**Gyratory Stability (CEI) vs. Hveem Stability**

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**Outline**

- **Goal.**
  - Gyratory Stability:
    - Background
    - Methodology
    - Experiment Program
    - Data Analysis and Results
    - Summary
    - Gyratory vs. Hveem Stability.

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**Main Goal**

Compare the **Gyratory Stability** with the **Hveem Stability** and to Evaluate the relation between them, if any.

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**A little Background**

**Pavement Distresses:**

- Permanent Vertical Deformation (Rutting).
- Fatigue Cracking.
- Thermal Cracking.

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**Contact Energy Index (CEI)**

or **Gyratory Stability**

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**Rutting**

#1 Distress
Rutting

- Researches have concluded that Rutting is caused mainly by shear failures in the asphalt pavement.
- A performance parameter based on shear stress is essential to evaluate rutting potential.

Superpave Gyratory Compactor

- SHRP has recommended the use of the Superpave Gyratory Compactor (SGC)
- SGC output is an essential step in the Superpave mix design process and is an important tool for quality control in the field

Shear Stress Formula

\[ S_N = (N_2 - N_1) \cos \theta + \frac{1}{2} (\Sigma P - W_N) \tan \theta \]

\[ N_2 - N_1 = \left( \frac{F + V}{2} \right) \left( x_0 - \frac{h}{2} \tan \theta \right) \frac{1}{2} (\Sigma P - W_N) \left( x_0 - \frac{r}{\mu} \tan \theta \right) \]

\[ \Sigma P = \frac{\text{Area} \times h \times \tau}{2L} \]

Pressure Distribution Analyzer (PDA)

Gyratory Stability

\[ \text{Gyratory Stability} = CEI = \frac{S_{\phi}}{N_{G_2}} \cdot d_e \]

where

- \( S_{\phi} \): The shear stress at N number of gyrations and angle \( \theta \)
- \( d_e \): The change in height per cycle in the shear zone
- \( N_{G_1} \): Number of gyrations when a mix starts in the shear zone
- \( N_{G_2} \): Chosen termination number of gyrations.
Gyratory Stability:
The Gyratory Stability was found to capture the changes of:
• binder content,
• % natural sand, and
• aggregate type and Texture.

The Gyratory Stability was in agreement with several mechanical properties of different mixes, e.g. the $G^*/\sin \delta$ parameter.
Gyratory Stability: Repeatability and independency of SGC Brand

Gyratory Stability: Independency of SGC Brand

Gyratory Stability: Performance of Tested HMA Samples

Gyratory Stability: (Summary)

- Sensitive to % binder, % natural sand, aggregate type and texture.
- Easy to calculate, and independent of the machine and the method of measuring forces in the Gyratory compactor.
Recommendations for Future Work

The results should be further evaluated, by comparing them with the actual performance of the HMA mixes used in this study.

Gyratory Stability vs. Hveem Stability

Main Goal

Compare the Gyratory Stability with the Hveem Stability and to Evaluate the relation between them, if any.

Methodology

- Method 1: Test and measure the Gyratory Stability values for mixes that are currently used in the state of Idaho.
- Method 2: Evaluate the relation between Gyratory and Hveem Stabilities, if any.

Mixes

- Range of mixes in the state of Idaho were provided by Idaho Transportation Dept. (ITD).
- Mixes were design based on Hveem Method.

Mixes Matrix

| Mixes Matrix |
**Proposed Design Values of Gyratory Stability for Hveem-Designed Mixes:**

<table>
<thead>
<tr>
<th>Mix Class</th>
<th>Traffic Category</th>
<th>Hveem Stability</th>
<th>CEI, kN.m</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Heavy (&gt; 10^6 ESALs)</td>
<td>&gt; 37</td>
<td>&gt; 15</td>
</tr>
<tr>
<td>II</td>
<td>Medium (10^4 - 10^6 ESALs)</td>
<td>&gt; 35</td>
<td>&gt; 12</td>
</tr>
<tr>
<td>III</td>
<td>Light (&lt; 10^4 ESALs)</td>
<td>&gt; 30</td>
<td>&gt; 5</td>
</tr>
</tbody>
</table>

**Gyratory Stability vs. Hveem Stability**

- The Gyratory Stability is **Performance-based**.
- The Gyratory Stability is calculated using a more **representative** sample.
- The Gyratory Stability is **easy and quick**.
- The Gyratory Stability is **non-destructive** test Parameter.

**Questions?**

Thank you