ROOFTOP RAINWATER HARVESTING (RRWH) AT GSSIT CAMPUS, BANGALORE: KARNATAKA - A CASE STUDY

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Abstract – Water scarcity is a serious problem throughout the world for urban and rural communities. With an increasing population, the demand of water required for domestic, industrial and agricultural purposes has grown manifold. With urbanization on the increase, open spaces are shrinking and landfill dumps are taking the place of water bodies. In addition to this indiscriminate paving both at micro and macro levels is preventing the natural seepage of rainwater into the soil. Urbanization has led to over exploitation of ground water reserves as a result of which the ground water table has been falling rapidly in most of the world. In the current scenario, ground water consumption is far exceeding the replenishment of aquifers. Although rainwater harvesting (RWH) is gaining popularity as a sustainable water saving system in urban as well as rural areas, estimating required storage area for water remains an important design challenge so we are going to design an effective plan by which we can collect rain water into a storage for a particular campus and we are also going to make a design by which we can collect water to the ground and use it for a domestic purpose. Present paper majorly focuses on Rooftop rainwater harvesting (RRWH) of the study area as GSSIT Campus, Bangalore. The prime objective of this paper is to fulfill the scarcity of the water in the campus and then it need to be use it for domestic & drinking water supply.

Keywords - Rainwater, Runoff, Catchment area, Rainwater Harvesting System

1. INTRODUCTION

Due to rapid urbanization, infiltration of rainwater into the subsoil has decreased drastically and recharge of ground water has diminished. This scenario requires an alternative source to bridge the gap between demand and supply. Rainwater which is easily available and is the purest form of water would be an immediate source to augment the existing water supply by catching water wherever it falls. Rainwater harvesting has emerged as a viable alternative to traditional perennial source of water in hilly areas, in places where the level of fluoride and arsenic is above permissible limits and in urban areas facing water shortage and flooding during monsoons.

The concept of rainwater harvesting is not a new concept. In India water harvesting is an age-old concept. Historical and Archaeological evidences suggest that effective systems of water management had been established and were being managed or operated by small communities in our country since time immemorial. The ancient scripts too contain several references to rainwater harvesting system. Collection of rain water from paved or G.I. corrugated roofs and paved court yards of houses either in storage tanks or in the ground water reservoir is known as rain water harvesting. This collected water serves as a good source of water in rural and water scarce areas. This practice has been adopted since olden times, particularly in rural areas in places having high rainfall intensity, well distributed in the year. Such areas in India include Himalayan areas, North Eastern states, Andaman and Nicobar Islands, Lakshadweep Islands, Rajasthan and Southern part of Kerala and Tamil Nadu. This technique is highly promising even for urban areas and places where the rainfall occurs only for a few months in a year, and where other sources of water are scarce and ground water levels have gone down, such as in Gujarat, Haryana, Delhi, Madhya Pradesh etc. So much so that roof top water harvesting in society buildings and other large sized complexes have already been made compulsory in Delhi and Tamil Nadu, and this movement is gathering momentum. This practice is already quite prevalent in water scarce Gujarat, where even the old house of Mahatma Gandhi at Porabandher can be seen to contain an arrangement for collection of rain water in a storage tank at ground level for its direct use.

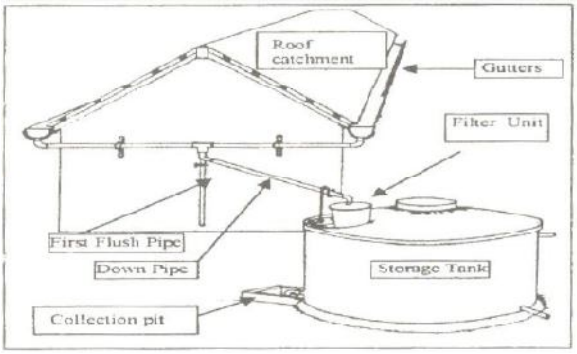

Fig. 1 (Source: Proceedings of "An Analytical Approach to Rainwater Harvesting – Urban and Rural Solution" – By Mr. Vishwanath.K.M, Scientist D, Central Ground Water Board, South Western Region, Bangalore)

II. OBJECTIVES OF THE STUDY

- To identify the possibility of RWH in GSSIT campus
- To improve the quality and quantity of existing water resource in the GSSIT campus
- To augment the existing water supply and to cut down the water supply cost

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- To create awareness regarding the importance of RWH
- Identification of potential site for RWH and recharge to groundwater.

III. STUDY AREA

The Campus of GSS Institute of technology is located **15.6 kms** away from the centre of Bangalore city. The location of the study area is **$12^0$55'10" N** latitude and **$77^0$28'0" E** longitude. The campus covers an area of **13.18 acres(53364.mts.mts).**The probability of annual and monthly rainfall is about **674mm and 70mm** (calculated for the period of 27 years), type of soil is Red Loamy and the type of the catchment is rocky and impermeable (roof top). The annual mean minimum and mean maximum temperature in the study area is 15^0 and 36^0. Number of floating and non floating population in the campus is **893 nos.**(As per the data collected).

As the Campus is involved with a large number of people and the requirement of water are phenomenal for a variety of uses. Currently, the campus is depending on **2**bore wells, with depth of the bore well ranging from 400 ft to 450 ft below the ground level. The water is being pumped to the overhead tanks which are placed on the roof of each building and underground sumps.

Out of **13.18 acres (53364.mts)** of the campus area, the building with flat roof covers **4505sq.mts,**the impermeable area (flat roof tops) contributes for a maximum yield of rainfall which is available for harvesting.

An ambitious scheme was taken up to create awareness among the masses regarding the conservation of water and to implement the same in the campus.

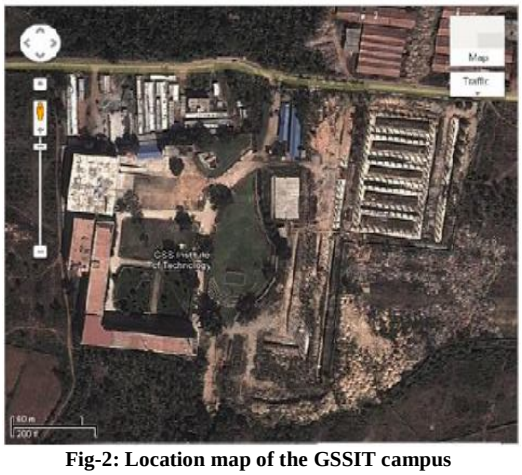

Fig-2: Location map of the GSSIT campus

4. MATERIALS AND METHODS

4.1 Survey: To survey the campus, which is, spread over 13.18 acres to ascertain the roof area and the catchments area from which we can collect water.

4.2: Rainfall Data Collection

The monthly harvestable water is estimated by taking into consideration the rainfall pattern over Bangalore City. The calculations of the same helps in quantifying the amount of rainwater that can be collected on a 67% probability in a month. The monthly harvestable water is found out by using the following.

- **Average monthly rainfall**

The rainfall data for Bangalore City for the years 1985 to 2015 obtained from the Directorate of Economics and Statistics have been tabulated and the average monthly rainfall has been calculated as:

Average monthly rainfall = $\frac{\text{Total monthly rainfall}}{\text{No. of years}}$

- **Probability of monthly rainfall**

Probability of Monthly Rainfall = $\frac{m - 0.375}{N + 0.25} x100$

P=probability in % of the observation of the rank m
M=the rank of the observation
N=total number of observations used

- **Roof top area**

X * Y (where A1 is the area, X is the length and Y is the width of one portion of the roof)

- **Monthly Harvestable Water(M)**

Monthly rainfall*roof top area

- **Monthly Harvestable After Losses**

Monthly rainfall*roof top area*0.85

M=P*I*A

We analyzed the rainfall data of 20years,estimating the monthly harvested water is calculated by Average monthly, Probability of monthly & yearly rainfall, Probability of maximum monthly &yearly rainfall, successive 2,3 and 4days probability rainfall. From the above method we obtain different values of probabilistic rainfall values for present condition. if we used this 2days successive maximum probability of rainfall for the design purpose then it will be economical.

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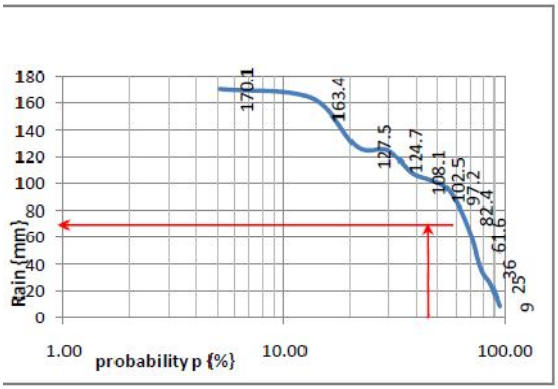

Fig. 3 Maximum 2days successive probability is 70.28%

The mean number of rainy days in a month is an important consideration in the estimation of the monthly harvestable water. The data obtained from the Indian Meteorological Department has been tabulated as follows:-

Rainy Days	
Month	**Mean Number of Rainy Days**
January	0.22
February	0.33
March	1.11
April	3.19
May	6.19
June	5.37
July	7.6
August	10.7
September	9.3
October	8.81
November	2.96
December	0.33

Table 1. Mean number of rainy days

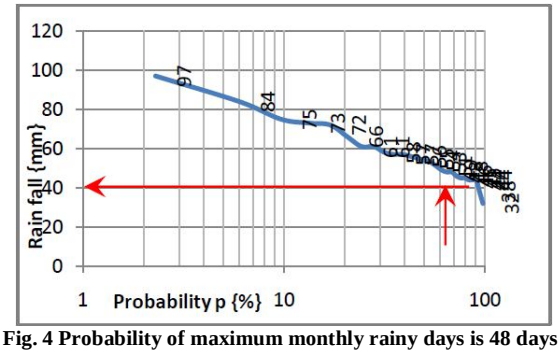

Fig. 4 Probability of maximum monthly rainy days is 48 days

Month	Average rainfall	Roof top area m^2	Monthly harvested water (mm)	Total monthly harvested water after loss (lts)	Total harvested water (cum)
Jan	2.76	4505	12433.8	10568.73	10.57
Feb	4.9	4505	22074.5	18763.32	18.77
Mar	10.02	4505	45140.1	38369.08	38.37
April	56.64	4505	255163.2	216888.72	216.88
May	93.25	4505	420091.3	357077.56	357.07
June	72.2	4505	325261	276471.85	276.47
July	95.03	4505	428110.2	363893.63	363.90
Aug	142.95	4505	643989.8	547391.28	547.40
Sep	174.37	4505	785536.9	667706.32	667.70
Oct	137.055	4505	617432.8	524817.86	524.82
Nov	36.1	4505	162680.5	138235.92	138.23
Dec	5.35	4505	24101.75	20486.48	20.48

Table2. Monthly Harvestable Water

4.3 Design of Storage Tank

Sl no	Name of the building	Area sq.m	Volume of water stored m^3	Size of storage tank
1	Main block (Block 1)	2006.76	120	(7.5x4x2) & (7.5x4x2)
2	Block 2	715.98	43	(5.3x4x2)
3	Block 3	1365.93	82	(8.2x5x2)
4	Hostel & Canteen	416	25	(5x2.5x2)

Table 3. Volume of storage tank for all building.

4.4 Quantity Estimation & Rate Calculations

Quantity Estimate for the Storage Tank of dimensions 5 x 2.5 x 2.0mts

Centre to Centre Length of Long Wall = {(0.23/2) + 5.0 + (0.23/2)} = 5.23 mts

Centre to Centre Length of Short Wall = {(0.23/2) + 2.5 + (0.23/2)} – 2.73 mts

SLNo	Particulars	Qty	Unit	Rate	Per	Amount Rs
1	Earthwork in excavation in foundation	29	m^3	160	m^3	4640
2	Cement Concrete in Bed in Foundation 1:4:8(except steel)	2.86	m^3	3850	m^3	11011
3	RCC Wall 1:4 : 8(except steel)	7.34	m^3	3850	m^3	28259
5	Internal 12mm Cement Plaster 1:3 with smooth finish	30	m^2	40	m^2	1200
6	12mm Cement Concrete flooring 1:3	12.5	m^2	60	m^2	750
7	RCC roof slab of 1 : 2 : 4, 15cm thick(except steel)	2.3	m^3	3850	m^3	8855
8	Mild steel	983	kg	55	kg	54065
					Total	108780

Area of the Tank = 5 x 2.5 = 12.5 m^2

Rate perSq.Mts = $\frac{108780}{12.5}$

= Rs. 8702.4

Rate per Sq.Mts = Rs. 8703 / -

4.5 Cost of Materials

Area of the tank including the materials = **Rs. 1,30,536/-**

Area of the Masonry Tank = 5.0 x 2.5 = 12.5 m^2

Rate per Sq.Mts =Rs.$\frac{130536}{12.5}$

= Rs. 10442.88 ~ Rs. 10443.00

Rate per Sq.Mts = Rs. 10,443.00/-

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Sl. No	Particulars	Unit Rate Per	Rs
01	Total Cost of Constructing a RCC Tank		108780
02	PVC Pipes, Tee's, Bends, Mesh, filling aggregate &sand Popup filter with first flush	20% of total cost of constructing a RCC Tank	21756
Total			130536

SUMMARY AND CONCLUSION

- Area of the catchment is 4505sq.mts
- Implementing Cost / sq.mtr of RWH system is Rs. 10,443 /-
- The water collected will be utilized for gardening and flushing of toilets
- A rain gauge can be implemented to study the actual rainfall in the study area
- The runoff of first rain should not be allowed into the rainwater harvesting structures. Thus it should be drained off through a bye pass arrangement provider near the harvesting structures.

The implementation of RAINWATER HARVESTING PROJECT to the campus of GSSIT will be the best approach to fight with present scenario of water scarcity in all aspects, whether it is from financial point of view or from optimum utilization of land surface.

By implementation in water harvesting project in GSSIT campus we can make little noble cause for rain water conservation which will be beneficial to the students of campus. It may also helpful to the campus. Our campus will become an example to others for rain water harvesting and if our campus would apply this than surely it will be in benefit. This paper fulfilled with all aspect of improving the water scarcity problem in the GSSIT campus by implementing ancient old technique of rainwater Harvesting.

Hence it was finally said that on an average nine months of rain water is harvested and the water from other sources are saved. It can be observed that during rainy days March to November the tank is filled to the capacity. Further, this will be sufficient to cater to the drinking water requirement for remaining non-rainy days.

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