



NAFEMS *The NAFEMS Benchmark Challenge*

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/m^2 . He has found, in the *Steel Designers' Manual*, that the plate should be able to withstand 103kN/m^2 . 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/m^2 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.

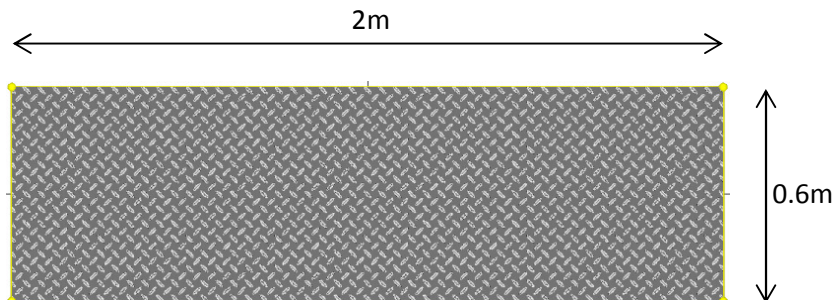


Figure 1: Simply Supported Steel Plate (2mX0.6mX0.01m) under UDL