DG12 – REVETMENT RIPRAP
LEARNING OUTCOMES

• Describe the various flexible revetments
• Describe the design guidelines for riprap size, thickness, gradation, filtration, and edge treatment
• Design riprap size given necessary hydraulic data
FLEXIBLE REVETMENTS

- Riprap – rock and broken concrete
- Concrete armor units and ACBs
- Vegetation
- Partially grouted riprap
- Gabions and gabion mattresses
CASE STUDY
FAILURE
DUMPED RIPRAP
MEDIAN STONE SIZE

\[ D_{50} = \frac{K_u C V_a^3}{d_{avg}^{0.5} K_1^{1.5}} \]
BANK ANGLE CORRECTION FACTOR

\[ K_1 = \left[ 1 - \frac{\sin^2 \theta}{\sin^2 \varphi} \right]^{0.5} \]
SPECIFIC GRAVITY AND STABILITY FACTOR

\[ C = \frac{1.61(SF)^{1.5}}{(S_S - 1)^{1.5}} \]
## STABILITY FACTOR

<table>
<thead>
<tr>
<th>Flow Condition</th>
<th>SF Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uniform Flow – straight or mild bend</td>
<td>1.0 – 1.2</td>
</tr>
<tr>
<td>Gradually varying flow – moderate bend</td>
<td>1.3 – 1.6</td>
</tr>
<tr>
<td>Approaching rapidly varying flow – sharp bend</td>
<td>1.6 – 2.0</td>
</tr>
</tbody>
</table>
DESIGN EXAMPLE

• Size revetment riprap at an eroding channel bank

• Discuss the mat thickness, gradation, filtration, and edge treatment
EXAMPLE SUMMARY

- Answers
- Other design constraints
- Further steps in the design process
- Questions
MAT THICKNESS

• Spherical diameter of at least $D_{100}$ or $1.5D_{50}$

• At least 0.3 m (1 ft) for practical placement

• Increase by 50 percent when placing underwater

• Increase thickness and stone size by 0.15 to 0.3 m (0.5 to 1 ft) when subject to attack by debris or waves
# RIPRAP GRADATION

<table>
<thead>
<tr>
<th>Stone Size Range (m)</th>
<th>Stone Weight Range (Kg)</th>
<th>Percent Smaller Than</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5D\textsubscript{50} to 1.7D\textsubscript{50}</td>
<td>3.0W\textsubscript{50} to 5.0W\textsubscript{50}</td>
<td>100</td>
</tr>
<tr>
<td>1.2D\textsubscript{50} to 1.4D\textsubscript{50}</td>
<td>2.0W\textsubscript{50} to 2.75W\textsubscript{50}</td>
<td>85</td>
</tr>
<tr>
<td>1.0D\textsubscript{50} to 1.15D\textsubscript{50}</td>
<td>1.0W\textsubscript{50} to 1.5W\textsubscript{50}</td>
<td>50</td>
</tr>
<tr>
<td>0.4D\textsubscript{50} to 0.6D\textsubscript{50}</td>
<td>0.1W\textsubscript{50} to 0.2W\textsubscript{50}</td>
<td>15</td>
</tr>
</tbody>
</table>
GRANULAR FILTER

\[
\frac{D_{15} \text{ (coarser layer)}}{D_{85} \text{ (finer layer)}} < 5 < \frac{D_{15} \text{ (coarser layer)}}{D_{15} \text{ (finer layer)}} < 40
\]

Note: See HEC-11 geotextile design criteria
EDGE TREATMENT

- Extend lower toe below expected contraction scour plus long-term degradation
- Place launching stone at toe of installation so that it will slide into developing scour hole
- Protect flanks with additional riprap at upstream and downstream edges