



# Standard Practice for Brushmattressing<sup>1</sup>

This standard is issued under the fixed designation D 6939; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice covers the material, preparation and installation work required for brush-mattress construction used in soil bioengineering.

1.2 The values in this standard are in SI units and are to be regarded as the standard. The inch-pound units given in parentheses are for information only.

1.3 This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace standard of care by which adequacy of a given professional service must be judged, nor should this document be applied without considerations of a project's many unique aspects. The word "standard" in the title of this document means only that the document has been approved through the ASTM consensus process.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

- 2.1 *ASTM Standards:*<sup>2</sup>  
D6765 Practice for Live Staking

## 3. Terminology

### 3.1 Definitions:

3.1.1 *brushmattress, n*—a layer of live woody material anchored with stakes and ties installed to cover and stabilize stream banks and shorelines.

## 4. Summary of Practice

4.1 A brushmattress is a layer of live woody plant material installed to cover and stabilize stream banks. Dead Stout Stakes (and/or Live Stakes) and ties (wire, string, rope, bailing twine) are used to anchor the material. Brushmattressing is commonly used on stream banks, shorelines and other moist environments. Often, a live fascine and/or rock toe is used at the base. The branches collect sediment as well as provide immediate protection against surface erosion. The live cuttings eventually root and provide permanent reinforcement.

## 5. Significance and Use

5.1 A brushmattress is used to provide erosion and sedimentation control primarily by armoring the bank. In addition to shielding the surface, a brushmattress can increase infiltration, slow runoff, and trap seed and sediments. This method provides surface slope stabilization through vegetative growth and shallow soil reinforcement through root development. The ability of a brushmattress to function properly depends on the quality and choice of the materials used to construct the brushmattress, the means and methods of fabrication and installation, and proper consideration of site characteristics and time of year. For the brushmattress to function completely, it is important that the live material develops suitable growth. The brushmattress helps to control soil erosion while serving as habitat for birds, small mammals, invertebrates and other organisms that in turn, are fed upon by fish and other higher organisms. Once the vegetation matures, it can provide shade to the stream—lowering water temperatures, offering protection from predators, and generally improving fish habitat. Figs. 1-3 show a brushmattress immediately after construction, in the first growing season, and in the 2nd season.

## 6. Materials

6.1 *Live Woody Plant Material*—Stem and branch cuttings of vegetatively self-propagating woody plant species. Typically, branches are harvested near the project site within the same climatic zone. The greatest success results from cutting and installing vegetation during the dormant season. Leave side branches intact and use only fresh or well-preserved viable cuttings. All material should be free of splits, rot, disease, and insect infestation. The stems or branches should be long

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org) or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.



FIG. 1 Brushmattress after Light Backfill of Soil



FIG. 2 Brushmattress in the First Growing Season



FIG. 3 Brushmattress during 2nd Growing Season

enough to allow the placement of the basal ends below the lowest water level that occurs during the growing season and for the growing tips overlap the top of the slope. This is typically at least 0.6 m (2 ft) longer than the length of slope. The caliper (diameter) of cuttings generally range from 12 to 25 mm (0.5 to 1 in.).

6.2 *Brush Cutting Implements*—Cut live vegetation with tools such as pruning shears, loppers, machetes, clearing saws, chainsaws, and brush axes.

6.3 *Ties*—The brush is secured to the stakes with string, rope, bailing twine, or galvanized wire.

6.4 *Anchors*—Wooden stakes (dead stout stakes or live stakes) or metal rebar is used to anchor the brushmattress.

6.5 *Dead Stout Stake*—Untreated 5 by 10 cm (2 by 4 in.) lumber 45 cm to 1.2 m (1.5 to 4 ft) long, cut diagonally to produce two stakes (Fig. 4). Length is dependent on soil conditions.

6.6 *Live Stake*—An individual live woody plant cutting used in live staking.

## 7. Installation

7.1 Choose appropriate stable points to begin and end the brushmattress treatment. Divert any drainage away from the top of the mattress.

7.2 Remove loose, failed or failing soil from face of slope. Prepare the slope to 1V:2H or flatter. Typically the slope length is 10 ft but this measurement may be lengthened or shortened depending upon site conditions. Excavate a shallow trench at the toe of the slope that is below the lowest expected stream level during the growing season. The typical depth of this trench is 0.3 to 0.6 m (1 to 2 ft). Temporarily stockpile excavated material. The entire slope should be straight and a relatively smooth surface from the top of the slope to the invert of the trench.

7.3 Harvest live woody plant material using a sharp, clean brush-cutting implement. For most species that are used, the plant material should not be allowed to dry. The cuttings may be temporarily stored outdoors in water or in a moist, shaded environment for a maximum of 2 days when the outdoor temperature remains below 10°C (50°F). They may also be kept in refrigerated storage for up to two (2) months at 1 to 3°C (33 to 39°F), provided humidity levels are also maintained above 90 %.

7.4 Place the cuttings on the slope with their basal (bottom) end in the trench and growing tips upslope. The branches should overlap and form a criss-cross pattern. The layer of cuttings should be approximately 15 to 30 cm (6 to 12 in.) thick before they are secured to the slope face. Typically, 6 to 20 branches should be used per foot of stream bank depending on the branch material used.

7.5 Drive dead stout stakes 0.3 to 1 m (1 to 3 ft) into the ground. Use longer stakes in less cohesive soil. The stakes should be perpendicular to the surface of the brushmattress

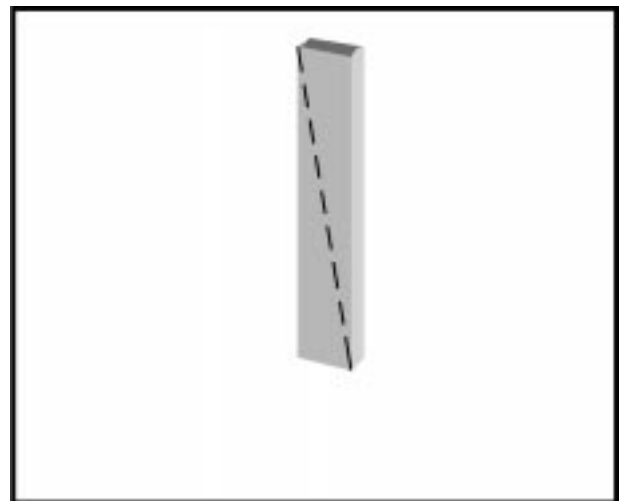


FIG. 4 Preparation of a Dead Stout Stake

(Fig. 5). Dead stout stakes can typically be driven more firmly into the soil and is therefore recommended for areas of higher stress. Live stakes, which offer the advantage of growing and becoming part of the vegetative cover with time, may be mixed with the dead stout stakes. The tops of the stakes should extend to the top of the brushmattress. Space stakes on approximately a 0.5- by 0.5-m (1.5- by 1.5-ft) grid or square. Start the first row of stakes 30-cm (1-ft) above the top of the trench.

7.6 Stand on the cuttings and secure them with ties to the stakes in a diamond pattern between the stakes. Wrap the wire (or string) firmly around the stake. Short lengths of individual ties are preferable to reduce the likelihood of the entire mattress coming loose if one stake or tie fails.

7.7 Drive the stakes into the ground an additional 12 to 25 mm (0.5 to 1 in.) to firmly secure the brush to the bank and ensure close contact with the soil.

7.8 Starting from the toe of the slope, place a thin layer of loose soil on top of the branches and work into the branch layer with water to achieve good soil to stem contact (Fig. 6). Approximately 1/4 of the depth of the mattress should be covered with soil. In semi arid climates, this depth should be 3/4 of the mattress.

7.9 Backfill the trench with stone or suitable toe protection (Fig. 7). The choice of toe protection should depend upon the anticipated stream energy.

7.10 In semi arid climates, trim the terminal bud so that stem energy will be routed to the lateral buds for more rapid root and stem sprouting. After installation, it may be necessary to water the area.

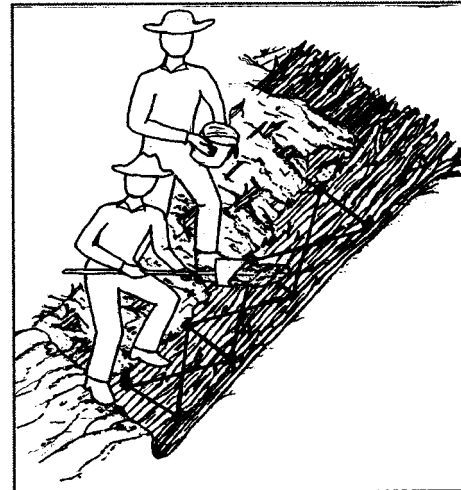
**8. Cautions**

8.1 A site suited to a brushmattress requires a hydrological regime that (1) keeps the basal ends of the live branches moist, during most of the growing season; and (2) sustains flows sufficient to keep the woody plants growing well, but not such large and long duration of flows so as to exceed the plants' flood tolerance. Given these requirements, streams best suited to brushmattresses are generally perennial although they can be intermittent if there is sufficient ground water or soil moisture. Additional information regarding limiting channel shear is provided in the appendix.

8.2 Substrate conditions are also important in site selection for anchoring and root penetration by the woody vegetation.



**FIG. 5 Install Stakes Perpendicular to the Mattress**



**FIG. 6 Placing Loose Soil on Top of Mattress and Working in with Water**



**FIG. 7 Backfill the Trench with Stone or a Suitable Toe Protection**

Non-cohesive material, such as sand or silt, may limit anchoring due to lack of friction. The stakes that hold the branch material in place need to be longer in these instances. Conversely, substrate interspersed with rock or with a rock underlayer can adversely impact anchoring unless special equipment or materials such as a metal rebar with a “J” shaped bent top end, are used.

8.3 It is important to take precautions to avoid having the brushmattress undermined by adjacent surface flow. A stable toe and flanks are required. Often a live fascine and/or stone is used to provide this stability. In addition, it is important to take precautions to avoid overbank runoff from eroding the top of the brushmattress.

8.4 A brushmattress is generally not suitable for fill slopes or slopes that are experiencing large mass movement.

8.5 A brushmattress is generally not suitable in areas with well-drained soils.

8.6 Factors in plant growth such as soil conditions, nutrients, shade, sunlight, and trampling should be considered in the selection of plant materials.

## 9. Keywords

9.1 brushmattress; erosion control; soil bioengineering; streambank stabilization

## APPENDIX

### (Nonmandatory Information)

#### X1.

X1.1 The affects of the water current on the stability of the brushmattress should be considered. Variations in published recommendations exist and the designer should consider modifying recommendations based on site conditions. Some guidance is provided in Table X1.1.

**TABLE X1.1**

Description	Permissible Shear Stress		Reference
	lb/ft <sup>2</sup>	N/m <sup>2</sup>	
Brush mat (immediately after construction)	1.0	50	Schiechtl and Stern, 1994, <i>Water Bioengineering Techniques for Watercourse Bank and Shoreline Protection</i> , Blackwell Science
Brush mat (after 3-4 seasons)	6.1	300	Schiechtl and Stern, 1994, <i>Water Bioengineering Techniques for Watercourse Bank and Shoreline Protection</i> , Blackwell Science
Willow Brush mat (immediately after construction)	4.1	200	Florineth, 1982, Begrünungen von Erosionszonen im Bereich über der Waldgrenze. Zeitschrift für Vegetationstechnik 5, S. 20-24
Willow Brush mat (after 3-4 seasons)	8.2	400	Florineth, 1982, Begrünungen von Erosionszonen im Bereich über der Waldgrenze. Zeitschrift für Vegetationstechnik 5, S. 20-24
Brushmattress with willows	6.5	320	Gerstgraser, 1999, <i>The Effect and Resistance of Soil Bioengineering Methods for Streambank Protection</i> , Proceedings of Conf 30, IECA, Nashville TN

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