DG4 – ARTICULATED CONCRETE BLOCK (ACB) SYSTEMS
LEARNING OUTCOMES

• Describe the FHWA background with ACB systems
• Describe the failure processes
• Describe the design procedures for bank protection, channel armor, and pier scour
• Design ACB systems for channel bank protection and bed armor
FHWA 1983 testing program of various erosion control systems

Promising yet sporadic results for ACB systems

Refined testing of ACB systems in late 1980’s
ACB FAILURE

• Definition: Local loss of intimate contact between the ACB and the subgrade that it protects

• Does not require loss of blocks from the ACB matrix

• Usually initiates via overturning of block or group of blocks
FORCES AT INCIPIENT OVERTURNING (FAILURE)
FAILURE PROCESSES

- Ingress of flow beneath system causing increase in uplift pressure
- Loss of subgrade soil through piping
- Rapid saturation and liquefaction of subgrade soil causing failure of slope
- Loss of block or group of blocks exposing subgrade to flow
APPLICATIONS

- Application 1 - Design procedure for revetment and bed armor
- Application 2 - Design guidelines for pier scour
DESIGN PROCEDURE FOR REVETMENT AND ARMOR

- Considers forces acting on a single block at incipient failure
- Uses a factor of safety concept
- Requires performance testing to determine allowable hydraulic loading
- Equations are complicated due to theoretical basis of design procedure
FACTOR OF SAFETY

\[ SF = \frac{\tau_a}{\tau_0} (SF_{a}) (K_1) \]
LABORATORY SCHEMATIC

- Flow Meter
- Carriage
- Point Gage & Velocity Probe
- Video Camera
- Soil Embankment
- Embankment Test Section
- Sill

- Headbox
ACB PERFORMANCE TEST
Allowable Tractive Force (Factor of Safety = 1.0)

Allowable Shear Stress, Pa
Bed Slope, percent
Block Size 1
Block Size 2
Riprap D50 = 610 mm

1200
1000
800
600
400
200
0
0 10 20 30 40 50

Bed Slope, percent
DESIGN EXAMPLE

• Estimate the factor of safety for two blocks that may be used to armor a trapezoidal channel

• The results should include the effects of the channel side slopes
EXAMPLE SUMMARY

• Answers
• Other design constraints
• Further steps in design process
• Questions
DESIGN GUIDELINES FOR PIER SCOUR

- Factor of safety approach can be used
- Failure process complicated by contraction scour
- In lab, pier seal is common failure point
- Consider additional structural capacity if ACB mat is to be grouted to pier
- Anchors may be required at pier seal
DESIGN GUIDELINES FOR PIER SCOUR

- Cable location and block shape should allow for maximum flexibility
- Communication of details to contractor is essential for proper performance
- Method not self healing
- Effective over wide range of conditions if properly constructed
Flow

1st Row of Blocks in Trench

Duckbill Anchors @ 4 ft.

Grouting

X1

WS/2

X2

Plan

Top View

Section

15"
12"
12"
15"
GROUT BAGS

Provide grout tubes at 4'-0" O.C. that extend to opposite side of seal. Provide shorter tubes to monitor grout fill at 4'-0" O.C. between longer tubes.

Place Grout Bags to form bulkhead tight to underside of seal (Typ).

#4 Bar (Typ) @ 4'-0" O.C. (Min. 2 per Bag)

2'-0" Overlap of Geotextile Between adjacent mats (Typ)

Note: Pump grout into each long tube until discharge at monitor tube. Close valve and repeat operation at next long tube until grout completely fills voided area below seal.
“TOP HAT” AND PILE SLEEVE

Fabriform mattress arrangement at a pile
GRANULAR FILTER AND RIPRAP