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Use of Cow Dung and Local Brewery Waste as a Partial Replacement of Cement for Plastering Low Cost Houses

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Abstract: *Globally the population grows on a daily basis so the need for housing. Sustainable construction is regarded as construction and management of the built environment and covering all aspects of sustainable human settlements and urban sustainability. It should be recognized that mankind is locked into a highly dynamic relationship with the natural world and that the two are acutely interdependent. So there is need to use non-conventional materials to embrace the aspect sustainable development. This paper presents the results on the study of the use of cow dung and local brewery waste as a partial replacement of cement for plastering low cost houses. Results show that at 40% and 50% replacement levels the compressive strength of mortar made from local brewery waste and cow dung increased as compared to the compressive strength of local brewery waste, cement sand mortar as a control which was above the minimum required strength. Hence indicating the potential of using cow dung and local brewery waste as a plastering material for low cost houses.*
Keywords: *Cow dung, Plastering, local brewery waste.*

I. Introduction

Throughout the world cement is a major construction material ([2]; [5]). However, given the environmental hazards associated with the use of cement there is urgent need to use alternative, cost-effective, non-conventional, locally available materials suitable for construction, especially those that can partially or wholly replace cement. Mehta [13]-[14] suggested that materials that use few natural resources, less energy, and minimize carbon dioxide emissions should be used to make environment-friendly concrete. Several studies have been undertaken to develop non-conventional materials;Ettu [9] investigated the compressive strength of binary and ternary blended cement containing cassava waste ash and plantain leaf ash and found that the compressive strength of cement sandcrete and soilcrete blocks increased at 150 days. Ogunbode and Akanmu [11] tested the strengths of cassava ash blended cement in laterized concrete and found a 46% reduction in the compressive strength. Faseyemei [14] found that cement replacement up to 10% with silica fume leads to an increase in the compressive strength, for C30 grade of concrete.

Currently, almost 50% of the world's population lives in Earth based dwellings [4]. Most of these earth constructions are found in the developing countries and are always plastered with mud plaster and rendered with cow dung slurry which is not resistant to weather. Therefore there is to find an environmentally friendly mix blending the local brewery waste, cow dung and cement in order to improve on the traditional method of plastering low cost housing.

II. Methodology

2.1 Compression tests

Specimens test for compressive strength for plaster cubeswas conducted from the laboratory according to the Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (ASTM C109). To perform this test, different plaster mixes were made from the cement-sand mix, cassava-flour-sand mix, local brewery waste-sand mix, cement-cassava sand mix, cement-local brewery waste-sand mix. A total of three cubes were made from each sample and tested for the compressive strength for 7, 14 and 28 days of curing. The testing was done in accordance with the standard procedures of cube testing using a Universal Testing Machine (UTM).The cube was removed from the curing place and dried by exposing it to air for a period of about two hours and then weighed with 0.5 g accuracy. The dimension of the cube was measured and the cube loaded in the compression test machine with trowelled faces perpendicular to the vertical axes to the machine. The cube was then tested, the maximum load and the compressive strength recorded.

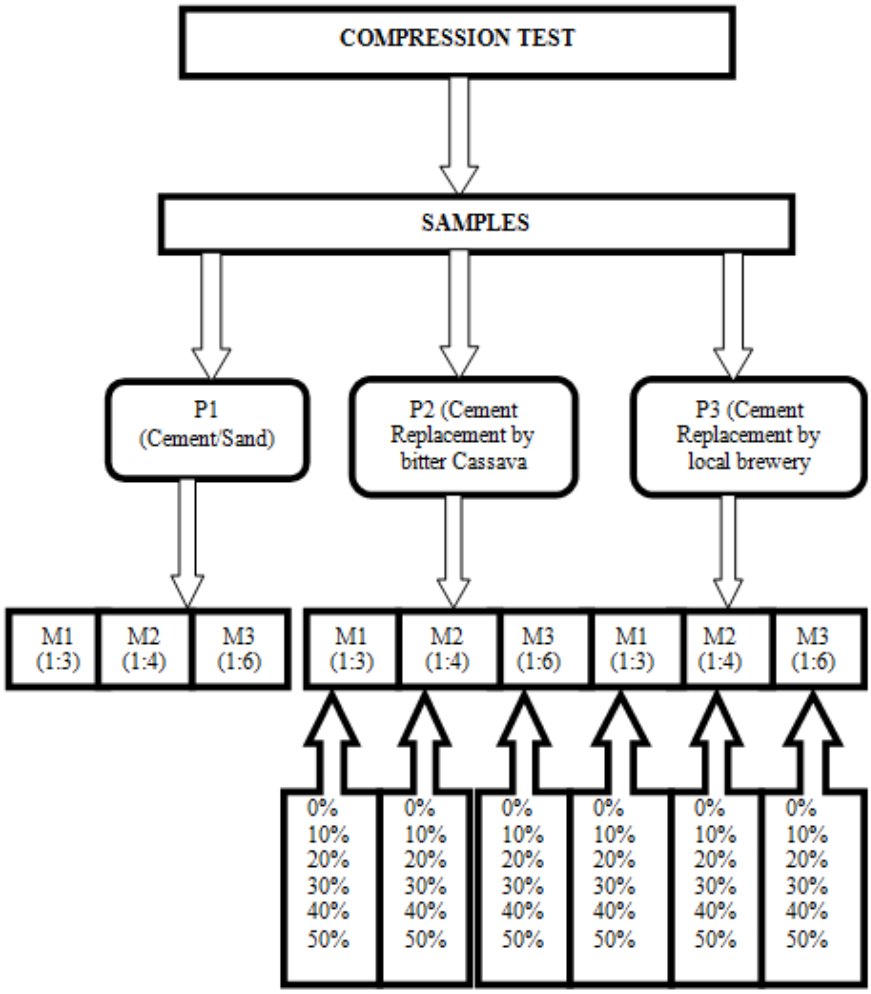

Figure 2.1: Diagram showing the schematic design of compression test

III. Results and Discussion

3.1 Compressive strength for mix ratio 1:3

Cement replacement with local brewery waste (P) and local brewery waste and cow dung (P+C) was investigated in this study ranging from 10%-50% and plaster cubes of 100×100mm. The cubes were cast in triplicates and tested on 7, 14 and 28 days of curing and the average compressive strength was determined.

3.1.1 The compressive strength of local brewery waste mortar

Local brewery waste is a by-product of cassava fermented alcohol after distillation. This waste was also investigated in this study ranging from 10-50% replacement of cement by weight. The results showed a reduction in compressive strength at 10% as compared to the bitter cassava flour and cement sand mortar. This great reduction in strength could be attributed to the increase in the water cement ratio [10], the presence of high amount of iron (Fe) about 8% as compared to that in cement and also due to the fact that cassava is mixed with other ingredients during the fermentation of the alcohol. At 10% replacement the attained compressive strength at 28 days was about 2.1 MPa which is slightly above the minimum requirement of the ASTM D1663 and the New Mexico Standards of 2.0 MPa. This strength can be used to plaster houses made from the above blocks. However, mortar cubes made of the local brewery waste and cement showed little reduction in the compressive strength as more cement is being replaced that is 20% 1.9 MPa, 30% 1.7 MPa, 40% 1.3 MPa and 50% 1.0 MPa. Mbereyaho [8] reported that the compressive strength of unburnt brick is 1.14 MPa. Several studies on the replacement of cement with other locally available materials reported a reduction in compressive strength. For example, Balwaik and Raut [1] reported that reduction in the compressive strength when cement was replaced with paper pulp. Ogunbode [11] reported a reduction in the compressive strength when cement was replaced with cassava ash. This finding relates well to the findings of this study. All levels of replacement with local brewery waste did not meet the minimum requirement for mortar for low cost housing as specified in ASTM C270 of 2.4 MPa.

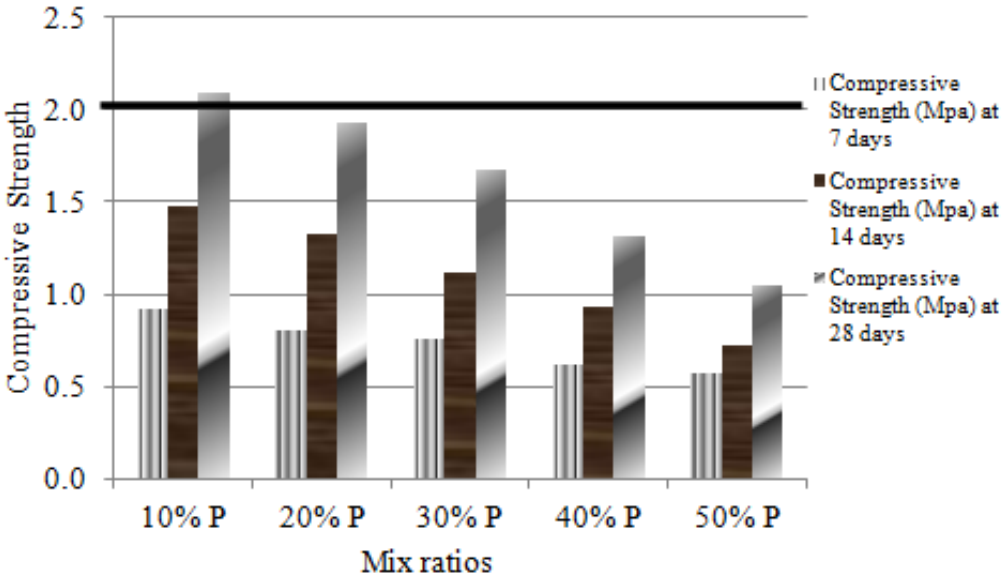

Figure 3.1: The compressive strength of local brewery waste and cement mortar

3.1.2 The compressive strength of local brewery waste and cow dung powder mortar

In an attempt to try to improve on the compressive strength of local brewery waste, cow dung was collected, sundried and milled using a milling machine to produce cow dung powder which was used in this study. It was found out that at 10% replacement with 5% constituting cow dung powder and 5% local brewery waste the compressive strength (1.6 MPa) reduced as compared to the one earlier on found with local brewery waste (2.1 MPa) and this trend was observed up to 30%. These were still below the required standards specified in the BS 5628, KS 02-170:1993 and ASTM D1663 as the minimum strength for earth stabilized blocks. It was also below the minimum requirements for ASTM C270 for mortar requirements for low cost housing. But at 40% and 50% the compressive strength increased as compared to local brewery waste alone (1.3 MPa and 1.0 MPa Vs 2.0 MPa and 2.6 MPa) which satisfy the minimum compressive strength for mortar for a stabilized earth block constructed house as specified by the ASTM D1663 and Kenya standards KS 02-170:1993.

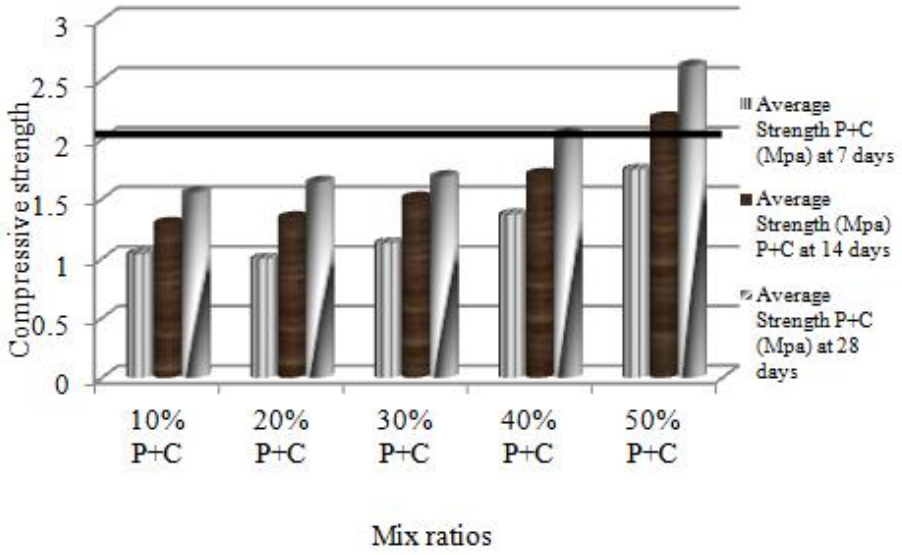

Figure 3.2: The compressive strength of local brewery waste , cow dung cement and sand mortar.

3.2 Compressive strength for mix ratio 1:4

Cement replacement with local brewery waste (P) and local brewery waste and cow dung (P+C) was investigated in this study ranging from 10%-50% and plaster cubes of 100×100mm. The cubes were cast in triplicates and tested on 7, 14 and 28 days of curing and the average compressive strength was determined.

3.2.1 The compressive strength of local brewery waste mortar

Pitti pitti is a by-product of cassava fermented alcohol after distillation. This waste was also investigated in this study ranging from 10-50% replacement of cement by weight. The results showed a reduction in compressive strength at 10% as compared to the bitter cassava flour and cement sand mortar. This great reduction in strength could be attributed to the increase in the water cement ratio [10] the presence of high amount of iron (Fe) about 8% as compared to that in cement and also due to the fact that cassava is mixed with other ingredients during the fermentation of the alcohol. However, mortar cubes made from the local brewery waste and cement sand showed small reduction in the compressive strength as more cement is being replaced. Mbereyaho [8] reported that the compressive strength of unburnt brick is 1.14 MPa. Several studies on the replacement of cement with other locally available materials reported a reduction in compressive strength ([6] [1]). These finding relates well to the findings of this study. All levels of replacement with local brewery waste did not meet the minimum requirement for mortar for low cost housing as specified in ASTM C270 of 2.4 MPa.

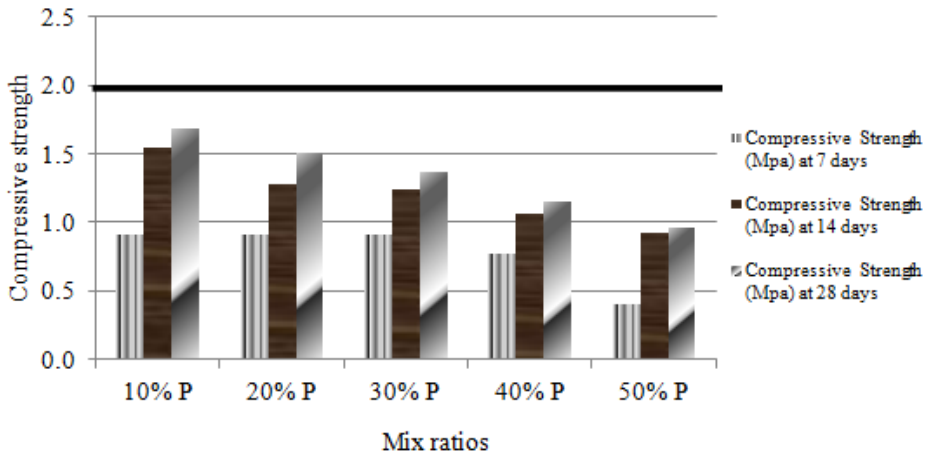

Figure 3.3: The compressive strength of local brewery waste ,cement and sand mortar

3.2.2 The compressive strength of local brewery waste and cow dung powder

It was found out that at 10% replacement with 5% constituting cow dung powder and 5% local brewery waste the compressive strength (1.5 MPa) increased as compared to the one earlier on found with local brewery waste (1.6 MPa) this trend was observed up to 50%. These were still below the required standards specified in the BS 5628, KS 02-170:1993 as the minimum compressive strength for earth stabilized blocks. It was also below the minimum requirements for ASTM C270 for mortar requirements for low cost housing of 2.4 MPa.

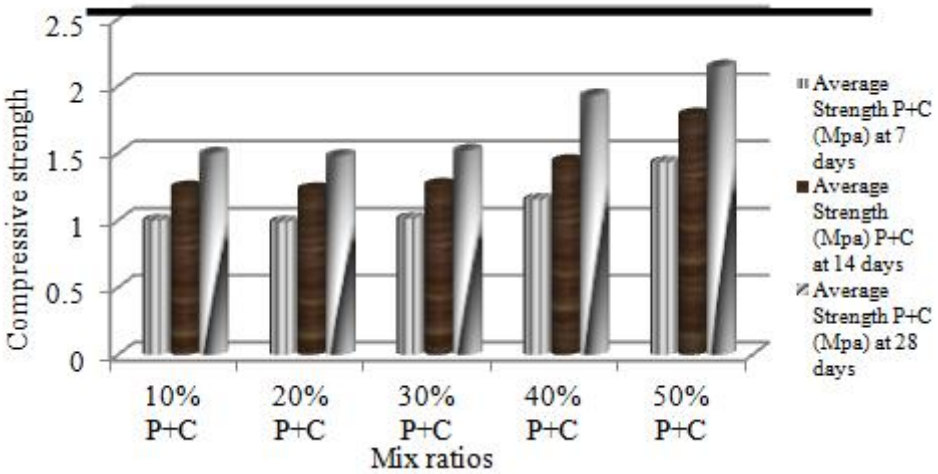

Figure 4.9: The compressive strength of local brewery waste, cowdung, cement and sand

3.3 Compressive strength for mix ratio 1:6

Cement replacement with local brewery waste (P) and local brewery waste and cow dung (P+C) was investigated in this study ranging from 10%-50% and plaster cubes of 100×100mm. The cubes were cast in triplicates and tested on 7, 14 and 28 days of curing and the average compressive strength was determined.

3.3.1 The compressive strength of local brewery waste

In the mix ratio of 1:6 local brewery waste was also investigated in this study ranging from 10-50% replacement of cement by weight. The result showed a significant reduction in compressive strength at 10% as compared to the bitter cassava flour and cement sand mortar. This great reduction in strength could be attributed to the increase in the water cement ratio [10], the presence of high amount of iron (Fe) about 8% as compared to that in cement and also due to the fact that cassava is mixed with other ingredients during the fermentation of the alcohol. This mix ratio attained very low compressive strength below all the specified standards as the minimum required compressive strength of a stabilized blocks used for the construction of an eco house. However, this plaster can still be used for plastering mud houses since Mbereyaho [8] reported that the compressive strength of unburnt brick is 1.14 MPa. Balwaik and Raut [1] Ogunbode *et al*.[11] reported reduction in compressive strength when cement was replaced with locally available materials. This finding relates well to the findings of this study. All levels of replacement with local brewery waste did not meet the minimum requirement for mortar for low cost housing as specified in ASTM C270 of 2.4 MPa.

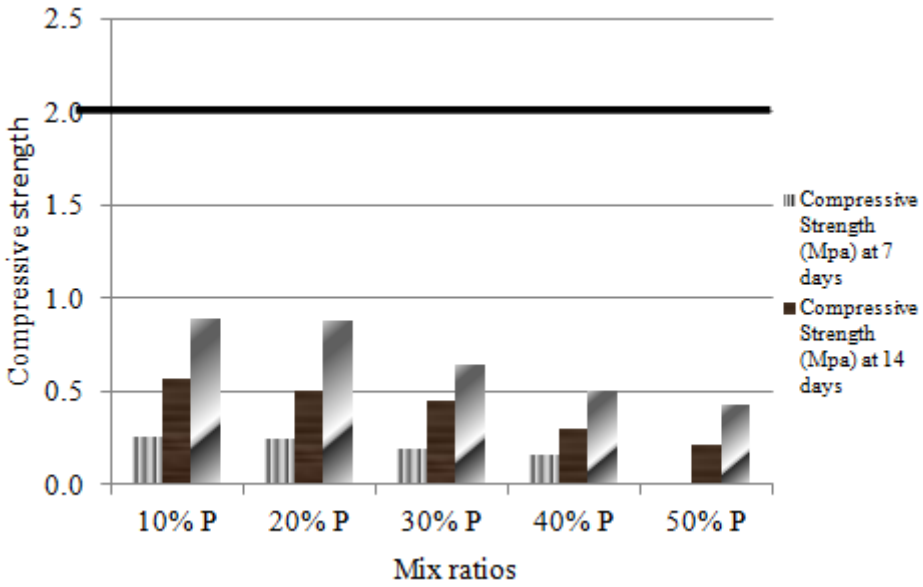

Figure 4.11: The compressive strength of local brewery waste,cement and sand mortar

3.3.2 The compressive strength of local brewery waste and cow dung powder

It was found out that at 10% replacement with 5% constituting cow dung powder and 5% local brewery waste the compressive strength (0.89 MPa) increased as compared to the one earlier on found with local brewery waste (0.96 MPa) and this trend was observed up to 50%. Much as there was increase in the compressive strength they were still below the required standards specified in the (BS 5628, KS 02-170:1993) as the minimum strength for earth stabilized blocks. It was also below the minimum requirements for ASTM C270 for mortar requirements for low cost housing.

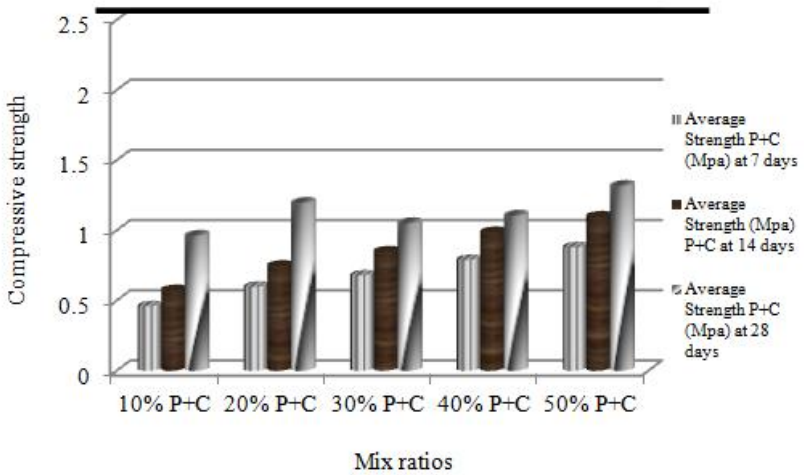

Figure 4.12: The compressive strength of local brewery waste,cow dung, cement and sand mortar

IV. Conclusion

At 40% and 50% replacement levels the compressive strength of mortar made from local brewery waste and cow dung increased as compared to the compressive strength of local brewery waste mortar. This strength is above the minimum required strength for mortar for low cost houses hence indicating the potential use of cow dung, local brewery waste as a partial replacement of cement for plastering low cost housing.

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