

Study of Roof Top Rainwater Harvesting In Urban Area

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Abstract:-In developing and under developing countries shortage of water is a cause of concern for domestic and industrial use and even for drinking purpose. The problem of water shortage will become very critical in near future unless preventive measure is taken especially in India which is already facing water shortage problem. Roof top rainwater harvesting is one of the preventive measure in which the process of collecting rain water from roof top is quite easy and stored in the reservoirs. The main objective of roof top rainwater harvesting is to make water available for future use. Roof top rainwater harvesting is the most common technique for domestic rainwater harvesting. Paper contains the detailed study of roof top rainwater harvesting, its importance and component.

Keywords:-Rainwater harvesting, Roof top, Rain water

Introduction: -

Roof top rainwater harvesting is especially suitable for urban areas in which rain water is directly collected from the roof and can be stored for further use whenever required. The main objective is to reduce flow of rain water to rivers through drains without making any use. Therefore rainwater harvesting is the one of rainwater conservation technique. Optimum utilization of natural resources is to be done through roof top rainwater harvesting.

Expected benefits of roof top Rainwater Harvesting:-

- Rise in ground water levels in wells
- Increased availability of water from wells
- Prevent decline in water levels
- Improve soil moisture
- Reduction in use of energy for pumping water and consequently the costs.
- Reduction in flood hazard
- Mitigating the effects of droughts

Roof top rainwater harvesting for artificial recharge to ground water:-

Rain water harvesting from roofs consist of collecting, storing and putting to use roof top rainwater from houses or any construction is roof top rainwater harvesting. Conservation of rainwater is done by roof top of the house and utilizes this rainwater for ground water storage for artificial recharge. It is a technique in which rainwater is collected from roof catchment and stored in tanks, reservoir or aquifer. The approximate volume of water available from harvesting with respect to roof top area and annual rainfall of that area has been shown in Table-1

Domestic roof top rainwater harvesting consist of storage tank, guttering system for transport water from roof to storage tank see Fig-1. First flush system are provided to divert dirty water which contains debris collected during non-rainy season and filter units to remove debris and contaminants before water store in to the storage tank. So domestic rainwater harvesting system is especially suitable for urban areas during the period of scarcity. Usually domestic roof top rainwater harvesting is designed to provide drinking and cooking needs of the family.

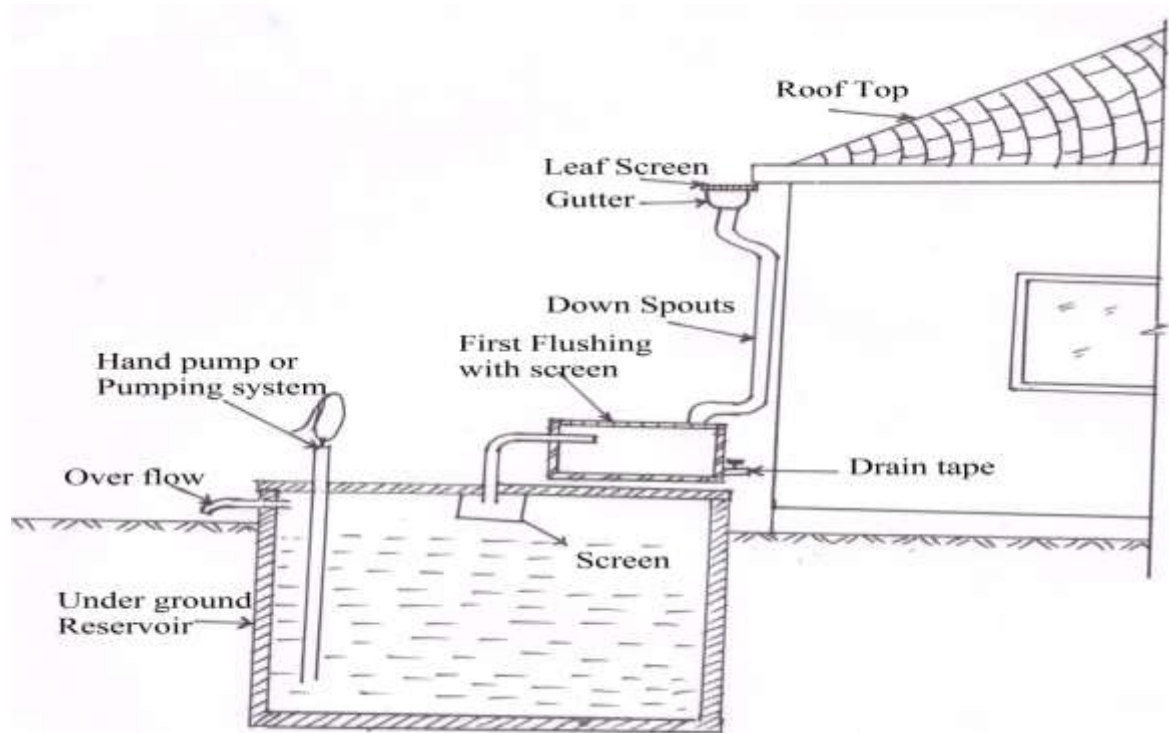


Fig-1 layout diagram of roof top rain water harvesting

Table-1

Availability of rain water through roof top rain water harvesting (Extract from CGWB guide) central ground water board

Rainfall (mm)	100	200	300	400	500	600	800	1000	1200	1400	1600	1800	2000
Roof top area (Sq. mt.)	Harvested water from roof top (Cu. Mt)												
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

Run off coefficient:-

Runoff coefficient plays an important role in assessing the runoff availability and it depends upon catchment characteristics. Due to evaporation and retention of rain water from roof catchment some rainfall will be lost. Run off coefficient is the factor that all rainfall falling on roof catchment cannot be collected to storage tanks. Table-2 give the coefficient of runoff require for various roof top surfaces.

Table-2 coefficient of runoff for roof

Types of roof top	coefficient of runoff
G I sheet	0.9
Asbestos	0.8
Tiled	0.75
Plaster on bricks or concrete	0.7

Roof top rainwater harvesting component:-

Roof top rainwater harvesting and conservancy systems require following basic component for harvesting water

- Catchment area/roof: Surface upon which rain falls
- Course mesh/Leaf screens: For removal of debris for the roof top area.
- Gutters and Downspouts: It acts as transport neck from roof catchment to storage tank.
- Conduit: It is a pipe line to carry rainwater.
- Flushing units: for runoff from first rainfall is flushed out
- Water treatment: Filters and equipment and additives to settle, filter and disinfect.
- Storage tanks: For storage of rainwater which is collected for roof top area.
- Conveying system: The delivery system for treated rainwater either by gravity or pumping

1. Catchments: It is a roof surface upon which rainwater is directly collected and provides water for rainwater harvesting system. The catchments may be flat or sloping area and may be a terrace area. How much rainwater is collected is depending upon the roof top area available. A roof is made of RCC or corrugated sheet. The roof slope affects how water runoff quickly. Steep slope will give more runoff.

2. Course mesh/Leaf Screen: Rainwater from roof may contain significant quantity of plant, debris. It can be removed by providing course mesh or Leaf screen at the top of roof to prevent the passage of debris as shown in Fig-2.

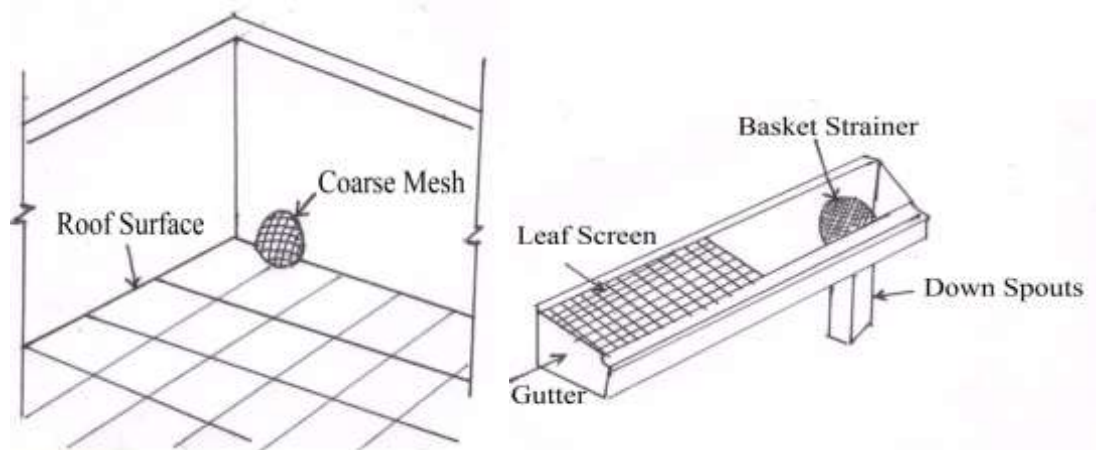


Fig-2 Course mesh and leaf screen

3. Gutter and Downspouts: Gutter is usually a horizontal chamber to collect rainwater from roof top through leaf screen as shown in Fig-2. Down spouts is vertically arrangement of pipe line to collect rainwater from gutter and extend to ground level for transport rainwater to storage tanks. The shape of chamber of gutter is generally rectangular or semicircular and depending upon following factors.

- Locally available material such as corrugated sheet.
- PVC material in the shape of semicircular prepared by cutting it in to two equal channels
- Bamboo

Depending upon the highest intensity of rain the size of gutter is decided. It needs to be properly supported so gutters do not sag when it is loaded with water. The size of gutter is at least 5" wide. The location of gutter and its fitting is depends on the construction of house. Generally gutter is fixed using iron or timber bracket with wall. For house having wider eaves some method of attachment is necessary with for support to the gutter.

4. Conduits: It is the pipeline which carries rainwater from roof catchment and stored in reservoir. Generally the PVC (polyvinyl chloride), Galvanized iron materials are commonly available for pipeline.

The central ground water board give an idea about the particular diameter of pipe which will be required to catch the certain roof surface area for given average rate of rain fall in mm per hour is shown in Table-3. This table will help in determine the number of pipe of particular dia. are required for given roof surfaces area and average rate of rain fall in mm per hour that area.

Table -3 Selection of diameter of pipe

Dia. Of pipe (mm)	Average rate of rainfall (mm per hour)					
	50	75	100	125	150	200
	Roof area (sq. mt)					
50	13.4	8.9	6.6	5.3	4.4	3.3
65	24.1	16.0	12.0	9.6	8.0	6.0
75	40.8	27.0	20.4	16.3	13.6	10.2
100	85.4	57.0	42.7	34.2	28.5	21.3
125	-	-	80.5	64.3	53.5	40.0
150	-	-	-	-	83.6	62.7

5. First-flushing: It is device in which arrangement of valve is provided. Valve is provided to ensure that first spell of runoff from rainfall is flushed out. The first spell of rainwater contains large amount of pollutants from the roof surface area, catchment area. The arrangement of first flushing is shown in Fig-3.

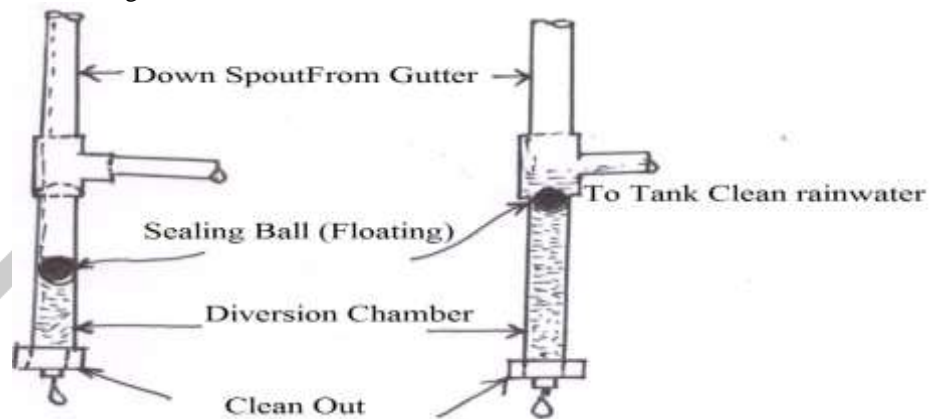


Fig-3 first flushing

6. Filter: The filter is an important part of roof top rainwater harvesting. It is provided to remove suspended particles of rainwater which is collected for roof top. It is a filtering media chamber made of fiber, coarse sand pebbles and gravel layer to remove suspended particles like debris and dirt from water before water enter into storage tanks. Following are the different types of filter use as filter media.

(I) Charcoal water filter

Charcoal water filter is a simple technique in which filter media is provided in a tank. The filter media is made of gravel, charcoal and sand. All such materials are easily available. The layers of filter media are shown in Fig-4.

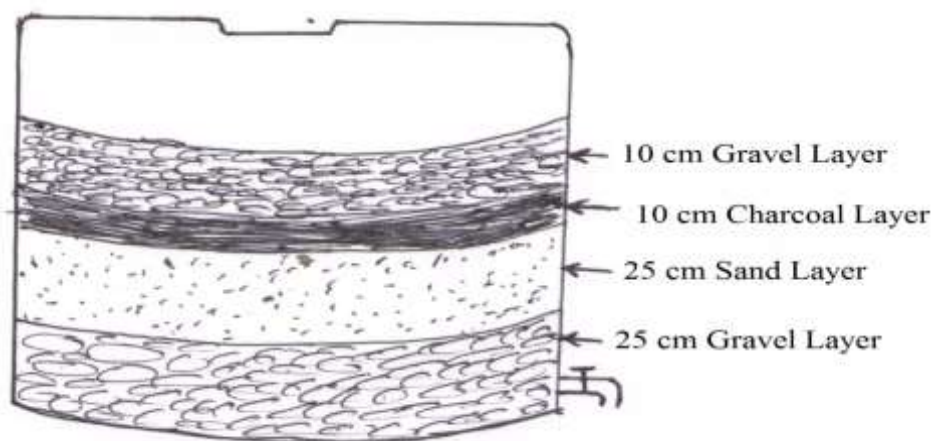


Fig-4 Charcoal Water Filter

(II) Sand filters

In this filter media suspended particles like silt and clay, colour and other microorganisms are effectively removed from water. In sand filter main source for filter is sand which is easily available. The construction of sand filter media is inexpensive. The top layer of sand filter made of coarse sand and followed by 5-20 mm layer of gravel followed by another layer of 5-25 cm of gravel and boulders as shown in Fig -5

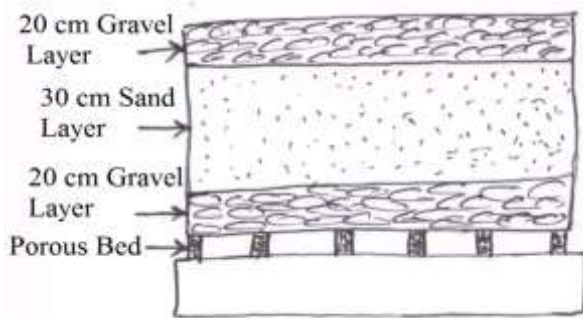


Fig-5 Sand filters

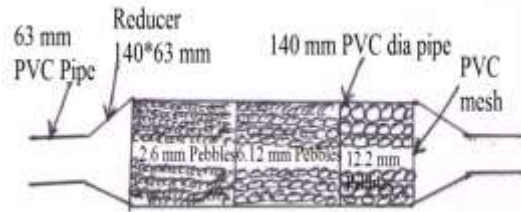


Fig-6 Dewas filters

(III) Dewas filters

Generally resident area from dewas or Madhya Pradesh have tube wells in their home. Most of them extract groundwater from wells. The rain water is collected from roof top and allowed to pass through dewas filter is a part of filter system designed by Mohan Rao, district collector of dewas and engineers of rural services. Keep the roof always clean specially in rainy season so that quality of rainwater do not deteriorated the filter unit

The filter consists of PVC (polyvinyl chloride) pipe of 1.5 mt long and 140 mm diameter. Three chambers are provided in it. The first chamber act as first purification made by pebbles of size between 2-6mm. The second chambers have larger pebbles of size 6-12 mm and last chamber have pebbles size of 12-20 mm. Mesh is provided at outer side of filter for clean water flow which is passing through different chamber as shown in Fig-6.

(IV) Filter for large rooftops

For larger roof area the rain water is harvested using filtering system which provides storage to the excess water flow. Filtering system is designed with chambers like outer, middle and inner most. These three chambers filled with sand, coarse aggregate with pebbles as shown in Fig-7. Due to provision of sand, gravel and pebbles the filtration area is increased. Rain water is collected at center core and finally collected in sump. Some treatment of chlorination is required to water for consumption.

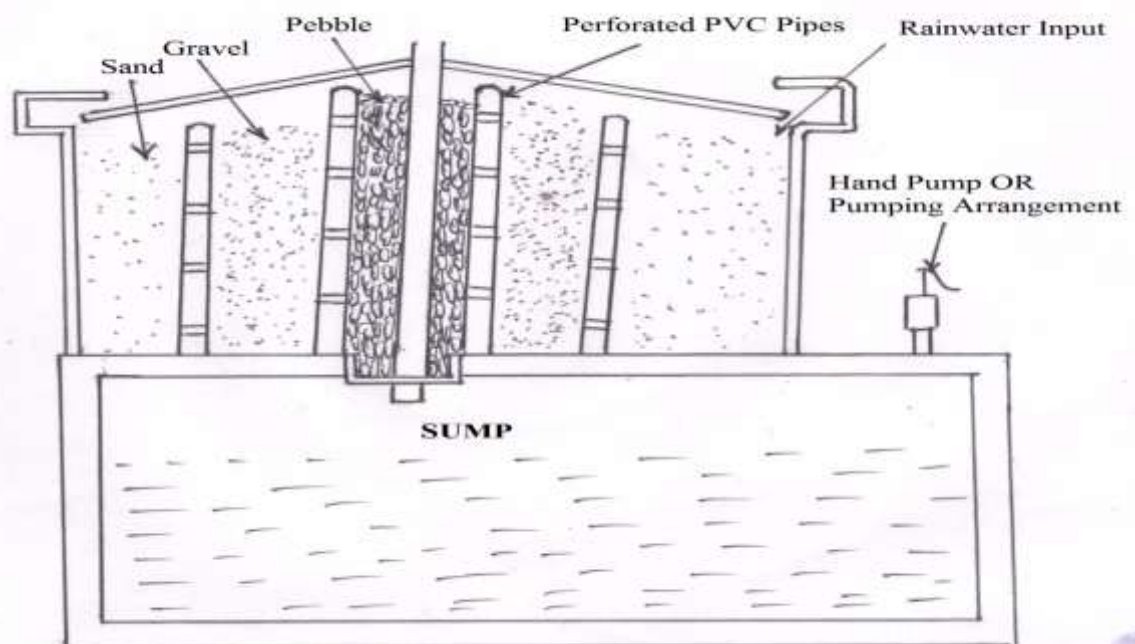


Fig-7 Filter for large roof tops

7. Storage facilities: According to various size, shape and the construction material various types of storage tanks are available for roof top rainwater harvesting. It may be square, rectangular or cylindrical. Different types of material used for storage tanks such as RCC, masonry, plastic, galvanized iron, Ferro cement etc. Storage tank should be constructed on the ground, above the ground or partially or fully underground. Periodically the maintenance is required such as cleaning and disinfection to ensure the quality of water stored in storage tanks.

Conclusion:

Roof top rainwater harvesting is an effective technique for conservation of water by guiding rainwater that falls on rooftops to storage tanks or underground sump for future use. It is especially suitable for urban areas where harvesting rainwater from roof is an easy method. By adopting roof top rainwater harvesting system, implementing dual water use for residential area by modifying plumbing work and save potable water which can be helpful for people in area where facing serious water shortage problem.

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