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A BIOENGINEERING SYSTEM FOR COASTAL SHORELINE STABILIZATION

INTRODUCTION

For many years, the Shoreline Erosion Committee of the Texas State Association of Soil and Water Conservation Districts has implemented shoreline erosion control projects with smooth cordgrass (Spartina alterniflora). However, many of these projects, where bluffs were encountered, failed to completely solve the shoreline erosion problem. Either the planting would not become established, or in some cases the bluff just continued to erode. With the development of geotextiles, there is the potential to implement low-cost shoreline projects that address these highly eroding bluff sites.

Geosynthetic turf reinforcement mats (TRM) provide a low-cost alternative to hard armor on eroding critical areas. The mats along with the root reinforcement of seeded or planted vegetation resist damage from wave energy and high velocity surface flows. On high-energy wave sites, cellular concrete blocks are an alternative to concrete and rip-rap. Both of these erosion control materials provide for the opportunity to install native salt tolerant plant species. These plants are not only aesthetically appealing but their roots and stems are a critical component of an effective long-term erosion control system.

In partnership with the San Patricio Soil and Water Conservation District we implemented such a project in October, 1997, under a grant from the Coastal Zone Management Program. We are evaluating turf reinforcement matting and cellular blocks while testing several plants such as marshhay cordgrass (Spartina patens), gulf cordgrass (Spartina spartinae), big sacaton (Sporobolus wrightii), marsh elder (Iva frutescens), wax myrtle (Myrica pusilla) and armed saltbush (Atriplex acanthocarpa) for adaptation and added environmental and engineering enhancement.

MATERIALS AND METHODS

The location is near the city of Portland, Texas along the Nueces Bay Shoreline. The site parameters when we started the project in July of 1997 were:

Soils: Monteola clay
Bluff: 0' to 8' in elevation
Bay Slope: 1:20, 5%
Fetch: 3 miles
Salinity: 25 ppt.

On July 1, 1997, we installed "Tensar" fence with three inch diameter size posts every ten feet as a wave barrier at approximately the mean tide level. It was secured to the post with 1" x 2" lathing and nailed at the top and bottom. "Vermilon" smooth cordgrass that was 18-24" tall, 1-2 stems and with 6" bare roots was planted as 4 rows 2' apart at 2" below to 12" above mean tide, ten feet toward shore from the Tensar wave barrier.

From August 25-28, 1997, we installed "PROTEC 420" cellular blocks and "North American Green C-350" TRM. We shaped the slope with an excavator at a 2.5:1 grade. We dug 1' below ground level for the toe and installed 3 blocks at 4:1 grade and then backfilled. We also dug 3' into the bank and installed three blocks at a 4:1 grade and then backfilled. All blocks were underlain with a nonwoven filter fabric. The blocks extended 48 feet in length and 3' in vertical height. The TRM was placed on the bank and extended for 152 feet in length and ranged from 0 feet to 8 feet in vertical height. The toe and the top of the bank was trenched to a 1 1/2 foot depth and the TRM was secured with either 8" staples or 6" (60d) nails with tin caps and buried. The TRM was secured every 18" with a 6" overlap of the mats.

Following a severe storm in October, 1997, which produced a 13" rainfall with high tide and winds providing waves 4-5' above mean tide, we had to make repairs. The corners where the cellular blocks ended were scoured out. We installed four inch "Terra cell" cellular confinement system underlain by filter fabric and overlaid with C-350 TRM at these locations. We also had to make some repairs to the TRM where the offshore wave barrier broke down, which caused some bank sloughing. We reshaped the slope and sandwiched the backfill between the old and new TRM.

On October 27, 1997, we planted an alternating sequence of a grass and a shrub. The grasses were gulf cordgrass (Spartina spartinae) and marshhay cordgrass (Spartina patens). The shrubs were marsh elder (Iva frutescens), armed saltbush (Atriplex acanthocarpa) and wax myrtle (Myrica pusilla). At 4 feet above mean tide, marshhay cordgrass was replaced with big sacaton (Sporobolus wrightii). Plants were chosen based on the published criteria found in Table 1.

Armed saltbush and big sacaton were chosen based on the author's personal experience and observations. The grass and shrub sequence was chosen to

provide a root network of fibrous and tap roots to secure the bank slope. The plants were also chosen for abundant top growth to cushion the bank against wave energy. All plants were chosen to grow no taller than 2 meters so as not to restrict shoreline views.

All grasses at planting time were 9" tall with a 6-8" rooting depth and were grown for ten months from vegetative splits in either a plastic container or a 1" x 6" paper band that had a commercial soil mix. Wax myrtle and armed saltbush were 9" tall with a 6" rooting depth and were grown for 10 months in a plastic container or a paper band. The marsh elder were 18" tall with a 6" rooting depth and were grown for 12 months in a plastic container or a paper band. Wax myrtle was grown from seed and marsh elder and armed saltbush were grown from cuttings. Plants received no fertilizer at planting time and were planted into good soil moisture. A planting bar was used to puncture the TRM and plants were spaced every 18" and were backfilled with a 50:50 sand and commercial soil mix.

The cellular blocks were planted with the same species sequence. However, the marshhay cordgrass and the marsh elder were grown in 3"x3"x6" plant bands. We punched a hole in the filter fabric and planted into an opening of the blocks. A 50:50 sand and gravel soil mix was used for backfill and for fill of any unplanted openings of the blocks.

RESULTS AND DISCUSSION

Erosion Materials

The TRM was easy to install and has stayed stable since planting in late October 1997. At the two locations where the bank sloughed during the early October storm, the site has also stayed stable. We believe the bank sloughed at these two locations because of the breakdown at these sites in the offshore wave barrier. The estimated wave energy for material stability at this site based on our experienced conditions is at two feet above mean tide, when protected with an secure offshore wave barrier or a mature cordgrass stand. Without wave barrier protection, we would only recommend using the TRM at three feet or more above mean tide (Table 2). The cost of the material was $.36 a square foot (sq. ft.) which makes this erosion material very attractive.

The cellular blocks have stayed stable under all wave conditions. However, the corners where the blocks made a transition to TRM did not stay stable. Where we made repairs and used the "Terracell" cellular confinement system, it has stayed stable at the upwind transition from the cellular block to the TRM. However, the downwind corner that was tied into a 14 foot jutting bank has not stayed stable despite repeated treatments of TRM and "Terracell". Waves continue to erode the nontreated slope, thus undermining this corner.

Installation of the cellular blocks was extremely difficult for us where we made changes in grade at the toe and at the top into the embankment. We recommend that where you are hand placing the blocks, you have a consistent, uniform grade. If you do have any changes in grade, consider using a cabled block system placed with an excavator. However, on small sites this will be more expensive. The cost of cellular blocks was $4.87 sq. ft., making this an expensive material that should be used only where other material is inadequate. The four inch "Terracell" cellular confinement system was a flexible material, making it easy to install. It has provided better stability then the TRM and is less expensive than cellular blocks at $1.15 sq. ft. Furthermore, on high shrink-swell clay soils, the cellular confinement system may give added protection against rilling and gullying of the bluff slope.

Vegetative Material

In February 1998, we surveyed the transplants for survival and found 40 dead plants out of 1400. No grasses were dead and most of the dead plants were at the shoreline of the cellular blocks, smothered by shoalgrass (Halodule wrightii). By April of 1998, the shoalgrass was 1-2 feet thick along the shoreline smothering the shoreline plants, especially at the deep corner of the blocks.

On July 9, 1998, we surveyed the plants for survival and growth (Table 3). The grasses have performed exceedingly well with all having survival rates over 90%. Both gulf cordgrass and marshhay cordgrass have grown well at this site and appear to be adapted to 11/2 to 2 feet above mean tide (Table 4). Marshhay cordgrass not only survived well but it extended runners from its rhizomes on 44% of the plants. Big sacaton had a 97% survival rate on the upper portions of the slope.

The shrubs did not perform as well as the grasses. Wax myrtle performed especially bad. It only had a 11% survival rate. This collection of wax myrtle came from a sandy site on Mustang Island and apparently was not adapted to the clay soils of this site. Where the bluff was a little bit sandy the wax myrtle performed better, with a 43% survival rate.

Marsh elder had overall a 72% survival rate. However, at those sites that were 2' above mean tide it had a 93% survival rate. The majority of its mortality occured where we planted it at the shoreline. Shoalgrass, which built-up to a 2 foot layer smothered many of these plants. Marsh elder also seemed to be sensitive to salt spray. It appeared in our April survey that many of the plants at the shoreline edge lost their leaves, apparently due to a high tide and salt spray. However, all these plants were resprouting from the branches. The native stands adjacent to this site are found at 11/2 to 2 feet above mean tide. Apparently the long term survival of these plants are good even if sensitive to salt spray. However, they may not tolerate it well when at a small transplant height. The native stands have plants that are 3-8' tall, well above most tidal spray and protected by a 20' section of smooth cordgrass. Since it is a major plant in the native shoreline community and has great shoreline stabilization characteristics with its tall canopy and deep woody roots, it requires additional monitoring.

Armed saltbush, which is not found very often along the shoreline, had an 89% survival rate. Armed saltbush is most frequently found on highly saline sites of inland south Texas. However, we have found plants along the shoreline of Hans Suter Park in Corpus Christi. This plant can produce many dense branches with a very wide canopy. It seems adapted to 3 feet above mean tide. We plan to continue to monitor this plant. However, we are cautious about its long term survival when its mature roots reach the saline water table.

CONCLUSION

It is recommended that smooth cordgrass be planted on sites where little shoalgrass is encountered and tidal slopes are less than 5%. Once the cordgrass is well established, bluffs less than 8' in elevation can be shaped and planted to adapted plant material. With the added toe protection, the bluff treatment has improved chances of success.

Where a smooth cordgrass stand is established, a combination of TRM and cellular confinement system with selected plant material should provide good shoreline stabilization. If smooth cordgrass cannot be established, then a bluff treatment that includes cellular concrete blocks for toe protection will be needed.

If the total length of a bluff site can not be treated, we would discourage any attempts at bluff shaping. However, on high value commercial or residential property where adjacent landowners are protecting their shoreline, we believe this system has promising value. We also think this system may have particular value for soil stabilization and wildlife habitat enhancement on man-made spoil islands along the Texas Gulf Coast.

TABLE 1

Establishment criteria for plants selected for shoreline stabilization in Portland, TX.

	Water Depth (inches)	Salinity Range (ppt)	Potential Plant Height (feet)	Potential Plant Width (feet)
Gulf cordgrass	-12" to 0+	0 – 18	2 - 3'	1'
Marshhay cordgrass	-4" to 0+	0 –16	2 - 3'	____
Big sacaton	____	____	4 -6'	1'

Marsh elder	-15” to 0+	2 –16	7’	6 -7’
Wax myrtle	-12” to 0+	0 – 4	4 - 5’	4 - 5’
Armed saltbush	___	___	2 -3’	5 -6’

Table 2

Recommended elevation for erosion control material based on our shoreline construction in 1997 at Portland, TX.

MATERIAL	ELEVATION (above Mean Tide)
TRM	3’ +
Cellular Confinement System	1’ +
Cellular Concrete Blocks	-0.5’ - 3’ +

TABLE 3:

Survival rates and dimensions of plants eight months after planting on October 27, 1997, in Portland, TX.

Species	Survival rates	Average Dimensions (inches) (height by width)	Number of Stems
Marsh elder	72%	22” x 13”	3.4
Wax myrtle	11%	6” x 4”	1.4
Armed saltbush	89%	11” x 21”	1.0
Gulf cordgrass	97%	16” x 3”	

Marshhay cordgrass	90%	19” x 3”
Big sacaton	97%	12” x 2.5”

TABLE 4: Recommended elevation for planting based on our Shoreline Plantings on October 27, 1997, in Portland, TX.

SPECIES	ELEVATION (above Mean Tide)
Marsh elder	2’-3’+
Wax myrtle	not recommended
Armed saltbush	3’ +
Gulf cordgrass	2’ +
Marshhay cordgrass	1.5’ +
Smooth cordgrass	-1’/2 to 1+

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