Use of geotextile as reinforcement in soil backfill for strength and stability analysis in J&K

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Abstract: **-The process of enhancing the load bearing capacity and engineering qualities of subgrade soil in order to sustain structures and pavements is referred to as soil stabilisation. In this study, the use of geotextile as a reinforcement for the stabilisation of alluvial soil samples was investigated. Particle size analysis, the Atterberg Limit test, moisture content, specific gravity, Direct shear test, standard proctor Compaction test, and the California Bearing Ratio test were all part of the battery of geotechnical tests that were carried out. Both with and without non-woven geotextiles present, CBR tests were carried out. For the purpose of determining the stability of the soil samples, the tests were carried out using non-woven geotextiles that were arranged in single and double layers at various locations, including the top, middle, and bottom surfaces of the soil in the case of single layers, and the top-middle, top-bottom, and middle-bottom positions for double layers. Incorporating non-woven geotextile into the soil in double layers at top-bottom led to an increase in the soil samples' inherent strength, as shown by the results of the experiment. The findings of the experiments provide conclusive evidence that the addition of geotextiles to soil improves its physical and chemical characteristics, including: Capacity to bear loads, levelling off, and stability As a result, geotextile should be used as a cutting-edge method of enhancing building on weak soils.**

Keywords**:-Soil and Foundation test, reinforcement geotextile, Direct shear test, stabilization, Standard proctor and CBR.**

I. INTRODUCTION AND BACKGROUND

Geosynthetics are goods that are formed of synthetic or natural polymeric materials that are utilised in contact with soil, rock, or other geotechnical materials. These products may be classified as either geotextiles or geogrids. The terms geotextile, geogrid, geocell, geonet, geomembrane, geosynthetic clay liner, and geo-composite are the most common types of geosynthetics. Other types include erosion control mats.

- Geotextiles are the most used kind of geosynthetics.
- The earliest application of geotextiles that was documented was in 1956, when nylon bags filled with sand were employed in the Dutch Delta Works.
- Over the course of the last sixty years, geotextiles have seen extensive use in geotechnical engineering. Within the realm of geotechnical engineering, geotextiles are capable of performing at least one of the following functions: In addition to being a barrier and providing protection from erosion, separation, filtration, and drainage are all important.
- In addition, the use of geotextiles in geotechnical engineering may be subject to a variety of challenging environmental circumstances
- Such as complicated acid-base environments, which will then result in greater performance requirements for geotextiles

As a result, advancements in geotextile technology should focus on high performance and many functions. Due to the widespread interest in environmentally friendly ideas, a large number of academics have investigated the feasibility of using biodegradable polymer geotextiles instead of natural geotextiles. At the current time, natural geotextiles are capable of substituting for materials manufactured geotextiles in fifty percent of all applications. Geotextiles are also progressing into the realm of multi-functional intelligence thanks to the incorporation of optical fibre sensor technology into geotextiles. When intelligent geotextiles are applied to the reinforcement of a geotechnical structure, it is also possible for them to carry out the health monitoring of the geotechnical structure. This ensures that the geotechnical structure and its locations with a high failure and damage risk can be found in the early stage, which is conducive to the early prevention and maintenance of failures and damages.

II. WHY GEOSYNTHETICS.

- Geosynthics have fundamentally transformed the way geotechnical engineering is performed.
- Innovative ideas to tackle complex challenges cheaply and expediently.
- Enables the use of local resources –Sustainable solutions
- Unskilled Labour may be hired
- Installation does not need heavy gear

III. GEOTEXTILE APPLICATIONS

1. To upgrade both paved and unpaved roads at airports and their surrounding areas
2. Regarding waste dumps and stone-based base courses.
3. For the filling of land gaps using tiny pieces of geotextile material.
4. Beneath the sidewalks and the layer of sand that serves as drainage
5. Beneath the parking lots and the surrounding curb areas.
6. To improve the verdant environment and the recreational amenities that are held within the confines of the retaining wall constructions.
7. Improvements to the soil capping brought on by the reinforcement and the pipe trenches.

IV. ADVANTAGES

The market for geotextiles necessitates the purchase of substantial amounts of material. When compared to woven geotextiles, warp-knitted weft-insertion geotextiles have a number of benefits, including the ones listed below:

1. When compared to woven geotextiles that use the same yarn, they are lighter yet having comparable strength. Because of this, the material can be moved and laid up on the site with less difficulty, which results in reduced expenses for both labour and transportation.
2. The tearing resistance of knitted geotextiles is very high. It is possible to design and include additional strength into the weft direction, which would allow for the creation of a bi-axial strong tenacity, good stiffness warp/weft geotextile, with values such as 500 kNm for the warp and 500 kNm for the weft.
3. Knitted geotextiles have the capability of incorporating an extra fabric to create a real composite geotextile, with the fabric just being knitted into the knitted geotextile.
4. Because the individual strands that make up the warp knitted weft-insertion geotextile are linear when they are included, they are able to take up the strain as soon as it is applied to the material. Interlacing occurs in those seen in woven geotextiles.

V. PLACE OF WORK

1. National Institute Of Technology Srinagar (NIT Srinagar) Jammu And Kashmir
2. Govt Degree College Pampore.

OBJECTIVES OF THE STUDY

- To strengthen the soil stability through the use of geotextile as reinforcement in the soil.
- To strengthen the soil bearing capacity so as to overcome from or reduce the floor cracks.
- To stabile the soil layers so that to overcome from floor settling.

VI. METHEDOLOGY

NEED OF RESEARCH:

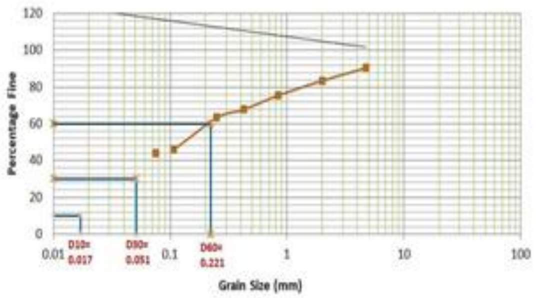
Nowadays, a number of initiatives and programmes have been started to promote and build geotextile reinforced soil stabilisation in various parts of India; nevertheless, its application is almost non-existent in Jammu and Kashmir. As is well known, the state of Jammu and Kashmir is located in the Himalayan area, and the state has a significant need for slope stabilisation due to its mountainous terrain. Another kind of soil that may be found on the plains of Srinagar and Kashmir is called alluvial, and it has a very limited ability to bear weight. There are no methods that may increase the bearing capacity or stability of the soil, so when it comes to building in Jammu and Kashmir, deep foundations are needed for big structures. As a result, Jammu and Kashmir are known for their mountainous terrain. Therefore, the purpose of this research is to investigate the usage of geotextile layers in soil as reinforcement in order to enhance the carrying capacity of the soil and its stability. In this project, I will experiment with geotextile in various soil layers in order to increase the quality of the soil. In addition to that, I will be collecting samples for testing from several locations in Srinagar, Jammu and Kashmir (like Government

Degree College, Pampore and NIT Srinagar). In addition, I will experiment with various reinforcing materials, including geotextiles, to determine which ones provide the greatest balance of strength and cost efficiency. It's possible that this research will be useful when it comes time to build pavement for roads.

LABORATORY TESTS:

1) Sieve Analysis:

Sieve Number	Diameter (mm)	Mass of empty sieve (g)	Mass of sieve + soil Retained (g)	Soil Retained (g)	Percentage Retained	Percentage Passing
4	4.75	116.23	116.13	49.9	9.5	90.5
10	2.0	99.27	135.77	36.5	7.0	83.5
20	0.84	97.58	139.68	42.1	8.0	75.5
40	0.425	98.96	138.96	40.0	7.6	67.8
60	0.25	91.46	114.46	23.0	4.4	63.4
140	0.106	93.15	184.15	91.0	17.4	46.1
200	0.075	90.92	101.12	10.2	1.9	44.1
Pan	-	70.19	301.19	231.0	44.1	0.0
			TOTAL =	523.7		



Graph of grain size distribution curve

From Grain Size Distribution Curve:

% Gravel = 9.5

% Sand = 46.4

% Fines = 44.1

D10 = 0.017mm

D30 = 0.051 mm

D60 = 0.221mm

Cu = D60/D10

= 0.221/0.017 = 13

CC = $(D30)^2$/ (D60 x D10)

= $(0.051)^2$ / (0.221 x 0.017) =0.69

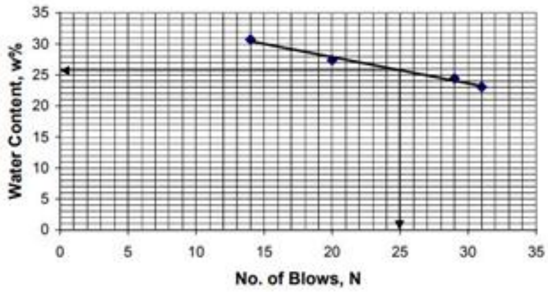
Result: - According to Unified Classification of Soil, the collected soil sample is:SC/SM

2) Atterberg's Limits (Liquid and Plastic Limit)

i) Liquid Limit:

Sample No.	1	2	3	4
Moisture can and lid number	11	1	5	4
Mc= Mass of empty, clean can + lid (g)	22.23	23.31	21.87	22.58
M_{CMS}=Mass of can, lid and moist soil (g)	28.56	29.27	25.73	25.22
M_{CDS}=Mass of can, lid and dry soil (g)	27.4	28.10	24.90	24.60
Ms=Mass of soil solids (g)	5.03	4.79	3.03	2.02
Mw=Mass of pore water (g)	1.16	1.17	0.83	0.62
W= water content, w%	23.06	24.43	27.39	30.69
No. of drops (N)	31	29	20	14

Table: Liquid Limit



Liquid Limit Chart

From above graph, Liquid limit **= 26**

ii) Plastic limit:

Sample no.	1	2	3
Moisture can and lid number	7	14	13
M_C = Mass of empty, clean can + lid (grams)	7.78	7.83	15.16
M_{CMS} = Mass of can, lid, and moist soil (grams)	16.39	13.43	21.23
M_{CDS} = Mass of can, lid, and dry soil (grams)	15.28	12.69	20.43
M_S = Mass of soil solids (grams)	7.5	4.87	5.27
M_W = Mass of pore water (grams)	1.11	0.74	0.8
w = Water content, w%	14.8	15.2	15.1

Table: plastic limit

Plastic Limit (PL) = Average W % =

$\frac{14.8 + 15.2 + 15.1}{3}$ = 15.0

Result:

- The liquid limit of soil sample collected is found to be = 26 .
- The plastic limit of soil sample collected is found to be = 15 .
- The plasticity of soil sample collected is found to be = 11 .

3) Specific Gravity Of Soil :

Results:

The specific gravity of a given soil sample is 2.65 .

4) Standard Proctor compaction test :

Results:

i) Optimum Moisture Content of a given soil sample is =13.1 %

ii) Maximum Dry Density of a given soil sample = 1.87 g/cm^3

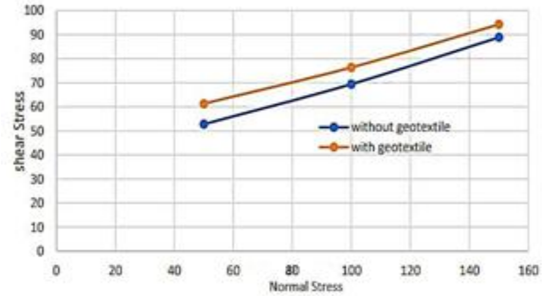
5) Direct shear test:

Test No	Shear Deformation	Normal Stress	Shear Stress
1	2.65	50	52.75
2	2.25	100	69.42
3	2.58	150	88.90

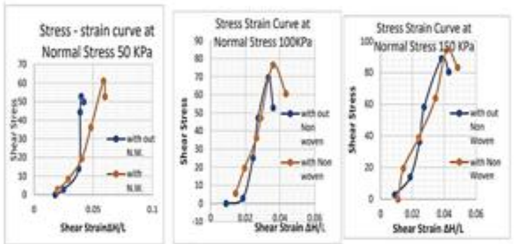
Table: Direct Shear without Geotextile

Test No	Shear Deformation	Normal Stress	Shear Stress
1	3.97	50	61.4
2	2.46	100	76.3
3	2.80	150	94.2

Table: Shear test with Geotextile



Graph between sample with and without geotextile



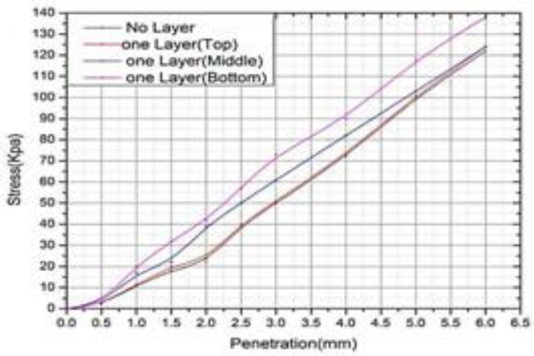
Graph between Shear stress and Shear Strain

6) CBR

I) Single layer

Penetration mm	No Layer Stress KPa	Layer at top Stress Kpa	Layer at middle Stress KPa	Layer at bottom Stress KPa
0	0	0	0	0
0.5	3	3	4	5
1	10	11	15	20
1.5	17	19	23	32
2	22	25	38	43
2.5	38	40	50	57
3	50	52	62	74
4	73	74	82	93
5	98	100	103	117
6	122	124	124	137

Table stress v/s penetration of single layer at different places and no layer

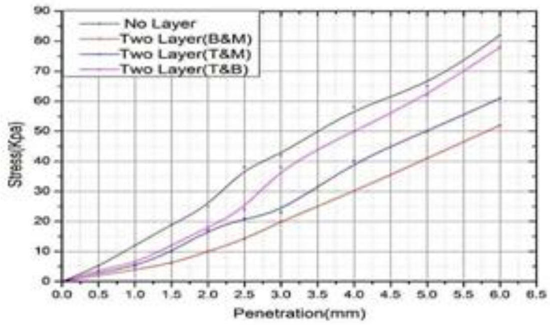


Single Layer geotextile at different places and no layer

i) Double Layers

Penetration mm	No Layer Stress KPa	Layer at top & Middle Stress KPa	Layer at Top & Bottom Stress KPa	Layer at Bottom & Middle Stress KPa
0	0	0	0	0
0.5	5	3	4	2
1	12	8	6	4
1.5	19	10	12	6
2	26	17	18	10
2.5	37	21	25	14
3	44	24	36	20
4	57	39	50	30
5	67	50	63	41
6	82	61	78	52

Table of two layer geotextile at different places and no layer



Graph of two layer geotextile at different places and no layer

CONCLUSION AND FUTURE SCOPE

- Experiments in the laboratory are performed on two different soil samples with and without the use of geotextiles, and the results are displayed. According to the findings, it is evident that the use of non-woven geotextiles contributes to an improvement in the qualities of the soil.
- Non-Woven geotextiles have a high tensile strength while also having a high frictional coefficient. They generate an internal frictional resistance and manage the deformations and stress that have arisen in the soil.
- Additionally, they operate as an excellent binding material with the soil particles. The shear characteristics, such as the frictional angle and the cohesiveness of the soil, will rise as a result of this.
- It can be deduced from the behaviour of stress strain curves that, in the case of reinforced soil as opposed to unreinforced soil, the curve progressively continues on growing, which

indicates an increase in the shear strength of the soil.

- As scientific knowledge expands and the global economy shifts, an increasing number of approaches will be implemented into subgrades in order to enhance the compatibility, durability, and strength of the materials. At the same time, more testing that is performance-based will be required in order to demonstrate that these stabilising strategies are successful.
- Because Jammu and Kashmir is located in an area classified as seismic zone IV, the potential applications of this study in the state's future are extensive.
- It plays an important part in the process of obtaining a structure with a secure foundation because it may assist in the structure settling evenly.
- The improvement of soil stability via the use of geotextiles may also be helpful in the construction of long-lasting roads in flood-prone locations. This is because geotextiles improve drainage and boost the shear and bearing strengths of the soil.

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