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Rainwater Harvesting By Using Concrete Block Pavement System

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ABSTRACT
Due to urbanization and improper drainage, flooding is a common phenomenon. The pavements and courtyards are presently covered with impervious concrete cement blocks which will not allow rain and drain water to percolate and reach groundwater table. Most of the cities get flooded even with little rainfall due to poor infiltration and drainage. Moreover, these concrete surfaces emit thermal radiation and create heat islands and enhance the global climatic temperature. If paving material is of pervious nature, it will enhance rain water harvesting and will recharge groundwater aquifers below urban areas. But all the available paving materials are impervious and heat emitting in nature, which creates health hazards too. In order to solve this problem, a cost effective, pervious concrete pavement block with a green cover on the top can be made from locally available materials. The more void space in this pavement blocks will allow water to percolate freely downwards and allow grass to be cultured and grown on top of this pavement block other than green aesthetic look and cool eco-friendly environment.
The main aim of our project is to improve the strength characteristics of pervious concrete. But it can be noted that with increase in strength, the permeability of pervious concrete will be reduced. Hence, the improvement of strength should not affect the permeability property because it is the property which serves its purpose.
Index Term :- OPC Cement, compressive strength, splitting tensile strength.

I. INTRODUCTION

Pervious concrete which is also known as the no-fines, porous, gap-graded, and permeable concrete and Enhance porosity concrete have been found to be a reliable storm water management tool. By definition, pervious concrete is a mixture of gravel or granite stone, cement, water, little to no sand (fine aggregate). When pervious concrete is used for paving, the open cell structures allow storm water to filter through the pavement and into the underlying soils. In other words, pervious concrete helps in protecting the surface of the pavement and its environment.

As stated above, pervious concrete has the same basic constituents as conventional concrete, 15 -30% of its volume consists of interconnected void network, which allows water to pass through the concrete. Pervious concrete can allow the passage of 11.35-18.97 liters of water per minute through its open cells for each square foot ($0.0929m^2$) of surface area which is far greater than most rain occurrences. Apart from being used to eliminate or reduce the need for expensive retention ponds, developers and other private companies are also using it to free up valuable real estate for development, while still providing a paved park.

Pervious concrete is also a unique and effective means to address important environmental issues and sustainable growth. When it rains, pervious concrete automatically acts as a drainage system, thereby putting water back where it belongs. Pervious concrete is rough textured, and has a honeycombed surface, with moderate amount of surface ravelling which occurs on heavily travelled roadways. Carefully controlled amount of water and cementitious materials are used to create a paste. The paste then forms a thick coating around aggregate particles, to prevent the flowing off of the paste during mixing and placing. Using enough paste to coat the particles maintain a system of interconnected voids which allow water and air to pass through. The lack of sand in pervious concrete results in a very harsh mix that negatively affects mixing, delivery and placement. Also, due to the high void content, pervious concrete is light in weight (about 1600 to 2000 kg/m^3). Pervious concrete. void structure provides pollutant captures which also add significant structural strength as well. It also results in a very high permeable concrete that drains quickly.

II. OBJECTIVE

The specific objectives of the study are:

1. To evaluate the aggregate suitability for preparing a porous pavement block based on their size gradation, compatibility, angularity and toughness index.
2. To evolve optimum size of coarse aggregate for maximum effective porosity and permeability.
3. To determine the strength characteristics such as tensile splitting strength, compressive strength and abrasion resistance to evaluate the suitability of porous concrete for pavement blocks.

III. MATERIAL USED AND THERE PROPERTIES

A) Cement:

Cement may be defined as adhesive materials capable of uniting fragments or masses of solid matter to a compact hole. The four major potential components are normally termed as Tri-calcium silicate, Di-Calcium Silicate, Tri Calcium Aluminates and Tetra calcium alumina ferrate. In this research work, Ordinary Portland cement (OPC) of grade 53 is used throughout the experimental work.

Table 1: Typical composition of ordinary Portland cement

Name of compound	Chemical Composition	Abbreviation
Tricalcium Silicate	3CaO.SiO2	C3S
Dicalcium Silicate	2CaO.SiO2	C2S
Tricalcium aluminate	3CaO.Al2O3	C3A
Tetracalcium alumino ferrite	4CaO.Al2O3.Fe2O3	C4AF

B) Fine Aggregate

Locally available good quality river sand was used. Locally available sand is used as a fine aggregate conforming to zone II of IS 383- 1983.Maximum size of aggregate used is 4.75 mm.

Table 2. Properties of Fine Aggregate

Sr. No.	Properties	Results
1.	Particle shape	Crushed angular
2.	Maximum Size	4.75 mm
3.	Fineness Modulus	3.2
3.	Specific Gravity	2.74
4.	Water Absorption	1.046 %

C) Coarse Aggregate

The properties such as moisture content, water absorption etc. would help in adjusting quality of mixing water for concrete mix. Locally available crushed stone aggregate with size

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12.5 mm to 20mm and of maximum size 20mm are used.

Table 3. Properties of Coarse aggregate

Sr. No.	Properties	Results
1.	Particle shape	Crushed angular
2.	Maximum Size	20 mm
3.	Fineness Modulus	7.018
4.	Specific Gravity	2.72
5.	Water Absorption	0.5%

D) Supplementary cementitious materials (scms):

➢ **Fly ash** is the waste by-product of burning coal in electrical power plants; it used to be land filled, but now a significant amount is used in cement. This material can beused to replace 5-65% of the Portland cement.

Fig.1.Flyash

- **Blast furnace slag** is the waste by-product of steel manufacturing. It imparts addedstrength and durability to concrete, and can replace 20-70% of the cement in the mix.
- **Rice husk ahs** husk can be burnt into ash that fulfils the physical characteristics and chemical composition of mineral admixtures.

Fig.2. Rice husk ahs

E) Water

Water is an important material of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quality and quantity of water is required to be looked into very carefully. Its PH value shall not be less than 6.

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IV. METHODOLOGY

- Mix design as per M30 grade concrete.

1:1:1.5

Testing of Specimens:

Testing of hardened concrete plays an important role in controlling and confirming the quality of raw materials, which help to achieve higher efficiency of material used and greater assurance of performance of concrete. In the present study test conducted on harden concrete were carried out by using Compressive Testing Machine(CTM) of capacity 3000 KN and as per IS 516:1959.

Test conducted on Concrete:-

a) Compressive Strength Test.
b) Split Tensile Strength Test.

a) Compressive Strength Test:(IS: 516-1959)

According to IS: 516-1959 for the compression test the cubes of size 150 mm x 150 mm x 75 mm (according to IS: 10086- 1982) are placed in machine in such a manner that the load is applied on the forces perpendicular to the direction of cast. The rate of loading is gradual and failure load is noted.

The compressive strength of specimen was calculated by the following formula:

b) Split Tensile Test :(IS: 5816-1999)

According to IS 5816:1999 for determining split

Where,

fcu = Pc /A

tensile strength cylinder specimens of size 150 mm in diameter and 300 mm in length (according to IS: 10086-1982) are horizontally placed between the two plates of compression testing machine. In these tests, in general a compressive strength is applied to a concrete specimen in such a way that the specimen fails due to tensile stresses induced in the specimen.

The split tensile strength of cylinder is calculated by the following formula,

fcys = 2Psp / π D L Where,

fcys=Split Tensile strength, Mpa Psp=Load at failure, N

L =Length of cylinder, mm D =Dia. Of cylinder, mm

c) Rainwater Harvesting by using recharge pit

A recharge pit allows the rainwater to replenish groundwater. It can be built to recharge a borewell or just to help the water infiltration in an area. A recharge pit can be totally invisible when finished. As it is filled of stones, it doesn't present any danger (contrary to an open well for example). Therefore, the percolation rate of a recharge pit is much less than of an open well. The water percolates slowly because there is no hydrostatic pressure in the pit. The cost of the pit will roughly depend on the cost of the filling materials (stones and sand).

Pc=Failure load in compression, A = Loaded area of cube,

fcu = Compressive strength, N/mm^2

Fig.3. Setup for Compressive Strength Test

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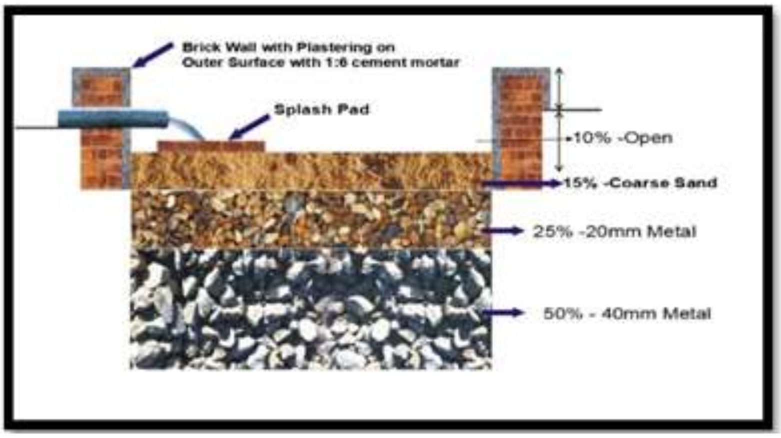

Fig.4: Recharge pit

V. RESULT

1. Permeability of Pervious concrete with 10% fine aggregates:

Quantities of materials:

Cement = 390 kg/m3
Coarse aggregates = 1494 kg/m3 Fine aggregates = 166 kg/m3 Water = 117 litres per CUM

Table 4.unit weight and coefficient of permeability of standard pervious concrete with 10% fines

S. No	Unit weight of standard pervious concrete (10% fines) after 24 hours(kg/m3)	Coefficient of permeability K (cm/sec)
1	1949.76	0.49

Table 5: compressive strength of pervious concrete with different quantities of fine aggregate

S.N	Age of conc	Standard pervious concrete (0%fine)	5%	6%	7%	8%	9%	10 %
1	7	16.72	17.21	17.82	18.58	17.91	18.36	18.13
2	14	19.21	19.52	19.68	20.11	21.41	21.11	20.91
3	28	21.31	21.88	22.44	22.94	23.33	23.09	22.88

VI. CONCLUSION

From the cost benefit analysis, it is found that the cost of this will be half of the present pavement blocks in the market thanks to the voids created, the type of aggregates used and optimum water consumption. From these studies, it is proved that the Green Porous Concrete Pavement Block is an alternate pavement block for many open utility area/surfaces such as open courtyards around buildings and public utility areas, gardens, playgrounds, green walls, etc

REFERENCES

[1]. Akash B. Jadhav et al (2018)Dynamics of fluids in porous media,Elsevier, New york.
[2]. Curtis, Kyle et al (2019)Beecham The

relationship between porosity and strength for porousconcrete Construction and Building Materials Volume 25, Issue 11, November 2011,Pages 4294–4298Celio,

[3]. Dania M. Abdel-Aziz et el (2015)Cements of yesterday and today: concrete of tomorrow. Haoran Zhu et al (2018)Chen, Zhihe, Chen, Xing, Chen, Xingzhen, Zhang, Danrong, 2017. Simulation of control efficiency of low impact development measures for urban stormwater. Water Resour. Protect. 02, 31–36.

[4]. Kevin Cai et al (2015) Hunt, William F. Hathaway, Jon M. "Hydrologic and Water Quality Comparison of Four Types of Permeable Pavement and Standard Asphalt in Eastern North Carolina."

[5]. Subramanian. N., Sustainability - Challenges and Solutions, The Indian

[6]. Concrete Journal, December 2007Mascio, P.D.; Moretti, L.; Capannolo, A. Concrete block pavements in urban and local roadsRaj N1 et al (2014), Md. Abdus Salam, Mohiuddin Abdul Kader, "Pervious concrete using brick chips as coarseaggregate: An experimental study",Journal of Civil Engineering, 2012, Page No: 125-137.

[7]. Shashi Kumara S.R et al (2016), Hao Wu, Xiang Shu, Edwin

[8]. G. Burdette (2010) "Laboratory evaluation of permeability and strength of polymer-modified pervious concrete" Construction and Building Materials 24, 818–823.