Master thesis proposal, Concrete Structures / Material and Computational Mechanics

Textile reinforced concrete: linking experiments through finite element analyses

Background:

Textile Reinforced Concrete (TRC) is a promising alternative to other more traditional construction materials and methods, offering the possibility to build corrosion resistant, slender, lightweight, modular, and freeform structures with relatively small environmental impact. It can be used for both new structures and strengthening of existing. The textile reinforcement commonly consists of two-dimensional open textile meshes, with spacing 1-5 cm, combined with fine grain concrete. TRC resembles fibre reinforced concrete as both include fibres more distributed in the concrete matrix compared to traditionally reinforced concrete structures; however, in TRC, the fibres are bundled and can thus be positioned considering the principal loading direction, which gives more effective use of the fibres. This resembles the use of traditional reinforcement. Thus, TRC combines the benefits of both traditional reinforcement and fibre reinforced concrete.

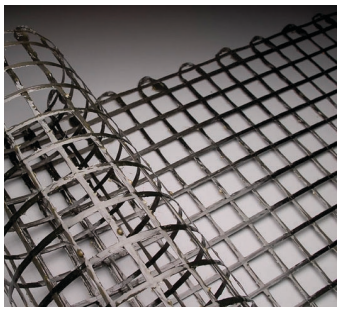
In earlier thesis projects, experimental methods have been developed to characterise the structural behaviour of TRC: four-point bending tests on TRC plates, pull-out, and tensile tests. A smaller test series will be repeated late autumn 2020.

Aim:

The aim is to develop modelling methods for TRC further. More in detail, to link the results from the experiments to each other in nonlinear finite element analyses. The possibility to apply earlier developed multiscale methods will be investigated, and depending on the interest of the students, further developed.

Method:

The first step is to develop modelling of TRC; resolving concrete cracking, interfilament slip in the textile yarns and interaction between the textile yarns and the adjacent concrete. Next, to calibrate the developed modelling by pull-out and tensile tests, and apply it to models of the TRC plates. Depending on the interest of the students, the last step can be done with one-scale (with full resolution) or two-scale models (FE^2). The numerical implementation can be carried out in, e.g., Matlab, OOFEM or Diana, depending on the experience /interest of the candidates.



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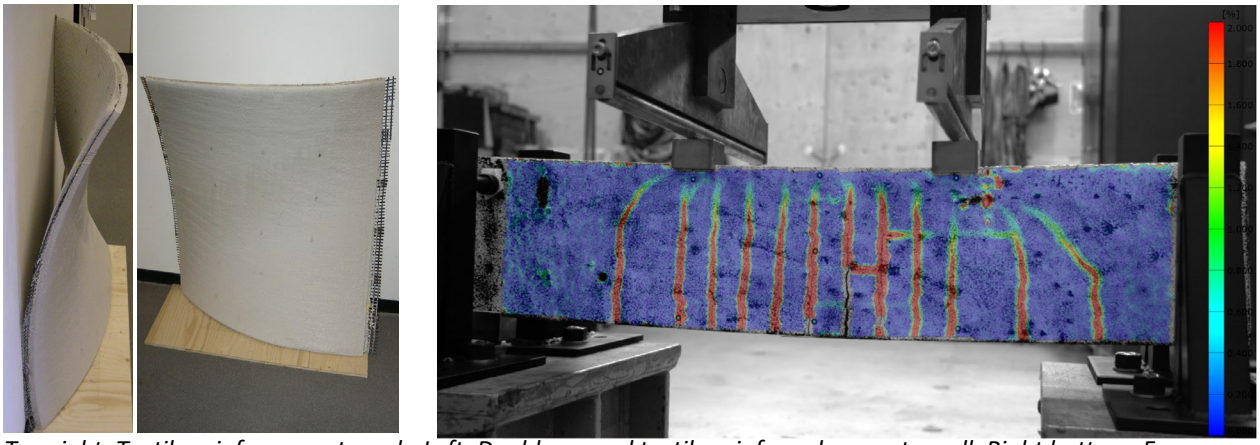

Top right: Textile reinforcement mesh. Left: Double-curved textile reinforced concrete wall. Right bottom: Four-point bending test of a thin textile reinforced plate loaded as a deep beam. The measured strain field is shown in contour plot.