CONSHEAR model from UPC: A shear-sensitive fibre beam formulation for nonlinear, time-dependent and phased analysis of RC structures.

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Abstract

In traditional fibre beam models, the Navier-Bernoulli plane section theory and the use of a fibre sectional discretization combined with adequate uniaxial constitutive laws, allows fairly accurate analyses of flexural dominant RC frames to be obtained [1]. When tangential forces are applied, the plane section hypothesis is no longer valid due to the appearance of distortion. In attempting to extend frame models to loading conditions that include shear effects, several theories for the sectional response under tangential and normal forces were developed with different levels of complexity and computational demanding [2].

The 1D fibre beam model presented in this communication accounts for axial force-bending-shear force interactions in a computationally efficient manner and allows for the nonlinear, time-dependent and strengthening analysis of shear critical concrete frame structures. The fundamentals of the model are represented in Figure 1 concerning different levels of analysis: structure, element, section and fibre.

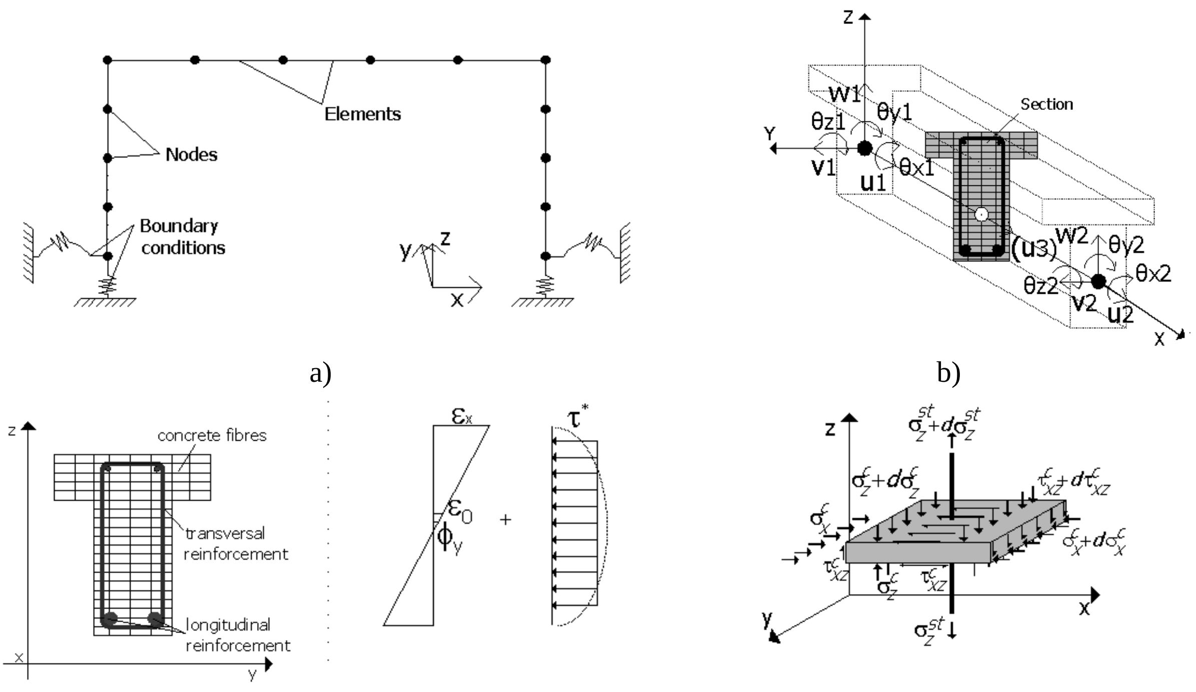

Figure 1. Fundamentals of the formulation of the flexural and shear fibre beam models: a) structural level b) element level c) section level d) fibre level

The Timoshenko beam theory is linked with a shear-sensitive sectional model that associates the Bernoulli-Navier plane section theory with an assumption of fixed shear stress pattern. Cracking is simulated through the smeared and rotating crack approach. The effects of shear and its interaction with normal forces are accounted in all levels of damage, from SLS and ULS. This allows including the effects of shear in deflections, strains in concrete and reinforcement and cracking behaviour in addiction to capture shear failure mechanisms. The model acts as an efficient alternative to 2D and 3D nonlinear FE models with much less degrees of freedom and parameters to be used in practical engineering.

The model, which detailed description can be found in [3, 4], was applied to several different studies of the concrete structural behaviour, including time-dependent response [5], strengthening [6, 7], early age effects [8] and assessment of existing structures [9, 10]. The model was recently used in the prediction of the experimental results of the large T-shaped prestressed concrete girders tested in TU Delft in 2014, to participate in the DIANA International Contest.

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