Increasing In-Place Densities to Improve the Performance of Asphalt Pavements

SHRP2 Performance Specifications for Rapid Renewal (R07)

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September 20, 2016
Density essential for good performance

• Some say that density is the most important factor that affects performance

• Density may not be the most important factor but it is clearly an important factor
National density variability

Cumulative Frequency of Construction Densities

Cumulative Frequency, %

Percent Maximum Density, %

84 85 86 87 88 89 90 91 92 93 94 95 96

0 10 20 30 40 50 60 70 80 90 100

78%

55%
Low density causes unacceptable permeability
FHWA funded project to improve density

- NCAT prepared report on expected savings due to increased density
- Ten states funded to investigate improved density
- For each state:
  - Best practices presentation by Asphalt Institute
  - Preconstruction meeting to discuss plans
  - Construction of control section and test section(s) documented by NCAT
NCAT report showed that 1% increase in density conservatively resulted in at least 10% increase in life

NCAT Report 16-02 (can be downloaded from ncat.us)

ENHANCED COMPACTION TO IMPROVE DURABILITY AND EXTEND PAVEMENT SERVICE LIFE: A LITERATURE REVIEW

By Nam Tran, Pamela Turner, and James Shambley
FHWA funded project to improve density

- Ten states funded to evaluate methods for improving density
- NCAT selected to monitor these projects
- Construction of projects were to be completed in 2016
- Seven of these projects have been completed
- Each project had to have a control section and at least one test section
- For control section the contractor followed his normal compaction procedures
- For test section, contractor looked for ways to improve compaction without changing mix or without adding additional rollers
- Some states elected to construct 2 test sections
Some items being used to improve density

- Increase number of passes
- Apply more passes with vibrator on
- Reduce speed of rollers
- Some states elected to construct a second test section where an additional roller was used
Target density

• Percent of Laboratory
  – Not used much today
  – In-place density compared to laboratory density

• Percent of TMD---Generally preferred method
  – Most common method used today
  – In-place density compared to theoretical maximum density

• Percent of Control Strip
  – Still used by some today but must use caution
  – In-place density compared to density obtained in control strip
What density level do we need

- How about 92% of TMD?
- How about 94% of TMD?
- How about 96% of TMD?
Type of mix

- Fine-graded mixes tend to be less permeable for equal density than coarse-graded mixes.
Mix consistency

- Mix variability results in increased variability in density
- Use of material transfer vehicle will help to reduce variability
- Use of infrared camera and IR bar will help to ensure reduced temperature variability
• Good procedures should be used for sampling whether samples taken from truck or behind paver or from some other location.
Material transfer vehicle

- Some devices remix asphalt and these are preferred
- Even if they don’t remix they do keep paver and trucks separated resulting in smoother pavement
Mix temperature

• As mix cools it generally becomes more difficult to compact
• Some have used WMA as a compaction aid
• Infrared gun measures the surface temp but not internal temp
• Thin layers cool quicker so must be rolled quicker especially in cool weather---this may mean more rollers
Keep rollers close up to paver

• Typically good to keep rollers close behind paver
Laboratory air voids

• Some have reduced laboratory air voids to help ensure specs are met for density
• Must be careful when adding asphalt cement to lower air voids since this may result in rutting
• This resulted in major rutting prior to Superpave
• Superpave placed emphasis on controlling volumetrics during construction and reduced the amount of projects adding additional asphalt to reduce in-place air voids
The thickness to NMAS should be at least 3 for fine-graded mixtures and at least 4 for coarse-graded mixtures.
Roller weight and type of roller

- Typically 10-12 ton vibratory rollers used. Weight and tire pressure important for rubber tire rollers.
Oscillating roller

- Oscillating roller has shown some promise to obtain good density but more research needed.
Quality of bond between layers

- Clean underlying surface
- Consistent application of tack coat should be applied
- Too much tack sometimes a problem
- Allow to cure before placing asphalt mixture
Ensuring satisfactory bond

- Bond test has been developed but not implemented by many
- Bond test would be helpful
Roller pattern

- What pattern works on one project may not work on the next project
- Use density gauge to help set rolling pattern
• Watch out for tender zone
Testing location is important

- Some areas receive more compaction than other areas
- Density tests should be at random locations
Summary

- Increased effort to obtain density can result in at least 1 to 2 percent higher density
- 1 to 2% higher density will provide a significant increase in pavement life, generally believed to be 10-20%