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State-Of-The-Art Review on Permeable Concrete

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Abstract

The main purpose of this review paper is to outline the various research works carried out in the field of permeable or pervious or no fines concrete in real time applications and understanding its behavior. This paper summarizes a wide range of literature carried out in the field of permeable pavement by keeping in view the current trends in research industry and highlighting the future cope in this area.

Keywords: *Permeable Concrete, Environmental Protection Agency (EPA), Polymer-modified pervious concrete (PMPC), Concrete Pavement.*

INTRODUCTION

Permeable concrete is a type of concrete which does not contain any fines and therefore also called a no fines concrete or porous concrete. Due to absence of fines the permeable concrete has high porosity which allows the water through precipitation to pass through it easily therefore minimizing the surface runoff and contribute greatly to groundwater recharge. Permeable concrete contains cement, little of no fines and coarse aggregate with a water binder ratio of 0.28 to 0.40 with 15 to 25 percentages of voids. The use of pervious concrete is one of the best management practices by Environmental Protection Agency (EPA) of United States for storm water management. Permeable concrete is like a infiltration basin which allows the water from the storm to infiltrate the sol over large area thus recharging the ground water supplies which in turn leads to more effective land use.

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EXPERIMENTAL INVESTIGATIONS

James and von Langsdorff studied the use of permeable concrete block pavement in controlling the environmental stressors in urban areas. The main objective of the study was to establish a relationship between the capacity of infiltration and the age of the no fine concrete on various land uses and maintenance practices. From the study it was found that the capacity of infiltration depends on the base specifications of the test installations, traffic and the percentage of fines which is inversely proportional to the rate of infiltration. Infiltration capacity to a smaller extent depended on the percentage of VOC present in EDC. In medium ADT applications the infiltration rates were found to be lower than the low traffic applications.

Eban Z, William F and David A investigated the infiltration rates of permeable pavement surfaces by conducting a field survey in around 40 pervious pavement sites in North Carolina, Maryland, Virginia, and Delaware. To determine the infiltration rates pre maintenance and post maintenance tests were performed on a 15 concrete paver filled with sand. It was found that after simulated maintenance the infiltration rate increased from 4.9 cm/hr to 8.6 cm/hr.

Dr. Soenke Borgwardt studied the long term In-situ performance of permeable concrete block pavement. In this research the infiltration of the pavement was determined by using infiltration instrument and it was determined that there is a significant relation between infiltration and age. By analyzing the infiltration it was concluded that due to the presence of mineral and organic entrainment the infiltration performance is highly affected by the age of permeable concrete. A runoff coefficient of 0.3 to 0.5 was recommended for permeable pavement as compared to non–permeable concrete which has a runoff coefficient of 0.8.

Nader Ghafoori and Shivaji Dutta studied the Development of no-fines concrete pavement applications in United States and Europe since 1852. Since 1950’s, due to extreme boom in the development of urbans areas there has been a drastic increase in the volume of runoff and peak stream flow resulting in instability of streams and degradation in the water quality. As a result new laws were passed which encouraged the land developers to implement safe storm water management

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practices. Detention and exfiltration tanks were installed to contain runoff but those required continuous maintenance and were expensive, to overcome such problems porous concrete or no fine concrete was introduced which resulted in reducing the run-off and increase in ground water recharge.

Liv M. Haselbach_, Srinivas Valavala, Felipe Montes predicted the permeability for sand-clogged Portland cement pervious concrete pavement systems. They developed a theoretical relation between the permeability of clogged and unclogged sand pervious block of concrete and measured the permeability of Portland cement fully covered with extra sand in simulated rainfalls. From the experimental results it was determined that the results correlated exceptionally well with the results calculated theoretically. A simulation was done for rainfall rates with a combination of both direct rainfall and storm water runoff for two different slopes 2% and 10 % and it was found that the pervious concrete block allowed a flow rate above 0.2cm/s.

Saeid Hesami, Saeed Ahmadi and Mahdi Nematzadeh investigated the effects of rice husk ash and fiber on mechanical properties of pervious concrete pavement. For this purpose, to strengthen the pozzolanic cement paste with 0%, 2%, 4%, 6%, 8%, 10% and 12% weight percentages as a cement replacement in concrete mixtures along with rice husk was used to determine the mechanical properties of concrete with 0.2% Vf of glass, 0.5% Vf of steel and 0.3% Vf polyphenylene sulfide (PPS) fibers (where Vf is the proportion of fiber volume to total volume of concrete). Various water cement ratios were adopted as trial and error to determine the physical and mechanical properties of the concrete. From the results it was concluded that the mechanical properties of concrete containing fibres improved drastically with a water cement ratio of 0.33.

Baoshan Huang, Hao Wu, Xiang Shu and Edwin G. Burdette conducted Laboratory evaluation of permeability and strength of polymer-modified pervious concrete. For the same a laboratory experiment was organized to boost the strength of pervious concrete by focusing on a balance between permeability and strength properties of polymer-modified pervious concrete (PMPC) by incorporating latex polymer, natural sand and fibers. From the tests obtained it was concluded that the

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combination of combination of latex, natural sand, and fiber produced justifiable pervious concrete with both strength and drainage properties whereas the use of latex and sand decreased the porosity and permeability but improved the compressive strength of concrete.

Alireza Joshaghani, Ali Akbar Ramezanianpour, Omid Ataei and Amir Golroo studied the optimizing techniques of pervious concrete pavement mixture design by using the Taguchi method. The major agenda of this investigation is to evaluate the physical and mechanical properties like density, strength, Porosity, and permeability of pervious concrete. From the results obtained it was concluded that with the increase in the size of coarse aggregates the porosity and permeability increased with a slight decrease in the compressive strength.

Yail J. Kim, Adel Gaddafi and Isamu Yoshitake conducted studies on permeable concrete mixed with various admixtures. The study included the live load intensity of traffic-induced distress of permeable concrete mixed with fly ash, fibers and tire chips along with the load bearing and hydraulic characteristics. From the investigations it was concluded that the inclusion of fly ash and tire chips reduced the load carrying capacity of the permeable concrete whereas the inclusion of fibers improved both the load carrying capacity as well as the infiltration rate.

C. Lian and Y. Zhuge worked out the Optimum mix design of enhanced permeable concrete. For the same three common types of aggregates from Australian local quarries were investigated and compared via laboratory testing From the experiments conducted it was found that the use of dolomite was effective in improving the strength and abrasive properties of porous concrete but had lesser permeability as compared to quartzite which had a lower flakiness index but the presence of impurities like iron oxide on the surface of quartzite made it less desirable as compared to dolomite.

CONCLUSION

Based on the experimental reviews it can be concluded that permeable concrete is one of the best practices to reduce the surface run off as it acts as an infiltration basin. As permeable concrete consists of only coarse aggregates and no fine aggregate therefore its strength characteristics are to be looked into. Various experimental investigations were

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conducted to improve the strength of the permeable concrete by using various admixtures and coarse aggregates and it was concluded that using admixtures the mechanical properties of the permeable concrete can be improved.

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