Schnabel ENGINEERING

SUSTAINABLE GEOTECHNICS & THE BENEFICIAL REUSE OF DREDGE MATERIAL

Presented To:

Southeastern Transportation Geotechnical Engineering Conference

October 23, 2012

By:

Jeffrey Nelson, PE

schnabel-eng.com

What is Sustainable Geotechnics?

Sustainable Geotechnics *is the practice of enhancing the geotechnical, geochemical and environmental characteristics of a material, industrial by-product, or waste by the addition/blending of other waste materials at designed ratios in order to create an environmentally safe, geotechnically competent and beneficially usable end product.*

Schnabel ENGINEERING

Baltimore Harbor Dredge Material

Schnabel ENGINEERING

Cox Creek
Dredge Material Containment Facility

- Owned by the Maryland Port Administration
- One of two DMCFs that can accept Baltimore Harbor DM.
- Capacity of 6 MCY
- Striving for renewable capacity, with a recycling goal of > 500,000 CY/YR
- DM consists of impacted organic silts and clays

Schnabel ENGINEERING

Three Phase Demonstration Project

Project Stakeholder Meeting
held mid-construction

Phase I

Material Characterization

Phase II

Laboratory Testing

Phase III

Field Demonstration

Schnabel ENGINEERING

Materials Considered for Blending with Dredge Material

- Steel Slag Fines (SSF)
- Blast Furnace Fines
- Cement Kiln Dust
- Portland Cement

Schnabel ENGINEERING

Why Steel Slag Fines?

- Potential for a single, granular amendment to provide significant geotechnical and environmental enhancements.
- Steel slag fines (3/8" minus) add significant strength, reduced settlement, and favorable aging effects.
- SSF materials are alkaline which will help immobilize arsenic and other heavy metals in DM.

Schnabel ENGINEERING

Source Materials

Cox Creek DMCF

Sparrows Point Steel Mill

Schnabel ENGINEERING

Steel Slag Fines Preparation

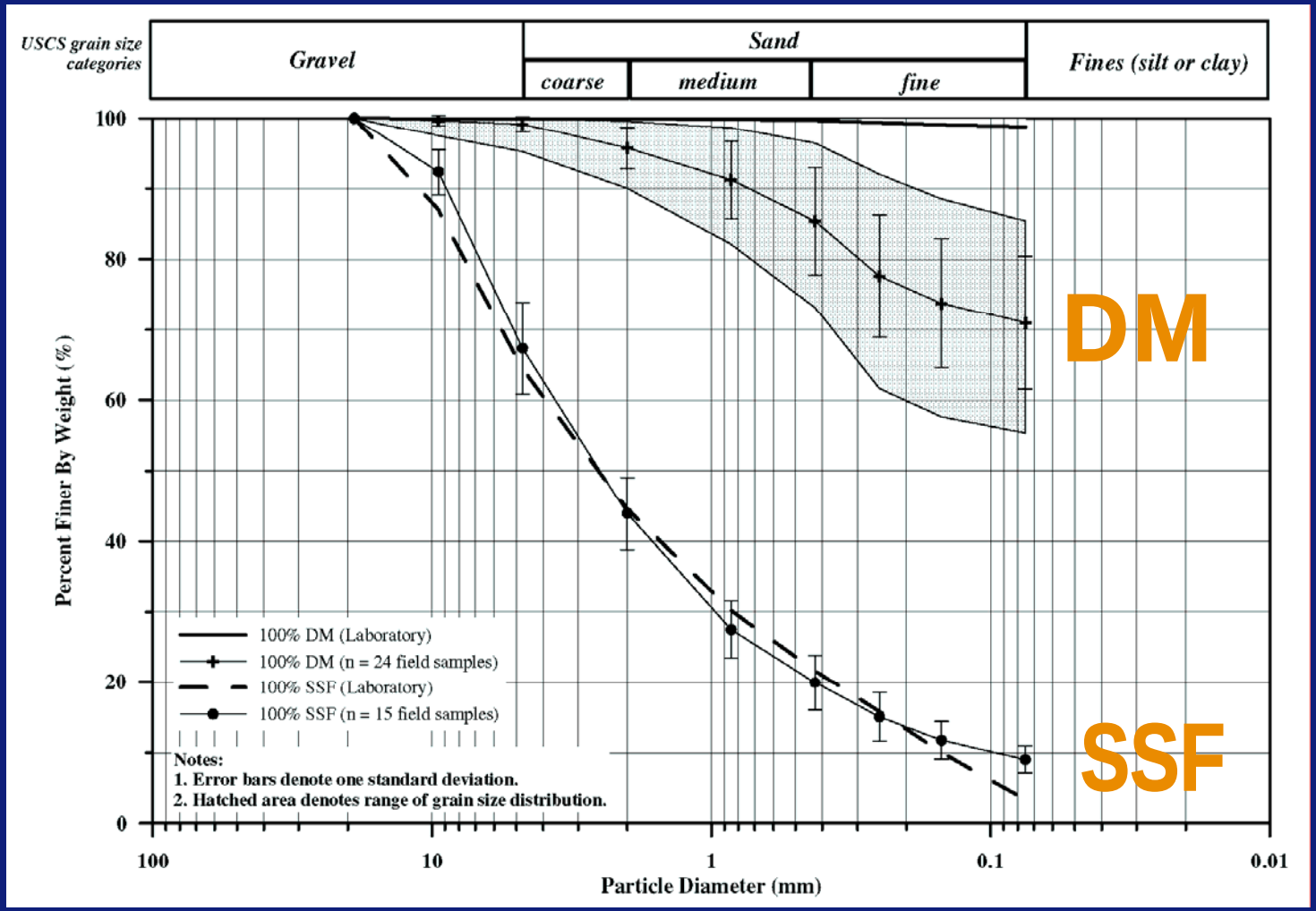
4-inch nominal slag crusher at Sparrows Point Steel Mill

9,335 tons of 3/8-inch minus SSF delivered to Cox Creek DMCF

- SSF is 20% of steel slag aggregate production
- Mill generates 10,000 tons SSF/month (during mill operations)
- Steel slag backlog is 3 million tons (2010 estimate)

Schnabel ENGINEERING

Gradation of Field Materials



Schnabel ENGINEERING

Five DM-SSF Blends

- 100% DM
- 80-20% DM-SSF
- 50-50% DM-SSF
- 20-80% DM-SSF
- 100% SSF

Schnabel ENGINEERING

Site Layout

Schnabel ENGINEERING

Material Blending

Schnabel ENGINEERING

Embankment Construction

Embankment Specs

- 50’-75’ Long
- 12’ High
- 12’ Wide
- 2:1 Side Slopes

Schnabel ENGINEERING

Construction Summary

DM-SSF Blending Operation

- All embankments met blending target (±5% DM content).
- Pugmill operated (as needed) at 200 tons/hr, often more.
- Maximum dry density of 80/20 DM-SSF blend exceeded 100 lb/ft^3.
- Fill materials were easy to place.
- Average compaction for each embankment met specification.

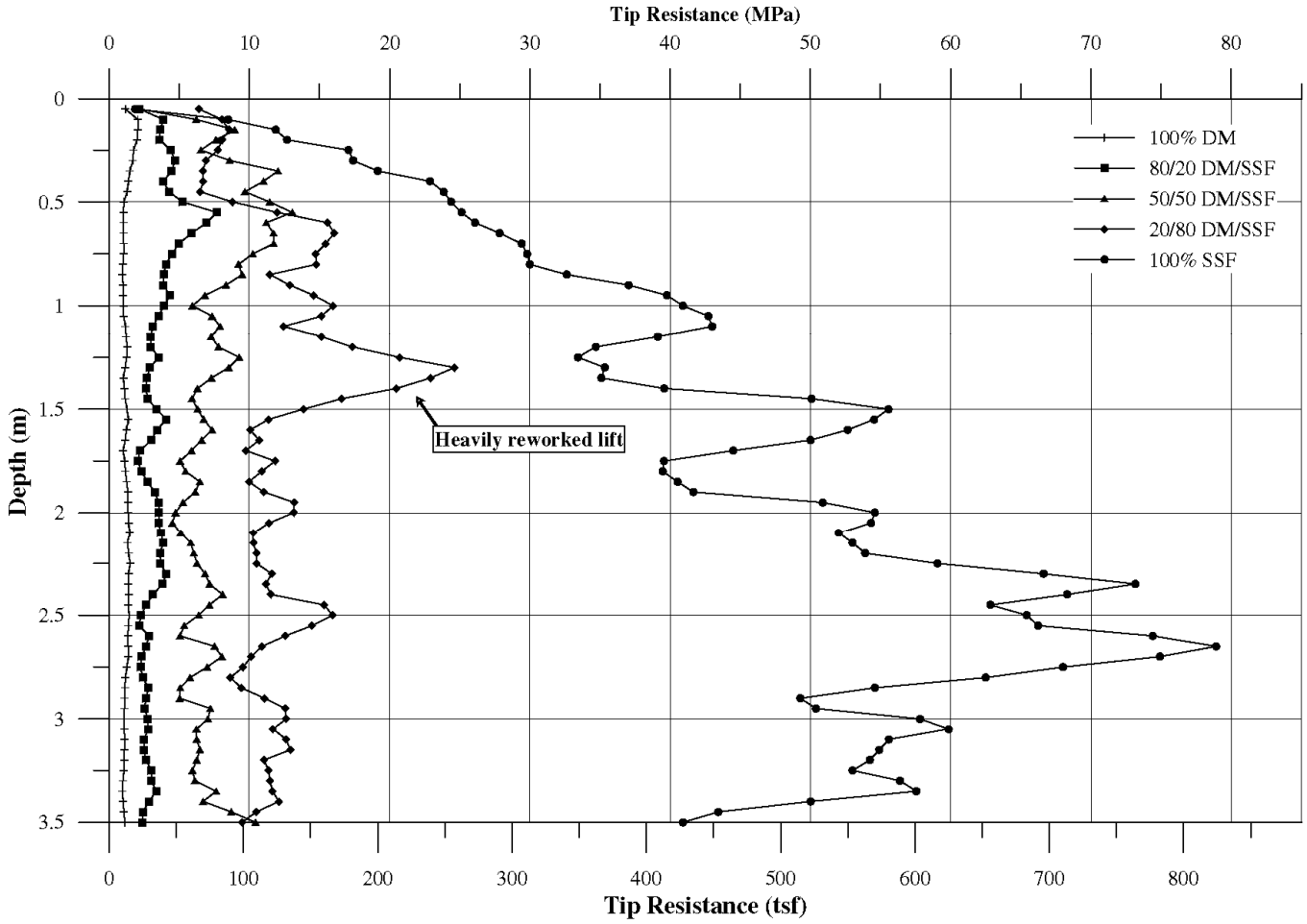
Schnabel ENGINEERING

Embankment Compaction Results (by ASTM D1557)

DM-SSF Embankment	100% DM	80/20	50/50	20/80	100% SSF
Max Dry Density (lb/ft^3)	86	104	115	132	158
Target % Compaction	85	90	90	92	95
Target Dry Density (lb/ft^3)	73.1	88.0	103.5	122	150
Mean Dry Density (lb/ft^3)	74	92	107	125	153
Ave. Moisture Content (%)	43	30	20	17	7

Schnabel ENGINEERING

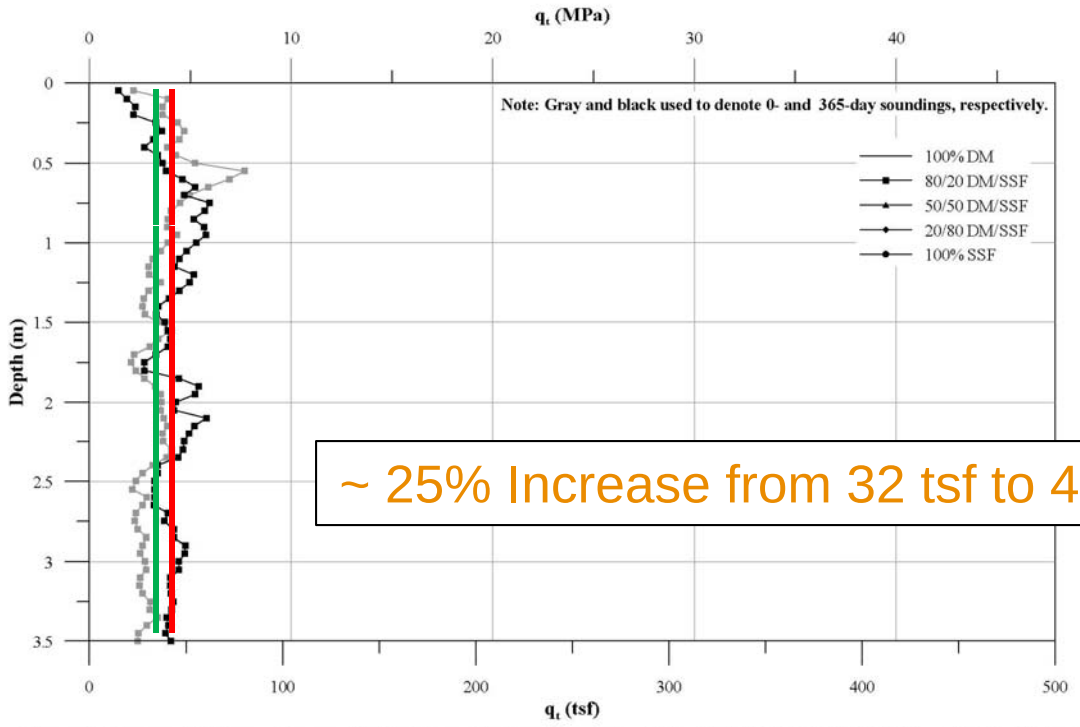
Cone Penetration Test Data - Initial



Average CPT sounding results for trial embankments constructed with 100% DM, 100% SSF and DM/SSF blends.

Schnabel ENGINEERING

CPT Data for 80-20% DM-SSF Blend Initial and 365 days



~ 25% Increase from 32 tsf to 42 tsf

Figure X: Average CPT sounding results for trial embankments constructed with 100% DM, 100% SSF and DM-SSF blends.

Schnabel ENGINEERING

365-day Aging Evaluation

Samples collected at mid-height
of each embankments at 3 locations

Schnabel ENGINEERING

Strength of laboratory vs. field samples from CIU Triaxial Tests

Media		Dry Density (lb/ft^3)	Water Content (%)	% Compaction (%)	c' (lb/ft^2)	ϕ ' (^{o})
100% DM	Lab (28-day)	80	38	95	856	27.3
	Field (365-day)	74	41	85	317	34
80/20 DM-SSF	Lab (28-day)	86	35	95	1,000	32.4
	Field (365-day)	92	28	85	0	52

Schnabel ENGINEERING

Effects of Aging

365-day Trial Embankments:

- CPT strength increased by factor of up to 2x, negligible sleeve friction and porewater pressures
- 80/20 DM-SSF Blend had Φ'=52°
- 80/20 DM-SSF Blend 18° stronger than 100% DM
- 100% DM acidified to pH~5.9, whereas 80/20 DM-SSF Blend remained strongly buffered (pH~10.8)

Schnabel ENGINEERING

Project Outcomes

ACEC

American Council of Engineering Companies
Maryland

2012

Outstanding Project Award

presented to

Schnabel Engineering, Inc.

whose project

MPA Innovative Use of Dredged Material

reflects innovative excellence in engineering design
presented this 16th day of February, 2012.

Jeffery P. McBride, P.E., President

- **DM-SSF Blends demonstrated to be geotechnically competent, and environmentally acceptable**
- **Database of information developed to provide basis for Beneficial Use Permit with Maryland Department of the Environment**
- **Public peer-reviewed results through 4 technical journal papers and 5 technical conference papers**
- **Recent awards from ACEC-Maryland and American Road and Transportation Builders Association**

Schnabel ENGINEERING

What's Next?

- Work with Maryland Port Authority and Maryland Department of the Environment to establish process for permitting the use of DM-SSF Blends for construction.
- Seek pilot project, in collaboration with the Maryland State Highway Administration, to demonstrate full scale use of DM-SSF material for highway embankment construction
- Promote use of DM-SSF blends to assist in achieving the MPA goal of using 500,000 CY/YR of DM
- Look for application of DM-SSF blends for beneficial use near other ports

Schnabel ENGINEERING

Thank You!

Schnabel Engineering Consultants, Inc.

Schnabel ENGINEERING