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Method for the construction of a rammed-earth wall using soil-cement

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ABSTRACT

In this report, we describe a method for the construction of a rammed-earth wall made of soil-cement, which was developed using ground-improvement technology. The rammed-earth wall is constructed using compaction and hardening agents. We performed a test for the physical properties of soil, a compression test, and an atmospheric exposure test. We also examined the solidification material, solidification-assistance material and fibers, including the type and amount used. The results showed that Portland blast-furnace slag cement was the most suitable solidification material, methyl cellulose was the most suitable solidification-assistance material and vinylon was the most suitable fiber. The strength, durability and water-tightness of an earthen wall were tested over a period of 12 months. Based on these results, we identified the ideal proportions of materials and the construction method.

KEY WORDS: Soil-cement, earthen wall, vinylon fiber, methyl cellulose, Portland blast-furnace slag cement

INTRODUCTION

It would be useful to be able to construct an earthen wall by using soil generated during the construction of a building site. The ability to construct an earthen wall around a building site should also reduce the cost of disposing of surplus soil, and improve the appearance of the overall area, since an earthen wall is more attractive than a concrete block wall. In addition, a small-scale warehouse could be constructed with an earthen wall. Another advantage is that an earthen wall can be constructed in any location worldwide. From ancient times, people have treated the soil for use as a material in construction. With regard to the use of soil-cement, rammed-earth homes are well known in the United States.

In Japan, rammed-earth walls are popular, although there is a problem with durability because of the high humidity. The criteria used to select and combine soil mixtures are not part of the general public knowledge. This information has traditionally only been available to plasterers through the master-apprentice relationship. Therefore, the ability to construct earthen walls of uniform high quality is not yet available in Japan. In this report, we describe the construction of a rammed-earth wall made of soil-cement, which was developed using ground-improvement technology.

TEST OF THE SUITABLE CHARACTERISTICS OF THE SOIL FOR USE IN AN EARTHEN WALL

Purpose

To construct an earthen wall with sufficient strength and durability, we must begin with an appropriate soil. Therefore, we clarified the physical properties of soil in terms of the moisture content, wet density, grain size distribution, liquid limit, plastic limit and unconfined compressive strength.

Experiment

We used the following 11 soil specimens in this experiment: 4 types of artificial compound soil a Kanto loam, 3 types of gardening soil and 3 types of mud wall soil in Kyoto. For the artificial compound soils, Kasaoka clay was mixed with silica sand No. 7 in ratios of 10:0, 7:3, 5:5 and 3:7 respectively.

Table 1 shows the physical properties of the soil specimens, and Fig. 1 shows the grain size distribution. In the test, we assumed that the hardest material would be obtained when the wet density was maximum, and the wet density was assumed to be associated with the moisture content. After the soil specimen was put in a steel form that measured φ50mm×100mm, we compacted it with a wooden stick (section of 30mm×30mm). The optimum moisture content that corresponded to the maximum wet density was obtained from the curve of wet density and moisture content. The moisture content of each soil was set from 10% to 100% in steps of 10%. The specified design strength was set at 0.5N/mm^2, which is sufficient to support the self-weight of the earthen wall.

The atmospheric exposure test was conducted on a rooftop at Tokai University, Shonan Campus in Kanagawa Prefecture, Hiratsuka City in Japan. The specimens measured 100mm x 200mm x 100mm. Table 2 shows the conditions used to make the test specimens.