Steel Furnace Slag: The Premium Construction Aggregate for Asphalt, Base and Embankment

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Definition of Steel Slag

The American Society for Testing Materials (ASTM) defines Steel Slag as:

- the nonmetallic product consisting essentially of calcium silicates and ferrites combined with fused oxides of iron, aluminum, manganese, calcium and magnesium, that is developed simultaneously with steel in basic oxygen, electric, or open hearth furnaces.

Steel Making Flow

Integrated Steel Mills
Availability - USGS 2010

United States of America

Available SFS Tonnage

- USA (USGS): 9 Million tons per year
- ~6 Million Cubic Yards

Sustainable / Renewable

Steel Furnace Slag(s)

- BOS / BOF:
  - Basic Oxygen Steelmaking
  - Basic Oxygen Furnace
- EAF:
  - Electric Arc Furnace
- LMF / Caster:
  - Ladle Metallurgy Furnace
- AOD:
  - Argon-Oxygen Decarburization (Stainless Steel)
Characterization
(Source / Type)
- Physical
  - Gradation
  - Durability
- Chemical
  - Volumetric Stability
  - Chemistry
  - Available Lime
- Environmental
  - TAL – metals
  - TCLP - Leaching

Applications
- Hot Mix Asphalt (HMA)
  - Surface
    - SMA / OGFC / Dense Graded
  - Intermediate
- Base
  - Bituminous
  - Aggregate
  - Stabilization
  - Secondary Road Stabilization
- Embankments
  - Ballast
  - Gabions
  - Run-Off
  - Environmental

Physical Properties
- Angularity
  - Coarse and Fine
- Durability
  - Freeze Thaw / Soundness
- Strength
  - LA Abrasion
  - Micro Deval
- Friction
  - Blends (Polish Resistant Aggregate)
INDIANAPOLIS MOTOR SPEEDWAY

Shape – Stability - Strength

Superior Performing Pavement

Surface Mixtures

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Williams Street
(Worlds Strongest Intersection)

I-55
(District 1, Illinois: 2,000,000+ tons)

I-65
(Indiana: Cat 4 & 5 – Dense / OGFC / SMA)

OGFC:
North Central Superpave Center: Durable and Quiet
Secondary Roads

Soil Stabilization
(Indiana: I-65)
**Embankments:**
Ballast / Gabions / Run-Off

**Railroad Ballast**

**Gabions**

**Embankments**
Contaminant Removal

Swales

Porous Reactive Wall Installation

Environment

John J. Yzenas - Steel Furnace Slag as Aggregate
Environmental Considerations

- Slag is not Slag / Characterization
  - Iron and Steel Slag
    - Copper
    - Lead
    - Etc.

- Benefits
  - CO2 Reduction
  - Remediation
  - Resource Conservation

- Concerns
  - Risk Assessments

RCRA

- Iron and Steel Slag are Excluded as a Hazardous Waste

- Processing Wastes Covered by the Mining Waste Exclusion
  - Iron blast furnace slag
  - Basic oxygen furnace and open hearth furnace slag from carbon steel production

HHRA 2002 (Human Health Risk Assessment)

- Over the past several years, the Steel Slag Coalition ("SSC"), a group of 63 companies that produce steel, process slag, or both, has undertaken a comprehensive study of the chemical composition of three slag types generated during the steelmaking process and the potential human health and ecological risks associated with possible exposure to such slag.

HHRA 2011

- Exposure: Contact / Ingestion / Inhalation
- Characterization by particle size.

- Based on new slag characterization data and the most current risk assessment guidance, including the new exposure models and toxicity information. As described herein, the current HHRA confirmed the previous assessment finding that commercial and construction uses of steel industry slags do not pose a health risk.