Round Table Intro - What is Needed?

Industrial Materials Conference

What is needed in terms of information, resources and training in order to increase the use of industrial materials in the highway environment.

Recycled Materials

- Air Cooled Blast Furnace Slag
- Concrete Riprap
- Fly Ash
- Foundry Sand
- Glass
- Ground Granulated Blast Furnace Slag
- Lime Kiln Dust
- New Waste Roofing Shingles
- Reclaimed Asphalt Shingles
- Reclaimed Asphalt Pavement
- Recycled Concrete
- Silica Fume
- Steel Slag

Coal Combustion Products

Coal Ash

Fly Ash - coal ash with 70% or less passing the No. 200 sieve

Bottom Ash - coal ash with 20% or less passing the No. 200 sieve and 10% or less retained on the No. 10 sieve

Coal Combustion Products

Coal Ash - Embankment Construction

- 7 projects since 1994
- 471,200 tons of coal ash
Round Table Intro - What is Needed?

Coal Combustion Products

- Minimum cement/fly ash ratio = 3.2
- Only between April 1 and October 15 of same year
- Not allowed when blended cements are used
- Minimum cement increased to 500 lb/yd³ when portland-pozzolan cements used

Coal Combustion

Wet Bottom Boiler Slag

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>% Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.5 mm</td>
<td>100</td>
</tr>
<tr>
<td>9.5 mm</td>
<td>95.0 - 100.0</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>90.0 - 100.0</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>30.0 - 60.0</td>
</tr>
<tr>
<td>75 µm</td>
<td>6.0 - 12.0</td>
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</tbody>
</table>

Foundry Sand

- Approved List
- IDEM waste classification certification for Type III or IV residual sands
- Restrictions
  - Type III not within 100 ft of a stream, river, lake, reservoir wetland, or other protected environmental resource area
  - Type II or IV not within 150 ft of a well, spring, or other ground source of potable water
  - Not placed adjacent to metallic pipes or other metal structures
  - Not used as encasement material
  - Not used in MSE wall applications

Slag

- Steel Slag
- Air-Cooled Blast Furnace Slag
- Granulated Blast Furnace Slag
- FY 12 - 200,000 tons
Certified Aggregate Producer Program

- Required for aggregates except snow and ice abrasives & for precast concrete items

Required Tests

Steel Furnace Slag

- 7 Certified Steel Slag Sources
- Required for HMA surface mixtures with ESAL ≥ 10,000,000
- Issues
  - Specific Gravity
  - Expansion of Material
**Round Table Intro - What is Needed?**

### Steel Furnace Slag
- **Specific Gravity** - 3.4
- Payment is by weight
- Quantity is adjusted and lay rate adjusted for HMA
- SMA
  - Specific gravity required at 1 test/2000 tons
  - Target bulk specific gravity established
  - Subsequent tests shall be within 0.050 of target
  - Moving average of 4 consecutive tests within 0.040 of target

### Steel Furnace Slag
- **Expansion**
  - Calcium oxide and magnesium oxide when hydrated will expand
  - Restricted to aggregate shoulders, HMA surface or SMA surface mixtures, dumped riprap, and snow and ice abrasives

### Steel Furnace Slag - Deleterious Materials
- Coarse aggregates in HMA Base and Intermediate mixtures
- ITM 219 - Autoclave
  - Conducted by Certified Aggregate Producer 1/2000 t
  - Deleterious ≤ 4.0%
  - Stockpiles failing may be tested again after 30 days from test date

### Air-Cooled Blast Furnace Slag
- 3 Certified Air-Cooled Blast Furnace Slag Sources
- Required for HMA Surface mixtures with ESAL ≥ 10,000,000
- Issues
  - Specific Gravity
  - Leachate
Round Table Intro - What is Needed?

Air - Cooled Blast Furnace Slag

- Coarse Aggregate Specific Gravity - 2.3
- Payment is by weight
- Quantity is adjusted and lay rate adjusted for HMA
- Not allowed in SMA

Air - Cooled Blast Furnace Slag

- ITM 212 - calcium sulfide
- pH of 6.0 - 10.5
- Rock color chart - greenish-yellow color
- Test conducted by Certified Aggregate Producer 1/2000 t
- Failing stockpiles may be tested again after 30 days

Granulated Blast Furnace Slag

- Rapid chilling in water of blast furnace slag
- Proposed for use in HMA
- Specific Gravity (2.2 → 1.9)
- Allowed as mineral admixture in concrete

Construction Materials

- Reclaimed Asphalt Pavement (RAP)
- Reclaimed Asphalt Shingles (RAS)
- Recycled Concrete
Round Table Intro - What is Needed?

**PG Binder Index**

*2011 PG 64-22 Average Monthly Price*

- 0 2 4 6 8 10 12
- $350
- $400
- $450
- $500
- $550
- $496.00 (2011)
- $466.00 (2010)
- $497.00 (2009)

**Reclaimed Asphalt Pavement**

- Allowed as binder replacement in all mixtures
- First used in 1980s by plant heat transfer method up to 50%
- Refined after SuperPave

**Reclaimed Asphalt Pavement**

- Processed into more sizes

**Reclaimed Asphalt Pavement**

- Plants have more RAP bins
Round Table Intro - What is Needed?

Reclaimed Asphalt Pavement
- HMA surface mixtures - friction resistance
  - Category 3, 4, & 5 -- 100% passing the 3/8 in. sieve and 95 -100% passing the No.4 sieve

Reclaimed Asphalt Pavement
- FY12
  - 4,100,000 tons of HMA
  - 895,000 tons RAP (22%)

Reclaimed Asphalt Shingles
- Allowed as binder replacement in all mixtures
- First used in 1980s - pre-consumer shingles
- Post consumer shingles introduced in 2010

Reclaimed Asphalt Shingles
- Issues
  - Asbestos - tested
  - Asphalt Grade - limited to 25% by weight of total binder content
  - Aggregate - 100% passing ½ in.
  - Deleterious - AASHTO MP 15
**Round Table Intro - What is Needed?**

### Maximum Binder Replacement, %

<table>
<thead>
<tr>
<th>Mixture Category</th>
<th>25.0 mm</th>
<th>19.0 mm</th>
<th>12.5 mm</th>
<th>25.0 mm</th>
<th>19.0 mm</th>
<th>12.5 mm</th>
<th>9.5 mm</th>
<th>4.75 mm</th>
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<tbody>
<tr>
<td>Base and Intermediate</td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>Dense Graded</td>
<td>40.0</td>
<td>25.0</td>
<td>40.0</td>
<td>25.0</td>
<td>25.0</td>
<td>25.0</td>
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<tr>
<td>Open Graded</td>
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<tr>
<td>Surface</td>
<td></td>
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</tbody>
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**Scrap Tires**

- **Embankments**
- **HMA**
  - Pyrolyzed Carbon Black
  - Dry Process
- Wet Process - waste tennis and racquet balls

**Scrap Tires - Embankments**

- Lightweight fill in embankments over peat, for landslides, and for retaining walls
- 1,342,000 tires since 2001 on 11 projects

Ron Walker - 2012 Industrial Materials Conference - IndustrialResourcesCouncil.org
Recycled Concrete Aggregate

- Subgrade Treatment
- Processed on contract to required size through the CAPP

Test Sections placed in 2012 containing 30% and 50% RCA

D-Cracking

ASTM C 666

- Introduced in early 1990s
- 350 freeze-thaw cycles - 3 month test
- Maximum beam expansion of .060
- 85 approved sources
- Most recycled concrete placed prior to 1990
Round Table Intro - What is Needed?

Hydraulic Fracture Test
- 7 day test to supplement ASTM C 666
- Allows Contractor to verify AP status quickly and reuse RCA from same contract

Internally Cured Concrete
- Highly saturated lightweight fine aggregate
- Absorbed water provides internal moisture that is slowly released to hydrating cement
- Intended to inhibit shrinkage and early age cracking of bridge deck

Expanded Shale
- Lightweight Fine Aggregate

Lime Kiln Dust
- Soil stabilization
- Over 4 million yd$^2$ of subgrade in lieu of lime in more than 100 projects in 2012
Crushed Glass as Bedding Material

- Bedding material beneath pipes and storm sewers
- Recycled glass beverage and food containers
- Type III or Type IV restricted waste
- No colored bottles because of the mercury

<table>
<thead>
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<tbody>
<tr>
<td>½ in.</td>
<td>85 - 100</td>
</tr>
<tr>
<td>No. 4</td>
<td>45 - 85</td>
</tr>
<tr>
<td>No. 10</td>
<td>25 - 70</td>
</tr>
<tr>
<td>No. 40</td>
<td>10 - 30</td>
</tr>
<tr>
<td>No. 200</td>
<td>0 - 10</td>
</tr>
</tbody>
</table>

Silica Fume

- Product from reducing high-purity quartz with coal in an electric arc furnace in the manufacture of silicon
- Allowed as mineral admixture in concrete
- Only used in high performance concrete

What is Needed?

- Website portals
- Material mapping
- Online training & webcasts
- CEU credits
- How to overcome the “not invented here” syndrome
- Can traditional suppliers become partners?