Strength of cracked concrete - shear behaviour of arch-shaped members

This industrial Ph.D. project "Strength of cracked concrete - shear behaviour of arch-shaped members" with the candidate Jens-Christian Kragh-Poulsen is carried out in cooperation between COWI's Marine & Foundation Engineering department, (Jens Mejer Frederiksen and Björn Frettlöhr), DTU Civil Engineering, (Linh Cao Hoang) and Aarhus University, School of Engineering, (Lars German Hagsten and Jakob Fisker). The three-year project will run from 2017 to 2020.

Arch-shaped concrete structures are commonly used in civil and marine structures, e.g. caissons, silos, and tunnels. However, shear capacity formulas for non-shear reinforced concrete in standards and guidelines are based on empirical formulas, which are calibrated on straight members. Those formulas are frequently used for arch-shaped members despite the fact that they are not necessarily applicable to such structures. Moreover, they are not necessarily applicable to major (thick) structures.

At present, scanty experimental data is available on the strength and behaviour of reinforced arch-shaped members without shear reinforcement subject to shear and bending. Furthermore, knowledge of the influence of crack width and composition of concrete on shear resistance of all types of structural members is insufficient. The project aims at improving our understanding of shear strength of arch-shaped members and the strength of cracked concrete.

The objectives of the project are:

1) Quantification of the impact of the grain-size distribution curve and initial crack width on the shear strength.
2) Investigation of the behaviour of cracked concrete structures and a better description of the strength of cracked concrete
3) Experimental investigation and analysis of the shear resistance of non-shear reinforced arch-shaped members.
4) Initiation of investigation of the shear fatigue behaviour of arch-shaped members.

Since the project concerns a subject with a potential for optimisation in the construction industry, it has a general technical and scientific interest. If the project succeeds, it will provide knowledge to improve the documentation of the shear carrying capacity of non-shear reinforced straight and arch-shaped members.

The success criteria may be divided into:

1) Improved knowledge to optimise the geometry of concrete structures and minimize the amount of reinforcement.
2) Better predictions of shear capacity of arch-shaped members without shear reinforcement. This will benefit the design of structures such as gravity-based foundations for offshore wind turbines and breakwater caissons.
3) Better predictions of expected lifetime. This knowledge may also be used to assess the lifetime of existing concrete structures.