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Design and Analysis of Tank Ring Wall Foundation by using STAAD Pro V8i

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ABSTRACT

In oil & gas and Petrochemical Industries, mostly large storage liquids are required. These storage tanks are of Steel shell, which require either concrete or earthen foundations as per the requirement. These foundations are to be designed for Tank liquid load, Wind or Seismic loads etc. for anchoring the tank, Anchor bolts may require. Different process conditions like, upward pressure inside tank etc to be considered while designing tank foundations. The Ring wall foundation for these tanks to be designed is not like ordinary building foundation design. The foundation just receives approximately 10% of the tank shell load, but all the load of the liquid contained in the tank is directly transferred to the soil and the soil has to lively bear this load. So the soil bearing capacity, soil condition takes the main role and design criteria is to be designed based on Height of the tank, soil conditions, soil bearing capacity, total liquid load contained in the tank. Also the settlement analysis has to be carried out carefully as the outer pipes connected to it may get disturbed and this Tank Settlement should be investigated by the geotechnical engineer as another primary issue in tank foundation performance and total Settlement, differential settlement, interior settlement, and edge settlement should be evaluated. In this paper taking all these considerations manual method is designed and it is modeled in STAAD.PRO Software. Performance of the designed Ring wall foundation as obtained from the STAAD.PRO analysis is then compared with that obtained from manual calculations.

Keywords: STAAD Pro, Earthen Foundations, Steel Shell, Anchor Bolt, Ring Wall

I. INTRODUCTION

A tank foundation is a base which is designed to support the weight of oil tanks that contains spillage. It is required to provide total support for the tank bottom. It is design to support the tank and its loads.

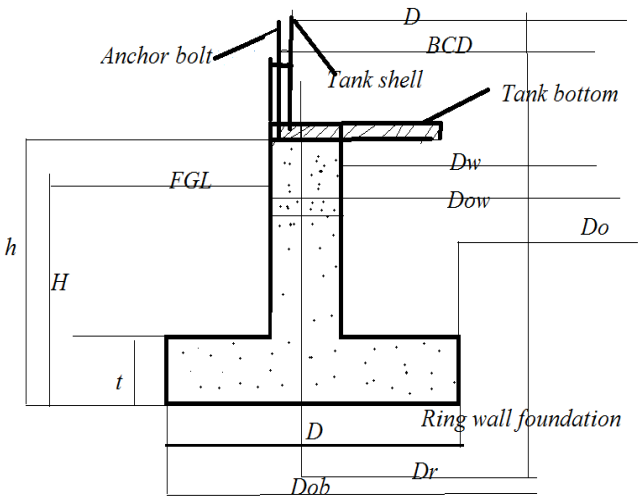
Large tanks, tanks with heavy or tall shells and or self-supported roofs impose a substantial load on the foundation under the shell. This is particularly important with regard to radial shell distortion at the tank top in floating-roof tanks. When there is some doubt whether a foundation will be able to carry the shell load directly, a concrete ringwall foundation should be used.

1.1 OBJECTIVE OF THE THESIS

The main objectives of the have been presented as follows.

1. Analyze and Design of tank ring wall foundation using manual analysis.
2. Model and analyze the tank ring wall foundation using STAAD PRO V8I.
3. Evaluate the Manual Method of tank ring wall foundation.

II. RING FOOTING DIMENSIONS & PROPERTIES



III. SHELL DATA

DESIGN OF RING FOUNDATION FOR TANK
TANK INPUT DATA

Mean diameter of tank (D) =21.336 m
Mean diameter of ring wall (D_r) =21.400 m
Bolt circle dia of tank (BCD) =21.400 m Height of tank shell (Hs) =12.192 m Type of roof = fixed roof Height of tank roof projection(H_r) =1.200m
Empty weight of tank (W_e) =1283.500 KN
Weight of tank roof + rafters +shell $W_r + W_s$ = 1283.500-283.900-232.200
=767.400 KN
Weight of tank bottom plates (Wb)
= 283.900 KN
Weight of roof (Wroof)
= 232.200 KN
Live load on tank roof (LLr)
=0.750 KN/M^2 Live load on platform = LLP = Live load on tank roof & platforms
W_{11} = LLr *π*D^2 /4 + Live load on platform
= 318.150 KN
Hydrotest weight of tank = W_t = max
=45637.500 KN
Operating weight of tank = W_o = max
=45028.800 KN
Lateral force / Base shear due to wind load = F_w
=157.065 KN
Overturning moment due to wind load = M_w
= 1200.377 KN-m
Enter load factor earthquake load
= 1.000
(based zone load factor is taken)
Lateral force / Base shear due to earthquake load = Feh
= 4113.810 KN
Overturning moment due to earthquake load = Meh
= 19507.210 KN-m

Table 3.1 Mechanical data ,weight, foundation loading data

Mechanical Data		
Tank	Contents	Brackish Water
	Type of Roof	Cone (Slope -1:6)
	Type of Bottom	Cone Up (Slope-1:120)
	Type of Roof Support	Rafter
Dimensions	Tank Inside Diameter	21336 Mm
	Tank Height	12192 Mm
	Nominal Capacity of Tank	4359.04 Cu.M
Weight		
Weights	Tank Empty	128.34 Mt
	Tank With Full of Water	4563.75 Mt
	Tank With Full of Product	4502.88 Mt
Foundation Loading Data		
Wind	Shear Force	157.065 Kn
	Moment	1200.377 Kn-M
Seismic	Shear Force	4113.81 Kn
	Ring Wall Moment	19507.21 Kn-M
	Slab Moment	35177.28 Kn-M
Anchoring		Not Applicable
Type of Foundation		Ring Beam

IV. DESIGN PHILOSOPHY

Ring beam foundation is a model in STAAD PRO software using plate elements are Annular ring beam with base slab is proposed. The width of the ring beam is 600mm, and breadth of the base slab is 0.45 km
Width of ring footing base
= 0.600 m
Loading states to be considered are, according to actual conditions, as follows
- State of live loading
- State of wind load
- State of earthquake
- State of Seismic load

Hoop tension results from staad output:

For plate 816 load combination 106 Sx=6827kN/m2 Sxy=7 kN/m2

Total Sx=Sx+|Sxy|=6827+7=6843kN/m2

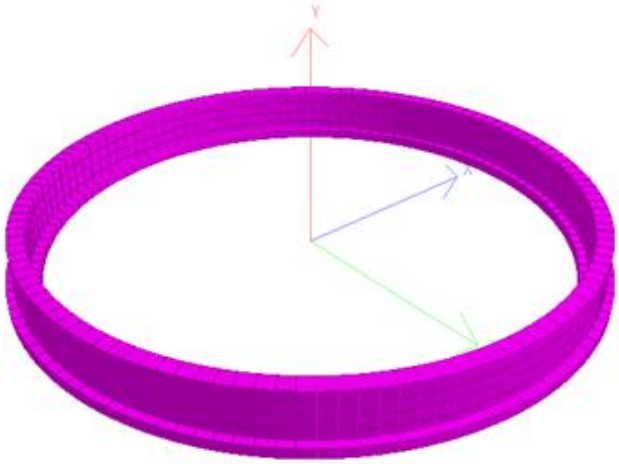
Sx,Sxy are membrane force in the plate as shown in the diagram

total Sx for design=6843=6843 kN/m2

Max hoop tension on the ring beam=6843 *0.5*0.6=2052.9 KN

Manual calculation value=1852.66kN

The value obtained by staad approximately matches with manual calculation values



V. CONCLUSION

This ring wall foundation have a good strength, deformability and prevent lateral movement. It may be applied to the large liquid storage structures for diameter < 30 m height is based structure. Most of the large storage structures having ring wall foundation. Because it will resist the loads properly and it is maintain uniform settlement, control the erosion. Ring wall foundation is Efficient and low-cost repair technique. The ring beam along with foundation was modeled in STAADPRO software, using 4 noded plate elements. The values obtained in software was compared with manual Analysis. It is matching. The design of the substructure elements was done manually. Vendor drawings are attached for reference. All possible loading scenarios considered. The primary loads are provided by the vendor. The design of elements was done using the worst possible load combinations. Structural drawing are prepared and attached in this project report for ready reference.

VI. REFERENCES

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[3]. Design criteria were based on the Canadian Farm Building Code (1977), and solutions were calculated for soils ranging from 72 to 288 kN/m2 (1500 to 6000 lb/ft2) safe bearing pressures.

[4]. D'Orazio and Doncan (1989) are very valuable because they are real data of settlement for steel tanks which are used to store oil materials.

[5]. Moradi , Amir Mahmoudzadeh and Yahya Rahim Safavi (Jan. - Feb. 2017), by various types of Storage Tank Foundations.

[6]. Stanislav Dovnarovitch and Yurji Ivanov(1988) by A simple technique has been proposed to prevent the failures that can be easily Applied when constructing the tanks.

[7]. Klepikov (1989) reviewed a large number of references related to allowable settlement.

[8]. USACE (1990) published an engineering manual, EM 1110-1-1904, for geotechnical procedures.