Effects of Specimen Compaction on Performance Characteristics:

Results of Triaxial tests on AC

Update of progress at ISBS

Konrad Mollenhauer
Compaction methods at ISBS

Roller Sector

Gyratory

Marshall
Compaction of Asphalt mix

Number of passes in German roller sector compactor

Goal: $V_m = 4\%$
Preparation of specimens

Number of passes in German roller sector compactor

- Roller Sector (slab)
- Impact compactor
- Roller Sector (specimen)

French Roller

Number of Blows / Gyrations

void content $V_m$ [%]
Triaxial Tests: Equipment

- LVDT (radial)
- LVDT (axial)
- specimen
- rubber membrane
- hydraulic oil (radial loading)
Triaxial Test: Loading (EN 12697-25)

- Sinusoidal axial stress: 
  \( \sigma_a = 0.3 \text{ MPa} \);
  \( \sigma_b = 0.15 \text{ MPa} \);
  frequency: \( f = 10 \text{ Hz} \)

- Static radial stress: 
  \( \sigma_{rad} = 0.15 \text{ MPa} \)

- Temperature: +50°C

- Specimen dimensions:
  Diameter: 100 mm (MPK: 101.4 mm)
  Height: 60 mm
  \( d/H: 0.6 \)
Triaxial test: Results

- Course of cumulated axial strain $\varepsilon_{ax}(N)$:
- creep rate $f_{c,ax}(N=1,000)$
Triaxial test: Results

- Course of cumulated axial strain $\varepsilon_{ax}(N)$:
- creep rate $f_{c,ax}(N=1,000)$

\[ \varepsilon_{1000,calc} = A \cdot N^B \]
Triaxial test: Results

- Course of cumulated axial strain $\varepsilon_{ax}(N)$:
  - creep rate $f_{c,ax}(N=1,000)$
    $\varepsilon_{1000,\text{calc}}$
- Course of cumulated radial strain $\varepsilon_{rad}(N)$:
  - $f_{c,rad}(N=1,000)$

\[
\varepsilon_{ax} = A \cdot N^B
\]
Triaxial Test: Results

\[ \mu = \frac{\sigma_{ax} \cdot \varepsilon_{rad} - \sigma_{rad} \cdot \varepsilon_{ax}}{\sigma_{rad} \cdot (2 \cdot \varepsilon_{rad} - \varepsilon_{ax}) - \sigma_{ax} \cdot \varepsilon_{ax}} \]

here:
\( \sigma_{ax} \): axial mean stress
\( \sigma_{c} \): radial (confining) stress
\( \varepsilon_{ax} \): \( f_{c,ax} \)
\( \varepsilon_{rad} \): \( f_{c,rad} \)
Triaxial Tests: cumulated axial strains

![Graph showing cumulated axial strains for different tests: French Roller, German Sector, Gyratory, Marshall. The x-axis represents Load Cycle N, and the y-axis represents cumulated axial strain in percent. The graph illustrates the strain behavior under different loading conditions.]
Triaxial Test: creep rate $f_{c,1000}$

![Graph showing creep rate for different samples: F2, F1, BK4b, BK6, G4, G3, M4, M3.](image-url)
Triaxial Test: strain after 1000 cycles $\varepsilon_{1000,\text{calc}}$

**French Roller**

**German Sector**

**Gyratory**

**Marshall**
Triaxial Tests: cumulated radial strains

- French Roller
- German Sector
- Gyratory
- Marshall
Poisson’s ratio $\mu$
Compaction method or void content?

**Further Tests necessary:**

- **Further specimens available:**
  - Marshall: \( V_m = 2.0 \% \)
  - Gyratory: \( V_m = 1.6 \% \)

- **New specimens**
  - Roller Sector (\( V_m : 1.5 \& 3.5 \))
    - (2 new slabs: 25 kg mix)
  - French Roller with varied compaction energy?
Comparative test program „Segment Roller Compaction”

Scope:
• Roller Sector Compactor Devices are commonly used Europe-wide
• Compaction Procedure varies considerably

Objective:
• Analysation of impact of given compaction procedure on mechanical properties of asphalt specimens
• Evaluation of reproducibility of Roller Sector compaction

Participants:
ISBS (Germany), ISTU (Austria), TUDD (Germany), UVT (Hungary); ifbGauer (Germany); TUD (Netherlands)
Comparative test program „Segment Roller Compaction”

Asphalt Mixture: AC11

<table>
<thead>
<tr>
<th>Sieve [mm]</th>
<th>passing [%]</th>
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<tr>
<td>0,09</td>
<td>0</td>
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<tr>
<td>0,25</td>
<td>10</td>
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<tr>
<td>0,71</td>
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<td>12</td>
<td>70</td>
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<tr>
<td>16</td>
<td>100</td>
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</table>

Each laboratory uses 2 compaction procedures:
1. Common procedure (according German Standard)
2. Laboratory standard procedure

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
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<tbody>
<tr>
<td>Maximum aggregate density [g/cm³]</td>
<td>2.698</td>
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<tr>
<td>&lt; 0.09 mm</td>
<td>9.5 %</td>
</tr>
<tr>
<td>&gt; 0.09 mm &amp; &lt; 2.0 mm</td>
<td>37.5 %</td>
</tr>
<tr>
<td>&gt; 2.0 mm</td>
<td>53.0 %</td>
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<tr>
<td>Content of crushed aggregate</td>
<td>C&lt;sub&gt;90/1&lt;/sub&gt;</td>
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<tr>
<td>Binder type</td>
<td>50/70</td>
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<tr>
<td>Softening point Ring &amp; Ball [°C]</td>
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<tr>
<td>Binder content [mass-%]</td>
<td>6.0</td>
</tr>
<tr>
<td>Maximum density [g/cm³]</td>
<td>2.476</td>
</tr>
</tbody>
</table>
German Standard Compaction Procedure

- Slab height during pre-compaction
- Slab-height during main compaction

Pre-Compaction:
- Force = 0.1 kN/cm slab width

Main-Compaction:
- Force = 0 kN

Height of asphalt slab [cm]

Force per cm slab width [kN/cm]
Comparative test program „Segment Roller Compaction”

Test program:

- Slab compaction: January/February
- Specimen preparation (cores) February/March
- Mechanical Tests (Triaxial tests) March/April
- Presentation of Results: May
ATCBM pre-conference workshop

Laboratory compaction of asphalt mixtures for the preparation of specimens for performance-based test methods

Topics:
Impact of specimen compaction
  - on aggregate structure
  - on performance properties
Comparability with site compacted asphalt
ATCBM pre-conference workshop

Laboratory compaction of asphalt mixtures for the preparation of specimens for performance-based test methods

Tuesday, May 26th
8 presentations about 20 min (selection according submitted 2 page abstract)

Deadline for abstract submission: February 15th
Notice of Acceptance until March 31st