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DESIGN OF ROOF TOP RAIN WATER HARVESTINGFORCOLLEGE CAMPUS

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ABSTRACT
Rainwater Harvesting is preventive technique of water conservation. In present work rainwater harvesting system for Indira Gandhi College, Solapur has been designed. This area comes under hot and dry climate with a scant rainfall.
An integrated design for rooftop rain waterharvesting system for Indira Gandhi College is done. The cost estimation of differentcomponents of roof top rainwater harvesting project is done. The main objectives of the project are given below:

1) To design Rainwater Harvesting system for Indira Gandhi College, Solapur.
2) To increase well recharge by Rainwater Harvesting system.
3) To check financial and technical feasibility of scheme.
4) To work out repayment period for Rainwater Harvesting project.

All campus building of Indira Gandhi College consist college building and hostel building having total roof top area is 3665 m^2. Assuming 607.88 mm average rainfall in last ten years. The total 1779770 liter water can be available. The rainwater harvesting designed as 50% of water is used for storage and remaining 50% of water is used for Bore well recharge. The total cost of project and repayment period is calculated. The rainwater harvesting system is financially and technically feasible.

KEYWORDS: Rain water harvesting, quantity of water collection, bore well recharge, repayment period.

I INTRODUCTION

Rainwater Harvesting is a preventive technique of water conservation. Rainwater harvesting is a system used for collecting and storing rainwater for human use from rooftops, land surfaces or rock catchments using simple techniques such as jars and pots as well as engineered techniques. Rainwater harvesting has been practiced for more than 4,000 years. It is an important water source in many areas with significant rainfall but lacking any kind of conventional, centralized supply system. It is also a good option in areas where good quality fresh surface water or ground water is lacking. The application of appropriate rainwater harvesting technology is important for the utilization of rainwater as a water resource.

a) METHODS OF RAINWATER HARVESTING SYSTEM

Rainwater harvesting system is the collection and storage of rainwater for reuse on-site, rather than allowing it to run off. These stored waters are used for various purposes such as gardening, irrigation etc.
There are two important methods of Rainwater Harvesting system:

1] Surface Runoff Harvesting:

In urban area rainwater flows away as surface runoff. This runoff could be caught and used for recharging aquifers by adopting appropriate methods.

2] Roof Top Rainwater Harvesting:

It is a system of catching rainwater where it falls. In rooftop harvesting, the roof becomes the catchments, and the rainwater is collected from the roof of the building. It can either be stored in a tank or diverted to artificial recharge system. This system is financially and technically feasible.

b) NEED FOR ARTIFICIAL RECHARGE

The techniques of artificial aquifer rechargeinterrelate and integrate the source water to ground water reservoir and are dependent on thehydro geological situation of the area.The rainfall occurrence in the country is monsoon dependent and in large part of the countryrain fall is limited to about three months period ranging from around 20 to 30 days. Thenatural recharge to ground water reservoir is restricted to this period only. The artificialrecharge techniques aim at increasing the recharge period in the post-monsoon season forabout 3 more months providing additional recharge.

c) NEED OF RAIN WATER HARVESTING

Due to pollution of both groundwater and surface waters, and the overall increased demand for water resources due to population growth, many communities all over the world are approaching the limits of their traditional water resources. Therefore they have to turn to alternative or 'new' resources like rainwater harvesting (RWH).

Rainwater harvesting has regained importance as a valuable alternative or supplementary water resource. Utilization of rainwater is now an option along with more 'conventional' water supply technologies, particularly in rural areas, but increasingly in urban areas as well.RWH has proven to be of great value for arid and semi-arid countries or regions, small coral and volcanic islands, and remote and scattered .human settlements.

Rainwater harvesting has been used for ages and examples can be found in all the great civilizations throughout history. The technology can be very simple or complex depending on the specific local circumstances.

d) REASONS FOR RAINWATER HARVESTING

The reasons for collecting and using rainwater for domestic use are plentiful and varied

1) Increasing water needs/demands

The increased need for water results in lower groundwater tables and depleted reservoirs. Many piped water supply systems fail. The use of rainwater is a useful alternative.

2) Variations in water availability

The availability of water from sources such as lakes, rivers and shallow groundwater can fluctuate strongly. Collecting and storing rainwater can provide water for domestic use in periods of water shortage. Rainwater may also provide a solution when the water quality is low or varies during the rainy season in rivers and other surface water resources.

3) Advantage of collection and storage near the place of use

Traditional sources are located at some distance from the community. Collecting and storing water close to households improves the accessibility and convenience of water supplies and has a positive impact on health. It can also strengthen a sense of ownership.

4) Quality of water supplies

Water supplies can become polluted either through industrial or human wastes or by intrusion of minerals such as arsenic, salt (coastal area) or fluoride. Rainwater is generally of good quality.

e) ADVANTAGES AND DISADVANTAGES

1)Advantages:

1. **Simple construction:** Construction of RWH systems is simple and local people can easily be trained to build these themselves. This reduces costs and encourages more participation, ownership and sustainability at community level.

2. **Good Maintenance**: Operation and maintenance of a household catchment system are controlled solely by the tank owner's family. As such, this is a good alternative to poor maintenance and monitoring of a centralized piped water supply.

3. **Relatively good water quality**: Rainwater is better than other available or traditional sources (Groundwater may be unusable due to fluoride, salinity or arsenic).

4. **Low environmental impact**: Rainwater is a renewable resource and no damage is done to the environment

5. **Convenience at household level:** It provides water at the point of consumption.

2)Disadvantages:

1. **High investment costs**: The cost of rainwater catchment systems is almost fully incurred during initial construction. Costs can be reduced by simple construction and the use of local materials.

2. **Usage and maintenance**: Proper operation and regular maintenance is a very important factor that is often neglected. Regular inspection, cleaning and occasional repairs are essential for the success of a system.

3. **Water quality is vulnerable**: Rainwater quality may be affected by air pollution, animal or bird dropping, insects, dirt and organic matter.

4. **Supply is sensitive to droughts**: Occurrence of long dry spells and droughts can cause water supply problems.

5. **Limited supply**: The supply is limited by the amount of rainfall and the size of the catchment area and storage reservoir.

II STUDY AREA

a) Location:

The Indira Gandhi Institute, Solapur started from the academic year 2004-2005 after getting approval from AICTE, New Delhi and recognized by Government of Maharashtra. It is affiliated to Solapur University, Solapur.

The institute spreads over picturesque, sprawling land of 10 acres. The Institute is having various building and Hostel Facility. In college there are three building namely CollegeBuilding, Workshop and Hostel Building. In this project 'Roof Top Rain Water Harvesting' for the College and Hostel buildings has been designed. The method of harvesting is gone be the artificial ground recharge through an existing bore well. In college campus there are two existing bore wells. The both bore well are located in the front of college. For the current project the collected water from roof top will be stored into the storage tank near the College building. All the water from these 2 buildings are transporting to storage tank by proper pipeline system with some chambers and filter media.

Figure No.1: Satellite Image of Indira Gandhi Institute

b) Objectives of project:

1) To design Rainwater Harvesting system for Indira GandhiCollege, Solapur.
2) To increase well recharge by Rainwater Harvesting system.
3) To check financial and technical feasibility of scheme.
4) To work out repayment period for Rainwater Harvesting project.

III METHODOLOGY FOR PLANNING AND DESIGN

a) Area Calculation:

The rooftop surface area is nothing but the catchment area which receives rainfall. Catchment areas of the 'College Building' and 'Hostel Building' are measured.

Table No. 1: Calculation of Rooftop Area of College and Hostel Building

Sr. No	Name Of Building	Rooftop Area (m^2)
1	College Building	3107.87
2	Hostel Building	557.22

b) Rainfall Pattern:

The number of annual rainy days also influences the need and design for rainwater harvesting. The fewer the annual rainy days or longer the dry period, the more the need for rainwater collection in a region. However, if the dry period was too long, big storage tanks would be needed to store rainwater. Hence in such regions, it is more feasible to use rainwater to recharge ground water aquifers rather than for storage

Table No.2: Average and Actual Rainfall in Last Ten Years

Sr. No	Year	Rainfall(mm)
1	2008	453.1
2	2009	582.9
3	2010	634.3
4	2011	680.9
5	2012	756.2
6	2013	610.2
7	2014	472.8
8	2015	534.7
9	2016	393.9
10	2017	479.9
	Average	**607.88**

c) Water Calculations:

The total amount of water that is received in the form of rainfall over an area is called the rainwater endowment of that area. Out of this, the amount that can be effectively harvested is called the water harvesting potential. Among the several factors that influence the rainwater harvesting potential of a site, climatic conditions specially rainfall and the catchment characteristics are considered to be the most important.

1) Total Roof Catchment Area **= 3665.09 m^2**

2) From data published by the Meteorological Department of India, the annual average rainfall in Solapur has been adopted **as 607.88 mm** as shown in table no.2

Therefore Height of rainfall = **607.88 mm or 23.93 inches**

3) The total quantity of rainwater that can be harvested annually is estimated as:

Volume of rainfall = Area of catchment x Height of rainfall x Runoff coefficient

= 3665.09m^2 x .607 m x 0.8

= 1779.77 $m^{3/}$year or 1779767.704 liters /year

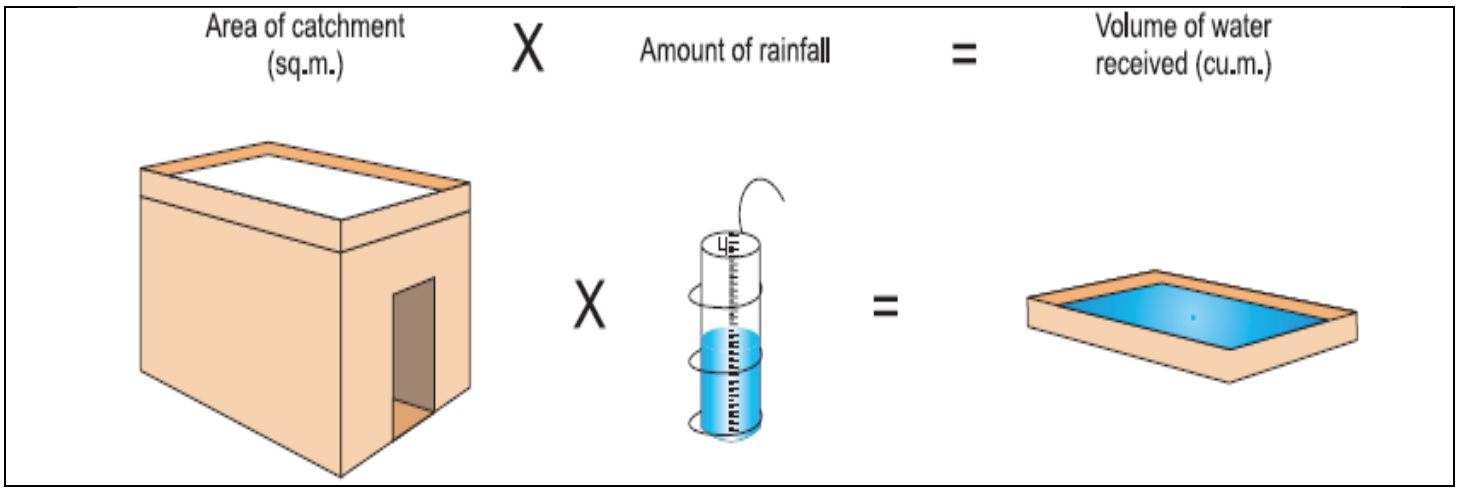

Figure No.2: Representation of Water Calculation

For the design of artificial recharge system, critical rainfall scenario has to be considered. The rainfall data of Solapur over the previous four decades indicates that on an average, there are 43 rainy days in a year. However, about 75% of the rains occur within a period of three months (July - September), with maximum rainfall during the month of September, which accounts for 30% of total annual rainfall. Even during the rainy months, rainfall may be occurring only for a few days.

IV COST ANALYSIS

Total Estimated Cost for Proposed Project:

Table no.3Total Estimated Cost for Proposed Project

Sr. No.	Description of item	Amount
1	Underground storage tank	Rs.1910521/-
2	Chamber 1&2	Rs.8975/-
3	Chamber 3&4	Rs.22239/-
4	Chamber 5	Rs.16786/-
5	Filter	Rs.91923/-
6	Pump	Rs.15000/-
7	Cost for other materials	Rs.396193/-
	Total cost	**Rs.2461637/-**
Twenty four lakhs sixty one thousand six hundred thirty seven		

V CONCLUSION

Rainwater Harvesting is a preventive technique of water conservation.On the basis of result it can be concluded that the Rainwater harvesting system is financially and technically feasible. Harvested water can

be used for various purposes during the dry season. Also harvested water can be used for recharge of bore wells.

The concluding points of our project are as given below:

- The total amount of water that can be harvested annually is around **1779770** liters. Cost analysis has been done.
- The total cost for design the rainwater harvesting system of Indira Gandhi college, Solapur is **Rs.24,61,637/-**
- The total annual cost required for water tanker is **Rs.2,68,000/-**
  After the application of rainwater harvesting system this amount may be saved.
- The total repayment period required for this project is given below:
  Repayment Period= Total cost of the project ÷ Total cost required for tanker
  = 24,61,637 ÷ 2,68,000
  = 9 years+ 3years interest of invest= **12 years.**

- Therefore it seems from above analysis Rainwater Harvesting system is financially and technically feasible and the repayment period is **12 years.**

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