International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Study on Geosynthetics in Pavement Design

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ABSTRACT:

Geosynthetic reinforcement is one of the techniques adopted to improve their performance in pavement design. Geogrid are single line and multi-layer materials usually made by extruding and stretching high density polyethylene, or by weaving or knitting and coating high-strength polyester yarns. The resulting lattice structure has large holes that improve interaction with the soil aggregate. Roads having mostly the problems like the formation of potholes, ruts, cracks and localized depression and settlement, especially during rainy season. These are mainly due to the insufficient bearing capacity of the subgrade in water saturated condition. Geogrids are reinforcing elements to strengthen the ground in order to work on very soft and weak ground in the construction of asphalted or unpaved vehicle roads and areas where the high traffic flow is expected. Laboratory and simulated field CBR tests are conducted on soil samples with and without the inclusion of geogrid layer and also by varying the position of it in the mould. Use of geogrid increases the CBR value of the subgrade and thereby reduces the pavement thickness considerably up to 40%.This study will have positive impact as it will be reduce both project and road maintenance costs.

KEYWORDS: Geogrid, Reinforcement, CBR value, Flexible pavement, Expensive soil.

1. INTRODUCTION:

Geogrids are a type of geosynthetic material that is commonly used in pavement engineering to enhance the strength and durability of pavements. Geogrids are made from high-strength polymer or fiberglass materials and are designed to provide tensile strength and reinforcement to pavement structures.

In pavement applications, geogrids are typically used as a reinforcement layer in the subgrade or base course of pavements. The geogrid is placed between the subgrade soil and the pavement base layer and serves to distribute the load from the pavement structure over a wider area, reducing the risk of pavement deformation and cracking.

The use of geogrids in pavements offers a number of advantages. They can increase the pavement's load-carrying capacity, reduce pavement deformation, and improve overall pavement performance under heavy traffic loads. They can also help to reduce the thickness of pavement layers required, reducing construction costs and improving sustainability.

Overall, the use of geogrids in pavement engineering has become an increasingly popular and effective tool for enhancing the strength and durability of pavements. As such, their use is expected to continue to grow in the future as engineers and designers seek to optimize the performance and sustainability of pavement structures.

OBJECTIVES OF THE PROJECT:

- To reduce the thickness of Pavement. So, as to reduce the cost of road construction.
- To Design Pavement thickness based on CBR as per IRC:1498-1970
- To increase the load carrying capacity of the road (Strength of road).
- Increase the Service Life of Road.

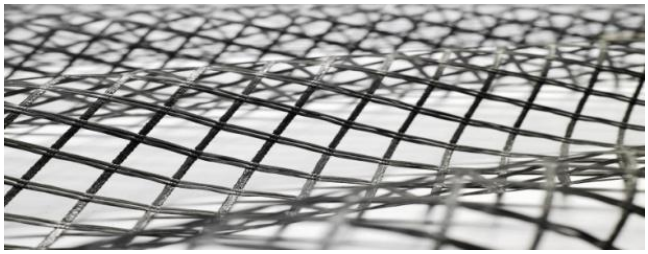
2. RESEARCH METHODOLOGY:

1. Selection of site
2. Collection of materials
3. set of samples
4. testing
5. Analysis of test results

SELECTION OF SITE:

- According to Site details we are collected the soil sample at Rajuplalem- Iskapalli road at tapathopu.
- The depth of collected soil sample at 1.5m.The quantity of collected soil sample is 15kgs.
- The reason behind the collected soil sample at particular road was the road shrinking beacause of low soil strength and also heavy vehicals passing on the road.
- In future the road was complusary damaged ,so in that area we have been tested the soil sample and providing geosynthetics(Geogrids).

Geogrid:



Tencate Miragrid XT geogrid with polymer coating has been purchased at Nellore, at muttukoor gate flyover construction.Following were the properties of geogrid.

Property	**value**
Thickness	10mm-13mm
Colour	Black
Hole shape	Square
Material	Polymer coating,Biaxial geogrid

Properties of Geogrid:

- **High tensile strength**: Geogrids are designed to resist tensile forces, meaning they can withstand pulling or stretching without breaking or deforming. This property is particularly important for reinforcing soil or stabilizing slopes.
- **Durability:** Geogrids are made from materials that are resistant to weathering, chemical exposure, and biological degradation. This property ensures that the geogrids will maintain their strength and performance over time, even in harsh environmental conditions.
- **High modulus:** Geogrids have a high modulus of elasticity, which means they can resist deformation even under heavy loads or stresses. This property is particularly important for reinforcing pavements or other structures that will be subject to frequent use.
- **Low elongation:** Geogrids have a low elongation or stretch under load, which means they can provide stable support and reduce the likelihood of differential settlement or uneven settling of soil or pavement.
- **Flexibility:** Geogrids are flexible and can be easily installed in a variety of soil and pavement conditions, making them versatile for different engineering applications.
- **Resistance to creep:** Geogrids are designed to resist creep or deformation over time, which ensures their long-term performance and stability.
- **Lightweight:** Geogrids are lightweight, which makes them easy to transport and install, reducing labor and transportation costs.
- **Increased safety:** Geogrids can help to prevent potholes and other types of pavement damage that can create hazardous driving conditions. This can help to increase safety for drivers and pedestrians alike.

3. TESTING OF MATERIALS:

After collection the materials,I have done testing of all materials Individually at SVCN college of Engineering, Northrajupalem, kodavalur mandal, Nellore d.t. The various tests are:

- Grain Size Distrubution
- Atterberg Limits
- Standard procter compaction Test
- California Bearing Ratio Test with soil and with soil+Geogrid

4. RESULTS AND DISCUSSION:

4.1 GRAIN SIZE DISTRIBUTION:

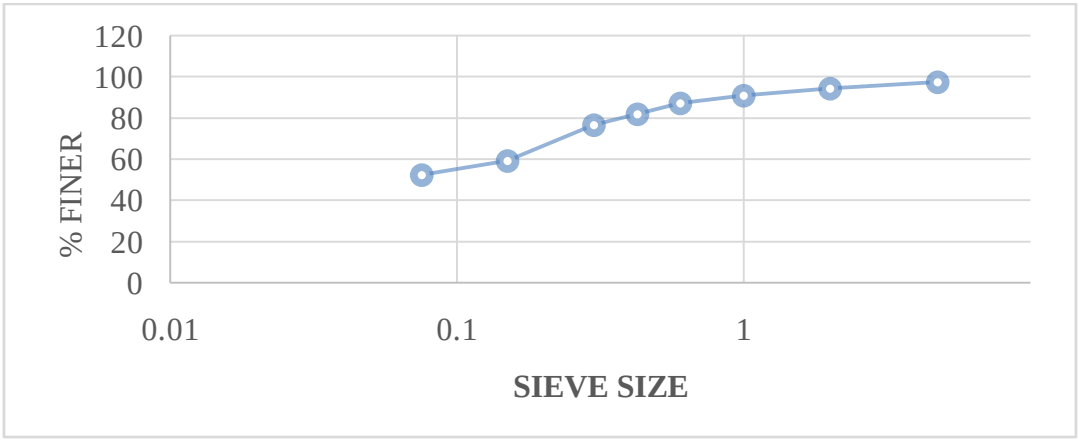
Sample weight: 2 kgs

SIEVE NO	WT.RETAINED (gm)	% RETAINED	CUMMULATIVE RETAINED	% FINER (100-N)
4.75mm	40gm	2.42	2.42	97.58
2.00mm	51gm	3.09	5.51	94.49
1.00mm	57gm	3.45	8.96	91.04
600	62gm	3.75	12.71	87.29
425	87gm	5.27	17.98	82.0

300	90gm	5.45	23.43	76.57
150	287gm	17.39	40.82	59.18
75	110gm	6.66	47.48	52.52
pan	784gm	60.5	100	0

Table-1 Grain Size Distribution Data Percentge(Size less than 75μ)<5%

GRAPH:



As per IS:1498 the soil is FINE GRADED SOIL(MH or OH).

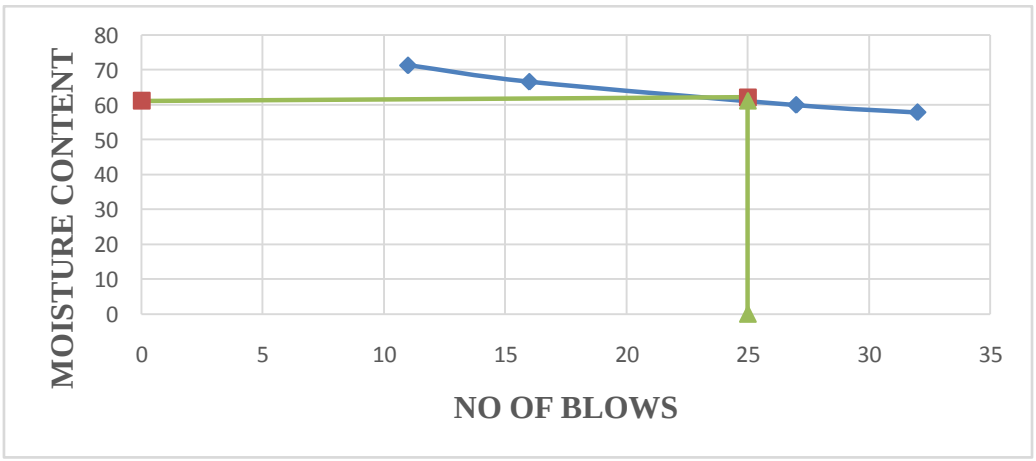
4.2ATTERBERG LIMITS

1.LIQUID LIMIT:

SI.NO	AMOUNT OF WATER ADDED IN (%)	MOISTURE CONTENT(%)	NO.OF BLOWS
1	35%	57.89%	32
2	38%	60%	27
3	40%	66.67%	16
4	41%	71.42%	11

Table-2 Liquid limit data of soil sample.

GRAPH:



Liquid limit WL=61

2.PLASTIC LIMIT:

SI.NO	DESCRIPTION	1	2
1	Container Number	1	2
2	Weight of Container	32gm	34gm
3	Weight of Container+Wet soil	42gm	41gm
4	Weight of Container+Dry soil	41gm	40gm
5	Moisture Content(%)	11.11%	16.67%
6	Average plastic limit Wp	13.89%	

Table-3 Plastic limit Data of Soil Sample.

Plasticity index Ip: Liquid limit - Plastic Limit =47.11
Ip>17.,**High plastity soil**

3.SWELL INDEX:

Before swell water (Vw) =15

Before swell kerosene (Vk) =15

After swell water (Vw) =17

After swell Kerosene (Vk) =13

Total swell index (%) =Vw-Vk/Vk*100

=17-13/13*100=30.76%.

4.3 STANDARD PROCTOR COMPACTION TEST:

Weight of Mould= 5.543 Volume of Mould= 2255

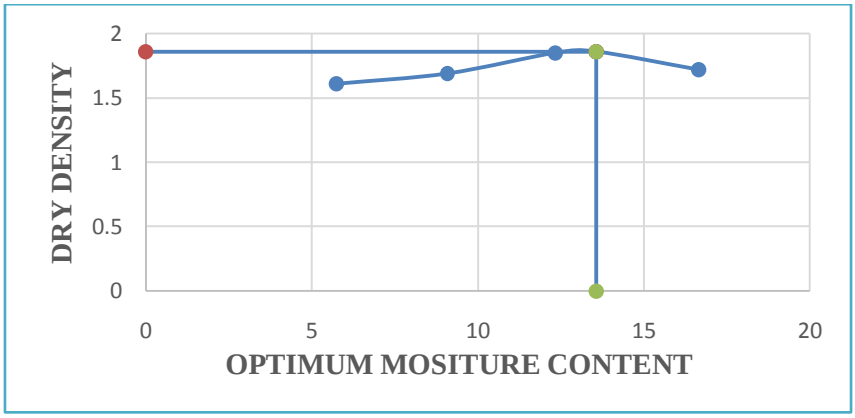
SI.NO	1	2	3	4	5
WT.OF COMPACTED SOIL+MOULD	9.404kg	9.708kg	10.236kg	10.318kg	10.062kg
AMOUNT OF WATER ADDED(%)	3%	6%	9%	12%	15%
EMPTY CONTAINER(W1)	17gms	23gms	23gms	21gms	20gms
EMPTY CONTAINER+WET SOIL(W2)	104gms	100gms	104gms	102gms	104gms
EMPTY CONTAINER+DRY SOIL(W3)	99gms	93gms	94gms	91gms	90gms
MOISTURE CONTENT (%)	5.74	9.09	12.34	13.58	16.67

BULK DENSITY(Kg/m3)	1.71	1.85	2.08	2.12	2.008
DRY DENSITY(Kg/m3)	1.61	1.69	1.85	1.86	1.72

Table-4 Standard Proctor Compaction Test Values

Where bulk density = $\frac{\text{Weight of wet soil}}{\text{Volume of Mould}}$, dry density= $\frac{\text{Bulk density}}{1+\text{Water content}}$

GRAPH:



From Graph:

OMC=14 **, MDD**=1.86

4.4.CALIFORNIA BEARING RATIO TEST

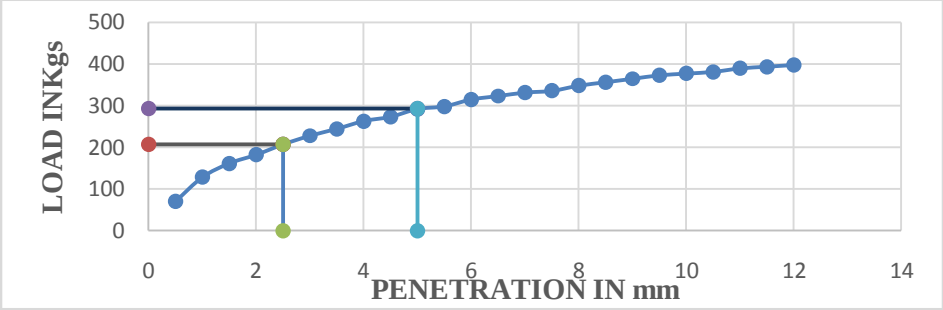
1. WITHOUT GEOGRID:

S.NO	STRAIN GAUGE READING	STARIN (mm)	PROVING RING READING	LOAD IN Kgs
1	50	0.5	3.4	70.48
2	100	1	6.2	128.52
3	150	1.5	7.8	161.69
4	200	2.0	8.8	182.42
5	250	2.5	10	207.30
6	300	3.0	11	228.03
7	350	3.5	11.8	244.61
8	400	4.0	12.7	263.27
9	450	4.5	13.2	273.63
10	500	5.0	14.1	292.29
11	550	5.5	14.4	298.51
12	600	6	15.2	315.09
13	650	6.5	15.6	323.38
14	700	7	16	331.68
15	750	7.5	16.2	335.82
16	800	8	16.8	348.26

17	850	8.5	17.2	356.55
18	900	9	17.6	364.84
19	950	9.5	18	373.14
20	1000	10.0	18.2	377.48
21	1050	10.5	18.4	381.43
22	1100	11.0	18.8	389.72
23	1150	11.5	19	393.87
24	1200	12.0	19.2	398.01
25	1250	12.5	19.4	402.16

Table-5 CBR Test Data Without Geogrid.

GRAPH: Without Geogrid:



CBR @ 2.5mm penetration : 15.13 **CBR @ 5.0mm penetration :14.22**

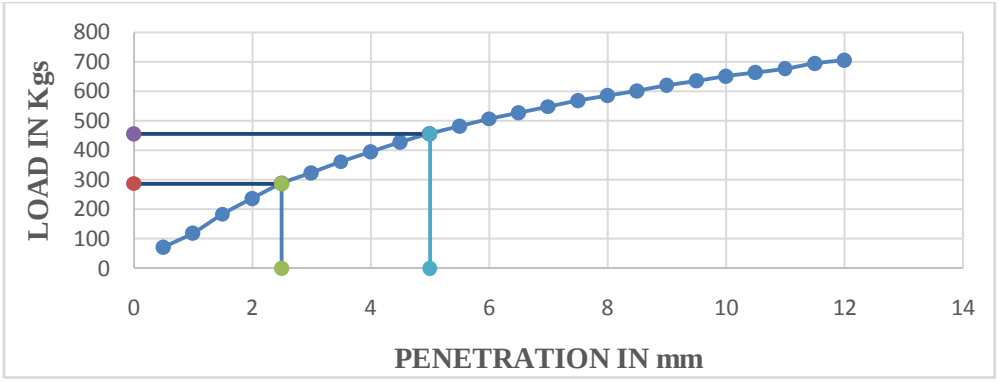
2.WITH GEOGRID:

S.NO	STRAIN GAUGE READING	STARIN (mm)	PROVING RING READING	LOAD IN Kgs
1	50	0.5	3.4	70.48
2	100	1	5.7	118.16
3	150	1.5	8.8	182.42
4	200	2.0	11.4	236.32
5	250	2.5	13.8	286.07
6	300	3.0	15.6	323.38
7	350	3.5	17.4	360.70
8	400	4.0	19	393.87
9	450	4.5	20.6	427.03
10	500	5.0	22	456.06
11	550	5.5	23.2	480.93
12	600	6	24.4	505.81
13	650	6.5	25.4	526.54
14	700	7	26.4	547.27
15	750	7.5	27.4	568.02
16	800	8	28.2	584.58
17	850	8.5	29	601.17
18	900	9	29.9	619.82
19	950	9.5	30.6	634.33
20	1000	10.0	31.4	650.92
21	1050	10.5	32	663.36

22	1100	11.0	32.6	675.79
23	1150	11.5	33.5	694.45
24	1200	12.0	34	704.82
25	1250	12.5	34.5	715.18

Table-6 CBR Test Data With Geogrid

GRAPH: With Geogrid



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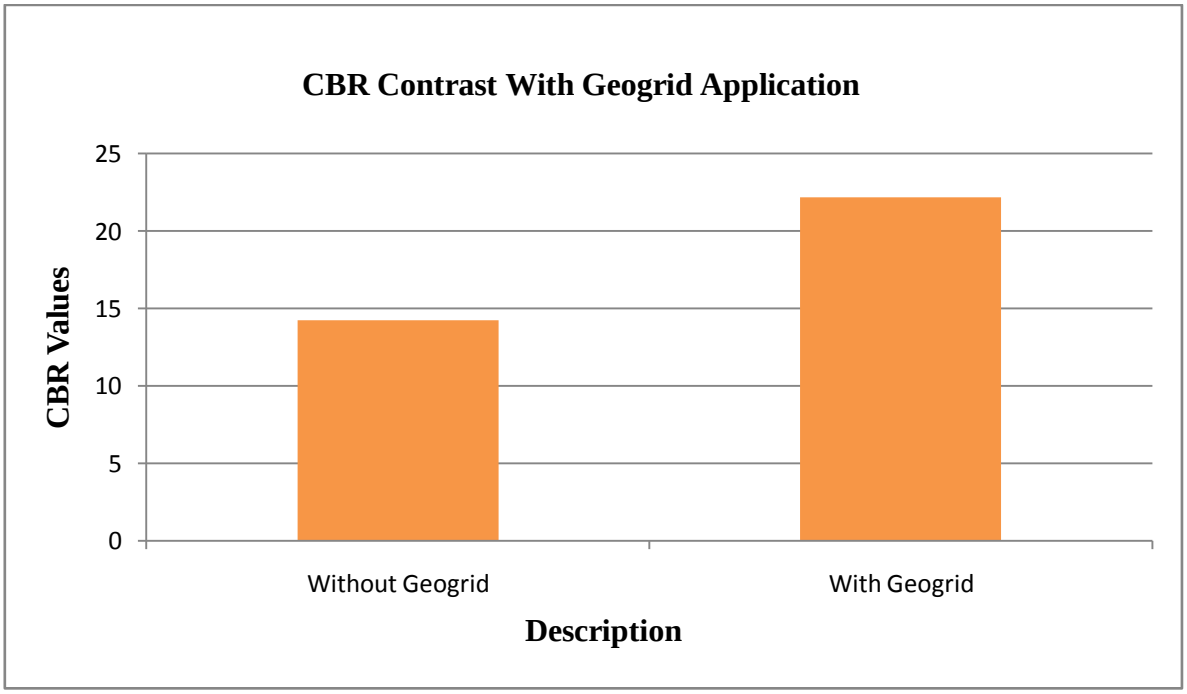
CBR @ 2.5mm penetration :20.88 **CBR @ 5.0mm penetration :22.19**

Description	CBR Value
Without Geogrid	14.22
With Geogrid	22.19

Table-7 CBR value Variation With Geogrid Application in Soil Sample

GRAPH:



5. DESIGN OF FLEXIBLE PAVEMENT:

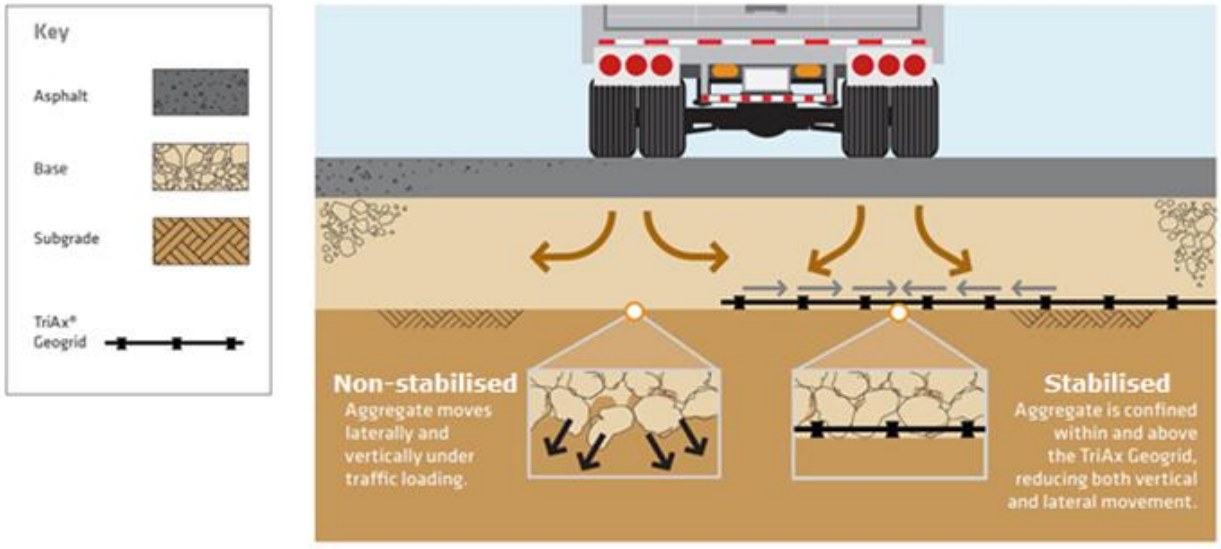


Fig-with and without geogrid pavement

6. CONCLUSION:

As we found performance of with soil and with soil+Geogrid by conducting laboratory test and the results are included as

Moisture content of soil is 14% and the dry density of soil is 1.86.

CBR Value for without Geogrid of soil is 14.22%

CBR Value withsoil+Geogrid is 22.19.

So,when compare to without geogrid of soil,with geogrid value is high,So here the strength will be Increases.

The positive effects of geogrid reinforced subgrade courses can economically and ecologically be utilized to reduce aggregate thickness. And it can also increase the life of the pavement and can also decrease the overall cost of the pavement construction with an increased lifetime. Reinforced Flexible pavements provide smooth, safe surfaces and minimize fuel consumption. These pavements are earth-quake resistance structures.

7. FUTURE SCOPE:

From above discussion, it can be said that geogrids may serve better even on soaked conditions too. It can be applicable for plain, rolling, hilly and steep roads also. For any industrial region where the traffic is high, it is suggested to place more than a single layer of geogrid**.**

Overall, the future of geogrids is expected to be very promising, as they offer many benefits in terms of durability, sustainability, and environmental protection. As new applications and technologies are developed, the use of geogrids is likely to become even more widespread in the years to come.

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