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MICROSCOPIC AND MECHANICAL ANALYSIS OF LATHE WASTE STEEL FIBERS AS FIBER REINFORCEMENT IN CONCRETE

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Abstract

Concrete is a material which is weak in tension and fails in brittle manner when subjected to tension and flexure. When steel scrap is added to concrete, the behavior of composite material is superior to plane concrete. In this paper an experimental investigation was carried out to study the feasibility of using steel scrap obtained from lathe machine in concrete by checking the compressive strength, splitting tensile strength and flexural strength of concrete. Properties at fresh and hardened were found out by varying proportions of lathe machine waste such as 0%, 0.5%, 1 %, 1.5% and 2% by weight of cement. All the tests were conducted on the basis of the guidelines set by ASTM standards. It was observed that the workability of the mixtures decreased with an increase in the percentage of lathe waste as fiber reinforcement, i.e. higher lathe waste, so little workability. Compressive, flexure and split tensile strength increases as the waste fiber content increases to a certain extent and then decreases as the fiber content increases further. 1.5 % of the waste fiber content is the optimum resistance content. The experimental results were verified by the images provided by SEM. It is recommended that for strength enhancement, the lathe waste can be used as steel fiber reinforcement up to 1.5% (by weight of cement).

Introduction

Plain concrete slabs are known to have low strength and low strain capacity; however, these structural properties could be improved by addition of fibers, allowing the thickness of the layer to be reduced. There are different fibers that are used in the concrete namely steel fiber, synthetic fibers and natural fibers. The improvement in the material behavior of the fiber reinforced concrete depends on dosage and characteristics of the used fibers [1]. The main important effect of fibers as reinforcement is to influence and control the tensile cracking of concrete. Yet, the fiber reinforced concrete is known to have considerable impact on the slab cost owing to reduced thickness needs, prolonged useful life and reduction in maintenance costs. Amongst the fibers mentioned, steel fibers are the most researched and more practical. Steel fiber reinforced concrete is a type of concrete that contains randomly oriented discrete steel fibers [2]. The main aim of addition of steel fibers to concrete is to control crack widening and crack propagation after the concrete matrix has cracked. By control of the cracking the mechanical properties of the composite material as a result will be improved significantly. Addition of randomly distributed steel fibers improves concrete properties, such as static flexural strength, ductility and flexural toughness. Steel Fiber Reinforced Concrete (SFRC) has been largely used in airport pavements due to the extreme and damaging loads acting on the pavement. The ability of steel fibers to resist crack propagation is primarily dependent on the bond between the concrete and fibers as well as fiber distribution (i.e. spacing and orientation). The bond between the concrete and fibers is the mechanism whereby the stress is transferred from the concrete matrix to the steel fibers [3]. Steel fiber reinforced concrete (SFRC) appears stiffer (lower slump) compared with conventional concrete without fibers even when the workability (judged by any test using vibration) is the same (Johnston, 2001). Steel fibers tend to interlock together. Vibration is encouraged to increase the density, to decrease the air void content and to improve the bond with reinforcement bars. In spite of a stiff appearance, a well-adjusted fiber mixture can be pumped. The size of the fibers relative to that of the aggregates determines their distribution. It is recommended to choose fibers not shorter than the maximum aggregate size to be effective in the hardened state. Usually, the fiber length is 2-4 times that of the maximum aggregate size [4].

Literature Review

Lathe waste is a material from lathe machines and that can be used as steel fibers. But the aspect ratio was not constant. Here manually processed lathe waste aspect ratio varying from 50 to 110 is used. The thickness varies from 0.45 to 1mm and length from 15mm to 50mm. Scrap from lathe machine is produced from different manufacturing processes which are carried out by lathe machine [5]. Scrap which is a waste can be used as a reinforcing material in concrete to enhance the various properties of concrete. Scrap from machine can act in a same way as steel fiber. Steel scrap which is a lathe waste is generated by each lathe industry and dumping of such wastes in barren soil causes contamination of soil and ground water, which creates unhealthy environment [6]. In addition to get sustainable development and environmental benefits, lathe scrap can be used as recycled fiber with concrete. With increase in population and industrial activities, the quantity of waste fibers generated will increase in coming years. Lathe Scrap which is a waste can be used as reinforcing material in concrete to enhance the various properties of concrete. Scrap from lathe machine act in a same way as steel fiber [7]. In every lathe industry, wastes are available in form of steel scraps which are produced in different manufacturing processes of lathe machine works and dumping of these wastes in the barren land causes the contamination of soil and ground water which builds an unhealthy environment. M30 (1:0.75:1.5) concrete is used and lathe scrap fiber is added with different proportions (0.5%, 1.0%, 1.5% &1.75%) to check the strength variations in concrete. Experiment on three different types of waste metal has been compared with commercial 40, 60 and 72 graded steel reinforcement bars. The fiber used is irregular in shape and with varying aspect ratio [8]. Work assess on the study of the workability and compressive strength of the concrete reinforced with waste lathe scrap. In each lathe industries wastes are available in form of steel scraps are yield by the lathe machines in process of finishing of different machines parts and dumping of these wastes in the barren soil contaminating the soil and ground water that builds an unhealthy environment. When the steel scrap reinforced in concrete it acquires a term; fiber reinforced concrete and lathe scrap fibers in concrete defined as Lathe scrap fiber reinforced concrete (LSFRC). M30 concrete is used and lathe scrap fiber is added up to 2% by weight, at a gap of 0.4%. Plain cement concrete and the fiber concrete containing steel (lathe) scarp in various proportions by weight was studied. The workability of fresh lathe fiber concrete is restricted to less lathe contents. The compressive strength of Lathe Fiber Concrete (LFC) is found to be maximum for 1.2% (28 days strength) lathe scrap fiber added concrete. These industrial waste fibers can be effectively used for making high-strength low cost FRC after exploring their suitability. Plain reinforced concrete is brittle material due to addition of steel fibers in concrete considerably increases the tensile strength, static flexural strength, durability, impact strength and shock resistance. The strength of FRC beams in shear and combined shear and bending is greater compared to plain concrete beams. Industrial waste creates hazardous and landfilling, they pollute the environment nowadays. So, it must be concern able thing to avoid such hazardous creating materials. For that reason, use the industrial wastes as replacing material in construction field. The huge amount of wastes produces from Iron and Steel industries. It creates a landfilling and hazardous to environment. The Lathe scrap is the waste collected from iron and steel industries. This paper is about reuse the industrial wastes in concrete. The purpose of use the waste materials to reduce the environmental hazards. In addition to this, to 4 find the properties of concrete while using replacement material Lathe scrap [9].

Experimental Work

The purpose of this research work was to study the feasibility of lathe waste-based concrete by checking out the following physical properties i.e. compressive strength, splitting tensile strength, flexural strength. All these physical properties were found out by varying proportions of lathe machine waste such as 0%, 0.5%, 1 %, 1.5% and 2% by weight of concrete. All the tests were conducted on the basis of the guidelines set by ASTM standards.

Workability Tests of Fresh Concrete ASTM 143/C 143M-05a

For workability test the mould was filled in on three layers. Each coating was around one – a third of the height of the mould. Each layer was roded with 25 rounded rod ends. Each stroke has a uniform rod that extends over the mould cross section. The surface concrete was taken off until the top coat was rodded. Remove the mould immediately by raising it slowly and carefully in the vertical direction. The height of the recession was assessed immediately. The mould height and average height of the upper surface of the concrete are determined.

Compression test ASTM C-39/39M

After taking out of curing, concrete cylindrical samples were tested. After removal from water the compression test shall be carried out as soon as possible. Before testing the concrete cylindrical samples, it is necessary to measure and record their respective heights and diameter with the help of a scale. Universal testing machine top and bottom plates were cleaned with a cloth. Now place the cylindrical concrete sample in universal test machine. Switch on the universal testing machine and apply constant load volume. Record the load after concrete cylindrical sample fails.

Splitting Tensile Strength of Cylindrical Concrete Specimens ASTM 496/C 496M

Determine specimen length to nearest 0.1 in. [2 mm] by averaging at least two measurements of length taken in the plane containing the lines marked on the two planes. Center one of the strips of plywood along the middle of the lower bearing block. Place the specimen on the strip of plywood and align it so that the lines marked at the ends of the specimen are vertical and centered over the strip of plywood. Place a second lengthwise plywood strip on the cylinder, centered on the lines marked at the ends of the cylinder. Place the assembly so as to ensure. The plane projection of the two lines marked at the specimen's ends intersects the center of the upper bearing plate. As used, the external bearing bar or plate and the core of the specimen are positioned immediately below the middle of the spherical bearing block thrust. Place the bearing bars, the test cylinder and the additional bearing bar by aligning the jig and center the jig such that the additional bearing bar and center of the specimen are placed immediately below the middle of the spherical bearing plate. Continuously and without shock, apply the load at a constant rate within the range of 100 to 200 psi / min [0.7 to 1.4 MPa / min] dividing tensile stress until the specimen fails. Record at fault the maximum load applied indicated by the test machine.

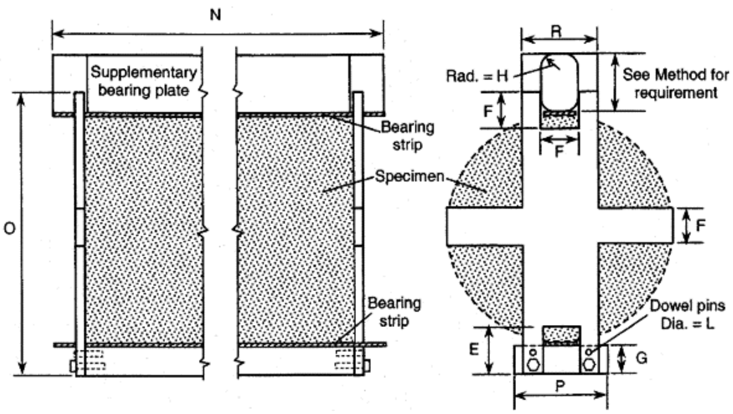

Figure 1: Splitting tensile test

Flexural strength test ASTM C-293/C293M-10

Upon separation from damp stock, flexural testing of wet-cured specimens shall be carried out as early as possible. Surface drying of the specimen results in a decrease in the measured rupture modulus. 6.2 Turn the test specimen on its side with regard to its molded position, and center it on the support blocks. Orient the loading device with respect to force applied. Bring the load-applying block into contact with the center surface of the specimen and add a load of 3 to 6 per cent of the projected ultimate load. Use 0.10 mm [0.004 in.] and 0.40 mm [0.015 in.] leaf-type sensor gages, assess if the distance between the specimen and the load-applying or supporting blocks is larger or smaller than either of the 25 mm [1 in.] or larger gauges. Grind, seal, or use leather shims on the touch surface of the specimen to remove any distance reaching 0.10 mm [0.004 in.]. Leather shims shall be of standard thickness of 6 mm [0.25 in.], 25 to 50 mm [1.0 to 2.0 in.] in diameter, which shall stretch across the entire breadth of the specimen. Lacks exceeding 0.40 mm [0.015 in.] shall be eliminated by capping or grinding only. Lateral surface grinding shall be minimized as the grinding of the specimens may change the physical characteristics. Continually prepare the test, always without shock. The load shall be added to the breakage point at a constant rate. Apply the load so that the maximum stress on the face of the tension increases at a rate from 0.9 to 1.2 MPa / min [125 to 175 psi / min].

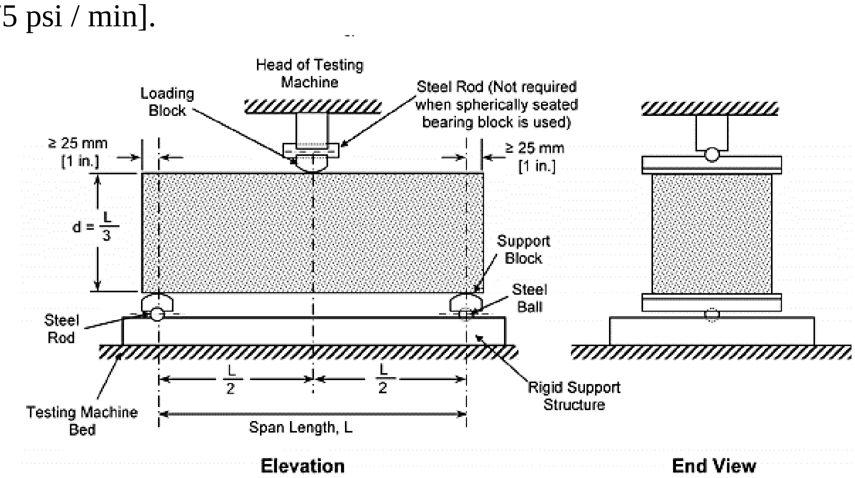

Figure 2: Flexure Test

Number of Concrete specimens

In order to test the mechanical properties of control concrete and concrete having addition of lathe waste fibers were casted. Total 20 concrete cylindrical specimens were casted. Concrete beam specimen were casted for control concrete and concrete having maximum strength of compressive and split tensile strength. Detail number of concrete samples is shown with respective percentage substitution of lathe waste.

Table 1: Number of concrete specimen

Concrete Mix	Lathe waste (%)	Compressive Test 28 Days	Split Tensile Test 28 Days
M0	**0**	2	2
M1	**0.5**	2	2
M2	**1**	2	2
M3	**1.5**	2	2
M4	**2**	2	2

Results and Discussion

Workability Tests of Fresh Concrete ASTM 143/C 143M-05a

Fresh concrete slump test was conducted to check the workability. For each batch of concrete, a slump check was conducted. Each batch of concrete had percent of the lathe waste as a partial addition to concrete fiber reinforcement. The addition was 0.5%, 1%, 1.5% and 2%, respectively. Slump test was also carried out for concrete control.

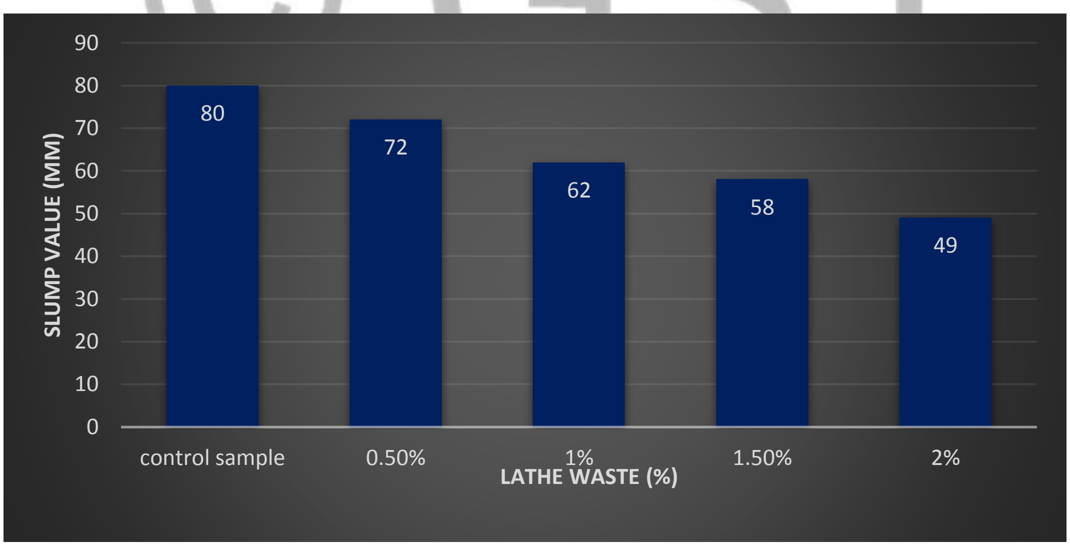

Figure 3: Slump test result

Results indicate that the control/ordinary concrete develops slumps of up to 80mm, while slumps of up to 72mm, 62mm, 58mm and 49mm are generated on 0.5%, 1%, 1.5 % and 2% using lathe waste as fiber reinforcement. In general, it was observed that the workability of a concrete mix on adding lathe waste decreased. Workability of the blends was observed to decline as the percentage of lathe waste raised as fiber reinforcement i.e. higher the lathe waste, less workability was observed.

Compressive, split tensile and flexure strength

The compression, split tensile and flexural test was performed on cylindrical and beam concrete samples with partial addition of lathe waste as fiber reinforcement.

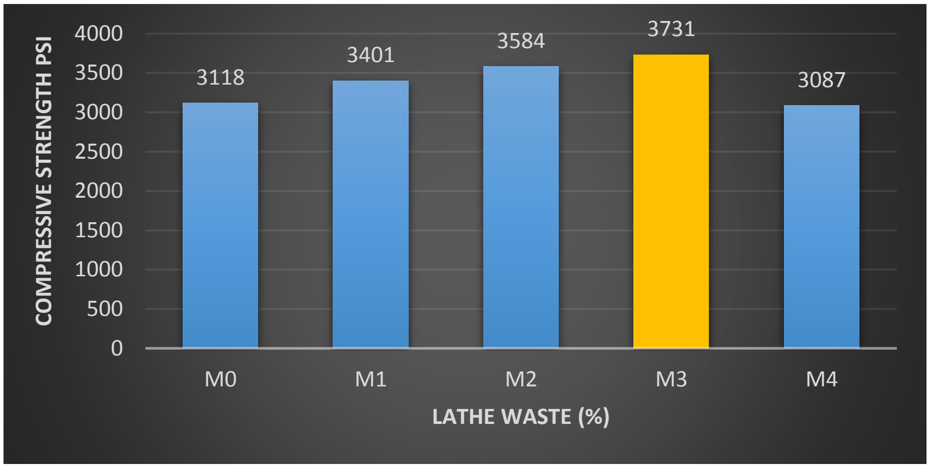

Figure 4: Compressive strength 28 Days

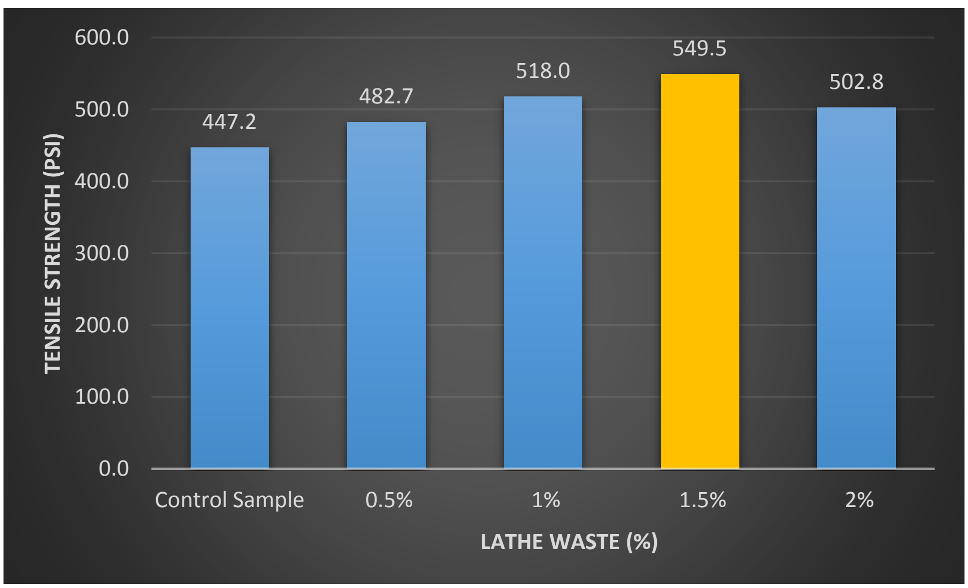

Figure 5: Splitting tensile strength (28 days age)

Table 2: Flexural strength (28 days age)

Addition of Lathe waste (%)	**Flexure Strength Psi (MOR)-28 days**			**Percent increase/Decrease**
	Sample 1	**Sample 2**	**Average**	
Control Sample	675.22	666.68	670.95	0
1.50%	815.87	820.23	818.05	21.92

Scanning Electron Microscopy

Looking at the fracture surface is also instructive with regards to the failure mechanism of the lathe waste in the concrete. While most of the lathe waste pulled out in the concrete when they were used, in the presence of lathe waste, broken lathe waste was observed. This can be seen in SEM images, where the exposed lathe waste protruding from the fracture surface are much shorter and fewer in number than in mixes with hybrid reinforcement. This is because more of the lathe waste broke at or near the crack surface. This suggests that the lathe waste was able to reinforce the matrix and strengthen its hold on the lathe waste, increasing the stress on the lathe waste and causing them to break. Therefore, choosing lathe waste can carry additional crack bridging loads without breaking, for example by increasing their diameter of lathe waste could significantly increase strength and toughness performance concrete.

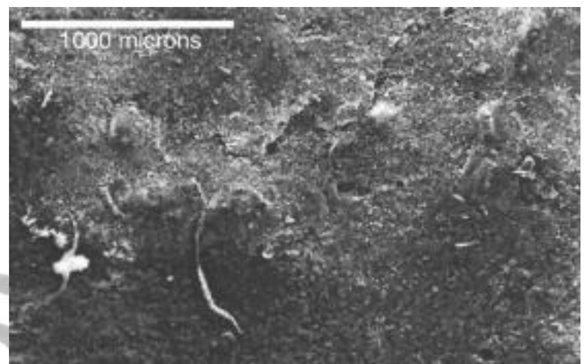

Figure 6: Scanning Electron Microscope Micrographs of fracture surface showing lathe waste pull out.

Conclusions

It was observed that the workability of the mixtures decreased with an increase in the percentage of lathe waste as fiber reinforcement, i.e. higher lathe waste, so little workability. Compressive, flexure and split tensile strength increases as the waste fiber content increases to a certain extent and then decreases as the fiber content increases further. 1.5 % of the waste fiber content is the optimum resistance content. The experimental results were verified by the images provided by SEM.

Recommendation

It is recommended that for strength enhancement, the lathe waste can be used as steel fiber reinforcement up to 1.5% (by weight of cement).

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