TxDOT
Joint Density Research
&
Specification Development

2007 SEAUPG Annual Meeting

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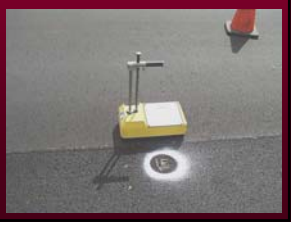
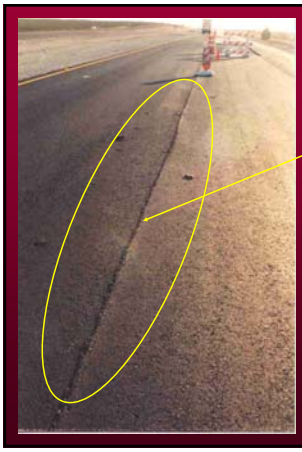
TxDOT - Construction Division

Flexible Pavements Branch



Why Joint Density ??

- 3 premature failures in 1999 related to low in-place density along longitudinal joints.
- Premature deterioration of pavement structure.
- Water seeps into pavement structure.
  - ✓*Stripping/moisture damage of HMA.*
  - ✓*Saturating base providing poor support.*
  - ✓*Cracking & raveling of pavement structure.*



- Poor compaction of longitudinal joint.
- Lip along joint may hold water.
- ~17 percent air voids at the joint and ~10 percent air voids in the main lane.
- GPR testing indicated higher air voids along the joint.

- Cracking evident within a week of construction.
- Other contributing factors.
  - ✓Heavily trafficked roadway.
  - ✓Construction during winter months.

Premature Deterioration

- Cracking & Raveling

Premature Deterioration

- Cracking & Raveling

Joint Density Research

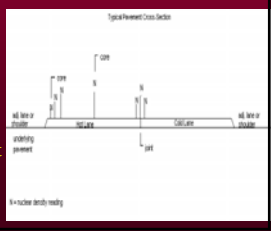
- Project 1757, Density Evaluation of the Longitudinal Construction Joint of Hot-Mix Asphalt Pavements
  - ✓ *Research Report 1757-1*
  - ✓ *Project Summary Report 0-1757-S*
  - ✓ *Technical Report 5-1757-01-1*
- Texas Transportation Institute (TTI)
- Sept 1999 thru Aug 2000

Joint Density Research

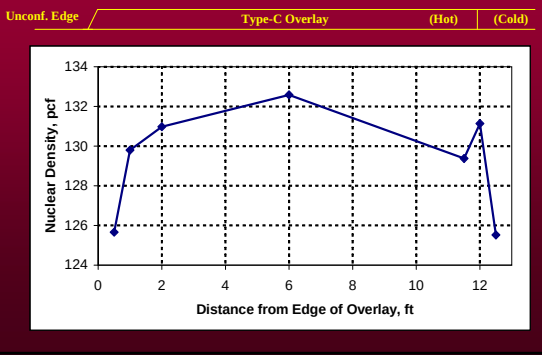
- Assess density along longitudinal joint.
- Collected density data on 35 pavements throughout Texas.
- Overlays of 1-1/2 to 2 inches thick.
  - ✓ *Type-C*
  - ✓ *Type-D*
  - ✓ *Coarse Matrix High Binder (CMHB)*
  - ✓ *Superpave*
  - ✓ *SMA*

Joint Density Research

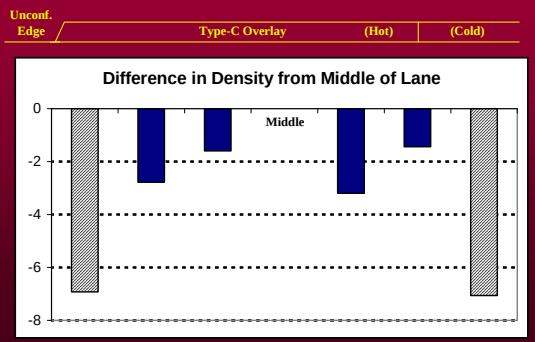
- Nuclear density measurements
  - ✓ Thin lift nuclear gauge - 4 minute readings.
    - 6 inches from edge
    - 12 inches from edge
    - 24 inches from edge
    - Middle of lane
    - Joint/edge
    - 5 locations ~ 200 feet apart



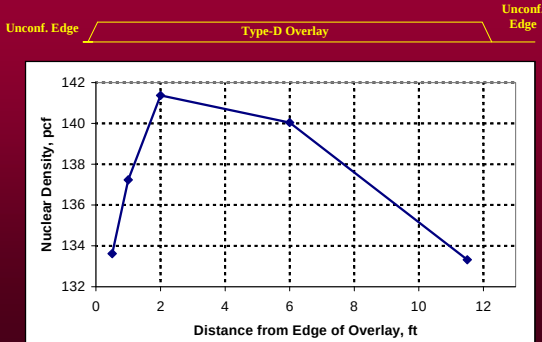
Joint Density Research



Joint Density Research

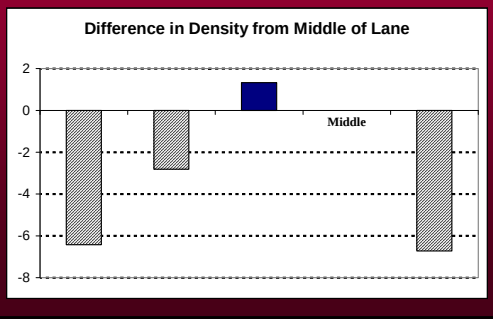


Joint Density Research



Joint Density Research

Unconf. Edge — Type-D Overlay — Unconf. Edge

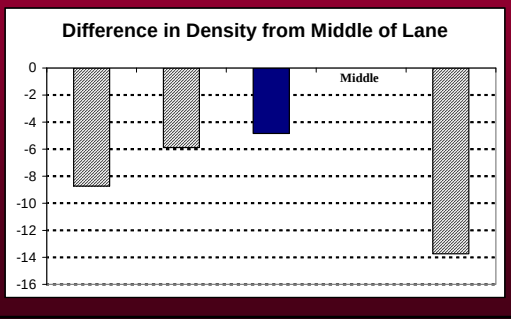


Joint Density Research

Unconf. Edge — CMHB Overlay — Unconf. Edge

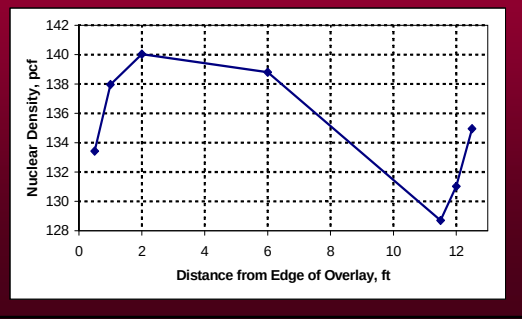
Joint Density Research

Unconf. Edge — CMHB Overlay — Unconf. Edge



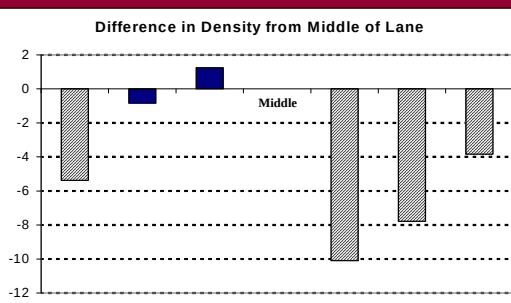
Joint Density Research

Unconf. Edge — Superpave Overlay (Cold) (Hot)



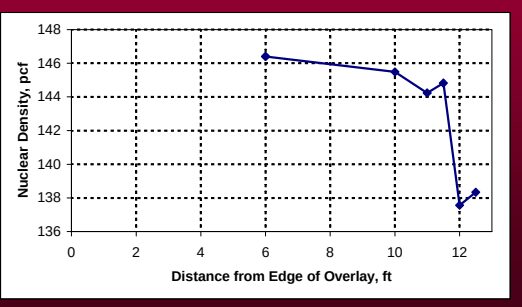
Joint Density Research

Unconf. Edge — Superpave Overlay (Cold) (Hot)

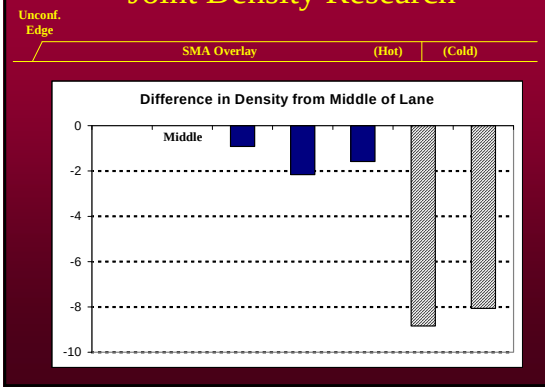


Joint Density Research

Unconf. Edge — SMA Overlay (Hot) (Cold)



Joint Density Research



Joint Density Research

- Field data shows a problem existed with low densities near the edge of the mat and justified the need of a joint density specification.
- Density improved as the measurements progress away from the edge.
- Density consistently low at unconfined edges.
  - ✓ *Average difference from 6 to 7 pcf. lower than mat density*
  - ✓ *Range of field data from 2 to 12 pcf.*

Joint Density Research

- Field cores requested at unconfined edge and middle of lane.
- Density & permeability testing.

Joint Density Research

- Permeability of cores at unconfined edge higher than cores taken at middle of lane.
- Specification recommendation from report:

"When the density within two foot of the mat edge is more than 5.0 lbs./c.f. below the interior mat density, the verification fails...."

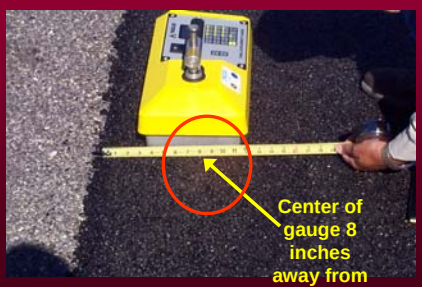
TxDOT Joint Density Specification

- Developed Texas test method Tex-207-F, Part VII "*Determining Longitudinal Joint Density Using A Density-Testing Gauge*"
- Developed special provision to 1993 QC/QA special specification of hot mix asphalt.

"When the density at the 8-inch offset from the mat edge is more than 3.0 lbs./c.f. below the interior mat density, the evaluation fails."

TxDOT Joint Density Specification

- Eight-inch offset from the mat edge.



TxDOT Joint Density Specification

- 2004 hot mix asphalt specifications.
  - ✓Specifications reference Tex-207-F, Part VII
  - ✓Record testing:

"The evaluation is considered failing if the joint density is more than 3.0 pcf below the density taken at the core random sample location and the correlated joint density is less than 90.0%."

TxDOT Joint Density Specification

- 2004 hot mix asphalt specifications.
  - ✓Informational testing:

"While establishing the rolling pattern, perform joint density evaluations and verify that the joint density is no more than 3.0 pcf below the density taken at or near the center of the mat."

Implementation of Specification

- *Technical Report 5-1757-01-1*
  - ✓Assess longitudinal joint construction after implementation of joint density specification.
  - ✓Evaluated 9 projects under construction.
  - ✓Identify beneficial construction techniques.

Implementation of Specification

- *Technical Report 5-1757-01-1*
  - ✓Develop and conduct training seminars
    - Construction techniques
    - New specification requirements
  - ✓Acquired non-nuclear density gauges

25 mm Stone-Filled HMA (Feb - Apr 2005)

Density Reading	Number of Readings	Average (pcf)	Number of Failures
Interior	37	142.5	
Confined & Unconfined Edge	47	138.6	
Density Difference Between Interior & Edge	47	4.5	23 (~ 49%)
Correlated Joint Density	20	91.0%	2 (10%)

Type B HMA (Mar – Apr 2005)

Density Reading	Number of Readings	Average (pcf)	Number of Failures
Interior	11	140.1	
Confined Edge	14	139.1	
Difference Between Interior & Confined Edge	14	1.0	0
Unconfined Edge	8	139.7	
Difference Between Interior & Unconfined Edge	8	0.4	0

CMHB-C HMA (Jul - Oct 2005)

Density Reading	Number of Readings	Average (pcf)	Number of Failures
Interior	39	144.3	
Confined & Unconfined Edge	78	143.6	
Density Difference Between Interior & Edge	78	0.8	0
Correlated Joint Density	78	91.7 %	5 (~ 6%)

Type C HMA (Dec 2003 – Jan 2004)

Density Reading	Number of Readings	Average (pcf)	Number of Failures
Interior	64	138.4	
Confined Edge	101	137.9	
Difference Between Interior & Confined Edge	101	0.7	0
Unconfined Edge	27	138.4	
Difference Between Interior & Unconfined Edge	27	0.7	0

Type D HMA (Nov – Dec 2005)

Density Reading	Number of Readings	Average (pcf)	Number of Failures
Interior	16	147.6	
Confined & Unconfined Edge	20	146.0	
Difference Between Interior & Edge	20	1.5	0

Conclusions from Implementation Research

- Significant improvement in longitudinal joint density.
- Compliance with specification criteria is achievable.
- No changes to specification recommended.

Research & Technical Reports

- Texas Transportation Institute (TTI)
- Project 1757, Density Evaluation of the Longitudinal Construction Joint of Hot-Mix Asphalt Pavements
  - *Research Report 1757-1*
  - *Project Summary Report 0-1757-S*
  - *Technical Report 5-1757-01-1*