TECHNICAL NOTE

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Planting Willow and Cottonwood Poles under Rock Riprap

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Introduction

Rock riprap is an engineering treatment that has been used extensively for streambank protection and stabilization. Blanket riprap is a hard structure that stabilizes the streambank in place. Riprap does not allow the stream to meander and has a low aesthetic value. Riprap alone provides little in the way of water quality benefits. Rock provides some fish habitat, but compared to natural vegetation, it is a poor substitute. Rock alone provides little to no wildlife habitat. However, under severe and emergency conditions, engineering techniques such as riprap are appropriate treatment measures.

Streambank soil bioengineering is defined as the use of live and dead plant materials in combination with natural and synthetic support materials for slope stabilization, erosion reduction, and vegetative establishment (Allen and Leech, 1997). Simply put, streambank soil bioengineering is using vegetation to increase the strength and structure of the soils through extensive root systems and aboveground biomass. Vegetation is flexible and if correctly installed can withstand high stream velocities. Plants are part of the natural streambank and buffer zone along a stream. Vegetation can offer a diverse plant community that provides wildlife habitat that is aesthetically pleasing.

Adding woody vegetation to an engineering structure increases the structure's strength, durability, and reliability (Schiechtl, 1997). Roots add tensile strength, binding together masses of stone and soil. Stems and branches create hydraulic roughness that dissipates wave and stream flow energy, and shields the soil and rock from erosive forces. Growing vegetation sprouts to fill in any open, eroding areas. As a supplement to structural efforts, live woody cuttings have the advantage of extending roots and sprouts that protect and bind masses of soil. Plant canopies create a microclimate for colonization by other species of plants which provides valuable habitat for wildlife. Vegetation overhanging the stream provides shade and hiding cover for fish as well as an energy input to the stream in the form of leaf fall.

A combination of rock riprap and vegetation can improve the overall performance of the rock and also provide needed streambank roughness in the form of stiff to flexible vegetative stem and leaf growth. Vegetation also improves fish and wildlife habitat, water quality, and aesthetics with a diverse community of woody plant materials. Woody vegetation often grows through the stone layer of riprap, adding strength, durability, and reliability. Vegetation also helps prevent movement of filter stone by binding stone and soil layers together.

Vertical willow bundles under rock riprap

Bundles of willows or cottonwoods can be placed vertically under rock riprap during initial construction. This method requires stems that are long enough to reach from the low water elevation to above the top of the planned rock. A Willow bundle is placed on the slope after shaping, but before the rock is placed. The bottom of the willow bundle needs to be put in the toe

Figures 2 and 3: Vertical bundles are placed on 6 feet centers with the tops 1 foot above the top of the bank and the bottoms touching the bottom of the keyway trench. Four months after planting, the vertical willow bundles have grown approximately 6 feet.

trench (a trench dug into the streambed to 'key' the rock into the bed of the stream) before the rock is placed in the trench. If possible, shallow depressions should be scraped out of the shaped bank for the bundles to fit in before they are covered by the rock riprap. Putting several inches of soil in an irregular pattern on top of the stems before placing the rock helps protect the cutting, but is not absolutely necessary if there is good soil-to-stem contact with the bank. Too much soil on top of the bundles would be detrimental to vigorous sprouting.

Installation Procedure for Vertical Bundles Under Rock

1) The bottom of the bundles ***must*** be 1 foot below the low water table elevation. If a toe trench is used for the rock riprap, then the bundles that are laid vertically up the bank need to have their butt ends in the trench ***before*** the rock is placed in the trench.
2) The top 1 foot of the bundle needs to stick above the rock riprap. They cannot be covered with rock or they will not grow.
3) The bundles should be prepared and on site before the construction starts. An ideal time to prepare and deliver bundles is when the rock moving equipment is being mobilized. Because willow placement must be timed carefully with rock placement, a preconstruction meeting with the machine operators will probably be useful.
4) Bundle diameters should be 3 to 6 inches. Bundles should be loosely tied with twine (that they will eventually degrade) every 2 to 3 feet. A bundle will have 3 to 8 stems per bundle. Individual cuttings should be larger than ¾ inch diameter at the butt end.
5) This method will also work if the design calls for blanket rock that is lower than the top of the bank (often called toe rock, half rock, etc…). The stems should stick out of the top of the rock at least 1 foot and should extend above anticipated high water level.
6) Vertical bundles should be placed on 6 foot spacing.

Figures 4 and 5: An example of a successful shoreline stabilization project on Henry's Lake and Targhee Creek where vertical bundles were placed under rock riprap. In four years, the willows had grown in solid above the rock providing excellent stabilization, better aesthetics, and better wildlife habitat. (Project by Bob Lehman and Ken Beckmann)

The 45 degree bundle method

This method is used when the banks are too high for the willows to reach the top of the riprap and/or the local willow sources are too short. The bundle is installed at a 45° angle to the bank so the top of the bundle hangs out over the water. First, the toe trench is dug and the bank sloped. Then rock is placed in the trench and rock riprap is laid up the bank to the elevation of the low water table. At this point, the bundles are installed as follows:

<u>Installation procedure for the 45 degree bundle method</u>

1) The backhoe bucket would be placed right above the laid rock, pointed down toward the base of the pre-sloped bank at a 45° angle.
2) The operator would push the bucket down on that 45° angle until he reached the same level as the streambed or the bottom of the key trench depending upon characteristics of the stream.
3) The operator would then stop pushing down and he would lift the bucket up high enough to create a small opening between the bucket and the soil underneath it. This opening would be only wide enough so the willow bundle could be the shoved to the bottom of the hole.
4) The willow bundle is then shoved into the hole ensuring the butt end is at the bottom of the hole and the bundle is laying on the rock riprap.
5) The backhoe operator then pulls the bucket out of the hole dropping the dirt onto the bundle.
6) The operator then continues laying the rock up the bank until the design elevation is reached.

Figures 6 and 7: Excavator bucket is pushed into the streambank above the rock riprap in the keyway trench. Operator lifts the soil up (without pulling the bucket out) to create a small hole underneath. Another person shoves the willow bundle into the hole and the operator pulls the bucket straight out and the soil drops on to the bundle.

The result of this method is to have the bundles sticking out over the water to provide shade, water quality benefits, and fish and wildlife habitat. The vertical bundle method puts the sprouting at the top of the bank and it will be several years before the willows are long enough to provide the same benefits.

The most important considerations for using this method are:

A) The butt ends need to be below the lowest water table elevation.
B) The bundles need to be installed at a 45° angle down, not horizontally. The most common mistake with this method is the operator will put the bucket into the slope almost horizontally, which is the more common movement of the bucket. This does not allow the bottom of the cuttings to be below the lowest water elevation.
C) The height above the streambed that the bundle is placed should be above "normal" flows, but not necessarily flood levels. Bundles placed with part of the length against "dry" soil (above the normal waterline), achieve better rooting.
D) Use only those willow species that have flexible stems so ice and debris will not hang up on the bundle when they mature.
E) The bundle should stick out of the rock no more that 1 foot. This will prevent debris and ice from catching on the bundles and causing scouring problems. Significantly less than 1 foot will create problems with the tops being covered and shaded causing a higher mortality.

References

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