International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 03 | Mar-2018 www.irjet.net p-ISSN: 2395-0072

Analysis of Properties of Mix Design Concrete Using Steel Scrap

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Abstract - *The aim of the paper was to study the feasibility of using steel scrap in mix design concrete by checking various concrete parameters like compressive strength, tensile strength and flexural strength. All the parameters checked with varying percentage by 0%, 0.5%, 1%, 1.5% and 2% by weight of concrete. In this experimental study M 30 grade concrete is used. For this concrete cubes, beams and cylinders were casted. Total 45 concrete specimens were casted and cured. Tests were done on cured concrete specimens at 28th day. The tests performed were compressive strength test, split tensile strength test and flexural strength test by following the guidelines set by Indian Standard. The test results were compared with plain cement concrete. The compressive strength of M-30 grade concrete was found out to be 33.33 N/mm², 36.44 N/mm², 38.36 N/mm², 35.18 N/mm² and 33.47 N/mm². The split tensile strength was 2.80 N/mm², 3.11 N/mm², 3.52 N/mm², 3.18 N/mm² and 2.85 N/mm². The flexural strength was 4.47 N/mm², 4.44 N/mm², 5.34 N/mm², 4.89 N/mm², and 4.36 N/mm² respectively steel scrap percentages. After comparing results, we know that the 28 days compressive strength, split tensile strength and flexural strength of steel scrap concrete is more than plain concrete.*

Key Words: Steel scrap, Concrete, Compressive Strength, Split tensile Strength, Flexural Strength

1. 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 to improve its properties. 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. These 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 well 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.

Experimental study done to know the compressive strength, Split tensile strength and Flexural strength of steel scrap concrete and plain cement concrete. Then, comparative study done on 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].

2. OBJECTIVES

- Use of Steel scrap in concrete.
- To study effect of waste steel scrap in concrete.
- To establish the alternatives of ingredients of concrete.
- To check the feasibility of waste steel scrap in mix design concrete.
- To check feasibility various tests done on prepared concrete specimen like compressive strength, Split tensile strength, Flexural strength etc.
- To compare test results with conventional concrete and decide optimum percentage of steel scrap for maximum strength of concrete.

3. MATERIALS

3.1 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 [5]. 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

Properties of Cement		
Sr. No.	Properties	Obtained Values
1.	Fineness (%)	3.5
2.	Standard consistency (%)	30
3.	Initial setting time(min.)	60
4.	Final setting time(min.)	575
5.	Specific gravity	3.15
6.	Compressive strength at day 28 days (N/mm^2)	53

3.2 Fine Aggregate

The aggregate having size less than 4.75 mm is termed as fine aggregate. 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 2.55.

3.3 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 2.95 and water adsorption is 0.5%. Coarse aggregate obtained from grading zone III.

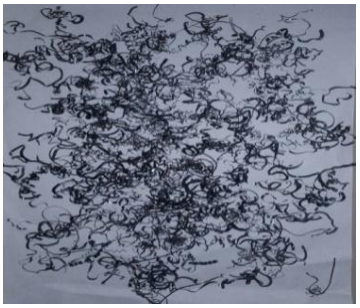
3.4 Water

Water plays an important role in concrete and acts as a lubricant between ingredients of concrete such as cement, sand and aggregate. Water helps in improving the workability of concrete. Water used for concrete mixing and curing shall be clean and free from oils, salts, alkalis, sugar, organic materials or other dangerous materials. Due to impurities slight reduction in strength of concrete. Its pH value should be lies between 6 and 8 [6]. Portable water used in this experimental work.

3.5 Turn Fiber as Steel Scrap

Lathe scrap used as turn fiber steel scrap and its dimensions is average 1.5 mm thickness, 25-30 mm length and 2 mm wide. The dimension of fiber varies from industry to industry and type of work done by industry. Its shape depends upon industry and type of work done by industry [2]. The shape of steel scrap may be rectangular or twisted.

Figure – 1: Turn Fiber



4. MIX DESIGN

Concrete is a mixture of cement, sand and aggregate. Cement, Sand and aggregates taken by weight as calculated proportions. This proportion defines M-30 grade concrete with W/C ratio 0.45. The aim of mixing of concrete to produce homogeneous and dense concrete.

For mixing concrete, mixer machine is used. Calculated quantity of dry coarse aggregates and fine aggregates added in the mixer machine drum. Rotate drum 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. The mix ration calculated was 1:1.73:3.3.

Materials quantity required for $1m^3$ concrete for M-30 grade concrete are as follows.

Table - 2: Material Quantity

Material Quantity for 1 m^3 concrete	
Material	Quantity (Kg)
Cement	378
Fine aggregate	655
Coarse aggregate	1246
Water	170

5. EXPERIMENTAL PROGRAMME

5.1 Compressive Strength Test

Specimen moulds were well-greased and oiling done before casting to prevent sticking of concrete inside the mould. Total 15 nos. cubes of size 150mm X 150mm X 150mm were casted to estimate the compressive strength of M 30 grade concrete. The moulds were filled with 0.0%, 0.5%, 1.0%, 1.5%, and 2.0%. Moulds were fitted on the vibrator platform and rigidly clamped on the table to enable the system to vibrate in balance. The

top surfaces of the specimens were levelled 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 specimens were noted [1]. The compressive strength was calculated as follows.

Compressive strength (N/mm^2) = Failure load/ Cross section Area
= P / A

Table – 3: Compressive Strength Test Results

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	750	33.33	33.33
	2	740	32.88	
	3	760	33.77	
0.5	1	830	36.89	36.44
	2	810	36.00	
	3	820	36.44	
1.0	1	850	37.77	38.36
	2	880	39.11	
	3	860	38.22	
1.5	1	800	35.55	35.18
	2	780	34.66	
	3	795	35.33	
2.0	1	755	33.55	33.47
	2	760	33.77	
	3	745	33.11	

5.2 Split Tensile Strength Test

The standard size of cylinder mould is 150 mm diameter and 300 mm height [6]. Cylinder mould filled with different percentages of steel scrap by weight of concrete. After 24 hours moulds open and concrete specimens were put in curing tank. After 28 days specimens were collected from curing tank and test performed to determine tensile strength of concrete. Split tensile strength test results are given below.

Split tensile strength (N/mm^2) = $2P / \pi LD$

Where, P = Failure load
L = Length of Cylinder
D = Diameter of Cylinder

Table – 4: Split Tensile Strength Test Results

Split Tensile 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	197	2.78	2.80
	2	198.5	2.81	
	3	199	2.82	
0.5	1	220	3.11	3.11
	2	215	3.04	
	3	225	3.18	
1.0	1	240	3.40	3.52
	2	255	3.61	
	3	250	3.54	
1.5	1	221	3.12	3.18
	2	230	3.25	
	3	225	3.18	
2.0	1	198	2.80	2.85
	2	201	2.84	
	3	205	2.90	

5.3 Flexural Strength Test

The standard size of beam mould is 700 X 150 X 150 mm [6]. Beam mould filled with different percentages of steel scrap by weight of concrete. After 24 hours moulds open and concrete specimens were put in curing tank. After 28 days specimens were collected from curing tank and test performed to determine flexural strength of concrete.

Flexural strength = Pl / bd^2

Where, P = Failure load
l = c / c span between support
b = width of specimen
d = depth of failure of specimen

Table -5 : Flexural Strength Test Results

Flexural 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	24.7	4.39	4.47
	2	25.0	4.44	
	3	25.8	4.59	

0.5	1	25.0	4.44	4.44
	2	24.8	4.40	
	3	25.2	4.48	
1.0	1	28.5	5.07	5.34
	2	30.0	5.33	
	3	31.7	5.64	
1.5	1	27	4.8	4.89
	2	27.5	4.89	
	3	28.0	4.98	
2.0	1	24.0	4.27	4.36
	2	24.6	4.37	
	3	25	4.44	

6. CONCLUSION

After completing experiment, we conclude that steel scrap can be used effectively to improve properties of mix design concrete. Steel scrap improves properties of mix design concrete such as compressive strength, split tensile strength and flexural strength. Use of steel scrap by percentage weight of concrete reduces cracks and shrinkage in mix design concrete. Steel scrap reduces the consumption of reinforcement in R.C.C. structures.

ACKNOWLEDGEMENT

The Authors thankfully acknowledge to G. J. Patel, Chairman, Sardar Patel Education Campus, Shree Sheetal Patel, Hon. Secretary, Sardar Patel Education Campus, Dr. Vashishthadhar Dwivedi, Campus director, Dr. Bhavesh Shah, Principal, Sardar Patel College Of Engineering, Nikunj R. Patel, Head and professor, Civil Engineering Department, Shweta J. Chauhan, Assistant Professor, Civil Engineering Department, Sardar Patel College of Engineering, V.V. Nagar-Vadtal road, Bakrol, Anand, Gujarat, India for their motivations and infrastructural support to carry out this research. The authors are also thankful to authors/ editors all those journal from where the lecture for this article has been discussed and reviewed.

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