International Journal of Advanced Technology in Engineering and Science
Vol. No. 11, Issue No. 06, June 2023
www.ijates.com
ijates
ISSN 2348 - 7550

PERVIOUS CONCRETE

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ABSTRACT

Pervious concrete is a special type of concrete with high porosity. It is used for concrete flatworks applications that allow the water to pass through it, thereby reducing the runoff from a site and allow in ground water recharge. The high porosity is attained by a highly inter connected void content. Typically, pervious concrete has water to cementitious material ratio of 0.28 to 0.4. The mixture is composed of cementitious materials, coarse aggregates and water with little or no fine aggregate. Addition of a small amount of fine aggregates will generally reduce the void content and increase the strength. The present report deals with the study and comparison of mechanical properties, workability density and permeability of different grades of pervious concrete (M-20,M25).

KEYWORD: - *Coarse aggregate, Fine aggregate, Cementitious materials, Void content.*

I. INTRODUCTION

As urbanization increases in India and many parts of the world the problem of water logging and requirement of drainage is also increase. This is partly due to impervious nature of the bituminous and concrete pavements. Pervious concrete which has an open cell helps significantly to provide high permeability due to its interconnected pores. Pervious Concrete is a special concrete used to allow water to intentionally pass through the surface of a pavement and allow storm water to eventually absorb back into the surrounding soils or evaporate. This keeps runoff water from downstream urban flooding and erosion. It also breaks the cycle of water treatment plants needing to treat storm water where municipalities have combined sewer and storm water systems.

Pervious concrete pavement has a 12 year history in Pennsylvania, a 25 plus-year history in Florida and other south-eastern states, and over 50 years in Europe. In addition to storm water control, pervious concrete pavement is a sustainable building product that aids in reducing the urban heat island effect and will provide 30+ years of low maintenance service at a low lifecycle cost.

(1) There are four advantages of pervious pavement:

1. Water treatment by pollutant removal.
2. Less need for curbing and storm sewers.
3. Provides a means to recharge local aquifers.
4. Less mass grading is required to create drainage gradients; pervious concrete is ideal for flat areas.

India is facing a typical problem of ground water table falling at a fast rate due to reduced recharge of rainwater into subsoil and unplanned water withdrawal for agriculture and industry by pumping. NFC if adopted for construction of pavements, platform/walkways, parking lots designed for lighter load. Pervious concrete can be successfully used in India in applications such as parking lots, driveways, gullies/sidewalks, road platforms, etc. Over the next 20 years there is expected to be a significant amount of housing construction India. The roads around the apartments/ homes and the surfacing inside the compound can be made with pervious concrete.

Another significant advantage in India as compared to Western countries is the significantly lower cost of labour. Much of the pervious concrete construction is manual and can be done without heavy equipment and therefore pervious concrete can be placed at a lower cost even in rural areas. A caution though is the higher prevalence of airborne dust in India that could lead to clogging of the pervious concrete. Pervious concrete can function with no maintenance and some level of clogging. Nevertheless, frequent preventative maintenance is recommended. In apartment communities, resident associations could perhaps take this over and those applications could be the first ones to be attempted. In future with increased urbanization, diminishing ground water levels and focus on sustainability, technologies such as pervious concrete are likely to become even more popular in India as well as other countries. (2,3) Pervious Concrete has been around for hundreds of years. The Europeans recognized the insulating properties in structural pervious concrete for their buildings. Europeans have also used pervious concrete for paving including on the Autobahn.

II. METHODOLOGY

2.1 Basic mix design

2.1.1 Cement & Cementations Materials

1. Portland Cement Type I, II or I/II is readily available in the market and used for pervious concrete production. (ASTM C150) 2.
2. Slag Cement (Ground Granulated Blast-Furnace Slag, aka. GGBFS) is a cementations material available in the market and used in pervious concrete production. (ASTM C989)
3. Fly Ash is available in the market and used in pervious concrete production. (ASTM C618) (3) Slag and fly ash are supplementary cementitious materials often used to replace the amount of cement. They both offer good benefits to concrete and they offer strength gain which means they add durability in the long run. Both require longer curing times for the concrete to initially set and gain strength.(7,8)

2.1.2 Aggregates

1. Aggregates can have a direct influence in the permeability, surface texture and the appearance of the pervious slab.
2. A uniform large aggregate size is preferable for maximum permeability. This is opposite of the optimized gradation usually wanted in a regular concrete mix
3. The size of the large aggregate will have an effect on aesthetics and the top size of the “holes” in the surface.

4. ¼" to ½" large aggregates are preferred. The specific gravity shall be >2.5 and the absorption shall be

2.1.3 Water

Water used for the pervious concrete mix shall be potable, drinkable water.

2.1.4 Admixtures

1. Air entraining admixtures can be used. Dosages usually start at 2 oz/cwt
2. Water reducing admixtures can also be used. Dosages for pervious concrete can exceed the ranges typically used for conventional concrete. A starting dosage rate of 6 oz/cwt is recommended.
3. Hydration stabilizers also known as extended control admixtures.
4. Viscosity modifying admixtures (VMA's).
5. New admixtures for pervious are appearing every day.

Recently admixture companies have bundled together water reducers, hydration stabilizers and viscosity modifying admixtures in one product to market for pervious mixes. These have been met with mixed reviews.

2.1.5 Mixture proportioning

Void Content

At a void content lower than 15%, there is no significant percolation through the concrete due to insufficient interconnectivity between the voids to allow for rapid percolation. So, concrete mixtures are typically designed for 20% void content in order to attain sufficient strength and infiltration rate.

2.1.6 Water- Cement Ratio

The water-cementitious material ratio (w/cm) is an important consideration for obtaining desired strength and void structure in pervious concrete. A high w/cm reduces the adhesion of the paste to the aggregate and causes the paste to flow and fill the voids even when lightly compacted. A low w/cm will prevent good mixing and tend to cause balling in the mixer, prevent an even distribution of cement paste, and therefore reduce the ultimate strength and durability of the concrete. W/cm in the range of 0.26 to 0.40 provides the best aggregate coating and paste stability. The conventional w/cm-versus-compressive strength relationship for normal concrete does not apply to pervious concrete. Careful control of aggregate moisture and w/cm is important to produce consistent pervious concrete. (9-11)

2.1.7 Cement Content

The total cementitious material content of a pervious concrete mixture is important for the development of compressive strength and void structure. An insufficient cementitious content can result in reduced paste coating of the aggregate and reduced compressive strength. The optimum cementitious material content is strongly dependent on aggregate size and gradation but is typically between 267 and 415 kg/m3. The above guidelines can be used to develop trial batches. ASTM C1688 test can be conducted in the laboratory to observe if the target void contents are attained. (1,2) Testing OF pervious concrete

Testing Pervious Concrete

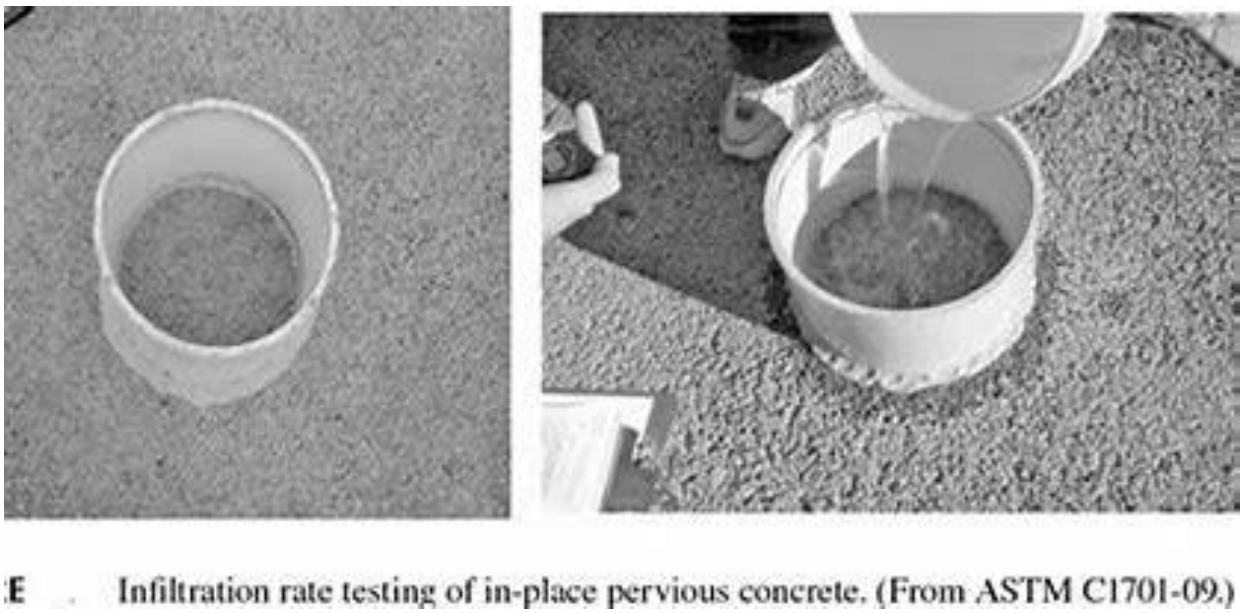
1. There are 2 ASTM tests designated specifically for pervious concrete
2. ASTM C1688, Standard Test Method for Density and Void Content of Freshly Mixed Pervious Concrete
3. ASTM C1701, Standard Test Method for Infiltration Rate of In Place Pervious Concrete

III. FIGURES AND TABLES

1.Infitration test of pervious concrete cube

Fig 1: infiltration test

2. Alternate method of testing of Pervious concrete slab for Infiltration rate (ASTM C1701)



E . Infiltration rate testing of in-place pervious concrete. (From ASTM C1701-09.)

Fig 2: Alternate method of testing of Pervious concrete slab for Infiltration rate (ASTM C1701)

TABLE – 1

COMPRESSIVE STRENGTH

Age (Days)	Wt. of Cubes (Kg)	Wt. of Cubes (Kg)
28	5.260Kg	30MPa

TABLE – 2

WATER ABSOPTION

Material Used	Wt .of slab before dipping into water for 24 hrs	Wt .of slab before dipping into water for 24 hrs
Pervious Concrete	5.260 kg	5.260 kg

So total water absorbed in % = 5.680-5.260=0.420 kg=0.08%

3.1 ECONOMIC BENEFITS

A parking lot properly constructed from pervious concrete has a life span ten times as long as an asphalt lot, thereby providing excellent long-term benefits. It is true that the initial costs for pervious pavement may be slightly higher due to the preparation of the sub-base, but those who look long term will realize the economic benefits. (6) As far as the material goes, pervious concrete is installed in a thicker quantity than conventional concrete, usually six-inches (15 cm.) vs. four-inches (10 cm.). However, one must look beyond the costs per square foot, at theproduct that overall system. (18-21)Pervious concrete is a sustainable saves money in the long run for the following reasons:

• Lower installation costs due to the elimination of costly curbs, gutters, storm drain outlets and retention basins that cost two to three times more to construct than pervious.

• Less money will be needed for labour, construction and maintenance of ponds, pumps, drainage pipes and other storm water management systems.

• Allows for the use of existing storm sewer systems for new developments.

• ncrease land utilization since there is no need to purchase additional land for large retention ponds and other filtering systems.

• Lower life-cycle costs equal to that of conventional concrete that if properly constructed will last for 20 to 40 years.

• Pervious requires fewer repairs than asphalt, and can be recycled once it has reached its lifecycle.

• Recent reports from multiple regions around the U.S. indicate that the cost for asphalt binder has recently increased as much as 50% and more, resulting in dramatic cost increases for asphalt pavement.

• Easy maintenance that consists primarily of prevention of clogging through pressure washing and power vacuuming.

IV. CONCLUSION

Pervious concrete is a cost-effective and environmentally friendly solution to support sustainable construction. Its ability to capture storm water and recharge ground water while reducing storm water runoff enables pervious concrete to play a significant role. Pervious concrete is a smart sustainable option with very high potential. Pervious concrete is an ideal solution to control storm water, re-charging of ground water, flood control at downstream and sustainable land management. Due to its low cost construction, if it gets utilized in Indian context then it proves to be very beneficial to solve environmental issues and water logging problems which are the major issues in India. Pervious concrete is the brightest star in the green building movements, according to past research history. It really a jump starts for our hurting industry right now, if we can do research to improve its basic properties then it has much bright start or its application in India. This study focuses on long term infiltration performances of pervious concrete parking lots and their storm water management credit. Concrete's clean look creates a good first impression and lasting sense of quality. Concrete can be fashioned with an array of decorative textures, shapes, patterns and colour.

Some research has been done on normal weight concrete, high performance concrete, self-compacted concrete and fibre reinforced concrete. pervious concrete with fewer works on properties like split tensile strength, flexural strength and bond strength. Very few research studies have been carried out on various properties, aggregate types like flaky, pebbles, angular etc. effect on PC properties.

1) In this study of pervious concrete flaky agg. Give better permeability, pebbles give better placing or workable and angular give better strength.

2) Pervious concrete made with pebbles as coarse aggregate results increasing permeability property due to its round shape nature.

3) Pervious concrete made with OPC as binder and pebbles as a coarse aggregate satisfies the pervious concrete requirements with adequate properties and it can be used for sustainable pavement construction.

V. ACKNOWLEDGEMENTS

We have taken efforts in this project. However, it would not have been possible without the kind support and help of many individuals and organizations. We would like to extend my sincere thanks to all of them.

We am highly indebted to Prof.Mr. Salim Mulla sir for their guidance and constant supervision as well as for providing necessary information regarding the project & also for their support in completing the project.

We would like to express my gratitude towards my parents & member of faculty for their kind co-operation and encouragement which help me in completion of this project.

We would like to express my special gratitude and thanks to industry persons for giving me such attention and time.

My thanks and appreciations also go to my colleague in developing the project and people who have willingly helped me out with their abilities.

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