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Structural Characteristics of Developed Sustainable Lime-Straw Composite

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Abstract

Construction materials made of renewable resources have promising potential given their low cost, availability, and environmental friendliness. Although hemp fibers are the most extensively used fiber in the eco-friendly building sector, their unavailability hinders their application in Iraq. This study aimed to overcome the absence of hemp fiber in Iraq and develop a new sustainable construction material, strawcrete, by using wheat straw and traditional lime as the base binder. A comparable method of developing hempcrete was established. The experimental program adopted novel Mixing Sequence Techniques (MSTs), which depended on changing the sequence of mixed material with fixed proportions. The orientation of the applied load and the specimen's aspect ratio were also studied. The mixing proportion was 4:1:1 (fiber/binder/water) by volume. Results showed that the developed strawcrete had a dry unit weight ranging from 645 kg/m3 to 734 kg/m^3 and a compressive strength ranging from 1.8 MPa to 3.8 MPa. The enhanced physical and strength properties varied with the MST and loading orientation. The properties of the developed hempcrete were compared with those of strawcrete.

Keywords: Hempcrete; Strawcrete; Wheat Straw Fiber; Mixing Sequence Technique; Compressive Strength; Loading Orientation; Strength Rating.

1. Introduction

In recent years, the tendency for designing low-environmental-impact buildings to meet the requirement of ecosystems has emphasized on the global use of bio-aggregate-based concretes. The term bio-aggregate concretes refers to the mixture of binders (lime, clay, plaster, and cement) and natural fibers (hemp, straw, flax, bamboo, and animal hairs) [1]. In this context, the use of eco-friendly concrete such as hempcrete [2], wood-concrete [3], papercrete [4], and mud-concrete [5] has been growing considerably. Hempcrete is most widely used in the field of green construction owing to its remarkable environmental quality as a non-CO_2 producer [6, 7]. Furthermore, walls made of hemp–lime composite exhibit better sound absorption and thermal isolation than conventional concrete walls [8]. Hempcrete had been introduced in the early 90s in France by using the matrix of lime and hemp shiv particles [9]. From the construction point of view, hempcrete, similar to several biomass concretes, is predominantly non-load bearing material; nevertheless, its strength is important to provide the solidity to hold its own weight [10, 11].

The strength of hempcrete significantly depends on the binder type, density, and morphology of hemp fiber. Hempcrete density varies with the applied tamping effort [12]. Four levels of densities are usually identified to be vary from very light density to high density [13]. Extensive research has been undertaken to determine the factors affecting hemp concrete strength. E. P. Aigbomian [14] stated that the compressive strength of hemp concrete varies with mixture

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