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MULTIPURPOSE FABRICATED BUBBLE WRAPPING PLASTIC LINER (BW-LINER) FOR GENERAL ENGINEERING APPLICATION

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ABSTRACT

Non-Biodegradable Plastic source namely Bubble Wrapped Plastic (BWP) mainly in the packaging industry has leading to the landfilling problems. Instead of landfilling, burning process can be the options. However, this kind of methods has contributing to the climate change impacts including ozone depletion due to the carbon dioxide (CO^2) increments. This study provides solution to the raised problem where the BWP itself is used as engineering layer in the construction of several infrastructure projects including drainage, road works and sanitary landfill (waste disposal site). This study proposed on the usage of fabricated BW-Liner as an alternative to conventional plastic sheets namely Geo-Membrane (GM). Raw bubble wrapped plastic was fabricated from a single layer into an engineered layer I with 30 layers of single plastic (4-mm thickness) and applied with hot-pressing technique to increase the strength in between the plastic surface. The single and fabricated engineered layer I were then tested for chemical (Thermogravimetric analysis - TGA) and mechanical (Tensile strength analysis) characteristics. Obtained results from TGA analysis shown fabricated BW-Liner and GM undergoing thermal degradation when temperature reached 480ºC to 490ºC. Findings from tensile (strength and stress) analysis shows that BW-Liner can withstand the higher forces at 185 N for 4-mm thickness while GM at 213 N at 2-mm thickness. The proposed BW-Liner can promote sustainable solution to landfilling problems by recycling the NBP waste and provide option to the industrial practitioner in term of using low-cost added material.

Keywords: construction, plastic waste, geo-membrane, TGA analysis, tensile strength

1. INTRODUCTION

Rising numbers of waste from packaging industry namely bubble wrapping plastic (BWP) causing disposal waste problems due to inability to degrade neither short nor long period of time. Furthermore, this non-biodegradable plastic waste (NBPW) has potentially given serious concern or impacts to the environment, ecosystem and human. Dramatically, if this kind of BWP wastes is in contact with rainfall, blackish water, or leachate (with high toxicity contents) will be produced and causing severe environmental pollution (groundwater contamination). An innovative solution has been introduced to improve the current situations by the installation of geosynthetics (GS) layer at the waste disposal site (Sanitary Landfill). GS is a thin and flexible sheets of material functions as a filtration, separation, or water proofing layers for general engineering application. Conventionally, geotextile (GeoTx) (permeable to fluids) and geomembranes (GM) (impermeable to fluids) are two types of classified GS materials founds for engineering usage including waste disposal facilities (landfill liner and leachate treatment pond), geotechnical work (slope

protection liner), transportation facilities (road base liner), irrigation and hydraulics work (concrete drain liner and industrial water pond) and others [1-4].A lot of researches have been conducted to study on the potential application of NBPW in general engineering applications such as the combination of used plastics water bottles with fly ash as reinforcement materials in geotechnical field. Sushovan et. al. [5] conducted a series of laboratory testing and found that cells made with used waste plastic water bottles and filled with proper infill material can carry huge compressive load (up to 5000 kPA) before failure as well as can sustain very large strains (30% – 40% axial strain). On the other hand, Mohammed et. al. [6] investigated the possibility of replacing 75% of both fine and coarse aggregates with plastic (polyvinyl chloride: PVC, high-density polyethylene: HDPE and polypropylene: PP) as aggregate in concrete. Furthermore, plastic waste has a positive effect on the concrete density and its usage in concrete helps to reduce the impacts on environment. Based on the previous literature, most studies focused on the usage of other types of recycled plastic namely PET, PVC, HDPE, and PP. Therefore, the present study states the feasibility of reusing BPW which categorized under low density polyethylene (LDPE) as a Multipurpose Fabricated Bubble Wrapping Plastic Liner (BW-Liner) in various engineering applications. A comparative study is conducted on the chemical (Thermogravimetric analysis - TGA) and mechanical (Tensile strength analysis) characteristics between GM and fabricated BW-Liner. The advantages on using fabricated BW-Liner as a sustainable liner was also listed out and compared with GM.

2. MATERIAL AND METHOD

2.1. Fabricated Bubble Wrapping Plastic

The present investigation includes one type of Geomembranes (GM) and one type of bubble wrapping plastic (BWP) waste collected from the construction site (Penang Island, Pulau Pinang) and local community (Permatang Pauh, Pulau Pinang), respectively. These GM and plastic waste were categorized under high density polyethylene (HDPE) and lowdensity polyethylene (LDPE), respectively. The diameter of the bubble is 1 mm. **Figure 1.** shows the collected BWP.

Figure 1. Collected BWP

In this study, a single layer and fabricated BW-liner were prepared. The collected BWP sample was cut into a dimension of 180 mm x 180 mm. Then, it was placed on top of the layer of baking paper (to avoid the sample from melted on the metal tray). Thickness of the single layer of BW-liner is 2-mm while fabricated BW-liner is 4-mm. Once 30 layers of single BW-Liner (2-mm) were prepared, it combined to form one thicker fabricated BW-Liner (4-mm). Hot pressing technique was applied to the fabricated BW-Liner (to ensure the layers are attached together). To further increase the attachment in between layers, a 16 kg load was put on top of the fabricated BW-Liner was oven heated for two hours at 200ºC.

2.2. Thermogravimetric Analysis (TGA) and Tensile Strength Analysis

Thermogravimetric analysis or thermal gravimetric analysis was conducted in this study for thermal analysis in which the mass of a sample is measured over time as the temperature changes while the maximum force and stresses applied on tested sample can be determined by conducted tensile strength test.

3. RESULT AND DISCUSSION

3.1. Thermogravimetric Analysis (TGA)

Obtained result from TGA testing confirm that both samples started to experience thermal degradation when the temperature was above 400°C. The thermal degradation of BW-Liner (4-mm) continues until it reached 480°C while GM (2-mm) reached 480°C, where all the weight loss indicated at 3%. The thermal degradation of bubble wrap remained constant until temperature of 800°C. **Figure 2** shows TGA analysis for BW-liner.

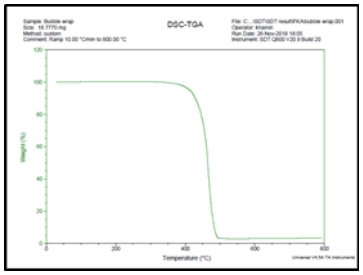

Figure 2. TGA testing for BW-Liner

3.2. Tensile Strength Analysis

The maximum force applied on BW-liner (2-mm), BW-liner (4-mm) and GM (2-mm) were 133 N, 185 N and 231 N, respectively as shown in Table 1. Obtained results show that the GM was having the highest value of maximum force applied on it while the BW-liner (2-mm) the lowest. Maximum applied forces for BW-Liner (4-mm) recorded small difference value of forces compared to GM. The obtained results show a remarkable finding on the BW-Liner (4-mm) as alternative to GM (2-mm). To increase the tendency of BW-Liner (4-mm) to withstand higher forces, thicker BW-Liner more than 4-mm is needed.

Table 1. Maximum Applied Forces for GM (2-mm) and BW-Liner (2-mm and 4-mm)

Type of Samples	Forces (N)
GM (2-mm)	231
BW-liner (4-mm)	185
BW-liner (2-mm)	133

4. CONCLUSION

Obtained results from TGA analysis show fabricated BW-Liner and GM undergoing thermal degradation when temperature reached in between 480^{o}C to 490^{o}C. Findings from tensile (strength and stress) analysis shows that BW-Liner can withstand the higher forces at 185 N for 4-mm thickness while GM at 213 N at 2-mm thickness. The proposed BW-Liner can promote sustainable solution to landfilling problems and provide options to landfill practitioner in choosing recycled, low cost and sustainable materials.

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Sekian, terima kasih.

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