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BIORETENTION BASINS REVIEW FOR NEED & FEASIBILTY

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ABSTRACT—Even though the sources of water are limited but the population, economical, industrial and commercial growth in the urban areas is growing exponentially. This gives a stress on the available resources. The wastage of storm water runoff is a potential source which is not effectively utilized. Both the issues can be solved by a single solution through the introduction of Bioretention basins.The Bio retention basins are provided at ground surface to treat the storm water runoff which can either be directed to ground for increasing the water level or can be reused for commercial and industrial applications. This paper gives a glance towards the basic requirements, need, knowledge, design and cost considerations n about Bioretention basin for a layman to understand the concept.
Keyword: Bioretention, Stormwater, Runoff, Pollutants, urban, infiltration, purification.

I. INTRODUCTION

Avoiding the wastage of stormwater runoff and utilizing it has become need of the day for satisfying the needs of the growing demands from the urban areas. The stormwater cannot be utilized directly after the storm precipitation. It will need treatment for removal of pollutants and the sediment load for safe utilization.The pollutant and sediment load is more especially in the urban areas owing to the impervious areas of concrete pavements and buildings. The treatment process should obviously be an onsite treatment facility where the stormwater can be directed for treatment. Bioretention basin can be introduced as the facility for treating the runoff.Bioretention basins use a combination of vegetation, mixed soils-organic and inorganic,sand and gravel to treat the runoff water.This treated water can be reused for domestic,commercial or industrial use depending upon the amount of pollutant removal efficiency or can be further directed to the groundwater for recharging the water table.

II. BIORETENTION BASIN

What is BioRetention basin

Bioretention basin isa shallow landscape feature that captures stormwater runoff and purifies it by applying the biological,chemical and physical process for the treatment and purification and filtration resulting in improving the stormwater quality. The improved stormwater can be reused or passed as groundwater to recharge the water table.

Need for Bioretention Basin

The need for Bioretention basin is the utmost in Urban areas. The urban areas are on a continuous growth in terms of population, industry and commerce, result of which is the increase in construction of infrastructure required to fulfill the growing demands.Urban areas therefore have been subjected to increase in impervious land area which fails to infiltrate the runoff from stormwater. These impermeable land areas include buildings and pavements.The stormwater is thus subjected to more addition of pollutants resulting in the decrease of water quality. These impermeable land areas also stop the stormwater from recharging the groundwater. Water table of the urban areas is very low and hence the availability of potable water resources from the urban areas is almost equal to zero.

Even after the growth in demand for water due to increase in population at the urban areas is continuously growing, the water resources still remain the same thus increasing the burden on present water resources.

Need to purify the Sormwater

The stormwater when entering the atmosphere, is subjected to numerous pollutants; gaseous and solid both.Further pollutants are added when the stormwater flows as runoff from buildings and pavements.This urban stormwater may bring with it the suspended solids, bacteria, metal particles, pesticides and poisonous gases.Before reuse or directing the runoff to groundwater,it will need treatment for removal of undesired content.

Feasibility of Bioretention basins in reuse of stormwater.

Introduction of Bioretention basins can have more than one advantages to urban areas. It will clean the stormwater by removing pollutants and improve its quality. This purified stormwater can be reused for different purposes or can be used to recharge the groundwater. Aesthetics of urban landscape can be improved by using Bioretention basins. It will add greenery to the building environment of the urban landscape.

III LITERATURE REVIEW

Jia Wang, Lloyd H. C. Chua and Peter Shanahan have studied the pollutant removal efficiency of Bioretention basins in Singapore. The authors studied data of purified stormwater from the Bioretention and analysed the factors that can decrease the efficiency of Bioretention basin.The authors concluded that lack of storage capacity in the Bioretention basin resulted in overflow of stormwater without getting infiltrated in the basin.The authors suggested to increase the volume of the bioretention basin.

Jia Liu, David J. Sample, Cameron Bell and Yuntao Guan have reviewed the needs for further research in Bioretention designs. The author have studied the computational models to simulate the design,operation and maintenance of Bioretention basins.The authors have also reviewed the maintenance practices to increase the lifecycle cost of Bioretention basins.

Xiangfei Li , Zengkai Liu , Chengjin Wang , Tong Yu, and Fayi Zhou studied the application of Bioretention basin for countries having cold climate.The authors have studied the design considerations required for a colder climate since the soil can freeze lowering the infiltration rate.The authors also provide a proposed plan to solve the problem faced in implementing Bioretention in colder countries.

Molly Eck analysed the infiltration of Bioretention and stormwater runoff in Chambersburg Borough,

Franklin County, Pennsylvania,USA.The author used softwares to evaluate the runoff and peak discharge quantities.Results showed that between 57% to 99% of runoff water was treated by the Bioretention basin

IV.STRUCTURE AND LAYERS OF BIORETENTION BASIN

A bioretenion basin consists of layers of coarse gravels, coarse sand, fine sand, clay below the ground surface. Above the ground surface, vegetation is placed in the form of small plants or trees depending upon the area of the Bioretention basin.

1.Components above ground surface

a. Grass around the boundary of the Bioretention basin

The grass reduces the velocity of the stormwater flowing in the bioretention basin and stops the suspended particles from the stormwater.

b. Plant or tree at the topmost level – The plants placed at the top layer should be locally available. If the area of Bioretention basin is large enough, trees can be planted. The function of the plant is to remove undesired nutrients from the storm water.

c. Mulch – It is an organic material used to cover the soil which protects it from soil erosion and keeps the temperature of soil cool. It is placed right above the topmost soil layer.

The mulch is available in many types like Bark Mulch, Grass clipping mulch, compost mulch etc.

d. Ponding area – The ponding area is the pool area within which the plants and mulch are situated. This ponding area helps to store the excess water that is directed to the basin. The time the excess water stays in the pond helps to settle some of the particles from the stormwater.

2. Components layers below ground surface

a. Mixed Soil – This soil is prepared by mixing locally available soil with clay. The clay in mixed soil helps in removing pollutants by biochemical process. Clay being an organic soil contains micro-organisms which combine with the components of pollutants by the process of adsorption to purify the stormwater.

b.Sand Bed – To facilitate the passage of water to the layers below.It also blocks the large sized particles from the stormwater

c.Gravel Bed – The gravel bed facilitated the process of aeration to the upper layer of soils and plants to support the purification process.

3.Provision of Underdrain Facility in Bioretention Basin

The underdrain facility is the introduction of perforated pipes at the bottom layer. This facility is provided in case of soils which have low permeability. In case of low permeable soil, the rate of infiltration will become low and water will get stagnated within the bioretenion basin. Hence the underdrain perforated pipe will let pass the stormwater from above layers thus increasing the speed of infiltration.

The underdrain facility has one more additional advantage. The water collected in the underdrain pipes can be reused for commercial purposes with the help of water lifting devices.

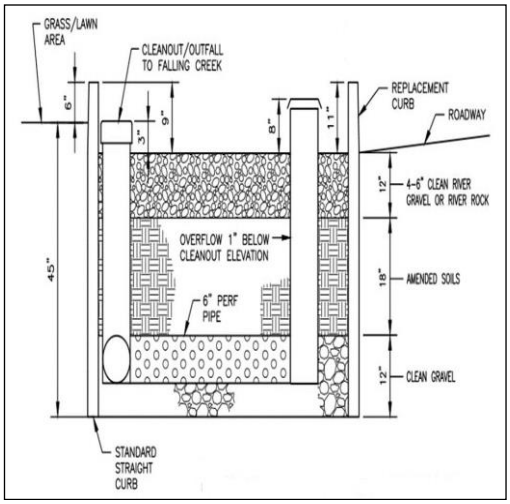

Fig.1 Section of a typical Bioretention Basin[4].

V.DESIRED SITE CONDITIONS

1. The most expected site requirement is the availability of impervious surface area. Parking areas of commercial and industrial parks, public gardens, parking areas of residential society compounds.

Approximately 05% of the impervious area can be dedicated to Bioretention basins. The sides of the basin should be vertical but a maximum side slope of 05% is allowable.

b. The head of water from topmost layer to the bottom layer must be minimum 150 cms i.e minimum total depth of a Bioretention basin must be 150 cms for effective purification.

c. The difference between the natural water table and bottom layer of Bioretention basin should be minimum 90 cms.

d. Depth of ponding area should be between 7.5 cms to 15 cms.

VI.COST CONSIDERATIONS

1. Cost of excavation – This cost will depend on the type of soil, depth and area of the area to be excavated.
2. The minimal cost of plants, grass strips around the basin.
3. Cost of sand, gravel and blending of locally available soil with clay.
4. Cost of impervious lining to the sides of the basin throughout its depth.5
5. Cost of perforated pipes to be used as underdrains.

VII.CONCLUSION

Bioretention basins are a hopeful concept towards the optimal utilization of naturally available storm water as a resource. Bioretention basins can treat stormwater and remove all its pollutants making it suitable for domestic, commercial and industrial applications reducing the load on present water resources. The governing authorities can play an important role in initiating the practice of Bioretention basins.

VI.FUTURE SCOPE

The Government authorities can initiate the use of Bioretention by making provision within the premises of residential, commercial and industrial complexes. Further research work in the Bioretention basins can be carried out by collaborating with Geotechnical professionals and data of rainfall from irrigation departments.

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