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Low Cycle Fatigue of Ultra High Performance Concrete

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Abstract

The development of concretes with higher compressive strengths and high ductility provides the ability to construct slender and lightweight concrete structures. These differ from the more traditional concrete structures in the way that a reduced dead weight makes the structures more susceptible to dynamic loads. The development of Ultra High Performance Fiber Reinforced Concrete (UHPFRC) with high tensile and compressive strength combined with an extreme high fracture energy makes it possible to make e.g. Wind Turbine Towers of heights over 200 m. An example of such a tower is the Conelto tower [1].
In this work, beams in three point bending have been performed in a newly developed test set-up. Both static and fatigue loading have been performed. Due to the high fatigue, resistance of the material focus has been on low cycle fatigue. In the tests, it is seen that the descending branch of the static experiments can be correlated to the fatigue life.
A previous developed analytical model for predicting the complete load deflection curves of plan reinforced beams has been extended to cyclic loading [2]. In the model, cyclic loading follows the model suggested by Yankelevsky, [3]. This is done by implementing a cyclic loop on the constitutive relation and thereby calculating a new stress distribution per cycle including crack growth.

By adapting the failure criterion seen in the experiments, an estimated relation between the inclinations of the cyclic loop and the stress level, it is possible to estimate the fatigue life of the beams and calculate an S-N curve with a good correlation to the experimental results.

[1] "Conelto - concrete element towers" available at http://www.conelto.dk/ (accessed 31. of august 2016)
[2] Ulfkjær, Jens Peder; Krenk, Steen and Brinker, Rune 1992, "Analytical Model for Fictitious Crack Propagation in Concrete Beams", Journal of Engineering Mechanics, No 34, vol R9206.
[3] Yankelevsky, David Z; Reinhardt, Hans W. 1987, "Response of Plain Concrete to Cyclic Tension", ACI Materials Journal, September-October 1987, No. 84-M37.