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An Investigation of Wind Loading Effects on the Design of Elevated Steel Tanks with Lattice Tower Supporting Structures

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Abstract : In recent times, South Africa has experienced extensive droughts that created the need for reliable small water reservoirs. These reservoirs have comparatively quick fabrication and installation times compared to market alternatives. An elevated water tank has inherent potential energy, resulting in that no additional water pumps are required to sustain water pressure at the outlet point – thus ensuring that, without electricity, a water source is available. The initial construction formwork and the complex geometric shape of concrete towers that requires casting can become time-consuming, rendering steel towers preferable. Reinforced concrete foundations, cast in advance, are required to be of sufficient strength. Thereafter, the prefabricated steel supporting structure and tank, which consist of steel panels, can be assembled and erected on site within a couple of days. Due to the time effectiveness of this system, it has become a popular solution to aid drought-stricken areas. These sites are normally in rural, schools or farmland areas. As these tanks can contain up to 2000kL (approximately 19.62MN) of water, combined with supporting lattice steel structures ranging between 5m and 30m in height, failure of one of the supporting members will result in system failure. Thus, there is a need to gain a comprehensive understanding of the operation conditions because of wind loadings on both the tank and the supporting structure. The aim of the research is to investigate the relationship between the theoretical wind loading on a lattice steel tower in combination with an elevated sectional steel tank, and the current wind loading codes, as applicable to South Africa. The research compares the respective design parameters (both theoretical and wind loading codes) whereby FEA analyses are conducted on the various design solutions. The currently available wind loading codes are not sufficient to design slender cantilever latticed steel towers that support elevated water storage tanks. Numerous factors in the design codes are not comprehensively considered when designing the system as these codes are dependent on various assumptions. Factors that require investigation for the study are; the wind loading angle to the face of the structure that will result in maximum load; the internal structural effects on models with different bracing patterns; the loading influence of the aspect ratio of the tank; and the clearance height of the tank on the structural members. Wind loads, as the variable that results in the highest failure rate of cantilevered lattice steel tower structures, require greater understanding. This study aims to contribute towards the design process of elevated steel tanks with lattice tower supporting structures.

Keywords : aspect ratio, bracing patterns, clearance height, elevated steel tanks, lattice steel tower, wind loads
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