Performance Of Compressed Lightweight Concrete Manufactured Using A Blend Of Sawdust, Fish Scales And Sand Aggregates

Timothy Ong’ino Oluchiri
Jomo Kenyatta University of Agriculture and Technology
timothyoluchiri@yahoo.com

Prof. Oyawaw Walter O
Jomo Kenyatta University of Agriculture and Technology
oyawaw@yahoo.com

Mathew Winja
Jomo Kenyatta University of Agriculture and Technology
mathewwinja@yahoo.com

Civil Engineering Department, Jomo Kenyatta University of Agriculture and Technology

Abstract: The performance of Masonry blocks with partial replacement of sand by sawdust blended with crushed and grounded fish scales is evaluated. The parameters used in this study comprised of analyzing the physical properties and compressive strength of the specimens. Both sawdust and fish scales are by-products of industrial processes and are considered to be waste organic materials. The blocks are manufactured by replacing sand by sawdust and crushed fish scales combined in specified ratios at 5%, 10%, 15% and 20% by weight. Both sawdust and crushed fish scales were subjected to a pre-treatment process that involved washing and sun drying them for 24hrs to remove all impurities and moisture content in them. In the case of fish scales grinding had to be done. Then they were mixed with lime to allow for compatibility with the cement matrix at 5% proportion. The analysis of the mixture was undertaken for a compressive strength for the masonry blocks on the 7th, 14th, 21st and 28th days. The compressive strength of the blended masonry blocks was found to be 5.7N/mm² which conforms to the acceptable standards of lightweight blocks. The production of masonry with a replacement of upto 5% fine aggregates for the sawdust blend is found to be viable. This research study aims to assist the construction industry to achieve low cost housing for low income earners.

Keywords: Masonry blocks; organic materials; Pre-treatment; compressive strength ; Compatibility; sun drying; low cost housing

1.0 Introduction
Building materials are said to constitute the single largest input in the construction of housing and other buildings accounting for about 70 to 80 percent of the total value of a building. Concrete which is a primary construction material is a combination of cement, fine and coarse aggregate and water, mixed in a particular proportion to get a particular strength. The cement and water react together chemically to form a paste, which bonds the aggregate particles together. The construction sector relies heavily on their conventional materials for the production of concrete. But the high and increasing cost of these materials has greatly hampered the development of housing and other infrastructural facilities in Kenya. It is the growing concerns of resource depletion and global pollution that has challenged many researchers and engineers to seek alternative options and hence develop new materials and technologies that rely on renewable resources (Oyedepo Joseph et al, 2014) these new aggregates include the use of agricultural and industrial waste materials in building and construction industry. Many of these by-products are used as aggregates for production of lightweight concrete. It is therefore, important that building materials are made available in sufficient quantities and at affordable cost. However, the materials available on the market, in most developing countries are either prohibitively expensive or are in scarce supply. Concrete is a primary construction material of modern age and over 13 billion metric tons being used every year (David Otieno Koteng , 2013). In Kenya the demand for natural aggregates the more specifically sand, has been rising tremendously due to rapid development of housing and other infrastructure works. Quite recently, several large infrastructure projects have been launched in several counties indicating that consumption of sand, ballast and cement is set to rise in the coming years (David Otieno Koteng 2013). High cost of building materials has affected many Kenyans who engage in cutting corners to achieve building production leading to collapse of these buildings.

2.0 Materials Sampling and Preparation

2.1 Aggregates
Aggregates are inert particles that are normally bound together by a cementing agent. The main characteristics of aggregates that influence the strength, durability and workability of concrete are cleanliness, grading, hardness and the shape. Both organic natural aggregate sawdust and grounded fish scales and inorganic natural i.e. sand are being blended for production of lightweight masonry blocks.

2.1.1 River sand Fine Aggregate
The fine aggregate used in river sand obtained from river Nzoia. The sand was free from any visible impurities and...
conformed to the requirements of BS 882 (1992) grading for fine aggregates.

River sand

2.1.2 Sawdust
The sawdust was sourced from sawmills and furniture markets in Kakamega town. It consisted of different wood species including Eucalyptus (hard wood) and pine trees (soft wood) which are widely used in furniture making in town. The sawdust was collected in plastic bags and sun dried for 24 hours to expel all moisture. To ensure uniform drying, they were thoroughly agitated and then stored in airtight and waterproof bags.

Saw Dust particles

2.1.3 Grounded Fish Scales (Course Aggregate)
Fish scales were obtained from the fish processing factories in Kisumu town and around the lake region, before being used the scales were subjected to a pre-treatment process that involved washing them to remove odor-smell; sun drying for 24 hours and then grinding to various sizes. They were then placed in airtight and water proof bags to avoid contamination and absorption of moisture from the air.

Dried and grounded fish scales

2.1.4 Cement and Lime
The cement used for this research was the commercially available Ordinary Portland cement of 32.5 grade and conforming to Kenya Bureau of Standards (KEBS).
2.1.5 Water
Portable water free from any visible impurities was used for this experiment.

2.2 Batching of materials
Batching materials for concrete was done by volume due to differences of specific densities of the aggregate. Batching was done in ratios of 1:2:3 and 1:2:4 with water-cement ratio of 0.55. the water cement ratio was increased by 0.8 to make it workable. The addition of sawdust-fish scale to concrete was done by 5% increment up to 20% by volume of the fine aggregate. In total twenty (20) concrete cubes of sizes 150mm*150mm*150mm were made after batching and mechanical mixing

Batched material

Batching is done by volume due to remarkable differences in specific gravity of materials

2.2.1 Optimum sawdust, sand and fish scales content
In this test, river sand is conventional concrete mix ratio of 1:1:5:3 for Portland cement, river sand and blended aggregates respectively was partially replaced with 5%, 10%, 15% and 20% of blended sawdust.

3.0 RESULTS AND DISCUSSIONS
The graphs below show the results obtained from the particle size distribution tests of sand, sawdust and fish scales aggregates.

Figure 1: Particle size distribution of sand
Effect of replacement of sand with saw dust and fish scales

Optimum Compressive Strength Test Samples

The variations of compressive strength with age at curing are presented in the charts and figures below. At the 28 days hydration period, only cubes made with 100% sand and 0% sawdust and fish scales met the required standards for concrete cubes. Only few samples at 5% replacement came closer to the standards and this could be taken as the optimum replacement of sand with sawdust and fish scales for strength criterion. The charts below show results obtained from the compressive tests after replacement of sand with saw dust and fish scales.
4.0 Recommendation and conclusion

- Based on the experimental investigation carried out in this study on the properties of sand, sawdust and fish scales concrete the following conclusion can be made:
  - As the proportions of sawdust-fish scales content increases concrete becomes less workable meaning that the water/cement ratio needs to be increased to make more mixes more workable
  - Considering the strength behavior of sawdust-fish scales blended concrete carried out a possibility exists for partial replacement of sand for the production of lightweight concrete
  - Optimum replacement of sand with sawdust-fish scales was found to be 5%. Beyond this limit concrete produced did not meet the minimum strength requirements
  - With the use of sawdust-fish scales concrete the benefits can be taken of the apparent availability of trees and sand and the low cost sawdust in many parts of the country. Thereby mitigating against pollution of...
the environment through the indiscriminate dumping and burning of sawdust and fish scales.

- When the sand-blended content is increased it is necessary to increase the water to cement materials ratio to attain optimum compressive strength.
- The compressive strength of density of concrete reduced as the percentage replacement of sand with sawdust blend content increased.
- Sand-blended concrete blocks can be used in situations where compressive strength is not a major requirement. A percentage of at least 5% can be used in producing concrete.
- Sawdust and fish scales aggregates can potentially replace 5% of sand in the production of concrete blocks.
- The compressive strength of the blended concrete blocks was found to be nearly 10 to 15% conventional concrete blocks.
- Thus the concrete blocks made with alternative concrete materials like saw dust and fish scales waste can be used for partition and filling purposes and nailing purposes where strength is not the criterion.

5.0 REFERENCES


[3] Antony Woode; Isaac Agyei-Boakye; Bright Aforia;David Kwame Amoah; Samuel Osei; Akambi Abn-dil Karimm and [4] Albert Kwadwo Abakah “Effect of sawdust on the compressive strength of concrete” ISSN 2224-5790 (paper) ISSN-0514 (online) Vol.8:No 11; (2016) Civil Engineering Department Accra Technical University, Po Box GP 561 Accra


[18]H. Z. Zhu; The development of regeneration of sawdust into concrete blocks.

[19]K. Ambiga, P. Meenakshi; Studies and Strength of Concrete by partial replacement of sand with sawdust.


[23]Neville A. M. (2000); “Properties of concrete”,


[30] R Sri. RAvindrarajah; Christopher Carrod; Nick Appleyant; “Development of sawdust concrete for block making; Centre for Infrastructure Research University Technology; Sydney Australia


