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DESIGN OF GROUND WATER RECHARGE SYSTEM

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ABSTRACT

In present scenario of water scarcity, water conservation plays a vital role. Recharge pit is one of the water conservation methods on small scale. Rain water harvesting is the gathering or accumulating and storing of rain water. Rain water can be used for ground water recharge purpose. Rain water can be collected from roofs, sloppy ground, roads, etc. Rainwater coming from roof tops is in good quality compared to others. The increase in demand for water has increased awareness towards the use of artificial recharge to augment ground water supplies. Artificial recharge (recharge pit) is a process by which excess surface water is directed into the ground.

Designing of recharge pit as per standard dimensions will reduce the cost of implementation, placing of plastic filter reduces maintenance cost i.e. It prevents mixing of material so that we can re use it again. Level of ground water is also rises so that pumping cost can be minimized.

Keywords: Ground water, Recharge Pit, Runoff

I. INTRODUCTION

RECHARGE PIT

Recharge pits are normally excavated pits, which are sufficiently deep to penetrate the low permeability layers overlying the unconfined aquifers. They are similar to recharge basins in principle, with the only difference being that they are deeper and have restricted bottom area.

In SVCE campus, only one bore well is in operating condition, this is mainly due to insufficient ground water table. This problem can be solved to certain extend by proper planning and implementation of recharge pits. Most of the rainwater is wasted with any conservation techniques. Hence we can use this water effectively by provision of recharge pits, which will increase groundwater level in turn meeting the water demands in our campus.

Water use pattern and the water scarcity problems make the district an ideal choice for implementation of artificial recharge/ rainwater harvesting structures. Accordingly, as part of the Central Sector Scheme on ‘Artificial Recharge to Ground Water’, site was selected for implementation of a demonstrative scheme on artificial recharge to ground water in the campus of SVCE. The scheme was aimed at demonstrating cost-effective technologies suitable for water conservation and ground water recharge.

II .OBJECTIVES

To meet increasing water demand.

- To avoid flooding of roads.
- To increase the level of ground water table
- To reduce the cost of consuming water.
- Utilization of rainwater effectively.

A. Water Demand as per Standards

Water demand is estimated by adopting the standards for various consumption units. Water is being utilized by people for various purposes such as drinking, sanitation, cleaning, gardening, construction, fire accidents, etc. Water consumption per day is 2388 LPCD.

Table 1: Description of area

Sl.NO	DESCRIPTION	AREA (Sq.m)
1.	ADMIN BLOCK ROOF TOP AREA OF THE COLLEGE AND NEW BLOCK	6425.10
2	BOYS AND GIRLS HOSTEL	618.90
3	BITUMEN ROAD	2299.8
TOTAL		9343.8

Table 2: Monthly Average Rainfall From 2006-2016

MONTH	AVG RAINFALL(mm)
January	1.62
February	3.68
March	15.74
April	39.49
May	106.44
June	64.37
July	115.89
August	131.31
September	121.11
October	111.06
November	72.03
December	24.93

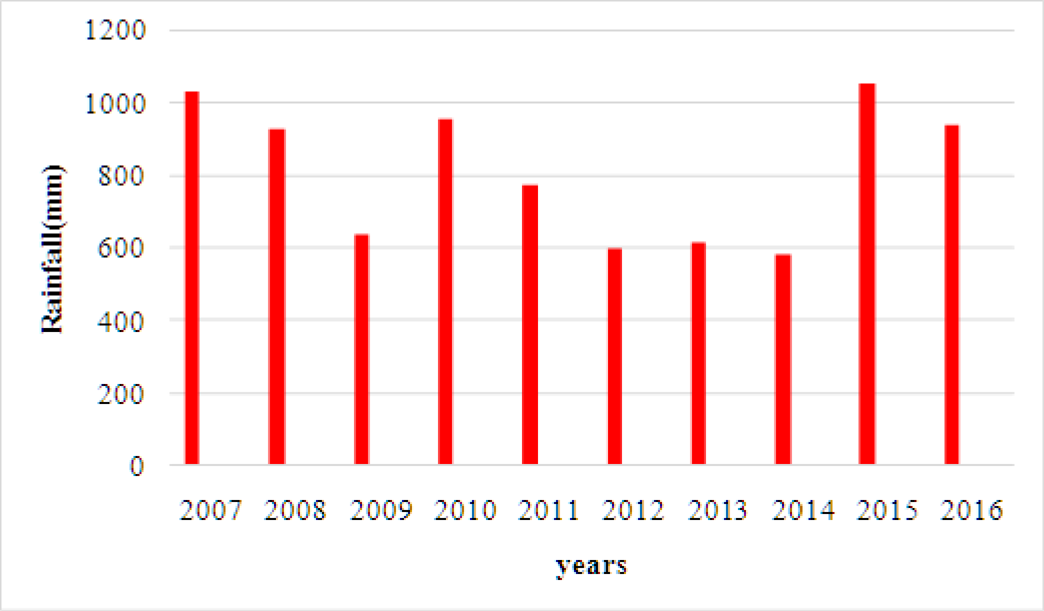

Fig 1: Monthly rainfall

B. 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.

$$Q = C \times I \times A$$

Q=surface runoff in m^3/s

I=Intensity of rainfall in $^m/_s$

C=runoff co-efficient,

A=Catchment area

Runoff volume

(m^3)=$C \times A \times annual \quad total \quad haverage \quad dept$

From the above formula the volume of water received to harvest is 31014.64m^3 per year, the intensity of the rainfall can be obtained from the formula

$$I = \frac{K\,T^x}{(D+a)^n}$$

$$I = \frac{(3.594) * (T^{0.52569})}{(D + 0.5)^{0.242678}}$$

T=Return period =10 years a=0.5 for southern India, D=75 min duration of rainfall, Where runoff co-efficient for different surfaces in study area are tabulated below.

Table 3: Runoff co-efficient for various catchment areas

SL.NO	TYPE OF CATCHMENT	CO-EFFICIENT
1.	ROOF CATCHMENT	
	TILES	0.8-0.9
	CORROGATED METAL SHEETS	0.7-0.9
2.	GROUND SURFACE CONDITIONS	
	CONCRETE	0.6-0.8
	BRICK PAVEMENT	0.5-0.6
3.	UNTREATED GROUND CATCHMENT	
	SOIL WITH SLOPES (<10%)	0.1-0.3
	ROCKY NATURAL CATCHMENTS	0.2-0.5

C.DESIGN OF RECHARGE PIT MODEL: Rain water is infiltrate through the recharge pit. The filter materials should be filled in graded form. Boulders at the bottom, gravels in between & coarse sand at the top. Usually in recharge pit sand, 20mm & 40mm aggregate will be used as filter material. In the present study recharge pit model had been taken in 1:10 ratio i.e. sand, 2mm & 4mm aggregate.

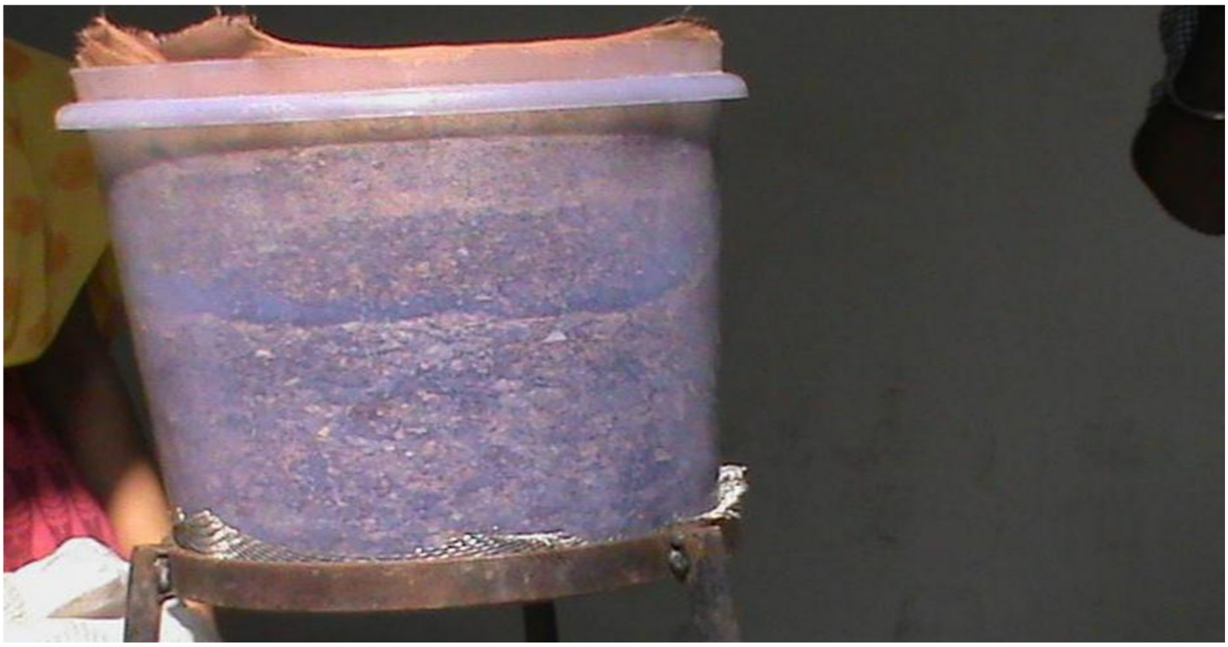

Fig. 2: Design Model

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III. METHODOLOGY

DATA COLLECTION OF RAINFALL,TOTAL SURAFCEAREA.

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TESTING OF SOIL SAMPLES

↓

ANALYSIS OF SURFACE RUNOFF, CATCHMENT AREA

↓

CALCULATION OF STORAGE CAPACITY OF ROOF TOP

↓

DESIGN OF RECHARGE PIT

IV. HYDROLOGICAL STUDY

Tests of soil sample

- Field density by core cutter method.
- Specific gravity determination (G).
- Water content determination (W_c).
- Porosity (n).
- Void ratio(e)

Field Density By Core Cutter Method

Observation and calculations

Internal diameter of the core cutter=**d=10cm**

Height of the core cutter=**h=13cm**

Volume of the core cutter=**V=1021.017cu.m**

V. ANALYSIS AND RESULTS

A mean precipitation, $P = P_1+P_2+\ldots\ldots\ldots+P_n/n$

$$P = 67.302 \text{ mm.}$$

Where, N=Number of rain gauge station, P = rainfall measurement at respective rainguage station

Table 4: Dry Density Determination

DETERMANTION NUMBER	PLACE 1 (gm)	Place 2 (gm)	Place 3 (gm)
Weight of core cutter (w1)	970	970	970
Weight ofcorecutter+soil (w2)	2650	2640	2640
Weight of soil (W)	1680	1670	1670
Bulk density	1.645	1.635	1.635
Water content (wc)	22.11	17.01	8.496
DRY DENSITY	1.347	1.397	1.506

- **Void ratio (e) = (G ∂w/∂d) -1**
- Sample 1 e = 0.467
- Sample 2 e = 0.541
- Sample 3 e = 0.431
- **POROSITY(n) = (e/e+1)**
- sample 1 n = 0.318
- sample 2 n = 0.351
- sample 3 n = 0.301

TRAIL NO	PLACE 1	PLACE 2	PLACE 3
Weight of container (w1)g	20.54	19.3	21.23
Weight of container + wet soil(w2)g	29.65	27.14	34
Weight of container + dry soil (w3)g	28	26	33
Water content (%)	22.11%	17.01%	8.496%

Table 5: MOISTURE CONTENT DETERMINATION (POROSITY)

* **GROUND WATER TABLE IN CAMPUS = 900 ft**

* MEAN PRECIPITATION = P = [(P1 + P2 +……..+ Pn) / n]

* Annual average total depth of rainfall = P = 67.302mm.

* **AREA OF CATCHMENT = 7044 sq m**

* RUNOFF CO EFFICIENT (for roof tiles) = 0.85

R = (Rainfall*area of catchment *runoff*coefficient)m^3

= (0.0673 * 7044 * 0.85)

R = 402.963 cubic meter.

VI. RESULTS AND DISCUSSION

Porosity between (0.39-0.59) comes under inorganic clays of high plastic dry density and moisture contentspecific gravity determination

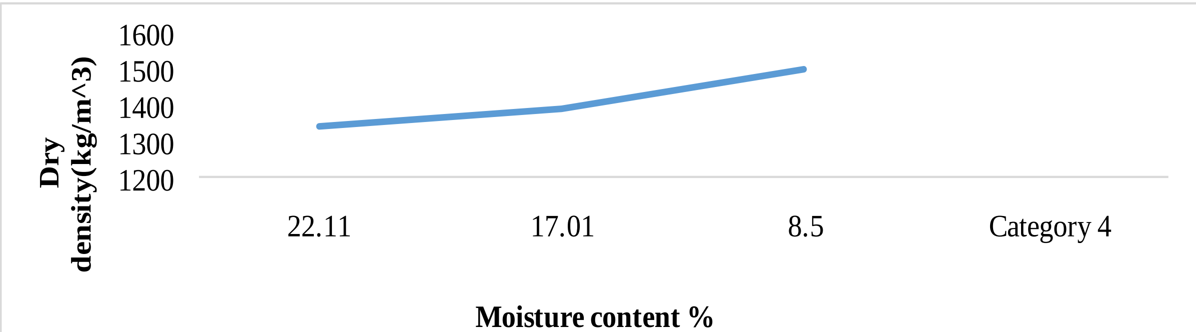

Fig 3: Variation of Moisture Content with Dry Density

SPECIFIC GRAVITY: The test results ranges between 2 to2.6 the soils having large amount of organic matter or porous particles have G < 2.6, hence the soil sample tested is "FINE SAND".

1. **DRY DENSITY**: The results are between 1200-1680 kg/m^3, hence the soil is "HIGHLY PLASTIC CLAY".
2. **MOISTURE CONTENT**: The results obtained are between 19%-36%, hence the soil is "HIGHLY PLASTIC CLAY".
3. **SPECIFIC GRAVITY**: The test results ranges between 2-2.6 the soils having large amount of organic matter or porous particles have G < 2.6,hence the soil sample tested is "FINE SAND"

VII. SUMMARY AND CONCLUSION

The results of this project are as follows:

- Average annual rainfall is 674.01mm.
- Total surface runoff is 402.63m^3
- S.V.C.E campus area is 5 acres

From the above information it is concluded that designing of recharge pit as per standard dimensions will reduce the cost of implementation, placing of plastic filter reduces maintenance cost i.e. It prevents mixing of material so that we can re use it again. Level of ground water is also rises so that pumping cost can be minimized. This paper is fulfilled with all aspect of improving the water scarcity problem in S.V.C.E. campus by implementing these techniques.

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