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Center for Advanced Cement - Based Materials

The Institute for Safe, Quiet, and Durable Highways

DEVELOPMENT OF QUIET AND DURABLE POROUS PORTLAND CEMENT CONCRETE PAVING MATERIALS

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By:
Jan Olek, Principal Investigator
W. Jason Weiss, Principal Investigator
Narayanan Neithalath, Research Assistant
Adam Marolf, Research Assistant
Eric Sell, Research Assistant
William D. Thornton, Research Assistant
School of Civil Engineering
Purdue University

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Approved By: Robert J. Bernhard, Director
Vincent P. Drnevich, Co-Director
The Institute for Safe, Quiet and Durable Highways

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16. Abstract
This report outlines the systematic research effort conducted in order to develop and characterize Enhanced Porosity Concrete (EPC) to mitigate the problem of tire-road interaction noise. The basic tenet of this research is that carefully introduced porosity of about 15% - 25% in the material structure of concrete will allow sound waves to pass through and dissipate its energy. EPC mixtures were proportioned with three different aggregate sizes, and the binary blends of these sizes. The physical and mechanical properties of these mixtures were studied in detail. Methods to determine the porosity of EPC were developed. Flexural strengths of EPC specimens were studied in detail, and the influence of sand content, and silica fume were ascertained. The acoustic absorption coefficients of EPC were determined using an impedance tube. It was found that the pore volume and pore sizes have a significant influence on acoustic absorption. The tortuosity of the pore network, which forces the waves to travel longer, and the frictional losses in the pore walls are the main mechanisms that are responsible for energy loss. The influence of specimen thickness on the acoustic absorption coefficient is also brought out. Using a simple shape specific model, and incorporating the principle of acoustic wave propagation through semi-open cells, the acoustic absorption in EPC has been modeled. The model agrees with the experimental values quite well.

In this study, EPC has been characterized by using electrical impedance spectroscopy. Using a multi-phase conducting model, a pore connectivity factor has been developed, that correlates well with the acoustic absorption coefficient. This factor takes into effect the features of the pore structure in addition to porosity, in determining the material performance. A falling head permeameter has been developed to ascertain the water permeability of EPC mixtures. Permeability depends on parameters other than porosity, which are hard to experimentally measure. Therefore, a hydraulic connectivity factor has been developed, the variation of which with intrinsic permeability is linear. This factor could be used to classify EPC mixtures based on their permeability. The intrinsic permeability also could be predicted using electrical conductivity. Thus, electrical conductivity is a single measurable quantity that can vastly help in the prediction of properties of EPC.

Selected EPC specimens were tested in TPTA to evaluate their noise reduction. It was observed that EPC specimens reduce the noise at greater than 1000 Hz frequency whereas at frequencies less than 1000 Hz, they are not very beneficial.

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