International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 03 , March 2017
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

USE OF PERVIOUS CONCRETE IN ROAD PAVEMENT

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ABSTRACT

Pervious concrete is a low-slump, open graded material consisting of hydraulic cement, coarse aggregate, admixtures and water. Because pervious concrete contains little or no fine aggregates such as sand, it is sometimes referred to as "no-fines" concrete. It is a special type of concrete having a high void content of about 30%, is becoming popular nowadays due to its potential to reduce the runoff to the drainage systems. Pervious concrete is a special high porosity concrete used for flatwork applications that allows water from precipitation and other source to pass through there by Reducing the Runoff from a site and Recharging Ground Water Levels. Durability and Permeability are important properties of Pervious Concrete. Cube of size 150x150x150mm are prepared to investigate both these properties. This investigation should be carried out at the end of 28 days for Compressive strength and Permeability. Different concrete mix proportion such as 1:5 & 1:6 with size of gravel such as 10 mm should be used to check both these properties of pervious concrete.

***Keywords*: *Air Voids, Drainage, Ground Water, Permeability, Pervious Concrete*.**

1. INTRODUCTION

Pervious concrete also called porous concrete, permeable concrete, no fines concrete and porous pavement is a special type of concrete with a high porosity used for concrete flat applications allows water from precipitation and other sources to pass directly through, thereby reducing the runoff from a site and allowing groundwater recharge. Pervious concrete is made using large aggregates with little to no fine aggregates. The concrete paste then coats the aggregates and allows water to pass through the concrete slab.

Pervious concrete is traditionally used in parking areas, areas with light traffic, residential streets, pedestrian walkways, and green houses. It is an important application for sustainable construction and is one of many low impact development techniques used by builders to protect water quality.

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

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ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

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. 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.

Pervious concrete can be used in a wide range of applications, although its primary use is in pavements which are in: residential roads, alleys and driveways, low volume pavements, low water crossings, sidewalks and pathways, parking areas, tennis courts, slope stabilization, sub-base for conventional concrete pavements etc.

Pervious concrete system has advantages over impervious concrete in that it is effective in managing run-off from paved surfaces, prevent contamination in run-off water, and recharge aquifer, repelling salt water intrusion, control pollution in water seepage to ground water recharge thus, preventing storm water sewer drains, absorbs less heat than regular concrete and asphalt, reduces the need for air conditioning. Pervious concrete allows for increased site optimization because in most cases, its use should totally limit the need for detention and retention ponds, swales and other more traditional storm water management devices. By using pervious concrete, the ambient air temperature will be reduced, requiring less power to cool the building. In addition, costly storm water structures such as piping, inlets and ponds will be eliminated. Construction scheduling will also be improved as the stone recharge bed will be installed at the beginning of construction, enhancing erosion control measures and preventing rain delays due to harsh site conditions.

Apparently, when compared to conventional concrete, pervious concrete has a lower compressive strength, greater permeability, and a lower unit weight (approximately 70% of conventional concrete). However, pervious concrete has a greater advantage in many regards. Nevertheless, it has its own limitations which must be put in effective consideration when planning its use. Structurally when higher permeability and low strength are required the effect of variation in aggregate size on strength and permeability for the same aggregate cement ratio need to be investigated.

II. LITERATURE REVIEW

[1].S.O. Ajamu1 et al., (2012) -

In this paper, structural property and permeability of pervious concrete made with different coarse aggregate sizes is presented. For the different aggregate/cement ratio used in this study, coarse aggregate size 9.375 mm has higher compressive strength values compared to those made from 18.75 mm aggregate size while 18.75 mm aggregate size had higher permeability value compared to that of 9.38 mm. The average specific gravity of the two aggregates sizes used was 2.7. Aggregate/cement ratio of 6:1, 8:1 and 10:1 respectively were used to produce three different batches of fresh concrete using 18.75mm aggregate size and same ratios were used for 9.375mm coarse aggregate size to produce another three different batches. In each case, aggregate/cement ratio of 6:1 gave the highest compressive strength compared to other aggregate/cement ratio of 8:1 and 10:1. The highest compressive strength obtained was 8.2N/mm2 and 10.8N/mm2 respectively for 18.75mm and 9.375mm coarse aggregate sizes. These values fall within the values stipulated by ACI 552R-10 (2.8N/mm2-28 N/mm2).

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ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

It was found that the aggregate/cement ratio of 10:1 produced pervious concrete of higher co-efficient of permeability of 3.12x10-3cm/sec and 3.89x10-3cm/sec for aggregate size 9.375mm and 18.75mm respectively.

[2].**A. M. Made et al., (2013) –**

This research paper was developed for high quality pervious concrete suitable for use in Maryland State Highway Administration (SHA) projects. The study utilized aggregates that are used in SHA projects, and the durability studies were conducted assuming Maryland weather conditions. Investigations were conducted to enhance the structural and durability characteristics of pervious concrete through the use of different admixtures. The admixtures included cellulose fibers, a delayed set modifier and a viscosity modifier. Pervious concrete specimens were tested for density, void content, compressive strength, split tensile strength, permeability, freeze-thaw durability, and abrasion resistance. Three different types of freeze-thaw durability tests were conducted to mimic potential field conditions, typical to Maryland, and including the possibility of clogged pavements. The freeze-thaw durability tests included: fully saturated tests, 50% saturated tests, and 0% saturated dry hard freeze tests.

[3].**Darshan S. Shah et al., (2013) -**

This paper is related to new concept for rural road pavement, with increase into the problems in rural areas related to the low ground water level, agricultural problem. Pervious concrete has introduced in rural road as a road pavement material. Pervious concrete as a paving material has seen renewed interest due to its ability to allow water to flow through itself to recharge groundwater level and minimize storm water runoff. This introduction to pervious concrete pavements reviews its applications and engineering properties, including environmental benefits, structural properties, and durability. In rural area cost consideration is the primary factor which must be kept in mind. So

that in rural areas costly storm water management practices is not applicable. Pervious concrete pavement is unique and effective means to meet growing environmental demands. By capturing rainwater and allowing it to seep in to the ground. This pavement technology creates more efficient land use by eliminating the need for retention ponds, swell, and other costly storm water management devices.

[4].**Ming-Ju Lee et al., (2013) –**

In this research, water quality and pollutants leached from pervious concrete pavement was investigated. This project mainly aims to study the pervious concrete pavement by pollutants such as acid rain, sea water or waste lubricating oil. The results show that pollutant and water purification of pervious concrete pavement both significantly improved in the acid rain, sea water or waste motor oil test. A diluted sulfuric acid solution (pH value 2.0) after the pervious concrete pavement system could significantly enhance its pH value to 6.5 above. This study demonstrates that implementing pervious concrete pavement is valuable for road design and hydrologic consideration.

[5]. **Jayeshkumar Pitroda et al., (2014) -**

This paper represents the experimental methodology and experimental results related to durability and water absorption. Cylinders of size 100 mm Ø and 200 mm height are prepared to investigate both these properties. This investigation should be carried out at the end of 28 days for water absorption and 56 days for durability in which cylinders are immersed in Sodium Chloride (NaCl) Solution after 28 days of casting. Different concrete

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ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

mix proportion such as 1:6, 1:8 and 1:10 with different size of gravel such as 18.75 mm and 9.375 mm should be used to check both these properties of pervious concrete. Test results indicates that pervious concrete made by 1:6 concrete mix proportion has more durability and less water absorption and pervious concrete made by 1:10 mix proportion has more water absorption and less durability that's why durability and water absorption are inversely proportional to each other.

[6].DARSHAN S. SHAH et al., (2014) –

This paper mainly focuses on the Compressive Strength and Flexural Strength of pervious concrete. Experimental methodology and results has been discussed for both these properties of pervious concrete. To investigate the result of compressive strength, "Cubes" of size 150 mm x 150 mm x 150 mm are prepared and for flexural strength, "Beams" of size 500 mm x 100 mm x 100 mm are prepared and investigation should be carried out at a regular interval of 7,14 and 28 days. Different concrete mix proportion such as 1:6, 1:8 and 1:10 with different size of gravel such as 18.75 mm and 9.375 mm should be used to check both these hardened properties of pervious concrete. Test results indicates that smaller size of gravel (9.375 mm gravel) has more Compressive Strength (12.71 N/mm2) and Flexural Strength (1.91 N/mm2) with 1:6 concrete mix proportion and for OPC 53 Grade Cement.

[7].M. Harshavarthana Balaji et al., (2015) –

Pervious concrete is a zero-slump, open graded material consisting of hydraulic cement, coarse aggregate, admixtures and water. Because pervious concrete contains little or no fine aggregates such as sand, it is sometimes referred to as "no-fines" concrete. It is a special type of concrete having a high void content of about 30%, is becoming popular nowadays due to its potential to reduce the runoff to the drainage systems which can provide a water flow rate around 0.34 cm/second. Pervious concrete has a large open pore structure hence less heat storage and faster. Pervious concrete also find its effective application in low loading intensity parking pavements, footpaths, walkways and highways. The pervious concrete is considered as an Environmental Protection Agency (EPA) for providing pollution control, storm management and suitable development. Here, pervious concrete mix is designed without sand and adding silica fume as an admixture using ACI 522R-06 code, the mechanical strength of the concrete is increased to an extent. The aim of this project is to lay the pervious concrete in platform and car parking thus transmitting the water to the underground surface very easily for maintaining the ground water table even in all the places.

[8].Prof. DR K.B. Parikh et al., (2016) –

In this review paper effects of mineral admixtures such as Fly ash and silica fume on properties of concrete. Various research papers, articles and thesis have been referred to understand various aspects of the pervious concrete, viz., basic behaviour, advantages, limitations, effects & mechanical properties. Various research papers published till date on different aspects of pervious concrete.

[9].Shubhashish Dadhich et al., (2016) –

In this paper research is done to increase in concrete's resistance to freeze-thaw damage is to modify its microstructure. It has been observed that there are several practical methods which help to counteract problems of freezing and thawing like 1) incorporating entrained air into the concrete. 2) Modifying the admixtures adding latex to them. 3) Mix design of the concrete can be made more effective by the use of polypropylene

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

fibers. This report reviews the frost damage mechanisms, considers the usefulness of current prevention techniques, and advances a new approach for making concrete resist the deleterious effects of freezing and thawing.

[10].**M. Rajeswari et al., (2016) –**

The paper determines the possibility of achieving maximum compression strength and permeability in concrete by replacing fine aggregate with coarse aggregate and cement along with the addition of admixture in order to increase the permeability of concrete. [1] In this study, the pervious concrete is obtained by removing the fine aggregate wholly (0%) and partially as 10% and 20% replacing the coarse aggregate.

III. METHODOLOGY

3.1 Materials to be used

3.1.1 Coarse aggregate :

The standard type of aggregate use in pervious concrete is 10mm rounded aggregate VSI (Vertical Shape Impacter).

3.1.2 Cement :

The standard type of cement use in pervious concrete is OPC grade 53.

3.1.3 Fly ash :

The Standard type of fly ash (class F)

3.1.4 Admixture : Superplasticizers

a) Sikament 5207 PQ:

Characteristics.:

- High water reduction.
- Higher strength and density.
- Improved durability.
- Improved surface finish.
- Improve cohesion properties.

b) Conplast M1:

Characteristics.:

- Improve strength and durability.
- Increase cohesion properties

c) ConplastAEA:

Characteristics.:

- Increase strength
- Reduces permeability.

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ISSN (O) 2319 - 8354
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3.2 Initial Testing On Material

3.2.1 Cement

1. Fineness - As per IS 269 – 1989 (sieve Analysis). Finer cement offers greater surface area for reaction to develop strength.

2. Consistency - As per IS 4031 part 2 (Vicat apparatus).To find Initial and Final setting time of cement.

3.2.2 Aggregate

1. Sieve analysis - As per IS 283-1970 (sieve Analysis).To find specific size of aggregate.

2. Impact Value test - IS 283-1970(Impact value apparatus).to find toughness of aggregate.

3.2.3 Test on fresh concrete

1. Slump test (Workability) - IS 516 – 1959 (Slump cone test).To find the workability of concrete.

3.2.4 Test on harden concrete –

1. Compressive strength test

IV. CONCLUSION

1. The smaller the size of coarse aggregate should be able to produce a higher compressive strength and at the same time produce a higher permeability rate.
2. The following conclusion comes through the study of the pervious concrete pavement in rural areas becomes more suitable to meet the rural area requirement such as to reduce the storm water runoff, to increase the ground water level, to eliminate the costly storm water management practices.
3. The results of pervious concrete specimens showed that the water penetration increases as the duration increases, but both compression strength and flexural strength seem unchanged as the duration increases.
4. In this research paper they found that water absorption is inversely proportional to durability of concrete
5. Pervious concrete made with smaller size of gravel (i.e. 9.375 mm) with 1:6 concrete mix proportion and with OPC 53 grade cement has highest compressive strength (12.71 N/mm2) compared to any other mix proportion.
6. The mix design with aggregate and cement ratio of 3 has the maximum strength.
7. For achievement of higher strength and workability in pervious concrete, it is not possible to get higher strength with conventional concrete mix. Modification is necessary in design. With use of fly ash and silica fume, it can be possible to increment in strength of pervious concrete.
8. pervious concrete obtained by removing the fine aggregate wholly (0%) and partially as 10% and 20% replacing the coarse aggregate get higher strength.
9. Admixtures can be made more effective by adding latex to it and removal of the clogged pores and annual cleaning using vaccum machines is must for the pervious concrete to sustain longer.

V. ACKNOWLEDGEMENT

This acknowledges me sincere thanks to my guide **Prof.D.D Shelke,** who helped me in selection of project topic, understanding of the subject and spending numerous hours helping me in completing this project report.

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

His valuable guidance and continuous encouragement throughout this work made it possible to complete this project well in advance.

I am also very thankful to Principal **Dr.S.D.Kalpande**, & Head of the Department **Prof.D.O.Bhavar**, for valuable guidance providing excellent computational facilitation and necessary aid in preparation of this project report.

I would like to thank all the staff of G.G.S.C.O.E.R.C Nashik, for there very usefull indispensable guidance during the project work and help for providing necessary matter required to me in completion of this project report.

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