FEASIBILITY STUDY OF RAINWATER HARVESTING INNOVATIONS BY USING MICRO BOREHOLES

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ABSTRACT

To improve flexibility and sustainability in water resource management, this study investigates the novel use of micro boreholes and waste materials including bitumen, M-sand, granite powder, and sand for rainwater gathering. The efficiency, scalability, and adaptation of conventional rainwater harvesting techniques to different geographic and meteorological circumstances are frequently limited. Therefore, creative solutions that tackle these issues with locally accessible resources are desperately needed.

Micro boreholes, or small diameter boreholes dug into the ground to effectively collect rainfall, are incorporated into the suggested process. Micro boreholes have a number of benefits, such as less environmental effect, enhanced groundwater recharge, and a smaller land footprint. Furthermore, they are a desirable alternative for rainwater harvesting systems due to their versatility in various terrains and simplicity of installation.

KEYWORDS: *— run off naturally or man-made catchment areas like- the rooftop, rock surface, hill slopes, artificially repaired impervious or semi-pervious land surface.*

I. INTRODUCTION:

A viable way to deal with water scarcity and lessen the effects of droughts and climate change is through rainwater gathering. Communities can lessen their dependency on conventional water sources and ease the strain on water supply systems by collecting and storing rainwater for a variety of purposes. Micro boreholes are a promising new technique for improving the accessibility and efficiency of water collecting brought about by advancements in rainwater harvesting technology in recent years.

The purpose of this feasibility study is to evaluate the viability of applying such innovations in various situations and investigate the possibilities of using micro boreholes for rainwater gathering. Because they offer a more affordable and scalable option for decentralized water storage than typical boreholes, micro boreholes—which are distinguished by their small diameter and short depth—offer advantages.

Micro boreholes for rainwater gathering are a paradigm shift in water management techniques that provide prospects for more efficient use of rainwater resources by both rural and urban people. Rainwater can be directly collected at the place of use by drilling small diameter boreholes fitted with collection equipment, which minimizes losses from evaporation and runoff.

Technical issues, economic viability, environmental impact, social acceptability, regulatory compliance, risk assessment, and market analysis are just a few of the topics of feasibility that will be covered in this study. Stakeholders can learn more about the possible advantages, difficulties, and possibilities related to micro borehole rainwater harvesting developments by methodically assessing these elements.

In the end, the results of this feasibility study will guide choices on the acceptance and application of technology for micro borehole rainwater gathering. Communities may become more resilient to water scarcity and help preserve valuable water resources for future generations by utilizing innovation and sustainable practices.

II. METHODOLOGY:

II.1 Materials:

1.**Bitumen waste:** Bitumen waste can act as a waterproofing agent, preventing water from seeping out of the micro boreholes and maximizing water retention in the soil. However, it's essential to ensure that the bitumen waste used is free from harmful chemicals that could leach into the soil.

2.**River Sand**: River sand is commonly used for its good drainage properties. It allows water to pass through easily while preventing clogging. However, there are concerns about the environmental impact of excessive sand mining from riverbeds.

3.**M-sand:** M-sand is an alternative to river sand produced by crushing rocks. It can have similar drainage properties to river sand but may vary depending on its source and manufacturing process.

4.**M-sand+bitumen waste:** Combining materials like M-sand and bitumen waste can provide a balance of drainage and water retention properties. However, it's essential to evaluate the compatibility of different materials and their long-term effects on soil health and water quality.

5.**Granite powder:** Granite powder is a byproduct of granite stone crushing processes and can improve soil structure and water retention. It may also contribute minerals to the soil, promoting plant growth. However, its effectiveness can vary depending on the particle size and composition.

6.**Medical waste:** The use of biomedical waste in rainwater harvesting trenches is not recommended due to potential contamination risks. Biomedical waste can contain pathogens and hazardous substances that could pose health and environmental hazards if released into the soil.

- Evaluate the site to determine the area available for rainwater harvesting, average rainfall patterns, soil type, and terrain slope. This assessment will help determine the size and placement of trenches and micro boreholes.
- Design trenches to capture and channel rainwater runoff. Consider factors such as slope, length, width, and depth of the trenches based on the site assessment.
- Determine the spacing and placement of micro boreholes within the trenches. This will depend on factors such as soil permeability and the desired infiltration rate.
- Develop a maintenance plan to ensure the long-term performance of the rainwater harvesting system. This may include regular inspections, cleaning of micro boreholes, and repair of any damage.
- The process involves collection and storage of rainwater with help of artificially designed systems, that runs off natural or man-made catchment areas.
- e.g. natural ground surface

I.1 e.g. natural ground surface

I.2 Standard Proctor Test (SPT)

The Standard Proctor Test is a technique for figuring out the highest soil density that can be reached with a given compaction effort. Typically, a hammer dropped from a predetermined height is used to compact soil samples in a mold using a defined compaction energy. Next, the density that results is measured and contrasted with the soil's maximum theoretical density.

Procedure:

- we create a surface model in the glass tank we use glass tank for the good visibility of the seepage of water.
- Tank size 2*1*2.The soil sample was compact in the tank with the hight of 18cm and the tank is divided into 3 parts for the different materials.
- To create a trench 10cm dia and put 2 micro borehole with the Dia of 2cm and 13cm depth in the tank. The borehole was fill with different material. The trench was collect the surface water and the water into the bore hole and slowly seepage into the surface. Then we calculate the seepage area in the surface.
- Calculate how many days to seepage the full water in the borehole. The test taken for each material.

- Bitumen waste is the main ingredient we are looking forward to make use of it in the filter. We will take a test on the bitumen and take out the characteristics and properties of that bitumen. This will help to decide to implement it in the design.

II. RESULTS AND DISCUSSIONS

STANDARD PROCTOR TEST:

Soil type: **Red soil**

Diameter of mould:**10cm**

Height of mould:**12.63cm**

Volume of mould:**992cm^3**

Weight of soil taken:**3000g**

TABLE I: STANDARD PROCTOR TEST:

Water	**Red soil in kg**
12%	6.020 kg
15%	6.050 kg
18%	6.100 kg
21%	6.060 kg

The standard proctor test result for finding the maximum dry density of soil. First we add 12% of water in 3kg of soil. Then add 15% of water in the soil sample. The weight of the soil will increase and add 18% of water in the soil again weight will increase. Add 20% of water in the soil sample the weight will be decrease. We stop the process. From the graph we take 18% of water will use for compaction.

Results from the study

Based on study:

We use different material in the micro bore hole. We analyse for one day for the result. Analyse the water seepage depth and distance in the glass tank.

TABLE II.

Mix Id	Water insisted capacity (ml)	Water spreaded depth (cm)	Water spreaded width (cm)	Water retained in boreholes (cm)
Trenches without boreholes	200 ml	7 cm	4.4 cm	Fully saturated
Micro bore hole with waste bitumen	250 ml	8 cm	5 cm	6.7 cm
Micro bore hole with sand	300 ml	8.5 cm	6.2 cm	Fully saturated
trenches with empty boreholes	450 ml	9.5 cm	5 cm	6 cm
Micro bore hole with waste bitumen	200 ml	7 cm	4.4 cm	Fully saturated

Result from the table II analyse for 1 days

TABLE III.

	Water insisted capacity (ml)	Water spreaded depth (cm)	Water spreaded width (cm)	Water retained in boreholes (cm)
Micro boreholes with M sand	300 ml	9 cm	5.5 cm	Fully saturated
Micro boreholes with M sand +bitumen	280 ml	7.4 cm	5 cm	2 cm
Micro boreholes with granite powder	400 ml	6 cm	6 cm	Fully saturated
Micro boreholes with medical waste	400 ml	9.5 cm	6.2 cm	Fully saturated

Result from the table III analyse for 1 days

TABLE IV.

Mix Id	Water insisted capacity (ml)	Water spreaded depth (cm)	Water spreaded width (cm)	Water retained in boreholes (cm)
Trenches without boreholes	200 ml	12 cm	7.5 cm	Fully dried in 5 days

Micro bore hole with waste bitumen	250 ml	10cm	7 cm	Fully dried in 14 days
Micro bore hole with sand	300 ml	12 cm	7.3 cm	Fully Dried in 8 days
trenches with empty boreholes	450 ml	15 cm	8 cm	Fully dried in 3 days

Result from the table IV analyse for 7 days

TABLE V.

	Water insisted capacity (ml)	**Water spreaded depth (cm)**	**Water spreaded width (cm)**	**Water retained in boreholes (cm)**
Micro boreholes with M sand	300 ml	13 cm	7.5 cm	Fully dried in 8 days
Micro boreholes with M sand +bitumen	280 ml	11 cm	7.3 cm	Fully dried in 7 days
Micro boreholes with granite powder	400 ml	14 cm	7.8 cm	Fully dried in 5 days
Micro boreholes with medical waste	400 ml	15 cm	8.3 cm	Fully dried in 4 days

Result from the table V analyse for 7 days

III.CONCLUSIONS

As per the study, bitumen waste usage in micro boreholes is holds up and retaining the water effectively for 7 days. The water is fully dried in 15 days. The water spreads 7 cm distance width from the trenches and penetrates 10 cm in deep.

By directing rainwater directly to tree roots, this method optimizes water usage, reduces dependence on external irrigation sources, and mitigates soil erosion and runoff.

By combining innovation with environmental stewardship, rainwater harvesting with bitumen-filled boreholes represents a promising strategy for nurturing healthy tree ecosystems amidst evolving climate challenges.

By harnessing natural rainfall, this method optimizes water distribution directly to tree roots, fostering efficient water usage and reducing reliance on external irrigation sources.

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