EVALUATION OF THE COMPRESSIVE STRENGTHS OF SOME LOCAL CANAL LINING MATERIALS

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ABSTRACT

The compressive strengths of some local materials were determined to ascertain their strength and suitability for canal lining. These materials were: (i) Concrete (GC): which comprised of Cement, Sand and Granite of average sizes of between 9.0 mm and 14 mm, in a ratio of 1:2:4. (ii) Termite Mound (TM) (iii) Clay Cement (CLC) (iv) Cementitious Clay (CCL), and (v) Clay Soil (CLS). These materials were moulded into 100 mm x 100 mm x 50 mm and allowed to cure for 28 days. The compressive strengths were determined at 7, 14, 21 and 28 days during the curing period. Concrete had the highest compressive strength of 2.373 N/mm^2, followed by Burnt Cementitious Clay, Clay Soil, Clay – Cement and Termite Mound, with values of 1.233 N/mm^2, 1.188 N/mm^2, 0.692 N/mm^2 and 0.315 N/mm^2, respectively. Results also showed that the compressive strengths increased as the curing days increased, while the dry density decreased. The materials can compete favourably with concrete in terms of strength.

KEYWORDS: Irrigation, compressive strength, canal lining, demoulded sample.

1. INTRODUCTION

The conveyance of water from the source to the farm and the losses encountered had been the greatest headache of farmers. The volume of water lost in conveyance is so enormous that if judiciously harnessed, it can be used to expand area of irrigation. Saving water is very Germaine to the production of food and meeting the urban water requirements. Therefore, lining of a canal is essential for efficient use of land and water resources (Swamee *et al.,* 2000).

Kasali *et al. (*2002), enumerated the materials currently used globally for canal lining as concrete, Polyvyl chloride (PVC), Asphaltic material, Polyethylene compounds, stone and brick masonries, etc. In many countries, low cost materials such as impermeable earth, bentonite, polythene sheets, etc, are being used as low cost linings to minimize water losses in irrigation at varying degrees of success but their durability is very uncertain (Khair *et al.,* 1991).

The conventional lining materials are expensive. It is therefore necessary to search for potential lining materials that are local and found in the vicinities of small holder irrigation farmers. The use of these materials will necessitate having the knowledge of their compressive strengths. Concrete which is usually used for lining in Nigeria and globally is particularly expensive due to the high cost of two of its components; cement and granite.

The escalating cost of cement is as a result of the energy crisis in Nigeria, which has an astronomical effect on its cost of production. Most of these local lining materials, especially Termite Mound and Clay soil have been confirmed to be efficient in lining of irrigation canals (Akamigbo, 1984; Hong *et al*., 2007); but little is known on their strength, an attribute that allows lining materials to withstand scouring. Compressive strength is the most often used property for determining the response of a material to maximum compressive loading per unit area. This property can be used as one of the indices to ascertaining the durability of a material.

The objective of this study was to determine the compressive strength of these materials to ascertain their suitability in irrigation canal lining.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was carried out at the National Centre for Agricultural Mechanization (NCAM), Ilorin. Ilorin is geographically located in the middle belt of Nigeria with a vegetation of derived savannah, and is situated on a longitude of 4^0 30' E and latitude of 8^0 26 N.

2.2 Sample Preparation

Samples of each of the treatment materials of dimension 100mm x 100mm x 50mm were prepared. The concrete samples were mixed at a ratio of 1: 2: 4 (Cement: Sand: Aggregate) in accordance with BS 1881(1970). A coarse aggregate of average sizes between 9.0 and 14.0 mm was used in the mix. The metal moulds were cleaned and oiled to ease the quick removal of the moulded concrete samples from the boxes without cracks. The mix was then moulded into the metal boxes. The moulded specimens were demoulded after 24 hours of casting and air-dried under a shed during the curing period.

Other samples; Clay, Termite and Cementitious - Clay, were also mixed with water and moulded into plastic mixtures. The samples were moulded in metal boxes of dimension 100mm x 100mm x 50mm. The moulded samples were air-dried under the shed to avoid cracking that could have occurred under direct sun- drying.

The resulted Cementitious - Clay moulds were demoulded after 24 hours of casting when the specimen had attained certain level of strength for handling. The Cementitious - Clay moulds were then arranged in a heap and traditionally fired at a temperature between 600 ^{0}C- 1300 ^{0}C (Apebo *et al.,* 2013).

Each specimen was weighed at 7. 14, 21 and 28 days, before the determination of the compressive strengths at the specified days. The weights were then used to compute the dry densities of the specimen to ascertain the changes in dry densities as the curing days increased.
The dry density was determined as:

$$\rho = \frac{Wms}{Vms} \tag{1}$$

where: ρ = Density of specimen (kg/m^3); W_{ms} = Weight of moulded specimen (kg);

V_{ms} = Volume of moulded specimen (m^3)

2.3 Compressive Strength of the Samples

Three samples from across the treatments were removed from the bulk samples for testing. The compressive strengths of the specimens were determined during the 28 - day curing period with the Universal Testing Machine (UTM) at ages of 7, 14, 21 and 28 days, respectively. At each measurement, the load was applied smoothly and gradually at the rate of 10mm/min. until the sample failed.

The compressive strength is given as:

$$\sigma = \frac{F_{\max}}{A_{ms}} \tag{2}$$

where: σ = Compressive strength (N/mm^2); F_{max} = Maximum load (N); A_{ms} = Area of moulded specimen (mm^2)

3. RESULTS AND DISCUSSION

Figure 1 shows the compressive strengths of treatments at 7, 14, 21 and 28 days of curing after lining. Results from Figure 1 show that the compressive strengths of all the treatments increased with increasing days of curing. This is expected because as the days of curing increased, the void in the specimen continued to reduce due to loss of moisture leading to loss of weight of samples and hence reduction in dry density (Table 1).

Table 1: Dry Density of Treatments Specimen

	Average Weight, Kg				Dry Density, kg/m^3			
Treatment	Curing Days							
	7	**14**	**21**	**28**	**7**	**14**	**21**	**28**
Clay-cement	1.875	1.179	1.061	0.923	1875	1179	1061	923
Concrete	3.000	1.598	1.535	1.500	3000	1598	1535	1500
Burnt Clay	0.900	1.181	1.160	1.200	900	1181	1160	1200
Clay	1.109	1.061	0.848	1.001	1109	1061	848	1001
Termite Mound	2.250	1.258	1.182	0.923	2250	1258	1182	923

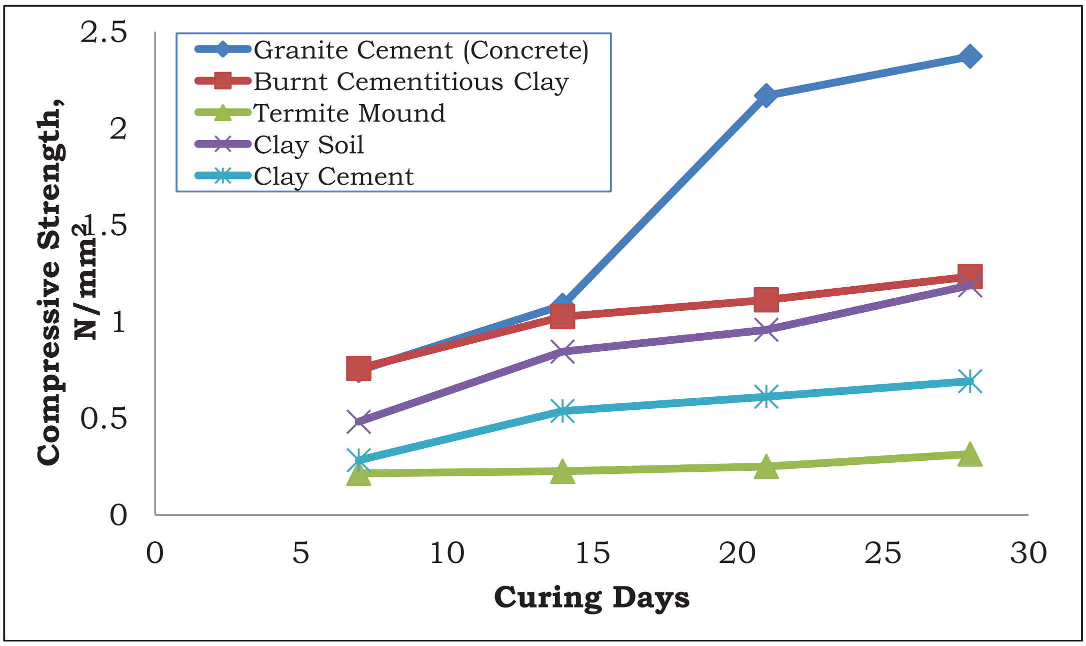

Figure 1: Compressive Strength of lining Materials

The compressive strength of Concrete of 2.373 N/mm^2 was the highest, followed by Burnt Cementitious Clay, Clay Soil, Clay – Cement and Termite Mound, with values of 1.233 N/mm^2, 1.188 N/mm^2,0.692 N/mm^2 and 0.315 N/mm^2, respectively. The values of the compressive strength of the samples were indicative of the stiffness of the composites of the samples and its resilience to scour and cracks that may lead to seepage. Since the forces acting on the lining are supposed to be the water pressure which is not a static load but evenly distributed along the channel, then the compressive strengths of the materials are adequate to resist scouring.

The low compressive strength of Termite Mound sample might be due to the high level of organic matter in the sample while, that of Clay - Cement sample might be due to the stabilization of the clay with cement. Ata *et al.* (2007), observed a decrease in compressive strength of sandcrete block as the percentage of laterite content increased.

Contrary to this, Aguwa (2009), reported a decrease in strength of stabilized laterite as the cement content increases. It could be deduced that the low value of the compressive strength of Clay – Cement might not be unconnected with the low proportion of cement in the clay in conformity with the results of Ata *et al.* (2007). Ithnin (2008), using various ratios of cement, sand and clay, obtained compressive strengths ranging between 0.29 N/mm^2 and 1.38 N/mm^2, which are similar to the range of results obtained in this study.

4. CONCLUSION

The study determined compressive strengths of some local materials as potential lining materials. The materials responded differently to maximum loading. The values of the compressive strengths revealed the resilience and stiffness of the materials. Since the lining materials are not subjected to static load bearing but being acted upon by hydrostatic forces, it is therefore concluded that these local materials have the potential and requisite strength for canal lining.

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