DEVELOPMENT OF A SOIL BASED FLOORING MATERIAL FOR TROPICS

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Degree of Doctor of Philosophy in Civil Engineering

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Abstract

The unplanned and rapid growth of developments has led to adverse impacts on the climate and biodiversity. Among them, the building industry is one of the foremost sectors. Therefore, the proper selection of building materials and techniques is of prime importance. Out of several sustainable materials, the soil has gained more attraction due to its advantageous features. Hence, this century has seen several notable milestones after passing thousands of years with the usage of soil in construction. Earthen flooring is one aesthetically attractive building element that has recently been restored and modernized. In fact, terrazzo, ceramic tiles woods, etc. are the widely available flooring materials associated with certain undesirable features. Hence, a necessity has arisen to seek alternative flooring materials. However, soil as a flooring material has not been investigated properly. Therefore, this research focuses on developing soil as a flooring material with sustainable features while pursuing possible means of increasing the strength of soil as a flooring material and enhancing the top surface finish. Then, the durability and service characteristics, cost benefits, thermal performance would be evaluated with the behavior on a real scale. The optimum soil gradation was first investigated. Next, investigation results showed that the increase in water content causes a decrease in the compressive strength, linearly at a constant rate for all cement percentages. The selected soil cement mix with water form a concrete and 150 mm standard cubes were used to determine the compressive strength. The best size and shape of test specimens were predicted and the relationship between compressive strength and specimen size and shape was identified in this background. Consequently, soil concrete was tested with the addition of metal as a course aggregate, but it did not influence the improvement of compressive strength in a significant level. Soil concrete with chemical admixtures showed that the admixtures were useful to enhance the workability and strength. The Mixed proportion consisted of fine particle contents 0-10%, a sand content 55%-60%, gravel content 30%-35% with a maximum gravel size of 25mm. The required cement was 18%-20% that depended on the usage of the admixture. The required moisture range was 16%-19% for soil concrete without admixtures to achieve a workable mix. To form the top surface to be architecturally attractive and for smoothness with regard to user comfort, the surfaces were smoothened in this background. Among several resins, one synthetic resin and floor sealer were selected and applied on the prepared soil floor samples as a surface coating. The Phenol-formaldehyde (novolac) resin was selected and cured with the Hexamethylenetetramine (HMTA) with heat treatment. The bonding capacity of coating in the soil floor, the water absorption, the abrasion resistance, the slip resistance and the stain resistance were analyzed according to the relevant standards to evaluate the soil floor with the resin coating for durability and service characteristics. Though all the tested parameters were within the standard requirements, the abrasion resistance of resin surface failed in this context. However, the floors which were with floor sealers showed positive results. At the end of the series of experiments, the mixing proportion, the top surface finishing material and the method of construction were decided for the continuation of the research. Thermal performance and cost benefits were then evaluated and compared with other selected existing floorings. According to the temperature variation pattern, the soil floor showed a significantly low top surface temperature compared to the other floorings and indoor air temperature. In fact, the Life Cycle Cost (LCC) for soil floor is significantly less compared to other existing floorings.

Finally, the study findings suggest that soil could be used as a flooring material and a floor sealer could be used as a top surface finishing layer with a long-term sustainability. However, further research is required to find the suitability for a building's upper floors and the use of natural resin as a top surface finishing material.

Keywords: soil-based construction, soil concrete, sustainable flooring materials, self-compacting in-situ cast floor

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