Experimental Study and Strength Properties of Light Weight Self Compacting Concrete (LWSCC)

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Abstract— The world is now growing rapidly in terms of construction industry. The reason is due to the rapid construction. A small attempt is made in our present project to assist this rapid construction by producing a lightweight self-compacting concrete. We have replaced coarse aggregate in terms of light weight aggregate (cinder) as partial replacement in concrete and also included two kinds of concrete i.e., light weight concrete and self-compacting concrete. The main aim is to reduce the self-weight of concrete and voids in concrete. From the results of the project we found that the replacement at 30% and 40% we found better strength and weight reduces up to 10% to 15% by compering to normal concrete the strength of light weight self-compacting concrete at 30% replacement 42.67N/mm^2 and 39.11N/mm^2 and weight 8.1kgs and 8kgs respectively. Hence it can be used for construction purpose and precast industries at moderate cost and effective result.

Key words: Nansu method, Compressible Packing Model Method

I. Introduction

Generally the 3 major characteristics of concrete area unit workability, strength, and sturdiness. It's sure that quality and strength area unit known with the coagulated cement and workability is known with the crisp cement, anyway coagulated properties maybe specifically attributable to the mix define and new properties. At the tip of the day, mix arrange and also the new properties of cement area unit the foremost basic focuses to manage in association to the mechanical attributes of coagulated cement the first assessment of coagulated solid properties is vital.

In this mainly that we dealing with the light weight concrete and self-compacting concrete is effective to use for construction as we following results are obtained studying and experimenting to the concrete. The mainly taken the light weight concrete and self-compacting concrete. The main aim is to reduce the self-weight of concrete and voids in concrete. From the results of the project we found that the replacement at 30% and 40% we found better strength and weight reduces up to 10% to 15% by compering to normal concrete the strength of light weight self-compacting concrete at 30% replacement 42.67N/mm^2 and 39.11N/mm^2 and weight 8.1kgs and 8kgs respectively. Hence it can be used for construction purpose and precast industries at moderate cost and effective result.

II. Literature review

A. [1] Revathy.S, Josina Thomas,(2016)

This paper converses the characteristics of three types of LWSCC, which are formed using fine pumice stone powder in one mix , aluminum powder in second mix and for third mix complaining both pumice powder and aluminum powder. Lightweight total SCC properties have been assessed as far as stream capacity, isolation opposition and filling limit of crisp concrete according to the norms. The estimation of the mechanical properties of solidified lightweight total SCC, with compressive quality, part elasticity, and thickness, and its particular quality were likewise passed out. In customary self-compacting solid 7 days and 28days compressive quality was 34 and 48.8MPa separately. In any case, in assemble 1 Self -compacting light-weight cement, was observed to be 33 and 48.4N/mm^2 individually. Ideal quality was found at 15% substitution of fine total by pumice stone powder.

B. [2] Niki Cauberg, Xavier Kestemont

This paper talks a coherent manner to address the blend outline of a light-weight SCC. The precept goal became to take an adaptable outline approach, in place of one superior combination piece. the available layout approach carries the supreme vital characteristics of the exceptional mechanisms, including water demand of filler and cement, and particle disseminations for filler, sand and light-weight aggregates.

The suggested method is primarily based at the tailored chinese mix design then combines the alternatives to comprehend a l-scc in function of essential factors: density elegance and compressive energy class. the theoretical foundation, the modelling and trying out and a case have a look at were provided, composed with a essential evaluation of assistances and downsides of this methodology for the common precast manufacturer. the checking out difficult oven-dry densities starting from 1400 kg/m³ to 2000 kg/m³, and consequences for the compressive power was starting from 20 N/mm² to sixty four N/mm².

C. [3]. A.A. Maghsoudi, Sh. Mohamadpour, M. Maghsoudi

The subsequent critical results can be summarized by using the research completed at the sclwc exams by means of use of leca as light-weight combination and four hundred and 500 kg/m3 of cement control, it became viable to produce a self-compacting mild concrete (with a selected weight a lesser quantity of than 1900 kg/m3) blend with compressive electricity of 28and 28.5 mpa at 28 days respectively. Such concrete strengths are identified as structural concretes in structural strengthened concrete codes. by no means the less the drawback of leca aggregates was its low compressive strength, which ended in reduced compressive strength of concrete. leca aggregates if well-formed are right use in SCLWC with the aid of purpose of spherical shape improving rheological residences of latest concrete mix and it is able to additionally provoked on the growing of compressive electricity of SCLWC through use of lesser quantity of cement.

III. MATERIAL AND METHODS

A. Cement

Cement, within the general feeling of the word, are often depicted as a with cement and powerful properties that create it equipped for holding mineral components. For constructional functions, the importance as to term concrete stands confined the holding of materials like stones, sand, blocks, building items, concrete, etc. the cements utilized in the production of concrete have the property of putt and hardening while mixed with water with the help of nobility of a chemical response and square measure, consequently referred to as „hydraulic cements within this examination everyday Portland cement (OPC) - fifty three grade (ultra tech) cement is employed. Care is taken that it's miles freshly designed and from one manufacturer.

B. Fine Aggregate

Fine aggregate used was river sand passing through IS sieves 4.75 mm found from a local source they top off the gaps among the CA in concrete and make it denser.

C. Coarse Aggregate (CA)

Coarse mixture (CA) or rock chips make up the fundamental part of any concrete. They supply institution to the concrete, moderate shrinkage, and effect economic system. Their effect on numerous bodily characteristics and residences of concrete is big. To recognize greater approximately any concrete its miles very vital that one need to recognize extra about the ca. It should be strong enough as it provides strength to concrete and occupies major portion in aggregates unit. the depth and type of research which are necessary to be made in admire of aggregate to apprehend their extensively various consequences and affect at the houses of concrete domestically available device crushed well graded angular granite aggregates of maximum length 20 mm become used.

D. Cinder

Cinders are extrusive igneous rocks. Cinders are akin to pumice, which has so many voids, causing its low-density of zero.641g/cm^3 that lets in it to uniform drift on water. Cinder is the kind of mineral which is obtained as by product of steel industry, cinder aggregate is normally having rough and highly porous surface due to its mineral structure, these cinder material vividly ranked as possessing 100% crushed face. Cinder is characteristically brown, black, or pink depending on its chemical content. “a extra present day name for cinder is scoria”.

E. Fly Ash

Also known as “pulverized-fuel ash”, it is a deposit coming about because of the burning of ground or powdered or pounded bituminous coal (anthracite) or sub-bituminous coal (lignite). Around 80 for each penny of the whole cinder is finely partitioned and escapes the heater alongside vent gases and is gathered by appropriate procedures. It is now and again eluded as smokestack slag and container fiery remains. The adjust around 20 for each penny of powder gets gathered at the base of the heater and is taken out by appropriate techniques and is alluded as "base fiery debris". Fly fiery remains is gathered and put away in dry condition. At the point when fly slag alone or alongside base fiery debris is conveyed to capacity or statement tidal pond or lake as water slurry and saved, it is named as "lake powder". Whereas though fly fiery remains, alone or alongside base powder is conveyed to a capacity or statement site in dry shape and kept, it is named as "mound ash".

F. Water

IS 456 Recommends that water used for mixing and curing concrete have to be ideal and unfastened from harmful measures of oils, acids, antacids, salts, sugar, natural materials or special substances that might be malicious to cement or metallic. Consumable water is for the most element concept to be appealing for mixing and curing concrete. Mixing or curing of cement with ocean water isn't prescribed in mild of the nearness of hurtful salts in ocean water. In the present paintings consuming water accessible inside the region of the lab changed into utilized for purchasing geared up and curing the SCC blends and examples.

G. Super Plasticizer

The utilization of super – plasticizers in concrete is a breakthrough in the progression of solid innovation super-plasticizers. Some high range water diminishing admixtures can impede last set by one to four hours and if delayed setting times are not con-venient, the admixture can be joined with a quickening admixture to check the hindering inclinations or even to give some increasing speed of setting. In this present works super plasticizer conplast SP430 DIS super plasticizer is utilized to make solid more workable with the self-compacting qualities.

IV. MIX DESIGN PROCEDURE AND RESULTS

A. Nansu Method

Aggregate size = 20 mm size aggregate
Particular gravity of coarse aggregate = 2.7
Particular gravity of cinder (light weight aggregate= 1.844
Bulk density of coarse aggregate = 1500 Kg
Bulk density of cinder =1100kg
Particular gravity of fine aggregate = 2.6
Bulk density of fine aggregate = 1410 Kg
Particular gravity of cement = 3.15
Capacity of fine aggregate = 50%
Volume proportion of coarse aggregate = 60%
Air content in SCC = 1.5%
Design strength of SCC = 30 N

1) Step 1: Finding out the amount required for course aggregate and fine aggregate:

Adopt packing factor (PF) = 1.15
Quantity of fine aggregate required per unit capacity of SCC

$W_s = PF \times W_s L \times \frac{s}{a}$

$= 1.15 \times 1410 \times 0.6$

$= 972.9 \text{ kg/m}^3$

Quantity of coarse aggregate required per unit capacity of SCC

$W_g = PF \times W_g \times (1 - \frac{s}{a})$

$= 1.15 \text{ x } 1500 \text{ x } (1-0.6)$

$= 690 \text{ kg/m}^3$

2) Step 2: Finding out the cement required.

Water cement ratio = 0.46

Amount of Water = 215 kg/m^3
Cement content = 467.39 kg/m^3

3) Step 3: Finding out the fly ash content required:

(fy/(fy +C×100)) = 0.10
fy= 0.10 (SF + C)×100
fy= (0.1fy + 40.53)×100
fy= 450.3 Kg.
(w/c)max = 0.45

4) Step 4: Determination of water cement proportion

W wc = (w/c)×c
W wc = 0.46 × 467.39 = 214.999 = 214.999 kg/m^3

Step 5: Determination of super-plasticizer dosages:

The strong substance of SP is 40%. According to engineering experience, the dose of super-plasticizers is 1.8% of substance of fasteners

The amount or Dosage of SP used
wsp =η%(c+wp+wb)
= 0.014 (467.39 + 45.03)
= 7.17 kg/m^3

B. Compressible Packing Model Method

1) Step 1: Finding out the amount required for course aggregate and fine aggregate:

The content of coarse aggregates in SCC
$Wg = PF \times \rho\, gL\, (\frac{1-Vfa}{Va})$
= 1.15 × 1500 × (1-0.6)
= 690 Kg
Assume, PF = 1.15.
The content of (FA) fine aggregates in SCC
$Ws = PF \times \rho\, sL \times (\frac{Vfa}{Va})$
= 1.15 x 1410 x 0.6
= 972.9 Kg.

2) Step 2: Determination of cement content:

The cement content to be used is C = fc'/0.14
= 405.3 Kg.

3) Step 3: Determination of water cement proportion:

Assuming 6 N/mm^2 standard deviation should be: $f$cr[Mpa] = max (+ 1.34.S. + 2.33.S35)
$f$cr = max (+ 1.34 x 6 + 2.33.S35) = 38.04 N.
w/c = 0.46
W = 0.46 x 405.3 = 186.438 Kg.

4) Step 4: Calculation of fly ash content:

(fy/(fy +C×100)) = 0.10
fy= 0.10 (SF + C)×100
fy= (0.1fy + 40.53)×100
fy= 450.3 Kg.

5) Step 5: Super-plasticizer dosage:

SP = C+fy ×1.4% = 405.3 + 42 × 1.4% = 13.705 Kg.

C. The Compressive Strength Result for Cubes

Material replacement	Compressive strength of cubes in kN/mm2 weight in kgs					
Replacement of course aggregate	7 days		14 days		28 days	
	Strength	Weight	Strength	Weight	Strength	Weight
100%Replacement of cinder	8.88	6.51	13.78	6.48	24.44	6.9
30%Replacement of cinder	24.88	7.81	30.67	7.69	42.67	8.1
40% Replacement of cinder	24.44	7.69	28.89	7.58	39.11	8
50% Replacement of cinder	19.55	7.56	22.23	7.43	36.44	7.78
60% Replacement of cinder	17.77	7.52	21.34	7.24	26.67	7.69
100% Natural course aggregate	24	8.25	27.55	8.30	42.24	8.25

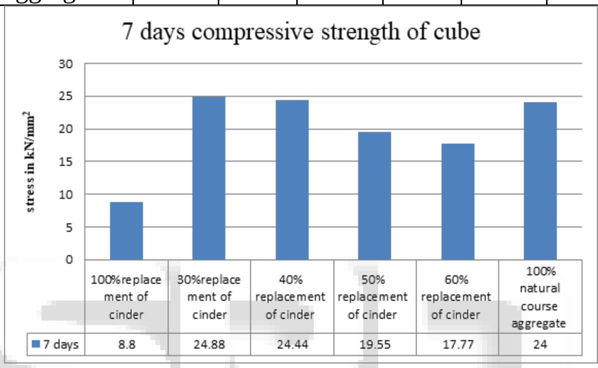

Fig. 4.1: 7 Days Cube Compressive Strength

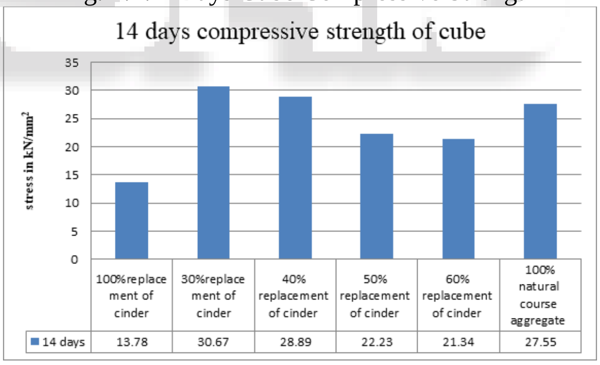

Fig. 4.2: 14 Days Cubes Compressive Strength

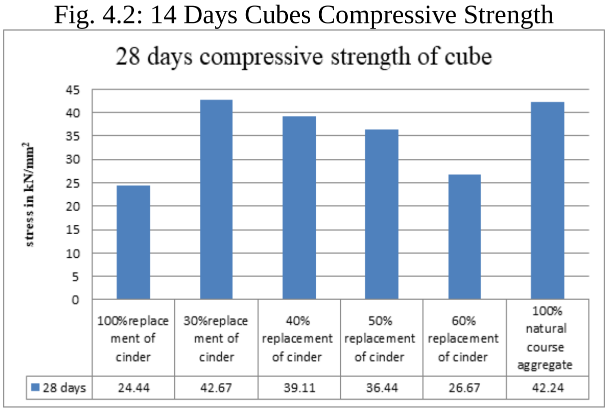

Fig. 4.3: 28 Days Cubes Compressive Strength

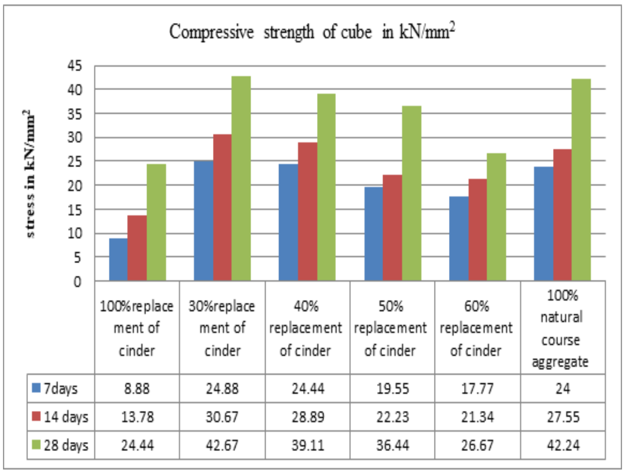

Fig. 4.4: Compressive Strength of Cubes in 7,14and 28 Days Respectively

D. The Flexural Test or Compressive Test of Cylinder

Material replacement	Flexural or Compressive strength test of cylinder in N/mm²	
Replacement of course aggregate	7 days	28 days
100%Replacement of cinder	0.707	1.55
30%Replacement of cinder	2.54	4.10
40% Replacement of cinder	1.98	3.39
50% Replacement of cinder	1.41	2.97
60% Replacement of cinder	1.27	2.405
100% Natural course aggregate	2.405	3.67

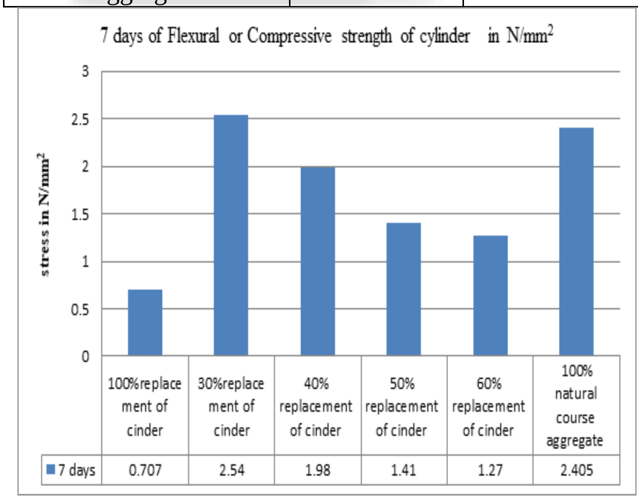

Fig. 4.5: 7 Day Flexural Strength of Cylinder

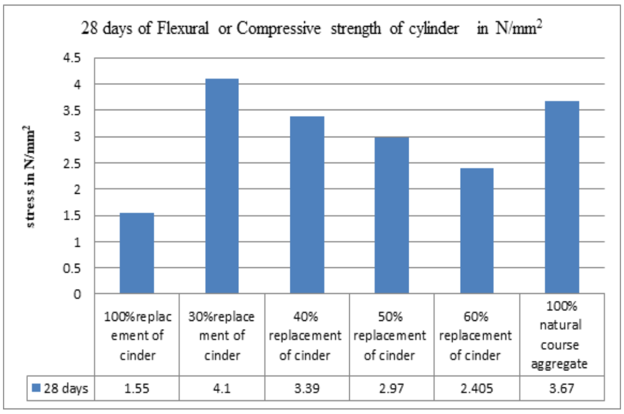

Fig. 4.6: 28 Day Flexural Strength of Cylinder

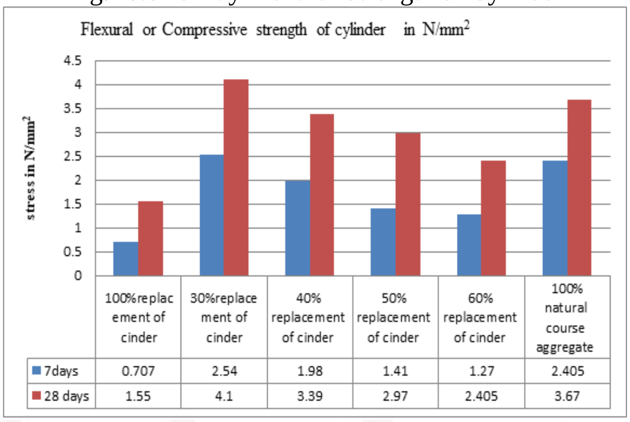

Fig. 4.7: Flexural Strength of Cylinder 7 Days and 28 Days Respectively

E. Flexural Test for Beam

Material replacement	Reading in flexural testing machine	Flexural test for beam in N/mm²
Replacement of course aggregate	Formula =3fl/2bd²	28 days
30%Replacement of cinder	34.5	11.5
40% Replacement of cinder	30.5	10.1
50% Replacement of cinder	29	9.6
60% Replacement of cinder	25.5	8.5
100% Natural aggregate	32	10.67

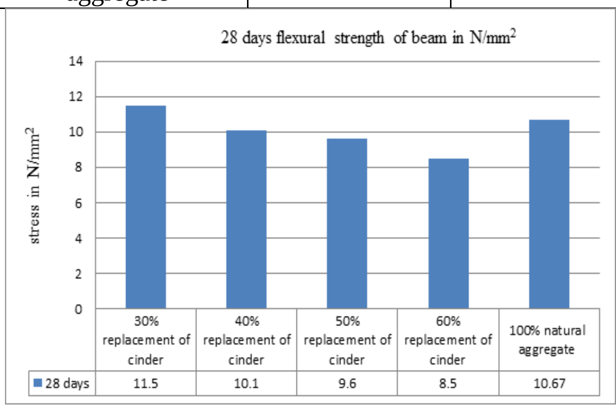

Fig. 4.8: 28 Days Flexural Strength for Beam

F. Deflection Calculation of Beam at the Size 150×150×750mm

1) 30% Replacement of Cinder in Abeam Calculation of That Beam

Deflection formula at the canter of the beam $= \delta max = \frac{pl3}{48EI} = \frac{34500\times750\times750\times750}{48EI}$ =0.034mm

2) Formula for calculation of deflection at different intervals

δat Intervals of distance =px/12EI(3l^2-x^2)for 0<x<1/2

3) Deflection at intervals of beam at 30% replacement of cinder in beam the value are below

Distance in mm	Deflection in mm
150	0.0194
300	0.0323
375	0.034
450	0.0318
600	0.01204

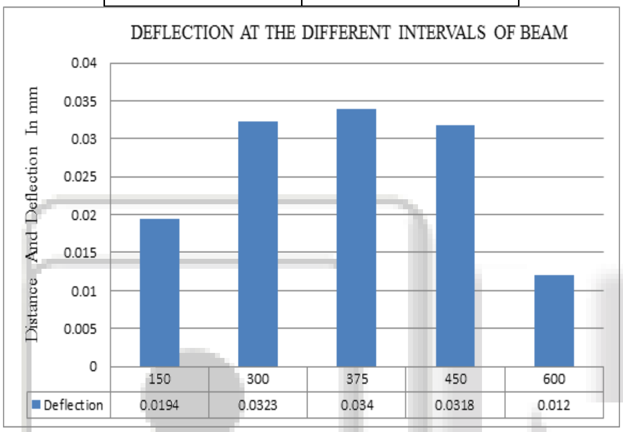

Fig. 4.9: 30% Replacement of Cinder in Beam Deflection of That Beam at Intervals

4) Deflection at intervals of beam at 40% replacement of cinder in beam the value are below

Distance in mm	Deflection in mm
150	0.017
300	0.0285
375	0.0302
450	0.0283
600	0.0106

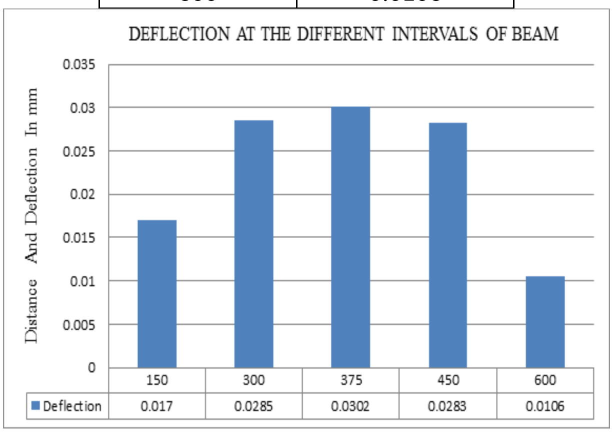

Fig. 4.10: 40% Replacement of Cinder in Beam Deflection of That Beam at Intervals

5) Deflection at intervals of beam at 50% replacement of cinder in beam the value are below

Distance in mm	Deflection in mm
150	0.0163
300	0.0271
375	0.0287
450	0.0269
600	0.0101

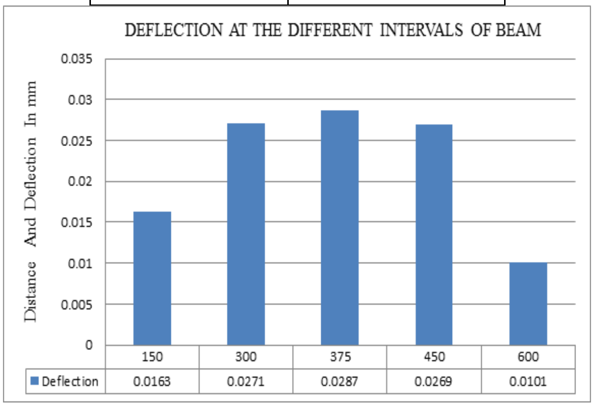

Fig. 4.11: 50% Replacement of Cinder in Beam Deflection of That Beam at Intervals

6) Deflection at intervals of beam at 30% replacement of cinder in beam the value are below

Distance in mm	Deflection in mm
150	0.0143
300	0.0238
375	0.0252
450	0.0236
600	0.0089

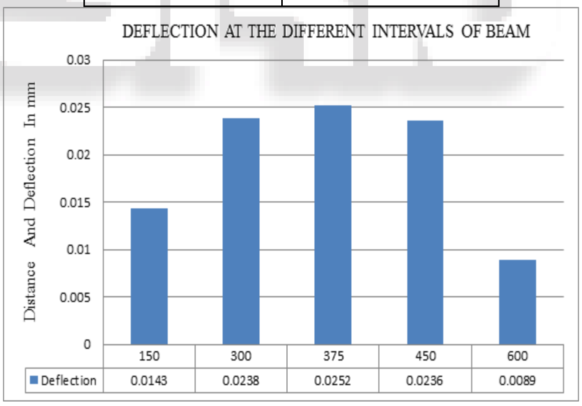

Fig. 4.12: 60% Replacement of Cinder in Beam Deflection of That Beam at Intervals

7) Deflection at intervals of beam at 100% replacement by natural aggregate in beam the values below

Distance in mm	Deflection in mm
150	0.0180
300	0.0299
375	0.0317
450	0.0297
600	0.0111

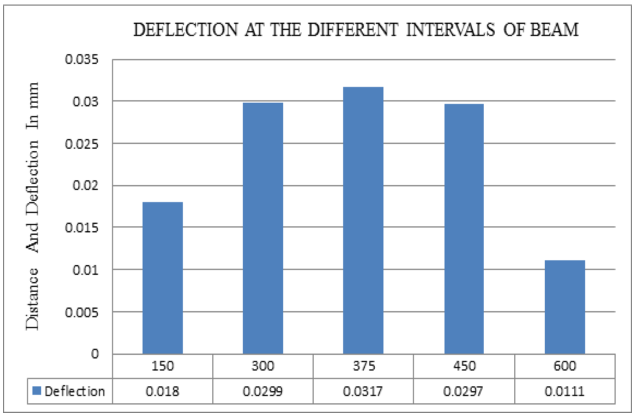

Fig. 4.13: 100% of Natural Aggregate Beam Deflection at Intervals

V. CONCLUSION

1) After analysing the test results we can conclude that for 30% replacement of cinder with natural aggregate (NA)we obtained that 28 days strength as 42.67N/mm^{2}When we compared with self-compacting concrete is 42.24N/mm^2 The light weight self-compacting concrete is value is little more the self-compacting concrete
2) Hence the combination of cinder in self-compacting concrete in the place of course aggregate partly replacement as 30%, 40%, can be used for construction purpose
3) Care should be taken regarding the percentage of voids during the construction. This can be over-come by using fly-ash to fill up the voids
4) There will be a percentage of reduction in voids and dead weight of the specimen when replaced with cinder by 30% and 40% respectively as compared with self-compacting concrete
5) The reduction in self-weight will make the construction process easier in terms of transportation and over handling
6) It can be used for precast member where in the transportation of the member will be easier
7) If the raw materials are available near-by to the site then the cost of construction can be reduced because the replaced raw materials are the waste produced from different industries.

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