Project Summary
Texas Department of Transportation

0-5261: Using Imaging Technology to Improve the Laboratory and Field Compaction of HMA

Background

The performance of asphalt mixtures is significantly influenced by the degree of compaction. Insufficient compaction leads to poor asphalt pavement performance even if all desirable mixture design characteristics are met. Poor compaction can result in premature rutting, excessive aging, and moisture damage. This project evaluated the effect of changes in field compaction patterns on degree of compaction and uniformity of air void distribution in asphalt pavements. This uniformity leads to asphalt pavements with more uniform properties and improved performance. The researchers developed a method to relate field compaction to laboratory compaction in order to predict asphalt mixture compactability based on laboratory measurements.

What the Researchers Did

The researchers compacted different types of hot mix asphalt (HMA) in a number of field projects and obtained cores from different locations of these projects. The researchers recorded information such as type of compaction equipment, number of passes, location of each pass, and mat temperature. The X-ray Computed Tomography (X-ray CT) system captured air void distributions in recovered field cores. The X-ray CT images were used to develop maps of air void distributions across the pavement surface and depth. For a given HMA, laboratory and field compaction data were compared. The effect of different levels of compaction on the performance of asphalt mixtures was studied using a fracture mechanics approach and the Discrete Element Method. Properties of HMA mixtures were measured using the Overlay Tester, Hamburg Wheel Tracking Device, and Permeability Test. An experimental laboratory procedure was developed to measure the moisture diffusion coefficients of HMA.

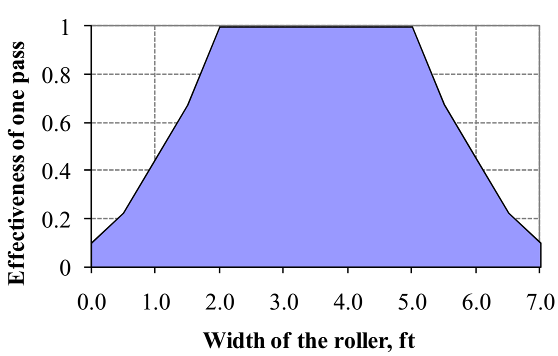

Figure 1. The Effectiveness Distribution Across a Roller Width.

Research Performed by:

Texas Transportation Institute (TTI),
The Texas A&M University System

Research Supervisor:
Eyad Masad, TTI

Researchers:
Arif Chowdhury, TTI
Emad Kassem, TTI

Project Completed: 8-31-08

What They Found

The findings of this study can be summarized as follows:

- The uniformity of air void distribution is highly related to the compaction pattern and the sequence of using different compaction equipment. More importantly, the efficiency of compaction (reducing air voids) at a point was found to be a function of the location of this point with respect to the roller compactor width. The efficiency of compaction at a point increases as the location of this point gets closer to the center of the roller (Figure 1).
- The researchers proposed the Compaction Index (CI) to quantify the compaction effort at any point in the pavement. This index is the summation of the multiplication of each pass with the effectiveness factor. The compaction of longitudinal joints can be improved with an increase in the CI by overhanging the roller about 2.0 ft from the joint.
- The slope of the compaction curve obtained from the Superpave gyratory compactor was found to correlate well with the CI (Figure 2). Such a relationship can be used to evaluate the compactability of mixtures in the field based on laboratory measurements.
- The overlay test results clearly show that specimens prepared with uniform air void distribution have less variation in the number of failure cycles.
- The level of compaction affects the diffusion coefficients of HMA. Poor compaction or higher percent air voids yield higher moisture diffusion coefficients. In addition, specimens compacted at lower air voids had better moisture damage resistance.

What This Means

The relationship between the slope of the laboratory compaction curve and the CI is useful to evaluate the field compactability during the mixture design stage. Using this relationship a mixture can be improved by selecting appropriate materials and mixture type, and achieve the desired air voids in the field. Uniform air voids across the mat cannot be achieved by applying a uniform number of passes as the efficiency of compaction of a roller is not uniform across its width. Rather, the compaction pattern should be set up to achieve a uniform CI. A compaction roller equipped with a geographic information system (GIS) and a simple software program can be used to monitor the CI across the mat. The operator can use this information in order to adjust the compaction process such that a uniform CI and a uniform percent air voids across the mat are achieved.

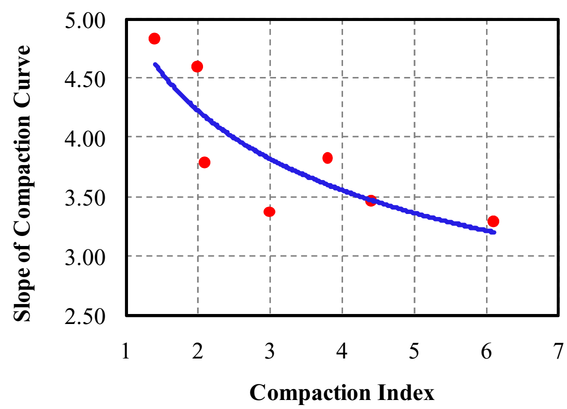

Figure 2. Relationship Between Compaction Index and Slope of Laboratory Compaction Curves.

For More Information:

0-5261-1 Application of Imaging Technology to Improve the Laboratory and Field Compaction of HMA

0-5261-2 A Method for Predicting Asphalt Mixture Compactability and its Influence on Mechanical Properties

Project Director - German Claros, TxDOT, 512-465-7403
Research Supervisor - Eyad Masad, TTI, 979-845-8308

www.txdot.gov
keyword: research

Texas Department of Transportation
Research and Technology Implementation Office
P.O. Box 5080
Austin, Texas 78763-5080
512-465-7403