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Durability Studies of Surface Modified Coir Geotextiles

Slomo Anna Daniel[1], Shahna A Rahman[2], Ben Johnson Paul[3], Nameer Mohamed Naseer[4] Prof. Basil Jaimon [5]

[1,2,3,4] UG Students, MA College of Engineering, Kerala, India
[5] Assistant Professor, Dept. of Civil Engineering, MA College of Engineering, Kerala, India

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Abstract - *The fabrics known as Coir Geotextiles are comprised of coir yarn and are entirely natural and biodegradable. Major applications of them include erosion control, separation, filtration, and strengthening. They are frequently employed in the building of roads, embankments, soil stabilisation against erosion through vegetation, and protection of the banks of rivers, canals, and lakes. These are subjected to various chemical and environmental conditions. Hence their durability is a matter of concern. In this project, natural rubber latex is provided as surface modification of coir geotextile. The initial tensile strength of the modified and unmodified coir geotextiles was tested. Modified and unmodified coir geotextiles were buried in laterite soil, submerged in plain water and in solutions of fertilizers (urea and factamfose) and exposed to natural environmental conditions. After 60 days, tensile strength of these samples was evaluated. The initial strength of coir geotextile has increased by 4.797% after modification with natural rubber latex. Urea has more effect on the degradation of coir geotextile than factamfose. An increase of 12.85% in strength for modified geotextile than the unmodified geotextile in urea solution implies that latex modifications are more effective when geotextiles are to be used in alkaline conditions. The degradation rate is slightly more for unmodified geotextile than the modified geotextile by 0.5% for those buried in laterite soil as the acidic nature of the soil deteriorates the latex modification. The modification was effective in protecting the geotextile from UV rays. The findings point to the potential of appropriately surface-modified coir geotextiles for prolonged use in adverse environment.*

Key Words: Coir, Natural Fibre, Geotextile, Surface Modification, submerged, Fertilizer effect, laterite soil effect.

1. INTRODUCTION

Geotextiles, geogrids, geonets, geomembranes, geosynthetic clay liners, geofoam, geocells, and geocomposites are all examples of the planar, polymeric heterogeneous class of materials known as geosynthetics. They are becoming more popular in civil engineering because they can be utilised for containment, drainage, filtration, reinforcement, and separation. Geotechnical and geoenvironmental engineering is the primary field in which geosynthetics are used. A versatile and affordable ground modification material, geotextile consisting of synthetic polymer or naturally derived synthetic composite polymer is used to build highways, embankments, canals, and other structures. Environmental awareness is increasing constantly, which stimulates research and results in the creation of more eco-friendly products. The production of geotextiles using natural, biodegradable fibres is the newest development in geosynthetics.

The thickest and most durable natural fibre is coir, which is made entirely of natural materials. The raw material for the coir business is provided by the coconut palm, also known as Kalpavriksha.It has the highest tearing strength of any natural fibre, even in extremely slick situations. Therefore, coir geotextiles, or net fabrics made of coir fibres, are frequently employed in the building of roads, embankments, soil stabilisation against erosion through vegetation, and protection of the banks of rivers, canals, and lakes. Due to its rough texture, it has a propensity to absorb moisture. With the progression of degradation, the capacity of coir to absorb moisture grows even more. The surface of the fiber's small pores and fissures allow moisture to enter, swelling the fibre as a result. Under normal pH, temperature, and nutritional conditions, this makes the cell wall weaker and opens it up to microbial attack. Natural geotextile can have its surface modified to stop moisture absorption and increase its lifespan.

1.1 Materials

Latex modified coir geotextile is a new genre of material with superior mechanical properties of coir fibre and durability of natural latex. 40sqm Coir Geotextile was collected from Shertallai Thaluk Small Scale Coir Matting Producers' Co operative Society Ltd and sent to a factory at Pathirappally for latex coating The latex was sprayed over the surface of the geotextile sample, which had been spread out on the ground, using a spray gun and compressor. It was sprayed on one side and then dried by exposing to sun for around two hours. After that, second surface was also modified similarly, and both surfaces are allowed to pass through a drier at 100 0 C.

Fig-1: Unmodified coir geotextile

Fig-2: Modified coir geotextile

2. Methodology

2.1 Soil burial

Six samples each of modified and unmodified coir geotextile of dimension 3 00mm × 3 00mm were buried in laterite soil for a period of 60 days. The samples were buried at a depth of 50cm where water was found. Since the experiment was conducted during rainy season, the water content of the soil was obtained as 69.8%.

Fig-3: Sample burying in soil

2.2 Exposed to Natural Condition

Fig-4: Samples exposed to natural condition

Six samples each of modified and unmodified coir geotextiles, of dimensions 300mmx300mm were placed on the roof top exposed to natural weather conditions for a period of 60 days.

Table-1: Properties of Unmodified & Modified Coir Geotextiles

Properties	**Unmodified Coir Geotextile**	**Modified Coir Geotextile**
Thickness (mm) @ 2 kPa	9.63	11.45
Mass per unit area (g/m^2)	1312	1804
Density (kg/m^3)	136.24	157.55
Tensile Strength (kN/m)	12.405	13

The average climatic conditions during the experimental period are as follows.

Table-2: Average Climatic Conditions

Precipitation (cm/day)	0.51	
Temperature (^0C)	Max.	Min.
	32.33	23.33
Humidity	75.33%	
Day Length (hrs)	12.45	
Night Length (hrs)	11.55	

2.3 Immersion in Water

Fig-5: Samples immersed in water

Six samples each of modified and unmodified coir geotextile of dimension 300mm×300mm were completely immersed in 20L plain water. To study the effect of fertilizers that might leach into water from agricultural land, similar samples were immersed in 3% urea solution and 3% factamfose solution. Urea and factamfose were selected as they are the most commonly used fertilizers in kol fields. 3% concentration was chosen as it is the maximum concentration of fertilizer that might leach into water.

2.4 Tensile Strength Testing

As per IS 13162 Part 5, tensile strength of coir geotextiles was determined in Universal Testing Machine at Central Coir Research Institute, Kalavoor, Alappuzha. The dimension of the samples used for wide width tensile strength test is 200mm×200mm (6). The samples were tested at a constant rate of traverse-20mm/min. Gauge length was 100mm.

Fig-6: Universal Testing Machine

3.Results and discussion

Tensile strength of the samples was tested initially and after 60 days in different experimental conditions. The results were obtained as follows:

Table-3: Results of wide width tensile strength test

Condition	Tensile Strength (kN/m²)	
	Unmodified	Modified
Initial	12.405	13
Immersed in plain water	10.816	10.903
Immersed in urea solution	8.08	10.138
Immersed in factamfose solution	10.105	10.508
Soil burial	10.202	9.765
Natural condition	8.08	9

Table-4: Comparison between initial strength and strength after 60 days

Condition	% decrease in tensile strength	
	Unmodified	Modified
Immersed in plain water	12.809	16.131
Immersed in urea solution	34.865	22.015
Immersed in factamfose solution	18.541	19.169
Soil burial	17.759	24.885
Natural condition	34.865	30.769

3.1 Initial Strength

200mm x 200mm geotextile samples were tested to determine the tensile strength. Initial strength of unmodified geotextile is obtained as12.405 kN/m2 while that of modified coir geotextile is 13 kN/m2. An increase of 4.797% of tensile strength is observed for modified geotextile.

3.2 Immersion in plain water

After immersion in plain water for 60 days, 200mm x 200mm geotextile samples were tested to determine the tensile strength. The strength of both modified and unmodified coir geotextile is found to decrease by 16.13% and 12.81% respectively. This is due to the leaching of soluble components of coir fibre like cellulose and hemicellulose.

3.3 Immersion in urea solution

After immersion in 3% urea solution for 60days, 200mm x 200mm geotextile samples were tested to determine the tensile strength. The strength of both modified and

unmodified coir geotextile is found to decrease by 22.015% 34.865 % respectively. From earlier studies it is evident that the degradation of coir geotextile is more in alkaline condition. Since urea on reaction with water gives ammonia, urea solution is alkaline in nature. This enhances the rate of degradation of coir geotextile.

3.4 Immersion in factamfose solution

After immersion in 3% factamfose solution for 60days, 200mm x 200mm geotextile samples were tested to determine the tensile strength. The strength of both modified and unmodified coir geotextile is found to decrease by 19.17% and that of 18.54% respectively. Rate of degradation in factamfose solution is greater than that in plain water and less than that of urea.

3.5 Soil Burial

The strength of both modified and unmodified coir geotextile is found to decrease by 24.89 % and17.76% respectively. Since the sample was buried in laterite soil, which is acidic in nature, the latex modification of coir geotextile is adversely affected.

3.6 Natural Conditions

The strength of both modified and unmodified coir geotextile is found to decrease by 30.77% and34.87% respectively. This clearly implies that the latex modification protects the coir geotextile from UV radiations and precipitations.

4. CONCLUSIONS

In this study durability of unmodified and latex modified coir geotextile was studied. The effects of laterite soil, plain water, fertilizers (Urea and Factamfose) and various environmental conditions were examined for a period of 60 days. The following conclusions could be drawn from the study:

- Tensile strength of coir geotextile has increased by 4.797% after modification with natural rubber latex.
- Results from immersion in urea solutions shows that there is a 12.85% increase in strength for modified geotextile. This implies that latex modifications are more effective when geotextiles are to be used in alkaline conditions.
- Comparing the effects of Urea and Factamfose on coir geotextile, the durability is more adversely affected by urea than factamfose.
- Latex modification of coir geotextile is not suggested in laterite soil since its acidic behavior deteriorates the latex modification.
- Latex modification protects the coir geotextile from UV rays in an effective manner.
- On an average latex modification costs about Rs. 100 per square meter. Hence it is slightly expensive.

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