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STUDY OF ROOFTOP RAINWATER HARVESTING FOR TYPICAL BUILDING IN NAGPUR

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Abstract - *Rain water harvesting is a method of collection and storage of rainwater. This rain water which is harvested can be further utilized for various activities such as drinking, gardening, groundwater recharge, etc. depending upon the rain water harvesting potential. This paper gives an overview of rain water harvesting, components of rain water harvesting systems, advantages and disadvantages of rain water harvesting, methods of rain water harvesting and the need for rain water harvesting systems.*

Key Keywords *– Rain water harvesting, components of RWH, need for RWH, advantages and disadvantages of RWH.*

1. INTRODUCTION

The world population is growing at an astonishing rate and so is the demand for water. To meet these increasing water demands, groundwater is being used on a large scale all over the world. Due to utilization of groundwater at greater extent, the groundwater is depleting at a faster pace than the rate at which it can be naturally recharged. As a result of this exploitation, many groundwater tables are various places around the world have already been exhausted or are on the verge of exhaustion. Cities and villages are growing and so there is increase in agricultural activities. To meet the water demands for these agricultural activities again groundwater sources such as wells, tube wells, etc. are being used.

During monsoon season, majority of rainwater gets wasted due to surface runoff; the water from rooftops go directly into sewer and the water from storm water runoff also goes to the sewer and ultimately goes to waste. To tackle all of these issues rain water harvesting is an environmentally sound solution. By implementation of rain water harvesting systems, the water can be collected, stored and used at later stage. This can ensure that not all rain water gets wasted and that the water is available for an extended period of time and not only in monsoons.

Water harvesting is not a new concept; rather it has been into practice since ancient times. Various water harvesting techniques and methods have been developed and improved from time to time to increase the efficiency of these systems. Though rain water harvesting is not a new concept, yet it is not being implemented in a large scale, as it should have been.

Rain water harvesting is the collection of rainwater and its storage. The stored rain water can be used for various activities as well as for groundwater recharge. Methods of rain water harvesting include surface runoff harvesting and rooftop rain water harvesting. The basic components of rain water harvesting include catchment area, filters, storage and groundwater recharge structures, etc.

2. STUDY AREA

As observed there has been an increasing in the urban population and as a result of which there has been a drastic increase in the water consumption in these urban areas. Nagpur is also one such area where increase in population has drastically affected the water demand in the area. To fulfill these water demands ground water is being utilized at an exponential rate. To tackle this problem it is important for people to implement the use of rain water harvesting systems and help in replenishing the decreasing ground water levels.

Nagpur is one of the rapidly developing metropolitan city in central India. Nagpur district is one of the district of the Vidarbha region of Maharashtra state. Nagpur has various benefits as it is located in the central part of Indian peninsula. Nagpur is also known as Orange City and tiger capital of the country.

Nagpur has a climate which is dry and hot throughout the year except for a few months. Nagpur experiences monsoon season from the month of June to September. Nagpur district has its major economic activities revolving around agriculture and related activities. Nagpur city gets water from various sources which include Gorewada, Pench reservoir, Kanhan River, etc.

Fig -1: Geographical Location of Nagpur

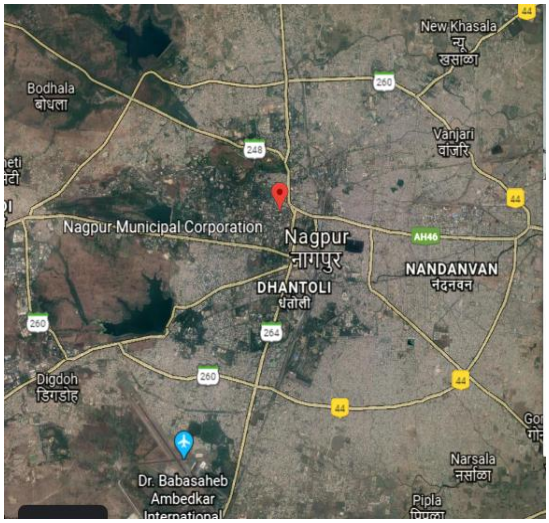

Fig -3: Location of NMC in Nagpur

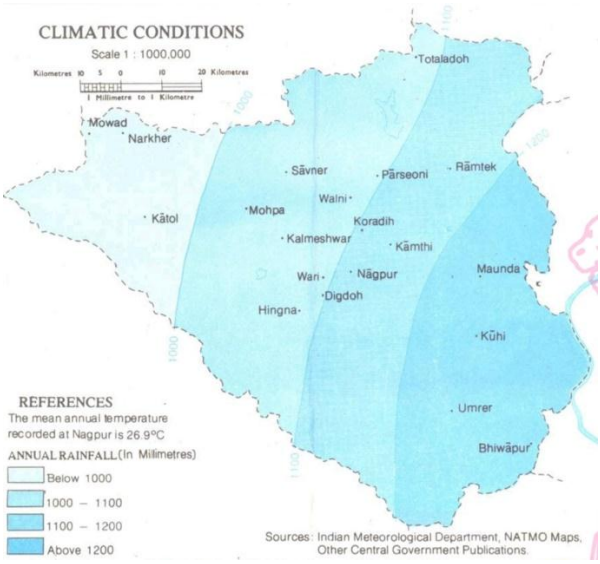

Fig -2: Climatic Conditions of Nagpur

Fig -4: NMC Building

Approach

Study of rainwater harvesting was conducted for a typical building in Nagpur. For this purpose of studying rainwater harvesting the building selected was Nagpur Municipal Corporation building. This building is office to various departments and staff which come under Nagpur Municipal Corporation. This building is located at 21.15°N, 79.08°E in the central part of Nagpur City in Civil Lines area near Zero Mile stone. Fig No. 3 shows the location of the building in Nagpur city and Fig No. 4 shows the satellite view of the building.

3. LITERATURE REVIEW

Literature review was done to study the rain water harvesting systems, methods of rainwater harvesting, components of rainwater harvesting systems, need for rainwater harvesting, its advantages and disadvantages. Various case studies were studied which included the campus study at campus of Government College of Engineering located in Aurangabad, Maharashtra, India (Abhijeet Keskar, et al. 2016), case study at VIKAS Complex B wing, Thane, Maharashtra (Sumedh R Kashiwar, et al. 2016), case study in Amba Township in Gandhinagar (Anant D. Patel, et al. 2015), a case study conducted in a household at Marjita village of Tirtol block in Jagatsinghpur district, Odisha (Mohanty R.R, et al.

2018), case study on residential and industrial buildings in Jaipur city (Naveen Lasiyal, et al. 2016), etc. Studying these cases and work various insights on components of rainwater harvesting systems were highlighted. Apart for rainwater harvesting systems, recharging ground water table with the help of rain water was also studied (N. Balamurugan and B. Anuradha, 2013).

IV. DATA COLLECTION & CALCULATION

A. Rainfall Data of Nagpur

Rainfall data of Nagpur was collected for past 5 years, studied and summarized below-

YEAR	2014	2015	2016	2017	2018
JAN	0.3	7.8	0.7	0.6	0.0
FEB	26.3	15.1	17.1	0.0	18.5
MAR	38.4	69.1	14.5	1.2	1.3
APR	2.8	32.5	3.6	0.0	14.4
MAY	11.9	14.0	8.2	16.4	36.4
JUN	92.3	277.2	132.3	140.3	242.0
JUL	402.8	173.7	418.3	236.2	397.2
AUG	133.0	382.3	117.5	345.4	224.7
SEPT	125.1	136.9	127.5	168.8	111.3
OCT	26.9	13.0	68.3	41.7	0.0
NOV	7.5	0.2	0.0	0.0	0.0
DEC	0.4	0.0	0.0	0.0	12.6

Table -1: Rainfall Data of Nagpur City

According to the collected rainfall data for Nagpur, the highest yearly rainfall in Nagpur in last five years was found out to be 1122mm. Average rainfall for monsoon season (June to August) was found out to be about 900mm.

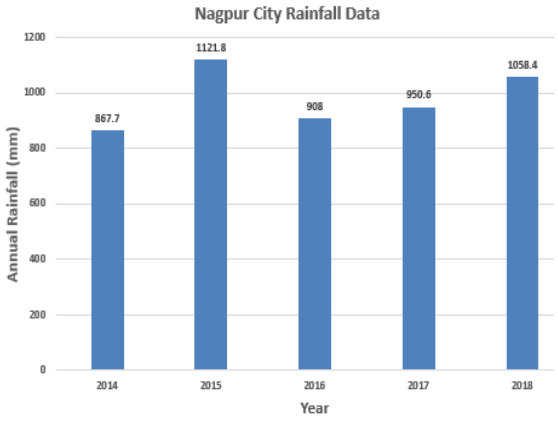

Fig -5: Annual Rainfall Chart

B. Rooftop Dimensions

Dimentions of the roof of the building were obtained by measuring and were plotted as below-

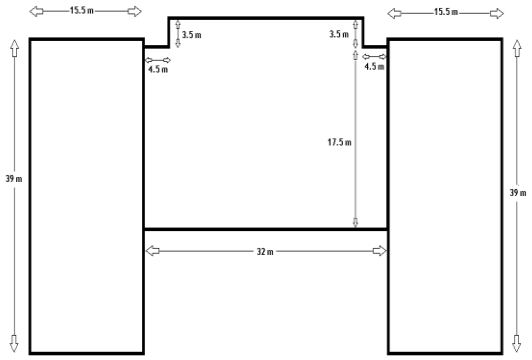

Fig -6: NMC Building Dimension Plan

According to the collected data catchment area of the rooftop of the building is found out to be 1850m^2.

C. Runoff Coefficient

Type of catchment	Runoff coefficient
Roof top	0.75 – 0.95
Paved area	0.50 – 0.85
Bare ground	0.10 – 0.20
Green area	0.05 – 0.10

Table -2: Runoff coefficient for different type of catchment surfaces

The roof of the building is of concrete flooring and so accordingly the runoff coefficient is 0.8.

D. Calculation

Calculation on the basis of rainfall per year in Nagpur is as follows-

Rainfall per annum = 1122mm (1.122m)

Area of roof = 1850m^2

Runoff Coefficient (Concrete roof) = 0.8

Harvestable rainwater = 1122*1850*0.8

= 16,60,560 litres

This is the volume of water that can be harvested from the roof of the building throughout the year. The required volume of the storage tank is the volume of harvestable rainwater in peak rainfall season (June to August) minus the volume of water consumed in these months. The required volume of the tank comes out to be about 2,40,000 litres (240m^3). Therefore the storage tank has to be designed for 240m^3 of harvested rainwater. Assuming the depth of the tank to be 4m, the dimensions for a rectangular storage tank is 4m x 6m x 10m.

E. Cost Analysis

The cost of designing of a rainwater harvesting system is negligible for a new construction project, but for developing a rainwater harvesting system for an existing building is considerably high as it requires redesigning of roof and gutter components.

The cost in developing a rainwater harvesting will also increase with addition of various other components such as filtration system, storage tanks, groundwater recharge structures, etc.

4. CONCLUSION

Population is increasing rapidly and so are the water demands. To meet these demands rain water harvesting is an environmentally sound solution. In highly populated country like India, water crisis is a serious problem and so the water resources should be managed carefully. Rain water harvesting helps to meet water demands, replenish groundwater, reduce water bills and improves environmental health.

Rain water harvesting means the collection of rain water and its storage, so that this water can be used for other activities such as gardening, pavement washing, toilet flushing and other non-potable uses. This rain water harvested can also be used for drinking purposes but not without doing proper treatment. This treatment can include filtration, disinfection, etc. A systematic planned approach has to be developed so that we can harvest and utilize this rain water at maximum efficiency. This will not only solve water scarcity problems but also help indirectly such as reduction in water bills, reduction of load on water supply systems and reduction of load on water and storm water treatment systems.

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