Comparative Study Of Normal And Optimized Cost Of Rooftop Swimming Pool

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Abstract- *Swimming pools are the most important public structures as it can be used for various purposes. Rooftop swimming pool is liquid retaining structure as it is subjected to hydrostatic pressure and the base is subjected to weight of water and it is designed by using IS 3370:2009 Part (I, II). This study focused on comparative study of normal and optimized design results on the basis of volume of concrete and steel for M30 and M40 grade of concrete. Optimization can be defined as the process of finding the conditions that give the maximum or minimum value of a function. In this study optimization is done by using Matlab software.*

Keywords- Rooftop swimming pool, Quantity of concrete, Quantity of steel, Normal and optimized cost

I. INTRODUCTION

Swimming pools are the most important public structures as it can be used for various purposes. Rooftop swimming pool is liquid retaining structure as it is subjected to hydrostatic pressure and the base is subjected to weight of water and it is designed by using IS 3370:2009 Part (I, II). Depending upon the location of the swimming pool the swimming pools can be named as roof top swimming pool, on ground swimming pool and underground swimming pool. Depending on shape of swimming pool they may be of circular shape, oval shape, and most commonly used rectangular shape.

Swimming pools can be classified as below

A. *Depending upon location-*

1] Underground swimming pools

2] On ground swimming pools

3] Roof top swimming pools

B. *Depending upon shape-*

1] Circular shape swimming pools

2] Oval shape swimming pools

3] Rectangular shape swimming pools

C. *Depending upon use-*

1] For sports (Olympic size swimming pool)

2] Public swimming pools

3] Private swimming pools

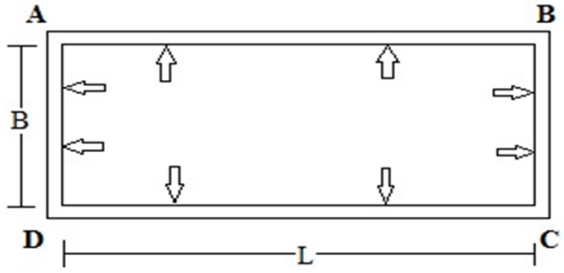
II. METHODOLOGY OF STRUCTURAL OPTIMIZATION

Optimization can be defined as the act of obtaining the best result under given circumstances or "The process of finding the conditions that gives the maximum or minimum value of the function". Primary aim of structural optimization is to determine the most suitable combination variables, so as to achieve satisfactory performance of the structure subjected to functional & behavioral and geometric constraints imposed with the goal of optimality being by the objective function for specified loading or environmental condition. Three features of structural optimization problem are:

1. The design variable.
2. The constraint.
3. The objective function.

The design variables and constraints are so chosen and Matlab program is prepared so that it can give optimized values of volume of concrete and steel for which the cost of structure is minimum.

III. COMPONENTS OF ROOFTOP SWIMMING POOL



A. Side walls:

Consider a roof top swimming pool having length L, breadth B and H is depth in meter. If L/B ratio is less than 2, the side walls are design as horizontal slabs. In that case continuous all round pressure subject of wH KN/m2. (Where w is density of fluid say water).

Larger ratios of L/B, longer sides are treated as vertical cantilever fixed at base, while shorter sides are treated as horizontal slabs running across the longer walls.

When L/B ratio comes greater than 2 the side walls are bifurcated in long wall and short wall for design convenience as behavior of walls changes as mention above. The thickness of wall is generally kept constant, and the reinforcements varied at different section.

B. Base slab:

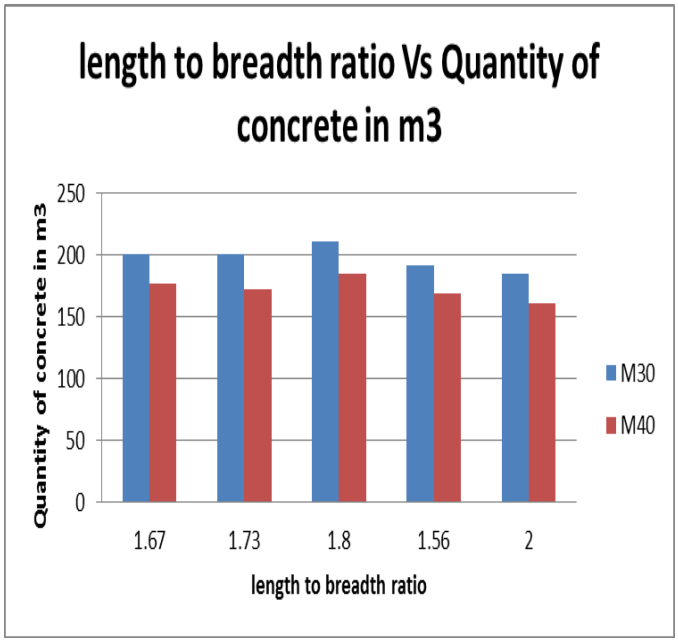
While designing the base slab for roof top swimming pool no any specific criteria is used, but it has to be designed as continuous slab for heavy water load.

IV. RESULTS

Results are obtained by using Matlab optimization to get optimized values of variables i.e. thickness of side walls and thickness of base slab. The quantities of concrete and steel are obtained. Comparative results are shown below

Length to breadth ratio	Quantity of concrete in m3 for M30	Quantity of concrete in m3 for M40
1.67	200.18	177.27
1.73	200.17	172.12
1.8	210.27	184.66
1.56	191.54	168.56
2	184.13	160.61

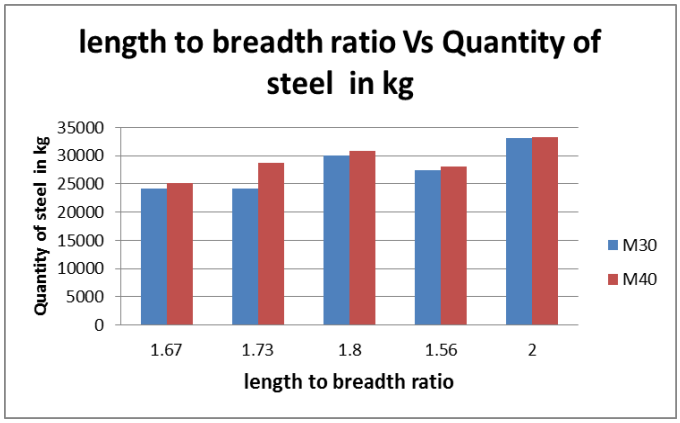
Table 1 Quantity of concrete m^3 for M30 and M40 grade



Graph 1 Length to breadth ratio Vs. Quantity of concrete in m3

Length to breadth ratio	Quantity of steel in Kg for M30	Quantity of steel in Kg for M40
1.67	24200	25103
1.73	24200	28799
1.8	30108	30815
1.56	27455	28100
2	33196	33233

Table 2 Quantity of steel in Kg for M30 and M40 grade



Graph 1 Length to breadth ratio Vs. Quantity of steel in kg

Following results show the percentage variation of cost of normal design and optimized design

Sr. No	L to B ratio	Grade of concrete	Cost of pool		%Variation
			Normal Design	Optimized design	
1.	1.67	M30	3130402	3037130	5.01
2.	1.67	M40	3107117	2951547	2.98
3.	1.73	M30	3342663	3037034	9.14
4.	1.73	M40	3327334	3069362	7.75
5.	1.8	M30	3473554	3405873	1.95
6.	1.8	M40	3506974	3289204	6.21
7.	1.56	M30	3195726	3103821	2.88
8.	1.56	M40	3300905	3001124	9.08
9.	1.47	M30	3422243	3273354	4.35
10.	1.47	M40	3536558	3160118	10.64
11.	2	M30	3918904	3296689	15.88
12.	2	M40	3975018	3156661	20.59

V. CONCLUSION

1. Results of optimum design for different grade of concrete shows that the quantity of concrete required for M30 grade concrete is more than quantity of concrete required for M40 grade concrete.

2. Quantity of steel required for M30 grade concrete is less than quantity of steel required for M40 grade concrete.

3. Comparison of cost of optimum Design and Normal design shows the cost of normal design and optimum design for various dimensions and grade of concrete. It can be seen from this table that the percentage of saving obtained for optimum design and also varies with different dimensions and grade of concrete. Maximum cost saving of 20.59% over the normal design is achieved in case of M40 Fe 415 grade for roof top swimming pool having length to breadth ratio equal to two .The saving achieved through optimization can be thus significant.

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