"SLOPE STABILITY BY LIVE STAKING METHOD OF SOIL BIOENGINEERING"

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Abstract: - *The use of plants for soil erosion protection and slope stabilization has a long tradition. Old methods with rocks and plants, structures of timber have been used over the past centuries. Recently these old soil conservation and stabilization techniques have been rediscovered and improved. Biotechnical engineering methods have become part of geotechnical and hydraulic engineering and have helped bridge the gap between classical engineering disciplines, land use management, landscape architecture and biological sciences. In this review the different uses of plants in hydraulic and geotechnical engineering design are presented. The core of this review is a comprehensive overview of the most important biotechnical construction methods used for soil erosion protection and slope stabilization. Methods, construction procedure, and the major advantages and disadvantages of these biotechnical methods are discussed. Considerations about construction and maintenance costs conclude in this review.*

Key Words: Soil Erosion, Slope Stabilization, Slope Failure, Soil Bio-Engineering.

1. INTRODUCTION

2.1. WHAT IS SLOPE?

A slope may be an unsupported, inclined surface of soil mass.

Slope may be above ground level as embankments or below ground level as a cuttings.

2.2. CAUSES OF SLOPE FAILURE

1. Gravitational force.
2. Seepage forces within the soil.
3. Erosion of the surface of slope due to flowing water.
4. The sudden lowering of water adjacent to the slope.
5. Forces due to earthquakes.
6. Settlement of soil

2.3. SOIL BIOENGINEERING

The use of live, woody and herbaceous plants to repair slope failures and to increase slope stability. Living plant material may be used alone or in combination with structural components such as rock, wood, concrete, or geotextiles.

3. METHODOLOGY

3.1 Bioengineering Techniques

1. Live staking,
2. Brush layering,
3. Live fascines,
4. Branch packing

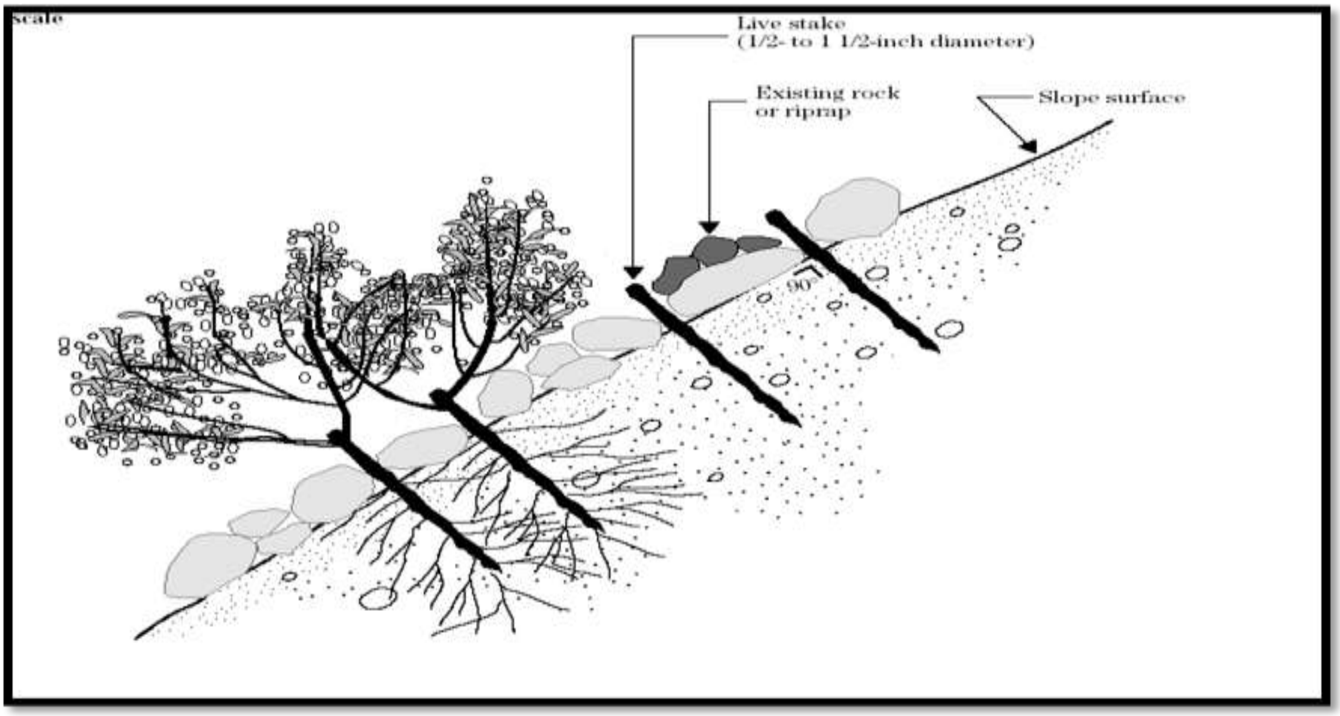
3.2 Design Criteria

The following conditions must be evaluated to help ensure a proper soil bioengineering design:

1. Soil type and moisture availability
2. Stream bed stability
3. Slope stability
4. Surface runoff

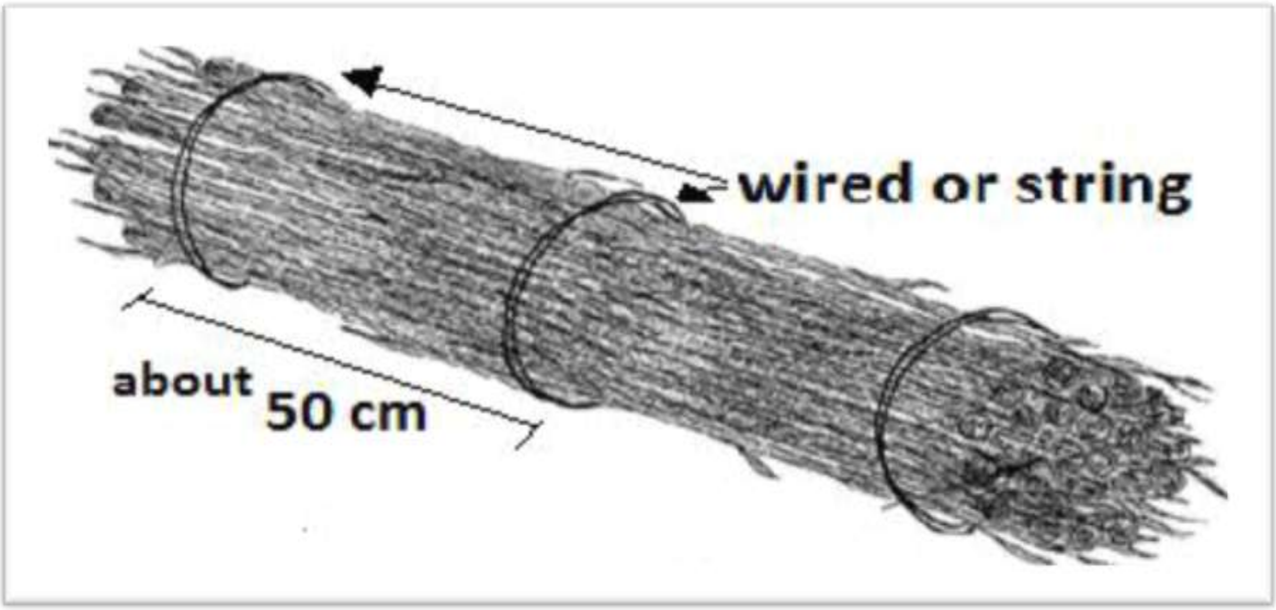
3.1.1 LIVE STACKING

1. Live staking involves the insertion and tamping of live, root able vegetative cuttings into the ground. If correctly prepared and placed, the live stake will root and grow.
2. A system of stakes creates a living root mat that stabilizes the soil by reinforcing and binding soil particles together and by extracting excess soil moisture.
3. Most willow species root rapidly and begin to dry out a slope soon after installation.
4. This is an appropriate technique for repair of small earth slips and slumps hat frequently are wet.



(**Figure 3.1.1 Live Stacking**)

3.1.2 LIVE FASCINE



(Figure 3.1.2 Live Fascine)

Live fascines are long bundles of branch cuttings bound together into sausage-like structures. When cut from appropriate species and properly installed with live and dead stout stakes, they will root and immediately begin to stabilize slopes. They should be placed in shallow contour trenches on dry slopes and at an angle on wet slopes to reduce erosion and shallow face sliding. This system, installed by a trained crew, does not cause much site disturbance.

3.1.3 BRUSHLAYER

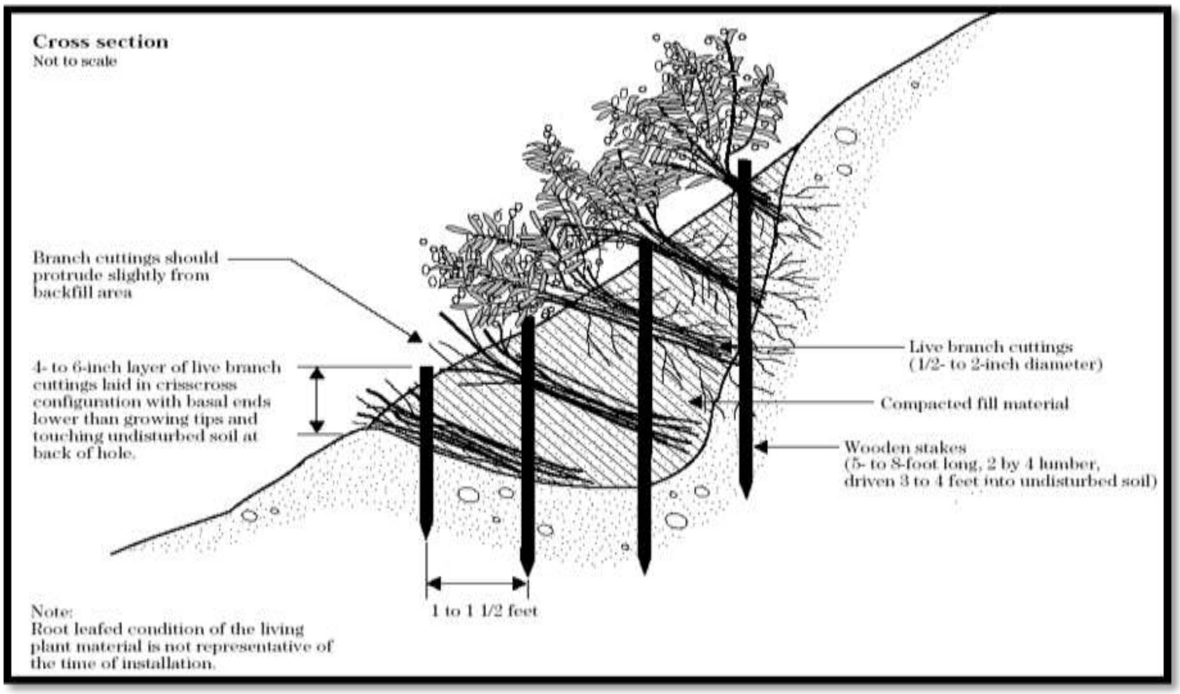
(Figure 3.1.3 Brush layer)

1. Brush layering is somewhat similar to live fascine systems because both involve the cutting and placement of live branch cuttings on slopes.
2. The two techniques differ principally in the orientation of the branches and the depth to which they are placed in the slope.
3. In brush layering, the cuttings are oriented more or less perpendicular to the slope contour.
4. The perpendicular orientation is more effective from the point of view of earth reinforcement and mass stability of the slope.
5. Brush layering consists of placing live branch cuttings in small benches excavated into the slope.
6. The benches can range from 2 to 3 feet wide.
7. These systems are recommended on slopes up to 2:1 in steepness and not to exceed 15 feet in vertical height.
8. Brush layer branches serve as tensile inclusions or reinforcing units. The portions of the brush that protrude from the slope face assist in retarding runoff and reducing surface erosion.

3.1.4 BRANCH PACKING

Branch packing consists of alternating layers of live branch cuttings and compacted backfill to repair small localized slumps and holes in slopes.

(Figure 3.1.4 A. Branch Packing)



(Figure 3.1.4 B. Branch Packing)

4. LIVE STAKING

1. Live staking is simply the installation of live cuttings that have the ability to root and grow thus acting as stakes.
2. Live staking involves the insertion and tamping of live, root able vegetative cuttings into the ground. If correctly prepared and placed, the live stake will root and grow.
3. A system of stakes creates a living root mat that stabilizes the soil by reinforcing and binding soil particles together and by extracting excess soil moisture.
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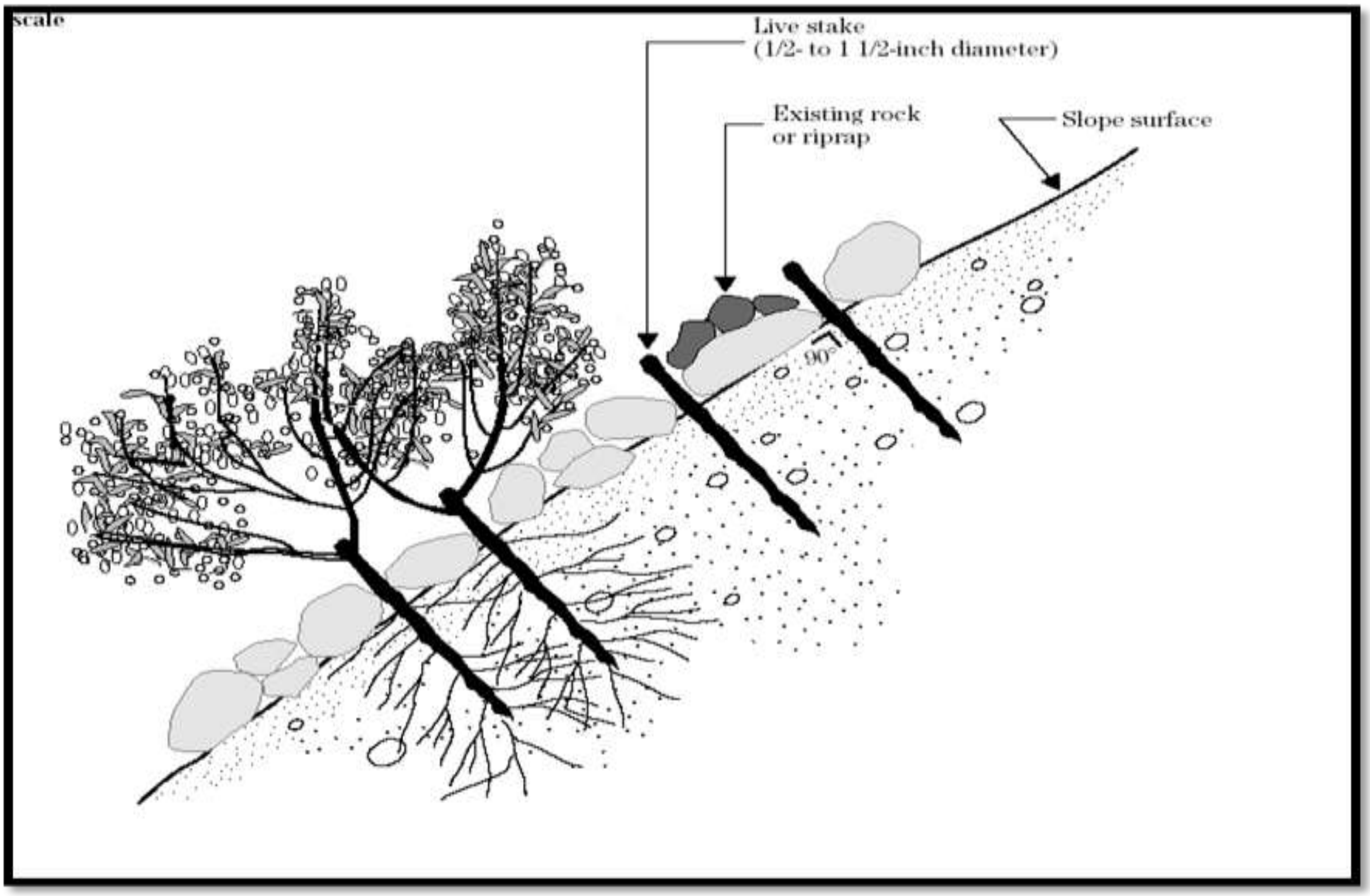

(Figure 4 Live Staking)

4.1 PURPOSE

1. Live stakes can be used as a simple and economic means of vegetating and stabilizing small, uncomplicated areas.
2. Live stakes also work very well as a means of introducing a particular plant species to a site.
3. They also are used as a means of securing other soil bioengineered structures or erosion control measures to the ground.

4.2 APPLICATION

1. Installed on their own, live stakes can be planted in slopes and stream banks to help control minor or shallow erosion. In this role the stability is provided by the root network of the growing plant.
2. When using live stakes for this purpose it is important to remember that the stakes will provide no protection until they have had an opportunity to grow.
3. Considering this aspect, live stakes should not be relied on when facing large or deep earth movements or bank failures. They are also an effective means of securing fascines, brush mattresses, and erosion control blankets.
4. The added advantage of using a live stake to secure a treatment lies in the extra plant growth that the stake itself will provide.
5. Live stakes can also be used to add growth to existing treatments. For instance, if there is sufficient soil present, live stakes can be added to the rip-rap to provide some natural strength and diversity.

4.3 CONSTRUCTION GUIDELINES

1. The materials must have side branches cleanly removed and the bark intact.
2. The basal ends should be cut at an angle for easy insertion into the soil. The top should be cut square.
3. Materials should be installed the same day that they are prepared.

4.4 INSTALLATION:

1. Tamp the live stake into the ground at right angles to the slope. The installation may best arted at any point on the slope face.
2. The live stakes should be installed 2 to 3 feet apart using triangular spacing. The density of the installation will from 2 to 4 stakes per square yard.
3. The buds should be oriented up.
4. Four-fifths of the length of the live stake should be installed into the ground and soil firmly packed around it after installation.
5. Do not split the stakes during installation. Stakes that split should be removed and replaced.
6. An iron bar can be used to make a pilot hole infirm soil. Drive the stake into the ground with ahead blow hammer (hammer head filled with shot or sand).

4.5 MATERIALS

For collecting and installing live stakes, you will need the following:

1. A ready supply of large, mature cuttings sharp pruning shears.
2. Dead blow hammer.
3. Steel bar for pilot hole.
4. Shovel.

4.6 DISCUSSIONS

Construction and Maintenance Cost

1. Maintenance Cost

The initial maintenance costs of biotechnical structures are much higher (ca. 50% during the first 3years) than those of conventional structures (wolf 1977; dahl and Schluter 1983), but they become much lower and also more steady later on. Maintenance of wood vegetation depends on maintenance frequency.

2. Construction Cost

Costs for planning and supervision of the construction (including surveying, negotiations with land owners, etc.) Are usually 10-20% of the overall costs: 7 – 15% planning phase (first concepts, alternatives, evaluation, and final concept) 3 – 7% approval phase (until the final completion of the maps) 3 – 7% realization phase (invitation for tenders, supervision of construction, accounting) construction costs vary. For comparisons the average required construction times for different biotechnical structures are listed in table 1. They include the time necessary to obtain the live material and prefabricate elements (e.g. Fascines). Knowing the appropriate wages, as well as the costs for machinery and materials, buildings costs of different methods in various regions can be estimated.

5. RESULT

In comparison with traditional engineering techniques, the non-technical benefits of plants are often stressed along with the usual technical advantages. Four general groups of benefits of biotechnical methods can be outlined:

5.1 Technical Advantages:

Protection against surface erosion an increase of slope stability by root reinforcement and draining of the soil protection against rock fall and wind.

5.2 Ecological Advantages:

Regulation of temperature and humidity close to the surface, thus promoting growth improvement of the soil water regime via interception, evaporation transpiration and storage.

Soil improvement and top soil formation.

Improvement of and provision for habitat.

5.3 Economic Advantages:

Reduction of construction and maintenance costs.

Creation of areas for agricultural and recreational use.

5.4 Aesthetic Advantages:

Structures fit into the landscape.

Landscape is more appealing.

These advantages make biotechnical techniques a worthwhile consideration in slope restoration.

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