Study Some Mechanical Properties of Mortar with Sawdust as a Partially Replacement of Sand

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ABSTRACT:

Some mechanical properties of mortar (compressive strength and hardness) with sawdust replacement of sand were investigated. Cubes of 50 mm × 50 mm were prepared, the compressive strength tests were done for a replacement levels ranging (5, 10, 15, 25, 50, 75) % by volume a reference mix were also prepared for comparison this test was done after 7, 14, and 28 days while hardness test were done after 28 day for a replacement levels (0, 5, 10, 15, 25) % by volume.

Result showed that the compressive strength of the specimen were decreased with higher sawdust content, hardness values were decreased slightly in the replacement levels 0, 5, 10 % while the values began to decrease noticeably in the replacement levels 15 and 25 % the hardness values were (59, 57.5, 56, 47.77 , 45.2) N/mm^2 respectively

A cost analysis was done, this analysis was based on a unit of mortar (1.0 m^3) made from conventional materials and a modified concrete made by substituting materials with sand using sawdust

Keyword: Sawdust, Compressive strength, Micro hardness, Lightweight concrete, Waste materials mortar.

1.INTRODUCTION:

Concrete is known to be the most widespread structural material due to its quality to shape up in various geometrical configurations. In some conditions, one might assume that normal weight concrete is inconvenient due to its density (2200-2400kg/m^3). Replacing partially or entirely the normal weight aggregate concrete with lower weight aggregates produces lightweight aggregate concrete [1]

Large increasing amount in the population of the world requires larger establishment of the settlement. Thus new techniques and materials should be developed to construct new buildings. Besides large number of the settlement security of those building against natural disaster is the durability of the construction and also thermal conductivity. Lightweight concrete (LWC) is a very versatile material for construction, which offers a range of technical, economic and environment-enhancing and preserving advantages and is destined to become a dominant material for construction in the new millennium . With the increasing high building construction, the construction weight becomes important and this problem can be solved using lightweight concrete. On the other hand lightweight concrete is its low density, allowing construction on ground with only moderate bearing capacity, the need for less reinforcement [2].

Structural lightweight aggregate concrete is an important and versatile material in modem construction. It has many and varied applications: multistory building frames and floors, curtain walls, shell roofs, folded plates, bridges, prestressed or precast elements of all types, and others. In many cases the architectural expression of form combined with functional design can be achieved more readily in structural lightweight concrete than in any other medium. [3]

Sawdust has been used in concrete, but not widely. Although seriously limited by its low compressive strength. It has serious limitations that must be understood before it is put to use. Within these limitations, the advantages that sawdust concrete are offers considerable reduction in weight of the structure, thereby reducing the dead loads transmitted to the foundation , high economy when compared to and normal weight concrete, reduce damage and prolonged life of formwork due to lower pressure being exerted, ,Easier handling, mixing and placing as compared with other types of concrete , improved sound absorbent properties due to its high void ratio [4, 5, 6] , improved thermal insulation because the incorporation of wood aggregates in concrete decreases its thermal properties . For a mass percentage of wood aggregates ranging from 0 to 10%, the reduction in the thermal conductivity increases until 35% for the concrete-sawdust [7, 8]. Sawdust is one of the major underutilized by products from sawmilling operations, generation of wood wastes in sawmill is an unavoidable hence a great efforts are made from the utilization of such waste [9].

Wood sawdust wastes are accumulated from the countries all over the world and cause certain serious environmental problems and health hazards [10]. This paper presents an experimental study which investigates the potential use of wood sawdust wastes producing a low-cost and lightweight composite as a building material. Some of the mechanical properties of concrete mixes having low and high levels of wood sawdust wastes are investigated.

2.MATERIALS AND METHOD:

The materials used in this study are:

- ASTM type I Portland cement (ordinary)
- Natural sand
- Sawdust, generated from the mechanical processing of raw wood in the sawing process, sieve to the fineness of the used sand (without pretreatment).
- Water

Batching of materials was done by volume due to the remarkable differences in the specific gravities of cement, sand and sawdust [5]. The percentage replacements of fine aggregates by sawdust were 0,5,10,15,25,50 and 75% .This was done to determine the optimum percentage that would give the most favorable result. The 0% replacement was to serve as reference mix for other sample.

The sawdust was sieve to the fineness of the used sand and then a dry mixing of the constituents is performed before the addition of water. The homogenized mixture is then introduced into moulds of dimensions (50 × 50 × 50) mm were prepared and tested for their compressive strength after 7, 14 and 28 day and hardness for the percentage of replacements 0,5,10,15,25 after 28 day

The cubes were cast in 50 mm moulds by hand and after 24 hr the cubes were subsequently cured in water up to the day of testing except the 50 and 75% these replacement levels need 48 hr to harden and can be removed from the mould and then cured in water up to the day of testing. The mortar intended for this study is based on 2 sand: 1 cement the specimens are made with a mass ratio of water to cement (W/C) of 0.45.

The using of these mix proportions, percentages of sand have been replaced with sawdust in proportions as previously indicated. The total number of test specimens was 63 cubes for compression test, in addition to 15 for hardness.

The micro hardness test was done by digital micro hardness tester HVS-1000 (Germany) **Fig.(1).**

3. RESULTS AND DISCUSSION:

From **Fig.(2)** it can be seen that an increase in the percentage of sawdust result in decrease in weight and compressive strength

It is also seen from **Table(1)**. That for reference mix, the compressive strength increased from 27.12 N/mm^2 at 7 days to 43.15 N/mm^2 at 28 days (i.e. about 59% increment). However, the strength of the 5% replacements by sawdust showed increased in compressive strength from 26.2 N/mm^2 at 7 days to 30.85 N/mm^2 at 28 days (18% increment). Similarly, the 10% replacements of saw dust showed an increase from 23.24 to 27.31N/mm^2 between 7 and 28 days so the results indicate that sawdust as a partially replacement of sand concrete can attain the same order of strength as conventional concrete at longer curing periods [11]

Results from micro hardness tests on samples are shown in **Table(2)** and **Fig.(3)**. Similar result to that of compressive strength was observed for micro hardness but hardness values were decrease slightly in the replacement levels 0, 5, 10 % it was (59, 57.5, 56) N/mm^2 respectively, while the values began to decrease noticeably in the replacement levels 15 and 25 % the hardness values were (47.77 , 45.2) N/mm^2 respectively.

4. COST ANALYSIS

The use of lightweight aggregate concrete in a structure is usually predicated on lower overall costs. While lightweight concrete may cost more per cubic yard than normal weight concrete, the structure may cost less as a result of reduced dead weight and lower foundation costs [3].

The analysis is based on a unit of mortar (1.0 m^3) made from conventional materials and a modified mortar made by substituting materials with sand using sawdust. **Table(3)** shows the unit price of materials. Proportion of materials for mix 1:2, the cost of production 1 m^3 mortar without sawdust and with 5% of sawdust replacement is given in **Table(4), Table(5)** and **Table(6)** shows the cost and percentage of cost saving per cubic meter of mortar with different sawdust replacement levels.

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Table(1): Compressive strength and weight of mortar with various percentage of sawdust.

Sawdust %	7 day			14 day			28day		
	Weight Gram	Density kg/m^3	Compressive strength N/mm^2	Weight	Density kg/m^3	Compressive strength N/mm^2	Weight Gram	Density kg/m^3	Compressive strength N/mm^2
0%	263.3	2106.4	27.12	282.5	2260	40.9	277.4	2219.2	43.15
5%	262.8	2102.4	26.2	270.7	2165.6	28.52	276.5	2212	30.85
10%	261.9	2095.2	23.24	247.6	1980.8	25.82	264.5	2116	27.31
15%	251	2008	13.56	238.1	1904.8	16.08	260.1	2080.8	17.84
25%	239.3	1914.4	12.9	235.2	1881.6	16.932	244.4	1955.2	19.52
50%	225.2	1801.6	9.83	227.3	1818.4	12.53	222.3	1778.4	16.33
75%	221.9	1775.2	4.31	221.4	1771.2	9.01	218.2	1745.6	12.4

Table(2): Micro hardness of concrete with various percentages of sawdust.

Sawdust %	Hardness N/mm^2
0%	59
5%	57.5
10%	56
15%	47.77
25%	45.2

Table(3): Unit price of materials.

Material	Price Iraqi ID	Mean price Iraqi ID	Market unit	Volume (m^3)	Unit price per m^3
Cement	7500- 9000	8250	Bag (50 kg)	0.035	253714
Sand	34000-38000	36000	$1m^3$	$1m^3$	36000
Sawdust	0		Waste material		0
Water					100

Table(4): Cost of production 1 m^3 mortar without sawdust.

Material	Required volume (m^3)	Unit price per m^3	Amount Iraqi ID
Cement	0.287 [12]	253714	72816
Sand	0.53 [12]	36000	19080
Sawdust	0	0	0
Water	0.168 [12]	100	16.8
Total cost of production 1 m^3			91912.8

Table(5): Cost of production 1 m^3 mortar 5% sawdust by volume.

Material	Required volume (m^3)	Unit price per m^3	Amount Iraqi ID
Cement	0.287 [12]	253714	72816
Sand	0.5035	36000	18126
Sawdust	0.0265	0	0
Water	0.168 [12]	100	16.8
Total cost of production 1 m^3			90958.8

Savings per cubic meter of concrete = 91912.8 – 90958.8= 954ID

Percentage savings = (954 / 91912.8) × 100 = 1 %

Table(6): cost and percentage of cost saving per cubic meter of mortar with different Sawdust replacement levels.

Sawdust replacement level	Savings per cubic meter of concrete ID	Percentage savings cost
0%	0	0
5%	954	1%
10%	1908	2.1%
15%	2862	3.2%
25%	4770	5.47%
50%	9540	11.58%
75%	14310	18.4%

Figure (1): Digital micro hardness tester HVS-1000 (Germany).

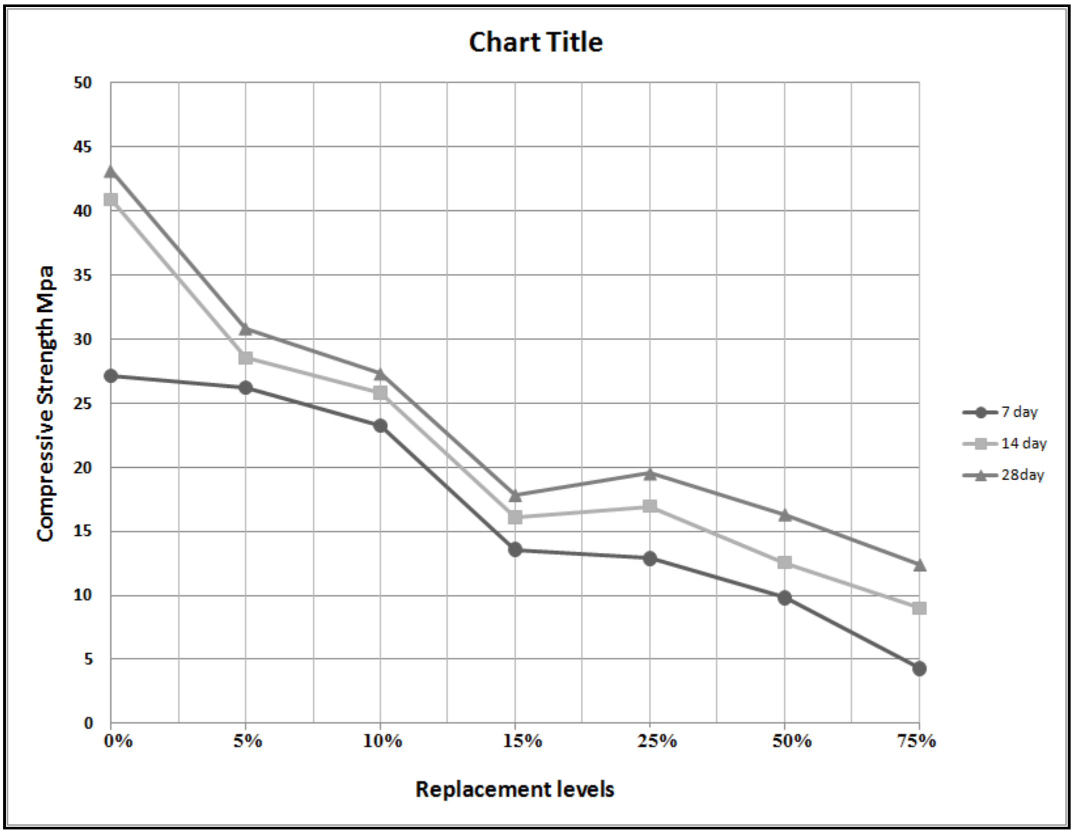

Figure (2): Compressive strength of mortar with various percentages of sawdust.

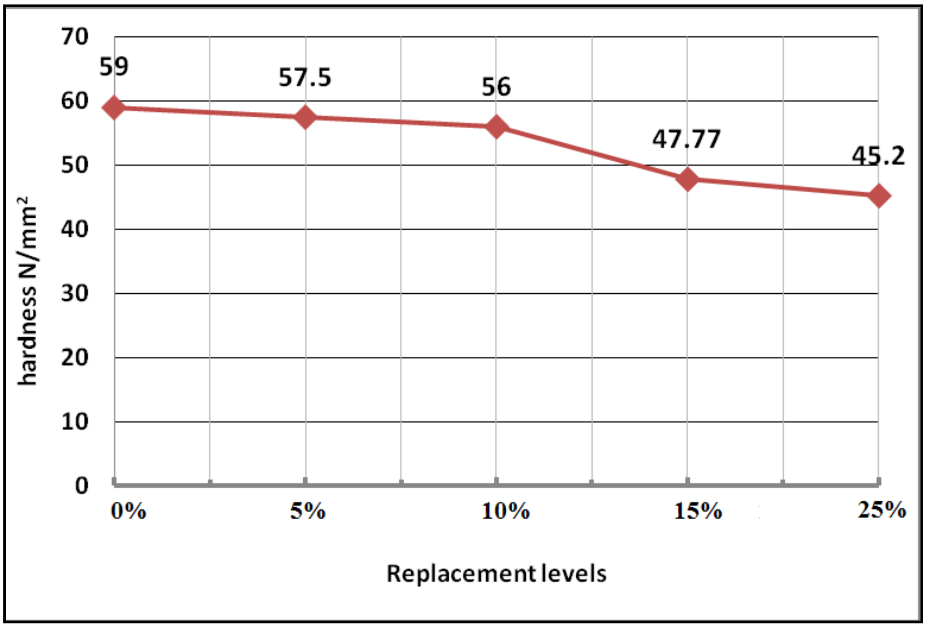

Figure (3): Micro hardness of mortar with various percentage of sawdust.

دراسة بعض الخواص الميكانيكية للمونة مع نشارة الخشب كبديل جزئي عن الرمل

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الخلاصــة:

في هذا البحث تم دراسة بعض الخواص الميكانيكية (قوة الانضغاط والصلادة) للمونة وذلك بعد استبدال جزئي للرمل بنشارة الخشب. تم تحضير مكعبات 50 ملم× 50 ملم لقياس قوة الانضغاط التي تم قياسها بنسب استبدال حجمية (0، 5، 10، 15، 25، 50، 75) % بالاضافة لمكعبات سيطرة للمقارنة وبعد 7، 14 و 28 يوم بينما اجري فحص الصلادة بعد 28 يوم ولنسب استبدال حجمية (0، 5، 10، 15، 25) %

وأظهرت النتائج أن قوة الانضغاط للعينة يتناقص مع المحتوى العالي من نشارة الخشب بينما اظهرت قيم الصلادة انخفاضا طفيفا لنسب الاستبدال(0، 5، 10) % في حين أن القيم تبدأ في الانخفاض بشكل ملحوظ في مستويات استبدال 15 و 25 ٪ وكانت قيم الصلادة بالتتابع كما يلي(59 ,57.5 ,56 ,47.77 ,45.2) نت/ملم^2

وقد اجري تحليل للتكاليف والذي يستند على وحدة من المونة (1.0) م^3 المصنوعة من المواد التقليدية والمونة المعدلة بواسطة استبدال الرمل بنشارة الخشب.