Study on the Strength of Thin Perforated Plate on Dimple Supports Subject to High-Pressure Loadings

M Mohammadi-Amin* and U Krühne

Technical University of Denmark
2800 Kgs. Lyngby, Denmark
mmoam@kt.dtu.dk

Abstract

Perforated plates are widely used in power generating plants and chemical processing systems as components in heat exchangers and steam generators. The integrity of these plates under different operational conditions, such as high-pressure loadings is vital to the safety of plant [1]. Therefore, various experimental test and numerical modeling are necessary to ensure about the strength and stability of such structures in combination to other components of system, e.g. supports, attachments, and other panels. As the computational tools are more efficient in compare to experiments, Finite Element Analysis (FEA) is mainly used to investigate the structural performance on a range of conditions [2]. This paper aims at studying the effect of perforations on the deflections of a steel sheet supporting by rigid dimple pattern, via three-dimensional FEA (ANSYS Mechanical). It is obvious that the presence of holes in the steel sheets certainly affects the mechanical properties, however the results of simulations show that precise locating of holes on low-stress regions will affect the strength of plate negligibly. To find those low-stress areas, FEA simulations have been carried out using solid and shell structure models considering normal pressure loadings up to 200 Bar. Even with 10% more deformation in shell model, nearly similar stress distribution for both models are observed that shows some low-stress regions in between dimple picks for possible perforations. Maximum stress regions are detected around dimple picks where the initiation of plastic deformations will occur (at 58 Bar). As shown in Figure 1(a), the strength of perforated plate placed on a dimple plate can be maintained nearly same as a non-perforated plate if the location of holes are exactly on low-stress regions between dimples, where indicated by arrows in Figure 1(b).

Keywords: Finite Element Analysis (FEA), High-Pressure Loading, Perforated Plate, Dimple Pattern, Rigid Support.

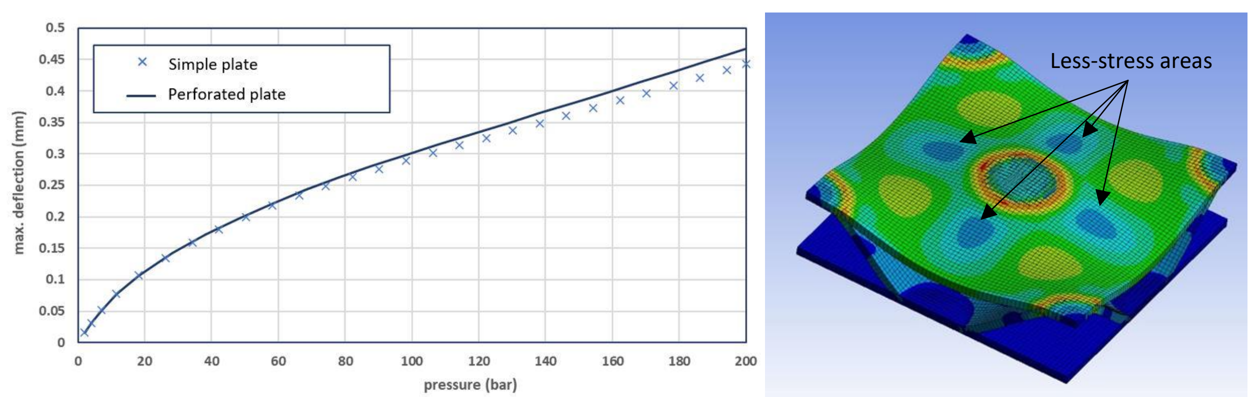

Figure 1. (a) Maximum total deflection vs pressure loading up to 200 bar (b) Stress distribution - shell structure model.

References

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