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FINITE-ELEMENT MODEL OF A VERTICAL TANK ON A RIGID FOUNDATION

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This study addresses the problem of finite element modeling of a 20,000 m^3 vertical steel tank subjected to static loads. The structure includes a cylindrical wall of total height 17,880 mm and diameter 39,900 mm. The shell thicknesses of the cylindrical wall are determined according to strength and buckling design standards. The geometric model is axisymmetric. The analysis involves the calculation of the stress and strain fields of the cylindrical wall and the contact zone between the flat bottom and the rigid foundation under various combinations of external loads, namely, excessive and hydrostatic pressures. The ANSYS Mechanical software is used for finite element analysis. Three-dimensional SOLID186 and SHELL281 elements are used for axisymmetric modeling of the shell structure in a three-dimensional formulation. To simulate the contact zone, CONTA174 and TARGE170 finite elements are used to model the moving contact surface of the bottom and the fixed surface of the rigid foundation, respectively. The model is verified by comparing the radial displacements calculated numerically and analytically. The discrepancy does not exceed 4%, thus evidencing the adequacy of the finite element model. The contact zone is analyzed for non-standard service conditions, such an excessive internal pressure in the tank (2.5 and 3 kPa compared to 2 kPa under normal conditions). The unilaterally constrained "bottom–foundation" contact zone model allows the bottom to detach from the foundation, thus leading to contact opening. A full detachment occurs under a certain combination of the excessive and the hydrostatic pressure. For certain liquid levels in the tank, the gap decreases, which may be due to a reduced effect of the excessive pressure. This is accompanied by the development of internal detachment caused by the increasing moment from the hydrostatic pressure. The internal detachment increases the bending moment at the wall–bottom junction, which, under certain conditions, may cause plastic deformations followed by the development of an emergency state.

Keywords: *shell, tank, modeling, foundation, pressure, finite element, contact, ANSYS.*

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