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EXPERIMENTAL INVESTIGATION OF SELF COMPACTING CONCRETE (SCC) WITH CONFINEMENT BY PARTIAL REPLACEMENT OF CEMENT WITH GGBS, LIME STONE AND FINE AGGREGATE WITH POND ASH

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ABSTRACT

Self-compacting concrete posses higher flow ability to settle without utilization of any mechanical vibration. The main motto of this study to explore the mechanical properties of reinforced self-compacting concrete (SCC) using Ground Granulated Blastfurnace Slag (GGBS) & limestone powder as mineral admixtures along with pond ash as substitution of fine aggregate. In the present study cubes cast to find compressive test & Cylinders for split tensile test, flexural strength destructive test on beam reinforced with 4mm bars was performed in the laboratory. The experimental work was done to observe the effects taking place during replacement of the GGBS, Limestone powder and pond ash on fresh and solidified properties of SCC. Replacement of pond ash by weight of fine aggregates in various percentages such as 20%, 40%, 60%, GGBS& limestone powder of same percentages such as 20%, 40%, 60% by weight of cement is replaced as a mineral admixture to attain self-compacting concrete properties to predict flow behaviour. The super plasticizer by 1% weight of cement is used to increase the workability of SCC. This replacement had proved to have some economic benefits as well as time effective techniques in concreting for the future.

Key words: Self-compaction concrete, Ground Granulated Blast furnace Slag (GGBS), confinement, Pond ash, stress-strain behavior.

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1. INTRODUCTION

Concrete has widely used a material in case of construction which is a combination of binder material such as fine aggregate, coarse aggregate, and water. The strength of concrete mainly depends on the water-cement ratio. It should easily be placed in terms highly reinforced areas. But due to some disadvantages in the setting of concrete such as surface finish and self-compaction and many other disadvantages aggregates segregation self-compaction concrete is introduced by adding some of the mineral admixtures. Self-compaction concrete (SCC) is a well-known word nowadays in concrete technology as usage is increasing widely throughout the world. As it eliminates the need for compaction through reinforcement so the chance of interlocking, blocking of passing and filling materials and air voids will decrease. Its origin takes place in Japan by the professor OKAMURA. Its draw a huge change in pre-caste construction industry. SCC is freely flowable under its own weight. Later its implementation and development took place in the west European countries. Many researchers are carried out on the SCC by the potential users and structural configurations.

Bharali (2015) investigated SCC by partial replacing with the GGBS and fly ash at various proportions in order to achieve SCC of M 30 grade. Tushae.g.more (2015) conducted his study on replacement of pond ash in fine aggregate at different percentages. He noticed 20 % replacement of pond ash is giving optimum strength. As replacement varies the workability decreases. Pai et. Al (2014) used to prove industrial by-products was more economical for the preparation of the concrete mixes. An investigation based on GGBS & silica fumes used to replace with cement to compare the strength between both of them. Anthony nkem et.al (2014) research conducted on the various parameters investigated attempts to predict flow behaviour when it partially replaced with the limestone & superplasticizer at different percentages. The main contrary of SCC is for good surface finish, increase in durability, poor workmanship, Ease of construction, reduction of noise and vibration and safer working environment. In using the industry by-products such as fly ash, Ground granulated blast furnace slag (GGBS), silica fume, M sand etc.

In the present investigation replacement with GGBS, limestone powder and pond ash by inducing the confinement at different percentages in cylinders and beams according to the variety of percentages and also to find the stress-strain values by using compressometer. Limestone powder and GGBS will give the fresh properties of concrete gives the high strength and excellence in finishing.

2. OBJECTIVE

The Essential goal of this examination is to explore the mechanical properties of reinforced self-compacting concrete (SCC) using Ground Granulated Blast furnace Slag (GGBS) & limestone powder as mineral admixtures along with pond ash as substitution of fine aggregate by providing the different percentages of confinement. There is a need to implement SCC for the use of R.C.C components in order to study the structural behaviour.

3. METHODOLOGY

3.1. Materials used

3.1.1. Cement

AS the part of the Experimental work OPC Penna of 53 Grade conforming the IS 12269: 1987 was used in this research area. The laboratory tests such as standard consistency, initial setting time, final setting time & compressive strength at different ages as per are 4031. The properties are given below

Table 1 Properties of cement

Properties	Results
Standard consistency	30 %
Initial setting time	135 min
Final setting time	260 min
strength for 3 days	28.9 N/mm^2
strength for 7 days	39.7 N/mm^2
strength for 28 days	55.7 N/mm^2

3.1.2. GGBS

Ground granulated blast furnace slag (GGBS) is formed from the chilling of the molten slag in the furnace with the help of water. During the quenching, the slag converts into the amorphous granules according to the requirement of the IS 12089: 1987. It tends to absorb the excess lime during the hydration. The physical and chemical properties given below

Table 2 Physical & chemical properties GGBS

Chemical properties		Physical properties	
Calcium	41 %	Particle size	10 microns
Silica	35%	Colour	Off –white
Alumina	12%	Specific gravity	2.9
Magnesia	8%	Bulk density	1.0

3.1.3. Limestone Powder

Limestone powder was collected from the local market near piduguralla. With the following physical and chemical properties.

Table 3 Physical & chemical properties of limestone powder

Chemical properties		Physical properties	
$CaCO_3$	84.85 %	Colour	Light grey
Silica SiO_2	7.06 %	P_h	11
Alumina Al_2O_3	2.85 %	Specific gravity	2.65 g/m^3
-	-	Bulk density	0.8

3.1.4. Pond ash

Pond ash was obtained from the wet disposal of bottom ash or fly ash into a pond like structure with the help of a water. For the present research pond ash collected from the NTTPS near Ibrahimpatnam. The physical and chemical properties are given below.

Table 4 Physical & Chemical properties of Pond ash

Chemical properties		**Physical properties**	
Silica	67.4	Specific gravity	2.16
alumina	19.44	Liquid limit	4.73
Iron oxide	8.5	Bulk density	890 kg/m^3
Calcium oxide	2.7	Grain size distribution 1 sand 2 clay	 72% 28%

3.1.5. Coarse aggregate

A coarse aggregate of size 12 mm tends to use in this investigation which was brought from a local market near Vijayawada satisfying the conditions of IS 383-1970.

3.1.6. Fine aggregate

River sand which is used for present investigation is procured locally and confirming zone III

3.1.7. Superplasticizer

Glenium B 233 V 6 is used in present work as a superplasticizer for more workability with less water usage. As it was consists of low alkali & chloride content it can be used in any type of cement. By conforming with the code IS 9103: 1999 Properties of Glenium B 233 V 6 are given below

Table 5: properties of superplasticizerColour	**Light brown liquid**
Relative density	1.09+0.01
P_h	≥6
Chloride content	≤0.2 %

3.1.8. VMA (viscosity modifying agent)

Auramix 400 is used for dispersion of cement and reduction in water content as well as for workability.

3.2. Processing of Methodology

3.2.1. Mix proportions

In the total experimental programme, three phases are involved at first preparing the SCC mix M 40. In the second phase involving the casting of the specimens which is of standard sizes cubes for compressive strength, cylinders for split tensile strength and beams for flexural strength by varying the percentage of replacements as well as the confinements. And in the third phase conducting the tests on the hardened properties of the specimens to know its mechanical properties. By using the compressometer to find out the stress-strain from axial compression. As the Self-compaction concrete is introduced in 1980. Till now there is no specific mix design. According to EFNARC guidelines, many investigations in SCC took place .some of the construction companies was used to follow their own proportion of mix design. now here we used the method introduced by the Okamura by using EFNARC guidelines. The detailed mix design is given below

Table 6 Mix design proportions of M 40

Materials	**Quantity (kg/m^3)**
Cement	415.5
GGBS	108
Limestone powder	38
Fine aggregate	1017.6
Coarse aggregate	902
Pond ash	270
Super plasticizer (lit/m^{3})	5.07
VMA(lit/m^3)	0.25

4. RESULTS & DISCUSSION

4.1. Fresh properties of SCC

In order to find workability, tests like slump flow, T_{50} slump, V-funnel, L-box and U-box conducted for every percentage of replacement such as 20 %, 40 %, and 60 %. The results for every mix was noted according to the EFNARC limits. In where GGBS took as 75 % and limestone powder is 25% in replacement with cement in every percentage and to predict flow behavior. From the test results, we can notice that as replacement increases time taking was increased for the flowability. The entire experimental programme used to define the fresh and hardened properties of the SCC. The test results for fresh properties are given below.

Table 7 Test Results for SCC

Test	Limits	20 %	40%	60%
Slump flow	650-800 mm	680 mm	620 mm	725 mm
T 50 slump flow	2-6 sec	5.78 sec	5 sec	5.2 sec
V-Funnel	6-12 sec	6 sec	6 sec	8 sec
L-Box (H_2/H_1)	0.8-1.0	0.9	0.8	0.8
U- box (H_2-H_1)	0-30 mm	29 mm	10 mm	0 mm

4.2. Hardened properties of concrete

For engineering properties of SCC cubes of 150x150x150 mm, cylinders of 150x300 mm beams of size 150 x 700 mm are cast in standard sizes to find compressive strength, split tensile strength, flexural strength. For every percentage of replacement 9 cubes, 9 cylinders, and 6 beams are cast in total 36 cubes, 36 cylinders and 24 beams are prepared for investigation on a normal mean of 3 cubes, 3 cylinders and 2 beams for every replacement to test at 3, 7 & 28 days. The percentage of confinement (reinforcement bars of 4 mm) also induced to change as 0%, 0.267% , 0.330% and 0.412 % in cylinders for replacement of 0%, 20 %, 40 % and 60% . Similarly in case of beams it tends to vary 0%, 0.026%, 0.0465% and 0.0631%.

4.2.1. Compressive strength

Compressive quality test directed according to code IS 516-1959 under the Universal testing machine (UTM) of capacity 100 tonnes used to test 9 cube samples for nominal mean 3 cubes for different curing period such as 3, 7 & 28 days. Tested for every replacement to evaluate compressive strength. From the table 8 compressive quality of 20 % replacement is 45.33 and for 40% is 47 N/mm^2. From the test, we conclude that strength at 40 % replacement is optimum. At 60% replacement strength radically attracts downwards to 26.2 N/mm^2. During demoulding, the specimens are fizzled at their edges and a long time over 24 hours to settle down. As the replacement increases strength decreases. The results are given below

Table 8 Compressive strength of M 40

Compressive strength (N/mm^2)			
% of replacement	**20%**	**40 %**	**60%**
3 days	19.6	20.5	13.96
7 days	27.4	30	22.6
28 days	45.33	47	26.2

4.2.2. Split tensile test

Split tensile (ductile) quality strength test cylinder specimens are cast by changing the confinement in the form of hoops. For 20% replacement 0.267% of confinement provided by

2 hoops. similarly for 40 % confinement of 0.330% of 3 hoops, 60% replacement confinement 0.412% of 4 hoops. for 60 % replacement during testing, specimen failed totally. And strength decreases as the percentage of replacement increases. Results are given below

Table 9 Split tensile strength

Split tensile strength			
% of replacement	**20 %**	**40%**	**60%**
3 days	1.75	2.23	1.36
7 days	2.61	2.73	1.76
28 days	4.12	4.19	2.09

4.2.3. Flexural strength

The destructive test on beams of specimens of standard sizes 150x700 mm. By differentiating the confinements at 0.026% for 20% replacement, 40% replacement with confinement 0.0465% similarly 60% replacement with 0.0631% provided. Average mean of 2 beams taken for curing period of 3, 7 & 28 days for every replacement. At 60 % replacement taken a long time to settle more than 30 hours. While expelling from moulds the edges are fizzled somewhat.

Table 10 Flexural strength

Flexural strength (Mpa)			
Replacement %	**20%**	**40%**	**60%**
3 days	1.51	1.47	1.321
7 days	2.33	2.57	1.85
28 days	4.425	4.80	2.365

4.3. Comparison between normal concrete & SCC

In order to know the nominal properties of concrete, 9 cubes, 9 cylinders, and 6 beams are cast to know compressive quality, split tensile strength & flexural strength and are tested for 3, 7 and 28 days respective. The comparison between nominal concrete & SCC given beneath.

Table 11 Comparison between normal concrete & SCC

Tests conducted	**Duration**	**Nominal mix M 40**	**Self compacting concrete of M 40**		
			20%	**40%**	**60%**
Compressive strength (Mpa)	3 days	18.13	19.6	20.5	13.96
	7 days	32.14	27.4	30	22.6
	28 days	42.5	45.33	47	26.5
Split tensile strength	3 days	2.19	1.75	2.23	1.36
	7 days	3.12	2.61	2.73	1.76
	28 days	3.36	4.12	4.16	2.09
Flexural strength (Mpa)	3 days	1.92	1.51	1.47	1.321
	7 days	2.92	2.33	2.57	1.85
	28 days	4.01	4.425	4.80	2.365

In examination with the normal concrete without utilization of any super plasticizer, the outcomes are great. By observing the comparison between normal concrete along with the substitutions of 20%, 40% & 60%. At 20 % and 40 % replacement was more satisfactory and attains high strength in comparison with 60 % replacement the compressive quality strength decreases drastically. There will be slight cost difference in between the replacement and nominal concrete. Its replacement up to 20% is recommended.

4.4. Stress-strain behaviour of SCC

A stress-strain curve is a graph derived from measuring load versus strain. In order to get the strain values, we cast cylinders of standard size 150x300mm we provided confinement to the cylinders at different percentages. As a section we utilized compressometer. Compressometer is utilized for assessing as well as deformation and strain characteristics of concrete cylinders while undergoing compression testing. The stress-strain behaviour of concrete is a vital parameter which is essential in designing and toughness of concrete. An entire stress-strain curve required for the design and examination of a concrete structure during the severe weather conditions to and difficulty in concrete repair.

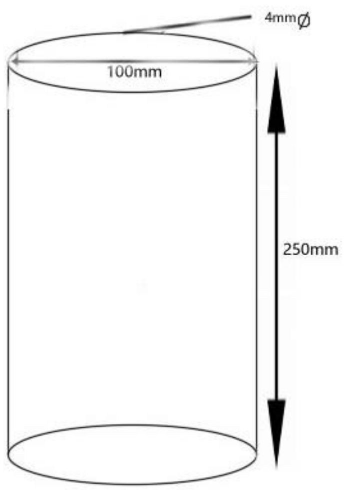

Fig 1: confinement of 0.267% steel

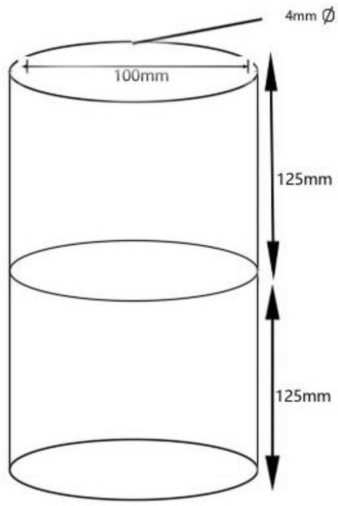

Fig2: confinement of 0.330% steel

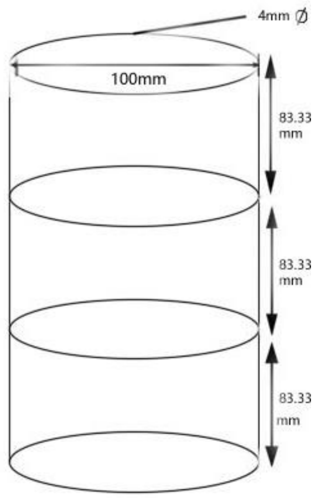

Fig 3: confinement of 0.4126% steel

4.4.1. Stress-strain values of 0 % confinement at 28 days

In order to find the stress-strain curves for concrete, we used to test cylinder specimen under strain control. The rate of strain 0.02 mm per second and measures at every 20 KN. And also here peak stress is 43.007 N/mm^2 and the peak strain is 0.0026. in order to conclude the values of normalized stress, we consider actual stress to the peaks stress. Similarly in case of normalized strain actual strain to the peak strain. And here the most extreme strain is 0.052. the stress and normalized stress graphs are given below.

Table 12 Calculation of stress-train for 0% confinement

S no	Strain	Stress	Normalised strain	Normalised stress
1	0.000006	1.1317	0.0023	0.02631
2	0.000026	2.2635	0.01	0.05263
3	0.00006	3.3953	0.023	0.07894
4	0.000093	4.527	0.03576	0.10526
5	0.00012	5.6588	0.04615	0.131575
6	0.00016	6.79057	0.0615	0.157891
7	0.0002	7.92234	0.07692	0.184207
8	0.00024	9.05411	0.0923	0.210523
9	0.00026	10.18588	0.1	0.236839
10	0.000306	11.31765	0.1176	0.263155
11	0.00036	12.44942	0.1384	0.289471
12	0.00038	13.58119	0.1461	0.315787
13	0.0005	14.71296	0.1923	0.342103
14	0.00046	15.84473	0.1769	0.368419
15	0.00048	16.9765	0.1846	0.394735

16	0.00054	18.10827	0.2076	0.421051
17	0.00058	19.24004	0.223	0.447367
18	0.00064	20.37181	0.24615	0.473683
19	0.00068	21.50358	0.2615	0.499999
20	0.00072	22.63535	0.2769	0.526315
21	0.00078	23.76712	0.3	0.552631
22	0.00082	24.89889	0.3153	0.578947
23	0.00089	26.03066	0.3423	0.605263
24	0.00092	27.16243	0.3538	0.631579
25	0.00097	28.2942	0.373	0.657895
26	0.00104	29.42597	0.4	0.684211
27	0.00109	30.55774	0.4192	0.710527
28	0.0011	31.68951	0.423	0.736843
29	0.00125	32.82128	0.4807	0.763159
30	0.00129	33.95305	0.4961	0.789475
31	0.00134	35.08482	0.5153	0.815791
32	0.00141	36.21659	0.5423	0.842107
33	0.00148	37.34836	0.5692	0.868423
34	0.00158	38.48013	0.6076	0.894739
35	0.0017	39.611	0.6538	0.921055
36	0.00178	40.74	0.6861	0.947371
37	0.002	41.875	0.7692	0.973687
38	0.0026	43.007	1	1
39	0.0028	40.177	1.07692	0.93419
40	0.0032	36.782	1.2307	0.85525
41	0.0036	33.38	1.8	0.775
42	0.0042	31.12	1.6153	0.72360
43	0.0046	28.08	1.7609	0.6529
44	0.0052	23.201	2.01	0.5394

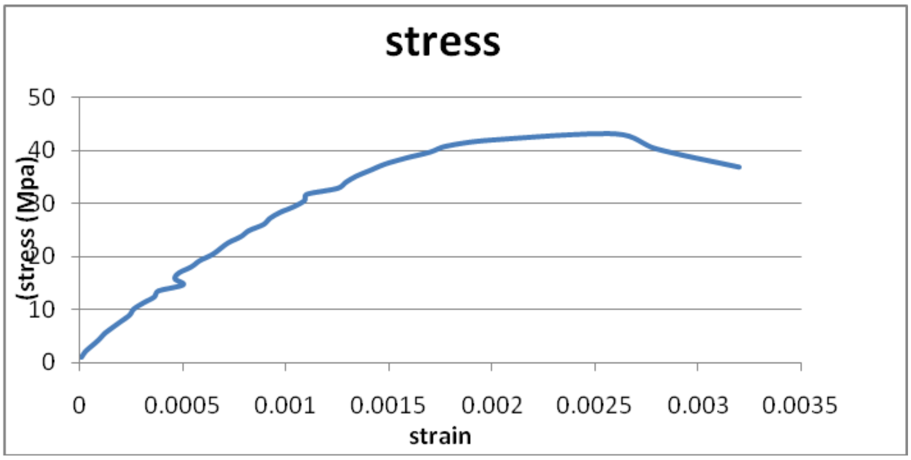

Figure 4 Stress-strain relationship of concrete of M40 & 0% steel

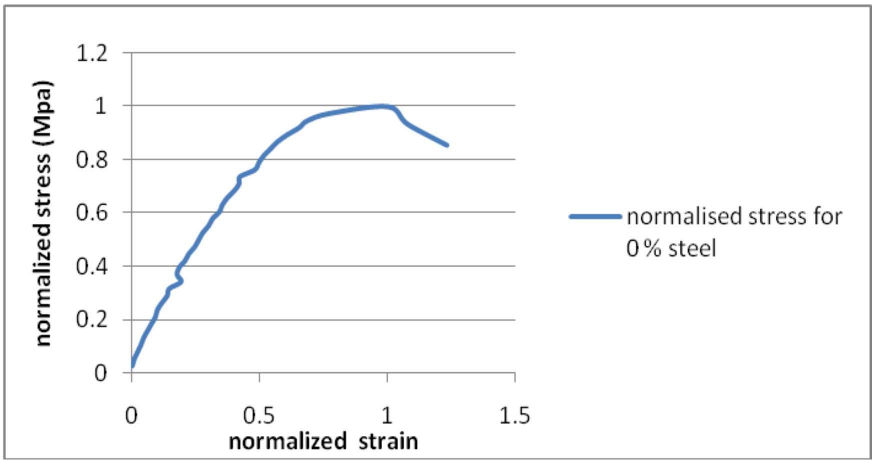

Figure 5 Normalized stress- strain relationship for concrete M 40 & 0% steel

4.4.2. Stress strain calculations for 0.267 % confinement

The stress-strain computations for 0.267% steel and for 20 % replacement at 28 days. The stress-strain curve and normalized stress – strain curve of 0.267%vwas given beneath. The peak stress is 48.666 N/mm^2 and peak strain is 0.0026 and maximum strain is 0.00317. similarly, peak stress & peak strain was calculated from the actual stress to the peak stress. Comparison of the normalized stress & strain values is given below in Fig 3 & Fig 4. The graphs are given below

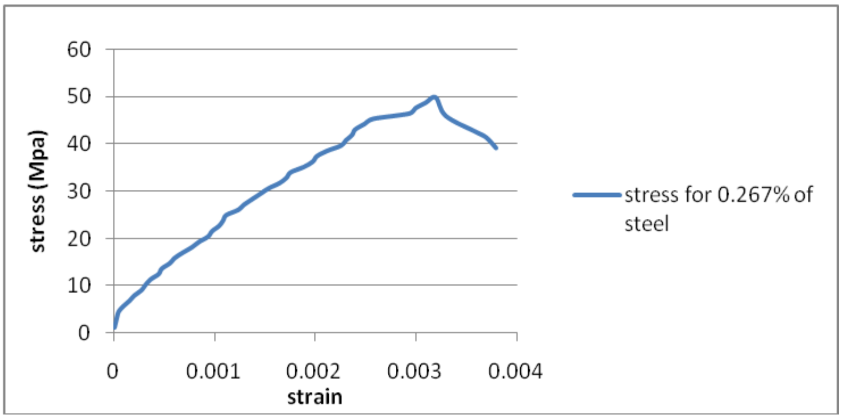

Figure 6 Stress-strain relationship for concrete M 40 & 0.267% steel

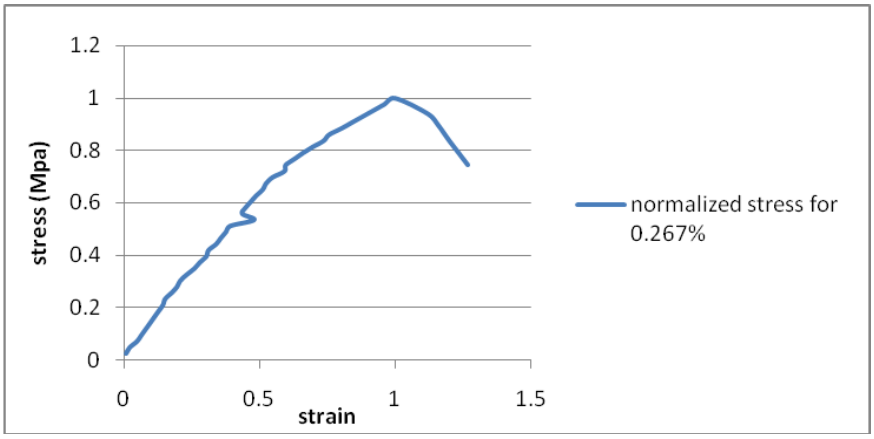

Figure 7 Normalized stress strain relationship for M 40 & 0.267% steel

4.4.3. Stress-strain calculations for 0.330 % steel for 28 days

The specimen readings along with the stress-strain computations for 0.330 percentage steel at 28 days was given beneath. The stress-strain curves and standardized stress-strain curves for confinement 0.330 % given beneath. Peak stress is 49.73 and strain at peak stress is 0.032. The extreme strain is 0.038. The stress and normalized stress graphs are given underneath.

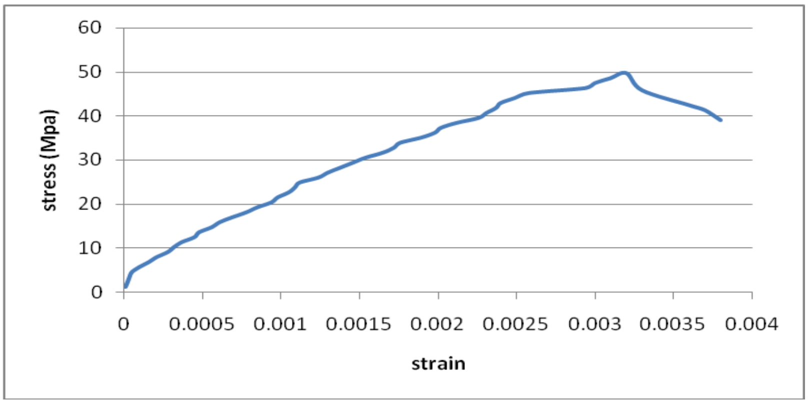

Figure 8 Stress strain relationship for M40 & 0.330% steel

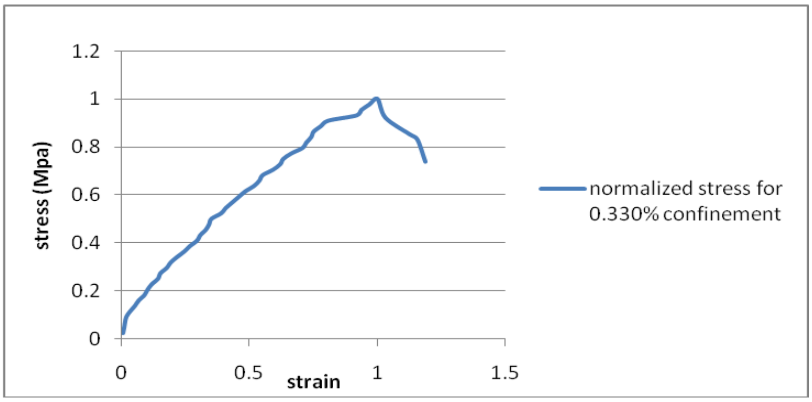

Figure 9 Stress strain relationship for M40 & 0.330% steel

4.4.4. Stress- strain calculations for 0.4126 % confinement at 28 days

The example readings along with stress-strain computations for 0.4126 % steel for 28 days were given below in table no 7. The stress-strain curves and standardized stress-strain curves are also given beneath. Peak stress is 38.429 and the strain at peak stress is 0.00237. and maximum strain is 0.00262. The comparison graphs are given below.

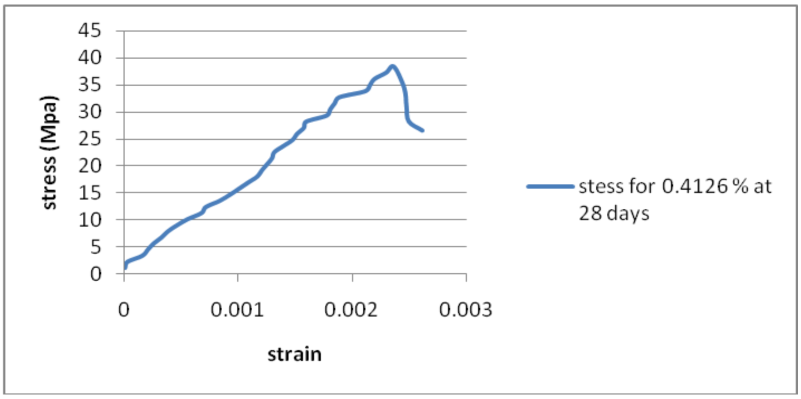

Figure 10 Stress strain relationship for M 40 & 0.4126 % steel

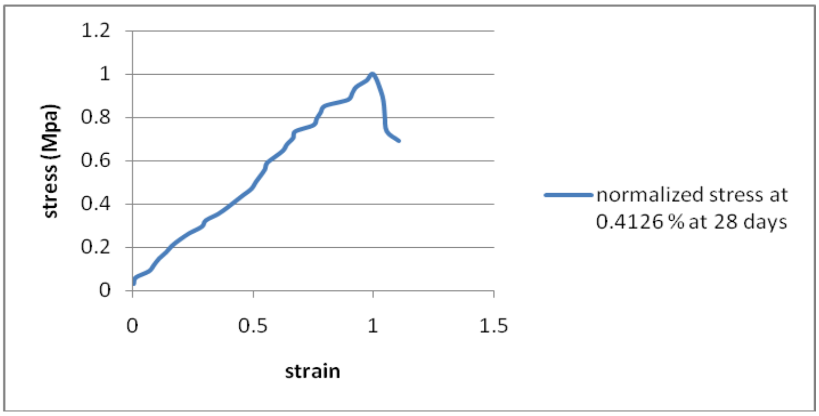

Figure 11 Stress strain relationship for M 40 & 0.4126 % steel

From the beneath fig 9 the correlation of experimental results of the cylinders with different percentages of confinement at 28 days. The graphs demonstrate the compressive quality at peak stress optimum at 0.330 % confinement & 40 % replacement. It decreases at 0.4126 % confinement and 60 % replacement. The peak strain is 0.025, 0.032, & 0.0237 obtained for the confinement s of 0.267, 0.330 & 0.4126 % of steel.

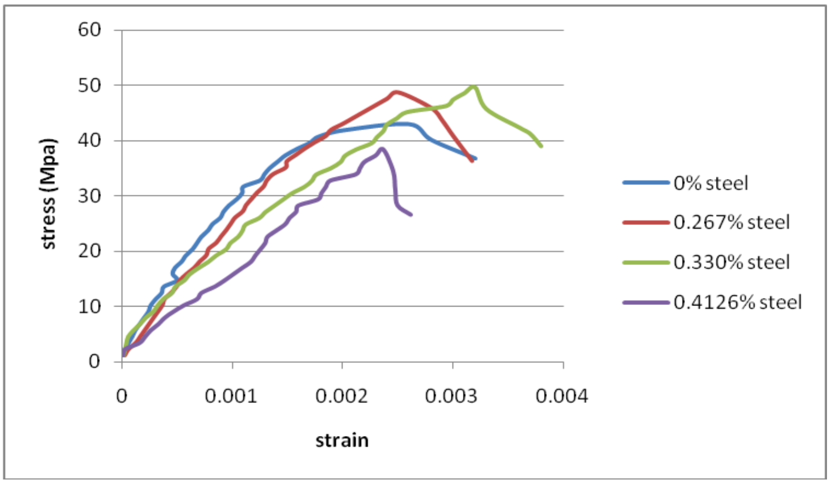

Figure 12 Comparison of stress-strain graphs at different confinements for 28 days

5. CONCLUSIONS

Experimental Investigation of SCC with Confinement by Partial Replacement of cement with GGBS and fine aggregate with pond ash discussed the different experimental programmes are conducted such as compressive quality test, split tensile strength and flexural strength for cubes, cylinders & beams that are carried out on the specimens to calculate the strength and durability properties of prepared concrete specimens and results obtained from the experimental programmes.

- By observing the experimental results 40% replacement is optimum. As a part of using pond ash, we noticed settlement undergoes long time to settle.
- After that 60 % replacement of any by-product was not good for usage.
- Pond ash-poor to use as fine aggregate due to lack of initial setting time and strength obtained.
- By providing the confinement at different percentages use to increase strength at 28 days.

- The results of confinement show that there is an increase in the volume of transverse confinement tends to increases the strength and ductility of concrete.

REFERENCES

[1] Magda I. Mousa, Mohamed G.Mahdy, Ahmed H. Abdel_reheem, Akram Z. Yehia, 2015, Physical properties of Self-curing concrete, Housing and Building National Research center, 11, 167–175.

[2] C.rajamallu, A. Balaji Rao, 2014, Behaviour of self-compacting concrete under axial compression with and without confinement, International Journal of Ethics in engineering & Managment Education, ISSN:2348-4748, Volume 1, issue 3

[3] Batham Geeta, Bhadauria S. S., Akhtar Saleem, 2013, A Review: Recent innovations in self-compacting concrete, an international journal of scientific research, volume 4, issue 11, ISSN 2229-5518.

[4] Gergely A. Sik, Salem G. Nehme, and Cecília Sik-Lanyi, 2012, The optimization of Self-Compacting concrete (SCC), production scheduling- specially the effect of fine aggregate, IACSIT International Journal of Engineering and Technology, Vol. 4, No. 4,

[5] Tushar. G. More, Pankaj B. Atade, 2015, A study on concrete properties by partial replacement of sand by Pond ash, International Research Journal of ENgeneering and Technology, Volume: 02 Issue: 08 | Nov-2015, e-ISSN: 2395 -0056, p-ISSN: 2395-0072

[6] Biswadeep Bharali, 2015, the Experimenetal study of Self Compaction Concrete using GGBS and Fly ash, International journal of Core Engineering & Managment, Volume 2, Issue 6.

[7] Aswathy P.U, Mathews M paul, 2015, Behaviour of self compacting concrete by partial replacement of fine aggregate with Coal Bottom ash, International journal of Innovative research in advanced engineering, ISSN: 2349-2163, issue 10, Volume 2.

[8] S.R. vaniya, Dr. K.B.Parikh, Harish M. Rabadiya, 2016, A study on properties self compacting concrete with Manufactured sand as Fine Aggregate: A Critical review, IOSR Journal of mechanical and civil engineering, e-ISSN:2278-1684,p-ISSN: 2320-334x, Volume 13, Iissue 1.

[9] Ravinder Kaur Snadhu, Rafat siddique, 2017, Influenece of Rice husk Ash on properties of self compaction of concrete, Construction and building materials 153 (2017) 751-764.

[10] Nileena M S, Praveen Mathew, (2014), Effecet of GGBS and GBS on the properties of SCC, International journal of innovative research in advance Engineering, ISSN: 2349-2163, volume 1 issue 9.

[11] IS 4031-1998 (PART-1), Standarad code of practice for methods of tests for Hydraulic cement, Bureau of Indian standards, new Delhi, 1997

[12] Magda I. Mousa, Mohamed G.Mahdey, Ahmed H. Abdel –reheem, Akram Z. Yehia, 2014, Mechanical properties of self curing concrete, HBRC journal (2015) 11, 311-320.

[13] Subhan Ahmed, Arshad Umar, Amjad Masood, 2017, properties of normal concrete, self-compacting concrete, Fiber-reinforced self compacting concrete: An Experimental Study, Subhan Ahmed et al, / Procedia engeneering 173 (2017) 807-813.

[14] Dhiyaneswaran, S., Ramnathan, P, Bakar I, Venkatasubramani. R, 2013, Study on durability Charactersticsof SCC with fly ash, Jordam journal of civil engeneering, Volume 7, issue 3

[15] J.M. Srishaila, Akshay K.A, P.Prakash, Veena jawali, 2015, Influence of GGBS and Silica Fumeon Workability and Mechanical properties of self compacting concrete, IOSR

Journal of Mechanical and civil engeneering, e-ISSN: 2278-1684, p-ISSN: 2320-332X, Volume 12, issue 4.

[16] Ch. Srinivasarao,SS.Asadi,M.Kameswararao,"Study Of High Grade Cementgranulated Blast Fin Portland Slag Concrete Containing Furnace Slag Asfine Aggregate"International Journal of Civil Engineering and Technology (IJCIET),Volume 8, Issue 5, May 2017, pp. 22–32, ISSN:0976-6316,

[17] SS. Asadi, M. Venkata Sravan Kumar Reddy,"An Analytical Approach For Evaluation Of Resources Management In Construction Industry: A Model Study"International Journal of Civil Engineering and Technology (IJCIET) Volume 9, Issue 2, February 2018, pp. 130–138.

[18] Shashi Kant Sharma, SandeepPanchal, Amrit Kumar Roy and Mohd. Mohsin Khan, Performance Comparison of Flyash and Wollastonite Micro - Fiber in Obtaining Self Compacting Concrete Mixes . International Journal of Civil Engineering and Technology, 8(3), 2017, pp. 137 –145.

[19] Kiran K. Shetty, Gopinatha Nayak, Shriharsha and M . D. Abdul Siddik, Plastic Shrinkage and Strength Parameters o f High Volume Fly Ash Self Compacting Concrete Admixed with Alkali Resistant Glass Fibres. International Journal of Civil Engineering and Technology, 8(8), 2017, pp. 324–333.