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Water Harvesting using Permeable Pavement for Guwahati city

Chandan Kumar Das¹, Dr. Mimi Das Saikia²

M. Tech (Student) Civil Engineering (Water & Soil) Assam Dawn Town University, Assam, India¹

Professor, Civil Engineering, Faculty of Engineering and Technology, Assam Dawn Town University, Assam, India²

ABSTRACT: The traditional method to overcome from rain water is to drain the water to a free area and harvesting the water for future uses. To manage the rainwater, infiltration and recharge the ground water and harvesting is the long run practice in the water engineering field. As population increases, the impermeable surface increases—the asphalt roads, concrete sidewalks, parking lots, building roofs, and areas of highly compacted soils prevents the rain water for percolations, result artificial flood and lower the quality of water at ground. If it is not managed in a proper way, the nearby water bodies also will be affected by this water produced from impermeable surface. Another good method is to adopt permeable pavement system to percolate storm water directly to the ground or can collect them for future use in dry season. It can solve both ground water recharge problem and water harvesting. Also, it can reduce somehow the flooding in the urban areas. However, some advantages there for permeable pavement, like it can be used only in light traffic area, as the strength of these pavement is limited to light vehicles only.

KEYWORDS: Permeable pavement, drainage of storm water, storage in underground tank, Construction, distribution. Etc.

I. INTRODUCTION

The Permeable pavement is made of either porous asphalt or permeable concrete or permeable concrete block. Both the material can pass the water through the air voids to the drainage layer and through permeable textile. Permeable pavement is to be design such a way that thicker than traditionally constructed pavement as to maintain the traffic load capacity. Permeable asphalt consists of asphalt binder and coarse stone aggregate, with a little fine aggregate. These have enough void space (normally designed for up to 30% voids) to allow speedy percolation of water and look like exposed aggregate concrete. Permeable pavement is economic and environmental friendly system.

II. RELATED WORK

The water quality of storm water harvested and stored using permeable pavements is an important consideration, particularly for fit-for-purpose reuse. Pratt et al. (1995) investigated water quality at the outlet of a permeable pavement located in Nottingham, UK, with four separate types of basecourse aggregate including blast-furnace slag, granite, limestone and an unidentified type of gravel. Steve Crossland is the Technical & Specifications Manager (Masonry) at Firth and has 17 years experience in masonry with a special interest in the manufacture, specification, research, design and construction, of pervious paving (since 2002) and pervious concrete (since 2009) systems. The urban drainage system is responsible for directing and controlling storm water runoff, dispelling it from its generation, just transferring the runoff from one point to another downstream basin, acting on the effect and not the cause of increased runoff, which is the increase on impervious surfaces (Paulo [4]). Other aspects can also be incorporated into paving related with sustainability, as such water reuse (Pratt [9], Imran et al. [10]), water reuse for energy saving purposes (Sañudo-Fontaneda et al. [11]), temperature decreasing (Asaeda and Ca[12], Smith [13] and Sarat and Eusuf [14]) the

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combination with photocatalytic cement based pavements in order to reduce air pollutants (de Melo et al. [15]) and improve water quality (Tota-Maharaj and Scholz [16]).

III. CONSTRUCTION

Construction of Permeable pavement can be done by using pervious concrete, paving stones, porous asphalt or concrete or plastic-based pavers. However, it is considered as porous solid for construction because it is readily available throughout time. Comprehensive concrete is a special type of concrete with high porosity used for concrete floorwork applications, which allows water to pass through rain and other sources directly. Large concrete is made using a large concrete with very little consolidation. Concrete paste then connects the aggregate and allows the water to pass through the concrete slab. The porous concrete is a unique and innovative medium to manage the water. In widespread concrete, carefully controlled quantity of water and cementitious material is used to make paste, which makes a thick coating around the total particles. A broad concrete mix has very little or no sand, which creates enough zero material. Using a sufficient paste to coat and bind the total particles becomes a system of highly permeable, interconnected voids that quickly emerge. Generally, 15% to 30% of the sound is obtained in harsh concrete, and the flow rate for water is generally about 480 inches / hour (0.34 cm / s, which is 5 gallons / feet² / minute or through a wide concrete) 200 L / m² / min), although they can be very high.

IV. ABOUT STUDY AREA, GUWAHATI

Guwahati is located in the coordination of 26.14450 N, 91.7360 E, along the southern edge of the Brahmaputra river and the foothills of the Shillong plateau, along with the LGB International Airport in the west, and formerly in the midst of the Narengi city, Guwahati (Sanskrit word meaning Sanskrit Prakash is the city), was the capital of the ancient state of Kamrup. A metropolitan, Guwahati is the largest city of Assam in India and ancient urban areas in northeast India. The average annual temperature is 22.20 Celsius, which was recorded at 2.00C on April 24, 2014, which was recorded on January 1964 and had been recorded as annual average rainfall of 2,054. The total area of the city is 328 km².

V. WATER SCARCITY IN GUWAHATI

As, large range of increasing the pavement and concrete surface in city area, the water infiltration reduces and hence the runoff water make artificial flood occurs within a few hours. The increasing of paved roads consequently decreases the area of pervious soil, due to which the ground water table is affected.

VI. ESTIMATION OF PERMEABLE PAVEMENT APPLICATION IN GUWAHATI CITY

A brief review has been presented about the precipitation data in Guwahati city in Table No. 1. (As per the India Meteorological Department).

Table No. 1: Precipitation data in Guwahati city

| Sl. No. | Month | Average precipitation (in mm) |
|---------|-----------|-------------------------------|
| 1 | January | 8 |
| 2 | February | 21 |
| 3 | March | 47 |
| 4 | April | 181 |
| 5 | May | 226 |
| 6 | June | 309 |
| 7 | July | 377 |
| 8 | August | 227 |
| 9 | September | 199 |

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| | | |
|----|----------|----|
| 10 | October | 92 |
| 11 | November | 25 |
| 12 | December | 10 |

On the basis of above data, the annual average rainfall in Guwahati is 1698 mm.

If we consider an area of permeable pavement road 1Km in length of width 5.50m then-

Area covered = 1000.00m x 5.50m = 5,500.00 m²

As, 1mm of Rain = 1.0 L / m²

There for receive rain water in 1 km area = 1698 L / m² x 5500 m²

$$= 93,39,000 \text{ L}$$

As permeable pavement allows to percolate maximum 30% water, therefore water can save

$$= 93,39,000 \times 0.3 = 28,01,700.00 \text{ Litre.}$$

There for we may consider 5% wastage and net water collected from storm water

$$= 28,01,700.00 - 28,01,700.00 \times .05$$

$$= 26,61,615.00 \text{ Litre}$$

$$\text{Approx.} = 26,00,000 \text{ Litre per Km}$$

As per IS: 1172-1993, under normal conditions, the domestic consumption of water in urban area in India is about average 85 litres/day/capita.

For the city like Guwahati the selected area like Anil Nagar, Nabin Nagar, Lachit Nagar etc. the no. of population average 250 in each Km. (calculating by considering population 4400 per Km²).

Total water required per day = 250 x 85 = 21,250 Litre per day

Therefore, water can be use = 26,00,000 / 21,250 = 122 days. / 30 = approx. 4 months, i.e. in dry weather in Guwahati from November to February.

From the above calculation it is seen that the project is feasible for water harvesting and can be relief from flash flood in such area under proper management and arrangement.

Advantages of Permeable Pavement:

1. Runoff Management: - They are effective in management of runoff from the fixed surfaces, thus providing local flood control. The large amount of urban runoff causes serious degradation and disturbances in surface water bodies.
2. Pollutants Control: - Most of the pollutants, such as oils and other hydrocarbon fluids, are found on the surface of the traditional pavement, and can be transported directly into the rivers and streams of storm water flow. By taking the rain and allowing it to dissolve in soil and soil, you can treat polluted water naturally.
3. Ground water recharge: - With using the permeable pavement, the water percolate to the ground and which improve the quality of ground water.
4. Reduction in cost: - In compering to the traditional pavement system, the construction cost is quite less in permeable pavement as no heavy machinery required for construction of permeable pavement.

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Disadvantages of Permeable pavement:

1. Traffic: Permeable Pavement are not ideal for high traffic / high speed areas as it has less load-bearing capability than conventional pavement. Nor should it be used on storm water "hotspot" with high pollutant load, because pre-treatment of storm water before intrusion cannot be done. Poor performance on sloped land: If yard slopes at a twenty-percent or higher, the effectiveness of permeable pavers is dramatically reduced.
2. Minor maintenance: Not more than traditional pavers, in fact, but it is worth mentioning that permeable pavers should be maintained once every few months. Depending on this type and location, widespread, or even vacuum may be required.
3. Higher price per-installation: While permeable pavers are likely to save money (and disappointment) in the long run, it is important to note that they are slightly more expensive in the initial establishment.

VII. CONCLUSION

Permeable pavement is not so complex and easy to set up. They give many advantages over traditional footpaths, some of which are very important as groundwater recharge and storm water management. However, they also have some disadvantages. They cannot serve the same tasks as traditional sidewalks, as they cannot be operated under heavy vehicles and should be more careful and cautious. There is also a physical need in the city like Guwahati, so such a different technique can be adopted for harvesting of water.

Permeable pavement systems are changing the way of human development with natural environment. Its application for highways, road shoulders, parking spaces and airport runways in India is all about improvement in water quality, water quality and safety.

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