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Project Title: The risk of hydrogen embrittlement in prestressed and post-tensioned structures due to electrochemical chloride extraction

Synopsis

Over the past 15 years the electrochemical chloride extraction (ECE) has become an established method for the treatment of chloride contaminated reinforced concrete structures. A great proportion of structures is constructed with prestressed and post-tensioned elements. Studies in the area of cathodic protection have shown the danger of embrittlement due to this type of repair. Research on concrete structures containing high strength steel corroborated those results.

The aim of the programme is to determine the extent of hydrogen embrittlement during ECE. 80 Small 100mm-cube specimens with three different types of high tensile prestressing steels will be tested. The steel will have tensile strengths of 1230, 1570 and 1860 N/mm^2. The treatment duration will be 800, 1500 and 2000 Amp-hours. The treatment rate will be 1, 2.5 and 5 A/m^2. Total treatments of 800, 1500 and 2000 Amp-Hours will also be investigated. Additionally to the small samples, 20 large specimens 2.5m x 0.5m x 0.2m with post-tensioned cable stressed to 0.45 and 0.6 of the ultimate tensile strength will also be treated to 800, 1500 and 2000 Amp. The specimens will have cast in chloride levels of 1,2 and 3 percent of the cement content. Results of the laboratory investigations to be incorporated in the working computational model, developed at the University of Ulster. The computational model incorporates several unique features and is accurately simulating many phenomena associated with ECE. It is based on a model for cathodic protection developed as part of the Strategic Highways Research Programme. ECE is treated as a combined electrical and chemical phenomenon using both diffusion and mitigation terms.

It will be necessary to provide guidance and set limits for any possible safe treatment of prestressed and post-tensioned structures due to the risk of hydrogen embrittlement. Currently the only repair option for chloride contaminated prestressed and post-tensioned concrete elements is the total replacement of the structure since concrete replacement is not practical and the impact of ECE not proven. The application of ECE for treatment of prestressed and post-tensioned structures would be therefore of considerable economic benefits.