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Flexural Behaviour of Self Curing Concrete with partial replacement of Cement by Silica Fume

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Abstract: *Scarcity of potable water increases day by day. The use of self curing agent is very important from the point view that water resources are getting valuable every day. Curing of concrete means maintaining moisture inside the body of concrete during the early days and beyond in order to develop the desired properties in terms of strength & durability. A good curing practice involves keeping the concrete damp until the concrete is strong enough to do its job.*

This study investigated the strength properties of Silica fume concrete. This work primarily deals with the strength characteristics such as compressive, Split tensile and flexural strength. Self curing concrete a set of different concrete mixture were cast and tested with different cement replacement levels (0%, 2.5%, 5%, 7.5% & 10%) of Silica Fume (SF) by wt of Cement and/or each trial super plasticizer has been added at constant values to achieve a constant range of slump for desired work ability with a constant water-binder (w/b) ratio of 0.42 for M40 Grade & 0.39 for M60 Grade.

Specimens were produced and cured in a curing tank for 3, 7, 14 and 28 days for normal concrete and at room temperature for Self curing concrete. The cubes were subjected to compressive strength tests after density determination at 3,7,14 and 28 days respectively. The chemical composition and physical composition of Silica Fume and cement were determined. The density of the concrete decreased with increased in percentage of Silica Fume replacement between 10% to 20% led to a reduction in the compressive strength of hardened concrete. This study has shown that between 7.5% to 10% replacement levels, concrete will develop strength sufficient for construction purposes. Its use will lead to a reduction in cement quantity required for construction purposes and hence sustainability in the construction industry as well as aid economic construction.

This project consists of two stages. In the first stage, the effect of PEG400 on compressive strength by varying the percentage of PEG400 by weight of cement from 0% to 2% were studied for M40, M60 mix. It was found that 0.5% of PEG400 by weight of cement was optimum for M40, M60 grade concrete respectively, for achieving maximum strength without compromising on workability.

And in the second stage, a comparative study on flexural strength of beams with normal and self curing concretes for M40, M60 concrete beams of sizes 0.1X0.15X1.2m, 0.1X0.2X1.2m for over reinforced, under reinforced sections are found at the age of 30days.

A research study conducted to evaluate the flexural behaviour of self curing structural concrete. Testing of the materials were done as per relevant IS codes, preparation of materials, weighing of materials and casting of cubes and mixing, compacting and curing of concrete are done according to IS 516: 1959. The plain samples of cubes were cured for 28 days in water pond and the specimens with PEG400 were cured for 28 days at room temperature by placing them in shade. Then, the reinforced concrete beams were casted for finding out the flexural behaviour of normally cured concrete and self curing concrete.

In this project, the results indicated that use of PEG400 during mixing of concrete with 7.5% of silicafume replacement improved the performance of concrete considerably.

I. INTRODUCTION

Cement concrete is the most extensively used construction material in the world, due to its moulding ability into any shape, good compressive strength and durability. It stands second to water as the most heavily consumed substance with about six billion tonnes produced every year. It has emerged as the dominant construction material for the infrastructure needs of the 21stcentury. The challenge for civil engineers in the future is to design the project using high performance materials within reasonable cost and lower impact on environment. Depending upon the nature of work the cement, fine aggregate, coarse aggregate and water are mixed in specific proportions to produce plain concrete. Plain concrete needs congenial atmosphere by providing moisture for a minimum period of 28 days for good hydration and to attain desired strength. Any laxity in curing will badly affect the strength and durability of concrete. Self-curing concrete is one of the special concretes in mitigating insufficient curing due to human negligence paucity 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.

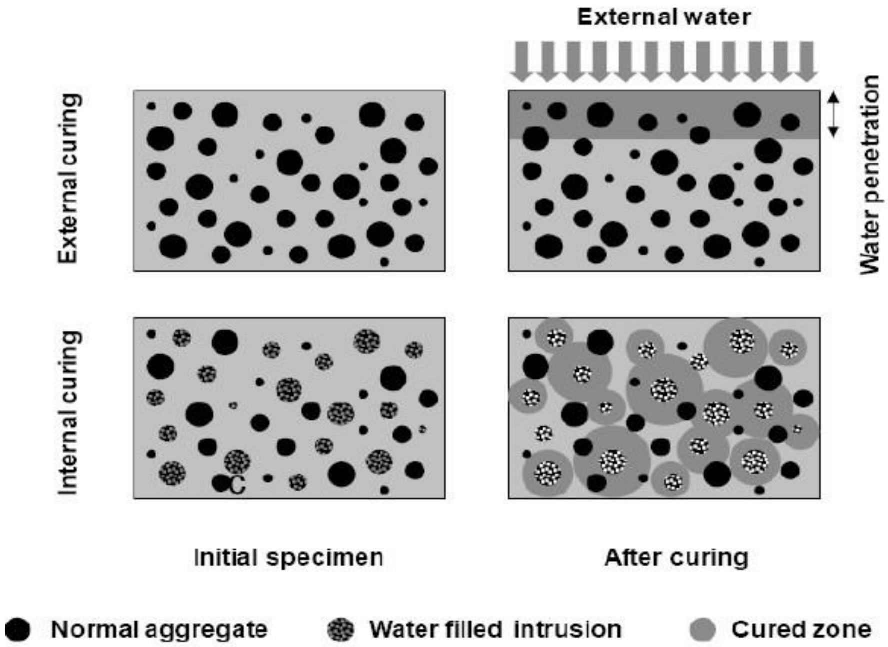
Excessive evaporation of water (internal or external) from fresh concrete should be avoided; otherwise, the degree of cement hydration would get lowered and thereby concrete may develop unsatisfactory properties. Curing operations should ensure that adequate amount of water is available for cement hydration to occur. This paper discusses different aspects of achieving optimum cure of concrete without the need for applying external curing methods.

Supplementary cementitious materials like silica fume (micro silica), fly ash, and blast furnace slag are commonly used to mobilize their pozzolanic action that improves the strength, workability, durability, resistance to cracks and permeability. Silica Fume is most commonly used supplementary cementitious material which results from the electric furnace operation during the production of silicon metal and ferrosilicon alloy as an oxidized vapour. Silica Fume consists of very fine vitreous particles with a surface area between 13,000 and 30,000m2/kg and its particles are approximately 100 times smaller than the average cement particles.

Optimum use of silica fume must be ensured to achieve the desired strength as well as durability requirement of the structural concrete.

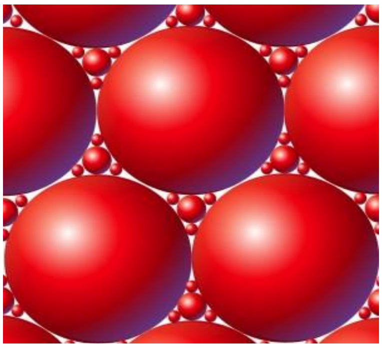
II. MATERIAL AND MIX PROPORTIONS

The ACI-308 Code states that "internal curing refers to the process by which the hydration of cement occurs because of the availability of additional internal water that is not part of the mixing Water.



SILICA FUME

Silica Fume is a finely-divided mineral admixture, available in both incompact and compacted forms . This ultra-fine material will better fill voids between cement particles and result in a very dense concrete with higher compressive strengths and extremely low permeability.

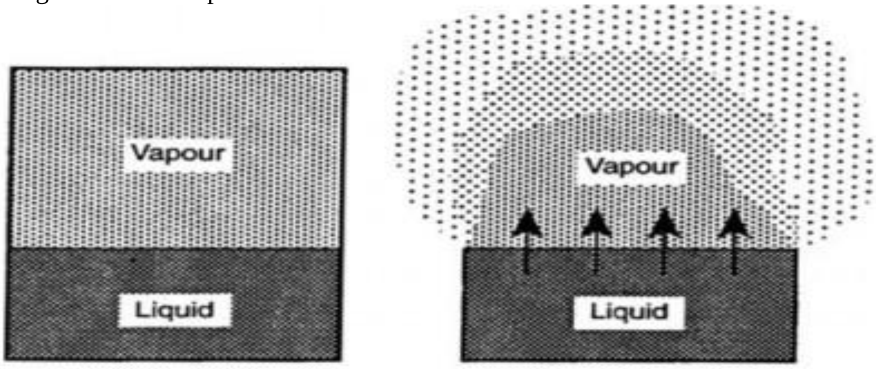



Uses of Silica Fume

For production of high strength concrete, corrosion-resistant concrete, abrasion-resistant concrete, and low permeability concrete. Used to make sewer and manhole repair products. Reduces rebound in shotcrete application.

Mechanism of Internal Curing

Continuous evaporation of moisture takes place from an exposed surface due to the difference in chemical potentials (Free energy) between the vapour and liquid phases. The polymers added in the mix mainly form hydrogen bonds with water molecules and reduce the chemical potential of the molecules which in turn reduces the vapour pressure, thus reducing the rate of evaporation from the surface.



a. In a closed system the vapour pressure above a liquid reaches a level at which the two phases have equal chemical potential and are therefore in equilibrium.

b. When the closed system is opened the vapour disperses. Continuous evaporation takes place in an attempt to reach equilibrium.

Advantages of Internal/Self Curing

- Internal curing (IC) is a method to provide the water to hydrate all the cement, accomplishing what the mixing water alone cannot do. In low w/c ratio mixes (under 0.43 and increasingly those below 0.40) absorptive lightweight aggregate, replacing some of the sand, provides water that is desorbed into the mortar fraction (paste) to be used as additional curing water. The cement, not hydrated by low amount of mixing water, will have more water available to it.
- IC provides water to keep the relative humidity (RH) high, preventing self-desiccation from occurring.
- IC eliminates largely autogenous shrinkage.
- IC maintains the strengths of mortar/concrete at the early age (12 to 72 hrs.) above then level where internally & externally induced strains can cause cracking. Hence, Higher early age (say 3 day) compressive strength, flexural strength.
- IC can make up for some of the deficiencies of external curing, both human related (critical period when curing is required is the first 12 to 72 hours) and hydration related (because hydration products clog the passageways needed for the fluid curing water to travel to the cement particles).
- Increase/maintain the strength of concrete if the optimum dosage of self-curing admixtures is used.
- When properly applied, provides a premium-grade film, which optimizes water retention.
- Furnished as a ready-to-use, true water-based compound. Produces hard, dense concrete, minimizes hair cracking, thermal cracking, dusting and other defects.
- Offers a compressive strength significantly greater than improperly or uncured concrete.
- Improves resistance to the abrasion and corrosive actions of salts and chemicals.

1.3.3. Advantages of Silica Fume.

- Lowers concrete permeability.
- Significantly increases concrete durability.
- Increases ultimate strength gain.
- Beneficial in all types of high strength concrete applications.
- Improves bond strength to steel.
- Significantly reduces alkali-silica reactivity.
- Provides excellent resistance to sulphate or seawater attack.
- Reduces steel corrosion.
- Improves freeze/thaw durability of concrete.

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II. MATERIAL AND MIX PROPORTIONS

PEG400

PEG 400 (polyethylene glycol 400) is a low-molecular-weight grade of polyethylene glycol. Polyethylene glycol is a condensation polymer of ethylene oxide and water with the general formula H(OCH2CH2)n OH, where n is the average number of repeating oxy-ethylene groups typically from 4 to about 180. It is a clear, colourless, viscous liquid. Due in part to its low toxicity, PEG 400 is widely used in a variety of pharmaceutical formulations. PEG 400 is soluble in water, acetone, alcohols, benzene, glycerine, glycols, and aromatic hydrocarbons, and is slightly soluble in aliphatic hydrocarbons.

Fig.1 PEG400 at room temperature

Q **Table :1 Properties of PEG 400**

S.No.	Property	Results
1	Specific gravity	1.002 at 27°C
2	pH	>6
3	Molecular weight	400

Concrete Mix Design:

Using the properties of cement aggregate concrete mix of M20, M40 grade was designed as per IS10262-2009; the following proportions by weight were obtained.

Table 2: Material requirement for Concrete

Concrete Grade	Cement –kg/m^3	W/C Ratio	Fine Aggregate-kg/m^3	Coarse Aggregate-kg/m^3	Water-kg/m^3
M40	400	0.42	660	1168.0	160
M60	505	0.39	683.24	1108.13	159.6

Workability:

Slump and Compaction Factor tests are the most commonly used methods of measuring consistency of concrete which can be employed either in laboratory or at site of work. It does not measure all factors contributing to workability. However, it is used conveniently as a quality control test and gives an indication of the uniformity of concrete from batch to batch.

Slump Test & Compaction Factor.

Slump test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site of work. It does not measure all factors contributing to workability. However, it is used conveniently as a control test and gives an indication of the uniformity of concrete from batch to batch. The compacting factor test is designed primarily for use in the laboratory but it can also be used in the field. It is more precise and sensitive than the slump test and particularly useful for concrete mixes of very low workability as are normally used when concrete is to be compacted by vibration. Such dry concretes are insensitive to slump test.

Compressive strength: The cube specimens were tested on compression testing machine of capacity 1000KN.The bearing surface of machine was wiped off clean and sand or other material removed from the surface of the specimen. The specimen was placed in machine in such a manner that the load was applied to opposite sides of the cubes as casted that is, not top and bottom. The axis of the specimen was carefully aligned at the centre of loading frame. The load applied was increased continuously at a constant rate until the resistance of the specimen to the increasing load breaks down and no longer can be sustained. The maximum load applied on specimen was recorded. fc = P/A , where, P is load & A is area

Split tensile strength: The cylinder specimens were tested on compression testing machine of capacity 3000KN.The bearing surface of machine was wiped off clean and looses other sand or other material removed from the surface of the specimen. The load applied was increased continuously at a constant rate until the resistance of the specimen to the increasing load breaks down and no longer can be sustained. The maximum load applied on specimen was recorded. fsplit =2 P/πDL, where P=load, D= diameter of cylinder, L=length of the cylinder

Description of Specimens

Three types of specimens were casted to conduct all sort of test regarding strength. Standard Cube specimen (dimension 150mm x 150mm x 150mm) for compressive strength test, Cylinder specimen (dimension 150mm diameter with 300mm height) for split tensile strength test and beam specimen (100mm x 100mm x 500mm) for flexural tensile strength test were casted. During curing period, the samples were stored in a place free from vibration and in relatively moist air at a temperature ranges from 25ºC to 27ºC. After one day, the mould was removed and marked with symbol to identify later.

The beam specimens were 100x150mm and 100x200mm in cross-section. They were 1200mm in length and simply supported over an effective span of 1000mm. The clear cover of the beam was 20mm. The geometry of the beam specimens is shown in Figure below.

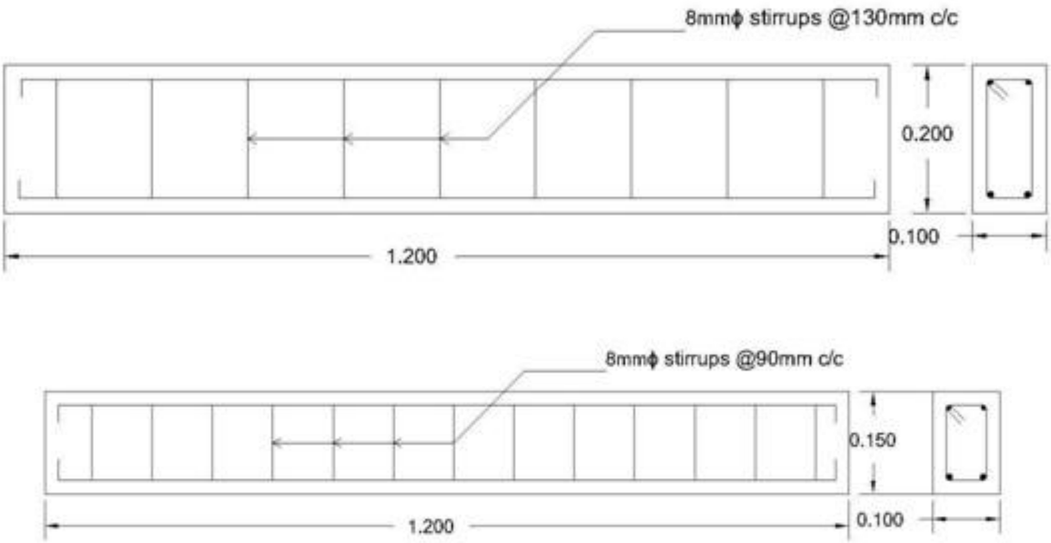


FIG 2: Geometry of beam specimens (All dimensions are in m)

High yield strength deformed steel bars of diameter 16mm, 12mm and 8mm were used as the longitudinal reinforcement in the specimens. Three different percentages of tensile reinforcement of 1.82 to 3.33% tension reinforcement (82-110% of corresponding balanced section reinforcement) were used. The reinforcement details are given in the Table for both compression steel and tension steel. Two legged vertical stirrups of 8 mm diameter at spacing of 90 mm and 130mm c/c were provided as shear reinforcement.

3: Reinforcement Details in Beam Specimens

1) Size of beam= 1200*100*150 mm.

	Hanger bars	URS	ORS	Stirrups
M60	2-10φ	2-16φ	2-16φ+1-12φ	8φ@90mm c/c
M40	2-8φ	2-12φ	2-12φ+1-10φ	8φ@90mm c/c

And,

2) Size of beam= 1200*100*200 mm.

	Hanger bars	URS	ORS	Stirrups
M60	2-10φ	2-16φ	2-16φ+1-12φ	8φ@130mm c/c
M40	2-8φ	2-12φ	2-12φ+1-10φ	8φ@130mm c/c

Preparation of Specimens

Prior to casting, the inner walls of moulds were coated with lubricating oil to prevent adhesion with the hardening concrete. The constituents of concrete were mixed in a pan type mixer of 100kg capacity for about 3-5 minutes. The concrete was placed in the moulds in three layers of equal thickness and each layer was vibrated until the concrete was thoroughly compacted. Along with beam casting, three numbers of 150mm cubes were cast to determine the 28 day compressive strength. Specimens were demoulded after 24 hrs. The normal beams were water cured, while the self curing beams were placed under shade for a period of 28 days after casting. After curing, the test specimens were tested for compressive strength and flexural strengths.

Beam Designations

In this project, a total no. of 16 beams was casted in variations. They are beams with normal and self curing concretes for M20, M40 concrete beams of sizes 0.1X0.15X1.2m, 0.1X0.2X1.2m for over reinforced, under reinforced sections are found at the age of 30days.

Total no. of beams= 2 (concretes) x 2 (grades) x2 (sections) x 2 (sizes) =16 no.s

Table : 4 Beam Designations

S.No	Code	Size of Beam	Type of Curing	Type of Section
1	1A	100x150x1200	self curing	over reinforced
2	1B	100x150x1200	Normal	over reinforced
3	2A	100x150x1200	self curing	under reinforced
4	2B	100x150x1200	Normal	under reinforced
5	3A	100x150x1200	self curing	over reinforced
6	3B	100x150x1200	Normal	over reinforced
7	4A	100x150x1200	self curing	under reinforced
8	4B	100x150x1200	Normal	under reinforced
9	5A	100x200x1200	self curing	over reinforced
10	5B	100x200x1200	Normal	over reinforced
11	6A	100x200x1200	self curing	under reinforced
12	6B	100x200x1200	Normal	under reinforced
13	7A	100x200x1200	self curing	over reinforced
14	7B	100x200x1200	Normal	over reinforced
15	8A	100x200x1200	self curing	under reinforced
16	8B	100x200x1200	Normal	under reinforced

Test Setup

The test setup for the flexural test is shown in Figure 4.4. The test specimen was mounted in a UTM of 1000 kN capacity. The supports of the beam rested on a adjustable steel rollers. The effective span of the beam was 1000 mm. The load was applied on two points each 333mm away from the support. Dial gauges of 0.01 mm least count were used for measuring the deflections under the load points and at mid span for measuring the deflection. The dial gauge readings were recorded at different loads.

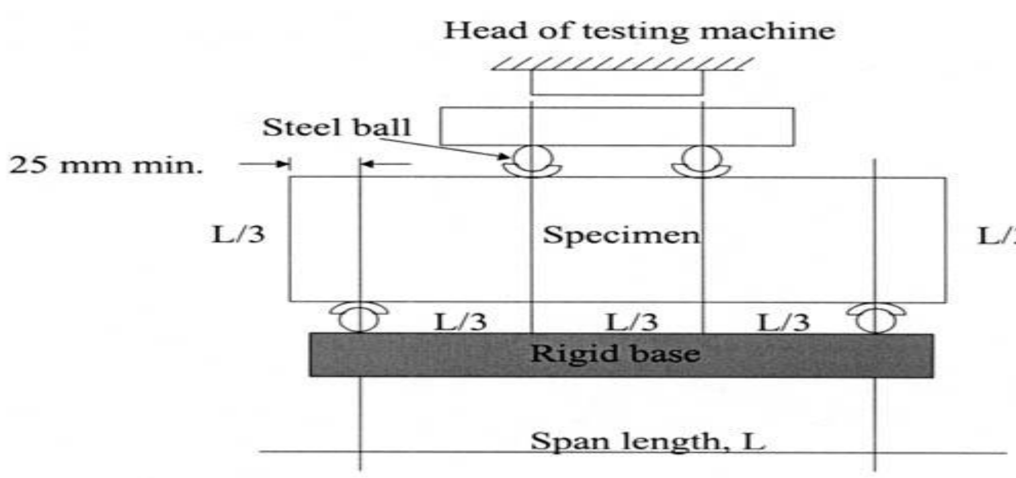


FIG 5 Test Setup for Third Point Loading

The strain in beam was measured using vernier callipers. The beam was instrumented to record the strain profile across a length of 200 mm at midspan at the extreme top for strain in compression fibre and at the centre of reinforcing steel for strain in tensile steel as shown in fig 4.5 below. And was recorded manually. The change in length of the portion under observation is taken at every interval of load using vernier callipers.

FIG 6 Pillets fixed for strain measurement

The load was applied at intervals of 4kN/min. The behaviour of the beam was observed carefully and the first crack was identified with magnifying glass. The deflections and strain values were recorded for respective load increments until failure. The failure mode of the beams was also recorded.

III. EXPERIEMENT RESULTS & DISCUSSION

General

In this investigation, self curing concrete of grades M40, M60 were used. The workability of the different concrete mixes was measured by using slump cone, and compaction factor tests. Minimum workability was maintained for all the mixes. This discussion is mainly divided into a) workability b) compressive strength c) flexural strength d) Split Tensile strength.

Effect of PEG -400 on Workability of Fresh Concrete:

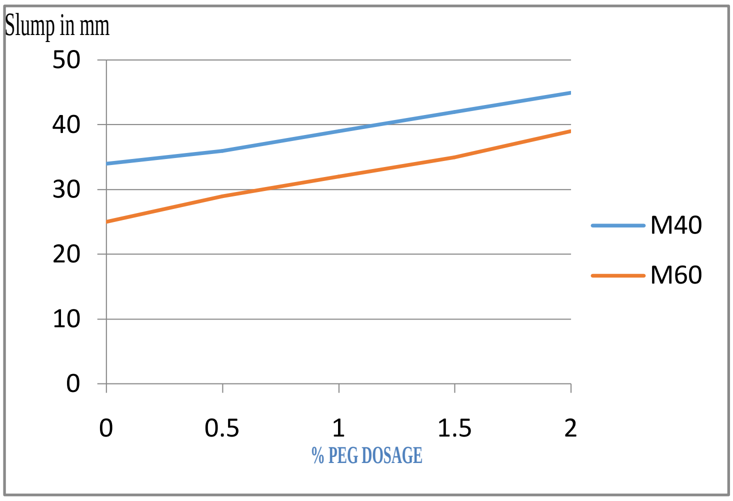
Slump and Compaction Factor tests are the most commonly used methods for measuring consistency of concrete. These tests are used conveniently as quality control tests and give an indication of the uniformity of concrete from batch to batch

Influence on Slump Value

In this project, as the % of PEG400 is increased the slump value is found to increase.

Table 5: Results of Slump Test

PEG %	slump in mm	
	M40	M60
0	34	25
0.5	36	29
1	39	32
1.5	42	35
2	45	39



PEG DOSAGE vs SLUMP

From the above results, As the % of PEG400 increased, the slump value was found to increase. For M40 concrete, at 0% (i.e., in conventional concrete) of PEG the slump value is 34 mm, and at 2% of PEG Dosage it is 45 mm. While for M60 concrete, at 0% (i.e., in conventional concrete) of PEG the slump value is 25 mm, and at 2% it is found to be 42 mm. The maximum variation (for 0-2% of PEG) of slump is 32.3% for M40 concrete and 38.5% for M60 concrete.

Influence on Compaction Factor Value

Table 6:Results of Compaction Factor Test

PEG dosage in %	compaction factor	
	M40	M60
0	0.85	0.83
0.5	0.87	0.85
1	0.9	0.87
1.5	0.91	0.89
2	0.94	0.92

From the above Results, as the percentage of PEG400 increased, the Compaction factor value was found to be increased as shown above. For M40 concrete, at 0% (i.e., in conventional concrete) of PEG the Compaction factor value was 0.85, and at 2% of PEG Dosage it was 0.94. While for M60 concrete, at 0% (i.e., in conventional concrete) of PEG the Compaction factor value was 0.83, and at 2% it was 0.92. The maximum increase in value (for 0-2% of PEG) of Compaction Factor was 11.5% for M40 concrete and 10.5% for M60 concrete.

INFLUENCE OF SELF CURING CONCRETE ON COMPRESSIVE STRENGTH:

	M40 CUBES COMP.STRENGTH VALUES						
		LOADING RATE- 5kN/Sec					
		SIZE OF CUBES-150x150x150MM					
S.NO	%OF Silica fume	CUBE ID	%OF PEG	1ST CUBE	2ND CUBE	3RD CUBE	AVERAGE

1	0	B	0	48.84	43.47	54.85	49.05
2	2.5	B1	0.5	44.6	45.8	43.04	44.8
3	2.5	B2	1	45.4	44.48	43.50	44.46
4	2.5	B3	1.5	42.87	41.98	43.1	42.65
5	2.5	B4	2	40.2	42	40.86	41.02
6	5	B5	0.5	43.45	42.96	44.45	43.62
7	5	B6	1	42.69	43.17	42.9	42.92
8	5	B7	1.5	42.69	42.85	42.2	42.58
9	5	B8	2	41.48	41.16	41.14	41.26
10	7.5	B9	0.5	54.25	55.23	55.67	55.05
11	7.5	B10	1	51.98	53.15	48.56	51.23
12	7.5	B11	1.5	52.48	47.91	51.65	50.68
13	7.5	B12	2	47.56	48.23	50.88	48.89
14	10	B13	0.5	40.16	41.12	39.26	40.18
15	10	B14	1	38.33	37.85	38.36	38.18
16	10	B15	1.5	37.58	36.98	37.19	37.25
17	10	B16	2	36.89	35.5	35.79	36.06

	M60 CUBES COMP.STRENGTH VALUES						
		LOADING RATE- 5kN/Sec					
		SIZE OF CUBES-150x150x150MM					
S.NO	%OF SF	CUBE ID	%OF SCC	1ST CUBE	2ND CUBE	3RD CUBE	AVERAGE
1	0	C	0	72.45	65.33	69.35	69.04
2	2.5	C1	0.5	64.27	65.88	60.23	63.46
3	2.5	C2	1	63.28	62.64	63.50	63.14
4	2.5	C3	1.5	61.95	60.48	62.73	61.72
5	2.5	C4	2	59.36	60.65	61.19	60.4
6	5	C5	0.5	63.78	66.16	64.22	64.72
7	5	C6	1	53.26	54.55	55.03	63.28
8	5	C7	1.5	61.66	63.54	62.48	62.56
9	5	C8	2	62.36	64.65	60.39	62.4

10	7.5	C9	0.5	79.25	74.65	75.57	76.49
11	7.5	C10	1	67.26	69.15	68.04	68.15
12	7.5	C11	1.5	64.78	66.16	68.16	65.72
13	7.5	C12	2	62.44	61.65	65.45	63.18
14	10	C13	0.5	58.26	57.28	61.07	58.87
15	10	C14	1	57.26	56.18	58.04	57.16
16	10	C15	1.5	56.98	58.25	58.32	57.85
17	10	C12	2	53.26	55.68	58.01	55.65

PEG DOSAGE vs COMP.STRENGTH FOR 2.5% OF SILICA FUME:

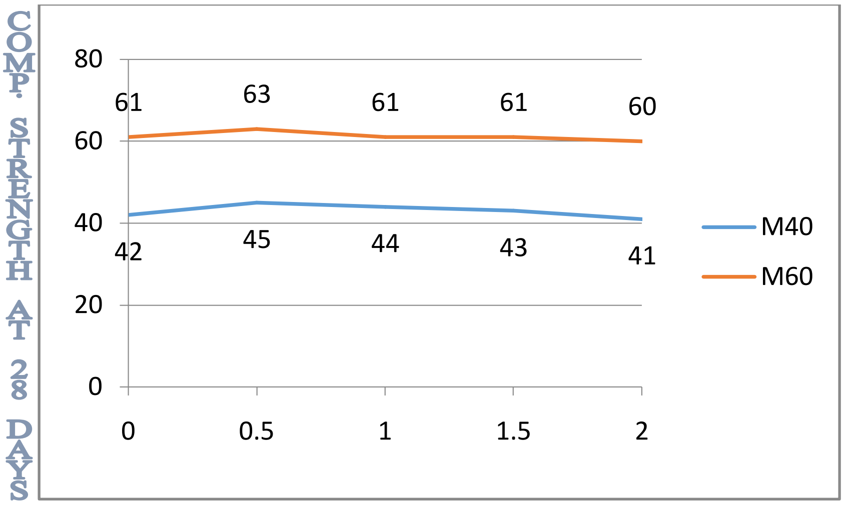


Fig:6 % OF PEG400

PEG DOSAGE vs COMP.STRENGTH FOR 5.0% OF SILICA FUME:

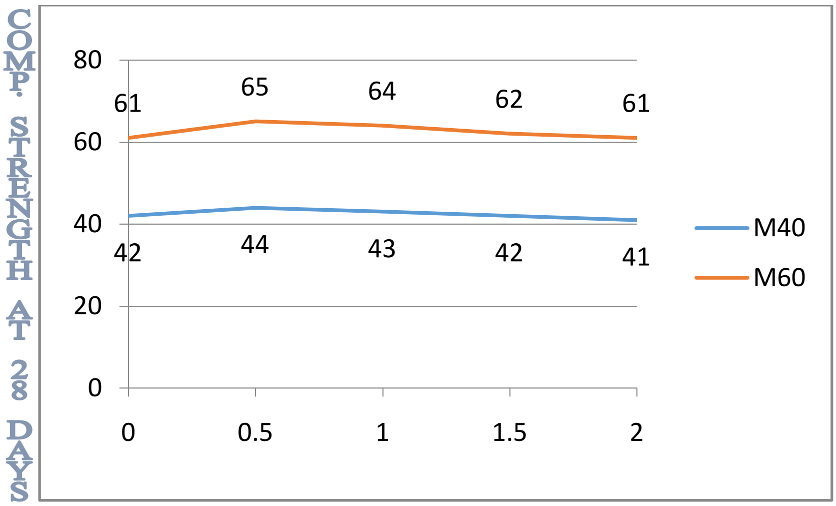


Fig 7 **% OF PEG400**

PEG DOSAGE vs COMP.STRENGTH FOR 7.5% OF SILICA FUME:

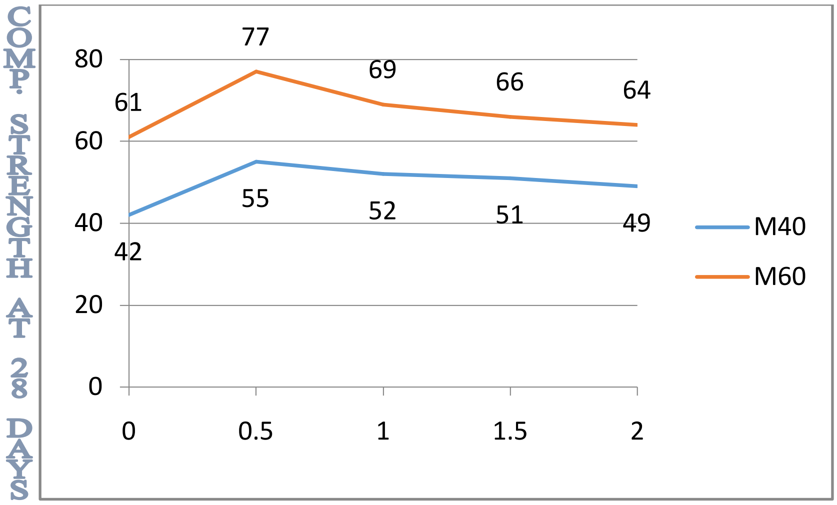


Fig 8 % OF PEG400

PEG DOSAGE vs COMP.STRENGTH FOR 10% OF SILICA FUME:

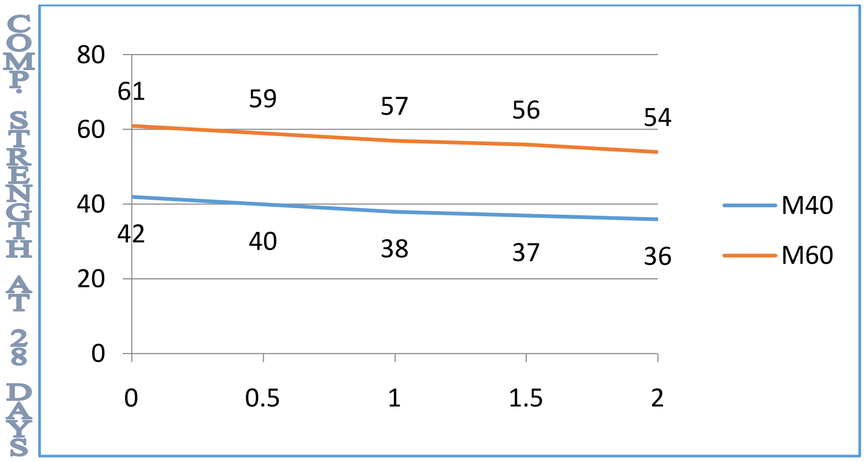


Fig 9 % OF PEG400

PEG Dosage vs. 28days Compressive Strength for M40, M60 Concretes:

The compressive strength is found to increase up to 0.5% PEG400 and then decreased for M40 grade. In the case of M60 also compressive strength was found to increase up to 0.5% and then decreased. The increase in compressive strength was 16.19% at 0.5% of PEG 400 compared to conventional concrete for M40, while the increase is 14.80% at 0.5% of PEG400 in case of M60 grade of concrete.

From the Table 5.2 it is clear that, as the dosage of PEG400 is increased, slump is increased. Slump is an indication of the relative consistency of the concrete,

as it increases there is chances of segregation and bleeding during vibration of concrete. As the percentage of PEG400 increases rate of hydration increases at early ages. This is the reason for decrease in compressive strength after optimum dosage of PEG400.

The beams were casted with self curing concrete for the optimum dosage and normal curing in two sizes i.e., 100X150X1200 mm and 100X200X1200 mm respectively for under reinforced section, over reinforced sections to know their flexural and cracking behaviour, and the results are compared for all the sections.

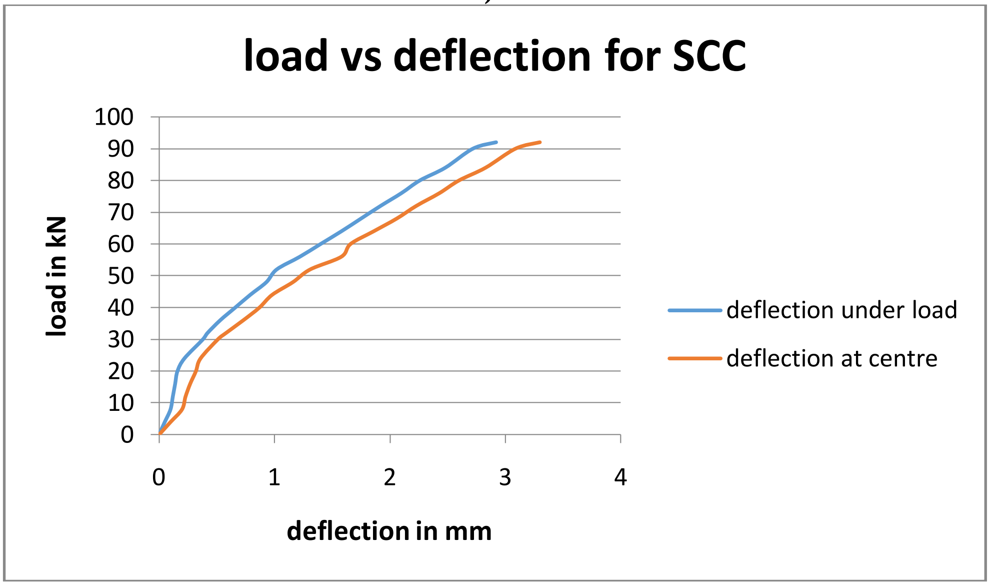
INFLUENCE OF SELF CURING CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT BY FLY ASH ON FLEXURAL STRENGTH OF BEAMS

GENERAL

In this project, totally 16 beams in 4 variations (such as 2 grades x 2 sizes x 2 modes of failures x 2 types of concrete) were casted. And all the beams were tested with the help of Universal Testing Machine of 1000 kN capacity. In this discussion, the effect of self curing concrete on the load carrying capacity of beams, deflections, and cracking behaviour are discussed.

INFLUENCE OF SELF CURING CONCRETE ON FLEXURAL STRENGTH OF BEAMS OF SIZE 100X150X1200.

A) Influence of Self Curing Concrete on M40-Over Reinforced Section:
B)



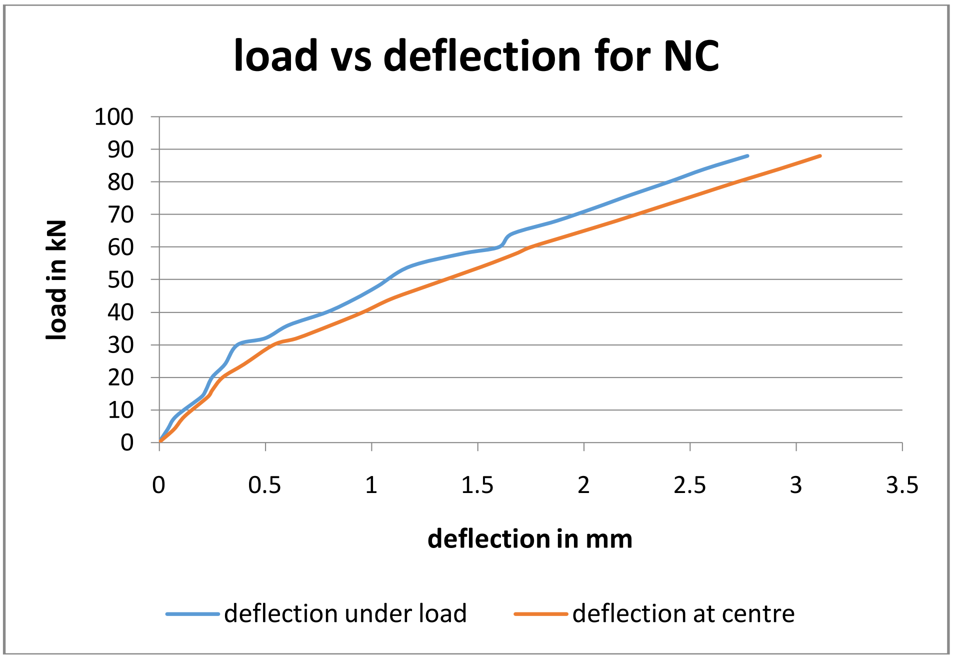
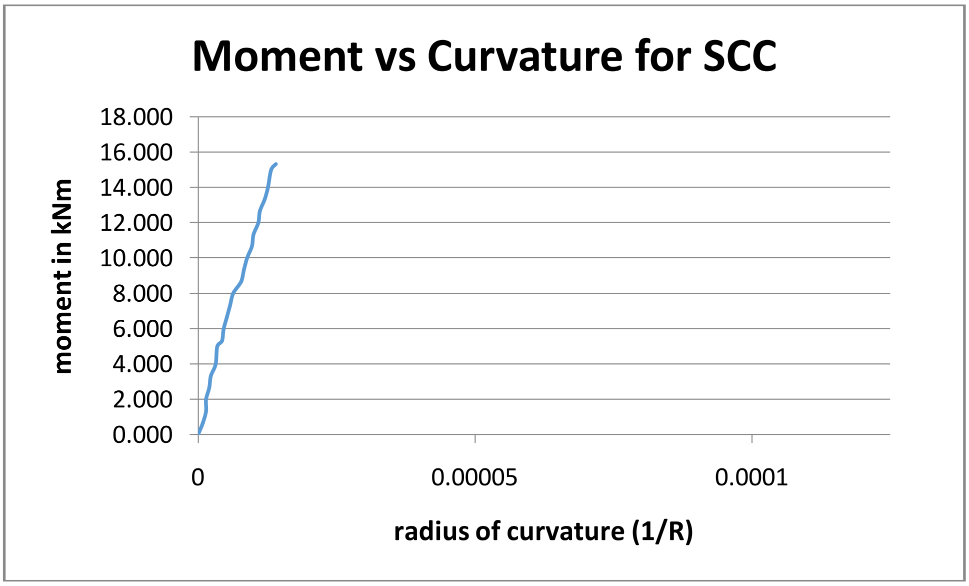
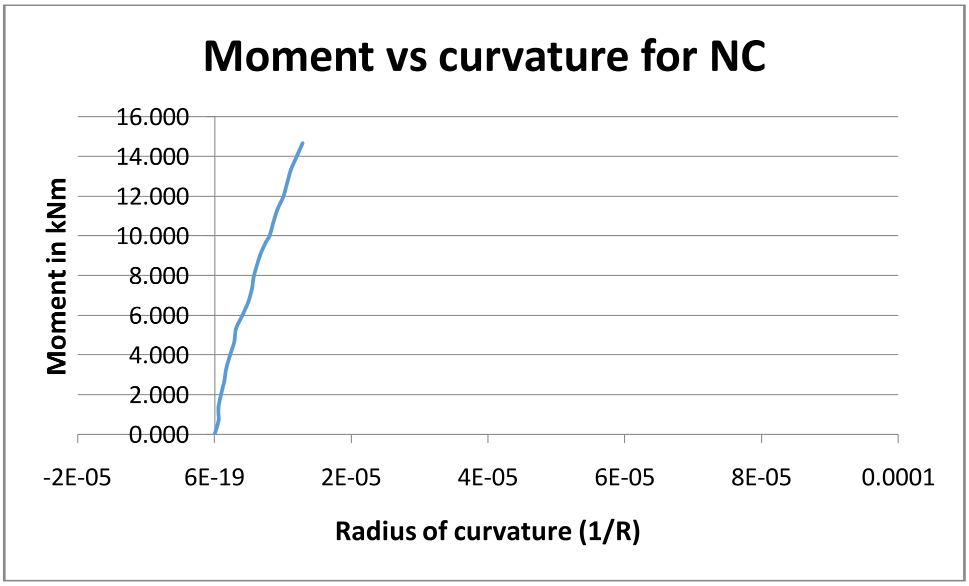


Fig 10: Load vs Deflection Curve

The above FIG.5.4 shows, the load vs. deflection curve of M40grade normal and self curing concrete, the flexural capacity of normal concrete and self curing concrete is found by using load vs. deflection graph, here I have taken over reinforced sections for comparison, and found that the variation of load vs. deflection for M40 self curing concrete is similar to that of M40 normal concrete, the first crack load is 44 kN for SCC & 40kN for NC specimens. But there is a slight variation in the ultimate load. The ultimate load of self curing concrete beam is 92 kN, where as the normal cured beam was found to be 88 kN. The self curing concrete beam has taken 4.03% more load at failure than conventional concrete beam. The maximum deflection at midspan of self curing concrete beam for the ultimate load was 3.3 mm, where as for conventionally cured beam, the deflection is found to be 3.11 mm. The maximum crack widths for self curing concrete and normal concrete were 0.2 mm and 0.2 mm respectively. So, the 28 days flexural strength of self curing concrete is slightly better than conventional concrete





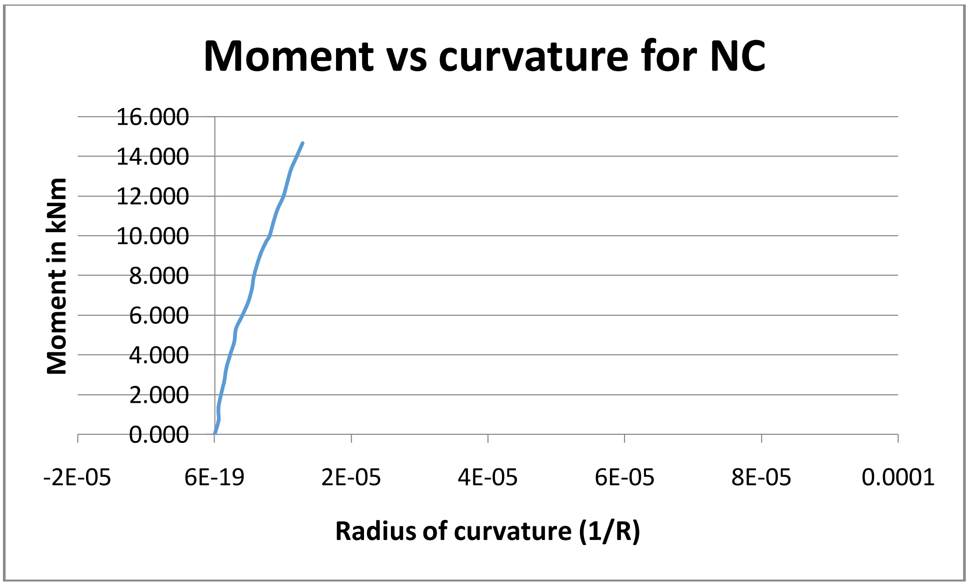
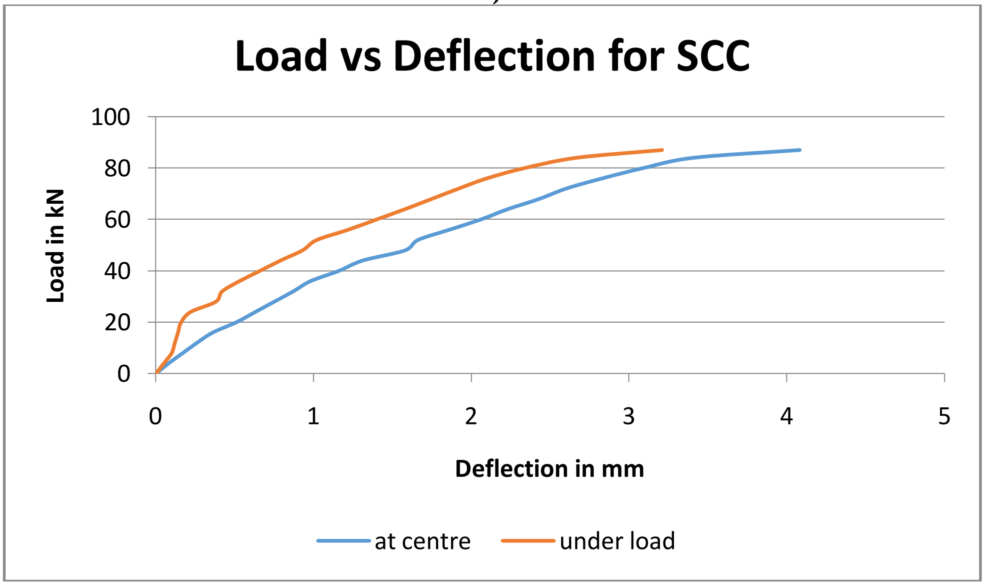


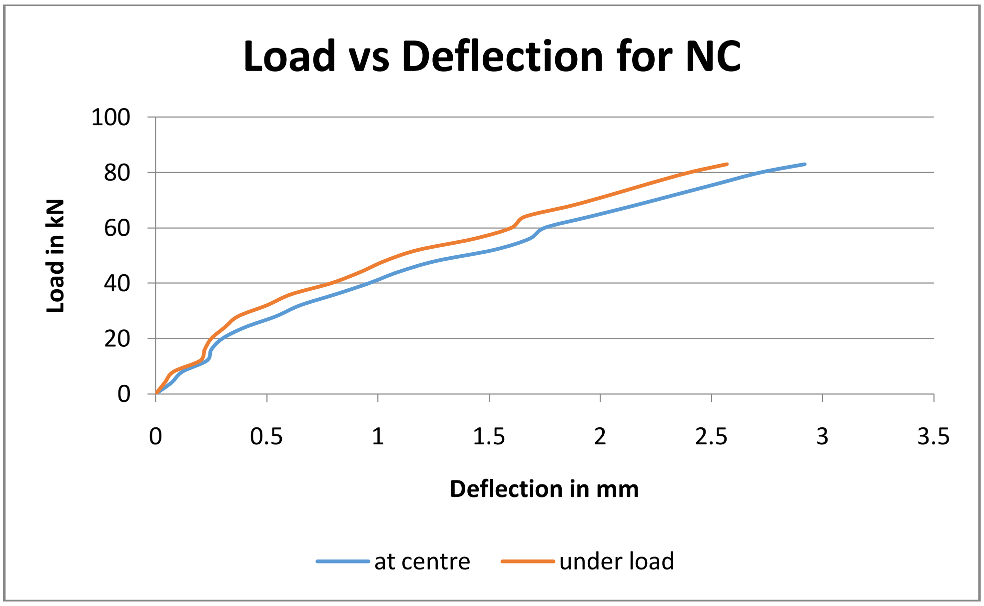
Fig 11: Moment vs Curvature Relationship

From the above Fig:5.5, the moment vs. curvature graph of M40grade normal and self curing concrete, as both the beams are over reinforced the curvatures are not as good as for under reinforced sections. The moment curvature graph will be linear upto elastic limit . Then, the tension steel remains in the elastic range up to collapse. As the limit state of collapse is approached, the tensile stress in steel increases proportionately with the tensile strain, where as the compressive stress in concrete does not increase proportionately with the compressive strain, because it is in the nonlinear range. Hence, in order to maintain equilibrium (C=T), the area of concrete has to increase; this is enabled by lowering of the neutral axis. The strains across the section remain relatively low. Consequently, the curvatures, deflections and crack widths (all the distress signals) also remain relatively low.

In the economy point of view the conventional concrete is very economical for over reinforced section because the cost of chemical (PEG) used for making self curing concrete is costly.

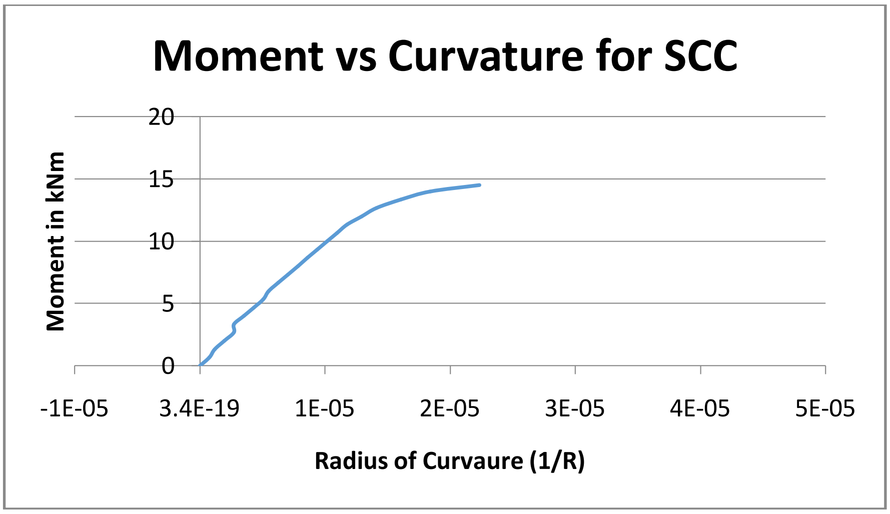
C) Influence of Self Curing Concrete on M40-Under Reinforced Section:
D)





Load vs Deflection Curve

The above FIG.5.6 shows, the load vs. deflection of M40grade normal and self curing concrete, the flexural capacity of normal concrete and self curing concrete is found by using load vs. deflection graph, here we have, under reinforced sections for comparison, and found that the variation of load vs. deflection for M40 self curing concrete is similar to that of M40 normal concrete, the first crack load is 40 kN for SCC & 32kN for NC specimens. But there is a slight variation in the ultimate load. The ultimate load of self curing concrete beam is 87kNwhere as the normal cured beam was found to be 83kN. The self curing concrete beam has taken 4.08% more load at failure than conventional concrete beam. As the beams are *under reinforced sections*, the deformations are more. The maximum deflections at the midspan for the ultimate load in case of self cured, normally cured beams were 4.87 mm, 2.92 mm respectively. While, the maximum deflections under the load for the ultimate load in case of self cured, normally cured beams were 3.21mm, 2.57 mm respectively. And, the maximum crack widths for self curing concrete and normal concrete were 0.46 mm and 0.41 mm respectively. So, the 28 days flexural strength of self curing concrete is on par with conventional concrete.



The moment vs. curvature graph of M40grade normal and self curing concrete, as both the beams are under reinforced the curvatures are good for under reinforced sections. The moment curvature graph will be linear upto elastic limit in both self curing and conventional concretes. And then, the beam starts yielding. At this stage, the yield strain ε_y is reached in the steel before the ultimate compressive strain is reached in extreme fibre of the concrete. A slight increase in the load (moment) at this stage causes the steel to yield and elongate significantly, without any significant increase in tensile strain causes the neutral axis to shift upwards, thus tending to reduce the area of the concrete under compression. Hence it exhibits more deformations as explained above.

Conclusion

- The workability of fresh concrete is increasing with the increase of PEG 400 dosage.
- In ordinary grade (M20) concrete, the compressive strength is increased upto 3.7% at 28 days on addition of self curing concrete when compared to conventional concrete.
- In standard grade (M40) concrete, the compressive strength is increased upto 2.8% at 28 days on addition of self curing concrete when compared to conventional concrete.
- The load carrying capacity of beams was found to be increasing with the usage of self curing concrete.
- For beams of size 0.1x0.15x1.2m with over reinforced section, the ultimate flexural strength of self curing concrete has an average increase of 2.1% over conventional concrete.
- For beams of size 0.1x0.2x1.2m with over reinforced section, the ultimate flexural strength of self curing concrete is increased by 3.03% over conventional concrete.
- For beams of size 0.1x0.15x1.2m with under reinforced section, the ultimate flexural strength of self curing is on par with conventional concrete. The average increase in flexural strength of beams is 2.7%.
- For beams of size 0.1x0.2x1.2m with under reinforced section, the ultimate flexural strength of self curing concrete is slightly more than conventional concrete. The average increase in flexural strength of beams is 2.5%.
- The structural behavior of Reinforced concrete beams with PEG400 resembled the typical behavior of conventional Reinforced cement concrete beams.
- The maximum deflections of self curing beams were more when compared to conventional beams. This indicates increase in ductility of PEG400 beam specimens.
- Strength of self curing concrete is on par with conventional concrete.
- Self curing concrete is the answer to many problems faced due to lack of proper curing.

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