

### Fiber Roll Toe

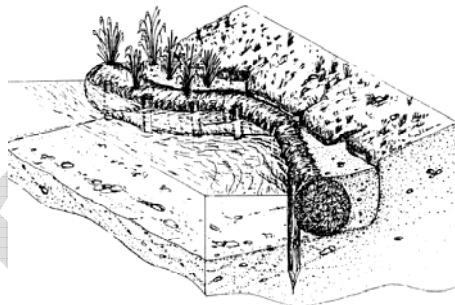
**Description of Method** – Fiber rolls are cylindrical tubes composed of coconut husk or excelsior fibers bound together with coconut or jute twine, or synthetic netting. They are manufactured in different lengths, densities, and diameters. WVIC has used three different diameter rolls 12", 16" and 20" in the highest density available. The most common length used has been 20 feet although some of the 20" diameter rolls were too difficult for two people to handle and some 7½-foot long rolls were used. An anchoring system of wedge shaped wooden stakes or Duckbill® anchors has been used in conjunction with fiber roll toes. Being completely biodegradable, the rolls will break down in 5 to 10 years depending on field conditions.

**Applications –**

**1992** WVIC installed a fiber roll toe (100 feet) as part of its Rainbow Reservoir Demonstration project. Half of the plot was installed with a rock trench below the fiber roll and the remainder without. The whole bank was regraded and willow wattling installed up the bank on both 50-foot plots. The portion of the bank installed without rock failed when the reservoir filled.

**1998** The site near the Hwy J Landing on Rainbow Reservoir was restored with a fiber roll toe. Over 800 linear feet of shoreline was covered with one or two tiered 12" diameter, 20' long fiber rolls depending on bank height and bottom slope. All fiber rolls were placed tightly against the bank and secured with wooden wedge shaped stakes. The fiber rolls were planted with several species of wetland plants that subsequently suffered high mortality. Willow cuttings were jetted in front of the rolls (36 cuttings in front of each 20' roll) and ones that did not survive were replaced annually. Besides replacing cuttings, the fiber rolls were reinforced with additional stakes where movement away from the bank was observed. An average of 12 stakes per 20-foot fiber roll was used. By 2002, the majority of the fiber roll toe had failed. The failure was probably caused by a combination of factors including: 1) the jute rope holding the coir together was destroyed by animals which caused the rolls to disintegrate faster than expected; 2) willow cuttings were not becoming established soon enough to dissipate wave energy; 3) the rolls had not been placed above the maximum water elevation in all areas allowing erosion to occur above them during high water conditions; and 4) the slope of the beach may have been too steep for this method in some areas. A 40' portion of the original installation is still intact and functioning. This portion has a gradual slope below the toe, already had some willow and grass established in front of the toe, and the rolls were not torn apart by animals.

**Fiber Rolls Anchored with Wood Stakes:**



**1999** As part of the Robinson Site restoration on Rice Reservoir, 150' of fiber roll toe was installed on one end of the site with a very shallow beach. The fiber rolls were placed tightly against the bank, 1 to 3 tiers high depending on the bank height and secured with wedge shaped wooden stakes. Any voids between the bank and the rolls were backfilled with topsoil and planted with rooted willows. Although the fiber rolls have mostly decomposed, the willows that established behind them appear to be holding the bank intact. An anchored log wave deflector that was in place for the first few months after the fiber roll toe was installed may have played an important role in the success of this severely eroded, moderate energy site. Native willow and other wetland plants that already existed in front of the area may have also functioned as a natural wave break.



**2000** An additional 683' of fiber roll toe was installed on Rainbow Reservoir across from the Hwy J Landing. The fiber rolls were installed utilizing a similar method to the one used in 1998 except for two differences: larger diameter (16") fiber rolls were used in some areas and the fiber rolls were backfilled and planted with rooted

willows. These modifications and a much higher survival rate of the willows jetted in front of the fiber rolls resulted in a more favorable outcome. Only minor maintenance has been required including pounding stakes back in that were heaved up by frost and replacing cuttings that did not survive. Most of the bank appears to be stable although recent damage from beavers required an alternate method to fill in several areas where burrowing below the fiber rolls caused new erosion.

**2002** Two separate projects utilized a fiber roll toe for a portion of the bank in combination with several other techniques. At a site on the upper end of Rainbow Reservoir, one fiber roll was installed for toe protection on the end of the project where the bank appeared to be fairly stable and wetland plants existed in front of the toe. The remainder of this project required a harder toe. On Rice Reservoir, a small island was restored using a combination of methods. Single fiber rolls were used on 76 feet of the shoreline. Bank height determined if a 16" or a 12" diameter was required. Both installations were completed using the same anchoring system with wedge shaped wooden stakes. Willow cuttings were jetted in front of all rolls installed. These installations are functioning well and have required no maintenance.

**2003** A trial fiber roll toe using an alternate anchoring system was installed in 2003 on a steep beach portion of the failed project near the Hwy J Landing on Rainbow Reservoir. It was determined that the original wood stakes may have played a part in the failure at this site since the stakes failed to hold the fiber rolls against the bank. A 100-foot section of the bank was selected and a double tiered fiber roll treatment was installed. The bottom tier consisted of 20" diameter fiber rolls and the top tier of 16" diameter rolls. The rolls were held in place with a combination of wooden stakes and pairs of Duckbill® anchors fastened together with Gripples®. Placement of the anchors varied with bank shape and bottom slope. Willow cuttings were placed between the fiber rolls and jetted in front of them. Any voids between the rolls and the bank were backfilled and planted with rooted willows. None of the cuttings placed between the rolls survived possibly due to an extremely dry late-summer and fall. After the reservoir filled in 2004, it became evident that the anchoring system was not functioning as expected. The rolls had pulled away from the bank allowing waves to overtop them and because of the steep bottom slope all of the jetted cuttings had drowned. In 2005, the anchoring system was modified. Cables were wrapped around both fiber rolls and anchored to a fence post driven in about 5' back on the shore. Also most of the Gripples® had failed leaving loose and disconnected cables. All were re-tightened and secured with cable clamps. Rooted willows that didn't survive behind the fiber rolls were replaced but no additional willow cuttings were jetted on the steep bottom slope. The technique is preventing further undercutting of the bank. Although some of the fiber rolls have settled, the root systems of the willows established behind the fiber rolls appear to be preventing displacement of the soil from waves during high water periods.



**2004** A portion of a large island on Rice Reservoir was restored using a variety of methods. A fiber roll toe was installed where the beach area was gradual and a natural wave break of native willows already existed on 100' of the shoreline. A combination of 16" and 20" diameter rolls was used. Depending on bank height, one or two tiers were installed. All were anchored in place with Duckbill anchors® and reinforced with cable clamps. All fiber rolls had willow cuttings jetted in front of them and two tiered installations had cuttings placed between the fiber rolls. Few of the cuttings placed between the rolls survived and they were not replaced. Almost 100% of the cuttings jetted in front of the toe survived and the site has required no maintenance.



**Cost** – The cost and construction time for fiber roll toes varies with each installation. Single tiered 12" diameter rolls can be installed for \$7-\$8/ft and require less than 1 hr/ft. Double tiered larger diameter fiber rolls with Duckbill® anchoring systems can cost over \$46/ft and require 2.2 hr/ft. The average cost of the 1,927 linear feet WVIC has installed in many different configurations since 1998 is \$14.74/ft and the average time required is 1 hr/ft. Maintenance has been required on almost all fiber roll installations since establishment of the willows is an integral part of the success of a fiber roll toe. If conditions do not allow for willow survival

the year of installation, they must be replanted the following growing season to ensure establishment prior to decomposition of the rolls. Also the anchoring systems may initially require some maintenance. Wooden stakes tend to get heaved up by frost and need to be checked and re-secured during the first few years and Duckbill® anchors may require tightening of the cables after the first year.

PROJECT	YEAR	# LINEAR FT	HOURS/FT	AVE. COST/FT (MATERIALS ONLY)
Rainbow Reservoir Hwy J Landing	1998	800	0.9	\$12.20
Rice Reservoir Robinson Site	1999	150	0.7	\$10.15
Rainbow Reservoir Hwy J Bay	2000	683	1.3	\$12.85
Upper Rainbow Reservoir 12" Fiber Roll Toe	2002	18		\$7.44
Rice Reservoir Small Island 16" Single Fiber Rolls	2002	37	0.7	\$13.39
Rice Reservoir Small Island 12" Single Fiber Rolls	2002	39		\$7.09
Rainbow Reservoir Hwy J Landing Double Tiered Fiber Rolls	2003	100	2.2	\$46.41
Rice Reservoir Large Island	2004	100	0.5	\$27.89

**Results & Conclusions** – Fiber rolls have been tried in many different configurations and in several combinations with other methods because it is a preferred softer approach. It requires very little bank preparation and provides an immediate natural appearance. Plants can be readily established in front of and behind the fiber rolls. The fiber rolls themselves are not a good growing medium until they have been in place for a few years. Volunteer vegetation does eventually establish on the surface of the rolls. Attempts to plant between and in the rolls themselves have not been successful.

Installations can be done by hand with few tools. A level should be used however to ensure that placement is above the maximum water elevation. Voids between the rolls and the bank should be filled and vegetated if possible. Favorable conditions for a fiber roll toe to succeed include a gradual beach slope below the toe. Moderate energy sites can be stabilized if plants already exist providing a natural wave energy dissipater or if new plantings can be established quickly.

Fiber roll toes must be monitored since they are susceptible to animal damage. Willow plantings are readily browsed by deer and beaver. Fiber rolls themselves are torn apart by animals using the fill for nesting materials. If this is a likely possibility, synthetic netting on the fiber rolls should be specified. Also frost heaving of wooden stakes may be a problem in certain climates and may require pounding stakes back into the ground in extreme cases. This can be avoided by using a Duckbill® or other anchoring system.

Visually the technique blends in with a wilderness shoreline. Vegetating as soon as possible after installation provides immediate cover and eventually adds strength with root reinforcement. Although the height of tiered fiber rolls could impede the movement of some wildlife and waterfowl from moving to and from the water, the rolls are made of a soft coir material which some species may be able to navigate over. Also the tiers are somewhat stepped, forming a face that is not completely vertical. After vegetation is established, this stabilization technique is not perceptible.

**ADVANTAGES:**

- **Can be installed without heavy equipment**
- **Can be installed without any bank disturbance**
- **Very flexible technique that can be installed in many different configurations**
- **Visually aesthetic and within 1-2 years blends into the existing bank and vegetation**

**DISADVANTAGES:**

- **If not successfully vegetated shortly after installation, failure will likely occur**
- **Annual monitoring and some maintenance is typically required**
- **Susceptible to damage by animals**

**LESSONS LEARNED:**

- **The least amount of bank disturbance results in the most successful bank restoration**
- **It is essential that the top of the fiber roll be placed above the maximum water elevation**
- **If using a Duckbill® anchoring system, do not rely on Gripples® alone to hold the system together, always reinforce with cable clamps**
- **If a steep bottom slope is part of the site, fiber rolls are not a good stabilization solution**