



Project Summary Report O-1757-S

Project O-1757: Evaluation of Densities of HMAC Pavements along  
Longitudinal Construction Joints

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## Density of Longitudinal Construction Joints in Asphalt Concrete Pavements: Is There a Problem?

PROJECT SUMMARY REPORT

When placing hot-mix asphalt concrete (HMAC), paving the full width of the pavement in a single pass is usually impossible; therefore, most bituminous pavements contain longitudinal construction joints. These construction joints can often be inferior to the rest of the pavement and can eventually cause an otherwise sound pavement to deteriorate.

The Texas Department of Transportation (TxDOT) specifications do not address compaction in the vicinity of the longitudinal construction joints. For this reason, it is presumed that there is poor compaction in the vicinity of the longitudinal construction joints, resulting in increased permeability, decreased density, and decreased performance of HMAC.

The objectives of this research project were to:

1. assess the density along the longitudinal construction joint of several Texas pavements to determine if a problem exists;
2. document information from the literature and other agencies regarding joint density issues;
3. synthesize aviation construction data where



Figure 1. Nuclear Density Testing and Core Locations.



a history of a joint density specification exists to determine if such a requirement can be met by paving contractors; and

4. if justified by the research, provide joint density specification recommendations.

### What We Did . . .

Researchers implemented a statistically designed field experiment to assess the density of the longitudinal construction joints of Texas pavements to determine if a problem existed. Of primary concern in the experiment design was to select an adequate sample size to identify whether or not there was a statistical difference in density between the mat and the longitudinal construction joint.

Researchers evaluated a total of 35 pavements during their construction from September 1999 through August 2000. The experiment design included three mixture types which were most

representative of the types of hot mix placed in the state: Type C, Type D, and coarse matrix high binder (CMHB). Generally, two aggregate types were included in the field projects evaluated: crushed limestone and crushed gravel. All of the pavement sections evaluated were overlays of 1.5 to 2 inches thick. A few other pavement types were included: Superpave, stone-filled asphalt, stone-matrix asphalt (SMA), and heavy-duty SMA mixtures.

Nuclear density measurements on each of the field pavements used a thin-lift nuclear gauge during construction, after the final roller pass, and while traffic was controlled for construction (see Figure 1). Measurements were made transversely across the paved lane at the joint, 6 inches from the joint and/or unconfined edge, 12 inches from the joint, 24 inches from the joint, and in the middle of the lane. These density measurements were made at five locations spaced about

200 ft apart. If only one pass of the laydown machine had occurred at the time of testing and no joint yet existed, measurements began 6 inches from the unconfined edge of what would become the joint.

Contractors were requested to provide eight 4-inch-diameter cores corresponding to density measurement locations: four cores near the unconfined edge and four cores in the middle of the lane as designated by researchers. One coring location is marked by circles in Figure 1. For the pavements where cores were provided, bulk density measurements were made to correlate with the nuclear measurements, and permeability measurements were also performed on the cores. Field/plant laboratories provided Rice specific gravity values for the day's production.

Researchers documented case studies in Texas in which joint density was an issue associated with performance. Published

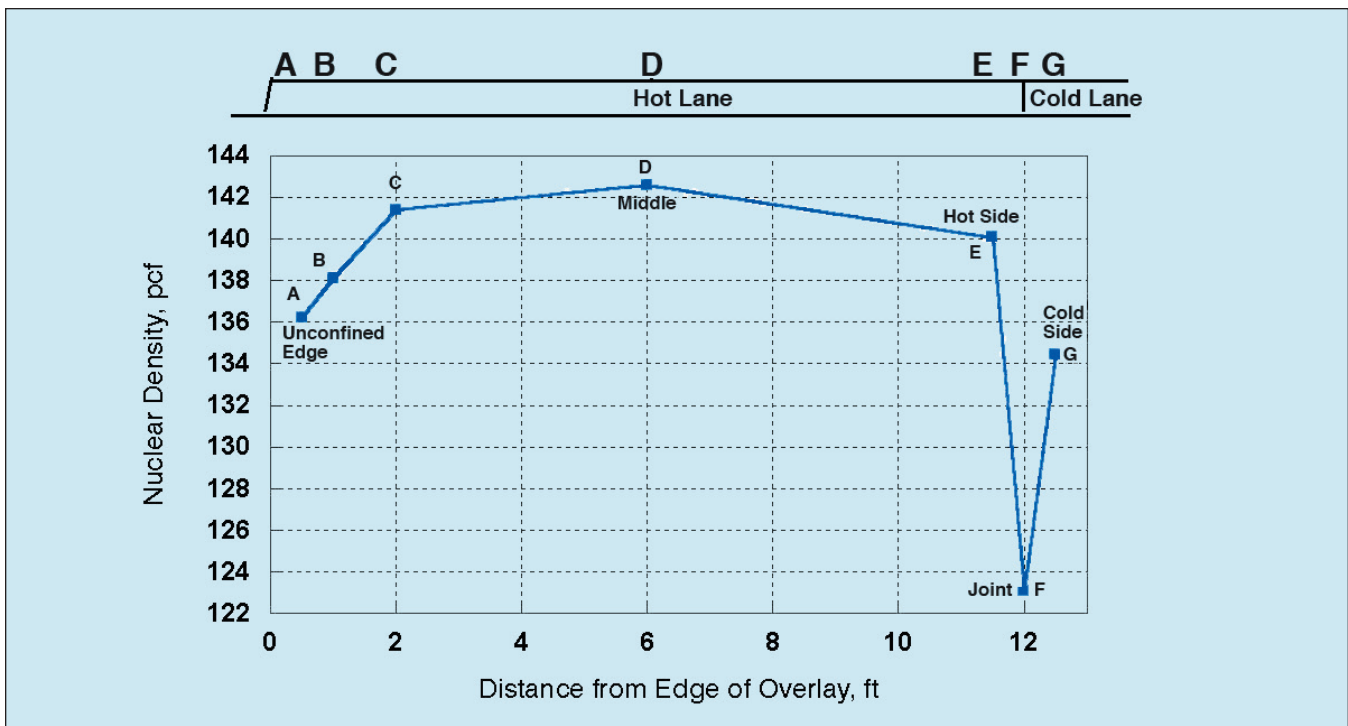


Figure 2. Mean Density Profile for 1 of 35 Pavements Evaluated (SH 114 Wichita Falls District, Type D Mix).



literature and other sources of information identified research that documents joint densities, densities associated with different types of joint construction techniques, and states that currently have a joint density specification.

The TxDOT Aviation Division provided researchers with construction data from five airfield asphalt paving projects constructed from 1999 through 2000. Since airfield pavements are constructed according to Federal Aviation Administration (FAA) specification item P-401, joint density determinations are made during construction. These joint density measurements were evaluated and documented as part of this project to determine if it was possible to meet such a specification.

### *What We Found . . .*

From the field evaluations of 35 pavements in Texas, researchers compared the density in the center of the mat to densities at the joint, 6 inches from the joint (or unconfined edge), 12 inches from the joint, and 24 inches from the joint. An area of consistently low density was found at the edge of the lane paved first (or the unconfined edge). [Figure 2](#) shows a typical density profile for a pavement. Almost all of the pavements showed a significantly lower density near the unconfined edge. This difference averaged about 6 to 7 lb per cubic ft (or 4 to 5 percentage points) lower than the mat density. While this was an average, the range was from 2 to 12 lb per cubic ft.

Permeability tests on field cores showed that for the dense-graded Type D and C mixes, permeability was higher for the cores taken near the unconfined edge compared to those from the middle of the lane.

There was no clear trend in the permeability data for the CMHB mixes.

In research studies done as early as 1964 that evaluated various joint construction techniques, the presence of a severe density gradient across the joint was observed similar to what was seen in the field data from these 35 Texas pavements. Researchers found the area of low density to be in the edge of the lane placed first, whereas practically all of the special joint construction procedures were concerned with attempts to get a high density in the lane placed subsequently. Many different joint construction techniques are described in [Report 1757-1](#), along with associated densities.

Specifications from several states that address density along the longitudinal construction joint were identified in this project. For example, the New York Department of Transportation requires that the density at the joint be at least 90 percent of the theoretical maximum compared to the mat density, which must be 92 percent. The Missouri Department of Transportation requires that the joint density not be less than 2.0 percentage points below the specified density.

[Report 1757-1](#) documents three case studies wherein forensic investigations were performed to identify causes of premature pavement failures. A thorough field and laboratory investigation of pavement cores was conducted. In each case, engineers attributed the pavement failures to inadequate density at the longitudinal construction joint, which allowed for excessive intrusion of water into the pavement structure.

Several projects were analyzed from recent Texas airfield asphalt paving projects constructed under the FAA P-401 specification,

which requires a longitudinal joint density of at least 93.3 percent and a mat density of 96.3 percent. Results evaluated from five airport paving projects exceeded the minimum required joint density of 93.3 percent. Based on these data, it is apparent that contractors are routinely able to meet this type of joint density requirement.

### *The Researchers Recommend . . .*

The primary objective of this research project was to assess the density along the longitudinal construction joints of Texas pavements to determine if a problem exists. Based on the field data presented in this report, researchers conclude that there is a strong indication that a problem exists and that a joint density specification for HMAC pavement construction is justified.

During this project, TxDOT developed a special provision to Special Specification Item 3146, Quality Control/Quality Assurance of Hot Mix Asphalt. The data presented in [Report 1757-1](#) support the criteria in this specification. The specification addresses the problem area identified in this project: the low density near the edge of the mat laid first. The specification density difference of 3.0 lb per cubic ft is lower than the 6 to 7 lb per cubic ft average difference observed in this project and should provide for a significant improvement in joint density for asphalt pavements in Texas.



## *For More Details . . .*

The research is documented in [Report 1757-1: Density Evaluation of the Longitudinal Construction Joint of Hot-Mix Asphalt Pavements](#).

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## *TxDOT Implementation Status—November 2003*

TxDOT has implemented the recommendations of this research project in the new standard specification for construction of longitudinal joints of HMA pavements. The new joint density specification solves the problem of the low density near the edge of the mat laid first.

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## *Disclaimer*

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