DESIGN AND CONSTRUCTION OF A LARGE-SCALE EROSION | SEDIMENT CONTROL TESTING FACILITY IN ALABAMA

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2009 AASHTO Construction Conference
August 6, 2009
Chicago, IL
Introduction

- A collaborative effort between the Highway Research Center (HRC) at Auburn University and the Alabama Department of Transportation (ALDOT).

- Testing Facility Objectives:
  - **Erosion Control:** polyacrylamide (PAM); rolled erosion control products (RECPs); hydromulches
  - **Sediment Control:** ditch checks; inlet protection devices; sediment basin performance
  - **Education:** understanding effectiveness of new and innovative BMPs while educating industry professionals
Background: Environmental Concerns

- **Nonpoint Source (NPS) Pollution** from construction sites:
  - Major source of concern for the environment
  - Identified as one of the leading contributors of NPS pollution
  - It is estimated that over *80 million tons of sediment* are washed from *construction sites* each year*

- Two common consequences of stormwater runoff: (1) **Erosion** and (2) **Sedimentation**

- **Best Management Practices (BMPs):**
  - Designed to provide practical field solutions to **reduce** and **eliminate** NPS pollution.

*Novotny, 2003*
Background / Motivation

- Currently, ad hoc practices are being utilized for BMP design and installation on highway construction sites

“There is a lack of scientific knowledge on designing and evaluating economical erosion and sediment control technologies” (EPA)

- Construction sites require effective BMPs to comply with EPA regulations
- We need cost effective methods for developing, testing, and evaluating new BMP applications
Large Scale Facility: Site Needs

SOLUTION:
- Erosion and Sediment Control (ESC) Testing Facility

SITE NEEDS:
- Adequate water supply
  - Most critical need
  - Should be renewable
- Elevation gradation similar to highway construction conditions
- Enough land to accommodate the required ponds and testing area
Site Characteristics

- National Center for Asphalt Technology (NCAT) Test Track, Opelika, AL

- Site proximity:
  - between two access roads with parallel drainage ditches
  - down grade from $7\frac{1}{3}$ acre impervious asphalt parking lot
Preconstruction: Site Conditions

- ESC facility area comprised of $2\frac{1}{4}$ acres
- Majority of site area was heavily wooded with juvenile pines
- Two concrete flumes drain runoff to culvert at the lowest point
- Over 90% of the runoff generated to the culvert is from the impervious parking lot area

Runoff Characteristics of Parking Lot Subcatchment

<table>
<thead>
<tr>
<th>Event</th>
<th>Peak Runoff (cfs)</th>
<th>Volume (acre-feet)</th>
<th>Depth (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-Year Storm</td>
<td>28.42</td>
<td>2.216</td>
<td>3.63</td>
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<tr>
<td>5-Year Storm</td>
<td>37.12</td>
<td>2.942</td>
<td>4.81</td>
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<tr>
<td>10-Year Storm</td>
<td>43.61</td>
<td>3.487</td>
<td>5.71</td>
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<tr>
<td>25-Year Storm</td>
<td>50.79</td>
<td>4.095</td>
<td>6.70</td>
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<tr>
<td>50-Year Storm</td>
<td>55.81</td>
<td>4.521</td>
<td>7.40</td>
</tr>
</tbody>
</table>
3-D Rendering of ESC Facility

- Intermediate-scale Testing Facility
- Upper Storage Pond
- Sediment Basin
- Lower Retention Pond
- Testing Channels
- Rip Rap Ditches
Hydrologic Needs: Site Drainage

- **Upper Storage Pond:**
  - Captures runoff from parking lot subcatchment
  - 28,000 ft\(^3\) (210,000 gals) capacity
  - Discharges into retention pond once capacity is attained

- **Lower Retention Pond:**
  - Captures all runoff from entire facility catchment
  - 45,000 ft\(^3\) (335,000 gals) capacity

- **Three riprap lined ditches**
  - Two reaches in series
    - Parking lot to upper storage pond
    - Upper storage pond to lower retention pond
  - One reach collecting runoff from track median to the retention pond
Hydrologic Needs: Facility Testing

- **Upper Storage Pond:**
  - **Water source** for experiments
  - **Max of 5,400 ft³** per experiment (40,400 gal)

- **Sediment Basin:**
  - **Captures runoff** from experiments
  - **12,000 ft³** (90,000 gal) capacity
  - **Promotes sedimentation** of experimental runoff
  - **Detention time** contingent on flashboard riser and/or skimmer setting(s)

- **Lower Retention Pond:**
  - **Retains water** that may be used if the upper storage pond’s water supply has been exhausted
  - **GCL helps maintain water level**
Preconstruction: Site Conditions

24” concrete discharge pipe
Construction: Clearing and Grubbing

48” Temporary Control Structure
Construction: **Control Structure**

48” Permanent Control Structure

40-ft of 24” RCP
Construction: Retention Pond

12-ft High Control Structure
Construction: Retention Pond (Cont’d)

Geosynthetic Clay Liner

12-ft High Control Structure
Construction: Retention Pond (Cont’d)

Retention Pond Final Grade

Hyrdro-mulch Application
Recycled Asphalt Pavement (RAP) was used as a pond liner.
**Construction: Upper Storage Pond**

**RAP** was used as a pond liner.
Construction: Upper Storage Pond

Rip-Rap channel conveys water into Upper Storage Pond

Spillway conveys water into rip-rap channel down to lower retention pond
Experimental Channel Characteristics

Three Experimental Channels
- Two ditch check and RECP testing channels (No. 1 & 3)
  - Sediment control
  - Channel erosion
  - Stabilization techniques
- One channel devoted to testing inlet control devices (No. 2)

Two channel zones
- Permanent:
  - Galvanized metal sheets (removable)
  - Allow for testing devices independent of channel performance
- Earthen:
  - Multi-zoned (permanent and earthen zones), simulates field conditions to set up device
  - Entire channel may be made earthen for RECP testing in conjunction with ditch check or tested independently
Experimental Channel Setup

- **Ditch check channels:**
  - 3:1 wing walls
  - 1.5-ft depth
  - 10’ longitudinal earthen section

- **Inlet control channel**
  - 3.75:1 wing walls
  - 2-ft depth
  - 48-in diam. drop inlet
  - 17-ft dia. earthen section
Experimental Setup & Protocols

**Ditch Check Tests**

- Prepare ditch per *ASTM D 7280–06* specifications
- *Use metal components* when testing ditch checks *independently of channel performance*
- *Survey* cross sections of ditch prior to testing
- *Install ditch checks* to *ALDOT* or manufacturer's specifications
- *May* Introduce *sediment laden flow*
  - *3 cfs* (ASTM D 7208–06)
  - *use other flow rates* for condition specific tests.
- *Sample runoff* before and after ditch check
- Experiment duration:
  - *30 mins*  **OR**  *until structural failure*
- *Survey cross sections* to determine deposition and/or erosion
Experimental Setup & Protocols (cont’d)

**Inlet Protection Tests**

- Prepare earthen section to specifications similar to *ASTM D 7280 – 06*
- Survey earthen area
- Install inlet protection to *ALDOT OR manufacturer’s specifications*
- Introduce sediment laden flow
- Sample flow:
  - prior to entering earthen area
  - entering drop inlet
- Experimental duration:
  - *30 mins OR until structural failure*
- Survey earthen area to determine deposition
**Experimental Setup & Protocols (cont’d)**

**Channel stabilization (RECP)**
- Prepare channel to *ASTM D 6460 – 07 standard specifications*  
- Survey channel cross sections  
- Introduce sediment laden flow using same method as ditch check test experiment  
- Sample flows: 
  - at beginning of channel  
  - at the end of channel  
- 30 min test duration or based on performance  
- Survey channel cross sections again to determine deposition within the channel  
- If possible, carefully remove RECP to determine erosion production
Intermediate-Scale Facility
Simulated Rainfall

Max Height: 10’

≈ 8’ X 8’

Pressure Regulator

Solenoid

Nozzle

Rainfall simulator can be calibrated to represent various rainfall events
Test Plot Features

- Rain Guards
- Adjustable Saw-Horses [Different Slopes]
- Surface Runoff Discharge Points
- Cinder blocks
- Runoff Collection
**Polymer-Enhanced Soft Armor Testing**

- **Polymer-enhanced soft armoring**
  - Soft, pliable open-weave mat (i.e. jute, coir, coconut, hemp, burlap, etc.)
  - Site-specific, dry-granular polyacrylamide
- The addition of PAM allows the chemical treatment to bond with soil particles, thereby enhancing the stability of the surface

**Instantaneous Turbidity vs. Eroded Soil**
Design and Construction of Field-scale Erosion and Sediment Control Testing Facility
- Construction is expected to finish August 2009
- Field-scale testing will commence Fall 2009 (calibration / validation)

Field-Scale Experiments
- Ditch check Testing
- Inlet Protection Devices
- Rolled Erosion Control Products

Providing economic solutions for environmental concerns on construction sites based on scientific evidence
This research was sponsored by the Alabama Department of Transportation (ALDOT). The support provided is gratefully acknowledged.