International Journal of Scientific Research & Engineering Trends
Volume 6, Issue 2, Mar-Apr-2020, ISSN (Online): 2395-566X

A Review on Efficiency of Geo Grid in Road Pavement Construction

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***Abstract* –Geosynthetics have grown in the civil industry in the past twenty years becoming key materials in the design of new roads and in maintenance programed. Geosynthetics are now widely used for strengthening of in situ soil, mechanical improvement of pavement layers from the subbase up to the asphalt wearing course using different type of geosynthetics, from geotextile to geogrids and geocomposite. Management of stormwater can be achieved using geocomposite for drainage instead of traditional gravel drainage. The paper will discuss the geosynthetic functions in pavements and their use in a pavement structure, highlighting advantages and disadvantages gained from literature and experience.**

***Keywords* – Geo Grid , Geosynthetics , Soil reinforcement**.

I. INTRODUCTION

Transportation contributes to the all-round development of a country and hence plays a vital role towards its progress. The present scenario in India demands maximum transit facilities to be developed at a low cost within shortest feasible time. India being predominantly rural in nature, road links are found to have distinct advantage over other modes of communication. However economy, time, environmental constraints and several other factors make a highway professional's job more challenging in delivering a safe and cost effective road network to its users. One of the major problems faced by the engineers in highway construction, in plains and coastal areas of India is the presence of soft/loose soil at ground level. This strata of being considerable depth cannot be removed by excavation, thus leaving no choice to build road over them. This condition may be further worsened if supplemented with poor drainage or lack of it. Assam being situated in a region of high rainfall area suffers from poor drainage as well as weak subgrade condition.

II. GEOSYNTHETICS: - HISTORICAL DEVELOPMENT

Geosynthetics is the collective term applied to thin, flexible, sheets of material incorporated in or above soil to enhance its engineering performance. It comprises a variety of products largely grouped under geotextiles, geogrids, geomembranes and geo composites. Applications of Geosynthetics fall mainly within the discipline of civil engineering and the design of these applications, due to the use of geosynthetics with soils, is closely associated with geotechnical engineering.

The earliest of civilizations used natural materials to improve soil behaviour. For instance, in the zigguraut s of Babylonia, woven mats of reeds were used and in the construction of the Great Wall of China, tree branches along with leaves were placed. In India, it is common to see dry branches and leaves of trees being used to reinforce soft soil (or softened shoulder on the roadside) on which heavy laden trucks get bogged down during monsoon. In the vast waterfront areas of Kerala, it has been an age old custom to spread coconut leaves on the ground before gravel/aggregate is laid over a road formation. Nature itself exercises control on erosion through vegetation (more specifically by the fine well spread roots which while supporting the plant upright, also hold the soil together). Walking on bundles of trees has enabled man to cover even marshy lands. Such examples are plenty. In British India, a certain Col. Powell, while constructing retaining walls found that the thickness of the wall could be reduced by incorporating construction waste like bamboos, canvas, etc. into the backfill. Textile material was perhaps first used in road construction in South Carolina in the early 1930's. One of the first mills to produce jute geotextile, popularly known as Soil Saver was established in Calcutta in the early forties. In the Ludlow Jute Mills a separate line was then established to manufacture this industrial by-product (as it was made from jute caddies, meaning waste jute). It was and even now is an export oriented product.

III. GEOSYNTHETICS FOR GROUND IMPROVEMENT

Long ago, when difficult sites for construction purposes were to be dealt, the conventional practice was limited to either the replacement of unsuitable soils or adopting suitable foundation which sometimes increases the cost of foundations. Innovative soil modification approaches are evolved to solve soil related problems. One among them is the usage of geo-synthetics. When used to enhance the soil strength they have following advantages.

- They are space savings,
- Better material quality control,
- Better construction quality control,
- Cost savings,
- Technical superiority,
- Construction time saving,
- Material deployment,
- Material availability,
- Environmental sensitivity.

IV. FUNCTIONS AND APPLICATIONS OF GEOSYNTHETIC

Geosynthetics serve the following principal functions:

1. Separation - in which a geosynthetic placed between two dissimilar geotechnical materials, prevents intermixing.
2. Filtration - in which a geotextile allows passage of fluids from a soil while simultaneously preventing the uncontrolled passage of soil particles.
3. Drainage - in which a geosynthetic may collect and transport fluids in its own plane.
4. Reinforcement - in which by virtue of the tensile characteristics, a geosynthetic resists stresses and contains deformations in geotechnical structures.
5. Barrier - in which a geosynthetic acts as a barrier to liquid/gas. In addition, geotextiles serves the following functions:
6. Protection or cushioning - in which a geotextile serves as a localized stress reduction layer to prevent or reduce damage to a given surface or layer.
7. Surficial erosion control - in which a geotextile may prevent the surface erosion of soil particles due to surface water run-off and/or wind forces.

V. LITERATURE REVIEW

Soil is used as construction material for various civil engineering structures. Engineers and scientist have been continuously endeavoring to improve its engineering properties and performances to exploit the advantage of its low cost and availability all over the globe. This has lead to the development of a number of ground improvement techniques broadly classified as (Naresh et al)

- Ground improvement by treatment of soil'
- Ground improvement by soil reinforcement

Treatment of soil includes soil stabilization by compaction or by addition of admixtures and even by pre consolidation. The technique of insertion of metallic strips (Venkataratnam et al,1986) or synthetic reinforcement (Datye,1981) into soil to improve its strength is referred to as "Reinforced soil" . The technique of soil reinforcement has been in use since ancient times though in a crude form, until recently. Vidal (1968) developed this concept on a rational basis. Consequently several model studies were initiated by various researchers, Bannerjee (1973), Lee et al (1973), Kennedy et al (1980), Hoshiyam & Mandal (1985), Sridharan (1986), Raghavendra (1996). Soil reinforcement by using geosynthetic are being extensively used in road and airport flexible pavement and in overlays. The behavior of road surface depends on the strength of the fill material and the subgrade below it. Pavement design deals with the techniques of determining thickness and laying configuration for the chosen pavement materials. Geosynthetics are used in road construction work for improving the performance of pavement and under some compelling situations where construction of road work demands over very soft subgrade. Over the last two decades, the use of geosynthetics has recorded a tremendous increase in civil engineering < constructions. This was a result continuous research in laboratory and field all over the globe about the use of geosynthetic in road construction application. The available literature on geosynthetic is very wide and general in nature. An attempt has been made to discuss certain topics which have a direct relevance on the present investigation.

Talwar (1981) reported the attempt made to evaluate the shear parameters on poorly graded fine sand reinforced with geosynthetics. The lateral confining pressures had been varied over a moderately large range to induce failures of both the types. Based on the study he concluded that triaxial samples of sand reinforced with rings of aluminium foil and discs of aluminium sheet, behave like brittle material in rupture plane. The axial strains at failure increases as the strength of reinforcement increases. Horizontal reinforcement in the sample in turn is responsible for the enhanced friction angle in slippage or apparent cohesion in repute, which involves the increase in strength.

Mehndiratta et al (1981) conducted some laboratory studies on flexible pavement reinforced with geogrid to see the effect of geogrids on load carrying capacity of flexible pavements when used at different levels. Laboratory tests such as triaxial tests and shear tests were conducted on aggregate with their maximum size limited to 25 mm by placing the geogrid at different heights. The laboratory test results indicated that intrinsic friction developed, increased in case of reinforced composite structure of flexible pavement and the angle of internal friction decreased with the increase in normal stress. The strength of subgrade was observed to increase with confining pressure when geogrid was placed at two third heights from bottom in case of triaxial tests. In another test setup, semi field pavement model sections using WBM layer with and without bituminous surfacing were laid. Geogrid-CE 121 was placed at interfaces of two layers. Plate load tests were conducted on these pavements using 30 cm diameter plate and pressure distribution over the subgrade was observed by placing pressure cells at subgrade level. Comparative evaluation of two types of pavements reinforced and unreinforced indicated that pavement reinforced with geogrid CE121 could carry more loads and for the same load intensity the settlement reduced by fifty percent.

Giroud and Noirway (1982) after an extensive study developed design chart of unpaved pavement for using geosynthetic at the interface of base layer and subgrade soil. Design chart given by him shows that for the same traffic and allowable rut depth the use of geogrid allows a reduction in base layer thickness.

Gray et al. (1986) reported a series of triaxial tests on sand reinforced with fabric layer and stress-strain responses were studied. The results indicated an improvement in strength due to reinforcement, increased axial strain at failure and reduction of post peak loss in strength.

Rao et. al (1987) reported the results of triaxial tests conducted on a fine uniform Yamuna and reinforced with two types of Indian made woven geotextiles. Based on their investigation it was concluded that

1. The effect of placement of reinforcement is maximum at a confining pressure of 100 KN/m2.
2. At higher confining pressures, the increase in deviator stress decreases : increase in deviator stress depends on tensile strength of reinforcements.
3. Deviator stress is increased by 15% when two discs of reinforcement were used.
4. Use of two discs are effective. At low confining pressures, reinforced sand registered an increase in the strength compared to unreinforced sand. At high confining pressures, Ø decreases and ‘increases.

Natarajan et .al. (1987) reported the study on a series of triaxial compression tests and unconfmed compression tests on samples of clay reinforced with geotextile discs at various spacings in the soil specimens. Three types of geotextile have been used in the investigations. Results of the study indicated the improvement in strength of soft clays due to presence of geotextiles. Improvement in strength depends on surface roughness of geotextiles, higher the roughness, higher the strength.

Subbarao et.al. (1987) investigated Ennore sand reinforced with indigenous polypropylene strips and subject to triaxial loading. They identified mainly three types of failures. The study indicated that the inclusion of reinforcement of polypropylene, forms a new composite material characterized by increased friction angle or cohesion or both.

Ramaswamy and Aziz (1989) did experimental investigation on the behaviour of jute reinforced subgrade soil under dynamic load. The equipment used for the dynamic load test consisted basically of a steel drum of 0.6 m diameter and 1.2 m high mounted on loading frame. A hydraulic jack having a capacity of 2 tonnes (20KN) provided the necessary loading force. The jacks were connected to a dynamic simulator. The dynamic load applied was 8KN, the simulated contact pressure being 255 KN/ m2 and upto 1000 applications were made. The subgrade material used was clay having a natural moisture content of 40%.

The clay was consolidated first for one month under 9 KN/m overburden pressure. Two sets of tests were conducted using two different thickness of aggregate. The result of the dynamic load tests indicated that without the use of jute fabric, the rut depth can be as high as 22 mm for a 100 mm thick layer of compacted aggregate. When the thickness of aggregate was doubled (200 mm) , the rut depth was found to be 18 mm under the same loading intensity. But with the use of jute fabric, the rut depth for 100 mm and 200 mm thick aggregate layers were decreased to 10 mm and 7 mm respectively. In both the cases, there were more than 50% reductions in rut depth with the use of jute fabric.

Ghosal and Som (1989) described the successful use of a spun bonded geotextile (170g/m2) in the construction of an offshore fabrication yard at a site reclaimed by dredged silt from the river Hooghli about 16 Km downstream of Haldia Port. The yard was meant for movement in tandem of cranes 250 t capacity weighing upto 200t on the soft silty clay/ clayey silt (with SPT =2-4 in top 8m) constructed in 1984/85, the yard is still performing well, which is also proven by settlement observations.

Sridharan et al (1991) while studying the frictional behaviour of reinforced earth reported that the performance of reinforced earth structure depends on the mobilization of internal shearing resistance between soil and reinforcement. This criterion typically eliminates the use of fine grained soil as backfill materials in reinforced earth structure. The relative movement between the soil and reinforcement is maximum at the interface and reduces to zero as lateral distance from the interface increases.

They monitored the plastic flow of reinforced soil in a direct shear apparatus using radiographic techniques. The radiographs from these tests have shown that the reinforcement influences only a thin zone of surrounding soil. Outside this zone of influence, the soil behaves much as in tests conducted on unreinforced sand. They had shown that the radial stress in a pull out test is at a maximum at the interface and reduces rapidly with increasing lateral distance from the interface. Thus the induced shear stress also maximum at the interface and decreases with lateral distance.

The total pull out resistance of the reinforcement depends on the magnitude of the induced shear stress at the interface. This induced shear stress in the soil mass counters the shear stress mobilized due to the actuating forces, thus ensuring the stability of the structure.

VI. CONCLUSIONS

The results of field, laboratory and numerical studies have demonstrated the benefits of using geosynthetics to improve the performance of pavements. However, selection criteria for geosynthetics to be used in reinforced pavements are not well established yet. The purpose of this paper was to summarize information generated so far in North America to quantify the improvement of geosynthetics when used as reinforcement inclusions in flexible pavement projects.

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