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DESIGN, ESTIMATE, COSTING AND EXECUTION OF A TWO TIER OUTDOOR FOUNTAIN

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ABSTRACT

A two tier outdoor fountain was designed to showcase the ornamental work and functionality of a concrete structure. The fountain is 3800 mm. The size of the footing mat is 1800mm X 1800mm. Diameter of the column is 450mm. The overall thickness of foundation is 350mm whereas the thickness at the edge is 200mm. The concrete used for the entire construction is of either M15 or M20 grade. This thickness was designed based on the requirement of bending, punching shear and beam shear. Two bowls were constructed at a certain height distance apart. The top of the fountain gives a shape of an earthen water pot with an opening at the top. The opening is fitted with a foam shower. There are 64 Nos. of nozzle jets are fitted all along in the inner part of the parapet wall in circumferential pattern that throws water to the bowls. Finally a 1HP pump is installed inside the static water storage of the fountain and four Nos. of coloured water proof flood lights were fitted at four elevated corners. The total cost of the fountain is estimated around one lakh forty six thousand and seventy two only in INR till execution. The design parameters are prepared by the authors taking different design factors.

Keywords: Two tier fountain, Estimation, Costing, Bhubaneswar, India.

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Contribution/ Originality

This project is one of very few studies which have been investigated minutely. This study documents a new flowery design and architecture with splendid lighting arrangement for an outdoor fountain. The cost of the project has been kept to its minimum so that anybody willing to construct such an outdoor two tier fountain can afford at a least price.

1. INTRODUCTION

Fountain is a Latin word representing "fons" or "fontis" whose english meaning is water from a source or spring that pours water into a basin or sprinkles into the air to supply drinking water or for a decorative purpose. In the early time usually fountains were connected to springs or aqueducts and were used to provide drinking and potable water for the residents of cities, towns and villages. Most of the fountains were gravity driven, and needed a source of water at higher RL than the fountain as for example a reservoir or aqueduct to make the water flow or thrown into the air by the action of gravity. In addition to those uses fountains were also used for decoration purposes. Romans were the

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initiaters of those fountains who decorate them with bronze or stone giving the shape of animals or their local heroes. In the Middle Ages, Moorish and Muslim were dominating in such sculturous activities followed by King Louis XIV of France who used fountains in the Gardens of Versailles. Romans were also great lovers of fountains. By the end of the 19th century urban fountains became purely decorative. Mechanical pumps were used to pump water into the fountains with high pressure with a provision to recycle. There are instance across the world which shoots water 140 metres (460 ft.) in the air (The Jet d'Eau in Lake Geneva, built in 1951,) and King Fahd's Fountain in Jeddah, Saudi Arabia, which spouts water 260 metres above the Red Sea. In todays time fountains are specially constructed for decorative purposes. In further development, musical fountains are massively used in different countries to attract tourists. Drinking fountains are also used to provide clean drinking water in public buildings, parks and public spaces. Garden fountains with light and sound prevails in almost all the countries. The sparkle and gurgle of flowing water is soothing tonic for frazzled nerves, and it also attracts a variety of birds and other wildlife to the inspired oasis (watergardenersinternational.org).

1.1. Fountains

Jet height of a fountain is usually designed to pump water half the radial distance of the fountain but to make more appealing multiple jet points are installed which extends the height equal or more than the radius of the fountain. Height can be added by using statuary or sculptures or if the area is free from wind velocity.

1.2. Design Considerations

The most common factors that influence water are light, temperature, wind, slope, shapes and surfaces. These all can play a role in considering the final design concept of the fountain.

1.3. Two Tier Pool Fountain

Various architectural views of fountains were referred for consideration. With the consultation of management, beautification committee, the faculty members of civil dept. as well as project team members, the two tier pool fountain structure was selected. A two tier pool fountain (showupdesign.com) consist of 2 bowls; one at the top and the other at the middle which pours water from one bowl to another and finally to the basal pool. The upper bowl is smaller in size in comparison to the lower one. A two tier fountain is more elegant than the normal jet fountain or other fountain and used mainly for decorative purpose in gardens or other infrastructures.

The location was selected as per the consultation of management, beautification committee and team members The selected location was very much accessible to water supply as well as electricity supply; thus economical to our cause.

1.4. Testing of Materials

a. To Test the Soil (Known as Atterberg's Limits)

1. Plastic Limit Test
2. Shrinkage Limit Test

b. Test of bricks

1. Hardness
2. Shape and size
3. Soundness
4. Colour and appearance
5. Strength
6. Water absorption test on bricks
7. Crushing strength of bricks

a. Test of Cement

1. Colour:
2. Physical properties:
3. Presence of lumps:
4. Strength
5. Fineness of Cement
6. Initial and final setting times of cement
7. Soundness Test

b. Compressive Strength of Hydraulic Cement Mortar

c. Test of aggregates

1. Sieve Analysis
2. Abrasion Value

d. Test of concrete

The different steps for construction work proceeded as follows:

1. Earthwork Excavation

The Excavation was done in a circular manner. The Diameter of the site was 2400mm and the depth was 1200mm.

2. Sand Filling with Compaction
3. PCC in Foundation

1. Specifications for Plain Cement Concrete (PCC)
2. Materials Specifications
3. Coarse aggregate
4. Fine aggregate
5. Cement
6. Water

4. Foundation
5. Centering and Shuttering
6. Application of RCC

Material used In RCC work

1. Cement
2. Aggregates
3. Steel
4. Water

7. Column
8. Finishing work in Plastering
9. Pipe Laying & Nozzle Fittings
10. Electrification
11. Pump Installation
12. Electrical Fittings
13. Execution of Fountain

1.5. Earthwork Excavation

The Excavation was done in a circular manner (Fi.1). The Diameter of the site was 2400mm and the depth was 1200mm.

Fig-1. Excavation work in progress for the foundation
Source: Orissa Engineering College Campus

1.6. Water Leveling

- Water level can be checked by means of two sides of a transparent nylon tube by putting water inside it as per the length of tube and both the sides had to be raised at the two points where it has to be checked.
- The level depends on gravitational force on earth from the centre of the earth. So surface of road is known as flat. We can use water levelling pipe to know the level.

1.7. Sand Filling and Compaction (Fig.2)

- The construction site is filled with sand before pouring of PCC.
- The compacted sand gives the PCC a strong base to settle & it also helps to distribute the loads of the superstructure evenly to the ground.
- So the compaction of sand is very important in this step.
- In our work sand of 250mm thickness was filled in the site.
- Then this sand was thoroughly compacted with ramming and vibrator to 150mm thickness
- Water was also applied for better compaction by removal of voids.

Fig-2. Sand filling and compaction
Source: Orissa Engineering College Campus

1.8. Plain Cement Concrete (Fig.3)

- Plain Cement Concrete (PCC) is a construction material, which is composed of cement (Ordinary Portland Cement), aggregate (generally a coarse aggregate made of gravels or crushed rocks plus a fine aggregate such as sand) and water [1].
- For PCC work generally M15, M10 grade of concretes are used.
- Here we used M10 grade for PCC work & the general cement, sand, aggregate ratio for M10 grade concrete is 1:3:6.
- The PCC was applied on the compacted sand.
- Thickness of PCC applied: 150mm
- Size of aggregates used: 40mm

Fig-3. PCC work in progress
Source: Orissa Engineering College Campus

1.9. Reinforced Cement Concrete

- Reinforced Cement Concrete is well versed as the mixture of cement, sand, water and aggregate in a certain proportion with steel bars.
- Generally M15 & M20 grade is used for RCC work.
- According to the project work, M15 & M20 grade concrete of proportion 1:2:4 & 1:1.5:3 were used [1].

Foundation (Fig.4)

- The lower most part of a structure which bears the load of the total structure, typically below ground level is called foundation.
- Here it was decided to provide isolated spread footing.
- The size of foundation was found out by taking the total dead load of the super structure and lateral force due to wind thrust with due consideration to the safe bearing capacity of the soil.
- Sloped footing was selected for our work as it is more economical.
- The size of the footing mat is 1800mm X 1800mm.
- In the mat steel bars of 12mm dia. were used @175mm c/c both ways.
- The sides of the steel bars were bent to L shape of length 150mm.
- The overall thickness of foundation is 350mm where as the thickness at the edge is 200mm. This thickness was designed based on the requirement of bending, punching shear and beam shear [2].

Fig-4. reinforcement and erection of column
Source: Orissa Engineering College Campus

1.10. Centering and Shuttering

- Shuttering means a mould of the required structural element which is made by the help of steel plates or wood planks to give a definite shape and size to the desired structure (Fig.5).
- Materials used for shuttering work
- Steel plates
- Timber
- Bamboo

Fig-5. Scaffolding and shuttering
Source: Orissa Engineering College Campus

1.11. Plumbing

- A PVC outer pipe of diameter 110mm is used as a casing for the inner water supply pipe connection.
- For water supply purpose a smaller diameter measuring 25mm has been encased within the outer casing pipe.
- At the base, L section joints are used at a height of 450mm from the surface of footing.

Brick work (Fig.6)

- The bond used in the work is English bond, in which stretcher and header courses are used alternatively. The cement water ratio used for bonding material is 1:6 [3].

- The bricks used in the work had the size 225*125*90 (in mm)

1. Second class brick were used for the work and following lab tests were conducted to find their suitability

a. Crushing strength
b. Absorption
c. Shape and size
d. Efflorescence

- The crushing strength of brick was found to be 70kg/sq.cm.
- As per the acceptance limit a quality brick should absorb less than 20% of water by its weight.
- Good brick must have uniform in size as well as regular plane surface.
- There should be no patches and no presence of alkalis.
- The height of the brick wall was kept 900mm.
- For the joint of bricks mortar of cement sand ratio 1:4 was used.

Fig-6. Brick work in full swing
Source: Orissa Engineering College Campus

1.12. Erection of Column

- An upright cylindrical compressive member which supports the superstructure is called as a column.
- Generally RCC work is done at a grade of M20 having 1:1.5:3 proportion for this work.
- Then shuttering is done around the cage by plywood which makes a frame for the construction of a column.
- The cross section and size was determined by keeping in mind the total load along with the wind thrust and seismic force (Fig.7).

Specification Details

- Diameter of the column = 450mm
- Height of the structure = 3800mm
- Longitudinal rods of 12 numbers having 12mm dia were used
- Lateral ties were used with rods having dia 8mm @250mm c/c both ways

Fig-7. Phase wise proceeding of central column

Source: Orissa Engineering College Campus

1.13. Finishing work in Plastering

- To cover rough surfaces of walls, columns & other building components with thin coat of cement mortar to form a smooth surface with durability plastering has been done.
- For plastering the wall, cement sand ratio was kept 1:4 with application of DPC to repel water.
- For the ornamental works the cement sand ratio was kept 1:3.
- Plastering work is done to the super structure to avoid any wear and tear against weather variation and water proofing compound of doctor fixit make has been used to make it water repellant.
- Punning has been done over the plastered surface to improve its adhesive capacity, for the application of enamel paints of various shades.

1.14. Ornamental Work

- The first bowl was constructed at a height of 1200mm from the foundation.
- Before the 1st bowl a vase structure of 600mm height was constructed this had a diameter 1625mm.
- After the 1st bowl another vase structure of 600mm was constructed.
- Then 2nd bowl of diameter 950mm was constructed.
- For more finishing works and ornamental works white cement, doctor fixit, fine sand and cement slurry were used.
- Chicken wire mesh was used for the construction of different decorative works such as vase and swans.
- Expanded metal mesh of diamond shape has also been used for ornamental work of the bowls.
- Different types of sculptures have been used to make it more lucrative (Fig.8).

Pipe Laying: Pipe line was laid from a nearby existing connection which was used to supply water to the fountain

Fitting of Nozzles: 64 Nos. of Nozzle jets were fitted all around the fountain with a foam shower at the top.

Installation of a Pump: A block water pump of 1HP was immersed inside the fountain for supply of water to the nozzles.

Electrification with Fittings: Four No of underwater coloured flood lights were fitted at four extended corners to give a fabulous view of sprinkling waters showered from nozzle jets.

Fig-8. Finishing and ornamental work in progress

Source: Orissa Engineering College Campus

After all the installations were completed the fountain was started in full fledge which gives a beautiful look in the evening after the sunset (Fig.9).

Estimation [4].

Details of Measurements and Calculation of Quantities

Item No	Particular to items	No	Length (m)	Breadth (m)	Height/Depth (m)	Quantity (cu.m)
1	Earthwork in excavation in foundation		5.15	5.15	1.5	37.1315
2	Sand filling in foundation		5.15	5.15	0.2	5.3045
3	Plane cement concrete in foundation		5.15	5.15	0.15	3.9783
4	Concrete used in RCC work in foundation		5.15	5.15	0.45	11.9351
5	1st column		D=0.533	R=0.2665	H=0.825	0.1840
	Ring 1		D=0.700	R=0.3500	H=0.075	0.0288
	Ring 2		D=0.517	R=0.2585	H=0.050	0.0104
	2nd column		D=0.533	R=0.2665	H=0.825	0.1840
	Ring 1		D=0.748	R=0.3740	H=0.075	0.0329
	Ring 2		D=0.978	R=0.4890	H=0.075	0.1152
	3rd column		D=0.400	R=0.2000	H=1.050	0.1319
	Ring 1		D=0.596	R=0.2980	H=0.075	0.0209
	Ring 2		D=0.644	R=0.3220	H=0.075	0.0244
	4th column		D=0.250	R=0.1250	H=0.575	0.0282
Total						1.0568
6	Brick Corner Portion	4	1.1	0.25	0.85	0.9350
	Arch Portion	4	2.85	0.25	0.85	2.4225

Estimate for Reinforcement

Item No.	Particulars of items of works	No.	Length (m)	Quantity (m)	Weight (kg)
1	Reinforcement used in mat foundation	36	1.8	64.8	57.5424
2	Reinforcement used in column from mat foundation to top level				
	Straight bar 12mm spacing 8mm	12	4.2	50.4	44.755
	Stirrups used in column	36	1.5	54	21.600
3	Reinforcement used in bowel				
	1st bowel				
	Gun ring	24	1.5	36	14.400
	Stirrup used in gun ring				
	1st stirrup	2	1.8	3.6	1.440
	2nd stirrup	2	2.1	4.2	1.680
	3rd stirrup	2	2.7	5.4	2.160
	4th stirrup	1	3.3	3.3	0.732
	5th stirrup	1	3.9	3.9	0.865
	6th stirrup	1	4.8	4.8	1.065
	7th stirrup	1	5.4	5.4	1.198
Total					23.540
4	2nd bowel				
	Gun ring	21	1.5	31.5	12.6
	Stirrup used in gun ring				
	1st stirrup	2	1.8	3.6	1.440
	2nd stirrup	2	1.8	3.6	1.440
	3rd stirrup	1	2.4	2.4	0.532
	4th stirrup	1	3.3	3.3	0.732
	5th stirrup	1	3.9	3.9	0.865
Total					17.609

Rate Analysis

Sl. No.	Description of items of work	Quantity (Cu.m.)	Rate per Cu.m.	Amount (in Rs)
1	Earthwork in excavation	23.481	300	7044.3
2	Sand filling in foundation	3.612	210	758.52
3	P.C.C. (1:1.5:3)	2.709	3812.00	10,326.70
4	Concrete used in mat foundation (1:2:4)	5.418	3411.24	18,242.09
5	Concrete in column & ring	0.6619	3411.24	2257.89
6	Concrete used in (2)	0.200	4140.48	828.09
Total				39457.59
7	Brickwork in foundation	3.357	4000.00	13428.00

Reinforcement

Sl.No.	Description of items of work	Quantity	Rate	Amount
1	Reinforcement used in mat foundation	57.542	53.00	3049.72
2	Reinforcement used in column from mat foundation to top level			
	Straight bars (12mm)	44.755	53.00	2372.00
	Stirrups (8mm)	21.600	53.00	1144.80
3	Reinforcement used in bowels			
	1st bowel	23.540	53.00	1247.62
	2nd bowel	17.609	53.00	933.27
			Total=	8746.61

Chicken Wire Mesh

Quantity	Rate per piece	Amount (in Rs)
2	270	540

1.15. Labour & Transport Charges in INR

- Mason per day = 500.00
- Labour per day = 300.00

- Mason per day for ornamental work = 600

One labour and one mason were used.

Total day worked by mason = 44days

Total cost of mason = 44*500 = 22,000

Total day worked by mason for ornamental work = 8

Cost of mason for ornamental work = 600*8 = 4,800

Total day worked by labour = 28

Total cost of labour=28*300 = 8,400

Total Cost = 22,000+4,800+8,400 = Rs.35,200.00

Transportation fees of material like cement, aggregate, sand, brick etc. = Rs.2,000.00

1.16. Electrification & Nozzle Charges in INR

- Cost of four Nos underwater lights = Rs.20,000.00
- Cost of Electrification + Distribution Box = Rs. 12,000.00
- Cost of Nozzles = Rs. 8000.00

Total Cost = Rs. 40,000.00

Cost of 1HP Pump in INR = Rs. 7000.00

Total Estimate Cost in INR

Total Material Cost	Rs.62,172.20
Mason And Labour Cost	Rs.35,200.00
Transportation Cost:	Rs.2,000.00
Nozzle + Lighting Cost:	Rs.40,000.00
Pump	Rs. 7,000.00
Total Cost Till Completion	Rs.1,46,372.20

Fig-9. Spectacular view of the fountain in working condition

Source: Orissa Engineering College Campus

2. CONCLUSION

The efforts taken by the team in constructing the entire fountain till the final demonstration cost around Rupees one lakh forty-six thousand and thirty two only. A total of six months period was spent. Maximum time consuming

part of the work was going for ornamental work which required a lot of manpower, increasing the cost of the project remarkably.

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