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To cite this article: F H Mohamed Ahmad *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **220** 012039

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Green technology and sustainable urban drainage systems using eco-composite porous concrete: A preliminary study

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Abstract. Eco-composite in porous concrete is designed with the mix of concrete and a cement replacement, which have the element waste material that being recycled, for example, rice husk ash (RHA), egg shells, palm oil fly ash, wood waste ash, and many more, for the purpose of ecologically sustainable development, and also for managing stormwater quantity and quality. The various researches related to eco-composite materials have been done, mainly as the construction and building materials. Besides, the porous concrete itself is mainly being used as paving material for the construction of parking lots, sidewalks and secondary roads. Thus, the good quality of porous concrete in terms of the concrete strength, the workability, the porosity, and so on are required. Meanwhile, previous researches related to effective microorganisms (EM) as an admixture in concrete have been done. However, the previous researches of eco-composite, specifically using RHA and EM did not focus on the drainage systems. Therefore, this paper presents a preliminary study of the eco-composite using RHA and EM as a cement replacement, as a green technology and sustainable development in urban drainage systems. For the part of the research, this technology, which is drain covers (slab) as part of the drainage system has been implemented in several areas in Selangor, specifically in Shah Alam in order to mitigate the flash flood, stagnant water lead to the mosquitos fertilization issue, and vandalism of the drainage cover, which cause a safety issue for public. The early findings seem encouraging that indicates the eco-composite porous concrete can be successfully in construction.

1. Introduction

Generally, eco-composite in porous concrete is designed with the mix of concrete and a cement replacement. The eco-composite have the element waste material that being recycled, such as, rice husk ash (RHA), egg shells, fly ash, wood waste ash, and many more. A number of research using porous concrete have been done, mainly for parking areas [1-7]. Porous concrete allows water to flow through it freely. However, there are lack of research related to the porous concrete in urban drainage system. The porous concrete in the drainage system for urban storm-water management mainly contribute to solve the flash flood. There are cases which the drainage system such drain, cover drain, kerb, pavement and other related to storm water management causes the flash flood even though the existing design fulfil the design of best management practices.



Meanwhile, the effective microorganisms (EM) will be added as admixtures in porous concrete drainage system as the EM have many benefits, such as improved the strength and the workability of the concrete, as investigated by several researchers [8-11].

Furthermore, lack of study using eco-composite, specifically RHA with EM, in porous concrete for drainage system in this country. However, there are various applications using these type of waste materials as construction and building materials such as RHA usage by researchers [12, 13], egg shells by [14], wood waste ash [15], palm oil fly ash [16], sawdust ash (SDA) [17], Palm Kernel Incinerated Ash (PKIA) [18], oil palm shell ash (OPSA) [19], groundnut husk ash (GHA) [20], palm bunch ash (PBA) [21], aluminium wastes (AW) [22].

This paper presents the preliminary study using eco-composite in porous concrete for drainage system as a part of the urban flood management systems for the purpose of ecological sustainable development, and also for managing stormwater quantity and quality. Besides, the purpose of the implementation of eco-composite in porous concrete for drainage system in order to mitigate the flash flood, stagnant water lead to the mosquitos fertilization issues, and vandalism of the drainage cover, which cause a safety issue for the public.

2. Problem statement

Selangor, specifically Shah Alam has been chosen as the study area due to the flash flood have been occurred so many times as the numerous of the impervious surfaces at parking lots, roads, drainage systems, and also along the pedestrian areas. Besides, improper drainage conditions also lead to the floods.

The improper drainage system (e.g. clogging, sedimentation, etc) is one of the reasons that the flash flood occurs. Thus, as part of best management practices in order to manage the urban stormwater, the eco-composite (e.g. RHA, egg shells, fly ash, saw dust ash, etc) can be used as the porous media in the concrete drainage system.

Shah Alam facing problem of flash flood every time as the rainy season comes. As is called the capital city of Selangor state, it has become an image problem for Majlis Bandaraya Shah Alam (MBSA) to public. With a budget that they have, it is an issue that being criticized and an urgent problem solving need to be done. Figure 1 shows the example of flash floods at Shah Alam, Selangor.



Figure 1. Example of flash flood in Shah Alam, Selangor.

Besides, dengue fever has been a serious health threat in Malaysia including Shah Alam area and more than 50 other countries which are located in tropical and subtropical regions. It is a vector-borne disease and its main vector is the *Aedes aegypti* mosquito (Figure 2). Therefore, Shah Alam; through MBSA; have to control some issues that contribute dengue and the poor drainage system is part of it to be tackled.



Figure 2. Stagnant water in the drain cause by unsmooth flow, which create the fertilization mosquitos.

As for the cover slab, there is an issue of the existing slab is not practical to as for safety and vandalism (Figure 3). There are consist of two types of cover drain, which is mild steel grating and concrete slab. The mild steel grating having problem of safety and stolen issues as mild steel can be sold as recycle material. For concrete slab, there are two designs which full covered concrete slab and few holes concrete slab; as both had it purposed for its design. For full covered, it is designed due to safety feature, but covered caused the slow water infiltration which contribute flash flood from surface runoff water. As for a few holes, the rate of infiltration is good, but strength becomes a problem as the design not strong to hold certain load from the vehicle. This issues being brought up the newspaper as the municipal council having a huge number of complaints from the public. The municipal council; such as MBSA; focusing to solve these complaints as the cost is high to replace the old traditional slab.



Figure 3. Vandalism of cover slab which cause safety issue for public.

As to reduce the flash flood in urban area, the porous concrete systems for drainage can be important part of context-sensitive construction and low impact development, designated to meet a number of goals related to the function of the site and structure in urban storm water management. This porous concrete system can be one of the elements in Best Management Practices (BMP's) in order to control stormwater from the aspect of quantity and quality runoff to achieve zero development impact contribution. The porous concrete systems for this study will be used eco-composite materials as the porous media. This new approach is more environmental and has been applied in many countries as the construction and building materials.

3. Preliminary study

The existing conditions of impervious concrete drainage systems before eco-composite porous concrete drainage systems being implemented in Selangor, specifically in Shah Alam are indicated in Figure 4. Figure 5 indicates the preparation of drainage cover using porous concrete. Meanwhile, Figure 6 shows the implementation of EM in the drainage system for this scope of the research.

The eco-composite porous concrete drainage covers (slab) have been implemented in some areas in Shah Alam, Selangor as a part of urban stormwater management in order to reduce the flash flood. Figure 7 presents the replacement of drain cover at several areas in Shah Alam.



Figure 4. Existing conditions before eco-composite drainage systems are implemented in Shah Alam, Selangor.



Figure 5. Preparation of porous concrete for drainage cover.



Figure 6. Preparation of eco-composite porous concrete with EM for V-drain.



Figure 7. Implementation of eco-composite porous concrete drainage covers in Shah Alam, Selangor.

4. Conclusion

The use of eco-composite in the porous concrete drainage system will contribute in improving storage capacity in the research area (Shah Alam, Selangor). This also will definitely reduce flooding, mainly flash flood and maximize water filtration.

Other than that, the research is expected to be a part of mitigation measures for main issues that occur in urban area, mainly in the research area of:

- i. Flash flood at roadside drain causing traffic problem.
- ii. Stagnant water in the drain cause by unsmooth flow, which create the fertilization mosquitos. These make Shah Alam has the record of highest dengue fever in Selangor state.
- iii. Vandalism of the cover slab, which cause a safety issue for the public.

5.0 References

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Acknowledgment

This research was supported by the UTM COE research grant Q.J130000.2409.04G00 and FRGS grant R.J130000.7822.4F722. The authors would like to thanks their respective university, Hydraulic and Hydrology Laboratory, Material and Structure Laboratory, Faculty of Civil Engineering, Universiti Teknologi Malaysia, all staffs of Urban Drainage Section for Engineering Department, Majlis Bandaraya Shah Alam (MBSA) including director and assistant director of Engineering Department, EM Malaysia Sdn. Bhd. and EMRO Japan for their cooperation in conducting this research.