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RESEARCH ARTICLE **OPEN ACCESS**

Effects of Filter Material on the Permeability of Sapric Peat in Flexible Wall Permeability Tests

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Abstract:

Introduction: Installation of Prefabricated Vertical Drains (PVDs) is one of the alternatives for ground improvement used in peatland deposits. However, filter paper is commonly used as standard filter material to determine the permeability of peat rather than the PVD material itself.

Aims: This paper presents preliminary data on the effect of using two different filter materials on the permeability behavior of Sapric peat.

Methods: A series of flexible wall permeability tests (FWPTs) was conducted to evaluate the peat permeability behavior under compression using two filter materials. This study compared Whatman standard filter paper and Prefabricated Vertical Drain (PVD), which is a non-woven geotextile filter material.

Results: The results showed that both tests using filter paper and a PVD filter exhibited a high initial coefficient of permeability, which depends on the hydraulic gradient. The coefficient of permeability significantly decreased until a certain period and then diminished with time. The coefficient of permeability from PVD filter tests was found to be approximately 2.6 times higher than that of the standard filter paper under the same compression. The duration required to reach a semi-steady state flow condition from the PVD test was 0.9 times faster than the standard filter paper. The random error of the coefficient of permeability data from the tests using the PVD filter was lower than the data of the standard filter paper.

Conclusion: This preliminary result suggests that standard filter material might not represent the actual coefficient of permeability of Sapric peat. The coefficient of permeability value was less consistent compared to the PVD filter. The selection of filter material plays a crucial role in ensuring accurate and reliable results, especially when dealing with PVD construction in peat. Using the PVD filter in FWPT appears to be suitable for the design of PVD in peat. The findings of this study contribute to evaluating the correct parameters for engineers to design and analyze the effectiveness of the ground treatment method using PVD in peat.

Keywords: Sapric peat, PVD, Permeability, Flexible wall permeability test, Filter material, Soils.

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1. INTRODUCTION

The rapid increase in population is driving infrastructural development, thus increasing the demand for land use, including expansion in peat formation. Peat is an organic soil originating from partially decayed vegetation accumulated over time in waterlogged areas [1-3]. Due to its formation under an anaerobic condition, peat soils are often brown to black [4]. Peat microstructures are hollow, with irregular pores size and a coarse texture compared to clay soil [3, 5]. Approximately 5 to 8% of the world's land surface is covered in extensive peat deposits [6, 7]. In Southeast Asia, it covers roughly 23 million hectares, mostly in lowland tropical regions. In Malaysia, peatland formation covers around 2.7 million hectares of lowland near the coast [8]. About 1.7 million hectares, equating to 63% of the peatland reserve of Malaysia, are in the state of Sarawak, which has the country's greatest peat deposits [9-11]. Fig. (**1**) illustrates peat deposits along the lowland of Sarawak's shoreline region. Ninety percent (90%) of peat deposits in Sarawak are more than 1.5 meters deep and are classified as deep peat [12, 13]. Due to their low mechanical quality characteristics, many engineers view peats as problematic soil. Peat has a high total porosity, often in the 70-95% range [14]. Porosity affects the water retention of peat, and its moisture content can reach 200% or more [15-17].

Installation of Prefabricated Vertical Drains (PVDs) is one of the alternatives for ground improvement used in peatland deposits [18]. In Sarawak, ground treatment using PVDs might have been introduced since the 1980s. A successful road project on approximately 10 meters depth of fibrous peat using PVD treatment was conducted on the 13.5km single-carriageway link road from Igan Bridge to University Technology Sarawak Campus [19, 20]. However, there was very limited data regarding PVD application in Sapric peat. The PVD shortens the vertical and horizontal drainage paths of the water flow, accelerates the consolidation processes, and, at the same time, increases the undrained shear strength [21, 22].

Hobbs highlights that permeability is the most important property of peat since it determines the settlement rate [23]. In this context, permeability is critical to assure the effectiveness of the peat-PVD system in the ground treatment approach. Fig. (**2**) shows the installation of PVDs as a ground treatment of a road embankment at one of the construction sites on a coastal highway, where peat was encountered.

Water movement capacities through peat pores are measured as peat permeability characteristics [24, 25]. Permeability plays an important role in controlling the consolidation rate of peat, which will manifest in settlement during construction and post-construction [3, 26]. The initial permeability of peat is typically 1000 times higher than soft clay deposits; however, it will decrease over time [27, 28]. An electrophoretic mobility study by Forsberg and Alden [29] discovered that peat had fine particles of less than one (1) µm. Fine particles of less than two (2) µm in peat are defined as peat colloids [30]. According to Amuda *et al*. [31], peat colloids have jelly-like texture and no intra-assemblage pore space. Colloids migrate with water during diffusion between peat pores, influencing permeability behavior [1, 29].

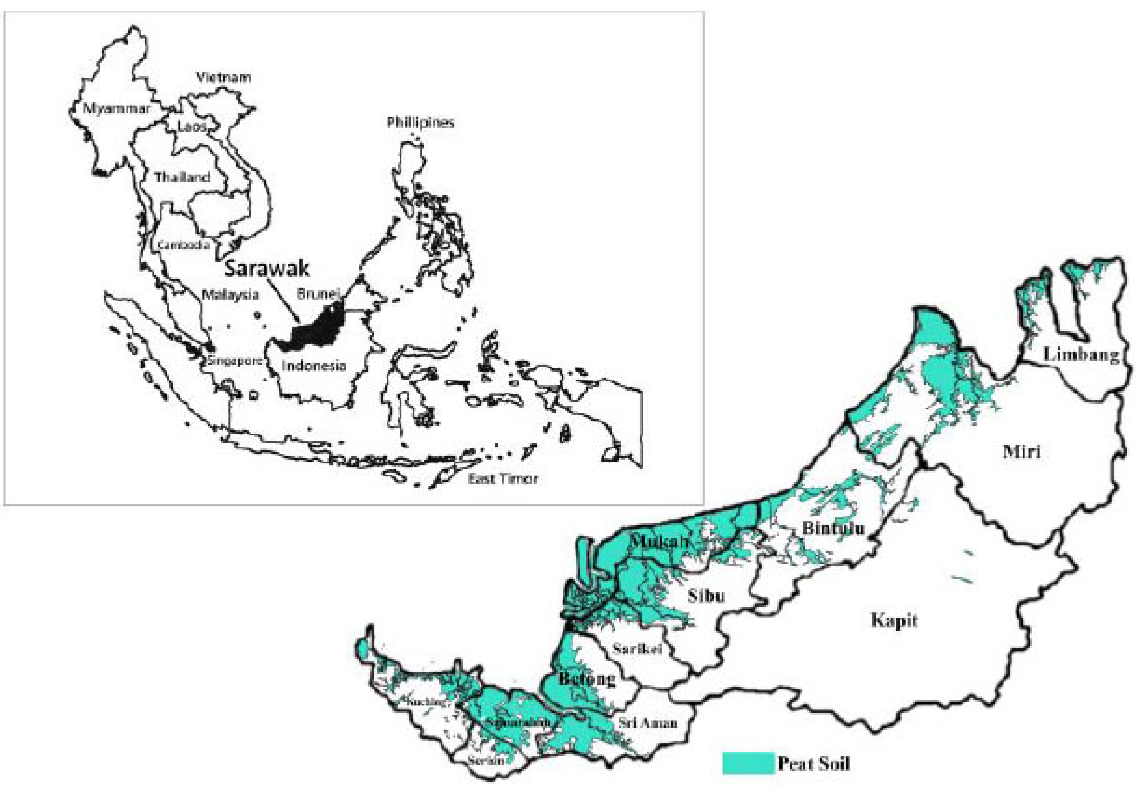

Fig. (1). Peat deposits in Sarawak, Malaysia.