International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 4 **Issue:** XI **Month of publication:** November 2016

DOI:

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Design of Sewage Treatment Plant to Recycle Waste Water Produced From Residential Buildings

Neelapu Pavani[1], Prof. ER S.B Sankar Rao[2], Prof. P. Mallesham[3]
[1]*PG Student, Structural Engineering, Department of Civil Engineering*
[2]*HOD & Professor, Department of Civil Engineering*
[3]*Principal & Professor, Department of Mechanical Engineering*
Sri Indu college of Engg & Tech (Autonomous), Hyderabad, India

Abstract: In this present scenario, the primary objective of this proposal of treatment plant design is to restore the availability of water resources and its optimal usage. Another foremost objective of this investigation is to develop an optimal cost design for waste water treatment system.which can satisfy a set of specified constraints and minimize lifetime costs which can be accomplished. The initiative in this project begins with the procurement of statistical (numerical) data regarding daily/annual intake of water (may be of drinking or domestic) and its distribution throughout the building. This is followed by the calculation of amount of sewage that is brought down which will be analyzed & undergone for treatment in samples for its efficient usage. Depending upon the amount of discharge and the mode of treatment required, a Sewage Treatment Plant is designed by taking both cost & reliability into consideration. It itself involves that the overall lifetime treatment plant cost is minimized if capital, maintenance and operational costs are considered in a single objective. It is concluded that the present proposal will drastically improve the efficiency of water usage at its optimum level and thus contributes a building block for the sustainable future.

I. INTRODUCTION

Water is seemingly abundant on earth and we take it for granted. When in scarcity however, it becomes our most precious resource. Ask any desert dweller about water to understand its real value.Water Water Everywher…We are literally surrounded with it. Our oceans, lakes,rivers and streams are full of it. We have water underground, in the air and in the clouds overhead. Indeed, we may assume that we have abundance of water for our needs. But let us not be fooled by this abundance. Although 70% of our earth is covered with water, only 3% is fresh water. Out of this, 2% is locked up in the form of ice, and it is only the balance 1% that recycles through the evaporation/condensation cycle, that rains down on the earth, flow into the rivers and lakes, to be used by mankind. Here again, most of the rain falls directly onto the oceans due to the large proportion of our planet surface being covered by oceans. How do modern cities source and use water? Our planners don't make rain friendly cities. Most of rain that falls in cities is allowed to drain away as run off; this rain could have recharged the ground water, but with the increase in built-up areas within cities, the land available for recharge is getting drastically reduced, even as the ground water is heavily abstracted. This situation is worsened by the extra-ordinary value attached to real estate, resulting in the conversion of natural recharge areas such as lakes, ponds and wetlands into built up areas.While the rainwater is thus wasted, city administrations go to great efforts to bring water at a huge cost through pipes and tankers. Much of this water is abstracted from far off areas- giving rise to potential points of conflict with the users of this water in those places.

II. LITERATURE REVIEW

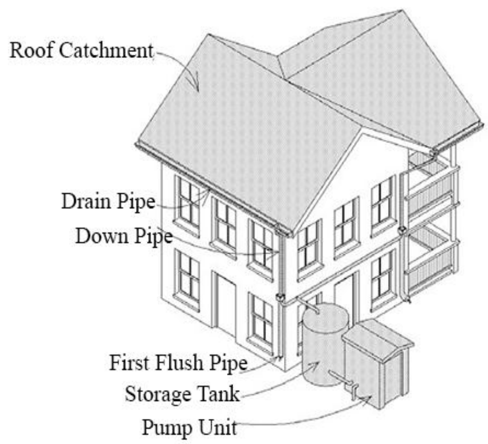
Water Harvesting and Sustainable Supply in India that brings alive and helps one understand various aspects and intricacies of water harvesting in the Indian context. Not that the two books are really comparable. Dying Wisdom was an extensive region by region survey undertaken in 15 ecological zones (interestingly enough, Athavale's book contains a table summarizing the various types of Agarwal and Narain) by a large number of persons from diverse backgrounds and of efforts, some quite well-known by now, to revive and adapt them in specific settings.

Athavale's volume is the effort of a hydrologist to provide a comprehensive definition of the subject matter and scope of water harvesting, describing the principle methods and practices (traditional as well as scientific/modern) of harvesting rain, surface and groundwater in India. It forms part of the environment and development book series of the Centre for Environment Education, Ahmedabad, seeking to bring development alternatives for a variety of ecological situations to the notice of decision-makers and policy-planners (by P.M. Natarajan and Shambu

The purpose of the Study on Rain water Harvesting in Bangladesh is to evaluate opportunities of water harvesting systems which is safe, affordable and socially acceptable. Therefore qualitative and quantitative data are used for this research. The methodology of this study confined to field observation, in depth interviews, sample collection, laboratory test, data presentation and analysis. For the better understanding of the site situation both primary and secondary data sources are used. In order to assess the appropriate water harvesting system, various formal and informal approaches are adopted in the field survey and data analysis. The location variation is analyzed by considering the physiography, climate, social structure and availability of materials for water harvesting systems. Community's idea and culture related to water harvesting system is analyzed carefully(John A Armstrong,Martin Mukul Roy, Nicholas Biswas).

III. METHODOLOGY

In a typical domestic roof top rainwater harvesting system, rainwater from roof is collected in a vessel or tank for use during periods of scarcity. Such systems are usually designed to support drinking and cooking. needs the family and comprise a roof, a storage tank and guttering to transport the water from the roof to storage tank. In addition a first flush tank to divert the dirty water, which contains debris collected on the roof during non rainy periods.



A. *Roof Catchment*

The roof of the building is used as the catchment for collecting the rain water. The style, construction and material of the roof determine its suitability of catchment. Roofs made of concrete can be utilized for harvesting rain water.

B. *Drain Pipes*

The drain pipes of suitable size made of PVC / Stoneware are provided in RCC buildings to drain off the rooftop water to the storm drains. They are provided as per the building code requirements.

Volume 4 Issue XI, November 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

C. Downpipe

Downpipe is the pipe that carries the rainwater from the gutters to the storage tank. Downpipe is joined with the gutters at one end, whereas the other end is the unit of storage tank. PVC pipe of 75mm (2inch to 3inch) diameter is used for downpipe. In the case of RCC buildings, drainpipes themselves serve as downpipes. They have to be connected to a pipe to carry water to the storage tank.

D. Pump Unit

A power pump fitted to the storage sump facilitates lifting of water to the user. The size of the pump has to be decided depending upon the consumption of the storage water.

E. First Flush Pipe

Debris, dirt and dust collect on the roofs during non-rainy periods. When the first rain arrives, these unwanted materials will be washed into storage tank. This causes contamination of the water collected in the storage tank, rendering it unfit for flushing purposes. A first flush system can be incorporated in the rooftop rainwater harvesting systems to dispose off the ‘first flush’ water so that it does not enter the tank. There are two such simple systems one is based on a simple manually operated arrangement, whereby the down pipe is moved away from the tank inlet and replaced again when the first flush water has been disposed. In another semi automatic system a separate vertical pipe is fixed to the downpipe with a valve provided below the T-junction. After the first rain is washed out through first flush pipe, the valve is closed to allow the water to enter the downpipe and reach the storage tank.

F. Storage Tank

Storage tank is used to store the water that is collected from the rooftops. Common vessels used for small scale water storage are plastic bowls, buckets, jerry cans, clay of ceramic jars, cement jars, old oil drums etc. For storing large quantities of water, the system will usually require a bigger tank with sufficient strength and durability.Storage tanks are usually constructed above ground level to facilitate easy detection of structural problems/leaks, easy maintenance, cleaning and easy withdrawal of stored water. They are provided with covers on the top to prevent contamination of water from external sources. They are also provided with pipe fixtures at appropriate places for drawing water, cleaning the tank and for disposal of excess water. They are called tap or outlet, drain pipe and overflow pipe respectively. Different types of storage tanks feasible for storing roof top rainwater are RCC, Masonry, Ferro cement & PVC

G. Recharge Pit

Recharge pits are small pits of any shape rectangular, square or circular, contracted with brick or stone masonry wall with weep hole at regular intervals. Top of pit can be covered with perforated covers. Bottom of pit should be filled with filter media.The capacity of the pit can be designed on the basis of catchment area, rainfall intensity and recharge rate of soil. Usually the dimensions of the pit may be of 1 to 2 m width and 2 to 3 m deep depending on the depth of pervious strata. These pits are suitable for recharging of shallow aquifers, and small houses.

Volume 4 Issue XI, November 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

H. Paved &Unpaved Area Catchments: These are smooth surfaces, clean and more impervious to seepage. These surfaces collect greater quantity and better quality of water. These could be roofs, driveways, parking areas, courtyards and roads. Unpaved areas found in gardens, lawns and playgrounds permit more infiltration and less runoff. These contain more impurities and silt. Water from unpaved areas is mainly used for groundwater recharge.

Table 1: Runoff Coefficients for Various Catchment Surfaces

Type Of Catchments	Coefficient
Roof Catchments Tiles	0.8 - 0.9
Ground Surface Coverings Concrete Brick Pavement	0.6 - 0.8 0.5 - 0.6
Untreated Ground Catchments Soils on Slopes < 10% Rocky Natural Catchments	0.0 - 0.3 0.2 - 0.5

IV. DISCUSSION & CALCULATIONS

After the collection of rainfall data, roof catchment area and all the data required, designing of Rainwater Harvesting System need to be done. The design of Rooftop Rainwater Harvesting System consists of Design of Storage tank, Design of Recharge pit and Design of Conduits. For Design of Storage tank and Recharge pit we need to calculate the Volume of annual Run-off and based on the Volume of annual Run off, volume of Storage tank and Recharge pit are fixed. From the volume the dimensions are calculated. Coming to the Design of conduits number of pipes and diameter of each pipe is assumed and the discharge through each pipe is calculated.

After Designing, next comes estimation and costing which includes earth work excavation, Cement Concrete in Foundation, Brick work, Plastering work, RCC work in slab and the materials required for the construction of both Storage tank and Recharge pit and the cost of all the materials required are calculated. Hence we get the total cost of construction of the project.

Finally Cost- Benefit Analysis is done to know how much amount of money spent on water can be saved through Rain Water Harvesting System and how many years it is going to take to recover the amount of money spent on constructing Rainwater Harvesting System. The water collected by Rainwater harvesting System is used for domestic purposes like flushing, for washbasins etc

Volume 4 Issue XI, November 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Table 2: Calculation of volume of runoff & design of storage tank & conduits

Volume of Runoff	Calculations
Area of roof top of the building	= 2351 m^2
Rainfall in the area	
	=887 mm
Taking runoff coefficient as	= 0.887 m
Total volume of runoff	= 0.85
	= Area of roof top x Rainfall in area x Runoff coefficient
	= 2351 x 0.887 x 0.85
	= 1773 m^3/yr
Taking average value of highest rainfall received days from rainy days in a year (94 mm)	
Volume of runoff	
	= 2351 x 0.094 x 0.85
Design of Storage Tank	= 188 m^3/day
Taking 94 m^3 of water stored & remaining water is sent into recharge pit.	
Assuming 1 day storage, volume of tank	
Assume depth of tank	= 94 x 1= 94 m^3
Area of tank	= 2 m
	= Volume / Depth
	= 94 / 2 = 47m^2 = 50m^2(approx).
	L x B = Area
	2B x B = 50
	B = 5 m, L = 10 m
	= Length x Width x Depth
	= 10 x 5 x 2 = 100 m^3
Design of Recharge Pit	
Taking 1/3rd of discharge	= 62m^3
Volume of recharge pit	= 3m
Assuming depth of recharge pit	= Volume / Depth
Area of recharge pit	= 62/3 = 20 m^2
Assuming Length : Breadth ratio as 1 : 2 i.e., L=2B	L x B = Area
	2B x B = 20
	B = 3.2 m, L = 6.4 m
Design of Conduits	
Taking Diameter of pipe	
Taking average value of highest rainfall received days from rainy days in a year (94 mm)	= 110 mm = 0.11m
Taking no. of pipes	
Vol. of water can be discharged through 10 pipes	
Vol. of water can be discharged through each pipe	= 10
	=2351×0.094×0.85
	= 188 m^3/day
	=188/10 = 18.8m^3/day
	=2.17×10^{-4} m^3/sec

V. SCOPE OF WORK

The depletion of water levels in the dug wells and bore wells can be attributed to the effects of over exploitation of groundwater from private irrigation bore wells by recharging ground water.

Studies can be made to understand the level of concentration ground water pollution that decreased due to ground water recharge.

The collected rainwater is stored in storage tank. This collected water can be used for long time and also during the water shortage period.

Studies related to reduction of sea water intrusion in coastal areas because of ground water recharge can be done.

VI. SUMMARY & CONCLUSIONS

Rainwater harvesting has a long history as both a philosophy and technology, dating back to prehistoric times.

It has been used by almost all societies in all parts of the world at some time.

After a period in which it was largely ignored in favor of more centralized 'engineering' approaches, rainwater harvesting is once again firmly on the agenda of both domestic and productive water supplies.

Rain is the earth's predominant source of fresh water and rainwater harvesting has an important role to play in integrated water resource management and watershed management.

In particular, in arid and semi arid (ARA) countries and regions, effective management of rainwater is essential for crop production, environmental protection, and the sustainability of ground and surface water supplies.

Maintenance costs are lower and households with no specialized skills can carry out maintenance activities.

The cost of construction is low; maintenance cost is low and doesn't require any skilled labor to construct and maintain the system.

There will no problem if the area has got less rainfall or heavy rainfall.

If less rainfall is registered then the collected water will be sufficient for few days, and if heavy rain is received then the excess water is sent into the ground water recharge.

REFERENCES

[1] Agarwal and S. Narain, "Dying wisdom: Rise, fall and potential of India's traditional water harvesting systems," State of India's Environment-A Citizens' Report No. 4, Centre for Science and Environment, New Delhi, India, 2003.
[2] A. K. Goel and R. Kumar, "Economic analysis of water harvesting in a mountainous watershed in India," Agricultural Water Management, Vol. 71, pp. 257–266, 2005.
[3] A. M. Abu-Awwad and M. R. Shatanawi, "Water harvesting and infiltration in arid areas affected by surface crust: examples from Jordan," Journal of Arid Environments, Vol. 37, pp. 443–452, 1997.
[4] Anil Agarwal,"Catch Water Where it Falls," Toolkit on Urban Rainwater Harvesting, pp. 37-112, 2013.
[5] B. Panigrahi, S. N. Panda, and B. C. Mal, "Rainwater conservation and recycling by optimal size on-farm reservoir," Resources, Conservation and Recycling, Vol. 50, pp. 459–474, 2006.
[6] Dutta, B.N.,"Estimation and costing in civil engineering".
[7] Dr. P. Jaya Rami Reddy, "Hydrology," pp 116-125, 2005.
[8] H. N. Verma and P. B. S. Sarma, "Design of storage tanks for water harvesting in rain fed areas," Agricultural Water Management, Vol. 18, pp. 195–207, 1990.
[9] M. Mehta and V. Jothiprakash, "Integrated rainwater harvesting system for a college campus in a metro city," Journal of Indian Association for Environmental Management, Vol. 35, No. 3, pp. 122–126, 2008.
[10] M. Qadir, Th. M. Boers, S. Schubert, A. Ghafoor, and G. Murtaza, "Rain water management in water starved countries: challenges and opportunities," Agricultural Water Management, Vol. 62, pp. 165–185, 2003.
[11] Punmia, B.C. and Jain ,Ashok, and Jain, Arun Kumar Jain, "R.C.C. Designs," Vol.1, pp. 857-896, 935-941.
[12] R. K. Sivanappan, "Status and prospects of rainwater harvesting," in proceedings of the workshop on rainwater harvesting, IIT Madras, pp. 1–10, 2001.
[13] R. Saha, P. K. Ghosh, V. K. Mishra, and K. M. Bujarba-ruah, "Low-cost micro-rainwater harvesting technology (Jalkund) for new livelihood of rural hill farmers," Cur-rent Science. Vol. 92, No. 9, pp. 1258–1265, 2007. .
[14] Th. M. Boers and J. Ben-Asher, "A review of rainwater harvesting," Agricultural Water Management, Vol. 5, pp. 145–158, 1982.