A Review Study of Pervious Concrete

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Abstract- *Pervious Concrete which is also known as porous Concrete is motley of cement, body of water and a particular sized coarse aggregate combined to form a porous structural material. Application of pervious concrete in pavements mainly focuses on storm water ascendency mostly in urban areas where scarcity of land is high gear. Permeable Pavement allows water from precipitation and other informant to liberty chit through it and therefore reduces the runoff from a site which final result in the recharge of land water and increase the level. This Pavement is made using coarse sum with no fine aggregates.*

Keywords- Pervious Concrete, No fines, permeable, sustainable storm water, water table, flooding.

I. INTRODUCTION

Pervious concrete is a very special type of concrete with high porosity used for flat work application basically that's allow water from precipitation and other sources to pass directly through thereby reducing the runoff from the site and allowing ground water recharge. And in this concrete porosity is attain by a highly interconnected void content. Also in permeable or pervious concrete has no fine aggregate and has just enough cementing paste to coarse aggregate particles while preserving the interconnectivity of the voids .permeable or pervious concrete is traditionally used in parking area with lo traffic ,walkways in park and garden residential , green house, basketball court , volleyball house.

Pervious Concrete in India

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/The Indian Concrete Journal AUGUST 2010-18 homes and the surfacing inside the compound can be made with pervious concrete.

Massive urban migration in Indian cities is causing the ground water to go much deeper and is causing water shortages. For example, in states like Tamil Nadu residents commonly pay for water delivered and it is not uncommon to receive water only for a few days of a week in many parts of the country. Flooding and extended water logging in urban areas is common since all the barren land which could hold the rain water are being systematically converted into valuable real estate with a result that impervious surfaces such as roads, parking lots, roof tops are covering the natural vegetation. It is indeed ironical that even the world's wettest place Cherrapunji suffers drought while the monsoons brings flooding. Further, the rain water that falls on the concrete and asphalt surfaces tend to carry a high level of pollution and this pollution ends up in our waterways ultimately. The use of pervious concrete can help alleviate the damage of all of these ills.

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.

MAIN OBJECTIVE OF PERVIOUS CONCRETE ARE:-

- To help restore ground water supply.
- Reduce pollution of coastal water;
- To pave parking.
- Recharge ground water table.
- Reduces runoff water.
- Reduces risk of flooding and topsoil wash away.

SCOPE

- Porous Concrete pavement system can offer a valuable storm water management tool.
- Storm water retention areas could also be reduced or eliminated.
- Ground water level & aquifer recharge can be increase by allowing the rainfall to infiltrate.

II. LITERATURE REVIEW

Anush K.Chandrappa, Krishna Prapoorna Biligiri

In this research paper did research on pervious concrete as a sustainable pavement material –Research findings and future prospects. This paper reviews the developments and state-of-the-art pertinent to pervious concrete research and practices. The investigations on mechanical-hydrological-durability properties of pervious concrete performed in various studies have been reviewed. The use of pervious concrete in low-volume road applications has been attracting urban developers and contractors due to its various benefits. The paper has discussed various properties of pervious concrete such as mechanical, hydrological, durability, field performance, environmental and cost-benefits aspects. Based on the previous studies, it was found that there exist several research gaps in the subject area, as indicate din the future scope of research. These gaps if considered and studied can help in the overall improvement of the understanding of the material and lead to the development and implementation of design standards for pervious concrete pavements. Overall, the past studies indicated that pervious concrete mix is a very promising candidate to be used as a pavement material in low-volume roads such as local streets, pedestrian walkways and driveways, and possibly materials and highways in future if mechanistic-based design procedures are developed.

R. Sriravindrarajah, H.M. Do & L. D. Nguyen & Y. Aoki

In this paper discussed the Effect of Clogging on the Water Permeability of Pervious Concrete. This paper discusses the results of an experimental investigation in to the effect of pore structure clogging and compaction on the water permeability of pervious concrete. The water permeability of pervious concrete was studied under falling head. The results showed that the clayey materials presence in the percolating water had seriously reduced the water permeability of pervious concrete. The effects of compaction and clogging on the water permeability of pervious concrete were investigated. The clogging of pores was achieved by using varying quantities of clayey materials in percolating water though pervious concrete under falling head method. The following conclusions are made from this study:

K. C. Mahboub, Jonathan Canler, Robert Rathbone, Thomas Robl, and Blake Davis

In this paper has study Pervious Concrete: Compaction and Aggregate Gradation. Pervious concrete is very different from traditional Portland cement concrete (PCC). Therefore, there are open questions regarding the suitability of the current standard concrete testing protocols as they may be applied to pervious concrete. There are unique features associated with pervious concrete that may require special testing considerations. This paper examines the compaction and consolidation of pervious concrete. This study presents cylindrical specimen preparation techniques that will produce laboratory specimens that are similar to the field pervious concrete slab. Additionally, a simple correlation is provided that allows concrete designers to estimate the porosity of pervious concrete based on its aggregate bulk density when crushed limestone is used. This practical tool saves time when designing pervious concrete mixtures. Accurately measuring the air content of pervious concrete is a challenge due to its highly porous nature. Current literature suggests that air porosity of pervious concrete should be within 18 to 35% to ensure a desirable permeability;1 however, there are no suitable AASHTO or ASTM International test methods for determination of air porosity for such a concrete. Tennessee Technological University researchers investigated this issue and conducted research for a new test method to determine pervious concrete air porosity. These researchers have investigated flexural, split-tensile, and compressive strengths of pervious concrete for pavement design inputs.

III. MATERIALS

Pervious concrete, also known as porous, gap-graded, permeable, or enhanced porosity concrete mainly consists of normal Portland cement, coarse aggregate, and water. In normal concrete the fine aggregates typically fills in the voids between the coarse aggregates. In previous concrete fine aggregate is non-existent or present in very small amounts (<10% by weight of the total aggregate). Also, there is insufficient paste to fill the remaining voids, so pervious concrete has a porosity anywhere from 15 to 35% but most frequently about 20%. Aggregate gradins used in pervious concrete are typically either single-sized coarse aggregate or grading 3/4 and 3/8 in (between 19 and 9.5 mm). A wide aggregate grading is to be avoided as that will reduce the void content of the pervious concrete. All types of cementitious materials such as fly ash, slag cement, natural pozzolans conforming to their ASTM specifications have been used. Pervious concrete can be made without chemical admixtures but it is not uncommon to find several types of chemical

admixtures added to influence the performance favorably. Since pervious concrete has a low workability,

IV. DESIGN

There are two factors that determine the design thickness of pervious pavements: the hydraulic properties, such as infiltration rate and volume of voids, and the mechanical properties, such as strength and stiffness. Pervious concrete pavements must be designed to support the intended traffic load and contribute positively to the site specific storm water management strategy. The designer selects the appropriate material properties, the appropriate pavement thickness, and other characteristics needed to meet the hydrological requirements and anticipated traffic loads simultaneously. Separate analyses are required for both the hydraulic and the structural requirements, and the larger of the two values for pavement thickness will determine the final design thickness.

Many applications have used a 5 to 6 in (125 to 150 mm) thick pervious concrete over an aggregate base generally of the same dimension. Field performance of these projects have shown that they are adequate to handle the traffic loads expected in parking lot applications (passenger cars) where the heaviest loads are generally from garbage trucks (equivalent of Indian lorries up to 5 times/day).If heavier loads and higher traffic are expected then a thicker pavement 8 to 12 in. (203 to 304 mm) has been used. Another approach would be to try and use the structural design techniques outlined in the ACI 330R which could help optimize the pavement thickness.
Traditional pavement design attempts to exclude water from entering the sub grade (soil) below the pavement. In most cases, porous paving is designed to encourage water to saturate the subgrade below paving. This condition should be taken into account when determining the properties for the subgrade. The more a soil is compacted, the less porous it becomes. For this reason, pervious paving subgrades are usually compacted to a lower density than subgrades for traditional concrete paving. The level of compaction is typically 90% of Standard Proctor Maximum Dry Density (SPMDD). The modulus of subgrade reaction used in design should account for this lower level of compaction.

Initial recommendations had been that pervious concrete should be used only in sandy soils with infiltration rate greater than 0.5 in./hr (12.5 mm/hr). However, a detailed hydrologic analysis (Leming et al. 2007) for a specific example with soils with infiltration rate of 1, 0.5, 0.1, and 0.01 in./hr (25, 12.5, 2.5, 0.25 mm/hr) has shown that the post construction run-off was lower in all 4 soils when compared to the pre-construction runoff. The draw down time (time taken for all of the accumulated water in the pervious pavement to be discharged into the sub grade) in all cases was acceptable except for the soil with the lowest infiltration rate and that too only when an aggregate base was used. The authors concluded that pervious concrete can be used in silty soils with a soil infiltration of only 0.1 in./hr (2.5 mm/hr) and that there is no need to arbitrarily limit its use only to sands. In soils with infiltration rates considerably less than 0.1 in./hr (2.5 mm/hr) one way to reduce the draw down time could be to use buried perforated pipes that can transfer the collected water elsewhere. If that is not feasible the pervious concrete system could be placed without an aggregate base and the resulting excess run off (over preconstruction but still lower than if an impervious system had been used) could be handled using additional detention devices. It is important to note that soils with infiltration rates much below 0.1 in./hr (2.5 mm/hr) are likely to have runoff even on undisturbed land. Over the last 10 years there have been several successful. The Indian Concrete Journal AUGUST 2010-14 pervious concrete pavement installations on soils with permeability of 0.1 in/hr (2.5 mm/hr) or lower.

V. EXPERIMENTATION AND TESTING

1. SIEVE ANALYSIS TEST:- For the design of pervious concrete we tested the 3 different size of aggregate

- 10mm to 12.5mm
- 12.5 to 16mm
- 16mm to 20mm

After the testing of cubes for above aggregate sizes, we extracted that higher compressive strength gain on 12.5 to 16 mm size of aggregates.

2. COMPRESSIVE TEST: - Compressive strength is dependent on size of coarse aggregate, void ratio, bond between mortar and coarse aggregate. In 7 days cubes of permeable concrete gain 30% of its strength, in 21 days of permeable concrete gain 70% of its strength, and for 28 days it gains 95% strength.

3. TENSILE STRENGTH:-In this project we conducted the split tensile test for cylinder. In previous concrete tensile strength vary from 1 to 3.5 Mpa.

4. PERMEABILITY TEST:- permeability of the pervious concrete is determined by special arrangement of cylindrical shape bucket or specific container which should be open from both the side and has to arranged in such a way so that one side could be used for pouring of water and other resting on pervious concrete as shown in figure below.

VI. MATERIAL PROPERTIES

1. AGRREGATES: - In pervious concrete generally singular size of coarse aggregates are used. For design of pervious concrete we used 16 mm of coarse aggregates as per the IS code 10262:2009 for mix design and also if coarse aggregate size decreases compressive strength increases.

2. CEMENTITIOUS MATERIAL:- We used portland pozzolana cement of o.p.c grade-53 (birla cement) as per the is code IS code 1489:1991.

3 ADMIXTURE: - water reducing agent for the pervious concrete generally styrinebutadien is used as a water reducing agent in pervious concrete.

VII. PERFORMANCE AND MAINTENANCE

Two common preventable problems with pervious concrete are surface raveling and clogging. Surface raveling is removal of loose aggregate material from the previous concrete surface and is caused by inadequate w/cm, inadequate compaction, or improper curing procedures. Good curing practices, appropriate w/cm (not too low), and adequate compaction is important to reduce raveling. Where as severe raveling is unacceptable some loose stones on a finished pavement is always expected. Once the top layer of loose stones is removed raveling usually stops. Use of snow ploughs could increase raveling. A plastic or rubber shield at the base of the plow blade may help to prevent damage to the pavement.

Clogging is the deposition of fines and vegetative matter on the pervious concrete surface or in its voids thus reducing its infiltration rates. Vegetative matter such as leaves can be deposited and may have to be removed periodically. Fines can be water-borne, wind-borne, or tracked onto the pervious concrete pavement by traffic. In preparing the site prior to construction, drainage of surrounding landscaping should be designed to prevent flow of materials onto pavement surfaces.

Due to the very high levels of initial infiltration rate, most pervious concrete pavements can work well with some amount of clogging. A recent investigation of several field sites in Southern USA (Wanielista et al. 2007) indicated that pervious concrete pavements that were installed 10 to 15 years ago, with no maintenance requirements, are operating in a satisfactory manner with insignificant amounts of clogging. The two commonly accepted maintenance methods are pressure washing and power vacuuming. Pressure washing forces the contaminants down through the pavement surface. This is effective, but care should be taken not to use too much pressure, as this will damage the pervious concrete. Power vacuuming removes contaminants by extracting them from the pavement voids. The most effective scheme, however, is to combine the two techniques and power vacuum after pressure washing.

For a pervious pavement system to perform well, it may need to be maintained at some regular interval. On a monthly basis, the paving area should be ensured to be clean of debris or sediments by broom sweeping. Power vacuuming is suggested on an annual basis. For critical projects ASTM C1701 testing could be conducted to evaluate if there is significant clogging and if there is more advanced measures could be considered. If a pavement is in a harsh environment, such as a coastal area, or anywhere that would cause heavy accumulations of fines, it may be necessary to perform this preventative maintenance more frequently

VIII. CONCLUSION

1. Compressive strength of pervious concrete depend upon the porosity of concrete ,age, binder material (type of cement),test specimen shape and size ,showed huge influence on the strength of pervious concrete .
2. Compressive strength is inversely proportional to porosity hence, when compressive strength increases porosity decreases
3. We also concluded that Reduction in the aggregate size decreases the porosity because of its inter relation with no fine aggregate property.
4. Porous concrete is unsuitable for heavy duty roads.
5. Extra amount of water exceeding the specific requirement make the wet cement settle at the bottom because due to porosity wet cement makes its way to the bottom.
6. More the required tamping decreases porosity.
7. Vibrations also decrease pervious concrete porosity.
8. Permeability of porous concrete is influence by the porosity
9. Friction is more on pervious concrete than other material roads. Small size of coarse aggregates (12.5 to 16mm)

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