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FEM analysis of reinforced concrete decks with compressive membrane action

Many bridges have to be upgraded because they are subjected to higher traffic loads than originally designed for. However, by introducing a so-called 'compressive membrane action' an additional load bearing mechanism will be activated. This mechanism has not been used up till now in the Netherlands.

First, the phenomenon has been explained and two different methods, based on the theory of plasticity and equilibrium equations, were compared. The method based on equilibrium equations was selected as the most reliable method. Second, the experimentally found results were compared with theoretical predictions and evaluated. Particularly, the punching shear and flexural capacity based on different codes were evaluated.

Third, advanced non linear finite element calculations were performed with different models. In order to select the model which represents the compressive membrane action accurately an analysis with five different FEM models (beam, plane stress, curved shell, axi-symmetric and solids) were performed and the results compared. To analyse the punching behaviour of the reinforced deck two finite element models i.e. 3D solids and axi-symmetric were used.

Finally, a practical example of a common reinforced deck was analysed and it was found that this deck fulfilled all requirements regardless the fact that the deck thickness was 70 mm smaller (160 mm instead of 230 mm) than applied nowadays.