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STUDY OF COST EFFECTIVENESS OF GEOSYNTHETIC MATERIAL IN ROAD CONSTRUCTION

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Abstract
Over the last 30 years, geotextiles have been actively advocated for pavement construction. In order to learn more about the impact of geotextile reinforcement on pavement design, further full-scale studies are needed. Geotextile-reinforced pavements under controlled loads and climatic conditions were the major focus of this investigation. Geosynthetics have been widely employed to conduct a range of functions that have substantially improved the performance of highways. All of these things serve to keep you safe and secure by isolating you from your surroundings while also filtering out contaminants. At least six significant highway applications employ one or more of these qualities. For example, reflecting crack migration in asphalt overlays may be addressed using these techniques. Other uses include isolating roads, stabilizing the road foundation, and providing lateral drainage. Natural materials like wood and stone may be replaced with geotextiles, which have both economic and environmental advantages. Various variables contribute to the occurrence of the study's typical pain difficulties in the road building industry. The current situation in India necessitates the construction of as many transportation facilities as possible in the least amount of time and money as possible. In this paper, we looked at the economics of using geosynthetic material in building projects, and the results were rather encouraging.

1. INTRODUCTION

Geotextiles are defined by the ASTM (1994) as permeable textile fabrics used in civil engineering projects, structures, or devices that come into contact with rock, soil, earth, or any other geotechnical materials. Inherently impermeable, geomembrane is often utilised as cut-offs and liners in the construction industry. Line-ups for landfills also make advantage of this. Soil, rock and earth or any other geotechnical substance can be penetrated using permeable geotextiles in civil engineering projects, structures or systems. As a polymeric structure in the shape of a produced surface with a basic network of integrally connected pieces, geogrids are employed in geotechnical, environmental, hydraulic and transportation engineering applications. To put it another way, a geonet, or polymeric sheet structure, has an aperture that is generally greater than the material that makes up the structure. Engineering polymers in the form of sheets or bars with at one geosynthetic component are known as geocomposite materials. These materials are employed in geotechnical environmental and transportation engineering applications. It is possible to join non-regular networks of yarns, fibres, and filaments, tapes, or other materials thermally or mechanically, resulting in a geomat with holes that are more than the sum of their parts.

2. GEOSYNTHETICS IN ROAD CONSTRUCTION

Geosynthetics may be used in a variety of ways, from preventing bank erosion to enhancing subsurface water flow. Most people are familiar with its usage in road building, particularly for temporary roads like construction access routes and wooded pathways. This is what geosynthetics can do for you in these situations. Figure 1 illustrates the application of a geotextile to a road infrastructure that prevents the layers from mixing together.

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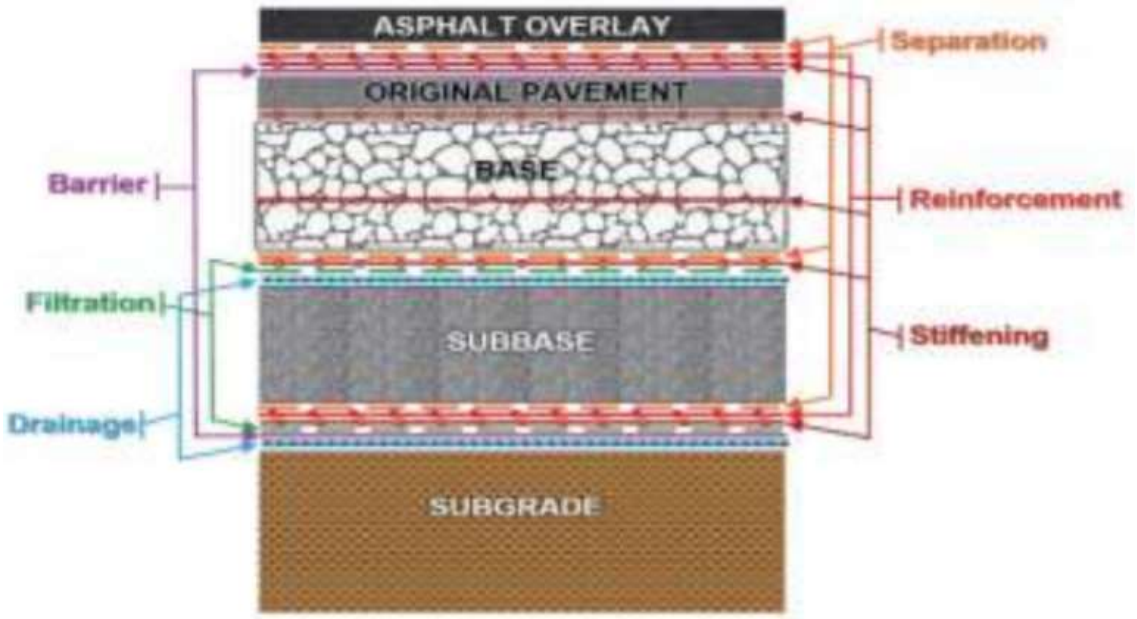

Figure 1.1: Multiple functions of geosynthetics in roadway applications.

3. LITERATURE REVIEW

Khan, Gawhar & Singh, Sukhdeep. (2020) The use of geotextiles in pavement construction is becoming increasingly common, since the material has shown to be an efficient engineering tool. Separation / stabilisation is the most common usage of geotextiles in the construction of paved and unpaved highways. Separation, stability, strengthening, and filtration are just a few of the benefits that geotextiles, whether employed on paved or unpaved roads, give. Geotextiles may often replace or reduce the usage of natural gate construction materials, which is both cost-effective and good for the environment. Due to a variety of causes, the pain difficulties that are discussed in this paper are common in road building. To meet India's existing transportation needs, the country's infrastructure must be built as quickly and cheaply as possible. Most of the failing roads have been traced back to the dirt that was used to build them.

Oğuzhan Bayraktar (2020) Geosynthetic reinforcing components are used in the formation of asphalted and unpaved rail system and vehicle road to reinforce the ground and operate on soft and weak ground. As a result, highway and railway building constructions are better able to withstand the effects of deteriorating ground conditions. Compared to standard road building goods, geosynthetics have a considerably greater value and the easy, rapid installation technique greatly decreases the formation time. Ahead the geosynthetic granular substrate is placed on roadways, geosynthetics are placed on the fragile foundation floor. The slab's formation integrity is protected by geosynthetics, which avert the granular and sub-base substance from sinking into the weak substrate. Using geosynthetics increases the amount of time and money needed to maintain a poor floor's new flooring.

Syed Ballari (2019) To lengthen the life of the pavement or to minimise the overall thickness of a pavement system, geotextiles have been employed. It's still not obvious what the financial benefits of employing this material are. An agency-only focus is common in most geotextile life cycle cost evaluations. Considered in this study are the original construction, maintenance and rehabilitation expenses of geotextile stabilised pavements as well as those incurred by users.

Elvir Akhmetshin and Kseniya Kovalenko (2019) Using geomaterials in road building is the focus of this paper. The authors also look at the economic indicators, surface density and unit cost relationships, as well as strength and unit cost relationships. As woven geomaterials are proved to provide economic and technological advantages, with geosynthetic materials, road infrastructure may

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be made stronger and built for less money, all while keeping their sturdiness and dependability. The permits and technical documents for Geogrid Road are in place, and the calculating techniques have been created to address the issue of road building. In Russia, nonwoven geomaterials are more commonly employed than woven geomaterials because of poor design processes that don't take into consideration the strength of the geomaterial and lower the density of pavements when employing thick geomaterials.

Jorge Zornberg (2017) A number of geosynthetic functions have been successfully implemented, all of which contribute considerably to the overall performance of roads. Separation, filtration, strengthening, stiffening, drainage, barrier, and protection are all included in their scope. At least six significant road applications have made use of one or more of these many functionalities. An asphalt overlay with reflecting cracks can be used to migrate cracks, to stabilise road foundations, and to stabilise road soft subgrades. The mechanics and major achievements in each of these various applications are explained in this work.

4. METHODOLOGY

A quantitative and Relative examination of the level of compactions and an evaluation of glide and maintaining of the paved road with and without geosynthetic materials was studied throughout the course of this project. Deflection material was analysed from the road alliance that included both geo-grid-covered and non-covered sections of road. For determining the cost effectiveness, the approximate rates were obtained from the public works department of the region and then the approximate rates were established and then furnished to get the idea how much cost effect would be induced when we incorporate the geotextile in the road construction.

5. RESULT & DISCUSSION

5.1 Cost Benefit of Geo synthetic Material

It is suggested that a life-cycle cost analysis be used for economic evaluation of a potential (RPP) reinforced pavement project. However, a geo synthetic reinforcement may save money by reducing the cost of original construction. An exhaustive life-cycle cost analysis may not be necessary in this situation, unless the overall savings over time required be calculated (e.g., to differentiate the savings in thickness reduction as compared to maintaining the thickness and increasing the design life). It's easy to oversimplify an evaluation by starting with just looking at the costs. If the basic cost method doesn't seems to offer a enough economic advantage for adopting (reinforcement), the life-cycle cost approach is advised.

Cost reductions for low subgrade construction may usually be shown through these approaches. For mild subgrade state, cost reductions can be calculated in terms of initial thickness reduction. Maintaining the thickness and prolonging the useful life of the design, on the other hand, may result in even greater financial savings over time. As previously stated, when basic construction costs not reveal a reduction with the usage of geo synthetic and reinforcement, lifespan costs should be considered. Other benefits, such as those that cannot be measured, should be taken into account while making a decision.

Initial construction costs

When building on a low subgrade, the initial construction costs are generally lower. Depending on the approach and/or geosynthetic utilized in the design, the projected savings may vary. However, the method for calculating the cost reductions is self-reliant of the design process and geosynthetics used in the project. One form of geosynthetic material is made in India at a cost of 30 INR (2mm Polypropylene woven geotextile) per square meter. Based on the preceding Table 1, geosynthetic road construction can save money and time at the outset. Let's take a look at an example of a road with a length of 1km, a width of 10m, and an excavation depth of 1m as an example of early construction costs.

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Table 1: initial construction Cost for road without geomembrane

No	Description	Unity	Quantity (L*W*H)	Unit per Rate	Total Amount
1	Excavation thickness of 1m.	M^3	1000*10*1=10000m^3	252.15/cum	25,21,500
1.1	Capping layer of subbase	M^3	1000*10*0.74=7500m^3	800/cum	60,00,000
1.2	Subbase	M^3	1000*10*0.25=2500m^3	1787.37/cum	44,68,425
1.3	Base coarse	M^3	1000*10*0.15=1500m^3	1824.75/cum	27,37,125
Total					1,57,27,050

Table 2: initial construction Cost for road with geomembrane

No	Description	Unity	Quantity (L*W*H)	Unit per Rate	Total Amount
1	Excavation thickness of 1m.	M^3	1000*10*0.5=5000m^3	252.15/cum	12,60,750
1.1	Capping layer under the .(subbase)	M^3	1000*10*0.41=4000m^3	800/cum	32,00,000
1.2	Geotextile	M^2	1000*10=10000m^2	30	3,00,000
1.3	Subbase	M^3	1000*10*0.175=1750m^3	1787.37/cum	31,27,898
1.4	Base coarse	M^3	1000 *10*0.074=750m^3	1824.75/cum	13,68,563
Total					92,57,211

Table 3: Initial construction cost comparison

First establishment cost comparison

Description	(RC) Road construction without geomembrane	(RC) Road construction with geomembrane
(ICC)Initial construction cost	1,57,27,050	92,57,211

Based on these findings, it is clear that geosynthetic materials, which improves road performance, also saves money by saving time and money in the building process. Base coarse and subbase materials are also saved as a result of this process.

6. CONCLUSION

- In pavement design and construction, geo synthetic reinforcement should be widely used and the construction of flexible and rigid roads to over weak subgrade conditions, geo synthetic reinforcements are used as base reinforcement in flexible pavements to help vehicle loads and the life of the pavement, as subgrade restraint to help support equipment loads on the unpaved base (or subbase) course during the construction.
- The inclusion of geotextile in the road is causing a significant decrease in overall construction cost of the road. The impact of inclusion of geotextile is not only on one layer of the road construction but it involves all the layers in the road construction from preparing of sub grade to base course.
- The percentage decrease in the overall estimated cost of construction would be decreased by 58.8% hence which can cost benefit the road construction projects.
- Also, it is pertinent to mention that it has been studied that the overall thickness of the road layers have significantly decreased thus making road construction easier, faster and sustainable. Certain

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reinforcements have been shown to give significant load-carrying improvements, but only up to a point. Geosynthetic and design requirements, as well as subgrade strength and aggregate qualities, determine the usability of a material.

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