Non-linear finite element analysis of steel fibre reinforced concrete in combination with conventional reinforcement

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In this study the modelling of steel fibre reinforced concrete is described. First, three beams, with varying fibre contents, were tested in four point bending and compared with results from FE-analysis. The beams were part of a larger experimental programme where relevant properties were investigated. FE-modelling was performed using a two dimensional plane stress model. Subsequently to these tests, fibre reinforced concrete slabs have been tested and different approaches for modelling have been studied.

Modelling the reinforced beams, concrete was represented by four-node quadrilateral isoperimetric plane stress elements. These elements were given a multi-linear material tensile behaviour determined from experiments, while utilizing the built-in function for elasto ideal-plastic compressive behaviour. The reinforcement was modelled by straight 2-point truss elements connected to the concrete by two-dimensional interface elements providing the bond-slip properties. The multi-linear bond-slip model was established through pull-out tests. As an alternative, analyses were also performed taking into account that the bond stress will drop when the reinforcement yields, in accordance with Engström (1992). General agreement between experiments and FE-analyses was obtained with regard to load-displacement behaviour. By observing the crack patterns, both from FE-analysis and experiments, it can be concluded that the general behaviour agreed; however, in the analyses not all cracks were fully localized. A higher degree of crack localization was obtained when the bond loss at yielding was included.

Concerning the slabs, a wide approach to modelling have been used studying the effect of modelling choice e.g. element type, material model complexity and linearity/non-linearity. The study features variations from linear shell models to non-linear three dimensional solid models, exploring the benefits of increased model detailing.

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References

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