

Combined in-plane and out-of-plane shear in concrete shell structures

- to avoid replacements of existing concrete bridges without shear reinforcement

The number of existing concrete bridges, whose design lifetime is soon to be exceeded or where a capacity to carry heavier traffic is desired, is increasing rapidly. When assessing whether the bridges need to be strengthened, replaced, or can be kept in service, it is important to have accurate and well-documented models. As the load-carrying capacity of many of these bridges is governed by a combination of the out-of-plane (transverse) shear and in-plane (longitudinal) shear, a model for combined shear is especially important. However, combined shear has received very little research attention. As a consequence, the approaches in current design guidelines are unsophisticated without foundation in research or experimental evidence and provide a conservative estimate of the shear capacity. This conservatism leads to bridges being unnecessarily replaced or strengthened, resulting in significant CO₂ emissions and excessive usage of natural resources. Therefore, this PhD project aims to establish an accurate model to determine the capacity for the combination of in-plane and out-of-plane shear. Furthermore, the project aims to derive an effective strengthening strategy for concrete bridges subjected to combined shear.

The project includes a large experimental programme that investigates the failure mechanisms and crack kinematics that are the basis for the derivation of the model. The derivation of the model will be conducted by means of the upper bound theorem of the plasticity theory.

Project organisation

This project is a collaboration between SDU Structures and COWI A/S.

The project will be carried out by PhD fellow Jens Skovgaard Larsen. The project is supervised by Associate Professor dr. Henrik Brøner Jørgensen from SDU, and from COWI A/S, the project is supervised by Associate Technical Director dr. Søren Gustenhoff Hansen (main supervisor) and Technical Director Lars Lundorf Nielsen (co-supervisor).

Time schedule

The project will be carried out in the period between the 15th of February 2023 and the 14th of February 2026.