Study and Analysis of Fiber Reinforced Concrete

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ABSTRACT

Concrete is one of the most widely recognized development materials for the most part delivered by utilizing locally accessible ingredients. The present trend in concrete technology is towards increasing the strength and durability of concrete to meet the demands of the modern construction. The main aim of the study is to study the effect of glass fibre and steel fibers in the concrete. FRC has the high tensile strength and fire-resistant properties thus reducing the loss of damage during fire accidents. In the present work the strength studies are carried out to compare the glass and steel fiber concrete. The FRC is added 0.5, 1, 2 and 3% are added for M20 grade concrete. Result shows the percentage increase in compressive strength, flexural strength and split tensile strength for 28days.

Keywords: Concrete, fiber, glass fiber, steel fiber, M20 grade concrete.

1. INTRODUCTION

Copper slag can be used in concrete production as a partial replacement for sand. Copper slag is used as a building material, formed into blocks. Such use was common in areas where smelting was done, including StHelens and Cornwall in England. In Sweden (Skellefteå region) fumed and settled granulated copper slag from the Boliden copper smelter is used as road-construction material. The granulated slag (<3 mm size fraction) has both insulating and drainage properties which are usable to avoid ground frost in winter which in turn prevents pavement cracks. The usage of this slag reduces the usage of primary materials as well as reduces the construction depth which in turn reduces energy demand in building. Due to the same reasons the granulated slag is usable as a filler and insulating material in house foundations in a cold climate. Numerous houses in the same region are built with a slag insulated foundation

1.1. Objective

The experiment was carried out analyse the behaviour of steel fiber reinforced concrete on the addition of copper slag when the same copper slag is added to the noral conventional concrete, some other objectives are :

- To study the properties and behavior of copper slag
- To study the physical properties of steel fiber reinforced concrete.
- To study the variation of the strength when copper slag is added to fiber reinforced concrete when compared to individual strength.
- To study the behavior of conventional concrete when copper slag is added.
- Finally, we compare both the results and then we analyse.

2. LITERATURE REVIEW

Durability and Strength Properties of High-Volume Fly Ash Concrete: High Volumes of Fly Ash in concrete is gaining significance and is considered as a sustainable option for many concrete

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constructions. Experimental results show that, HVFAC has lower strength at early ages but at later age HVFAC shows continuous increase in strength properties. Significantly both the crack width and drying shrinkage reduce and thus contribute to the long-term durability of concrete. HVFA Concrete exhibits comparable costs, increased strengths, and enhanced durability. Thus, the HVFA concrete is more suitable for warm weathers and where early strength is not essential. This paper reviews the durability and strength properties of High-Volume Fly Ash Concrete.

Effect of Copper Slag on Strength of Polypropylene Fiber Reinforced Concrete: Due to exponential growth in the usage of concrete world over, there is a huge demand for natural river sand as construction material. Off late, this excessive consumption of sand led to acute shortage and led to slowing down of construction projects. Hence to protect the natural shoreline, a necessity is felt to find suitable replacement material for sand in concrete as concrete is consumed second largest in the world. In this work copper slag, which is an industrial waste is used as a replacement material for sand and its effect is studied on the strength of concrete. Also, to improve the strength and ductility, polypropylene fibers are added in the ratios of 0.1%, 0.2%, 0.3% and 0.4% content. The effect of copper slag is investigated by replacing fine aggregate in concrete in the proportions of 10%, 20%, 30%, 40%, 50% 60% and 100%. The results obtained are analyzed and presented

Behaviour Aspects of Copper Slag and Steel Fibers In Concrete Subjected to Destructive and Non-Destructive Tests: Now–a-days the availability of sand is becoming more difficult for the constructions. Sand plays a vital role in the mixing of a concrete. So many researchers investigated that silica (sio2) composition is used as a replacement of fine aggregate. The materials like fly ash, stone dust, Copper Slag are used. Copper slag is the waste material which comes from the copper. The decomposition of copper slag is exceedingly difficult, so if it is used it will decrease the pollution. In this paper, Copper slag is used in different proportions such as 20%, 30%, 40%,and 50% as a partial replacement of fine aggregate for casting cubes, prisms and beams in order to determine the strength parameters such as compressive, split tensile and flexure (destructive and non-destructive tests such as Ultrasonic pulse velocity and Rebound Hammer). From these tests, the optimum percentage of copper slag is determined. Later, the steel fibers of different proportions such as 0.5%, 1%, 1.5% by volume of cement are added to the optimum percentage of copper slag to observe its impact on strength thereby calculating the optimum percentage of steel fiber. Using this optimum percentage, beams were casted of size 130cmx20cmx20cm to observe the flexural behaviour.

An Experimental Investigation on Strength Properties of Copper Slag Fibre Reinforced Concrete: This paper presents a study of the mechanical properties of copper slag fibre reinforced concrete considering the effect of fibre content (0%, 0.5%, 1%, and 1.5%). Also, an attempt has been made to establish the relationship between different mechanical and non-destructive test properties of concrete. Furthermore, a mathematical model was proposed to determine different strength properties of copper slag concrete with variation of fibre content in it. The suggested model successfully epitomizes the rise of tensile and flexure strength properties of copper slag concrete with increase in fibre content, however a different pattern has been observed in case of compressive strength. In the present experimental investigation, concretes of grade M20 and M30 were used with crimped steel fibres having an Aspect Ratio of 60.

Mix Design for Different Combinations in M30 Replacing copper slag and steel fiber

All the steps above will be same in all the cases only the ratio of changes as the effective specific gravity changes i.e., only last two steps will change in each case

Mix	Cement	Fine Aggregate	% Replacement of Copper Slag	Coarse Aggregate	% Addition of Steel Fibers	Copper Slag	Water
CS0	390	582	0	1298	1	0	175.5

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CS1	390	524	10	1298	1	58.2	175.5
CS2	390	465.4	20	1298	1	116.4	175.5
CS3	390	407.3	30	1298	1	174.6	175.5
CS4	390	349.1	40	1298	1	232.7	175.5
CS5	390	290.9	50	1298	1	290.93	175.5
CS6	390	232.7	60	1298	1	349.3	175.5

Mix Design for Different Combinations in M40 Replacing copper slag and steel fiber

Mix	Cement	Fine Aggregate	% Replacement of Copper Slag	Coarse Aggregate	% Addition of Steel Fibers	Copper Slag	Water
CS0	420	569.5	0	1278	1	0	180.6
CS1	420	512.5	10	1278	1	56.95	180.6
CS2	420	455.6	20	1278	1	113.9	180.6
CS3	420	398.6	30	1278	1	170.9	180.6
CS4	420	341.7	40	1278	1	227.8	180.6
CS5	420	284.7	50	1278	1	284.8	180.6
CS6	420	238.6	60	1278	1	227.8	180.6

Slump values of different proportions in M30 Grade Concrete

Mix Proportions	Slump
CS0	55
CS1	57
CS2	58
CS3	60
CS4	62
CS5	65
CS6	72

Mix Proportions	Slump
CS0 +1%SF	53
CS1+1%SF	56
CS2+1%SF	58
CS3+1%SF	60
CS4+1%SF	62
CS5+1%SF	65
CS6+1%SF	68

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Slump values of different proportions in M40 Grade Concrete

Mix Proportions	Slump
CS0	58
CS1	60
CS2	62
CS3	63
CS4	65
CS5	68
CS6	69

Mix Proportions	Slump
CS0 +1%SF	54
CS1+1%SF	57
CS2+1%SF	59
CS3+1%SF	60
CS4+1%SF	63
CS5+1%SF	65
CS6+1%SF	68

3. EXPERIMENTAL RESULTS

Physical Properties

	Natural Aggregates	Fine aggregates	Copper Slag	cement
Specific gravity	**2.7**	**2.65**	**2.52**	**3.2**
water absorption	**0.28%**	**0.35%**	**-**	**-**
Bulk density	**1685.2kg/m^3**	**1647.2kg/m^3**	**1710.2kg/m^3**	**-**
Fineness	**-**	**-**	**-**	**92.7%**
Initial setting time	**-**	**-**	**-**	**29min**

Compressive Strength, Flexural Strength and Split Tensile strength Results for M30 Grade Concrete with Copper Slag

	Compressive Strength		Flexural Strength	Split Tensile Strength
Mix Proportions	7 Days Strength	28 Days Strength	28 Days Strength	28 Days Strength
CS0	34	39	4.32	2.02

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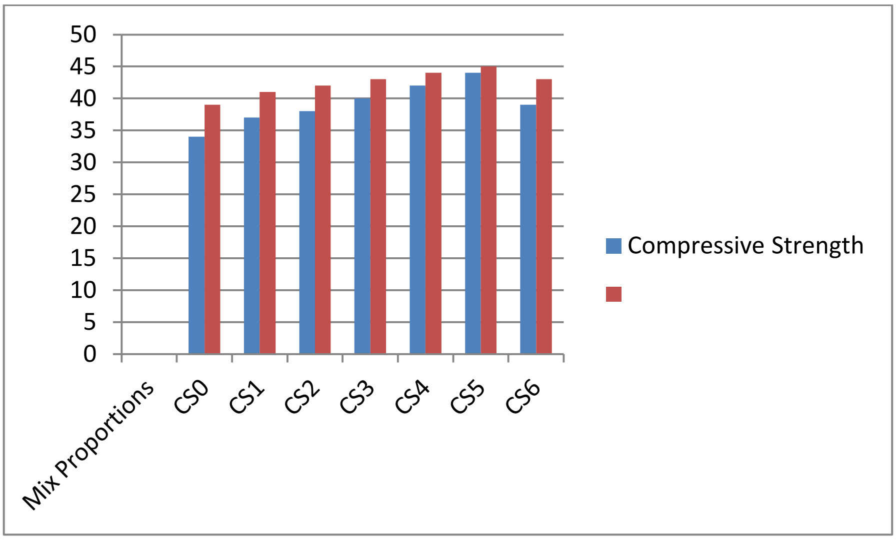
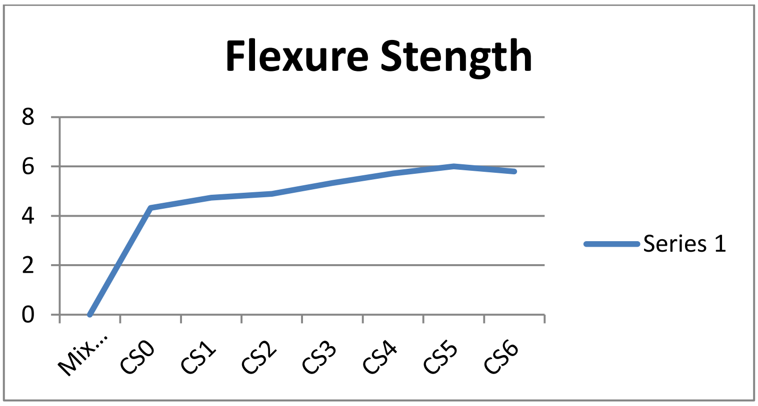
CS1	37	41	4.73	2.19
CS2	38	42	4.89	2.2
CS3	40	43	5.33	2.4
CS4	42	44	5.72	2.63
CS5	44	45	6.0	2.87
CS6	39	43	5.8	2.56





Compressive Strength, Flexural Strength and Split Tensile strength Results for M30 Grade Concrete with Steel Fibre and Copper Slag

	Compressive Strength		Flexural Strength	Split Tensile Strength
Mix Proportions	7 Days Strength	28 Days Strength	28 Days Strength	28 Days Strength
CS0 +1%SF	39	43	6.93	3.23
CS1+1%SF	41	46	7.0	3.62

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CS2+1%SF	43	48	8.3	3.87
CS3+1%SF	45	48.4	8.79	4.23
CS4+1%SF	47	51.3	9.3	4.95
CS5+1%SF	45	49	6.73	3.7

Compressive Strength, Flexural Strength and Split Tensile strength Results for M40 Grade Concrete with Copper Slag

	Compressive Strength		Flexural Strength	Split Tensile Strength
Mix Proportions	7 Days Strength	28 Days Strength	28 Days Strength	28 Days Strength
CS0	44	50	4.9	2.54
CS1	47	52	5.4	2.7
CS2	49	53	5.6	2.86
CS3	51	56	5.9	3.04
CS4	53	58	6.63	3.43
CS5	50.6	55	5.42	2.8

Compressive Strength, Flexural Strength and Split Tensile strength Results for M40 Grade Concrete with Steel Fibre and Copper Slag

	Compressive Strength		Flexural Strength	Split Tensile Strength
Mix Proportions	7 Days Strength	28 Days Strength	28 Days Strength	28 Days Strength
CS0 +1%SF	49	54	6.9	4.09
CS1+1%SF	51	55	7.2	4.72
CS2+1%SF	51	57	8.7	4.95
CS3+1%SF	51	59	9.3	5.23
CS4+1%SF	53	62	10.1	5.94
CS5+1%SF	52.6	57	8	5.63

4. CONCLUSIONS

This article summarizes as follows:

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- The optimum strength for M30 and M40 grade concrete is observed at 50% and 40% replacement of copper slag with fine aggregate.
- Due low water absorption nature copper slag there is a increase in the workability of conventional concrete when compared with steel fiber reinforced concrete due addition of hooked end steel fibers.
- Maximum percentage increase of compressive strength for conventional concrete is 29.4where as for steel fiber reinforced concrete is 34.28% for M30.
- Maximum percentage increase of compressive strength for conventional concrete is 20.5% whereas for steel fiber reinforced concrete is 23% for M40.
- Steel fiber reinforced concrete is having an increase in compressive strength is 7%, Flexural strength is 50%, Split tensile strength is 68%when compared with conventional concrete.
- So, addition of hooked end steel fibers increases mechanical properties of concrete and provides superior resistance to cracking.
- While testing the specimens, the plain cement concrete specimens have shown a typical crack propagation pattern which leaded into splitting of member in two-piece geometry. But due to addition of steel fibers in concrete cracks gets ceased which results into the ductile behavior of SFRC.
- Increase in replacement of copper slag with F.A beyond the optimum percentage causes increase in workability and causes strength reduction. Increase in fiber content can result in balling effect and reduces workability according to ACI544 (3R-08) it is advisable up to 0.5%-1.5%.Further researches can be carried out to improve the strength and acid resistance by the addition of some admixtures.

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