NAFEMS Benchmark Challenge

The Benchmark Challenge was launched the October 2014 edition of Benchmark and on the NAFEMS Challenge blog. The concept behind this initiative is to provide seemingly simply problems for readers to consider. The challenges will typically contain in interesting 'twist' which is intended to be thought-provoking and to provide an opportunity for learning.

The first challenge involved finding the 'Stress at the Centre of a Square Plate with Linear Boundary Tractions' and there has been a great response so far. As this is the first challenge the deadline for submission of responses has been extended to the end of January. So if you've not yet had a go at this then there are still a few weeks to get your submission in. If you need a further incentive over and above an interesting challenge then prizes are being offered for the best responses!

This second challenge involves an assessment of the collapse of a floor plate for the owner of a building. Published solutions for this problem vary widely and the challenge is to use your engineering skills and FE software tools to provide advice to the owner as to which solution to use. Why not challenge yourself and submit a response?

challenge@nafems.org

nafems.org/challenge

NBC02: Assessment of a Simply Supported Plate with Uniformly Distributed Load

A building has a floor opening that has been covered by a durbar plate with a yield stress of 275MPa. The owner has been instructed by his insurers that for safety the load carrying capacity of the plate needs to be assessed. The owner has calculated (possibly unrealistically but certainly conservatively) that if 120 people each weighing 100kg squeeze onto the plate then it must be able to cope with 100kN/m². He has found, in the Steel Designers' Manual, that the plate should be able to withstand 103kN/m². This is rather close to the required load and looking in Roark's Formulas for Stress and Strain he finds that the collapse load is more like 211kN/m² which he feels does provide an adequate factor of safety. However, with the huge difference between the two published values he has asked you to provide him with an independent assessment of the load carrying capacity of the plate.
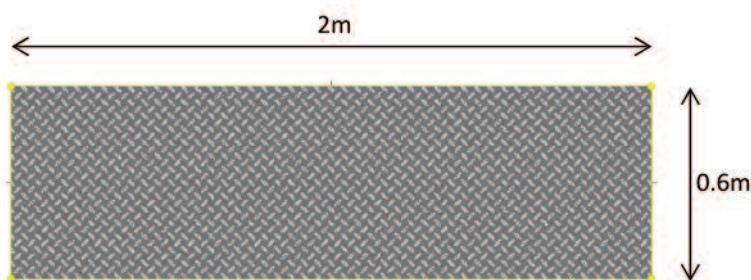
The Challenge

As an experienced engineer you realise that under increasing load the plate will eventually reach first yield after which the stress will redistribute until the final collapse load is reached. You will appreciate that the steel will have some work hardening capability and that if transverse displacements are considered then some membrane action will occur. However, opting for simplicity and realising that ignoring these two strength enhancing phenomena will lead to a degree of conservatism in your assessment, you decide that this is a limit analysis problem in which the flexural strength of the plate governs collapse.

Unless you have specialist limit analysis software you will decide to tackle this as an incremental non-linear plastic problem with a bi-linear stress/strain curve and a von Mises yield criterion.

Please carry out an assessment of the strength of the plate and provide your best estimate of the actual collapse load together with evidence of the verification you have conducted sufficient to convince the owner and his risk averse insurer.

Figure 1: Simply Supported Steel Plate 2mX0.6mX0.01m) under UDL