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Mechanical Characteristics of Lathe Scrap Waste Fiber with Concrete

P. Asha[1*], R. Balaraman[1], G. Swarna Priya[1], Viswas Koundinyan[1], R. Aravind[1], S. Karthikeyan[1]

[1]*Department of Civil Engineering, Jerusalem College of Engineering, Chennai, Tamil Nadu, India.*

**Corresponding author: asha.p@jerusalemengg.ac.in*

Abstract. The purpose of this study is to determine whether waste from lathes is suitable for use in concrete as a partial substitute for coarse aggregate. The percentages of lathe waste that are utilized to substitute aggregates in terms of weight are as follows: 4%, 6%, and 10%. Twelve concrete cubes of grade M20 were made in total before the mix was used. In addition to the main components of concrete, the cubes are cast with 4%, 6%, and 10% of lathe waste. The specimens are allowed to be cured for a total of 28 days. To investigate the attributes of strength that concrete has, both compression and split tensile strength tests are carried out. It is concluded that lathe wasteisalowweightmaterialand4% replacement of lathe waste in the concrete is more efficient and beneficial. Thus, it can be said that using lathe waste in concrete with 4% replacement for aggregates is advantageous compared to using standard concrete, which also minimizes environmental pollution while also giving the waste material a financial return. The constituent materials employed in this investigation include waste lathe scrap fibre, cement, fine and coarse aggregate, and water. Use of OPC 53 grade cement and cement's chemical makeup

Keywords: Lathe Scrap, Lathe waste, Scrap fiber, Concrete

INTRODUCTION

The globe is currently faced with the challenge of building extremely complex and difficult engineering constructions. Concrete is the substance that is most important and is used the most often for creating engineering buildings, pavements, and other similar things. In the realm of concrete technology, there are attempts to improve the qualities of concrete by utilizing fibres and some other admixtures in concrete up to amounts. This is because concrete is required to possess extremely high compressive strength as well as sufficient workability properties. To meet these requirements, concrete must have certain qualities. [1]. The composite building material known as fibre reinforced concrete is made by randomly distributing short, discontinuous fibres throughout the concrete part (FRC) [2].

Steel, glass, and polymer are the main components utilized to make the fibres used in cement-based composites, but other materials can also be employed [3]. The most common type of fibre used to strengthen concrete is steel fibre. SFs are initially employed to stop/regulate shrinkage caused by plastic and drying in concrete. The addition of SFs improves the strength, crack resisting capacity and ductility of concrete specimens [4]. One thousand two hundred million tons of lathe scrap are being obtained annually. Hence this research focuses on determining the effects of waste lathe scrap steel fiber on the strength properties of concrete [5]. These wastes make up between 3 and 5% of the weight of the metal casting. In addition, it has been determined that industrial lathes generate three to four kilograms (kg) of chips every working day, and a study by the ICI estimates that lathes and CNC machines generate up to one thousand two hundred thousand tons (Mt) of waste on an annual basis. Because the chip surface becomes contaminated with oil or even other coolants during the milling operation, the storage of this waste has a negative impact on the environment and incurs extra costs. [6] This contamination of the chip surface occurs because of the milling process. In addition to their elongated spiral structure, tiny size, and surface contamination, recycling metal chips is difficult for several reasons [7].

Lathe waste is a low weight material, and its substitution in concrete at a rate of 4% is shown to be more effective and advantageous. Using lathe waste in concrete with 4% replacement for aggregates is therefore preferable to using regular concrete because it reduces environmental pollution and provides a financial return

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for the waste material. The constituent materials used in this experiment include water, cement, fine and coarse aggregate and waste lathe scrap fibre, use of OPC 53 grade cement and chemical composition of cement [8].

Malek et al. (2021) modified the concrete by adding steel chips at rates of 5 percent, 10 percent, and 15 percent of the cement weight. Steel chips were used to study the thermal and structural characteristics of concrete [9]. They made the discovery that the quantity of steel chips added led to an increase in the materials compressive and split strength properties. Specific heat capacity increased as thermal diffusivity decreased. The inclusion of steel chips had no effect on heat conductivity [10]. According to Rubén (2016), concrete with the inclusion of polypropylene fibres or steel fibres is a good substitute for conventional concrete since it has better strength and fire behaviour, which delays the emergence of cracks and explosive concrete spelling [11]. The evaporation resistance of steel fiber reinforced concrete specimens was evaluated by Sustersic (1991) using the CRD-C 63-80 test methodology, and the abrasion resistance was evaluated using the Bohme test method. Nine mixed amounts were employed. W/c ratios were used in the range of 0.30 to 0.65. At each w/c, mixtures without fibres were also created.

According to [12], adding steel fibres to concrete increases its resistance as determined by both test techniques. The findings of experimental research of steel fibre reinforced concrete were presented by Ghugal (2003). Strength properties were found. Utilized are a concrete mixture of M25 grade and 50 aspect ratio crimped steel fibres. By weight of cement, the fibre volume percentage varies from 0.5 to 4.5 percent at intervals of 0.5 percent [13]. Amin (2016) gave a presentation on concrete that included steel fibers. His research focuses on the influence that fibers have on shear checks. The tests, in addition to a comprehensive characterization of the material, were examined together to quantify the post-cracking behavior of the SFRC [14]. The flexural behavior of concrete reinforced steel fibers with varying amounts of fiber was investigated by Shweta and Kavilkar (2014). Four different aspect ratios were chosen to test in the trials that were carried out [15]. The proportion of steel in 40, 50, 60, and 70 ranged from 0.5% to 2.5% at intervals of 0.5% across all these cases. The codal rules were followed to study the strength parameters. The improvement in bending strength from 36.7% to 58.65% was attributable to an increase in the fiber ratio from 40 to 70 [16]. Different object detection and surface defects detection approaches are discussed in [17-18].

MATERIALS AND TESTING

Cement: The constituent materials used in this present study are coarse aggregate, fine aggregate; cement, water and waste lathe scrap fibre. Cement of the OPC 53 grade is used, and Table 1 provides information on the cement's chemical make-up.

Lathe Scrap Steel Fibres: Scrap Steel Fibers of length twenty to thirty millimeters were collected from the lathe machines of width 2 mm and thickness around 0.6mm are added to the concrete matrices. The aspect ratio varies from 50-70 and modulus of elasticity was 200 GPa. Rectangular, twisted and/or fibres with metallic bright appearance as seen in Figure 1 were used.

TABLE 1: Chemical Ingredients of Cement

Constituents	Percentage
CaO	60-67
SiO_2	17-25
Al_2O_3	3-8
Fe_2O_3	0.5-6.0
MgO	0.4-4.0

Fine Aggregate: Manufactured sand falling in Zone – II as per IS: 383-1970 is used as shown in Figure 2. It was tested as per IS codal provisions.

Coarse Aggregate: Coarse aggregates having a size of 20mm was used.

Water: Mixing takes place using drinkable water that is readily accessible on the campus.

Quantities of Materials: Quantities of different materials for control mix and mixes with 4%, 6% and 10% lathe scrap steel fibre for one cube are presented in Table 2.

FIGURE 1. Lathe scrap steel fibres

FIGURE 2. Manufactured Sand

TABLE 2. Quantities of Materials

Percentage of Lathe Scrap Steel Fibre (%)	Lathe Scrap Steel Fibre (kg)	Specimen Designation	Cement (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	Water (lit)
0%	0	CM	2.946	4.418	8.836	1.474
4%	0.530	LS4	2.946	4.328	8.658	1.474
6%	0.796	LS6	2.946	4.286	8.570	1.474
10%	1.326	LS10	2.946	4.198	8.394	1.474

Test for Compressive Strength: Concrete cubes after 24 hours of casting were removed from mold. They were soaked in water for curing before being put through compressive strength test utilizing compression testing equipment with a capacity of 2,000 kN, as shown in Figure 3.

Test for Split Tensile Strength: The split tensile test is conducted using cylinders that are 300 millimeters in height and 150 millimeters in circumference. After 24hours of casting, the instance was removed from the mould and subordinated to water curing. After 28 days of curing, the instance was tested for split tensile strength using contraction testing machine as shown in Figure 4.

FIGURE 3. Compression Strength Testing of Cubes

FIGURE 4. Split Tensile Strength Testing of Cylinders

RESULTS AND DISCUSSION

Compressive Strength: Figure 5 illustrates the variation in compressive strength that occurs at 7 days and 28 days with various types of lathe scrap steel fibers. At both 7 days and 28 days, the compressive strength of LS4 was the greatest, with values of 22.4 N/mm2 and 29.5 N/mm2 respectively. When compared side by side, the compressive strength of LS4 at 28 days was 11% greater than that of CM. Additional increases in the fiber % resulted in a reduction in the compressive strength. After 4% replacement of lathe scrap steel fiber, compressive strength begins to drop after 7 days and again after 28 days. This phenomenon occurs at both times. It is possible for up to four percent of the replacement fibers to be distributed consistently, which will result in an improvement in compressive strength. After that point, the fibers may begin to ball together, which will result in a reduction in the material's compressive strength. Jhatia and colleagues also saw a similar pattern of behavior (2018).

Split Tensile Strength: Figure 6 illustrates the variation in split tensile strength that occurs at 7 days and 28 days with various types of lathe scrap steel fibers. It can be noticed that LS4 had the split tensile strength at 7 days with values of 2.34 N/mm2 and at 28 days with values of 2.96 N/mm2 correspondingly. The tensile strength of LS4 after 28 days of splitting was 3.5% greater than that of CM, which was higher by 11%. The split tensile strength declined more when the proportion of fiber in the material increased. It's possible that this is because of the balling effect that fibers have.

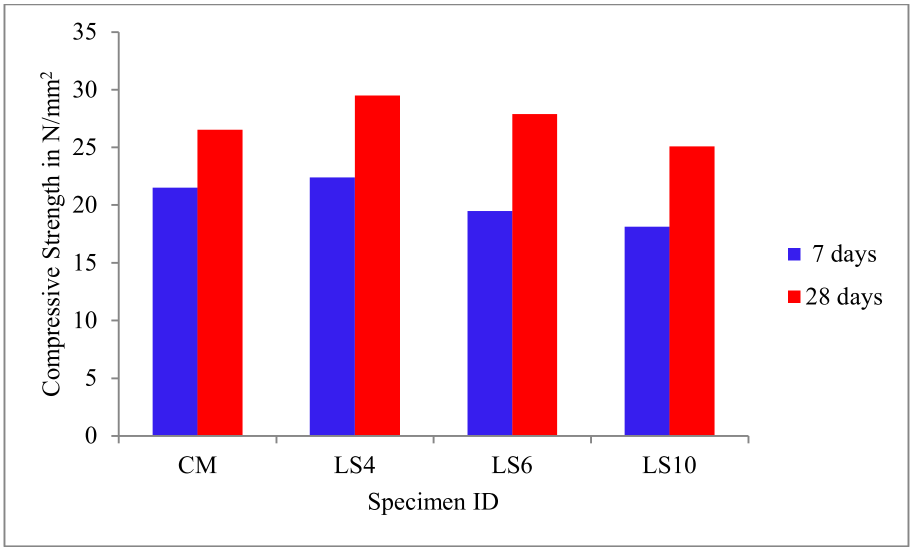

FIGURE 5. Compressive Strength of Specimens with Lathe Scrap Steel Fibres

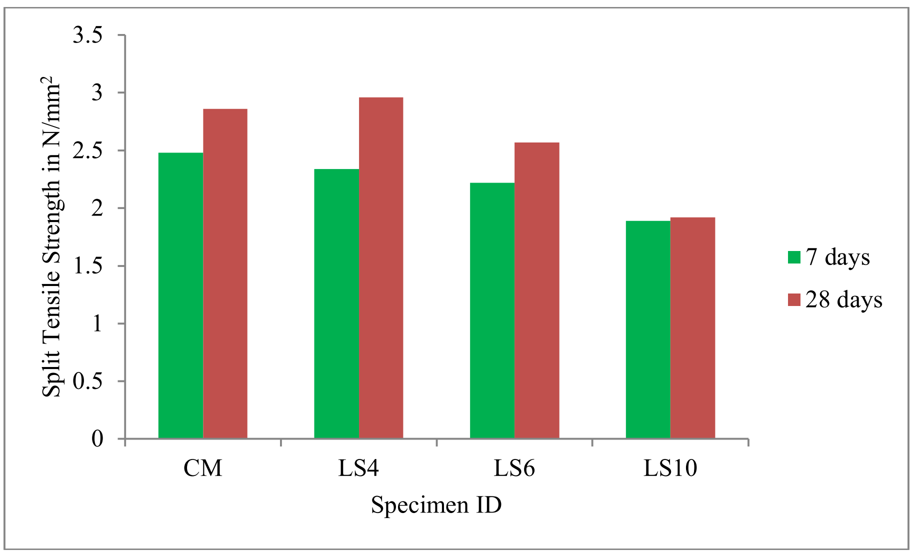

FIGURE 6. Split Tensile Strength of Specimens with Lathe Scrap Steel Fibres

Water Absorption: Water absorption increases with increase of lathe scrap steel fibre. It is seen from Figure 7 that water absorption of LS4, LS6 and LS10 was 0.14%, 0.76% and 1.02% respectively higher than CM. This may be attributed to the increased spacing within concrete due to the interlocking of lathe scrap steel fibres as observed by Aldikheelia and Shubber (2020).

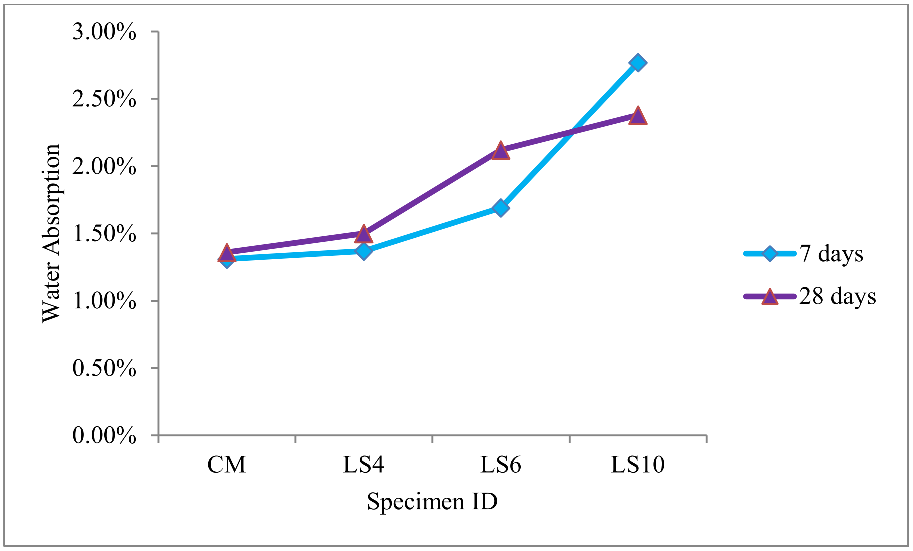

FIGURE 7. Water Absorption of Specimens with Lathe Scrap Steel Fibres

Weight of Specimens: Weight of cube specimens with and without lathe scrap steel fibre was measured at 7days and 28days. It was found that the weight of LS4 was 47% less than CM and the least among all specimens with lathe scrap steel fibre as presented by Altun and Aktas (2013). Further increasing the content of lathe scrap steel fibre, weight of specimens showed an increasing trend as seen in Figure 8.

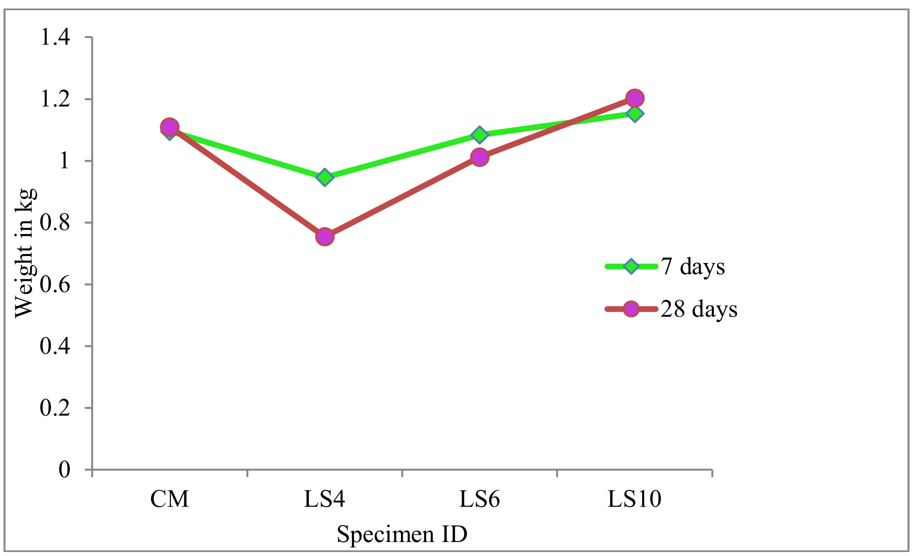

FIGURE 8. Weight of Specimens with Lathe Scrap Steel Fibres

CONCLUSIONS

This experiment makes use of a variety of elements, including water, cement, fine and coarse aggregate, and waste lathe scrap fiber. Utilization of OPC 53 grade cement, as well as the chemical make-up of cement According to the findings of this experiment, replacing concrete with lathe waste enhances the material's mechanical qualities. After casting the specimens, several tests were carried out seven and twenty-eight days later. The following observations were made because of experimental research carried out on concrete using leftover lathe fiber:

• The increase in compressive strength test was 11% when aggregates were substituted with 4% of lathe waste (LS4) as compared to the control mix (CM)

• When using 4% replacement, superior results are achieved compared to those obtained using ordinary concrete in terms of compressive and split tensile strengths.

• The LS4 model absorbed the least amount of water and had the lowest unit weight

Therefore, it can be concluded that the utilization of lathe waste in concrete at a replacement rate of 4% for aggregates is advantageous in comparison to the use of conventional concrete. This not only lowers the level of pollution in the surrounding environment, but it also creates economic value for the waste material.

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