Modeling of severely corroded reinforced concrete beam with anchorage failure

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ABSTRACT

Corrosion of steel reinforcement is one of the most common causes of deterioration of reinforced concrete. Some existing concrete structures like parking garages, harbours and bridges show significant corrosion; it is not uncommon that cover spalling has occurred. This is a practically important problem, both for assessment of the residual load-carrying capacity of corroded structures, but also for lifetime design of new structures. A rather common approach is to assume that the lifetime is ended when corrosion is initiated. However, if the structural effects of corrosion are not checked in the lifetime design, initiation can only be allowed to occur with a very small probability. This will lead to unreasonably large concrete covers. To be able to use covers of more practical size, it is often necessary to include the structural effects of corrosion in the lifetime design. Hence, there is a need for models of how corrosion affects the structure.

Earlier research within this field by the author has identified the main uncertainties in the models and methods available today. One uncertainty is the remaining bond capacity in concrete structures with severely corroded reinforcement, especially where the cover has totally spalled off. This uncertainty is further investigated through finite element analysis of a concrete beam with anchorage failure. In the FE model of the beam, both concrete and main reinforcement were modeled with solid elements and the stirrups were embedded in concrete elements. In analysis, the concrete was modeled with a constitutive model based on non-linear fracture mechanics using a smeared rotating crack model. Interface elements were used at the surface between the bar and the concrete, which included a frictional bond model and a corrosion model. The volume increase of the corrosion products was modeled in the corrosion layer. This was done in Diana by a user subroutine. The results from the FE model were compared with the experimental results and the involved mechanism contributing to the residual bond capacity was discussed.

- 2D (surface) interface elements
- Bond and corrosion model developed by Lundgren (2005)