Feasibility of Porous Pavement: A Case Study at Hatkeshwar Area of Ahmedabad City

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Abstract **- This study represents the experimental work related to porous pavement feasibility. Now a days porous pavement is a new concept introduced worldwide. In India and other countries research is going in positive direction. There are many advantages of porous pavement. Porous pavements allow storm water runoff to filter through surface voids into an underlying stone reservoir where it is temporarily stored and/or infiltrated. For this study Hatkeshwar area of Ahmedabad city has been selected with the specific road network nearby to the Narol-Naroda corridor link joining CTM cross road to karnavati bunglows. The above road network has the history of the accumulation of water in the area during the monsoon season for long duration. To study the above objective the rainfall data for the area during the different day, month is collected. The volume data is the other important aspect for identifying the low volume road. The quality of soil sub grade is the other data, which is collected for determining the thickness of porous asphalt concrete at this road network. The soil quality is also useful in order to identify suitability of disposal of the seepage ground water nearby to the stream/artificial drainage link.**

I.INTRODUCTION

Porous pavement is a storm water drainage system that allows rainwater and runoff to move through the pavement's surface to a storage layer below, with the water eventually seeping into the underlying soil. Permeable pavement is beneficial to the environment because it can reduce storm water volume, treat storm water quality, replenish the groundwater supply and lower air temperatures on hot days. Typically, between 15% and 25% voids are achieved in the hardened concrete, and flow rates for water through pervious concrete are typically around 480 in./hr (0.34 cm/s, which is 5 gal/ft²/ min or 200 L/m²/min), although they can be much higher. Due to the increased void ratio, water is conveyed through the surface and allowed to infiltrate, and evaporate, whereas conventional surfaces will not do so. A porous pavement surface therefore becomes an active participant in the hydrological cycle: rainfall and snowmelt are conveyed back through soils into groundwater.

II.STUDY AREA

Ahmedabad city is the major city of Gujarat, which attracts people from the different place of Gujarat for different activities. Hatkeshwar area of the Ahmedabad is one of the prime locations. The total population of Hatkeshwar area is about 92000 people (**source: Hatkeshwar zonal office**). It is the most waterlogged area in Ahmedabad city during the high rainfall. Main spots in this area where the most water logging occurs are Hatkeshwar circle, Radhikapark society, Rajesh park society, Karnavati society and Tripada society. Out of which karnavati society is selected as the study area. The rainfall data of Hatkeshwar area from the Ahmedabad municipal corporation is collected. The traffic volume count survey is carried out for the purpose of identifying the area having low traffic volume. The traffic survey is conducted in the internal street road of the Hatkeshwar area in front of karnavati society.

Data Collection and Analysis

Infrastructure development in major cities of the country is getting covered with high buildings and road pavements. Traditional pavements cannot absorb the water through the pavement surface during the rainy season, which leads to problems like surface runoff and water logging on the site. Because of this the feasibility of porous pavement is carried out in internal area of Hatkeshwar. For porous pavement application in this area the following data are collected which consists of (1) rainfall data of the area, (2) traffic volume on the road link, and (3) soil quality of the road segment.

Road Pavement

The pavement section at the road link joining from CTM cross road to karnavati banglows consists of the following cross section (Fig 5.1). On the site, the bituminous concrete layer is about 40mm as shown. The sub grade layer having thickness of 90mm to 127mm contains stone dust, debris etc. Above that the sub grade grouting is done by using metal having thickness of 25mm to 40mm and DBM layer having thickness of 55mm above this layer.

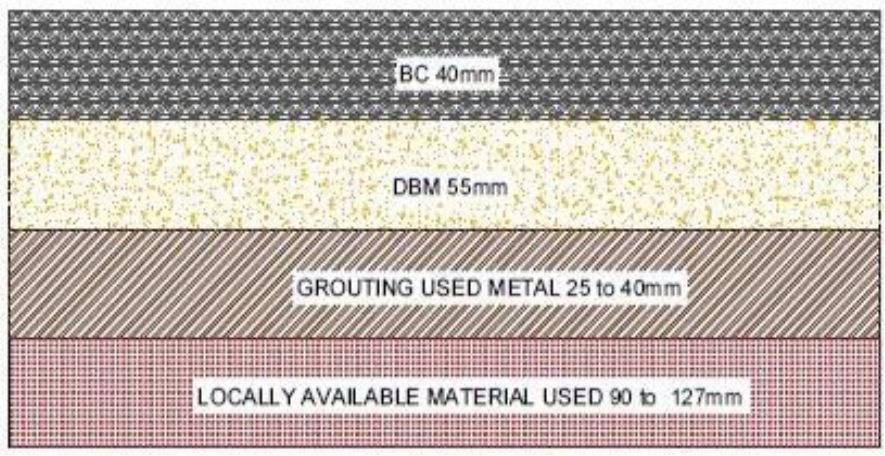

Fig. 1 Cross Section of Existing Road Pavement

Road Drainage and Storm Water Drainage

A drain or drain system is designed to drain excess rain and ground water from paved streets, parking lots, sidewalks, and roofs. They are fed by street gutters on most motorways, freeways and other busy roads, as well as towns in areas which experience heavy rainfall, flooding and coastal towns which experience regular storms. Many storm drainage systems are designed to drain the storm water, untreated, into rivers or streams. The cross section of drainage line is shown below. The depth of invert level to bottom of manhole is about 6.5 feet and the diameter of pipe is about 18 inch. The thickness of the pipe is about 2.5 inch.

Rainfall Data

The total rainfall data of the Ahmedabad city of west zone, new west zone, south zone, central zone, north zone and east zone is collected from the Ahmedabad municipal corporation office. Hatkeshwar area is situated in the east zone of Ahmedabad city. There are three places Odhav, Nikol and Chakudia at which the rain gauges are provided to record the daily rainfall of east zone. The daily rainfall of Hatkeshwar area is recorded at chakudia. Day to day Rainfall data is collected from the Ahmedabad municipal corporation office from the year 2010 to year 2013.

Table 1: Summary of Monthly Rainfall

MONTHLY SUMMARY				
MONTH	**2010**	**2011**	**2012**	**2013**
JUNE	65.00	0.00	32.00	67.00
JULY	419.50	245.00	120.00	598.00
AUGUST	572.30	303.50	332.00	198.00
SEPTEMBER	144.90	98.00	264.50	259.00
OCTOBER	0.00	0.00	0.00	38.00
TOTAL(mm)	1201.70	646.50	748.50	1152.00
INCH	47.31	25.86	29.47	45.35

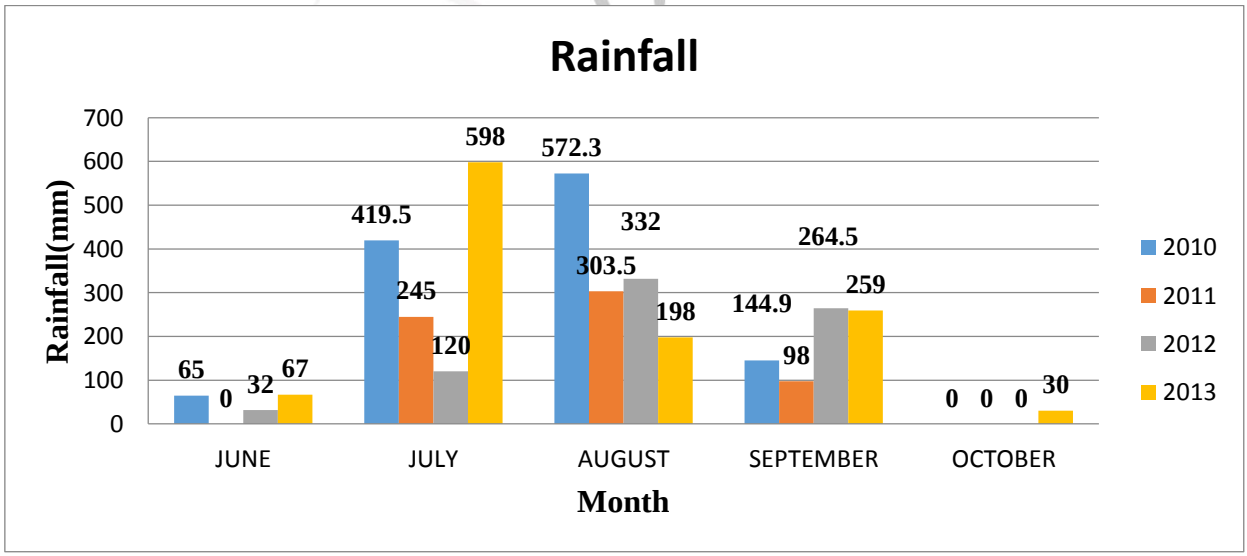

Fig.2 Graph of Monthly Rainfall

Traffic Volume Survey

The traffic volume count survey was carried out for the purpose of identifying the area having low traffic volume. The traffic survey is conducted in the internal street road of the Hatkeshwar area in front of karnavati society. Traffic volume details in PCU/hr are tabulated as below:

Table 2 Traffic Volume Detail

Direction	T/W PCU/Hr	CAR PCU/Hr	AUTO PCU/ Hr	LCV PCU/Hr	CYCLE PCU/ Hr	Total
Hatkeshwar to CTM	83	17	14	14	7	135
CTM to Hatkeshwar	96	19	11	15	3	144
Karnavati to Hatkeshwar	49	6	2	6	2	65
Hatkeshwar to karnavati	62	8	5	6	2	83
Karnavati to CTM	10	0	0	2	3	15
CTM to karnavati	9	0	2	3	0	14
Total	309	50	34	46	17	456

Soil Sample and CBR

For this study the soil sample is collected from the under construction road site at Hatkeshwar area. After the collection of soil sample, the California bearing ratio test is carried out to design the different layer of pavement for the conventional pavement.

Table 3: Observation of MDD and OMC

Sr. No	Wt. Of Wet Soil + Mould W1 (Gm)	Wt. Of Mould W2 (Gm)	Wt. Of Wet Soil W3 (Gm)	Volume Of The Mould V (Cc)	Bulk Density Yb	Moisture Content W %	Dry Density Yd
1	3860	1958	1902	981.25	1.939	4%	1.864
2	3898	1958	1940	981.25	1.977	5%	1.883
3	3945	1958	1987	981.25	2.025	6%	1.910
4	3995	1958	2037	981.25	2.076	7%	1.940
5	4040	1958	2082	981.25	2.122	8%	1.965
6	4058	1958	2100	981.25	2.140	9%	1.963
7	4066	1958	2108	981.25	2.148	10%	1.953
8	4066	1958	2108	981.25	2.148	11%	1.935
9	4063	1958	2105	981.25	2.145	12%	1.915
10	4054	1958	2096	981.25	2.136	13%	1.890
11	4039	1958	2081	981.25	2.121	14%	1.860
12	4019	1958	2061	981.25	2.100	15%	1.826

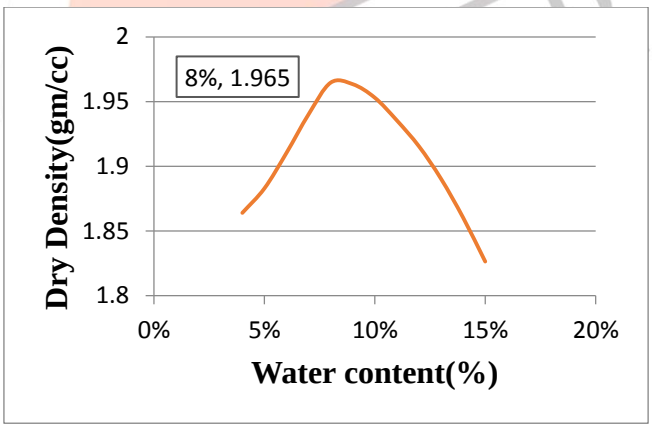

Fig.3 Graph of Dry Density vs. Water Content

Table 4: Load Penetration Test Data

Calibration Factor: 5.66

Before soaking			After soaking		
Penetration(mm)	**Load Measuring Unit**	**Load (Kg)**	**Penetration(mm)**	**Load Measuring Unit**	**Load (Kg)**
0.5	2	11.32	0.5	1	5.66
1	3	16.98	1	2	11.32
1.5	5	28.3	1.5	4	22.64
2	6	33.96	2	7	39.62
2.5	8	45.28	2.5	12	67.92
4	25	141.5	4	17	96.22
5	42	237.72	5	19	107.54

7.5	65	367.9	7.5	23	130.18
10	76	430.16	10	27	152.82
12.5	84	475.44	12.5	31	175.46

Table 5: Calculation of CBR

Condition of sample	Load(kg)		Corrected Load(kg)		CBR%		CBR of specimen
	2.5mm	5.00mm	2.5mm	5.00mm	2.5mm	5.0mm	
96 hours soaked	67.92	107.54	82.00	113.00	5.99	5.50	5.99%
Unsoaked	45.28	237.72	86.00	284.00	6.28	13.82	13.82

Design Of Pavement According To CBR Value

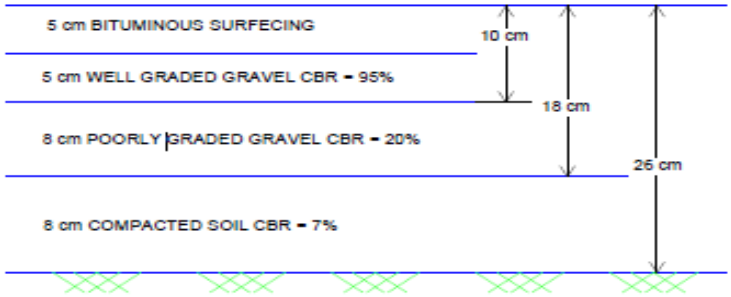

Fig 4: Cross Section of Pavement for CBR 5.99 %

Table 6: Comparative Properties of the Three Major Porous Pavement Types

Design Factor	Porous Concrete (PC)	Porous Asphalt (PA)	Interlocking Pavers (IP)
Scale of Application	For large area having high Rainfall	For area having medium Rainfall	For all type of Rainfall area
Pavement Thickness	10 cm to 20 cm	As per the design of area having different CBR value	From 5 cm to 10 cm as per the traffic condition of that area
Bedding Layer	NA	As per the design of area having different CBR value	Sand layer of 5 cm thickness
Reservoir Layer	NA	As per the design of area having different CBR value	NA
Construction Properties	Cast in place, seven day cure, must be covered	Cast in place, 24 hour cure	No cure period; manual or mechanical installation of pre-manufactured units, over 5000 sf/day per machine
Design Permeability	30 mt/day	1.8 mt/day	0.6 mt/day
Construction Cost	800 Rs/m2 for 10 cm 1600Rs/m2 for 20 cm	340 Rs/m2 for CBR value of 5.99 having thickness 26 cm	400 Rs/m2 having I section consisting of 24 no. per sqm
Min. Batch Size	150 sqm/day	150 sqm/day	NA
Longevity	20 to 30 years	15 to 20 years	20 to 30 years
Overflow	Drop inlet or overflow edge	Drop inlet or overflow edge	Surface, drop inlet or overflow edge
Temperature Reduction	Cooling is good	NA	Cooling is good
Colors/Texture	Limited range of colors and textures	Black or dark grey color	Wide range of colors, textures, and patterns
Traffic Bearing Capacity	Can handle all traffic loads, with appropriate bedding layer design.		

III.CONCLUSION

From the rainfall data it is concluded that the study area is most heavily rainfall area. Total average PCU/hr in the internal road of the study area is about 456 PCU/hr which is shows that the area is low traffic volume.so the study area is applicable for the porous pavement study. There are mainly three types of solution like porous concrete, porous asphalt and interlocking concrete paver block for applicability of porous pavement. From the above table it is evident that the porous cement concrete pavement is costly for the construction of per sqm area, but due to its long life it will be most cost effective because of its little or no maintenance requirement. Porous asphalt concrete is cheaper at the time of construction out of all the options but there is a very heavy maintenance cost applicable per year after monsoon. Interlocking paver block is most appropriate and reasonable solution as it does not required maintenance every now and then as well as it is having a reusable capacity.

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