User-supplied subroutines developed for use in Diana

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In several research projects at Chalmers, user-supplied subroutines for Diana have been developed and used. This is a brief overview of those subroutines, and what they can be used for.

The subroutines representing most of our efforts deal with the interaction between reinforcement and concrete. They are intended to be used in analyses where both the reinforcement bars and the concrete are modelled with solid elements, and surface interface elements are used in between. Thus, these models are meant for use in analyses of anchorage regions, such as end anchorage or splices, where the bond between the reinforcement and the concrete is important. In the subroutine developed first, a model based on friction, with an upper limit due to compressive failure of the concrete, describes the interaction between the reinforcement and the concrete, see Lundgren (2005a). We have also developed a model of corrosion of reinforcement, where the swelling effects and mechanical properties of the corrosion products are included, see Lundgren (2005b). Later on, this model was further developed to include transport of corrosion products through cracks, see Zandi Hanjari *et al.* (2011). Thus, by the use of these subroutines, it is possible to model the structural effects of a corrosion process, especially in anchorage regions.

Another subroutine dealing with bond is meant for use in line interface elements between reinforcement modelled with truss or beam elements and concrete. With this subroutine, a bond-slip relation is given as input, and if the reinforcement starts yielding, the loss of bond at yielding is modelled in a simplified way as suggested by Engström (1992). This can be of importance if e.g. the deformation capacity of a beam is in question. Finally, we have two smaller subroutines that vary 1) concrete strength and 2) bond strength depending on the element age.

References

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