RAIN WATER HARVESTING OF PIET CAMPUS

[1]Bhupender Singh, [2]Sandeep Kumar
[1]Assistant Professor [2]Assistant Professor
[1]Civil Engineering Department [2]Civil Engineering Department
[1]Panipat Institute of Engineering and Technology, Panipat, India [2]Panipat Institute of Engineering and Technology, Panipat, India

Abstract: In this project first we collect Rain Water on the roof by means of various basins. This basin water is supplied into the tank by means of various pipes. The drain pipe is designed according to discharge of rainfall. The tank design is basically of underground type in rectangular shape. We calculate water demand of the institute in one year. The tank design is for the peak discharge coming from the rainfall, which is mostly occurred in the August month. And the water collected is can be used for various purpose like drinking, flushing, and gardening. A slow sand filter is design and it is placed after the tank. A gutter is provided to collect the filter water.

I. INTRODUCTION

RAINWATER HARVESTING SYSTEM AND ITS FEATURES

It was very problematic to visualize few decades earlier that you will need paying for drinking water. The consumption value of water was never challenged, but it's nearly time that even its exchange cost is given due importance. Fresh (Potable) water today is a threatened resource. More than 2000 million folks would live under the circumstances of great water worry by the year 2050, according to the –UNEP (United Nations Environment Program)‖, which notifies water could prove to be a regulating element for improvement in a number of regions in the world. Approximately one-fifth of the world's residents lack access to potable drinking water and with the existent consumption patterns; 2 out of every 3personnel on the earth would live in water-stressed surroundings by the year of 2025. About one-third of the world population currently lives in countries with moderate to great water stress—where water consumption is additional than 10% of the renewable potable water amount. Pollution and insufficiency of water assets and climate variation would be the key evolving matters in the following century. These problems would be followed by complications of desertification &deforestation, poor authority at the national and the global levels, the loss of biodiversity and population progression.

2. LITERATURE REVIEW

This chapter reviews the literature relevant to the objective of the study, i.e., Rainwater harvesting system in the campus of Engineering Institute, Panipat Institute of Engineering and Technologies well as the information on development of its components. A brief review on complete analysis & designing of the different component of this system has also been included. A discussion on the purpose of rainwater harvesting i.e. storing harvested water in tank after different available way of filtration.
A very decent work done by Ranjit Kumar Sharma in his paper entitled –Rainwater Harvesting at National Institute of Technology, Rourkela‖. In his work he has Rain-Water is being conserved and harvested for the NIT campus the design of the water tank constructed and finally the cost of construction was calculated.
A very good work done on rainwater harvesting techniques by J.R. Julius, Dr.R.Angeline Prabhavathy, Dr. G.Ravikumar in their paper entitled –Rainwater Harvesting: A Review‖.
Also a very good work done to tackle different problems in rainwater harvesting techniques in the paper entitled –Rainwater Harvesting Initiative in Bangalore city: Problems and Prospects‖ by K. S.Umamani and S.Manasi.
Apart from it, two books entitled was referred.

a) Estimation and costing in civil engineering, by:-Dutta, B. N.
b) R.C.C. Designs, By:- Punmia B.C., Jain Ashok, & Jain Arun Kumar

3. STUDY AREA &DATA COLLECTION

P.I.E.T. College is situated in Pattikalyana village in Samalkha, Panipat. Whose co-ordinates are 29°12'38''N and 77°1'0''E.? It's Height above mean sea level is 213.49 meters. This is a plain terrain area and receives a high rainfall during the monsoon season i.e. July, August and September.
The average monthly rainfall data are being taken from the rain-gauge station present at Panipat city. Again it is followed that, Panipat is a small city and thus has a uniform average rainfall throughout the city in all location. Thus monthly rainfall data of the Panipat city is given below which is assumed to be same for the station of PIET Campus for the year (2006-2016).

Fig. 1 Study Area

Table 1 Rainfall Data of Year 2006-2016 (All Values in mm)

Months	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Avg. (mm)
Jan.	3	0	0	0	0	0.8	11.2	34.7	36.1	0	0	7.8
Feb.	0	51.8	2.2	0	0	18.6	0	106	30.2	2.8	3.69	19.5
Mar.	9	15	0	0	0	14.1	0.2	1.3	31.8	1.5	35	9.8
Apr.	0	0	2	5	0	7.2	8.8	2	5.7	7	12.34	4.549
May	4	7	37	3	0	2.3	1.7	1.3	21.5	15	18.69	11.04
Jun.	9.6	61	50.5	4.8	0	91.5	7.7	35	13.9	9.65	3.25	26.07
Jul.	172.5	44.5	137	73.2	163	13.6	42.5	38.1	30.3	3.28	36.86	68.62
Aug.	24	41.5	110	32.7	146	58.4	155	138	42.5	166	190	100
Sep.	44.5	69.5	91.3	153	190	129	32	15.3	141	130	120	101.7
Oct.	0	0	0	0	0	0	0	17.6	6	0	0	2.14
Nov.	0	0	0	0	0	0	1.9	1.1	0	0	0	0.27
Dec.	0	0	0	0	5.3	0	9.8	2.8	1.8	0	1.32	1.91
Total	266	290	430	264	505	335	271	395	361	362	422	343.1

The rooftop surface area is nothing but the catchment area which receives rainfall. The design is done mainly for A+B+C+D+E+F block of PIET College Campus for design purposes. Thus the measurement was done manually with the help of reinforced fiber tape –which is the simplest technique known as „tape survey‖. Before using the tape, tape was checked for any zero error and also length of the tape was also carefully checked for its accuracy.

4. OBSERVATIONS AND CALCULATIONS

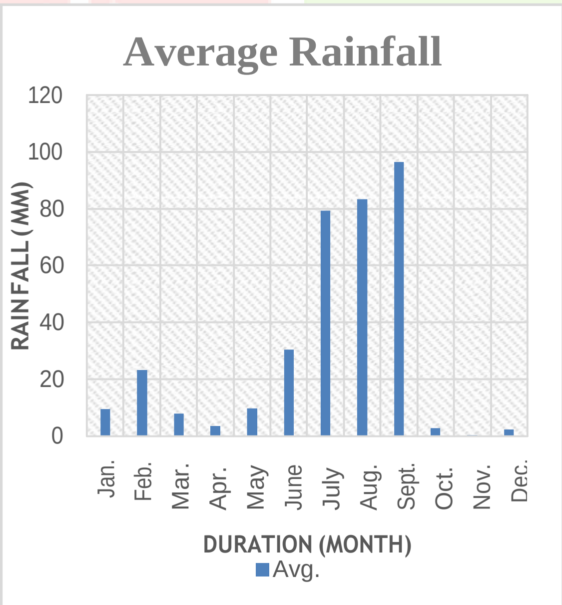
THE AREA OF A-BLOCK	THE AREA OF B-BLOCK
• Total length (L)=48 meter • Total width (B)=20 meter • Area = 48*20 =960 sq. meter • Additional Area=8*(4.4*.75) =26.4 sq.meter • Total area of A-block =960+26.4 =986.4 sq. meter.	• Length = 47.50 meters • Breadth = 20.20 meters • Area = 47.50*20.20 • Area = 959.5 sq. meter. • Approximately taken as 960 sq. meter.

THE TOTAL AREA OF C-BLOCK • Length (L)=47.6 meter • Breadth (B)=12 meter • Area = (47.6*12)*2 =1142.4 sq. meter • Additional Area =(9.7*12.20)*2=236.68 sq.m • Total Area = 1142.4+236.8 • Area =1379.08 sq. meter.	THE TOTAL AREA OF D-BLOCK • Length (L)=47.6 meter • Breadth (B)=12 meter • Area = (47.6*12)*2 =1142.4 sq. meter • Additional Area =(9.7*12.20)*2=236.68 sq.m • Total Area = 1142.4+236.8 • Area =1379.08 sq. meter
4.5.. THE TOTAL AREA OF E-BLOCK • Length = 33 meter • Breadth = 23.6 meter • Area = 33*23.6 • Area =778.6 sq. meter • Additional Area =4.6*28.8 =132.48 sq. meter • Extra Area =2*1 = 2 sq. meter • Total Area =778.6+132.48-2 =909.2 sq. meter.	THE TOTAL AREA OF F-BLOCK • Length =18.4 meter • Breadth =38 meter • Area = 18.4*38 • Area =699.2 sq. meter • Additional Area = 2(1.6*2.5)+(1.15*12.8)+(5.6*3.8) =8 +14.72+21.38 =44 sq. meter • Total Area=44+699.2=743.2 sq. meter.

4.7. THE TOTAL AREA OF ALL BLOCKS

- Total Area = Area of A-block + Area of B-block + Area of C-block + Area of D-block + Area of E-block + Area of F-block = 986.4+960+1379.6+773.3+909.2+743.2
- AREA =5751.6 sq. meter

Discharge calculation is done by multiplying the rainfall and Catchment area.
The first graph on the next page shows the average rainfall for year 2006-2014.
The second graph on next page shows the discharge.
Discharge = (Catchment Area*Rainfall) cubic meter.



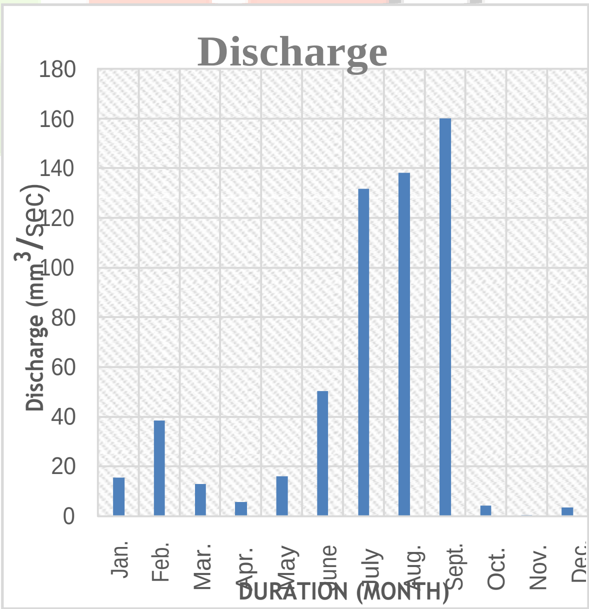


Fig. no. 2 Average rainfall of each month for (2006-16) (All data is in "mm".)

Fig. no. 3: Discharge for each month for Average rainfall (2006-16)(All data is in cubic meter)

But for design considerations the discharge is calculated for the maximum rainfall which occurs in the months of July, August and September.

Table 2: Discharge for Max. Rainfall for 2006-16

Year	Max. Rain Intensity (mm/day)	Discharge (m^3/day)	Discharge (m^3/sec.)
2006	266.66	4.20	.0011
2007	290.312	1.32	.0003
2008	430.5	2.9	.0008
2009	264	1.10	.0003
2010	505.1	4.20	.0011
2011	335.8	1.77	.00049
2012	271.9	1.16	.0003
2013	395.3	2.4	.00066
2014	361.7	2.06	.00057
2015	362.016	2.09	.00058
2016	422.116	1.02	.00028

- Year-11
- Total Area = 3905.4 sq. meter.
- Total discharge = 22475.746

5. DEMAND OF WATER

Calculation of total strength of PIET Campus

- Total number of student in PIET Campus =4000
- Total faculty members = 500
- Total strength = 4000+500 =4500

According to Indian Standard Demand of water is given below

- Standard Drinking water demand = 5 l/c/d
- Institutional water demand =2 l/c/d
- Min. Flushing water = 20 l/c/d
- Total water demand for one student = 22 l/d
- Total working days in one year = 365-2*52-25= 235 days
- Total water demand = 22*235*4500 =23265000 liter= 23265 cubic meter
- Total drinking demand for student = 235*4000*2 = 1880000 liter= 1880 cubic meter
- Total drinking demand for faculty = 500*(235+52)*2 =287000 liter= 287 cubic meter
- Total water demand for drinking = 2160cubic

6. LOSSES IN PIPE

- Tank is design according to per year rainwater capacity. Per year rain water = 2045.067 cubic meter.
- Losses in pipe
- Major pipe loss
  1) Friction loss = $F*L*V^2/2*g*D$
  2) Leakage loss
- Minor loss
  1) Sudden enlargement = $(V_l-V_f)^2/2g$
  2) Sudden contraction = $.5\ V^2/2g$
  3) Exit loss = $1.5\ V^2/2g$

     Where V_l= initial velocity of water in pipe

     V_f= final velocity of water in pipe
- By the standard result of the losses the total pipe losses are considered 2 to 5%. Hence we take total loss 2%.
- Discharge after losses =2045*.98 = 2004.1 cubic meter

7. DESIGN OF TANK AND FILTER

7.1 OPTIMUM DIMENSION OF THE TANK:

- For A+B + C+D+E+F block, total amount of water collected = size of the tank = 589 m^3.
- Taking height of tank = 7m.
- Area of the base = 589/7= 84.14 m^2, Approx. = 90 m^2.

Design a tank of 600 cubic meter capacity :- Problem Statement:

Height of tank= 7 meter
Area of base = 90 m^2
Taking subsoil consists of sand, angle of repose = 30° 17000 N/m3
Saturated unit weight of soil = 17 KN/m^3 or
Water table likely to rise up to ground level
M20 concrete, Fe-415 steel bars
Unit weight of water = 9.81 KN/m^3 or 9810 N/m^3
Design when tank is full

Step 1:- Given data

Let us assume tank of 15*6*7 mete dimensions. L/B =15/6 = 2.5 >2

- Take M-20 ,comp. stress =7 N/mm^2
- Tensile stress = 150 N/mm^2 for HYSD bar
- Take k =0.2886 j =0.9038 Q or R =0.9130

Step 2 :- Design of long wall

a. Active earth press. =85446 N/mm^2
b. Bending moment at the base of wall = 115.35 KN-m= 115.36 *10^6 N-mm
c. Thickness of long wall :-
   Thickness = 275 mm
   Provide total depth = 300 mm
   Cover = 25 mm
d. Area of reinforcement :-
   A_{st} = 3484 mm2
   Using 18 bars of 16 mm diameter @ 50 c/c.
e. Min. area of reinforcement :- A_{st1} = 720 mm^2

Step 3 :- Reinforcement will be provided

a. At base = 16 mm dia. Bars 2@ 50 mm c/c
b. At 1 m above base , up-to top :-
   16 mm dia. Bars @ 200 mm c/c
   A_{st} = 720 mm^2
   Area on each face = 360 mm^2
   Spacing = 320 mm
   Actual Area = 418 mm^2

Step 4 :- Direct pressure on long wall

The earth pressure acting on short wall will cause compression in long wall because two portion of long wall act as slab supported on short wall.

Pa = 97653.3 N/m^2

The direct compression developed on long wall is given by

P_{lc} = Pa* B/2
= 292960 N

This will be taken by distributed steel and wall reaction.

Step 5 :- Design of short wall

a. Active earth pressure = 56247.9 N/m^2
b. Bending moment:-
   1) At support =(P_a* L_2)/12 = 168732.5 Nm
   2) At Centre = 1856148.3 Nm
c. Thickness of short slab:-
   Thickness =275-(25+16+8)
   = 236 mm
d. Area of reinforcement:-
   1) At support = 5453.60 mm^2
   Spacing = 50 mm
   2). Area for mid span = 2726.5 mm^2
   Spacing = 75 mm

Hence provide 16 mm diameter bars @ 75 mm c/c.

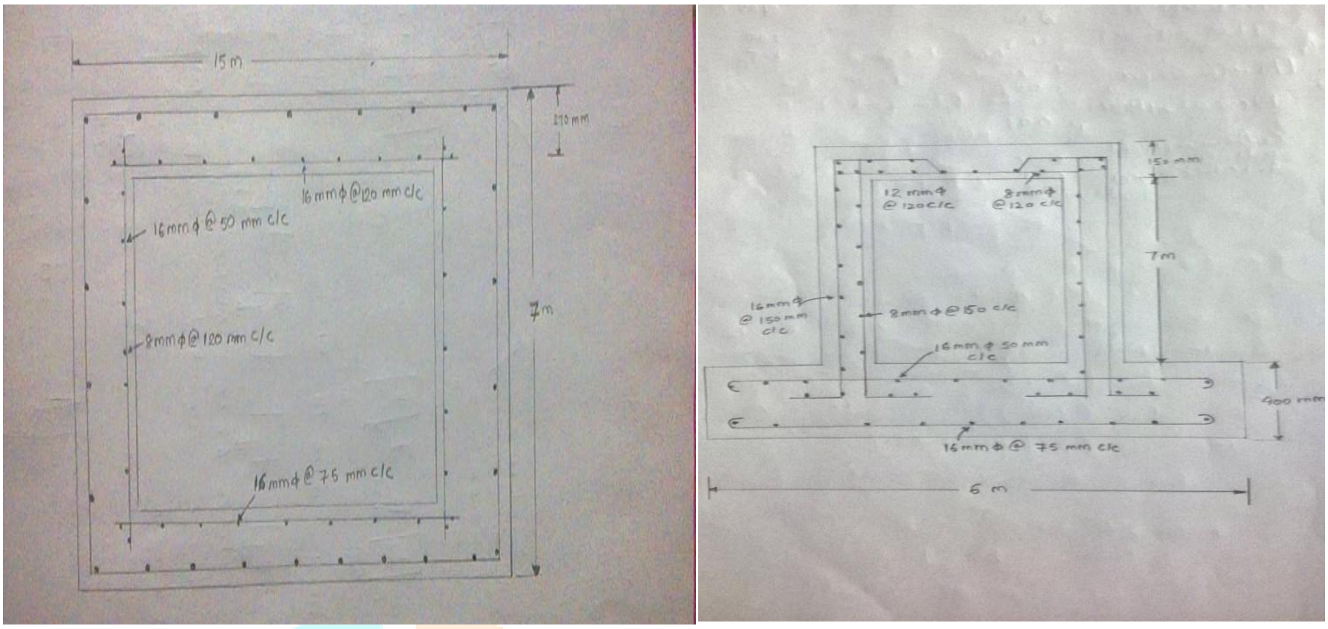


Fig. 4- Reinforcement Detailing

CONCLUSION

1) This project dealt with all aspect of improving the water scarcity problem in the PIET campus by implementing ancient old technique of rainwater Harvesting. The water is collected from the roof is sufficient quantity of water. Thus for this quantity the under-ground water tank has been designed.
2) Since we collect only 2045 cubic meter water from rooftop rain water which we can only satisfied the drinking demand of the Piet campus. If want to use water also for the purpose of flushing water, so we need rainwater harvesting for the complete Piet campus.
3) It was concluded that RCC tank which is to be constructed should be an under-ground one, so that upper surface of the tank can be exploited economically for any land purpose such as play-ground or cycle stands or any such small structure.
4) Our pipe losses are 2% which we can reduce 30% by using proper good quality pipe of PVC and CPVC pipe to collect water from the roof to ground level then using RCC pipe in underground water carrying system up to tank position.
5) The maximum rain water in Piet campus is loosed due to lack of pipe maintenance if regular maintenance of the pipe is done then large amount of water losses is reduce.
6) By providing a water tank behind the Piet stage we can eliminate large cost of the pipe.
7) Since the roof top level of C-Block is .567 meter high than roof of B-Block, so we can directly collect the water of the C-Block into B-Block by which we can save cost of pipe from C-Block to tank.
8) Hence it was finally concluded that implementation of RAINWATER HARVESTING PROJECT to the campus of P.I.E.T will be a good approach towards harvesting the rainwater and decreasing the over dependence on the ground water. Even from optimum utilization of land surface point of view. Therefore, water is highly a precious natural resource which is always in high demand in the campus of P.I.E.T and thus, RAINWATER HARVESTING AT P.I.E.T campus is highly recommended.

REFERENCES

1. Aladenola OO, Adeboye OB (2010), Assessing the potential for Rainwater Harvesting, Water Resource Management, Vol. 24 992129-2137, Springer Science.
2. Umesh CK, Monika JK, Sekar R, Vairamani M, Ajit KS Parashar DC (2001). Investigation of alkaline nature of Rainwater in India. Water, Air and Soil Pollution 130: 1689 – 1690, 2001.
3. Sivanappan RK (2006). Rain Water Harvesting, Conservation and Management Strategies for Urban and Rural Sectors. National Seminar on Rainwater Harvesting and Water Management 11-12 Nov. 2006, Nagpur, India, pg 1-5
4. WHO, Guidelines for drinking water quality, 3rd Edition, Chapter 10. Retrieved Aug, 2006 from http://www.who .int/water_ sanitation health
5. UNESCO (2000). The Hydrological Cycle. Proceedings of the World Day for Water 2000. Accessed on various dates at http: //www. google.com
6. Sridhar MKC, Coker AO, Adegbuyi SA (2001). Rainwater Harvesting in Nigeria: Prospects and Problems. Proceedings at the 10th Inter. Rainwater Catchment Systems Conference Mannheim, Germany, Sep. 10-14, p 122.