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Study the Behaviour of Using Steel Scrap in Concrete

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ABSTRACT- Today the construction industry is in need of finding cost effective materials for increasing the strength of concrete structures. This project work emphasis on the study of using steel scrap in the innovative construction industry. Steel Scrap concrete is a concrete containing fibrous material that is uniformly distributed and casually oriented. This paper aims to have a comparative study between turn fiber, binding wire and steel nail in M25 concrete. The tests conducted were slump test, compressive strength test, split tensile strength test and for this concrete cubes, beams and cylinders were cast and cured and tests were done at 3rd day, 7th day and 28th day.

KEYWORDS- LSSRC- Lathe steel scrap reinforced concrete, flexural strength, compressive strength, split tensile strength

I. INTRODUCTION

Concrete is considered as one of the most important construction materials among all other construction materials, which is manufactured at site. Since all the ingredients of concrete are of geological origin which are required for extensive construction activities can always be made available. Various researches and efforts are being made to obtain a durable, strong and economical concrete mix. The present time is witnessing the construction that is very challenging and difficult. Current world is watching that the construction is very challenging and difficult for civil engineering structures. In the field of concrete technology efforts are being made to develop such a materials which will have good characteristics. All over the world researchers are trying to develop high performance concretes by using fibres and admixtures in concrete with proportions. (FRC) Fibre reinforced concrete which is a new construction material they improve through various research and development of work during last 16 years. In concrete mixer of fibre has found to improve different properties such as cracking resistance, impact and wear resistance ductility and fatigue resistance. [1-2].

II. OBJECTIVE OF THE RESEARCH

- To investigate experimentally the strength variation in concrete on addition of steel lathe scrap from industry waste.
- Compression.
- Splitting tension.
- Flexure.
- To find out the optimum percentage of steel scrap that can be used in concrete.
- To study cost sensitivity analysis at different percentages.

A. Significance of study

It is necessary to think about workable development by reducing the wastes or reusing it. A comparative study is done between plain concrete and reinforced concrete with lathe scrap. Every lathe machine produces steel scrap which can be used in concrete to enhance various properties of concrete. The reinforcing material used in this study is turned lathe steel scrap. They are the scraps from lathe shops. Lathe scrap which largely shows the property of steel fibres can be used as an alternate for steel fibres. Steel fibres are available in market but costly which makes fibre reinforced concrete uneconomical. It is necessary to determine the effect of steel scrap on the strength characteristics of the concrete. Subsequently determining the percentage of fibre at which maximum strength and minimum cost can be attained [1,3].

III. RESEARCH METHODOLOGY

The investigational work was carried out to check the effect of lathe scrap on various properties of concrete. The samples were casted with different percentages of lathe scraps (0%, 1% 1.5%, 2%) to find the adjusted percentage oflathe steel scrap which can used in concrete for maximizing the strength of concrete. Cost analysis for lathe scrap and steel fibre was carried to check the variation of cost with different percentages of lathe scrap and steel fibre and determining the economical one[1,6].

A. Materials

The material to be used for casting of specimen is discussed below:

B. Cement

Locally available Ambuja cement (PPC) was used in present experimental investigation work. Portland pozzolana cement is preferred over ordinary Portland cement because it makes concrete more impermeable and more denser. Ambuja cement satisfies nearly all the requirements of the Indian standard code. The properties determined in laboratory are given in table 1[1,2,3,6].

Table 1: Physical properties of cement

S.No	Description	Values obtained	Requirements as per Is 8112-1989
1	Standard consistency(using vicat apparatus)	28%	-
2	Initial setting time, min	50	>30min
3	Final setting time, min	7hours 3min	<10hrs
4	Specific gravity (specific gravity bottle)	3.0	3.0-3.15

C. Cement Test

Standard consistency of cement may be defined as that water content at which the needle of the apparatus fails to penetrate the specimen by 5mm from bottom of moulds

D. Fine Aggregates (Coarsesand)

Coarse sand was used which is locally available. As per IS 383-1870 sieve analysis of the fine aggregates was carried out in the laboratory. The material whose particles are of size as are retained on IS sieve no 480(4.75mm) is termed as coarse sand. See fig.1

Figure 1: Coarse sand

E. Coarse Aggregates

Crushed coarse aggregates which are locally available were used. Analysis of the coarse aggregates was carried out. The coarse aggregates used in this experiment investigation are of20 mm crushed angular in shape. The aggregates are free from dust before used in concrete. The fineness modulus was found to be 6.3 and specific gravity of coarse aggregates is 2.64.See fig 2.

Figure 2: Coarse aggregates

F. Lathe machine Steel scrap

Scrap from lathe machine is produced from different manufacturing processes which are carried out by lathe machine. Scrap which is a waste can be used as an reinforcing material, in concrete to enhance the various properties of concrete. Scrap from machine can act in a same way as steel fibre. 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. In addition to get sustainable development and environmental benefits, lathe scrap can be used as recycled fibre with concrete. With increase in population and industrial activities, the quantity of waste fibres generated will increase in coming years. The lathe scrap used in this investigation was tested in production laboratory with the help of universal testing machines (UTM) see fig 3&4, different properties of lathe scrap were find out. The universal testing machine in production engineering lab consists of computer attached to it [1,3,4,6]. Scrap is tested using universal testing machine and its properties are shown on screen. Given below are some of the properties. Scrap properties include breaking strength, breaking load, elongation and modulus of elasticity.

Figure 3: UTM Figure 4. UTM Display Screen

G. Water

The potable tap water is suitable and can be used in the concrete mix. Water of streams and lakes not rivers and sea's, which contain the marine life, also satisfy the requirements and no necessary sampling of water is required when its coming from these so source's and it should notbe used if the water that is coming contains waste, sewage or mine water that is coming from different industrial plants, or can be used once testing is done and tests show positive results. In this study, potable tap water is used for casting concrete specimen.

H. Instrumentation

There are many instruments which are used in the experimental research work. All these instruments are shown below

I. Dial gauges

Dial gauges with stand having magnetic base is used to measure the deflection. The least count of the gauge was 0.01.

J. Loading machines

UTM of 10 ton capacity was used, which is operated manually for the testing of beams. For cylinders and beams testing electro-hydraulically operated compression testing machine of 200 ton capacity was used.

K. Concrete Mix Design

M-25 concrete mix was used with coarse aggregates of size 10mm. Mix design was carried out as per ACI-544 guidelines.

L. Methdology

Mix design is the process of selecting suitable ingredients of concrete and to determine their properties with object of producing concrete of certain maximum strength and proper durability, and as economical as possible. The main purpose of designing is to achieve the stipulated strength, durability and to get concrete which is highly economical.Final mix proportion is in Table 2.

Table 2: Final Mix Proportions [1]

CEMENT	FA	CA	W/C
1	1.88	2.86	0.52

M. Mixing of concrete

Electrically operated concrete mixer was used for mixing of concrete. Proper care was taken for prevention of concrete balls. Required proportions of coarse aggregates, fine aggregates, and cement were mixed until a homogenous mix was obtained. Water was added and then whole mixture is thoroughly mixed.

N. Moulds of specimens

The size of moulds that were used was 100x100x500mm for beams, 150x300mm for cylindrical specimens and 150x150x150mm for cubes see FIG.5,6,7. Mouldswere oiled properly to avoid the adhesion of concrete to mould.[1,2].

Figure 5: Beam moulds

Figure 6: Cylinder moulds

Figure 7: Cube moulds

O. Casting of specimen

Cubes, cylinders and beams were casted as per the prepared mix design of concrete. Calculated amount of lathe scrap was added during the mixing of concrete in electrically operated concrete mixer. Care was taken in order to prevent the formation of balls during addition of lathe scrap. After the concrete mix was prepared as per the mix design, concrete was poured in the concrete moulds (of cast iron) which had already been oiled with medium viscosity oil. Concrete was filled in the moulds in three layers and vibrated on the vibrating table each time.

P. De-Moulding of specimens

Before the filling of concrete the moulds are properly oiled from inside so as toavoid the breaking of specimens during de-moulding. The specimens are de-moulded after 24 hours of casting. The moulds screws are loosened with suitable means.

Q. Curing

Steel moulds are de-moulded by loosening the screws, after de-moulding the specimens were poured into the water tank for curing for a period of 28 days outside the laboratory. Water tank is to be filled with fresh water free from any type of harmful material. Specimens are to be dipped completely into the water.

R. Workability

Workability plays a very vital role. The lathe scrap is mixed with concrete proportions in which the concrete is of adequate workability for the placing conditions of the concrete and can be properly compacted with the available means. During casting specimens it was found out that upto 1.5% scrap the concrete was easy to work with but with 2 % scrap content the workability decreases up to some extent see Table 3 below,[1,3]

Table 3: Casting specimens

Scrap content	0	1	1.5	2
Slump value	30	22	16	10

IV. EXPERIMENTAL INVESTIGATION

Tests were conducted on concrete specimens as per guidelines, Test procedures are described below.

A. Compression Test Setup and Procedure

Cube specimens have to be placed centrally in the machine in a way that the load is applied to opposite sides of cubes as casted, which is not to the top and bottom. The load is applied in uniform and continuous fashion without any shocks with the help of compression testing machine. Thus the specimens have been tested under controlled stress loading. To obtain the compressive strength we have to use the formula given below.

σ=P/A

Where, P is load at which cube specimen fails (KN)

A is cross-sectional area of cube which is 150x150mm2.[1,3,]

B. Split Tensile Test Setup and Procedure

Splitting test also called as indirect test are used for determining of tensile strength of concrete sometimes are known by name as split tensile strength of concrete. In this test compressive line load is applied along the opposite generator of a concrete cylinder. Because of compression loading a fairly uniform tensile stress is developed over nearly 2/3 of the loaded diameter as obtained from elastic analysis. The tensile stress acts in direction perpendicular to line of action of applied loads and is given by the formula (IS 5816-1970).Fsp (split tensile strength)= 2P/πdl.

Where, P=Load at which specimen fails (KN)d=diameter of cylinder (mm)l=length of cylinder specimen (mm).Ratio of split tensile strength to cylinder strength not only varies with grade of concrete but it also depends on the age of concrete. With time after a month this ratio decreases. Tensile strength of moist cured concrete is higher than air cured concrete.[1,3,4].

C. Flexural Strength Test Setup and Procedure

In flexural strength test of beam, the specimen of size 100x100x500mm is placed over three point loading arrangements and stress produced during breakage of specimen.

Flexural strength (IS:516-1959) is reported as modulus of Rupture and it is calculated as

Ft=3PL/2bd2Where, P=load at which the beam specimen fails (KN)L=effective length of beam (mm)b=width of beam (mm)

b=width of beam (mm)

d=depth of beam (mm)

After 28 days of curing, the specimens are left out for one day to dry before the testing can be done. Specimens were tested in flexure where load is applied by loading rod.

The overall direct flexural test setup is shown in figure below. Direct flexural loading is carried out manually. Dial-gauge is used to measure the deflection under the load of beam. The force was recorded by a meter attached with the machine. All measurements were noted down. The beams were tested in 10T universal testing machine. Both the endsof beam were supported on roller support formed. A three point loading was applied. Load is applied through lever attached with the machine.

The initial readings of the dial gauge were recorded prior to load application. Load is applied at an interval of 5KN.[1,5].

V. RESULTS

A. Compressive strength of LSSRC

The compressive strength shows significant increase when compared with plain concrete. A total of 12 specimen cubes were casted having size of 150x150x150mm for different proportions (0% to 2%) of scrap and 3 cubes were used for taking average value (see fig.8).

Figure 8: Compression Testing Machine

Table 4: Addition of lathe scrap in concrete increases the compressive strength of concrete

S. No	SCRAP %	SPECIMEN 1 Failure Load (KN)	SPECIMEN 2 Failure Load (KN)	SPECIMEN 3 Failure Load(KN)	AVERAG ELOAD (KN)	COMPRESIV E STRENGTH (N/MM^2)
1	0	580	595	550	575	25.5
2	1	600	625	590	605	26.8
3	1.5	615	660	645	640	28.4
4	2	520	550	505	525	23.33

From table no. 4 it is observed that addition of lathe scrap in concrete increases the compressive strength of concrete. For 0%, 1%, 1.5% scrap content concrete the compressive strength obtained zis 25.5N/mm2,26.8N/mm2,28.4N/mm2 respectively but at 2%scrap content the strength obtained is 23.33N/mm2 which shows decrease in compressive strength. Compression strength increases up to 11.37% for 1.5% scrap as compared to conventional concrete[1,2,6].

B. Split tensile strength of LSSRC

12 cylinders specimens were casted for different percentages of lathe steel scrap of size 150mm dia. and 300mm in height. The compression load is applied diametrically and along the length of cylinder until the failure of the cylinder along vertical diameter seeFig. 9.

Figure 9: Split Tensile Strength Test

it is observed that with addition of lathe scrap increase the splitting tensile strength of concrete. For 0%, 1%, 1.5% scrap content the strength obtained are 2.85N/mm2, 3.04N/mm2 and 3.37N/mm2. But at 2% of lathe scrap addition there is decrease in splitting tensile strength and value obtained is 2.94N/mm2.Split tensile strength it increases up to 18% for 1.5% scrap when compared with conventional cylinder[1,5].

C. Flexural strength of LSSRC

In flexural strength test of beam, the specimen of size 100x100x500mm is placed over three point loading arrangements. Flexural strength is a mechanical parameter and is defined as the material ability to resist deformation under load See fig 10&11; [1,5]

Figure 10: Flexural crack, Figure 11. Three point loading machine

it is observed that with addition of lathe scrap increase the load carrying capacity of concrete. For 0%, 1%, 1.5% scrap content the load values obtained are 4.33kn, 5kn and 5.66kn. But at 2% of lathe scrap addition there is decrease in load carrying capacity and value obtained is 4.83kn. Flexure strength increase up to 30% for 1.5% scrap content as compared to conventional beam.

Comparison Load Deflection Curve Of Different Proportions of Lathe Scrap shown below on Fig.12

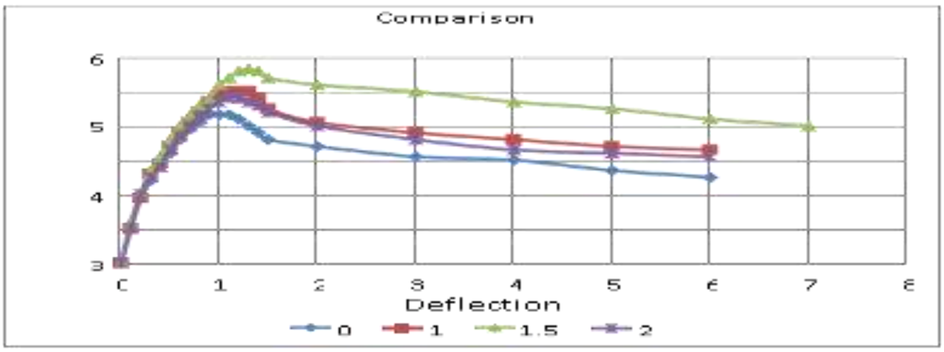

Figure 12: Comparison load deflection curve

The load carrying capacity of 1.5% scrap content beam is maximum when compared to other beams. It has also shown maximum deflection in comparison to other beams. Also 1.5% scrap content beam is more ductile than other beams.[1,2]

Cost and strength sensitivity analysis at different percentages of scrap and steel fiber.

Cost analysis was done at different proportions of lathe scrap and steel fiber . The steel fiber strength and cost values were obtained from thesis work of a student who performed his thesis work in Guru Nanak Dev Engineering College, The comparison is made between the cost of lathe scrap and steel fiber and strength (Compressive, split and flexure) of lathe scrap and steel fiber . Comparison of lathe scrap was made with big hooked steel fiber having following properties are in table 5;[1,5]

Table 5: Steel Fiber and Lathe Scrap Properties

S. No	Property	Steel fiber	Steel scrap
1	Type	Big hooked	Turned and deformed
2	Length	60mm	40-60 mm
3	Diameter	0.75mm	0.4-0.8 mm
4	Aspect ratio	75	70-100
4	Tensile strength	1.5 N/mm2	0.02-0.08N/mm2
5	Young's modulus	0.21 N/mm2	0.04-0.06 N/mm2

VI. CONCLUSIONS AND FUTURE SCOPE

In this study compressive, split tensile and flexure test were done on concrete with varying percentages of lathe scrap. From the test done and strength obtained following conclusions can be made which are as under.

.The study proves that mechanical properties of concrete are increased by adding steel scrap up to certain proportions.

Strength increases up to 1.5% of steel scrap from 1.5 to 2% steel scrap there is slight decrease in strength of concrete

- At 1.5 % scrap content concrete has shown maximum strength in compression, tension and flexure.
- During testing it was observed that specimen tested for split tensile and flexural strength the controlled specimen has broken into two pieces but LSSRC specimens retained the geometry. It shows improvement in ductility due to addition of lathe scrap.
- With further increase in percentage of lathe scrap workability and strength decreases as steel scrap clump together and tend to "ball" formation. It results in higher presence of voids.

1.5 % scrap is optimum percentage because with further increase in percentage of scrap there is enhancement in cost but decrease in strength.

The lathe scrap shows better results compared to steel fiber when cost is taken into consideration.

Future Scope

- Further work can be done for higher grades of concrete.
- Durability properties of concrete can be determined by using lathe steel scrap.
- Shear strength parameters can also be investigated using lathe steel scrap.

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