Management of storm water drainage in Chandigarh

Lakhwinder Singh, S.K Singh

1Water Resource Engineering Department, PEC, Chandigarh, erballakhwinder@gmail.com
2Professor, Department of Civil Engineering, PEC, Chandigarh, sksingh@pec.ac.in

Abstract: Storm water management involves the control of runoff from precipitation. Due to developmental activities impervious surface is increasing which prevent the infiltration of rainfall into soil. Hence, volume and rate of runoff both substantially are increasing. Pervious concrete pavements has potential to reduce runoff effectively by allowing water from precipitation through it and temporary storing storm water and releasing it slowly to ground after storm subsides. Pervious concrete pavements are traditionally used in parking areas, areas with light traffic, residential streets and pedestrian walkways. Chandigarh is rapidly growing city and in last decade (2001 to 2011), its population growth rate was 17.19 % and its population density was 9262/km² and average annual rainfall is 1110.7 mm. So more runoff is generated and existing storm water drains in Chandigarh in some areas, are not sufficient due to rapidly increasing paved area. Storm water drains are not capable in draining storm water so ponding occurs in various places. Pervious concrete pavement could be an alternative to manage storm water in Chandigarh. Pervious concrete pavements design depends upon native soil properties such as infiltration capacity and other properties also. For management of storm water, five sectors of Chandigarh were selected viz. 12, 34, 26, 17 and 14. Areas were calculated for selected sectors where pervious concrete can be provided e.g. Parking areas. As pervious concrete is to be used for parking areas it should be of strength range 15 to 20 MPa which is achieved by design mix prepared. Compressive strength and permeability for design mix pervious concrete were found to be 19.33 MPa and $0.89 \times 10^{-3}$ cm/sec, respectively. A model was fabricated to find out hydraulic response of pervious concrete pavement for different intensities applied for different durations. Pervious concrete pavement effectively managed rain events and could be able to store more than 42.16 % of rainfall and release it slowly from the pavement structure. Volume discharged from pervious concrete pavement ranged 42.16 % to 88 %. Runoff generated in selected areas was calculated before and after providing pervious concrete. It was seen that there was a decrease in runoff by 7.54 % to 15.30 % when pervious concrete provided. For the design of pervious concrete pavements stone reservoir depths were found to be 448.7 mm, 450 mm, 441 mm, 443 mm and 446 mm for sector 12, 34, 26, 17 and 14, respectively.

Key words: Storm water management, Pervious concrete pavements, Infiltration capacity, Permeability

I. INTRODUCTION

Storm water is rain, melted snow or any other form of precipitation that has come into contact with the ground or any other surface. This water seeps into the ground, is absorbed by vegetation, evaporates or flows over land or impervious surfaces contributing to the storm water runoff. The addition of roads, driveways, parking lots, rooftops and other surfaces that prevent water from soaking into the ground, greatly increase the runoff volume created during storms. The runoff from a drainage area/ watershed/ catchment i.e the area of land contributes runoff generated from a precipitation event to a single outlet point from where it is usually carried to a river, lake, reservoir, wetland or ocean.

Storm water management involves the control of the surface runoff. The volume and rate of runoff both substantially increase as land development occurs. Construction of impervious surfaces, such as roofs, parking lots, and roadways and the installation of storm sewer pipes which efficiently collect and discharge runoff, prevent the infiltration of rainfall into the soil. Management of storm water runoff is necessary to compensate for possible impacts of impervious surfaces such as decreased groundwater recharge, increased frequency of flooding, stream channel instability, concentration of flow on adjacent properties, and damage to transportation and utility infrastructure.
The management of storm water runoff is the main factor in the potential effectiveness of Sustainable urban drainage system (SuDS). Thus SuDS are designed to deal with runoff at source (i.e. close to the area where rain falls), and therefore the management technique can be defined as source control as it stores water temporarily close to the source in order to reduce the runoff volume during rainstorms. In addition, SuDS also cover further method control such as site control, regional control; this concept known as “SuDS management train” which uses drainage techniques in series to achieve:

- Flow rate reduction;
- Volume reduction;
- Pollution reduction.

Pervious pavements are one of the control structure of sustainable urban drainage systems capable of greatly improving storm water management (Castro-Fresno et al.2005; Freni et al. .2010). These devices allow rainwater to infiltrate through the surface into a storage layer. Therefore, pervious pavements reduce the volume and rate of runoff formation and risk of urban flooding (Couple et al. 2006). However, the same time, pervious pavements improve urban water quality by reducing the environmental effects of pollution in runoff: through reducing the drag of materials on the streets or erosion problems and decreasing non-point source pollution which deteriorates the quality of urban runoff (Brattebo et al. 2003; Gilbert etal. 2006). Thus, these techniques help in urban storm-water management by solving problems related to rainwater quantity and quality and offer an aesthetic and environment friendly solution (Rushton 2001; Coupe et al. 2006; Scholz et al. 2007). Alsubih et al (2017) research involved the construction of a one metre square surface area of permeable pavement and a laboratory rainfall simulator to investigate the influence of rainfall intensity on the hydrologic response of permeable pavements. The design of the permeable pavement complied with the SuDS Manual guidance and British Standards (BS 7533-13:2009). The laboratory test programme was designed to investigate the influence of rainfall intensity on the hydrologic response of permeable pavements. The results demonstrate that the hydrologic performance varied according to rainfall intensity. The total volume of discharge from the permeable pavement ranged between 8% to 60% of the inflow. More than 40% of the total rainfall from all rain events was temporarily detained within the structure. Permeable pavement design optimization has therefore been tested in the study. The SuDS Manual guidance has been found to meet current optimization requirements.

Pervious concrete pavements designed to store temporarily rain water which depends upon stone reservoir of pervious pavements. The stone reservoir must be designed to meet both runoff storage and structural support requirements. Clean washed stone is recommended as any fines in the aggregate material will migrate to the bottom and may prematurely clog the native soil (Smith, 2006). The bottom of the reservoir should be flat so that runoff will be able to infiltrate evenly through the entire surface. If the system is not designed for infiltration, the bottom should be sloped at 1 to 5% toward the under drain. A permeable pavement design can feature connection of a roof downspout directly to the stone reservoir of the permeable pavement system, which is sized to store runoff from both the pavement surface and the roof drainage area.

The following calculation is used to size the stone storage bed (reservoir) used as a base course for designs without under drains. It is assumed that the footprint of the stone bed will be equal to the footprint of the pavement. The following equations are taken from the ICPI Manual (Smith, 2006).

The equation for the depth of the stone bed is as follows:

$$d_b = \frac{(Q_c \times R + P \times I \times T)}{V_r}$$  
………………………………Eqn. 2.1

Where:  
- $d_b$ = Stone bed depth (m)
- $Q_c$ = Depth of runoff from contributing drainage area, not including permeable paving surface (m)
- $R = \frac{A_c}{A_P}$ = Ratio of contributing drainage area ($A_c$) to permeable paving area ($A_P$)
- $P$ = Rainfall depth (m)
- $I$ = Infiltration rate for native soils (m/day)
- $T$ = Time to fill stone bed (typically 2 hr)
- $V_r$ = Void ratio for stone bed (typically 0.4 for 50 mm dia. stone)

Note that the contributing drainage area ($A_c$) should not contain pervious areas.
For designs that include an under drain, the maximum depth of the stone reservoir below the invert of the under drain pipe can be calculated as follows:

\[ d_{\text{max}} = \frac{[I * t_s]}{V_R} \]  

Eqn. 2.2

Where:  

- \( d_{\text{max}} \) = Maximum stone reservoir depth (m)
- \( I \) = Infiltration rate for native soils (m/hr)
- \( V_R \) = Void space ratio for aggregate used (typically 0.4 for 50 mm clear stone)
- \( t_s \) = Time to drain (design for 48 hour time to drain is recommended)

The value for native soil infiltration rate (I) used in the above equations should be the design infiltration rate that incorporates a safety correction factor based on the ratio of the mean value at the proposed bottom elevation of the practice to the mean value in the least permeable soil horizon within 1.5 metres of the proposed bottom elevation. On highly permeable soils (e.g., infiltration rate of 45 mm/hr or greater), a maximum stone reservoir depth of 2 metres is recommended to prevent soil compaction and loss of permeability from the mass of overlying stone and stored water.

\[ q_u = k * m \]  

Eqn no. 2.3

Where:

- \( q_u \) = Outflow through the underdrain (per outlet pipe, assumed 0.15 m diameter) (m/day)
- \( k \) = Hydraulic conductivity for the reservoir layer (m/day – assume 30 m/day)
- \( m \) = Underdrain pipe slope (m./m.)

Equation no. 2.3 can be used to approximate the outflow rate from the underdrain. The hydraulic conductivity, \( k \), of gravel media is very high (~ 5200 m/day). However, the permeable pavement reservoir layer will drain increasingly slower as the storage volume decreases (i.e. the hydraulic head decreases). To account for this change, a conservative permeability coefficient of 30 m/day can be used to approximate the average underdrain outflow rate.

\[ d_b = \frac{(Q_c * R) + P \left( \frac{I}{2} * T \right) - (q_u * T)}{V_r} \]  

Eqn no. 2.4

Once the outflow rate through the underdrain has been approximated, Equation 2.4 is used to determine the depth of the reservoir layer needed to store the design storm.

Where:

Where:  

- \( d_b \) = Stone bed depth (m)
- \( Q_c \) = Depth of runoff from contributing drainage area, not including permeable paving surface (m)
- \( R \) = \( A_c / A_p \) = Ratio of contributing drainage area (\( A_c \)) to permeable paving area (\( A_p \))
- \( P \) = Rainfall depth (m)
- \( I \) = Infiltration rate for native soils (m/day)
- \( T \) = Time to fill stone bed (typically 2 hr)
- \( V_R \) = Void ratio for stone bed (typically 0.4 for 50 mm dia. stone)
- \( q_u \) = Outflow through Underdrain (m/hr)
The maximum allowable depth of the reservoir layer is constrained by the maximum allowable drain time, which is calculated using Equation 2.5.

Where: \( d_{\text{max}} \) = Maximum stone reservoir depth (m)

\[ d_{\text{max}} = \frac{\left(\frac{l}{2} + t_s\right)^2 + q_s^2 + t_s^2}{V_a} \]

II. STUDY AREA

Chandigarh city is divided in different sectors which having dimensions approximately equal to 0.8 x 1.2 km². Some of the sectors are having big market and some having educational so from all sectors five are selected for study purpose. For this study selected sectors are 12, 34, 26, 17 and 14 sectors because these sectors are more prone to flooding. Sectors 12 have mostly institutional area such as PGIMER and Punjab Engineering College Chandigarh. Because of large parking area of PGIMER ponding is taking place at different locations due to more impervious area. Sector 17 is heart of Chandigarh. This sector has main buildings, shops, ISBT Chandigarh, Court Complex etc. Due to large impervious area ponding problems are occurring in this sector. Sector 34 is crowded area as this sector having lot of market, institutes, hotels and city center so a big area for parking and footpaths. Sector 26, the study area, is located in the south east of the city of Chandigarh. The sector has institutional area and grain market of Chandigarh and this sector has less residential area. Sector 14 has only Punjab University and in university ponding problem is found generally near library, hostel parking and other places also. For this study data about drainage system, land-use pattern, existing drains network, footpaths area, parking area and rainfall data has been studied for these sectors for management of storm water drainage in these sectors.

III. METHODOLOGY

For management of storm water drainage in Chandigarh areas has been selected where flooding frequently occur and study of layout of storm water drainage system in Chandigarh of these selected areas. Main objective of study is to reduce runoff so pervious concrete pavement has potential to reduce runoff so areas has been calculated of selected sectors where pervious concrete can be laid. For this study only parking areas has been taken. Design of pervious concrete pavement depends upon infiltration capacity and other native soil properties. So experiments has been done to finding out the soil properties such as grain size distribution, water content, infiltration capacity and permeability of soil.Since pervious concrete is used in parking areas strength of pervious concrete should be 15 to 20 MPa which is achieved by Mix design. Several experiments have been performed on pervious concrete such as compressive strength, split tensile, flexural strength and permeability of concrete. For native soil model has been fabricated and model testing has been done to finding out actual hydraulic response of pervious concrete pavement under the different range of the precipitations. Calculations of runoff generated in selected sectors by rational method, calculations of runoff coefficient for Chandigarh and calculations for maximum yearly rainfall of Chandigarh city for past 35 years. Calculations of area in selected sectors where conventional concrete can be replaced by pervious concrete with the help of layout of storm water drainage graphs of selected sectors. Lastly design of pervious concrete pavements for selected sectors of Chandigarh.
IV. EXPERIMENTAL WORK

Experiments were done to finding out the properties of soil of selected area such as water content, field density, grain size distribution, infiltration capacity and permeability. The double ring Infiltrometer was used for determining water infiltration of the soil (Measurements according to ASTM D3385-03 standard test method and DIN 19682 ). The rings were partially inserted into the soil and filled with water, after which the speed of infiltration was measured. The double ring limits the lateral spread of water after infiltration. Dimensions of Infiltrometer used – Outer Ring Diameter: 26 cm Inner Ring Diameter: 15 cm Depth of instrument: 15 cm. Permeability was measured using the laboratory setup for constant head permeability test as specified according to guidelines stated in IS 2720 (Part 17): 1986 Methods of test for soils.

The Pervious concrete surface layer forms the upper layer of the pervious pavement. The function of this is to allow the water to infiltrate the layer and at the same time transport the traffic load into the lower layer reducing the traffic abrasion effects. Pervious concrete was made up according to mix proportion by which cement content was 461.8 kg/m³, Fine Aggregate Content 10 % by wt. of total aggregate, Water cement ratio as 0.30 and Aggregate: Cement ratio - 4:1. Experiments performed on pervious concrete to find out pervious concrete properties were compressive strength, split tensile, flexural strength and permeability of concrete.

For native soil model has been fabricated and model testing has been done to finding out actual hydraulic response of pervious concrete pavement under the different range of the precipitations. A model set-up was fabricated to simulate the pervious concrete pavement and response of rainfall of different intensities and durations through it (Figure 1). It was made of strong welded steel frame. The dimensions of the model were 500 mm x 500 mm x 1000 mm, with one side made of Perspex to allow visual inspection of the subsurface material. At the base of the frame, a stainless steel mesh was provided to support the base of the structure. The depth of the pervious pavement was kept as 850 mm. It consisted of 150 mm of pervious concrete paving, a course substrate bedding layer of 50 mm sand and 50 mm gravel, a sub-base layer of 300 mm, and subgrade layer of 300 mm. The brief description of the components of the materials from the base up as: Geotextile was placed over the stainless steel mesh, preventing sub-grade materials from washing into the lower container. Native soil compacted to its field density and moisture content was placed in thickness of 300 mm to represent sub-grade layer. Geotextile layer was positioned between the sub-grade and sub-base layer and bedding layer and sub base layer to prevent the migration of the sand particles to the aggregate. The sub-base layer (stone reservoir layer) comprised of 300 mm of coarse aggregate (size 20-75 mm). The bedding course layer comprised of 50 mm of fine aggregate (2-6mm). The designed paving pervious concrete (permeability - 0.89 x 10⁻³ cm/hr) was then placed on the top.

Fig. 1 Pervious Pavement Specimen
The Chandigarh has increasingly population and water demand and the runoff generated in the Chandigarh city is directly goes to storm water drains so chances of flooding and ponding is more. Ponding is great problem because the storm water drains are not sufficient to drain all the runoff generated from the precipitation and hence ponding was takes place. By using pervious concrete this type of problems like ponding and flooding are controlled and water directly goes into the ground and increase ground water level and hence the runoff volume and rate will be reduced for managing storm water, land-use maps of Chandigarh, runoff coefficient, drains sizes and rainfall intensity are required. By collecting data about to managing storm water are collected and calculation are done. Calculations of runoff coefficient of different sectors or for selected areas for study.Read land-use pattern maps and hatching or found the area in which pervious concrete can be laid.Collecting the data regarding rainfall intensity and maximum rainfall for determining runoff volume for Chandigarh city or for selected areas.Makes a calculation regarding runoff difference and runoff volume by rational method.By knowing the runoff difference, potential of pervious concrete is easily find to managing storm water or find their capacity for Chandigarh.

V. RESULTS

Results were obtained for finding out the properties of soil of sector 12 Chandigarh. Moisture content or water content of soil was 4.94 % and in situ field density was 1.77 g/cm$^3$. Results of grain size distribution of soil of sector 12 shown in and Figure 2 depicts grain size distribution curve $D_{60}$, $D_{30}$ and $D_{10}$ was 0.14 mm, 0.35 mm and 0.85 mm respectively than Cu was 6.06 and Cc was 1.03 hence gradation was SM-SW.

![Fig. 2 Particle size distribution curve](image)

Infiltration rate of sector 12 was tested by double ring Infiltrometer test results are shown in Table and Figure 3 which results that infiltration rate 16.02 mm/hr was recorded.
Test results of experiments conducted on pervious concrete mix was compressive strength after 7 and 28 days was 15.23 and 19.33 MPa respectively. Split tensile strength after 7 and 28 days was 2.23 and 3.23 MPa respectively. Flexural strength after 28 days was 2.84 MPa and Permeability of test specimen was $0.89 \times 10^{-3}$ cm/sec.

Rainfall simulations were performed using six rainfall intensities: 8, 24, 40, 64, 80 and 120 mm/hr. For each rainfall intensity was simulated for four different durations viz. 15 min, 30 min, 45 min, and 60 min. A total of 24 rain events were applied with only 14 resulting in any outflow (the first ten events had no outflow). This section presents and analysis the results of the rain events that were applied on the surface of the pervious concrete pavement. Full details of the analysis of all rain events can be found in Tables 1.
Table 1. Individual Rainfall event analysis

<table>
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<th>Event no.</th>
<th>Rainfall intensity</th>
<th>Rainfall intensity</th>
<th>Start of rainfall event</th>
<th>Rainfall volume inflow</th>
<th>Time of duration of rainfall</th>
<th>Outflow start</th>
<th>Total outflow</th>
<th>Start to delay time</th>
<th>Volumes of outflow peak</th>
<th>Time delay to peak discharge</th>
<th>Time to full empty</th>
<th>Inflow-Outflow</th>
<th>Outflow during storm</th>
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<td>2.195</td>
<td>0.648</td>
<td>14.352</td>
</tr>
<tr>
<td>23</td>
<td>120</td>
<td>30</td>
<td>10/4/2018</td>
<td>22.5</td>
<td>45</td>
<td>8</td>
<td>20.002</td>
<td>8</td>
<td>255</td>
<td>55</td>
<td>8.78</td>
<td>2.498</td>
<td>1.08</td>
<td>21.42</td>
</tr>
<tr>
<td>24</td>
<td>120</td>
<td>30</td>
<td>11/4/2018</td>
<td>30</td>
<td>60</td>
<td>8</td>
<td>25.545</td>
<td>8</td>
<td>288</td>
<td>75</td>
<td>10.2</td>
<td>4.455</td>
<td>1.869</td>
<td>28.131</td>
</tr>
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</table>
Table 1 illustrates the volume of rainfall and outflow during the course of the experiment. It includes all rainfall events, outflows and retention during storm. The results of the first two rainfall intensities viz. 8 mm/hr and 24 mm/hr are different from others due to the dry initial condition of pavement structure. During first two rainfall intensities, the first ten rainfall events produced no outflow, as the water was totally taken up by the sub-surface pavement material. In the 11th rain event, which were applied during 40 mm/hour intensity the outflow began 60 minutes after the rainfall started and 15 minutes after the rainfall stopped. Then outflow continued for 1.5 hours. Only 42.16% of the rain was discharged from the pavement during this rain event. It can be seen that the pavement for first 10 events had no discharge and for rain event 7.5 Litres in 45 minutes duration of intensity 40 mm/hr discharged lowest outflow volume. Table 1 shows the retention volume during the experiment period. It can be seen that the pavement showed good performance in retaining rainfall with in the structure of pervious concrete pavement.

The response of outflow the outflow was different in initial rain events. For example while pavement discharged 42.16% of rainfall during initial start of outflow during intensity 40mm/hour which was applied for 45 minutes duration. Furthermore pavement discharged 69 % of rainfall during 64 mm/hour applied for 15 minutes. However percentage increased to 76% and 80% for Rainfall intensities 80 and 120 mm/hour respectively applied for 15 minutes duration when pavement in saturation condition. The observed outflow volume varied significantly from partial saturation condition of pavement. It can be observed from data in the Table 4.9 that volume discharged from pervious concrete pavement ranged between 42.16 % to 88 %. It can be confirmed that the performance of the pervious concrete pavement effectively managed rain events and was able store more than 42.16 % of rainfall and release it slowly from the pavement structure.

Five sectors were selected for study and these selected areas are sector 12, 34, 26, 17 and 14. Data of rainfall from metroligical department of Chandigarh and calculation for average annual rainfall for past 35 years determined. Average annual rainfall from 1982-2017 was obtained after calculations 775 mm and average runoff coefficient after calculation before pervious concrete provided and after pervious concrete provided 0.51 and 0.48 respectively.

For selected area layout of storm water drainage system selected sectors figures were collected from Public Health Department and found areas where pervious concrete pavement can be provided. In graphs hatching is done in areas where pervious concrete pavement can be provided. The selection of areas for providing pervious concrete pavement is done by site seen and from figures of selected areas. Calculate area on and then multiplying from their scale gives total area of the sector where pervious concrete can be provided.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Sector Name</th>
<th>Total Area (km²)</th>
<th>Area in which P.C. may be Provided (km²)</th>
<th>Runoff coeff. Before PC Provided</th>
<th>Total Precipitation (m)</th>
<th>Runoff coeff. after PC laid</th>
<th>Total Runoff (cu-m)</th>
<th>Calculated runoff after P.C. Provided</th>
<th>Runoff Difference</th>
<th>Percentage Runoff reduced</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Sector 12</td>
<td>1.712</td>
<td>0.2628</td>
<td>0.51</td>
<td>775</td>
<td>0.48</td>
<td>676668</td>
<td>572796</td>
<td>103992</td>
<td>15.3 %</td>
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<td>02</td>
<td>Sector 34</td>
<td>0.960</td>
<td>0.119</td>
<td>0.51</td>
<td>775</td>
<td>0.48</td>
<td>379440</td>
<td>332405</td>
<td>47035</td>
<td>12.39 %</td>
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<tr>
<td>03</td>
<td>Sector 26</td>
<td>1.007</td>
<td>0.076</td>
<td>0.51</td>
<td>775</td>
<td>0.48</td>
<td>398016</td>
<td>367977</td>
<td>30039</td>
<td>7.54 %</td>
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<tr>
<td>04</td>
<td>Sector 17</td>
<td>0.960</td>
<td>0.100</td>
<td>0.51</td>
<td>775</td>
<td>0.48</td>
<td>379440</td>
<td>339915</td>
<td>39525</td>
<td>10.41 %</td>
</tr>
<tr>
<td>05</td>
<td>Sector 14</td>
<td>0.960</td>
<td>0.112</td>
<td>0.51</td>
<td>775</td>
<td>0.48</td>
<td>379440</td>
<td>335172</td>
<td>44268</td>
<td>11.67 %</td>
</tr>
</tbody>
</table>

Runoff reduced by providing pervious concrete = 264859 cum
Total runoff before PC provided =2213004 cum
Total runoff after pervious will be provided PC= 2184619-1948145=264859 cum
%age of reduced runoff from PC = 264859 * \frac{100}{2213004} = 11.96 %
VI. CONCLUSIONS

The present study was undertaken to investigate the use of pervious concrete pavement to reduce surface runoff and use it for storm water management in Chandigarh. For this study areas were sectors 12,34,26, 17 and 14. Pervious concrete pavements are traditionally used in parking areas, areas with light traffic, residential streets and pedestrian walkways. Based on result obtained from the present study, the following conclusions have been drawn.

- Pervious concrete was made up of mix proportion by which cement content was 461.8kg/m³, coarse aggregates 1759.11 kg/m³ of size 20 mm, fine Aggregate Content 10 % by wt. of total aggregate, Water cement ratio - 0.30 and Aggregate: Cement ratio - 4:1 found cube compressive strength after 7 and 28 days was 15.23 and 19.33Mpa respectively. Split tensile strength was 2.23 Mpa after 7 days and after 28 days 3.23 Mpa. Flexural strength was 2.84 Mpa. The design permeability of the cylindrical specimen was 0.89x10⁻² cm/sec.

- Infiltration rate of native soils in sectors 12, 34, 26, 17 and 14 Chandigarh were found to be 16.02 mm/hr, 15.5 mm/hr, 19 mm/hr, 18 mm/hr and 17.5 mm/hr respectively.

- The Model which was prepared to study the infiltration of storm water through pervious concrete pavement showed good response in storing storm water and releasing it slowly after storm subsides. Storm water simulation was applied by using different intensities for different durations. Pervious concrete pavement effectively managed rain events and was able store more than 42.16 % of rainfall and releases it slowly from the pavement structure. Volume discharged from pervious concrete pavement ranged 42.16 % to 88 %. For the intensity 120 mm/hr (Maximum rainfall intensity for the study area) applied for duration of 60 minutes, storm reservoir stores 85% of rainwater and releases it in 10 hours and 20 minutes.

- After calculating and comparing runoff it can concluded that for sectors 12, 34, 26 and 14 of runoff will be decreased by 15.30 %, 12.39 %, 7.54 %, 10.41 % and 11.67 % respectively by providing pervious concrete pavements in parking area, footpaths and low traffic roads.

- Depth of stone reservoir that can be provided in sector 12,34,26,17 and 14 Chandigarh were 448.7 mm, 450 mm, 441 mm, 443 mm and 446 mm respectively. Accordingly pervious pavements in these sectors are designed.

REFERENCES


ASTM D3385-03 and DIN 19682-7 Standard method for infiltration measurement with the double ring Infilrometer.


