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Sensitivity Analysis on Semi-Circular Bending Tests Using the Plackett-Burman Matrix

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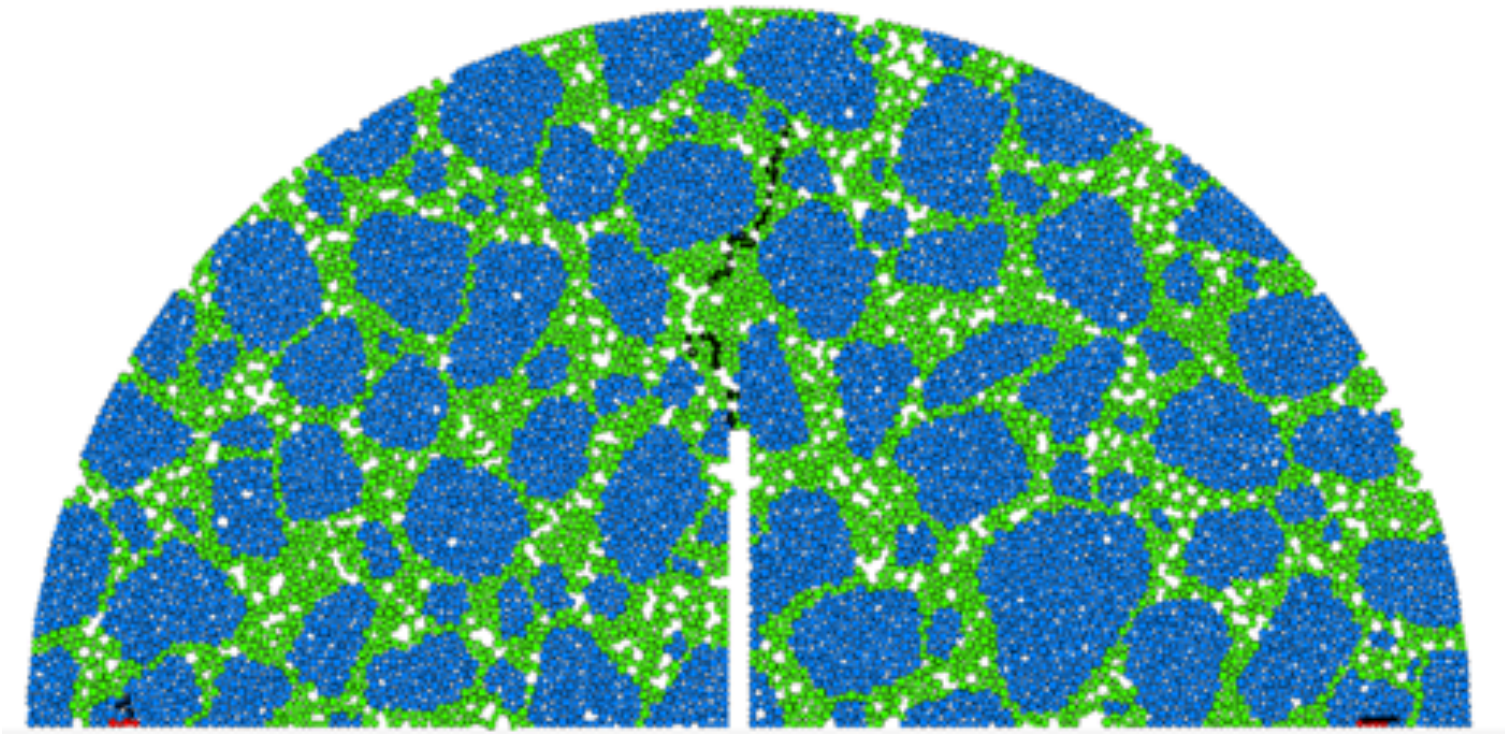

Fatigue resistance of asphalt concrete (AC) is defined as the ability of the AC to resist repeated traffic loading without significant cracking or failure. Several fatigue tests were developed to investigate the fatigue resistance of AC. There have been multiple standards and tests to make sure that asphalt concrete mixture can withstand the traffic load. The Semi-Circular Bending test (SCB) is a standardized test accredited by ASTM to compare the cracking resistance of asphalt mixtures prepared with different binder grades and aggregate types. SCB test has plenty of parameters that affect its results; in this study, some of these parameters were examined to find the impact of each of these parameters on SCB test results. Examining all these parameters would be cumbersome using traditional statistical techniques, as they require a significantly high number of samples.

Study Methods

The Plackett-Burman (PB) technique was used to perform a sensitivity analysis. The PB method relies on a limited number of scenarios to study the effects of multiple parameters. Seven parameters have been examined and include, notch location, notch depth low, intermediate and high, air voids, loading rate, and span length. Even with the usage of the PB technique there have been 16 scenarios that need to be tested for each of the three notch depths; whereby the process requires plenty of time and material. In order to turn around this problem, a Discrete Element Method (DEM) is used to develop a model that will substitute the need for an actual lab test.

Findings

The key findings

- Intermediate notch depth had the most impact on the Jc Value. As seen in table 8, intermediate notch depth had the highest absolute value of all parameters making it the most critical to the output of the SCB.
- Notch location had the second highest impact on the Jc Value; a 1 mm misplacement of the blade from the center would cause the results of the SCB to change significantly.
- Loading rate and air voids had a negative impact on the Jc Value. In other words, an increase in the values of these two parameters caused the SCB results to decrease, their impact is also significant when compared to the other parameters.
- Low and high notch depths appeared to be the least impactful on the Jc Value. Low and high notch depths have only 1 - 2% impact when compared with the intermediate notch depth.

Changes in the notch location from the center has a high impact on the results of the SCB.

Policy Recommendations

The results showed that it is highly recommended to be careful when preparing SCB samples specifically when cutting the middle notch and when centering the notch location because any mistake in these two parameters will cause a significant error in the test results and that might cause fatigue cracking at an earlier than expected period and multiple hazardous problems.

About the Authors

Shadi Saadeh is a professor at California State University Long Beach. He holds a bachelor's degree in civil engineering from University of Jordan, a master's degree in civil engineering from Washington State University, and a doctorate degree in civil engineering from Texas A&M University. Yazan is a master's student at California State University Long Beach. He holds a bachelor's degree in civil engineering from Yarmouk University. He has an interest in construction management, pavement design, and development. David Renteria is a Field Engineer at Terracon Consultants. He holds a Bachelor's Degree in Civil Engineering from The University of Texas Pan American, and a master's degree in Mechanical Engineering from the University of Texas Rio Grande Valley.

To Learn More

For more details about the study, download the full report at transweb.sjsu.edu/research/1869.

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