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Biodegradable Geomeshes for Rainsplash Erosion Control

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Abstract

Geomeshes can be employed to control erosion in conjunction with revegetation efforts, supplying seedbed protection from rainsplash erosion. In this study, jute and coir geomeshes were tested for erosion control performance under simulated rainfall conditions and germination using Shiwalik region soil. The performance of coir and jute geomeshes for rain splash erosion control were tested based on ASTM-D-7101 using a bench-sale setup with some modifications. Germination tests were performed according to ASTM-D-7322. Rain splash erosion control tests were carried out on three different slope angles of 15°, 30° and 45°. Jute geomeshes resulted in the improvement of erosion control and soil stability than that of Coir. Also, the erosion control performance of geomeshes was observed to be influenced by the angle of soil slope. The objective of this study is to assess the performance capacities of biodegradable geomeshes that are commonly used for slope erosion control and vegetation establishment.

Keywords: Shiwalik Ranges; Rainsplash Erosion Test; Germination Test; Geosynthetics

1 Introduction

Rainsplash erosion, involves three distinct actions – soil detachment, movement and deposition. This normally leaves to the loss of soil structure and other organic matter in the soil, along with other devastating problems like landslides, floods, and desertification [1-3]. The greater the intensity and duration of rainstorm, higher is the erosion potential. The impact of raindrops on the soil surface can break down soil aggregates and disperse the aggregate material. Lighter aggregate materials such as very fine sand, silt, clay and organic matter are easily removed by the raindrop splash and runoff water. Soil management systems or bio-engineering techniques (utilization of vegetation) with geomeshes can be used to control soil erosion [4].

Geomeshes include a variety of temporary or permanently installed manufactured products designed to control erosion and enhance vegetation establishment and survivability, particularly on slopes. For applications where natural vegetation alone will provide sufficient permanent erosion protection, temporary products such as geomeshes made of biodegradable natural materials (e.g., jute and coir fiber) can be used. These products are often used on disturbed areas on steep slopes, in areas with highly erosive soils. The products function by protecting the ground surface from

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the impact of raindrops and stabilize the surface until vegetation can be established as well as better control of water flow velocity [5-9]. Geomeshes also promote the growth of vegetation by helping to keep seeds in place, and by maintaining a consistent temperature and moisture content in the soil.

In this paper, coir and jute geomeshes have been studied for soil erosion control performance using lower Himalayan Shiwalik (highest erosion prone areas) soil at three different slope angles of 15°, 30° and 45°. In geomeshes, the contact of longitudinal warp and traverse weft yarn to the soil influences the water flow velocity and rainsplash erosion control.

2 Materials and Methods

The performance of jute and coir geomeshes of 500 and 700 g/m^2 mass was studied for rainsplash erosion control using soil from the lower foothills of the Himalayan/ Shiwalik ranges, which is composed of 40% sand, 40% silt and 20% clay particles. The Table 1 shows the characteristics of coir and jute geomeshes used. The North-western lower Himalayan foothills experience an average annual rain fall of 950 mm/year. During heavy rainy day, average rainfall of 100 mm occurs in a single day with 3 rain spells of 20 to 30 minutes each [10-13]. Testing conditions were maintained similar to these geographical factors which has a greater impact over the performance of geomeshes. The E_r ratio (ratio between the average rainfall per day to the average rainfall per year) of these regions is 0.1 [4].

Table 1: Characteristics of coir and jute geomeshes

Grade	Nominal mass/unit area (g/m^2)	% cover	Ends/ meter	Picks/ meter	Warp linear density (Tex)	Weft linear density (Tex)	Mesh opening size (mm×mm)	Flexural Rigidity (μNm)			
								Dry		Wet	
								warp	weft	warp	weft
Coir	500	21	52	40	5895	4646	19 × 21	6388	1646	2025	498
geomesh	700	33	58	46	4942	4942	17 × 19	7979	3694	2500	1114
Jute	500	23	52	48	3696	4623	19 × 21	861	668	189	72
geomesh	700	25	52	55	4049	4827	19 × 15	972	1089	227	292

Note: Tex is used to represent the linear density of yarns and is defined as the mass of 1000 meters of yarn in grams

The performance of coir and jute geomeshes were tested in terms of rainsplash erosion control performance and germination test. The rainsplash erosion control was tested based on ASTM D 7101 using a bench-scale setup with some modifications (Fig. 1(a)) [14]. Since geomeshes have open structures with mesh opening size of 17-21 mm, the test core of 20 cm diameter used in ASTM D7101 were substituted by a test tray of 75 cm × 50 cm × 25 cm [15]. Shower type rainfall simulator for heavy rainfall of 100 mm/hr was used for simulating rainfall conditions in the laboratory.

The test trays were filled with 2 cm of sand at the bottom and with 20 cm of soil to be tested (Shiwalik soil) at the topand allowed to settle for 120 days [8]. Testing was carried out at three different slope angles of 15°, 30° and 45°, so the settled test trays were placed in the required angle of slope and covered with and without geomesh. Rainsplash based on the geographical conditions