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Percolation Tank - A Sustainable Resource

(Collection and analyse of data for construction of Percolation Tank)

Harshal A. Parate[1], Vaibhavi V. Kale[2], Ritesh V. Harad[3], Jay M. Gaikwad[4], Sahil P. Kamble[5]
[1]*Assistant Professor, Civil Engineering, Datta Meghe College of Engineering, Airoli, Navi Mumbai, India*
[2,3,4,5] *Civil Engineering, Datta Meghe College of Engineering, Airoli, Navi Mumbai, India*

***Abstract*—A percolation tank is the area of land where all of the water that drains off goes into the groundwater table. A percolation tank was constructed to increase the level of the groundwater table. The recharge from the percolation tank helped generate additional groundwater potential to increase demand, irrigation activity, and water supply for drinking purposes. It has been noticed that even after 65 years of independence, there is a scarcity of water in many Indian villages, and water has to be supplied by tankers in these villages. This demonstrates the importance of percolation tank development, which makes villages self-sufficient. Thus, Indian farmers depend entirely on rainwater for agricultural purposes instead of finding measures to conserve water. Key to increasing agricultural output and improving economic conditions. To address these problems, we are constructing a percolation tank to reserve the trend or to reduce the effect of over-exploitation, as well as to recharge groundwater aquifer. The study also highlights that percolation tanks have immense potential to store rainwater, and the artificial recharge of groundwater aims to augment the groundwater reservoir by modifying the natural movement of surface water.**

***Index Terms*—Groundwater Recharge, Rainfall, Irrigation, Rainwater harvesting.**

I. INTRODUCTION

This is a semi-arid region in which rural communities depend mostly on livestock farming (mostly pastoralists) and small-scale agriculture. Both activities are highly constrained by water availability; there are Co-Perennial Rivers and with varying rainfall, both spatially and temporally, communities live in very remote areas with no access to water, electricity, or sanitation facilities. Children in this region have the lowest school results into literacy rates in the country. Spending substantial amounts of time collecting water and in addition to other domestic tasks, water harvesting has proven to be an attractive decentralized water source in areas where other means of water supply have little potential.

However, roof water harvesting from the thatched roof SSSSSSis not effective, and the storage of surface runoff in the tank only provides sufficient water for the day period. And the quality is questionable technology provides; Therefore, the percolation tank technology provides an attractive solution for the people Climate change is expected to increase the duration and frequency of extreme events. For example, floods and droughts threaten water availability and food security for millions of (Poor) people, and local storage of water is increasingly seen as an important adaptation for ensuring water availability and food. Security for rural and urban populations, especially in developing countries. This is particularly the case in semi-arid and arid regions outside the reach of perennial rivers, where there is no (little or) no groundwater available. The need for increased storage capacity (and thereby an increase in water security) is underpinned by millennium developments. Goals that specifically address storage need to adapt to global changes such as sharply growing populations, climate change, and catchment degradation. Ensuring water storage capacities is a complex issue, and water storage for urban water schemes may include options such as the construction of dams and long distances.

A percolation tank is a small dam built into the riverbed of a seasonal valley or a river. The function of a percolation tank is based on the sedimentation of coarse sand upstream of the structure, in which the natural storage capacity of the riverbed aquifer is enlarged. The aquifer fills with water during the wet season, resulting from surface runoff and groundwater recharge within the catchments when the riverbed aquifer is full, usually within one or two large rainfall events, and starts to flow as it does in the absence of a dam. However, the groundwater flow through the riverbed is now obstructed by the bund wall, creating additional groundwater storage for the community. A percolation tank is a partially subsurface dam built in a dry and sandy riverbed on a bedrock or an impermeable layer. It was constructed across a river to block the riverbed surface flow of water, thus creating a reservoir upstream of the dam within the riverbed material. The main function of the percolation tank is to store water in the riverbed or in the valley bed and increase the groundwater table. The reservoir is filled owing to the percolation of water during flood events. The water within the riverbed can be used domestically, and other functions of sand dams can be sand harvesting.

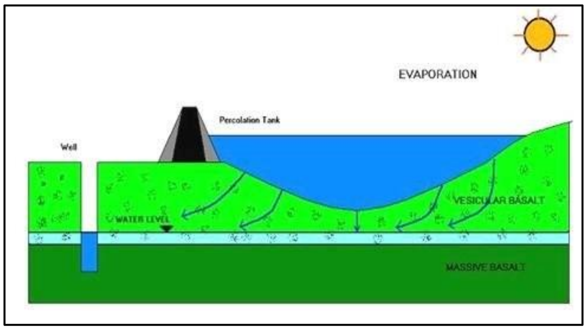

Fig.1 Percolation Tank

II. METHODOLOGY

When constructing a percolation tank designed to collect and store rainwater, several problems or challenges can arise. Some of the common issues faced during the construction of percolation tanks include the following.

Site Selection: Choosing an appropriate location for the percolation tank is crucial. Factors such as soil type, slope, groundwater level, and proximity to structures or utility lines must be considered. An unsuitable site selection can lead to inadequate percolation or structural problems.

Soil Conditions**:** The soil at the site plays a critical role in the effectiveness of the percolation tank. If the soil has a low permeability or is highly compacted, it may hinder water infiltration and reduce the efficiency of the tank. Conducting soil tests and analyses is essential to determine its suitability.

Design Considerations**:** Proper design is crucial for the efficient functioning of a percolation tank. Factors such as tank capacity, shape, depth, and overflow provisions must be carefully calculated and designed to ensure optimal water storage and percolation rates. An inadequate design can lead to insufficient water storage and flooding issues.

Construction Techniques: Constructing a percolation tank requires careful execution of construction techniques. Common challenges include excavation difficulties, ensuring the proper compaction of soil layers, installation of appropriate filtration systems, and maintenance of structural integrity. Inadequate construction techniques can result in leakage, collapse, or poor percolation.

Maintenance and Longevity:

Percolation tanks require regular maintenance to ensure their longevity and optimal functioning. Issues such as siltation, sedimentation, filter clogging, and vegetation growth can reduce the percolation rates over time. Adequate maintenance and periodic inspections are essential to address these challenges and ensure tank effectiveness.

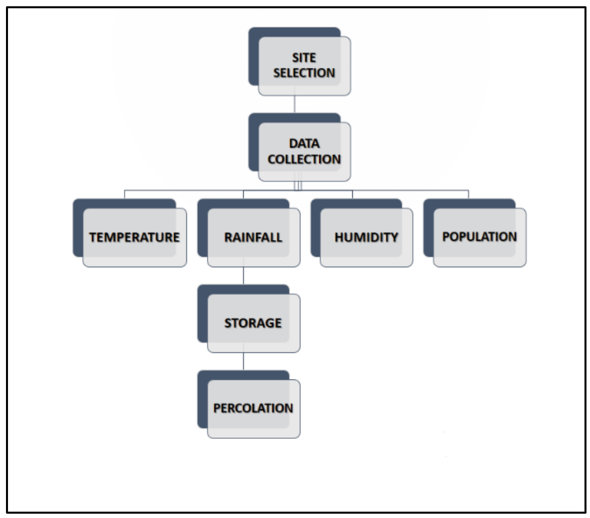

Fig.2 Methodology

III. SITE SELECTION

Topography of site selected site: Jawsaigaon (Ambernath)

1. Village Name: Jawsaigaon Ambernath
2. City name: Ulhasnagar District Thane
3. State Maharashtra, Region: Konkan
4. Elevation / Altitude: 13 meters, Above Sea Level
5. Jawsaigaon Ambernath Live Weather Temperature: 29°C Periodic clouds
6. Humidity: 74%
7. Wind: 6 Km/hr

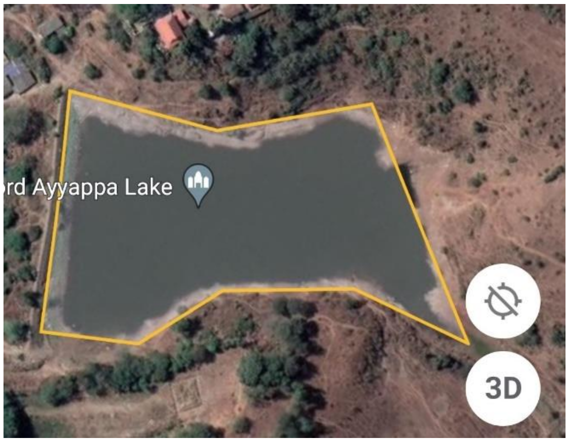

Fig.3 Area of site – 13,889 m^2

How-Does Percolation Tank Look Like

The percolation tank is an artificial reservoir that is constructed across streams, submerging a land area with adequate permeability to facilitate sufficient percolation to collect surface water runoff and allow it to percolate within the permeable land. This is an effective method for refilling the groundwater table (also known as groundwater recharge). These are earthen dams with masonry structures for spillways only and are preferred over second- or third-order streams. The ideal size of the percolation tank is governed by the capacity of the strata in the tank bed. Usually, percolation tanks are designed for a storage capacity of 0.1 to 0.5 MCM and a ponded water column should generally be between 3 & 4.5 m.

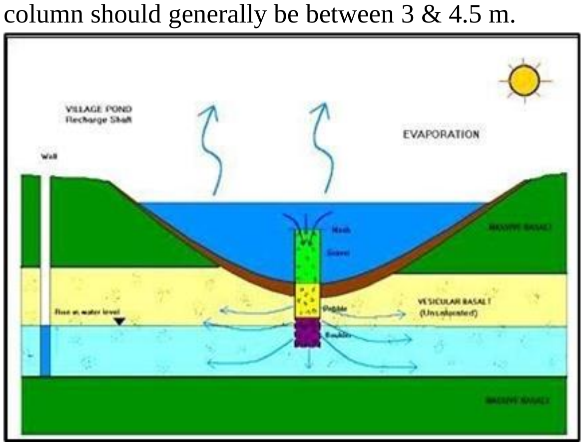

Fig.4. Percolation Tank

IV. GEOLOGICAL DATA

The Deccan trap Basalt of Upper Cretaceous to Lower Eocene age is the major rock type, covering about 80% of the district, and coastal alluvium is another formation occurring only at the western end of the district.

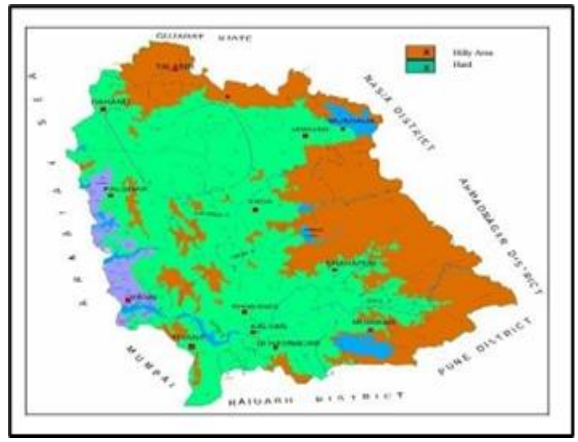

Fig.5 Map Depicting the Hydrological Features

A. Deccan Trap Basalt

Ground water in Deccan Traps mostly occurs in weathered and fractured parts down to 10-15m depth. At places, potential zones are encountered at deeper levels in the form of fractures and interflow zones, which are generally confined to 60-80m in the district. The weathered portions of both the vesicular and massive units have better porosity and permeability. The intensity of weathering is lower in the hilly region, as seen in the eastern part of the district, while it is higher in the plain area. The yield of dug wells tapping phreatic aquifers ranges between 18 to 152cum/day, with have 5-12m depth range. The bore wells are generally drilled down to 40 to 60m tapping weathered and fracture/vesicular zones; these wells have a discharge of 2 to 4lps.

B. Alluvium**.**

They are developed in the western part of the area along the coast and river courses and are lacustrine in nature. Along the coast, alluvium consists of clay and mud deposits. The quality of water is slightly brackish, and pumping from this formation must be restricted to prevent the ingression of seawater. Alluvium constitutes a potential aquifer in this area. The yield of the dug well's ranges between 122 to 252cum/day, with have 8-16m depth range. Bore wells are generally drilled down to 20–30m tapping weathered and fracture/vesicular zones; these wells have a discharge of 4 to 6lps.

V. DESIGN

Design of open well

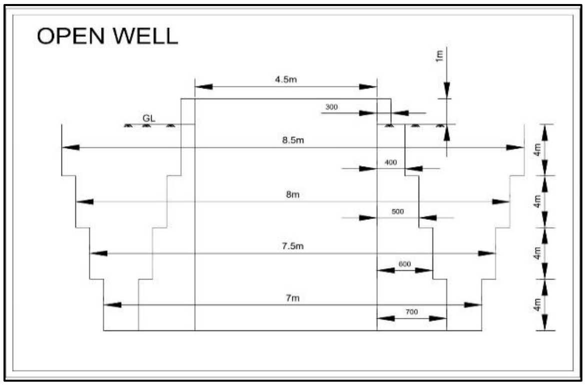

Fig 6. Open Well Excavation

Table 1

Sr.No	Description of Item	No	Length (m)	Breadth (m)	Depth (m)	Quantity (m^3)
1	Excavation					
	1st Step	1	πr^4	8.5^2	4^2	226.8
	2nd Step	1	πr^4	8^2	4^2	201.06
	3rd Step	1	πr^4	7.5^2	4^2	176.71
	4th Step	1	πr^4	7^2	4^2	153.93
						Total = 758.68 m^3
2	Laterite for dry packing					
	3rd Step	1	πr^4	$5.9^2 - 4.5^2$	4	45.741
	4th Step	1	πr^4	$5.7^2 - 4.5^2$	4	38.53
						Total = 84.271 m^3
	Laterite for M.S Work					
	3rd Step	1	πr^4	$5.5^2 - 4.5^2$	4	31.41
	4th Step	1	πr^4	$5.3^2 - 4.5^2$	4	24.63
						Total = 56.04 m^3

3	Refilling	L	B	H	Quantity
	1st Step	πr^4	$7^2 - 5.9^2$	4	138.37
	2nd Step	πr^4	$7.5^2 - 5.7^2$	4	106.02
	3rd Step	πr^4	$8^2 - 5.5^2$	4	74.64
	4th Step	πr^4	$8.5^2 - 5.3^2$	4	44.58
					Total = 363.97

1. Excavation Quantity = 758.68 ~ 759 m^3

Rate = 1600/m^3 (Average value)

Amount = 759 x 1600

= Rs.12,14,400

2. Use M30 Grade of Concrete

Rate = 3900/m^3

= 98.217 m^3

3. Steel Fe415 (30% of 98.217 m^3)

= 30/100 x 98.217

= 42.09 m^3

4. Amount for Concrete = 98.217 x 3900

= Rs. 3,83,046.3

5. Amount for steel = 42.09 x 150

= Rs. 6313.5

6. Refilling

Rate = 1800/m^3

Quantity = 363.97 m^3

Amount = Rs. 6,55,146

DESIGN OF FILTER MEDIA

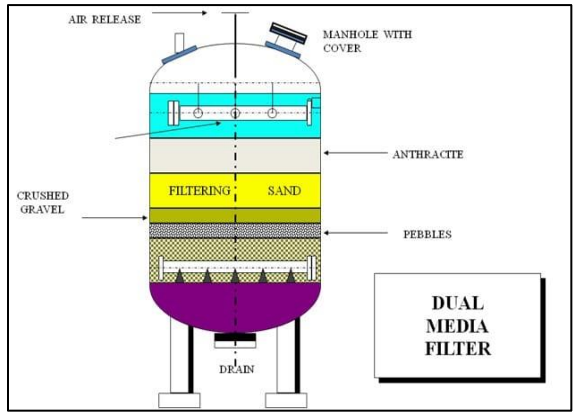

Fig 7. Filter Media

1. Volume of Cylindrical media = $\pi r^2 h$

$= \pi \times (2.25)^2 \times 2.5$

= 39.76 m^3

2.Total water quantity in filter media

Density of water x Volume = 1000 x 39.76

= 39,760 litres

3.Volume / Quantity of media

(Total bed filled inside any filter is 60% of total volume of filter)

= 60 % of Total Volume

= 60/100 x 39.76

= 23.856 m^3

4. 60%-40% Ratio

(60% Media Filter 40% supporting filter)

For Media Filter = 60% of Total Volume of Media

= 60/100 x 23.856

= 14.31 m^3

For Supporting Filter = 40% of Total Volume of Media = 40/100 x 23.856

= 9.546 m^3

5. Supporting Bed Quantity

(a)Density of Gravel = 1900 Kg/m^3

(b)Density of pebbles = 1700 Kg/m^3

(c)Average Density = 1800 Kg/m^3

Supporting Bed Quantity

= Average Density x Volume for Supporting Filter

= 1800 x 9.546
= 17,182.8 Kg
6.Media Bed Quantity
(a)Density of silica sand = 1500 kg/ m^3
Media Bed Quantity = Density of silica sand x Volume of Media Filter
= 1500 x 14.31
= 21,465 Kg
7.Total Bed Quantity
Supporting Bed Quantity + Media Bed Quantity
= 17,182.8 + 21,465
= 38,647.8 Kg

V. RESULTS AND CONCLUSIONS

It enhances groundwater recharge by collecting surface runoff, allowing water to percolate into the soil and replenish the underground aquifers. This method helps in maintaining water levels, supporting agriculture, and ensuring the availability of water for domestic use, particularly during dry seasons. Percolation tanks also promote better land health by improving soil moisture and preventing soil erosion. Their low-cost and eco-friendly nature makes them an effective solution for long-term water conservation and sustainable resource management.
The results and conclusions of a percolation tank study or project typically revolve around its design efficiency, water recharge capacity, and impact on the surrounding ecosystem. The following are examples of the results and conclusions that can be drawn from this study:

VI. RESULTS

1. Soil Percolation Rate:
The average percolation rate observed was 4.5mm/day, indicating the capacity of the soil to absorb water, and variations in percolation rates were noted at different sections, ranging from 3.5 mm/day to 4.5 mm/day.
Soil is of different types: clayey, loamy and sandy.
i. The maximum deep percolation rate of sand clay loam, sand clay, and clay are estimated to be 4.5 mm/day, 3.5 mm/day, and 2.4 mm/day, respectively.
ii. The average monthly percolation rates of sand clay loam, sand clay, and clay vary 2-4.5 mm/day, 1.5-3.5 mm/day, and 0.5-2 mm/day.
The annual percolation ratios of sand clay loam, sand clay, and clay are 0.34, 0.27 and 0.04, respectively.
2. Water Storage Capacity:
The tank's designed storage capacity is supposing A cubic meter. Post-construction, the effective storage capacity was measured as B cubic meters, with minor adjustments for seepage and silting.
3. Groundwater Recharge:
Groundwater levels in the surrounding area increased with increasing C m within a radius of D Km. Seasonal recharge contributed to a P% increase in the water availability.
4. Catchment area efficiency
The runoff coefficient of the catchment area was calculated as E to ensure optimal water collection during monsoons. The tank captured Q% of annual rainfall runoff from the catchment.
5. Siltation and Maintenance
The tank experienced R mm/y of siltation, indicating the need for desilting every T year. Vegetative bunds and check dams reduced sedimentation by U%.

VII. CONCLUSIONS

1. Efficacy of Design:
The percolation tank successfully met the intended objectives of groundwater recharge and rainwater harvesting. Design considerations, including slope, depth, and catchment area, align well with local topography and soil characteristics.
2. Environmental Impact:
The project has positively affected the local ecosystem, including increased vegetation growth and improved soil moisture content. The biodiversity around the tank area showed a noticeable improvement.
3. Water Security:
The surrounding wells and bore wells showed improved water levels and reduced dependency on external water sources during the dry season. The tank significantly mitigated water scarcity issues for agricultural and domestic use.
4. Challenges and Recommendations
Regular maintenance, including desilting and vegetation management, is crucial for long-term effectiveness, and community involvement and training are essential for sustainable operation and monitoring of the tank. The installation of check dams

or contour bunding in the upstream area could further enhance efficiency.

5. Replicability:

This project demonstrates a cost-effective, eco-friendly model that can be replicated in other semi-arid or drought-prone regions.

REFERENCES

[1] Groundwater Recharge and Quality: A case study of roorkee town, uttaranchal.
[2] Seth owusu, olufunke o. cofie, marloes l. mul
[3] Subhra Chakravarty title - technologies for enhancing ground water recharge.
[4] Debu Mukherjee, "a review on artificial groundwater recharge in India," ssrg international journal of civil engineering, vol. 3, no. 1, pp. 57-62, 2016"
[5] Groundwater Recharge – an overview.
[6] Efficiency of percolation tanks in jeur sub basin of Ahmednagar district, Maharashtra state, India. (visited June 2011).
[7] India groundwater governance case study.
[8] Goggle Earth.
[9] IS code 456 for general construction
[10] Is code 3370 water tank
[11] IS code 8419 Part 1 - sand and gravel