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Effect of Lathe Waste in Concrete as Reinforcement

Prof. Kumaran M[1],Nithi M.[2], Reshma, K. R.[3]
Civil Engineering[1], Professor1, Universal Engineering College, Thrissur, Kerala, India.
Research scholar [2], NIT Calicut, Kerala, India.Civil Engineering[3]P G student[3], Universal Engineering College, Thrissur, Kerala, India,
Email kumaranhodce@gmail.com[1],nidhi.srijith@gmail.com[2], reshooresh@gmail.com[3]

Abstract- An Experimental investigation is carried out on the strength of lathe waste concrete and deformational behavior of lathe waste concrete beams. The waste steel scrap available from the lathe is used. Optimum combination of lathe waste is studied. For this cube and cylinder compressive strength, flexural test and split tensile strength tests were carried out. The deformational behavior was investigated with this optimum content.A total of 24 reinforced lathe waste concrete beams had been tested to investigate the influence of lathe waste and combined effect of lathe waste and stirrups on the deflection, cracking, ultimate load and failure pattern.Beams without stirrups and with stirrups are studied. The experiments have demonstrated the advantages of combining lathe waste with steel stirrups. Load- deflection behavior of simply supported beams is increased. Reinforced lathe waste concrete beams show less deformation than similar reinforced normal conventional concrete beams. The combination of lathe waste and stirrups increases the ultimate load of concrete beams. Test results indicated that the inclusion of lathe waste significantly improves the strength and deformational characteristics of concrete.

Index Terms*: Lathe waste concrete; Shear and bending; Shear strength; Stirrups; Simply supported beams.*

1. INTRODUCTION

Steel fibers strengthen concrete in tension. But for a long time Steel Fiber Reinforced Concrete (SFRC) was useless because of its high material cost. In the recent years the research of SFRC became more interesting and more users are there in all over the world. But still SFRC is not common in small and medium scale construction. But still SFRC is not common in the residential and ordinary buildings because steel fibers available in market are costly.

Lathe waste in crimped fiber formis a waste from lathes. Various experimental studies conducted on lathe waste concrete reveal that there is considerable increase in compressive strength and flexural strength than conventional concrete (Vijayakumar G.*et al*. 2012). Recently waste generated from lathes is more and lathe waste concrete (LWC) can be a useful way of waste management. So the study of behaviour of lathe waste concrete in RC beams is important.

The main aim of this thesis is to determine the strength characteristics of RC beams under combined bending and shear and pure bending. For this optimum percentage of lathe waste is considered while casting the RC beams. The lathe waste was processed manually to get an aspect ratio ranging from 50 to 120. From the literature survey it was found that too long fibers form as "ball" and create workability problems. (Ashok S. P. et al 2012). So it is necessary to maintain the aspect ratio.

The inclusion of short steel fibers in reinforced beams changed the failure pattern from shear to flexure (Mansur M. A. et al 1986). The lathe waste also changed the failure pattern in RC beams. The strength of FRC beams in shear and combined shear and bending is greater compared to plain concrete beams (Niyogi S. K. et al 1987). Form the experimental study is was found that the load carrying capacity of lathe waste concrete RC beams was greater than normal concrete RC beams both in combined shear and bending and pure bending.

2. MATERIALS

Materials consist of cement, fine aggregate, coarse aggregate, lathe waste, super plasticizer and water.

2.1. *Cement*

Portland Pozzolana Cement confirming to IS: 1489(Part 1)1991 was used.

2.2. *Fine aggregate*

Manufacturing sand (M sand) passing through 4.75mm IS sieve conforming to grading zone II was used. Sieve analysis was done to find out the grading zone.The Properties like fineness modulus-3.83, specific gravity-2.5, bulk and loose density were 1725kg/m3 and 1636kg/m3satisfied the requirements of IS 383-1970.

2.3. *Coarse aggregate*

Crushed stone aggregate with particle size less than 20mm size were used for present investigation. Samples were tested as per IS: 2386-1997 and IS: 383-1970.

2.4. Lathe waste

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.

Figure 1. Processed Lathe Waste

2.5. *Super plasticizer*

Super plasticizer used was CONPLAST SP 430 confirms to IS:9103-1999was used to improve the workability.

2.6. *Water*

Portable water available from laboratory which satisfies the drinking standard was used for mixing and curing.

3. CONCRETE MIX DESIGN

In the present study M30 grade concrete mix design as per IS: 10262-2009iscarried out. The concrete mix proportion was1:1.73:3.3:0.45 and water content was 170*l*/m^3.

Table 1. Concrete mix design

Sl No	Items	Per m^3 of concrete
1	Cement	377.8 kg
2	Fine aggregate	655 kg
3	Coarse aggregate	1246 kg
4	Water	170*l*

4. CASTING OF SPECIMENS

The specimens were cast as per mix design. The lathe waste content is varied as 1%, 1.5% and 2% of total weight of concrete (weight of cement, fine aggregate, coarse aggregate and water).

A total of 24 numbers of 150mm cubes for compressive strength, 12 numbers of cylinders of 150mm diameter and 300mm height for split tensile strength and 12 numbers 100x100x500 prisms for flexure test were cast. A total of 24 RC beam specimens were cast for combined bending and shear test and pure bending test.

5. TESTING OF SPECIMENS

The cube specimens were tested after 7 and 28 days curing. All the other specimens were tasted after 28 days curing. The compressive strength test and split tensile tests were carried out using automatic compression testing machine with capacity of 5000kN. Flexural test was carried out using flexural testing machine. Figure 2 shows the test set up for compression test.

Figure 2.Test set up for compression test

All the beams were tested on loading frame, loaded by hydraulic jack of capacity 500kN. Table 2 gives the details of tested simply supported beams. All the beams were whitewashed after 28days curing. Then the loading points, support points and grids were marked in the specimen. The dial gauge was placed at the mid span to record the deflection at mid span. The deflection was taken up to two third of expected ultimate load. All the beams were tested under two point symmetric loading. Total span of beams were 990mm. Figure 3 shows the test set up for RC beams. Out of the 24 RC beams, 12 RC beam specimens were tested for combined bending and shear and 12 RC beam specimens tested for pure bending.

In the present study RC beams without stirrups (A type) were considered for combined bending and shear and beams with stirrup spacing 150mm c/c (B type) were considered for pure bending test. The longitudinal reinforcement was also varying. According to the variation in longitudinal reinforcement there were three types. Type I was 2 numbers of 12mm diameter bars, type II was 2 numbers of 16mm diameter bars and type III was 3 numbers of 16mm diameter bars. The loading and reinforcing details of all the specimens were given in table 2. Figure 4 and figure 5gives the details of loading of Type IA and Type IB specimens.

Table 2. Details of RC specimens

Specimen	No of specimen	Longitudinal reinforcement	Stirrups	(*a*/d) ratio	Lathe waste content (%)
Type I A NC	2	2 # 12mm dia bars	Without stirrups	1.48	0
Type I A LWC	2	2 # 12mm dia bars	Without stirrups	1.48	1.5
Type II A NC	2	2 # 16mm dia bars	Without stirrups	1.50	0
Type II A LWC	2	2 # 16mm dia bars	Without stirrups	1.50	1.5
Type III A NC	2	3 # 16mm dia bars	Without stirrups	1.92	0
Type III A LWC	2	3 # 16mm dia bars	Without stirrups	1.92	1.5
Type I B NC	2	2 # 12mm dia bars	Stirrups @150mm c/c	1.95	0
Type I B LWC	2	2 # 12mm dia bars	Stirrups @150mm c/c	1.95	1.5
Type II B NC	2	2 # 16mm dia bars	Stirrups @150mm c/c	1.98	0
Type II B LWC	2	2 # 16mm dia bars	Stirrups @150mm c/c	1.98	1.5
Type III B NC	2	3 # 16mm dia bars	Stirrups @150mm c/c	1.98	0
Type III B LWC	2	3 # 16mm dia bars	Stirrups @150mm c/c	1.98	1.5

Figure 3. Test set up for RC beams

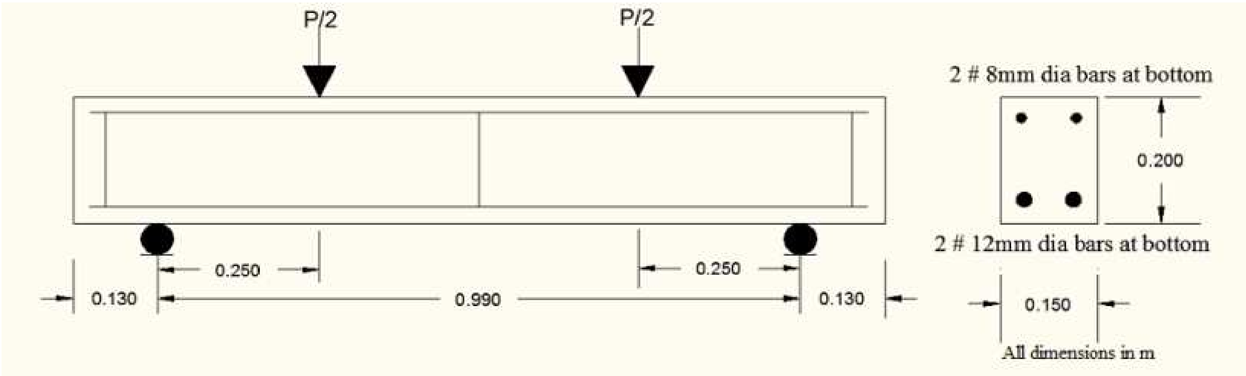

Figure4. Loading and reinforcing details of Type IA beams

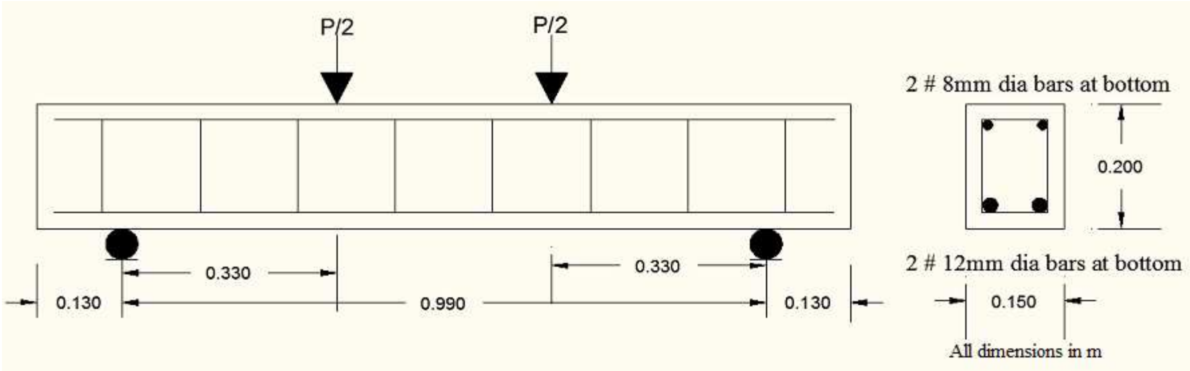

Figure 5. Loading and reinforcing details of Type I B beam

6. RESULTS AND DISCUSSIONS

The 7days and 28 days compressive strength of the concrete was found to be optimum in 1.5% lathe waste and there was 8.4% increase in cube compressive strength for the optimum percentage mix than control mix at 7 day and 11.25% increase at 28 day. In the split tensile strength test optimum mix of LWC showed 14.75% higher strength than control mix and in the case of flexural strength there is 18% increase than control mix. The test results of concrete are given in table 3 and 4.

Table 3. Cube compressive strength

Lathe waste content	7 Days in MPa	28 Days in MPa
0	31.6	39.1
1	32.9	41.2
1.5	34.25	43.5
2	33.5	42.5

Table 4. Split tensile and flexural strength

Lathe waste content	Split tensile strength (28 Days) in MPa	Flexural strength (28 Days) in MPa
0	2.98	5.79
1	3.3	6.29
1.5	3.42	6.88
2	3.36	6.35

In the case of RC beams, beams tested for combined bending and shear, the increase in ultimate strength of lathe waste concrete beams compared to normal concrete beams in Type IA, Type IIA and Type IIIA were 12.6%, 6.95% and 5.6% respectively. It was found that in the lathe waste concrete RC beams the initial crack load was greater than normal concrete ones. The percentage increase in initial crack load in Type IA, Type IIA and Type IIIA are 44%, 30% and 10% respectively.

Failure pattern changed from shear compression failure to combination of shear compression and flexure failure in Type IA specimens. But in the case of Type IIA and Type IIIA specimens the failure pattern of normal concrete was shear compression where as the failure pattern of LWC was shear tension. The load- deflection curves of Type IA, Type IIA and Type IIIA specimens of both normal concrete and lathe waste concrete are given in figure 6, figure 7 and figure 8 respectively.

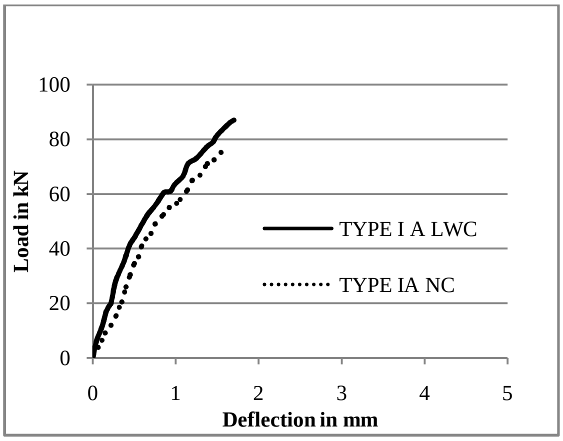

Figure 6. Load- deflection of Type IA NC and LWC beams

Table 4. Test results of RC beam specimen

Beam Designation	Shear span to effective depth ratio (*a*/d)	Load at initial crack in kN	Ultimate laod in kN	Nature of failure
Type I A NC	1.48	30.50	120.00	Shear compression
Type I A LWC	1.48	44.00	135.00	A combination of shear compression and flexure
Type II A NC	1.50	35.00	115.00	Shear compression
Type II A LWC	1.50	45.50	123.00	Shear tension
Type III A NC	1.92	45.00	125.00	Shear compression
Type III A LWC	1.92	49.50	132.00	Shear tension
Type I B NC	1.95	37.00	143.00	Flexure failure with flexure shear crack
Type I B LWC	1.95	53.00	155.00	Flexure failure
Type II B NC	1.98	37.50	160.00	Shear Compression
Type II B LWC	1.98	52.00	179.00	Shear Compression
Type III B NC	1.98	42.50	192.00	Shear Compression
Type III B LWC	1.98	56.00	220.00	Shear Compression

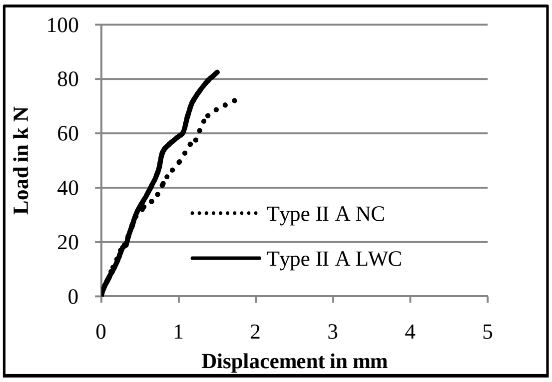

Figure 7. Load- deflection of Type IIA NC and LWC beams

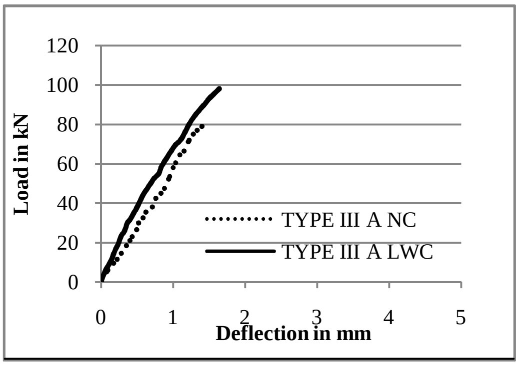

Figure 8. Load- deflection of Type IIIA NC and LWC beams

In the case of pure bending condition in Type IB, Type IIB, and Type IIIB beams the percentage in increase in ultimate loads are 8.4%, 11.8% and 15%. The percentage increases in initial crack load is 45.7%, 38.6%, and 22.4%. The load-deflection curves of Type IA, Type IIA and Type IIIA specimens of both normal concrete and lathe waste concrete are given in figure 6.7, 6.8 and 6.9.

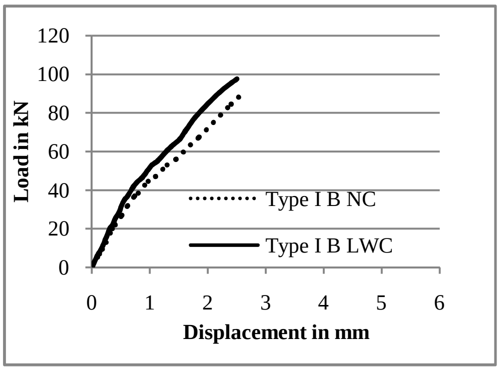

Figure9. Load- deflection of Type IB NC and LWC beams

Flexure failure occurred in both Type IB specimens. But the flexural shear crack formed and developed in the case of NC RC beams. In the case of Type IIB and Type IIIB specimens the failure pattern is same in normal concrete and lathe waste concrete and the failure pattern was shear compression failure

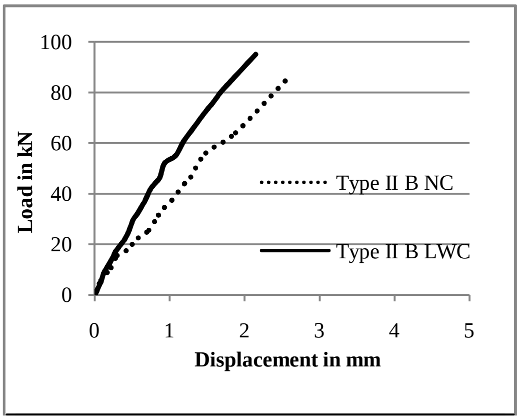

Figure 10. Load- deflection of Type IIB NC and LWC beams

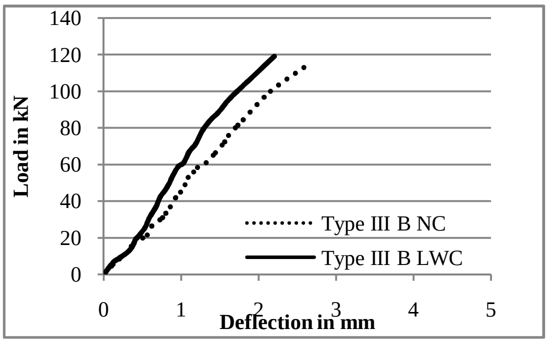

Figure 11. Load- deflection of Type IIIB NC and LWC beams

Figure 12. Failure mode in Type IB NC specimen

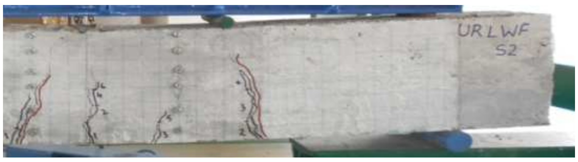

Figure 13. Failure mode in Type IB LWC specimen

Figure 14. Failure mode in Type IIIALWC specimen

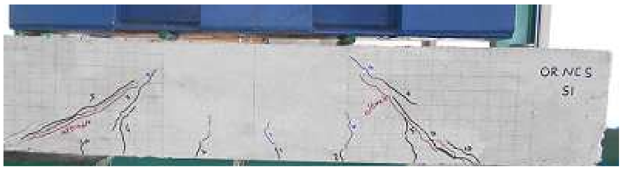

Figure 15. Failure mode in Type IIIA NC specimen

7. CONCLUSIONS

Based on the experimental investigations carried out the following conclusion are drawn

- The initial crack load has an enhancement about 10- 45% in LWC beams than NC beams
- The Enhancement in ultimate load in LWC beams compared to NC beams is 5.6-15%.
- The load deflection curve of LWC lies over NC upto 2/3rd load of expected ultimate load which indicates that the initial deflection is less in LWC concrete specimens than control specimens

These conclusions are made with reference to the investigations in only 12 type specimens and for generalizing the conclusion more tests are needed.

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