Cracking risk analysis of the Bjøvika submerged tunnel at hardening phase

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The present paper is based on part of the research results of the Norwegian project NOR-CRACK, and is focused on how to determine the early age cracking risk of concrete structure by using the Finite Element Program Diana. A concrete tunnel is built in Bjørvika in Oslo, Norway. The total length of the tunnel is about 1110 meters, and among them 675 meter is submerged under the seawater. The cracking of concrete tunnel during the hardening phase will be a critical issue, because it will not only seriously compromise the structure integrity, but also the durability and long-term service life.

The cracking risks of five types of concretes, including one typical Norwegian bridge concrete, two concretes with 40%, and 60% blast furnace slag, and two concretes with 40%, and 60% fly ash, were analyzed. A comprehensive experimental test program was performed at NTNU to determine the material properties. The test data of material properties was first used to calibrate the stress development in the TSTM, and then the will-documented material models were applied in 3-D numerical analysis to predict temperature, strain and stress developments of the concrete tunnel.

The analysis results showed that the concrete with 60% FA has both the lowest maximum temperature (42.2°C) and the lowest stress/strength ratio (the cracking index) for the outer wall which will experiences the water pressure.