RAIN WATER CONSERVATION OF JAYPEE UNIVERSITY

A ***Project Report Submitted in partial fulfilment of the requirement for the award of the degree of***

BACHELOR OF TECHNOLOGY

in

CIVIL ENGINEERING

By

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Under the supervision of

Dr.Veeresh Gali
and
Mr.Abhilash Shukla

to

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

WAKNAGHAT SOLAN – 173 234

HIMACHAL PRADESH, INDIA

CERTIFICATE

This is to certify that the work which is being presented in the project report titled **"RAINWATER CONSERVATION IN JUIT "** in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering and submitted to the Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by Kartik Sharma (131608) , Paaras Jamwal (131682) , Mayank Chaudhary (131696) during a period from July 2016 to May 2017 under the supervision of **Dr. Veeresh Gali and Mr. Abhilash Shukla**, Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of our knowledge.

Date: - ………………………

Dr. Ashok Kumar Gupta	Mr.Abhilash Shukla	External Examiner
Professor & Head of Department	Assistant Professor	
Civil Engineering Department	Civil Engineering Department	
JUIT Waknaghat	JUIT Waknaghat	

ABSTRACT

Over the years, the rising population, growing industries and expanding agricultural practices have raise the demand of water supply. Monsoon is still the main hope and source of our agriculture. Hence water conservation had become need of the time. Rainwater harvesting is a way to capture the rainwater at the time of downpour, store that water above the ground or charge the underground water and use it later. As the groundwater resources are depleting, the rainwater harvesting is the only way to solve the water problem. Rainwater harvesting will not only be helpful to meet the demand of water supply but also be helpful to improve the quantity and quality of water. Here, in this paper our focus is to design a tank to store rainwater from rooftop of the building to cater the need of water requirement for Jaypee University.

ACKNOWLEDGMENT

We would like to take this opportunity to express our heart filled thanks to all the people who have directly or indirectly given a hand in making this project possible. We would especially like to thank the faculty and the staff members of the Civil Engineering Department, JUIT, and Waknaghat who have always been supportive and made this project possible. We would like to thank our project supervisor **Dr. Veeresh Gali and Mr. Abhilash Shukla**, for clearing all our queries regarding the project till now and giving us the opportunity to do this project on such a beneficial topic for our career and guiding us throughout the whole project. Without his presence this project would not have been possible. He had been very helpful and supportive.

We would also like to thank **Dr. Ashish Kumar** who was always present for comments and suggestions.

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to

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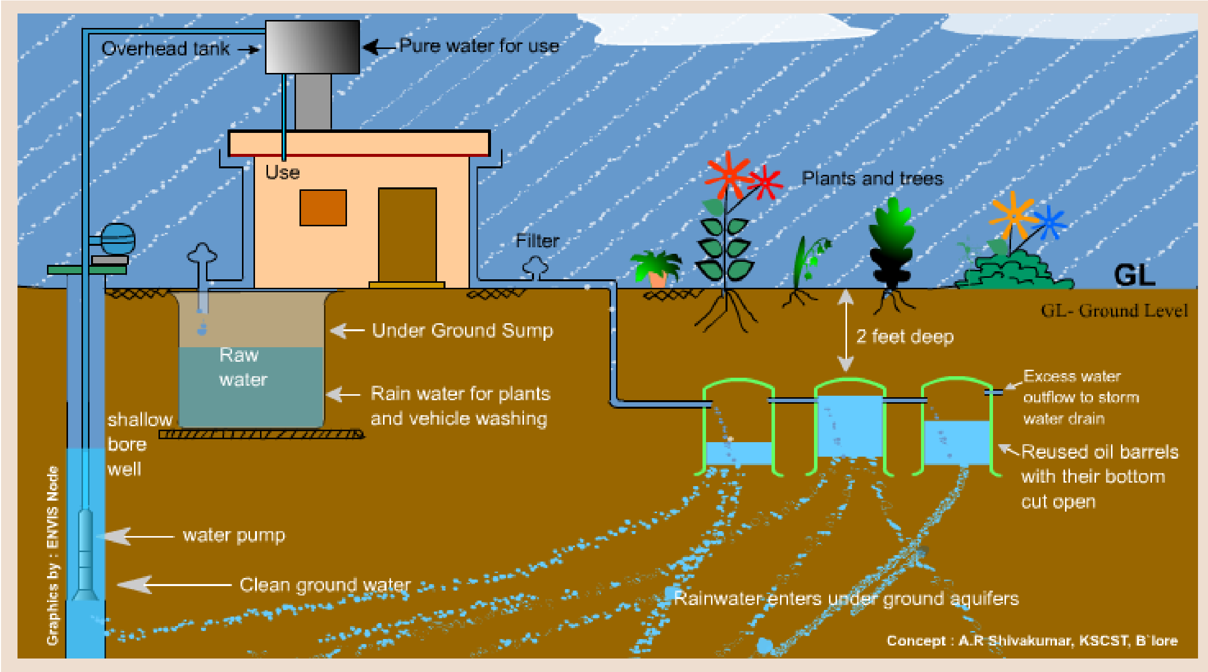
CHAPTER 1

INTRODUCTION

One of the biggest challenges of this century is to overcome the growing water shortage. Rainwater harvesting (RWH) has thus regained its importance as a valuable option or additional water resource, along with more traditional water supply technologies. Water shortages can be reduced if rainwater harvesting is practiced more widely. People collect and store rainwater in buckets, tanks, ponds and wells. This is commonly referred to as rainwater harvesting and has been practiced for years. Rainwater can be used for multiple purposes ranging from irrigating crops to washing, cooking and drinking. Rainwater harvesting is a simple low-cost technique that requires minimum specific prowess or knowledge and provides many benefits. Rainwater harvesting is one of the alternative technology for delivering drinking water. In fact, through the ages, this has been a traditional way of enhancing domestic water supply. Rainwater harvesting systems are possible options both for storing water for domestic use and for recharging groundwater aquifers.

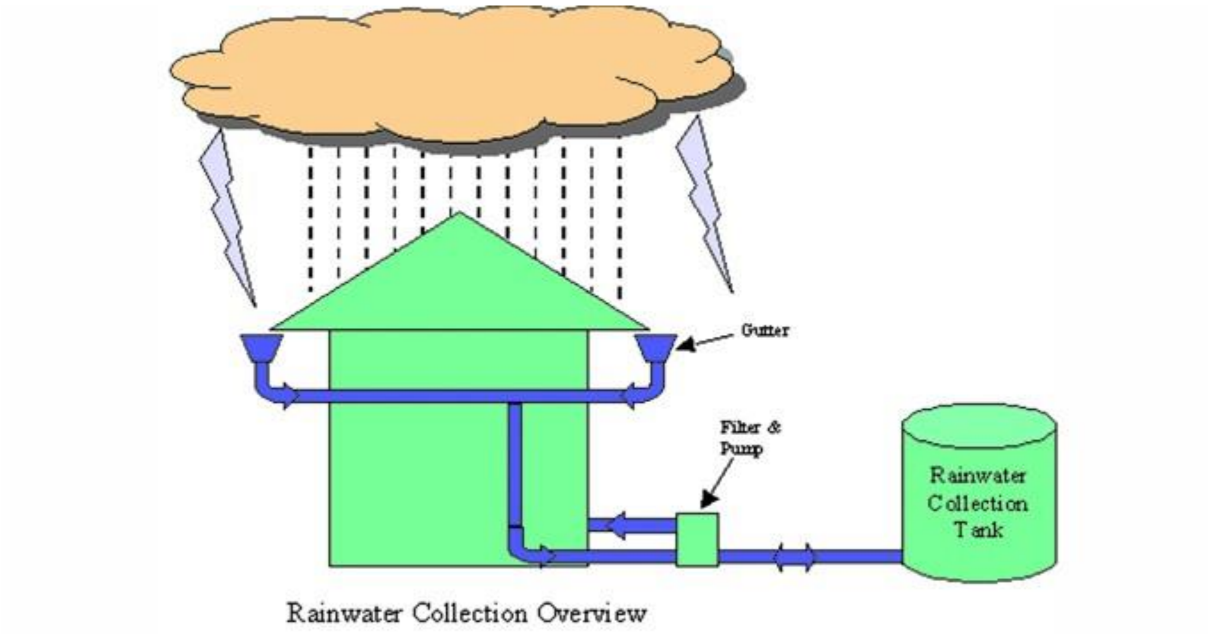
1.1 RAIN WATER HARVESTING

Rainwater harvesting is a technology used for collecting and storing rainwater from rooftops, the land surface or rock catchments using simple techniques such as jars and pots as well as more complex techniques for storage. Continents like Asia and Africa use techniques which arise from practices employed by ancient civilizations still serve as a major source of drinking water supply in rural areas. Commonly used systems are constructed of three principal components; namely, the catchment area, the collection device, and the conveyance system. The project seeks to address the issue of rainwater harvesting for **JAYPEE UNIVERSITY OF INFORMATION & TECHNOLOGY**. Water demand all over the country and internationally is rising rapidly like a wild fire. Though agriculture continues to be the single largest consumer of water worldwide, industrial demand for water is also mounting sometimes at a much faster pace than any other demand. Traditional and Centralized piped water supply system s are finding it difficult to cope with meeting such escalating demand. Ground water is also depleting especially in Metropolitan Cities.



Rainfall Harvesting Depiction

Fig 1.1



Simple Rainwater Depiction

Fig 1.2

1.2 PROJECT OBJECTIVE

The main aim of this project is to identify the amount of rainwater which can be stored and used for alternate purposes which in turn reduces water demand from external source.

The purpose of this project is to assess a sustainable water harvesting solution for communities of the study area of JAYPEE UNIVERSITY OF INFORMATION. It also seeks to give the overview about the methods of water harvesting in India. The main objective of the project is to find out the appropriate water harvesting system for the communities who do not have the enough access to safe water. Therefore the basic objectives are:

- Collect and analyse rainfall data of the study area.
- Analyse the water demand in the campus.
- Calculate the catchment area of the campus.
- Analyse the variation of demand with respect to supply and plot mass inflow curve.
- Designing of water tanks for the harvested water by following IS 3370 Part-2, Part-4 and IS 456:2000 guidelines.

1.3 ASSUMPTIONS

The project aims to find appropriate, affordable and environment friendly approaches for the water harvesting system. Considering the above criterion the basic assumptions has been predefined. The assumptions are:

- The rainwater harvesting method is socially accepted in the study area.
- Water consumption for designing purpose is assumed to be above 40 MLD (excluding gardening and landscaping).
- Rainfall in the area supports the RWHS.
- The rainwater used is almost distilled and requires least treatment
- No environmental or other contamination other than those from the catchment area will be present in the harvested water.

LITERATURE REVIEW

Water forms the lifeline of a society. Safe water is vital for the environment, disease reduction as well as for sustainable development. Availability of drinking water and provision of sanitation facilities are the basic minimum requirements for healthy living. Water supply and sanitation, being the two most important urban and rural services, have wide ranging impact on human health, quality of life, environment and productivity. Despite the technological advancements, the global scenario still remains dreary, as all the inhabitants of the world do not have access to safe water and adequate sanitation. Rainwater Harvesting includes gathering and storing rainwater. This technique has been used refill aquifers in a process called groundwater recharge and also for drinking, water for livestock, water for irrigation. Rainwater can be a source for water as out of 8760 hours in a year, most of the rain in India falls for 100 hours. Rainwater is one of the secured alternatives for supplying freshwater at the time of increasing water scarcity and to meet with the increasing water demand. Rainwater harvesting is a cost effective alternative to other water-accruing methods. It yields a copious amount of water. For an average rainfall of 100 cm, approximately four million litres of rainfall can be collected in a year an acre of land (4047 m^2), post evaporation.

1.5 SYSTEM OF RAIN WATER HARVESTING

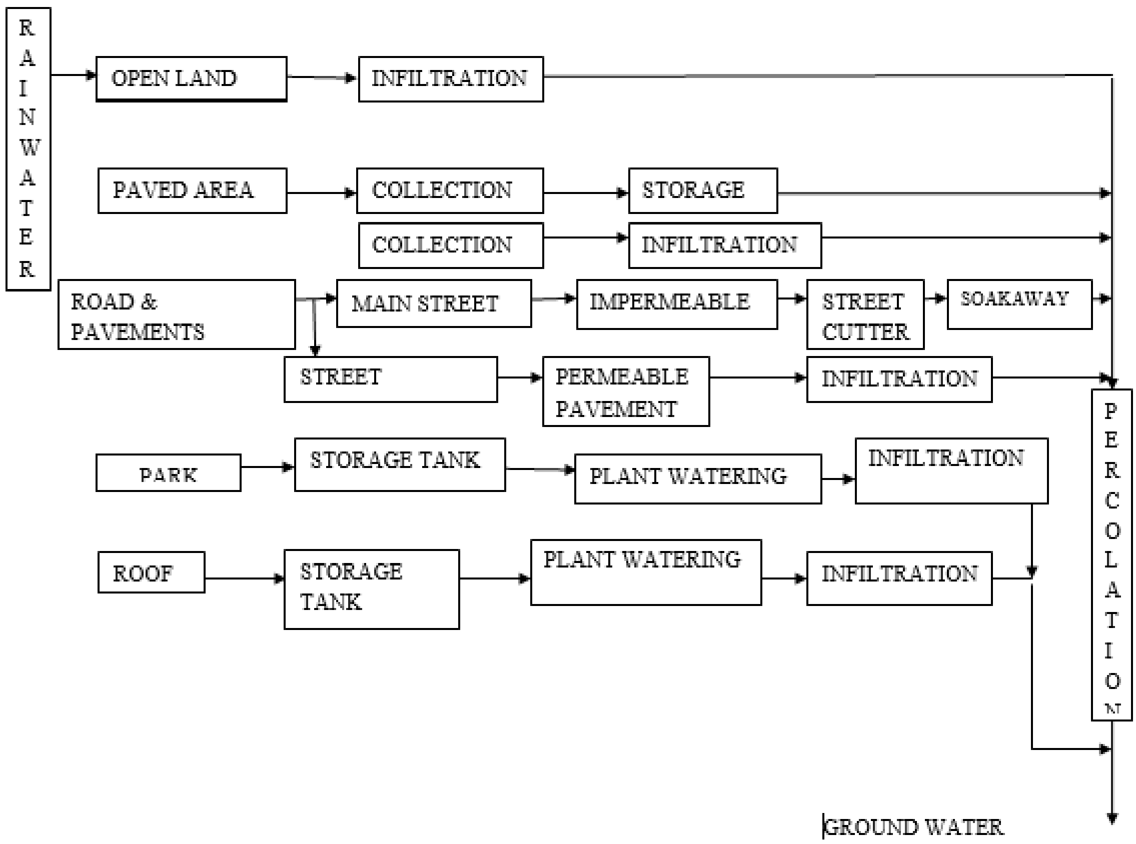


Fig 1.3

1.6 SOURCES OF URBAN WATER SUPPLY

Rivers or lakes are the primary source of water and the constant quest of engineers is to seek these perennial sources. Then comes the putting up of reservoirs for storage, treatment plants, pumping stations, supply lines, storage reservoirs and distribution pipes. From other sources like Underground aquifers, open wells or deep bore wells, water is pumped up and distributed. As local sources dry out, become polluted or are simply insufficient the city marches farther and farther for its water.

1.7 LIMITATIONS

- Rainwater Harvesting system is site specific and depends on local rainfall hence it is difficult to give a generalized idea and make it successful.

- Household base Rainwater Harvesting Scheme is used to harvest safe drinking and cooking water.

- Other daily activates are not possible by the harvesting system due to very low supply.

- Big and community base RWHS can provide chance to use water for other purpose like bathing, washing, irrigation but the maintenance of this types of RWHS is difficult.

- Roofs may seep chemicals, insects, dust or animals feaces that can harm plants if it is used for gardening.

- The collection and storage facilities may also impose some kind of restrictions as to how much rainwater you can use. During the heavy rainfall, the collection systems may not be able to hold all rainwater which ends in going to to drains and rivers.

- While the time and energy might be small these systems can be prone to algae growth and mosquitoes. Thus, this requires regular maintenance of the systems.

CHAPTER 2
TRADITIONAL TECHNIQUES

2.1 HISTORY

The storage and collection of rainwater was started for utilization of land for agriculture and to find a new technique for irrigation especially in Africa and The Indus Valley, where rainfall was the driving force for life.

RAINWATER HARVESTING IN INDUS VALLEY

People in the Indus valley had shown advancements in rainfall conserving techniques. They built two storm water channels Manhar (north), and Mansar (south) flanked the city. The city was laid out on a gradient of 13 m (from east to west), with 16 reservoirs between inner and outer walls to collect monsoon runoff from the channels. This water was used for population and for land throughout the Year

SOME EXAMPLES

Tanks-Underground tanks found especially in western part of RAJASTHAN (INDIA) mostly in Bikaner district. They collect the rainwater in circular holes made under ground.

BAMBOO-Used especially in Northeast part of India by using bamboo pipes to plantation and irrigation and used from hills to lower regions by gravity.

Other techniques like Tankas, Khadins and Kuls have been extensively used in India to conserve rainwater .

2.2 TANKAS

Fig 2.1

2.3 KHADIN

Fig 2.2

2.4 BAMBOO RWH

Fig 2.3

2.5 KULS

Fig 2.4

CHAPTER 3

RAINFALL TREND ANALYSIS AND METHODOLOGY

We collected rainfall data of past 10 years (2006-2015) from meteorological department Shimla and carried out various rainfall trend analysis

The methodology of analysis includes:-

- Yearly Average Rainfall
- Monthly Average Rainfall
- Daily maximum minimum Rainfall
- Probability Analysis Using Empirical Method

3.1 YEARLY AVERAGE TREND:-

This graph has been plotted in accordance with Annual average rainfall from the year 2006-2015. It is calculated by

$$\frac{Summation\ of\ rainfall\ of\ all\ Year}{10}$$

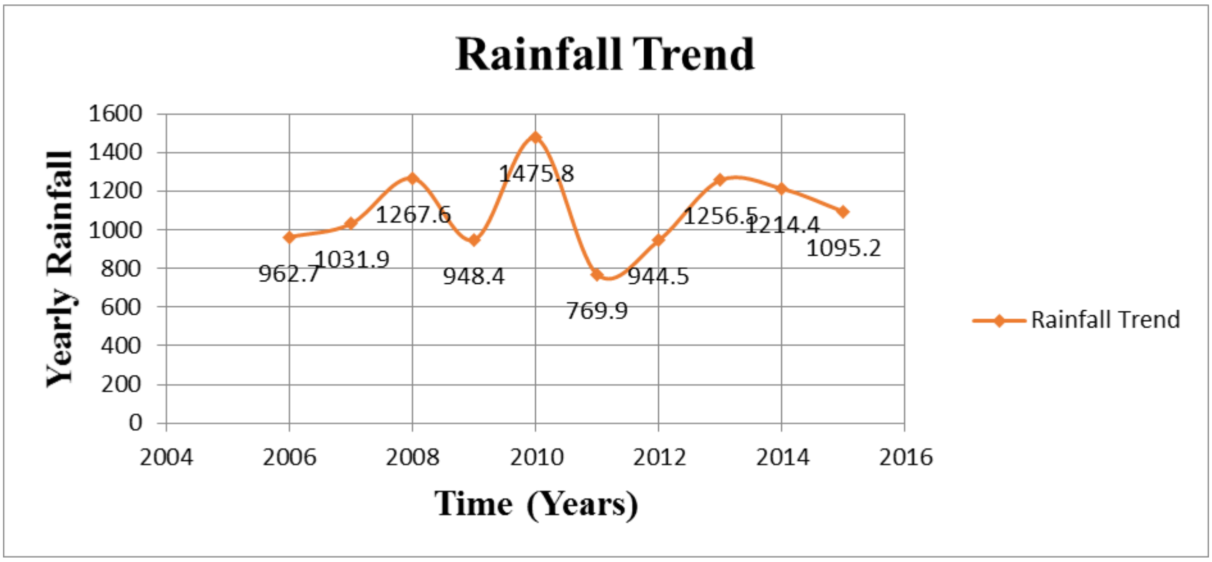


Fig-3.1

According to the graph the maximum magnitude of rainfall was recorded in the year of 2010 due to higher density of south west monsoons. It is seen that the rainfall trend follows a decreasing pattern from the year 2013 to 2016. Rainwater harvesting technique could be effective in order to conserve water in this period.

3.2 MONTHLY AVERAGE TREND:-

This graph has been plotted in accordance with Monthly average rainfall from the year 2006-2015. It is calculated by taking summation of rainfall of a month in every year.

$$\frac{Summation\ of\ rainfall\ of\ a\ month\ in\ every\ year}{10}$$

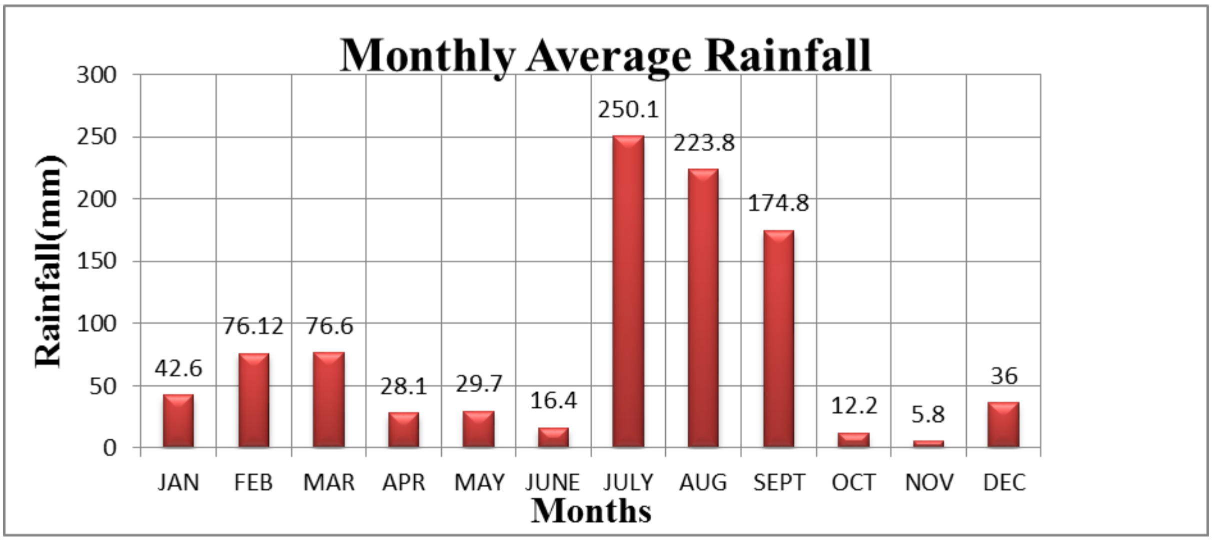


Fig-3.2

On the basis of the graph shown above the maximum rainfall occurs in the month of July. Maximum amount of rain water can be harvested in the month of July.

3.3 PROBABILITY ANALYSIS USING EMPIRICAL METHOD

There are several empirical methods to calculate the probability P. Weibull method is the most popular method for calculating the probability of occurrence of given rainfall data.

Table 3.1

Order(m)	TOTAL YEARLY RAINFALL(	Probability	Return Period
1	147.58	0.1	11.0
2	126.76	0.2	5.5
3	125.65	0.3	3.7
4	121.44	0.4	2.8
5	109.52	0.5	2.2
6	103.19	0.5	1.8
7	96.27	0.6	1.6
8	94.84	0.7	1.4
9	94.45	0.8	1.2
10	76.99	0.9	1.1

Name Of Method(Weibull)
P=m/(n+1)
P=Probability
m=Order no.
N=Number of years of record

3.4 MAXIMUM AND MINIMUM RAINFALL DETERMINATION (2006-2015)

Table 3.2

Kandaghat Station - Daily Rainfall Data in mm for month of February										
Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1	0.0	0.0	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	NA	0.0	0.0	0.0	0.0	0.0	0.0	26.0
4	0.0	0.0	NA	0.0	0.0	0.0	0.0	11.4	1.6	0.0
5	0.0	0.0	NA	0.0	0.0	0.0	0.0	28.8	0.0	0.0
6	0.0	0.0	NA	0.0	0.0	0.0	0.0	97.2	0.0	0.0
7	0.0	6.0	NA	0.0	0.0	5.0	0.0	10.0	15.8	0.0
8	0.0	0.0	NA	0.0	13.0	14.3	0.0	0.0	16.4	0.0
9	0.0	0.0	NA	0.0	59.0	0.0	0.0	0.0	0.4	0.0
10	0.0	0.0	NA	0.0	10.0	0.0	0.0	0.0	0.0	0.0
11	0.0	58.0	NA	9.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	72.0	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	7.0	NA	0.0	0.0	0.0	1.4	0.0	0.0	0.0
14	0.0	10.0	NA	0.0	0.0	12.2	0.0	0.0	17.8	0.0
15	0.0	0.0	NA	0.0	0.0	14.4	0.0	0.0	27.8	0.0
16	0.0	0.0	NA	0.0	0.0	8.2	0.0	8.4	16.4	5.2
17	0.0	3.0	NA	0.0	0.0	8.4	0.0	9.8	3.0	0.0
18	0.0	0.0	NA	0.0	0.0	0.0	0.0	2.0	0.0	0.0
19	0.0	6.0	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	NA	0.0	0.0	0.0	0.0	0.0	0.0	14.2
21	0.0	0.0	NA	0.0	0.0	0.0	1.2	0.0	0.0	13.4
22	0.0	0.0	NA	0.0	0.0	0.0	0.0	10.2	1.4	0.0
23	0.0	0.0	NA	0.0	12.2	0.0	0.0	14.6	0.0	0.0
24	0.0	0.0	NA	0.0	2.0	6.3	0.0	0.0	0.0	0.0
25	0.0	0.0	NA	0.0	0.0	8.0	0.0	0.0	0.0	11.6
26	0.0	0.0	NA	0.0	0.0	0.0	0.0	0.0	0.0	5.2
27	0.0	3.0	NA	0.0	0.0	0.0	0.0	6.4	1.8	0.0
28	0.0	25.0	NA	0.0	0.0	0.0	0.0	0.0	9.8	0.0

3.5 *DAILY AVERAGE TREND*

The graph showing Daily Average trend has been calculated in accordance with the maximum and minimum daily rainfall for a particular month of the year 2006. Average rainfall has been calculated by summation of rainfall for every day for a month divided by the number of days of the given month.

Table 3.3

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Max.Rainfall(mm)	16	26	122	30	7.8	23.8	111	33	21.8	14	4.6	43
Avg.Rainfall(mm)	1.9	2.7	8.3	3	0.4	1.69	9.6	4.9	1.12	1	0.3	1.4
Min.Rainfall(mm)	2.4	5.2	1.2	2.2	1.2	1.2	0.8	0.2	0.4	2	0.4	0.8

STANDARD DEVIATION

When the daily average rainfall trend is plotted against time, large deviations in maximum rainfall with respect to average and minimum rainfall has been seen. Therefore standard deviation is calculated so as to reduce this deviation and smoothen the curve plotted. The Standard deviation has been calculated as :

$$\sigma = \sqrt{\frac{\sum_1^m (Pi - Pm)^2}{m-1}}$$

Where: Pi = Precipitation Magnitude on the i^{th} day.

$$Pm = \frac{\sum_1^m Pi}{m}$$

m = Number of days in a month.

The value of standard deviation = 38.75 mm

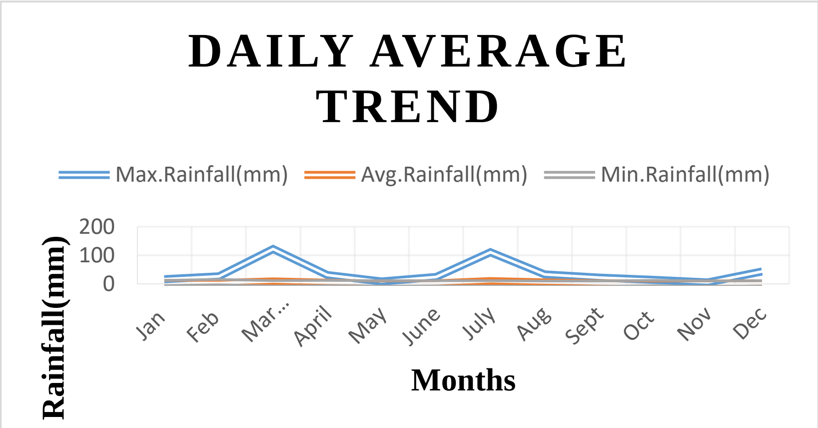


Fig 3.3

3.6 YEARLY AVERAGE TREND

The graph showing Yearly Average trend has been calculated in accordance with the maximum and minimum yearly rainfall for all the years. Average rainfall has been calculated by summation of rainfall for every year divided by the number of years.

Table 3.4

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Max Rainfall	280	297	384	482	380	259	297	361	378	296
Avg.Rainfall	80.23	81.7	106	79	123	64.2	78.8	105	110	86.3
Min Rainfall	4	0.3	9	1	7.1	9.3	2.8	4.4	15.8	8.8

Standard Deviation = 67.65 mm

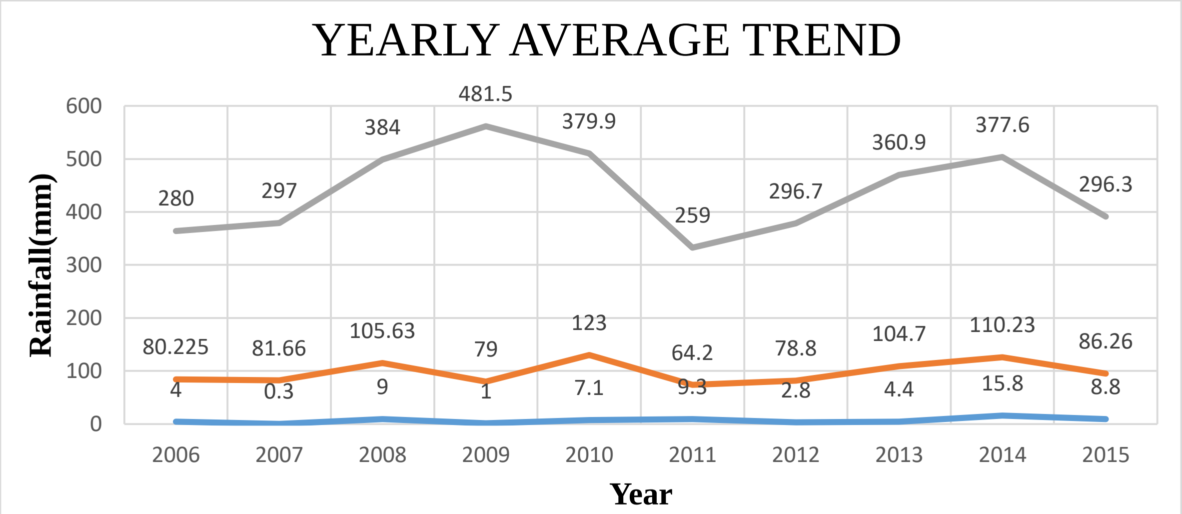


Fig 3.4

CHAPTER 4

AREA COMPUTATION OF JUIT

Fig 4.1

Fig- 4.2

4.1 Carpet/Non –Carpet Area

Malviya Bhawan (A)	926m^2
Malviya Bhawan (B)	1813m^2
Malviya Bhawan (C)	362m^2
Malviya Bhawan (D)	1044m^2
Service Quarters	655m^2
Temple	326m^2
Vasant Bhawan	1096m^2
BBC	1279m^2
Academics	6150m^2
Shastri Bhawan	4454m^2
Geeta Bhawan	1665m^2
Azad Bhawan	1260m^2
Parmar Bhawan	1557m^2
Teachers Quarters	453m^2
Dispensary	192m^2
Civil Dept.	1143m^2
Pavement Area	8580m^2

Total Area	=101171m^2
Carpet Area	=32955m^2
Non-Carpet Area	=101171-32955 = 68216m^2

4.7 JUIT ROAD AREA

Fig- 4.3

Length of road = 1100 m

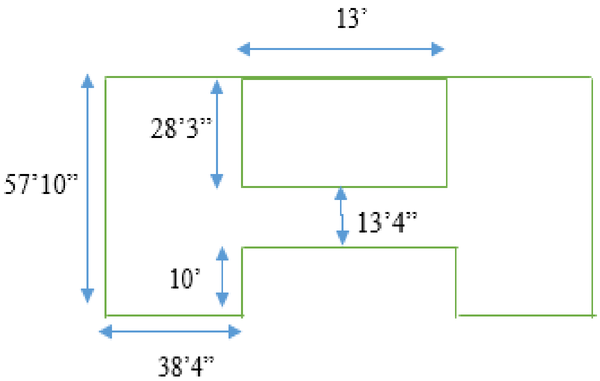
Breadth of road = 6.5 m

Area = 1100 X 6.5 = 7150 m^2

Increasing Area by 20% = 7150 + 20 % of 7150 = 8580 m^2 (As the width of road in front of Geeta Bhawan and Vasant Bhawan is greater than 6.5 metres so taking an approximate increase in area.)

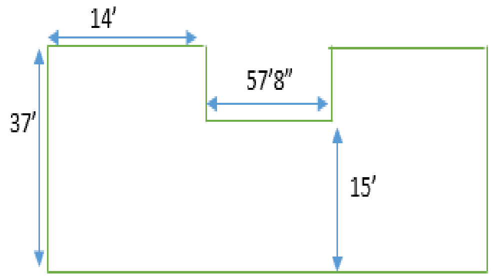
AREA COMPUTATIONS OF JUIT

ACADEMIC BLOCK



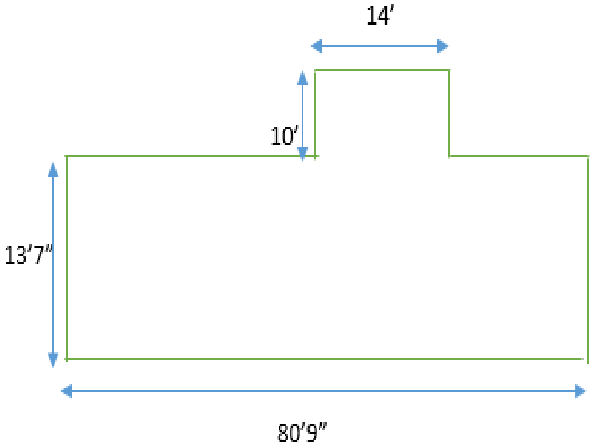
Area=418m^2

3rd Floor

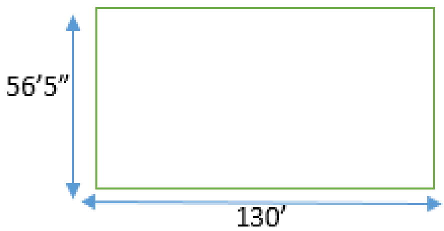


Area=411.37m^2

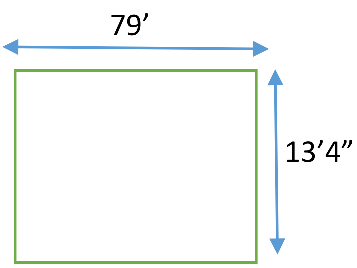
4th Floor



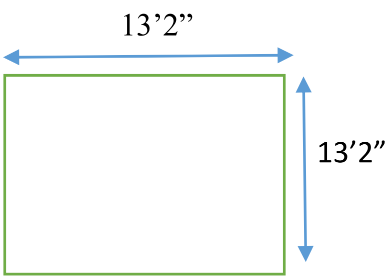
Area=113.4 m^2



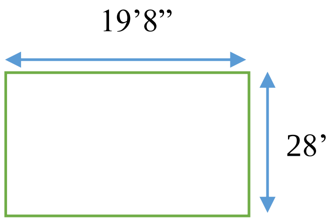
Area =682.32m^2



Area=95.5 m^2



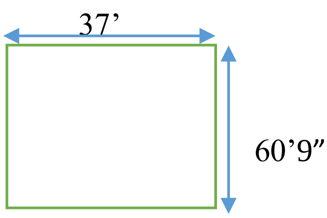
Area = 21.17 m^2



Area=51.51 m^2

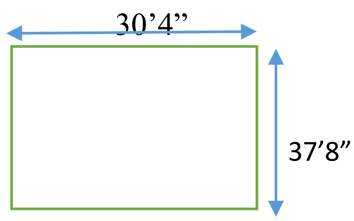
Total Area=418.1+411.4+113.35+682.32+95.5+21.2+51.51=1793.4m^2

PARMAR BHAWAN



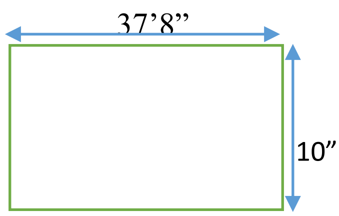
Area = 208.8 m^2

Top roof B Block (+1)



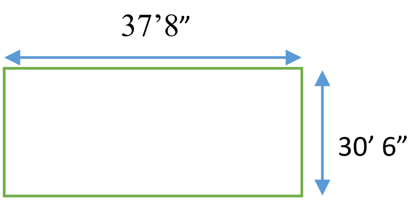
Area = 106.1m^2

Zero floor balcony



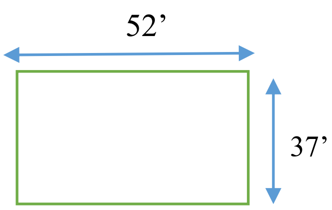
Area=35 m^2

(-1 and -2) B-Block Balcony



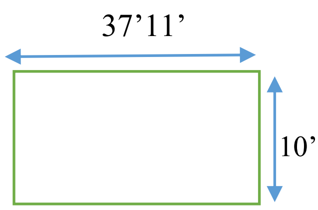
Area = 106.1m^2

TT Room Balcony



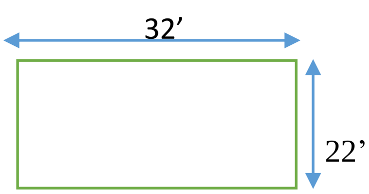
Area = 179 m^2

D Block Roof



Area = 35.23 m^2

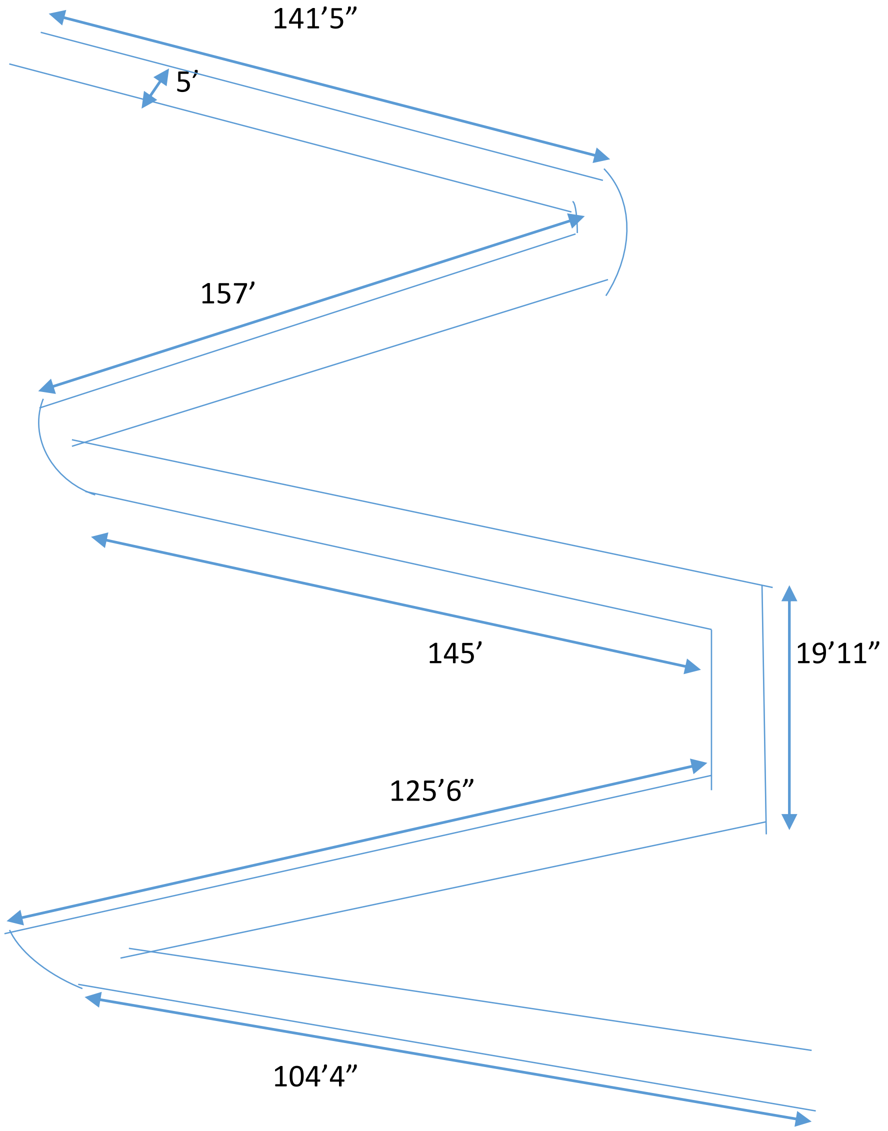
(-3) C-Block



Area= 65.4 m^2

TV Room Roof

Ramp:



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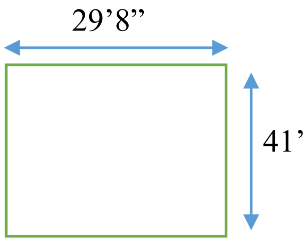
Area = 322 m^2

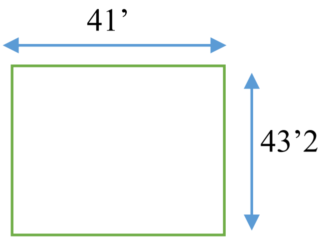
Total Area = 208.8+ 106.1 +35+ 35+ 106+ 179+35+ 65+328**= 11741**

SHASTRI BHAWAN



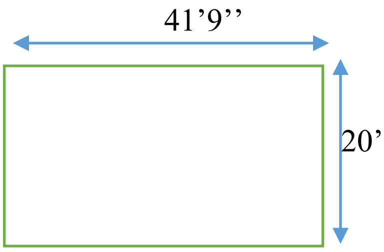
Area = 111.25 m^2

H1, H2, H3



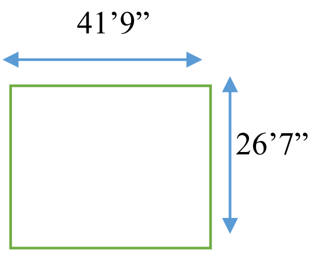
Area = 165 m^2

H4, H5, H11, H8



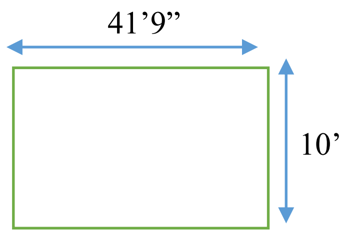
Area = 75.6 m^2

H6



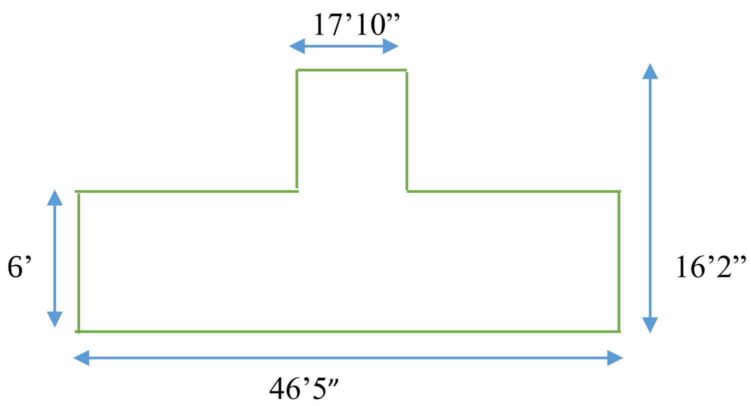
Area = 100.17 m^2

H6



Area = 38.40 m^2

OC Balcony

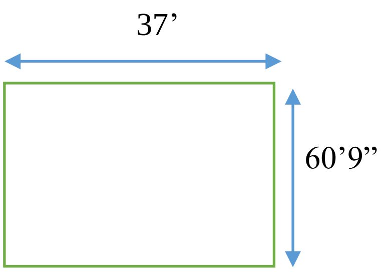


H6 Balcony

Area= 41.90 m^2

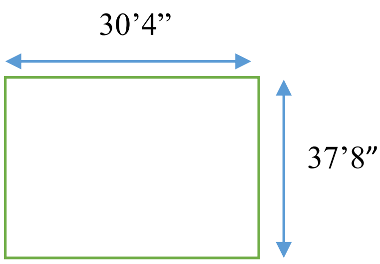
Area = 41.90 + 38.40 + 100.17 + 75.6 + 111.25 X 3+ 164.33 X 4= 1651 m^2

GEETA BHAWAN



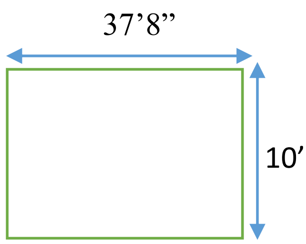
Area = 209m^2

Top roof B Block (+1)



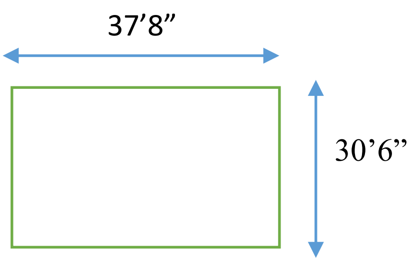
Area = 106 m^2

Zero floor balcony



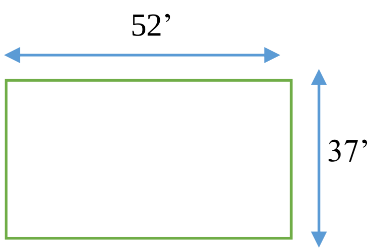
Area = 35 m^2

(-1) B-Block Balcony



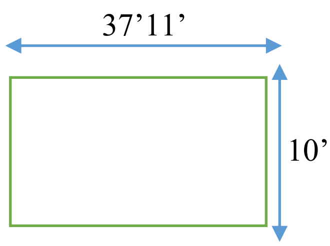
Area = 106 m^2

TT Room Balcony



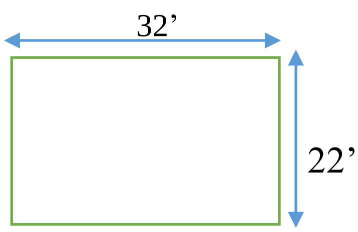
Area=179m^2

D Block Roof



Area = 35 m^2

(-3) C-Block



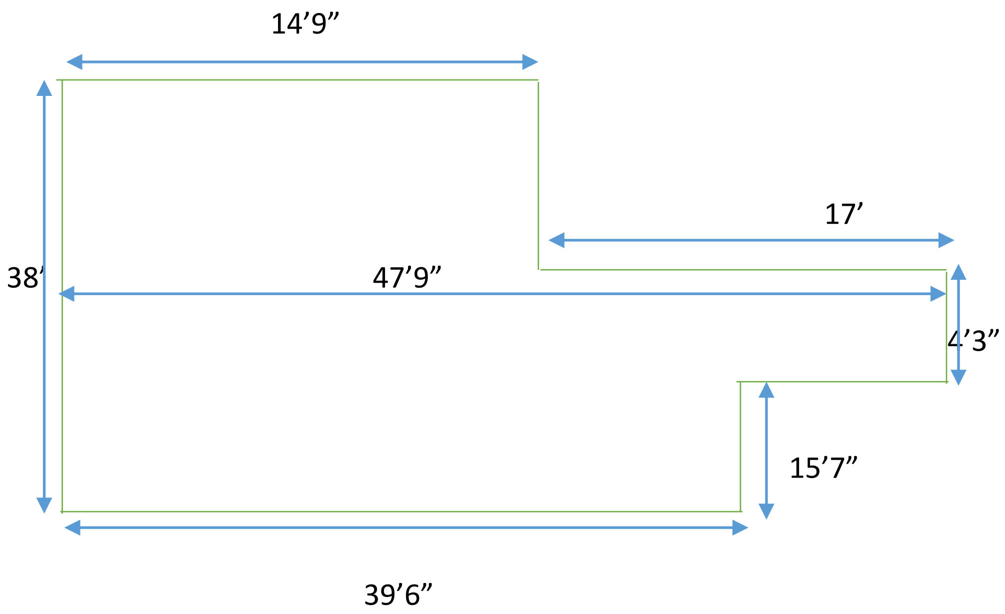
Area = 65 m^2

TV Room Roof

Total Area = 208 + 106 + 35 + 35 + 106+ 179+35+ 65 = 852 m^2

AZAD BHAWAN

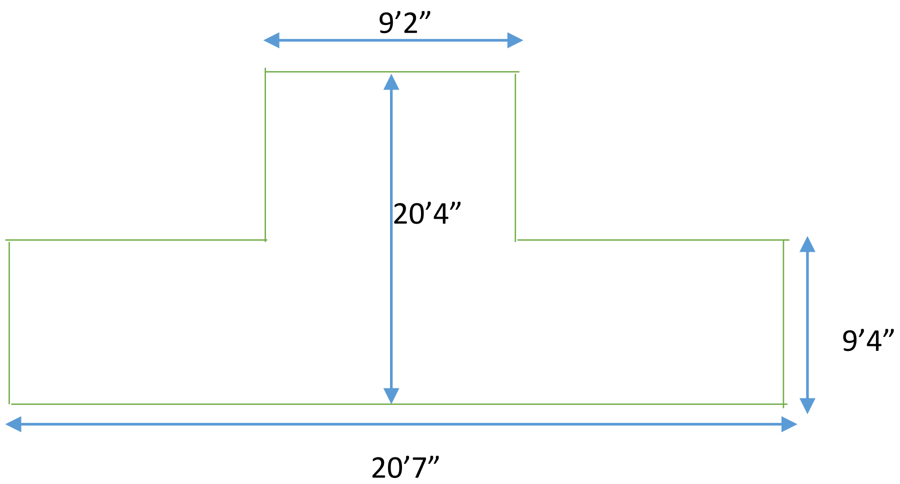
1. B-Block



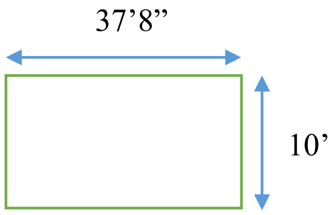
Area= 82m^2

2.

`

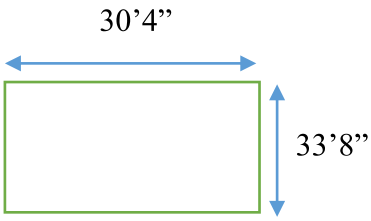


Area=17.3+5.1=22.4 m^2



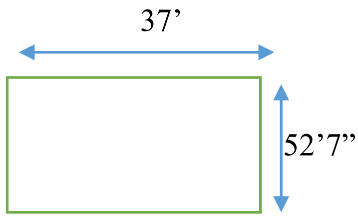
Area=70 m^2

C-Block



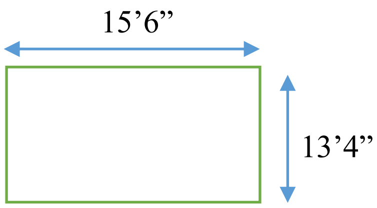
Area=95 m^2

D-Block



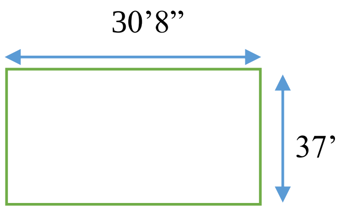
Area=181 m^2

D-Block



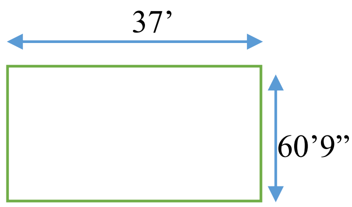
Area=19.2 m^2

D Block



Area=105 m^2

D Block



Area = 209 m^2

D Block

Total Area=82+22.4+70+95+181+19.2+105.41+208.8=783.81 m^2

CHAPTER 5

MASS INFLOW CURVE

Table 5.1

Monthly Average Rainfall (2006-2015)

MONTHS	RAINFALL(mm)
JAN	42.6
FEB	76.12
MAR	76.6
APR	28.1
MAY	29.7
JUNE	16.4
JULY	250.1
AUG	223.8
SEPT	174.8
OCT	12.2
NOV	5.8
DEC	36
TOTAL	**972.22**

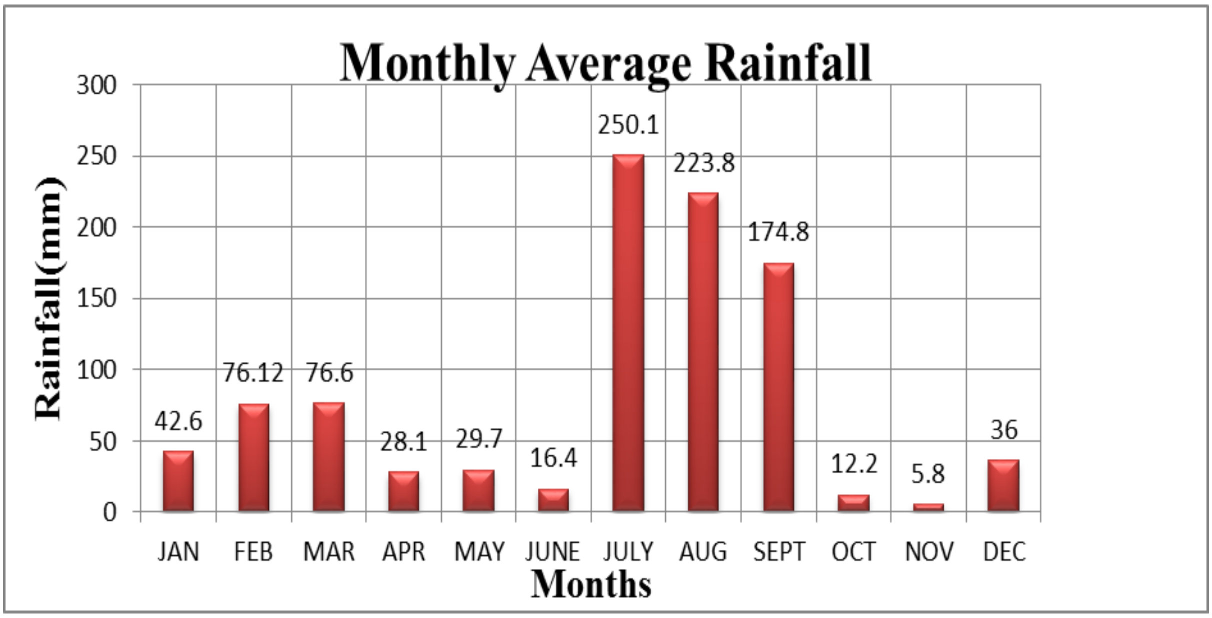


Fig 5.1

5.1 PARMAR BHAWAN

Total Catchment area = 1174 m^2

Average annual rainfall = 972mm

Total water that can be harvested= 0.80 X 0.85 X 1174 X 0.972=775967L

CASE 1 (150 lpcd)

Monthly Demand=150*329*30=1480500L/Month

Total yearly requirement =150*329*335=16532250L/Year

CASE 2 (40 lpcd)

Monthly Demand=40*329*30=394800L/Month

Total yearly requirement = 40*335*329= 4408600L/Year

As the amount of water harvested is much less than the annual demand so this water can be used only for some specific domestic use such as for sanitation, washing etc.

WATER SUPPLY IN JUIT

Natural Water supply of JUIT is 3, 00,000 litres (from domehar bani), remaining is supplied through tankers including private and jaypee owned.

Average Tanker = 10 per day

Capacity of each tanker = 10000 litres

Amount of water supplied through tankers is 100000 per day
Total Supply =400000L/day

MASS INFLOW CURVE

Curve is the plot of accumulated inflow (i.e. Supply) or outflow (i.e. demand) vs time. The mass curve of supply (i.e. Supply line) is therefore first drawn and is superimposed by demand curve.

For computational convenience two cases were considered:

***CASE 1*:** When water consumption is assumed to be 150lpcd

Table 5.2

Month	Rainfall(mm)	Runoff(cu.m)	Cumulative Runoff(cu.m)	Demand(cu.m)	Cumulative Demand(cu.m)
Jan	42.6	40	40	1480	1480
Feb	76.12	71.5	111.5	1480	2960
March	76.6	72	183.5	1480	4440
Apr	28.1	26.4	209.9	1480	5920
May	29.7	28	237.9	1480	7400
June	16.4	15.4	253.3	1480	8880
July	250.1	235	488.3	1480	10360
Aug	223.8	210.2	698.5	1480	11840
Sept	174.8	164.2	862.7	1480	13320
Oct	12.2	11.4	874.1	1480	14800
Nov	5.8	5.4	879.5	1480	16280
Dec	36	34	913.5	1480	17760

According to data mentioned above the mass inflow curve is as shown in fig.

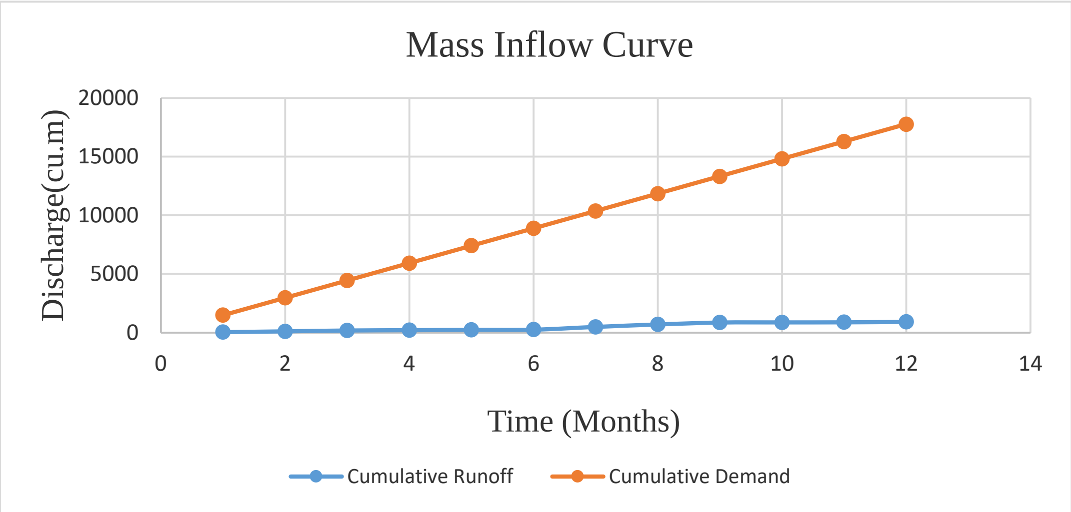


Fig 5.2

The mass curve obtained above is not feasible as the water demand is much greater than the water supplied or harvested. So, we have to use the rain water for other house hold purpose like sanitation, washing etc.

***CASE 2*:** When water consumption is assumed to be 40lpcd (for sanitation and washing purpose)

Table 5.3

Month	Rainfall(mm)	Runoff(cu.m)	Cumulative Runoff(cu.m)	Demand(cu.m)	Cumulative Demand(cu.m)
Jan	42.6	40	40	395	395
Feb	76.12	71.5	111.5	395	790
March	76.6	72	183.5	395	1185
Apr	28.1	26.4	209.9	395	1580
May	29.7	28	237.9	395	1975
June	16.4	15.4	253.3	395	2370
July	250.1	235	488.3	395	2765
Aug	223.8	210.2	698.5	395	3160
Sept	174.8	164.2	862.7	395	3555
Oct	12.2	11.4	874.1	395	3950
Nov	5.8	5.4	879.5	395	4345
Dec	36	34	913.5	395	4740

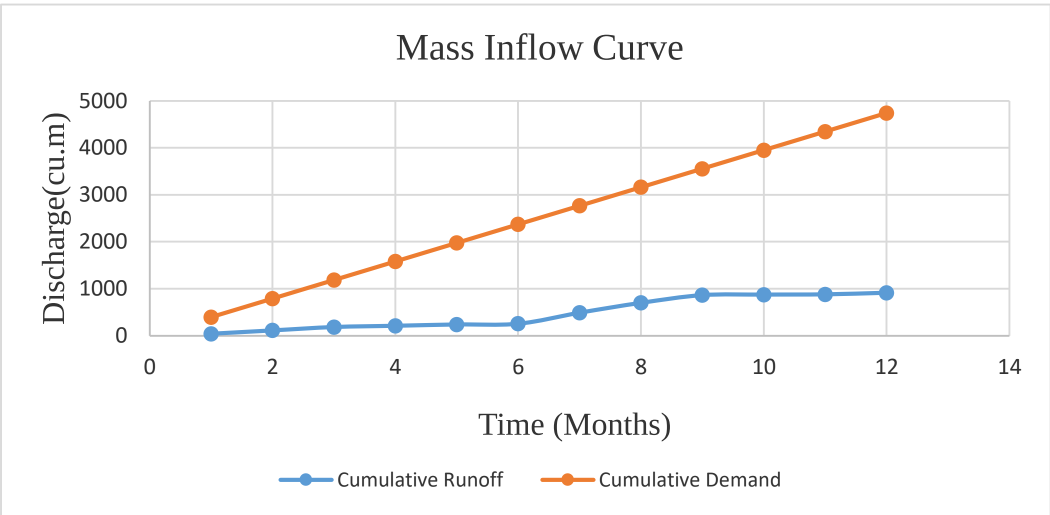


Fig 5.3

5.2 AZAD BHAWAN

Total Catchment area = 784 m^2

Average annual rainfall = 972mm

Total water that can be harvested= 0.80 X 0.85 X 784 X 0.972=518193L

CASE 1 (150 lpcd)

Monthly Demand=150*309*30=1390500L/Month

Total yearly requirement =150*309*335=15527250 L/Year

CASE 2 (40 lpcd)

Monthly Demand=40*309*30=370800L/Month

Total yearly requirement = 40*309*335= 4140600 L/Year

MASS INFLOW CURVE:

Case 1: When water consumption is assumed to be 150lpcd

Table 5.4

Month	Rainfall(mm)	Runoff(mm)	Cumulative Runoff(cu.m)	Demand(cu.m)	Cumulative Demand(cu.m)
Jan	42.6	26.718	26.718	1390	1390
Feb	76.12	47.742	74.46	1390	2780
March	76.6	48.043	122.503	1390	4170
April	28.1	17.624	140.127	1390	5560
May	29.7	18.627	158.754	1390	6950
June	16.4	10.286	169.04	1390	8340
July	250.1	156.862	325.902	1390	9730
August	223.8	140.367	466.269	1390	11120
September	174.8	109.634	575.903	1390	12510
October	12.2	7.651	583.554	1390	13900
November	5.8	3.637	587.191	1390	15290
December	36	22.579	609.77	1390	16680

According to data mentioned above the mass inflow curve is as shown in fig.

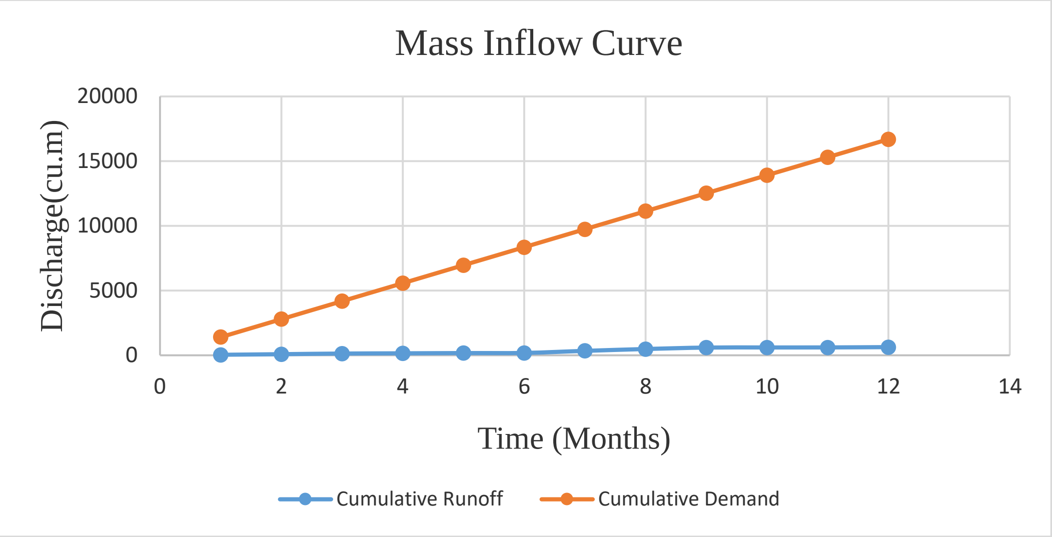


Fig 5.4

The mass curve obtained above is not feasible as the water demand is much greater than the water supplied or harvested. So, we have to use the rain water for other house hold purpose like sanitation, washing etc.

***CASE 2* :** When 40 lpcd is used.

Table 5.5

Month	Rainfall(mm)	Runoff(mm)	Cumulative Runoff(cu.m)	Demand(cu.m)	Cumulative Demand(cu.m)
Jan	42.6	26.718	26.718	370	370
Feb	76.12	47.742	74.46	370	740
March	76.6	48.043	122.503	370	1110
April	28.1	17.624	140.127	370	1480
May	29.7	18.627	158.754	370	1850
June	16.4	10.286	169.04	370	2220
July	250.1	156.862	325.902	370	2590
August	223.8	140.367	466.269	370	2960
September	174.8	109.634	575.903	370	3330
October	12.2	7.651	583.554	370	3700
November	5.8	3.637	587.191	370	4070
December	36	22.579	609.77	370	4440

According to data mentioned above the mass inflow curve is as shown in fig.

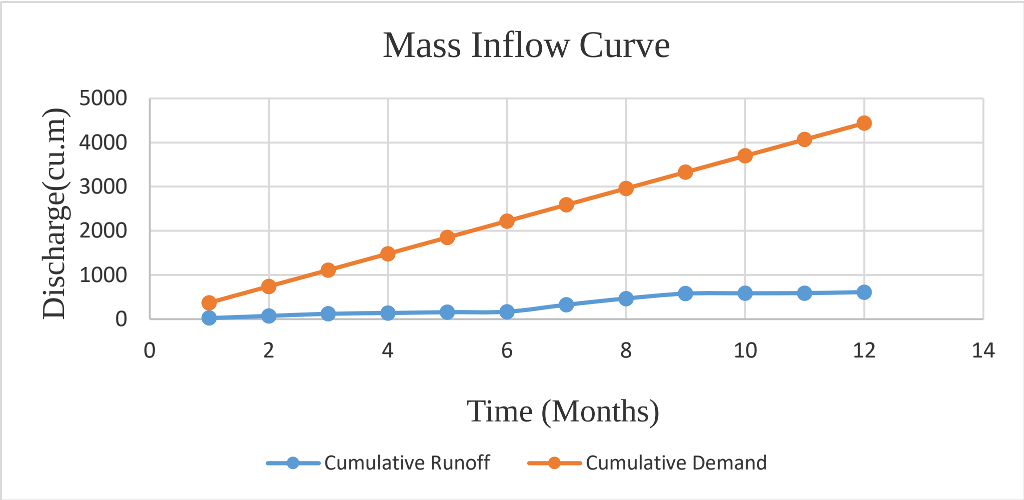


Fig 5.5

5.3 SHASTRI BHAWAN

Total Catchment area = 1651 m^2

Population =567

Average annual rainfall = 1096.69 mm

Total water that can be harvested= 0.80x0.85x1651x0.972=1091245L

CASE 1 (150 lpcd)

Monthly Demand=150x567x30=2551500L/month

Total yearly requirement =150x567x335=28491750L/year

CASE 2 (40 lpcd)

Monthly Demand=40x567x30=680400L/month

Total yearly requirement = 40x567x335=7597800L/year

MASS INFLOW CURVE:

CASE 1: When water consumption is assumed to be 150lpcd

Table5.6

Month	Rainfall(mm)	Runoff(mm)	Cumulative Runoff(cu.m)	Demand(cu.m)	Cumulative Demand(cu.m)
Jan	42.6	56.26	56.26	2551.5	2551.5
Feb	76.12	100.5	156.76	2551.5	5103
March	76.6	101.17	257.93	2551.5	7654.5
April	28.1	37.11	295.04	2551.5	10206
May	29.7	39.23	334.27	2551.5	12757.5
June	16.4	21.66	355.93	2551.5	15309
July	250.1	330.3	689.23	2551.5	17860.5
August	223.8	295.6	981.83	2551.5	20412
September	174.8	230.8	1212.63	2551.5	22963.5
October	12.2	16.11	1228.74	2551.5	25515
November	5.8	7.66	1236.4	2551.5	28066.5
December	36	47.55	1283.95	2551.5	30618

According to data mentioned above the mass inflow curve is as shown in fig.

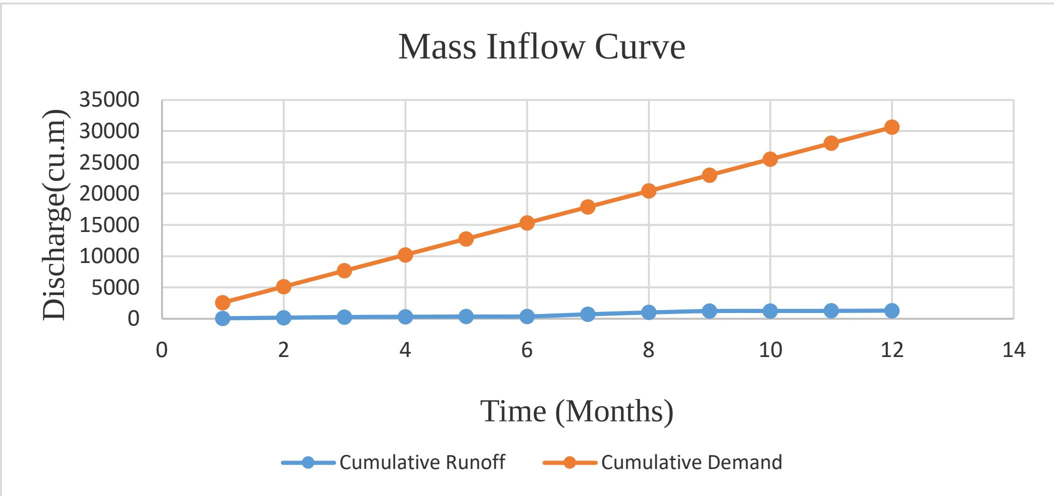


Fig 5.6

The mass curve obtained above is not feasible as the water demand is much greater than the water supplied or harvested. So, we have to use the rain water for other house hold purpose like sanitation, washing etc.

***CASE 2* :** When 40 lpcd is used

Table 5.7

Month	Rainfall(mm)	Runoff(mm)	Cumulative Runoff(cu.m)	Demand(cu.m)	Cumulative Demand(cu.m)
Jan	42.6	56.26	56.26	680.4	680.4
Feb	76.12	100.5	156.76	680.4	1361
March	76.6	101.17	257.93	680.4	2041.2
April	28.1	37.11	295.04	680.4	2722
May	29.7	39.23	334.27	680.4	3402
June	16.4	21.66	355.93	680.4	4082.4
July	250.1	330.3	689.23	680.4	4763
August	223.8	295.6	981.83	680.4	5443.2
September	174.8	230.8	1212.63	680.4	6124
October	12.2	16.11	1228.74	680.4	6804
November	5.8	7.66	1236.4	680.4	7484.4
December	36	47.55	1283.95	680.4	8165

According to data mentioned above the mass inflow curve is as shown in fig.

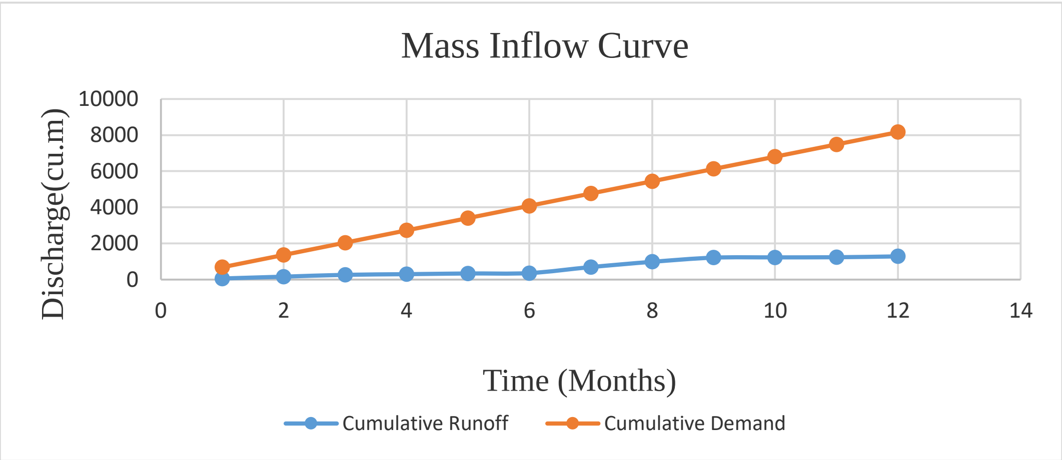


Fig 5.7

5.4 GEETA BHAWAN

Total Catchment area = 852 m^2

Average annual rainfall = 972mm

Total water that can be harvested= 0.80 X 0.85 X 852 X 0.972=563137 L

CASE 1 (150 lpcd)

Monthly Demand=150*392*30=1764000L/Month
Total yearly requirement =150*392*335=19698000L/Year

CASE 2 (40 lpcd)

Monthly Demand=40*392*30=470400L/Month
Total yearly requirement = 40*335*392= 5252800L/Year
As the amount of water harvested is much less than the annual demand so this water can be used only for some specific domestic use such as for sanitation, washing etc.

MASS INFLOW CURVE:

Curve is the plot of accumulated inflow (i.e. Supply) or outflow (i.e. demand) vs time. The mass curve of supply (i.e. Supply line) is therefore first drawn and is superimposed by demand curve.
For computational convenience two cases were considered:

CASE 1: When water consumption is assumed to be 150lpcd

Table 5.8

Month	Rainfall(mm)	Runoff(cu.m)	Cumulative Runoff(cu.m)	Demand(cu.m)	Cumulative Demand(cu.m)
Jan	42.6	29.03	29.03	1764	1764
Feb	76.12	51.88	80.91	1764	3528
March	76.6	52.21	133.12	1764	5292
Apr	28.1	19.15	152.27	1764	7056
May	29.7	20.24	172.51	1764	8820
June	16.4	11.17	183.68	1764	10584
July	250.1	170.46	354.14	1764	12348
Aug	223.8	152.54	506.68	1764	14112
Sept	174.8	119.14	625.82	1764	15876
Oct	12.2	152.54	778.36	1764	17640
Nov	5.8	8.32	786.68	1764	19404
Dec	36	3.95	790.63	1764	21168

According to data mentioned above the mass inflow curve is as shown in fig.

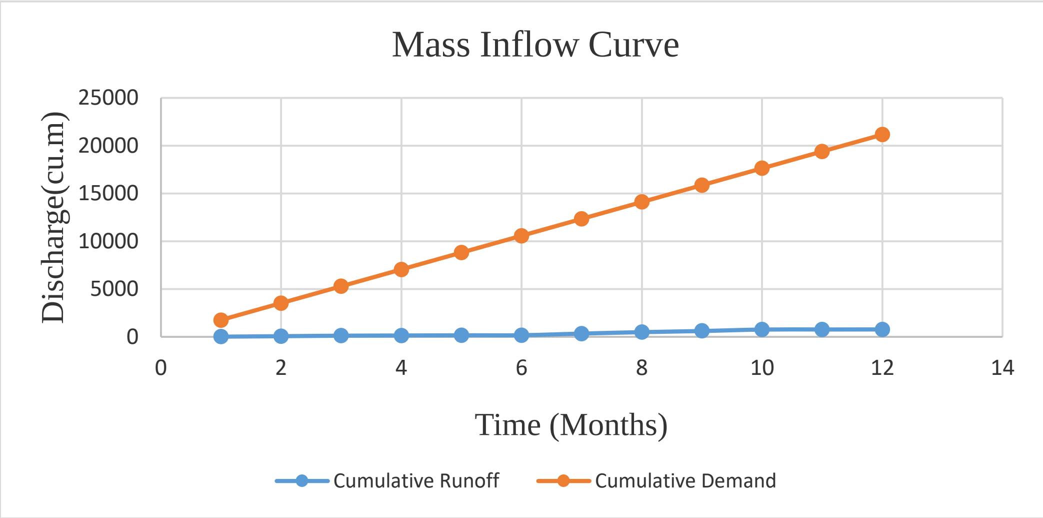


Fig 5.8

The mass curve obtained above is not feasible as the water demand is much greater than the water supplied or harvested. So, we have to use the rain water for other house hold purpose like sanitation, washing etc. purpose

***CASE 2* :** When water consumption is assumed to be 40lpcd (for sanitation and washing)

Table 5.9

Month	Rainfall(mm)	Runoff(cu.m)	Cumulative Runoff(cu.m)	Demand(cu.m)	Cumulative Demand(cu.m)
Jan	42.6	29.03	29.03	470	470
Feb	76.12	51.88	80.91	470	940
March	76.6	52.21	133.12	470	1410
Apr	28.1	19.15	152.27	470	1880
May	29.7	20.24	172.51	470	2350
June	16.4	11.17	183.68	470	2820
July	250.1	170.46	354.14	470	3290
Aug	223.8	152.54	506.68	470	3760
Sept	174.8	119.14	625.82	470	4230
Oct	12.2	152.54	778.36	470	4700
Nov	5.8	8.32	786.68	470	5170
Dec	36	3.95	790.63	470	5640

According to data mentioned above the mass inflow curve is as shown in fig.

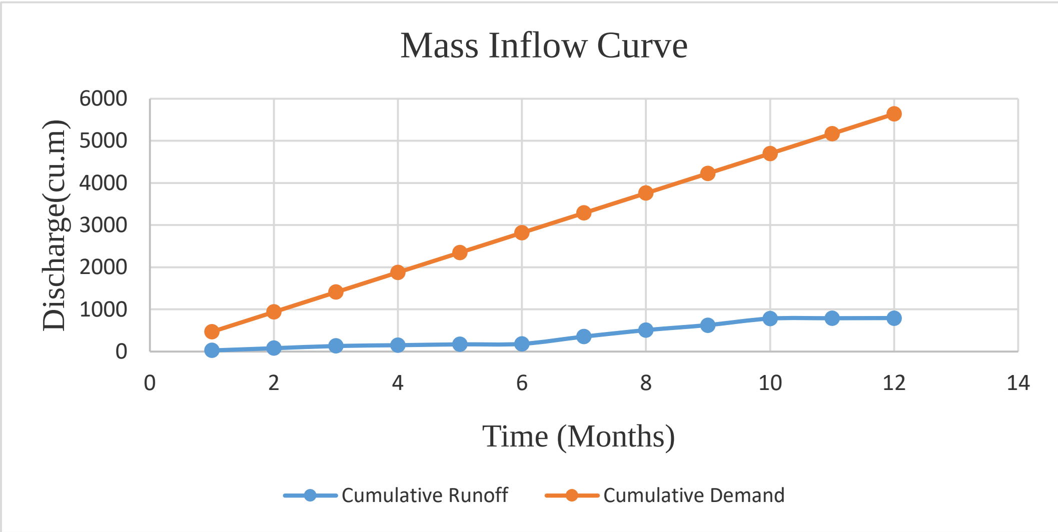


Fig 5.9

5.5 MALVIYA BHAWAN FACULTY BLOCKS:

Considering the 4 blocks i.e. A, B, C and D the calculations are as follows:-

A block - 7 flats

Fig 5.10

B block – 24 flats

Fig 5.11

C block – 21 flats

D block – 20 flat

Fig 5.12

Total Flats = 72

Average number of persons residing in a flat = 4

Total number of persons in all blocks = 288

CATCHMENT:-

Area utilized for Rainwater harvesting

Roof Area

Area of roof = 36 X 27 sq. ft

No. of roofs = 10

Total roof area = 36 X 27 X 10 = 903 sq. m

Balcony Area

A- Block: -6 balconies

6x (34’5”x8.5’) = 163 sq. m

1 Balcony of area 8.5 X 27 = 21.32 sq. m

1 Balcony of area 10.5x18.5= 18 sq. m

For B block = (12 X21.32) + (4 X18) = 328 sq. m

For C block = (9 X21.32) + (3X18) = 246 sq. m

For D block = (6 X 21.32) + (2 X18) = 164 sq. m

Total Catchment area= $1804m^2$

Total Water that can be harvested=0.80x0.85x0.972x1804=1192372L

WATER DEMAND

CASE 1 :

Assuming water demand = 150 lpcd

For A block

Monthly Demand = 7X4X150X30= 126000L

Annual Demand = 7X4X150X335 = 1407000L

For B block

Monthly Demand = 24X4X150X30= 432000L

Annual Demand = 24X4X150X335 = 4824000L

For C block

Monthly Demand = 21X4X150X30= 378000L

Annual Demand = 21X4X150X335 = 4221000L

For D block

Monthly Demand = 20X4X150X30= 360000L

Annual Demand = 20X4X150X335= 4020000L

So,

Total Monthly Demand= 1296000L

Total Annual Demand= 14472000L

Case- 2

Assuming Daily Demand =30+10 = 40 lpcd (as 150lpcd is not feasible)

For A block

Monthly Demand = 7X4X40X30= 33600L

Annual Demand = 7X4X40X335 = 375200L

For B block

Monthly Demand = 24X4X40X30= 115200L

Annual Demand = 24X4X40X335 = 1286400L

For C block

Monthly Demand = 21X4X40X30= 100800L

Annual Demand = 21X4X40X335 = 1125600L

For D block

Monthly Demand = 20X4X40X30= 96000L

Annual Demand = 20X4X40X335= 1072000L

So,

Total Monthly Demand= 345600L

Total Annual Demand= 3859200L

CASE 1: When water consumption is assumed to be 150lpcd

Table 5.10

Month	Rainfall(mm)	Runoff(mm)	Cumulative Runoff(cu.m)	Demand(cu.m)	Cumulative Demand(cu.m)
Jan	42.6	26.718	26.718	346	1296
Feb	76.12	47.742	74.46	346	2592
March	76.6	48.043	122.503	346	3888
April	28.1	17.624	140.127	346	5184
May	29.7	18.627	158.754	346	6480
June	16.4	10.286	169.04	346	7776
July	250.1	156.862	325.902	346	9072
August	223.8	140.367	466.269	346	10368
September	174.8	109.634	575.903	346	11664
October	12.2	7.651	583.554	346	12960
November	5.8	3.637	587.191	346	14256
December	36	22.579	609.77	346	15552

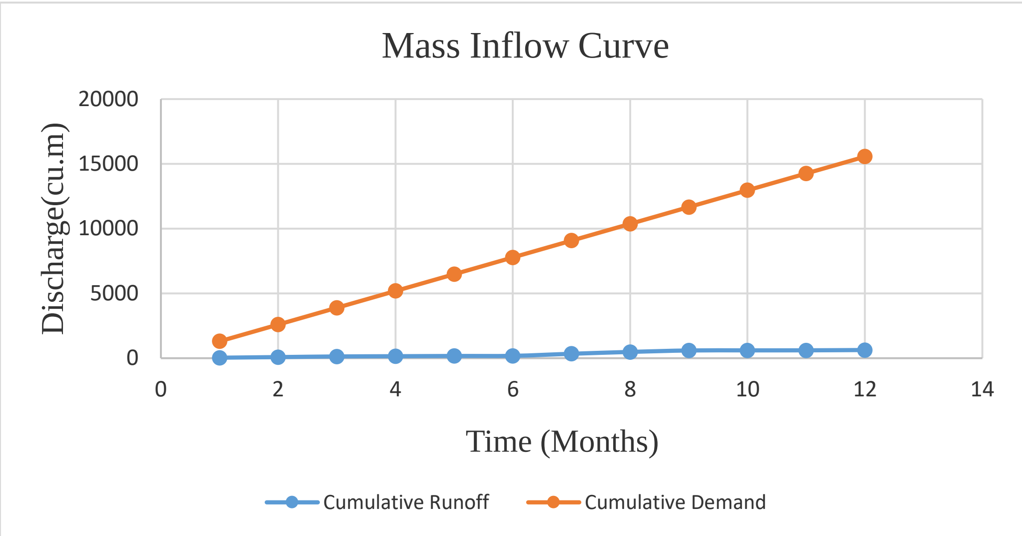


Fig 5.13

The mass curve obtained above is not feasible as the water demand is much greater than the water supplied or harvested. So, we have to use the rain water for other house hold purpose like sanitation, washing etc.

***CASE 2* :** When water consumption is assumed to be 40lpcd (for sanitation and washing)

Table 5.11

Month	Rainfall(mm)	Runoff(mm)	Cumulative Runoff(cu.m)	Demand(cu.m)	Cumulative Demand(cu.m)
Jan	42.6	26.718	26.718	346	346
Feb	76.12	47.742	74.46	346	692
March	76.6	48.043	122.503	346	1038
April	28.1	17.624	140.127	346	1384
May	29.7	18.627	158.754	346	1730
June	16.4	10.286	169.04	346	2076
July	250.1	156.862	325.902	346	2422
August	223.8	140.367	466.269	346	2768
September	174.8	109.634	575.903	346	3114
October	12.2	7.651	583.554	346	3460
November	5.8	3.637	587.191	346	3806
December	36	22.579	609.77	346	4152

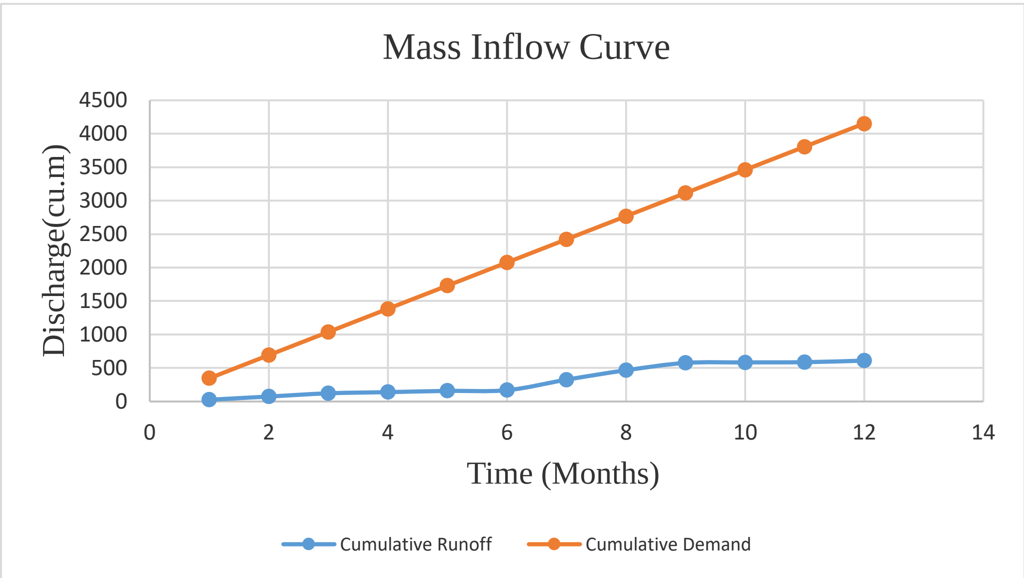


Fig 5.14

5.6 ACADEMIC BLOCK:

Total Catchment area = 1794 m^2

Average annual rainfall = 972mm

Total water that can be harvested= 0.80 X 0.85 X 1794 X 0.972=1185762 L

Taking an average population of the Academic block as 800. (Including faculty, Student and non-teaching staff)

CASE 1 (150 lpcd)

Monthly Demand=150*800*30=3600000 L/Month

Total yearly requirement =150*800*335=40200000L/Year

CASE 2 (40 lpcd)

Monthly Demand=40*800*30=960000 L/Month

Total yearly requirement = 40*335*800= 10720000 L /Year

As the amount of water harvested is much less than the annual demand so this water can be used only for some specific domestic use such as for sanitation, washing etc.

MASS INFLOW CURVE :

Curve is the plot of accumulated inflow (i.e. Supply) or outflow (i.e. demand) vs time. The mass curve of supply (i.e. Supply line) is therefore first drawn and is superimposed by demand curve.

For computational convenience two cases were considered:

***CASE 1*:** When water consumption is assumed to be 150lpcd

***CASE 2*:** When water consumption is assumed to be 40lpcd

***CASE 1*:** When water consumption is assumed to be 150lpcd

Table 5.12

Month	Rainfall(mm)	Runoff(cu.m)	Cumulative Runoff(cu.m)	Demand(cu.m)	Cumulative Demand(cu.m)
Jan	42.6	61.13	61.13	3600	3600
Feb	76.12	109.24	170.37	3600	7200
March	76.6	109.93	280.3	3600	10800
Apr	28.1	40.32	320.62	3600	14400
May	29.7	42.62	363.24	3600	18000
June	16.4	23.53	386.77	3600	21600
July	250.1	358.94	745.71	3600	25200
Aug	223.8	321.19	1066.9	3600	28800
Sept	174.8	250.87	1317.77	3600	32400
Oct	12.2	17.51	1335.28	3600	36000
Nov	5.8	8.32	1343.6	3600	39600
Dec	36	51.67	1395.27	3600	43200

According to data mentioned above the mass inflow curve is as shown in fig.

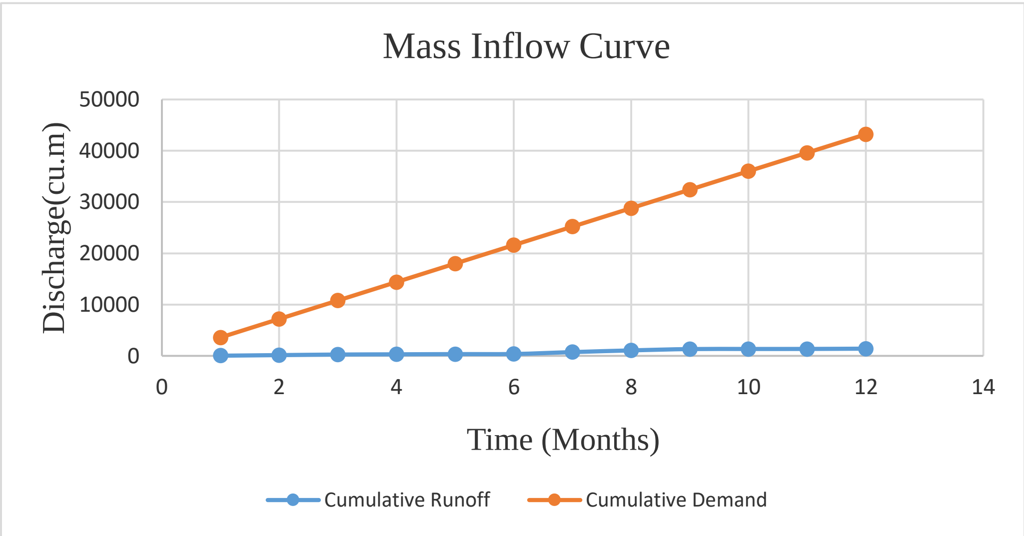


Fig 5.15

The mass curve obtained above is not feasible as the water demand is much greater than the water supplied or harvested. So, we have to use the rain water for other house hold purpose like sanitation, washing etc. purpose

***CASE 2*:** When water consumption is assumed to be 40lpcd (for sanitation and washing)

Table 5.13

Month	Rainfall(mm)	Runoff(cu.m)	Cumulative Runoff(cu.m)	Demand(cu.m)	Cumulative Demand(cu.m)
Jan	42.6	61.13	61.13	960	960
Feb	76.12	109.24	170.37	960	1920
March	76.6	109.93	280.3	960	2880
Apr	28.1	40.32	320.62	960	3840
May	29.7	42.62	363.24	960	4800
June	16.4	23.53	386.77	960	5760
July	250.1	358.94	745.71	960	6720
Aug	223.8	321.19	1066.9	960	7680
Sept	174.8	250.87	1317.77	960	8640
Oct	12.2	17.51	1335.28	960	9600
Nov	5.8	8.32	1343.6	960	10560
Dec	36	51.67	1395.27	960	11520

According to data mentioned above the mass inflow curve is as shown in fig.

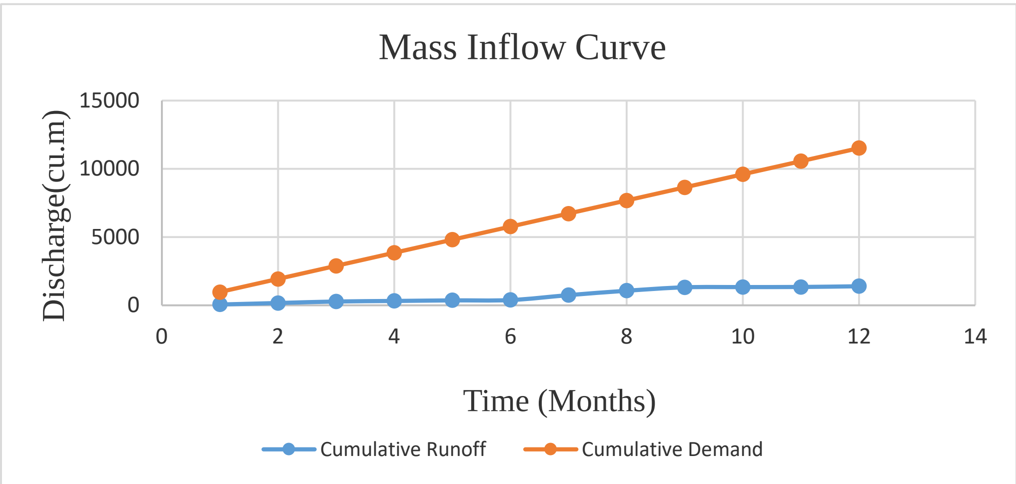


Fig 5.16

5.7. JUIT Mess

Yearly Water demand = (1725+1655+1655) * 40 *365= 73511000 L

Average annual rainfall = 972mm

Total rainwater harvested (from SHASTRI BHAWAN) = 1091245 L

Table 5.14

Month	Rainfall(mm)	Runoff(mm)	Cumulative Runoff(cu.m)	Demand(cu.m)	Cumulative Demand(cu.m)
Jan	42.6	56.26	56.26	73511	73511
Feb	76.12	100.5	156.76	73511	147022
March	76.6	101.17	257.93	73511	220533
April	28.1	37.11	295.04	73511	294044
May	29.7	39.23	334.27	73511	367555
June	16.4	21.66	355.93	73511	441066
July	250.1	330.3	689.23	73511	514577
August	223.8	295.6	981.83	73511	588088
September	174.8	230.8	1212.63	73511	661599
October	12.2	16.11	1228.74	73511	735110
November	5.8	7.66	1236.4	73511	808621
December	36	47.55	1283.95	73511	882132

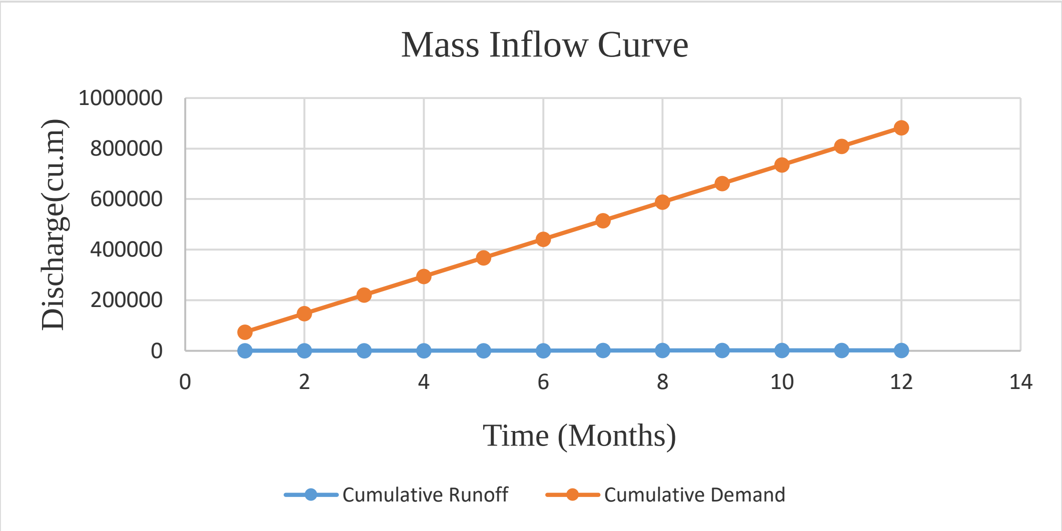


Fig 5.17

CHAPTER-6

COLLECTIVE MASS INFLOW CURVE FOR JUIT CAMPUS

For 150 LPCD Water Demand:

Total Monthly Demand = 150 x 2397 x 30 = 10787 m^3/ Month

Table 6.1

Month	Rainfall(mm)	Runoff(cu.m)	Cumulative Runoff(cu.m)	Demand(cu.m)	Cumulative Demand(cu.m)
Jan	42.6	247.6	247.6	10787	10787
Feb	76.12	490.68	738.28	10787	21574
March	76.6	493.78	1232.06	10787	32361
Apr	28.1	181.14	1413.2	10787	43148
May	29.7	191.45	1604.65	10787	53935
June	16.4	105.72	1710.37	10787	64722
July	250.1	1612.17	3322.54	10787	75509
Aug	223.8	1442.63	4765.17	10787	86296
Sept	174.8	1126.78	5891.95	10787	97083
Oct	12.2	78.64	5970.59	10787	107870
Nov	5.8	37.39	6007.98	10787	118657
Dec	36	232.1	6240.1	10787	129444

The mass inflow diagram representing 150 LPCD Demand:

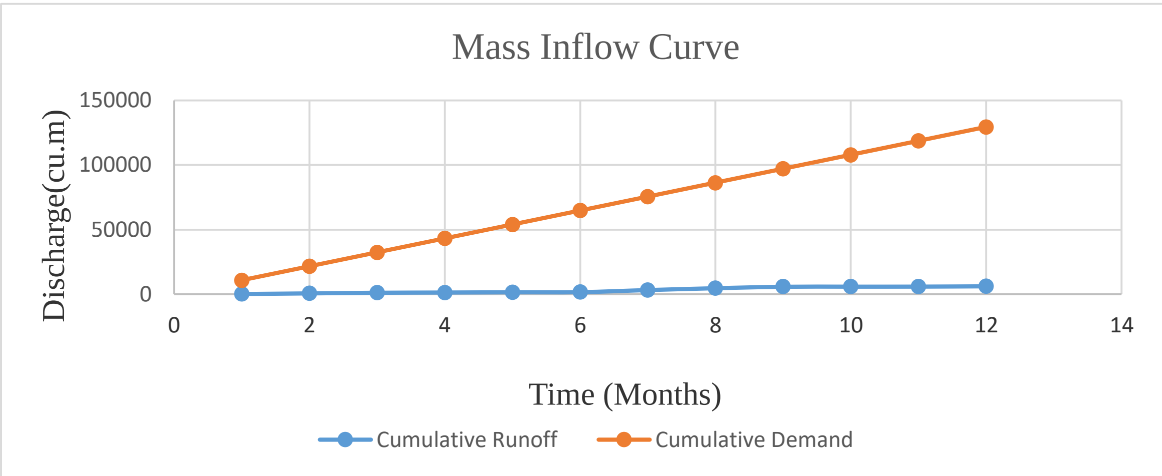


Fig 6.1

For 40 LPCD Water Demand:

Total Monthly Demand = 40 x 2397 x 30 = 2876m^3/ Month

Table 6.2

Month	Rainfall(mm)	Runoff(cu.m)	Cumulative Runoff(cu.m)	Demand(cu.m)	Cumulative Demand(cu.m)
Jan	42.6	247.6	247.6	2876	2876
Feb	76.12	490.68	738.28	2876	5752
March	76.6	493.78	1232.06	2876	8628
Apr	28.1	181.14	1413.2	2876	11504
May	29.7	191.45	1604.65	2876	14380
June	16.4	105.72	1710.37	2876	17256
July	250.1	1612.17	3322.54	2876	20132
Aug	223.8	1442.63	4765.17	2876	23008
Sept	174.8	1126.78	5891.95	2876	25884
Oct	12.2	78.64	5970.59	2876	28760
Nov	5.8	37.39	6007.98	2876	31636
Dec	36	232.1	6240.1	2876	34512

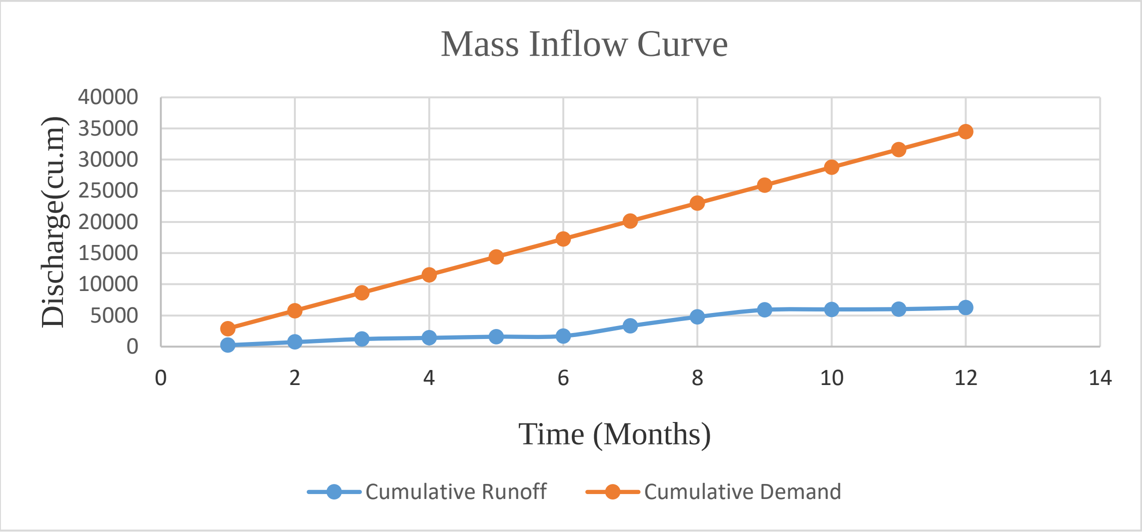


Fig 6.2

CHAPTER 6

TANK DIMENSIONS

DIMENSIONS OF TANK: (As per BS 8515 2009)

The size of tank depends upon the factor like daily demand, duration of dry spell, catchment and rainfall.

For each block there will be separate tank

6.1 PARMAR BHAWAN

The size of tank depends upon the factor like daily demand, duration of dry spell, catchment and rainfall.

Annual Demand = 4408600L

Annual Supply = 775967L

The Capacity of storage tank is = 5% of Annual Demand or 5% of Annual supply

=0.05x4408.6 or 0.05x775.97

=220.43 cu.m or 39.79cu.m

Taking the minimum value, Size of Tank is 40cu.m

6.2 AZAD BHAWAN

The size of tank depends upon the factor like daily demand, duration of dry spell, catchment and rainfall.

Annual supply = 518193L

Annual demand = 4140600 L

The Capacity of storage tank is = 5% of Annual Demand or 5% of Annual supply

=0.05x518.2or 0.05x4140.6

=25.91cu.m or 207.03cu.m

Taking the minimum value, Size of Tank is 26cu.m

6.3 SHASTRI BHAWAN

The size of tank depends upon the factor like daily demand, duration of dry spell, catchment and rainfall.

Annual supply = 1091245L
Annual demand = 7597800L

The Capacity of storage tank is = 5% of Annual Demand or 5% of Annual supply

=0.05x1091.2 or 0.05x7597.8

=54.56 cu.m or 379.89cu.m

Taking the minimum value, Size of Tank is 55cu.m

6.4 GEETA BHAWAN

The size of tank depends upon the factor like daily demand, duration of dry spell, catchment and rainfall.

Annual supply = 563137L
Annual demand = 5252800L

The Capacity of storage tank is = 5% of Annual Demand or 5% of Annual supply

=0.05x563.137or 0.05x5252.8

=29.15 cu.m or 262.64 cu.m

Taking the minimum value, Size of Tank is 30 cu.m

6.5 ACADEMIC BLOCK

The size of tank depends upon the factor like daily demand, duration of dry spell, catchment and rainfall.

Annual supply = 1185762L
Annual demand = 10720000L

The Capacity of storage tank is = 5% of Annual Demand or 5% of Annual supply

= 0.05x1185.762 or 0.05x10720

= 59.28 cu.m or 536 cu.m

Taking the minimum value, Size of Tank is 59.28cu.m

6.6 MALVIYA BHAWAN FACULTY BLOCK

• *A Block*-

Annual Demand = 375200L

Annual Supply = 0.80x253.2x0.972= 196888L

The Capacity of storage tank is = 5% of Annual Demand or 5% of Annual supply

=0.05x375200 or 0.05x196733

=18.76 cu.m or 9.84cu.m

Taking the minimum value, Size of Tank is 10 cu.m

•*B Block*-

Annual Demand = 1286400 L

Annual Supply = 0.80x(328.4+4x90)x0.972= 535299L

The Capacity of storage tank is = 5% of Annual Demand or 5% of Annual supply

=0.05x1286400 or 0.05x534989

=64.32cu.m or 26.75cu.m

Taking the minimum value, Size of Tank is 27cu.m

•*C Block*-

Annual Demand = 1125600L

Annual Supply = 0.80x (246.3+90x3) x0.972= 401242L

The Capacity of storage tank is = 5% of Annual Demand or 5% of Annual supply

=0.05x1125.6 or 0.05x401.242

=56.3cu.m or 20.06cu.m

Taking the minimum value, Size of Tank is 20cu.m

•*D Block*-

Annual Demand = 1072000L

Annual Supply = 0.80x (164.2+2x90) x0.972= 267650L

The Capacity of storage tank is = 5% of Annual Demand or 5% of Annual supply

=0.05x1072 or 0.05x268.27

=53.6cu.m or 13.41cu.m

Taking the minimum value, Size of Tank is 14cu.m

CHAPTER 7

CHARACTERISTICS OF RAIN WATER

Various quality parameter testing has been done on the rainwater and the following result has been obtained:

1. **pH**- pH is defined as the negative logarithmic of hydrogen or hydroxyl in concentration.. The pH test is an important preliminary test. Small changes in pH (0.3 units or even less) are usually associated with relatively large changes in other water qualities. pH measurement can be done by potentiometer and also by colour indicator phenolphthalein and methyl orange. Natural waters will have pH values from pH 5.0 to pH 8.5.

2. **Turbidity**: Turbidity is a measure of water clarity how much the material suspended in water decreases the passage of light through the water

3. **Hardness**: Hardness refers to the amount of mineral content present in water.

4. **Alkalinity**: Alkalinity is the measurement of acid neutralizing capacity of water. The compounds in water that determine alkalinity includes carbonate and bicarbonate ions. Maximum permissible value of alkalinity of drinking water is 200 mg/l

5. **Acidity**: Acidity is the measurement of base neutralizing capacity of water.

6. **TDS**: Total Dissolved solids is a measure of combined content of all inorganic and organic substances contained in water. Maximum permissible value of TDS of drinking water is 500 mg/l

7. **Chloride Content**: Amount of chlorine present in water. Maximum permissible value of chlorine in drinking water is 200 mg/l

Table 7.1

S. No.	TEST	Result	Prescribed Values
1	pH	7	6.6 – 8.5
2	Turbidity	6	5 – 10 NTU
3	Hardness	44 mg/l	75 – 200 mg/l
4	Alkalinity	43 mg/l	200
5	Acidity	0 mg/l	
6	TDS	7 mg/l	500mg/l
7	Chloride Content	0.8 mg/l	Up to 250 mg/l

CHAPTER 8

DESIGNING OF TANKS (IS 3370: PART- 2&4)

8.1 PARMAR BHAWAN

Tank Capacity 40,000L.

Depth of water tank 3.5m Use M-30/fe415.

Unit weight of Water 9.8kN/m^3

Permissible tensile stress in mild steel (**σ_{st}**) =130N/mm2

Permissible tensile Stress in concrete (**σ_{ct}**) =1.5N/mm2

π/4 xD^2x3.5=40

D=3.8m

T (Hoop Tension) = 9.8x3.5x3.8/2=65.2 kN/m height of wall

T=σ_{st} x Ast

$A_{st\ requd}$ = (65.2x1000)/130

=502mm^2

Using 12mm Dia bars

Spacing= (1000)/502 x π/4x12^2

=225.3 mm

Providing 12 mm dia bars @220 mm c/c

$A_{st\ provided}$=1000/220 x π/4x12^2

=514mm^2

At a distance 1.5m from top

T=30 kN/m

$A_{st\ requd}$ =30x1000/130=231 mm^2

Spacing=1000/ 231 x π/4x12^2 =490 mm

This spacing is exceeding the max Limit i.e. 300 mm c/c

Spacing at 1.5m from top i.e. 300 mm c/c

$$\sigma_{ct} > \frac{T}{1000t+(m-1)Ast}$$

$$1.5 > \frac{65.2X1000}{1000t + (9.33-1)X514}$$

t>39.2mm

For M-30 Grade of concrete nominal clear cover is 40 mm

Hence providing thickness of 100 mm for tank wall

$A_{st\ min}$ =0.35%of x-sectional area of surface zone

=0.35/100 x 1000 x 100/2

175mm^2 < 514 mm^2 (O.K)

Distribution Reinforcement

Distribution and temperature steel is provided @0.35%

Providing 8 mm dia bar, spacing =1000/175 x π/4x8^2 =287.23mm

Providing Spacing of 250 mm c/c

$A_{st\ provided}$ =1000/250 x π/4x8^2

201mm^2

Design of Base Slab

Since the tank floor is resting on the ground, the load gets directly transferred to the soil. Hence providing a minimum thickness of 150 mm and 0.35% minimum steel in each direction.

Min thickness of base slab=150mm

Area of steel provided =0.35/100 x1000 x150/2

=263mm^2

Providing 8mm dia reinforcement @180 mm c/c in both direction at top and bottom face of floor slab.

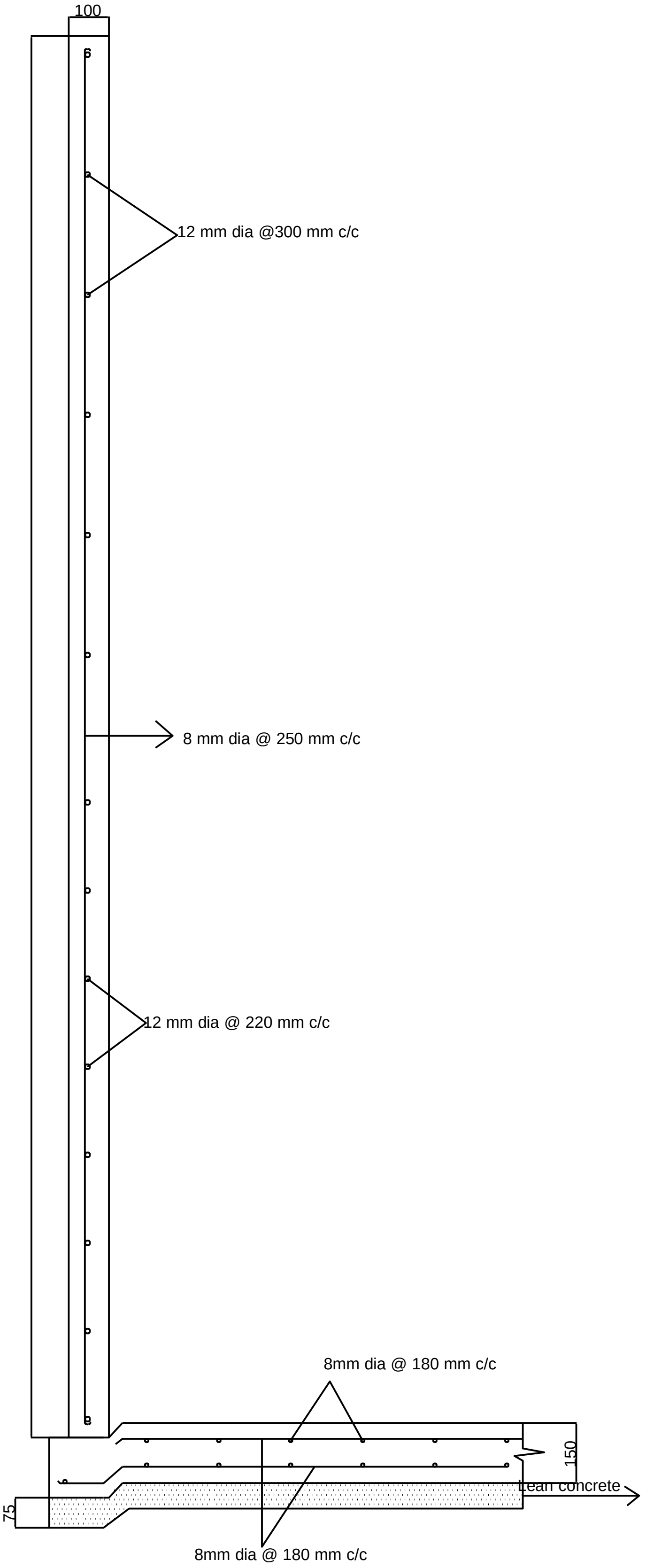

100
12 mm dia @300 mm c/c
8 mm dia @ 250 mm c/c
12 mm dia @ 220 mm c/c
8mm dia @ 180 mm c/c
150
Lean concrete
75
8mm dia @ 180 mm c/c

Fig 8.1

8.2 GEETA BHAWAN

Tank Capacity 30,000 L.

Depth of water tank 3m Use M-30/fe250.

Unit weight of Water 9.8KN/m^3

Permissible tensile stress in mild steel (**σ_{st}**) =115N/mm^2

Permissible tensile Stress in concrete (**σ_{ct}**) =1.5N/mm^2

$\pi/4 \text{ x} D^2 \text{x} 3=30$

D=3.5 m

T (Hoop Tension) = 9.8x3.0x3.5/2=51.45 kN/m height of wall

T=σ_{st} x A_{st}

$A_{st\ requd}$ = (51.45x1000)/115

=447 mm^2

Using 12 mm Dia bars

Spacing= 1000/447 x $\pi/4 \text{x} 12^2$

=253.01 mm

Providing 12 mm dia. bars @ 250 mm c/c

$A_{st\ provided}$ =1000/250 x $\pi/4 \text{x} 12^2$

=452 mm^2

At a distance 1.5m from top

T=25.73 kN/m

$A_{st\ requd}$ =25.73x1000/115=224 mm^2

Spacing=1000/ (224 x $\pi/4 \text{ x} 12^2$) =505 mm

This spacing is exceeding the max Limit i.e. 300 mm c/c

Spacing at 1.5m from top i.e. 300 mm c/c

$$\sigma_{ct} > \frac{T}{1000t+(m-1)Ast}$$

$$1.5 > \frac{51.45X1000}{1000t+(9.33-1)X452}$$

t>30.53 mm

For M-30 Grade of concrete nominal clear cover is 40 mm

Hence providing thickness of 100 mm for tank wall.

$A_{st\ min}$ =0.35%of x-sectional area of surface zone

=0.35/100 x 1000 x 100/2

175mm^2 < 314 mm^2 (O.K)

Distribution Reinforcement

Distribution and temperature steel is provided @0.35%

Providing 8 mm dia bar, spacing =1000/175 x π/4x8^2 =287.23mm

Providing Spacing of 250 mm c/c

$A_{st\ provided}$=1000/250 x π/4x8^2

201mm^2

Design of Base Slab

Since the tank floor is resting on the ground, the load gets directly transferred to the soil. Hence providing a minimum thickness of 150 mm and 0.35% minimum steel in each direction.

Min thickness of base slab=150mm

Area of steel provided =0.35/100 x1000 x150/2

=263mm^2

Providing 8mm dia reinforcement @180 mm c/c in both direction at top and bottom face of floor slab.

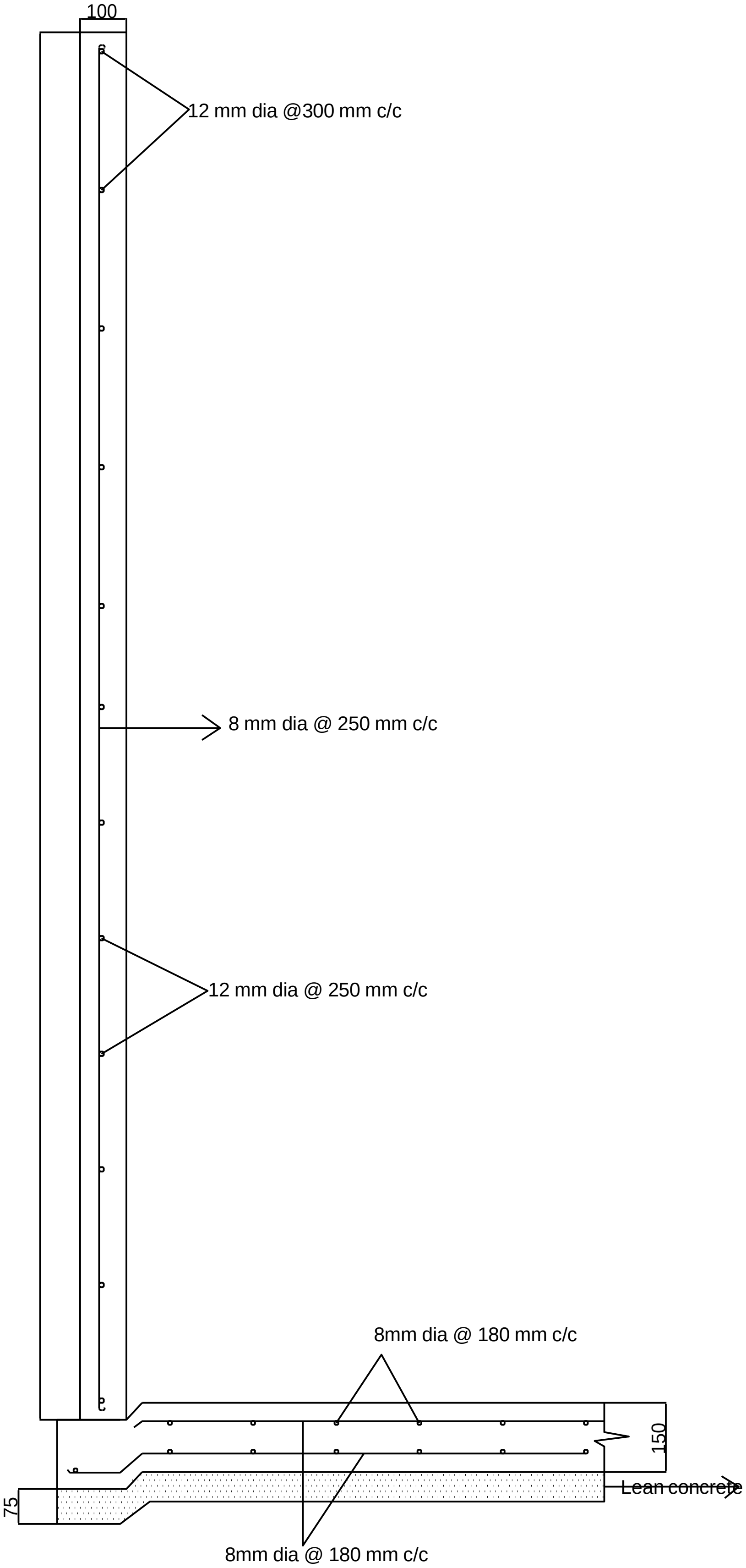

100
12 mm dia @300 mm c/c
8 mm dia @ 250 mm c/c
12 mm dia @ 250 mm c/c
8mm dia @ 180 mm c/c
150
Lean concrete
75
8mm dia @ 180 mm c/c

Fig 8.2

8.3 AZAD BHAWAN

Tank Capacity 26,000L.

Depth of water tank 3 m. Use M-30/Fe250.

Unit weight of Water 9.8KN/m^3

Permissible tensile stress in mild steel (**σ_{st}**) =115N/mm^2

Permissible tensile Stress in concrete (**σ_{ct}**) =1.5N/mm^2

$\pi/4 \text{ x} D^2 \text{x} 3=26$

D=3.3 m

T (Hoop Tension) = 9.8x3.0x3.3/2=48.5 kN/m height of wall

T=σ_{st} x A_{st}

$A_{st\ requd}$ = (48.5x1000)/115

=422 mm^2

Using 10mm Dia bars

Spacing= (1000)/ 422 x $\pi/4 \text{x} 10^2$

=186 mm

Providing 10 mm dia. bars @ 150 mm c/c

$A_{st\ provided}$= (1000/150) x $\pi/4 \text{x} 10^2$

=524mm^2

At a distance 1.5m from top

T=24.25 kN/m

$A_{st\ requd}$ =24.25x1000/115=211 mm^2

Spacing=1000/ 211 x $\pi/4 \text{x} 10^2$ =372 mm

This spacing is exceeding the max Limit i.e. 300 mm c/c

Spacing at 1.5m from top i.e. 300 mm c/c

$$\sigma_{ct} > \frac{T}{1000t+(m-1)Ast}$$

$$1.5 > \frac{44.1X1000}{1000t+(9.33-1)X393}$$

t>26.12 mm

Hence providing thickness of 100 mm for tank wall

$A_{st\ min}$=0.35%of x-sectional area of surface zone

=0.35/100 x 1000 x 100/2

175mm^2 < 393 mm^2 (O.K)

Distribution Reinforcement

Distribution and temperature steel is provided @0.35%

Providing 8 mm dia bar, spacing =1000/175 x π/4x8^2 =287.23mm

Providing Spacing of 250 mm c/c

$A_{st\ provided}$ =1000/250 x π/4x8^2

201mm^2

Design of Base Slab

Since the tank floor is resting on the ground, the load gets directly transferred to the soil. Hence providing a minimum thickness of 150 mm and 0.35% minimum steel in each direction.

Min thickness of base slab=150mm

Area of steel provided=0.35/100 x1000 x150/2

=263mm^2

Providing 8mm dia reinforcement @180 mm c/c in both direction at top and bottom face of floor slab.

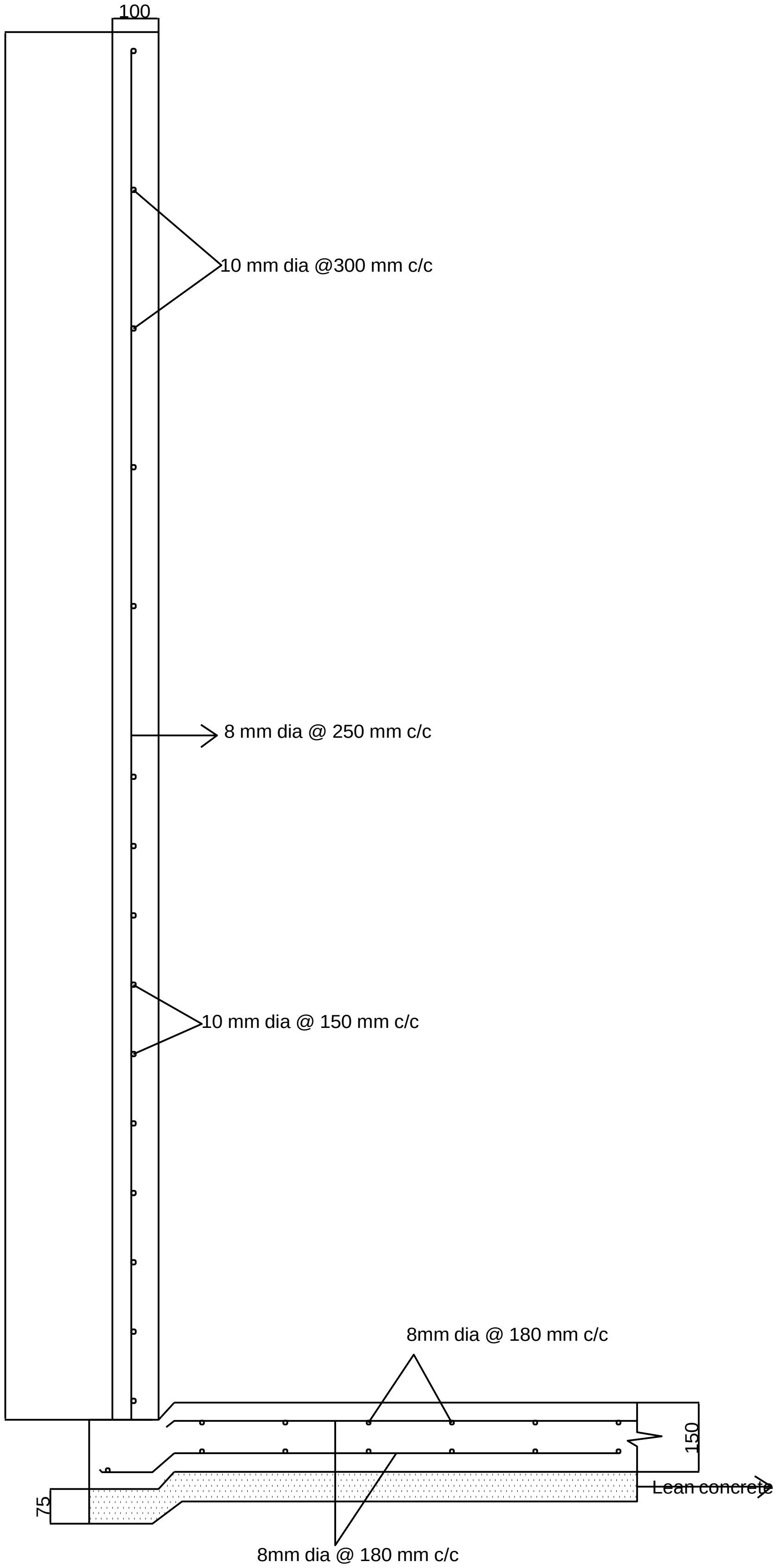

100
10 mm dia @300 mm c/c
8 mm dia @ 250 mm c/c
10 mm dia @ 150 mm c/c
8mm dia @ 180 mm c/c
150
Lean concrete
75
8mm dia @ 180 mm c/c

Fig 8.3

8.4 SHASTRI BHAWAN

Tank Capacity 55,000L. Depth of water tank 3m Use M-30/Fe415. Unit weight of Water 10kN/m^3

Permissible tensile stress in deformed bars (σ_{st}) =130 N/mm^2

Permissible tensile Stress in concrete (σ_{ct}) =1.5 N/mm

Max. Permissible compressive Stress in concrete (σ_{cbc}) = 10 N/mm^2

1. Design constants

m(Modular Ratio)= $\frac{280}{3\sigma cbc} = \frac{280}{3X10}$ = 9.33

k= $\frac{m.\sigma cbc}{m.\sigma cbc+\sigma st}$ $=\frac{9.33x10}{9.33x10+130}$ =0.416

j= 1 - $\frac{0.416}{3}$ =0.86

R=$\frac{1}{2}$. σ_{cbc}.k.j

=$\frac{1}{2}$x10x0.416x0.86

=1.78

Assuming the wall to be 200 mm thick

t=200mm

H=3 m

D=4.61m

= $\frac{HxH}{Dt}$

=$\frac{3x3}{4.61x0.2}$ =9.76

Using IS 3370 (Part-4):1967,Table -10 for moments in cylindrical wall fixed at base and free at top subjected to triangular load

Max. Moment coefficient at the bottom of wall

$= -0.0146+\left(\frac{-0.0122+0.0146}{2}\right)x1.76$

=-0.0125

Max. –ve moment at the bottom of the wall

Max. Moment coefficient X γ X H^3

$=-0.0125x10x3^3$

M=3.4kNm per m height of wall (Tension at inner face)

2 . Thickness Required (t)

$$t=\sqrt{\frac{M}{R.b}}$$

$$t = \sqrt{\frac{3.4x1000000}{1.78x1000}} = 44mm$$

Assuming an effective cover of 50mm

t_{requd} =44+50

=94mm<200mm (O.K)

3. Maximum Hoop Tension (T): Using IS 3370:1987 (Part 4), Table 9, Maximum Hoop Tension Occurs at

0.6H=1.8m

$$= \frac{HxH}{Dt}$$

$$=\frac{3x3}{4.61x0.2} =9.76$$

Hoop Tension coefficient $=0.575+\left(\frac{0.608-0.575}{2}\right)x1.76$

=0.604

Maximum Hoop Tension= Hoop Tension coefficient X γ X H X D/2

=0.604x10x3x4.61/2

=42kN

Area Of steel Required $= \frac{42x1000}{130}$

$=323mm^2$

$A_{st\ min}$=0.35% of area of surface zone

$=\frac{0.35}{100}x\left(1000x\frac{200}{2}\right)=350mm^2$

$A_{st\ min} > A_{st\ requd}$

Providing area of steel $=400mm^2$

Using 10 mm dia hoops and providing reinforcement on both faces

Spacing = $\frac{78.5x1000}{\frac{400}{2}}$ =393mm

Therefore providing 10 mm dia hoops @ 300 mm c/c

$A_{st\ provided}$ =2x1000/300 x π/4x10^2

$=524mm^2$

$\sigma'_{ct} = \frac{T}{1000t+(m-1)\,Ast}$

$= \frac{42x1000}{1000x200+(8.33)x524}$

$=0.205N/mm^2 < \sigma_{ct}$ i.e $1.5N/mm^2$

4. Design For Moment

$A_{st} = \frac{M}{\sigma st.j.d}$

$A_{st} = \frac{3.4x1000000}{130x0.86x150}$

$=203mm^2 < 350mm^2$

Spacing= $\frac{1000}{350}$ x 50.26

=143.6 mm c/c

Using 8 mm dia bars @140 mm c/c on inner face as vertical steel at bottom of the wall. These are required at height of 1 m from bottom only.

$L_d = \frac{\varnothing x \sigma st}{4x\ \tau}$

$=\frac{8x130}{4x2.4}$

=108.3 mm

For the outer face providing minimum steel @0.35%

A_{st}=350mm^2

8mm dia bars @140 mm c/c on outer face as vertical steel

5. Base Slab

Base Slab is provided as 200 mm thick with minimum steel as 350 mm^2 in each direction. Hence providing 8 mm dia bars @ 140 mm c/c in both direction at top and bottom face.

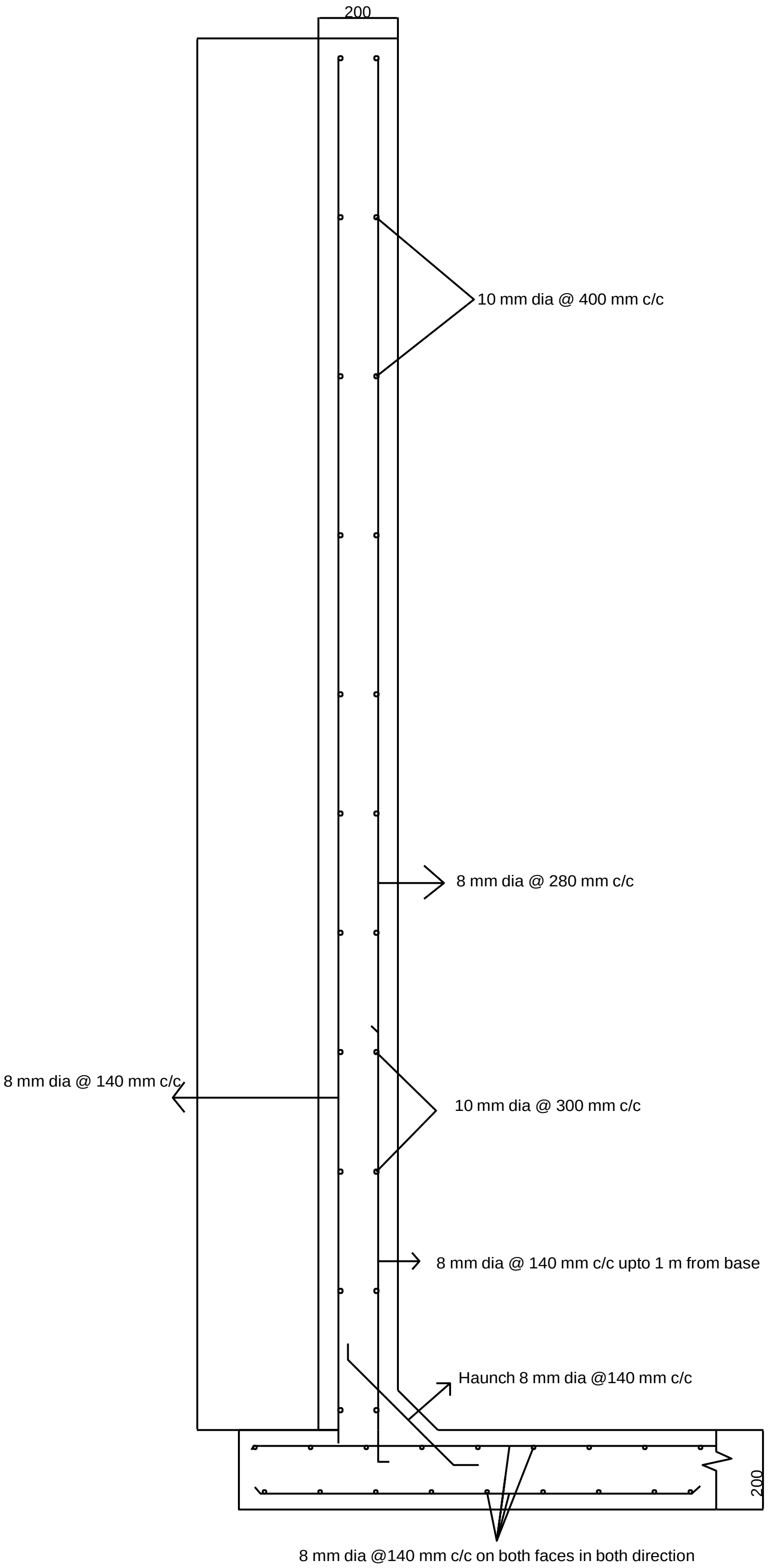

200
10 mm dia @ 400 mm c/c
8 mm dia @ 280 mm c/c
8 mm dia @ 140 mm c/c
10 mm dia @ 300 mm c/c
8 mm dia @ 140 mm c/c upto 1 m from base
Haunch 8 mm dia @140 mm c/c
200
8 mm dia @140 mm c/c on both faces in both direction

Fig 8.4

8.5 ACADEMIC BLOCK

Tank Capacity 60,000L. Depth of water tank 3.5m Use M-30/Fe415. Unit weight of Water $10kN/m^3$

Permissible tensile stress in deformed bars (σ_{st}) =130 N/mm^2

Permissible tensile Stress in concrete (σ_{ct}) =1.5 N/mm

Max. Permissible compressive Stress in concrete (σ_{cbc}) = 10 N/mm^2

1. Design constants

m(Modular Ratio)= $\frac{280}{3\sigma cbc} = \frac{280}{3X10}$ = 9.33

k= $\frac{m.\sigma cbc}{m.\sigma cbc+\sigma st}$ $=\frac{9.33x10}{9.33x10+130}$ =0.416

j= $1 - \frac{0.416}{3}$ =0.86

R=$\frac{1}{2}$. σ_{cbc}.k.j

=$\frac{1}{2}$x10x0.416x0.86

=1.78

Assuming the wall to be 200 mm thick

t=200mm

H=3.5 m

D=4.67

$= \frac{HxH}{Dt}$

$=\frac{3.5X3.5}{4.67x0.2}$ =13.12

Using IS 3370 (Part-4):1967,Table -10 for moments in cylindrical wall fixed at base and free at top subjected to triangular load

Max. moment coefficient at the bottom of wall occurs at

1H=3.5m

= -0.0104+$\left(\frac{-0.0090+0.0104}{2}\right)$x1.12

=-0.0096

Max. –ve moment at the bottom of the wall

Max. Moment coefficient x γ x H^3

=-0.0096x10x3.5^3

M=4.12kNm per m height of wall

2. Thickness Required (t)

t=$\sqrt{\frac{M}{R.b}}$

t = $\sqrt{\frac{4.12x1000000}{1.78x1000}}$ = 48mm

Assuming an effective cover of 50mm

t_{requd} =48+50

=98mm<200mm (O.K)

3. Maximum Hoop Tension (T): Using IS 3370:1987 (Part 4), Table 9, Maximum Hoop Tension Occurs at

0.7H=2.45m

$=\frac{HxH}{Dt}$

$=\frac{3.5x3.5}{4.67x0.2}$ =13.12

Hoop Tension coefficient =0.633+$\left(\frac{0.666-0.633}{2}\right)$x1.12

=0.651

Maximum Hoop Tension= Hoop Tension coefficient X γ X H X D/2

=0.651x10x3.5x4.67/2

=53kN

Area Of steel Required =$\frac{53x1000}{130}$

=408mm^2

$A_{st\ min}$=0.35% of area of surface zone

$$=\frac{0.35}{100}x\left(1000x\frac{200}{2}\right)=350mm^2$$

$A_{st\ requd} > A_{st\ min}$ (O.K)

Providing area of steel =408mm^2

Using 10 mm dia hoops and providing reinforcement on both faces

$$\text{Spacing} = \frac{78.5x1000}{\frac{408}{2}} = 385mm$$

Therefore providing 10 mm dia hoops @ 300 mm c/c

$A_{st\ provided}$ =2x1000/300 x π/4x10^2

=524mm^2

$$\sigma'_{ct} = \frac{T}{1000t+(m-1)\,Ast}$$

$$= \frac{53x1000}{1000x200+(8.33)x524}$$

=0.26N/mm^2 < σ_{ct} i.e 1.5N/mm^2

4. Design for Moment

$$A_{st} = \frac{M}{\sigma st.j.d}$$

$$A_{st} = \frac{4.12x1000000}{130x0.86x150}$$

=245mm^2 <350mm^2

Providing area of steel 400 mm^2

$$\text{Spacing}=\frac{1000}{400}\ x\ 50.26$$

=125.65 mm c/c

Using 8 mm dia bars @120 mm c/c on inner face as vertical steel at bottom of the wall. These are required at height of 1 m from bottom only.

$$A_{st\ provided}=\frac{1000}{120}\ x\ 50.26=419mm^2$$

$$L_d = \frac{\emptyset x \sigma st}{4x\ \tau}$$

$$=\frac{8x130}{4x2.4}$$

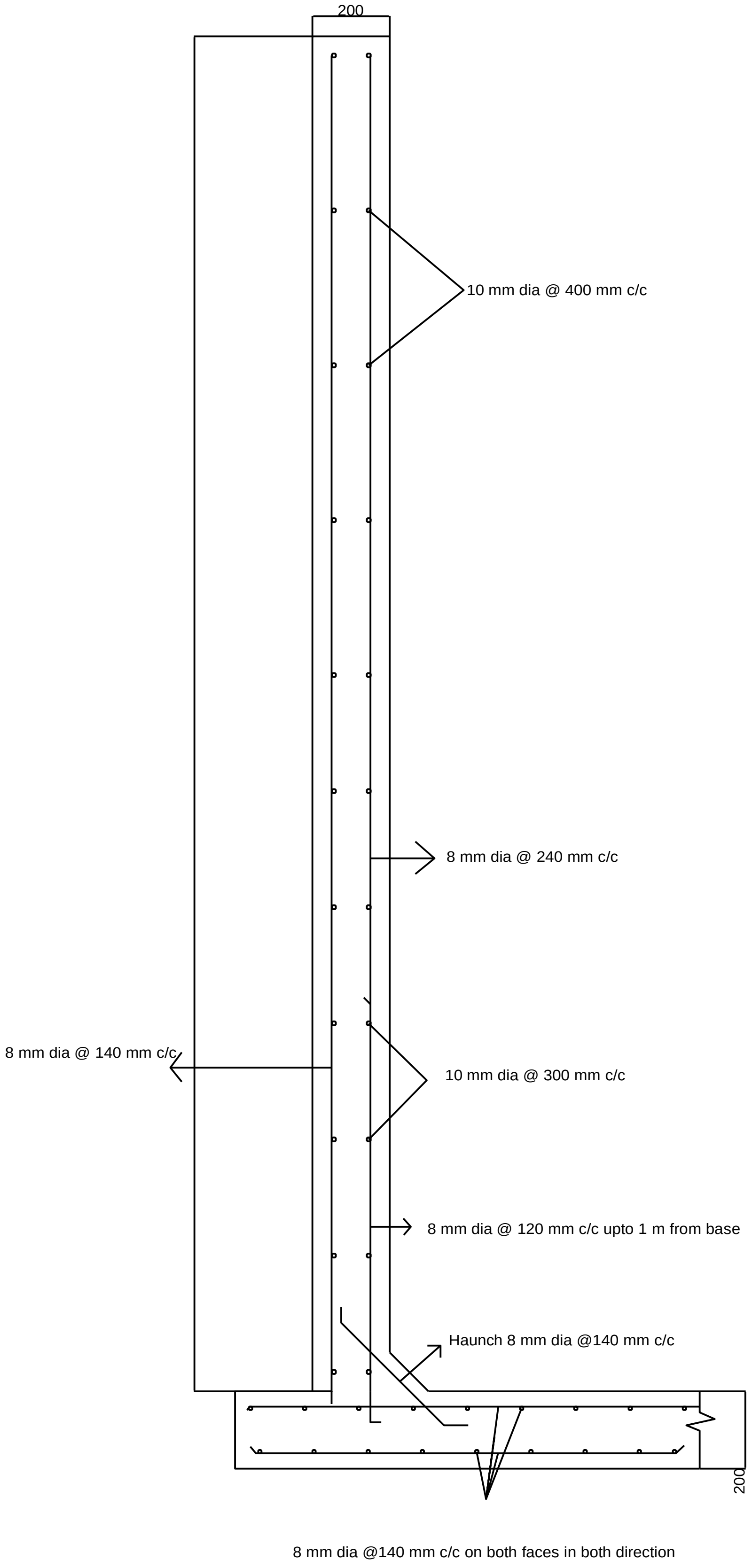
=108.3 mm

For the outer face providing minimum steel @0.35%

A_{st}=350mm^2

8mm dia bars @140 mm c/c on outer face as vertical steel

5. Base Slab Base Slab is provided as 200 mm thick with minimum steel as 350 mm^2 in each direction. Hence providing 8 mm dia bars @ 140 mm c/c in both direction at top and bottom face.



200
10 mm dia @ 400 mm c/c
8 mm dia @ 240 mm c/c
8 mm dia @ 140 mm c/c
10 mm dia @ 300 mm c/c
8 mm dia @ 120 mm c/c upto 1 m from base
Haunch 8 mm dia @140 mm c/c
200
8 mm dia @140 mm c/c on both faces in both direction

Fig 8.5

8.6 MALVIYA FACULTY BLOCKS

A-BLOCK

1. Tank Capacity 10,000L. Depth of water tank 3m Use M-30/Fe250. Unit weight of Water $9.8kN/m^3$

Permissible tensile stress in mild steel ($\boldsymbol{\sigma}_{st}$) $=115N/mm^2$

Permissible tensile Stress in concrete ($\boldsymbol{\sigma}_{\mathbf{ct}}$) $=1.5N/mm^2$

$\pi/4 \, xD^2x3=10$

D=2.1m

T (Hoop Tension) = 9.8x3.0x2.1/2=30.87 kN/m height of wall

T=σst x Ast

$A_{st\ requd.}$ = (30.87x1000)/115

$=268.4mm^2$

Using 10mm Dia bars

Spacing= (1000)/268.4 x $\pi/4x10^2$

=293mm

Providing 10 mm dia bars @250 mm c/c

$A_{st\ provided}$ =1000/250 x $\pi/4x10^2$

$=314mm^2$

At a distance 1.5m from top

T=15.43kN/m

$A_{st\ requd.}=15.43x1000/115=134mm^2$

$A_{st\ min.}=175mm^2$

$A_{st\ min.} > A_{st\ requd.}$

At a distance of 1.5 m from top $A_{st}=175mm^2$

Spacing=1000/175 x $\pi/4x10^2$=449 mm

This spacing is exceeding the max Limit i.e 300 mm c/c

Spacing at 1.5m from top i.e 300 mm c/c

$$\sigma_{ct} > \frac{T}{1000t+(m-1)Ast}$$

$$1.5 > \frac{30.87X1000}{1000t+(9.33-1)X314}$$

t>17.96mm

For M-30 Grade of concrete nominal clear cover is 40 mm

Hence providing thickness of 100 mm for tank wall

$A_{st\ min}$ =0.35%of x-sectional area of surface zone

=0.35/100 x 1000 x 100/2

=175 mm^2<314mm^2(O.K)

Distribution Reinforcement

Distribution and temperature steel is provided @0.35%

Providing 8 mm dia bar , spacing =1000/175 x π/4x8^2 =287.23mm

Providing Spacing of 250 mm c/c

Ast provided =1000/250 x π/4x8^2

201mm^2

Design of Base Slab

Since the tank floor is resting on the ground, the load gets directly transferred to the soil. Hence providing a minimum thickness of 150 mm and 0.35% minimum steel in each direction

Min thickness of base slab=150mm

Area of steel provided =0.35/100 x1000 x150/2

=263mm^2

Providing 8mm dia reinforcement @180 mm c/c in both direction at top and bottom face of floor slab.

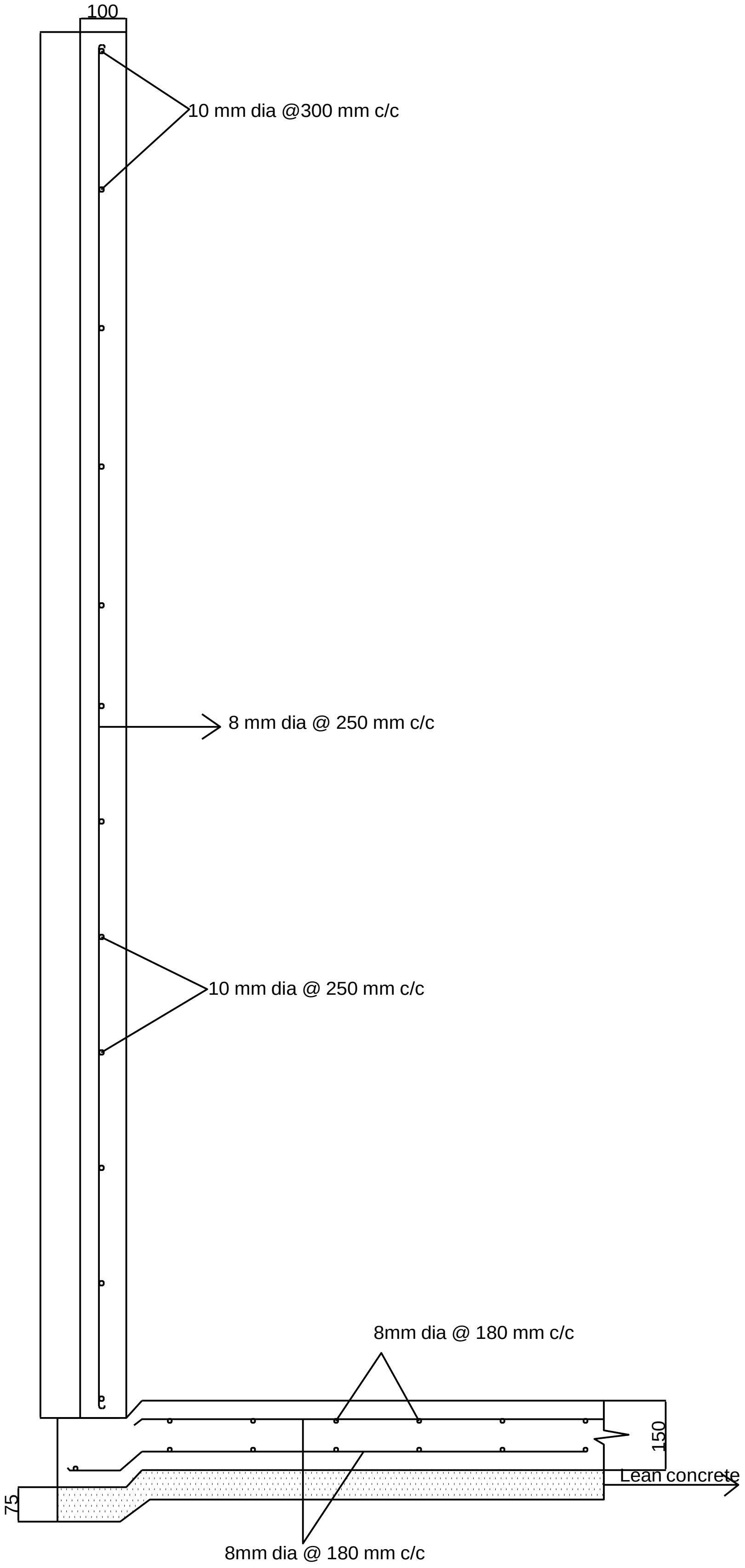

100
10 mm dia @300 mm c/c
8 mm dia @ 250 mm c/c
10 mm dia @ 250 mm c/c
8mm dia @ 180 mm c/c
150
Lean concrete
75
8mm dia @ 180 mm c/c

Fig 8.6

B-BLOCK

Tank Capacity 27,000L. Depth of water tank 3.5m Use M-30/Fe250. Unit weight of Water $9.8kN/m^3$

Permissible tensile stress in mild steel ($\boldsymbol{\sigma}_{st}$) $=115N/mm^2$

Permissible tensile Stress in concrete ($\boldsymbol{\sigma}_{ct}$) $=1.5N/mm^2$

$\pi/4 \, xD^2x3.5=27$

D=3.1m

T (Hoop Tension) = 9.8x3.5x3.1/2=53.2 kN/m height of wall

T=σst x Ast

$A_{st\ requd.}$ = (53.2x1000)/115

$=462.6mm^2$

Using 12mm Dia bars

Spacing= (1000)/462.6 x $\pi/4x12^2$

=244.5mm

Providing 12 mm dia bars @240 mm c/c

$A_{st\ provided}$=1000/240 x $\pi/4x12^2$

$=471.2mm^2$

At a distance 1.75m from top

T=26.6kN/m

$A_{st\ requd.}=26.6x1000/115=231.3mm^2$

$A_{st\ min.} =175mm^2$

$A_{st\ min.} < A_{st\ requd.}$ (O.K)

At a distance of 1.5 m from top $A_{st\ requd.} =231.3mm^2$

Spacing=1000/231.3 x $\pi/4x10^2$=340 mm

This spacing is exceeding the max Limit i.e 300 mm c/c

Spacing at 1.75m from top i.e 300 mm c/c

$$\sigma_{ct} > \frac{T}{1000t+(m-1)Ast}$$

$$1.5 > \frac{53.2X1000}{1000t+(9.33-1)X471.2}$$

t>31.54mm

For M-30 Grade of concrete nominal clear cover is 40 mm

Hence providing thickness of 100 mm for tank wall

$A_{st\ min.}$ =0.35%of x-sectional area of surface zone

=0.35/100 x 1000 x 100/2

175 mm^2 < 471.2 mm^2 (O.K)

Distribution Reinforcement

Distribution and temperature steel is provided @0.35%

Providing 8 mm dia bar, spacing =1000/175 x $\pi/4x8^2$ =287.23mm

Providing Spacing of 250 mm c/c

Ast provided =1000/250 x $\pi/4x8^2$

201mm^2

Design of Base Slab

Since the tank floor is resting on the ground, the load gets directly transferred to the soil. Hence providing a minimum thickness of 150 mm and 0.35% minimum steel in each direction.

Min thickness of base slab=150mm

Area of steel provided =0.35/100 x1000 x150/2

=263mm^2

Providing 8mm dia reinforcement @180 mm c/c in both direction at top and bottom face of floor slab.

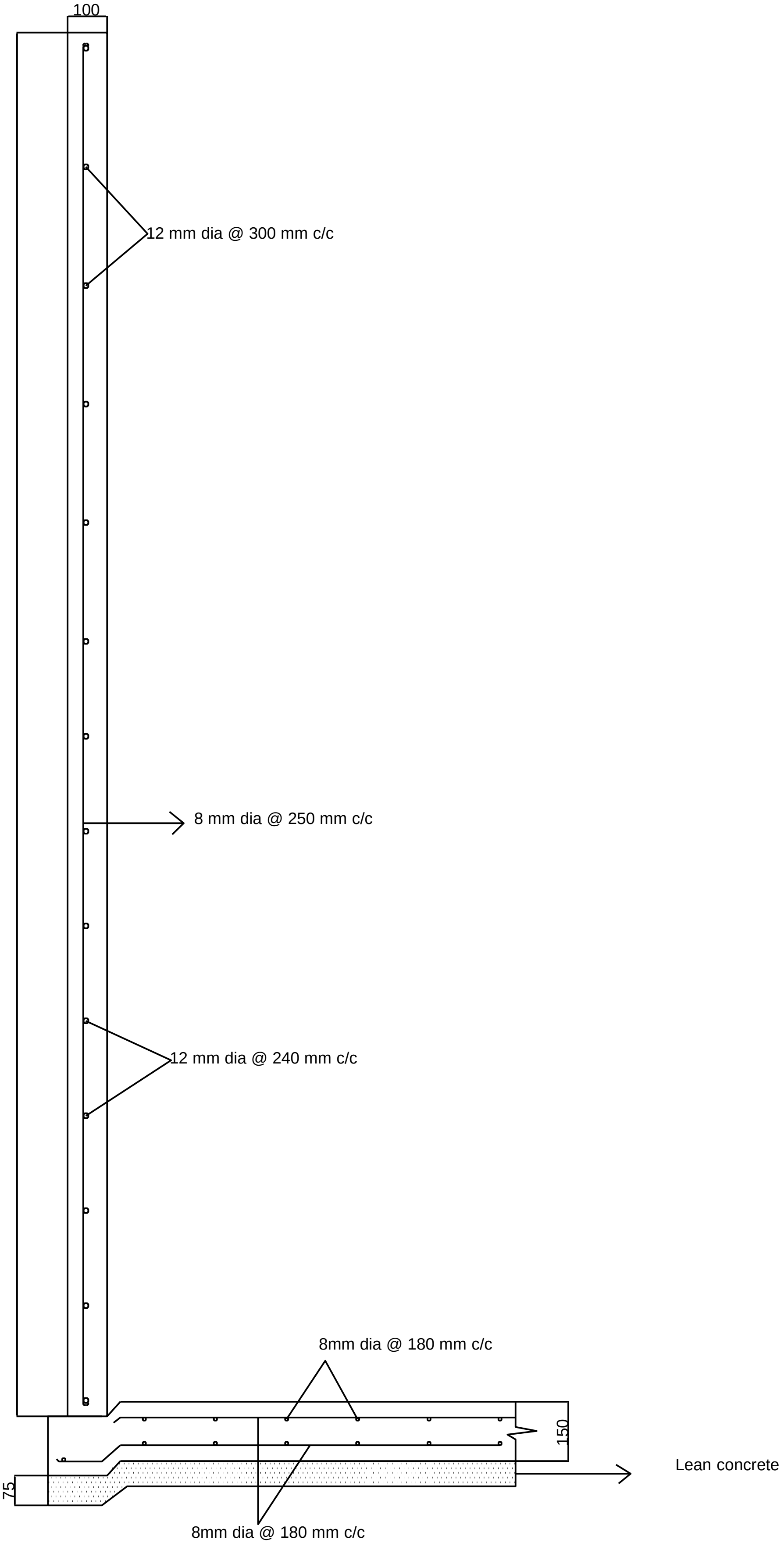

100
12 mm dia @ 300 mm c/c
8 mm dia @ 250 mm c/c
12 mm dia @ 240 mm c/c
8mm dia @ 180 mm c/c
150
Lean concrete
75
8mm dia @ 180 mm c/c

Fig 8.7

C-BLOCK

Tank Capacity 20,000L. Depth of water tank 3m Use M-30/fe250. Unit weight of Water $9.8kN/m^3$

Permissible tensile stress in mild steel ($\boldsymbol{\sigma}_{st}$) $=115N/mm^2$

Permissible tensile Stress in concrete ($\boldsymbol{\sigma}_{ct}$) $=1.5N/mm^2$

$\pi/4 \text{ x} D^2 \text{x} 3=20$

D=2.91m

T (Hoop Tension) = 9.8x3x2.91/2=42.7 kN/m height of wall

T=σst x Ast

$A_{st\ requd.}$ = (42.7x1000)/115

$=371.3mm^2$

Using 12mm Dia bars

Spacing= (1000)/371.3 x $\pi/4 \text{x} 12^2$

=304.59mm

Providing 12 mm dia bars @300 mm c/c

$A_{st\ provided}$ =1000/300 x $\pi/4 \text{x} 12^2$

$=377mm^2$

At a distance 1.5m from top

T=21.35kN/m

$A_{st\ requd.}$ $=21.35 \text{x} 1000/115=186mm^2$

$A_{st\ min.}$ $=175mm^2$

$A_{st\ min.} < A_{st\ requd.}$ (O.K)

At a distance of 1.5 m from top $A_{st\ requd.}$ $=186mm^2$

Spacing=1000/186 x $\pi/4 \text{x} 10^2$=422.25mm

This spacing is exceeding the max Limit i.e 300 mm c/c

Spacing at 1.5m from top i.e 300 mm c/c

$$\sigma_{ct} > \frac{T}{1000t+(m-1)Ast}$$

$$1.5 > \frac{42.7X1000}{1000t+(9.33-1)X377}$$

$t>25.3mm$

For M-30 Grade of concrete nominal clear cover is 40 mm

Hence providing thickness of 100mm for tank wall

Ast min=0.35%of x-sectional area of surface zone

=0.35/100 x 1000 x 100/2

$175mm^2<377mm^2$ (O.K)

Distribution Reinforcement

Distribution and temperature steel is provided @0.35%

Providing 8 mm dia bar, spacing $=1000/175 \times \pi/4 \times 8^2$ =287.23mm

Providing Spacing of 250 mm c/c

Ast provided $=1000/250 \times \pi/4 \times 8^2$

$201mm^2$

Design of Base Slab

Since the tank floor is resting on the ground, the load gets directly transferred to the soil. Hence providing a minimum thickness of 150 mm and 0.35% minimum steel in each direction.

Min thickness of base slab=150mm

Area of steel Provided =0.35/100 x1000 x150/2

$=263mm^2$

Providing 8mm dia reinforcement @180 mm c/c in both direction at top and bottom face of floor slab.

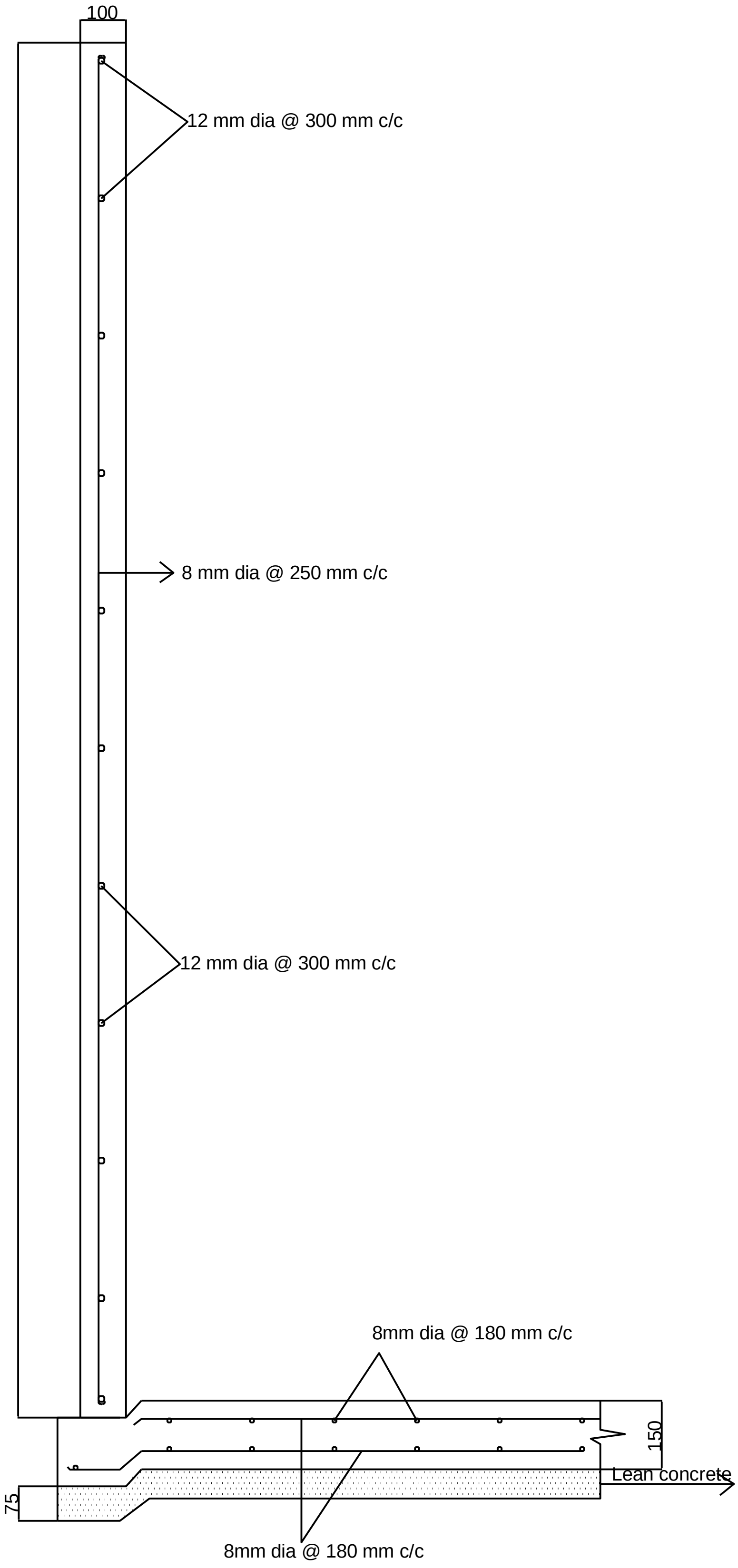

100
12 mm dia @ 300 mm c/c
8 mm dia @ 250 mm c/c
12 mm dia @ 300 mm c/c
8mm dia @ 180 mm c/c
150
Lean concrete
75
8mm dia @ 180 mm c/c

Fig 8.8

D-BLOCK

Tank Capacity 14,000L. Depth of water tank 3m Use M-30/fe250. Unit weight of Water $9.8KN/m^3$

Permissible tensile stress in mild steel ($\boldsymbol{\sigma}_{st}$) $=115N/mm^2$

Permissible tensile Stress in concrete ($\boldsymbol{\sigma}_{ct}$) $=1.5N/mm^2$

$\pi/4 \text{ x} D^2 \text{x} 3=14$

D=2.4m

T (Hoop Tension) = 9.8x3.0x2.4/2=35.28 kN/m height of wall

T=σst x Ast

$A_{st\ requd.}$ = (35.28x1000)/115

$=306.78mm^2$

Using 10mm Dia bars

Spacing= $(1000)/306.78 \text{ x } \pi/4 \text{x} 10^2$

=256mm

Providing 10 mm dia bars @250 mm c/c

$A_{st\ provided}=1000/250 \text{ x } \pi/4 \text{x} 10^2$

$=314mm^2$

At a distance 1.5m from top

T=17.64kN/m

$A_{st\ requd.}$ $=17.64 \text{x} 1000/115=153.4mm^2$

$A_{st\ min.}$ $=175mm^2$

$A_{st\ min.} > A_{st\ requd.}$

At a distance of 1.5 m from top $A_{st}=175mm^2$

Spacing=$1000/175 \text{ x } \pi/4 \text{x} 10^2$=449 mm

This spacing is exceeding the max Limit i.e 300 mm c/c

Spacing at 1.5m from top i.e 300 mm c/c

$$\sigma_{ct} > \frac{T}{1000t+(m-1)Ast}$$

$$1.5 > \frac{35.28X1000}{1000t+(9.33-1)X314}$$

$t>20.9mm$

Hence providing thickness of 100 mm for tank wall

Ast min=0.35%of x-sectional area of surface zone

=0.35/100 x 1000 x 100/2

175mm^2 < 314 mm^2 (O.K)

Distribution Reinforcement

Distribution and temperature steel is provided @0.35%

Providing 8 mm dia bar, spacing =1000/175 x π/4x8^2 =287.23mm

Providing Spacing of 250 mm c/c

Ast provided =1000/250 x π/4x8^2

201mm^2

Design of Base Slab

Since the tank floor is resting on the ground, the load gets directly transferred to the soil. Hence providing a minimum thickness of 150 mm and 0.35% minimum steel in each direction.

Min thickness of base slab=150mm

Area of Steel provided=0.35/100 x1000 x150/2

=263mm^2

Providing 8mm dia reinforcement @180 mm c/c in both direction at top and bottom face of floor slab.

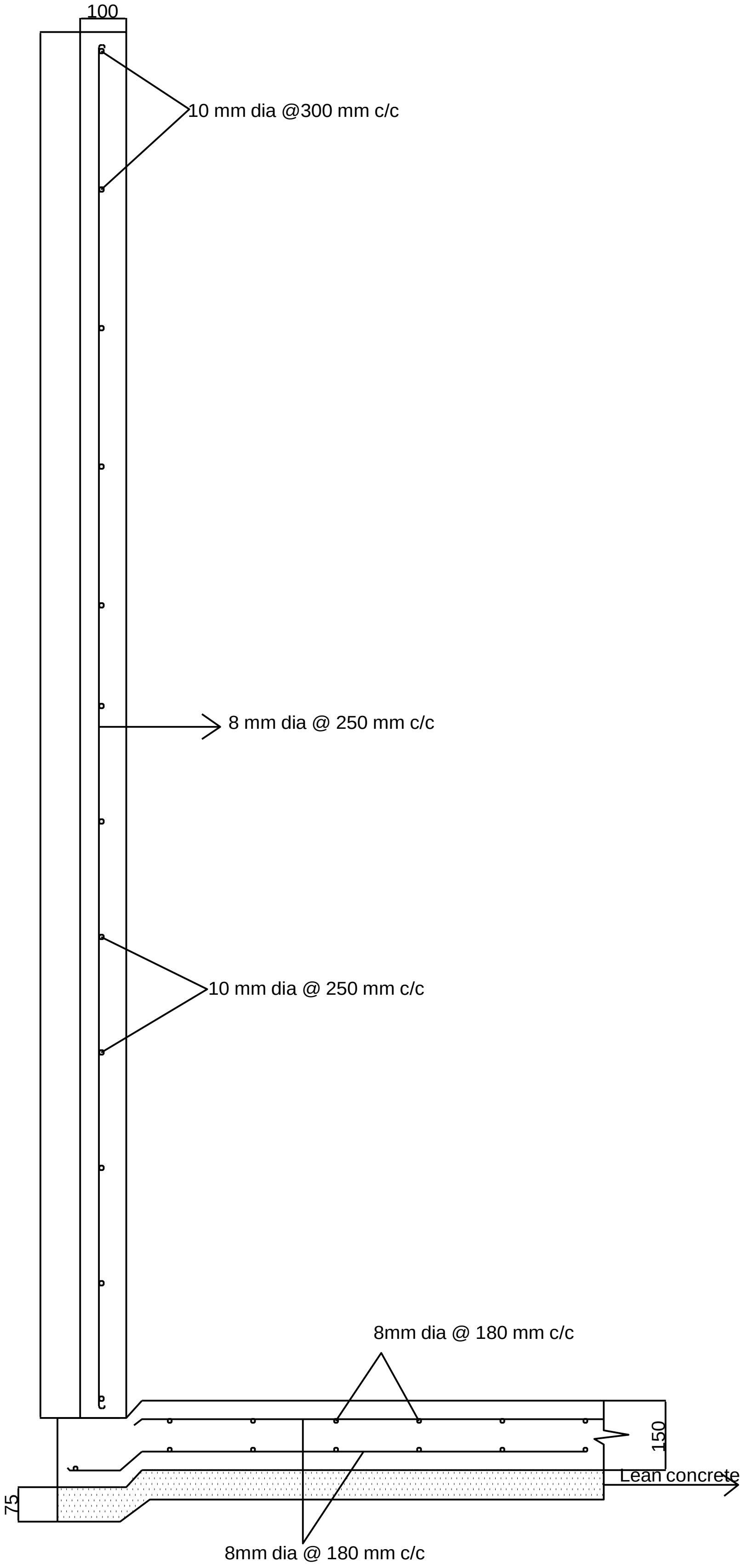

100
10 mm dia @300 mm c/c
8 mm dia @ 250 mm c/c
10 mm dia @ 250 mm c/c
8mm dia @ 180 mm c/c
150
Lean concrete
75
8mm dia @ 180 mm c/c

Fig 8.9

RESULT

The main aim of this project was to check rainwater as a potential alternative water source which can cut some of the demand which met from the external supply (via Water Tankers and pipes).

Total water harvested by the Rainwater Harvesting Scheme = 44.624 X 10^6 litres/ year

Total water supplied from pipeline and the water tankers = 144 X 10^6 litres/year

Water saved = 31 %

CONCLUSION

As the water table is falling rapidly, and with concrete buildings, paved car parks, business complexes, and landfill dumps taking the place of water bodies, Rainwater Harvesting is the most reliable solution for groundwater level increase. Rainwater Harvesting provides longevity to water supply. It lowers the cost of groundwater pumping. It also reduces soil erosion. Rainwater Harvesting systems are easy to construct, operate and maintain. Rainwater harvesting also improves management of vegetation**.** Rainwater harvesting is a potential source of water as 80% of annual rainfall of 117 mm is received during three months period and during this period rain falls in about 200 hours and half of it in 30 – 40 hours. Due this runoff can be easily captured and used effectively later on. By capturing rainwater, storm water is subsequently reduced.

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