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Buckling strength analysis for the construction phase of oil storage tanks

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Cylindrical tanks are used to store energetic materials and products. Wind loads acting on the shell tank may cause

buckling failure, especially during the construction phase of the storing structure. Wind girders are stiffeners mounted onto the shell to increase stiffness and strength of the structure and hence maximize buckling resistance. However, what happens in the construction of the tank, particularly during the mounting of wind girders has never been investigated in a systematic way. This study aims to fill this gap in technical literature. For that purpose, it is analyzed how structural strength changes during mounting intermediate wind girders on the tank shell. Parametric analysis is performed to understand how to reach the desired level of stiffness/strength in the fastest way as possible. In particular, tank shells with different radius-to-thickness ratio and height-to-diameter ratio are considered to evaluate how the buckling resistance changes during the mounting of the wind

girder at shell middle height. Finite element analyses are carried out to assess either linear or nonlinear buckling behavior of the tank structure. The load transfer from shell to wind girders is investigated by correlating the tributary height of the tank with the stiffness ratio between the shell and the wind girders. Stiffness increments are strongly dependent on oil tank geometry and the selected cross section of wind girders.

Interestingly, mounting a partial wind girder can increase the structure's stiffness more than adopting a full wind girder. In summary, it is demonstrated that using partial wind girder is an effective way to reduce material consumption, costs and times of construction as well as to optimize maintenance of large shell storage tanks.

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