(47)

LB/DON/09/10
DCE 23/48

OPTIMIZATION OF CIRCULAR TYPE GROUND RESERVOIRS

A THESIS SUBMITTED TO THE DEPARTMENT OF
CIVIL ENGINEERING
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF MASTER OF ENGINEERING IN STRUCTURAL
ENGINEERING DESIGN

LIBRARY
UNIVERSITY OF MORATUWA, SRI LANKA
MORATUWA

By

N.R.S Wickramasinghe

Supervised By

Professor S.M.A Nanayakkara
Department of Civil Engineering

DEPARTMENT OF CIVIL ENGINEERING
UNIVERSITY OF MORATUWA
SRI LANKA

624 "09"
624.01(043)
TH

AUGUST 2009

University of Moratuwa
93881

93881

93881

DECLARATION

I herewith declare that the work included in this Thesis in part or whole has not been submitted for any other academic qualification at any institution.

17/09/2009 ------------------------ Date

------------------------------ N.R.S. Wickramasinghe

Certified By

------------------------ Date

------------------------------ Prof. S.M.A. Nanayakkara

Supervisor.

ABSTRACT

Ground reservoirs of various types are often used as water storage reservoirs in major water supply schemes. Mainly there are two types of ground reservoirs viz. circular and rectangular. Circular type ground reservoirs are the most efficient reservoir form for enclosing space and at present these are widely used throughout the world.

There are various types of structural forms available for circular type ground reservoirs. It is very important to select the most economical structural form and optimum wall height when designing a ground reservoir. Also it is necessary to have an idea about the cost of the structure as well. The main aim of conducting this research is to introduce a method to find the most economical structural form and optimum dimensions for a circular ground reservoir when the capacity is known.

Circular ground reservoirs of different capacities were selected for the analysis and several structural forms were considered for each capacity. Different wall heights were considered for each capacity and structural form in order to find the optimum height for each case.

In the case of domed circular reservoirs, in addition to the wall height, various roof angles were also considered to find the optimum cost of the reservoir.

Finally, variation of the cost with respect to capacity was obtained for each structural form. Similarly the variation of optimum tank height to diameter ratio with respect to capacity for each structural form was also obtained. These relationships can be used to determine the most economical structural form for a given capacity and also the cost of the reservoir. Once the economical structural form is selected, the optimum height of the reservoir can be decided based on the relationship developed for optimum tank height to diameter ratio with respect to capacity and this would be very much helpful to the designer when designing ground reservoirs.

It was found that flat roof pinned type ground reservoirs are the most economical structural form for capacities larger than $2000m^3$ and there is not much difference in cost for small capacities.

ACKNOWLEDGEMENT

I take this opportunity to express my gratitude and indebtedness to my supervisor Prof. S.M.A. Nanayakkara, for his scholarly guidance and advice at every stage of the research study to complete it successfully.

I am grateful to the National Water Supply & Drainage Board and University of Moratuwa for the assistance extended to me.

Also I am extending my gratitude to Librarian and her staff of National Water Supply & Drainage Board for providing very valuable documents to me.

I should thank my wife and son for bearing with me and supporting me to do this research study during weekends and nights and sacrificing limited time available for family get-togethers. Further, I thank my parents, brother and sister for their supports as well.

Finally I offer my appreciation to all officers in National Water Supply & Drainage Board who helped me to complete this research successfully.

N.R.S. Wickramasinghe.

CONTENTS **PAGE NO**

LIST OF TABLES

LIST OF FIGURES

UNIVERSITY OF MORATUWA LIBRARY SRI LANKA

NOTATIONS

A_c – Area of concrete section

A_s – Area of tension reinforcement

A_{sv} – Total cross sectional area of links

A_{sc} – Area of compression reinforcement

a' – Distance from the compression face to the point at which the crack width is calculated

a_{cr} – Distance from the point considered to the surface of the nearest longitudinal bar

b – Width of the section

C_{min} – Minimum cover to reinforcement

D – Effective depth

E_c – Modulus of elasticity of concrete

E_s – Modulus of elasticity of steel

e – Eccentricity

ϵ_m – Average strain at the level where cracking is considered

ϵ_1 – Strain at the level considered

ϵ_2 – Strain due to the stiffening effect of concrete between cracks

f_{yv} – Characteristic strength of shear links

f_y – Characteristic strength of tension reinforcement

f_{cu} – Characteristic strength of concrete

f_s – Service stress of tension reinforcement

f_{ct} – Direct tensile strength of immature concrete

G_k – Characteristic dead load

H_R - Resultant force on ring beam

H_0 - Horizontal force at an edge

L – Span

l_e - Effective span or height of member

l_{ex} - Effective height for bending about major axis

l_{ey} - Effective height for bending about minor axis

M – Bending moment

M_R - Resultant moment on ring beam

M_{add} – Additional moment to be provided by compression reinforcement

$m_\varnothing$ - Meridional bending moments

m_θ - Transverse bending moments

$N_\varnothing$ - Meridional forces

N_θ - Hoop force

N – Ultimate axial load

Q_k – Characteristic imposed load

S_{max} –Maximum crack spacing

s_b – Spacing of bars

T – Torsional moments due to ultimate loads

T_1 – Fall in temperature between hydration peak and ambient temperature

T_2 – Temperature change due to seasonal variation

V – Shear force due to ultimate loads

v – Shear stress on section

v_c – Ultimate shearing resistance per unit area provided by concrete along

v_t – Shearing stress due to torsion

W_{max} – Maximum crack width

x – Depth to neutral axis

Z – Lever arm

Ø - Bar size

ρ_{crit} – Critical steel ratio

ν - Poisson's ratio

β - Shell constant

δ - Displacement due to edge forces and moments

Δ - Membrane displacement