Rainwater Harvesting in engineering campus: A case study.

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Abstract— **This paper gives overview on the rainwater harvesting. In this paper, college campus taken as case study. Different methods also explained in specific format. Designa consideration and design pattern also explained with case study. We can satisfy the water demand of the college campus by arranging the rainwater harvesting in proper manner. Basic requirement of water can be solve in college campus.**

Keywords— **Rainwater harvesting, Recharge-well Methods, Spreading Methods, Induced Infiltration Method.**

I. INTRODUCTION

Every year the college campus faces the large water problem in summer season & to reduce this problem by some amount the college spends large money. Also the college is situated at water scarcity area as well as the rain water waste through the runoff. So avoid this problem our project is beneficial to the college campus.

M. Dinesh Kumar[1] have mentioned critical issues in rain water harvesting efforts in water scarce regions of India and the impact of water harvesting activities on local hydrological regime in in terms of net water gain. The positive physical impact of water harvesting structures also leads to rise in land value, it generating more social welfare in the local areas. Economic evaluation of water harvesting /ground water recharge system possess several complexities due to difficulty in quantifying the inflows, the storage and recharge efficiency and economic value of the incremental benefits. Which are social, direct economic or environmental.

Government of India Consultancy Public Work Department CPWD, rain water harvesting can be done by storage of rain water on surface for future use and recharging of ground water. The consultancy services organization CPWD has brought out a manual 'Rain water harvesting & conservation' is completion of guidelines for optimum utilization of rain water. In this manual they gives meaning of rain water harvesting, design of storage/settlement tanks & recharge structures design which is useful to design the rain water harvesting projects.

S. D. Khadagle, V. A. Joshi [3]has mentioned rainwater harvesting proves to be the most effective way to conserve water. They were suggested to collect the rainwater into the tanks and prevent it from flowing into drains, being wasted. They explain the need of rainwater harvesting, rooftop/runoff rain harvesting for artificial recharge to groundwater, advantages of rainwater harvesting, design considerations, components of rainwater harvesting system & they concluded if exact or proper measures are not taken up immediately, we will face a crisis which will be detrimental to the very survival of mankind.

Dr. R. K. Sivanappan[5]had mentioned need of rain water harvesting, methods of water harvesting in rural and urban areas like in-situ rain water harvesting, direct surface runoff harvesting, stream flow/runoff harvesting, sub surface flow harvesting, micro-catchment/watershed, runoff inducement by surface treatment. They concluded that a role of everybody with respect to water to empowerment of our urban & rural community.i.e. to manage their own affairs with the state playing a critical supportive role.

Y.ArunakarReddy[7] has mentioned a wide variety of methods and materials have been used to increase precipitation runoff In to storage facilities. Some material like concrete and sheet metal can be used almost any situation. Rain water harvesting depends on natural precipitation and he also explained poorly designed & managed water harvesting can causes soil erosion soil instability and local flooding. Design of water harvesting system has received less attention than method or treatment for increasing runoff from the soil surface.

Mohd. MahboobHussain [9]has mentioned the requirement of water for the agricultural purpose but rain fall water is limited for particular month so by using the different methods of rain water harvesting how can use the rain water for season of the crop periods. The main part of his design is rain water harvesting tank. Due to this the flood can be reduces and also the flood damages.

R. K. Parghane, [10]have mentioned the rain water goes waste through the run off. And the water scarcity produces. So this water scarcity can be decreased by using this waste run off. For this they use different methods of rain water harvesting such as Spreading Method, Recharge-well Method and Induced Infiltration Method.

II. DESIGN CONSIDERATIONS

The following are the most important component considered at the moment of design the rainwater harvesting for building or structure[4].

1. Hydrogeology of the area including nature and extent of aquifer, soil cover, topography, depth to water levels and chemical quality of groundwater
2. Area contributing for runoff i.e. how much area and land use pattern, whether industrial, residential or green belts and general built-up a pattern of the area
3. Meteorological Data of the particular area.

A. Components of Rain Harvesting System-

A rainwater harvesting system have comparative many stages - transporting rainwater through pipes or drains, filtration, and storage in tanks for reuse or recharge. Some important component explained in proper manner.

1) Catchments

The catchment is played the most important role in the rainwater harvesting system. The volume of water dependant on the characteristic of catchments like the roughness of a surface, area of a building, or an unpaved area like a lawn or open ground.

2) Coarse mesh

Coarse mesh used to prevent the passage of debris into storage.

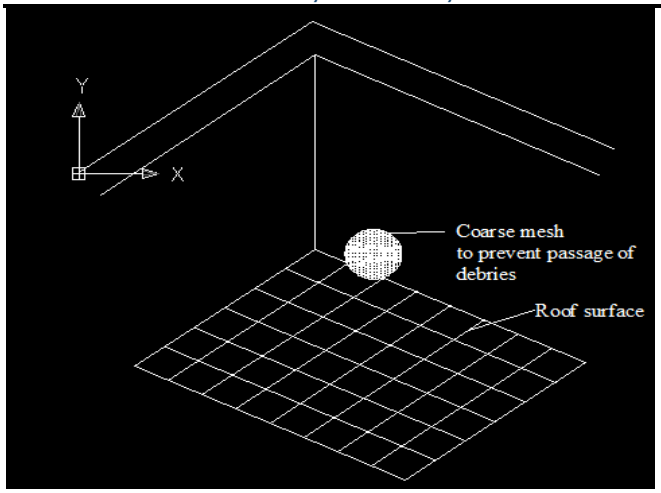

Fig.1.2 catchment and coarse mesh

3) Gutters

Gutters are used to collect and transport rainwater to the storage tank. There are many types of gutter as per shape, size, material. Planning of gutter direction depend on the construction of the houses. Pipes are fixed by using iron or timber brackets into the walls.

4) Conduits

There are some Pipelines that carry the rainwater from the catchment area to the storage system. These pipes called a conduit

5) First-Flushing - Starting runoff from the surface have to remove or not entered into the storage tank. First or starting runoff contained with lots of pollutant which present on surface area of terrace.

6) Filters

Pollutant can be removed by using filter. This filter contained with no. of layers like course, sand, gravel layer. The purpose of this filter is to remove dirt from water before storage. Additional material can be used like charcoal[4].

a.*Charcoal water filter*

A charcoal filter can be used in a drum or an earthen pot. .

b.*Sand filters*

Local available sandy material used for the Sand filters. Cost of this filter very less as well as easy to construct. Coarse sand put up on the gravel which have the 5-10mm layer and another layer added of 5-25mm gravel, boulders.

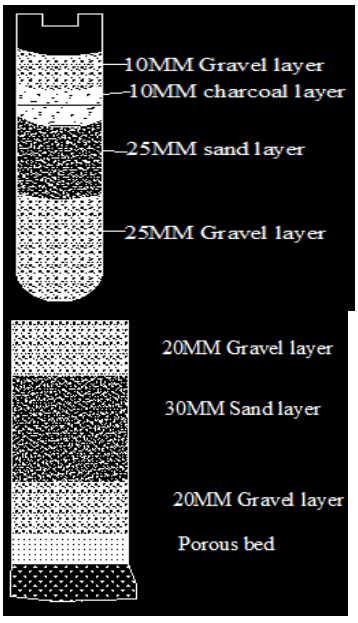

Fig.1.3 Charcoal water filter and sand filter(SourceRef.3)

III. GROUNDWATER RECHARGING METHOD :-

Following methods used for ground water recharge.

1. Spreading Method.
2. Recharge-well Method.
3. Induced Infiltration Method.

1. *Spreading Methods:*

This method commonly used where permeable soil available. Water spread on the surface to infiltration. Water infiltrate in to the ground directly. In this method, the water is temporarily stored in shallow ditches or is spread over an open area by constructing low earth dykes (called percolation bunds)[5].

2. *Recharge-well Methods:*

Recharge well mean a bore well and water flow directly attached with this well. Depending upon the favorable condition of surface, the water is fed in to recharge wells by gravity or for increasing the recharge rate, it may be pumped under pressure. In fact the ordinary wells are many a times could directly use for recharge during the off season, when the water is not required in use. Recharge rate can be higher than other method because water enter into the ground water level directly. Moreover, this method may help in injecting water in to the aquifers and also where it is most needed[6].

3. *Induced Infiltration Method:*

This method is sometimes used for recharge is that of the induced infiltration which is accomplished by increasing the water table gradient from a source of recharge.The recharge to ground water is accomplished by using some of the structures are Pits: The pits have been constructed about 3 meters deep & 1 to 2 meters wide filled with boulders,gravel and coarse sand such types of ponds are constructed for recharging shallow aquifer[7].

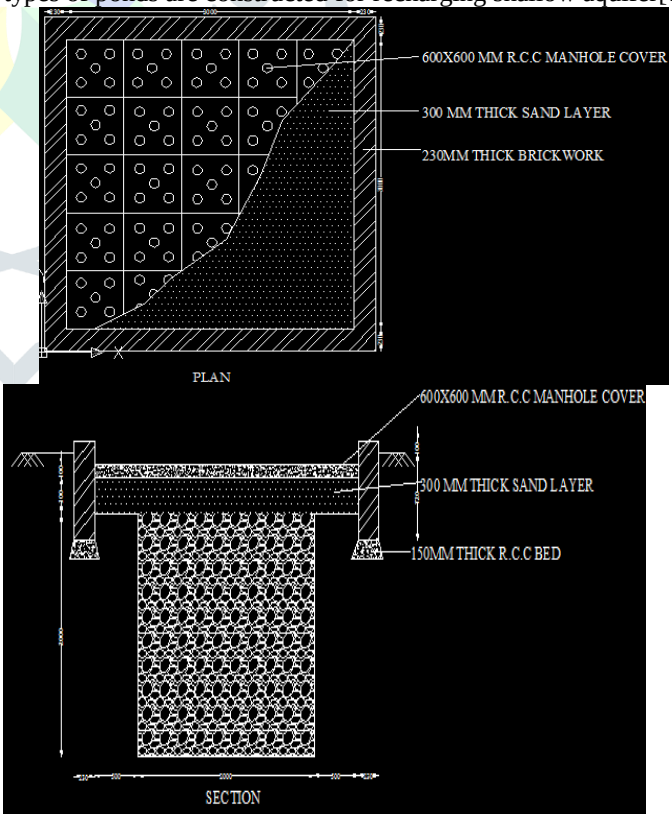

Fig.1.4 Typical Recharge pit structure

4. *Trenches:* Trench connect the water with the permeable layer of ground or where permeable strata present. These trenches are back filled with filter materials. The trenches may be 0.5 to 1

meter wide, 1 to 1.5 meter deep and 10 to 20 meters long depending on the availability of water.

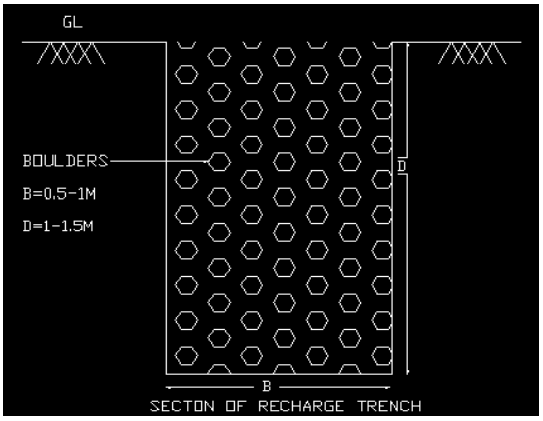

Fig.1.5 Section of recharge Trench

IV. METHODOLOGY

1. studyarea -

This campus is located in the southern part of Kolhapur and totally a plain and just like a hilly area. The campus is situated at the highest elevation from the surrounding area. So in this college campus, sufficient rainfall is available.

Our college campus gets good water supply in winter and also in the rainy season, but face a large water scarcity problem in summer. Also to avoid this problem by some amount the college spends a large amount of money on it. So to avoid this all problem one of the best methods is rainwater harvesting. Our college gets good rainfall but all the water goes weastthroug the runoff. And this college is on the hillock, so all water not percolates properly in the ground and goes west. So this project is important.

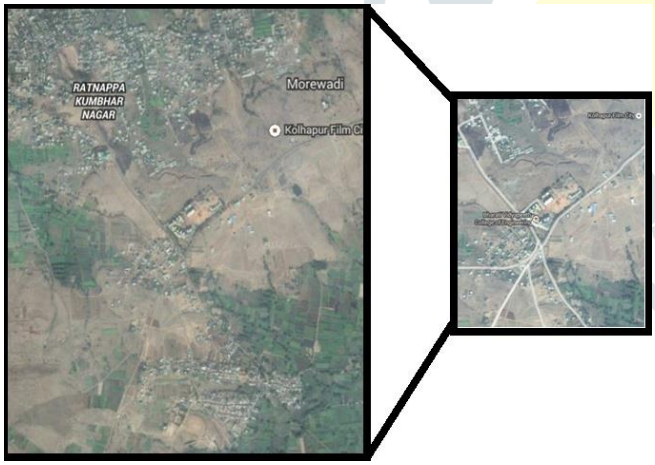

Fig. 3.1. BharatiVidyapeeth College Campus, Kandlgoun

2. Roof top area:-

The total area of college campus is 50604 sq m, and the built up area is 25376.85 sq m. The total campus included 13 buildings. They have the total roof top are as given in the following table.

TABLE IROOF TOP AREA

Building	***Area (m2)***
Engineering main building (E1 – E4)	5034.6
E5 wing	1026.90
New workshop	1052.58
Old workshop	494.21
Hostel building	272
Prashala Building	965
Total	8845.29

3. Rainfall data-

Kolhapur is a plane terrain area and it collects a good rainfall every year. We are collect the data from Irrigation department, hydrology project sub-division, Kolhapur department and from last 47 years.

We take the rainfall values from wadnge R.T rain gauge station which is near to our project site and annual average rainfall is 985 mm.

4. Surveying-

For this project, the flow direction of water is very important. So for that, we prepare a counter map by doing all the campus survey.

5. Calculation of quantity of water-

With referring above data we calculate the amount of water collected from roof top area

Amount of water collected = A X R X C X C'

Where,
A = roof top area
R = Annual rainfall in mm
C = Coefficient for roof surface
C' = Coefficient for evaporation, spillage and first flush wastage

Amount of water collected from roof-top
From slab = 9851.42 X 985 X 10-3 X 0.85 X 0.8
= 6,598.48 m3
= 65, 98,480 lit

From A. C. sheets = 295.54 X 985 X 10-3 X 0.8 X 0.8
= 186.308 m3
= 18,308 lit

Total water collected = 65, 98,480 + 18,308
= 66, 16,788 lit

Construction cost of R. C. C. storage tank
Cost required to storage for above quantity of water = 66, 16,788 X 10
= 6, 61, 67,880 Rs.

Water demand for college campus = 3000 X 45 X 300

= 4, 05, 00,000 lit

So, the demand of college campus is not satisfied and also the cost of construction is high. For this purpose we go to the advice from technical experts and our guide as well as staff member. All they suggest

- R.C. C. storage tank will use for drinking water storage.
- Some water collect from ground surface in farm pond.
- Remaining roof top water will use for recharge ground water through recharge pit.
- Remaining water will use for recharge ground water by contour trenches.

Required drinking water = 2 X 3000 X 300
= 18, 00,000 lit
= 1800 m3

Cost required for construction = 1, 80, 00,000 Rs.

Amount of water collected from Ground surface-

From paved surface= 148.37 x 985 x 0.8 x 0.8
= 93,532.44 lit
From unpaved surface= 40457.54 x 985 x 0.3 0.8
= 95, 64,162.45 lit

Total water collected from campus = 95, 64,162.45 +
93,532.44 + 66, 16,788

= 1, 62, 74,482.89 lit

V. CONCLUSION

As early says, our college campus is on the hillock. And also it get good rainfall every year. The total rainfall is 965 mm per anum. And the required quantity of water is 4, 05, 00,000 lit and we get the rain water of about 1, 14, 57,694.89 lit, so we can fulfill the 28% water requirement of college campus, in that we can fulfill all amount of drinking water requirement.

All this collection are done by different methods of recharge and storage all are given below.

1. Storage in tank for drinking purpose - 18, 00,000 lit
2. Store water in farm pond - 32, 40,000 lit.
3. Water for ground water recharge through
   1. Recharge pit - 8, 13,532.44 lit.
   2. Recharge trenches- 7, 21,020 lit.

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