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DESIGN OF RAIN WATER HARVESTING SYSTEM AT SPSU UDAIPUR

Avinash Ojha*, Lokesh Gupta

* Asst. Professor, Dept. of Civil Engg., Sir Padampat Singhania University, Udaipur, Rajasthan, India
Asst. Professor, Dept. of Civil Engg, Sir Padampat Singhania University, Udaipur, Rajasthan, India

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ABSTRACT

Rainwater harvesting and conservation in principle is a simple technique of catching and holding rainwater where it falls such as rooftops, land surface or rock catchments using simple techniques such as jars and pots as well as more compound technique for instance underground check dam. These techniques usually found in Asia and Africa arises from practices engaged by primeval civilization within these regions and still performs as a major source of drinking water supply in rural areas. Effectiveness of the rainwater harvesting depends on appropriate design of the systems. Be it storage or a recharge structure, an inappropriately planned system will guide to operational problems, thereby raising the operation and maintenance cost. This research study mainly focous on design of rain water harvesting system at Sir Padamapat Singhania University(SPSU), Udaipur. This also includes the design of recharging dug wells or abandoned bore well. This facility will collect water from roof top and carry it all the way up to recharge dug well or abandoned bore well. Running cost of the facility is almost trivial. Water harvested from the roof catchments usually is of acceptable quality for household requirements. Depending upon household requirement water collection capacity can be increased as needed within the available catchment area.

KEYWORDS: Rainwater Harvesting, Dug Well, Catchment, Water conservation

INTRODUCTION

The history of rainwater harvesting in Asia can be unearthed during 9th or 10th Century. The evidence of teensy harvesting of water from roof and simple check or brush dam construction has been found in the rural areas of South Asia as well as South-East Asia. The harvesting of rainwater from the eaves of roofs or via simple channels into traditional jars and pots has been trailed back almost 2 000 years in Thailand. Rainwater harvesting techniques has long been utilized in the Loess plateau regions of China. More recently, about 40,000 well storage tanks in a variety of different forms were constructed between 1970 and 1974 using a technique which stocks rainwater and storm water runoff in ponds of various sizes. To minimize the water loss a thin layer of red clay is generally laid on the bottom of the ponds. Trees are planted at the edges of the ponds which help to minimize evaporative losses from the ponds (UNEP, 1982).

In Philippines, rainwater harvesting was first pioneered in 1989 with the backing of the International Development Research Center, Canada. Many number of rainwater storage tanks were built about 500 in the Capiz province during this project. The capacity of tanks differs from 2 to 10 m3 and the tanks are made of wire framed ferro-cement. The construction of the tanks employed building a steel reinforcing frame and wire mesh on a strong reinforced concrete foundation. The tanks were then plastered both inside and outside at the same time, which condense their susceptibility to corrosion when compared with metal storage tanks.

OBJECTIVE OF PRESENT STUDY

The objective is to utilize and design the roof top rainwater harvesting and conservation technique to reduce the over exploitation of natural fresh underground water resource.

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RAINWATER HARVESTING

Rainwater harvesting is defined as an activity of straight collection and storage of rain water, towards best use of humanity. This technique conserves the accumulation and deposition of rain water for reuse on-site, rather than allowing it to run off.

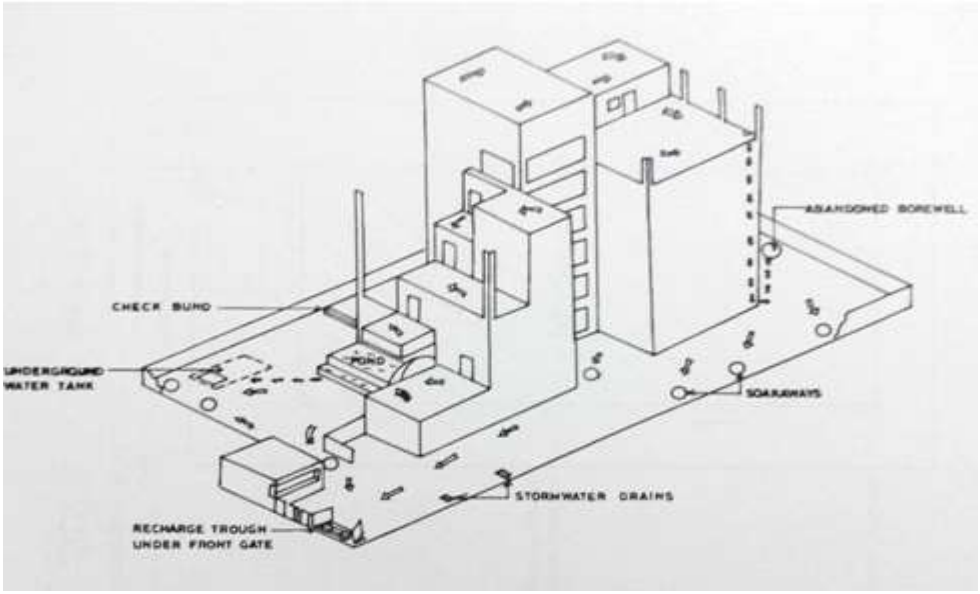

Fig-1: Water Harvesting System in Building

FEATURES OF RAINWATER HARVESTING AND CONSERVATION

The various features related to rain water harvesting and conservation can be summarized as-

1.Reduces flood issue in urban regions.
2.System can be develop and construct in a lesser amount of time.
3.Economically feasible and cheaper in construction with respect to dams, Diversion etc.
4.Utilizes the prime source of water and avoid the runoff from going away into sewer or storm drains, thus reducing the burden on treatment plants.
5.Recharge the underground aquifer which helps in improving the water level of existing place and their over exploitation.

GAIN OF RAIN WATER HARVESTING SYSTEM

1.Easy Construction - Most people can build the system by their own with readily available materials.
2.Effortlessness of Maintenance - Operation and maintenance of a domestic rainwater collection system is controlled by an individual without depending upon the maintenance practices of municipal corporations.
3.Quality water - Rainwater is generally one of the superior sources of water supply compared with other sources of available water.
4.Comfortableness – it provides a convenient source of water on spot where it will be used or consumed.
5.Flexible and adjustable - The systems can be adapted to suit most individual situations and to fit any household's budget.

METHODOLOGY

Rain Water harvesting from the top of roof or household Rain Water harvesting is the system all the way through which rain water is captured from roof catchments and reserved. It consists of conservation of roof top Rain Water in urban and utilizing it to augment Ground storage by artificial recharge. It requires connecting the outlet pipe from roof top to divert collected water to existing well/tube well/or specially designed.

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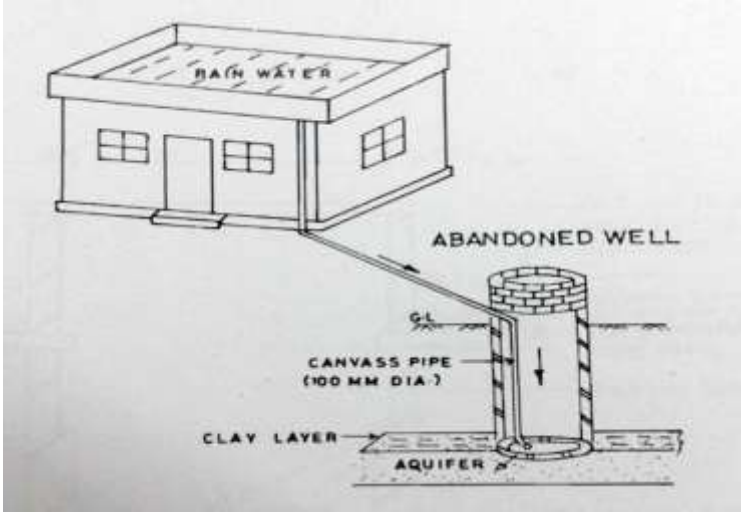

Fig-2: Schematic Representation Of Water Collection

Roof Top Rain Water Harvesting & Conserving Systems consists six basic components as described below:
1. Catchment Area/Roof: Surface upon which rain falls.
2. Gutters and Downspouts: transport channels from catchment surface to storage.
3. Leaf screens and Roof Washers: Systems that remove contamination and debris.
4. Cisterns or Storage Tanks: where collected Rain Water is stored
5. Conveying: the delivery system for treated Rain Water, either by gravity or pump.
6. Water Treatment

The system consists of water that falls on zinc, asbestos or tiles roof of a house during rain storms, and conveying sort of means to a nearby covered storage unit or cistern. Rain Water yield differ with the size and surface of the catchment area. A more impervious, cleaner and smoother roofing material contributes large amount and better quality of water.

Rainfall(mm) Roof top area (Sqm)	100	200	300	400	500	600	800	1000	1200	1400	1600	1800	2000
	Harvested Water from Roof Top (cum)												
20	1.6	3.2	4.8	6.4	8	9.6	12.8	16	19.2	22.4	25.6	28.8	32
30	2.4	4.8	7.2	9.6	12	14.4	19.2	24	28.8	33.6	38.4	43.2	48
40	3.2	6.4	9.6	12.8	16	19.2	25.6	32	38.4	44.8	51.2	57.6	64
50	4	8	12	16	20	24	32	40	48	56	64	72	80
60	4.8	9.6	14.4	19.2	24	28.8	38.4	48	57.6	67.2	76.8	86.4	96
70	5.6	11.2	16.8	22.4	28	33.6	44.8	56	67.2	78.4	89.6	100.8	112
80	6.4	12.8	19.2	25.6	32	38.4	51.2	64	76.8	89.6	102.4	115.2	128
90	7.2	14.4	21.6	28.8	36	43.2	57.6	72	86.4	100.8	115.2	129.6	144
100	8	16	24	32	40	48	64	80	96	112	128	144	160
150	12	24	36	48	60	72	96	120	144	168	192	216	240
200	16	32	48	64	80	96	128	160	192	224	256	288	320
250	20	40	60	80	100	120	160	200	240	280	320	360	400
300	24	48	72	96	120	144	192	240	288	336	384	432	480
400	32	64	96	128	160	192	256	320	384	448	512	576	640
500	40	80	120	160	200	240	320	400	480	560	640	720	800
1000	80	160	240	320	400	480	640	800	960	1120	1280	1440	1600
2000	160	320	480	640	800	960	1280	1600	1920	2240	2560	2880	3200
3000	240	480	720	960	1200	1440	1920	2400	2880	3360	3840	4320	4800

(Extract from CGWB Guide) Central Ground Water Board

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Fig-3:Availability Of Rain Eater Through Roof Top Rain Water Harvesting

The figure 3 will help in determining the numbers of pipes of particular diameter are required for design part and average rate of rain fall mm/hr for that region. The graph gives fair idea about amount of peak precipitation may likely to happen (on Y-axis) for different duration of rain falls shown by curved lines with respect to recurrence intervals in the year represented on X-axis. This will give idea about peak rainfall intensity for a particular station for which settlement time are to be designed for 15 minutes duration of peak rain falls.

S.No.	Diameter of pipe (mm)	Average rate of Rain Fall (mm per hour)					
		50	75	100	125	150	200
		Roof Area (Sqm)					
(i)	50	13.4	8.9	6.6	5.3	4.4	3.3
(ii)	65	24.1	16.0	12.0	9.6	8.0	6.0
(iii)	75	40.8	27.0	20.4	16.3	13.6	10.2
(iv)	100	85.4	57.0	42.7	34.2	28.5	21.3
(v)	125	-	-	80.5	64.3	53.5	40.0
(vi)	150	-	-	-	-	83.6	62.7

(Extract from SP-35)

Fig-4:Sizing of rain water ppes for roof drainage

The board ideas about the particular diameter of pipe which will be required to cater the average rate of rain fall mm/hr and certain roof part.

SAMPLE CALCULATION

The amount of water i.e. received in the form of rainfall over an area is called the rain water endowment of that area. Out of this the amount can be effectively harvested is called the rainwater harvesting potential.

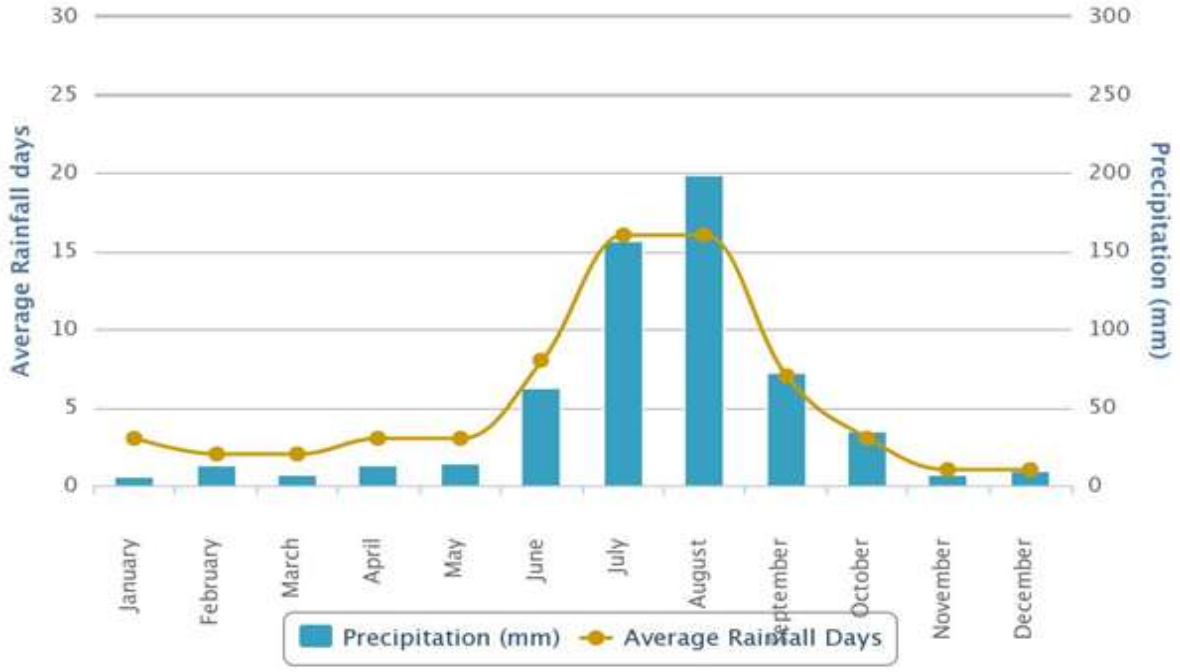

Fig-5:Average Rainfall(Mm) Graph For Udaipur

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Rainwater Harvesting Potential = Collection efficiency * Rainfall (mm)
Annual rain fall of city (Udaipur) = .042m (Seasonably)
Area of roof Catchment = 3962.30m^2 (Roof top Catchment Area, SPSU,BH-4)
Height of Rain fall = 0.42m (average seasonably)
Rain fall volume over plot = Height of rainfall× Area of plot
Rain Water endowment of that area = 1664.1m^2

EFFECTIVELY HARVESTED WATER FROM TOTAL RAINFALL

1. Roof catchment is having tile finish and corrugated metal sheets. So coefficient for roof surface as per the Indian Standards (IS: 15797-2008) is adopted as 0.80 & 0.85 respectively.
2. Another constant coefficient for evaporation, first flush wastage and spillage can be considered as 0.80 (for all situations).

Statically and approximately only efficiently harvested water quantity may be considered as
= Rain water endowment of that area × 0.80 × surface efficient
= 3962.30×0.42×.85×.80
= 1132 liters

The collection efficiency accounts for the particulars that total amount of rain water of a region is difficult to be effectively harvested because of evaporation, spillage etc. Characteristic like run off coefficient for different types of roofs and land surfaces etc. and the first flush dissemination i.e. Wastage of water after first rain , evaporation and spillage does not enter the system. Therefore a constant co-efficient of 0.80 may be considered for all solutions. This is done because the first spell of rain carries with it a relatively larger amount of toxic and hazardous waste from the air and catchment area.

STORAGE / SETTLEMENT TANKS

In a water harvesting system, the quantity of water stored depends on size of catchment area and the size of storage tanks. The storage tank has to be designed according to the water requirements, rain fall and catchment availability. The rain water is to be stored for drinking, cooking, washing, gardening purposes etc.

Basic Data

i) Average annual rainfall =.042(seasonably)
ii) Size of catchment = 3962.30m^2

Storage Tanks – About 1000-2000 liters of storage tanks are available in the market. According to our requirement we need the storage tank of 1200liters (approx.)
Approximate size of tank = Cylindrical type (Diameter-1m and height-1.3m)

CONCLUSION

The rainwater harvesting technology utilizing building roof area runoff is simple to install and operate. Locals can be easily taught to execute such technology, and the materials are also readily available. The system is convenient in the sense that it supply water at the point of consumption, and family members have full charge of their own system, which to a great extent minimizes operation and maintenance problems. Running costs, also, are almost insignificant. Water harvested from roof catchments generally is of acceptable quality for domestic purposes. As it is gathered strictly utilizing existing structures only, rainwater harvesting system has few negative environmental impacts with respect to other water supply technologies. Although local factors can modify the regional climatic conditions, rainwater can proved to be a continuous source of water supply for both the rural and poor. Depending upon domestic capacity of each household and demands, both water collection and its storage capacity may be increased as needed within the available catchment area.

With plentiful rainfall annually between Udaipur and Vallabhnagar tehsil, rain water harvesting system can be implemented in this region. That why we decided to adopt and propose this technical idea for our college where good amount of water can be harvested which has been calculated above and can be used for different purposes.

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