Facts on Coir: Lessons from the Past

(Degradation and strength retention in field applications)

Lanka Santha, P.E.
Calista Santha, Ph.D.
RoLanka International, Inc. 1998

Abstract

There is a rapid growth in the use of bioengineered soil erosion and sedimentation control designs especially in environmentally sensitive areas. Most of these designs incorporate coir products to provide the required initial structural stability until the establishment of sustainable vegetation. Design criteria in these designs assume a certain rate of degradation in the coir products. As a result, there is a growing concern about durability and strength retention in field applications of coir erosion control products. This article discusses the contributing factors for strength retention and durability of coir products in field applications and several relevant experiences in the use of coir products by horticultural and agricultural industries that are applicable to environmentally sensitive soil erosion and sedimentation control designs.

Introduction

Coir (coconut fiber) usage has become very common among professionals in various industries due to its versatility. In the horticultural industry, agricultural industry, or erosion control industry, coir has established a remarkable reputation for its superiority to other available natural materials. Compared to the horticultural and agricultural industries, coir is relatively new to the erosion control industry and it may take some time for this industry to learn and understand about coir. Recognition of coir in the erosion control industry has come from the fact that it is an abundant, renewable natural resource with an extremely low decomposition rate and a high strength compared to other natural fibers. In traditional erosion control blanket applications, coir blankets are well known for superior performance compared to other organic blankets. In most of these applications, long-term tensile strength in the blankets is not a critical design criterion. The rapid growth of environmentally concerned designers with their innovative bioengineering designs has increased coir use in the erosion control industry. These designs incorporate coir products as structural components in the construction. Figure 1 shows such a design using high strength brown bristle coir woven blanket. This design was selected for the Environmental Excellence Design Award at the 1996 International Erosion Control Association (IECA) annual meeting. This award winning design expects the woven coir blanket to retain considerable tensile strength until the establishment of well grown vegetation. Figure 2 is another bioengineering design using coir rolls with high strength brown bristle coir outer netting. This design requires the outer netting in coir rolls to retain strength for several years. Therefore, high strength retention or slow rate of degradation of coir products in field applications fulfills the design expectations in these types of bioengineering designs.

It is normal for designers to look for more information relative to their design criteria. Because of this need, there is a growing concern regarding durability and strength retention in field applications of coir erosion control products. The intent of this article is to discuss the contributing factors for strength retention and durability of coir in field applications and to present several relevant experiences in the use of coir products by horticultural and agricultural industries that are applicable to erosion control designs.

Coir is typically processed from ripe coconut husks which are dark brown in color and have been retted in freshwater for three to six months. The retting process of coconut husks acts as a curing process for fiber in coconut husks. Curing coconut husks in freshwater increases resistance to UV (ultraviolet) degradation and also increases the flexibility of processed fiber without causing deterioration. During traditional processing, coconut fiber from cured husks is separated by skilled labor into grades depending on the length of fiber. The longer and stronger fibers are called bristle coir and the shorter and thinner fibers are called mattress coir **(Santha, 1994)**. Coir processed from ripe husks cured in freshwater is dark brown in color.

Figure 1: Bioengineered river bank stabilization, an innovative fabric-encapsulated technique.

Figure 2: Use of coir rolls in shoreline stabilization.

When the ripe coconut husk is dry, it is an excellent firewood. As a result in countries with a high population density, most of the ripe brown coconut husks are used for firewood and the coconut husks available for processing coir are unripe green husks. Unripe green coconut husks are usually soaked in brine to make the coir processing easier **(Meerow, 1997)**. An economical way to soak coconut husks in brine is to use lagoons **(Nedia Enterprises, 1996)**. Coir processed from lagoon-cured green husks is light brown or white in color. This coir is referred to as white coir. Salt in lagoon water makes it easier to process unripe green coconut husks. Needless to say, fibers in coir processed from unripe green coconut husks are not fully mature compared to fibers coming from ripe brown coconut husks. Lagoon-cured brown coconut husks also produce white coir. Salt in lagoon water acts as a bleaching agent that can weaken coir used in field applications. White coir is, therefore, much weaker than brown bristle coir processed from ripe brown husks.

High demand for coir has led to new coir processing methods which may produce a weaker product than the traditional freshwater-curing process. Mass-scale coir manufacturers recently implemented coconut husk defibering machines. These machines can separate fiber from uncured or partially-cured husks or unripe green husks or ripe brown husks. Advantages of these defibering machines to the coir producer include reduced expense and faster production rates since skilled labor is not required and the six-month curing time is reduced or eliminated. Some of these mass-scale coir manufacturers go further and soak unripe green husks in a bacterial solution and process for white coir within 72 hours of curing **(Joseph**

and Sarma, 1997). These machines do not separate fiber into bristle coir and mattress coir but yield a mixture of long and short (strong and weak) fibers. A quick way to produce white colored coir for decorative coir products is chemical bleaching of the coir. In chemical bleaching, brown or light-brown colored coir is treated with chemicals to remove the brown color. Chemical bleaching may have some negative effects on the strength and durability of coir. On the other hand, coir from the ripe husk is well known as a natural fiber and the rich brown color is more attractive than a white color for erosion control applications. Most importantly, addition of chemicals to natural coir may create a potentially hazardous situation in many environmentally sensitive applications.

Experience with coir in the agricultural industry has shown that only the traditional brown bristle coir which is processed from ripe brown coconut husks cured for at least six months in freshwater has performed well in applications where durability and strength retention are critical for satisfactory field performances.

Experience in the Agricultural Industry

For well over twenty years, hop growers in the agricultural industry have used coir twine to train hop vines (Figure 3). Hop growing season starts in April and harvesting is done in mid-August to September. As shown in Figure 3, young hop plants climb and grow on the 20 feet long coir twine. When hop vines reach their maturity, the vines are very heavy and the twines must be able to carry the weight in wet and windy conditions in hop growing areas (Oregon, Washington and Idaho states). Years ago, hop growers went through the phase that erosion control industry professionals are now going through, seeking answers to questions on strength retention and durability of coir in field applications. Coir twines made of different coir types were introduced to hop growers by different sources. Finally after years of experience with coir twines made of different coir types, hop growers determined the only acceptable coir twine for the hop industry is the 80-90 lb. initial strength brown bristle coir (freshwater-cured) twines. This twine has proven that it can support hop vines throughout their growing season without any problem. During the period that hop growers used a variety of coir twines made of different coir types, including white coir, they paid a huge price as coir twines other than the traditional brown bristle coir twines failed to support mature hop vines.

Figure 3: Use of coir twine in hop farms to train hop vines.

Experience in the Horticultural Industry

Coir dust or pith, the leftover dust after extracting coir from coconut husks, was introduced to the horticultural industry about fifteen years ago as a soilless plant growth medium. Due to its high water holding capacity and the ability to wet easily without wetting agents, coir dust became more popular than peat moss. This popularity has created a high demand for coir dust. Similar to the hop industry, the horticultural industry found there were different coir dust sources and very soon understood that all sources of coir dust do not have similar properties but depend on the processing method. The main problem experienced was the high salt content in some coir dust **(Cresswell, 1992)**. The curing of coconut husks in lagoons increased the salt content in coir dust. Now there are very strict quality control practices for coir dust and some veteran coir dust users go one step further and buy coir dust produced in geographic regions where saltwater-curing of coconut husk is not available.

An Explanation for Strength Retention and Durability of Coir in Field Applications

Experience in the hop industry provides a good example to help us understand coir's strength retention and durability properties in field applications. Currently, the hop industry uses only the freshwater-cured brown bristle coir twines. Let's take a closer look at why they chose this after years of trial and error with coir produced from different methods. Figures 4 shows enlarged cross sections of currently available different types of coir twines. Figure 4a is an enlarged cross section of freshwater-cured brown bristle coir twine. Figure 4b is an enlarged cross section of saltwater-cured (lagoon-cured) white bristle coir twine. Figure 4c is an enlarged cross section of freshwater-cured mixed brown coir twine, and Figure 4d is an enlarged cross section of saltwater-cured mixed white coir twine. In general, strength and especially in wet strength, bristle coir twine is stronger than coir twine of similar size made of mixed coir. However, for the sake of argument, let us assume that all four coir twines shown in Figure 5 have the same initial wet strength. Conditions to which coir twines are subjected in the hop fields are similar to the conditions coir products undergo in erosion control field applications. In both cases, coir is undergoing degradation, ultraviolet (UV) and biological, while under stress. The higher the resistance to degradation, a product will have longer strength retention. Lagoon-cured coir contains salts and when it comes in contact with moisture, degradation is greatly accelerated. As a result, degradation of lagoon-cured coir is much faster than freshwater-cured coir. Furthermore, degradation of smaller diameter fibers occurs much faster than degradation of larger diameter fibers. Increased degradation speed occurs because coir twine made of smaller diameter fibers has a significantly higher surface area compared to the same sized coir twine made of larger diameter fibers. In addition, fibers in white coir processed from unripe green husk are weaker compared to fibers from ripe brown husks. Also, resistance to UV degradation in brown coir processed from ripe husk is much higher than white coir processed from unripe green husk. Therefore, coir twine made of freshwater-cured mixed brown coir, lagoon-cured mixed white coir, or lagoon-cured bristle coir has a faster degradation rate than coir twine made of freshwater-cured brown bristle coir (Figure 4a). The same arguments are true for coir twines made of chemically bleached white coir. This explains why freshwater-cured brown bristle coir twines are the most durable and retain the highest strength in field applications compared to coir twines made of any other coir. The hop industry provides convincing proof for this explanation showing that freshwater-cured brown bristle coir has superior resistance to degradation and the highest strength retention compared to any other coir type in field applications. In addition, freshwater-cured brown coir contains no excess salt or chemicals which may be present in lagoon-cured or chemically-bleached white coir. Considering horticultural industry's experience with coir dust, designers may find it valuable to look closely at the use of coir that has excess salt or chemicals for soil erosion control and bioengineering applications.

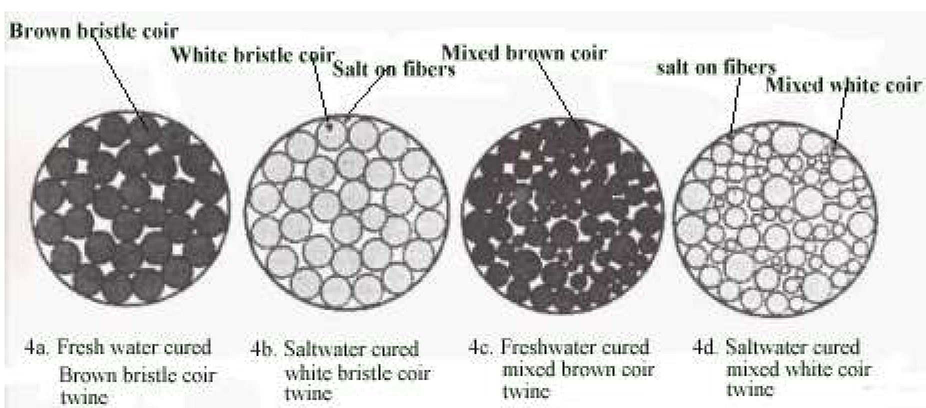

Figure 4. Enlarged cross section of currently available different types of coir twines

Conclusions

The most common question today in erosion control and soil bioengineering designs regarding coir product usage involves the rate of degradation and strength retention of coir products in field applications. This issue is basic to total quality control where high quality raw materials and production standards build high quality into the final product. It is time for erosion control industry professionals to look into the findings of other industries such as horticulture and agriculture for their valuable experience with coir. Such experience will guide the erosion control industry in making better use of coir products and also will help to identify problems and failures in coir products without blaming the entire coir industry. It is also profitable for industry professionals to learn the real facts about coir instead of accepting unfounded or untrue information published solely for purposes of marketing coir products. Most importantly, understanding the contributing factors to coir durability and degradation will help to develop industry standards for high quality coir products. In today's environmentally sensitive soil erosion and sedimentation control designs where a slow rate of decomposition and a high retention of strength is important in field applications, it is wise for designers to look for the brown bristle coir raw material in coir products.

References

1. Calista R. Santha, Ph.D., "Coir an Abundant Natural Fiber Resources", Land and Water Magazine May/June 1994, p 42 - p 43.

2. Alan W. Meerow, Ph.D., "Coir Dust, A Viable Alternative to Peat Moss", Internet http://www.ftld.ufl.edu/coir%20potential.htm.

3. Nedia Enterprises, "Product Literature", 1996.

4. K. GeorBge Joseph and U. S. Sarma, "Retted (White) Coir Fibre Netting - The Ideal Choice as Geotextiles for Soil Erosion Control", IECA Proceedings 1997, p 67 - p 75.

5. C. Geoffrey Cresswell, Ph.D., "A Comparison of the Chemical and Physical Properties of Coir Dust with Sphagnum and Sedge Peats: Laboratory and Glasshouse Studies", Biological and Chemical Research Institute, Australia.

This article was (Facts on Coir) published in February 1999 Landscape Architect and Specifier News magazine was developed from this technical paper.