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# 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

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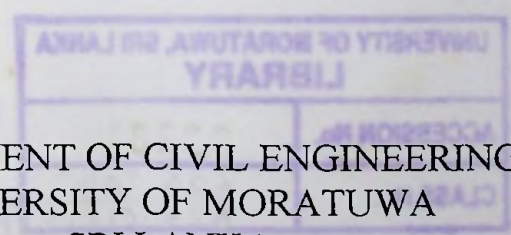
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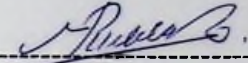


## DECLARATION

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.

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## 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  $2000\text{m}^3$  and there is not much difference in cost for small capacities.

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## 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
- $\epsilon_m$  – Average strain at the level where cracking is considered
- $\epsilon_1$  – Strain at the level considered
- $\epsilon_2$  – 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
- $m_\phi$  - Meridional bending moments
- $m_e$  - Transverse bending moments
- $N_\phi$  - Meridional forces
- $N_e$  - 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
- $\phi$  - Bar size
- $\rho_{crit}$  - Critical steel ratio
- $\nu$  - Poisson's ratio
- $\beta$  - Shell constant
- $\delta$  - Displacement due to edge forces and moments
- $\Delta$  - Membrane displacement