Riverbank Protection

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Objectives

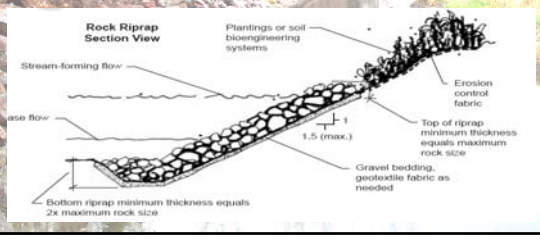
Riverbank Protection

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

2. Bank Protection

Definition of Riprap

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



Design with the velocity method

Equation

$$V_c = K_c\sqrt{2(G-1)gd_s}$$

$$K_c = \log\left(\frac{4h}{d_s}\right)\sqrt{\tan\phi}$$

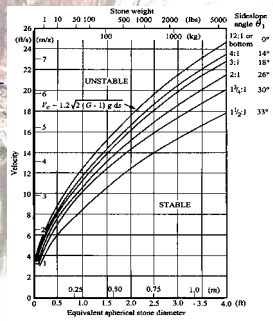


Figure 8.4. Particle-stability diagram.

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 8.2. *Suggested riprap size gradation*

Percent finer by weight	Sieve diameter ($\times d_{50}$)	Stone diameter ($\times d_{50}$)
0	0.25	—
10	0.35	0.28
20	0.50	0.43
30	0.65	0.57
40	0.80	0.72
50	1.00	0.90
60	1.20	1.10
70	1.60	1.50
90	1.80	1.70
100	2.00	1.90

Gravel Filters

- **Gravel filters should not be less than 6-9 inches**
- **½ thickness of Riprap layer is a good guideline**
- **Suggested gravel filter gradation equations are shown to the right**

$$\frac{d_{50}(filter)}{d_{50}(bank)} < 40$$

$$5 < \frac{d_{15}(filter)}{d_{15}(bank)} < 40$$

$$\frac{d_{15}(filter)}{d_{85}(bank)} < 5$$

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**

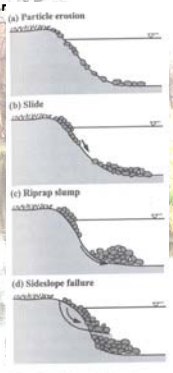
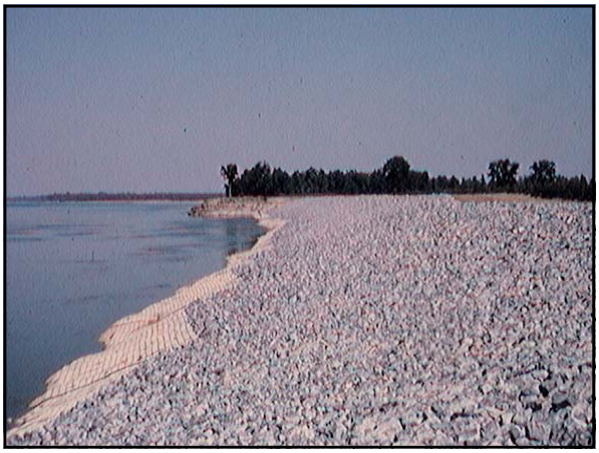


Figure 8.6. Riprap-failure types.



Poorly Designed Riprap

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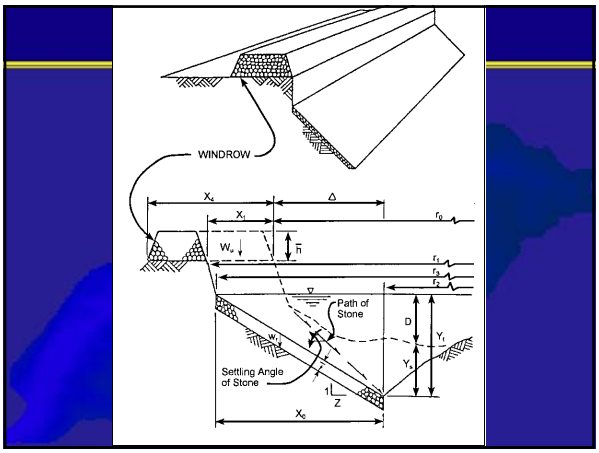
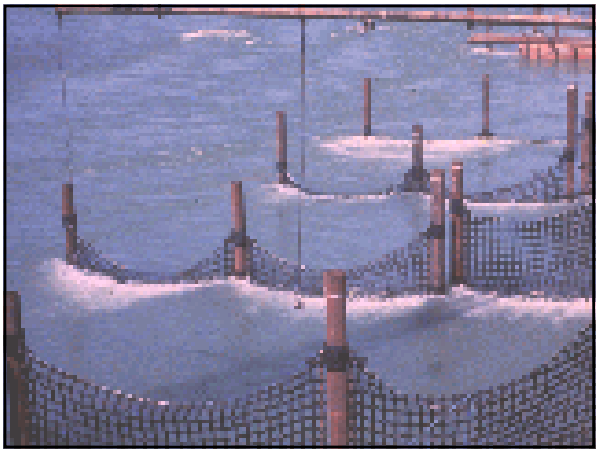
REQUIREMENTS OF BANK STABILIZATION

- Effective
- Environmentally Sound
- Economical

(Listed in order of necessity)


WINDROW
Path of Stone
Settling Angle of Stone
D
1
Z


APR



Timber Pile Revetment

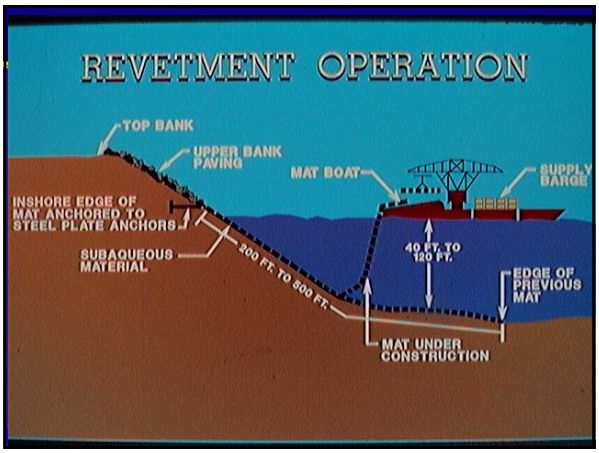
Stonefill Revetment

Revetment Capout

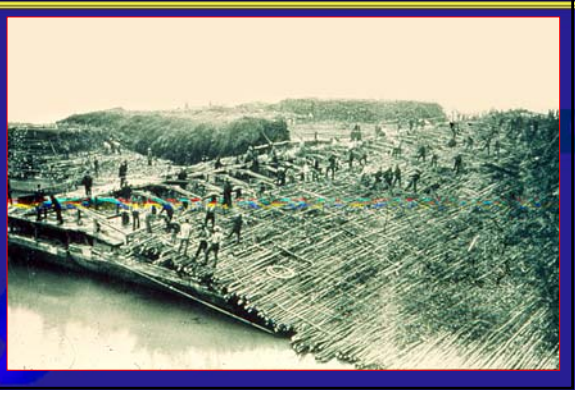
Timber Pile Revetment

Geobags

Geo Containers


REVETMENT OPERATION
TOP BANK
UPPER BANK PAVING
MAT BOAT
SUPPLY BARGE
INSHORE EDGE OF MAT ANCHORED TO STEEL PLATE ANCHORS
SUBAQUEOUS MATERIAL
200 FT. TO 500 FT.
40 FT. TO 120 FT.
EDGE OF PREVIOUS MAT
MAT UNDER CONSTRUCTION

Willow Mats



Erosion and River Mechanics Textbooks

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THANK YOU for your Attention!