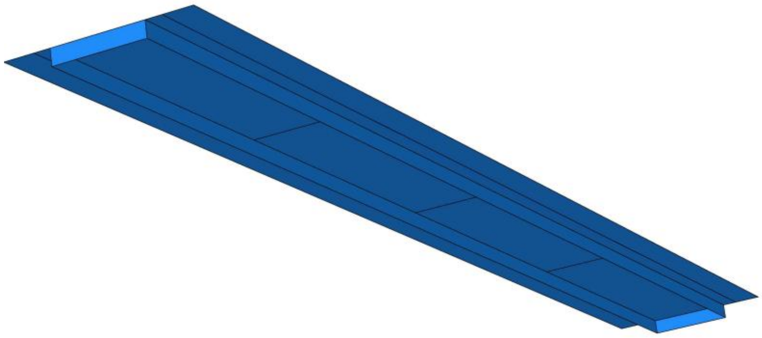
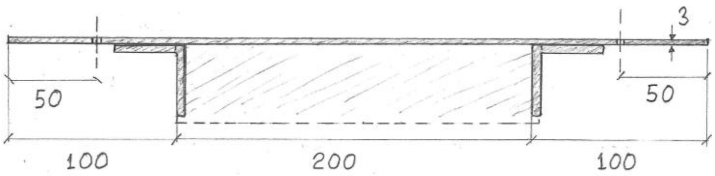
Project 2 – Dynamic response of a bridge

Structural dynamic computing 2019



You are provided with a scale model of a bridge-like structure, according to the picture above, for laboratory testing. It is a slender structure, made of steel, sensitive to bending and torsion and it is going to be analysed in terms of its dynamic response. You are to perform laboratory measurements and dynamic FE analyses using ABAQUS on the scale model.

The geometry of the cross section of the bridge model is shown below:



The bridge consist of a 3x0.4 m^2 plate bridge deck with L-shaped reinforcements that are 40x40x4 mm^3 in cross section, also made of steel. Masses (5.4 kg each) are placed on various locations on the bridge. An accelerometer is attached at a certain location on the deck of the bridge. The exact placement of the accelerometer and the masses have to be measured on the bridge model. The bridge is simply supported at both ends, resting on end plates shown as shaded areas in the cross section drawing above.

Laboratory testing:

The laboratory testing is divided into the following steps:

A. The displacement of the bridge is determined by applying impulse loading at different positions. The mode shapes and the resonance frequencies are determined by using three accelerometers. The task is to determine at least the six lowest modes and frequencies.

B. Transient loads are applied on the bridge deck by using an impulse hammer at a given position. The response of the bridge is recorded with the same sensors as in A.

Analysis assignments:

1. Use ABAQUS to perform an eigenvalue analysis of the bridge. Compute at least the six lowest natural frequencies and corresponding mode shapes. Compare with the experimental findings obtained in step A.
2. Estimate the damping from the measurements, use the measured peaks in the frequency domain to determine the damping at the resonances.
3. Make a transient analysis in ABAQUS using a full model of the bridge including damping. Perform a response analysis for the impulse loads as applied in the laboratory testing B described above. Use a Rayleigh damping model. Compare the numerical results with the experimental data in terms of accelerations. You may have to adjust the damping in the model to make the computed response comparable with the experiments.
4. Set up a reduced model for the transient analysis (Modal dynamics) in ABAQUS using a few modes of the bridge and:
    a. Check how many modes you need in order to accurately capture the behaviour of the bridge due to the impulse loading.
    b. In a Modal dynamics analysis, the damping is given in the step module and you can use modal damping to set the damping for each individual mode. Is it possible to produce results that agrees better with the experimental data by use of modal damping?

Note! It is important to check convergence of the FE-model in both *time* and *space*, i.e. check that both the elements and the time steps are small enough.

Report and presentation:

The work and findings in project 2 should be presented by each group in a written report and also orally in a seminar. Each report and presentation will be evaluated by two other groups.

Report: The results are to be reported as a technical report to an "intelligent" reader, which means that the reader is presumed to have basic knowledge of structural dynamics. The report should be focused on the results but also describe the initial problem setup and analysis procedure. Code and data are, if needed, preferably amended to the report as appendices. Use illustrative figures and diagrams for the results. The report should be delivered in electronic form as *one .pdf-file* to Per-Erik Austrell. Deadline for the reports is according to the course program.

Oral presentation: Each group will have a *scheduled presentation*, together with one or two other groups, in the exam week according to the course program. A suitable time for the presentations will be set in consultation with the course participants. You can record animated sequences for the oral presentation if you want.

Written comments on the report and comments on the presentation: When all reports have been completed, reports from one or two other groups will be given to each group for evaluation and comparisons with their own report. A *written note*, not more than two pages, discussing the different approaches should be completed and delivered to Per-Erik Austrell before the oral presentation according to the course program. The oral presentation will also be commented by the other group(s).

Related information: (in Swedish)