

Palm Oil Clinker as Drainage Layer in Green Roof System under Malaysia Climatic Conditions

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Abstract

Green roof has become common in most of developed countries in Europe. It has many benefits in term of storm water management, urban heat island mitigation, and thermal performance thus leads to energy conservation. However, the green roof system is still based on the conventional materials which use expanded clay, expanded shale or pumice as drainage layer. Being among of the largest producer of palm oil in the world, Malaysia produces palm oil clinker as a waste material in the process of extracting the oil. The palm oil clinker has a potential of replacing the conventional materials for the green roof system. The fine aggregates produced from clinker are lightweight, porous and irregular in shape and thus having low values of bulk density and specific gravity. This paper emphasizes on the potential of using palm oil clinker as drainage layer in green roof system as replacement of conventional materials (expanded clay, expanded shale, pumice, etc.). The ability for draining of palm oil clinker is studied since the purpose of drainage layer is to drain the excess water and to ensure aeration of substrate layer and root. This study used an experimental procedure in which hydraulic conductivity, infiltration rate and bulk density was measured. Besides, the plant developments of selected green roof plants were also monitored to see any effect from the palm oil clinker replacement by means of experimental trays to simulate the real green roof system. It was found that palm oil clinker has a good ability of draining the excess water and there is no effect in term of plant development when the palm oil clinker is used as drainage layer.

Introduction

In recent years, the needs for design environmentally friendly building become a demand due to global warming which could leads to extreme and unpredictable weather condition. Green roof is one of the technologies that widely used these days to reduce urban heat island effect. The modern green roof design is formed by a few layers such as vegetation layer, substrate layer, root barrier, drainage layer and water proofing layer [Minke G. Hauser, 1982]. Materials used for substrate layer is usually topsoil which has capacity retain water gives nutrient to the plant. As based on current design, material used for drainage layer is porous stone materials such as expanded clay, expanded shale and pumice also used as drainage layer in green roof design. The function of drainage layer is primarily to get the optimum balance between air and water in green roof system [Gabriel Perez et al., 2012]. Environmental sustainability becoming global issues recently and therefore, recycling is the best practice in order to minimize the waste product. Waste materials such as rubber crumbs can be used as a drainage layer in green roof system [A. Vila et al., 2012]. In this research, the possibility of using palm oil clinker as drainage layer in green roof system is investigated. The palm oil clinker is used to replace the porous stone materials which currently used as the drainage layer in green roof system.

Methodology

Palm oil clinker was collected at palm oil factory near Felda Lepar Hilir, Kuantan. Then it was crushed and sieved into three different sizes namely 2 mm, 5 mm and 10 mm. The three samples were

tested to see the drainage ability of the palm oil clinker and compared with conventional stone material (pumice). Three parameters were investigated namely saturated hydraulic conductivity, infiltration rate and cumulative infiltration rate. These parameters can be determined through constant load permeameter test. Bulk density was also calculated before the test. The experiments were done individually for every single size of the palm oil clinker (drainage layer). Then, those samples were tested with adding substrate layer on top of them (substrate layer + drainage layer). In order to observe the behaviour of green roof system and the effects when replacing the drainage layer with palm oil clinker, a few experiment trays were installed. The experimental trays have 5 cm of substrate layer and 4 cm of drainage layer and three numbers of plants were studied.

Result and Discussion

Figure 1 shows saturated hydraulic conductivity for drainage layer materials (palm oil clinker) for three different sizes namely C-Small (2 mm), C-Medium (5 mm) and C-Big (10 mm) and pumice (3-10 mm) respectively. Based on the result, water can pass through the drainage layer (palm oil clinker) very quick. These indicated that palm oil clinker has the ability to drain the water. The hydraulic conductivity of the palm oil clinker is proportionate to the size of clinker.

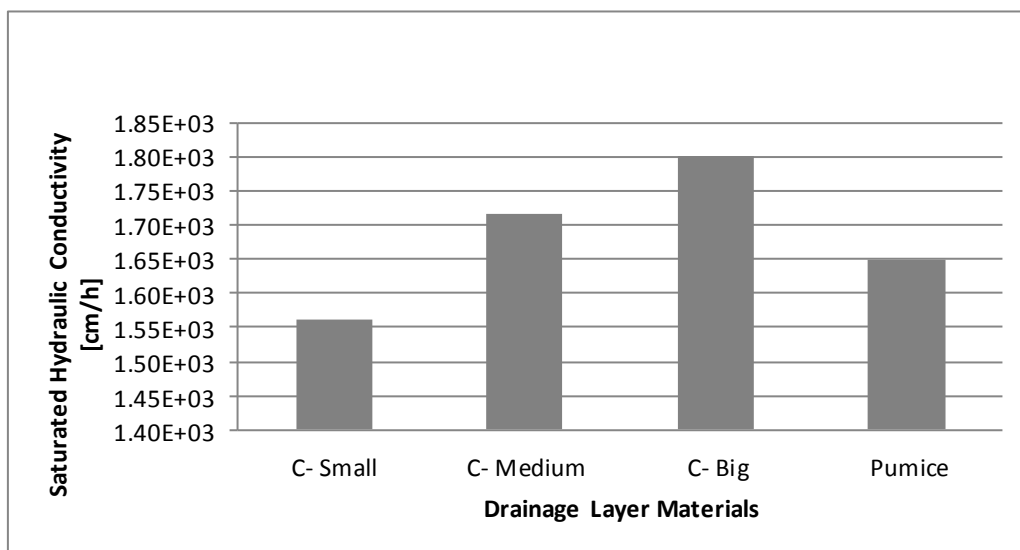


Figure 1: Saturated Hydraulic Conductivity of Drainage Layer Materials

Conclusion

Based on the result analysis, it was found that palm oil clinker has a good ability of draining the excess water and there is no effect in term of plant development when the palm oil clinker is used as drainage layer. This indicates that there is a possibility of replacing the conventional stone materials with palm oil clinker.

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