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Evaluation of workability and strength of green concrete using waste steel scrap

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Abstract. This project works on the study of workability and mechanical properties of concrete using waste steel scrap from the lathe industry. Lathe industries produce waste steel scrap from the lathe machines. In this study, an attempt is made to use this waste in concrete, as accumulation of waste steel scrap cause disposal problem. Tests like compressive test, split tensile test, NDT test (UPV test) were conducted to determine the impact of steel scrap in concrete. The percentages of steel scrap considered in the study were 0%, 0.5%, 1%, 1.5%, and 2% respectively by volume of concrete, 7 day, 28 days test were conducted to find out strength of steel scrap concrete. It is observed that split tensile strength of steel scrap concrete is increased slightly. Split tensile strength of Steel scrap concrete is found to be maximum with volume fraction of 2.0% steel scrap. The steel scrap gives good result in split tensile strength of concrete. From the study concluded that steel scrap can be used in concrete to reduce brittleness of concrete to some extent.

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1. Introduction

Concrete being the most important and widely used material possess very high strength and sufficient workability properties. Now a days, due to urbanization concrete serve a good purpose for high strength shelter and is also suitable for any architectural shape and design. Concrete being weak in tension fails in brittle manner when applied with flexure and tension forces. Besides growing urbanization, there is also growth in industries. Industries contribute lots of waste production, accumulation and disposal problems the waste from industries end up either as land fill or as pollutant, which in turn possess environmental threats due to its hazardous and polluting nature. In order to keep a check over such industrial waste, attempt was made to use it in concrete. Utilizing waste in concrete prevents disposal problem and environmental impact. It also contributes to enhance some of the properties of concrete. It has been marked from previous researches that wastes like fly-ash, steel scrap, blast furnace slag, foundry sand etc., are effectively used to improve the properties of concrete. One such attempt is made in this paper by adding lathe steel scrap from lathe industries in concrete.

2. Materials and Properties

The following materials were used for the present study.

2.1. Cement

Cement used in this study is of OPC 53 grade corresponding to IS 12269:2013, The Specific gravity of cement is 3.15.

2.2. Sand

River sand which is naturally available aggregate it has rounded in shape with smooth texture. Fine aggregate passing through 4.75mm sieve is used as per IS 383:1970. As per IS 2386: 1963 specific gravity test is conducted on the fine aggregate and the value is 2.74.

2.3. Coarse aggregates

Basalt rock aggregates with angular shape and rough texture. Coarse aggregate retaining on 4.75mm sieve is used as per IS 383:1970.

2.4. Steel scrap

Steel scrap is used in the study is obtained from a lathe industry which is a waste product. Specific gravity test is conducted using pycnometer and the value is 3.54. Figure 1 show the steel scrap obtained from lathe.

Figure 1. Lathe Steel scrap

3. Methodology

In this study, M30 grade concrete is used. The mix proportion obtained was 1:2.2:2.8 with water cement ratio 0.35. The mix design was done as per IS 10262:2009. Table 1 shows the details of mix proportion of concrete.

Table 1. Mix proportion of concrete for different % steel scrap

Mix	% of steel scrap	Water (lit)	Cement (Kg)	Sand (kg)	Coarse Agg. (kg)	Steel scrap (kg)
A	0	1.6	4.5	15	11	0
B	0.5	1.6	4.5	15	11	0.14

C	1	1.6	4.5	15	11	0.2
D	1.5	1.6	4.5	15	11	0.4
E	2	1.6	4.5	15	11	0.55

Waste steel scrap of different percentages from 0%, 0.5%, 1%, 1.5%, and 2%[6] were added to total volume of concrete. The slump cone test is conducted for each percentage of steel scrap to find out workability of steel scrap concrete as per IS 1199:1959. The compressive strength and tensile strength of cubes and cylinders respectively is tested for 7 and 28 days as per IS 516:1959. The compression loads were noted and averages of three specimens were taken to determine compressive and tensile strength. Non-destructive technique Ultrasonic Pulse Velocity Test (UPV) was also conducted for compressive strength.

4. Results and Discussion

4.1. Workability results

From Figure 2, it can be observed that the value of slump test shows decreasing trend with varying percentages of steel scrap. It can be inferred from Table 2 that workability of concrete reduces gradually with increase in percentage of steel scrap. Decrease in workability improves strength of concrete and also a check over water cement ratio is achieved.

Table 2. Slump test results

S.No	% of steel scrap	Slump
1	0	26
2	0.5	23.2
3	1	21
4	1.5	19
5	2	15

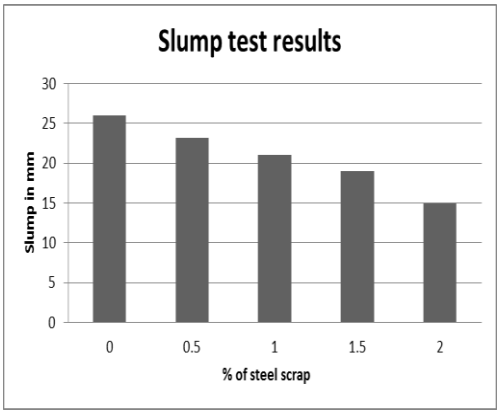

Figure 2. Slump test results

4.2. Effect of steel scrap on compressive strength of concrete

From Figure 3, it can be observed that the value of compressive strength of conventional concrete found to be 31.6 Mpa and 37 Mpa respectively and 7days and 28 days. It can be seen that with addition of steel scrap, the value of compressive strength gradually decreased with percentage of steel scrap. From the results, it can be inferred that there is not much increasing compressive strength of concrete using steel scrap.

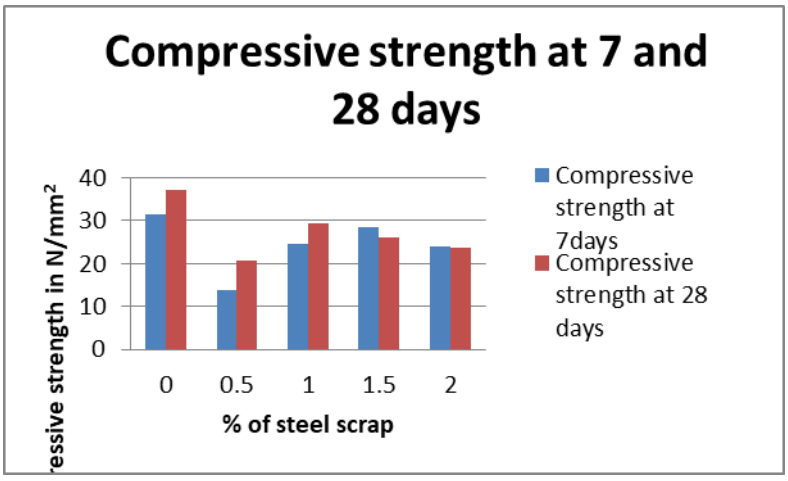

Figure 3. Compressive strength results for 7 and 28 days

4.3. Effect of steel scrap on tensile strength of concrete

From Figure 4, it can be observed that the value of tensile strength of conventional concrete is found to be 2.13Mpa and 3.35Mpa respectively and 7days and 28 days. It can be seen that with addition of steel scrap, there is a considerable increase in tensile strength of concrete. From the figure, it is observed that at 2% of steel scrap, tensile strength value is 2.36Mpa and 3.54Mpa at 7day and 28 day respectively. Tensile strength was increased by 6%.

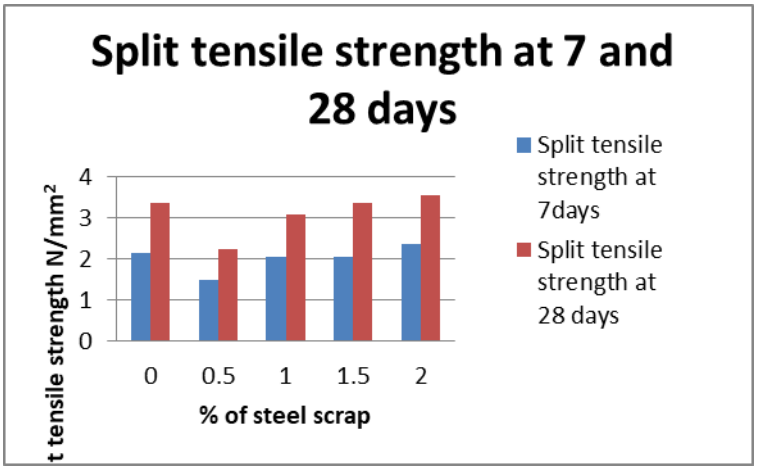

Figure 4. Split tensile strength values for 7 and 28 days

4.4. Ultrasonic Pulse Velocity test (UPV)

Table 3 shows the conditions of concrete based on pulse velocity. The results obtained at 28 days for compressive strength and UPV test are nearly similar. From Table 3, comparing with standard results of velocity, conventional concrete shows excellent results.Table 4 shows the values of compressive strength based on UPV test results. Maximum value of compressive strength value was obtained at concrete with 1% steel scrap out of all the percentages considered, but less than conventional concrete.

Table 3. Pulse velocity for concrete

Pulse velocity (m/sec)	General conditions
4575	Excellent
3660-4575	Good
3050-3660	Questionable
2135-3050	Poor
2135	Very poor

Table 4. UPV Compression test results

M30 grade with steel scrap percentage	Path length(m)	Time(µsec)	Velocity(km/sec)	Compressive strength for 28 days(N/mm^2)
0	0.2	68.3	4.5	35.4
0.5	0.2	36.5	2.41	20.6
1	0.2	53.4	3.52	28.7
1.5	0.2	46.0	3.03	23.9
2	0.2	42.2	2.78	23

5. Conclusions

From the present work, the following conclusion could be drawn:

1) With addition of steel scrap in concrete, there is decreasing trend in compressive strength values both at 7days and 28 days.
2) Addition of steel scrap showed considerably increase in tensile strength of concrete at 2% of steel scrap.
3) From the UPV test, concrete with steel scrap showed satisfactory with reference to Table 3 and Table 4. Hence it can be concluded, that steel scrap can be used in concrete to improve the tensile strength, there by reduces brittleness in concrete.

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