Construction and Building Materials 184 (2018) 143–150

Contents lists available at ScienceDirect

Construction and Building Materials

journal homepage: www.elsevier.com/locate/conbuildmat

Strength development of termite mound cement paste and concrete

Augustine Uchechukwu Elinwa

Civil Engineering Department, Abubakar Tafawa Balewa University, PMB 0248, Bauchi, Bauchi State, Nigeria

HIGHLIGHTS

- Termite mound clay is pozzolanic in action, and accelerates setting times.
- It has high affinity for water.
- The compressive strength decreased as percentage of termite mound clay by wt% of cement increased.
- Statistical analysis showed that reliable concrete of good quality can be produced.

ARTICLE INFO

Article history:
Received 23 February 2018
Received in revised form 9 June 2018
Accepted 27 June 2018

Keywords:
Termite mound
Splitting tensile
Compressive strength
Water absorption and statistical parameters

ABSTRACT

The strength development of termite mound cement paste and concrete was investigated using the termite clay mound material to replace cement by mass in the proportions of 0%–25%, and evaluating its effects on the termite mound clay paste and concrete. The setting times of the material showed, it behaved like an accelerator. The compressive strength decreased as the percentage replacement increased, and 5%–20% of the material can be used to produce good quality concrete. The statistical evaluation further confirmed the suitability of the material for concrete production.

1. Introduction

Termites are the most important soil fauna of the semi-arid tropics [1]. Soldier-ants (Termites) are polymorphic social insects that live in nests known as mounds or termitaria (Fig. 1). Termite mound is composed of 46% sand, 44% silt and 10% clay, with compressive and bending strengths of the magnitude 5.1 $\pm$0.3 and 1.3 MPa, respectively [2]. The function of the mound is to house and protect the colony, store food and maintain optimum environment. Termite mounds have been classified as nuisance to agricultural farm lands because of the space occupied and voracious nature of the termites themselves [3]. An extract of the brown acidic substance of the soldier termite (petroleum ether) is cementitious. It is a mixture of acetic, 2-aminno glucose protein, both being hydrolysis products of chitin and proctodeal matter [4]. The primary objectives in using termite mound had always been to investigate the pozzolanic potentials of the material and therefore, its effects on cement mortar and concrete properties is very important for proper application [3]. The reason for this had been that over 24 (Twenty four) species are found mostly in the northern part of Nigeria, which is arid to semi-arid. Olusola et al [5] in their work have encouraged the used of these 'seemingly' less-fancied natural products as construction material especially in low-cost housing, and housing developers in investing in house construction incorporating these materials.

Fig. 2 shows the section of the incredible termite mound [6]. The termite mound has been in focus recently as a viable alternative in many of the engineering and architectural activities. In 2006, a team of mechanical and civil engineers at Loughborough University, UK, hoped to construct buildings that can create comfortable living conditions by extending our use of renewable forms of energy by unlocking a few of the mysteries in the termite mounds on the plains of Namibia, Africa [7]. The detailed description of the items marked as (1)–(5), are contained in the Animal House [7].

2. Review of past works

Studies on the physical and chemical properties of termite mounds have indicated that micro landforms are important bioengineers [8]. Reddy [9] undertook a study on the termite mound, as an effective geotechnical tool in mineral exploration, using ten

E-mail address: auelinwa@atbu.edu.ng

https://doi.org/10.1016/j.conbuildmat.2018.06.220
0950-0618/

Fig. 1. Termite Mound.

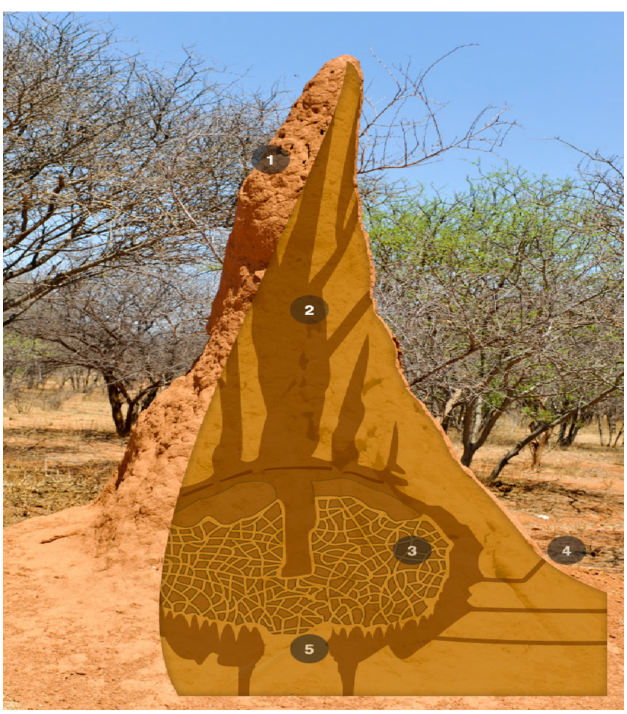

Fig. 2. Section of Termite Mound [7]

(10) samples from Chromite mining area of Kanataka, India. The results of the chemical analysis are shown in Table 1. The elemental analysis of soils and termite soils showed that generally, concentrations of Cr and other associated elements Co, Ni, Pb, Zn, Cu, Fe, Mn, and Mo, are higher in termite soils than those of their adjoining surface termite free soils. The values obtained are indicator characteristics of the moulds for the prospecting of these minerals. The same was also collaborated in the works of Ackerman et al [10]. They worked on the impact of mould-building termites on surface soil properties in a secondary forest of central Amazonia, analyzing twenty termite mounds. Table 2 shows the chemical analysis of the termite mound.

Millogo et al [2] investigated the plasticity and mechanical behaviour, and the microstructure of a mound material. The objective of the study was to assess, how far this material could be considered as a construction material. They used the x-ray diffraction, thermal analyses, scanning electron microscopy and energy dispersive x-ray spectrometry for the analyses. Table 3: showed the chemical composition and Atterberg limits of the studied mound. Some of their results showed that the mound consisted of quartz, kaolinite and K-feldspar (76, 21 and 3 wt%, respectively) as well as organic matters, Also, the magnitudes of porosity and mechanical strength were comparable with those of adobe brick-sand was much lower (Tables 4 and 5).

Elinwa [3] undertook the study of calcined soldier-ant mound clay (CSAMC), and its effects on cement mortar and concrete. He mounted experiments both in the fresh and hardened conditions. Calcined soldier-ant mound clay was used to replace cement in proportions of 0%–40%, by mass of cement to produce cement and mortar pastes which were used for the determination of the setting times, temperature and degree of hydration, and compressive strength respectively. He also used a mix of 1: 2: 4 with w/c ratio of 0.6 as a reference mix, while four other mixes containing CSAMC in proportions of 0%–40%, by mass of cement to determine the slump, flexural and split tensile strengths of the concrete. Some of his conclusions are that CSAMC is pozzolanic, can reduce the heat of hydration by about 17%, when cement was replaced with 40% CSAMC, and accelerated the setting time of concrete. The mortar compressive strength of mix containing 10% CSAMC superseded the reference mix when cured above 60 days. The ratio of the splitting tensile strength to flexural strength was approximately 0.33.

Olusola et al [5] investigated the use of termite hill and lime as partial replacement for cement in plastering. The compressive strength and water absorption capacity of mortar cubes made from mixes containing lime termite hill and cement and sand were used for the investigation. They used mix ratios of 1: 4 and 1: 6, and varying binder replacements of cement with lime or termite hill in varying proportions of 0%, 10%, 20%, 30%, 40% and 50% were used. The results showed that the compressive strength of the mortar cubes increased with age and decreased with increasing percentage replacement of cement with lime and termite hill. However, the mix with termite hill/cement performed optimally both in compressive strength and water absorption, and the optimum performance was at 50% replacement.

Ikponmwosa et al [11] studied the strength characteristics of concrete cubes and beams with cement partially replaced by uncalcined soldier-ant mound clay (SAMC). The soldier-ant mound

Table 1
Concentration of trace elements (in ppm) of termite soils.

Chemical composition (ppm)								
Cr	Co	Ni	Pb	Zn	Cu	Fe	Mn	Mo
1400–4500	13–35	38–72	15–45	35–60	12–50	75–200	25–100	4–10
Average value								
67.746	21.9	51.6	27.0	47.2	28.9	126.0	62.0	6.4