Report Hold 1: Truss bridge – Static calculations

This Report shall explain the assumptions and performed calculations for the assessment of the statical system and structural response to static loading of the Truss bridge.

1. Statical system

This subsection explains the assumptions made to identify and create the static system from the chosen design from the teams Architect. Figure 1 shows the chosen design for the truss bridge.

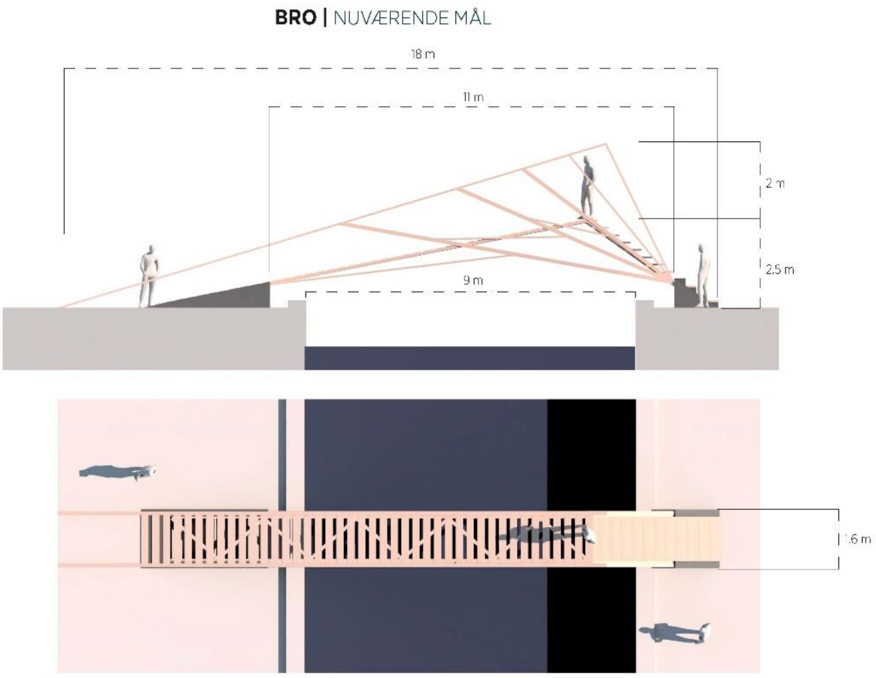

Figure 1 Chosen Design

The bridge consists of a main deck which is supported by angled truss members on the side of the bridge which will additionally act as a railing when the bridge is in use. The load bearing capacity of the truss members is seen only for the parts that are underneath the main deck, the parts that mainly act as railing do not significantly contribute to the load bearing capacity of the bridge.

On the basis of the design, the static system has been identified as shown in Figure 2.

Figure 2 is a non-dimensional sketch that should only act as a visualization of the static system.

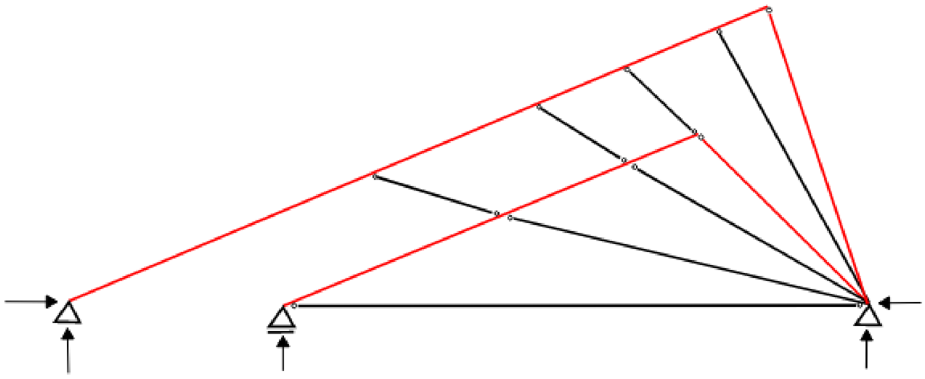

Figure 2 Static system

The black members of the bridge act as truss members in compression and tension and are therefore assumed as hinged at both ends. The red elements, the main deck and the top cord of the railing, are displayed as beams that can also act in bending, the connections of the beam elements have been assumed as hinged.

As there is going to be an interaction of the bridge railing system that is over the deck because of continuous truss elements that span over the entire length, the railing system has been modelled and considered in the calculations as well. The railing will not considerably contribute to the load bearing capacity.

2. Loads and Finite element model

From the static system, a 2-Dimensional and a 3-Dimensional finite element model has been created to assess the bridges loading response.

For this a vertical line/surface load over the whole length of the deck, has been applied.

The Software “FEM Design” has been used for the finite element calculations, where the bridge has been modelled according to the assumptions made in Section 1. The bridge has been modelled according to the preliminary dimensions, specified in Figure 1.

Figure 3 shows the bar internal normal forces in the bridge elements in a 2D section of the 3D model when loaded with a surface load on the deck and taking a fictional self-weight into account. In Figure 3, green showcases the members that act in compression whereas red represents members that act in tension.

All main members of the bridge act in compression, the bottom tension tie acts in tension. Figure 3 also displays the magnitude of the loads in the members, in reference to each other, the left part of the main deck and the first two truss members take the most load. As described in Section 1, there is load being transferred to the railing members, these loads are of relatively small magnitude, compared to the resulting loads in the main load bearing elements.

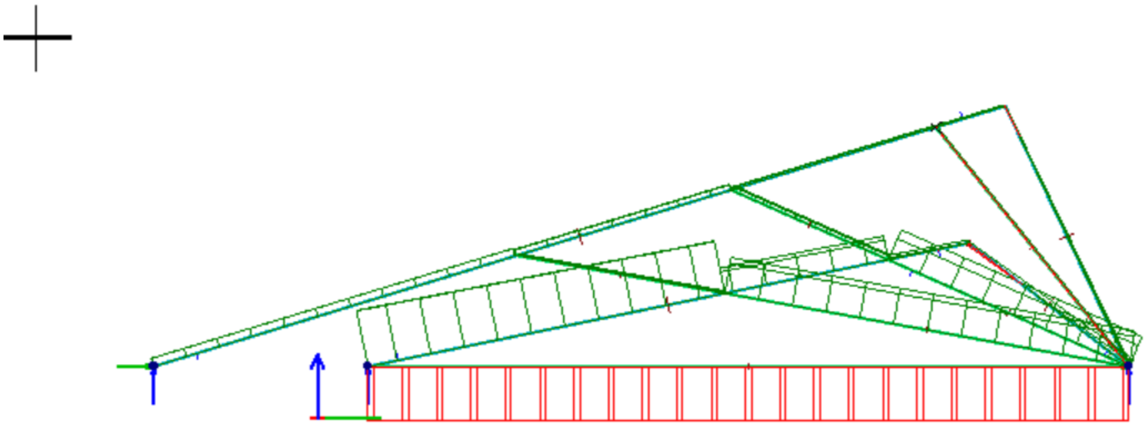

Figure 3 Bar internal forces- Normal force in Members

Figure 4 shows the Bending moment distribution in the beam elements in the main deck, resulting from the applied load and the structural dead load from the 2D FEM model.

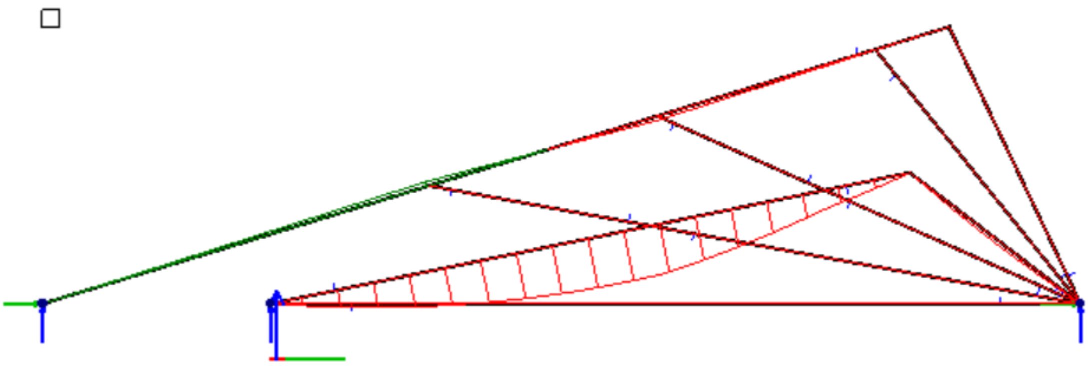

Figure 4 Bar internal forces - Bending moment in members

In the appendix the bending moment and the normal force distribution with local minima and maxima in the structural members are displayed after applying a surface load of 1 kPa, disregarding the structural dead load.

3. Following steps

On the basis of the 3D Finite element system the members of the bridge will be dimensioned and verified. The single elements and the bridge will be verified for Structural dead load plus an additional Load of 100 kg/m^2. The main elements of the bridge are going to be built in timber with bolted connections.

The main elements of the deck may need to be verified and dimensioned for the critical construction stage of the first erection of the preliminary arch shaped bridge without truss supports.

4. Appendix

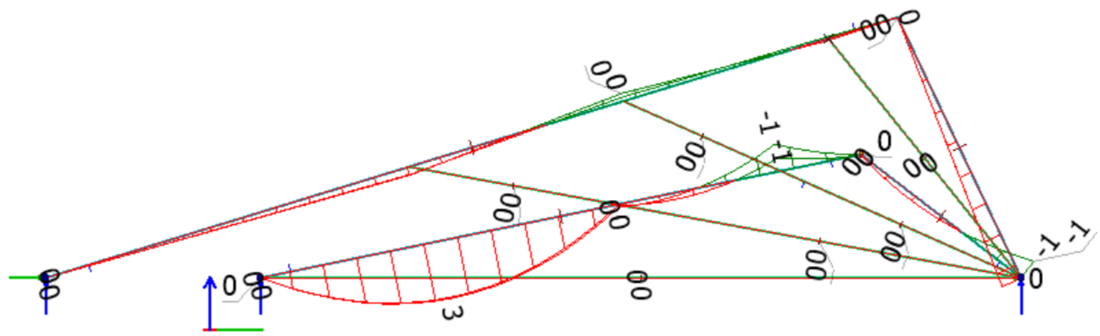

Figure 5 Bending moment from 1 kPa load

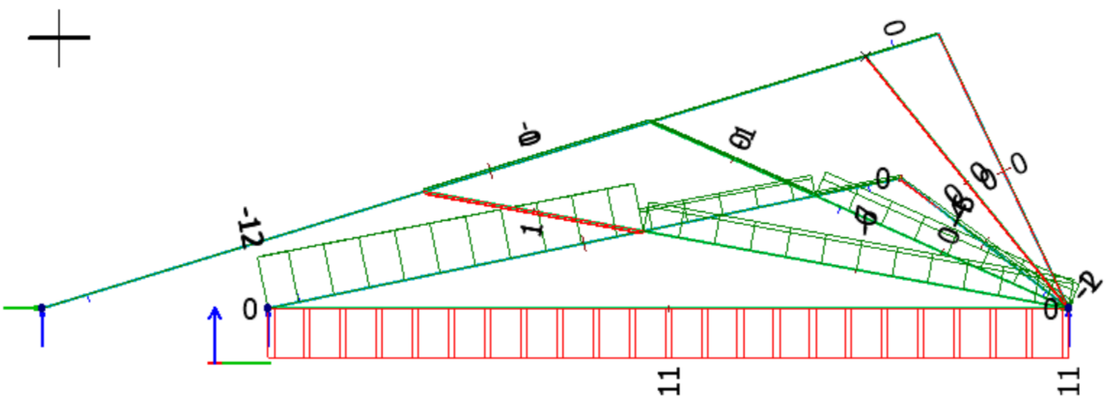

Figure 6 Normal force from 1 kPa load