ISSN: 2278-4632
Vol-12 Issue-01 No.01: 2022

A METHOD FOR WATER-PROOFING OF SANDY SOILS TO CONSERVE WATER

P VINAY ANAND [1], K.SRINIVAS [2], V SATYA SAI [3], K RAJA [4], P ARAVIND [5]

Department of Civil Engineering,

Vignan's Institute of Information Technology, Duvvada 530046, India.

vinayanand031@gmail.com[1], *srinivas.civil@vignaniit.edu.in[2]

ABSTRACT

Sandy soil has been a non-renewable resource for humans since the dawn of time. Sandy soils are used in a variety of human activities, including construction, agriculture, the brick industry, the glass manufacturing industry, and capillary barriers in landfills. Sand particles have a natural tendency toward water, and as a result of this tendency, sand particles absorb water to a certain extent, which is a "major problem to treat and rectify." The hydrophilic property of soils refers to the ability of soil particles to absorb and hold water to varying degrees. Because of the coarser particle size of sandy soils in 'Arid and semi-arid regions,' sandy soils dry out quickly or irrigated water is lost due to seepage in agriculture practices. 'A potential solution is to change the grain surfaces of soil to make them water repellent by mixing or coating the soil and covering the material with hydrophobic agents (HAs).'

Key words: Hydrophobic agent, M-sand, River sand and Beach sand,

1. INTRODUCTION

1.1 General

Earth's surface is covered with soil and rocks. Sand is a type of soil so people often confuse sand with soil. Although the sand is a type of soil, it is entirely different from the soil.

The soil is a natural resource like air and water. It is primarily made up of three components: minerals from the rocks, organic matter (remains of plants and animals), and living organisms that dwell in the soil. Thus, it is a complex mixture of minerals, water, air, organic matter, and living organisms.

Soil is formed at the Earth's surface and serves as the Earth's skin. It is essential to life on Earth because it supports plant life and other forms of life. Furthermore, it serves several important functions in almost all ecosystems, including forests, marshes, prairies, and suburban watersheds.

Sand is a granular loose material that is commonly found on beaches, riverbeds, and deserts. Depending on the location, it can be different colours such as white, black, or green. The sand is a mixture of small rock grains ranging in size from 0.0625 to 2 mm. Sand is commonly composed of silicon dioxide in the form of quartz. Sand is nonporous and does not retain water. It can be of various types, such as coral sand, glass sand, gypsum etc.

Water depletion at the root zone in agriculture due to downward infiltration of applied irrigation water when regular desert sand lies beneath in desert areas, water bleeds endlessly downward, leaving roots dry until the next watering.

To keep up with rising food demand, 14% more fresh water will need to be withdrawn for agricultural purposes over the next 30 years.

Various problems in soil due to the presence of soil water and Specific areas under the influence of soil water

- Agriculture
- Construction
- Pavements
- Natural water bodies and their boundaries
- Fish farm ponds
- Canal boundaries, Etc.

ISSN: 2278-4632
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2. LITERATURE STUDY

The fact that a literature review was conducted on the experimental work done.

D. A. L. Leelamanie, Jutaro Karube, Aya Yoshida. [1] "Characterizing water repellency indices: Contact angle and water drop penetration time of hydrophobized sand." The objectives of this paper is to compare contact angles obtained using three different methods and to investigate the relationship between contact angle and water drop penetration time (WDPT) using sands ranging from non-repellent to extremely repellent. The measurements were performed on fine silica sand that had been artificially hydrophobized with stearic acid. The molarities of an ethanol droplet (MED) test, the capillary rise method (CRM), and the sessile drop method were used to calculate contact angles (SDM). Nestingen, Rebecca; Asleson, Brooke C.; Gulliver, John S.; Hozalski, Raymond M.; Nieber, John L [2]. "Laboratory Field Infiltrometer Comparison" In this paper, three devices for measuring hydraulic conductivity of soil in the field were tested in the laboratory under controlled conditions using three different types of media to compare their accuracy and precision: a modified Philip-Dunne infiltrometer, a double-ring infiltrometer, and a mini-disk infiltrometer. The precision was determined by comparing the hydraulic conductivity values obtained with these devices to those obtained with reference falling-head tests. The modified Philip-Dunne infiltrometer had the lowest relative error of the three devices, while the double-ring infiltrometer was the most precise. The relative error for the coarsest media was higher for the mini disc infiltrometer, indicating that it is not suitable for use on coarse sands and gravels. Toshiko Komatsu; Shaphal Subedi; Ken Kawamoto; Lakmal Jayarathna; Meththika Vithanage; Per Moldrup; Lis Wollesen de Jonge; [3] Characterizing Time-Dependent Contact Angles for Oleic and Stearic Acid Hydrophobized Sands Hydrophobic CBs made of sands and environmentally friendly HAs (oleic acid [OA] and Stearic acid [SA]) were investigated in this study. Water repellency (WR) characteristics were measured for hydrophobized sand samples with varying HA contents and coating methods (mixing in and solvent aided). B. T. Lesbayev, M. Nazhipkyzy, N. G. Prikhodko, M. G. Solovyova, [4] "Hydrophobic Sand based on Super hydrophobic Soot Synthesized in the Flame" The paper presents the findings of research on the synthesis of super hydrophobic soot and the advancement of its technology-based production of bulk material (sand) with hydrophobic properties. The hydrophobic properties of sand were attached by affixing a super hydrophobic nanoscale layer of soot to the surface of the sand grains. Scanning electron microscopy was used to determine the structural and morphological parameters of the resulting sand. S. Alazawi (2015) [5-15] “Hydrophobic sand to combat water scarcity – Properties and possible chemical risk" When saturated with water, hydrophobic sand has higher permeability than normal sand, according to the study. However, it takes much longer to reach saturation, so recommendations were made to use a separate layer of hydrophobic sand beneath the normal sand layer where vegetation is planted and to avoid using sand mixtures. [16-22] Herman Bouwer "Cylinder Infiltrometer: Intake Rate" Cylinder infiltrometer are metal cylinders that are pushed or driven into the soil for a short distance. The cylinder's interior is flooded with water, and the rate at which the water moves into the ground is measured. When using infiltrometer to predict infiltration rates for a given system, it is critical to ensure that the system's conditions, such as water quality, temperature, soil conditions, and surface conditions, are replicated as much as possible with the infiltrometer to ensure that the measurement is realistic.

3. METHODOLOGY

Various materials used for the present study are:

- ***M-Sand:*** Manufactured sand (M-Sand) is a substitute of river sand for concrete construction. Manufactured sand is produced from hard granite stone by crushing.

- ***River Sand:*** Rivers sand is a naturally occurring granular material composed of finely divided rock and mineral particles.

- ***Beach Sand:*** Beach sand is also formed by erosion. Over thousands of years, rocks are eroded near the shoreline from the constant motion of waves and the sediments build up.

- ***Stearic acid***: Stearic acid is a saturated fatty acid with an 18-carbon chain. The IUPAC name is octadecanoic acid. It is a waxy solid and its chemical formula is $\mathbf{C_{17}H_{35}CO_2H}$.

Procedural methodology followed

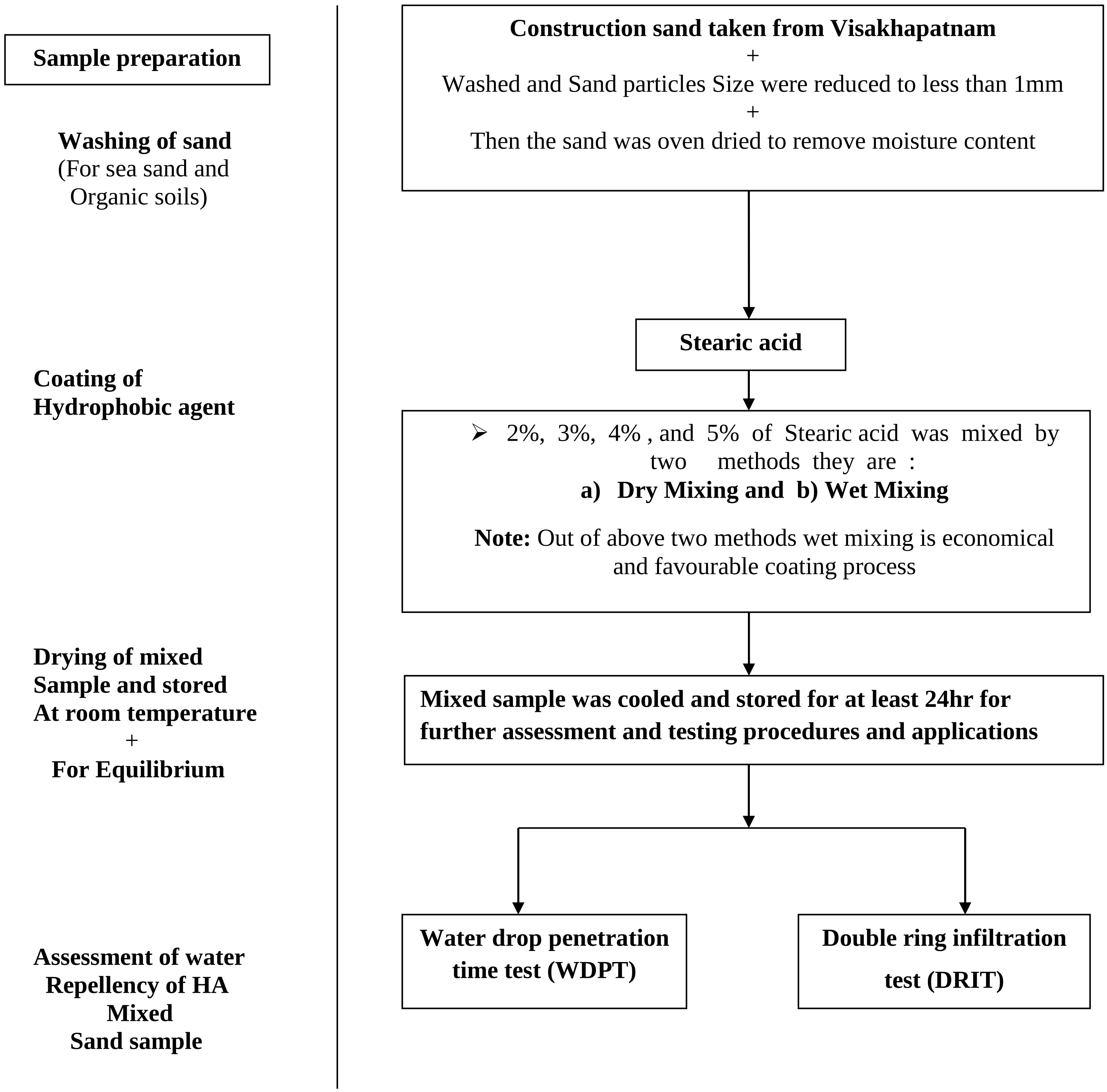

Fig 1 Wet Mixing Of Sand with 'HA'

Fig 2 C-Drum for wet mixing

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Water drop penetration test on sand samples

Table 1: Water drop contact angle with sand surface

S.No	Description of sand	% HA added to sand	Contact angle	Photo description	Remarks
1.	River Sand	4%	>150		As the contact angle is >150, it is 'super hydrophobic'.
2.	M-Sand	4%	>150		As the contact angle is >150, it is 'super hydrophobic'.
3.	Beach Sand	4%	>90		As the contact angle is >90, it is 'hydrophobic'.

Water drop penetration time on sand sample

Note: Water drop penetration time test was done up to 3600 seconds and for sand samples whose repellency greater than 3600 seconds is taken as ,WDPT >3600 seconds.

Table 2 Water drop penetration time

S.no	Description of sand	Water drop penetration time(seconds) (WDPT)	Repellency category
1.	River sand	>3600 s	Extremely repellent

ISSN: 2278-4632
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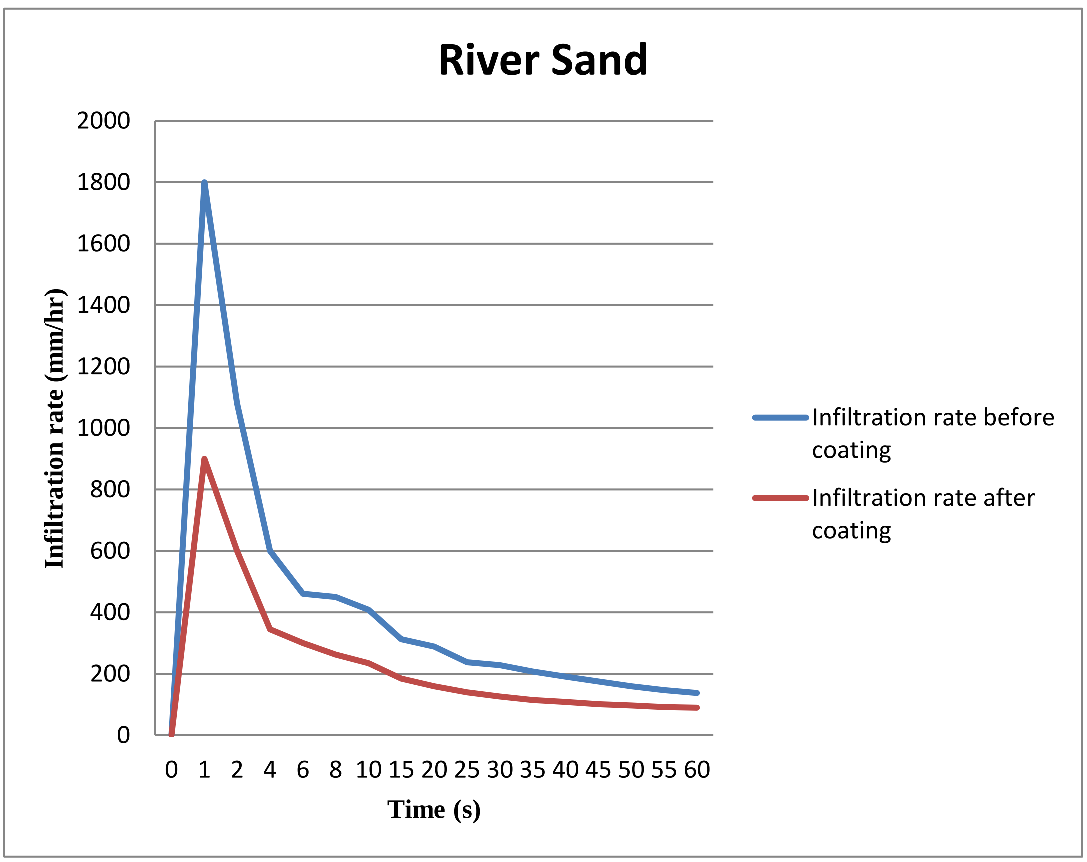
2.	M-Sand	>3600 s	Extremely repellent
3.	Beach sand	1800 (600-3600) s	Severely repellent

4. Results

River sand Graphical compares of infiltration rates of River sand before and after coating with HA

Graph 1 River Sand infiltration rate



- For River sand the water drop penetration time is greater than 3600, so it is Super Hydrophobic.

ISSN: 2278-4632
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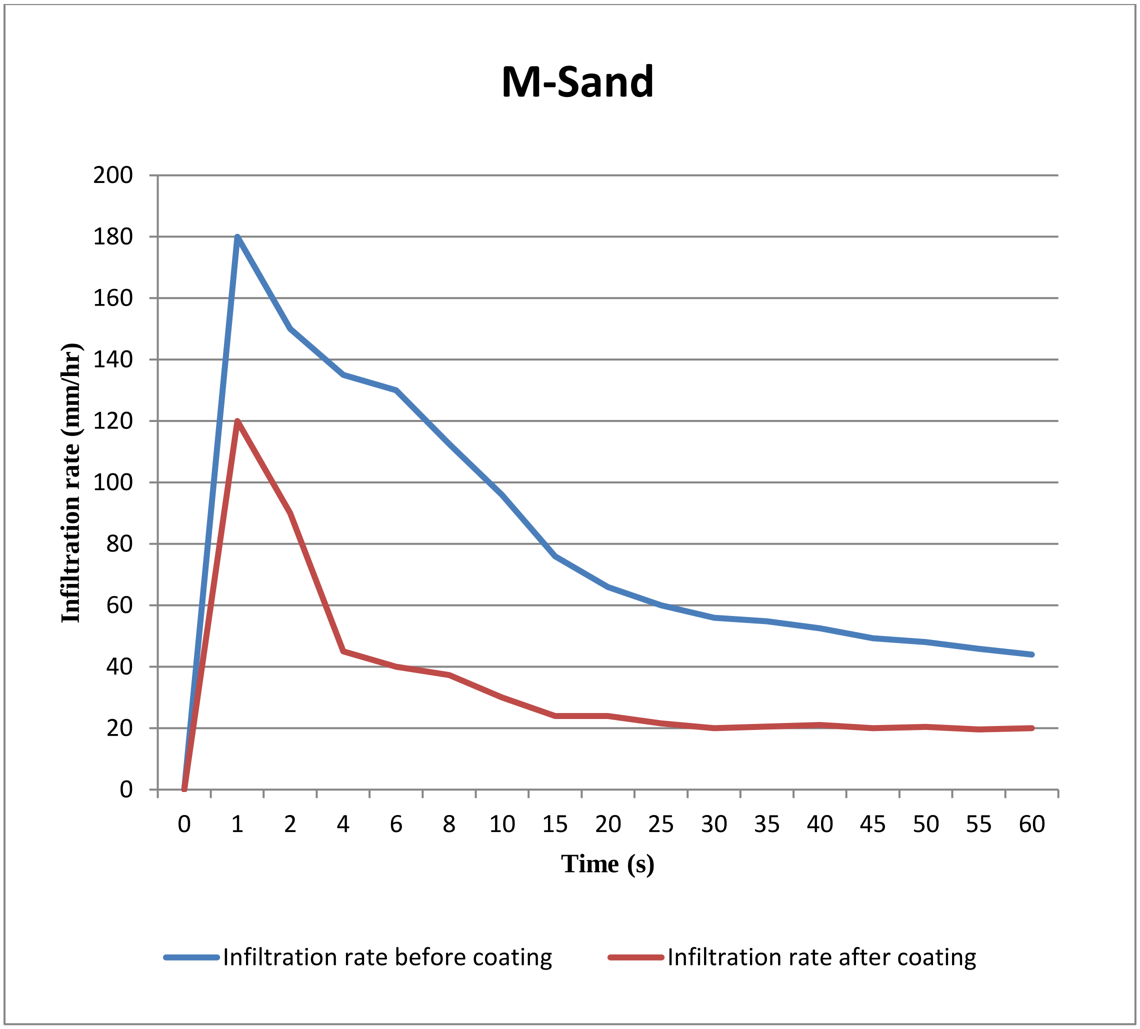
M-Sand *Graphical compares of infiltration rates of M-Sand before and after coating with HA*

Graph 2 M-Sand infiltration rates



- For M-Sand the water drop penetration time is greater than 3600, so it is Super Hydrophobic.

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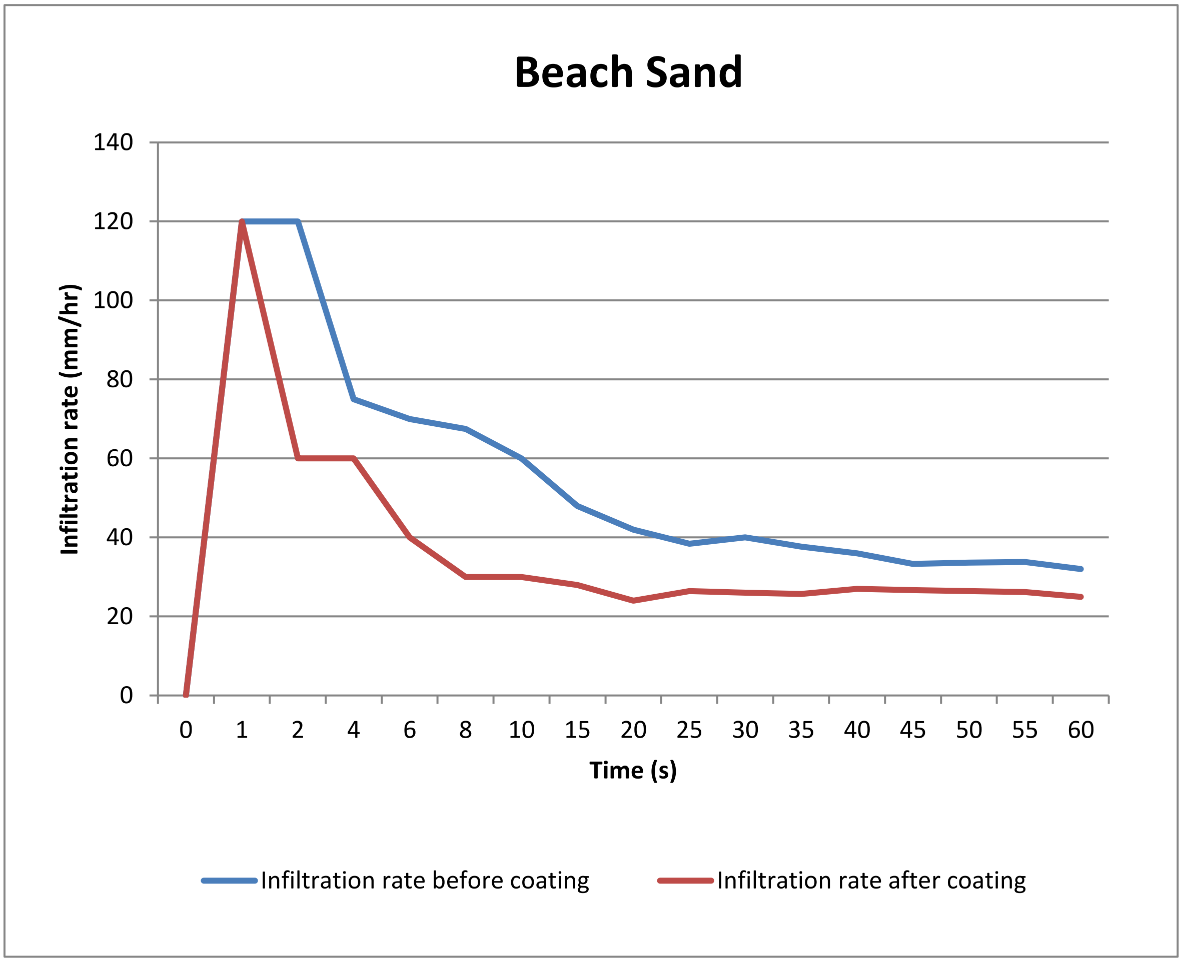
Beach sand Graphical compares of infiltration rates of Beach sand before and after coating with HA

Graph 3 Beach sand infiltration rate



- For Beach Sand the water drop penetration time is within the range of 600- 3600 i.e., 1800, so it is Hydrophobic.

5. Discussions

Recommendations of above synthesized sandy soil are:

- ✓ Hydrophobic sand can be used in order to reduce sand permeability and consequently **reduce irrigation water consumption and duration**; a separate layer of hydrophobic sand should be placed beneath the normal sand layer of planted vegetation.
- ✓ The thicknesses of the hydrophobic sand layers depend basically on the type of the planted vegetation.
- ✓ Hydrophobic sand may be used as **bedding sand underneath pavers, roads, Surfaces**, etc because it may inhibit water migration through the bedding layers.
- ✓ Hydrophobic sand may be used as a hydrophobic layer around, underneath or above underground objects (pipes, tanks, cables, construction bases, poles, electronic devices, etc.).
- ✓ Another important quality of hydrophobic sand is the reduction of water contact with metallic underground objects; such reduction may result as major **corrosion inhibition.**
- ✓ Another important quality of hydrophobic sand is the reduction of water contact with underground electronic objects; such reduction may result as major **electrical insulation** and corrosion inhibition.
- ✓ Hydrophobic sand may be used as a **hydrophobic layer in ponds/pits.** In ponds/pits it may replace clay soil layers, it may not require extensive compaction, it may not Swell when in contact with water and it may not shrink when dry (does not develop shrinking cracks as clay soils).
- ✓ It is noted that waste pits are sealed below and above the waste by the hydrophobic sand because it may **avoid leach ate** to contaminate ground water.
- ✓ Hydrophobic sand may be used as a **sealer of pond/ reservoir leakage**, placing hydrophobic sand above such leak location will result with the seal of the leak.

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- ✓ Hydrophobic sand may be used as a hydrophobic layer around buildings, basements, cellars, poles or other partially buried objects to avoid contact with water and further seepage and inhibit corrosion.
- ✓ It may be easy to use, efficient and cheap because it may **inhibit weed growth,** it may inhibit washout by rain/wash water.
- ✓ It may inhibit corrosion of metals, and it may enable easy clearing and replacing even under wet and/or frozen weather conditions. The most important quality of Such sand is its ability to be easily removes and replaced at any weather conditions
- ✓ For temporary dewatering and permanent dewatering techniques this hydrophobic sand can be a reliable solution due to its ease of placing and removing from the site.

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