Riverbank Protection

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Objectives

Riverbank Protection

1. Riprap design guidelines
2. Examples of bank protection measures for small streams
3. Examples of bank protection measures for large rivers

Project Goals

- Protect Levee
- Create a Functioning Floodplain
- Improve Wildlife Habitat
**Definition of Riprap**

A permanent, erosion-resistant ground cover of large, loose, angular stone.

**Design with the velocity method**

Equation

\[ V_t = K \cdot \sqrt{2(G - 1)gd_s} \]

K = \log \left( \frac{d_s}{\tan \theta} \right)

**Determination of Riprap thickness:** U.S Army Corps of Engineers

- 12 in. (30cm) for practical placement
- Less than the diameter of the upper limit of d100 stone
- Less than 1.5 times the diameter of upper limit d50 stone, whichever is greater.
- If riprap is placed under water, the thickness should be increased by 50%.
- If it is subject to attack by large floating debris or wave action it should be increased 6-12 in. (15~30 cm).
Gradation of Riprap

- Well graded riprap scours less than uniform size riprap due to the process of armoring.
- Suggested Riprap gradation from USACE is shown to the right.
- Riprap with poor gradation may be used, but a “filter” layer is required.

<table>
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<tr>
<th>Percent</th>
<th>Size diameter</th>
<th>Size diameter</th>
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<tr>
<td>6</td>
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<td>0.29</td>
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<tr>
<td>10</td>
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</tr>
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<tr>
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<td>1.70</td>
</tr>
<tr>
<td>100</td>
<td>3.00</td>
<td>1.90</td>
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</table>

Gravel Filters

- Gravel filters should not be less than 6-9 inches.
- \( \frac{d_{50} \text{(filter)}}{d_{50} \text{(bank)}} < 40 \)
- \( \frac{5}{d_{15} \text{(filter)}} < \frac{40}{d_{15} \text{(bank)}} \)
- \( \frac{d_{15} \text{(filter)}}{d_{85} \text{(bank)}} < 5 \)

Riprap Failure

- There are four main types of riprap failure: particle erosion, transitional slide, riprap slump, and sideslope failure.
- The four types of riprap failure are shown in the figure to the right.
- The most common failure type is particle erosion from flow.
Poorly Designed Riprap

- $d_{15}$ of riprap is more than 5 times larger than $d_{85}$ of bank material, no filter layer
- Riprap is pitted
- Riprap is not well graded
REQUIREMENTS OF BANK STABILIZATION

- Effective
- Environmentally Sound
- Economical

(Listed in order of necessity)
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THANK YOU for your Attention!

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