Application of Geosynthentic Material in Construction of Flexible Road Pavement

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Abstract – Geosynthetics have been successfully used for decades in the construction of roads. They fulfil almost all classical function like separation, protection, filtration, Drainage, sealing, and reinforcement. In recent time the scope of application has been extended significantly by the construction of road pavement. Field evidences indicate that geosynthetic reinforcements can improve pavement performance by avoiding cracking, rutting, patholes & by reducing deflection of road surface.

Keywords : Geosynthetic, Road Construction, Separation, Filtration, Reinforcement.

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1) INTRODUCTION

What Are Geosynthetics?

A planar, polymeric (synthetic or natural) material used in contact with soil/rock and/or any other geotechnical material, for Filtration, Drainage, Separation, Reinforcement, Protection, Sealing and Packing.

Geosynthetics have proven to be among the most flexible, functional and cost-effective ground customization, adjustment materials. Their use has expanded rapidly into {practically} every area of municipal city geotechnical, environmental, coastal, and hydraulic engineering.

Geosynthetics are an established family of geomaterials used in a wide variety of civil engineering applications. A large number of polymers (plastics) common to everyday life are found in geosynthetics. The various types of geosynthetics available.

Types of geosynthetic materials:-

1) Geogrids – Geogrids are single or multi-layer materials usually made from extruding and stretching high-density polyethylene or polypropylene or by weaving or knitting and coating high tenacity polyester material polyester-made,fabric-made yarns. The resulting main grid structure possesses large opportunities, spaces, availabilities that improve interaction with the ground soil or aggregate. The high ultimate tensile strength| and stiffness of geogrids make them especially effective as soil and aggregate reinforcement.

2) Geonets – Geonets are constructed with| created from constructed of stacked, criss-crossing polymer hair strands that provide in-plane draining.

3) Geo membranes - Geo membranes are comparatively rubberized sheets of plastic. There are two general classes of geo membranes: shiny and extruded.

4) Geofoam – A newer category of geo synthetic product is geofoam, which is the generic name for any foam material utilized for geotechnical applications. Geofoam is manufactured into large blocks which are stacked to form a light weight. The most common type of polymer used in manufacturing of geofoam materials is polystyrene.

5) Geo pipe - Another significant product which has been "adopted" as a geo synthetic is plastic pipe. The specific polymer resins used in the manufacturing of plastic pipes are: high density polyethylene (HDPE), polyvinyl chloride (PVC), polypropylene (PP), polybutylene (PB), acrylonitrile butadiene styrene (ABS).

GEOSYNTHETIC ADVANTAGES: -

Geosynthetics including geotextile, geomembranes, geonet,geocomposites and geosynthetic clay liners, often used in combination with conventional materials, offer the following advantages over traditional materials:

1. Space Savings
2. Material Quality Control
3. Construction Quality Control
4. Cost Savings
5. Technical Superior
6. Construction Timing
7. Material Deployment
8. Material Availability
9. Environmental Sensitivity

Functions of Geosynthetics :-

1. Separation - A Geosynthetic placed at the interface between two dissimilar geotechnical materials functions as a Separator when it prevents these materials from mixing under the action of applied loads
2. Drainage
3. Filtration
4. Reinforcement
5. Moisture Barrier

2) LITERATURE REVIEW:-

(i) Surajo Abubakar Wada Int (Feb. 2016)**"Journal of Engineering Research and Applications"** (Bituminous Pavement Failures) :-

Pavement deterioration is a serious problem for road and traffic sector in almost every country, the most affecting causes of bituminous pavement failures have been studied in this paper. The paper describes the lessons learnt from pavement failures and problems experienced. Failures of bituminous pavements are caused due to many reasons or combination of reasons. Application of correction in the existing surface will enhance the life of maintenance works as well as that of strengthening layer. Along with the maintenance techniques there are various methods for pavement preservation which will help in enhancing the life of pavement and delaying of its failure.This paper discusses the possible causes of pavement failures, and recommendbetter ways to minimize and hopefully eliminate the causes of failures in bituminous pavements

(ii) Jorge G. Zornberg (Sept. 2011),"**Advances in the use of Geosynthetics in Pavement Design"**:-

Discipline evidences indicate that geosynthetic reinforcements can improve sidewalk tarmac performance. Yet, the specific conditions or mechanisms that permit and govern the reinforcement function are, at best, unclear as they have remained largely unmeasured. Significant research has just lately been conducted with the objectives of:

(iii) Deciding the governing mechanisms and relevant properties of geosynthetics that contribute to the {increased} performance of sidewalk systems,

(iv) Developing appropriate analytical, laboratory and field methods capable of quantifying the above properties for geosynthetics, and

(v) Allowing the prediction of sidewalk| performance {depending on various types of geosynthetics used.

(vi) K. Rajesh Kumar,N.Mahendran,R. Gobinath (March 2010), "**Experimental Studies on viability of Using Geosynthetics on fibre in Concrete" :-**

It really is| evident from literature review that in the recent decades the thrust for locating an alternative to the costly steel encouragement is increasing, several alternatives have be end examined across the globe. Several viable alternatives are found, also many techniques of replacing the steel and addition of tensile durability to concrete is researched. The methods which are found to be cost effective and possible are also tried in construction in various areas. Once such alternative approach is providing subsidiary support in the way of addition of natural or artificial fibers to the concrete. Several fibers are also tried with |concrete floorsome turned out to be successful in adding strength and durabiliity to the concrete but still many fibers are in research stage only. Copious materials were introduced as additional materials concrete such as polypropylene, glass fibers, FRP, coir etc. This kind of paper describes anmake an effort made to incorporate geosynthetics, a material can be employed recognized soil as fibers in concrete. Geosynthetics are being used widely soil reinforcement, separators, drainage, filters and also used across the earth in various infrastructure assignmentsThis kind of paper details the look made to look into the stability of using geosynthetics as fibers in concrete.

(vii) H.Brandl& D. Adam(9th sept. 2014), "**Application of Geo synthetics in the construction of roads & railways" :-**

Geosynthetics have been successfully used for decades in the construction of roads and railways. They fulfil the all classical functions like separation, protection, filtration, draining, sealing and reinforcement. In recent time scope of application has been expanded significantly by construction of steep slope and geogrid reinforced bridge abutments, the crossing of areas with soft soil by using geosynthetics in case of sand columns and the brideing of areas succeptable to sink holes. Especially for the last circumstance geo synthetics to additional features have been developed allowing a pavement monitoring of the deformations

(viii) Lou Tasa (Dec 2011), "**Using Geo synthetics to improve road performance" :-**

To boost performance, roads are sometimes reinforced with geosynthetic plastic materials, including geogrids and geotextiles. Geogrids consist of polymers formed into relatively rigid.

3) PROBLEM STATEMENT

INFLUENCING PARAMETERS ON PAVEMENT PERFORMANCE:

The factors usually considered are as follows:-

- Traffic Loads,
- Subgrade Soil
- Climatic Factors
- Pavement Component Materials
- Drainage and Environmental Factors

GENERAL CONCEPT OF PAVEMENT DETERIORATION:

Bituminous pavement deterioration generally will take place due to put together action of traffic, weather changes, drainage, environmental factors and so forth Versatile pavements generally deteriorate at a very rapid rate when compared to tight} pavements because of above factors, however, flexible pavements continue to deteriorate at a slow rate even without the traffic movement on the top| due to the climate and environmental factors (Khanna, Justo and Veeraragavan, 2014).

TYPES OF BITUMINOUS PAVEMENT DETERIORATION

The common types of distresses in bituminous pavement are classified in to the following four major groups:-

SURFACE DEFORMATION:

Rutting:

This is actually the longitudinal deformation or depressive disorder of the pavement surface along the wheel way of heavy vehicles shaped due to repeated applications of heavy load along the same wheel route resulting in cumulative non-recoverable or pavement deformation of the pavement layers including subgrade and one or more of the sidewalk layers.

CRACKING:-

The common types of cracks include the following;

(a) Fatigue cracking

(b) Transverse cracking

(c) Longitudinal cracking

(d) Edge cracking

(e) Reflective cracking

DISINTEGRATION :-

The progressive breaking up of the pavement into small, loose pieces is called disintegration. The two most common types of disintegration are:

(a) Potholes:-

Patholes are small, bowl-shaped depressions in the pavement surface that penetrate all the way through the combine| asphalt layer down to the base course. causes: Generally, potholes are the finish result of fatigue damage. As fatigue cracking becomes severe, the interconnected fractures creates small chunks of pavement which may be dislodged as vehicles pass over them.

b) Patches**:-**

A place of pavement that has been replace by new materials to repair present pavement. A patch is recognized as a defect no subject how well they perform because it never completely meshes with the existing pavement neither is it structurally bound to it. The causes include the previous localized pavement destruction that has been removed and patched, and also the utility cuts along the pavement.

4) CORE PROBLEMS & CAUSES

A) Cracking in pavement:-

Cracks in highway emanate from either

1) The surface where traffic induced fatigue, thermal movement and warping stress will initiate cracking.

2) The subbase, where seasonal expansion and contraction of pavement causes reflecting cracking

B) Rutting:-

1) Inadequate stability of the subgrade or sub-base or base course or surface course or few of these pavement layers.

2) Inadequate compaction of the subgrade or any of the pavement layers

3) Channelized movement of heavy wheel a lot creating significant vertical stress on the subgrade

4) Improper design and specification of bitumen mix Inadequate thickness of the pavement or weakened pavement structure

C) Patholes:-

Generally, potholes are the end result of fatigue damage. As fatigue cracking becomes severe, the interconnected breaks creates small chunks of pavement which is often dislodged as vehicles get past them. The remaining hole following your pavement chunk is dislodged is called a pothole. Repair by excavating and rebuilding. Area repairs or reconstruction may be required for intensive potholes.

5) TESTS ON BITUMEN AND SOIL

1) Moisture content test on soil by oven dried method.IS2720:1983 PART 1

2) Specific gravity test on soil by using pycnometer.IS 2720 PART 3:1980

3) Marshal stability test on bituminous material.IS ASTM-D6927

4) Deflection measurement of flexible road pavement by using Benkelman beam.

1) Moisture content test on soil by oven dried method. IS2720:1983 PART 1

Observations Table :-

Sr. No	DETERM-INATION	SAMPLE1	SAMPLE2	SAMPLE3
1	Container no.	1	2	3
2	Mass of container with lid w1 (gm)	0.059	0.067	0.589
3	Mass of container with lid + wet soil w2 (gm)	259	450	258
4	Mass of container with lid + dry soil w3 (gm)	220	363	216
5	Mass of water (Ww= w2 – w3)	39	87	42
6	Mass of dry soil (Wd = w3 –w1)	161	362.93	158
7	Moisture content %	24.37%	23.94%	26.58%

Sample Calculations : –

Moisture content on soil,

=[(W2 - W3) / (W3 – W1)]*100

=[(259 -220) / (220 – 0.059)]*100

=24.37%

Result –

The water content present in this wet soil is 23.97%

2) Specific gravity test on soil by using pycnometer- IS 2720 PART 3:1980

Observation Table:-

Sr. No	Determination No.	Sample1	Sample2	Sample3
1	Pycno. No.	1 kg	2 kg	3 kg
2	Mass of pycno. W1	0.542 kg	0.649	0.755
3	Mass of pycno. +dry soil W2	0.929	0.977	0.893
4	Mass of pycno. +dry soil+ water(w3)	1.314	1.693	1.496
5	Mass of pycno. + water	1.451	1.518	1.543
6	Specific gravity	1.856	2.241	1.27

Sample Calculations –

Specific gravity of soil,

= (M2 - M1) / [(M2 - M1) – (M3 - M4)]

= (0.929 -0.542) / [(0.929–0.542) – (1.314 – 1.451)]

=1.856

Result :-

The specific gravity of soil sample is 1.856 gm/cc

3) Marshal stability test on bituminous material-IS ASTM-D6927

Collection of fine aggregate less than 16mm

Sieve sizes	Wt. of sample (gm)
12 mm	504
10 mm	96
4.75 mm	96
2.36mm	480
pan	24

Observation table: -

Sr. no	% of bitumen content		Stability (kg)	Marshal flow value	remark
	By wt. w.r.t agg.	By wt. w.r.t mix			
1	4.17	4	1048.56	2.5	Designed optimum bitumen content and conformity test results arrived from marshal test.
2	4.71	4.5	1092.25	3.2	
3	5.26	5	1105	3.52	

Result :- marshal flow value is 2.5, 3.2, 3.52 obtained w. r. t % of bitumen content.

4) Deflection measurement of flexible road pavement by using Benkelman beam:-

Benkelman beam deflection apparatus.

Obsrevation Table :-

Regular road Deflection Reading :-

Sr. No	Chaina-ge	Wh-eel Pat-h	Dial guage reading			Maximum Deflection	True Pavement Deflection (Xt)	Remark
			600mm	2.7m	4m			
1	2.15	OWP (S)	3.1	0.2	1.5	5.8	3.0	Rutting & Cracking
2	2.16	IWP (I)	3.0	0.5	1.8	5.3		
3	2.17	OWP (F)	3.5	0.7	2.0	6.2		

Sample calculation :-

(S – I) & (S-F)

= (3.5 – 0.7) & (3.5 – 2.0)

= 2.8 mm& 1.5 mm

Xt = 2 (S - F)

= 2 (3.5 – 2.0)

= 3.0 mm

Geosynthetic road Deflection Reading :-

Sr. no.	Chainage	Wheel Path	Dial Guage Reading			Maximum deflection	True Pavement Deflection (Xt)	Remark
			600 mm	2.7m	4 m			
1	2.15	OWP (S)	2.9	0.2	1.0	4.1	2.6	Less rutting & avoide cracking.
2	2.16	IWP (I)	2.7	0.3	1.2	4.2		
3	2.17	OWP (F)	2.8	0.5	1.5	4.8		

Sample calculations: -

1) (S – I) & (S-F)

(2.8 – 0.5) & (2.8 – 1.5)

= 2.3 mm& 1.3mm

Xt = 2 (S-F)

= 2 (2.8– 1.5)

= 2.6 mm

Result :-

1) By using the geogrid material true pavement deflection is 2.6 mm

2) True pavement deflectionin ordinary roadpavementis 3.0 mm

6) CONCLUSION:-

According to envoirmental condition, traffic condition and geotechnical condition of ground srata, we usedgeogrid material in flexible road pavement for the purpose of reducing deflection of road surface.

The most significant effect of geogrid material insert in road pavement to avoid the rutting & cracking, patholes occurring on road surface due to traffic and envoirmental condition.

Due to use of geogrid material in flexible road pavement, improves strength as well as life span of road pavement.

By using the geogrid material in ordinaryroad,true pavement deflection is 3mm& in ordinary road true pavement deflection is 2.6mm. The difference between two pavement deflection is 0.4 mm

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