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Answers to your Resistivity Questions and Helpful Findings to Develop a Robust Resistivity Specifications

- TRB 2024

Projects and Mixture Designs

- Data from 25 plus states
- 2011-2022
  - Only mainline paving projects
- Variety of mixtures
  - Geography
  - Cementitious content
  - SCM types and contents
  - Water to cementitious ratio
  - Maximum size of aggregates
  - Interstates to rural roads
- Publications
  - Practical (no research)
  - Implementation focused
  - Unique data set

Highlights Only

MCTC
Objectives of the Paper

1. Evaluate the difference between SR and BR measurements
2. Compare resistivity data from different equipment
3. Assess average, range, and variability in resistivity measurements
4. Assess rate of change in resistivity from 28 to 56 days testing
5. Evaluate the change in resistivity between short term (28/56 days) and long term (beyond a year) measurements
6. Assess differences in resistivity measurements between specimens conditioned in lime water and moisture room

Take Aways!

- Excellent correlation between SR and BR measurements
  - All three vendors
  - SR results approximately two times the BR results at 28 and 56 days
  - Either SR or BR methods for assessing the permeability potential of mixtures
- Very good correlation between equipment from two different vendors
  - No equipment bias
- Fifty percent of the mixtures were in the low permeability category
- Rate of change in resistivity between 28 and 56 days is mixture specific
  - Specifying 28-day testing in lieu of 56-day testing (under regular curing conditions) is not a good option
Take Aways!

- Resistivity measurements continue to increase significantly even after two years
  - Continued SCM reaction for years
  - Validation with future work
- Bias exists in resistivity measurements of specimens conditioned in lime water versus moisture room
  - Very important consideration when specifying resistivity in agency specifications
- Resistivity testing is well suited for Quality Assurance
  - Consideration to curing method, curing temperature, and testing temperature during development of agency specifications

Paper 2

Performance Engineered Mixtures (PEM) Approach for Improved Concrete Durability and Sustainability – Case Studies

- International Conference on Concrete Pavements, 2024
Paper 2: Durability and Sustainability Case Studies

- Optimize the combined gradation
  - Pack more aggregate
  - Reduce cement / cementitious content
  - Reduce paste volume
    - Cement+SCM+Water
- Same material
  - Introduce intermediate aggregate

Non-Optimized Mixture
Optimized Mixture

Paper 2: Durability and Sustainability Case Studies

- Oklahoma
  - I-35 (Interstate) – Expansion
- Iowa
  - US-29 (Interstate) – Grade & Replace
- New York
  - RTE 7 (State Route) – Repair & Rehabilitation
- Minnesota
  - MnROAD (Research) – Mainline Highway
Paper 2: Durability and Sustainability Case Studies

- Compare
  - Standard Mixture (red)
    - Non-optimized
  - PEM Mixture (green)
    - Optimized

- Reduction in Cementitious contents and paste volume

<table>
<thead>
<tr>
<th></th>
<th>OK</th>
<th>IA</th>
<th>NY</th>
<th>MN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cementitious Content, lbs</td>
<td>517</td>
<td>534</td>
<td>570</td>
<td>570</td>
</tr>
<tr>
<td>Paste Volume, %</td>
<td>22.6%</td>
<td>23.9%</td>
<td>27.9%</td>
<td>27.9%</td>
</tr>
</tbody>
</table>

Reduction in Cementitious Content, lbs 47 35 35 69
Reduction in Paste Volume, % 1.7 1.8 2.7 3.2
Take Away

Optimize combined gradation

- Reduce cement / cementitious content
  - Lower cost
  - Lower CO2
- Reduce paste volume
  - Improve performance
- Increase workability
- Minimize segregation

Non-Optimized Mixture

Optimized Mixture

Thank You!