Slope Protection – Soil Bioengineering with Coir

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Soil erosion is the most serious problems faced by mankind today. In India, about 27 per cent of the land is subjected to severe erosion. It is estimated that 7000 million MT of precious topsoil is lost annually whereas it takes around 1000 years to build one inch of topsoil. Deforestation, unsustainable methods of land use, mining, road laying and construction accelerate the rate of soil erosion.

This is where the importance of geo-textiles comes in. Any material used for improving the soil behaviour, thereby preventing soil erosion is termed as geo-textiles. Synthetics, straw, jute and now coir are used as geo textiles. In fact, the concept of geo-textile is very old. According to historical findings wood, bamboo, straw, reed, and wood were used as geo-textiles in ancient times too. In industrial age synthetic material like polyester, polyamide, polypropylene and polyethylene took their place as geo-textiles for engineering applications due to their long life. These geo-textiles, however, had their own disadvantages. Their production caused air and water pollution while their non- biodegradability was responsible for increasing soil pollution.

In an age of growing environmental awareness, the use of eco-friendly biodegradable material as geo-textile started gaining momentum. Natural geo-textiles like straw and jute were used but their performance was not up to the mark. Coir fibre with very high lignin content comparable to that present in teak wood became the ideal choice as a geo-textile material. The lignin content in a fibre determines the resistance to microbial attack. Coir geo-textile with a lignin content of about 46 per cent scores heavily above jute (12 per cent) and leaf fibre (10 per cent).

Coir geotextiles - coir nettings forms a small check dam it prevent soil particle to move along with water / wind. Coir absorbs water and slowly releases it which help seeds germination / plants growth. Coir creates an idel climate for the plant growth. It protects the soil till the roots of the plant take over the job of holding the soil particles together. You can see the difference in this photo.

The coir geotextile roll (CGR) is a sausage-like roll of nonwoven fibers made from coconut husks bound within a polyethylene or coir woven mesh rope. The CGR incorporates wetland plants (usually as rooted sprigs or cuttings) whose roots become interlocked with the CGR fibers. The CGR with its plants is used along the face of an eroded stream bank and acts principally to armor the bank, though it can also be configured to act as a current deflector. The CGR has the potential to accumulate sediment and, together with the plants, develop a strong network of interlocking roots and plant stems.

In the context of sustainable watershed management, coir is less expensive and biodegradable material that can be used to strengthen traditional earthen bunds or protect the banks of village ponds from erosion. Particularly in developing countries, where coir is abundantly available and textiles can be produced by small-scale industry, this is an attractive alternative for conventional methods.

It might be difficult to improve upon the works of nature, but today's slope stabilization experts are proving they can do exactly that as a blend of human ingenuity and bold techniques are producing results that are as aesthetically extraordinary as they are effective.

Some techniques incorporate the best features of nature, including a heavy reliance on vegetation to camouflage and complement hard structures.

A downstream rebound of the floodwaters off the coir fiber log revetment did occur. This was due primarily to the lack of

vegetation in the coir fiber logs at the time of flood.

The coir erosion control blankets are designed for flow rates of 3.66m/sec (12ft/sec) without vegetation. The vegetation development that had taken place before the flood increased the erosion control blankets ability to withstand greater flow rates.

The coir fiber revetment walls provided medium stream bank protection. As the coir fiber logs biodegraded, the plant root system armored the bank, and as the plants developed they slowed the down stream erosion caused by water rebound off the coir fiber log revetment. Additionally, the coir fiber log revetment was easily installed without machinery. This reduced the impact on the zone being protected. However, log crib revetments and rock and root wad revetments required heavy equipment for installation. This operation equipment can often create more areas, which must be treated for erosion control and shoreline stabilization.

Eroded stream banks subjected to high energy flows can be stabilized without hard structural treatments in a manner that is compatible with habitat restoration objectives.

Brush layering was installed between the soil wraps and at other points along the slope. That new practice was geotextile flaps, which involves allowing the coir netting to lie as a flap over the face of the slope instead of wrapping the netting back over the soil, as performed with soil wraps. The flaps were with wood lathes along their edges and long wood/ steel anchors driven into the slopes.

There are still a lot of skeptical people, especially on stream projects. They think that if you use vegetation it will reduce flow and cause floods. But some engineers have really come to

love bioengineered approaches, especially if the vegetation is well maintained. That may require some extra effort, but the benefits vastly outweigh the costs.

People think vegetation and the results that come from it are unpredictable, but that isn't true if you involve all the right disciplines at the start.

Some people will say live willow cuttings just don't work. They're working off their experience, but it means those cuttings weren't planted right. Installation is very important, of course, and that's why you have to have a hydrologist, biologist, and botanist on hand. We want to get everyone onsite to put their thoughts, knowledge, and experience into the project. When you do that, it's a much more successful project in the end and you don't have to go back and fix things over and over.

Coir fiber logs were chosen because they were constructed of soft, natural fibers. They were installed to absorb the energy of high water flows along the creek channel. This soft armor, technique dampened the rebound effect of the water flow, thus reducing the water energy's impact on the down stream bank and reducing down stream erosion.

The first coir fiber lift was installed on rock rubble at the toe of the stream bank. The rock rubble was placed in a trench below the creek bottom. The second and third coir fiber log lifts were stepped back 15cm(6 in). The coir fiber logs were anchored with wood stakes 120cm (4 in) on center along the stream face of the logs and on the soil side of the logs. The upstream end of the coir fiber log installation was keyed into the bank.

The coir logs used on the project are composed of shredded coconut husk fiber packed at 144 Kilograms per cubic meter (9 pound per cubic foot) into polyethylene mesh netting exterior. They are 30.5 centimeter (12 inch) diameter cylinders, 6.1 meters (20 feet) in length and weighing 65.3 kilograms (144 pound) each when dry.

Proper installation is critical to ensure any successful erosion control project with careful grading of the vertical portions of the top of bank using a backhoe to create a more gradual slope (1.1 to 1.5: 1) for improved stability and larger planting area. A row of hay bales was staked along the lower bank prior to grading as a sediment trap, which prevented any soil from falling in the river. The coconut fiber rolls were installed securely with wooden stakes cut diagonally from 1.2 meter (4 foot) to 1.8 meter (6 foot) long construction lumber measuring about 5 centimeters thick by 10 centimeter wide (" two by- fours"). The rolls were anchored by a network of polypropylene cords attached to notches in the stake and then hammered down taut with the surface.

The coir fiber logs withstood the floodwaters of very well. They were not damaged by ice, and the soil behind the coir fiber logs did not erode. Some sediment was deposited on the log surface. The planted dogwood as well as volunteer vegetation had taken root and began to develop.

The stabilized bank will with stand severe storm flows the first winter. The treatment will remain intact after withstanding higher flow velocities. The treated stream bank has now successfully held up to several storm events over four winter. An eroding bank unable to support vegetation and with little wildlife use has now been stabilized and restored to a valuable and scenic native riparian habitat, threats to adjacent land have been eliminated, and erosion/silation minimized. This project demonstrates that biotechnical stream bank stabilization is a viable alternative to riprap that can reduce erosion and sedimentation while enhancing habitat values.