Master of Science Project

Structural mechanics section, Concrete section, Spanbeton

Torsion and shear in ZIP bridges

A very successful bridge type for highway overpasses consists of prestressed concrete girders and a cast-in-place concrete deck (Fig.). In some situations – such as non-perpendicular crossings – considerable torsion moments can occur in such bridges. These torsion moments can be computed in several ways, for example with

- an orthotropic plate model (Scia engineer),
- an isotropic plate model with eccentric beam elements (Scia engineer),
- a model in which girders and deck are modeled by shell elements (Scia engineer),
- a model with volume elements (Ansys),
- a physical nonlinear model with volume elements (Atena 3D).

The advantages and accuracies of these methods are not clear. In addition it is not obvious how to include the torsion moments in the reinforcement design. Depending on the model used different code rules apply. Therefore, the reinforcement result and the design effort can vary considerably between the models.

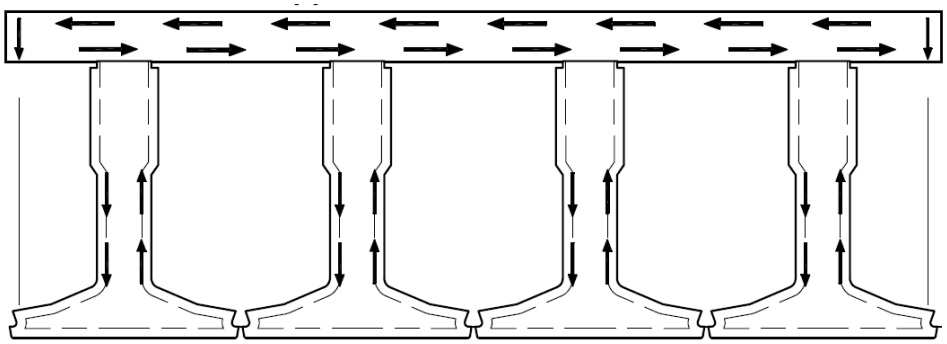

Figure: Cross-section of a ZIP bridge loaded in torsion

Alternatively, the orthotropic plate model can be computed without torsion stiffness at all. In this case the force flow represents an equilibrium system without torsion, for which it is very simple to design reinforcement for the ultimate limit state.

Assignment

- Apply different bridge models and compare the force flow results.
- Design reinforcement (NEN, Eurocode) and compare the reinforcement quantities and design effort.
- Perform three-dimensional nonlinear finite element analyses of bridge parts to check the designed reinforcement for the SLS and ULS.
- Recommend which method to use by the construction industry

The research will be partly conducted at Spanbeton, Koudekerk aan den Rijn

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