# Brush Mattress (Brush Mat)

A brush mattress or brush mat is a revegetation technique that provides a protective covering to a slope or streambank as soon as it is installed. A brush mattress is typically constructed using live willow branches or other species that root easily from cuttings, but can also be constructed with any brushy, woody branches in order to provide immediate and effective slope protection.

***Conditions Where Practice Applies***

Brush mattresses are ideal for eroding streambanks or slopes where immediate protection is needed. Streambanks which are in jeopardy of being scoured due to high erosive forces can be rapidly stabilized by installation of a brush mattress along the eroding reach. Because of the dense layer of brush, the brush mattress can deflect water from the bank and protect it from scouring, while also providing habitat directly along the waters' edge. Brush mattresses also work well for shoreline protection. The density of the mat will break the impact of waves and instantly provide a thick protective layer of brush along the shoreline. If the desire is to stabilize and revegetate an eroding streambank or shoreline and discourage foot trails along sensitive areas, brush mats work well as impenetrable barriers, giving time for vegetation to become established. On slopes, brush mattressing provides rapid protection against surficial erosion. Brush mats are often combined with other soil stabilization techniques such as vegetated riprap, wattles, live Fascines, root wads, live siltation, or coir logs, which may be needed to secure the toe of the slope. The brush mattress technique is usually most effective on slopes no steeper than 2H:1V.

The following chart shows recorded shear stress and velocities withstood by brush mattresses.

| Bank Material/Protection | Shear | | Velocity | | | Reference |
|---|---|---|---|---|---|---|
| | $lb/ft^2$ | $N/m^2$ | ft/s | m/s | | |
| Sandy Loam | 0.0167 | | 1.75 | 0.53 | Design | Temple, 1980 |
| Silt Loam | 0.0218 | | 2 | 0.61 | Design | Temple, 1980 |
| Alluvial silts | 0.0218 | | 2 | 0.61 | Design | Temple, 1980 |
| Ordinary firm loam | 0.0341 | | 2.5 | 0.76 | Design | Temple, 1980 |
| Very light loose sand, no vegetation or protection | | | 1-1.5 | .3-.46 | Limit | Fortier & Scobey, 1926 |
| Average sandy soil | | | 2-2.5 | .61-.76 | Limit | Fortier & Scobey, 1926 |
| Stiff clay, ordinary gravel soil | | | 4-5 | 1.2-1.5 | Limit | Fortier & Scobey, 1926 |
| Willow mat (immediately after construction) | 1.02 | 50 | | | Limit | Schiechtl & Stern, 1994 |
| Willow mat (after 3-4 seasons) | 6.12 | 300 | | | Limit | Schiechtl & Stern, 1994 |
| Brush mattress with willows | 6.5 | 318.5 | | | Limit | Gerstgrasser, 1999 |

### *Materials*

See Harvesting and Handling of Woody Cuttings for information on collecting willow cuttings for the brush mattress. Wooden construction stakes and/or live stakes will be needed. The length of stakes will vary based on soil conditions. Biodegradable natural fiber rope is usually preferable to wire in most situations.

- live willow cuttings (20-50 branches per m)
- live stakes and/or wood stakes (saw a 2 x 4 diagonally to produce 2 stakes)
- sledgehammer for driving in wooden stakes
- dead-blow mallet and pilot bar (rebar) for live stakes
- clothesline cord, natural fiber rope, or 10-12 gauge wire
- chain saw or loppers (to harvest willows)
- shovel
- 5 gallon bucket (for watering in)
- 2 person minimum

### *Advantages*

Brush mattresses quickly stabilize a slope or streambank by providing a dense network of branches which prevent surficial erosion, while also collecting soil and native seeds. The overlapping branches provide an ideal environment for native seeds to germinate and establish. As the live branches root and grow, the soil is reinforced with an underground matrix of spreading roots. If used on streambanks, a brush mat will trap sediments during high water, and eventually the plant growth on the stabilized streambank will provide

aquatic habitat. Brush mattresses work well for stabilizing reconstructed stream channels, as they provide immediate cover for fish and instant bank protection, even before they become established and grow.

Of all the streambank biotechnical practices, brush mattresses can withstand the highest velocities. Studies conducted by Christoph Gerstgraser, Universitat fur Bodenkultur, Vienna, Austria, demonstrated that brush mattresses stabilized the bank in a test flume against velocities exceeding 7 m/s (20 f/s), while other techniques, even rock riprap, failed.

***Disadvantages***

Large numbers of cuttings are required, probably more than any other biotechnical method, and the availability of plant material should be carefully evaluated before including this technique in a revegetation design. Brush mat installation is a labor-intensive construction method. As with most biotechnical projects, if using live cuttings, brush mattresses must be installed during the dormancy period of species used. In areas which receive little rainfall, brush mattresses installed on dry slopes may not survive long, as this technique does not entrench the branches deeply into the soil.

***Implementation***

- Prepare the slope or streambank by clearing away large debris, and the slope should be graded so that branches will lay flat on the bank. Do not disturb the slope or bank any more than necessary. Excavate a horizontal trench, 8 to 12 inches deep, at the toe of the streambank or at the base of applicable area on the slope. The basal ends of the branches should extend into moist soil.

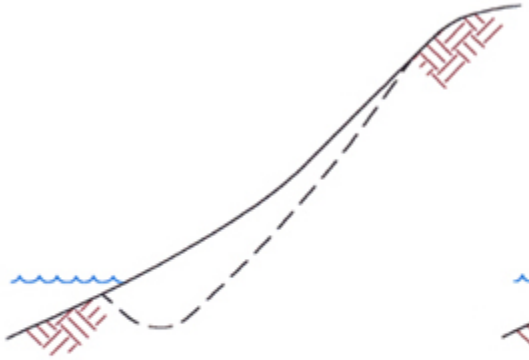
- Lay the cuttings flat against the graded slope, slightly crisscrossed, with the basal ends placed as deeply into the trench as possible. Continue to lay the cuttings along the face of the bank or slope until about 80% groundcover is achieved (about 6-12 inches thick). If the length of the slope or bank is longer than the cuttings, stagger and overlap the cuttings so the entire area has adequate coverage. Rooted plants can be planted within the brush mattress, but these should be planted before the branches are laid, as it is too difficult to plant through the mattress afterward.

- Pound in a grid of 24 to 36 inch long stakes into the mattress at 3 to 4 foot centers (see typical drawing: Brush Mattress, below). Do not pound the stakes completely in, as this will be done after tying. Use longer stakes in less cohesive (sandy) soil. Secure the brush mattress by using cord, rope, or 10-12 gauge galvanized wire tied in a diamond pattern between each row of stakes. (Tie the cord or wire to the stakes in such a manner that if it breaks, the integrity of the remaining cord or wire is still maintained). Notching or drilling stakes may make securing cord or wire to stakes easier, but is not necessary.

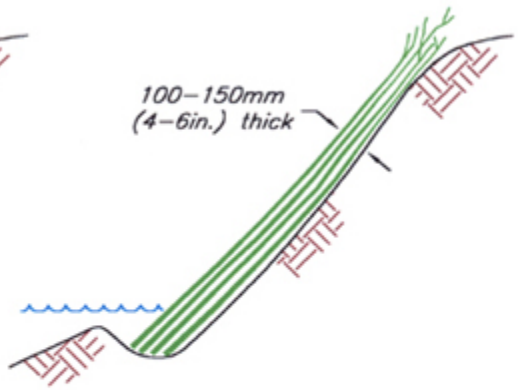

- After networking the mattress with cord or wire, drive the stakes in further to compress the mattress tightly against the slope. If constructing a brush mattress on a streambank, be careful not to leave loose overhanging branches which may catch on material floating down the stream channel. The mattress may be ripped from the streambank if this occurs.

- Secure the toe of the mattress using the technique best suitable for the site conditions. To secure the toe of the mattress using a willow wattle, first construct a wattle the length of the area to be treated (see wattle technique). Make sure the wattle is tied together tightly. Place the wattle in the trench over the cut ends of the brush mattress. Secure the wattle with 18 to 48 inch long wedge-shaped wooden stakes every 3-4 feet. In some cases, such as small streams or gentle slopes, simply placing large locally collected rocks around and on top of the basal ends of the cuttings is enough to secure the toe of the mattress. Other techniques which may be used include vegetated riprap, wattles, live fascines, rootwad revetments, live siltation, or coir logs.

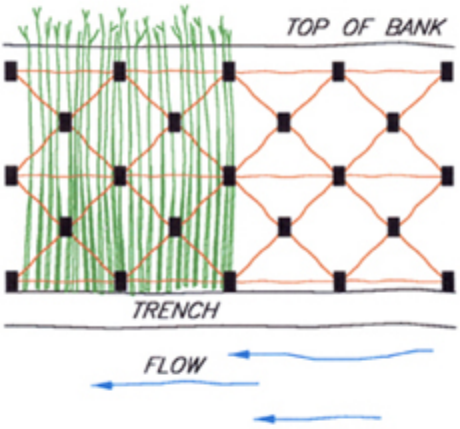

- Backfill around and in between the branches of the mattress by using material excavated from the trench, working the soil in well. Buckets of water will help to wash the soil down into the stems. It is most important for the thicker, basal ends of the mattress to get good soil cover for rooting, but generally cover at least 1/4 of the depth of the mattress with soil. If installed along a stream, make sure the upstream end of the mattress and wattle is keyed into the streambank to prevent high flows from scouring behind the mattress. It is also a good idea to protect this area with some revetment, large rocks, or tree trunks. If possible, tie the mattress to existing vegetation or roots on the bank for extra security.



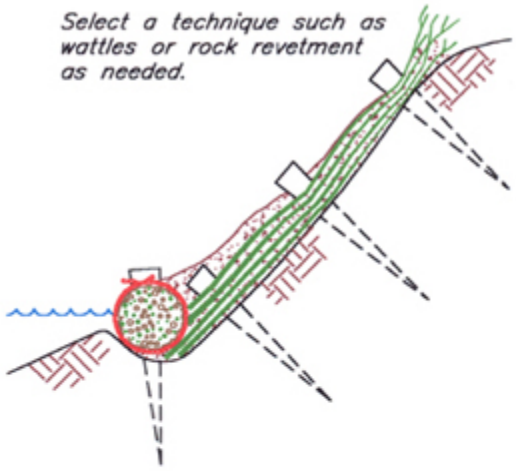
Step 1: Excavate trench and grade bank.




Step 2: Place willow branches making sure that the butt ends reach the bottom.




Step 3: Place stake (notched) on 1.0m (3ft.) centers and secure the mattress with twine, rope or wire.




Step 4: Drive the stakes deeply into the bank to tightly compress the branches against the soil. Cover and partially bury the mattress to encourage rooting.

# BRUSH MATTRESS



FILE: BRSHMATT

**Brush mattresses can be built along the edges of gabion mattresses and can actually be tied into the mattress for better security.**

***Maintenance***

It is important to monitor the brush mattress after it has been installed. Periodic monitoring of the project will provide valuable insight into the stabilization process and may offer important information for future biotechnical projects. If the willow does not grow, the mattress will still provide stability, especially if it is backfilled and seeded with native grasses, sedges, or rushes.

Periodic maintenance includes making sure the stakes and cord/wire are still securing the mattress to the streambank. The upstream end should be carefully checked to make sure flows are not getting behind the mattress. To ensure the highest success for the treated area, determine the land management practices that created the eroded streambanks and modify those practices as necessary (From Bentrup and Hoag, 1998).

If the area is grazed, restrict livestock from treated area to allow the eroded section of the streambank to heal. Exclosure fences are the most efficient means to accomplish this goal. Managers should resist the temptation to put the exclosure fences at the high water line. The exclosure area should include enough of the riparian zone to allow the stream to shift naturally over time.

If the area is farmed, a riparian buffer strip should be established and maintained. A buffer strip on both sides of the stream should be set aside to allow for natural riparian vegetation and stream function. A wider buffer strip is strongly encouraged and will yield greater benefits.

Finally, a stream is an interconnected system. Land use practices both upstream and downstream will affect the success of your bioengineering work.

***Costs***

Allen & Fischenich (2001) report a cost of approximately 0.5 to 1.5 labor hours per $m^2$ (4.6 to 13.9 work hours per 100 $ft^2$ ) for plant harvest, collection, transport, fabrication and installation. Costs for other necessary materials, such as stakes and twine, were an additional $3 to $5 per $m^2$ ($28 to $46.5 per 100 $ft^2$ ). They reported further that the average cost of brush mattress projects they were involved in was about $18 per $m^2$ ($1.67 per $ft^2$ ), although projects going to contractor bid typically cost between $25 and $55 per $m^2$ ($2.30 to $5.10 per $ft^2$ ).

***References***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