Coir Fibre Degradation

BIODEGRADATION

Among the broad spectrum of natural fibres, coir fibre possess the highest resistance against biological degradation, mainly due to the higher percentage of lignin present in them. However, hemicellulose and other fibre components can be subjected to biological attack, thereby exposing the crystalline cellulose and lignin to the external degrading environment. Soil can be attacked by both bacteria and fungi, and each have their own preferential environmental conditions. Studies have reported higher biodegradation for coir fibres at shallow depths and normally favoured in a pH range of 5 to 9.

PHOTODEGRADATION

Coir geotextiles subjected to direct sunlight exposure (ex: during applications such as canal lining, slope protection etc.) can undergo photo-oxidation. Lignin is the most affected upon the UV exposure, whereas crystalline cellulose exhibits the highest resistance against photo-degradation.

PHYSICO-CHEMICAL DEGRADATION

Exposure to cycles of alternate wetting and drying/ freezing and thawing will make only minimal impact over the properties of coir fibre. However severe damage can be induced during acid/base exposure. Acid exposure normally attacks the cellulose by hydrolysing it to simple sugars. On the other hand, hemicellulose gets removed in the presence of alkali, making the fibre more porous and thereby facilitating moisture entry. However, since hemicellulose is the major component of water absorption, its removal can result in overall dip in the adsorbed moisture and thereby imparting better durability to the material.

WATER ABSORPTION

The structure and composition of coir fibre helps in its hydrophilic nature. Significant amount of water gets absorbed to the fibre due to the capillary action. Also, the amorphous component phase (such as amorphous cellulose, hemicellulose, etc.) forms hydrogen bond with polar water molecules, thereby causing moisture diffusion. The absorbed water can significantly affect the engineering properties of the fibre. The increase in moisture content can reduce the tensile strength as it results in partial breakage of hydrogen bond between the amorphous and crystalline phase. Also, the absorbed water can facilitate the biological degradation of coir fibre, which can act as forerunner for the remaining degradation sequence to occur.

Mechanism	Degree of susceptibility
Biological degradation	*Hemicelluloses >>> Accessible cellulose > Non-crystalline cellulose >>>> Crystalline cellulose >>>>> Lignin*
Moisture sorption	*Hemicelluloses >> Accessible cellulose >>> Non-crystalline cellulose > Lignin >>> Crystalline cellulose*
Photo-degradation	*Lignin >>>>> Hemicelluloses > Accessible cellulose > Non-crystalline cellulose >>> Crystalline cellulose*
Thermal degradation	*Hemicelluloses > Cellulose >>>>> Lignin*
Strength	*Crystalline cellulose >>Non-crystalline cellulose + Hemicelluloses + Lignin > Lignin*

Comparison of attributes of cell wall polymers (after Rowell et al., 1992)