An Investigative Study on Implementation of Asphalt Cracking Screen Tests

CONS 477-Capstone Project- Spring 2022- Sean Shepard, Dyllon Bougor, Ryan Permual, Truman Jones, Dr. Adrienne Rygel, Dr. Aksel Seitllari

Introduction

For years, asphalt has been used to make the roadways of the United States smoother, safer, and more convenient for travel for the general public. Along with the convenience of asphalt, the state department of transportation has struggled with finding a balanced mix design that will resist premature failure of asphalt pavements (i.e., cracking and rutting), and improve the overall service life. Premature failure of pavements could be costly, and their rehabilitation often requires full closure of traffic. The end goal of pavement engineers is to develop an asphalt mix that will improve cracking and rutting performance of asphalt pavements within a reasonable budget.

Methodology of a Balanced Mix Design

A balanced mix design (BMD) can be defined as a mixture of binder, aggregate, and mixture proportions that will meet performance criteria for a diverse number of pavement distress for given traffic, climate, and existing pavement conditions. (2) There are three approaches to BMD.

1. Volumetric Design with Performance Verification- most commonly used, uses performance testing and volumetric and performance testing criteria. (5)

2. Performance-Modified Volumetric Design- begins with volumetric evaluation of asphalt and aggregate combinations followed by performance testing. (5)

3. Performance Design- no volumetric considerations, objective is to meet performance testing criteria. (5)

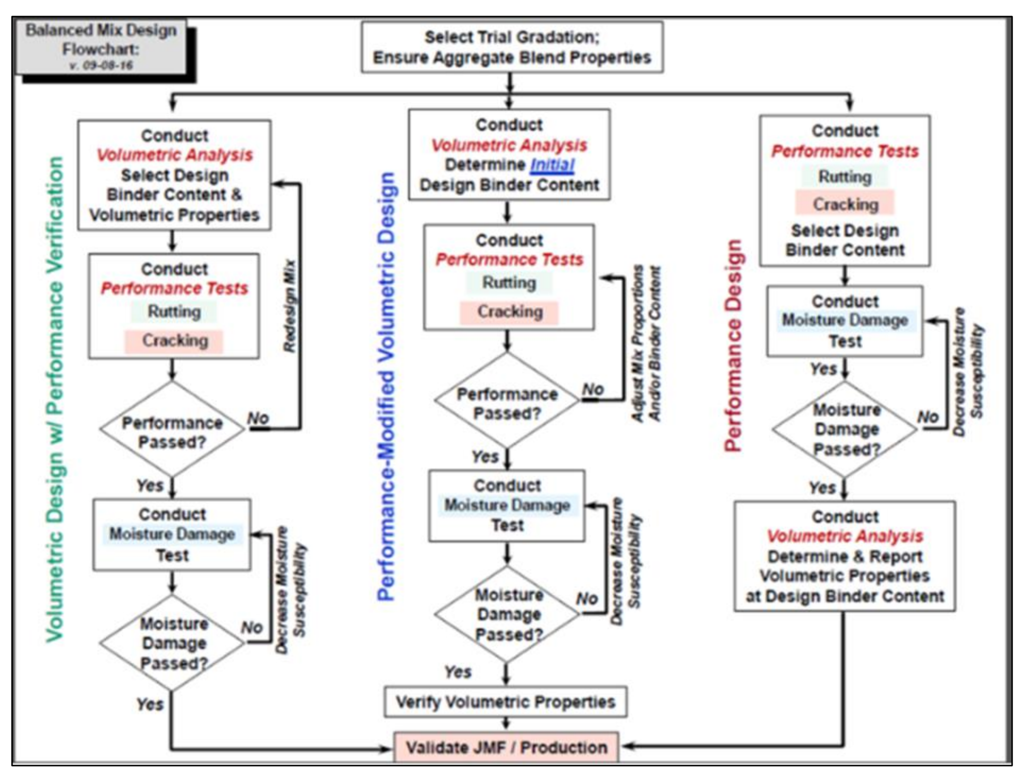

Figure 1: Balanced Mix Design Approaches

Common Pavement Distresses

What is Cracking?

- Cracking is deemed the one of the most common pavement distress methods.

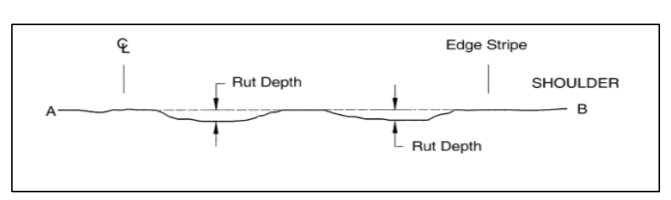

Figure 2: Cross Section of Rutting

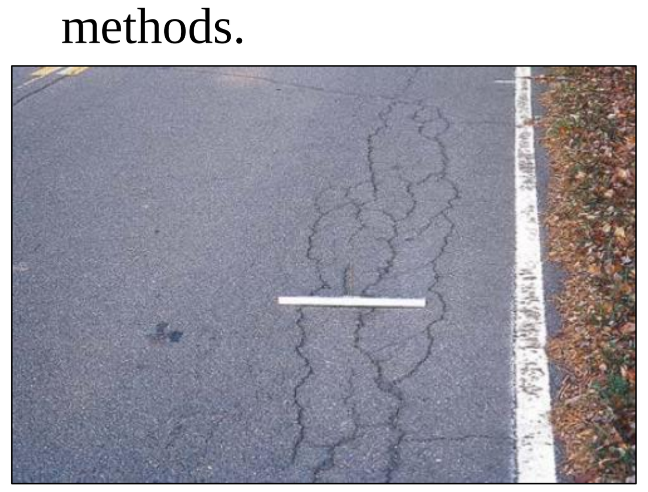

Figure 3: Fatigue (bottom-up) Cracking

- The factors that affect distresses in pavement are climate, traffic loading, and structure.
- Cracking is caused by tensile and compressive strains.
- Specifically the most common distresses are called fatigue (bottom-up) cracking and rutting.

Objectives

Two testing procedures to determine the cracking resistance of pavement samples have been performed and evaluated. The two tests are the Indirect Tension Test (IDT), and the Semi-Circular Bend (SCB) Test. The objectives from these two tests are to:

- Learn how to analyze the results from the two tests.
- Compare the results and determine if one or both tests are reputable.

Testing Procedures

1) Indirect Tension Test – IDT

The Indirect Tension Test (IDT) is used to simulate cracking of asphalt pavements. To perform this test, the asphalt sample is:

- Placed in the testing apparatus
- Subjected to a compressive load at a rate of 50mm per minute until the sample reaches failure.

A Load versus Displacement Curve is generated, and from the curve the CT_{index} of the sample is established and used to determine cracking performance.

Figure 4: IDT Testing apparatus and sample

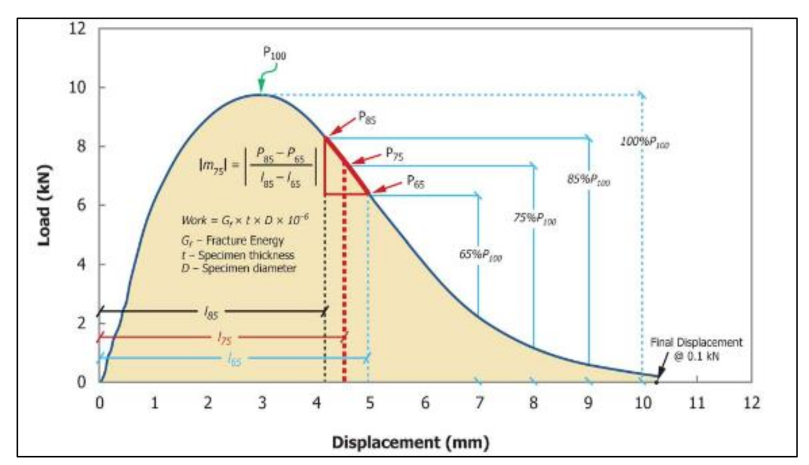

Figure 5: Recorded Load (*P*) vs. Load-Line Displacement (*l*) Curve

What is the Ct_{index} ?

- The CT_{index} can be defined as the cracking tolerance index, value used to evaluate a mixtures resistance to cracking.

2) Semicircular Bend Test - SCB

The SCB is used to simulate cracking of asphalt pavements. To perform this test, the asphalt sample is:

- Precisely cut in half and notched along the curved edge
- Subjected to a compressive load at a rate of 0.03- 0.05mm per minute until failure.

The Flexibility Index (FI) is found from the SCB with the use of a Load versus Displacement Curve. Using the post-peak data, specifically the slope, the FI can be calculated.

Figure 6: SCB Testing Apparatus

What is the Flexibility Index (FI)?

- The flexibility index can be defined as the value used to determine a mixtures resistance to cracking.

Results and Analysis

Four mixtures containing varying design parameters were subjected to the IDT Test and evaluated.

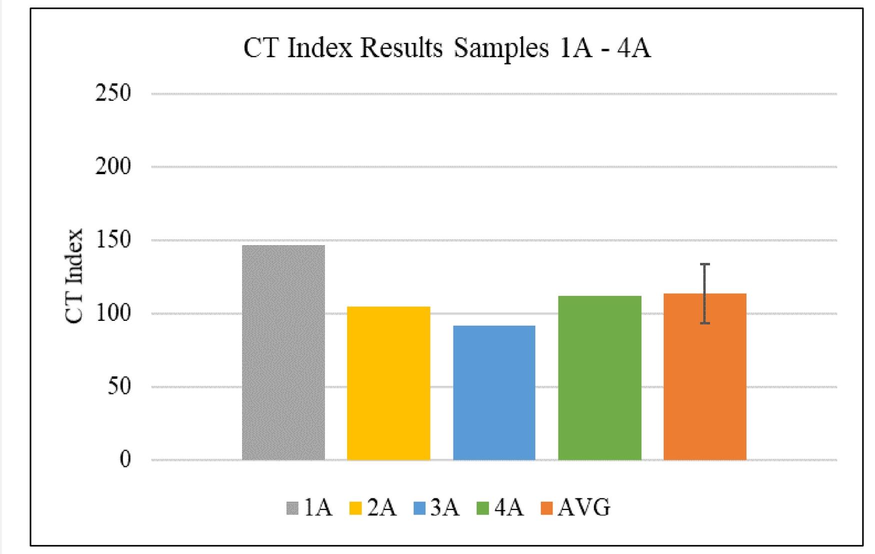

Figure 7: Results of IDT of Mixture A

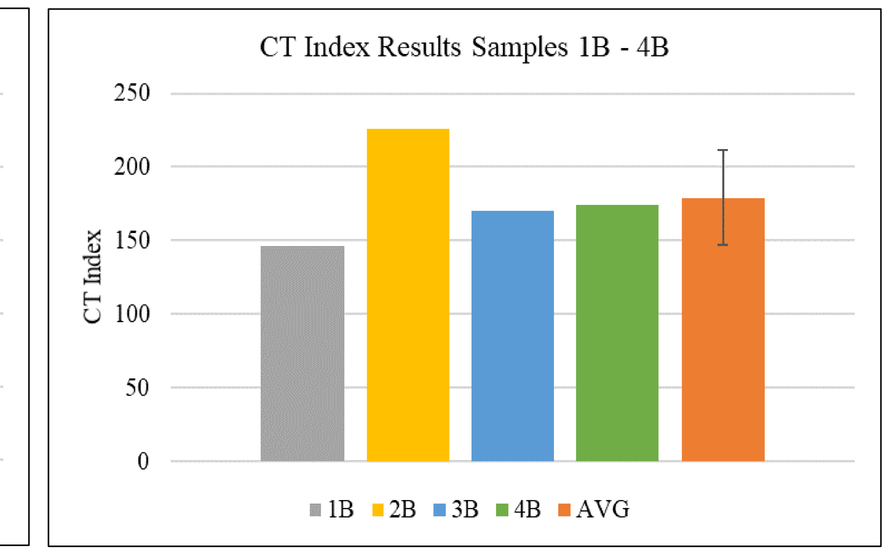

Figure 8: Results of IDT of Mixture B

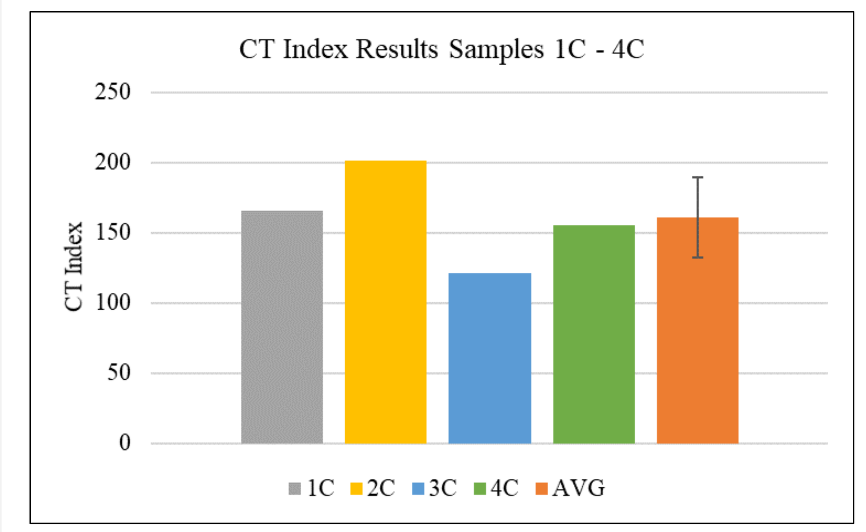

Figure 9: Results of IDT of Mixture C

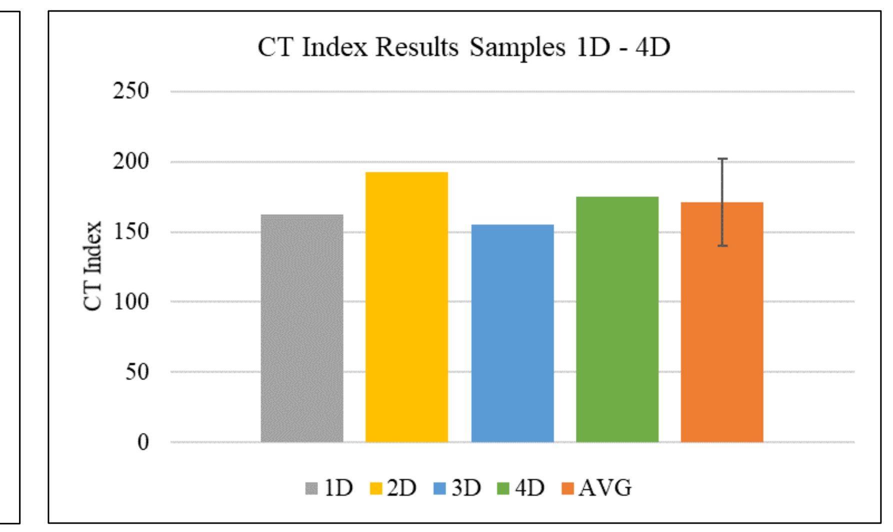

Figure 10: Results of IDT of Mixture D

A total of 4 samples were tested for each mixture. Each mixture contained separate design parameters. The CT_{index} of each and the average are summarized below.

Mixture A
- Sample 1A = 146.82
- Sample 2A = 104.42
- Sample 3A = 91.42
- Sample 4A = 111.92
- **Average A = 113.65**

Mixture B
- Sample 1B = 146.63
- Sample 2B = 225.68
- Sample 3B = 169.83
- Sample 4B = 174.39
- **Average B = 179.13**

Mixture C
- Sample 1C = 165.30
- Sample 2C = 201.60
- Sample 3C = 121.35
- Sample 4C = 155.19
- **Average C = 160.86**

Mixture D
- Sample 1D = 162.50
- Sample 2D = 195.22
- Sample 3D = 155.35
- Sample 4D = 174.87
- **Average D = 171.24**

Mixture B, based on the average CT_{index} values, appears to have performed as the best mixture. When analyzing CT_{index} values, the higher the CT_{index} values the better the mixture will perform under traffic loading in the field. Mixture B will have a higher cracking resistance when compared to the other mixtures.

The SCB Test is ongoing and the results will be analyzed upon it's completion. At this time, the two test methods will be compared and conclusions derived.

References

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