A Review Paper on Pervious Concrete

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Abstract— Pervious concrete pavement is sustainable type of concrete pavement that can protect and restore natural ecosystem. Pervious concrete is emerging as an alternative material for paving to help curtail non-point source pollution problem. It is one of the most effective pavement material to address a no. of important environmental issue, such as recharging groundwater and reducing storm water runoff. In this experimental investigation on properties of pervious concrete are reported and discussed. The amount of general Portland cement has been reduced by introducing fly ash as cementitious agent in pervious concrete sample. The properties of pervious concrete samples including density, porosity, compressive strength, etc. According to the result, high porosity samples indicated higher permeability, whereas compressive strength was reduced. There was no significant difference between properties of pervious concrete samples containing fly ash and those samples only comprises only cement as cementitious agents.

Key words: Pervious Concrete, Cementitious Agent

I. INTRODUCTION

A. General:

Urbanization and the resulting increase in urban storm water over the past few decades have led to an increase in runoff and pollution. This increase directly affects the surrounding rivers and streams, with impacts such as increased stream bank erosion, decreased water quality, and decreased base flow as areas become less and less pervious. In recent years, porous concrete pavements have become popular as an effective storm water management device. Porous concrete pavement may be new in some areas in the world. According to Mark et al. porous concrete technology has been used since 1970s in various parts of the United State as an option to complex drainage systems and water retention areas.

Ghafoori and Dutta found in their literature review, the earliest application of porous concrete was in the United Kingdom in the year 1852. The most common application includes driveways, parking lots, sidewalks, streets and also other low traffic volume areas.

B. Porous Concrete Pavement

Porous concrete also called as pervious concrete, No-fines concrete and Permeable concrete. Porous concrete is a special type of cementitious material composed of gap graded aggregates, coated with a thin layer of cement paste and bonded by the cement paste layers partially being in contact. Porous concrete is a concrete with continuous voids which are purposely incorporated into concrete. This type of concrete completely different category from conventional concrete and therefore its physical characteristics differ greatly from those of normal concrete. Fig. 1 show a schematic diagram of porous concrete. The figure shows that the porous concrete has a large size of voids. It differs with conventional concrete which have small or micro voids.

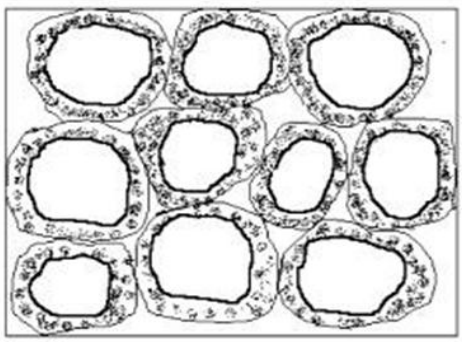

Fig. 1: A schematic diagram of Porous Concrete

Porous concrete was developed as an environmentally friendly material in the 1980s. Because of the multiple environmental benefits to control storm water runoff, restoring groundwater supplies and reducing water and soil pollution, it has been widely used in Japan, USA and Europe. The porous concrete has been utilized in road pavements due to its performances of water-permeating, water-draining and water retaining. In addition, it is currently used in various applications that require noise absorption or thermal insulation. According to Specifier's Guide for Pervious Concrete Pavement Design, the recommended structure's void of the porous concrete is 15% minimum and 25% maximum. A lot of study has been conducted by other researcher and usually, the ranges of voids percentage are within 15% to 30%. There is several reason of hardened concrete strength tends to decrease. One of the reason are voids content in the hardened concrete itself. From the literature review, it is also found that, when the void percentage increases, the strength of the hardened concrete tends to decreases. Porous concrete has been used for many years, but there are still many outstanding issues related to its structural performance. Even though fundamental information including the influence of the water-cement (W/C) ratio, void ratio, cement paste characteristic, volume ratio of coarse aggregate, size of coarse aggregate and strength of porous concrete have been studied, the optimum condition to produce good porous concrete still not been established.

II. LITERATURE REVIEW

Satish Kumar, Dr. Devinder Sharma, Er. Neeraj Kumar, A review paper on permeable concrete as a road pavement (December 2017), There is analysis of size of aggregate (25mm), for future study or analysis. Pervious concrete is a special type of concrete with a high porosity used for concrete pavement application that allows water from precipitation and other sources to pass directly through it, thereby reducing runoff from a site and allowing ground water recharge.

Shriravindrarajan Rasiah, Properties of pervious concrete containing fly ash (March 2012), Compressive strength of pervious concrete is relatively low due to high porosity and it can be decreased by 40% if a high percentage replacement of cement concrete with fly ash (i.e. 50%) is used. The average water permeability coefficient of pervious concrete is approx. 13mm/sec . Due to the water flow from laminar to turbulent , a low water head of 100mm would be suitable water head to determine the water permeabilty,.Physical properties of environmental friendly pervious concrete are in acceptable range for limited use, when produces with upto 50% fly ash as a partial replacement of Portland cement.

S. Dash, B. Kar, Environment friendly perious concrete for sustainable construction(2018), The paper looked at varies studies conducted on permeable pavement system and their current applications such as detailed design of permeable interlocking concrete pavement, maintenance and water quality control aspect. The permeable pavement system are changing the way human development interacts with natural environment. Its application towards parking lots, highways and even airport runways are all improvement in terms of water quality, water quantity and safety.

V. M. Malhotra, Permeable concrete – Its properties and application (1976), It is found that the density of permeable concrete is generally about 70% of conventional concrete when made with similar constituents. The density of permeable concrete using conventional aggregate varies from 1602-1922 kg/m³.The use of mechanical vibrator and ramming is not recommended with permeable concrete. The light rodding ensure that the concrete has penetrated all the areas impeded by reinforcing steel

Abadjieva, Investigations on some properties of permeable concrete (1997), the compressive strength of permeable concrete increases with age at a similar rate to conventional concrete. The 28 day compressive strength obtain by aggregate –cement ratio 6:1 to 10:1 range from 1.1 and 8.2MPa. He found that aggregate –cement ratio of 6:1 being the strongest. He concluded that the reduce strength was caused by the increase porosity of the concrete sample.

Ghafoori, Experimental investigations on permeable concrete (1995), The curing types were investigated to determine if there was any difference between wet and sealed curing It was clear from the test results that the strength development of permeable concrete was not dependent upon the curing condition. The indirect tensile test conducted by Ghafoori found that the sample tests varied between 1.22 and 2.83 MPa. He produce permeable concrete with a compressive strength in excess of 20MPa when using an aggregate–cement ratio of 4:1.

Porous Pavements: The Overview Ferguson, B. K., University of Georgia, Eight years of research have recently concluded with the first comprehensive review of porous pavement technology and applications resulting in the book, Porous Pavement, authored by Bruce Ferguson. It defines nine families of porous paving material each of which has distinctive costs, maintenance requirements, advantages and disadvantages for different applications, installation methods, sources of standard specifications, and performance levels.
Learning Pervious: Concrete Collaboration on a University Campus Hein, M. F. and Schindler, A. K., Auburn University, on the campus of Auburn University, architecture and construction students are working side by side with university facilities personnel as they learn by building with pervious concrete. Since the fall of 2003, six pervious concrete slab projects have been successfully built including: a sidewalk, a parking lot, a paved picnic area, and colored pervious arboretum walking trails. Each new project has been filled with learning opportunities as students and workers have experimented with the materials and application techniques of pervious concrete.

The Use of Pervious Concrete at Wal-MartPool, A. V., National Ready Mixed Concrete Association This presentation highlights the use of pervious concrete at a number of Wal-Mart stores, including two environmental "experimental" Wal-Mart stores. Pumped-in-Place Permeable Grout Systems,

Permeation Grouting Bechtel Corporation Technical Grant, pp. 1-44, 2002 Yen, P. T., Sundaram, P. N., and Godwin, W. A., The technology of grout injection to provide structural support beneath foundations has been practiced in construction since 1802. The materials have traditionally been a mixture of portland cement, water and often a filler, such as sand. This is mixed as a slurry and pumped into the desired area, usually the interface between constructed foundations and the in situ soil or rock, forming a structural bond that is rigid and not normally pervious.

ACPA, Cement-Treated Permeable Base for Heavy-Traffic Concrete Pavements, IS404, American Concrete Pavement, In recent years, several agencies have experimented with or specified drainable pavements on interstate and other major roadways where experience has indicated the potential for pavement faulting and pumping. These drainable systems consist of highly permeable base courses and edge drains that are designed to carry infiltrated surface water away very rapidly.

Pervious Concrete Pavements On Slope, 2004 Pages 13 to 14 Tennis, P. D., Leming, M. L., and Akers, D. J., PCA and NRMCA, Pervious concrete pavements have been placed successfully on slopes up to 16%. In these cases, trenches have been dug across the slope, lined with 6-mil visqueen, and filled with rock (CCPC 2003). (See Figures 8 and 9.) Pipes extending from the trenches carry water traveling down the paved slope out to the adjacent hillside. The high flow rates that can result from water flowing downslope also may wash out subgrade materials, weakening the pavement. Use of soil filter fabric is recommended in these cases.

Pervious Concrete: The Smart Stormwater Solution Morrison, C. L., You know the stuff: impervious to water, channels runoff. But what happens when - without sacrificing strength or durability - water drains right through it? Consider if roads and driveways, sidewalks and parking lots could let rain wash directly into the ground, where it's naturally filtered on its way to our aquifers. No runoff, no drains, no catch basins, detention vaults or piping systems. No kidding.

Permeable Concrete for Drainable Pavement Bases Rapp, C. A., Permeable concrete is gaining acceptance for use as a pavement base course. As shown in Figure 1, this material produces a finished base course that is highly porous but stable. These properties produce three benefits: The material’s drainable nature protects the primary pavement from harmful effects of surface and subsurface water.

Strength and durability of permeable concrete provide a highly protective cover over the aggregate base and a strong working platform for placing concrete pavement. Ease of construction is a significant cost and scheduling factor. The material can also be used for erosion control on side slopes and in paving ditches. In this usage it reduces runoff by allowing water percolation but still prevents soil erosion.

III. SUMMARY

In this chapter literature of various research paper of different authors are cited and their summary is presented. However, it was observed that most of the research paper has discussed the properties of pervious concrete are from foreign countries. There are very less no. of research paper from India which have discussed about the pervious concrete. It is also observed that pervious concrete has a great potential to reduce roadway noise, improve splash and spray, and improve friction as a surface wearing course. A pervious concrete mix design for a surface wearing course must meet the criteria of adequate strength and durability under the site-specific loading and environmental conditions. To date, two key issues that have impeded the use of pervious concrete are strengths of pervious concrete have been lower than necessary for required applications

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