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ENHANCING OF WOOD CHIPPING CONCRETE PROPERTIES BY ADDING WASTE FIBRE

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ABSTRACT

The recycling of wood chippings, an industrial waste product, has a potential use in the production of a lightweight concrete. In modern countries, the low cost and the proximity of supply makes this material a good candidate for local building applications. This study aims to examining the ability of enhancing of a wood fibre lightweight concrete strength by reinforcing it with lathe scrap from lathe industry. Specimens have been casted, compressive and split tensile strengths were measured in addition to the wet and dry weight as per relevant British standard specifications. The wood chippings are saturated with a water for 24 hours, this is to prevent chippings from sorption the water of the mixture. Test results indicate that addition of waste fibre from lathe enhances the strength markedly and in the same time increases the weight.

KEYWORDS

Lightweight concrete, Wood chippings, Fibre ,reinforced concrete, Industrial waste fibres, Composite materials

INTRODUCTION

In many countries, the wood industries generate a large amount of waste products. The low costs, the proximity of the sources and the potential pollution from wood wastes have led to studies into the possible use of the wood chippings as fibres in concrete. These types of material have several potential applications such as acoustic and thermal insulation, fire resistance cladding ect.

Several studies mention the use of wood ash as fillers in concrete or mortars [1-5], without revealing a great improvement in mechanical properties. Bouguerra [6] included wood chippings (3-8mm) in a cement and clay matrix and tested the water sorptivity : the macro porous wood aggregates reduced the capillary absorption inside the material.

This composite material also displays good thermal and insulating properties [7]. From other hand, Abdulla introduced a study included finding an active and cheep way for enhancing properties of this material by using white oil to disembarrass the wood chipping defects and to increase its strength against insects, decrease its sorption to water and later decrease volumetric changes [8]. Other natural fibres have also been studied (hemp[9], rice husks [10], or other vegetal fibres [11]): mortar mixes containing these admixtures display a good durability and are already used for insulating or coating applications.

In a previous paper, Temba et al. [12] described the physico-chemical properties of the wood chippings and the preparation procedure of this wood-based concrete, particularly the difficult presented by the high water absorption properties of the wood. Sekar studied the feasibility of using locally available industrial waste fibres for making FRC such as (i) lathe scrap from lathe industry, (ii) copper-coated waste steel wire from wire winding (ie, motor rewinding) industry, and (iii) waste material (obtained during the manufacturing of small size steel rods used for the preparation of sparklers in fire works industries) from wire drawing industry [13]. He found that addition of waste fibres from lathe and wire winding industries in plain concrete enhances the strength markedly, whereas inclusion of waste fibres from wire drawing industry decreases the strength of concrete (the percentage of the three types of fibre in concrete is 6%) .

In this paper, we report an attempt to study the feasibility of using the lathe scrap from lathe industry as an industrial waste fibres for making fibre reinforced wood chippings concrete and test its strength and density after treated with water for 24 hours. Test results obtained are presented and discussed here in this paper.

LIGHTWEIGHT CONCRETE

Lightweight concrete uses widely and for many purposes in all countries. Lightweight concrete gives good thermal isolation and has suitable durability but it has weak resistance for abrasion. In general lightweight concrete is more expensive and its mixing, transfusing and casting needs more professionalism than ordinary concrete. Lightweight concrete is classified according to its using and its necessary to recognize between lightweight concrete uses for structural purposes and that uses in unloaded walls or for thermal isolation. Minimum compressive strength is the control properties to classify the lightweight concrete, in USA, for example, minimum compressive strength for cylindrical lightweight concrete sample is about 27 N/mm^2 in 28 days and the dry density about 1840 kg/m^3 . Generally dry density of lightweight concrete is between (1400-1800)kg/m^3 when the dry density of isolating lightweight concrete is less than 800 kg/m^3 and its strength is between (0.7-7.0)N/mm^2 [14] .

SAMPLE PREPARATION

1. Materials

1.1. Cement

A Portland cement was used manufactured by united cement company (Tasluja – Sulaymaniyah). The specific gravity of the cement used was 3.15. The chemical analysis of this cement is given in table (1) and its mechanical properties, provided by the manufacturer, are summarized in table (2).

1.2.Aggregate

Obtained from natural deposits in Salah Aladdin.

- Fine aggregate: satisfy the British standard (B.S.882: 1973), grading area (3), specific gravity in saturated surface dry (SSD) was 2.65 and SO3 ratio was (0.05%).
- Coarse aggregate: satisfy the British slandered (B.S.882: 1973), specific gravity (SSD) was 2.73, SO3 ratio was (0.01%) and maximum aggregate size (20mm).

1.3.Water

Water available in the college campus conforming to the requirements of water or concerting and curing as per BS: 1881:1970.

1.4.Wood chippings

Pine wood chippings passing from sieve of 600micron. The network of capillaries in wood, which allow sap circulation, is responsible for the hydrophilic nature of wood. When mixed directly with cement, the wood chippings could potentially affect the water cement ratio, this could limit the water available for hydration due to migration of water into the wood particles. Tamba [12] proposed to saturate the wood chippings with water and carried out an estimation of the kinetic of water absorption. After 24h, the chippings are totally saturated with water (Fig. 1).

1.5 Fibre

Lathe scrap fibres from lathe industry (LI) passing from sieve of 600 micron was used. (Fig. 2).

2. Specimens and experimental work

In this experimental work, a total of 60 numbers of concrete specimens were cast with and without adding wood chippings or waste fibres. The specimens considered in this study consists of 30 numbers of 150mm side cubes, 30 numbers of 150mm diameter and 300mm height cylinders. Two kinds of mixtures were used to, the first one contained 30 numbers of concrete specimens (15 cubes and 15 cylinders) with adding only a variable percentages of wood chippings (ie, ratio of weight of wood chippings to the weight of cement), these percentages are (0%,5%,10%,15%,20%), the second one contained 30 numbers of concrete specimens (15 cubes and 15 cylinders) with adding a variable percentages of wood chippings (0%,5%,10%,15%,20%) and a constant weight fraction of fibre (ie, ratio of weight of fibre to weight of concrete) of 6% [13]. The nominal mix proportion used for casting the specimens was 1:2:4:0.5 by weight (cement : sand : coarse aggregate : water/cement ratio) when designed is satisfy the American standard (ASTM C143)[14]. The wood chippings were saturated with water for 24 hours to ensure the wood chipping will not reduce the water that needed for hydration of the cement; however, there exists the potential to improve the bond at the cement/wood interface [8,12]. Cement, sand, coarse aggregate, wood chippings and lathe fibre were mixed in dry state handy and then the required quantity of water was added and mixed thoroughly. Before casting, machine oil was smeared on the inner surfaces of the cast iron mould. Concrete was poured into the mould and compacted thoroughly using a standard compact metal rod of squire section with 25mm side, 1.08k weight and 380mm long. The number of compact beats was 25 times for cubes and 20 times for cylinders for each layer [15]. The top surface was finished by means of a trowel. The specimens were removed from the mould after 24hrs. and then cured under water for a period of 28 days. The specimens were taken out from the curing tank just prior to the test. The tests of compressive and split tensile strengths were conducted using a 3000 kN compression testing machine. These tests were conducted as per the relevant standard British specifications[15] .

RESULTS AND DISCUSSION

The average compressive and split tension strengths of the standard concrete cubes and cylinders for different concrete mixtures are presented in figures (3) & (4). The results reported are average of 3 specimens. From the figures, it is clear that the addition of (LI) waste fibre in wood chippings concrete enhances its strength under compression and tension. The increase in strength achieved by adding (LI) waste fibres in the aforesaid wood chippings percentages are 17.0%, 15.0%, 13.0%, 33.3% and 44.4%, respectively for compression strength test. The corresponding values for tension strength test are 7.0%, 7.3%, 15%, 21.4% and 30%. This indicates that the strength of wood chippings concrete increase markedly under compression and marginally under tension and the best increasing are when the percentage of wood chippings in concrete are 15% and 20% for the two kinds of strength. The marginal improvement in the tensile strength of wood chippings concrete may be attributed to two reasons: (i) the small diameter (~ 600micron) of (LI) waste fibres, (ii) the small diameter of (LI) waste fibres failed to develop proper / adequate bond with concrete. Because of these reasons, the improvement in the tensile strength of concrete is only marginal. The variation of dry density and wet density of wood chippings concrete with and without fibres is shown in figures (5,6,7 and 8). It is seen from the figures that the dry and wet weight increased when adding the (LI) waste fibres, this is due to the heavy weight of (LI) waste fibres. It was observed during the test that the cylindrical specimens with and without fibres failed catastrophically in a brittle manner and these have broken into two pieces suddenly, ie, without any warning while cubic specimens failed slowly by developing small size crack on the tension side of the specimens and also these did not break into two pieces which indicate a ductile failure. This sort of failure is one of the most criteria for the design of structures subjected to seismic, impact, and dynamic loadings. Plate (9) shows the tested wood chippings concrete specimens with and without fibres.

CONCLUSIONS

Based on the results of the present experimental work, waste fibres from waste industry can be used in the production of fibre reinforced wood chippings concrete. This use of waste fibre, which will reduce costs and environmental pollution, seems to be practicable in ternary fibre reinforced wood chippings concrete mixtures. The use of ternary mineral additives can improve the compressive and split tension strength and increase the dry and wet weight of wood chippings concrete.

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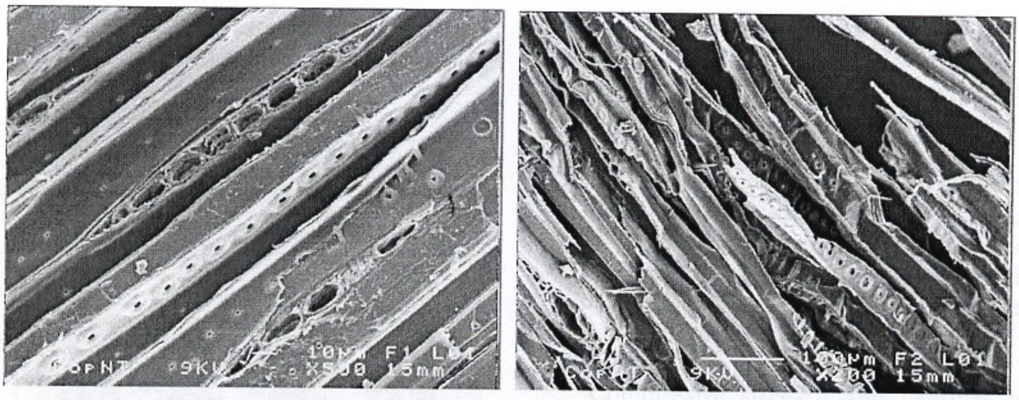
Table (1)
Chemical composition of cement

Compound	%by weight
Insoluble	1.32
SiO_2	16.5
Al_2O_3	8.6
Fe_2O_3	3.5
MgO	0.9
SO_3	1.5
C_3A	4.84
Loss on ignition	1.21

Table (2)
Mechanical properties of cement

Properties	Average
3 day compressive strength (standard mortar) (MPa)	23.8
Initial setting (min.)	57
Final setting (min.)	470
Fineness (m^2/kg)	280



(unsaturated) **(saturated)**

Figure (1) : Observation of the wood chippings, showing their fibrous nature and the capillary network [5].

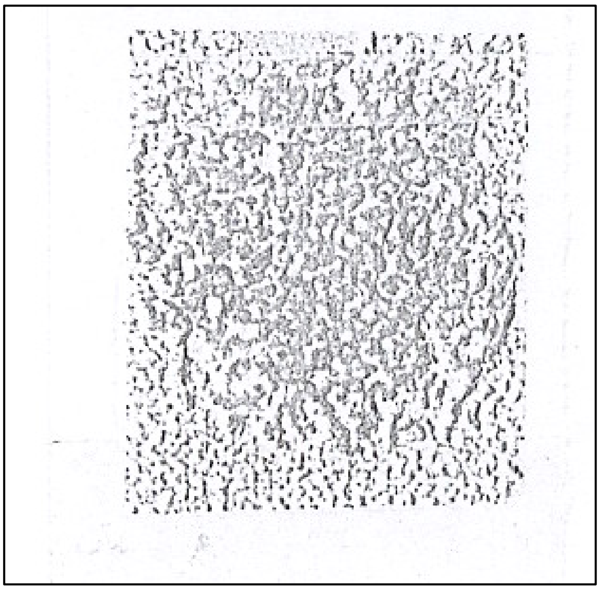


Figure (2) : Fibre used in the study (lathe scrap fibre).

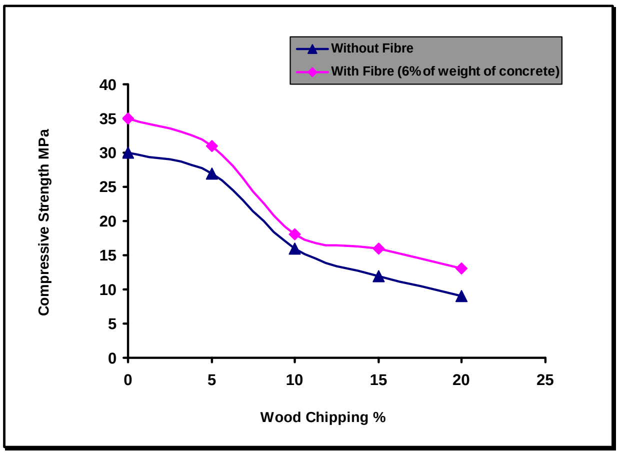


Figure (3) : Influence of using fibre on compressive strength of wood chippings concrete

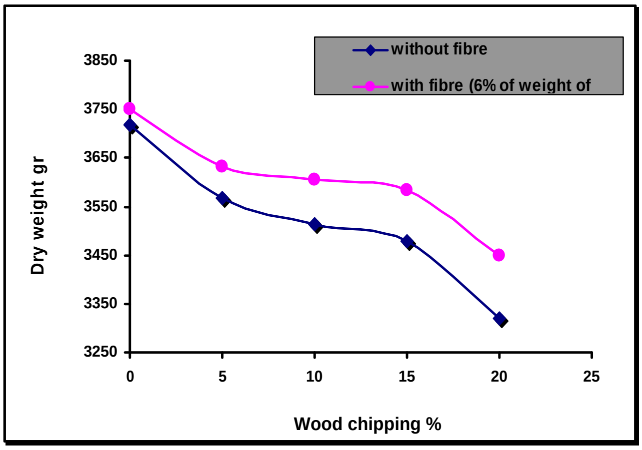


Figure (6) : Influence of using fibre on dry density of wood chippings concrete (cylindrical specimens)

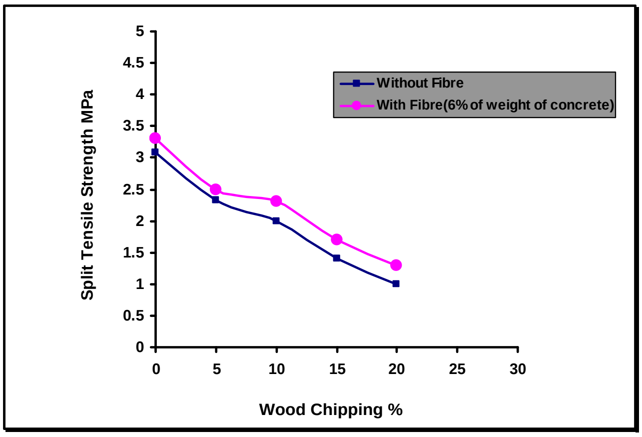


Figure (4) : Influence of using fibre on split tensile strength of wood chippings concrete

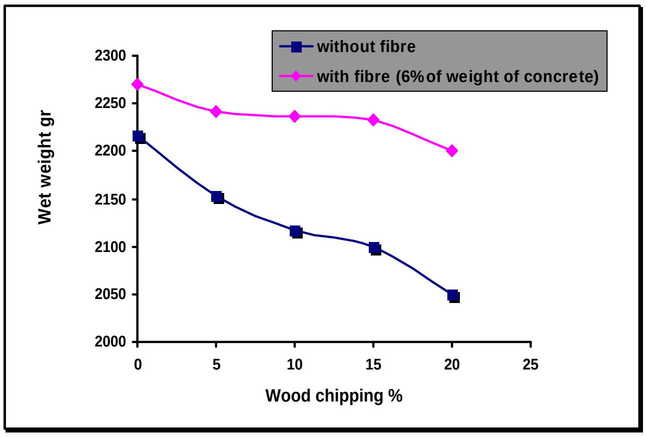


Figure (7) : Influence of using fibre on wet weight of wood chippings concrete (cubic specimens)

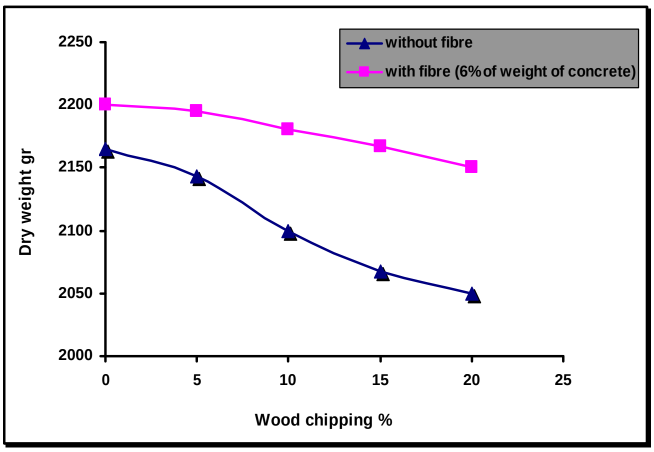


Figure (5) : Influence of using fibre on dry weight of wood chippings concrete (cubic specimens)

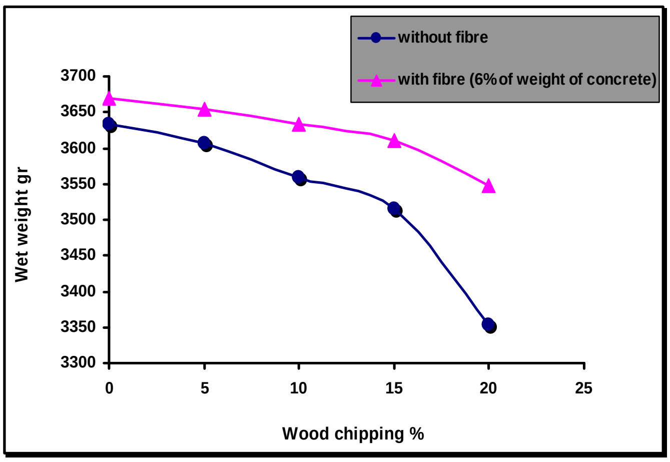


Figure (8) : Influence of using fibre on wet weight of wood chippings concrete (cylindrical specimens)

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(a) : Failure of cubic wood chipping concrete specimens (without fibre)

(b) : Failure of cylindrical wood chipping concrete specimens (without fibre).

(c) : Failure of cubic wood chipping concrete specimens (with fibre).

(d) : Failure of cylindrical wood chipping concrete specimens (with fibre).

Plate (9) : Tested concrete specimens

تحسين خواص خرسانة نشارة الخشب بألياف صناعية

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الخلاصة

إن مخلفات النشارة عبارة عن ضائعات لمنتجات صناعية تتميز بإمكانية استخدامها لإنتاج الخرسانة الخفيفة الوزن. في الدول المتقدمة ، فان الكلفة القليلة وقرب المصدر تجعل هذه المادة مرشح جيد للاستخدام في تطبيقات المباني المحلية. هذه الدراسة تهدف إلى فحص إمكانية تحسين مقاومة الخرسانة المسلحة بألياف الخشب الخفيفة الوزن بواسطة تسليحها بمخلفات الخراطة الناتجة عن الخراطة الصناعية. تم تحضير النماذج وفحص مقاومة الانضغاط والشد غير المباشر إضافة إلى الكثافة الرطبة والجافة بموجب المواصفات البريطانية. قبل استخدام ألياف الخشب تم غمرها بالماء وذلك لمنعها من امتصاص ماء الخليط. نتائج الفحص بينت إن إضافة الألياف الصناعية (البرادة) أدت إلى تحسين مقاومة الشد والضغط بشكل ملحوظ وفي الوقت نفسه سببت زيادة كثافتها الرطبة والجافة.

الكلمات الدالة

الخرسانة الخفيفة الوزن، الخرسانة النشارية، الخرسانة المسلحة بالألياف، ضائعات الألياف الصناعية، المواد المركبة .