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WOOD WASTE IN CONCRETE BLOCKS

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Abstract- This paper experimentally investigates the potential use of poplar sawdust as replacement material to sand in semi-dry concrete, manufactured and used in concrete masonry blocks. The substitution of sand by wood waste can relieve the scarcity of raw materials and lighten concrete masonry block weight. The introduction of a varying proportion (30, 40, 50 and 60 %) of poplar sawdust in the concrete has a significant influence on its thermophysical and mechanical behavior. The inhibition of hydration of cement with this poplar sawdust has a main influence. It affects the hydrates formed in the concrete and has an impact on the compressive strength at 7 days. This strength decreases significantly with increasing poplar sawdust proportion. But the method of concrete manufacturing increases the strength and could decrease the inhibitory effect of wood on the hydration reaction of the concrete. Substitution of 50 % of sand by poplar sawdust in the masonry concrete block manufactured is proposed. Indeed, this concrete composition gives similar mechanical strength to that of the conventional manufacture of masonry concrete block.

INTRODUCTION

The scarcity of raw materials and the need to develop environmentally friendly materials has led the construction sector to direct towards the use of materials from agricultural resources due to their renewability. The enormous amount of wastes produced during wood processing operations in many countries provides challenging opportunities for the use of wood waste as a construction material,

In the most recent research, wood waste was added as a supplement in concrete mix or as a replacement of ordinary portland cement in concrete. But the substitution of sand in the concrete is also important to study because of the depletion of raw materials. The replacement of sand by wood waste gives advantages of lightness and decreases carbon dioxide emissions in the field of construction. The workability of the mortar was enhanced with the increase of the substitution ratio of the sand by the wood particles until an optimum of 30 %. However, the problem of the hydration reaction inhibition was evidenced by a slowdown and a diminution of heat emission which led to a considerable reduction in compression strength of these mortars.Following these results, our choice of application was oriented to semi-dry concrete blocks. This material does not require high strength and is commonly found in the construction industry.The concrete formula of our industrial partner was taken for our study as a reference. The criterion to be met by the new product developed is a compressive strength of 6 MPa at 7 days, because the company (project partner) delivers its blocks 7 days after manufacturing. Compression tests were also carried out at 14 and 28 days. They showed the very low resistance enhancement (less than 1 MPa) because the product is dry; there is a high porosity in these hardened blocks. The results obtained were used for the development of concrete blocks with wood by-products

2. Materials

2.1.Cement

Cement is a binding material which possess very good and cohesive properties which make it possible to bond with other materials to form a compact mass. Ordinary Portland cement is the most commonly used cement for general engineering works. The specific gravity of all grades namely 33, 43 and 53 grades. In this project Ordinary Portland Cement of 53 grades is used for experimental work. Initial and final setting time of the cement was 30 minutes and 600 minutes.

2.2.Fine aggregate

The fine aggregate used was locally available river sand and wood waste and conforming to IS: 383 – 1970. The fine aggregate was tested for its physical requirements such as gradation, fineness modulus, specific gravity and bulk density. A concrete can be made from sand consisting of rounded grains as good as form that in which the grains or granular.

2.3 Coarse Aggregate

Coarse aggregate for structures consists of material within the range of 5mm to 150mm size. Rocks having water absorption value greater than 3% or specific gravity of less than 2.5 are not considered suitable for mass concrete. However, in practice mixes of same workability for round shaped aggregates required less water than angular shaped aggregates.

2.4 Water

Water is an important ingredient of concrete as it activity participates in the chemical reaction with cement and potable water available in laboratory with pH value of not less than 6.5 and not more than8.5 ,conforming to the requirement of IS 456 2000 were used for mixing concrete and curing the specimen. The water which is fit for drinking should be used for making concrete.

2.5 Properties of SAWDUST

- Apparent specific gravity – 0.14
- Moisture content – 10.8
- Porosity (%) -- 84
- Water retention (%) --50

2.6Experimental Work

2.6.1 Measurement of Workability

The workability of a fresh concrete is a composite property which includes the diverse requirements of stability, mobility, placing of ability and finishing ability. There are different methods for measuring the workability. Each of them measures only particular aspects of it and there is no unique test which measures workability of concrete in its totality. The test measures the relative effort required to change a mass of concrete from definite shape to another by means of vibration.

2.6.2 Slump Cone Test

Slump test is the most commonly used method of measuring consistency of concrete which can be employed either in the laboratory or at the site of work. It is not a suitable method for very wet or very dry concrete. It does not measure all factors contributing to workability, nor is it always representative of conveniently as a control test and gives an indication of the uniformity of concrete from batch to batch.

Figure 1.Slump Cone Test

2.7 Compression Test on Concrete

Compression test is the most common test conducted on harden concrete, partly because it is an easy test to perform, and partly because most of the desirable characteristics properties of concrete are qualitatively related to its compressive strength.

The compressive test is carried out on specimen cubical or cylindrical in shape. Sometimes, the compression strength of concrete is determined using parts of a beam tested in flexure. The end parts of beam are left intact after failure in flexure and since the beam is usually of square cross section, this part of the beam could be used to find out the compressive strength.

Figure 2. Compressive test on concrete

Table 1. Compression Test Results

Sl. No	Specimen	Compressive strength in N/mm^2		
		7th day	14th day	28thday
1	30% sawdust	7.1	8.88	18.67
2	40% sawdust	5.77	8	17.33
3	50% sawdust	12.44	15.66	21.78
4	60% sawdust	8	13.33	20

2.8 Split Tensile Test on Concrete

The tensile strength is one of the basic and important properties of the concrete. The concrete is not usually expected to resist the direct tension because of its low tensile strength and brittle nature. However, the determination of tensile strength of concrete is necessary to determine the load at which the concrete members may crack. The cracking is a form of tension failure. The tensile strength values for different types of mixes at 7, 14, 28 days are given.

Figure 3. Split tensile test

Table 2. Split Tensile Test Results

Sl.	Specimen	Split tensile strength in N/mm^2		
		7th day	14th day	28thday
1	30% sawdust	3.39	4.52	6.5
2	40% sawdust	2.27	3.39	6
3	50% sawdust	4.52	6.22	9.05
4	60% sawdust	1.69	3.39	7.3

2.9 Compression Test on Concrete

The compressive strength of different types of mixes at 7 days, 14 day, 28 day are shown in graph1

Graph 1. Compression Test Results

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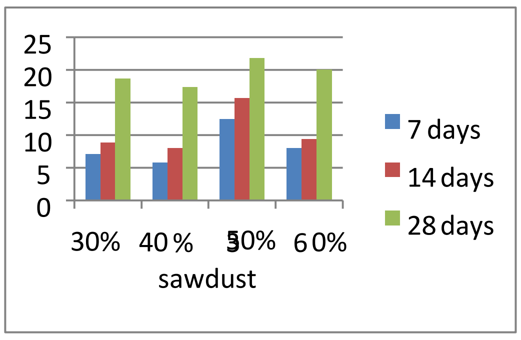
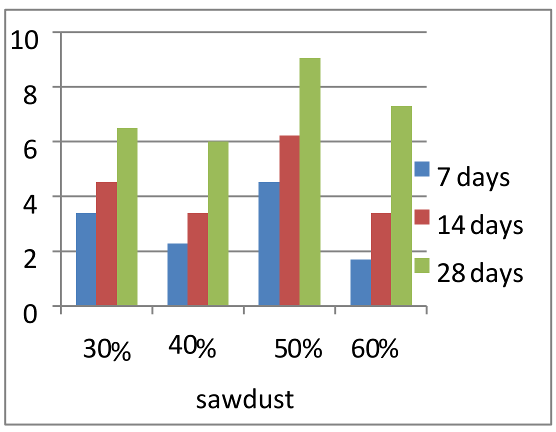


3.0 Split Tensile Test on Concrete

The flexural strength of different types of mixes at 7th day, 14th day, 28th day are shown in graph 2.

Graph 2. Split Tensile Test Results



Conclusions

The study of the incorporation of poplar sawdust in concrete showed that it is possible to develop wood concrete blocks with a mechanical strength greater than 6 Mpa and to decrease weight. The inhibition of the setting of concrete with poplar sawdust is characterized by maturity tests that affect its mechanical strength. This strength decreases significantly with increasing poplar sawdust proportion. The decrease of the strength reaches 50 % for a concrete with a 30 % sand substitution by sawdust, and 65 % with a 60 % substitutionThe method of concrete manufacture by vibrocompaction increases its mechanical strength. A compaction stress and a vibration time duration were optimized in this study at 40 kPa and and 15 s, respectively. In the case of concrete with 0 % poplar sawdust, the vibrocompaction performed at a 40 kPa stress results in a strength increase by 3 times in comparison to non-compacted concrete, and beyond this force, the concrete strength decreases.An almost 100 % increase of mechanical strength is observed for the concrete with 30%

poplar sawdust substitution and 40 % increase for 40 % substitution, which could, in the case of our concrete, decrease the effect of wood inhibition on the hydration reaction. A proposal for 50 % sand substitution by poplar sawdust in the PSC concrete is retained. Indeed, this concrete composition gives similar mechanical strength to that of the reference concrete for the manufacture of masonry concrete blocks.

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