Static and Hydrodynamic Study of Tanks From Theory to Application Using Simplified Method and Shell Theory

S

Mourad Belgasmia
https://orcid.org/0000-0003-0224-3658
University of Setif 1, Algeria

INTRODUCTION

Shell theory is well suited to better understanding the behavior of a tank. The shells of revolution, represented by their average surfaces (sphere, spherical cap (cover), cone, truncated cone, cylinder, paraboloid, hyperboloid, etc.) are widely used in the construction of civil engineering (tank, water towers, silos, chimneys, TV towers, reactor enclosures, tunnels, galleries, penstocks, cooling towers, covers, foundations, etc.). They also find many applications (tanks, pressure vessels, boilers, pipes, bottles, aircraft fuselages (hulls), rockets, submarine hulls, etc.) in other very varied fields of the engineering (mechanical, aeronautical, hydraulic, shipbuilding, offshore, chemical, purification, etc.).

The membrane theory gives, for the shells of revolution, easy results to obtain, and good values for the cases of loading of revolution, which is frequent in practice.

Several studies have been made for the calculation of structures containing a liquid, namely the water tower and tank, some are in static domain (Rugonyi et al., 2001) other are in dynamic one (Sezena et al., 2008; Zhou et al., 2009), for different shape, regtangular (Chen et al., 2008; Cheng et al., 2009;Ghaemmaghami et al., 2010), and circular (Khouri et al., 2012).

A Tank is a capacity intended to contain a liquid. It can be placed, partially or totally buried on the ground. A tower, walls or columns can also raise it.

Raised structures for water storage, are usually referred to as water towers. There are three types of tanks: - Buried, Semi-buried,- Elevated or water tower.

These tanks can be built uncovered or, on the contrary, provided with a domed or flat slab cover. Tanks can be simple or complex and formed from several superposed cells.

The plan shape can be any. However, most of the time, small tanks are square or rectangular, but the circular shape is less expensive. When the means of execution allow it, tapered and cylindrical-truncated tank are produced instead of cylindrical one for large volume.

In this chapter, we focus on static analysis using two approaches, one with simplified formulas, the other using shell theory. Another part of the chapter is devoted to hydrodynamic analysis using Houzner's method.

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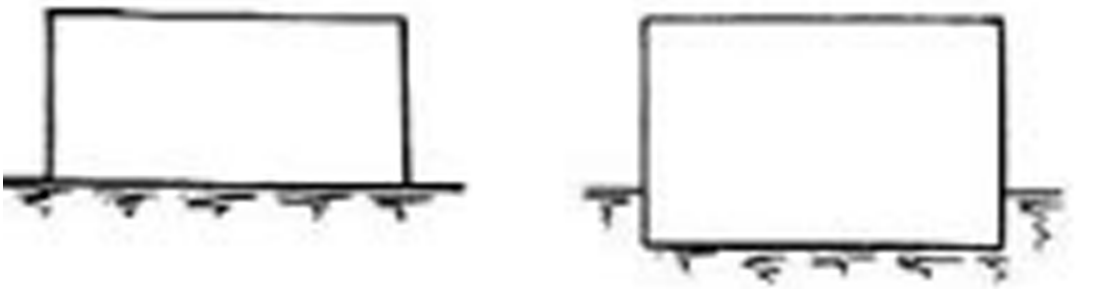
TANK CLASSIFICATION

Tanks can be classified according to:
Position of the tank relative to the ground

- At ground level (or very slightly buried see figure 1), the tank slab is always placed in contact with the ground on lean concrete 5 to 10 cm thick.

Figure 1. Tank at ground level and very little buried



- On columns (slightly raised figure 2) this is the case for swimming pools

Figure 2. Tank slightly raised