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 thelittle 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 possiblewithout water. As water, being a limited resource,its efficient use is basic to the survival of the everincreasing population of the world. In India, theground water is mainly used for drinking andagricultural purposes. About 90% of drinking wateris available through dug well, bore well, filter pointand tube well etc. The per-capital availability ofwater at national level has reduced from about 5,175m3 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 isendowed with many large rivers, lakes and wellsthat need to be conserved, better managed, rechargedand channelized for meeting the ever growingrequirement of agriculture, industrial and urbangrowth. Moreover exploitation of ground water hasbeen taken up by millions of individual farmersmostly in regions where surface water is eitherscarce or absent to meet their dire water needs.Although this has lead to local depletion or declineof ground water levels causing serious concern aboutrainwater 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 inoverexploitation of groundwater and surface waterresources and resultant deterioration in waterquality.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 take of keep it to the underground storage form to avoid all this water crisis.

1.2 Rain Water Availability in India

India receives precipitation includingsnowfall and rain of around 4,000 billion cubicmetres (BCM), only 1,869 BCM is accessible water,of which India uses barely a third. Nearly 1,179BCM of water drains in to the sea. Region, whoseyearly renewable freshwater availability is below1,700 m^3 /person, is called as the water stress region.And the region whose yearly availability falls below1,000 m^3/person is termed as water scarcity region.But national figure of annual average per capitawater availability is 2,464m3. It shows that thecountry is not in the water stress range so far.However in some regions likeKanyakumari, Pennar, Kutchh,Kathiawar, Krishna basin, etc., per capita availability isas low as 411m3.

1.3 Need of Ground Water Recharge

Collecting rainwater as it falls from the skyseems immensely sensible in areas struggling tocope 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 ofthe purest sources of water available as it containsvery low impurities. Rain water harvesting systemscan be adopted where conventional water supplysystems 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 wayof recharging ground water and reviving thewater table.
- It offers advantage in water quality for bothirrigation and domestic use.
- It provides naturally soft water and containsno dissolved minerals or salts, arsenicand other heavy metals.

- Also, Unreliability of municipal corporation water supplies bothin 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 torecharge the ground water. The recharging willcertainly help to increase the ground water storage.The design and the location of these rechargesystems is site specific and needs to be evolved asper the requirements.When the rainwater falls on the ground, some of itseeps into the soil but the surplus adversely flowsout as a stream or as run-off. The top soil however,can hold only a fraction of water that falls on it andthe rest gradually percolates down, depending onthe type of the soil and joins the aquifers that aregroundwater-bearing formation Artificial rechargeis a process of augmenting the underground watertable by artificial infiltration of rain water andsurface runoff.The roof water from the top through the rainwater pipes can be collected by series of chamberswith interconnected pipes and diverted to therecharge 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 importantof which are according to the type of catchment surface used and by implication the scaleof activity. Essentially these are either rooftop, ground, or rock with rooftop being mostsuited to individual household or community water supply, while ground and rock beingmore 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 toa storage tank. Water from storage tank can be used for domestic purposes such aswashing, flushing and gardening etc. One problem is that the quantum of rooftop-rain wateravailable in arid and semi-arid regions is generally so low that it will not producenoticeable effects in improving the yields of bore wells.Surface runoff harvesting for groundwater recharge can be done in many wayscheck 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 theunavailability of lands for new tanks in villages and limitations of structures like checkdams, one possible innovation is to enhance groundwater recharge by directing runoffinto functional bore wells and/or abandoned bore wells through recharge pits aroundthe bore wells. A recharge pit allows rain water to replenish groundwater. The rechargepit can be filled with stones of different sizes and sand, they act as a filter medium torunoff 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

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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.

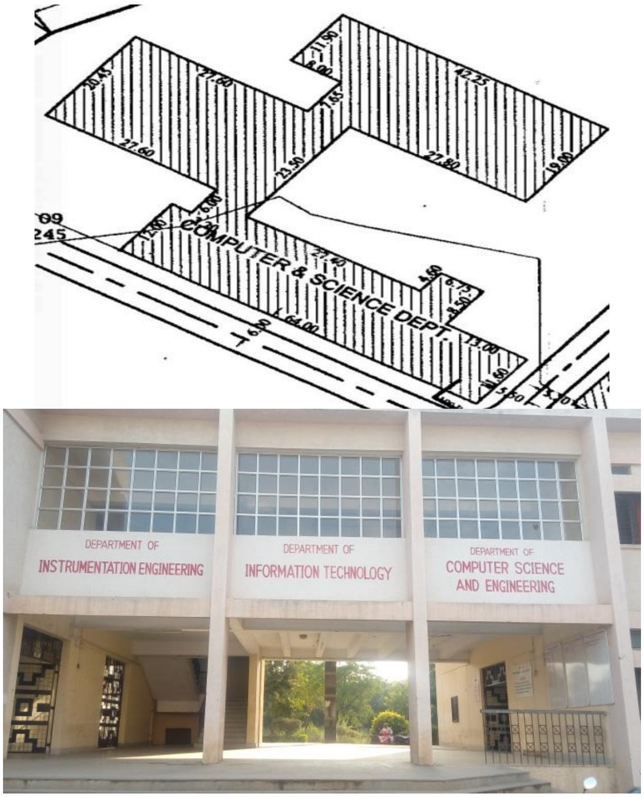

Fig. -2.Computer Engineering department, Govt. College of Engineering, Amravati.

3.1.1 Present Roof Top Rain Water Collection System Ofdepartment Of Computer Science And Engineerinng

Presently, the rain water falling on the roof of Computer Engineering departmentis diverted directly towards the collection channels which are already attached towards inner face of the department. The rain water in the channel is the 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 ofComputer 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 departmentis supplied through water supply mains which receive water from bore well by means of pumping. The additional institutional waterrequirement whenever required as well as water forlawns and gardens is supplied through five bore wells on the campus, whichamounts to about 24% total water usage. Theexisting 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 departmentalroof 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 x 0.85667 x 0.85
  = 1683.50 m^3 /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 10^3 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 harvestedis found to be quite high. However in the presentstudy, only partial rainwater quantity was consideredduring planning and designing of rooftop rainwaterharvesting 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 systemusing full potential of the rooftop rainwater can alsosupplement the existing water supply and help inrecharging the ground water. Institutions should beencouraged to practice rooftop rainwater harvestingon their campus which would promote self-sufficiencyand helping to foster an appreciation forthis essential and precious resource.

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