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ANALYSIS OF COMPRESSIVE STREGTH OF CONCRETE USING STEEL SCRAP

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Abstract: *This paper assesses the effective use of steel scrap in concrete. In this study, total 39 nos. concrete cubes of size 150 mm x 150 mm x 150 mm casted using steel scrap concrete grade M-20. Steel scrap used up to 2.4% by weight, at a gap of 0.2% (i.e. 0.2%, 0.4%, 0.6%, 0.8%, 1.0%, 1.2%, 1.4%, 1.6%, 1.8%, 2.0%, 2.2%, 2.4%). As per Indian standard, after 28 days compressive strength test done on casted concrete cubes and test results are compared with plain cement concrete. After completing study, we know that the 28 days compressive strength of steel scrap concrete is more than plain cement concrete. The main objective of this study to find out optimum percentage of steel scrap in concrete up to which its compressive strength initially increased and then gradually decreased. At the end of the study, we found that up to 1.4% of steel scrap, compressive strength increased then after more percentage of steel scrap causes slight reduction in compressive strength.*

Keywords: *Steel scrap, compressive strength, Concrete, Optimum percentage of steel scrap, Concrete cubes, Analysis*

I. INTRODUCTION

Concrete is the most suitable material which is used in construction worldwide [1]. Generally, concrete is made by mixing cement, sand and aggregate together and water as lubricant. Also, some admixtures and chemicals used in concrete making to improve properties of concrete . Along with the development of technology, the research conducted to improve the properties of concrete, among others, with the addition of fiber [2]. Nowadays, different wastes such as fly ash, blast furnace slag, quarry dust, brick bats, broken glass waste and its powder, Steel waste, Coconut shells, E-waste, Plastic waste, Marble dust powder, Paper and pulp mill waste, Sugar cane industry waste etc. can be used in many developed countries [3].

As per rapid Industrialization, steel producing industries increasing year and year. This industries produced steel waste and gases which are very harmful to the environment. In India steel waste generated from steel industry is very high. This waste may be dumped in to the barren land and other disposal places. Recycling of steel waste reduces the steel waste but recycling steel has low quality and recycling cost is high. However recycled steel is not used in construction, so we are using steel scrap waste in concrete which reduces the consumption of reinforcement and cost of structure [4].

At present day Reinforced concrete structures are very popular worldwide. R.C.C. structure has good load bearing capacity. Also it has very good resistant against wind and earthquake forces. R.C.C. structures are made from concrete and steel. Concrete has good compressive strength and steel has good tension strength. So, structure remains stable against various forces.

The main objective of paper to find out optimum percentage of steel scrap which improves maximum compressive strength concrete [5]. Experimental study done to know the compressive strength of steel scrap concrete and plain cement concrete. Then comparative study done on both steel scrap concrete and plain cement concrete. This scrap waste may also improve properties such as reduction in shrinkage, reduction in cracking, toughness etc. [2].

II. MATERIALS AND ITS PROPERTIES

A. Cement

Ordinary Portland cement 53 grade cement was used in this experimental work. Cement satisfied all physical properties with in its limit as given in IS 12269-1987 [6]. The weight of each bag is 50 kg. Cement is the expansive material among all ingredients of concrete. Cement acts as a binding material in concrete. Various test values obtained are described in table-1 given below.

Table 1. Properties of Cement

Sr. No.	Properties	Obtained Values
1.	Fineness (%)	2.25
2.	Standard consistency (%)	33
3.	Initial setting time(min.)	30
4.	Final setting time(min.)	600
5.	Specific gravity	3.15
6.	Compressive strength at day 28 days (N/mm^2)	53

B. Fine aggregate

The aggregate having size less than 4.75 mm is termed as fine aggreagate. Locally available fine aggregate get from river bed used in experimental work. Fine aggregate obtained from grading zone III. Fine aggregate having properties satisfied the requirement as per IS-383:1970 and it has divided the fine aggregate into four zones (i.e. I, II,III, IV). The specific gravity of fine aggregate can be found out by pycnometer bottle. The specific gravity of fine aggregate is 2.65.

C. Coarse aggregate

The aggregate having size more than 4.75mm is termed as coarse aggregate. Generally, Aggregates are angular in shape. Flaky and elongated aggregate should not be used in concrete. It makes concrete porous and more permeable. The aggregates used in concrete should be durable, clean, tough and proper gradation. The average size of 20 mm aggregate used in experimental work. The specific gravity of coarse aggregate is 2.70 and water adsorption is 1%. Coarse aggregate obtained from grading zone III.

D. Water

Water plays an important role in concrete and acts as a lubricant between ingredients of concrete. It helps in improving the workability of concrete. Water used for concrete mixing and curing shall be clean and free from injurious amounts of oils, salts, alkalis, sugar, organic materials or other dangerous materials. Impurities causes reduction in strength of concrete. Its pH value should be lies between 6 and 8 [7]. Portable water used in this experimental work.

E. Steel scrap waste

Lathe scrap used as steel scrap and it's dimensions are average 1.5 mm thickness, average 25-30 mm length and 2 mm wide. The dimension of fiber varies from industry to industry. It is like a steel fiber but it's properties are not same as steel fiber. The shape of steel scrap may be rectangular or twisted. It's shape depends upon industry and type of work done by industry [2].

Figure 1. Fiber strip as a Steel scrap

III. MIX PROPORTIONS

Concrete is a mixture of cement, sand and aggregate. Cement, Sand and aggregates taken by weight as decided proportions 1:1.5:3. This proportion defines M-20 grade concrete with W/C ratio 0.5. The aim of mixing of concrete to produce a homogeneous and dense concrete.
Materials quantity required for $1m^3$ concrete for M-20 grade concrete are as follows.

Table 2. Material and its quantity

Material	Quantity
Cement (kg/m^3)	372
Fine aggregate (kg/m^3)	657
Coarse aggregate (kg/m^3)	1197
Water (kg/m^3)	199

For mixingconcrete, mixer machine is used. First of all calculated quantity of dry coarse aggregates and then fine aggregates added in the mixer machine drum and rotating it about 2 minutes. Then, calculated quantity of cement added into the drum. Calculated quantity of water added in to the drum. At the last calculated quantity of fiber added into the drum. Mixing is done till uniform homogeneous mix obtained.

IV. COMPRESSIVE STREGTHTEST AND RESULTS

Cube moulds well-greased and oiling done before casting to prevent sticking of concrete inside the mould. Total 39 nos. cubes of size 150mm X 150mm X 150mm were casted to estimate the compressive strength of M 20 grade concrete. The moulds were filled with 0.2%, 0.4%, 0.6%, 0.8%,1%, 1.2%, 1.4%, 1.6%, 1.8%, 2%, 2.2%, 2.4%. Moulds were mounted on the vibrator platform and rigidly clamped on the table to enable the system to vibrate in balance. The top surface of the specimen was levelled and finished using trowel. After 24 hours the specimens were demoulded and placed in curing tank for 28 days. After 28 days curing, the cubes were tested in Universal testing machine. The failure load of the specimen noted and average value of three specimen were noted [1]. The compressive strength was calculated as follows.

Compressive strength (N/mm^2) = Failure load / Cross sectional area of specimen
= P / A

Test results are described in given table-2 below.

Table 3. Compressive strength test results

Scrap fiber (%)	Sr. No.	Load at failure (KN)	Strength at 28 days (N/mm^2)	Average strength at 28 days (N/mm^2)
0	1	480	22.10	22.56
	2	485	22.70	
	3	490	22.90	
0.2	1	510	23.90	24.43
	2	530	24.65	
	3	545	24.75	
0.4	1	520	24.30	24.53
	2	540	24.50	
	3	550	24.80	
0.6	1	525	24.38	24.60
	2	540	24.55	
	3	555	24.88	
0.8	1	525	24.40	24.71
	2	535	24.64	
	3	560	25.10	
1.0	1	535	24.40	24.80
	2	560	25.30	
	3	545	24.70	
1.2	1	530	24.25	24.82
	2	550	24.88	
	3	565	25.35	
1.4	1	540	24.60	24.90
	2	565	25.70	
	3	535	24.40	
1.6	1	515	24.20	24.38
	2	530	24.35	
	3	540	24.60	
1.8	1	500	22.95	23.71
	2	505	23.90	
	3	520	24.30	
2.0	1	510	23.80	23.50
	2	500	22.90	
	3	510	23.80	
2.2	1	495	23.00	23.00
	2	500	23.10	
	3	490	22.90	
2.4	1	485	22.85	22.63
	2	495	22.15	
	3	490	22.90	

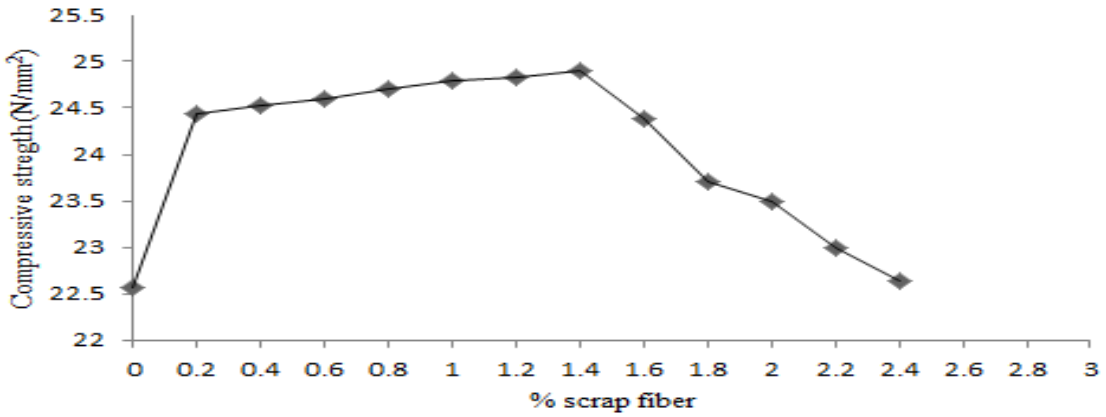

Figure 2. 28 day Compressive strength

V. CONCLUSION

The compressive strength of M-20 grade concrete was obtained with different steel scrap percentage by weight in concrete. The average compressive strength of M-20 grade concrete is 20 N/mm^2. The compressive strength was found out to be 22.56N/mm^2, 24.43N/mm^2, 24.53N/mm^2, 24.60N/mm^2, 24.71N/mm^2, 24.80N/mm^2, 24.82N/mm^2, 24.90N/mm^2, 24.38N/mm^2, 23.71 N/mm^2, 23.50 N/mm^2, 23.00 N/mm^2, 22.63 N/mm^2 for 0%, 0.2%, 0.4%, 0.6%, 0.8%, 1%, 1.2%, 1.4%, 1.6%, 1.8%, 2%, 2.2%, 2.4% steel scrap respectively. At the end of experiment, observed that compressive strength increased by adding steel scrap up to 1.4% and this is optimum percentage of steel scrap for maximum compressive strength of concrete. Then after adding more percentage of steel scrap causes slight reduction in compressive strength but strength is more than plain cement concrete.

VI. SCOPE OF FUTURE STUDY

Further investigations to be carried out in this field by utilizing other types of scrap from industry or with waste binding wire and waste steel nails. The work can be extended by adopting other mixes like M25, M30, M40 etc. with varying percentage of steel scrap either by weight of concrete or by volume of concrete or any kind of partial or fully replacements. The other parameters such as split tensile strength, flexural strength, Impact resistance etc. also can be tested.

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