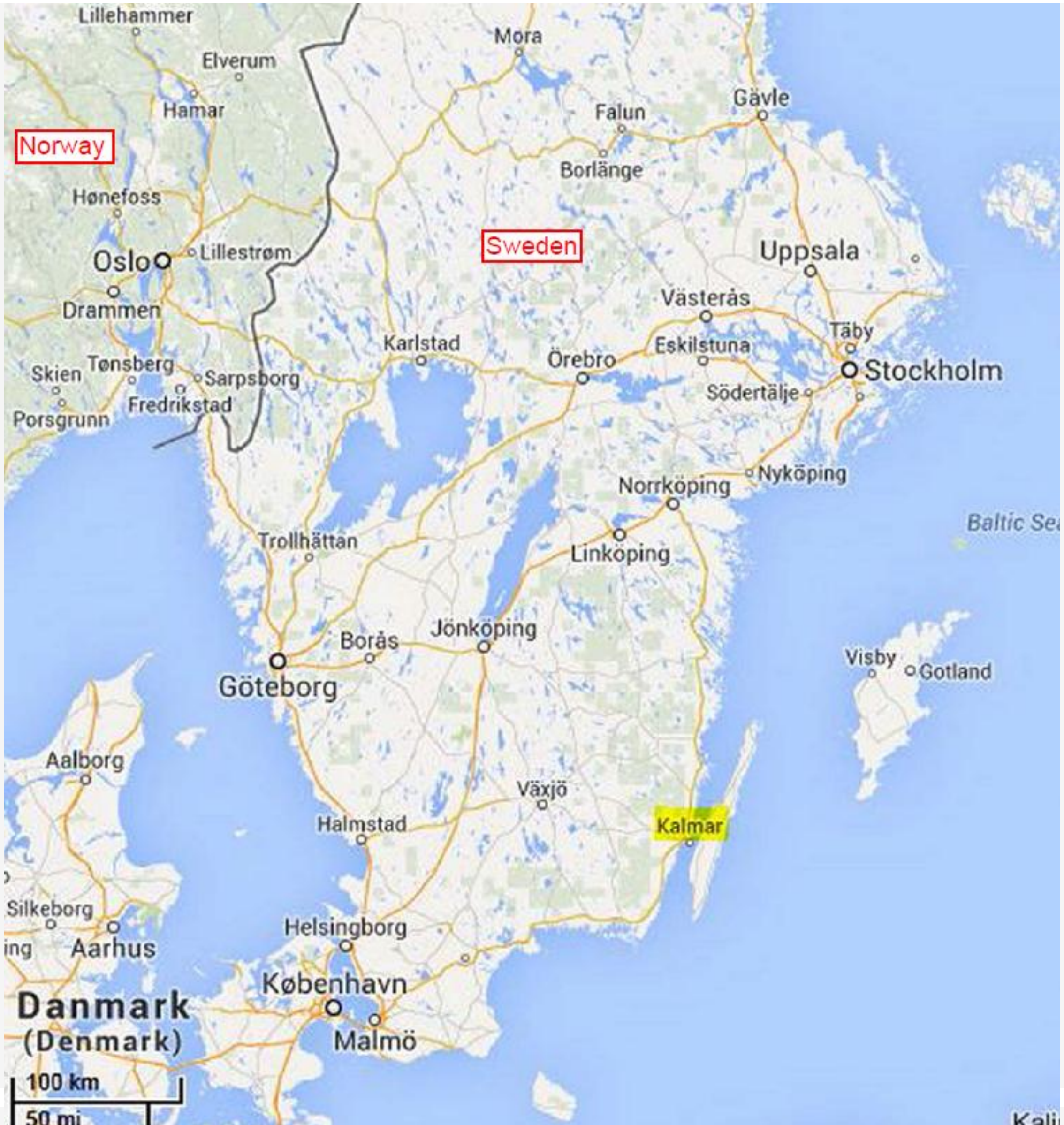

Location

- 400 km south of Stockholm
- 330 km east of Copenhagen

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The bridge connects Kalmar's pedestrian and bicycle network with the Hansa City shopping area as well as the city's new football arena

The bridge crosses the E22 motorway

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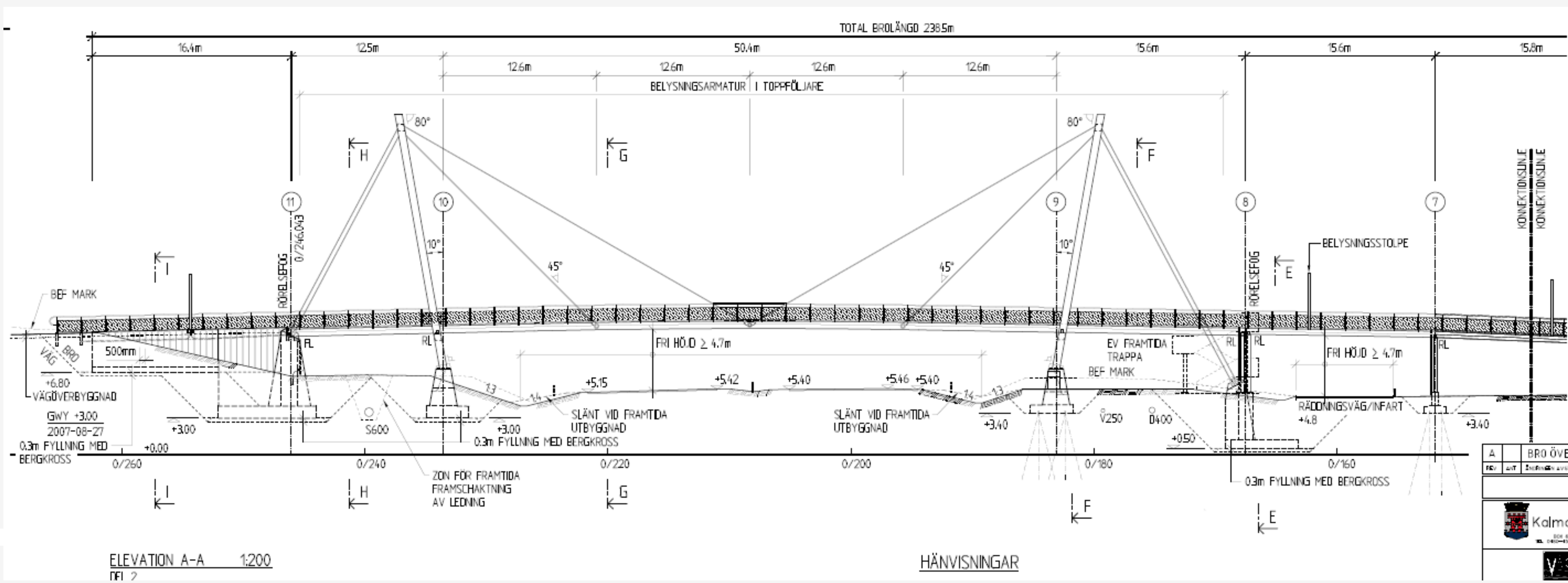
- In 2011 the municipality of Kalmar developed a bridge design proposal and held a competition to build the Hansabron bridge. This is a cable-stayed bridge with steel pylons and a 186 m long and 4.5 m wide glulam deck.
- The Swedish construction company NCC won this competition
- The proposal showed a bridge with only 4.7 m clearance above the motorway and crossbeams through the prestressed timber deck



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Sweco's assignment:

- NCC hired Sweco and Finnmap Consulting to do the bridge design
- Finnmap designed all foundations and concrete structures, as well as the T-beam timber deck between axes 1-7
- Sweco designed the steel and timber structures between axes 7-11, which is the part of the bridge over the motorway.
  Sweco also led the design management

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Prestressing of the timber deck:

- According to Eurocode the bridge must be designed for a vehicular impact load of 500 kN. This horizontal load must be transferred to the abutments/pylons via the deck
- The impact load leads to a large shear force in the deck, and subsequently a very high prestressing level
- Swedish authorities allowed the use of friction values based on the Nordic Timber Bridge project, which are somewhat higher than the values in the Eurocode.
- The initial prestress level on the 600 mm thick deck is 1.4 N/mm^2
- Dywidag WR 26 bars spaced 500 mm with 419 kN load were used

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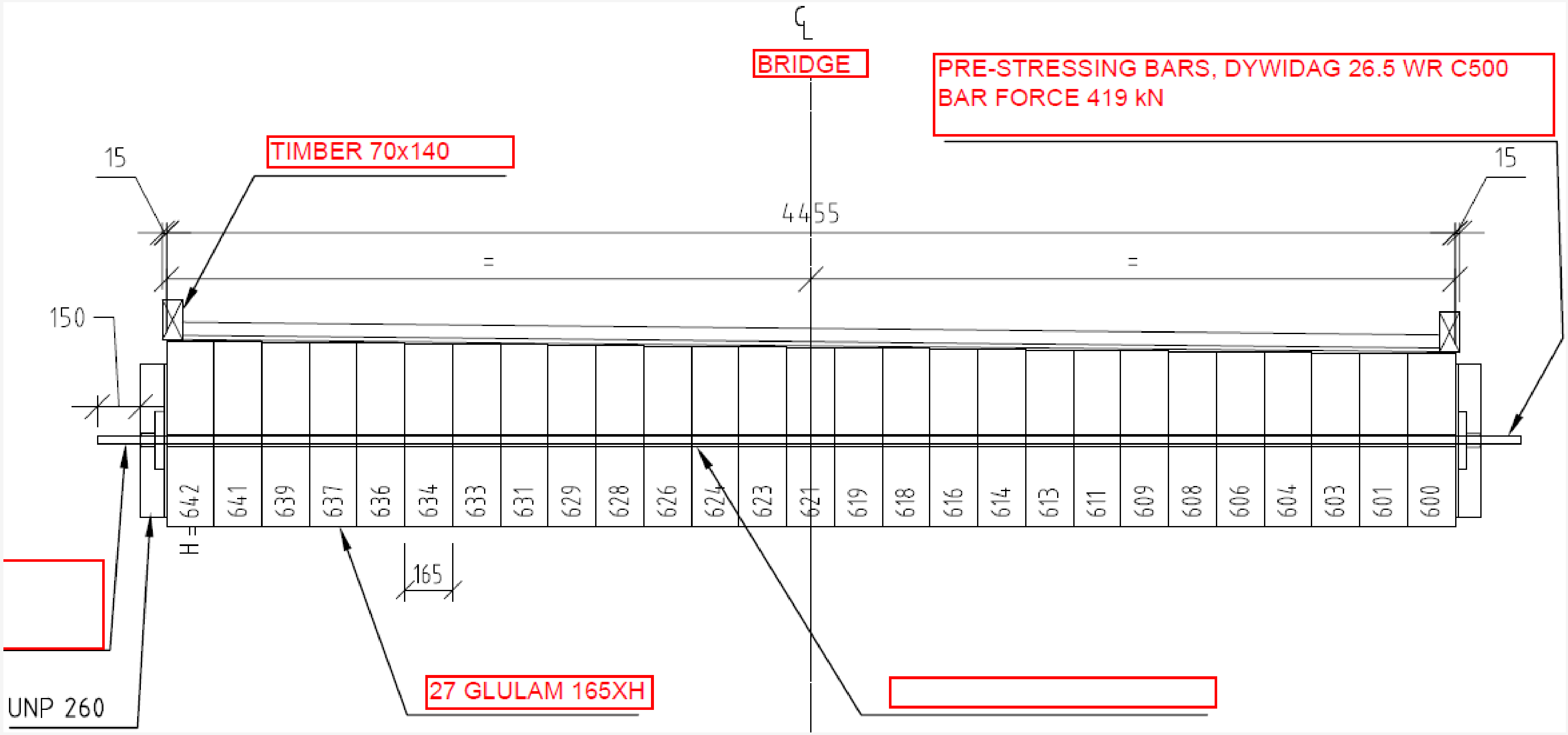
Cross-section of the deck showing the prestressing system



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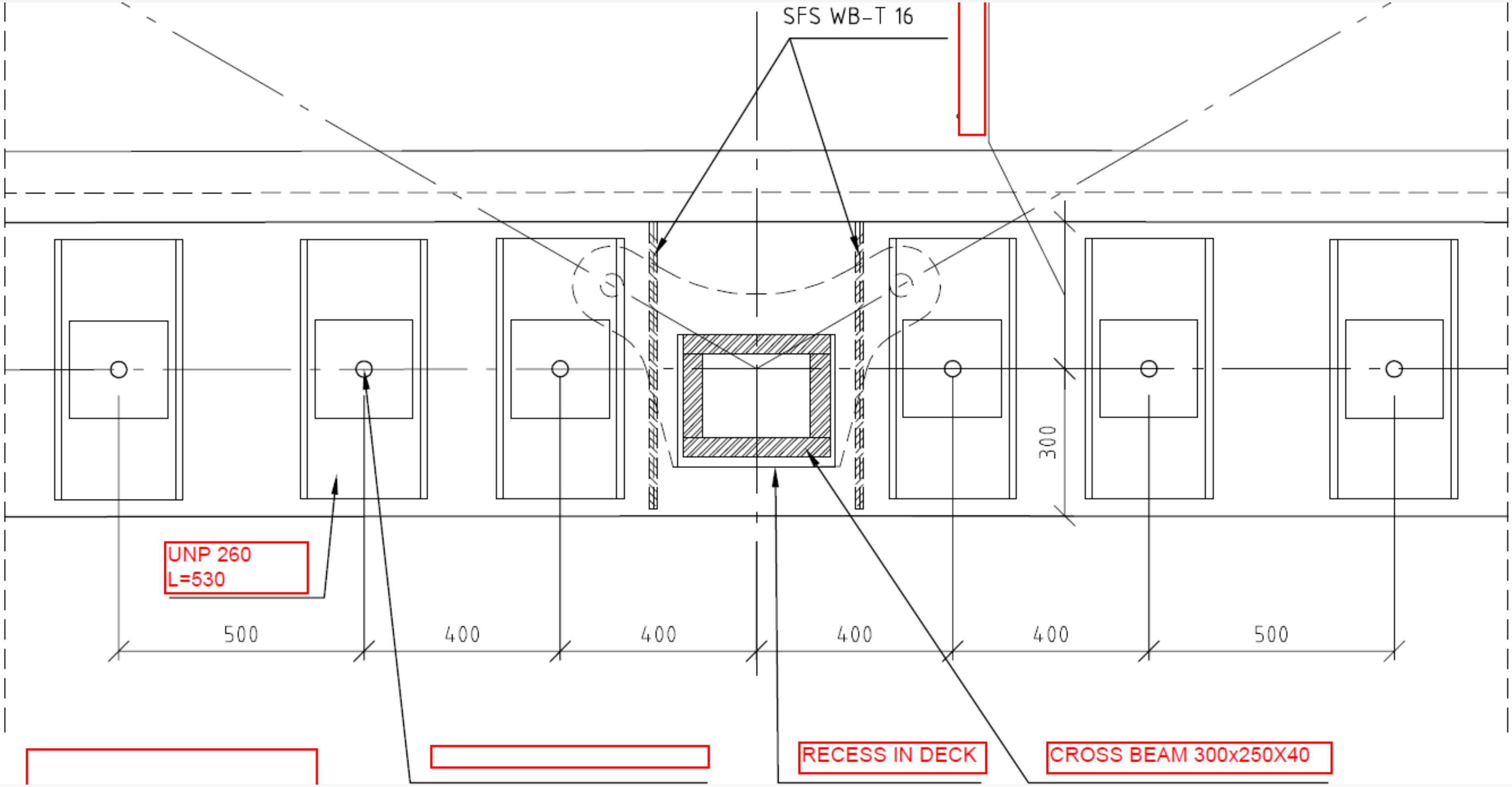
- Large channel sections to handle the prestressing force
- Rectangular crossbeams through the deck. Reinforcement screws



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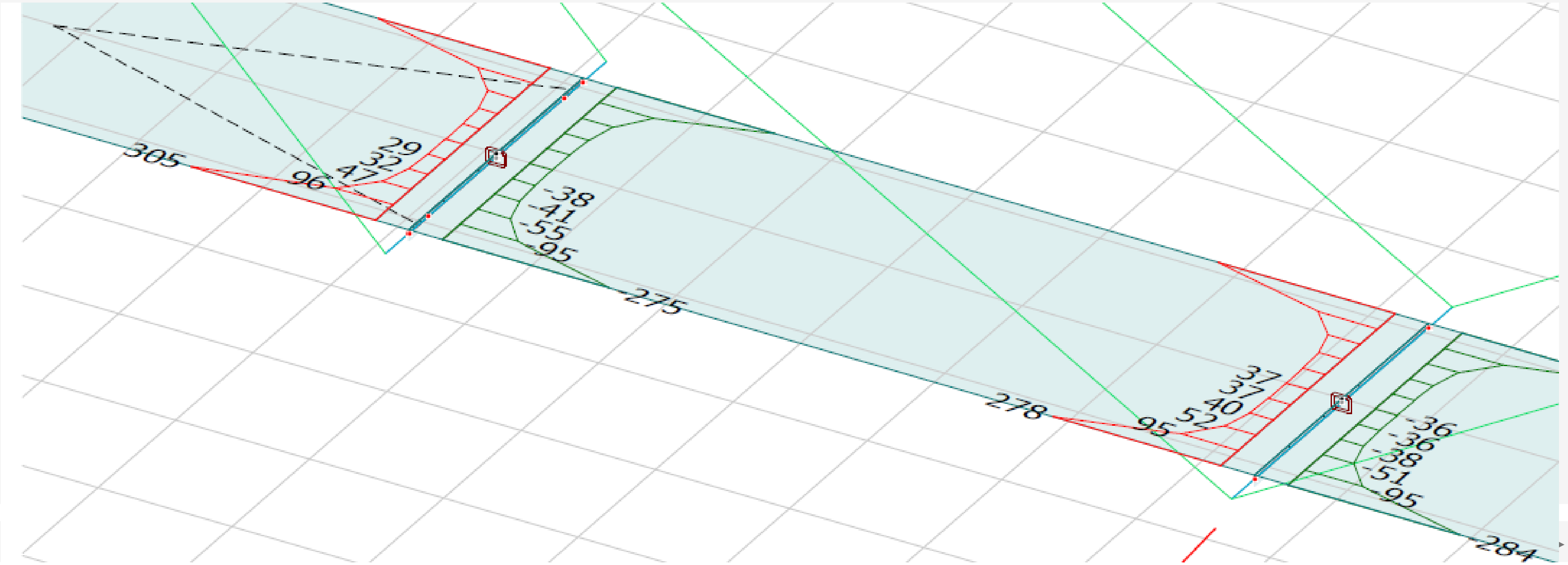
- An orthotropic finite element program was used to optimize the stiffness of the crossbeam in relation to the timber deck in the transverse direction
- The forces are concentrated around the deck edges
- We chose a crossbeam with adequate stiffness so that we achieved acceptable shear forces in the deck



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Proposal of design

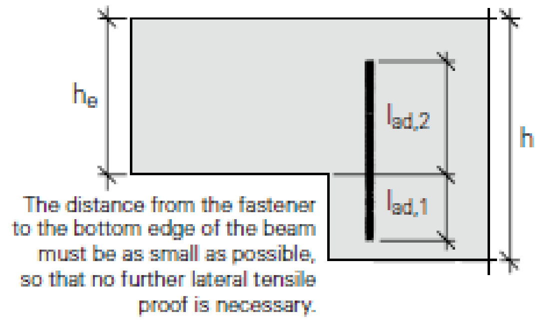
according to DIN 1052: **2004-08**

The reinforcements must be calculated for the following tensile force $F_{t,90,d}$

$$F_{t,90,d} = 1.3 \cdot V_d \cdot [3 \cdot (1-\alpha)^2 - 2 \cdot (1-\alpha)^3]$$

$$\text{mit } \alpha = \frac{h_e}{h}$$

V_d design value of transverse force



$$\frac{F_{t,90,d}}{n \cdot R_{ax,d}} \le 1$$

n number of fasteners (only one fastener is permitted in the longitudinal direction of the beam)

$R_{ax,d}$ design value of the load-bearing capacity of a fastener

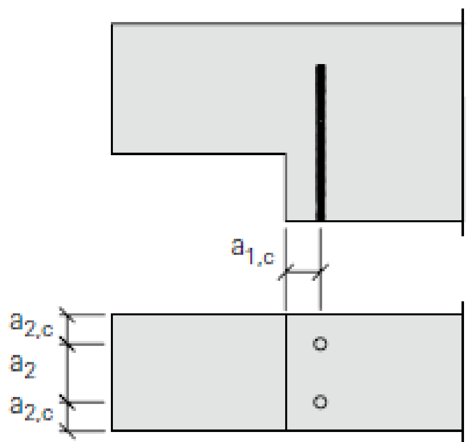
Values $R_{ax,d}$ can be found in the table below

$$l_{ef} = \min [l_{ad,1} ; l_{ad,2}]$$

Arrangement

Minimum spacing

	WB-T-16	WB-T-20
a_2	48 mm	60 mm
$a_{1,c}$	40 mm	50 mm
$a_{2,c}$	40 mm	50 mm



Please note that in the case of notching only one rod may be allowed in the longitudinal direction of the beam.

The crossbeam through the deck is similar to a notch in a beam.

To increase the shear capacity we used SFS WB-16 threaded rods

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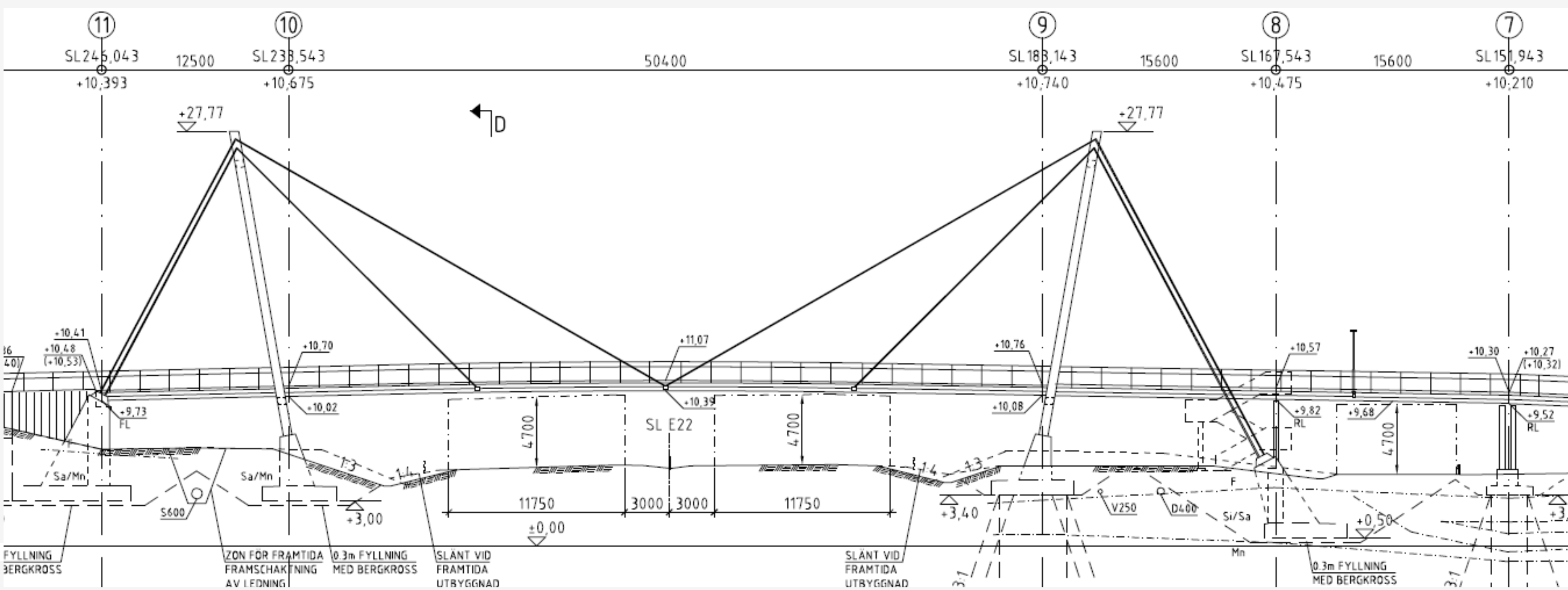
Assembly procedure

- The 94 m long timber deck between axes 7-11 was split in three large prefabricated elements.
- The elements were produced in Finland and transported to Kalmar by truck



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Large cranes lifted the 35 m long elements into position

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The prefabricated elements were joined in a 3,0 m long connection zone. This installation was not super smooth, but it worked out fine in the end

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After installation the bridge deck's sides were covered with thin steel plates

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Conclusions:

- A lot of steel was needed to prestress the deck to handle impact load from vehicles
- Considerable amounts of timber and steel can be saved by ensuring sufficient clearance above the underlying road
- Future timber bridge projects in Sweden should be allowed to use Nordic/Norwegian values and experiences for bar loss and friction values. The Eurocode is too conservative in this respect
- Letting the crossbeams run through the deck complicates design and installation significantly as well as increases the costs
- On the positive side crossbeams through the deck give the bridge a somewhat smoother look, and improve the aesthetics.

Thank you for your attention