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# Design of Roof Top Rain Water Harvesting System in BCE

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**ABSTRACT:** Rainwater harvesting entails the collection, storage, treatment, and utilization of rainwater for various purposes, including irrigation, domestic use, and groundwater recharge. The system comprises several key components, such as catchment surfaces (roofs, pavements), conveyance structures (gutters, pipes), storage tanks, filtration units, and distribution networks. The effectiveness of rainwater harvesting systems relies on numerous factors, including climatic conditions, catchment area, storage capacity, and local regulations. By capturing rainwater at the source, these systems reduce reliance on centralized water supply systems, alleviate pressure on dwindling water reserves, and minimize runoff, thereby mitigating flood risks and soil erosion.

**KEYWORDS:** Such as catchment surfaces (roofs, pavements), conveyance structures (gutters, pipes), storage tanks, filtration units, and distribution networks.

## I. INTRODUCTION

Rainwater harvesting or collection of monsoon showers for future utilization has been proven since ages but it is becoming strongly practiced method all over world from the last 4 decades. The advancement in the research and technology in terms of filtering, disinfecting, collection and storage has led to better and more capable rainwater harvesting systems where many sectors are now less dependent on the municipal fed water supply for domestic and commercial water needs.

Shivalik mountain range is sitting crown in the northern hemisphere of India and in the footsteps of these hills lies Chandigarh, the first developed city of India. Developed over an area of 114sqkm this union territory receives about 700-1200mm of annual rainfall, i.e. 900mm on average. Around 75-80% of what is received as precipitation goes out as surface runoff in water removal structures. With an estimated decennial population growth 17.19% and hasty overexploitation of water and nearly drying underground wells, the city needs a disparate approach for water solutions. With the help of rainwater harvesting recharging, retention and reutilization of the rainwater can call forth to more sustainable approach of water management in Chandigarh. This city depends upon the 200 wells feeding the overall population of the city and the augmented water from the Beas channel. With rainwater harvesting structures specifically designed for small buildings and markets which covers most of the area of individual sectors, the additional pressure on the wells for water pumping can be limited and various areas can be developed where the rainwater can recharge those wells, the parks or the green areas can also be helpful in recharging with right plant choice. This will also help in finding adequate zone for water harvesting catchment and storage.

As the global demand for fresh water continues to rise, innovative and sustainable water management practices are becoming increasingly essential. One such practice is rainwater harvesting, a time-tested method that captures and stores rainwater for later use. This technique not only alleviates the pressure on conventional water supply systems but also contributes to water conservation, reduced erosion, and flood mitigation.

Rainwater harvesting involves collecting runoff from surfaces upon which rain falls, such as rooftops, land surfaces, and rock catchments. The collected water is then stored in tanks, cisterns, or reservoirs for various uses, including irrigation, domestic consumption, industrial processes, and even potable supply after appropriate treatment. The

simplicity and adaptability of rainwater harvesting systems make them suitable for both urban and rural settings, offering a viable solution for water-scarce regions and communities.

Implementing rainwater harvesting systems can be cost-effective and environmentally friendly. With proper design and maintenance, these systems can provide a sustainable water supply for years to come, offering significant savings on water bills and reducing the environmental footprint of water consumption.

In conclusion, rainwater harvesting is a practical and beneficial strategy for addressing water scarcity and managing water resources more sustainably. As populations grow and climate change exacerbates water challenges, the adoption of rainwater harvesting systems will become increasingly important for ensuring a resilient and secure water future.

## II. RELATED WORK

### APPLICATION AREA

Rainwater harvesting systems can be installed in both new and existing buildings and harvested rainwater used for different applications that do not require drinking water quality such as toilet flushing, garden watering, irrigation, cleaning and laundry washing. Harvested rainwater is also used in many parts of the world as a drinking water source. As rainwater is very soft there is also less consumption of washing and cleaning powder. With rainwater harvesting, the savings in potable water could amount up to 50% of the total household consumption.

### 2.1 CRITERIA FOR SELECTION OF RAINWATER HARVESTING TECHNOLOGY

- Type and size of catchment area.
- Local rainfall data and weather patterns.
- Length of the drought period.
- Alternative water sources.
- Cost of the rainwater harvesting system.
- Rainfall amounts, intensities, and evapo-transpiration rates .
- Soil infiltration rate, water holding capacity, fertility and depth of soil.
- Crop characteristics such as water requirement and length of growing period.

### 2.2 OBJECTIVES

- To determine the amount of rain fall on roof top of college buliding.
- To design and calculate capacity of storage tank.
- To estimate the cost of installation of project.
- To develop a working model

### 2.3 BENEFITS OF RAINWATER HARVESTING

- Rainwater is a relatively clean and free source of water .
- It is socially acceptable and environmentally responsible .
- It promotes self-sufficiency and conserves water resources .
- Rainwater is friendly to landscape plants and gardens .
- It reduces storm water runoff and non-point source pollution.
- It uses simple, flexible technologies that are easy to maintain .

Model materials used for the model work (1) Mount board (2) Mdf sheet (3) Staws (4) Paints. We taken scale as 1:100 for the model

Required capacity of water tank : roof water flow is collected in water tank. roof water collected from north area of campus i.e. the campus of bahubali college of enigneering .according to survey we have observed that the bore wells and the open wells in this area are dry. bore well provided in the north side. hence, run off calculation we can provide a water tank for the north direction.

Area of campus. (1)Total area of open ground=1566m<sup>2</sup>. (2)Total area of pavement =165 m<sup>2</sup>. (3)Total area of roof Top =

4737m<sup>2</sup>. (4) Runoff coefficient (C)=0.9 , total water collected in one month,Q=895.4 m<sup>3</sup>.

### III. METHODOLOGY

1. SELECTION OF SITE :The various data collected for our project are Bahubali college of engineering shravanabelagola , hassan.

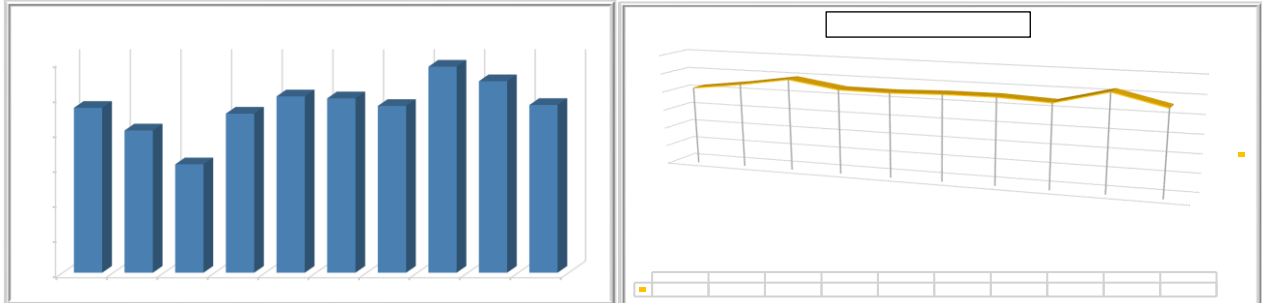


2. COLLECTION OF DATA: Data collection is a crucial step in designing and implementing an efficient rainwater harvesting (RWH)system.

Year	Rainfall (mm)	Temperature ( °C)	Evaporation (mm)
2014	233.95	20.92	2.32
2015	201.85	22.6	3.56
2016	153.79	24.66	2.50
2017	225.73	22.66	3.81
2018	250.22	22.58	4.56
2019	247.50	23.0	4.85
2020	236.68	23.08	6.91
2021	292.4	22.42	4.70
2022	271.76	25.92	5.20
2023	238.01	22.75	2.80

3. ANALYSIS OF SELECTION OF CATCHMENT : Rooftop rainwater harvesting (RRWH) involves collecting and storing rainwater from roof tops for various uses.

The total area under project is calculated as 4737m<sup>2</sup>. the total cost of the project is 12,49,340/ though it is quite high but the rainwater harvesting is the need of this era. this is one time investment but the achievements are too high.



4. STORAGE AND CONSERVATION OF WATER: Effective storage and conservation of harvested rainwater are critical components of a successful rainwater harvesting.

Rainfall intensity (i) = 7mm/day

$$Q = C \times i \times A \quad Q = 0.95 \times (7/1000) \times 4737$$

$$Q = 31.50 \text{ m}^3/\text{day}$$

$$\text{Total discharge} = 31.50 \text{ m}^3/\text{day}$$

Quantity of water collected in rainy season.

$$\text{Quantity of water collected in rainy season. } Q = 31.50 \times 30 \times 1$$

$$Q = 4,75,500 \text{ lit.}$$

Demand of water for drinking purpose :

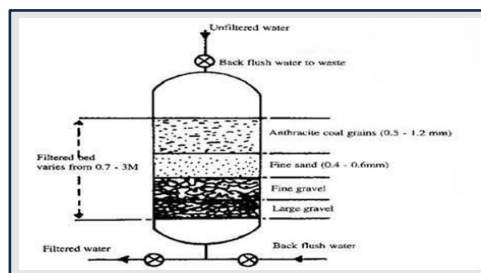
$$= \text{No. of users} \times \text{requirement of water per head} \times 270 \text{ days}$$

$$= 250 \times 3 \times 270$$

$$= 2,02,500 \text{ litre.}$$

5. CONSERVATION OF HARVESTED RAINWATER: Install low flow faucets, showerheads and dual flush toilets to reduce water consumption.

Rainwater harvesting system is done for Bahubali college of engineering, fig (a) shows the model work of our project. Here rainwater is collected from roof top surface and stored in storage tank.



C filter tank

6. ANALYSIS OF RAINWATER HARVESTING SYSTEM COST ANALYSIS: Conducting a cost analysis for a rainwater harvesting system is essential to determine its economic viability.

The total Cost of the project is **12,49,340/-** though it is quite high but the rainwater harvesting is the need of this Era. This is one time investment but the achievements are too high.

#### IV. EXPERIMENTAL RESULTS

Figures shows the results of rainwater harvesting system for Bahubali college of engineering shravanabelagola , Hassan , Karnataka.



Fig (a): Model work



Fig (b): Working model

##### 1. Total Area of open ground =12062 m<sup>2</sup>

Runoff coefficient=0.3

Rain fall intensity= 7mm /day  $Q=C \times i \times A$

$$Q=0.3 \times (7/1000) \times 1566$$

$$Q= 3.288\text{m}^3/\text{day}$$

Total Discharge = 3.288m<sup>3</sup>/day

Total water collected in one rainy season  $Q=3.288 \times 30 \times 1$

$$Q=49.32\text{m}^3$$

Water is collected From open ground of Bahubali college of Engineering is 49.32 m<sup>3</sup>.

##### 2. Total Area of Pavement =165.0m<sup>2</sup>

Runoff coefficient=0.7

Rain fall intensity= 7mm /day  $Q=C \times i \times A$

$$Q=0.7 \times (7/1000) \times 165$$

$$Q= 0.808 \text{ m}^3/\text{day}$$

Total Discharge = 0.808m<sup>3</sup>/day

Total water collected in one rainy season  $Q= 0.808 \times 30 \times 1$

$$Q=12.12 \text{ m}^3$$

Water is collected From Pavement area of Bahubali college of Engineering is 12.12 m<sup>3</sup>.

#### Design

##### [1] Required Capacity of Water tank

Roof water flow is collected in water tank. Roof water collected from north area of campus i.e. the campus of Bahubali college of Engineering .

Hence,

Runoff calculation:

We can provide a water tank for the North area of campus.

1) Total Area of open ground =1566 m<sup>2</sup>

2) Total Area of pavement = 165 m<sup>2</sup>

3) Total Area of Roof Top = 4737m<sup>2</sup> Now, runoff coefficient

$$C=0.9$$

$$A = 4737\text{m}^2$$

$$Q =C \times i \times A$$

$$= 0.9 \times (7/1000) \times 4737$$

$Q = 29.84\text{m}^3/\text{day}$   
Total water collected in one rainy year;  
 $Q = 29.84 \times 30 \times 12 = 10742.4 \text{ m}^3$   
The amount of water collected in one rainy year = 895.2m.

### DESIGN OF TANK

$Q = 895.2 \text{ m}^3$   
Assuming additional 10 % losses,  $Q = 895.2 - 0.1 \times 895.2$   
 $Q = 805.68 \text{ m}^3$   
Total depth = 5m Hence,  
 $A = 805.68/5 = 161.13\text{m}^2$   
 $= B \times W$   
To provide rectangular storage tank  
 $= 2W$  Therefore,  $B = \sqrt{100} = 10 \text{ m}$   
Hence, size of tank = (5 x 10 x 15) m

### COST ANALYSIS AND ESTIMATION

SL NO	DESCRIPTION	UNIT	NOL (m)	W (m)	D/H (m)	QTY	Rate	Amount	
	<b>SEWAGE TREATMENT PLANT</b>								
A	<b>Preliminary Work</b>		1	15	10	5			
1	Excavation								
a	Up to 1.5 m	Cu.m	1	15	10	5	750	110	8,25,00
2	Plain Cement concrete with 12-20 mm	Cu.m	1	16	11	0.1	17.6	5800	1,02,080
3	Reinforced cement concrete (M-30) including formwork								
a	Bottom Slab	Cu.m	1	15.4	10.0	0.2	30.8		
b	Vertical Walls	Cu.m	2	15.4	0.2	5	15.4		
c	Vertical Walls	Cu.m.	2	15.0	0.2	5	15.0		
						Total	61.2	6300	3,85,560
4	Corrosion Resistance Steel (CRS) reinforcement for RCC work	MT					7.0	78,000	5,46,000
					<b>Cost of Civil Works</b>				<b>11,16,140</b>

### Cost of PVC pipes for rooftop collection :

- Total length of PVC pipes = 167m.
  - Cost of 6" PVC pipe =Rs. 600/ m (market value)
  - Total cost of PVC pipes =Rs.1,00,200 /-
  - Cost for fitting and fixtures =Rs. 10,000/-
- Total cost = Rs. 1,10,200/-**

Table 1 : PVC COST ANALYSIS

SL.No	Description	
1	Total cost of construction water tank	11,16,140/-
3	Total cost of PVC pipe	1,10,200/-
4	Cost for fitting and fixtures	10,000/-
5	Cost of Pump and Fixing	13,000/-
6	Total Cost	12,49,340/-

## V. CONCLUSION

- The total area under Project is calculated as **4737m<sup>2</sup>**.
- This is one time investment in the work of rainwater harvesting though its Costly but the requirement of the drinking purpose is fulfilled upto **66%** only through rain.
- In future water collected from surface run off is harvested in bore wells which will serve the purpose of recharging aquifers and fulfill the increasing demand of water.
- The total Cost of the project is **12,49,340/-** though it is quite high but the rainwater harvesting is the need of this Era. This is one time investment but the achievements are too high.

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