2016 PAPA BUS TOUR

Slag

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August 1-3, 2016
District 1-0

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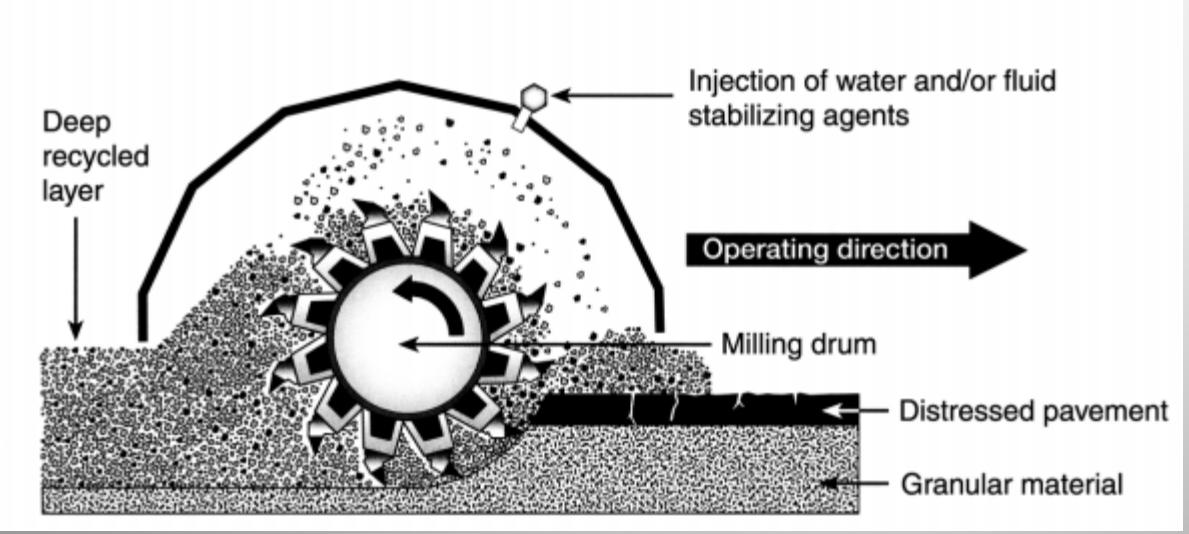
Topics

- 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?



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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)

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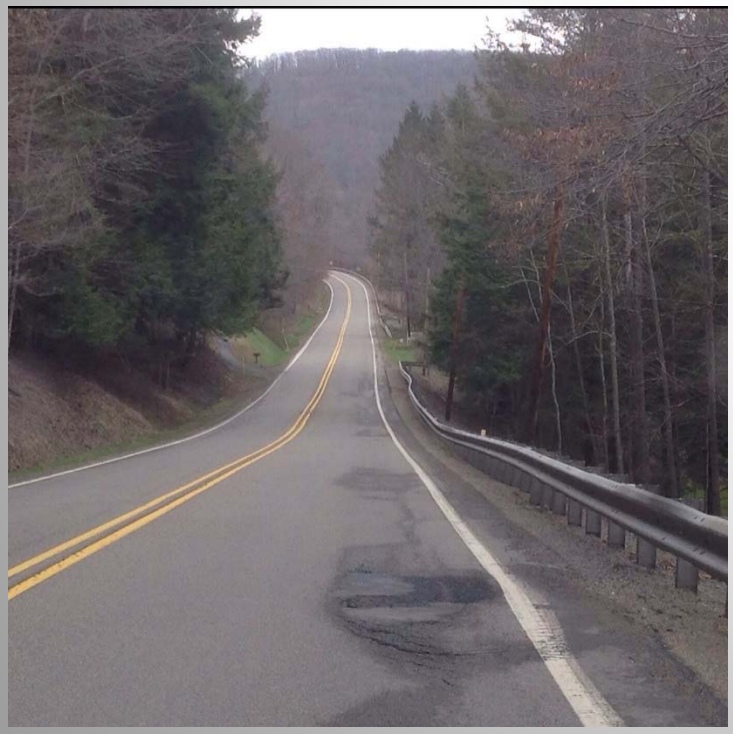
Slag FDR Pilot Project – SR0046 – Cont'd.

- 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



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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

Slag FDR Pilot Project – Evaluation/Research Goals

- **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

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Slag FDR Pilot Project – Evaluation/Research Goals – Cont'd.

- **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

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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.

Steel Slag

Blast Furnace Slag

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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'***

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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** can**not** 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.

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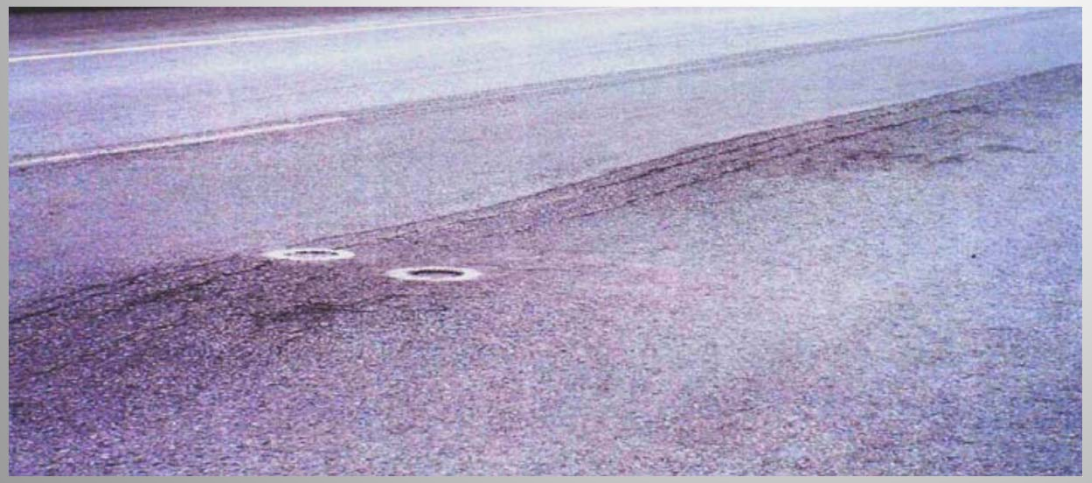
Slag as Subbase

- **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%.



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Slag – District Special Provision – Cont'd.

- 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

Status: Active
District: CO

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

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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

Slag Anti-Skid Pilot Projects – Cont'd.

- 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

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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 Determiniations

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

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