Developing Balanced Mix Design Gyrations ($N_{design}$) for North Dakota’s HMA Pavements

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Problem Statement

• **SuperPave Mix Design Compactive effort**
  - $N_{\text{design}} = 75$ for 20 year design ESALs of 0.3-3.0 Millions
  - **ND kept 75 gyrations for all pavement classes**
    - Does not represent compaction of low-volume pavements

• **Observations – Low volume Pavements**
  - Pavements are dry (low binder content)
  - Brittle (Cracking)
  - Low Density/permeability
  - Rut resistant pavements are failing due to durability issues
Motivation

- Experience with Lower number of gyrations in ND
  - 65 and 50 gyrations on LVR were tried
  - Increased binder content by 0.1 - 0.2 percent
  - Helped with durability
Research Approach

- **Lower the Design Gyrations (N_{design})**
  - Keep gradation the same
  - Higher Air Voids
    - Higher Binder Content
    - Higher VMA

- **Determine the effect of Lowering N_{design} on:**
  - Rutting Resistance - APA
  - Low Temperature Cracking Resistance - DCT
  - Fatigue Cracking Resistance - SCB
Outcome

• **Durable Pavements** - should be resistant to
  • Low-Temperature cracking (LTC)
  • Fatigue Cracking (FC)

• **Stable Pavements** - should be resistant to
  • Rutting (compromise)
  • Fatigue cracking
<table>
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<tr>
<th>Project</th>
<th>FAA</th>
<th>Oil Type</th>
<th>Gyration Level 1</th>
<th>Gyration Level 2</th>
<th>Gyration Level 3</th>
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<tr>
<td>1</td>
<td>40</td>
<td>PG 58S-28</td>
<td>50</td>
<td>65</td>
<td>75</td>
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<td>2</td>
<td>43</td>
<td>PG 58S-28</td>
<td>50</td>
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<td>3</td>
<td>45</td>
<td>PG 58H-28</td>
<td>55</td>
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<td>4</td>
<td>45</td>
<td>PG 58H-34</td>
<td>55</td>
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</tbody>
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Projects for Design Gyrations
Laboratory Mix Designs

- Perform Laboratory mix designs for all pavement classes and gyration levels
  - \{FAA 40 & PG 58S-28\} @ 75, 65, and 50 gyr
  - \{FAA 43 & PG 58S-28\} @ 75, 65, and 50 gyr
  - \{FAA 45 & PG 58H-28\} @ 75, 65, and 55 gyr
  - \{FAA 45 & PG 58H-34\} @ 75, 65, and 55 gyr
Laboratory Testing

(1) Rutting Resistance

- Perform APA Test (AASHTO T 340)
- Four specimens for each pavement class and gyration level will be produced and tested
- 8,000 cycles in the APA @ 100psi
  - 130 cycles per rutting ESAL
- 7-9mm failure criterion
Laboratory Testing

(2) Low Temp Cracking Resistance

- Perform disk-shaped compact tension (DCT) Test (ASTM D7313)
- Four specimens for each pavement class and gyration level will be produced and tested
- Condition for 12 hours @ test temp
  - Test temp is @ low PG grade + 10°C
- Test determines fracture energy
  - Acceptable Fracture energy:
    - Min. 400 joules/m² (low traffic)
    - Min. 460 joules/m² (medium traffic)
    - Min. 490 joules/m² (high traffic)
Laboratory Testing

(3) Fatigue Cracking Resistance

• Perform semi circular bending (SCB) Test

• Four specimens for each pavement class and gyration level will be produced and tested

• Condition for 2 hours @ test temp
  • Test temp is @ 25°C

• Test determines fracture energy & calculate flexibility index (FI)
  • FI <1 (brittle)  FI <2 (poor)
  • 2<FI<6 (medium)  FI>6 (high)
NDDOT would like to have answers to the following questions:

- How much more oil can be put into the lower and medium-volume mixes, FAA 40 & 43, before distresses are unacceptable?

- How much more oil can be put into the higher volume mixes, FAA 45, to help fight against dryness/brittleness, while continuing to keep rut in check?

- And how do different high-volume mix oil types affect these results?
Thank You

Questions??