IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

Impact Factor: 7.301

Volume 3, Issue 4, June 2023

Application of Previous Concrete as Sustainable Material

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Abstract*: Perforated pavements are a new type of pavement with high porosity which usually used for flat work applications in order to allow water to pass through it .It reduces the volume of direct water runoff from a site and increases the quality of storm water and water pollution .Due to the high flow rate of water through perforated pavement, rainfall can be captured and percolate into the ground, recharging groundwater, supporting sustainable construction, reducing storm-water runoff, and providing a solution for construction that is sensitive to environmental concerns. An attempt is made in this project perforated pavement concept at decided location of Surface runoff data is collected from the site location and various tests are performed to check its efficiency against surface runoff.*

Keywords: Perforated pavements, storm-water runoff

I. INTRODUCTION

Perforated pavement systems have emerged as a topic of considerable interest in recent years. The main objectives of perforated pavement systems are to increase groundwater recharge, reduce surface runoff, treat Storm water and prevent pollution of receiving water bodies through surface runoff. Typically, perforated pavement systems enable storm water to infiltrate through the pavement surface, into the filter layer and eventually releasing it as flow either through pipeline or surrounding soils.

Design and construction of permeable pavement, regardless of the type of surface pavement, requires structural and hydrologic analysis with both requirements being satisfied in order for the pavement to function properly. Generally, the structural design of the pavement is performed to determine the thickness of the aggregate depths that are necessary to support the design traffic loads while protecting the subgrade from permanent deformation. The hydrological design determines the depth required to store a design volume of infiltrated water in order to achieve stormwater management objectives. An optimal permeable pavement design is one that is just strong enough to handle design traffic load and speed while maintaining the necessary porosity to provide sufficient porosity and storm water management.

II. OBJECTIVES

- To solve traffic jam problems due to water logging onroads
- To increase the quantity of water retained on site and penetrate into aquifers thus promoting healthy water levels which sustain our steams and drinking water.
- Eliminating the high cost of underground piping systems
- Preventing pollutants from reaching watercourses which frequently occur with regular storm water systems during heavy rainfall events.

III. LITERATURE REVIEW

JAMES, W. AND VON LANGSDORFF [1]. Studied the relationship, between infiltration capacity and the age of a permeable concrete paver installation for various land uses and maintenance practices .Appropriately designed interlocking concrete block pavers may reduce the amount of pollutants reaching receiving waters, by allowing water to infiltrate into the subsurface layers .

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MEYSAM KAMALI A, MADJID DELKASH B. [2]. Studied the construction of permeable pavement PP)in sidewalks of urban areas is an alternative low impact development (LID)to control storm water runoff volume and consequently decrease the discharge of pollutants in receiving water bodies.

EBAN Z .BEAN; WILLIAM F .HUNT; AND DAVID [3]. Studied the surface infiltration rates of 40 permeable pavement sites were tested in North Carolina, Maryland, Virginia, and Delaware Two surface infiltration tests pre and post maintenance were performed on 15 concrete grid paver lots filled with sand .Maintenance was simulated by removing the top layer of residual material 13–19 mm..The median site surface infiltration rate increased from 4.9 cm /h for existing conditions to 8.6 cm /h after simulated maintenance.

MIKLAS SCHOLZ,PIOTR GRABOWIECKI [4]. Studied the wide-range but diffuse literature on predominantly permeable pavement systems(PPS), highlight current trends in research and industry, and to recommend future areas of research and development .The development of PPS as an integral part of sustainable drainage systems is reviewed in the context of traditional and modern urban drainage .Particular emphasis is given to detailed design, maintenance and water quality control aspect .

MD .AMINUR RAHMAN, PHD STUDENT, DR MONZUR A .IMTEAZ, SENIOR LECTURER, ARUL ARULRAJAH, [5]. Studiedthat Permeable pavements are increasingly being used as urban storm water management systems .Permeable pavement systems enable storm water to infiltrate through the pavement surface and into the filter layer

IV. RESEARCH METHODOLOGY

TYPES OF PERMEABLE PAVEMENT

Porous asphalt

Porous asphalt, developed about 1970, greatly resembles non-porous asphalt except the fines (very fine sand and dust) have been removed, leaving additional air voids where the fines would have been. This leaves space for water to flow through and collect. Large aggregate is also used to raise the void space

pervious concrete

Pervious concrete (also called porous concrete, permeable concrete, no fines concrete and porous pavement) is a special type of concrete with high porosity used for concrete flat work applications and that allows water from precipitation and other sources.

Permeable Interlocking concrete pavers

Permeable Interlocking Concrete Pavement (PICP) comprises a layer of solid concrete pavers separated by joints filled with small stones. Water enters the joints between the pavers and into an “open-graded” base- crushed stone layer with no small or fine particles. The void spaces among the crushed stone store water and infiltrate it back into the soil subgrade. The stones in the joints provide permeability, and the base filters stormwater and helps reduce pollutants.

Concrete grid pavers or “green parking lots” originated from the need to reduce the urban heat island and stormwater runoff from impervious surfaces. CGP with an open graded stone in their openings and bedding can store storm water and allow for partial treatment of pollutants. These can improve pavement to be constructed as the infiltration capacity of PC is highest. As shown in the figure 9 generally a cross-section consists of the surface permeable pavement (asphalt, concrete or interlocking pavers) on top, a choker coarse stone sub base recharge bed, and uncompacted subgrade. A geotextile fabric can also be used to separate the reservoir bed with subgrade soil. The aggregate used for the porous asphalt recharge bed should be clean, crushed stone with little to no fines and a minimum void ratio of 40%. Rounded and crushed aggregate, both normal and lightweight have been used but flaky or elongated aggregate should not be used. Aggregates should also be hard, clean, and have no coating. To prevent fines from entering the subbase, geotextile filter fabric is typically placed between the subgrade layer and underlying soil. Finally, the subgrade is uncompacted to allow for infiltration.

A typical cross- -section of pervious concrete is shown in Figure.I As shown, the subbase is a stone reservoir that can store a finite volume of water and drain tiles (not shown) can be added below the pavement to convey water downstream in the storm water management system. Water- -to- - cement ratios should be low and typically range from to 0.40; specifically targeted 0.32 to improve workability and density.

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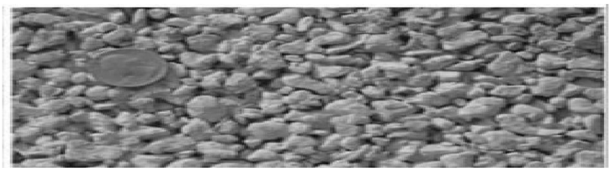


FIG. I ; PERVIOUS CONCRETE

Table-I. Test Of Cement

Sr. No.	Characteristics	Value obtained	Standard Value
1.	Normal consistency (%)	30%	26%-33%
2.	Initial setting time (min.)	30	Not less than 30
3.	Final setting time (min)	600	Not less than 600
4.	Fineness (%)	8%	<10
5.	Specific gravity	3.15	3.15

Tabe. No.-II Properties of Coarse Aggregates

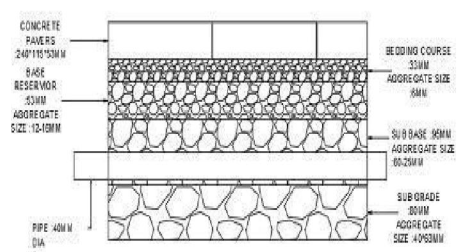
Sr. No.	Characteristics	Value
1.	Type	Crushed
2.	Maximum size	20mm
3.	Specific gravity	2.69
4.	Total water absorption	0.402%

Table. No. -III Sieve Analysis of Coarse Aggregates

Sr.No.	SieveNo.	Weight Retained (gms)	Cumulati ve Weight Retained (gms)	Percentag e Retained	Percent age Passi ng
1.	80mm	0	0	0	100
2.	40mm	0	0	0	100
3.	20mm	2073	2073	41.46	59.54
4.	10mm	2927	5000	100	0
5.	4.75mm	0	5000	100	0
6.	2.36mm	0	5000	100	0

FIG.II. LAYERS OF PAVEMENT

PRECAST CONCRETE PAVERS:



DOI: 10.48175/IJARSCT-11514

Pavers are typically a minimum of 80 mm (3 1/8 in.) thick for vehicular areas, and pedestrian areas may use 60-mm (2 3/8-in.) thick units. Pavers are manufactured in a range of shapes and colors. Filled with permeable joint material, freely infiltrate through the pavement surfaces. We have used standard size of 240*115*53 mm pavements.

OPEN-GRADED BEDDING COURSE:

This permeable layer is typically 50 mm (2 in.) thick and provides a setting bed for the pavers. It consists of small-sized, open-graded angular aggregate, typically ASTM No. 8 stone or similar-sized material.
Bedding course consists of aggregates size 4.75-6mm and thickness is 33mm

OPEN-GRADED BASE RESERVOIR:

This is an aggregate layer that is typically
100 mm (4 in.) thick. The base material is primarily made of crushed 25 to 13-mm (1 to ½- in.) stones, typically ASTM No. 57 stone. For pedestrian applications, the base layer is a minimum of 150 mm (6 in.) and the subbase may be omitted. Besides providing water storage capacity in the spaces among the stones, this highly permeable material also serves as a choking layer between the bedding and subbase layers. Thickness of layer adopted is 95mm and material size used is 12-16mm

OPEN-GRADED SUBBASE RESERVOIR:

The stone sizes are larger than the base, primarily 75 to 50 mm (3 to 2 in.), typically ASTM No. 2, 3, or 4 stone. Like the base layer, water is stored in the spaces between the stones. The subbase layer thickness depends on water storage requirements and traffic loads. A subbase layer may not be required in pedestrian or residential driveway applications. In such instances, the base layer thickness is increased to provide water storage and support. We have adopted material size 16-25mm and thickness 95mm.

UNDERDRAIN (AS REQUIRED)

Where pavement is installed over low- infiltration soils, underdrains facilitate water removal from the base and subbase. These underdrains are perforated pipes draining to a swale or stream or connecting to an outlet structure. They can also connect to plastic or concrete vaults or infiltration galleries, storing significant amounts of stormwater. The outflow is typically raised to leave some water in the subbase to infiltrate into the subgrade. We have used an under drain pipe of 40mm diameter.

GEOTEXTILE:

This functions primarily as a separation material between the subbase and subgrade by preventing soil migration into the aggregate the sides of most PICP applications. The engineer may also choose to place geotextile across the bottom of the system.

SUBGRADE:

This is the layer of aggregates immediately beneath the aggregate base or subbase. The infiltration rate of the saturated subgrade determines how much water can exfiltrate from the aggregate into the underlying.

Mix Design

Aggregate size, water-to-cement ratio and percentage of cement paste were considered as control factors for optimizing (maximizing) compressive, splitting- tensile and flexure strengths of concrete. The data were analyzed for mean objective/ response function. The Taguchi method examines the variation of w/c ratio. There is no specified IS mix design method for concrete mix of pervious concrete as compared to conventional concrete. Taguchi method of mix design is used for pervious concrete mix. The cement: aggregate ratio comes out to be 1:4 for Preparation of moulds and testing

Cement was well checked and the entire field tests on cement for its satisfactory use were done. The aggregate of 20 mm size were used for concreting the material used was clean from all types of impurities and standard concrete

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procedure was followed while concreting.The casting was done of standard size moulds of Cube and Beam. Moulds of standard size were easily available at the concretetechnology laboratory of GES's R. H. SAPAT COE, Nashik. The mould with good conditioned were used for the concreting purpose.

The various sizes were made ready one day prior to concreting. All the nuts and bolts of the moulds were checked and tightened. Oiling was done with brush.

Casting of Cubes

The mould of the cube of standard size 15x15x15cm was made ready. All these moulds were of castIron and were well cleaned and all the nuts and boltswere well tightened. All the holes or the gaps werefilled properly so as to reduce bleeding. There weretotal 9 cubes casted in all. The table 4 shows thecasting and testing of cubes accordingly. These cubeswere casted according to grades and curved accordingto specific time.

Fig.III Casted Cube

Table- IV. Casting of cubes

GRADE	CUBES	DAYS
25	3	7
25	3	14
25	3	28

Casting of Beams

The mould of beam was cast in standard mould size of 150x150x750 mm of cast iron. The mould was well cleaned from dust and impurities and all nuts and bolts are tightened, the gaps are filled to avoid bleeding of concrete. There were total 6 beam casted where 3 beams had reinforcement with coating and 3 beams had reinforcement without coating. The table shows the detail information of casting of beam accordingly. These beams were cast to various grades and cured according to specified time.

Fig.No. IV. Casting of Beam

Table-IV casting of beam

GRADE	BEAM	DAYS
M25 (coated)	3	28
M25 (non coated)	3	28

Testing of cube specimen for compressive strength.

For the compression test the cubes were placed in machine in such a manner that the load was applied on faces perpendicular to the direction of cast. In CTM, the top surface of machine is fixed and load is applied on bottom surface of specimen. The rate of loading was gradual and failure load was noted. Also the failure pattern was observed precisely.

Cost and Benefit Analysis of PermeablePavements in Water Sustainability

UC Davis at one point was ranked #1 in Sierra Club'smagazine 2012 Cool Schools Survey

for its sustainable practices in transportation, waste management, and green purchasing. This magazine ranks schools based on their environmentalachievements and goals. UC Davis' West Village was praised by the magazine for being the largest planned zero net energy community. Its wide variety of eco-friendly public transportation methods give students more options to travel while reducing their ecological footprint. In their cafeterias', UC Davis buys organic and sustainably grown vegetables and manages an extensive recycling and composting program. The university is also a leader in green innovations with the creation of a bio detail information of casting of beam accordingly. These beams were cast to various grades and cured according to specified time.

Table-V Observations of TSS

Sample	TS	TDS	TSS
Polluted water	200mg/l	80mg/l	120mg/l
Infiltrated water	120mg/l	40mg/l	80mg/l

Preparation of PP module

module size of 30*18*22inch has been decided to prepare with the help of 18mm thick plywood at bottom and 9mm thick plywood for the sides. The front portion of the mold has been kept transparent with the use of glass with thickness12mm of mm. The front and back side plywood was provided with mm diameter hole at the height 7cm and 7.5cm respectively. A slope of 1/120 has been provided to the drainage pipe.

The edges of the mold have been sealed to prevent seepage of water from the sides except front side. water is allowed to drain out of the mold from drainage pipe and the bottom of front facing. All the edges and sides has been secured with and iron rod to prevent the buckling of plywood and to prevent the front glass from cracking**.** The periphery of pipe is also sealed to prevent leakage. To prevent bulking of wooden plywood, sunmica has been provided on the surfaces.

Construction of mould and pouring of concrete:

using wooden mould prepare a concrete slab of 150mm depth and 300*180mm size.

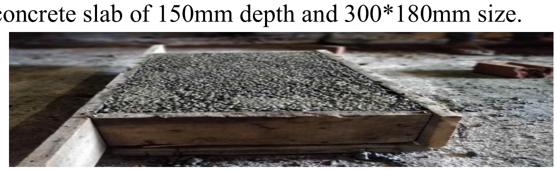

Fig. V. Construction of model

Construction of drainage: using 50mm dia pvc pipe which is placed under slab for collection of water which drains through slab.the percolated water is drained out through pipe.

Working of model: when the water is placed on the surface of slab the water percolates through the voids and gets collected in drainage pipe which allows the water to store in tank of ground.

Fig.VI Construction of model

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FigVII Pervious concrete pavement

V. RESULT

GENERAL

The various test conducted on hardened concrete such as void ratio, compressive strength, flexural strength and corrosion of reinforcement are tested according to standard procedure of testing of cubes moulds and beams. The various test are conducted on concrete are discussed in chapter no 4. The various results are stated in below table.

VOID RATIO

The test is conducted for dry concrete sample. Weight the dry sample, water fill up to initial mark of water container. Then immerse the concrete sample into the water up to 5min and then remove the excess water above initial level then weight it.

Table.VI Void Ratio

Concrete Type	Void Ratio	Unit Weight
Conventional Concrete	0.01	2518.53
Pervious Concrete	0.26	2014.83

Table. VII Results Of Compression Test on Cube

Grade Of Concrete	7days (Mpa)	Average Strength(Mpa)	14days (Mpa)	Average Strength (Mpa)	28days (Mpa)	Average Strength (Mpa)
M25	8.23		15.11		19.12	
M25	8.45	8.27	15.32	15.41	18.34	18.67
M25	8.14		15.80		18.56	

RESULTS OF FLEXURAL TEST ON BEAM

Table.VI Flexural test on beam for 28 days

Grade Of Concrete	28days (Mpa)	AverageStrength(Mpa)
M25	6.14	
M25	5.16	5.73
M25	5.89	

Result of evaluation of pavement againstpolluted water.

Table. VIII Evaluation of pavement againstpolluted water.

Sample	quantity	TS	TDS	TSS	Filtration time
Tap water (2NTU)	3.6 kg	90.36	47.11	43.25	8 seconds

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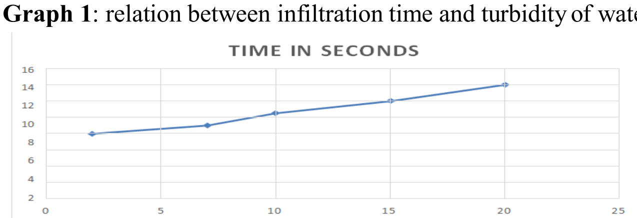
Muddy water (7 NTU)	3.6kg	150.9	54.56	96.34	9 seconds
Muddy water (10 NTU)	3.6kg	210.3	90.3	120	10.5 seconds
Muddy water (15 NTU)	3.6kg	256.96	96.56	160.4	12 seconds
Muddy water (20 NTU)	3.6kg	340.3	100.3	240	14 seconds

Graph 1: relation between infiltration time and turbidity of water



X axis – time
Y axis- Turbidity of water

Results: TSS of infiltrated water is found to beand that of polluted water is 120mg/l
Result of infilteration rate of pervious concrete.
As per the results the infiltration rate of pavement is 2200mm/hr. In this section we are comparing the capacity of infiltration and precipitation in the area. The precipitation data of PCMC area has been shown below. According to the weather department the maximum rainfall recorded in PCMC area is 621.05mm

Graph 2: Average annual rainfall (mm) in Pune.

As the proposed pavement possess infiltration capacity of 2200mm/hr. Water runoff canbe efficiently handled in the campus.

VI. CONCLUSION

As we know pervious concrete does not have sand therefore its compressivestrength is less as compared to conventional concrete. The range of water cement ratio 0.26 -0.45 will provide the best aggregate coatingand paste stability.

- If w/c ratio is more workability is less

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- If w/c ratio is less adhesion of cement and aggregate is less and dry.
- If the void content is more, then the percolation rate will be high but thecompressive strength will be low.
- If the void content is less, then the percolation rate will be low and compressivestrength will be high.
- From the table.no.5.4 we can see that pervious pavement is more economical andcheap

REFERENCES

[1] JAMES, WILLIAM AND HARALD VON LANGSDORFF. Towards Restoring Infiltration in Permeable Pavers—Initial Demonstration of Rapid Clean-Out Concepts. Journal of Water Management Modeling 25:C405. https://doi.org/10.14796/JWMM.C405 © CHI 2016. www.chijournal.org ISSN 2292-6062

[2] MEYSAM KAMALI A, MADJID DELKASH B,'The influence of paving-block shape on the infiltration capacity of permeable paving', uly 2007Land Contamination & Reclamation 15(3):335-344

[3] EBAN Z .BEAN; WILLIAM F .HUNT; AND DAVID A , ' STUDY ON THE SURFACE INFILTRATION RATE OF PERMEABLE PAVEMENTS' Prepared for: Interlocking Concrete Pavement Institute 1444 I Street, NW - Suite 700 Washington, DC 20005

[4] MIKLAS SCHOLZ,PIOTR GRABOWIECKI Review of Permeable Pavement Systems,' November 2007 Building and Environment 42(11):3830-3836

[5] MD .AMINUR RAHMAN, PHD STUDENT, DR MONZUR A .IMTEAZ, SENIOR LECTURER, ARUL ARULRAJAH,' Recycled construction and demolition materials in permeable pavement systems: geotechnical and hydraulic characteristics 0959-6526/© 2014 Elsevier Ltd.

[6] C.F .YONG, D.T. MCCARTHY, A DELETIC, 'Predicting physical clogging of porous and permeable pavements' Journal of Hydrology,