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Experimental investigation of self curing concrete with partial replacement of fine aggregate by steel slag

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Abstract: Today concrete is most widely used construction material due to its good compressive strengthand durability. Depending upon the nature of work the cement, fine aggregate, coarse aggregate and water are mixed in specific proportions to produce plain cement concrete. The improper curing will badly affect the strength and durability of concrete. Self curing concrete is one the special concretes in mitigating insufficient curing due to human negligence scarcity of water in arid areas, inaccessibility of structures in difficult terrains and in areas where the presence of fluorides in water will badly affect the characteristics of concrete. The present study involves the use of shrinkage reducing admixture polyethylene glycol (PEG-600) in concrete which helps in self curing and helps in better hydration and hence strength. In the present study, the effect of the admixture (PEG – 600) on compressive strength by keeping the percentage of PEG 1% as constant and it is also study by varying the percentage of STEEL SLAG by weight of fine aggregate from 10%, 20%, 30% and 40% were studied M25 mix. It was found that PEG -600 could help in self curing by giving strength on par with conventional curing. It was found that with constant 1% PEG -600 by weight of cement was optimum moisture content for M25 grade concrete with and without steel slag for achieving strength without compromising workability. It is also found that by replacing up to 30% of steel slag with fine aggregate shows increase in strength of concrete shows increase in strength of concrete and shows slight reduction in strength for 40% replacement

Keywords: PEG-poly ethylene glycol, steel slag, internal curing.

I. Introduction

Concrete is a composite material composed of fine aggregate, coarse aggregate in which cement is used as the binder, also water is a key ingredient which produces paste when mixed with cement. Curing of concrete is very important. Curing is the process of maintaining of a satisfactory moisture content and temperature in concrete during its early stages so that desired properties (of concrete) may develop.

Curing is essential in the production of concrete that will have the desired properties. Proper curing is necessary to achieve desired strength and performance of concrete. In conventional concrete curing is done by after various stages like mixing, placing and finishing.

Self-Curing is a technique which is used to retain proper moisture contents in concrete for better hydration for a long time. Self-Curing agent works to reduce self desiccation contents present in the concrete. So some of shrinkage reducing agents are used to avoid and the concrete cures itself. Steel slag is an industrial by product from the steel manufacturing industry. This can be used as fine aggregate in concrete. Steel slag is the residue of steel making industry; the emission amount is about 12 to 20 percent of rough steel production. However, steel slag has not been used efficiently and thoroughly for long, which causes its great accumulation, waste of land, and serious air and water pollution. Steel slag has certain amount of important minerals of cement clinker, such as C2S and C3S.So it can be used as cement and concrete admixtures. India's steel output ranks No2 in the world, but the comprehensive utilization rate of steel slag and slag is only 10 percent at with Iron and steel production amounting to 8 million tons in 2009, is an important iron and steel base of India. If the steel slag occupies 15 percent of steel production (quality percentage) then the emission amount is 1.2 million tons. So, if cement can be replaced by steel slag and not only can beactivity of slag be fully simulated but also the durability of concrete can be improved.

II. Experimental Study

1. Materials:

1.1 Cement

OPC (53 grade) conforming to IS: 12269-1987

1.2 Fine aggregate conforming to IS:383-1970

1.3 Coarse Aggregate conforming to IS: 383-1970

TABLE 1.Final result on test of fine Aggregate

S. No	Particular	Fine aggregate
1	Source	crusher
2	Zone	zone- ii
3	specific gravity	2.60
4	water absorption	3%

TABLE 2. Final result on tests of coarse aggregate

S. No	Particular	Fine aggregate
1	Source	Crusher
2	max aggregate size	20mm
3	specific gravity	2.7
4	water absorption	0.5%

1.4. Water - Potable water was used in the experimental work for both mixing and curing purposes.

1.5. Polyethylene Glycol-400(PEG-400) (Used as an internal curing compound):- Polyethylene glycol is a condensation polymer of ethylene oxide and water with the general formula H(OCH2CH2)nOH, where n is the average number of repeating polyethylene groups typically from 4 to about 180. One common feature of PEG appears to be the water-soluble nature. Polyethylene glycol is non-toxic, odorless, neutral, lubricating, non-volatile and non-irritating and is used in a variety of pharmaceuticals. Thus, it is a shrinkage reducing admixture.

1.6. STEEL SLAG

In this study the collection of steel slag is done from Agni steel private ltd Erode. Steel products are widely used nowadays everywhere. Steel is durable and strong. Steel has greater demand everywhere in industrial areas. This large amount of mass of waste means steel slag is today one of the environ-mental problem around the word. Proper disposal of steel slag is not possible.

TABLE 3

PROPERTY	**VALUE OF STEEL SLAG**
specific gravity	3.2 to 3.6
unit weight ,kg/m^3	1600 – 1920
Absorbtion	Up to 3%
CONSTITUNT	**COMPOSITION**
Cao	40-52
Sio_2	10-19
FeO	10-40

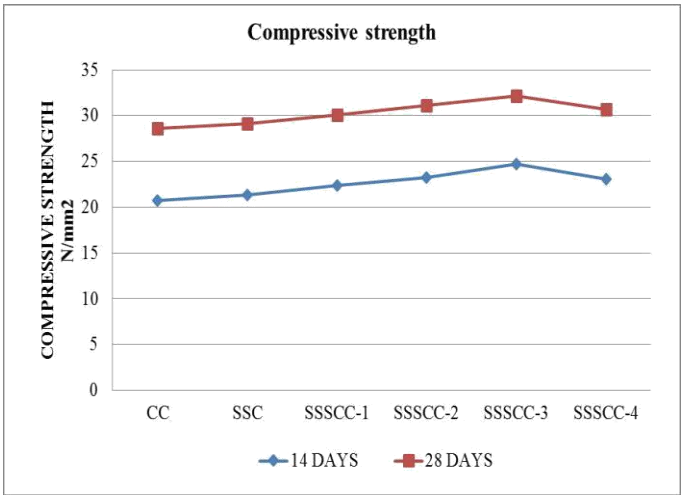
TABLE 4 mix proportion

Cement	water	Coarse aggregate	Fine aggregate
360 kg/m^3	162lit/m^3	715 kg/m^3	1256 kg/m^3
1	0.45	1.98	3.5

TABLE 5 mix proporation

Mix	No of cubes	No of cylinder	Water (lt)	Cement (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	Steel Slag(kg)	PEG (ml)
CM	6	6	9.4	20.7	41.2	72.3	0	0
SSSCC-1	6	6	9.4	20.7	36.72	72.3	4.08	207
SSSCC-2	6	6	9.4	20.7	33	72.3	8.25	207

SSSCC-3	6	6	9.4	20.7	28.8	72.3	12.6	207
SSSCC-4	6	6	9.4	20.7	24.56	72.3	16.3	207
SCC	6	6	9.4	20.7	41.2	72.3	0	207



Graph 1 COMPRESSIVE STRENGTH

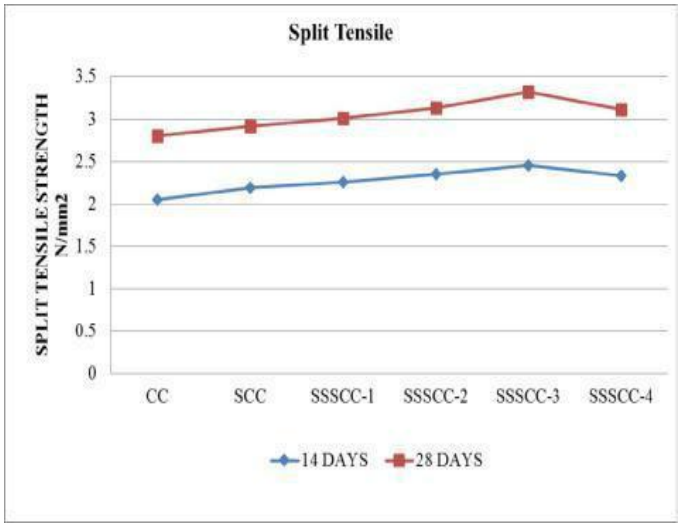
TABLE 6 Compressive strength

S.NO	SPECIMEN	LOAD(KN)	RESULT(KN)	AVERAGE
1	Conventional Concrete 14 days	490	21.78	20.74
		450	20.22	
		460	20.44	
2	Scc PEG-1% 14 days	500	22.22	21.31
		480	21.32	
		460	20.44	
3	SSSCC PEG 10% 14 days	530	23.50	22.40
		500	22.21	
		490	21.78	
4	SSSCC PEG20% 14 days	550	24.40	22.23
		520	23.11	
		500	22.20	
5	SSSCC PEG 30% 14days	570	25.33	24.73
		560	24.88	
		540	24.05	
6	SSSCC PEG 40% 14 days	550	24.44	23.10
		510	22.66	
		500	22.22	

TABLE 7 -Mean Split Strength

MIX	% PEG	% STEEL SLAG	14 DAYS (N/mm^2)	28 DAYS (N/mm^2)
CC	0	0	2.05	2.80
SCC	1	0	2.19	2.92

SSSCC-1	1	10	2.26	3.01
SSSCC-2	1	20	2.35	3.13
SSSCC-3	1	30	2.45	3.32
SSSCC-4	1	40	2.33	3.11



III. Scope for Future Study

There are many scopes for future study in this experimental study. In this paper we have studied only about the mechanical properties of SCC (self-curing concrete) and SSC (steel slag concrete). We can also study the following properties as follows:

Flexural strength
sulphate resistant properties Durability properties

Fire resistant properties

IV. Conclusion

Based on the experimental investigation carried out on mechanical properties of self-curing concrete mix with steel slag as a partial replacement of fine aggregate by steel slag at various percentage replacements of fine aggregates. The following conclusions are made.

Strength of self-curing concrete is more when compared with conventional concrete.

Self-curing concrete is the answer to many problems faced due to lack of proper curing.

The compressive strength obtained at 1% PEG 600 is 29.16 N/mm^2 at 28th day is more than the conventional concrete which is 28.59 N/mm^2. Whereas the varying percentage of steel slag as 10%, 20%, 30% and 40% in normal self curing concrete shows gradual increase in strength than the 1% PEG 600 self curing concrete.

Hence the self curing concrete gains more strength than the conventional concrete and the steel slag self curing concrete gives better strength than the self curing concrete.

Likewise in split tensile test the normal self curing concrete and the steel slag Self curing concrete increases the strength than the conventional concrete.

Up to 30% of steel slag is the optimum range for the replacement. Beyond 30% the compressive strength and split tensile strength gradually starts to decrease.

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