RUNNING HEAD: Literature Review

Effectiveness of the application of Geo-synthetics in Australian Highway Construction Industry

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***Introduction***

Geo-synthetics are available in various forms and materials. They are synthetic products responsible for stabilizing terrain. In this paper literature review regarding strength, lifespan and cost-effectiveness of geosynthetic material are discussed. Additionally, the use of geosynthetic material in highway construction and estimated expenditure on construction is also discussed.

***Literature review***

Geo synthetic material is widely used for construction purposes. The author Werner in his paper also explained the advantages of using geosynthetic materials for construction. According to him, geosynthetics are used to seal water storage facilities, flood reconstruction after a natural disaster and in waterproofing the building, and, etc. Further, he discussed categories of geosynthetics such as Geotextile, Geo-net, Geo-composite and Geo-composite drain. The author also explained that as compared to their natural soil counterparts geo-synthetics are generally cost effective due to increased longevity and less maintenance requirement. Despite economic effects, the author also discussed the environmental benefits of geo-synthetics by comparing geosynthetic grain with conventional drains. The results showed that geosynthetic drains are more environmentally friendly than the conventional drains as the cumulative green-house gas emission is more in a conventional drain as compared to geosynthetic drain. Also, the transportation and handling of the geosynthetic drain are more environment-friendly as to make the drain fewer truckloads of clay and gravel were required. Thus reducing not only the cost but the amount of carbon footprint (Müller & Saathoff, 2015). Specifically talking about geotextiles Dr Bipin in his paper explained several advantages of using geotextiles in construction while also explaining some disadvantages as well. According to the author, geotextiles are used in road works, railway works, and agriculture, etc. They are non-biodegradable that increase longevity and thus is cost-effective. However, due to this non-destructive nature of geotextiles, they directly affect the environment. As if they come in contact with the life cycle of several microorganisms they can disturb the ecosystem which will in turn damage the environment. However, as they are economically beneficial they are widely used in construction (Agrawal, 2011).

 In a study conducted by Dolez, a method to test the geotextile is explained. The author first collected the sample of geotextile and kept them in cool and dry places free of dirt. The composition of the material was identified using two ways. The first is through Fourier transform infrared spectrometer and the other is based on solubility analysis of the material. To test the hydraulic properties of the material several techniques can be used such as using a series of glass beads to measure the apparent opening size of the material. The other is using glass beads that rely on hydrodynamic forces to identify the filtration opening size of geotextile. To test the thermal properties an environmental chamber is used that measures geotextile material’s tensile strength and elongation at break. To measure durability geotextile material is exposed to UV rays that help in understanding the degradation mechanism that includes photo-oxidation and thermos-oxidation. The results showed that geotextile materials are less prone to environmental effects due to which they ensure longevity. Also, they are cost-effective and can be recycled. However, there is a need to do more research on this material as they can be very beneficial in future construction processes (Dolez, 2018).

Geo-synthetics plays a key role in the construction process. Specifically, discussing road construction geosynthetics are widely used due to its immense benefits. The author in this paper (Paygude et al., n.d.) also discussed the role of geosynthetics in road construction. According to the author geosynthetics in a road, industry is used in separation, filtration, drainage and reinforcement. The author further explained the methods of installing geotextiles. The first step is to clear the site then roll geotextile onto subgrade. The fabric seams and overlaps should be made accordingly. Vehicles should not able allowed to pass during the installation. It is important to not grade ruts down rather fill them with additional compact and aggregate. This rule remains the same for future maintenance. Despite the advantages of geotextiles, there are some limitations as well. It is necessary to protect them from light while installing them. Some geotextile material needs to be disposed of in a landfill that makes them less desirable. However, if the right fabric is selected all the advantages such as better drainage, stabilize subgrades and cost-effectiveness can be achieved.

Due to the rapid increase in traffic, there is a constant need to make new roads to accommodate the heavy traffic flow. Due to heavy traffic roads are prone to cracks of the asphalt layer. Thus to improve pavement performance reinforcement of asphalt is necessary. The author Sina in his paper also focused on the reinforcement of asphalt by using geosynthetic material. According to the author to prevent unnecessary settlement of road structure a certain bearing capacity of subbase is required while constructing roads on soft soil. This bearing capacity can be increased by using geosynthetic material. This material has the ability to prevent moisture from infiltrating into pavements thus delaying the distortion. Also, geosynthetic materials are known for absorbing stress thus using them in construction of pavements will help reduce cracks and ensure the longevity of the road (Mounes & Khodaii, 2011). Similarly, the author A. Khodaii in his paper also discussed the cracking of road problem. According to the author, several factors such as wheel loads and temperature variations etc are the reason for cracking of roads. The author conducted an experiment in which he used geo-grid in the construction of sample and performed various tests to measure its effectiveness. Results showed that the inclusion of geo-grid in asphalt sample significantly increase the overlay performance regardless of the phenomenon of old pavements (Khodaii & Fallah, 2008).

In terms of cost, geosynthetics materials are considered to cost-effective in construction rather than traditional materials. The author Barry in his research paper identified four types of cost savings that are a reduction in the quantity of raw material, easy construction, longevity and sustainability. According to the author using geosynthetic material to construct road costs less as compared to the alternate material in terms of longevity. According to the research conducted by author there were fewer cracks visible on the roads that were made using geosynthetic material after 5 to 7 years as compared to the alternate material. Also, using geosynthetic material can improve sustainability as the volume of geosynthetic materials small and therefore require fewer trucks thus saving money on transport and reducing carbon footprint as well (Christopher, 2014). Moreover, the author Montanelli also discussed the cost-effectiveness of using geo-synthetic materials. For this purpose, he designed a method for geosynthetic reinforced pavement. Previously, a method known as AASHTO method was used but in this paper, the author used a modified version of this method to test results of the required aggregate thickness of pavement using geosynthetic material. The results showed that aggregate thickness using alternate material is 45.52cm while that if geosynthetic material is 28.35 cm due to which the net saving of $2.93/m2 is achieved (Montanelli & Rimoldi, 1997). Furthermore, while comparing the use of geosynthetic materials and traditional construction material with respect to the life span of a road the author Rolf in his article discussed four indicators. These indicators are filtered layer, landfill construction, slope retention and foundation stabilization based on which the life cycle impact was measured. Results showed that a filter that used the geosynthetic layer cause lower impact as compared to the traditional filter. Also, the use of conventional road has high impact as compared to the road constructed with geosynthetic material. Also, using geo-grids can help in the construction process in lower climate as well (Stuck & Wallbaum, 2011).

 To construct several civil engineering related products geosynthetics are used widely. However, to use them it is necessary to understand the behaviour of different geo-synthetic materials. The author Hsuan in his paper also discussed the influence of external factors on the life of geo-synthetic materials. For this purpose, the author explained different types of polymers used in geosynthetic materials such as polyethylene, polyvinyl chloride and polyethylene terephthalate. These materials were tested using three categories that are chemical degradation, weathering and time-dependent mechanical properties. The results showed that using geo-grids helps in increasing lifespan of roads even in certain climatic conditions. Also geosynthetic material is less prone to chemical degradation (Hsuan & Koerner, 2008).

It has been more than half a century since geo-synthetics has been introduced yet still many engineers are unaware of its benefits. In past when during construction conventional practice was limited to replacing unsustainable soil and bypassing them with deep foundations which were very expensive. Also, many buildings and roads were vulnerable and were prone to damage and cracks. However, due to the invention of geosynthetic material, these problems were addressed. The worldwide demand for geosynthetics rises to 5.3% annually. The author in his paper (Koerner, 2000) also discussed emerging geotechnical applications such as reinforced walls, slopes and revetments, concrete dams and tunnel waterproofing. Also, the author highlighted the hydraulic applications as well such as canal liners, geotextiles containers and tubes for erosion control and aquaculture liners. Previously all these applications of geosynthetics were not identified yet due to the latest inventions in technology researchers are more focused on improving the quality of geosynthetic materials.

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