Investigation of Physical and Dynamic Properties of High Porous Concrete

Investigating dynamic properties of porous concrete as a function of grain size, concrete mixture composition, and permeability

Highly porous concrete is a new promising technology, which can be applied to the construction of pavements, walkways, streets, and parking lots in Louisiana. Porous concrete allows water to penetrate through the pavement during heavy rain periods, which helps avoid flooding, increases safety, and reduces the number of accidents. While maintaining high permeability, the concrete must also sustain high compression stresses to resist destruction from various loads. This challenging issue can be solved through the correct mixture of gravel size, weight percent content of the composition, and experimentally optimizing the compression stress and permeability relationship. The project includes cost optimization of the best suitable sample compositions in order to evaluate economic sustainability of the product.

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Background

Louisiana has the 11th largest highway system in the nation and 30th national ranking in total miles of public roadways. Water related crashes are those that occur in the presence of adverse weather and slick pavement conditions. According to data from the US DOT for 2004 – 2015, flooded roads experienced approximately 15x more damage compared to well-drained cases. Futhermore, 15% of all accidents with fatalities are a result of wet road conditions. With the occurrence of inclement and hazardous weather conditions such as flood and hurricanes, standing water is a safety concern for drivers and pedestrians in Louisiana (and other states where residents rely on walking or accessing transit for their primary mode of transportation).

Project Summary

The following objectives are part of this study:

- Developing a new cost effective material to enhance the durability of infrastructure;
- Responding to regional priorities in transportation to enhance resiliency under the hazardous weather conditions;
- Promoting workforce development opportunities in keeping with BRCC's mission of excellent teaching using innovative techniques.

Concrete samples of different porosity and permeability are produced from commercially available granular material, Portland cement, and some additives to make the sample more stress resistant. Using different size of granular material, it is possible to control permeability of the sample. However, stress resistance is backward proportional to permeability, therefore the optimal grain size is needs to be determined in order to reach acceptable permeability and high compression stress. A group of research students are producing samples at the BRCC laboratory facility. Students are developing hands-on skills in preparing and evaluating samples. Laboratory activities include: weighing ingredients, mixing the concrete slurry, and observing the process of shaping and solidification.

Ten samples with the same mixture composition will be used for collecting data. Students will be testing concrete samples for defining permeability, maximum compression stress and strength, and water absorption.

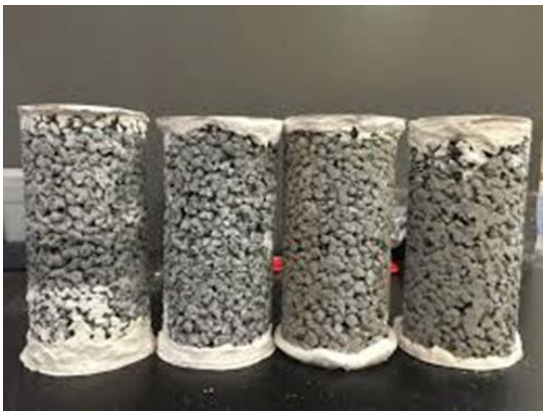

Figure 1. Concrete samples of varying porosity and permeability.

The obtained data will be analyzed (using statistical computer software) to define the optimal mixture composition.

Status Update

At this stage of the research, 36 samples have been prepared and waiting for the laboratory tests to measure stress-strain and permeability. The initial water absorption test was conducted by a student team for three sample groups. The grain size increase in the cement mixture leads to increasing water absorption, as predicted. The next step will include producing additional 64 samples of different composition and analyzing collected data.

Figure 2. Concrete samples ready to be tested.

Impact

The potential impact of this project is significant. The partnership with the Louisiana Department of Transportation and Development (LaDOTD) has been successful and will lead to the opening of a new certificate program for highway engineering technician training at Baton Rouge Community College (BRCC).

The research findings may initiate new pavement design applications involving high porous concrete that will benefit the state of Louisiana. Under the supervision of LaDOTD, the new product can be implemented in Louisiana parking lots, sidewalks, and other walking paths. Additionally, the partnership with Tran-SET is leading to a new era/research approach in BRCC education that combines hands-on experimental work and theoretical knowledge.

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

Learn More

For more information about Tran-SET, please visit our website, LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Mr. Christopher Melson (Tran-SET Program Manager) directly at transet@lsu.edu.