TO FORMULATE THE CONCEPT OF RAINWATER HARVESTING IN URBAN AREAS

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ABSTRACT

At the rate in which India population is expanding, it is said that India will definitely supplant China from its number 1 position of most densely populated nation of the world after 20-30 years. These will prompt high rate of utilization of most profitable regular asset; Water's subsequent in enlargement of weights on the allowed freshwater assets. Old technique for damming waterway and transporting water to urban zone has its own issues of everlasting inconveniences of social and political. Keeping in mind the end goal to save and take care of our day by day demand of water prerequisite, we have to think for elective savvy and generally less demanding mechanical techniques for monitoring water. Rain water reaping is outstanding amongst other techniques satisfying those necessities. The specialized parts of this paper are water gathering gathered from housetop which is thought to be catchment territories from all lodgings and Institutes departmental working at D.Y. Patil College of Engineering, Akurdi Campus. As a matter of first importance, required information are gathered i.e. catchment zones and hydrological precipitation information. Water gathering potential for the inns and workforce flats was ascertained, and the tank limit with appropriate plan is being considered. Volume of tank has been ascertained with most suitable strategy for estimation. Ideal area of tank based on hydrological investigation.

Keyword : - *RWHS, Catchment Area, Hydrological, Precipitation, Infiltration.*

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1. INTRODUCTION

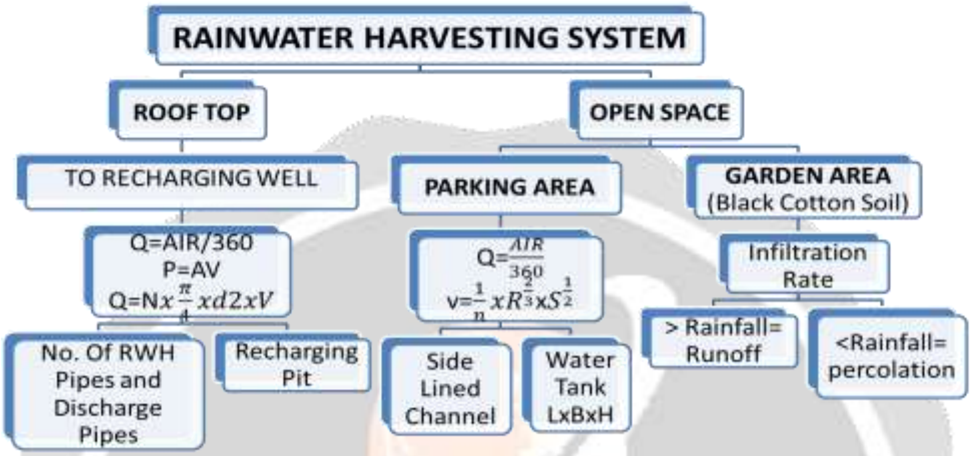
In present scenario of water scarcity, water conservation plays a vital role. Rainwater Harvesting is the storing and recharging ground water tables, of rainwater for reuse, refill the aquifer. Rainwater collected from the roofs of houses, tents and local institutions can make an important contribution to the availability of drinking water. Water collected from the surface, open spaces, sometimes from areas which are especially prepared for this purpose, is called Storm water harvesting. Rainwater harvesting systems can be simple to construct from inexpensive local materials, and are potentially successful in most habitable locations. The technical aspects of this project are rainwater harvesting collected from rooftop and surface which is considered to be catchment areas for our Project. First of all, required data is collected i.e. catchment areas & hydrological rainfall data. Along with the data and consumption we have to increase the efficiency of collecting rainwater to increase ground water table as the alternative cost.

1.1 Objectives

- To study various methods of rainwater harvesting in urban areas and execution of rooftop rainwater harvesting system limiting to medium rainfall condition.
- To design open space runoff harvesting system and improve the collecting efficiency of rainwater.

- To check for infiltration rate for ϕ-index.
- To check the cost for the adopted system.
- To prepare draft procedure of sanctioning and monitoring for rainwater harvesting in urban areas.

1.2 Methodology



2. STUDY AREAS AND DATA COLLECTION

2.1 Study Area

As discussed earlier in the section of introduction – importance of rainwater harvesting at D.Y. Patil College of Engineering, we clearly came to know that all the advantages which we can draw out by implementing this small but highly efficient technique in the campus. Thus to increase the potential, benefits of this system and draw maximum advantages from it, we need to have large rooftop and open areas which will be going to act as catchment areas. More the catchment areas more will be the surface runoff and thus more will be the amount of harvested water.

Therefore as much as possible, we have included and considered all the major buildings having large rooftop areas. Hence, study areas includes all the 4 block, 1 Garden, 1 paved Parking Area. Given below a satellite picture, showing majority of the buildings considered for rainwater harvesting system at D.Y Patil College Campus.

Fig 1.: Satellite Picture of Campus

2.2 Data Collection

Statement showing Month-Wise Average Rainfall (mm) for the last 5 years in the Pune district :-

Year	Jan mm	Feb mm	Mar mm	Apr mm	May mm	Jun mm	Jul mm	Aug mm	Sept mm	Oct mm	Nov mm	Dec mm
2013	0	0.1	0.3	0.2	3.7	251.43	354.58	148.03	192.17	73.97	7.8	5.2
2014	2.8	3.39	16.5	1.1	7	45.1	342.9	264.03	132.93	78.04	31.88	10.95
2015	1.86	4.23	26.69	1.5	3.19	124.49	33.05	41.76	102.63	75.69	51.32	0.1
2016	0.2	0.91	13.59	5.61	3.48	164.33	190.84	58.96	170.11	75.89	0	0
2017	0	0	0.2	0	3.3	134.1	93.2	67.4	453.2	156.3	0	1.5

Chart 1 : Monthly Average Rainfall for last 5 Years in Pune

Fig.2: Average annual Rainfall (2017)

Fig.3: Average Annual Rainfall (2016)

3. DESCRIPTION OF STUDY AREA

The rooftop surface area and the open surface area is nothing but the catchment area which receives rainfall. Catchment areas of the Institutional departments are measured. This measurement was done manually with the help of tape which is the simplest technique known as "tape survey". Those places which area not accessible to land on, are measured by using the ruler from tool box of Google Earth. Given below the table for calculated the rooftop areas of all the buildings suited inside the campus:-

SR. NO.	BUILDING NAME	ROOF AREA (m^2)
1	**Wing A**	681.636
2	**Wing B**	631.636
3	**Wing C**	801.482
4	**Wing D**	588.132
Total		**2752.88 m^2**

Chart -2: Roof-top Area

4. DESIGN AND ESTIMATION

4.1 Runoff Estimation

Computation of runoff volume used to design of recharge pits and storage volume. Amount of discharge coming from surface runoff can be computed by the following expression.

Q = C x I x A /360

Where,

Q = surface runoff in m^3/sec

I = Intensity of rainfall in mm/hr

C = runoff co-efficient.

A = Catchment area.(ha)

Runoff volume

m^3= C x A x annual average total depth

From the above formula the volume of water received to harvest is 1375.02 m^3/ year.

4.2 Determination of ϕ-index of in garden area

If rate of infiltration ≥ rainfall intensity, then no runoff occurs. If rate of infiltration < Rainfall intensity, then runoff takes place.

ϕindex = Rainfall – runoff / Duration

For Black cotton Soil, Infiltration rate is 2.5 mm/hr.
In Pune maximum rainfall intensity is 0.25 mm/hr.
As, infiltration rate for black cotton soil is greater than maximum rainfall intensity in Pune. Therefore, No runoff takes place on garden are surrounded by Black cotton soil.

Example: Amount of runoff takes place on garden area surrounded by black cotton soil.
Rainy seasons (June, July, August, September)
No. of days = 4 x 30 = 120 days
Average maximum intensity of rainfall in Pune = 0.25 mm/hr.
In these 1 to 120 days, Considering 6 – 7 hrs of continuous rainfall (7 x 120 = 840 hrs)
Total amount of rainfall collected = 840 hrs x 0.25 mm/hr
= 210mm = 0.0210 m
Total garden area = 2062 m^2
Total amount of rainfall collected as runoff = 2062 x 0.0210 = 43.30 m^3.

As D.Y. Patil College Campus covered by Black cotton soil, Infiltration Rate 2.5 mm/hr.
Average intensity of rainfall in pune is 0.25 mm/hr
Hence,

No runoff takes place in garden area of the Campus.

4.3 Design of Recharge Well

The design of recharge well is done on the basis of two criteria

- Time of Concentration.
- Maximum water to be stored at the longest rainfall with chocked filters.

Time of Concentration It is a fundamental hydrology parameter and used to compute the peak discharge for catchments. The peak discharge is a function of the rainfall intensity of particular return period and duration. Time of concentration is the longest time required for the a water to travel in catchments and reach to outlet point (in our case, roof top and length of drain to recharge pit). The mathematical equation used for calculation of time of concentration requires inputs for the longest watercourse length in the watershed (catchments area (L), the average slope of that watercourse (S). The average value of slope will be different for different surfaces e.g. Roof, road, lawn, drain etc. The Tc is generally defined as the time required for a drop of water to travel from the most hydro-logically remote point in the sub-catchments to the point of collection A time of concentration value is essential to determine critical intensity of rainfall because maximum discharge will occur for rainfall intensity of duration equal to the time of concentration. Time of concentration can be calculated by using following formula

$$T_c=0.0195\, L^{0.77}S^{-0.385}$$

Where,

T_c = Time of Concentration in minutes.
L = Overland flow length in m.
S = Average slope of the overland area.

This equation has been adopted from Kirpich 1940 (Soil and water conservation Engineering by Glenn O. Schwab John Wiley). If the slope of overland flow surface is different for different portion of overland flow then we can use the following formula

$$T_c= {}_{i=1}\Sigma i{=}n0.0195\, L_i^{0.77}S_i^{-0.385}$$

Where,

L_i = overland flow length of I stretch in m.

S_i = Average slope of I stretch of overland flow.

n = no. of different stretches.

Volume of the Recharge well = Q x $T_{c.}$

Considering the maximum intensity of rainfall with chocked filter , volume of recharging pit is calculated and the maximum value from both the condition is selected.

4.4 Estimation Of RWH System

Detailed Estimation

Sr. No.	Particular	No.	Length (m)	Breadth (m)	Height (m)	Quantity (m^3)
1	**Earthwork in Excavation**	1				58.032
2	**Cement Concrete 1:3:6**	1	6	4	0.2	4.8
3	**I Class Brick work in 1:4 Cement Mortar**					
	Long Wall	2	6.6	0.3	1.5	5.94
	Short Wall	2	4	0.3	1.5	3.6
4	**RCC work for Slab Cover**	1	6.6	4.6	0.20	6.072
5	**12mm plastering inside with 1:2 cement mortar**					
	Long wall	2	6	-	1.5	18
	Short wall	2	4	-	1.5	12
					Total	108.44

Abstract Of Estimation Cost

Sr. No.	Particular	Quantity	Rate	Cost (Rs.)
1	**Earthwork in Excavation**	58.032	100 Rs./m^3	5804
2	**Cement Concrete 1:3:6 in Foundation with brick Ballast**	4.8	2700 Rs./m^3	12960
3	**I Class Brick work 1:3 Cement mortar**	9.54	3000 Rs./m^3	28620
4	**RCC work for Slab Cover**	6.072	2700 Rs./m^3	16395.4
5	**12mm Plaster with 1:2 Cement Mortar**	30	2700 Rs./ m^3	81000
6	**100mm Pipe**	3512.92 kg	51 Rs./kg	179158.92
Total				318135
6	**Contingency + Work Charges establishment**	3% + 2%= 5%	15906.75	334041.75
7	**Engineers Profit**	10%	33404.175	
Total Estimated Cost				Rs. 367446

4. CONCLUSIONS

In the most water-scarce regions of India, RWH offers limited potential. In many other regions, which have medium rainfalls but experience 'medium to high evaporation', the poor groundwater potential of the hard-rock that underlie these regions pose a constraint for recharging. This was illustrated by water-level fluctuation data in the wells. In many water-scarce basins, there is a strong tradeoff between maximizing the hydrological benefits from RWH and making them cost-effective. In many water-scarce basins, RWH interventions lead to the distribution of hydrological benefits rather than to their augmentation. Both these techniques will be helpful to save the water from wastage. So collecting rain water is cost effective and a best alternative to the scarcity for water worldwide.

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