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TENSILE STRENGTH AND DURABILITY OF OIL PALM EMPTY FRUIT BUNCH FIBER IN SOFT SOIL

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ABSTRACT: Natural fibers are already being used to stabilize the soil. However, the exact mechanism by which natural fibers improve the shear strength of soil is still not clear, and it varies according to the morphology of each fiber. Its durability in the soil is also an important issue in the use of natural fibers for soil stabilization. This study focused on the strength and durability of oil palm empty fruit bunch (OPEFB) fiber as a stabilizing material for soft clay. The durability was determined according to the changes in tensile strength and friction of the soil after a certain period. The clay was obtained from Banyu Hirang in South Kalimantan. The OPEFB fiber was obtained without further treatment from a palm oil processing plant. Tensile, soil-fiber friction, and unconfined compression tests were conducted for mixtures of fiber and soil. Preparations were made for each test with the same duration and conditions (1, 7, 14, 28, and 90 days) in closed and open conditions. The results showed that the average tensile strength of the fiber before use was 101 MPa. This value decreased sharply after 14 days in the soil, leaving a strength of 35.71 MPa in the open condition and 23.89% in the closed condition on the 90th day. The soil-fiber friction increased with increasing time, reaching 0.15 MPa in both conditions from the initial value of 0.06 MPa. The compressive strength of the soil-fiber mixture also increased with time. The corresponding scanning electron microscope results strengthened the findings of this study.

Keywords: Tensile strength, Durability, Soft soil, Fiber, OPEFB.

1. INTRODUCTION

In addition to concrete, synthetic or natural fibers can be used for soil stabilization. The synthetic fibers presently being used include strands of waste tires [1], nylon fibers [2], polypropylene fibers [3–5], glass fibers [6], and basalt fibers [7]. The emerging natural fibers include coir fiber [8], wheat straw, barley straw, wood shavings [9], bamboo fiber [10], and oil palm empty fruit bunches (OPEFBs) [11,12]. In contrast to synthetic reinforcements such as geotextiles and geogrids, fiber reinforcements can be easily implanted for slope improvement and thin-layer reinforcement in field applications [13]. The inclusion of fibers is an efficient method for decreasing the cement content of collapsible soils [3]. Wu et al. [14] reported that natural fibers contribute not only to reinforcement, but also to proprotectainst slope soil losses and riverbed erosion; they can also provide filtration or drainage for eliminating heavy metals.

Soil stabilization with fiber is influenced by many factors, including the amount of fiber [1,2,4–7,9,10,12,15,16], fiber length [5,7,10,15], moisture contents of the samples [16], fiber characteristics [6,9,12,17], fiber diameter [10], soil properties [2,17], and soil stress [1,8,17]. In some cases, natural fibers can absorb sufficient quantities of water [9,18,19]. This causes an increase in the fiber's moisture content, resulting in poor interface adhesion between the fiber and composite material [19]. Arifin et al. [11,20] found that a 7% OPEFB fiber absorbed water, allowing soft soil to be further compacted. Consequently, the compressive strength increased. In general, this tendency is particularly important for the stabilization of soft, high-water-content soils.

Although they have been widely studied, the interactions between soil and fiber remain very interesting for improving the geotechnical properties of soils. The shear strength of fiber-reinforced soil comprises two components: the shear strength of the soil matrix and the tensile stress acting on the fiber [13]. In addition, the contribution of the fiber to the increase in shear strength is caused by the bonding of the soil and fiber in the pull-out mechanism as well as the tensile strength of the fiber itself [16]. These mechanisms explain the interactions between the soil and fiber in general, but other interactions may occur between the soil and fiber, especially natural fibers. However, it is still unclear which of the two mechanisms—the shear of the soil matrix with the fiber or the tensile strength of the fiber—is the most