

ROOF TOP RAIN WATER HARVESTING OF COMPUTER ENGINEERING DEPARTMENT OF GOVERNMENT COLLEGE OF ENGINEERING, AMRAVATI - A CASE STUDY

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ABSTRACT

Water is a scarce natural resource, even though 71% of land is covered by water. Out of total water on the earth near about 2.5% are fresh which is being utilized for various purposes viz. domestic, irrigation and industrial. Water scarcity has become a serious global threat due to hazardous population growth, frequent droughts and changing climate pattern. Now a day, the need of water is magnifying tremendously in a developing country like India. Here, an attempt has made to estimate the potential of roof top rain water harvesting in a Government College of Engineering, Amravati, with geospatial techniques. Google image of study area, global mapper and few calculations were used to identify and calculate the various types of roof areas of departmental buildings. Rande's coefficient of runoff index for various types of roof and Gould and Nissen formula have been utilized for calculation of potential of roof top rain water harvesting. Analysis reveals that, the total potential of roof top rain water harvesting has estimated nearly as 1683.50 m³ /year for Department of Computer Engineering, which would be more than enough to satisfy the little bit requirement of the students within the department.

Keywords: Rooftop Rainwater harvesting, types of Roof top rain water system, Filter design, Ground water recharge

I. INTRODUCTION

Water is the most important resource of the entire world as a whole, since no life is possible without water. As water, being a limited resource, its efficient use is basic to the survival of the ever increasing population of the world. In India, the ground water is mainly used for drinking and agricultural purposes. About 90% of drinking water is available through dug well, bore well, filter point and tube well etc. The per-capital availability of water at national level has reduced from about 5,175 m³ in the year 1951 to present level of 1,870 m³. In view of this, water management is very critical for the growth and development of any economy, more so in a large country like India which is endowed with many large rivers, lakes and wells that need to be conserved, better managed, recharged and channelized for meeting the ever growing requirement of agriculture, industrial and urban growth. Moreover exploitation of ground water has been taken up by millions of individual farmers mostly in regions

where surface water is either scarce or absent to meet their dire water needs. Although this has led to local depletion or decline of ground water levels causing serious concern about rainwater harvesting & the need to recharge groundwater.

1.1 Scarcity of Water

Water scarcity is a serious problem throughout the world for both rural & urban community. Urbanization, industrial development and increase in agricultural field and production have resulted in overexploitation of groundwater and surface water resources and resultant deterioration in water quality. Simply put, water scarcity is either the lack of enough water available or lack of access to safe water. It's hard to imagine that clean, safe water is not something that can be taken for granted. According to the UNICEF report on water, there will be constant competition over water, between urban dwellers, farmers and industrialists. Even the World Bank report shows alarming results. In 1997, the available underground water was approximately 600 cubic kilometers per annum and the demand was also almost equal to the availability. But by 2050 the level of ground water will be below 100 cubic kilometers per annum mark and the demand will rise to 1200 cubic kilometers per annum. Further, in the same year, the level of surface water was approximately 300 cubic kilometers per annum which would fall to 50 cubic kilometers per annum by 2050. Hence there is great need to collect and store water either in the form of constructing the storage tank or to keep it in the underground storage form to avoid all this water crisis.

1.2 Rain Water Availability in India

India receives precipitation including snowfall and rain of around 4,000 billion cubic metres (BCM), only 1,869 BCM is accessible water, of which India uses barely a third. Nearly 1,179 BCM of water drains in to the sea. Region, whose yearly renewable freshwater availability is below 1,700 m³/person, is called as the water stress region. And the region whose yearly availability falls below 1,000 m³/person is termed as water scarcity region. But national figure of annual average per capita water availability is 2,464 m³. It shows that the country is not in the water stress range so far. However in some regions like Kanyakumari, Pennar, Kutchh, Kathiawar, Krishna basin, etc., per capita availability is as low as 411 m³.

1.3 Need of Ground Water Recharge

Collecting rainwater as it falls from the sky seems immensely sensible in areas struggling to cope with potable water needs. Occurrence of rainfall in India is mostly limited to about three months in a year. The natural recharge to ground water reservoir is restricted to this period only in a major part of the country. Artificial recharge techniques primarily aim at extending the recharge period in the post-monsoon season for about two to three or more months, resulting in enhanced sustainability of ground water sources during the lean season. Rainwater is one of the purest sources of water available as it contains very low impurities. Rain water harvesting systems can be adopted where conventional water supply systems have failed to meet surrounding demand. Following are the immersed conditions where need of harvesting rain water and stored it in the form of ground water recharge can be satisfied as

- It is the most scientific and cost effective way of recharging ground water and reviving the water table.
- It offers advantage in water quality for both irrigation and domestic use.
- It provides naturally soft water and contains no dissolved minerals or salts, arsenic and other heavy metals.

- Also, Unreliability of municipal corporation water supplies both in terms of quantity and timings, driving people to their own sources.
- The raising of the water table by artificial recharge may help in building pressure barriers to prevent sea water intrusion within coastal areas.

1.4 Possibility of Ground Water Recharge Through Rain Water Harvesting

The water in the premises can be harvested to recharge the ground water. The recharging will certainly help to increase the ground water storage. The design and the location of these recharge systems is site specific and needs to be evolved as per the requirements. When the rainwater falls on the ground, some of it seeps into the soil but the surplus adversely flows out as a stream or as run-off. The top soil however, can hold only a fraction of water that falls on it and the rest gradually percolates down, depending on the type of the soil and joins the aquifers that are groundwater-bearing formation. Artificial recharge is a process of augmenting the underground water table by artificial infiltration of rain water and surface runoff. The roof water from the top through the rainwater pipes can be collected by series of chambers with interconnected pipes and diverted to the recharge well. Ground water recharge of existing bore wells is one of the best method of modifying the hydrological cycle and thereby providing ground water in excess of that available by natural processes. It is accomplished by augmenting the natural infiltration of precipitation or surface water in to underground formations by some important method of construction, by providing or spreading of water or by artificially changing the natural conditions.

II. TYPES OF RAIN WATER HARVESTING

Rainwater harvesting can be categorised in a number of different ways, the most important of which are according to the type of catchment surface used and by implication the scale of activity. Essentially these are either rooftop, ground, or rock with rooftop being most suited to individual household or community water supply, while ground and rock being more geared towards agricultural productivity. Rain water harvesting can be done broadly in following two ways

- Rooftop rain water harvesting
- Surface runoff harvesting

In rooftop harvesting, rainwater collected from the roof of the building is diverted to a storage tank. Water from storage tank can be used for domestic purposes such as washing, flushing and gardening etc. One problem is that the quantum of rooftop-rain water available in arid and semi-arid regions is generally so low that it will not produce noticeable effects in improving the yields of bore wells. Surface runoff harvesting for groundwater recharge can be done in many ways check dams, deepening of ponds, stream channel ponding, diversion channel, openwell recharge, etc. Various water and soil conservation measures like contour bunds, contour trenches and gully plugs etc., are being practiced. Considering the unavailability of lands for new tanks in villages and limitations of structures like checkdams, one possible innovation is to enhance groundwater recharge by directing runoff into functional bore wells and/or abandoned bore wells through recharge pits around the bore wells. A recharge pit allows rain water to replenish groundwater. The recharge pit can be filled with stones of different sizes and sand, they act as a filter medium for runoff water percolates into underground.

III. A CASE STUDY OF GOVERNMENT COLLEGE OF ENGINEERING, AMRAVATI

Government College of Engineering, Amravati, is one of the Regional Engineering College, located in the Maharashtra, a city in the western, India. The Government College of Engineering, Amravati established under the scheme sponsored by Government of Maharashtra. Government College of Engineering, Amravati is uniquely placed to contribute significantly to the quality of technical manpower to maintain and enhance the technological pre-eminence of the state. The campus is centrally situated within Amravati city which is situated in western Maharashtra between 28021' to 28016' Latitude North and 780 4' to 790' Longitude East. Fig.1 shows the bird's eye view of campus of Government College of Engineering, Amravati along with Computer Engineering Department. The climate of Amravati City is extreme in all the three seasons. According to the past 20 years data obtained from the Hydrology department Amravati, the annual rainfall ranges from 400 mm minimum to 1600 mm maximum. There is great demand of water in Government College of Engineering, Amravati mainly for laboratories used in Civil Engineering, Mechanical Engineering, Electrical Engineering, laboratories of Chemistry and Physics etc. The Requirement of water for cleaning the floors of labs as well as classes and also for use in horticulture purpose and sprinkling the water in dry land and gardens of Government College of Engineering, Amravati especially in summer season for preventing the soil dust particle in air etc.



Fig.-1. Government College of Engineering, Amravati.

The reasons for collecting and using rainwater for institutional use are plentiful and varied for place to place. The increased need for water severally results in lowering down groundwater tables and depleted reservoirs. Many piped water supply systems fail to maintain equality of water supply. The use of rainwater is a useful alternative to provide continuous flow of water for the students and Laboratories and different purpose for the Campus. Presently Government college of Engineering Amravati has separate buildings for various departments such as Civil Engineering, Mechanical Engineering, Electrical Engineering, Electronics Engineering, Computer science and I.T. along with Administrative department etc.

3.1 Design of Rooftop Rainwater Harvesting System for Department of Computer Engineering, Government College of Engineering, Amravati.

Department of Computer Engineering is constructed in the year 2002-03 by P.W.D. and handed over in 2003. The department building is used by Computer Engineering department. The building consist of 3 class room, 8 laboratories, along with necessary other infrastructure in the form of area under amenities. Available built up area as per P.W.D. Amravati is equal to 1951 sq. m and calculated floor area after deduction wall area is 1783

sq. m. Top view of Computer Engineering department is shown in the fig. 2. Calculated Roof top area of Computer Engineering department is 2312.00 sq. m. Department of Information Technology Engineering is also a part of Department of Computer consist of 3 class room, 5 laboratories, seminar hall along with necessary other infrastructure in the form of area under amenities. The infrastructure on the campus includes the departments & laboratories buildings, hostels, residential accommodation for teaching & non-teaching staff and other amenities.

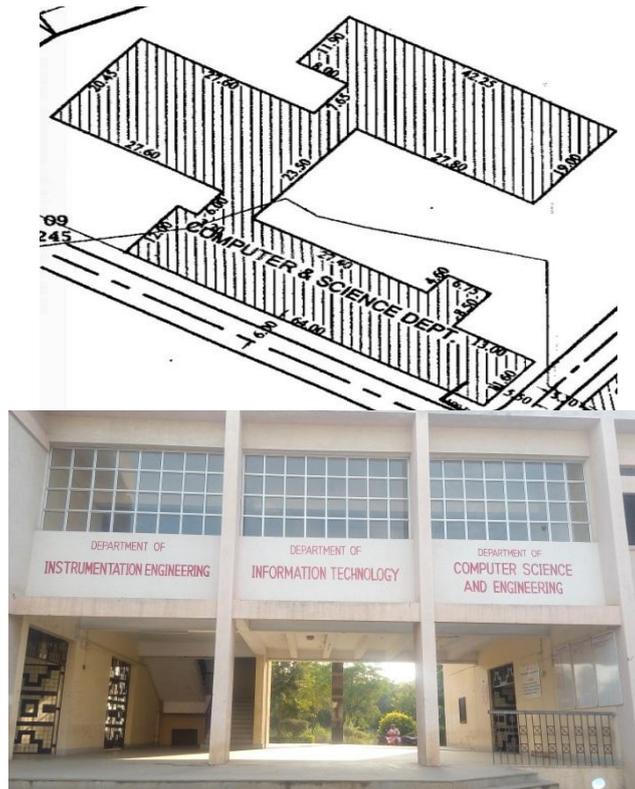


Fig. -2. Computer Engineering department, Govt. College of Engineering, Amravati.

3.1.1 Present Roof Top Rain Water Collection System Of department Of Computer Science And Engineering

Presently, the rain water falling on the roof of Computer Engineering department is diverted directly towards the collection channels which are already attached towards inner face of the department. The rain water in the channel is diverted into the rectangular gutter constructed at partly submerged ground level. The collected water is then directly run away towards irregular direction. Because of this runoff the rain water can neither become useful for fulfilling present demand of Computer Engineering department nor comes in use of increasing ground water table. Hence, it is essential to collect this runoff and store it for useful purpose in order to fulfill water demand. There are already two bore wells constructed nearly Computer Engineering department. The collected water can either be in use of recharging the bore well or can be stored in the form of constructing the storage tank. The present system of harvesting of water for the department is as shown in Figure 3.



Fig. - 3. Water collection system at Computer Engineering department, Govt. College of Engineering, Amravati

3.1.2 Available Resources For Rain Water Harvesting At Computer Science And Engineering Department

There are two bore wells, one at the front and another on the back side of the Computer Engineering department. Presently, the water falling on the roof of Computer Engineering department is supplied through water supply mains which receive water from bore well by means of pumping. The additional institutional water requirement whenever required as well as water for lawns and gardens is supplied through five bore wells on the campus, which amounts to about 24% total water usage. The existing water usage is fulfilled from various sources enlisted above.

3.2 Collection Of Roof Top Rain Water For Computer Science And Engineering Department

A rooftop rainwater harvesting system was planned and designed considering a design period of 50 years. This system was designed only from academic point of view. The amount of rainwater to be harvested from the rooftop catchments area identified is calculated by multiplying the measured rooftop area by runoff coefficient and the average intensity of rainfall. The total amount of rainfall that can be harvested from Computer Engineering departmental roof is calculated as per following calculations.

- Area of rooftop = 2312.00 sq. m.
- Average annual rainfall = 856.67 mm/year
- Assuming coefficient of runoff = 0.85
- Total amount of rainfall which can be harvested = $2312.00 \times 0.85667 \times 0.85$
= **1683.50 m³ /year.**
- Minimum estimated water consumption = 40 L/person/day.
- Total annual consumption of water = (n * per capita demand * working days).
- The annual water demand is = 250 (no. of students & staff) x 40 x 200 (working days)

= **2000 x 10³ Liters/year.**

This shows that the water demand of Computer Engineering department is satisfied nearly 70 to 80% by means of collecting roof top rain water. The amount of potential rooftop rainwater harvested is found to be quite high. However in the present study, only partial rainwater quantity was considered during planning and designing of rooftop rainwater harvesting system.

3.3 Design Of Filter Bed

The filter bed is mandatory in order to obtain the impurities free water. The recharge pit should be filled with the metal to recharge silt free water. The size of Filter bed of 1.5 m x 1.5 m x 1.5 m is constructed on the ground

near the well. Fig. 4 shows the typical sand bed filter used for water purification purpose. The materials is to be filled in this pit are 60 mm metal, 40 mm metal, 20 mm metal and fine sand respectively. The material is filled depth wise in the recharge pit. The coarser material is filled at the bottom and the finest material is placed on the top. The uppermost layer of fine sand is separated from the 30 mm metal layer by using non corrosive wire mesh. It will help for the maintenance of the structure. A First-Flush Diverter is attached to this filter bed retains the initial runoff which contains the impurities from a roof in a length of pipe which is capped at the end. The pipe is filled with rain water and a ball or flapper shuts off the top of the pipe for additional rainfall directly flow into the rainwater storage tank. The pipe cap has a small diameter outlet which slowly releases the first flush water so that by the next rain the pipe gets empty and is ready to receive more water with lesser impurity. The design value of this mechanism is taken as 8liters /10m². And Ball-Valve design has been used as a first flush diverter attached to the filter bed.As stated in BS8515, filters must be water and weather resistant, removable and accessible formaintenance purposes. It should have an efficiency rating of atleast 90% and should pass a maximum particle sizeof less than 1.25mm.

3.4 Ground Water Recharge Using Bore Well

The recharge of bore wells can becarried out through water shed approach while driedup dug well can be used directly for storing water ofsurround catchment.The rainwater harvesting to increase the watertable should be graded so as to prevent theaccumulation or retention of surface water within aradius of 15 meters from the bore well. The collection chambers are designed to be of 0.5 m x 0.5m x 0.5m in size and the interconnecting pipes are of 6 inches in diameter. The recharge well which is already constructed is of 2m x 1.5m x2m in size, and the recharge bore of 20m depth approximately. Another small pit of 1.5 m x 1.5 m x 0.6 m depth is made at the bottom of large pit and filled with filter media. This recharge well can be filled with filtering materials consisting of layer of pebbles and sand each of 0.3m in thickness. A 75 mm diameter PVC pipe is connected to the bore well casing pipe which is fixed after first layer of 75 mm pebbles. An inverted elbow is connected to the pipe. In the recharge well, a recharge bore well of 6 inch diameter of 50m depth should be drilled using air compressor. A slotted casing pipe of 1m length should be provided inside the recharged well. This slotted pipe will be wrapped with coir rope to prevent the entry of fine silt into the recharge bore well.The cost for recharge well including collection chambers and interconnecting pipes is Rs.30, 000 approximately.Total collection of water and recharge per bore well is given below

- Average available rainfall quantity = 856 mm
- Available rainfall quantity for harvesting = 430 mm
Approximately, 50% after evaporation, to harvest 10% of abovequantity=430 mm (0.043 M)
- Total water available for recharge = 10,000 sq. m. x 0.039 M = 3,90,000 Liters
- This water is available in one year viz. 90 days ofrains per bore well assuming unpaved area aroundbore well.

IV. CONCLUSION

The campus has huge potential of roof top rain waterharvesting. The present designed roof top harvestingsystem, would meet fully the additional waterdemand for lawns and gardens. An integrated

system using full potential of the rooftop rainwater can also supplement the existing water supply and help in recharging the ground water. Institutions should be encouraged to practice rooftop rainwater harvesting on their campus which would promote self-sufficiency and help to foster an appreciation for this essential and precious resource.

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