EXPERIMENTAL STUDY ON SELF CURING CONCRETE BY INCORPORATING GGBFS AS SUPPLIMENTARY CEMENTITIOUS MATERIAL

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***Abstract*-An experimental investigation was carried out to evaluate the influence of GGBFS on mechanical properties of Self curing concrete for M30 and M20 Grade. In this work cement is replace by 20% of GGBFS. The poly ethylene glycol 400 is used as self-curing admixture with 0,0.5,1,1.5,2% by weight of cementitious materials the optimum dosage of poly ethylene glycol 400 is find out for M30 and M20 Grade . Concrete is evaluated for compressive strength, split tensile strength and flexural strength at different ages 7 days, 28 days and 56 days. The strengths of normal curing and self-curing concrete are compared.**

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.

Need for Self-Curing

When the mineral admixtures react completely in a blended cement system, their demand for curing water can be much greater than that in a conventional ordinary Portland cement concrete. When the water is not readily available for sufficient curing then de-percolation of water takes place from the capillary pores and it results in cracking and shrinkage.

Due to the chemical shrinkage occurring during cement hydration, empty pores are created within the cement paste, leading to a reduction in its internal relative humidity and also to shrinkage which may cause early-age cracking. This situation is intensified in high performance concrete due to its generally higher cement content, reduced water/cement (w/ c) ratio and the pozzolanic mineral admixtures (fly ash, silica fume). The empty pores created during self-desiccation induce shrinkage stresses and also influence the kinetics of cement hydration process, limiting the final degree of hydration. The strength achieved by IC could be more than that possible under saturated curing conditions. Often specially in high performance, it is not easily possible to provide curing water from the top surface at the rate required to satisfy the ongoing chemical shrinkage, due to the extremely low permeabilities often achieved.

DEFINITION OF INTERNAL CURING (IC)

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.”

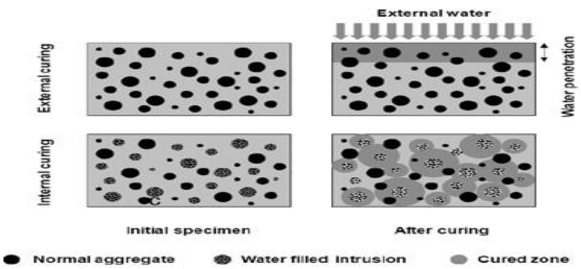
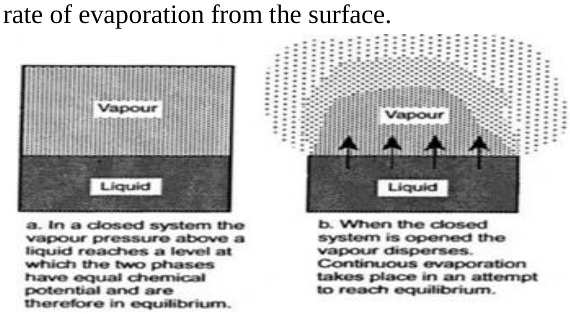


Fig 1.1 Illustration of the difference between external and internal curing

Conventionally, curing concrete means creating conditions such that water is not lost from the surface i.e., curing is taken to happen 'from the outside to inside'. In contrast, 'internal curing' is allowing for curing 'from the inside to outside' through the internal reservoirs created. 'Internal curing' is often also referred as 'Self–curing'.

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.



POTENTIAL MATERIALS FOR INTERNAL CURING

The following materials can use as internal curing agents:

Lightweight Aggregate (natural and synthetic, expanded shale)

Super-absorbent Polymers (SAP) (60-300 nm size)

SRA (Shrinkage Reducing Admixture) (propylene glycol type i.e. Polyethylene-Glycol PEG)

LIGHT WEIGHT AGGREGATE (LWA)

Water/moisture required for internal curing can be supplied by incorporation of saturated-surface dry (SSD) lightweight fine aggregates (LWA). It is estimated by measuring desorption of the LWA in SSD condition after exposed to a salt solution of potassium nitrate (equilibrium RH of 93%). The total absorption capacity of the LWA can be measured by drying a Saturated Surface Dry (SSD) sample in a dessicator. About 67% of the water absorbed in the LWA can get transported to self-desiccating paste. Some water remains always in the LWA in the high RH range and it becomes useful when the overall RH humidity in concrete is significantly reduced. The water retained in LWA in air-dry condition may not be enough to prevent autogenous shrinkage whose magnitude reduced. The fine lightweight aggregate, in saturated condition, produce a more uniform distribution of the water needed for curing throughout microstructure.

The grain size of the LWA used as curing agent should be less in order to minimise the paste–aggregate proximity, i.e. the distance to which the internal curing water could diffuse. The grain size of down to 2–4 mm is found to be beneficial.

II.RELATED WORK

This chapter deals with the review of literature relate to self curing concrete. A wealth of information as found in the literature and was studied with respect to different aspects of self curing concrete. Many researchers have studied the water retention, hydration, water permeability with the various chemicals by different tests. P. Muthukumar, K. Suganyadevi (2015) have studied the behavior of self-compacting self curing concrete. This research was proposed to replace the constituent materials by mineral Admixtures and adding chemical admixtures. Also it was proposed to use self-curing compound instead of conventional water curing. And concluded as the Strength of the specimen with 1.5% of PEG400 increased when compared to the conventional specimen. From the 7 days compressive strength results the specimen with 1.5% of PEG400 increased with conventional specimen with 0.5% of PEG400 by 12.54% From the 7 days splitting tensile strength results the specimen with 1.5% of PEG400 increased with conventional specimen with 0.5% of PEG400 by 4.28% From the 28 days compressive strength results the specimen with 1.5% of PEG400 increased with conventional specimen with 0.5% of PEG400 by 30%From the 28 days splitting tensile strength results the specimen with 1.5% of PEG400 increased with conventional specimen with 0.5% of PEG400 by 22%. The flexural behavior of beam with 1.5% PEG performed well when compared to the specimen with 0% PEG. The ultimate load for specimen with 1.5% PEG was increased by 23.53% when compared with control specimen. The ultimate deflection of 1.5% PEG specimen was increased by 35.48% when compared to control specimen. M.V. Jagannadha Kumar et al, carried out work on the use of shrinkage reducing admixture polyethylene glycol (PEG 400) in concrete which helps in self curing and helps in better hydration and hence strength. In the present study, the affect of admixture (PEG 400) on compressive strength, split tensile strength and modulus of rupture by varying the percentage of PEG by weight of cement from 0% to 2% were studied both for M20 and M40 mixes. It was found that PEG 400 could help in self curing by giving strength on par with conventional curing. It was also found that 1% of PEG 400 by weight of cement was optimum for M20, while 0.5 % was optimum for M40 grade concretes for achieving maximum strength without compromising workability. Magda I. Mousa , Mohamed G. Mahdy, Ahmed H. Abdel-Reheem, Akram Z. Yehia have studied the mechanical properties of concrete containing self-curing agents were investigated in this paper. In this study, two materials were selected as self-curing agents with different amounts,and the addition of silica fume was studied. The self-curing agents were, pre-soaked lightweight aggregate (Leca), 0.0%, 10%, 15%, and 20% of volume of sand; or polyethylene-glycol, 1%, 2%, and 3% by weight of cement. To carry out this study the cement content of 300, 400,500 kg/m3, water/cement ratio of 0.5, 0.4, 0.3 and 0.0%, 15% silica fume of weight of cement as an additive were used in concrete mixes. The mechanical properties were evaluated while the concrete specimens were subjected to air curing regime (in the laboratory environment with 25C, 65%R.H.) during the experiment. The results show that, the use of self-curing agents in concrete effectively improved the mechanical properties. The concrete used polyethylene-glycol as self-curing agent, attained higher values of mechanical properties than concrete with saturated Leca. In all cases, either 2% Ch. or 15% Leca was the optimum ratio compared with the other ratios. Higher cement content and/or lower water/cement ratio lead(s) to more efficient performance of self-curing agents in concrete. Incorporation of silica fume into self-curing concrete mixture enhanced all mechanical properties, not only due to its pozzolanic reaction, but also due to its ability to retain water inside concrete. Gowripalan (2001), carried out investigation on self curing concrete and explained the mechanism of self- curing as follows: "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 polymer 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. Physical moisture retention also occurs. This reduces the rate of evaporation from the surface. Self-Curing concrete is the newly emerging trend in the construction industry. Water soluble alcohols are general used as self-curing agents. With conventional ingredients it is possible to design reasonably good fast track concrete mixture using admixture. Karjinni Vilas V., (2012). SuryawanshiNagesh Carried out an experimental study to investigate the use of water soluble polyvinyl alcohol as a self- cutting agent. He concluded that Concrete mixes incorporating self-curing agent has higher water retention and better hydration with time as compared to conventional concrete. Use of 0.48% of polyvinyl alcohol by the weight of cement as a self-curing agent provides higher compressive, flexural as well as tensile strength than the strength of conventional mix. With increase in the percentage of polyvinyl alcohol there is a reduction the weight loss of concrete. The concept of self - curing agents is to reduce the water evaporation from concrete and hence increase the water retention capacity of the concrete compared to conventional concrete. It was found that water soluble alcohols can be used as self- curing agents in concrete. R.K.DhirP.C.Hewlett, J.S.Lota (1994) were carried out weight loss measurements on both self-cure and ordinary pastes exposed to controlled ambient conditions. The research concluded that three mechanisms by which water retention is improved in self-cure cement paste have been identified: a) Lowering of vapor pressure , which reduces the rate of evaporation throughout the drying process, and also is a potentially a factor in reducing the rate of water vapor diffusing during the third stage of drying. b) Reduction of bleeding, which reduces the amount of water lost during the first stage of drying. c) Reduction of permeability, by modification of hydration product microstructure, which contributes to one reduction in the rate of water vapor diffusion during the final stage of drying. Alaa A Bashandy (2015), has investigated the coupled effects of elevated temperature levels of 200C, 400C and 600C and heating periods of 2h and 4h as well as air and water cooling action on the compressive strength of conventional curing concrete and self curing concrete are studied respectively. Results show that self curing concrete can be used at elevated temperatures considering its loss of strength. Air cooling is better for ordinary concrete but that may differ for self curingconcrete , which may cool using water cooling up to 400C. Increasing elevated temperature and heating time decreases the values of residual strengths.

III. EXPERIMENTAL PROGRAMME

Ordinary Portland cement is used for general constructions. The raw materials required for manufacture of Portland cement are calcareous materials, such as limestone or chalk and argillaceous materials such as shale or clay. The manufacture of cement consists of grinding the raw materials, mixing them intimately in certain proportions depending upon their purity and composition and burning them in a kiln at a temperature of about 13000C to 15000C at which temperature, the material sinters and partially fuses to form nodular shaped clinker. The clinker is cooled and ground to a fine powder with addition of about 2 to 3% of gypsum. The product formed by using the procedure is a "Portland cement". In the present experimental work Deccan 53 grade ordinary Portland cement was used Lower the needle gently and bring it in contact with the surface of the test block and quickly release. Allow it to penetrate into the test block. In the beginning, the needle will completely pierce through the test block. But after some time when the paste starts losing its plasticity, the needle may penetrate only to a depth of 33-35mm from the top. The period elapsing between the times when water is added to the cement at the time of which the needle penetrates the test block to a depth equal to 33-35mm from the top is taken as initial setting time. Replace the needle of the Vicat apparatus by a circular attachment. The cement shall be considered as finally set when, lowering the attachment gently cover the surface of the test block, the centre needle makes an impression, while the circular edge of the attachment fails to do so. In other words the paste has attained such hardness that thecentre needle does not pierce through the paste more than 0.5mm.

S. No	Property	Test results
1	Normal consistency	30%
2	Specific gravity	3.12
3	Initial setting time	90 minutes
4	Final setting time	215 minutes

The list of self- curing agents was given below:

1. Poly Ethylene Glycol (PEG) (Molecular Weight varying from 380 – 420)
2. Propylene Glycol (PG)
3. Dipropylene Glycol (DPG)
4. Butylene Glycol (BG)
5. Neopently Glycol (NPG)
6. Glycerine
7. Sorbitols
8. Phytosterols, etc.,

Polyethylene glycol is a condensation polymer of ethylene oxide and water with the general formula H(OCH2CH2)nOH, where n is the average number of repeating oxyethylene groups typically from 4 to about 180. The abbreviation (PEG) is termed in combination with a numeric suffix which indicates the average molecular weights. One common feature of PEG appears to be the water-soluble nature. Polyethylene glycol is non-toxic, odorless, neutral, lubricating, non-volatile and non-irritating and is used in a variety of pharmaceuticals. Rate of evaporation was depends up on molecular weight. Low molecular weight self-curing agent possess low rate of evaporation and hydroxyl value. High molecular weight self-curing agent possess low hydroxyl value and effects blockage of pore in concrete. If molecular weight increases, the solubility in water decreases. Low molecular weight self-curing agent has remarkably good effect on surface quality. For this reason, the low molecular weight Poly Ethylene Glycol (PEG-400) given in Table 3.6.

S.NO	SPECIFICATION	VALUE
1	Molwt	380 – 420
2	Appearance	Clear liquid
3	Color,apha	10 max
4	Moisture	0.2% max
5	pH	4.5 – 7.5
6	Specific gravity	1.12 – 1.13
7	Hydroxyl value	264 – 300mgKOH/g)

POLY ETHYLENE GLYCOL - 400

POLY ETHYLENE GLYCOL – 400

WATER

This is the least expensive but most important ingredient of concrete. The quantity and quality of water is required to be looked in to very carefully. In practice very often great control on the properties of all other ingredients is exercised, but the control on the quality of the water is often neglected. Since quality of the water effects strength, it is necessary for us to go in to the purity and quality of water. The water, which is used for making solution, should be clean and free from harmful impurities such as oil, alkali, acid, etc. in general, the distilled water should be used for making solution in laboratories. Water containing less than 2000 milligrams per litre of total dissolved solids can generally be used satisfactorily for making concrete. Although higher concentration is not always harmful they may affect certain cements adversely and should be avoided where possible. A good thumb rule to follow is, if water is pure enough for drinking it is suitable for mixing concrete.

Physical Properties of Water

S. No	Property	Value
1	pH	7.1
2	Taste	Agreeable
3	Appearance	Clear
4	Turbidity(nt units)	1.75

GROUND GRANULATED BLAST FURNACE SLAG (GGBFS)

Blast furnace slag is a by-product of iron manufacturing industry. Iron ore, coke and limestone are fed into the furnace, and the resulting molten slag floats above the molten iron at a temperature of about $1500^\circ C$ to $1600^\circ C$. The molten slag has a composition of 30% to 40% silicon dioxide (SiO2) and approximately 40% CaO, which is close to the chemical composition of Portland cement. After the molten iron is tapped off, the remaining molten slag, which mainly consists of siliceous and aluminous residues is then rapidly water- quenched, resulting in the formation of a glassy granulate. This glassy granulate is dried and ground to the required size which is known as ground granulated blast furnace slag (GGBS). The production of GGBS requires little additional energy compared with the energy required for the production of Portland cement. The replacement of Portland cement with GGBS will lead to a significant reduction of carbon dioxide gas emission. GGBS is therefore an environmentally friendly construction material. It can be used to replace as much as 80% of the Portland cement when used in concrete. GGBS concrete has better water impermeability characteristics as well as improved resistance to corrosion and sulphate attack. As a result, the service life of a structure is enhanced and the maintenance cost reduced. High volume eco-friendly replacement slag leads to the development of concrete which not only utilizes the industrial wastes but also saves significant natural resources and energy. This in turn reduces the consumption of cement.

Ground Granulated Blast-furnace Slag (GGBFS)

Ground granulated blast-furnace slag is the granular material formed when molten iron blast furnace slag is rapidly chilled (quenched) by immersion in water. It is a granular product with very limited crystal formation and is highly cementitious in nature. It is ground to cement fineness and hydrates like Portland cement. Properties of GGBS are shown in Table 4.8

Table 3.8 Physical Properties of GGBFS

COMPOUND	COMPOSITION
Calcium Oxide (CaO)	40%-52%
Silicon Dioxide (SiO2)	10%-19%

Iron Oxide (FeO)	10%-40% (70%-80% FeO2; 20-30% Fe2O3)
Manganese Oxide (MnO)	5-8
Magnesium Oxide (MgO)	5-10
Aluminium Oxide (Al2O3)	1-3
Phosphorous Pentoxide(P2O5	0.5-1
Sulphur (S)	<0.1

IV. RESULTS AND DISCUSSIONS

In this chapter, the experimental observations are discussed and presented. Observations of slump in respect of fresh concrete are noted. The test results such as compressive strength, split tensile strength and flexural strength of hardened concrete of M30 and M20 grade replacement of cement with 20% GGBFS with self curing admixture PEG 400 with 0.5 %,1.0%,1.5% and 2.0% by weight of cementatious material were presented at different ages of curing.

SLUMP CONE TEST:

The slump cone test was conducted for all the five Mixes. Slump for different Mixes are shown below.

Table: 4.1 Slump cone results for M30

S. No.	Mix	% of PEG 400(Internal curing agent)	Slump(mm)
1.	Mix 1	0	45
2.	Mix 2	0.5	45
3.	Mix 3	1.0	45
4.	Mix 4	1.5	45
5.	Mix 5	2.0	50

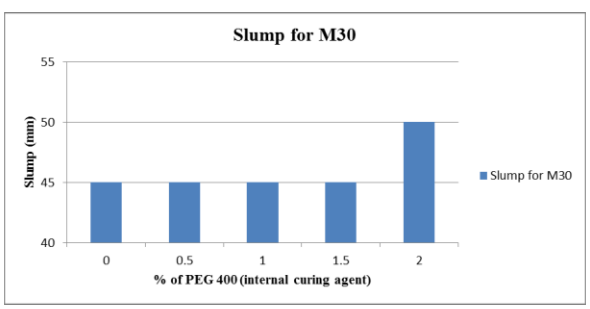


Fig: 4.1 Slump Vs % of PEG 400 (internal curing agent)

For M30 grade the slump value of mix 2 was reduced by 11.11% when compared to Mix 1 and for Mix 3,Mix 4 and Mix5 were same as Mix 1 (i.e.,0%) and Mix 6 was increased by 11.11%.

Table: 4.2 Slump cone results for M20

S. No.	Mix	% of PEG 400(Internal curing agent)	Slump(mm)
1.	Mix 1	0	45
2.	Mix 2	0.5	45
3.	Mix 3	1.0	45
4.	Mix 4	1.5	50
5.	Mix 5	2.0	50

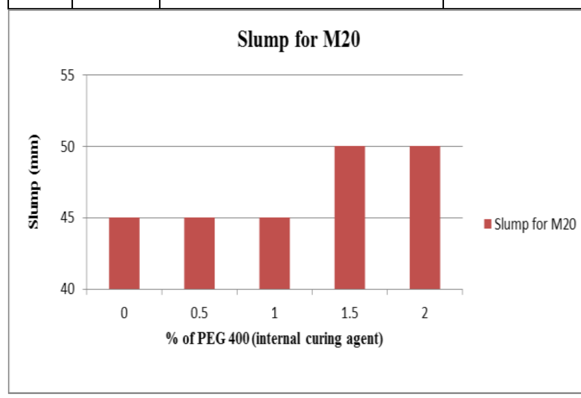


Fig: 4.2 Slump Vs % of PEG 400 (internal curing agent)

For M20 grade the slump value of Mix 2, Mix3 and Mix4 was reduced by 10% when compared to Mix 1where as for Mix 5 and Mix 6it was same as Mix 1(i.e., 0%)

4.3 COMPRESSIVE STRENGTH TEST:

The compressive strength of the concrete was done on 150 x 150 x 150 mm cubes. A total of 108 cubes were cast for the twelve Mixes. i.e., for each Mix 9 cubes were prepared. Testing of the specimens was done at 7 days, 28 days and 56 days, at the rate of three cubes for each Mix on that particular day. The average value of the 3 specimens is reported as the strength at that particular age.

Compressive strength of M30 and M20 grades of concrete by replacement of cement with 20% GGBFS with self curing admixture PEG 400 with 0.5 %,1.0%,1.5% and 2.0% by weight of cementatious material were presented at different ages of curing shown in below.

Table: 4.3 Compressive strength test results for M30 grade

S. No .	Mix	% of PEG 400(Internal curing agent)	Compressive strength in N/mm^2		
			7days	28days	56days
1	Mix 1	0	33.86	41.06	43.87
2	Mix 2	0.5	35.02	42.48	45.74
3	Mix 3	1.0	30.81	37.02	41.34
4	Mix 4	1.5	28.04	34.12	39.54
5	Mix 5	2.0	25.86	31.06	36.82

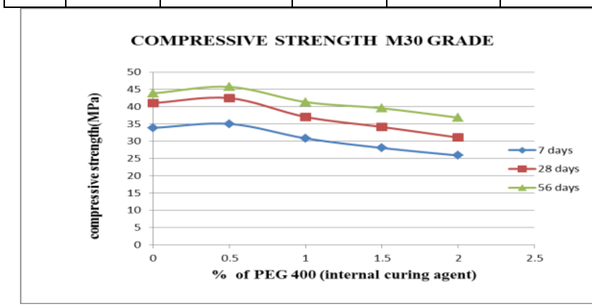


Fig: 4.3 Compressive Strength test Vs %of PEG 400 (internal curing agent)

For M30 grade, It was observed that the compressive strength (at 7days) of MIX2 is increased by 3.425% when compared to MIX 1. For, MIX 3, MIX 4 and MIX 5 are decreased by 9%, 17.18 % and 23.626% respectively when compared with MIX 1.

For M30 grade, It was observed that the compressive strength (at 28days) of MIX2 is increased by 3.458% when compared to MIX 1. For, MIX 3, MIX 4 and MIX 5 are decreased by 9.839%, 16.902 % and 24.354% respectively when compared with MIX 1.

For M30 grade, It was observed that the compressive strength (at 56days) of MIX2 is increased by 4.262% when compared to MIX 1. For, MIX 3, MIX 4 and MIX 5 are decreased by 5.767%, 9.87% and 16.07% respectively when compared with MIX 1.

Table: 4.4 Compressive strength test results for M20 grade

S. No .	Mix	% of PEG 400(Internal curing agent)	Compressive strength in N/mm^2		
			7days	28days	56days
1	Mix 1	0	25.36	32.38	35.28
2	Mix 2	0.5	25.84	33.49	36.89
3	Mix 3	1.0	26.89	35.62	39.04
4	Mix 4	1.5	23.69	31.53	33.46
5	Mix 5	2.0	23.25	30.08	32.24

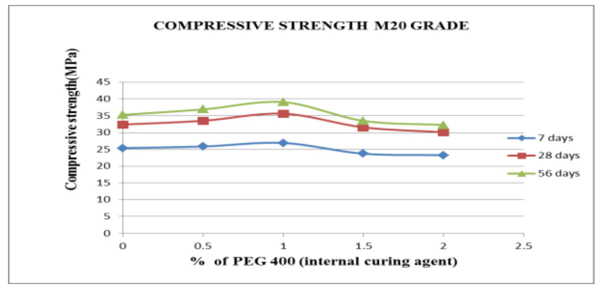


Fig:4.4 Compressive Strength test Vs %of PEG 400 (internal curing agent)

For M20 grade, It was observed that the compressive strength (at 7days) of MIX 2 and MIX 3 are increased by 1.892% and 6.033% respectively when compared to MIX 1. For, MIX 4 and MIX 5 are decreased by 6.58% and 8.32 % respectively when compared with MIX 1.

For M20 grade, It was observed that the compressive strength (at 28days) of MIX 2 and MIX 3 are increased by 3.28% and 10.00% respectively when compared to MIX 1. For, MIX 4 and MIX 5 are decreased by 2.625% and 7.103 % respectively when compared with MIX 1

For M20 grade, It was observed that the compressive strength (at 56days) of MIX 2 and MIX 3 are increased by 4.563% and 10.657% respectively when compared to MIX1. For, MIX 4 and MIX 5 are decreased by 5.158% and 8.616 % respectively when compared with MIX 1

SPLIT TENSILE STRENGTH TEST:

The indirect tensile strength was measured on 150 x 300 mm cylinders and the results were shown below. A total of 27 cylinders were cast for 3 Mixes. Three specimens were tested each time and the average value at the particular age was reported as the tensile strength of the concrete. Split tensile strength of concrete tested on cylinders at different partial replacement of Self curing agents were shown in below.

Table: 4.5 Split tensile strength test results for M30 Grade

S. No.	Mix	%of PEG 400 (Internal curing agent)	Split Tensile strength in N/mm^2		
			7days	28days	56days
1	Mix 1	0	2.38	2.9	3.24
2	Mix 2	0.5	2.54	3.24	3.45
3	Mix 3	1.0	2.09	2.69	3.0
4	Mix 4	1.5	1.96	2.51	2.84
5	Mix 5	2.0	1.82	2.29	2.68

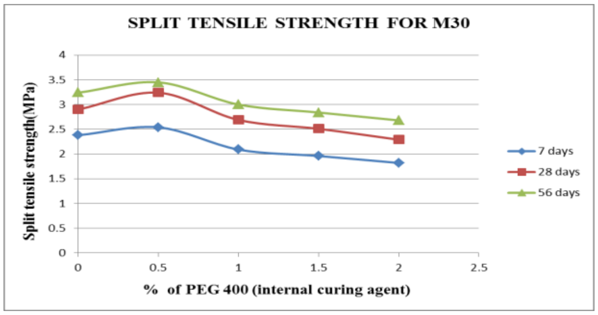


Fig: 4.5 Split Tensile Strength Test Vs %of PEG 400 (internal curing agent)

For M30 grade, It was observed that the split tensile strength (at 7days) of MIX 2 is increased by 6.772% when compared to MIX 1. For, MIX 3, MIX 4 and MIX 5 are decreased by 12.182%, 17.647% and 23.529% respectively when compared with MIX 1.

For M30 grade, It was observed that the split tensile strength (at 28days) of MIX 2 is increased by 11.724% when compared to MIX 1. For, MIX 3, MIX 4 and MIX 5 are decreased by 7.241%, 13.44% and 21.034% respectively when compared with MIX 1.

For M30 grade, It was observed that the split tensile strength (at 56days) of MIX 2 is increased by 6.481% when compared to MIX 1. For, MIX 3, MIX 4 and MIX 5 are decreased by 7.407%, 12.345% and 17.284% respectively when compared with MIX 1.

Table: 4.6 Split tensile strength test results for M20 Grade

S. No.	Mix	% ofPEG 400(Internal curing agent)	Split Tensile strength in N/mm^2		
			7days	28days	56days
1	Mix 1	0	2.04	2.49	2.74
2	Mix 2	0.5	2.12	2.54	2.82
3	Mix 3	1.0	2.26	2.77	2.96
4	Mix 4	1.5	1.89	2.38	2.53
5	Mix 5	2.0	1.74	2.26	2.40

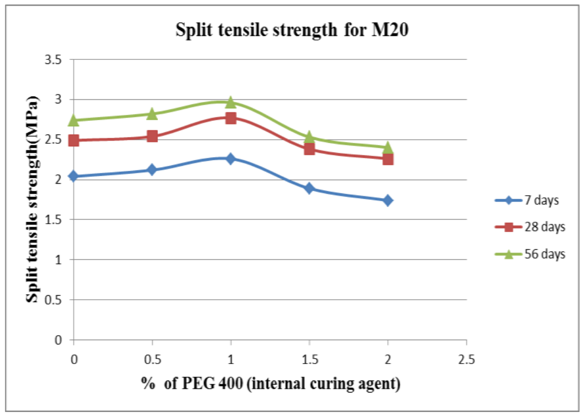


Fig: 4.6 Split Tensile Strength Test Vs %of PEG 400 (internal curing agent)

Table: 4.8 Flexural strength test results for M20 grade

S. No.	Mix	% ofPEG 400(Internal curing agent)	Split Tensile strength in N/mm^2		
			7days	28days	56days
1	Mix 1	0	5.17	6.4	7.0
2	Mix 2	0.5	5.22	6.5	7.6
3	Mix 3	1.0	5.67	6.83	7.9
4	Mix 4	1.5	4.66	5.66	6.82
5	Mix 5	2.0	4.33	4.83	6.33

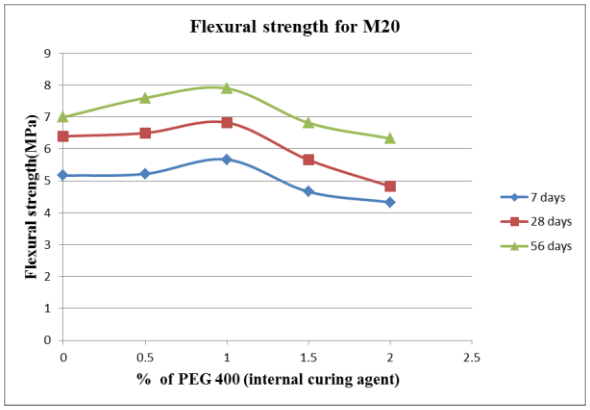


Fig: 4.8 Flexural Strength Test Vs of PEG 400 (internal curing agent)

For M20 grade, It was observed that the flexural strength (at 7days) of MIX 2 and MIX 3 are increased by 0.967% and 9.671% respectively when compared to MIX 1. For, MIX 4 and MIX 5 are decreased by 9.864% and 16.247% respectively when compared with MIX 1.

For M20 grade, It was observed that the flexural strength (at 28days) of MIX 2 and MIX 3 are increased by 1.562% and 6.718% respectively when compared to MIX 1. For, MIX 4 and MIX 5 are decreased by 11.562% and 24.531% respectively when compared with MIX

For M20 grade, It was observed that the flexural strength (at 56days) of MIX 2 and MIX 3 are increased by 8.57% and 12.857% respectively when compared to MIX 1. For, MIX 4 and MIX 5 are decreased by 2.571% and 9.571% respectively when compared with MIX 1.

V.CONCLUSION AND FUTURE WORK

The tests such as compressive strength, split tensile strength and flexural strength of hardened concrete of M30 and M20 grade replacement of cement with 20% GGBFS with self curing admixture PEG 400 with 0, 0.5%,1.0%,1.5% and 2.0% by weight of cementatious material were presented at different ages of curing On the basis of the present study, following conclusions are drawn.

5.2 CONCLUSIONS

1. The addition of GGBFS and self curing admixture does not influence the workability of concrete.
2. The Compressive strength of 7days, 28days and 56days values increased for 20% replacement of cement with GGBFS.
3. The optimum dosage of self curing admixture PEG400 is found to be 0.5% by weight of cementatious material for M30 grade of concrete for compressive strength spilt tensile strength and flexural strength.
4. The optimum dosage of self curing admixture PEG400 is found to be 1.0% by weight of cementatious material for M20 grade of concrete for compressive strength spilt tensile strength and flexural strength.
5. As the Grade of concrete increases the optimum dose self curing admixture is reduced.

5.3 SCOPE FOR FURTHER RESEARCH

1. The self curing concrete can be made by using rise husk ash, palm oil fuel ash, baggasse ash and other waste materials to reduce environmental pollution.
2. External self curing concrete can be made by using GGBFS.
3. The behaviour of self curing concrete can be studied by incorporating fibers.
4. Self curing concrete can be made for high strength concretes.

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