STABILIZATION OF SOIL USING SYNTHETIC GEOTEXTILES – A REVIEW

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Abstract : Roads are the most vital component for the economic and social development of any country. Its importance further increases if the economy of a country is based on agriculture. The life and quality of flexible pavements depends upon the type and quality of subgrade soil as it serves as the foundation for pavement. In India more than 8 lakh square kilometers of area is covered with soils having low strength and stability, high settlement and liquefaction potential. In such cases, it is often impossible to build a stable base over soft subgrade without losing expensive base material. To overcome these problems it is necessary to improve the properties of soil either by replacement of by reinforcement. Replacing the existing soil might not be an economically viable option. The reinforcement materials used are in the form of fibers which are randomly oriented or in the form of sheets which are placed in layers in soil. The present study describes the available knowledge on the use of synthetic geotextiles in soil stabilization purposes.

***Index Terms* – geotextile, pavements, reinforcement, subgrade.**

I. INTRODUCTION

Geotextiles are permeable geosynthetics comprised solely of textiles (ASTM D4439) and can be used with foundation, rock, soil and any other geotechnical engineering related material. The major chunk of geotextiles are made from polypropylene polymers, which are converted into fibers or yarns which may be monofilament, multifilament, slit-film monofilament, slit-film multifilament, staple fiber or continuous filament and finally manufactured as a woven, non-woven or knitted fabric.

They form the largest group of geosynthetics consisting of synthetic or natural fibers. Fibers for natural geotextiles are obtained from plants, minerals and animal sources e.g. coir, jute, ramie, flax, cotton etc. Synthetic fibers are polymeric materials obtained from polymerization process of monomers.

This paper describes the available state of the art knowledge and reviews the work of various researchers on stabilization of poor subgrade soil.

II. REVIEW OF LITERATURE

Murtaza and Shah (1989) studied the effect of using geofabrics as reinforcement to improve the load bearing characteristics of flyash. Laboratory triaxial and CBR test are conducted by using geofabrics in different layers. Arrangement of 3 layers shows maximum improvement in CBR value with an increase of 150% as compared to unreinforced sample. Triaxial test shows that there is not any specific pattern in improvement of stress-strain behaviour. It was concluded that flyash reinforced with geofabrics can be used for construction of embankments.

Haeri et al. (2000) studied the effect of geotextile reinforcement on dry beach sand. The sand sample was collected from shores of Caspian sea, Babolsar, Iran and was classified as poorly graded sand (SP) as per USCS. Three non-woven geotextile samples of different mass per unit area were used in different layers. The effect of sample size, confining pressure and geotextile arrangement was studied through triaxial compression test. It was found that geotextile inclusion increases axial strain at failure, peak strength and reduces post-peak loss of strength and this effect is better observed in more number of geotextile layers and in smaller size samples.

Scholz et al. (2007) reviewed the permeable pavement system (PPS) used in residential, industrial and commercial applications. PPS not only vested as a sustainable drainage system but also helped to retain and degrade oil. The retention of hydrocarbons, metals and pesticides was provided by a layer of geotextile which prevented their movement to groundwater, while degradation of hydrocarbons upto 99% was achieved through bacteria and fungi.

Viswanadham and Satkalmi (2008) carried out the field trials to evaluate the performance of road reinforced with woven polypropylene geotextile of 268GSM. Two studies have been conducted, one was 2 km rural road (MDR 82) in Maharashtra constructed on black cotton soil and another was petroleum outlet unit in Gujarat. It was found that there are no possible signs of distress even after 38 months of construction in road section provided with geotextile with reduced pavement thickness, while in portion with no geotextile initiation of rutting and distress are noticed.

Raisinghani & Viswanadham (2010) studied the permeability characteristics of geosynthetic layers under confinement with soils having relatively low permeability. They used two types of soil-soil A (mixtures of sand and kaolin in ratios of 5.67:1 by dry weight) and soil B (mixtures of sand and kaolin in ratios of 3:1 by dry weight). It was found that with increase in normal stress, the permeability characteristics of a geosynthetic reinforced soil decreased. The permeability characteristics were found to improve significantly with the provision of sand cushion and an increase in its thickness showed a uniform increase in permeability improvement factor. The equivalent coefficient of permeability for both the soils increased with increase in number of layers of geosynthetic and provision of sand cushion around the geosynthetic significantly enhanced the equivalent coefficient of permeability of Soil A by 3-4.5 times and 70-180 times for soil B.

Tailor et al. (2011) studied the effect of using geotextile layer made of polypropylene just below the sub base layer. The study was conducted at SVNIT campus. The soil in this area is highly expansive with CBR value of 1.77%. The visual ground observation showed that there was improvement in stability of subgrade below pavement where the geotextile was laid. The portion with geotextile shows less undulation at top as well as very few cracks are observed. The length without geotextile showed number of cracks and also there was more settlement observed.

Tuna and Altun (2012) studied the effect of geotextile reinforcement on the shear strength parameters of sand. Five types of geotextiles were used in which three were non-woven and two woven. Two different gradations of sand samples namely well and poorly graded sand were taken. Effect of mold size and number of reinforcing layers were analyzed by conducting direct shear test. It was observed that in case of reinforced soils, the loss of shear strength seen after peak strength was considerably reduced. The cohesion value increased as the size of mold decreased, due to restraint impact of smaller sized sample.

Kumar and Rajkumar (2012) studied the performance of non-woven and woven geotextile, placed between soft subgrade and unbound gravel on the reinforcement ratio value of soil using CBR load penetration relationship. It was found that use of both the geotextiles in soft subgrade, increased the penetration resistance and hence the reinforcement ratio. The improvement in reinforcement ratio of soil with woven geotextile was found to be more as compared with non-woven geotextile. The reinforcement ratio value for a penetration of 20mm was observed as 2.1 and 1.7 for woven and non-woven geotextile, respectively.

Ghazavi et al. (2013) studied the effect of freeze-thaw cycles on the strength properties of clayey soil (CL) before and after placing geotextile. The geotextile used was of non-woven variety and was placed in single layer at the middle of the sample. An unconsolidated undrained triaxial test was conducted for 0, 1, 3, 6 and 9 freeze-thaw cycles. It was found that strength loss after 9 cycles reduced from 43% for unreinforced to 14% for geotextile reinforced sample. There was greater reduction in triaxial strength ratio, cohesion and angle of internal friction for unreinforced sample as compared to reinforced one as the number of cycle's increases. It was also found that height of sample increases with the number of freeze-thaw cycles. Tomography images and water content ratio indicates that use of geotextile sheet helps in collecting water and takes it to the deeper parts of the soil and reduces the freeze-thaw effects in the upper portion of ground.

Yeole and Patil (2013) studied the effect of using nonwoven polypropylene geotextile in layers on granular soil. CBR tests were performed by placing geotextile in one or two layers at various depths in soil sample. It was observed that use of geotextile material in soil improves the CBR value and hence the strength of soils. The maximum increase of 38.21% in CBR value was observed when two layers of geotextiles are placed at depths of 25 mm (H/5) and 75 mm (3H/5) from the top as compared to virgin soil specimen.

Prasad et al. (2014) studied the effect of using nonwoven polypropylene geotextile on the CBR value of soil. The soil sample was collected from Srikakulam road, Rajam, A.P. and was classified as clay of intermediate plasticity (CI) as per ISC. The soil was mixed with 8% flyash and geotextile sheets were provided in single and multiple layers. By addition of flyash, the CBR value increased by 17.41% and it further increased by 158% when geotextile was placed at all four layers compared to virgin soil.

Philip and Charly (2016) focused on recent developments in the field of geosynthetic products including geotextiles, their applications as reinforced soil and in environmental protection works. Granular soil samples were tested with and without geotextile reinforcement. It was observed that bearing ratio of reinforced soil increases significantly as compared to unreinforced one. It was concluded that geotextile can be used in various earthen structures for numerous applications.

III. CONCLUSIONS

It can be concluded that geotextiles play a very important role in civil engineering works such as pavements, railways, embankments, canals, retaining walls, landfills and disposal of sludge. Due to versatility of its functions like separation, filtration, drainage and reinforcement; greater cost reduction is achieved as compared to other conventional methods of soil stabilization. The cost of construction and maintenance of pavements reduces significantly. However, more research work is required to fully understand the working mechanism of geotextiles for soil stabilization. Hence it's time to support geotextiles in sake of better development of our community.

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