15.7.9 Ground-Supported Storage Tanks for Granular Materials

15.7.9.1 General

The intergranular behavior of the material shall be considered in determining effective mass and load paths, including the following behaviors:

a. Increased lateral pressure (and the resulting hoop stress) due to loss of the intergranular friction of the material during the seismic shaking.
b. Increased hoop stresses generated from temperature changes in the shell after the material has been compacted.
c. Intergranular friction, which can transfer seismic shear directly to the foundation.

15.7.9.2 Lateral Force Determination

The lateral forces for tanks and vessels storing granular materials at grade shall be determined by the requirements and accelerations for short period structures (i.e., S_{DS}).

15.7.9.3 Force Distribution to Shell and Foundation

15.7.9.3.1 Increased Lateral Pressure The increase in lateral pressure on the tank wall shall be added to the static design lateral pressure but shall not be used in the determination of pressure stability effects on the axial buckling strength of the tank shell.

15.7.9.3.2 Effective Mass A portion of a stored granular mass will act with the shell (the effective mass). The effective mass is related to the physical characteristics of the product, the height-to-diameter (H/D) ratio of the tank, and the intensity of the seismic event. The effective mass shall be used to determine the shear and overturning loads resisted by the tank.

15.7.9.3.3 Effective Density The effective density factor (that part of the total stored mass of product that is accelerated by the seismic event) shall be determined in accordance with ACI 313.

15.7.9.3.4 Lateral Sliding For granular storage tanks that have a steel bottom and are supported such that friction at the bottom to foundation interface can resist lateral shear loads, no additional anchorage to prevent sliding is required. For tanks without steel bottoms (i.e., the material rests directly on the foundation), shear anchorage shall be provided to prevent sliding.

15.7.9.3.5 Combined Anchorage Systems If separate anchorage systems are used to prevent overturning and sliding, the relative stiffness of the systems shall be considered in determining the load distribution.

15.7.9.4 Welded Steel Structures

Welded steel granular storage structures shall be designed in accordance with the seismic requirements of this standard. Component allowable stresses and materials shall be per AWWA D100, except the allowable circumferential membrane stresses and material requirements in API 650 shall apply.

15.7.9.5 Bolted Steel Structures

Bolted steel granular storage structures shall be designed in accordance with the seismic requirements of this section. Component allowable stresses and materials shall be per AWWA D103.

15.7.9.6 Reinforced Concrete Structures Reinforced concrete structures for the storage of granular materials shall be designed in accordance with the seismic force requirements of this standard and the requirements of ACI 313.

15.7.9.7 Prestressed Concrete Structures

Prestressed concrete structures for the storage of granular materials shall be designed in accordance with the seismic force requirements of this standard and the requirements of ACI 313.

15.7.10 Elevated Tanks and Vessels for Liquids and Granular Materials

15.7.10.1 General

This section applies to tanks, vessels, bins, and hoppers that are elevated above grade where the supporting tower is an integral part of the structure, or where the primary function of the tower is to support the tank or vessel. Tanks and vessels that are supported within buildings or are incidental to the primary function of the tower are considered mechanical equipment and shall be designed in accordance with Chapter 13.

Elevated tanks shall be designed for the force and displacement requirements of the applicable reference document or Section 15.4.

15.7.10.2 Effective Mass

The design of the supporting tower or pedestal, anchorage, and foundation for seismic overturning shall assume the material stored is a rigid mass acting at the volumetric center of gravity. The effects of