DESCRIPTION OF EROSION RATE TESTING DEVICES AND CORRELATIONS BETWEEN ROCK EROSION RATE AND COHESION

6th International Conference on Scour and Erosion
Paris, France
29 August 2012

Dr. Raphael Crowley, Dr. David Bloomquist, and Corbin Robeck
University of Florida
Department of Civil & Coastal Engineering
365 Weil Hall
Gainesville, FL 32611
Rotating Erosion Testing Apparatus (RETA)

Photograph of RETA

Schematic Drawing of RETA

Torque Measurement and Clutch

Rock/clay sample

Water

Rotating outer cylinder
Sediment Erosion Rate Flume (SERF)

Photograph of SERF

- Pressure Ports
- Ultrasonic Array
- Shear Sensor
- Sample OD: 3.25 in. Height: 12.0 in.
- Stepper Motor

Schematic Drawing of SERF

- Flume
- Flow Direction
- Sample Cylinder & Sample (Shelby Tube)
- Piston
- Lead Screw
- Advancement Mechanism
SERF Unique Features

Inside the SERF

Ultrasonic Array

Pressure Port
(0.5 in. Diam)

Photoelectric Sensors

Lasers
Erosion as a Function of Cohesion

- Intuitively, Erosion should be function of material strength
  - Slagle (2006): $E = kC^{-n}$; as $C \to 0$, $E \to 0$
    - $E = \text{Erosion Rate}; \ C = \text{Cohesion}, \ k, n = \text{Correlation constants}$

- $E = M(\tau_b - \tau_c)$
  - Can Slagle’s apparent correlation be made to appear like known relationship?
  - $M = \text{Material Constant}; \ \tau_b = \text{Bed Shear Stress}; \ \tau_c = \text{Critical SS}$
Erosion as a Function of Cohesion

- Rock obtained from Aucilla River, FL; Mill Creek, OR, Jewfish Creek, FL

- Erosion Function was approximated as $E = N\tau_b - Z$
  - $N, Z =$ Erosion constants

- Instead of correlating $\tau_c$ to $C$, $N$ and $Z$ were correlated separately
  - $N, Z = a + b\exp\left(\frac{-c}{c}\right)$, $a, b, c =$ correlation coefficients
New Model Results

Measured vs. Modeled Results

\[ y(x) = a \cdot x \]
\[ a = 0.85862 \]
\[ R = 0.85714 \] (lin)
Analysis of New Model

- \[ E = N \tau_b - Z \]
- \[ N = a_1 + b_1 e^{c/c_1} \]
- \[ Z = a_2 + b_2 e^{c/c_2} \]
- \[ E = N \left( \tau_b - \frac{Z}{N} \right) \]

Critical Shear Stress vs. Cohesion
Issues with New Model

Erosion Constant as a Function of Grain Size using SERF Data
DISCUSSION