Corrosion resistance of steel fibre reinforced concrete structures

A theoretical and experimental study on the durability of carbon-steel fibre reinforced concrete structures exposed to chlorides and carbon dioxide.

Carbon steel fibre reinforced concrete (SFRC) is widely utilized in the civil engineering industry. The use of SFRC without reinforcement bars in compressed elements, such as segmental linings for bored tunnels, is an attractive solution for the precast industry, as the homogeneity of the material simplifies the production processes and reduces production defects.

Former research indicates an improved durability of SFRC exposed to corrosive environments compared with traditional reinforcement, as well as a good chemical stability of commercial carbon-steel fibres in chloride contaminated concrete. Yet, the consideration of the steel fibres for the structural verification of SFRC structures exposed to aggressive conditions, is still controversial among a number of international standards and guidelines.

The contrast between the positive scientific results and the concern of some regulators, points out uncertainty regarding the degradation processes of steel fibres and its impacts on the long-term mechanical properties of SFRC elements exposed to chlorides. These discrepancies restrain the development of new optimized designs for civil infrastructure, hindering the commercial development of manufacturers and engineering consultants.

Therefore, the aim of this project is to evaluate the durability of precast SFRC structures exposed to aggressive corroding environments, and compare its long-term mechanical behaviour with conventional reinforcement systems. The project will focus on identifying the microscopic changes occurring on corroding steel fibres in concrete and quantifying the risks of fibre corrosion and its impact on the mechanical properties of prefabricated structures exposed to chlorides and carbon dioxide.

The project is led by DTU-Byg (Henrik Stang, Gregor Fischer and Alexander Michel) and COWI A/S (Carola Edvardsen and Anders Solgaard). The commercial side of the project is strengthened with the incorporation of KrampeHarex GmbH (Stephan Müller) as an experienced steel fibre producer and VejDirektoratet (Barbara Boesen MacAulay) as civil infrastructure commissioner. The academic area integrates VIA University College (Torben Brøchner) as partner.

The knowledge established in the project will support the management of existing and new projects, reinforcing COWI as a world-leading expert in durability of concrete infrastructure. Notwithstanding the close collaboration with the two commercial partners, KrampeHarex GmbH and VejDirektoratet, will provide a wider perspective to study the durability limits of SFRC through the whole building process: design, production and commissioning.

The identification of the specific deterioration mechanisms affecting SFRC structures undergoing fibre corrosion will provide valuable input for service-life assessment of new concrete structures with SFRC.