Slag

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Topics

- Full Depth Reclamation (FDR)
- Slag FDR
- Slag & Slag Use in PA
- Slag as Subbase / Warranty Requirement
- Slag Anti-Skid Pilot Projects
Full Depth Reclamation (FDR)

- What is FDR?
- What is the FDR Process?
- Where to use FDR?
Slag Full Depth Reclamation (Slag FDR)

- **Aggregates added** to FDR when roadway needs to be:
  - widened or raised

- 2015 PennDOT met with the National Slag Association (NSA)

- District 2 pilot Slag FDR project:
  - for improvements to SR0046 in McKean County
Slag FDR Pilot Project – SR0046

- 20’ wide with 10’ cartways
- 10 ton weight restriction
- Heavy truck traffic (timber cuts, Marcellus Shale well development traffic)
Slag FDR Pilot Project – SR0046 – Cont’d.

- Widen base from 20’ to 24’ with 11’ cartways
- 12” FDR with 3” binder, 1.5” wearing
- Overall project length 20 miles across 2 state routes
  - 4.65 miles of FDR on SR0046
Slag FDR Pilot Project – SR0046 – Cont’d.

- Contract award ➔ IA Construction ($3,013,877) - July 12, 2016
- NTP ➔ July 21, 2016
- PennDOT McKean County Dept. Maint. ➔ drainage work
- FDR SR0046 scheduled ➔ 1st week in October 2016
- PennDOT ➔ 1st FDR project using asphalt emulsion (stabilizing agent)
- Physical work completion (PWC) ➔ mid-November 2016
Intent of Study:
- How slag aggregate performs in an FDR under heavy truck traffic

3 phases of study over a 3-yr Evaluation/Research contract with Applied Research Associates (ARA):
1. Pre-Construction
2. During Construction
3. Post-Construction

Evaluation/Research items:
- Price and quality of slag aggregate materials
- Strength properties of reclaimed base
- Resistance of reclaimed base to freeze/thaw cycles
- Overall viability of slag in future FDR projects
• **NSA/PennDOT Partnership:**
  
  – Helped develop Slag FDR special provision
  
  – Helped develop evaluation/research project
  
  – Provide technical assistance to PennDOT over the course of evaluation/research project
What is Slag?

- Slag is a by-product of either iron or steel making processes
  - **Blast Furnace Slag** – Produced as a by-product from iron making. Typically air cooled, then crushed and graded.
  - **Steel Slag** – Produced from steel making processes such as electric arc furnace, basic oxygen furnace, etc.
Sources in PA

- Only **two (2)** of PA’s **11 approved sources** are ‘**pure slags**’
  - **Lafarge** buys exclusively from US Steel – **fresh 100% blast furnace slag**
  - **Harsco** is **100% steel slag** from a steel mill outside of Harrisburg (Steelton/Middletown area)

- All **remaining 9 sources** are from waste sites commonly referred to as ‘**Brownfields**’
Slag use in PA

- **Slag aggregates** are **approved** for a number of **uses** (although there are restrictions)
  - **Approved Uses:**
    * Embankment
    * Subbase
    * Wearing Courses
    * Anti-Skid
    * FDR
  - **Steel slag** cannot be used in **confined applications** (such as in **concrete**, **pipe** or **structure backfill**) due to the potential for **expansion**.
  - **Blast furnace slag** may be used in as aggregate in concrete mixes.
Slag as Subbase

- Both types (Steel slag and Blast Furnace slag) may be used as subbase material
  - Past performance concerns (as subbase)
  - District Restrictions (DSP’s)
  - New acceptance criteria
Slag – District Special Provision

- 1999, Dist. 9
  - substantial frost heaving on US-22, Cambria Co.
- Slag aggregate (used as subbase)
- Dist. ➔ frost heave was due to high absorption
  - instituted Dist. Special Provision (DSP)
    - restricting subbase aggregate absorptions to < 3.5%.
• Other Districts w/slag aggregate bad subbase experiences
  – Adopted & implemented DSP

• NSA ➔ not happy w/this action
  – Requested PennDOT prohibit use of DSP
  – Countered not related to the subbase
    • i.e., attributable to other causes
Technical Workgroup

- NSA-PennDOT technical workgroup formed

- Study ➔ assess material performance
  - Ten-50 lb. bags of 2A (Dist. staff sampled)
    - Sent to NSA’s selected private lab (Bowser Morner)

- European Test methods (also) used
  - Extensive use & testing of slag aggregates for transportation
  - Over 27 countries utilize DIN test standards.
Technical Workgroup – Cont’d.

- Based on the correlation testing, PennDOT implemented **SSP B03501** for projects let after February 13, 2015:

**Detail**

- **Index or Category:** Section Related
- **Sequence ID:** 3501
- **Version:** A
- **Provision Name:** b03501 SECTION 350 - SUBBASE

**Provision Body**

In accordance with Section 350 and as follows:

- **Revise Section 350.2(a) Aggregates. to read as follows:**

(a) **Aggregate** - Provide Type C or better, No. 2A material with freeze-thaw resistance according to European Standard DIN EN 13242 with a maximum freeze/thaw loss of 2% as determined by European Standard DIN EN 1367-1 for all slag aggregates and any natural aggregate whose absorption exceeds 2%. Test for thermal and weathering properties of aggregates, Part 1: Determination of resistance to freezing and thawing.
Subbase Warranty

• Revision to Pub. 408, **Section 350 – Subbase**

• **Adds a Warranty** if certain criteria are **NOT** met
  – New Section 350.4

• Performance criteria developed for **Asphalt Pavement**, **Concrete Pavement** and **Shoulders**
Subbase Warranty – Cont’d.

- 120-Month (10-Year) Warranty

- Provide material with a maximum freeze-thaw loss of 4.49% as determined by European Standard DIN EN 1367-1 for the following:
  - All slag aggregates
  - All recycled crushed concrete
  - Any natural aggregate whose absorption exceeds 2.49%

- When freeze-thaw loss exceeds 2.49%, subbase will be warranted

- Warranty and freeze-thaw testing not required for natural aggregates with absorptions ≤ 2.49%
Next Steps

• **Clearance Transmittal (CT)**
  - for revised testing & qualification criteria for 2A (for subbase)
    - Introduces new Type 2 aggregate

• **Replaces** European Test Method (*DIN EN 1367-1*) in previous slide’s SSP with *AASHTO T-103* (uses freezing & thawing in water)
  - The higher limit (6.0%) of loss is based on a correlation analysis performed through LTS testing
Slag Anti-Skid (AS) Pilot Projects

- Pilot Program started in 2013

- 2013-2014 (1st Pilot)
  - Armstrong, Elk, Washington

- 2014-2015 (2nd Pilot)
  - more in-depth pilot
  - Over 300 performance surveys (by Counties & Consultant)
  - Armstrong, Cambria, Clearfield, Washington

- Total **Slag AS** Purchased To-Date: 3,550 Tons
• 2014-2015 Pilot Project
  – Background
  – Participating Counties
  – Work Plan
  – Deployment

– Results indicated satisfactory perf. to competitively bid w/other traditional (natural aggregates) anti-skid materials
Slag Anti-Skid Pilot Projects – Cont’d.

- New AS gradation designation (AS4)

- Anti-Skid Procurement **Mandate**
  - (AS4 with any combination)

- Environmental Requirements
  - Permits / Co-Product Determinations
Next Steps

- Procurement Webinar
  - Held July 26, 2016
  - Anti-Skid Procurement **Mandate to continue for 2016-2017 season**

- SEMP ➔ continue review/approve **ALL** Permits & Co-Product Determinations

- Districts & Counties starting to purchase material
2016 PAPA BUS TOUR

Thank You