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Study on Utilization of Waste Plywood Dust as Partial Replacement of Sand in HCB Production

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ABSTRACT

River sand is large scale depletion of resources and costly due to transportation. Thus in this research, study was carried out to assess the feasibility of waste plywood dust which is easily located in Dire Dawa university as a sand replacement material in hollow concrete block production. Laboratory-based investigation was conducted by replacing sand with waste of plywood dust in proportions of 0% (control), 5%, 10% and 15% of sand and compressive strength behavior and density test of replaced waste plywood dust studied in comparison to controlled hollow concrete block. As a result, the replacement of fine aggregate with certain waste of plywood dust made the hollow concrete blocks lighter in weight and the compressive strength of waste plywood dust 5% replacement range satisfy the minimum compressive strength set by Ethiopian standard of HCB for class.

Key words: partial replacement, HCB and Plywood.

1. INTRODUCTION

The development in the construction industry all over the world is progressing. Many structures are being built, both residential and non-residential. As a result of the increase in the cost of construction materials, especially cement, crushed stone (coarse aggregate), sand (fine aggregate); there is the need to investigate the use of alternate building materials which are locally available. Since most building construction works consist of hollow concrete blocks; therefore, reduction in cost of hollow concrete block production will reduce the cost of building construction.

Requirement of large amount of sand with acceptable cost is one of the challenges in the construction around river areas and other relatively far sites. Investigation of alternative option for the source of such sand will have great import for the current construction activities in the country. (Ayenew. Y, Sep-2017)

As per the Ethiopia standard of specification in construction, hollow concrete blocks shall be classified in the following three classes:

Class A and B are load beading units and suitable for:

- ✓ External walls pointed, rendered and plastered
- ✓ The inner leaf of cavity walls or stonemasonry
- ✓ internal walls or partitions
- ✓ Panels in steel framed and reinforced steel framed buildings.

Class C - non- load bearing units suitable for:

- ✓ Non load bearing walls and partitions
- ✓ None load beating internal panels in steel framed and reinforced concrete buildings.

Plywood is a panel product built up wholly or primarily of sheets of veneer called plies. It is constructed with an odd number of layers with the grain direction of adjacent layers oriented perpendicular to one another. (Madison, 2010)

2. LITRATURE REIVEW

A study on comparative study on proportion of hollow concrete blocks to its compressive strength, the proportion of 1:5 (cement to sand) was proven to be the minimum proportion for gaining the target compressive strength of Quality. Mud content below 5% will not guarantee the target compressive strength reach precisely. Preliminary treatment of sand should be needed as the mud content more than or equal to 5% in order to avoid the failure of target strength. Water cement ratio of 0.5 was suitably workable for mixing the hollow concrete block as well as the target compressive strength. **(Rio, Feb-2016)**

Experimental study on Effect on Strength and Durability of Fly Ash Based Hollow Concrete Blocks Having Different Configurations Using Polypropylene Fibers concluded that any type of waste materials which can increase the concrete that can be used to make this kind of hollow concrete blocks so that this blocks should be made eco-friendly. Here I use the fly ash as a partially replacement of cement to made these hollow concrete blocks lighter in weight. **(pawar, Jun-2015)**

An investigation on the use of sawdust as partial replacement for fine aggregates in concrete production, concluded that sawdust was used to replace fine aggregates from 0% to 50% in steps of 10%. Concrete cubes measuring 150 x 150 x 150mm were cast and their compressive strengths evaluated at 7, 14, 21 and 28 days. Increase in percentage of sawdust in concrete cubes led to a corresponding reduction in compressive strength values. From the results, the optimum sawdust content was obtained at 10% and its corresponding compressive strength at 28 days is 7.41 N/mm^2 which falls

within the characteristic strength of plain concrete (7 – 10 N/mm^2). This concrete cannot be used for structural applications. **(Abubakar, May 2013)**

Experimental investigations on the effect of replacing sand with sawdust on the properties of concrete, with mix of 1:2:4 was used as control while sawdust was used to replace 25%, 50%, 75% and 100% of sand by volume. The percentage reduction in density are 5.96%, 12.44%,13.56% and 17.93% respectively while the corresponding percentage reduction in compressive strength were 57.5%, 68.1%, 83.7%, and 87.3% respectively. The results of the study indicate that both the density and compressive strength of concrete decreased as the percentage replacement increased but replacement of sand by sawdust produced a higher percentage reduction in compressive strength than in density. Sawdust can potentially be used as aggregate in the production of both non-structural lightweight concrete and structural concrete. **(Osei, April-2016)**

Study on the partial replacement of the fine aggregate with Teak Wooden Dust with the varying proportion in the concrete and to check the different properties of the concrete by comparing with the controlled concrete. The replacement of Fine aggregate (sand) with certain Teak wooden dust in concrete that makes the structure lighter in weight. For making M20 grade of concrete replacing sand with teak wood dust in proportions of 0%, 5%, 10%, 15%, 20%, 25% and 30%. The Workability, strength and durability test are studied in this project. The most important properties of concrete are the compressive strength and Tensile strength. Also, increasing the teak wooden dust incorporation caused decreases in unit weights and strength values of mortars with a parallel increase in water absorption values at all ages. **(Tiwari, Jan-2018)**

3. OBJECTIVES

The objectives of this research are:-

1. To determine replacement rates at which waste of plywood dust can be effectively put into service in hollow concrete block production.
2. To experimentally investigate the effects of waste of plywood dust in HCB production using density and compressive strength tests of produced blocks.
3. To compare the economic advantage of waste plywood dust HCB with the normal HCB.

4. MATERIAL AND METHODOLOGY

Plywood dust

Plywood is a panel product built up wholly or primarily of sheets of veneer called plies. Minimal edge-swelling makes plywood a good choice for adhesive-bonded tongue and-groove joints, even where some wetting is expected. Wood waste is produced by a number of sectors and as part of the municipal waste stream. But for this study we take form Dire Dawa university, which is available easily as waste and we conducted moisture content, water absorption, specific gravity and unit weight tests.

Water

The purpose of using water with cement is to cause hydration of the cement. Water in excess of that required for hydration acts as a lubricant between coarse and fine aggregates and produces a workable and economical concrete. In addition to this water is also used for washing aggregates and curing. Throughout the investigation, tap water supplied for drinking consumption was used.

Cement

Specifications for cement place limits on both its physical properties and often chemical composition of cement. Tests of the physical properties of the cements should be used to evaluate the properties of the cement, such that fineness test, setting time test, consistency test etc. In this research Pozzolana Portland cement (PPC) was used.

Aggregates

Aggregates are the materials basically used as filler with binding material in the production of HCB. Properties of aggregate such as shape and texture, size graduation, moisture content, specific gravity and bulk unit weight are important to produce well strengthen HCB. Mixes are prepared by using grade 01 aggregates and fine aggregates.

Mix proportion

The ratio used in this investigation is 1:2:4; cement, sand and coarse aggregate respectively (Birhanu, Feb-2007): The method used in the mix preparation is batching by weight using balance. As the information collected from TVET Bureau, using the above ratio it can be produce 20 pieces of HCB in average for class A. This study is conducted by taking 3 samples for each percent of replacement for 7 days and 28 days.

Preparation of HCB samples

The methods we used for the production of HCB listed step by step in the following:

- ✓ The waste plywood dust is collected and dried for 10 days. After that we sieved by standard sieve that we used for fine aggregate.
- ✓ Accordingly, all the ingredient amounts the sand, coarse aggregate, cement, and also plywood dust batched by weight and ready for mixing.
- ✓ The amount of water needed in production also calculated and evaluated to be added on the mixing in liters.
- ✓ Finally, the raw materials will be mixed and hallow concrete blocks will be produced using the mechanical equipment.
- ✓ Every produced hallow concrete blocks will be marked on it by the paints or markers which specify their composition of the ingredients.
- ✓ The produced blocks arranged in one layer and cured for a period of 7 days and 28 days under controlled area.


Figure 1. Dust plywood mixing and placing of HCB

Compressive strength test

For observing the performance of control (0%) and changes due to the substitution of 5%, 10% and 15% part of sand by dust waste plywood in hollow concrete block production. Three pieces of HCB from each sample of replacement and allowing the samples to expose to air for four hours before the test performed. After this tested for compressive strength at 7 and 28 days. All the trials were 20x20x40cm size hollow concrete block with two holes in a single block.

Figure 2. Compressive strength test for HCB

5. RESULTS AND DISCUSSION

This chapter contains the results obtained from the study. The density and compressive strength parameters of HCBs were measured in the study. These results are then compared with the standard ranges of recommended values.

Table 1. Test result of fine aggregate

Fine Aggregate	Test Result
Moisture content	0.16%
Water absorption	2.54%
Finesse modulus	3
Unit weight	1666.45
Specific gravity	2.96
Silt content	2.25%

Sieve Analysis for fine aggregate

Figure3. Particle size distribution of sand

Table 2. Test result of course aggregate

Course Aggregate	Test Result
Moisture content	0.05%
Water absorption	0.34%
Finesse modulus	5.53
Unit weight	1309.1
Specific gravity	2.43

Table 3. Test result of cement

Cement	Test Result
Initial setting time	50
Fineness	6.2%
Consistency	9.7
Specific gravity	2.52

Table 4. Test result of cement

Plywood	Test Result
Moisture content	2.28%
Water absorption	9.9%
Unit weight	360.5
Specific gravity	2.29

Compressive strength test result

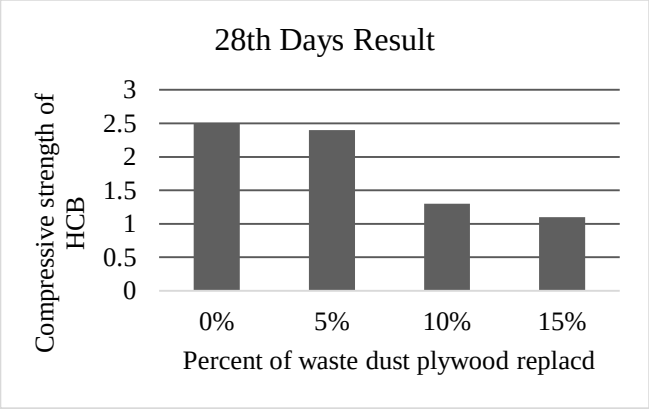

Figure 4. Compressive strength versus % of waste dust plywood replaced

The compressive strength of 5% replaced waste plywood dust with sand reduce by 0.1 MPa from the control. But, both satisfy the minimum requirement of Ethiopian standard for class C. The other samples of 10% and 15% are not satisfy the requirement.

Density test result

Table 5. Average density of control and trial mixes

% replacement	Test age (Days)	Average of Weight (Kg)	Average Density of HCB (Kg/m^3)
0	7	13.83	868.75
5	7	13.6	850
10	7	12.18	761.25
15	7	12.53	783.33
0	28	13.80	862.5
5	28	13.83	864.58
10	28	12.4	775
15	28	12.73	795.83

As per Ethiopian standard ES 596:2001, the recommended density of HCB is 900-1200 kg/m^3, our test results are below 900kg/m3. Therefore, the produced HCB is light in weight.

Economic Benefit

Table 6. Cost of sand replaced by waste dust plywood in Dire Dawa

% replacement	Sand in m^3	Unit price of sand/m^3	Cost (birr)
0	16	90	1440
5	15.2	90	1368
10	14.4	90	1296
15	13.6	90	1224

The above Table clearly show that using of dust plywood waste in replacement of sand in Dire Dawa can play cost reduction in hollow concrete block production.

6. CONCLUSIONS

In this research, utilization of waste plywood dust as partial replacement sand in production of hollow concrete block has been studied. Based on results obtained from compressive strength and density test of hollow concrete block, the following conclusions are drawn:

1. The Compressive Strength of partially replaced sand by waste plywood dust in hollow concrete block production with ratio of 1:2:4 for proportions of 0%, 5%, 10% and 15% are 2.5MPa, 2.4MPa, 1.3MPa and 1.1MPa respectively at 28th day of curing. The 5% replacement of sand can satisfy the minimum requirement set by Ethiopian standard of compressive strength for hallow concrete blocks of class C.
2. Replacement of sand by waste plywood dust up to 5% satisfy minimum density requirement of hollow concrete block set by Ethiopian standard.
3. By replacing waste plywood dust with sand, it is possible to save 5% of cost per 16 m3 (volume of dump truck) of sand compared to hollow concrete block produced without replacement of sand.

7. RECOMMENDATIONS

Our construction industries need to benefit from the using of wastes. Therefore, based on the investigation made the following recommendations are forwarded for studies for the purpose of future excellence.

1. Waste plywood dust in Dire Dawa university can be used for production of partition wall making in the university with intense study of long term effect of the replacement.
2. In this research, only compressive strength and density of hollow concrete block are investigated; therefore, further investigations are required in water absorption property of the hollow concrete blocks.
3. Since saw dust are not exposed to rain and sun, further research on replacing sand by saw dust rather than waste plywood dust will be intended for better s

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