International Journal For Technological Research In Engineering
Volume 4, Issue 11, July-2017 *ISSN (Online): 2347 - 4718*

A REVIEW ON STATUS AND FEASIBILITY OF USING PERVIOUS CONCRETE PAVEMENT FOR CONSTRUCTION OF NEW ROADS IN INDIA

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Abstract: ***Flooding and water logging problems are the Major environmental issues now a days Particularly in a country like India for this sustainable development has become a necessity. Various sustainable and Eco-friendly methods are being implemented to fight with these problems. The concrete technology has made remarkable progress in past decades. Pervious concrete pavement is one of them. Pervious Concrete is a light-weight concrete produced by omitting the fines from conventional concrete. Also known to as "No-fine Concrete" or "Porous Concrete" is material comprised of narrowly graded coarse aggregates, cement materials, water and admixture. The purpose of this review paper is to consolidate the wide range and spread the relevant works on permeable pavement systems, and also to recommend the future areas of research work. Pervious concrete pavement is an environmentally friendly paving material that allows water to drain directly through the pavement structure and infiltrate into the sub grade. By reducing runoff, pervious concrete pavement decreases the demand on the storm water management system. The pervious pavement have wider application for construction of parking pavements, residential streets, sidewalks, and walkways, apartment-ways where there is light traffic and the loading intensity is low. The void content in Pervious concrete ranges from 15-30% with compressive strengths ranging from 3.5 MPa to 28 MPa .This paper makes an attempt to put forth the facts of the pervious concrete and the suitability of its use in India. This review paper includes literature reviews related to pervious concrete and its applicability for Indian roads.***

Keywords: Porous pavement, Light weight concrete, storm water management, runoff management, Eco- Friendly Construction, Indian roads.

I. INTRODUCTION

Pervious concrete is different from the conventional concrete. It is defined as "no fines concrete". The pervious concrete mix contains very little or practically no fine aggregate. It is a mixture of cement paste which forms a thick coating on coarse aggregates. The conventional concrete as is known is a mixture of cement paste and aggregates. Cement paste is composed of cement and water and aggregates are composed of fine and coarse aggregates. The cement paste actually coats on the aggregates and forms a coherent mass known as Concrete. This concrete can be molded into any shape when freshly mixed. It is therefore called as plastic and it becomes strong and durable when it gains strength and is known as hardened concrete. Compared with the conventional concrete proportions, proportioning pervious concrete mixture must have better control on batching all the ingredients necessary to produce the desired results. Pervious concrete is different from the conventional concrete. It is defined as "no fines concrete". The pervious concrete mix contains very very little or practically no fine aggregate. It is a mixture of cement paste which forms a thick coating on coarse aggregates. Thus the careful proportioning and mixing of the ingredients place very important role to get the desired workability for the fresh concrete and the required durability and strength of hardened concrete.

Fig 1: Infiltration of water through Pervious Concrete

II. LITERTURE REVIEW

(Md. Abid Alam & Shagufta Naz 2015)They conducted study on 3 batches of no-fine concrete each with two different sizes of aggregate were prepared to find the mix that generated high compressive strength and study the effect of percentage of fine aggregate on the compressive strength of no-fine concrete. The purpose of this project is to analyze the feasibility of producing highly sustainable no-fine concrete mixtures and evaluating the effect of fine aggregate on their properties. No-fine concrete is produced by using ordinary Portland cement, coarse aggregates, and water. This concrete is tested for its properties, such as slump value, porosity and compressive strength. However 10 to 20% fine aggregate is Used to partially replace coarse aggregate. The results showed that porosity has significant effect on compressive strength of no-fine concrete. Replacement of

coarse aggregate with fine aggregate up to 20% had significant effect on the porosity and compressive strength of the no-fine concrete.

(V.G.Khurd, Nitish M. Patil 2015) Based on the experimental investigation into the properties of pervious concrete, the following conclusions are made: Pervious concrete could be made with conventional concrete making materials to have permeability between 4mm/s and 8 mm/s. Cement replacement with fly ash contributed to the reduction in long term strength of pervious concrete similar to that noted with the conventional concrete. Since the water permeability as the main criterion for the pervious concrete, fly ash can be used in the production of pervious concrete to achieve an environmentally friendly concrete. The flexural strength of pervious concrete with fine aggregate is lower than the strength requirement of highway pavements therefore this concrete is suitable for light traffic pavements and can be a applicable for village roads in India.

(Tanvir Hossain etal 2015) They have made experimental studies on pervious concrete using brick chip as coarse aggregate and have found that pervious concrete made of brick chips perform well in respect of permeability , however the strength of this concrete is lower than that of stone aggregate. In the experiments the gradation of the brick aggregate has been suggested by the authors.

Darshan Shah et al (2013) Cost comparison of normal concrete and pervious concrete shown for 1 m 3 is Rs 587 and Rs 558 for M 20 grade concrete. It has been proved that that there is a considerable saving in using the pervious pavement. In another research they have shown 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.

(Talsania et al 2013) Theystudied the effect of rice husk ash on properties of pervious concrete. The investigation suggested that compressive strength achieved up to 10% replacement of cement with rice husk ash is optimum.

(Neetu B Yadav et al, 2013) India has been facing severe problem of falling ground table every year due to reduced recharge of rain water into sub soil and unplanned water withdrawal for agriculture and industry by pumping. Pervious concrete if adopted for construction of pavements, walkways, parking lots, it can become a component of rainwater harvesting schemes being prepared by Government of India on a priority basis. It may help us in reducing the runoff thereby decreasing the load on drainage system.

(Amanda Lidia Alaica, 2010) They focused on evaluating the performance of different pervious concrete mixtures in an endeavor to achieve an optimized mix with adequate tensile strength and porosity. In addition, a relationship was investigated between permeability and porosity of different mixtures. This is done in an attempt to use the porosity as a quick and easy quality control test for evaluating the permeability of pervious concrete. The mix design variables investigated in this study included aggregate-to-cementing materials ratio (A/CM), aggregate gradation and cementing materials blends; ternary blends of silica fume/slag and Met kaolin/Slag were examined. Single and hybrid fibre systems were also evaluated. These included Wollastonite natural fibres and polypropylene macro-fibres. Modifications to the permeability test proposed by ACI522R, "Pervious Concrete", were made to evaluate permeability of the specimens.

(Tighe, 2007, Henderson, 2009) Implementation of pervious concrete throughout requires that all parties involved have an understanding of the material as it is unique from conventional concrete. Mixes tend to be very stiff with low slump values, often 0mm. Construction practices for pervious concrete are not challenging but are different than those for conventional concrete streets and parking lots. Finally, the required maintenance for pervious concrete to perform in the climate needs to be understood.

(Schaefer, 2006) Pervious concrete pavement is a sustainable paving material that is beneficial to not only pavement and transportation industries but also stormwater management and planning groups. The concrete contains 15% to 30% air voids by limiting the fine aggregate content. Schaefer et al note that when comparing pervious concrete mixes in laboratory freeze-thaw testing mixes containing small amounts of fine aggregate performed better than those without. The inclusion of some fine aggregate in the mix also increased the strength of the samples. In addition, mixes containing admixtures such as latex and air entrainment had the best performance in freeze-thaw testing.

(Nader Ghafoori, Member ASCE, and Shivaji Dutta Student Member, ASCE 1995) This Paper traces the Development and applications of no-fine concrete for building and non-pavement applications. When compared with conventional concrete, no-fines concrete exhibits substantially different properties. Some of the noted characteristics of no-fines concrete are:

- Lower unit weight and drying shrinkage
- Higher permeability
- Higher thermal insulation values
- Lower compressive, tensile, and bond strengths
- Lower pressure on formwork during construction and longer curing time required prior to form removal
- Elimination of capillary attraction, and
- Economy in materials

III. CHARACTERISTICS OF PERVIOUS CONCRETE

As have been reported by researchers the properties of pervious concrete has been displayed in Table-1

Table -1 Physical Characteristics of Pervious Concrete

SrNo	Characteristics of pervious Concrete	Range of Values reported
1	Density in Kg/m^3	1500-2100
2	Void content, %	15-40
3	Permeability , L/m^2/min	100-300
4	Compressive strength, MPa	3.0 - 30
5	Flexural strength, MPa	1-4
6	Early Shrinkage in %	40-80

PERVIOUS CONCRETE AND ITS VOID SYSTEM

The objective of developing the pervious concrete is to design the void content to give optimum percolation of water. Now the void content of the pervious concrete depends upon the characteristics of the ingredients, proportioning and consolidation of the ingredients. The pervious concrete is typically designed for a void content of 15-40 %, But as the void content increases, the compressive strength decreases thus through the trial batches depending upon the optimum void content and compressive strength, the mixture should be proportioned. Further the mixture so designed must be workable and properly consolidated. Any way, it is a substantial fact that the absence offine aggregates will as such create substantial void content. Thus in pervious concrete the cement paste will coat the aggregate making it highly permeable. This permeable system is developed due to inter connected voids.

IV. ENVIRONMENTALLY FRIENDLYMATERIAL

The pervious concrete thus can allow the passage of water through it. In other words compared with conventional concrete, pervious concrete is porous as well as permeable and therefore it can be used in collecting the storm water and allowing it to percolate in the ground. Consequently, the ground water gets recharged Water table of the surrounding area gets improved. Thus the most important application of pervious concrete is recharging the ground water and reducing the storm water runoff. The pervious concrete is therefore called as, "Environmentally Friendly Material" This material has wider application for construction of parking pavements, residential streets, sidewalks, walk ways, apartment- ways where there is light traffic and the loading intensity is low.

V. PERVIOUS CONCRETE AND ITS APPLICABILITY IN INDIAN ROADS

It is possible to use the ecofriendly material in India. For the smart cities the use of pervious concrete will be suitable specifically for parking lots, pedestrian ways in the green spaces, morning walkways and in rural areas. The roads around the houses in rural and even in urban areas could be successfully constructed in pervious concrete and surfacing inside the compound can be made with pervious concrete. The objective however should be to improve the ground table. Most of our states find acute shortage of water in summer and the situation is horrible in cities. It is most essential that the urban spaces use pervious concrete and retain the filtered storm water for summer. This is another method of water harvesting which is quite safe and systematic for the states where residents do not get water for days together. The heavy construction cost can be eliminated by the use of pervious concrete. Field experience of many countries and current research have confirmed that it is a highly durable and strong material and its life is 25 years if properly constructed in its right proportions, compacted and cured in its correct perspective. It is said that the cracks development possibilities are less in pervious concrete and aesthetically the pavements appearance is also good and can be acceptable in India.

VI. CONCLUSION

This review paper looked at various studies conducted on permeable pavement systems and their current application. These permeable pavement systems are changing the way human development interacts with the natural environment. Its application towards parking lots, highways and even airport runways are all improvements in terms of water quality, water quantity and safety. From the previous research carried out on pervious concrete, the following points were drawn:

- The main objective of this paper is to introduce the importance of pervious concrete and its benefits for new pavements.
- The paper has discussed various properties of pervious concrete like mechanical, hydrological, environmental and durability aspects.
- The research gaps in the previous research studies will be helpful in the overall improvement and implementation of standards for pavements.
- Review of various papers shows that strength is inversely proportional to the permeability.

FUTURE ASPECTS

In the context of pervious concrete, making concrete eco-friendly with the needed properties such as permeability, abrasion resistance, flexural strength and compressive strength to be studied. By further research scheme, we can achieve eco-friendly, optimum compressive, tensile, flexural strength and good permeable concrete. 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 admixtures it can be possible to increment in strength of pervious concrete.

SUMMARY

In designing the concrete pavements for infrastructure and transportation planning, the porous pavements made from pervious concrete can help in reducing storm water runoff and recharging the ground water. The excess runoff can be prevented during heavy rainfall. Pervious concrete is environmentally friendly material and can be used in India. The research work in this direction is on the way.

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