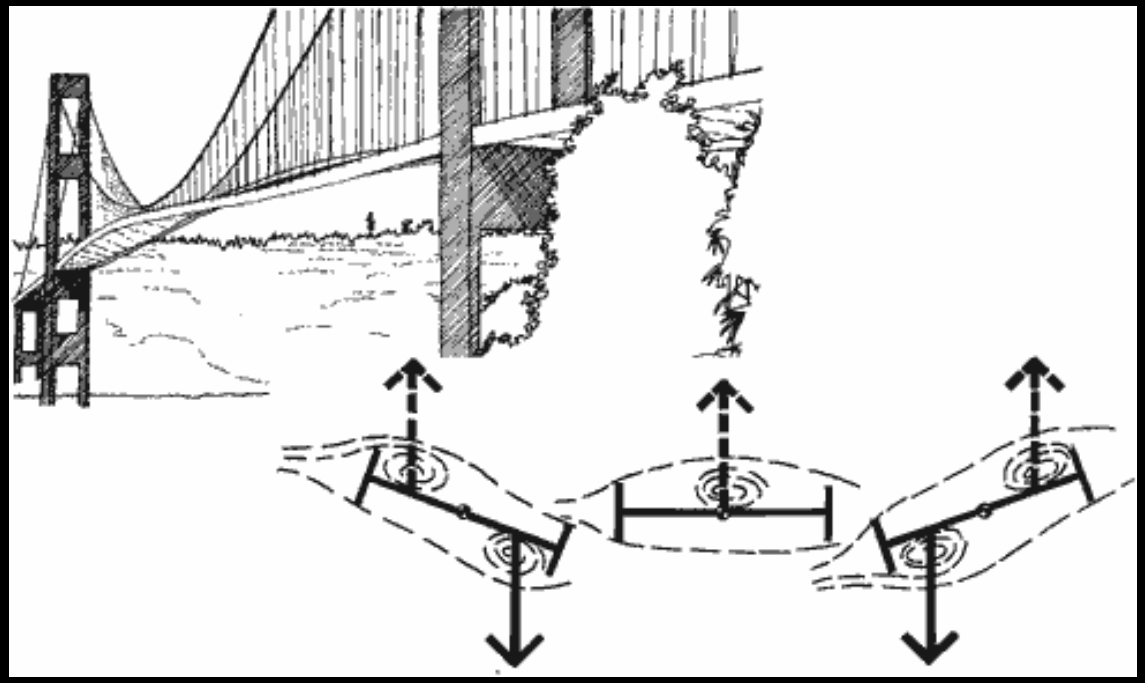
Bridge aeroelasticity simulation by using ANSYS software



Gergely Szabó

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Budapest, Hungary

Bridge stuctures

- Bridge types
  - Simple beam
  - Truss
  - Arc
  - Suspension
  - Cable supported

Bridge structures

Bridge structures

Bridge structures

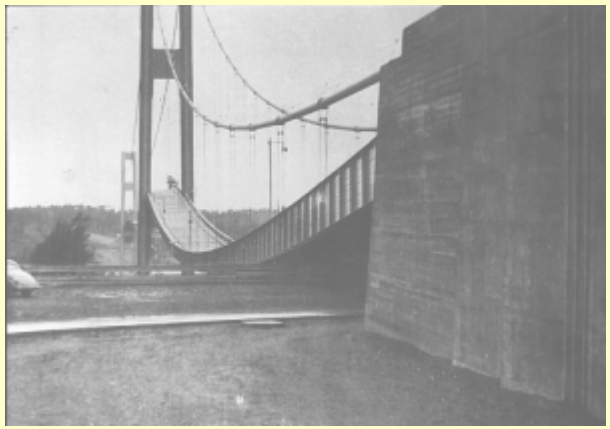
Bridge structures

- Dynamic load types
  - Vehicle
  - Pedestrian
  - Earthquake
  - Wind

Aeroelasticity

- Tacoma flutter



Aeroelasticity

- 3D airplane instability

Background

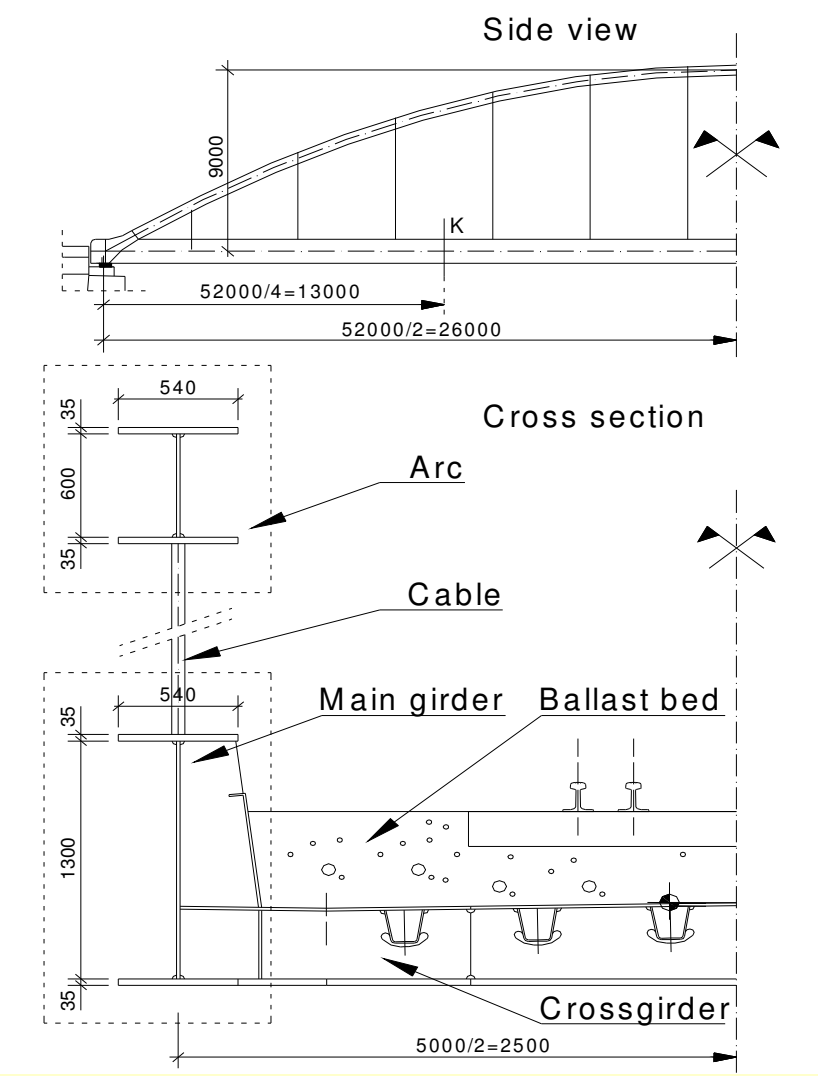
- Structural dynamics (CSD)
- Fluid dynamics (CFD)
- Fluid-structure interaction (FSI)
- Instabilities
  - Flutter
  - Divergence
  - Galopping
  - Vortex shedding

Railway bridge

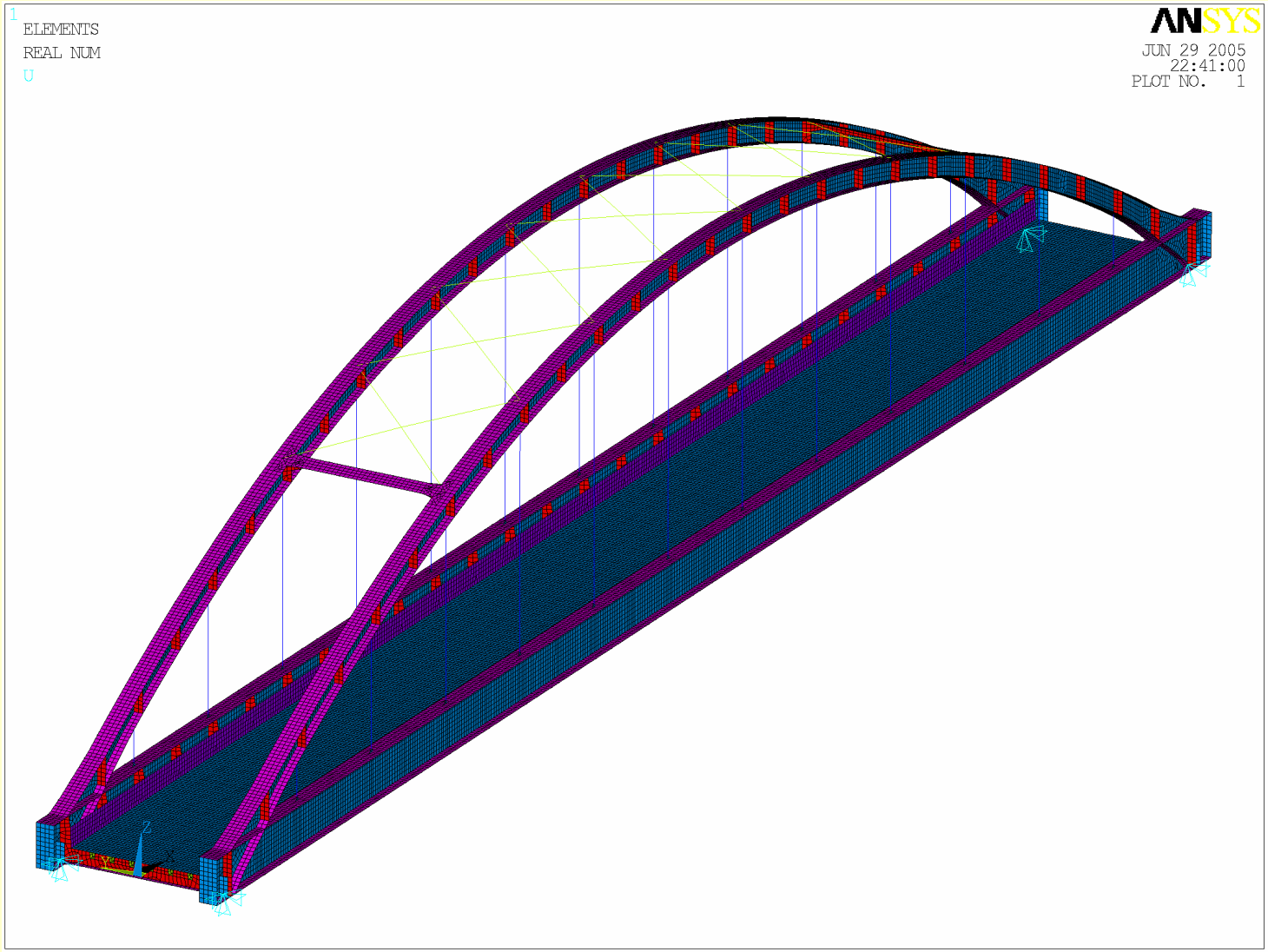
- FEM model of the bridge
- Load model
- Dynamic simulation
- Dynamic displacements

Railway bridge

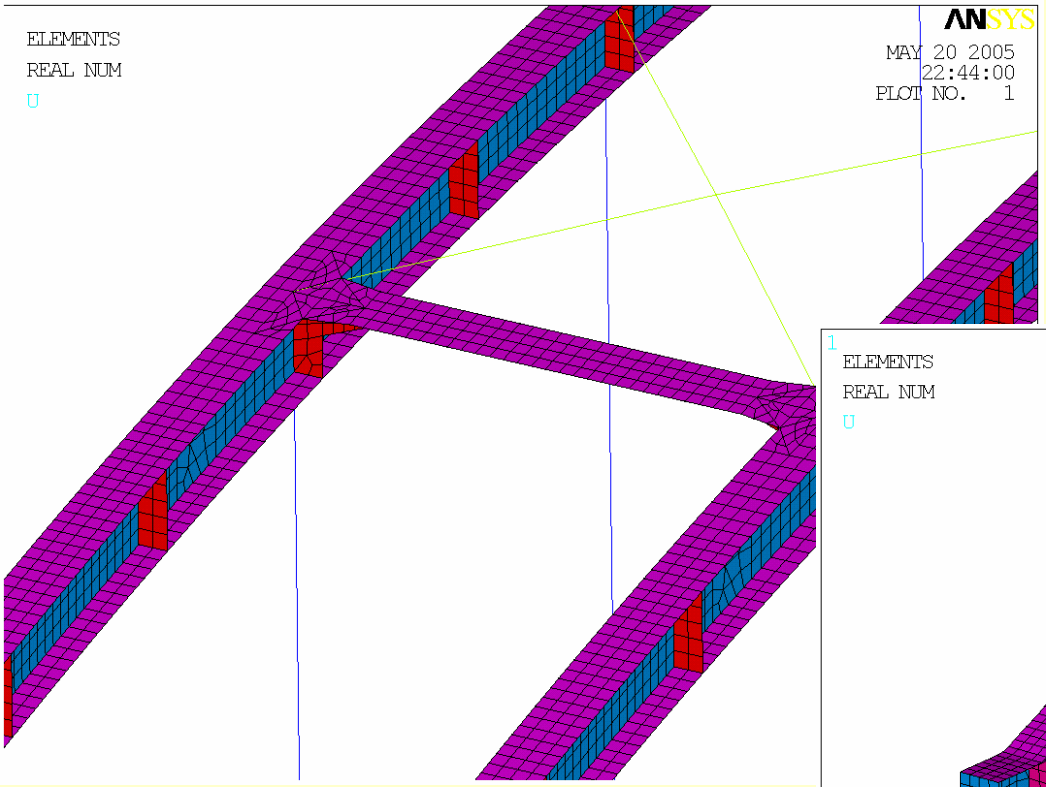
- Bridge structure

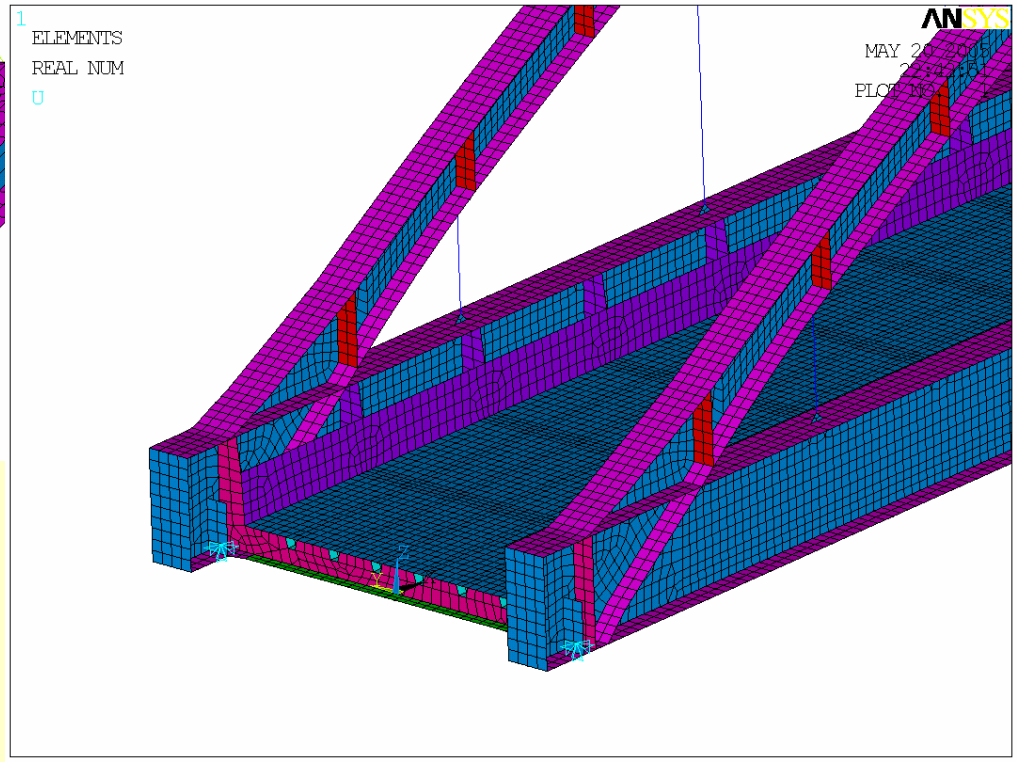


Railway bridge



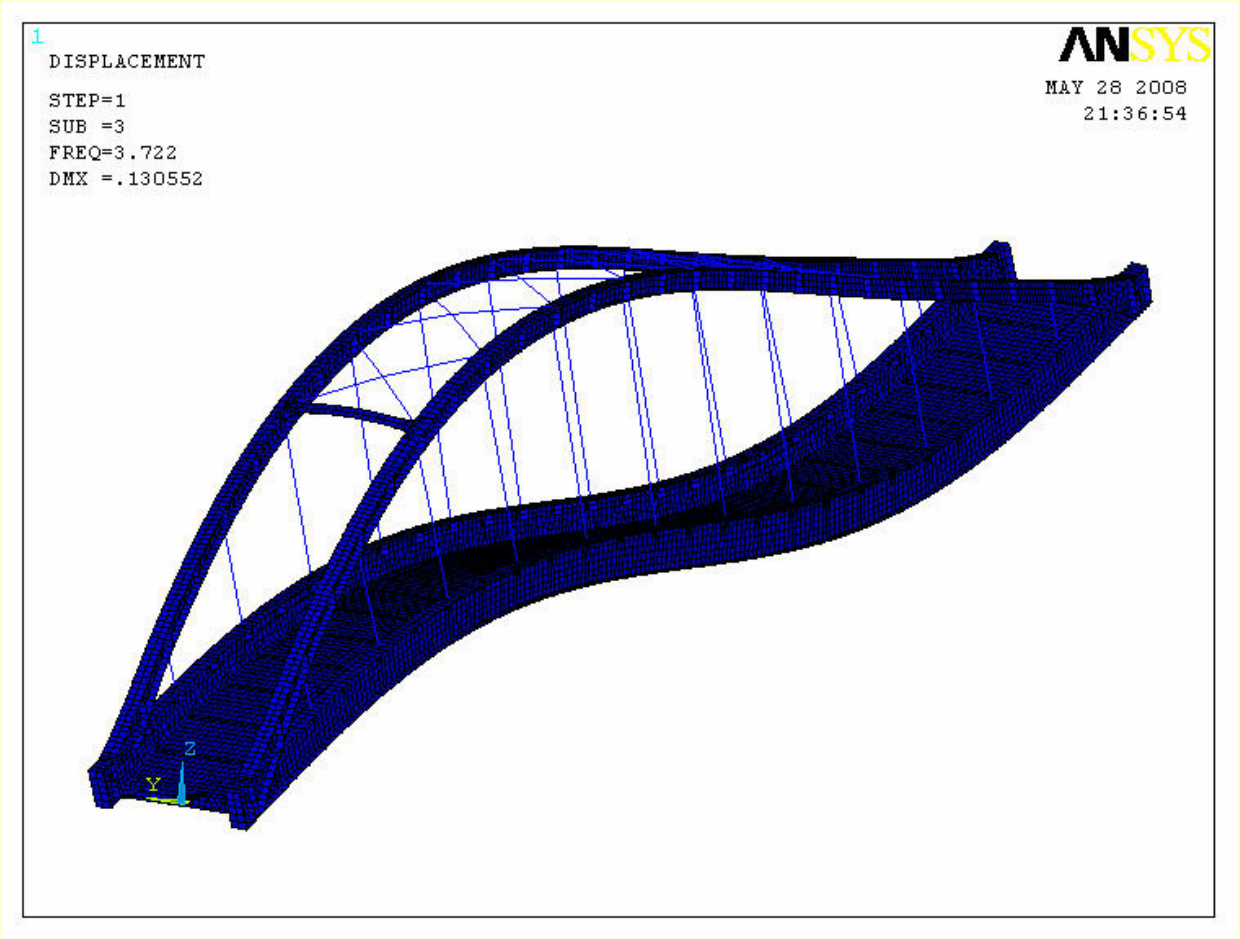
Railway bridge





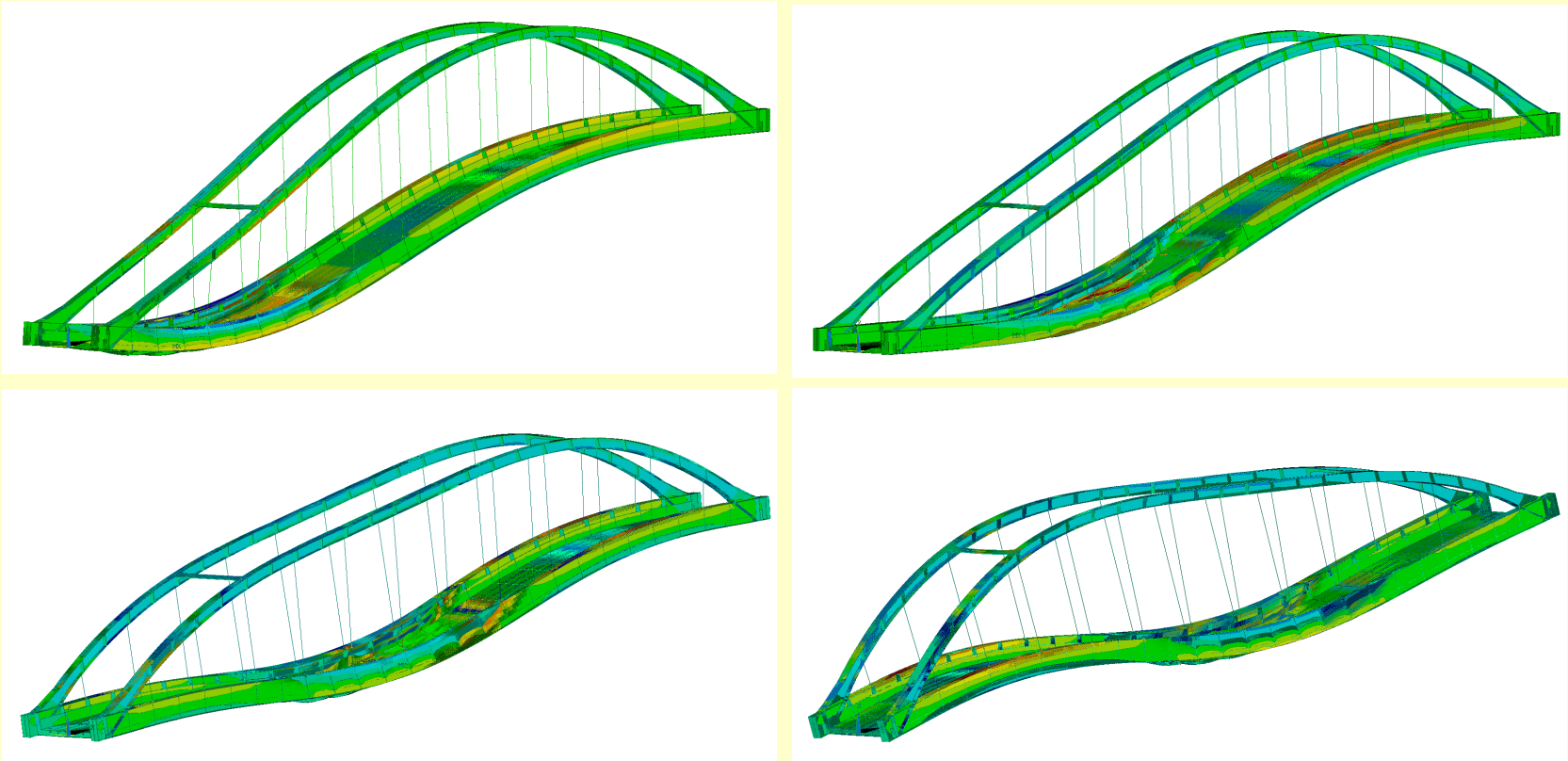
Railway bridge

- 1st mode shape



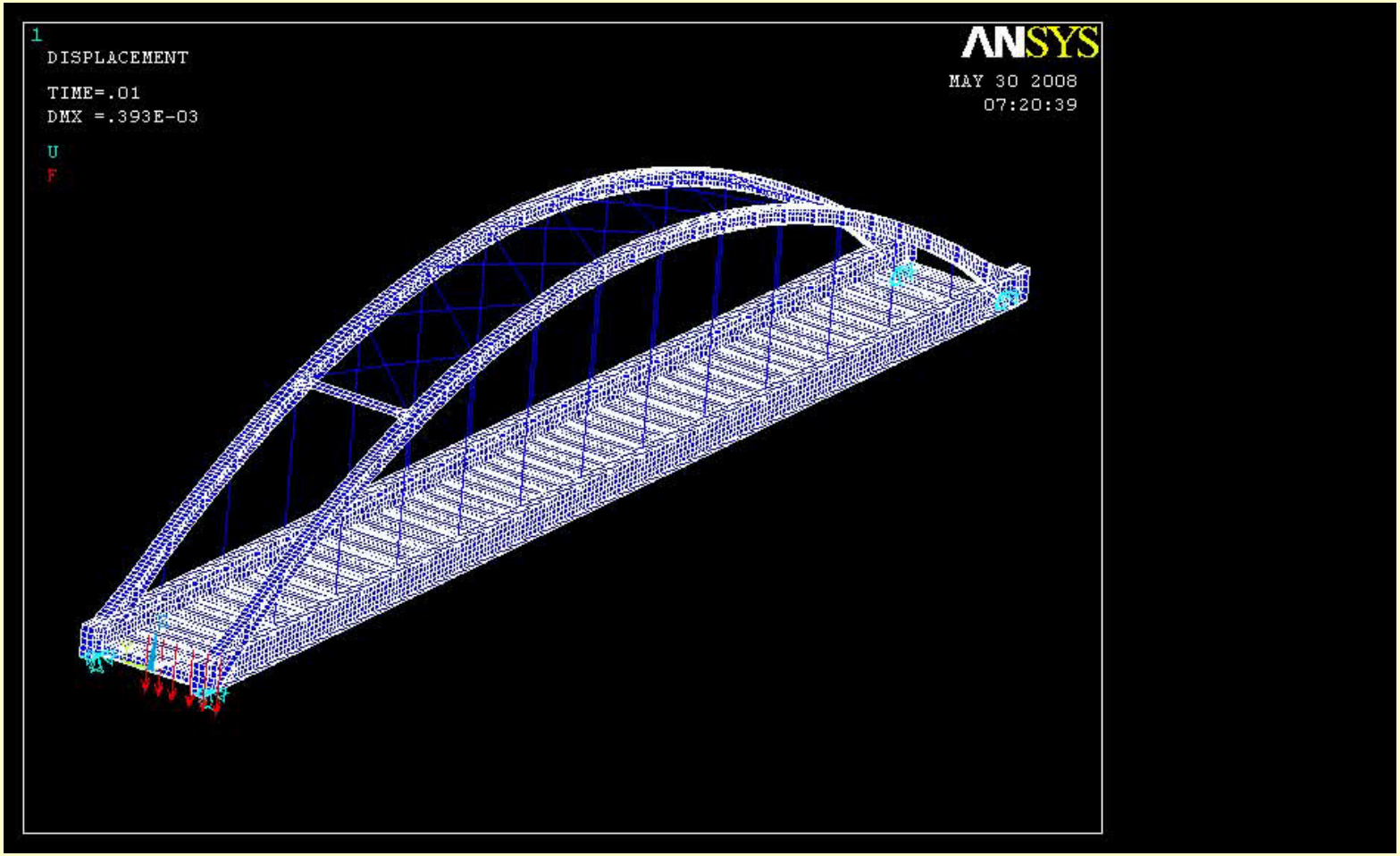
Railway bridge

- Displacement, stress field



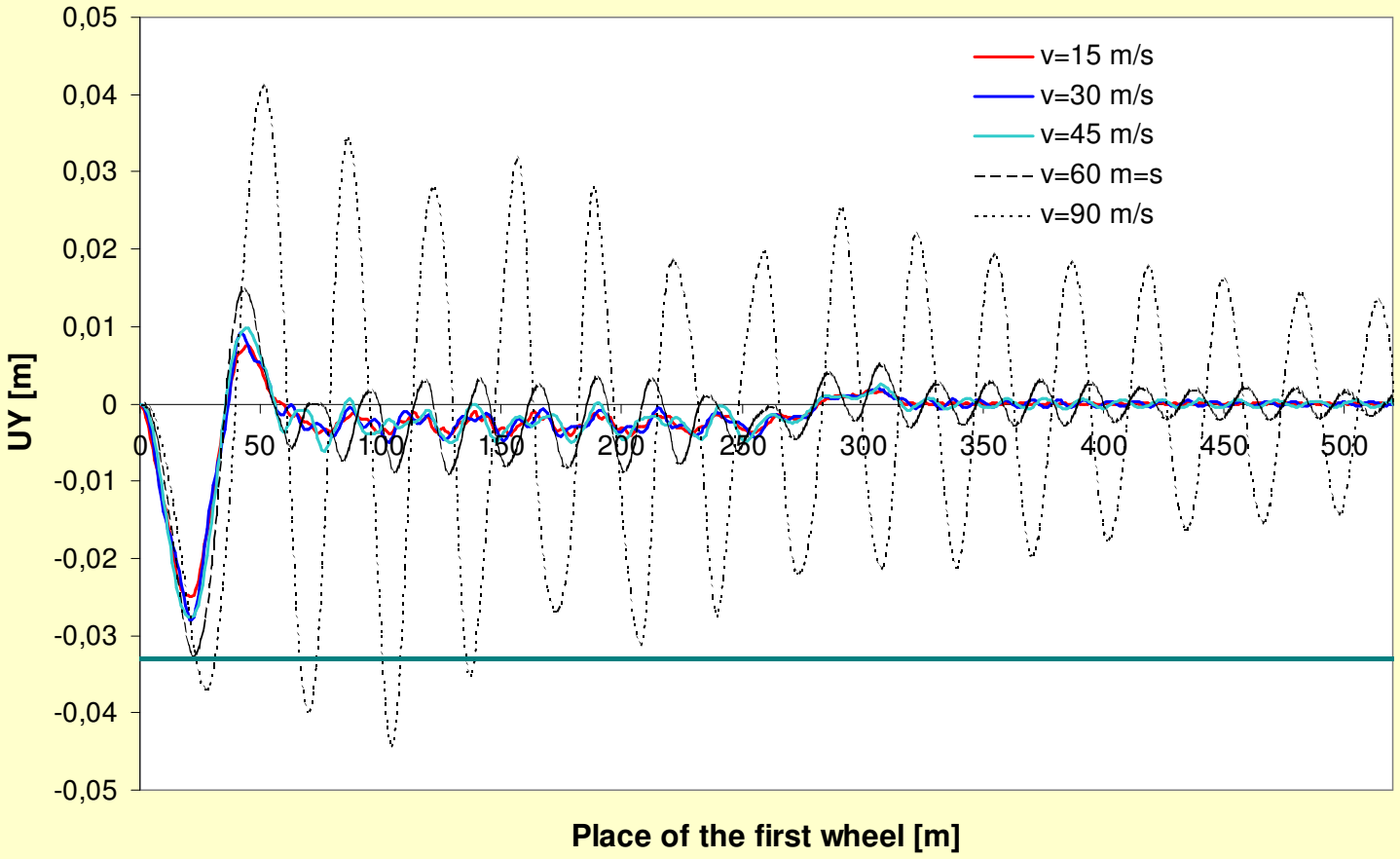
Railway bridge

- Rolling train



Railway bridge

- Displacements

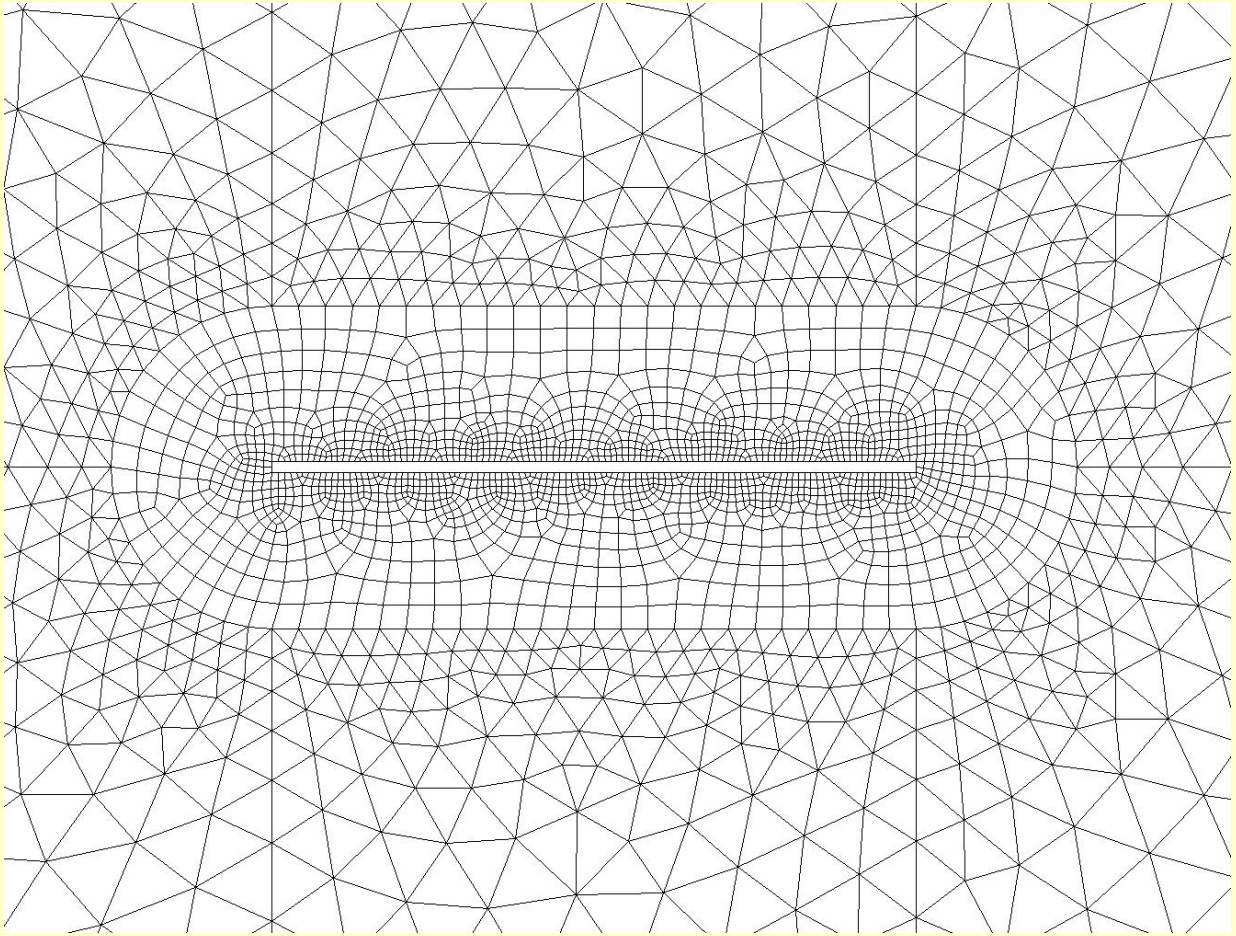


Oscillating flat plate

- Theodorsen flat plate theory
- Time dependent forces and moments
- Reduced velocities (U_{red}; U, omega, B)
- Flutter derivatives (H_{1-4}, A_{1-4})
- CFD model
- Validation of the CFD simulation

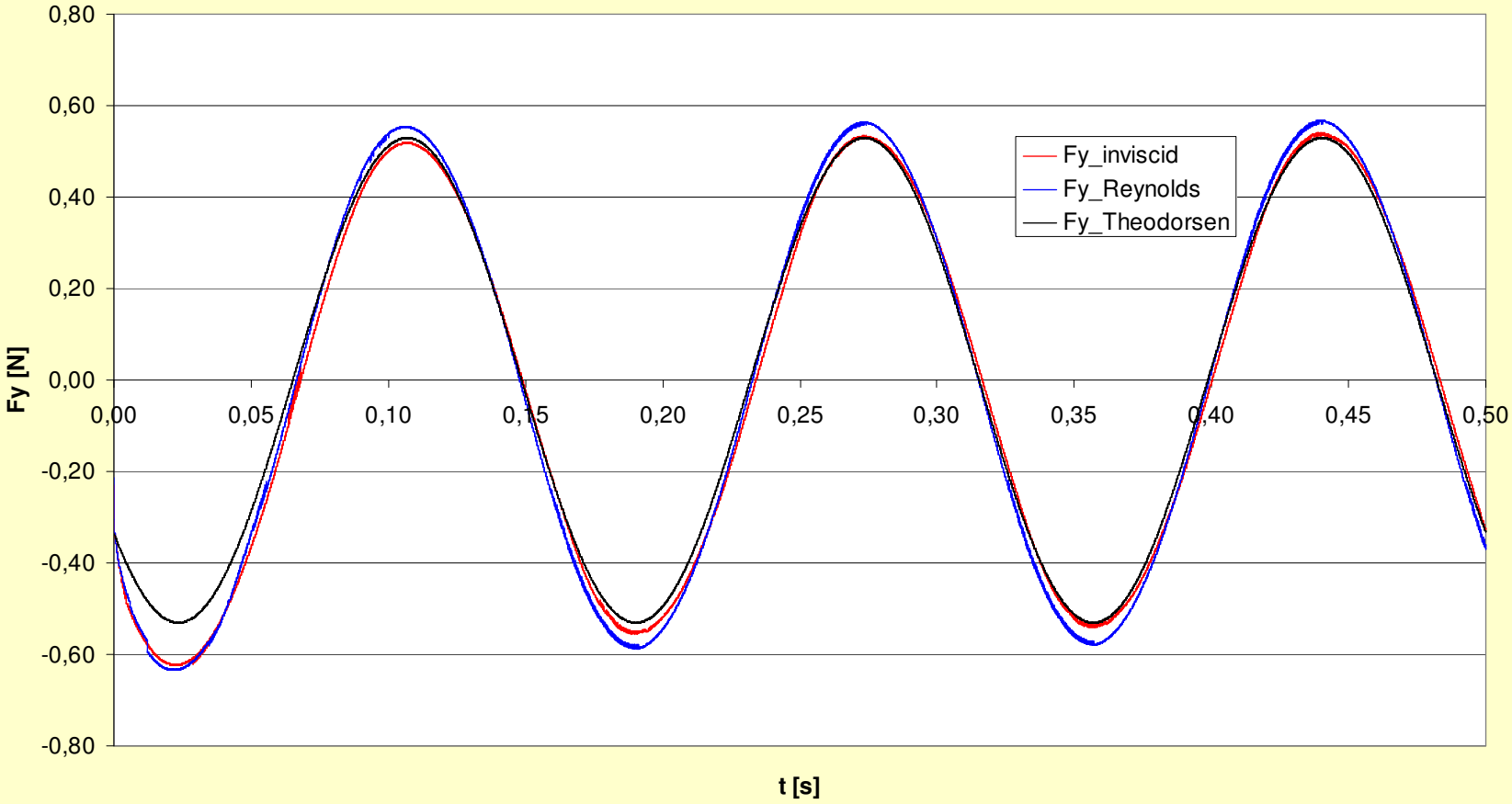
Oscillating flat plate

- CFD mesh



Oscillating flat plate

- Comparison

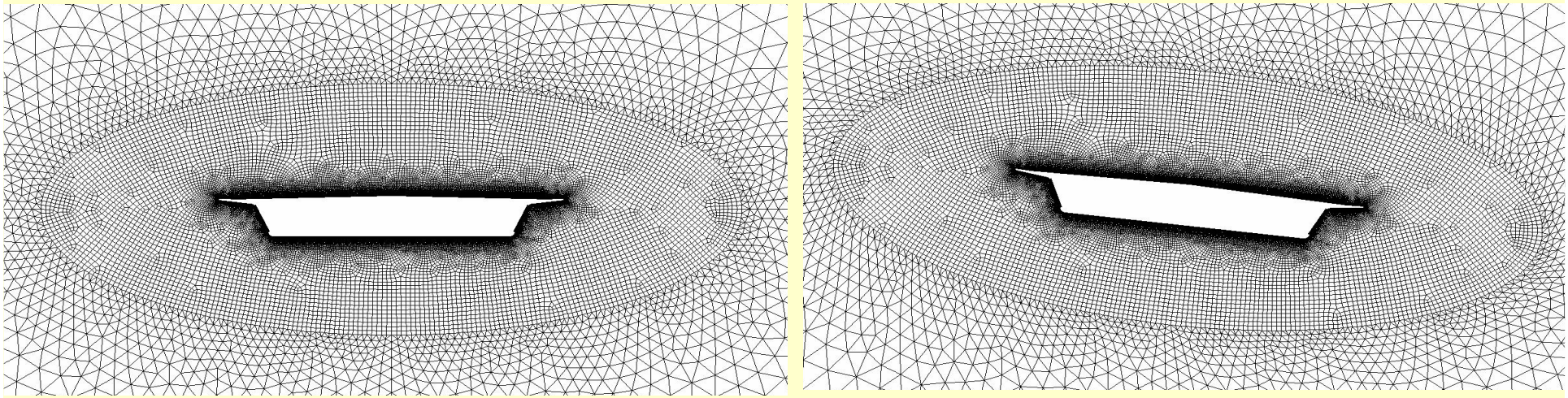


Bridge deck

- Bridge over the Tisza river
- Wind tunnel tests
- Forced vibration method
- CFD simulation
- Comparison

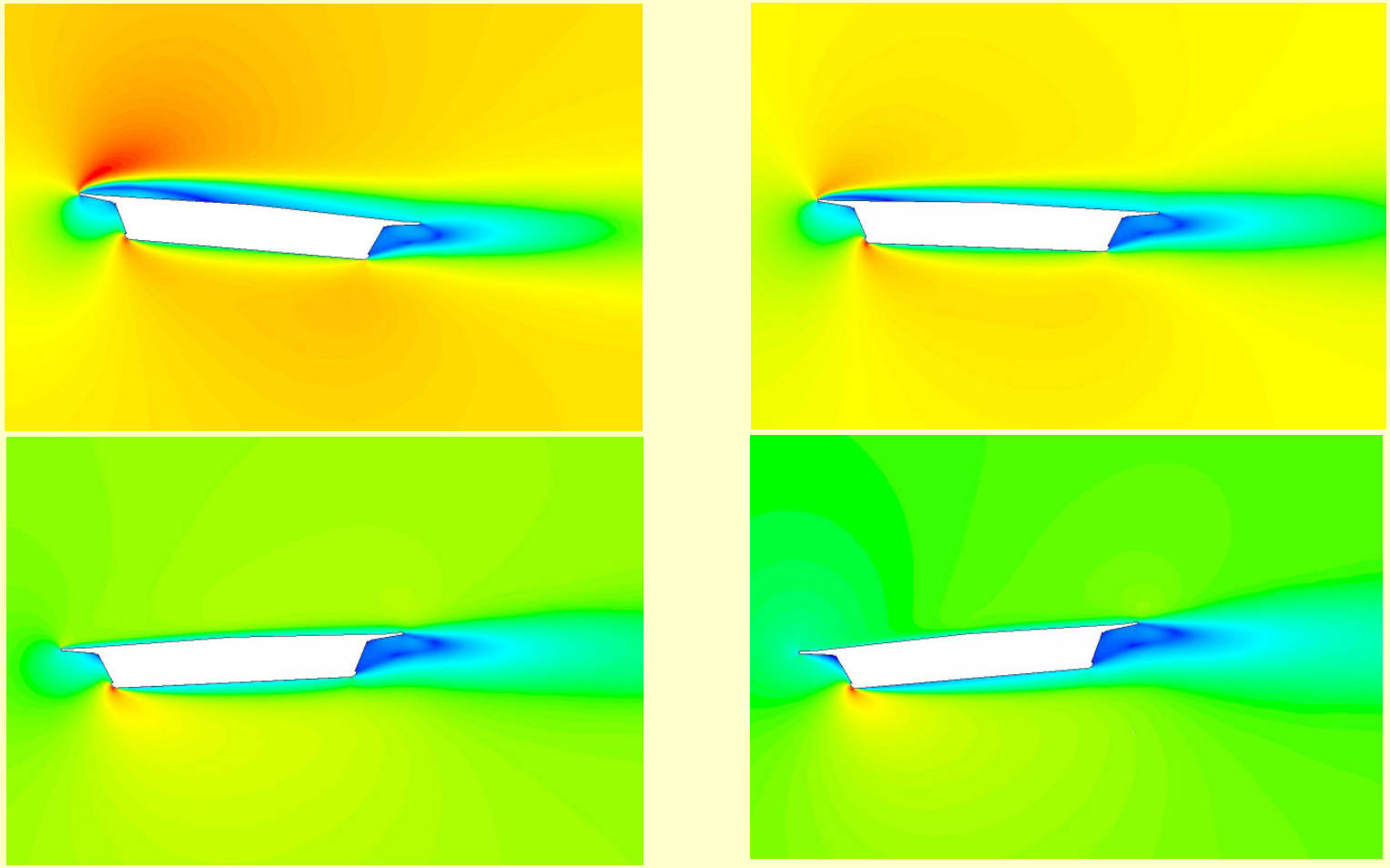
Bridge deck

- CFD mesh

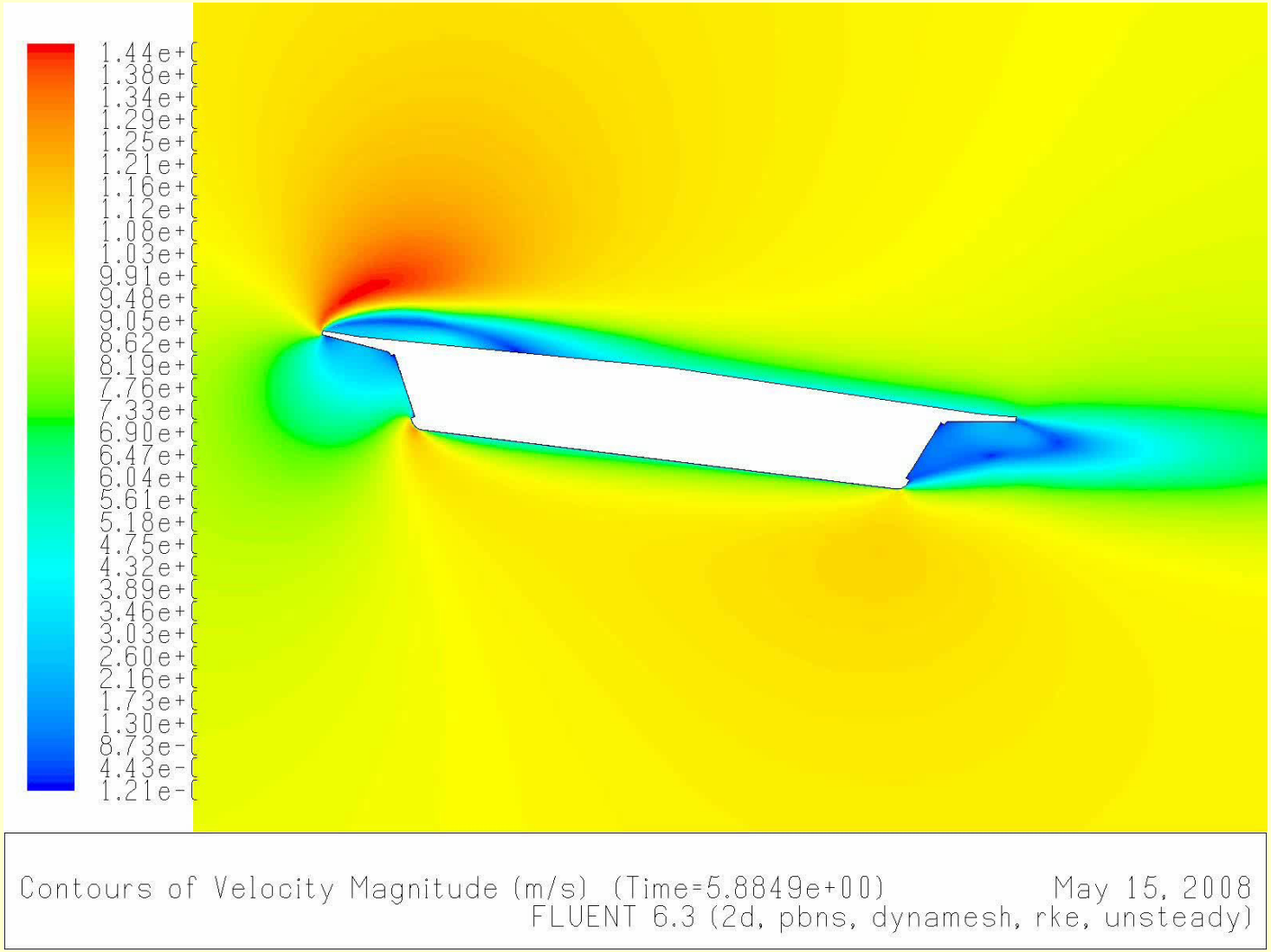


Bridge deck

- Velocity contour

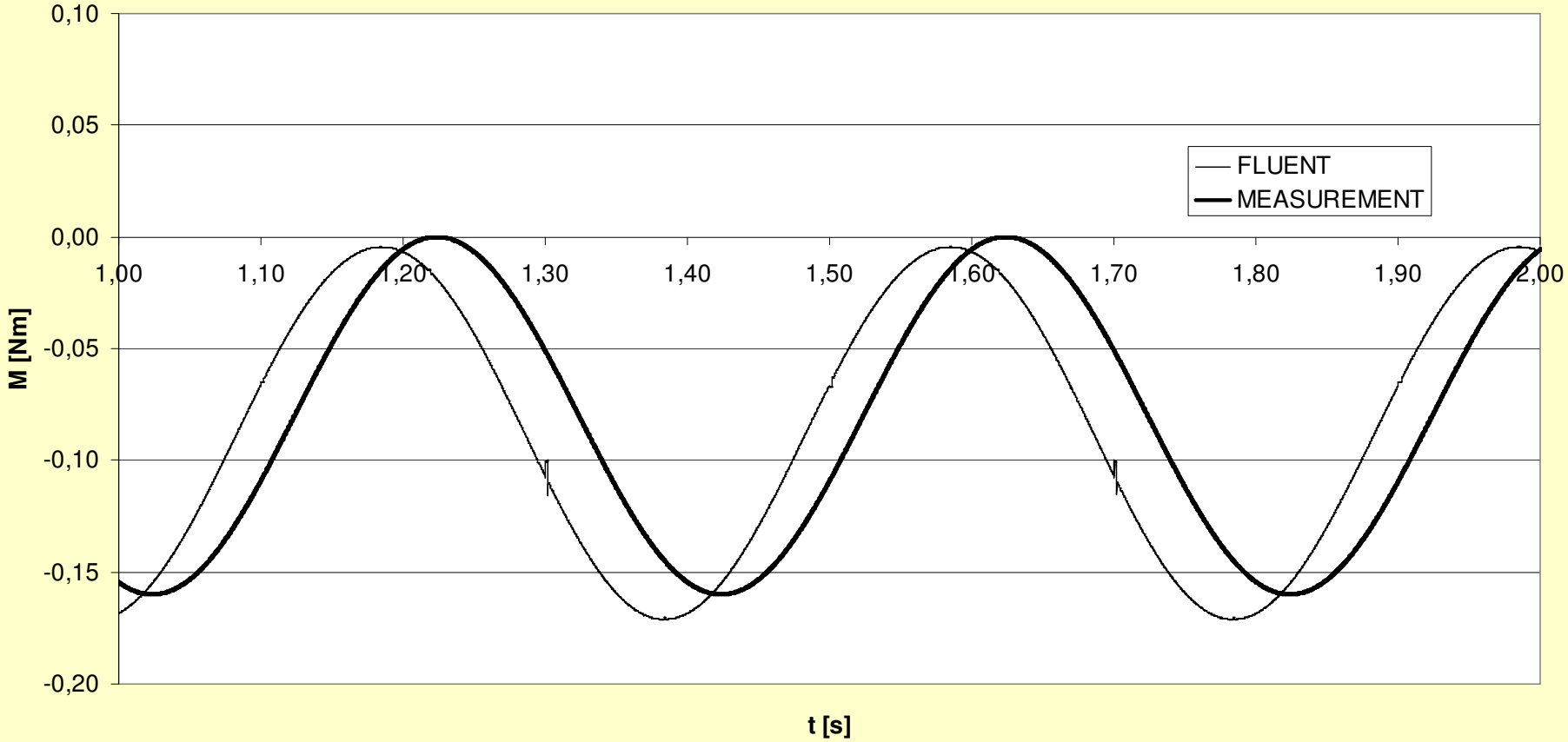


Bridge deck


1.44e+
1.38e+
1.34e+
1.29e+
1.25e+
1.21e+
1.16e+
1.12e+
1.08e+
1.03e+
9.91e+
9.48e+
9.05e+
8.62e+
8.19e+
7.76e+
7.33e+
6.90e+
6.47e+
6.04e+
5.61e+
5.18e+
4.75e+
4.32e+
3.89e+
3.46e+
3.03e+
2.60e+
2.16e+
1.73e+
1.30e+
8.73e-
4.43e-
1.21e-
Contours of Velocity Magnitude (m/s) (Time=5.8849e+00)
May 15, 2008
FLUENT 6.3 (2d, pbns, dynamesh, rke, unsteady)

Bridge deck

- Comparison

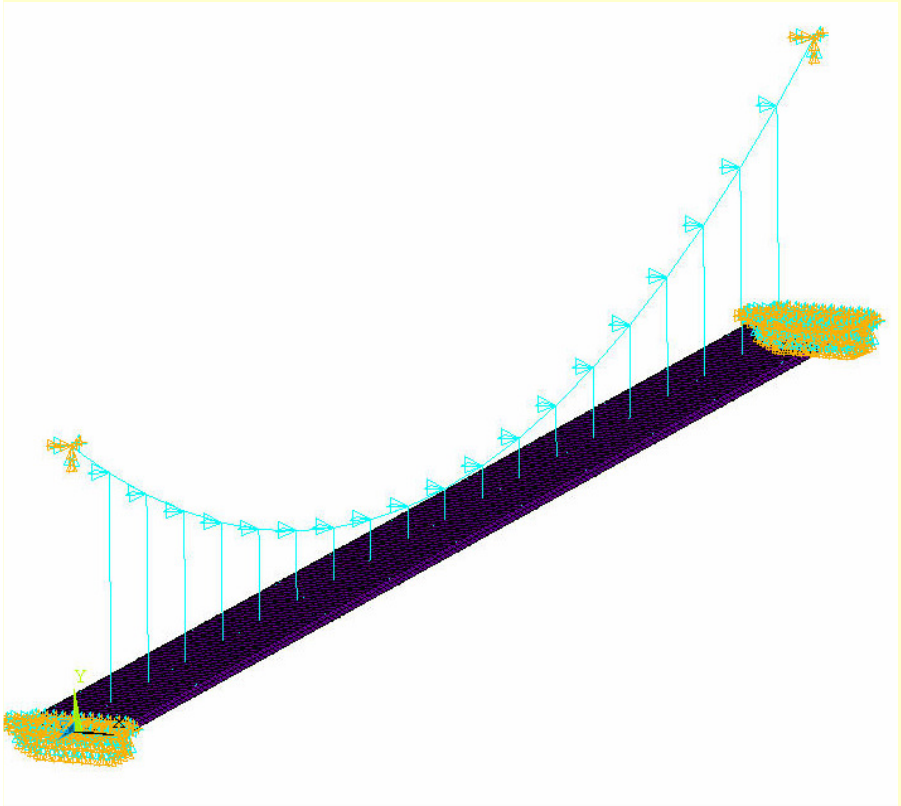


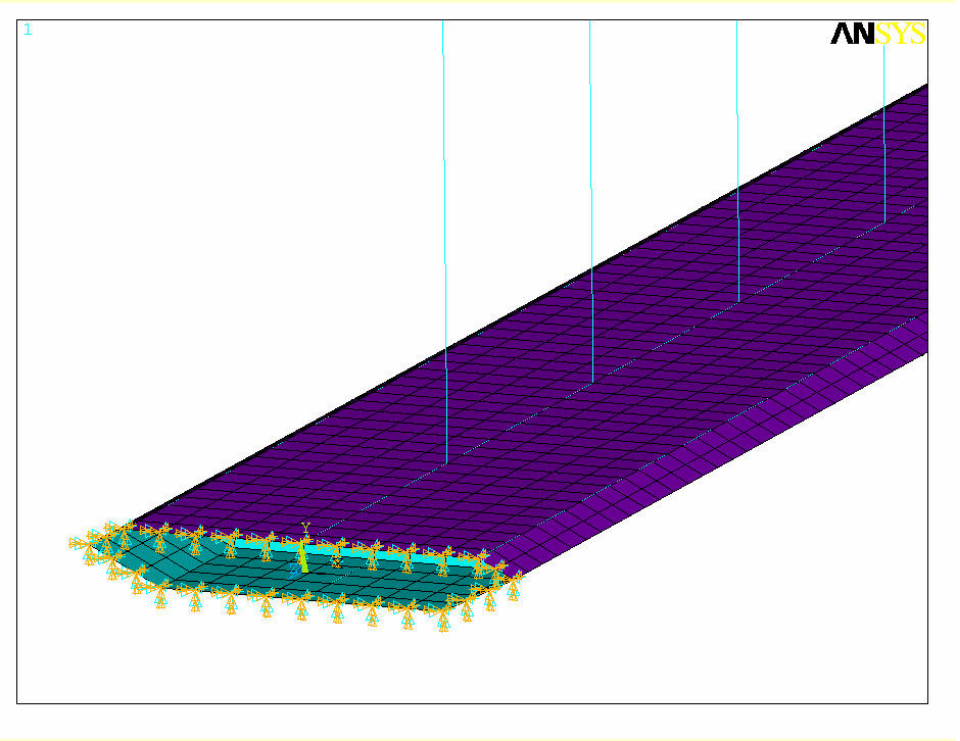
3D aeroelastic bridge model

- Full aeroelastic wind tunnel model
- FEM approximation for the mechanics
- Rough mesh for the fluid flow
- Simple turbulence model
- Coupling of the fields
- Comparison

3D aeroelastic bridge model

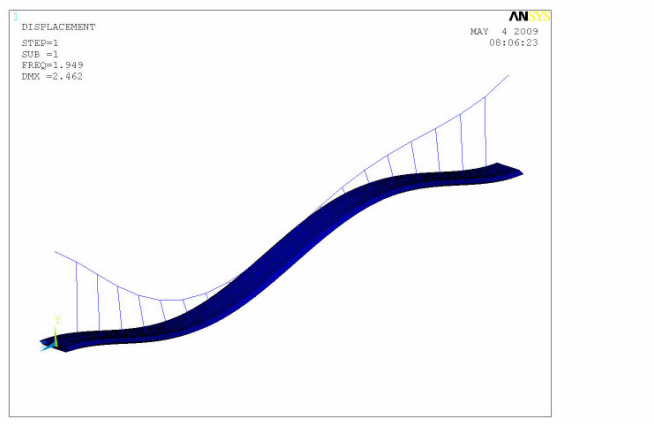
- FEM approximation

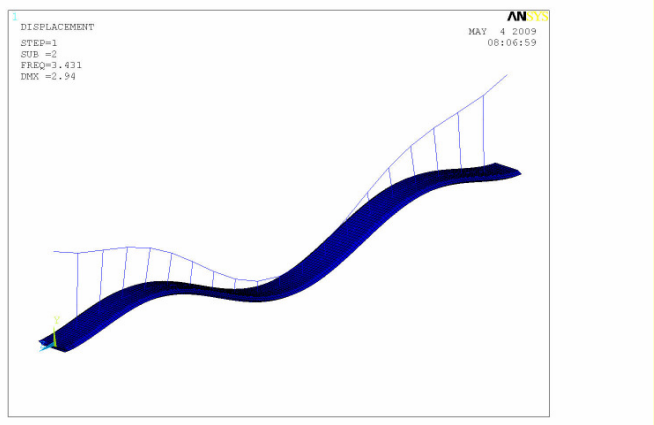


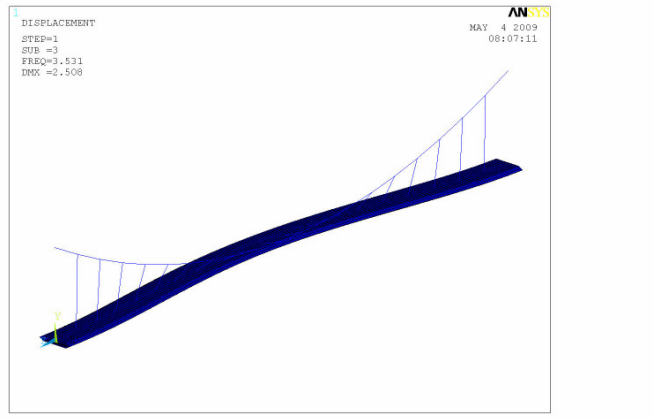


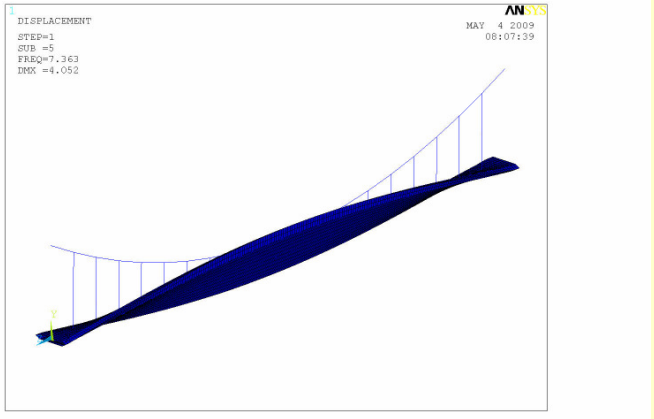
3D aeroelastic bridge model

- Dynamic mode shapes of the bridge



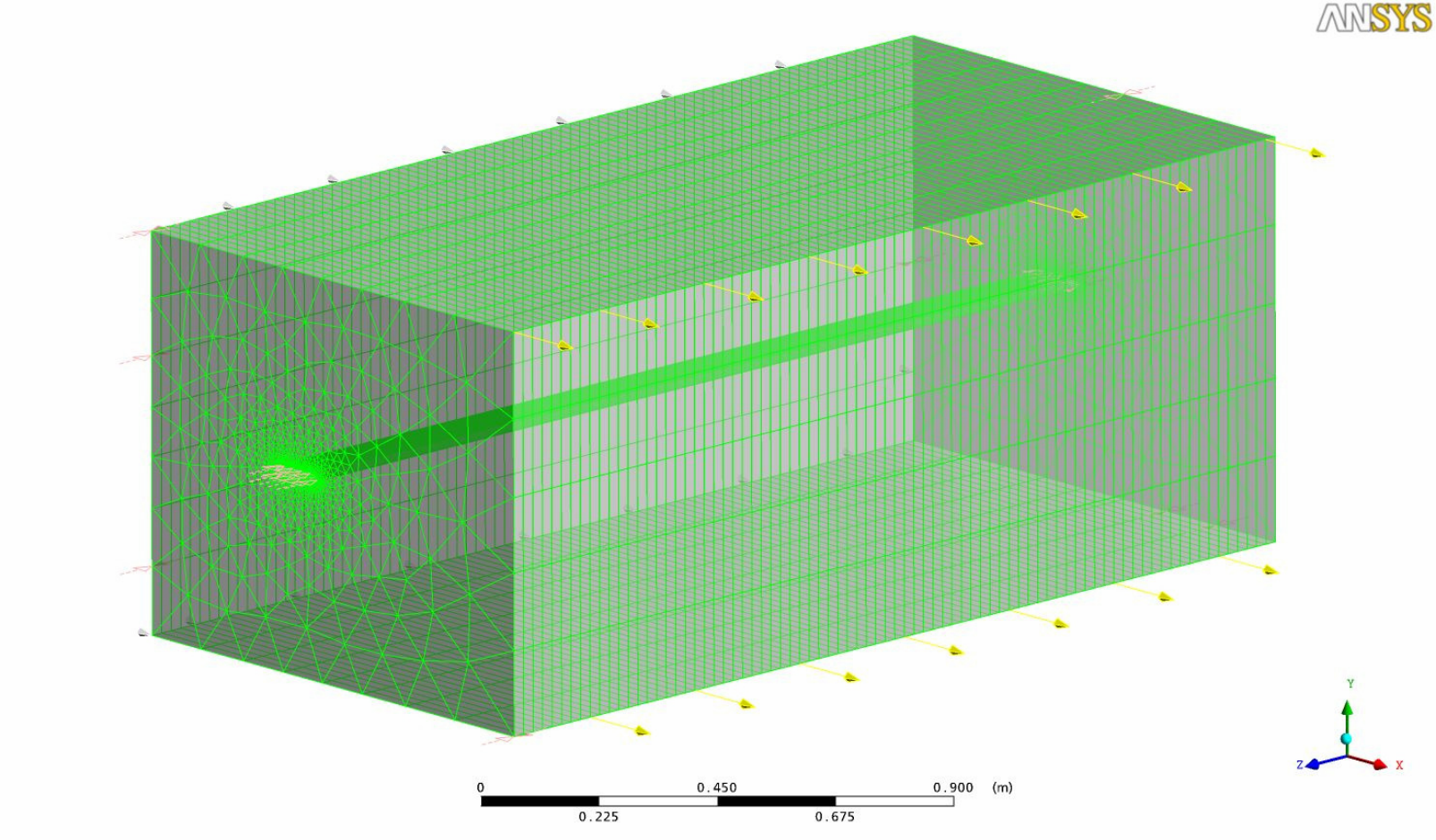




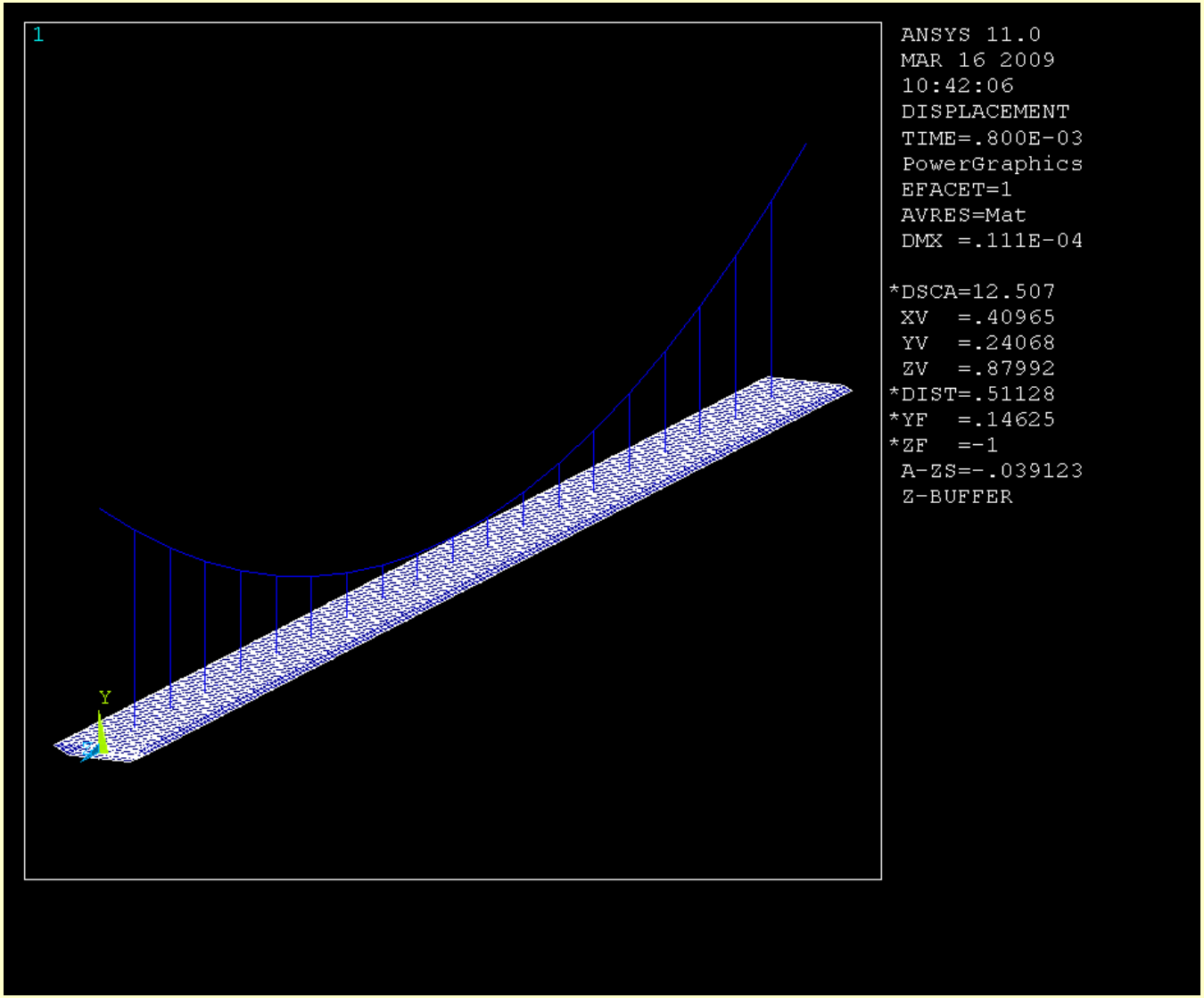


3D aeroelastic bridge model

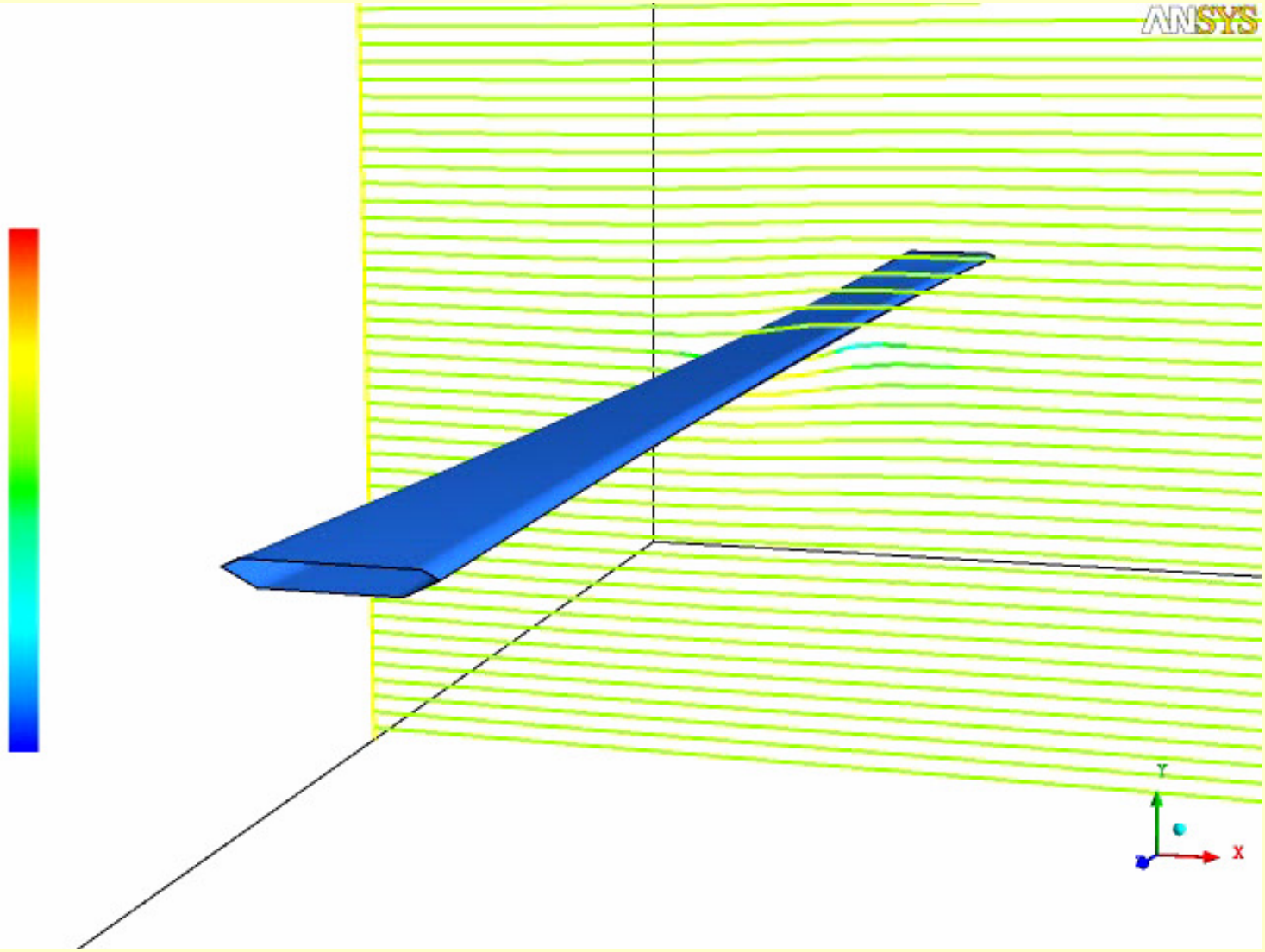
- CFD mesh



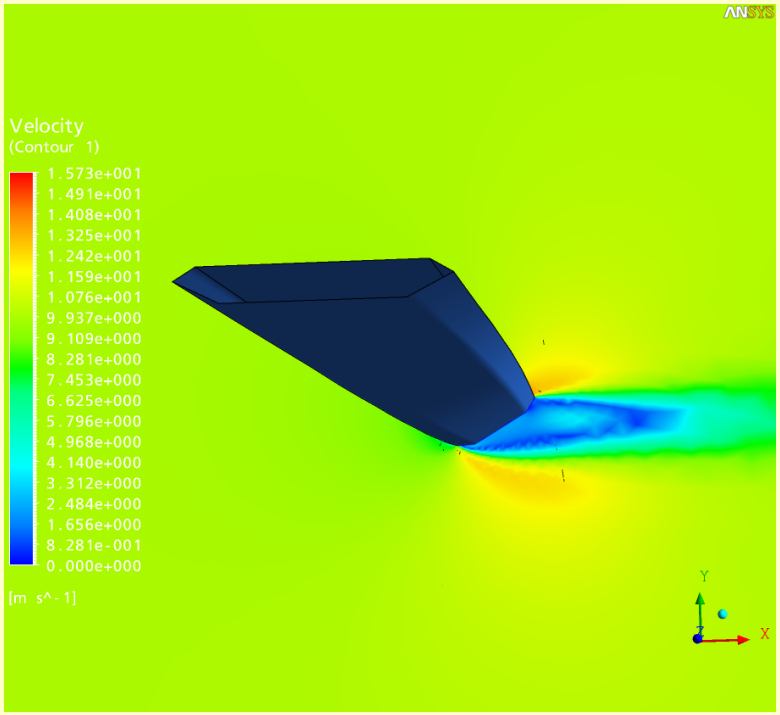
3D aeroelastic bridge model

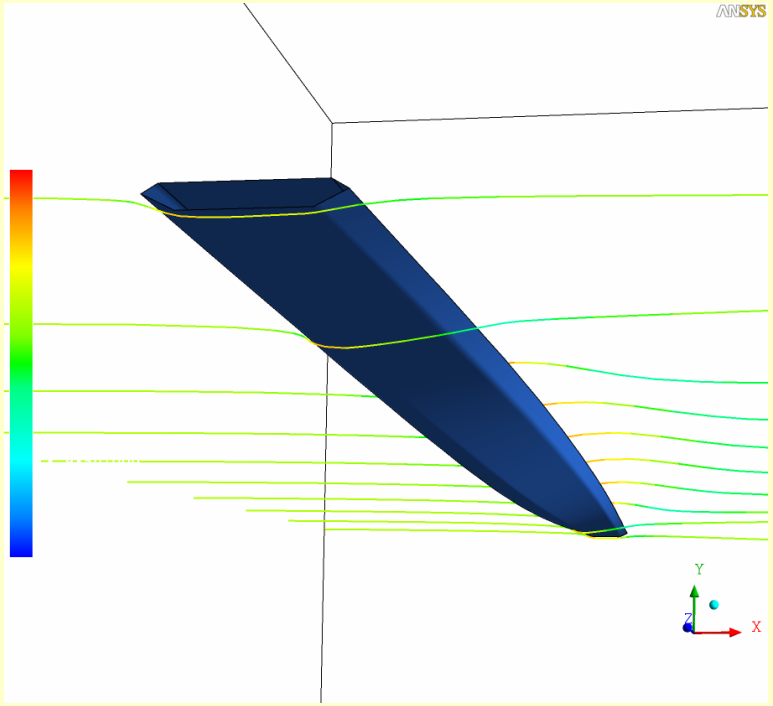


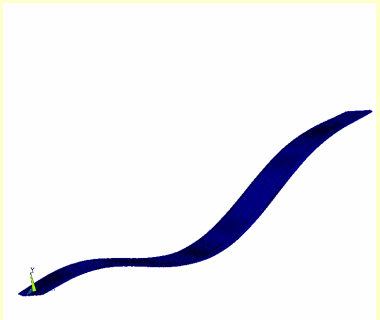
3D aeroelastic bridge model

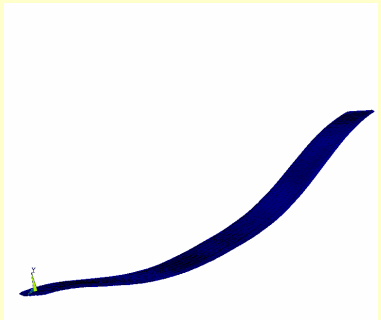


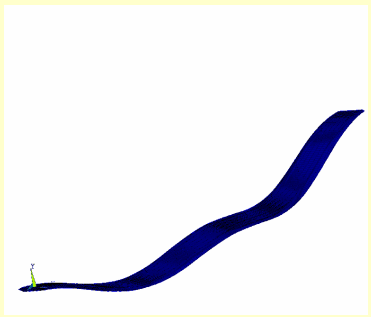
3D aeroelastic bridge model

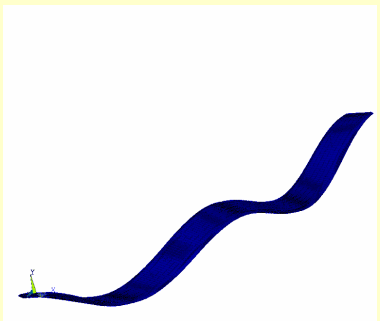












Objectives

- Full aeroelastic wind tunnel model
- Measurements
- Critical wind speed
- More detailed CFD and CSD models
- Validation

Thank you for your attention!