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Abstract

Comprehensive static and dynamic 3D stability finite element analyses of a cylindrical steel silo composed of corrugated sheets and open thin-walled vertical stiffener profiles were carried out by taking the geometric and material non-linearity into account. The silo was subjected to axisymmetric and non-axisymmetric loads imposed by a bulk solid following Eurocode 1. Theoretical and measured initial geometric imperfections were considered in calculations. The results of non-linear analyses were compared to those according to Eurocode 3. Modifications of the Eurocode formulae were proposed. Some recommendations for the silo engineering design were elaborated.

Keywords: silo stability, finite element method, geometric imperfections, non-linear dynamic analyses, non-linear static analyses, corrugated walls, columns

1. Introduction

Thin-walled metal cylindrical silo shells are vulnerable to buckling failure caused by the wall friction force due to shearing of bulk solids along silo walls. The buckling failures occur particularly during silo eccentric filling or discharge which are unavoidable because of a non-homogeneous nature of bulk solids [1], [2]. As a consequence, non-uniform horizontal wall pressures develop which contribute to undesired meridional bending and a non-symmetric distribution of wall compressive forces. The non-symmetry of pressures distribution can also result from local deformations of silo structural elements and global geometric inaccuracies during a silo