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Fibre Reinforced Concrete Slab from DYNARDO

Dynardo markets software (multiPlas) which acts as a non-linear material library for the ANSYS suite of finite element software. In their publicity documentation they present a number of problems for concrete including the flat slab shown in figure 1.
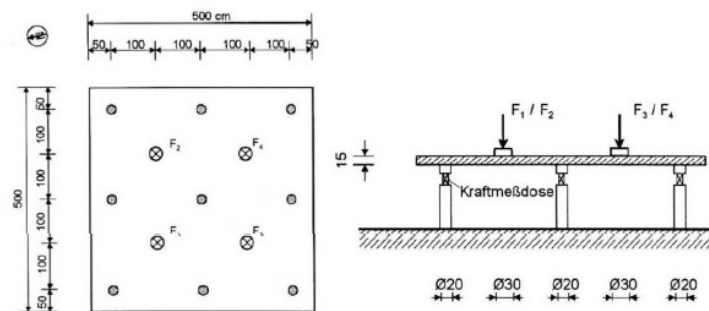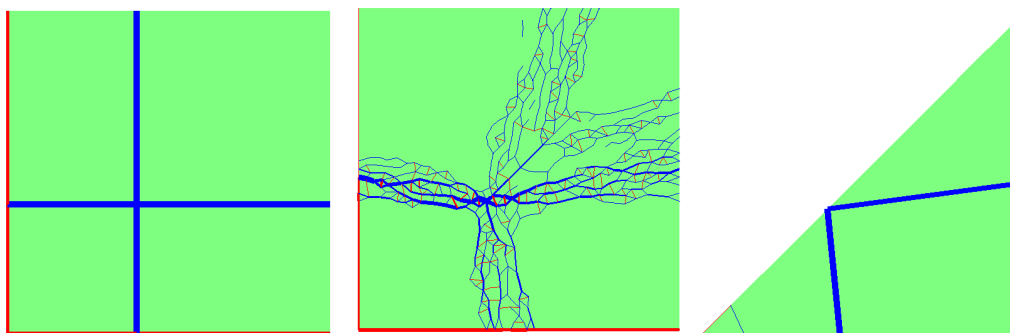

Figure 1: Dynardo's Flat Slab Problem

This problem has been modelled in RMA's limit analysis software EFE using a Nielsen biconic yield criterion and a moment capacity of 100kNm/m. The point loads are assumed equal and taken as 10kN each.

(a) Quarter (Structured)   (b) Quarter (Unstructured)   (c) Eighth (Optimised)

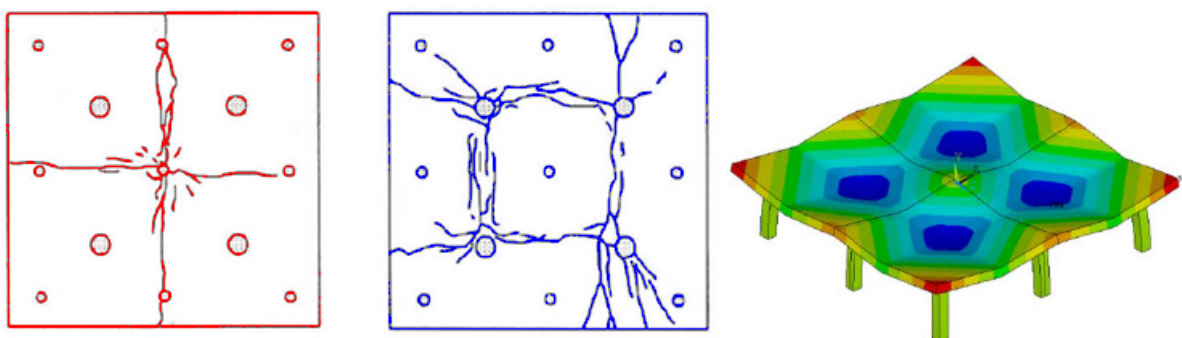**Figure 2**: Yield Line Patterns (Red – Hogging, Blue – Sagging)

Figure 3: Crack Patterns (Red – Top, Blue – Bottom) and Deflected Shape

The yield line patterns for three EFE models are shown in figure 2. The quarter structured model gives a good first impression of the collapse mechanism and the quarter unstructured mesh indicates that the sagging yield lines are not actually parallel to the sides of the slab. This knowledge is used in the eighth model in which the positions of the ends of the sagging yield lines on the sides of the slab have been optimised. Figure 3 shows the experimental crack patterns together with the ANSYS solution at collapse and these correlate reasonably well with the results from EFE.

The load factor achieved using EFE was in the order of 70 so that the collapse load is 70x10kN=70kN for the moment capacity of 100kNm/m. It would be good to correlate these quantities with the results produced by Dynardo.

Figure 4 shows the utilisation for the three EFE models. The utilisation illustrates the degree to which the material is utilised in terms of the moment compared to the collapse moment. In the figure red indicates full utilisation whereas blue indicates under-utilised material.
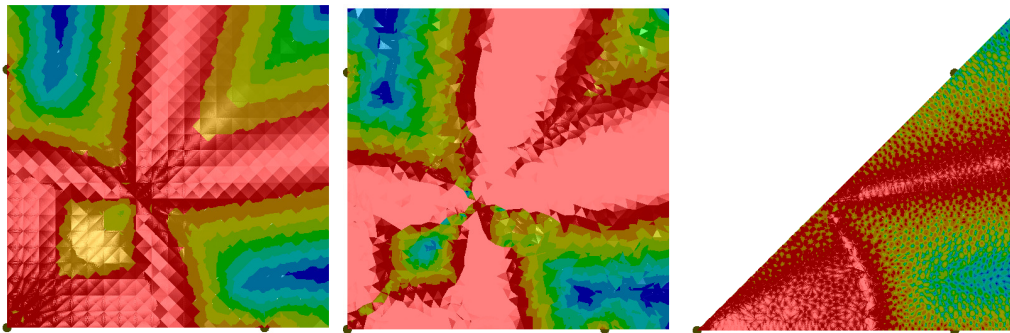

Figure 4: Utilisation for the three EFE Models

The principal moments for the eighth model are shown in figure 5. The sagging moments show that the sagging line nearer to the centre is not actually straight and that there is a fan mechanism centred about the central support – the corresponding hogging region, presumably with radial hogging yield lines, is seen in the hogging principal moments.
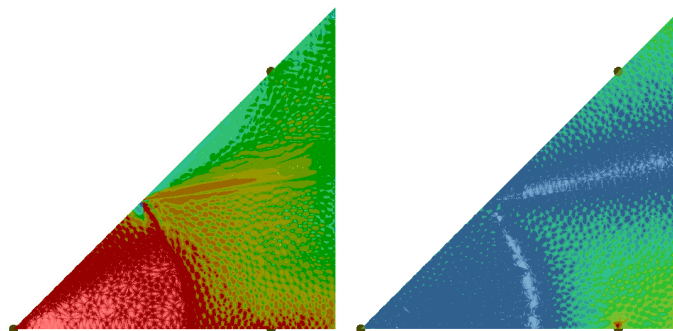

Figure 5: Principal Moments (Hogging and Sagging) for the Eighth EFE Model