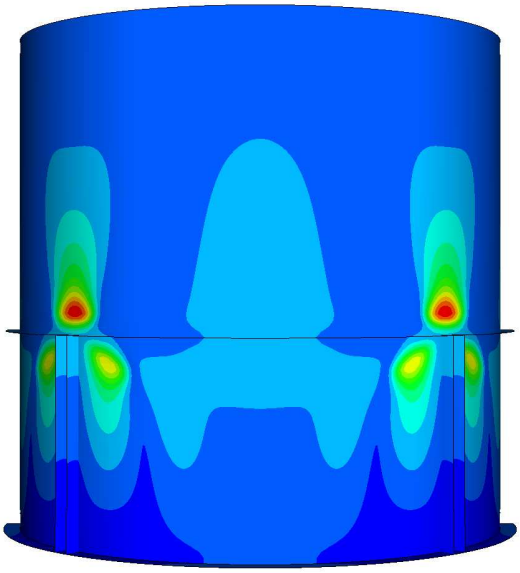
UGent LMO Project sheet

Research project : Stiffened steel cylinders on local supports

Image :



Researchers involved :
- JANSSEUNE, Arne; (PhD researcher)
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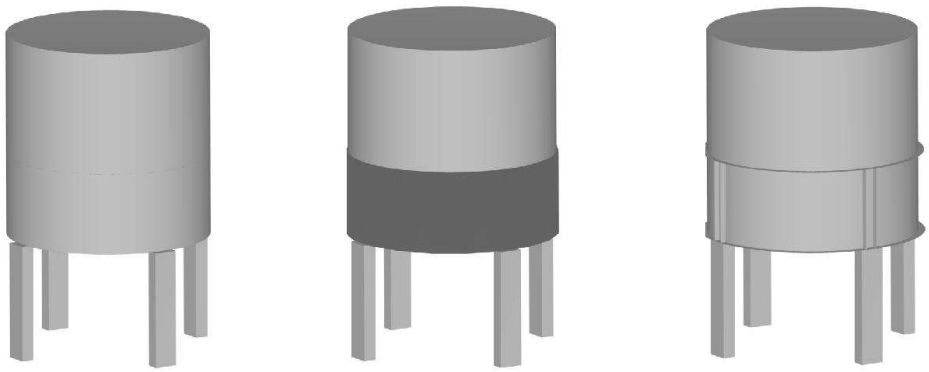
Time span : 2001 – ongoing

Description :

Cylindrical shells on local supports appear in steel silos. The main part of this structure is the cylindrical vessel that rests upon a limited number of supporting columns. This discrete support leads to a local force introduction in the cylinder, entailing axial stress concentrations in the shell wall. These stress concentrations are detrimental to the stability of the structure and structural measures have to be taken in order to prevent the failure of the silo.

In the recent past, a number of possible solutions for the instability problem were investigated. The first studies investigated the necessary thickness for the entire shell wall so that instability was not to be feared (Fig. 1a). These studies led to design rules as the one proposed by Guggenberger et al. In this solution, the stresses in the cylindrical shell are reduced so that the danger of instability disappears.

However, it should be noted that the stresses are only elevated in small regions in the cylinder wall above the supports and therefore, it is not necessary to increase the wall thickness over the entire height of the silo. This consideration led to the second solution for the instability problem. This solution consists in making the lower part of the shell wall 50% thicker than the upper part of the cylinder (Fig. 1b).



(a) (b) (c)

Fig. 1. A locally supported cylinder (a) Unstiffened; (b) Bottom course wall thickening; (c) With longitudinal stiffeners and ring stiffeners.

Although the material that is needed for this second solution is already reduced, even more economical alternatives are possible. A third solution is shown in Fig. 1c. Here the extra material is added as stiffeners in the regions where the stresses are elevated, i.e. the regions just above the local supports. The cylinder is stiffened with two longitudinal stiffeners above each support. These stiffeners have a limited length and ring stiffeners are placed above and below them. It is the goal of the present study to develop a design rule for these stiffened cylinders on local supports. For this purpose, experiments on scale models will be combined with numerical simulations with the finite element package ABAQUS.

Most important publications :

- VANLAERE, W.; DOERICH, C.; LAGAE, G.; VAN IMPE, R.
  Steel cylinders on local supports with rigid stiffeners
  Proceedings of IASS symposium 2009, 2569-2576.
- VANLAERE, W.; VAN IMPE, R.; LAGAE, G.; DE STRYCKER, M.
  Stringer Stiffened Cylinders on Local Supports – The Plastic Buckling Behavior
  Key Eng Mat 2007: 340-341; 1303-1308.
- VANLAERE, W.; VAN IMPE, R.; LAGAE, G.; MAES T
  Effect of varying the size of flatbar stiffeners on the buckling behavior of thin cylinders on local supports
  Struct Eng Mech 2005: 19(2); 217-230.
- VANLAERE, W.; VAN IMPE, R.; LAGAE, G.; BELIS, J.; BUFFEL, P.; DE BEULE, M
  Inclusion of Real Material Behaviour in the Numerical Model for Stringer Stiffened Cylinders
  Key Eng Mat 2004; 691-696.
- VANLAERE, W.; BELIS, J.; BUFFEL, P.; LAGAE, G.; VAN IMPE, R.
  The Influence of Plasticity on the Local Buckling Behaviour of a Cylinder with Discrete Stringer Stiffeners above Local Supports
  Key Eng Mat 2003: 233-236; 761-766.

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