Rainwater Harvesting System Design For College Premises

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Abstract- *The rainwater received in the campus was not allowed to percolate to the ground due to the developments solidifying the ground zone. Rainwater harvesting can be used in the campus to scientifically collect and store the precipitation to meet the water demand in the event of severe water scarcity in the region. Employing such a cost effective and efficient solution will help to maintain a sustainable water source which can meet the demand without depending on external sources.*

Keywords- Rainwater Harvesting, Sustainable Water Source, Water Demand

I. INTRODUCTION

Rain is a definitive wellspring of new water. With the ground zone in the campus being solidified, water which keeps running off from patios and rooftops, was depleting into low-lying territories and not permeating into the dirt. Consequently, valuable water is wasted, as it is depleted into the ocean in the end. Rainwater gathering is a framework by which, the water that gathers on the rooftops and the region around the structures is coordinated into open wells through a channel tank or into a permeation load, constructed particularly for this reason. Water is gathered straightforwardly or revived into the ground to enhance ground water stockpiling. Water that isn't removed from ground amid blustery days is the water spared. Rainwater harvesting is a straightforward technique of catching and storing rain wherever its falls. Either, we will reserve it in tanks, or we are able to use it to recharge groundwater.

Rainwater harvesting is the ideal solution for those areas wherever there's inadequate groundwater availability or surface resources. It had been terribly troublesome to imagine few decades before that you simply would require to pay for drinking water. Even though rainwater harvesting system requires initial investment, it helps in preserving water. [1][2]
The objective of this paper is to develop and design a rainwater harvesting system for the college campus to make sure that the premises can self-sustain in case of water scarcity and to integrate it into the scope of a Green Campus in the near future.

II. METHODOLOGY

Catchment Area

To increase the potential benefits of this system and draw maximum advantages from it, we need to have large rooftop areas which will be going to act as catchment areas. More the catchment areas, more will be the surface runoff. Therefore, as much as possible, we have included and considered all the major buildings having large rooftop areas. Hence, study areas include all the 3 blocks, workshop building and the auditorium which amounts to a total of 9487m2 of roof area.

Rainfall Data Collection

Chittilappilly is located at 10.56N latitude and 76.14E longitude in Thrissur district of Kerala at an elevation of about 35.19 meters above mean sea level. Under the Köppen climate classification, the city features a Tropical monsoon climate. Since the region lies in the south western coastal state of Kerala, the climate is tropical, with only minor differences in temperatures between day and night, as well as over the year. The average annual rainfall is 2800 mm. The South-west monsoon generally sets in during the last week of May. After July the rainfall decreases. On an average, there are 177 rainy days in a year The average monthly rainfall data taken from the Meteorological Centre, India and Meteorological Department, Thiruvananthapuram is given below in figure 2.1.

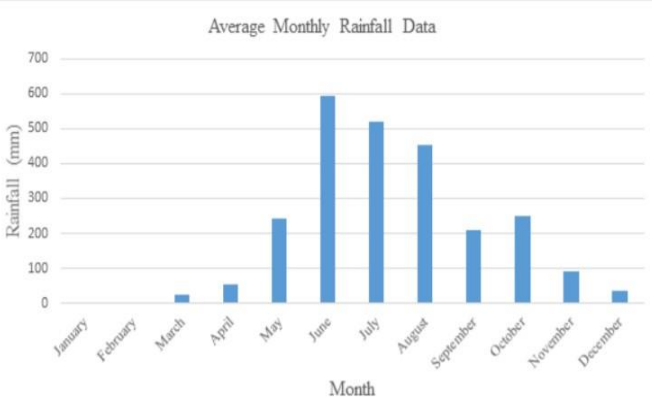

Figure 2.1: Average Monthly Rainfall Data

Storage of Rainwater

The college campus already has a rainwater harvesting pit which can be utilized for this project. However, as it cannot contain the calculated rainwater potential, an additional R.C.C tank is designed to be constructed in the college premises. The water is stored for a long period of time along with rapid consumption to ensure that the campus can self-sustain round the year without water scarcity during summer or overflow of tanks during monsoon .

Gutter and Filtration

Design Due to long dry period, the catchment area generally gets dirty. Hence to prevent entry of excess dirt from the catchment area from entry into tank and polluting the water, first flush mechanism is designed. The design value of this mechanism is fixed to be 8litres/10m2 and Ball-Valve design was chosen.

III. HYDROLOGICAL ANALYSIS

Annual Rainwater Harvesting Potential

Annual rainwater harvesting potential is given by:

$$V = K \times I \times A$$

The runoff coefficient for flat roof and sloped roof is taken as 0.80 and 0.95 respectively as per manual of artificial recharge of ground water, Government of India Ministry of Water Resource Central Ground Water Board. The total annual rainwater harvesting potential from all the selected rooftops amounts to approximately 21924.7222 m3 B.

Discharge Calculations

To find out the required diameter of the pipe to be used for draining the rainwater down from the roof first we need to calculate the discharge Q is given by:

$$Q = C \times I \times A$$

Table.3.1:Discharge Calculations

Building Name	C (Constant)	I (mm/hr)	A (m^2)	Q (m^3/s)
Main Block	0.80	25	3685	0.020472
EEE Block	0.80	25	1569	0.008717
Mechanical Block	0.80	25	1569	0.008717
Auditorium	0.80	25	1428	0.007933
Workshop	0.80	25	1236	0.006867

Calculation for Number of Rain water Pipes to be Installed

Let us consider the R.W.P. to be provided areofdiameter120mm.So, calculations will be as follows:

$$Q=CxIxA=nx\pi/4xd^2xv$$

From the calculations, weneed52pipesforourproject.

IV. OPTIMISTIC DETERMINATION OF SIZE AND DESIGN OF RAIN WATER STORAGE TANK

Annual rain water harvesting potential of campus =Size of tank = 21924.72m^3

As water is stored on monthly basis, Size of the tank will be equal to the excess amount of water left over after consumption. Hence, mostly excess amount of water assumed to be collected during the period of maximum rainfall–June.

Central Ground Water Authority, Government of India recommends adapting a value of 135 liters per head per day water consumption for school/educational institutions with boarding facilities.

The Kerala Municipality Building Rules, 1999 in Chapter XVI-A:

Rainwater Harvesting classifies Educational Institutions as Group B and requires a minimum capacity of storage tank of 50litres/m2 for Group B buildings.

Assuming amount of water consumed per month = 1300 x 0.1 x 30 = 3900m3

The harvesting potential of the system during the peak month of June = 4618.66m3 Hence, maximum amount of water to be stored = 4618.66 – 3900 = 718.66m3 Taking a

F.O.S of 1.1, the required capacity of water storage tank = 790.52m3 ≈ 825m3

The IES Engineering College already has a rainwater harvesting storage tank of capacity 585.38m3 . The tank has a plan dimension of 10.70m X 19.10m with 3 sections each of 17.30m X 8.90m, 15.70m X 7.30m and 14.30m X 5.90m at depths of 2.00m, 1.50m and 1.25m respectively. The total quantity of water to be stored at peak conditions is calculated and 555.39m3 of water can be diverted into the existing rainwater storage tank for storing. The rest of the water, i.e. the must be stored in a new water tank which must be designed meeting requirements.

Table4.1:Rain water Storage Distribution

S.No	Tank	Buildings Included	Water for Storage at Peak Conditions	Tank Capacity
1.	Existing water tank – Near Auditorium	Main Block	554.39m^3	585m^3
		Auditorium		
		Workshop		
2.	Water tank 2 – In front of EEE Block	EEE Block	231.28m^3	240m^3
		Mechanical Block		
			Total Tank Capacity	825m^3

The above capacity of tank also meets the minimum capacity of the storage tank as stipulated in sub rule (2) (iv) of the rainwater storage in Kerala Panchayat Building Rules 2011, Chapter XVI[4] . It recommends 50liters/m2 of rooftop area which comes to 474.35m3 or 474350 liters.

V. ADVANTAGES

- Rainwaterharvestingcanreducestormwaterrunofffromapr operty.Theeliminationofrunoffcanreducecontamination of surface water with pesticides, sediment, metals, and fertilizers.
- By reducing storm water runoff, rainwater harvesting can reduce a storm's peak flow volume and velocity in local creeks, streams, and rivers, thereby reducing the potential for stream bankerosion.
- Collecting and using rainwater to replace municipal water use reduces your water bill
- It is an excellent source of water for plants and landscape irrigation since it has no chemicals such as fluoride and chloramines(chlorine)

VI. FUTURE SCOPE

Integration into the Green Building concept

Implementation of rainwater harvesting will lead pavement for the campus to be a self-sustaining green building. Being able to recirculate the water within the campus along with the collection of rainwater will help in keeping the self-sustainability of water part in check.

System Integration

This will help in capturing waster energy and water for other structures or parts of the campus to ensure systems are programmed to work together

Water Reuse and Efficiency

Using of rainwater and an in-house water treatment facility will reduce total water consumption from source and allows us to sustain with a circulating supply of water.

VII. RESULT AND DISCUSSION

All aspect of improving the water scarcity problem in the campus is dealt by implementing rainwater harvesting system. The Chittilappilly area situated in Thrissur District has an annual average rainfall of 2819mm and the whole of campus has an annual harvesting potential of around 21,924,722 liters.

The received water is then carried out from the roof tops through pipes which were carefully designed for optimum conveyance and then discharged into two tanks. This allows the campus to self-sustainon its water demand.

Rainwater harvesting is a very efficient method of taking the campus eco-system to an integrated self-sustainable campus. Implementation of the system will help to meet the water demand of the campus without having to depend on external sources and the storage of the same will help in case of waters car city.

REFERENCES

[1] Gupta, Lokesh & Ojha, Avinash. (2016). Design Of Rainwater Harvesting System at Spsu Udaipur. 10.5281/Zenodo.54654.

[2] Keskar, Abhijeet & Taji, Satish & Ambhore, Rushikesh & Potdar, Sonali & Ikhar, Prerana. (2016). Rainwater Harvesting – A Campus Study
[3] Arun Kumar Dwivedi, Virendra B. Patil, Amol B. Karankal, Dr. Rooftop Rainwater Harvesting for Groundwater Recharge in An Educational Complex. Global Journal of Research In Engineering, [S.L.], Mar. 2013.
[4] Chapter XVI Rainwater Harvesting, Kerala Panchayat Building Rules 2011
[5] Energy conservation: Indian Scenario and green building concept, Author by Jay Prakash, Scientist 'C', CCE(R&D) North, New Delhi