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_{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
- **<u>Observations</u> – Low volume Pavements**
  - Pavements are dry (low binder content)
  - Brittle (Cracking)
  - Low Density/permeability
  - Rut resistant pavements are failing due to durability issues

Motivation

- **<u>Experience</u> 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

Projects for Design Gyrations

Project	FAA	Oil Type	Gyration Level 1	Gyration Level 2	Gyration Level 3
1	40	PG 58S-28	50	65	75
2	43	PG 58S-28	50	65	75
3	45	PG 58H-28	55	65	75
4	45	PG 58H-34	55	65	75

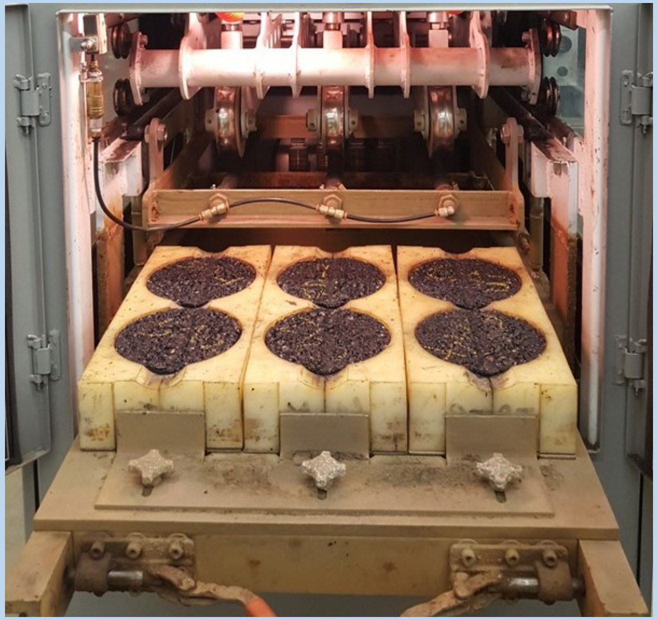
Laboratory Mix Designs

- 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

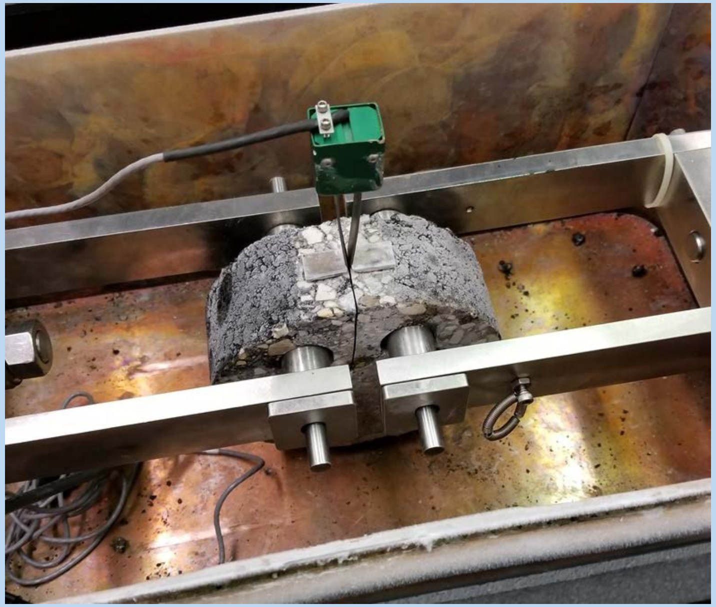
- Perform APA Test (AASHTO T 340)
- Four specimens for each pavement class and gyration level will be produced and tested
- 8,000 cycles in the APA @ 100psi
    - 130 cycles per rutting ESAL
- 7-9mm failure criterion



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/m^2 (low traffic)
    - Min. 460 joules/m^2 (medium traffic)
    - Min. 490 joules/m^2 (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)

Results - Implementation

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