THE RESPONSE OF CONVENTIONAL STRUCTURES IN SRILANKA FOR EARTHQUAKE

THES IS SUBMITTED TO THE DEPARTMENT OF CIVIL ENGINEERING IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF ENGINEERING IN STRUCTURAL ENGINEERING DESIGNS

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DECLARATION

I, Navaratnarajah Sudesan, hereby declare that the content of this thesis is the output of original research work carried out at the Department of Civil Engineering, University of Moratuwa. Whenever the work done by others was used, it was mentioned appropriately as a reference.

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ABSTRACT

Ground water reservoirs are commonly used in this country for storing 200m3 to 2000m3 water capacities when the area needed water supply having an elevated area (which elevation is sufficient for the head required)and this reservoir can be built on this. In Sri Lanka ground reservoirs are designed as per BS8007 and this design does not cover for earthquakes. However, it seems that no detail investigation has been carried out for response of these ground reservoirs for dynamic loads such as earthquakes.

This research work concentrates on detail dynamic analysis of existing cylindrical ground reservoirs. The results reflect that existing cylindrical ground reservoirs are not sufficiently adequate to withstand even minor earthquakes. This implies that they must be analyzed for earthquakes since their natural period of vibration give high response for earthquakes which could even trigger structural failure.

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NOTATIONS

C_c C_i and C_t = Period-dependent seismic response coefficients defined in 9.4 and 9.5

C_l, C_w = Coefficients for determining the fundamental frequency of the tank -liquid system 9refer to Eq.(9-24) and Fig.9.3.4 (b))

D = Inside diameter of circular tank, ft (m)

h_c = height above the base of the wall of to the centre of gravity of the case including base pressure (EBP), ft (m)

h'_i = height above the base of the wall to the centre of gravity of the convective lateral force for the case including base pressure (EBP), ft (m)

h_i height above the base of the wall to the centre of gravity of the convective lateral force for the case including base pressure (EBP), ft (m)

h'_i = height above the base of the wall to the centre of gravity of the convective lateral force for the case including base pressure (EBP), ft (m)

h_r = height above the base of the wall to the centre of gravity of the tank roof, ft (m)

h_w = height above the base of the wall to the centre of gravity of the tank shell, ft (m)

H_L = Design depth of stored liquid, ft (m)

H_w = Wall height (inside dimension), ft (m)

I = Importance factor, from Table 4.1.1 (a)

m = Total mass per unit width of a rectangular wall = mi + mw' ib-s2/ft per foot of wall width (kg per meter of wall width)

m_i = Impulsive mass of contained liquid per unit width of a rectangular tank wall, Ib-s2/ft per foot of wall width (kg per meter of wall width)

m_w = Mass per unit width of a rectangular tank wall, Ib-s2/ft per foot of wall width (kg per meter of wall width)

M_b = Bending movement on the entire tank cross section just above the base of the tank wall, ft-Ib (kN-m)

M_c = Bending movement on the entire tank cross section just above the base of the tank wall (FBP) due to the convective force Pc, ft-Ib

M'_c = Overturning movement at the base of the tank, including the tank bottom and supporting structure (IBP), due to the convective force Pc, ft-Ib (kN-m)

M_i = Bending movement on the entire tank cross section just above the base of the tank wall (FBP) due to the convective force Pc, ft-Ib (kN-m)

M'_i = Overturning movement at the base of the tank, including the tank bottom and supporting structure (IBP), due to the convective force Pc, ft-Ib (kN-m)

M_o = Overturning movement at the base of the tank, including the tank bottom and supporting structure (IBP), ft-Ib (kN-m)

M_r = Bending movement on the entire tank cross section just above the base of the tank wall (FBP) due to the convective force Pc, ft-Ib (kN-m)

M_w = Bending movement on the entire tank cross section just above the base of the tank wall (FBP) due to the wall inertia force Pw' ft-Ib (kN-m)

P_c = Total lateral convective force associated with Wc, Ib (kN)

P_i = Total lateral impulsive force associated with Wi, Ib (kN)

P_r = Lateral inertia force of the accelerating roof Wr, Ib (kN)

Pw = Lateral inertia force of the accelerating wall Ww, Ib (kN)

r = Inside radius of circular tank, ft (m)

R = Response modification factor, a numerical coefficient representing the combined effect of the structure's ductility, energy-dissipating capacity, and structural redundancy (Rc for the convective component of the accelerating liquid; Ri for the impulsive component) from Table 4.1.1 (b)

W_c = Equivalent weight of the convective component of the stored liquid , Ib (kN)

W_i = Equivalent weight of the implosive component of the stored liquid, Ib (kN)

W_L = Total equivalent weight of the stored liquid, Ib (kN)

W_w = Equivalent weight of the tank wall (shell), Ib (kN)

Y_c = Density of concrete, [150 Ib/ft3 (kN/m3) for standard – weight concrete]

Y_L = Density of contained liquid Ib/ft3 (kN/m3)

Y_w = Density of water, 62.43 Ib/ft3 (9.807 kN/m3)

ε = Effective mass coefficient (ratio of equivalent dynamic mass of the tank shell to its actual total mass), Eq (9-44) and (9-45)

θ = Polar coordinate angle, degree

ω_c = Circular frequency of oscillation of the first (convective) mode of shoeshine, radian/s

ω_i = Circular frequency of the impulsive mode of vibration, radian/s

SD1 = Design spectral response acceleration, 5% damped, at a period of 1 second as defined in 9.4.1, expressed as a fraction of the acceleration due to gravity g

Tw = Average wall thickness, in, (mm)

Tc = Natural period of the forst (convective) mode of sloshing, s

Ti = Fundamental period of oscillation of the tank (plus the impulsive component of the contents), s

Ts = S_{D1} / S_{DS}