

Research on Permeable Pavement

A Case Study of Sitapura Institutional Area, Jaipur

Mukul Nama, Akshay Galav,
Amit Sharma, Jitendra Singh, Kapil Asoriya
Department of Civil Engineering
Poornima Group of Institutions

Abstract- Porous pavement or permeable roadway is an engineered landmark surface that passes water to flow through it. Main difference between permeable pavement and traditional pavement is permeability and converts most rainfall to runoff. Permeable pavestone is an assortment of sustainable materials and technique for permeable pavements with a base and sub base that permit the progress of storm water through the surface. In addition to reducing runoff, this effectively traps suspended solids and filter pollutants from the storm water. Example consist of roads, paths, lawns and lots that are subject to light vehicular transfer, such as car/parking lots, cycle-paths, service or emergency access lanes, road and airport shoulders, and residential sidewalks and driveways. Although a number of permeable paving resources appear nearly indistinguishable from nonporous resources, their environmental property are qualitatively different. Whether pervious concrete, porous asphalt, paving stones or concrete or plastic based pavers, every these pervious materials permit storm water to percolate and infiltrate the outside areas, conventionally impervious to the soil lower. The aim is to control storm water at the source, decrease runoff and get better water advantage by filtering pollutants in the substrata layers.

Keyword:- Permeable Pavement, porous pavement, Grass

I. INTRODUCTION

Transportation is one of the key element of human society for development and growth of living standard. In this scenario, Road network becomes necessary for human life for better convenience. But natural disaster like storm water reduces the durability and strength of pavement which directly affects human society. Therefore porous pavement came into reality for augmentation of better durability and greater strength of pavement and it get better the society road transportation network. [1] Porous pavements are quite successful in civil colonies and apartment where atmospheric exposure is high. Porous pavement helps us also restoring of storm water in our storage for further waste water application. Permeable pavement can be based on: permeable asphalt and concrete surfaces, concrete pavers (permeable interlocking concrete paving systems - PICP), or polymer-based grass pavers, grids and geo-cells. Porous pavements and concrete pavers (actually the voids in the middle of them) allow storm-water to drain through a stone bottom sheet for on-site infiltration and filtering. These provide grass reinforcement, soil stabilization and gravel preservation. The 3Dstructure

reinforces infill and transfers vertical loads from the surface, distribute them over a wider region. Thus porous pavement reduces the impact of natural disaster and enhances the quality of transportation network.

II. AREA OF STUDY

Jaipur is old heritage city in India which are fighting with natural disasters like storm water and its discharge in civil colonies and nearby villages where no heavy vehicles are available. Institutional area of Sitapura, Jaipur comes under this category. We research about the weather condition and the types of soil and suitability of pavement for better transportation.[2] We found that porous pavement will help in enhancement of durability and better improvement in road transportation of proposed area.



Figure 1. Study Area (Source: Google Maps)

III. ANALYSIS

In this research, we analyzed about the soil classification and weather exposure in institutional area of Sitapura, Jaipur. Analysis during research work is as following:

A. Soil Analysis of Proposed Area

Jaipur district is characterized by wide range of landscapes including hillocks, pediments, undulating fluvial plains, Aeolian dune fields, ravines, Palaeo channel etc. Structural hills (mostly in northern and northeastern parts)

trending NNE-SSW are generally composed of Delhi quartzite.

TABLE 1: AGGREGATE ANALYSIS

| Place | Soil Type | Bearing Capacity | CBR Value |
|--|--|------------------|-----------|
| Institutional area nearby Poornima College | Fine-grained soils in which silt and clay-size particles predominate | Low | 2.15 |

TABLE 2: ANALYSIS OF PROPERTIES OF AGGREGATES

| S.N. | Test | Result | Quality |
|------|--|--------|---------|
| 1 | Crushing Test | 19.5% | Good |
| 2 | Impact Test | 20.29% | Good |
| 3 | Abrasion Test(by Los angles testing machine) | 27.08% | Good |
| 4 | Flakiness Test | 12.44% | Good |
| 5 | Elongation Test | 9.09% | Good |

B. Rainfall data in Sitapura institutional area

The semi-arid district receives standard yearly rainfall of 527mm (1901-71) while normal annual precipitation for the previous 30 years (1977-2006) is 565mm. yearly normal rainfall during the age 2001 to 2010 has be 527mm (Table 3). Over 90% of whole yearly rainfall is recognized during monsoon. Total annual latent evapotranspiration is 1744.7mm. The coefficient of difference is modest at 32.6% indicating slightly unreliable pattern of rainfall. Though, Jaipur city has knowledgeable floods in 1981, the district is prone to drought spells as witnessed during 1984 to 1989 and 1999 to 2002[4].

IV. METHODOLOGY

Method of construction techniques is similar to IRC (Indian Road Congress) and also with Indian Standard. But it may vary according to the type of soil and weather exposure of that place. For construction pedestrian areas and driveways need 80mm blocks lay on a 50mm laying path. This is laid on a 200mm sub-base with a geo-textile membrane separating the sub-base from the ground. In sub-base 40mm aggregates and in open graded base 20mm aggregates are used. In laying surface, 10mm aggregate are used for fine surface. Thickness of open base is 80mm during construction. This design is suitable for cars and light vans.

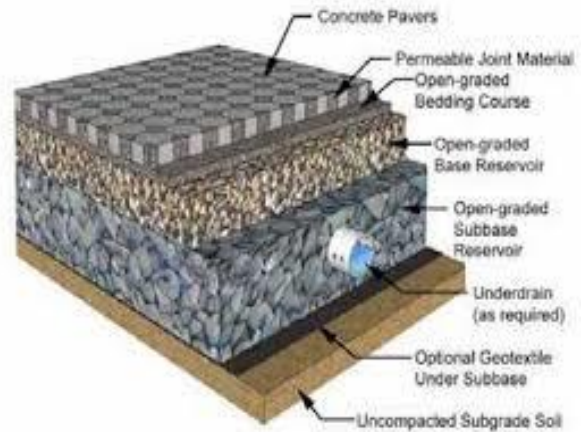


Fig 1: Structure diagram of pavement displaying different layers

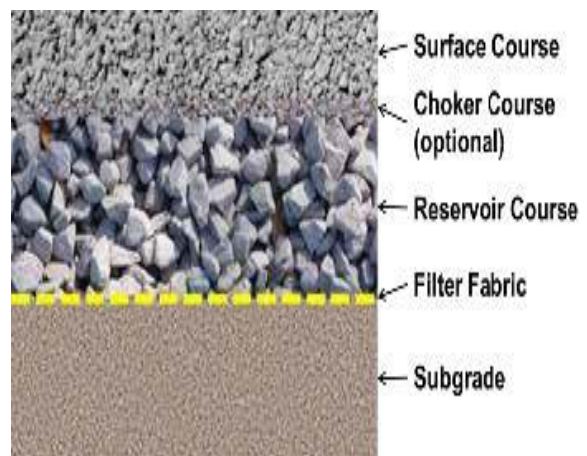


Fig 2: Structure diagram of analysis of strata

V. RESULT AND DISCUSSION

In this research, we got information about the strength and durability of porous pavement by following significance of the aggregate. As per our analysis, life span of permeable pavement is approx. about 8-10 years and permeability of pavement increases the durability of road pavement. In new sub-urban growth, permeable pavements guard watersheds. In presented developed areas and towns, redevelopment and renovation are opportunities to apply storm-water organization practice. Permeable paving is an important component in Low Impact Development (LID). The infiltration ability of the local soil is a input plan consideration for determining the depth of base rock for storm-water storage or for whether an below exhaust system is required.

Table 1. Rainfall Data of Jaipur District

| S. No | BLOCK | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | Average |
|-------|---------------|--------|--------|---------|---------|--------|--------|--------|---------|--------|---------|---------|
| 1 | AMER | 432.00 | 235.00 | 679.00 | 790.00 | 470.00 | 354.00 | 529.00 | 547.00 | 277.00 | 729.00 | 504.20 |
| 2 | BASSI | 401.00 | 201.00 | 647.00 | 590.00 | 634.00 | 293.00 | 487.00 | 578.00 | 344.80 | 933.00 | 510.88 |
| 3 | DUDU | 403.95 | 152.40 | 409.05 | 467.40 | 313.10 | 311.15 | 341.90 | 634.30 | 258.55 | 716.30 | 400.81 |
| 4 | GOVINDGARH | 503.80 | 214.00 | 581.00 | 296.00 | 306.00 | 209.00 | 323.00 | 424.00 | 268.00 | 735.00 | 385.98 |
| 5 | JANWAR AMGARH | 373.00 | 341.00 | 1066.00 | 1061.00 | 980.00 | 460.00 | 673.50 | 1160.00 | 572.00 | 1042.00 | 772.85 |
| 6 | JHOTWARA | 426.80 | 222.40 | 511.00 | 807.00 | 408.60 | 335.00 | 521.00 | 572.00 | 306.00 | 653.00 | 476.28 |
| 7 | KOTPUTLI | 407.60 | 273.67 | 906.73 | 591.37 | 916.67 | 576.00 | 608.10 | 928.00 | 278.00 | 711.67 | 619.78 |
| 8 | PHAGI | 429.30 | 202.00 | 531.80 | 525.25 | 524.20 | 351.30 | 568.75 | 634.70 | 376.50 | 869.00 | 501.28 |
| 9 | SAMBHAR | 519.10 | 141.50 | 518.45 | 501.05 | 464.85 | 310.90 | 367.60 | 631.20 | 232.05 | 800.75 | 448.75 |
| 10 | SANGANER | 585.00 | 237.00 | 552.30 | 805.00 | 397.00 | 407.00 | 557.30 | 572.00 | 275.00 | 745.00 | 513.26 |
| 11 | VIRATNAGAR | 628.50 | 262.00 | 1065.00 | 489.50 | 976.00 | 465.50 | 454.00 | 969.50 | 344.00 | 922.00 | 657.60 |
| 12 | Average | 464.55 | 225.63 | 678.85 | 629.42 | 580.95 | 370.26 | 493.74 | 695.52 | 321.08 | 805.16 | 526.52 |

We establish a relation of discharge of storm water through the upper surface of pavement and finally collect it by the help of discharge pipe. As per analysis, 10 m³/sec discharge of storm water is passing through the permeable pavement, We collect the discharge through drainage pipe for further application the storm water for irrigation purpose which helps us to recover the cost of maintenance and also get some advantage in conditions of inexpensive factor. Pollutants are captured during infiltration, reducing contaminant weight to narrow waterways. Infiltrated overflow recharges groundwater supplies, improves run in streams, and reduces the need for landscaping irrigation. Permeable paving surfaces have been demonstrated as effective in managing runoff from paved surfaces. Large volumes of storm water in urban area, causes serious erosion and siltation in surface water bodies. Therefore, permeable pavement may be good option for flood control and also improve the qualities of transportation network in civil colonies.

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