NORTH DAKOTA ASPHALT CONFERENCE

Compaction Basics

April 3-4, 2012
Compaction is equally important in extending pavement life. Ultimately determines life & performance.
Importance of Compaction

- Improve Mechanical Stability
- Improve Resistance to Permanent Deformation
- Reduce Moisture Penetration
- Improve Fatigue Resistance
- Reduce Low-Temperature Cracking Potential
Effects of Compaction on Pavement Properties
Factors Affecting Compaction

- Properties of the Materials
- Environmental Variables
- Laydown Site Conditions
Properties of the Materials

- Aggregate
- Asphalt Cement
- Mix Properties
Environmental Variables

- Layer thickness
- Air and base temperature
- Mix laydown temperature
- Wind velocity
- Solar flux
Laydown Site Conditions

- Lift thickness versus aggregate size
- Lift thickness uniformity
- Base Conditions
Compaction Equipment

- Screed unit on paver
  - weight of screed
  - tamping/vibratory unit
- Rollers
  - static steel–wheeled
  - pneumatic
  - vibratory steel–wheeled
Forces of Compaction

- Four forces
- Static pressure and manipulation are low force
- Impact and vibration generate higher forces
Steel Drum Static Force

- Force is weight divided by contact area
- Most units are classed by PLI
- PLI is drum weight divided by drum width
- Static pressure is fixed, linear force
**Pneumatic-Tired Rollers**

- Reorients particles through kneading action
- **Tire pressures:**
  - ~70 psi (cold) for compaction
  - ~50 psi (cold) for finish rolling
- Tires must be hot to avoid pickup
- Not used for open-graded mixes or SMA
Vibratory Rollers

• Commonly used for initial (breakdown) rolling
• 7–17 tons, 4–8 ft wide
• Frequency: 2000–3000 impacts/min.
• Operate to attain min. 10 impacts/ft
Vibratory Rollers

- Amplitude
- Frequency
- Impact Spacing
- Operation
Vibratory Frequency

- Frequency is impacts per minute
- Working speed must match frequency
- Impact spacing is 10–14 per foot
Vibratory Amplitude

- Spinning weight causes drum movement
- Distance drum moves is called amplitude
- Amplitude = impact force
Impact Spacing (I) = \frac{\text{Roller Speed, fps}}{\text{Frequency, Hz}}
Effects of Vibration
Frequency Too Low?
Test Strip Construction

- Simulating Actual Conditions
- Establishing Roller Patterns
- Calculating Effective Roller Speed
Rolling Pattern

- Speed & lap pattern for each roller
- No. of passes for each roller
- Min. temperature by which each roller must complete pattern

**IMPORTANT:**

Paver speed must not exceed that of the compaction operation!!!
How Many Repeat Coverages to Assure Density?
### Compaction of Dense Graded Mixes

<table>
<thead>
<tr>
<th>Compactive Force</th>
<th>Pressure and/or Vibration</th>
<th>Pressure Manipulation</th>
<th>Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>300° – 285°F</td>
<td>240° – 200°F</td>
<td>170 – 150°F</td>
</tr>
</tbody>
</table>

**Temperature Zones**
# Compaction of Coarse Graded Mixes

<table>
<thead>
<tr>
<th>Compactive Force</th>
<th>Pressure Vibration</th>
<th>Pressure Manipulation</th>
<th>Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>300° – 240°F</td>
<td>240° – 190°F</td>
<td>170 – 150°F</td>
</tr>
</tbody>
</table>

Compaction Issues – Rolling off Edge

- Never roll off unconfined edge
- Collapsed edge will create a joint failure
Compaction Issues – Rippled mat

- Too much force–ripples and fractured rock
- Roller Speed
- Finish roller will not clean up
Compaction Issues – Washboard

- 4” thick mat
- Excessive speed caused roughness
- Lower speed = 10–14 impacts per foot
Compaction Issues – Rutting

Possible causes:
- Inadequate asphalt compaction
- Mix Design?
MOBA Corporation

THANK YOU!

Jim Hedderich
jhedderich@mobac.com
770-842-7580