Literature Review and Case Study of Rain Water Harvesting System

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Abstract- *The largest environmental challenge that faces today is the scarcity of water. Current water use already exceeds renewable supply. Many methods have been suggested to increase the sources of water supply.In present scenario management and distribution of water becomes centralized. Most of the people depend on government system, which has results in disruption of community participation in water management and collapse of traditional water harvesting system. Living creatures of the universe are made of five basic elements viz. earth, water, fire, air and sky. So water is one of the most important elements and no creature can survive without it. Human being could not save and conserve water and its source because of its availability in abundance but this irresponsible attitude resulted in deterioration of water bodies with respect to quality and quantity and now the situation has arrived when even a single drop of water matters.Systems of collection and conservation of rain water for further need has traditionally been practiced in Indian. With Traditional technics the newer technics like Furaat, Cross-waves are also been practiced from recent past.We have carried out the studies regarding components of Rain Water Harvesting System, materials used and methodology. Study on advantages and disadvantages of Rain Water Harvesting also discussed. A case study on Rain Water Harvesting System installed at MHADA building in Mumbai has been carried out.*

Keywords- Case Study-MHADA, Cross-Waves, PLC enabled RWH system, Laws and Legalizations for RWH.

I. INTRODUCTION

As we all know that 70% of earth has water but most of water present on earth is in oceans. Only 3% of water is available as fresh water out of which 2% is non-accessible i.e. locked in the form of ice caps so only 1% of fresh water is accessible to utilized. Increasing population together with the intensifying urbanization and industrialization affects fresh water both qualitatively and quantitatively. Water is a single largest problem facing in Indian Today. The annual Rainfall of India is about 150% of world's average rainfall but the spatial and temporal distribution is erratic.We received most of the rainfall during monsoon season and nearly seven to eight months are without any rainfall.

Recent droughts highlighted the risks to human being, while irrigation has most obvious response to droughts. The centralized system of water management proved costly and can only benefit afortune few. Therefore there is now increasing interest in low cost alternative generally referred as Rain Water Harvesting.

1.1 Need of Rain Water Harvesting:

The natural filter for rain water is ground, this filter allows the penetration and hence ground water was at substantial level. But prior to industrialization and successive increased rate of urbanization water is continuously pumped which results in dropping of ground water level. The concreting in urban areas also responsible for less filtration and more surface runoff of rain water leading towards sea. Hence it is the responsibility of mankind to increase this level. In this regard the Rain water Harvesting is a very cost effective solution to improve depleted water level. India has 16% of total population of world but the country has only 4% of water resources present on earth. Though India is one of the wettest regions of world with average annual rainfall of 117 $m^3$the water scarcity hunts to various parts of India with varying intensity. There is large variation in rainfall resulting in flood in some areas and drought in others. Centralized water supply in most Indian cities is unreliable many villages do not have portable water supply hence Rain water harvesting has been proposed as an ideal sustainable solution in Indian likewise other countries.

1.2 Objectives of Rain Water Harvesting

One on the biggest challenge of 21th century is to overcome the growing water shortage. Rain Water Harvesting thus regained its importance as a valuable alternative or supplementary water resource. Due to pollution of ground water, surface water and overall increased demand of fresh water many countries all over the world approaching the limits of their traditional water resources. Therefore during past decades Rain Water harvesting actively introduced and quickly regained popularity as user realized the benefits of relatively clean and affordable water source at home. The basic objectives are as follows.

1. To control and increase ground water table and its availability.
2. To collect rain water for use as secondary purpose so that the load on municipal water system for drinking get reduced.
3. Rehabilitation of existing tradition water harvesting structures like ponds, percolation tanks etc.
4. To control flow of sea water within ground water.
5. To improve physical and chemical quality of ground water.

1.3 History of Rain Water Harvesting in India:

The Evidences of water system for irrigation and drinking supply can be seen in Indus Valley civilization (3000 BC to 1500 BC) at Dholavira, Mohenjo-Daro, Harappa and Lothal. Various rulers like The Satvahans, The Gupta and The Pallavas expanded irrigation system during period of 1st century BC to 7th century AD. The Cholas (985 to 1205 AD) introduced the concept of chain tanks. During Mughal Rule, Abdul Rahim Khan built the unique supply system in Burhanpur Town by constructing underground tunnels with vertical airshafts to tap ground water flow from Satpuda Hill range to Tapi River. Under Nizam Shahi Kings (1490 to 1635 AD) 15 channels were built to supply water to city of Ahmednagar from deep well at foot of nearby hills. Hence rain water harvesting is as old as civilization and practiced continuously in different ways in India.

II. LITERATURE REVIEWS

B. P. Radhakrishna-A rain water harvesting time honored practice- need & revival. [1]: Carried out the studies of present surface and sub-surface water scenario. In study he state the evil effect of large scale exploration of underground water resource from 1980. The depth of ground water is about 100 m and falls down to 300 m and continuously falling in some areas of India. He also suggests the methods for artificial recharge of ground water and initiates mass movement for Rain Water Harvesting by giving wakeup call to
ground water authorities of India.

III. COMPONENT PARTS OF RAIN WATER HARVESTING SYSTEM

1. Catchment Area: the surface area utilized for capturing the rainwater.
2. Conveyance system: the system of pipes through which water is transported from the catchment area to the collection system.
3. Collection Systems: like Tanks, Percolation pits used for collecting and holding the water.

3.1 Methods of Rain Water Harvesting

1.Traditional Methods of various regions in India
- Trans Himalayan region: Zing.
- Western Himalayan Region: Kuls, Naula, Khatris, Kuhls
- Estern Himalayan region: Apatani, Zabo
- Bamboo Drip Irrigation
- Thar Desert: Kundis, Beris, Jhalaras, Nadis, khadin, Virdas
- Eastern Ghats: Korambu,

2. In situ Rainwater harvesting
- Bunding and terracing.
- Vegetative barriers.
- Contour trenching.
- Contour stone walls.
- Farm ponds.

3. Direct surface runoff harvesting
- Roof water collection
- Dug out ponds / storage tanks
- Temple tanks
- Diversion bunds
- Water spreading

4. Stream flow / runoff harvesting
- Nalla bunding
- Gully control structures
- Check dams – Temporary/Permanent
- Silt detention tanks
- Percolation ponds

5. Sub-surface flow harvesting
- Sub surface dams
- Diaphragm dams

6. Recent Technics
- Furaat
- Cross Waves

3.1.1 Furaat:

It is cost effective modular construction technics. This system can be used for both applications i.e. storage and ground water recharge.Two key components are used – an octagonal horizontal component and a circular vertical components. These are made in high quality concrete.The modular construction gives the used and planner the flexibility in making the particular unit to suit the needs of the site condition as well as the available budget since a level, two

levels or multi -levels unit can be made with same basic components in a very short time.

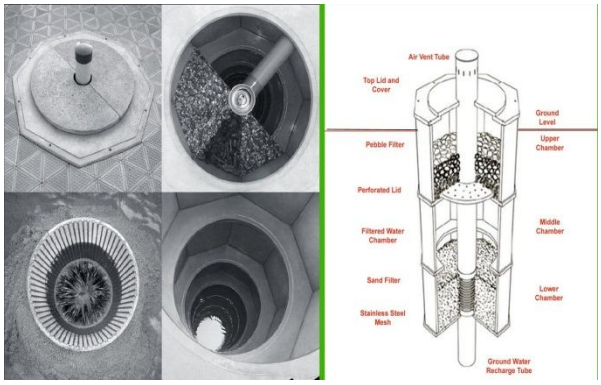

Fig. 3.1.1.1Cross section of Furaat system

3.1.2 Cross Wave:

It is a water holding material for rain fall accumulation installed within underground reservoirs. This system can be used for both applications i.e. storage and ground water recharge. Underground water space is created by cross wave effectively controls flood of river and drainage caused by heavy rain. At the same time it also provides a system through which stored rain water can be used according to necessity. Cross wave system is a light weight, easy to transport and simple to install. The installation process simply involves excavation. Spreading lining sheets piling up cross wave setting spacer and finally covering up protection sheet. Due to high void ration of 95% large amount of space could be utilized. It can easily take 25 ton truck load. The finished surface can be used as parking lot, gardens etc.

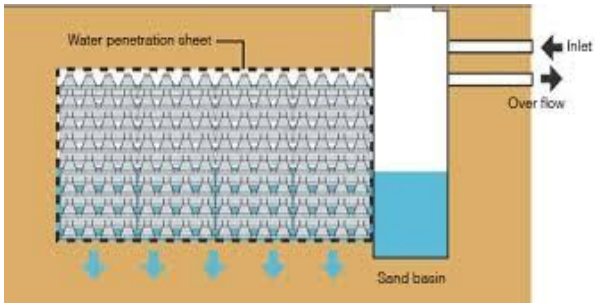

Fig. 3.1.2.1Cross wave for ground water recharge

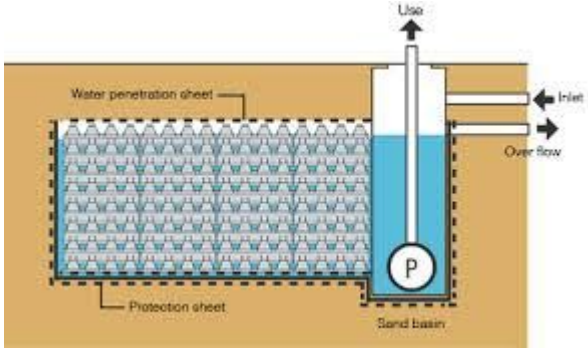

Fig. 3.1.2.2 Cross wave for storage and reuse of rain water

3.2 Utilization of Harvested Rain Water:

- Utilizing Rainwater for Dewas Roof Water Filter
- Utilization of Rainwater for Recharging Pit
- Utilization of Rainwater for Well Recharging
- Utilizing of Rainwater for Bore well Recharging
- Utilizing Roof Water to Recharge Trench
- Utilizing Surface Rainwater to Recharge Tube Well
- Utilizing Roof Water to Collect into the Storage Tanks

3.3 Success Stories of MAHARASHTRA:

1. In Yaval taluka, Jalgaon District, Six percolation tanks, two recharge shafts and one injection well were constructed- A total of about 546 ha area benefited.
2. In Amravati District, three percolation tanks and ten cement plugs benefiting an area of 280 ha and 100 ha respectively have been constructed- rise in water level up to 10 meters recorded.
3. Experiments of catchments treatment carried out at Adgaon and Palaswadi in Aurangabad, Ralegaon Siddhi in Ahmednagar and Naigaon in Pune by Shri Anna Hazare - effort have led to revival of streamlets and enhanced availability of ground water in the water shed.

IV. SOME LEGISLATION AND INCENTIVES IN INDIA

1. **Nagpur:** As per the regulation, all layouts of open spaces, amenities spaces of housing societies and new constructions of area more than 300 sq. meter shall have one or more rain water harvesting structures such as an open well or bore well, underground storage tank or percolation pits. If fails the municipal corporation would levy a fine of up to 1000 Rs. Per annum per 100 sq. meter of built up area.
2. **Hyderabad:** Rain water harvesting has been made mandatory in all new buildings with an area of 300 sq. meters.
3. **Rajashtan:** the state government has made rain water harvesting mandatory for all public establishments and all properties in plots covering more than 500 sq. meters in urban areas. If completion certificate for RWH is not submitted to Municipal, water supply connection can be terminated.
4. **Indore:** Rain water harvesting has been made mandatory in all new buildings with an area of 250 sq. meters or more. Under Madhya Pradesh Bhumi Vikas Rules, 1984, roof top rain water harvesting has been enforced in

municipalities for buildings with an area of 250 sq. meters or more. Rain water harvesting has been made mandatory for G+3 structures. A rebate of 6% on property tax has been offered as an incentive for implementing rain water harvesting systems.

V. CASE STUDY ON RAIN WATER HARVESTING SYSTEM

The Rain Water harvesting system installed at CAO Building MHADA is considered for study purpose. The building is situated in kalanagar near Western Express Highway Bandra (E), Mumbai. The climate of Mumbai is tropical wet and dry with high level of humidity. The average precipitation is about 250cm. the monsoon period is from June to September. July receives maximum amount of rain. But due to 85% of houses consist of RCC structure and 15% consist of GI roofed covered volume of infiltration get reduces and runoff towards sea water increased. Therefore though Mumbai has plenty of rainfall it suffers from water scarcity.

- **Name of scheme**: Rooftop RWH
- **Location:** CAO Building MHADA Bandra (E)
- **Roof Area:** 1386m^2
- **Starting Date:** 10 May 2010
- **Completion Date:** 20 February 2011
- **Organization involved:** BMC

5.1 Coating of equipment's and consultancy charges is as follow:

Sr. No	Description	Qty.	Unit Rate	Total Amount in Rs.
1	Collection System	500 m	750/m	375000
2	Bore well	3	30000	90000
3	Recharge Pits	3	100000	300000
4	Submersible pumps	3	30000	90000
5	Collection Tank (5000 Lilts)	3	25000	75000
6	Collection Tank (5000 Lilts)	2	15000	30000
7	Geographical Survey	--	--	20000
8	Pressure filter	1	200000	200000
9	Consultancy charges	--	--	100000
10	Contingencies	--	--	50000
Total				1330000

5.2 Rain Water Harvesting potential:

- Avg. annual Rainfall of Mumbai = 250cm
- No. of rainy Days = 80 days
- Rooftop rain water harvesting potential = Roof area X Avg. Annual rainfall X Runoff coefficient
  = 1386 X 2.5 X 0.8
  = 2772 m^3/yr.
  = 2772000 Lit/yr.
- Avg. rooftop rainwater availability during rainy season = 34650 Lit/rainy day

5.3 Cost benefits analysis:

- Source of water supply = BMC water supply
- Avg. consumption per month = 223745 lit.
- Consumption for secondary purpose = Avg. Consumption X 0.7
  = 223745 X 0.7
  = 156622 approx. Lit/month
- Daily secondary water consumption = 5220.73lit.

As Avg. rooftop rainwater availability during rainy season is greater than Daily secondary water consumption so the harvested water will be sufficient for secondary water requirement and surplus water can be diverted to bore wells for artificial recharge of ground water.

5.4 Pay Back Calculation:

- Total water bill paid = 129028 Rs/month
- Cost of water bill paid for secondary purpose = 0.7 X 129028
  = 90320 approx. Rs./month
- Total annual charges paid for water bill used for secondary purpose = 90320 X 12
  = 1083840Rs/yr.
- Total Cost of project = 1330000 Rs.
- Pay back = 1330000/1083840 = 1.23 yrs.
- Say 2 yrs. Of rainy season
- Operation and maintenance cost = 30000 Rs/Yrs.

VI. CONCLUSION

Water is essential element of life. Everyone knows that, if we do not harness available sources of water and use them judiciously with proper care the problem of water scarcity is going to be serious. Irrespective of fast development in all fields of science there can be no substitute to water. Hence, it is necessary to opt for various water harvesting measures. It is the responsibility of government

organization as well as individual to harvest each drop of water falling on earth surface. The scarcity of water has gained global attention. The developing countries due to lack of expertise, funds, national policies, public awareness cannot do much about this complicated problem. The efforts are being taken by the NGOs and other organizations from the micro level. The municipal offices, town planners of the urban sectors are changing their outlook positively towards meeting water scarcity of the future generations. That is a useful step!

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