International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Collection and Treatment of Storm Water using Drains and Sedimentation Tank

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A B S T R A C T

An in-depth study was carried out to identify the most effective options for reducing the risk of flooding in cities and protecting water resources. The research results enabled the identification of sustainable drainage infrastructure solutions to be used to increase the efficiency of traditional drainage systems. Flood water is collected through storm drains and diverted in to sedimentation tank for treatment of storm water for further usage. Stormwater drains are designed to relieve water from stagnation in the flood prone areas, regardless of the width of the road. After treating this storm water can be used for agriculture purpose. For quality analysis and for sedimentation design criteria, we take different water samples from main supply line, and storm water to compare the quality of water by conducting laboratory tests in AITS, Tirupati. For collecting storm water, we designed storm drains and for collection we designed a plain sedimentation tank.

Key Words – *Storm drains, Storm Water Quality, and Sedimentation Tank.*

1. Introduction

Stormwater is rainwater that runs off from roofs, roads, parking lots, and other impervious surfaces, often carrying pollutants such as oil, pesticides, and other chemicals. It can also cause flooding if it is not managed properly. Collecting and treating stormwater using drains and sedimentation tanks is an effective way to mitigate the negative effects of stormwater.

The collection of stormwaters using drains involves the installation of a system of pipes and channels that are designed to direct the runoff water to a sedimentation tank or other type of treatment system. The drains are usually made of concrete or PVC and are placed underground to capture the runoff water.

The sedimentation tank is a type of treatment system that allows for the settling of sediment and other pollutants from the stormwater. The tank is designed to slow down the flow of the water, allowing heavier particles to settle to the bottom of the tank. The water is then discharged from the tank into a filtration system or other treatment method, which removes any remaining pollutants.

The sedimentation tank can be designed in different sizes and shapes to fit specific needs, and they can be made of various materials such as concrete, steel, or plastic. They are typically designed to be easy to maintain, with regular cleaning and removal of accumulated sediment.

Overall, the collection and treatment of stormwater using drains and sedimentation tanks is an important component of managing urban and suburban runoff, helping to protect both the environment and public health.

1.1 Storm drain

Storm drains are underground channels or pipes that are designed to collect and carry rainwater, melted snow, and other forms of precipitation away from urban areas and into natural waterways, such as rivers and streams. These drains are typically found in cities and towns, where the large amounts of impervious surfaces, such as roads, sidewalks, and buildings, can prevent rainwater from being absorbed into the ground and cause flooding.

Storm drains are often located along the sides of roads and are covered by grates or other types of covers to prevent debris and large objects from entering the drainage system. The collected water is then transported through a network of underground pipes and channels to a larger body of water, such as a river or ocean.

It is important to note that storm drains are not connected to sewage systems, and any pollutants, chemicals, or waste that enters a storm drain can harm the environment and wildlife in nearby waterways. Therefore, it is essential to dispose of waste properly and avoid dumping anything into storm drains.

1.2 Types of storm drains?

There are several types of storm drains that are commonly used in urban areas, including:

1. **Catch Basins:** Catch basins are the most common type of storm drain, and they are designed to capture and collect water runoff from streets, sidewalks, and other impervious surfaces. They are typically installed at the curb side and consist of a basin or pit with a grate or other cover.
2. **Slot Drains:** Slot drains are linear drains that are installed in a trench along the edge of a street or sidewalk. They are designed to capture water runoff and transport it to an underground pipe system.
3. **French Drains:** French drains are shallow trenches that are filled with gravel or other porous material. They are designed to collect and transport water away from a specific area, such as the foundation of a building.
4. **Bio-Retention Basins:** Bio-retention basins are shallow depressions that are designed to capture and treat stormwater runoff. They are typically planted with vegetation and filled with soil or other porous materials that help filter pollutants from the water.
5. **Dry Wells:** Dry wells are underground structures that are designed to capture and store stormwater runoff. They are typically used in areas where there is not enough space to install a traditional stormwater management system.

These are just a few examples of the types of storm drains that are commonly used. The specific type of storm drain that is used will depend on a variety of factors, including the location, the amount of rainfall, and the available space for installation.

1.3 Sedimentation Tank and its types

Sedimentation is the process by which particles and other solid materials settle out of a liquid or gas and form a sediment layer at the bottom of a container or body of water. This process occurs naturally in bodies of water, such as rivers, lakes, and oceans, as well as in water treatment and wastewater treatment processes.

There are several types of sedimentation tanks that can be used for stormwater treatment, including:

1. Inlet sedimentation basins: These are typically shallow, rectangular tanks that are placed at the inlet of a stormwater treatment system. The purpose of these tanks is to capture and settle out sediment and other pollutants before they can enter the rest of the treatment system.

2. Detention basins: These are larger, deeper tanks that are designed to detain stormwater for a period of time to allow sediment and pollutants to settle out. Detention basins can be designed with multiple cells to provide additional settling time.

3. Infiltration basins: These are similar to detention basins but are designed to allow stormwater to infiltrate into the ground. The bottom of the basin is typically lined with a permeable material to allow for infiltration while still preventing sediment and pollutants from entering the groundwater.

4. Up flow sedimentation tanks: These tanks use a vertical flow design, with stormwater entering from the bottom and flowing upward through a series of settling chambers. The settling chambers allow sediment and pollutants to settle out, with clean water exiting from the top of the tank.

5. Downflow sedimentation tanks: These tanks use a similar design to up flow sedimentation tanks, but with stormwater entering from the top and flowing downward through settling chambers. The settling chambers allow sediment and pollutants to settle out, with clean water exiting from the bottom of the tank.

1.4 Objectives

The different possibility as shown below:

- Flood Prediction in various areas.
- Storm water drains for collecting water.
- Design of a sedimentation basin for collecting storm water.
- Solve problematic water jams in storm drains.
- Reduce disease spread in adjacent areas.
- Collect rainwater from gullies and use it for irrigation purposes.
- To determine various storm water quality parameters such as pH value, total dissolved solid content, Hardness, Alkalinity and Dissolved Oxygen.

2. Materials

There are various materials that can be used for the collection and treatment of stormwater using drains and sedimentation tanks. The choice of materials will depend on factors such as the site conditions, the size and design of the system, and the specific treatment objectives. Here are some common materials used for stormwater collection and treatment:

Concrete: Concrete is a commonly used material for building stormwater drains and sedimentation tanks due to its strength, durability, and resistance to erosion. It can be cast in different shapes and sizes to fit specific design requirements.

PVC: Polyvinyl chloride (PVC) pipes are lightweight, easy to install, and have good chemical resistance. They are commonly used for stormwater collection systems because they are cost-effective and low-maintenance.

3. Methodology

3.1 Collection of Water Sample

Fig 3.1: Collection of Water Samples

3.2 Various Tests on Water Samples:

Storm water samples collected as described above were subjected to the following tests: PH, Total Hardness, Total Dissolved solids, Alkalinity, Electrical conductivity.

3.2.1 pH

The purpose of a pH test is to determine the acidity or alkalinity of a solution. pH is a measure of the concentration of hydrogen ions (H+) in a solution, with a pH of 7 indicating neutrality, pH values less than 7 indicating acidity, and pH values greater than 7 indicating alkalinity.

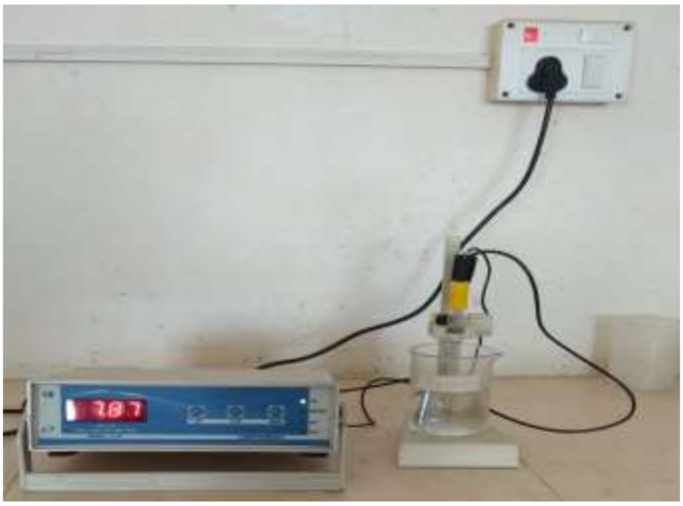

Fig 3.2.1(a): pH meter

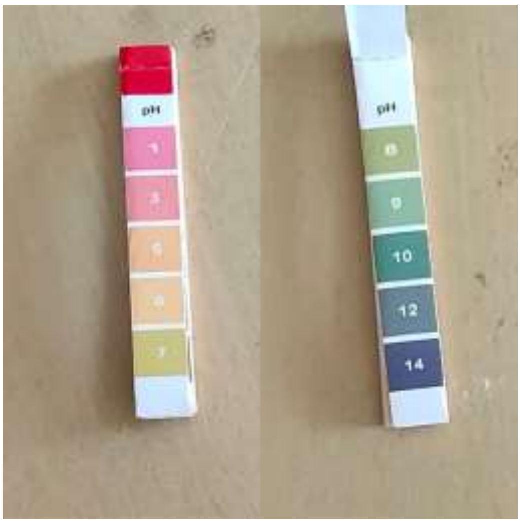

Fig 3.2.1(b): pH paper

3.2.2 Conductivity

Electrical conductivity (EC) is a measure of water's ability to conduct electricity. It is a measure of the concentration of ions, i.e., charged particles, in the water.

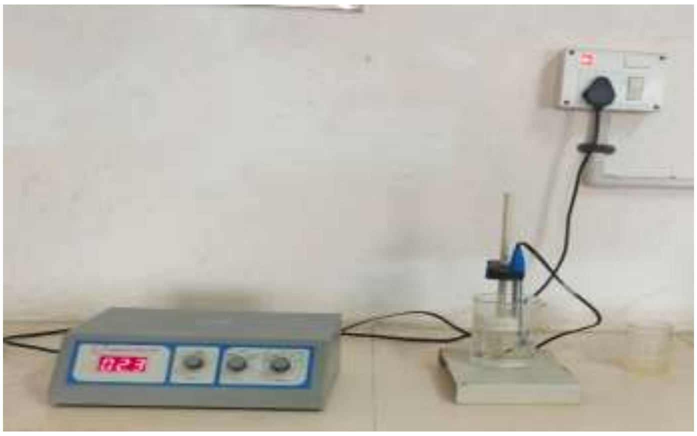

Fig 3.2.2: Conductivity Meter

3.2.3 Total Dissolved Solids

Total dissolved solids (TDS) are an important measure of the quality of water in various contexts. TDS refers to the total amount of inorganic and organic substances dissolved in water, including minerals, salts, and other substances.

Fig 3.2.3: Drying Oven

3.2.4 Total Hardness

The principle behind measuring the total hardness of water is to determine the concentration of calcium and magnesium ions present in the water. Hardness typically expressed in terms of calcium carbonate equivalent (CaCO3) in parts per million (ppm) or milligrams per litre (mg/L).

Fig 3.2.4: Hardness Test

3.2.5 Alkalinity

Alkalinity of water refers to its ability to neutralize acids. It is a measure of the concentration of bicarbonate, carbonate, and hydroxide ions in the water. Alkalinity is typically expressed in terms of calcium carbonate equivalent (CaCO3) in parts per million (ppm) or milligrams per litre (mg/L).

Fig 3.2.5: Alkalinity

3.3 Installation of storm drains

- Plan the layout and design of the stormwater drainage system, including identifying drainage areas, determining pipe sizing and slope, and adhering to regulations.
- Excavate the area where the drain will be installed, dig trenches and create a slope to allow water to flow towards the drainage point.
- Laying the pipes in the trenches, connecting the sections with connectors and fittings.
- Backfilling the Digging and testing the facility for proper function.

Fig 3.3: Installation of storm drains

3.4 Design Considerations of Sedimentation Tank

1. Sedimentation tanks must be appropriately sized to accommodate the flow rate, detention time, and settling velocity of suspended solids.
2. The inlet and outlet should be designed to distribute flow evenly and prevent short-circuiting.
3. The depth of the tank should be optimized for effective settling without excessive compaction of solids.
4. Baffles may be used to control flow and prevent turbulence.
5. The tank should be designed for easy maintenance and sludge removal

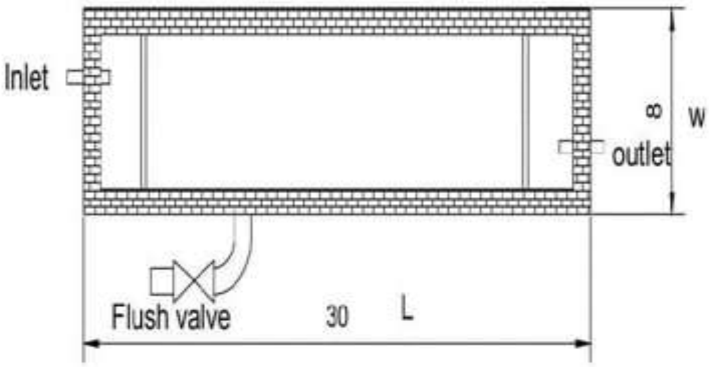

Fig 3.4(a): Design of Sedimentation tank in AutoCAD

Fig 3.4(b): Construction of Sedimentation Tank

4 Results and Discussions

4.1 pH

pH is one of the most important operational water quality parameters, with the required optimum pH often being in the range of 7.0 to 8.5: the maximum allowable limit for pH in drinking water is 8.5 as specified by the WHO pH values in collected water samples varied from 7.51 to 7.67 with an average value of 7.59. This shows that the stormwater quality of some study areas is within the desirable limit. The spatial distribution of PH concentrations is shown in the figure

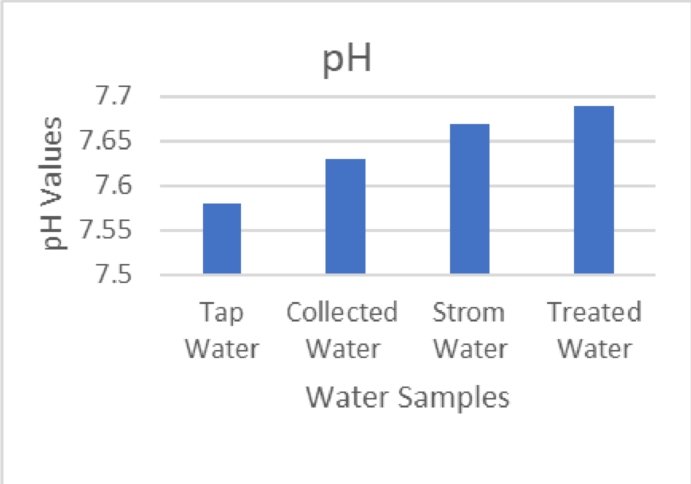

Fig 4.1: Graphical Representation of pH values

4.2 Electrical Conductivity

The Electrical conductivity values at different Ms of collected water samples are shown in below graph.

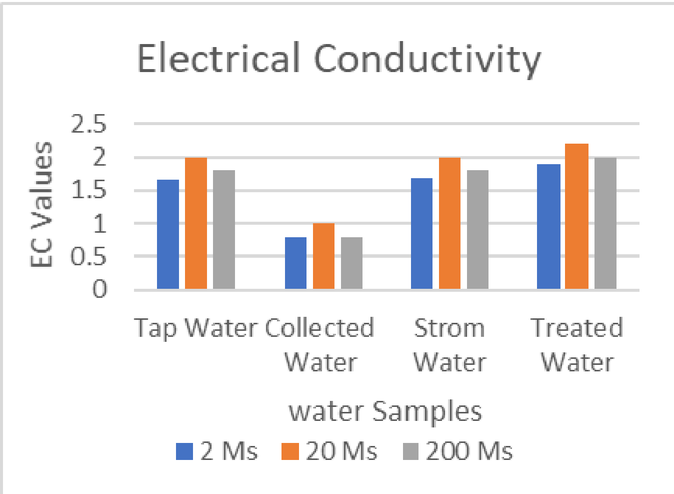

Fig 4.2: Graphical representation of Electrical Conductivity Values

4.3 Total Dissolved Solids

In the collected water samples, the TDS amount ranges from 430 mg/1 to 540 mg/l with an average of 485.4 mg/l. The spatial distribution of TDS concentrations is shown in Figure.

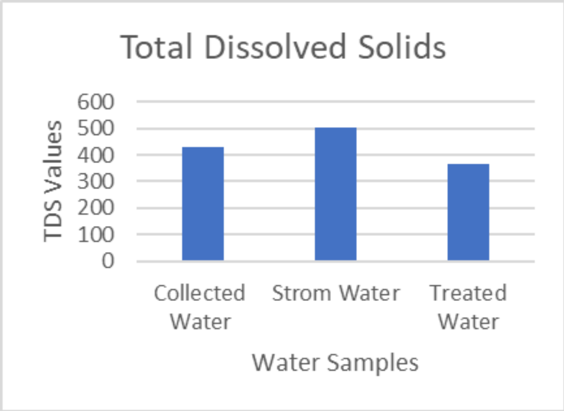

Fig 4.3: Graphical Representation of TDS Values

4.4 Total Hardness

Water with a hardness of less than 75 mg/l is considered soft. A hardness of 75-150 mg/l is safe for most purposes. Minimum total hardness of 140 mg/l and maximum value of 590 mg/l are obtained in collected water samples. The spatial distributions of the TOTAL HARDNESS concentrations are shown in the figure.

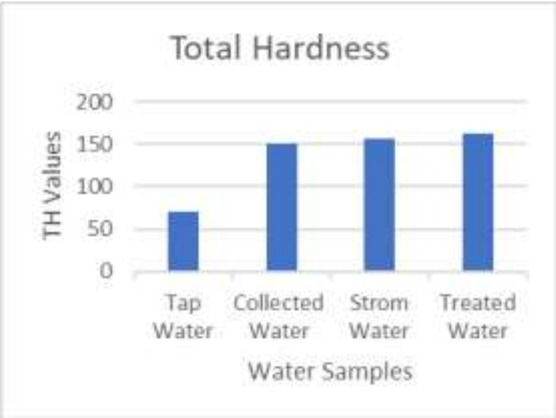

Fig 4.4: Graphical representation of Total Hardness Values

4.5 Alkalinity

Bicarbonate is expressed in mg/l as caco$_3$ and the limit for drinking water is 100 mg/l as caco$_3$. The total bicarbonate in the collected water samples is between 65 mg/l and 124 mg/l. The spatial distribution of the bicarbonate concentrations is shown in the figure.

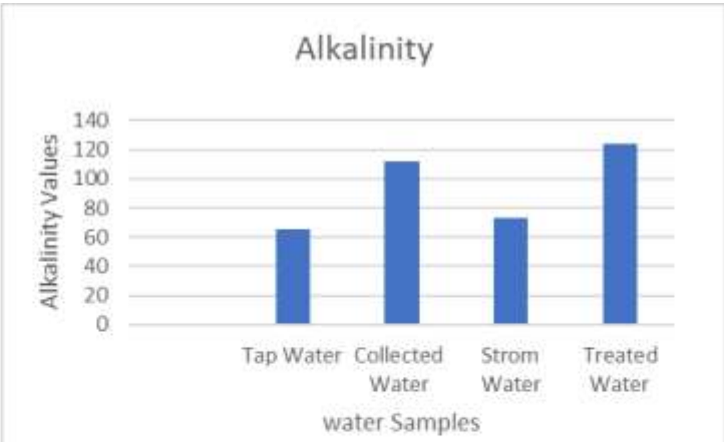

Fig 4.5: Graphical representation of Alkalinity Values

4.6 Turbidity

Turbidity of storm water is that it can have negative impacts on aquatic ecosystems and human health if left untreated. Storm water runoff can pick up pollutants such as sediment, nutrients, metals, and bacteria from various sources such as streets, parking lots, and construction sites. These pollutants can increase the turbidity of the water, making it cloudy and reducing light penetration, which can harm aquatic plants and animals. In collected water samples the turbidity values range from 3.46 to 26.35. The spatial distributions of the TURBIDITY concentrations are shown in the figure.

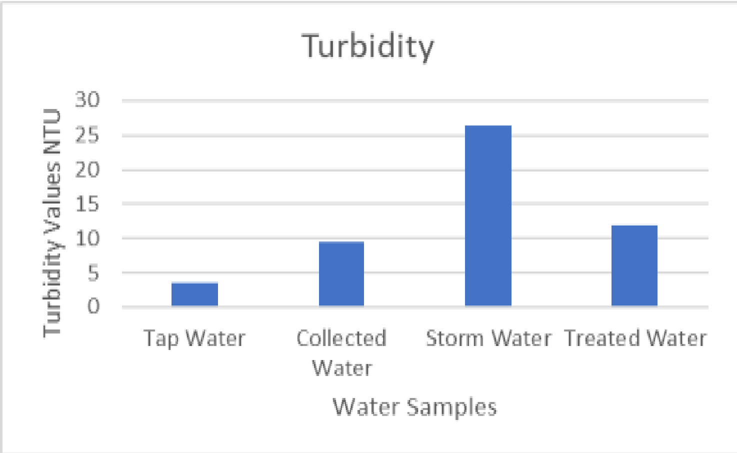

Fig 4.6: Graphical Representation of Turbidity Values

5. Conclusion

In conclusion, the use of drains and sedimentation tanks is an effective method for collecting and treating stormwater runoff. Stormwater runoff can carry pollutants and contaminants that can be harmful to the environment, so it is important to manage it properly.

Drains are designed to capture runoff from impervious surfaces such as roads, sidewalks, and roofs. They direct the water to a sedimentation tank where sediment, debris, and pollutants are allowed to settle to the bottom. The water is then released into a receiving water body or further treated if necessary.

Sedimentation tanks are an important component of the stormwater management system. They allow sediment and pollutants to settle, which reduces the number of pollutants that are discharged into water bodies. Proper maintenance of sedimentation tanks is important to ensure they function effectively.

Overall, the use of drains and sedimentation tanks is an effective way to manage stormwater runoff, reduce pollutants and contaminants, and protect the environment. However, it is important to ensure proper design, installation, and maintenance of these systems to ensure their effectiveness.

Fig 5: Final output of Project

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