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A Study on Mechanical Properties of Self Curing High Strength Concrete by Using Sodium Ligno Sulphonate

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Abstract:
The concrete structures with high strength concrete is essential in present situation such as in high rise structures, long span bridges, sky scrapers, marine structures and in many structures where high strength needed. Concrete which has compressive strength more than 40 mpa at 28 days age of concrete is known as High Strength Concrete. High strength concrete can be made by using suitable design mix, materials used, proper compaction and curing. Due to lack of curing the desired strength and durability of concrete is not attained. Proper curing of concrete cannot be performed where the water sources are low and in desert places . So the Self Curing of concrete is the new enthusiasm concept in present days. In this thesis, I had designed a mix of grade M60 by using ACI211.4R-93. By using trail and mix , the suitable mix proportion is adopted then the cement is partially replaced with fly ash at varing dosages of 20%,25% and 30%. By testing the specimens ,at 20% of fly ash replacement the concrete had optimum compressive strength than the conventional concrete. In this paper Sodium Ligno Sulphonate is used as a self curing agent. Sodium ligno sulphonate is added to the concrete mix in varying dosages of 0% ,0.25% ,0.50% and .75% by the weight of cementious material. and the specimens are casted for compressive test at 3 days ,7 days ,28 days and 56 days and spilt tensile test at 28 days age of concrete. When compared with conventional concrete the self curing concrete with 0.25% sodium ligno sulphonate had shown optimum maximum compressive and split tensile strengths.

Key words: High Strength Concrete, Fly Ash, Self Curing, Sodium Ligno Sulphonate, Compressive Strength, Split Tensile Strength.

1. INTRODUCTION

Concrete is the most used construction material. Concrete is a mix of cement, fine aggregate, coarse aggregate and water, with or without adding admixtures. Concrete gain strength based on materials used, mix design, water cement ratio, proper mixing and compaction and curing of concrete. Curing is defined as the providing of required moisture content to the concrete for heat of hydration. Curing has a vital role in the strength gaining of concrete. Curing can be done in two ways. They are external curing and internal curing. External curing is defined as the provision moisture content from outside to inside. Whereas internal curing is defined as the provision of moisture content from inside to outside. Due to lack of curing concrete does not get desired strengths. To overcome this, some of internal curing or self curing methods are adopted. In internal curing there is no need of additional water content for curing of concrete. In this research I had designed and prepared a high strength concrete of grade M60 by using ACI 211 .4R. The cement is partially replaced with fly ash with varying dosages of 20% ,25% and 30 %. These concrete specimens are externally cured. For the finalized mix proportion, the self curing agent sodium ligno sulphonate is added at dosages of 0.25%, 0.50% and 0.75% by weight of cementious material and specimens are placed in room. I had compared the compressive strength and spilt tensile strength of High strength concrete with external curing and a high strength concrete with self curing. In this investigation, for self curing of concrete I used sodium ligno sulphonate as a self curing agent.

2. LITERATURE REVIEWS

- Mohammed Suhail studied on An Experimental Investigation on Self-Cured Concrete. He used sodium ligno sulphonate as a self curing agent in his research. He added sodium ligno sulphonate in varying dosages of 0.5%, 1%, 1.5% and 2% by the weight of cement. In his study, the compressive strength ,tensile strength and modulus of rupture of self cured concrete for 7 days and 28 days are tested and compared with conventional concrete of same mix design for M20 and M25.He got optimum maximum compressive strength, tensile strength and modulus of rupture at 0.5% dosage of sodium lignosulphonate for M20 and M25 grade of concrete compared to conventional concrete. In his paper, with the increased dosage of sodium ligno sulphonate the slump of concrete increases.
- Riyaz Ahemad studied on Experimental Study On Self Curing Concrete Using Sodium Ligno Sulphonate . In his research study,he compared the compressive strength and split tensile strength of conventional concrete of grade M20 with the self cured concrete of same grade made by sodium ligno sulphonate. He varied the dosage of sodium ligno sulphonate 0.5% ,1%,1.5%,2%,2.5%and 3% by the weight of cement and tested the specimens at 7 days ,14 days ,and 28 days. He got optimum compressive and tensile strengths at 0.5% of sodium ligno sulphonate than conventional concrete.
- Vishnu T research on An Experimental Investigation of Self-Curing Concrete Incorporated with Light Weight Fine Aggregate and Polyethylene Glycol. In his research he varied different dosages of leca *i.e.*10% ,20%,30% by weight of fine

aggregate and poly ethylene glycol varied at 1%,2%,3%,4% by the weight of cement. He compared compressive strength ,split tensile strength and flexural strength of conventional concrete of grade M40 with self cured concrete. He got optimum strengths at 20% of leca with 2% of polyethylene glycol compared to conventional concrete.

- Shikha Tyagi research on n Experimental Investigation Of Self Curing Concrete Incorporated With Polyethylene Glycol As Self Curing Agent. He used polyethylene glycol 400 as self curing agent. He conducted compressive, split tensile tests on conventional concrete and self cured concrete of grades M25 and M40.In his study reported that at 1% of PEG400 for M25 got optimum compressive and tensile strengths than the conventional concrete. whereas for M40 grade concrete at 0.5% of PEG400 shows the maximum values than the conventional concrete. With the increased percentages in PEG400 the slump values also increased.

3.MATERIALS AND PROPERTIES

3.1 Cement

In these research ordinary Portland cement 53 grade confirming to is 12269:2013 is used. The cement is in grey colour and without any lumps. Different types of ordinary Portland cement are available in market. In this context zuari ordinary Portland cement 53 grade is used and their properties are tabulated below.

Table 3.1.: Table representing the properties of cement

particulars	**Cement**
Specific gravity	3.15
Normal consistency	31%
Initial setting time	30 minutes
Final setting time	600 minutes
soundness	6mm

3.2.Fine Aggregate

Aggregates most of them are passed through 4.75mm is sieve and retained in 150micron IS sieve is known as fine aggregate..In this investigation we used locally available river sand as fine aggregate. The physical properties of fine aggregate are shown below.

Table 3.2.Table representing the properties of sand

particulars		River sand
Specific gravity		2.46
Bulk density	Compacted	1640kg/m^3
	Without compaction	1543.33 kg/m^3
Bulking of sand		14%
Percentage voids		33%

3.3 Coarse Aggregate

The aggregates which are retained in **IS** sieve 4.75mm then the aggregates retained are known as coarse aggregate. In this investigation locally available crushed coarse aggregates are used. They are collected from chandragiri quarry near Chandragiri Kota Chittor (Dist), Andhra Pradesh.The aggregates are in angular shape are used.Their properties are showed below.

Table 3.3. showing the properties of coarse aggregates

Particulars	Coarse aggregate
Bulk density	
Bulk density without compaction	1.37Kg/lit
Bulk density with compaction	1.48Kg/ lit
Specific gravity	2.62
Water absorption	0.25
Percent air voids	44.65%

3.4 Fly Ash

In this investigation, class F type fly ash is used. It is purchased from indiamart. According to IS specifications the fly ash can be used as partial replacement to cement varying from 20 % to 35%. The properties of fly ash are given by the **Indiamart** and shown below.

Table3.4 :The physical properties of fly ash

Properties	Results
Specific gravity	2.4
Consistency	Non-plastic
Grain size	Fine,fairly uniform
Moisture	3.14%
Colour	Grey
Physical state	Powder

3.5 Sodium Ligno Sulphonate

Sodium ligno sulphonate is yellow brown colour water soluble multifunctional polymer. It is rich in sulfo and carboxyl group and has better water solubility, surf activity and dispersion capacity.Sodium ligno sulphonate is a byproduct of sulfite pulping process for paper, ether from use of sodium bisulfate on the wood or by treatment of sulfite liquor from calcium bisulfate pulping with sodium sulphate.In this investigation, Sodium ligno sulphonate is purchased from indiamart. Sodium ligno sulphonate is in powder form with yellow brown colour of grade NALS-1 is used. The properties of Sodium ligno sulphonate are given by **Indiamart** and they are showed below.

Table 3.5: shows the physical properties of sodium ligno sulphonate

Appearance	Yellow brown colour
Ph value	7-9
Dry maters	95%
Water insoluble	1%
Sulfate	2-4%
Calcium and magnesium	0.5% max
Lignosulfonates	60% min
Moisture	7% max

4.THE MIX DESIGN FOR A CONCERETE OF M60 GRADE AS PER ACI 211.4R-93

STEP 1: **Target Mean Strength**

Characteristic strength $\boldsymbol{F'_{ck}} = \frac{\mathbf{F_{ck}} + \mathbf{1.65} * \mathbf{S}}{\mathbf{0.9}}$

$$= \mathbf{77.67\ N/mm^2}$$

STEP 2:Selection Of Slump : As per **ACI 211.4R** Table 4.3.1 recommended slump for concrete made without HRWR -- **50 mm to 100mm**.

STEP 3:Selection Of Maximum Size Of Aggregate: As per **ACI 211.4R** Table 4.3.2 Suggested maximum size of Coarse aggregate for required concrete strength greater than 9000 psi - 9.53 mm to 12.7 mm. Maximum size of aggregate used -**12.5 mm**

STEP 4:Selection Of Optimum Coarse Aggregate Content:

The optimum coarse aggregate content is selected from table number 4.3.3 of **ACI 211.4R** is **0.68**

Coarse aggregate content = (optimum coarse aggregate content * bulk density of c.a)

=0.68*1484.35

= **1009.35 Kg/m^3**

STEP 5: Estimation Of Mixing Water:

Based on slump value of 50mm to 100mm ,and 12.5 mm maximum size of coarse aggregate, the required mixing water chosen from table 4.3.4 is **182.9 Kg/m^3** .

Void content of fine aggregate $= \frac{\text{specific gravity of fine aggregate} - \text{bulk density of F.A}}{\text{pecific gravity of fine aggregate}}$

$= \frac{2.46-1.64}{2.46}$ =**33%**

Mixing water adjustment=(33-35)*8*0.59 =9.44

Total mixing water required for 1m^3 of concrete is 182.9-9.44 =**173.46 Kg/m^3**

STEP 6: Selection Of Water Cement Ratio:

For required strength of concrete without using HRWR the w/c is **0.29** from table number 4.3.5(a) of ACI 211.4R

STEP 7:Determination Of Cement Content:

$\frac{173.46}{0.29} = C$

Cement content =598.14Kg/m^3

STEP 8: Calculation Of Fine Aggregate:

Volume of cement $= \frac{598.14}{3.15*1000} = 0.19$ m^3

Volume of water$= \frac{173.46}{1*1000} = 0.173$ m^3

Volume of coarse aggregate $= \frac{1009.35}{2.62*1000}$ = 0.385 m^3

Volume of air content=0.02

Volume of (cement + fine aggregate +coarse aggregate +water+air content) = 1

volume of fine aggregate =1-(0.190+0.385+0.173+0.02) = **0.232 m^3**

Fine aggregate content = 0.232*2.46*1000 = 570.7kg/m^3

By using trail and mixing of concrete ,the following mix proportion is adopted.

MIX PROPERTIONS		
Cement	495.6	1
Fine aggregate	649.25	1.31
Coarse aggregate	1009.35	2.04
Water	173.46	0.35

5.TEST RESULTS

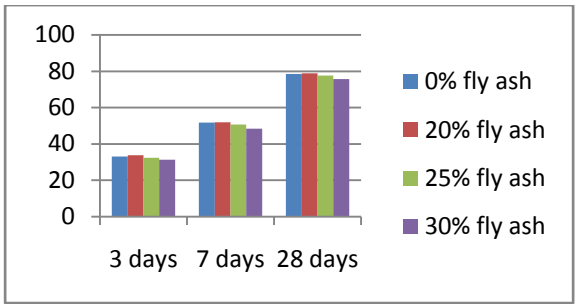
5.1.Compressive Strength The results of compressive strength of conventional concrete and self curing concrete at ages of 3days, 7days , 28days and at 56 days are showed below.

TABLE.5.1

Table shows the compressive results of conventional concrete

Fly ash in %	Compressive strength In N/mm^2		
	3days	7days	28days
0	33.11	51.76	78.58
20	33.85	51.99	78.81
25	32.46	50.77	77.61
30	31.33	48.33	75.66

From the compressive results, observed that at 20% replacement of fly ash to the cement had maximum compressive strength then other varying percentages of fly ash. So that the mix proportion of that 20% replacement of fly ash to cement is taken for further mixes in this investigation

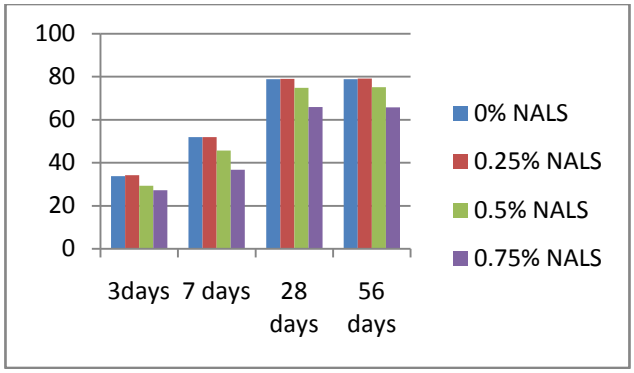


Graph5.1. the comparison of compressive results of conventional concrete.

5.1.1 Compressive Results Of Self Curing Concrete The compressive strengths of concrete mix with dosages of sodium ligno sulphonate had been tested at 3 days ,7 days , 28 days and at 56 days. The results are shown below.

Table 5.2. Table shows the compressive results of self curing concrete:

Dosage of NALS	Compressive strength N/mm^2			
	3days	7 days	28 days	56 days
0	33.85	51.99	78.81	78.89
0.25	34.18	51.88	79.02	79.11
0.50	29.30	45.7	74.86	75.19
0.75	27.30	36.79	65.93	65.84



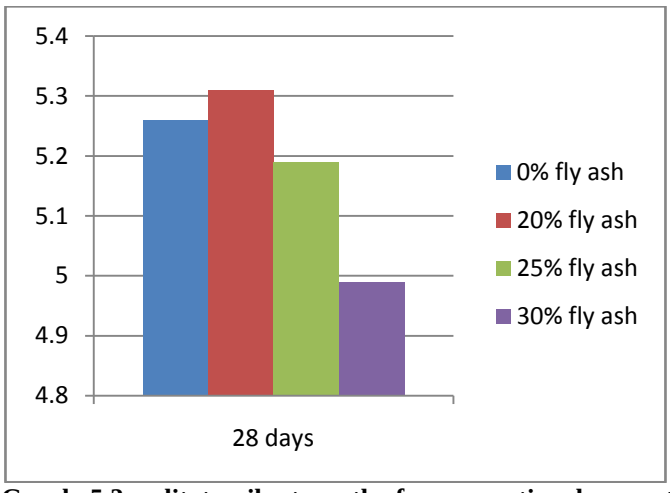
Graph 5.2: Graph showing the comparison of compressive results of self curing concrete

5.2.Split Tensile Strength

The split tensile test had been conducted on finalized convensional concrete and on self curing concrete at 28-days age of concrete. The split tensile results are showned below.

Table.5.3.Split Tensile Strength Of Conventional Concrete

Dosage of fly ash in %	Split tensile strength in N/mm^2
0	5.26
20	5.31
25	5.19
30	4.99



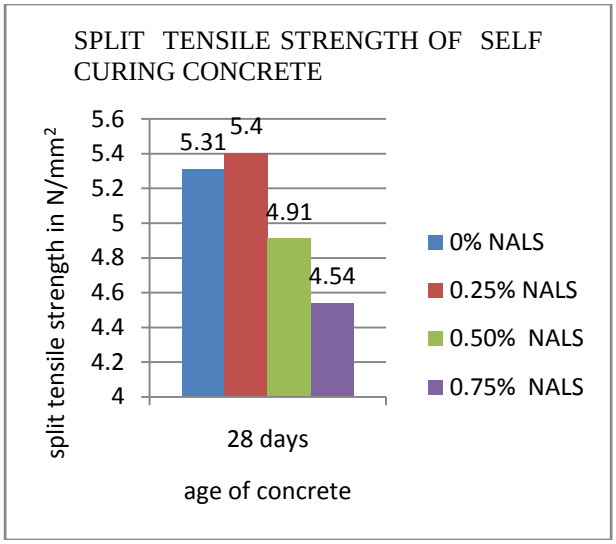
Graph 5.3 :split tensile strength of conventional concrete

5.2.1 Split Tensile Results Of Self Curing Concrete

The split tensile strength of self curing concrete are tested at 28 days age of concrete.the results are shown below.

Table 5.4.Split Tensile Strength Of Self Curing Concrete

Dosage of NALS in %	**Split tensile strength in N/mm^2**
0%	5.31
0.25%	5.40
0.50%	4.91
0.75%	4.54



5.3. SLUMP CONE TEST RESULTS:

The fresh properties of conventinol concrete and self curing concrete are tested by using slump cone test.the results of slump cone are shown below.

Table 5.5. Fresh Properties Of Conventional Concrete By Slump Cone

varing dosages of fly ash	Slump in mm
0%	0
20%	9
25%	14
30%	17

Table5.6. fresh properties of conventional concrete by slump cone

dosages of NALS	Slump in mm
0%	9
0.25%	58
0.50%	82
0.75%	106

6.CONCLUSION

From this investigation on self curing high strength concrete, the following conclusions were founded.

- In this research, the conventional concrete of grade M60 is designed and the cement content is partially replaced with fly ash in varying dosages of 20%,25% and 30%.
- We got maximum compressive and tensile strengths at 20% of fly ash in conventional concrete.
- The sodium ligno sulphonate is added to conventional concrete in a dosages of 0.25%,0.50% and 0.75% by the weight of cement.
- The self cured high strength concrete of grade M60 at 0.25% sodium ligno sulphonate dosage had optimum compressive and split tensile strength than the conventional concrete of similar mix design.
- The workability of self cured concrete is increased with increase in dosage of sodium ligno sulphonate.

- From these conclusions it is found that self curing of high strength concrete can be done by using sodium ligno sulphonate.

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