Finite element models

Initial FE-model (design phase)

Before any measurements are done, the vibration serviceability of the construction can be assessed by creating a finite element model, based on the architectural plans.

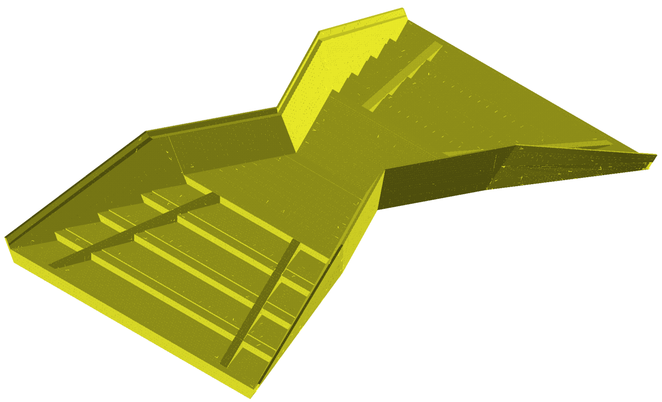

Figure 1: FE-model initial model bear cage (ANSYS).

The FE model of the bridge consists of four-node shell elements (Mindlin-Reissner theory) with six degrees of freedom at each node. The additional mass due to the epoxy finish and illumination devices is included by increasing the mass density of the related elements. The staircase and bike path at the sloping zones are modelled by adding the longitudinal beams positioned at the inner side of these zones. The more detailed elements (e.g. the steps and the sloping bike surface) are not included, since these elements will probably not have a significant effect on the stiffness of the structure. Initially the boundary conditions are applied as indicated on the architectural drawings (figure 2).

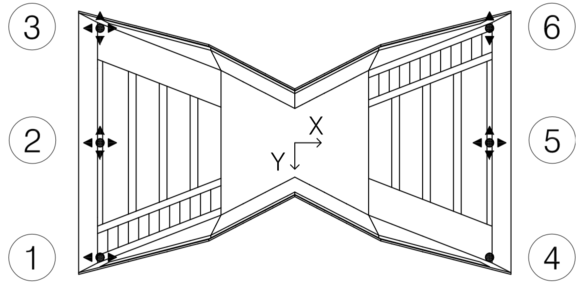

Figure 2: Boundary conditions (the permitted translations are indicated by arrows)

Calibrated FE-model (post-construction phase)

After the construction was built, the vibration serviceability can be reassessed based on a finite element model which is calibrated by adapting model parameters such that an optimal correspondence is found between the experimentally identified and calculated modal parameters. For the vibration serviceability after construction, the measured damping will be taken into account.

After identifying the modal parameters during a measurement campaign, it was clear that there was a large difference with the modal parameters that were calculated with the original model. Especially the first natural frequency is much higher than expected, indicating that the supports may be stiffer in the longitudinal direction than previously assumed. The prevented translations in the model were substituted by spring elements, and fine tuned during a calibrating process (table 1). Also the Young modulus of the longitudinal beam elements that represent the staircase and bike path at the sloping zones was calibrated (table 2).

Support position	Longitudinal spring stiffness [N/m]
1	5.28×10^8
2	5.28×10^8
3	5.28×10^8
4	∞
5	∞
6	∞

Table 1: Longitudinal spring stiffnesses of the calibrated FE-model

$E_{beam,init}$	2.1×10^{11} N/m^2
$E_{beam,calibrated}$	1.271×10^{11} N/m^2

Table 2: Calibrated Young modulus of the staircase-beam