STORM WATER MANAGEMENT BY NEW TECHNIQUES

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Abstract - Urbanization and climatic change have adverse effects on the changes of natural hydrological regime, which results in more frequent floods and landslides. Besides the increased quantity of the storm water that drainage channels have to store, negative consequences of urbanization are also evident through increased pollution of runoff stormwater. India has been witnessing devastating floods. Due to lack of drainage systems, the larger cities are more prone to frequent flooding. The drainage system and management should be

adapted to these changes so that the adverse effects of hydrological conditions of runoff and storm water pollution in the urban and developing areas are mitigated. This project aims at presenting challenges and opportunities for the better storm water management practices in these areas. Some of

the storm water management technologies are presented here. Out of these technologies the green roof is more used in urban areas.

Keywords: urbanization, storm water, runoff, new techniques of storm water management, Green roof, constructed wetland.

I. INTRODUCTION

Storm water is an important resource as population and demand for water particularly in arid and drought-prone climates. In recent times, the water scarcity in India has become very critical, affecting thousands of people across India. Most of the water crises are not caused not by natural disasters, but because of mismanagement of water. The term "Storm water management" indicates an approach to the planning, design, implementation, and operation of storm water drainage improvements. resources and bad governance. Stormwater management techniques can make some environments self-sustaining in terms of water. Shahapur taluka shows tremendous growth in size and population but residential and commercial drainage systems are not yet developed. Therefore, Shahapur taluka has been selected to study the different methods of storm water management.

A. Storm water

Storm water is rainwater or liquefy snow that runs off streets, lawns and other sites.It is rainwater and everything which carries in it.It can pick up pollutants and sediments from exposed soil,oil and grease from roadways.If it is not properly maintained then it can lead to erosion,flooding and many other environmental and health issues.

B. Storm water management

Storm water management refers to the control and use of storm water runoff. It consists of planning for runoff, maintaining stormwater systems, and modulating the collection, storage, and movement of stormwater. This also considers drainage in the design of urban areas and housing developments. The objectives of stormwater management include protecting our environment; reducing flooding conditions to protect people and property; supporting healthy streams and rivers; and creating more sustainable communities. Effective stormwater management leads to the environmental, social, and economic benefits to local communities.

C. Storm water management Techniques

i. Green roofs

Green roofs is a system for decentralized management of rainwater falling on buildings having vegetative roofs. It helps to reduce the volume of runoff, delays and reduces peak stormwater runoff flow rates and can reduce pollutants carried to water bodies through the runoff.

ii.Permeable pavements

Permeable pavement surfaces are load-bearing pavement structures made of either a porous material that enables storm water to flow through it or nonporous blocks spaced so that runoff water can pass and infiltrate into the ground. In this system the majority of water to be stored and infiltrated into the sub-grade soil and the excess water flows through an underdrain system. Permeable pavements can remove between 65and 85 percent of undissolved pollutants and up to 95 percent of sediment from runoff.

iii. Bioswales

Bioswales are long, gently sloping, landscaped depressions, linear channels designed to concentrate and convey storm water runoff while removing debris and pollution. When it rains, water runs over pavement and other rigid surfaces, picking up pollutants along the way and goes to storm drains. Bioswales can be implemented in areas that require stormwater management to regulate the runoff velocity and decontaminate the runoff.It is also useful in recharging groundwater.

iv.Bioretention basin

It's a shallow shoveled face depression containing mulch and a set soil blend and planted with especially named native foliage that captures and treats runoff. Bioretention ponds can be veritably effective in removing suspended solids, organic matter and essence through sedimentation.

v. Constructed wetland

Constructed wetland systems use embedded swamp shops and shallow, swamped or impregnated soil to give wastewater treatment. Constructed wetland are artificial wetland that are used for treating organic, inorganic and redundant nutrient pollutants in face water, external wastewater, domestic sewage, refinery backwaters, acid uranium mine drainage or tip leachate. It improves the effectiveness of the processes that help to purify water analogous to naturally being washes.

II. LITERATURE SURVEY

The most suitable technologies identified in the shahapur are green roofs, porous pavements, bioretention basins and bioswales.

1. **Parmar S. and Bhavsar V. et. al. 2017** conclude that storm water can be used to support the Green Infrastructure and recharge the groundwater table.

2. **Pavan Kumar K. and Dilip B. et. al 2015** identified that construction of a new network and Retrofitting of the current network are most suitable.
3. **Shah D. et. al. 2006** found that to change the path of natural drains due to urbanization,it is important to consider the natural topography and proper planning of drainage systems

4. **L. Coffman et. al. 2002** examined that runoff volume, discharge, hydraulic geometry, channel modifications, upstream erosion and sediment loads, decreases in wetted perimeter, instream habitat, and large woody debris are important parameters while designing drainage systems.

5. **Niachou et. al. 2001** analyzed that without the green roof the internal air temperature exceeded 30˚C (86˚F) for 68 percent of the period, but with the green roof this percentage was reduced to 15 percent.

6. **Schmid (2005)** concluded that the presence of “vegetation” established a very constant velocity distribution with depth as water travels through the wetland.

7. **Brattebo and Booth (2003)** studied about the best water quality and to know toxicity and stormwater infiltration and found out the quantity of copper and zinc obtained in the water samples from the conventional asphalt concrete runoff were alarming.
8. **Zhang (2010)** found bioretention had a significant increase in plant and invertebrates

taxa, both of which are used as indicators of aquatic ecosystem health. While microbial action and plant uptake play a role in the treatment process involved in bioretention.

9. **Lauren W., Katherine L., Matthew J.** recognizes the process of purification of water through a bioswale and the effects of this on the environment. This method is beneficial to urban areas, as bioswales can reduce flooding, and the vegetation inside are able to clear water and capture carbon dioxide from the surrounding to reduce its concentration.

III. METHODOLOGY

Out of the total five techniques (green roof, permeable pavement, bioswale, bioretention pond and constructed wetland) green roof has been studied carefully.

A model was made to understand the concept of a green roof having a roof area of 361 cm.If a building similar to this model is erected then how to install this living roof and how much rainwater can be saved is studied.

Fig -1: Model of green roof

A. Layers of green roof

Green roofs consist of various layers and each layer has a different function.

i. Root barrier

To prevent the roof from penetrating in the roofing membrane root barrier is present above the deck layer.Asphalt and bituminous membrane can be used having thickness of 0.8 mm.

ii. Protection layer

Protection layer is placed to prevent the water damage and protect the roof. It is generally made up of hot applied rubberized asphalt. This membrane has a thickness of 0.3 mm.

iii. Insulation Layer

It helps to maintain the heat flux of a building. To reduce the demand for air conditioning in the summer season it is used. It is generally made up of Polyurethane foam. It should be 3mm thick.

iv. Drainage layer

Drainage layer is placed to remove the excess water from the vegetation zone quickly. It consists of a cup-like structure for water storage purpose so that plants can survive in dry weather. It is mostly in HDPE form having a thickness of 6 cm.

v. Filter Fabric

This membrane is placed in between the drainage layer and substrate so that substrate particles do not enter and hence does not make clogging in the drainage layer. It is 2 mm thick membrane made up of geotextile.

vi. Substrate

To provide the nourishment to the plantation this layer is placed which can be a combination of inorganic and organic material.For korean grass carpet substrate needed the thickness of 6 cm.

vii. Vegetation

The uppermost layer in the green roof is vegetation which helps to reduce wind erosion as well as it maintains the temperature.Plant selection in most of the areas are restricted to native variety of grasses. Korean grass carpet is available and suitable in shahapur which may grow up to the height of 2 - 5 cm.

B. Working of green roof system

We have collected rainfall data from the last 10 years from shahapur weather averages website. We found that the average annual rainfall of Shahapur is 2556 mm.

As rain is falls on the green roof ,vegetative layer which is upper layer (e.g.korean carpet) having height about 6-20 cm gets the water to grow the plant and then water passes through the substrate, filter media and then goes towards drainage layer having a cup like structure in which water get accumulates.

When there is heavy rainfall,these drainage boards are fully filled up with the water ,extra water gets spilled out on the surface. Because of this,we need to provide a proper water system to store and reuse the storm water for various purposes.That overflow water spills out on the waterproofing membrane which is generally made up of rubberised asphalt which is situated just below the drainage layer. Water then goes towards the outlet at the roof by providing slope. Outlet is attached to the tank with sufficient capacity by using a pipe system which is situated at ground level,water stores in this tank.But this water is impure and contaminated, hence we have to filter it or purify it by using any type of filter. This purified water gets stored in another water tank and again conveyed to the green roof for watering purposes by using drip or sprinkler irrigation.As it is an extensive type of green roof, a sprinkler irrigation system is used.

In summer days if there is a scarcity of water, we can use this filtered water for various purposes like household,gardening,etc.From this whole working of green roof system, we analyzed that green roof is an effective storm water manage green roof.

Fig -2: Water system of green roof

C. Cost estimation of green roof

For Area = 361 m = 3890 sq. feet, cost estimation is done.

Layers	Cost per sq feet or per Kg (In Rs.)	Total Cost (In Rs.)
Vegetation layer	13	50570
Drainage layer	30	11670
Soil (in Kg)	12	746.88
Root barrier	13.5	52515
Filter layer	19	73910
Protection layer	110	427900
Overall cost		722341.88 ~722350
Labour 10 %		72235
Transportation 5%		36118
Overhead 5%		36118
Total		866821 ~866800

Table -1: Cost estimation of green roof

IV. CONCLUSION

New techniques in stormwater management help to reuse and reduce the stormwater effectively in particular areas. In the case of Shahapur which is a developing area we can install techniques like constructed wetland, bioretention ponds in larger areas, bioswale along roads, permeable pavement in the city and green roofs on commercial or residential buildings so that the natural hydrological cycle will also be maintained.

Green roof technique proved to be a sustainable method to mitigate the impact of rapid urbanization and climate changes in developed and developing areas. Green roof helps to retain stormwater for a longer period of time by reducing the flow rate of runoff. It also helps to reduce air pollution, provide habitats for some insects, increases roof life, and in summer a green roof maintains the temperature of roof surface and surrounding air. In case of poorly insulated buildings, a green roof also can provide energy savings.

Extensive green roofs are most suitable as its weight is less than intensive and it is more economical than intensive green roof because it requires less maintenance cost. Water storage capacity of a green roof depends on the age of the green roof, substrate used and also on the rate of evapo-transpiration. All these factors considered for installing a green roof. After studying the green roof from environmental friendly approach it can be concluded that this technique is good for constructing green spaces in urban areas.

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