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Investigational studies on the impact of Supplementary Cementitious Materials (SCM) for identifying the strength and durability characteristics in self curing concrete

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ABSTRACT

For optimal heat of hydration and high strength, conventional concrete requires optimum curing and moisture levels for a minimal of 28 days. The durability and strength may decline if the curing is inadequate. Self-curing concrete (SCC) is a specific type of concrete that reduces inadequate curing resulting from human error. Water scarcity in arid regions, difficulty in accessing buildings in challenging terrain, and locations where the concentration of fluorides in the water may adversely impact the concrete's mechanical properties. Developing concrete using Supplementary Cement Materials (SCM's) that have pozzolanic qualities in nature as well as self-curing additives would be seen as a prospective enterprise for meeting sustainability commitments. Industrial wastes like as Silica Fume (SF), Ground granulated blast furnace slag (GGBFS), Fly Ash (FA) and Alccofine (AF) are used as SCM. Polyethylene Glycol (PEG) is an instance of a self-curing compound. Throughout the study, FA and SF will be used as cement substitutions, and Polyethylene Glycol (PEG 400) will be used as a self-curing agent, with just a focus on quantifying the influence mostly on hardened qualities of concrete. To test the qualities of concrete, different ratios of cement were substituted for the cement with varying percentages of SF at 5%, 10% and 15% and FA at 30%, 25%, 20%. Different dosages of PEG varying from 0%, 0.1%, 0.5% and 1.0% are used to understand the optimal dosage of self-curing agent.

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1. Introduction

SCC signifies that it doesn't require watering after placement or even an external curing. The properties of this concrete are at least equal to or even better than those of conventionally cured concrete (CCC). For the concrete mixture to perform the "internal curing" procedure known as self-curing, a water-soluble polymer must have been added. As the internal curing (IC) composition is a part of the blending, this approach avoids the difficulty of ensuring that labourers adhere to the proper curing procedures. For SCC, there are presently two basic approaches. The first approach makes use of lightweight saturated porous aggregate (LWA) to provide an intrinsic water source that can replenish the water used by the chemical contractions while cement's hydration process taken place. The second technique makes use of polyethylene glycol (PEG), which aids in water retention and minimizes water evaporation from concrete surfaces. The continual evaporation of moisture from the exterior concrete's outermost layer is a result of the variance in chemical potential in between vapor and liquid states. Most of the polymers that are included in the concrete mix generate hydrogen bonds with molecules of water and lower the chemical reactivity of their molecules, which expresses itself as a reduction of vapor pressure and delays the pace of surface

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Abbreviations: AF, Alccofine; GGBFS, Ground Granulated Blast Furnace Slag; SCM, Supplementary Cementitious Materials; LWA, Light Weight Porous Aggregate; PEG, PolyEthylene Glycol; SF, Silica Fume; FA, Fly Ash; CS, Compressive Strength; STS, Split Tensile Strength.

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evaporation. The condensation of ethylene oxide and water results in the polyether known as PEG.

The basic formula for PEG is $H(OCH_2CH_2)_n$ OH, where n is the average number of repeated oxyethylene groups, often ranging from 4 to 180. Diethylene glycol, triethylene glycol, and tetra ethylene glycol are generated as pure chemicals and belong to the lower-molecular-weight family with n = 2 to n = 4. A number suffix that denotes the average molecular weight is used in conjunction with the PEG. Hydrated cement can absorb moisture from all sorts of sources (approximately 0.07 g water/g cement), with the water integrated into it and acquired either by products of cement hydration having a specific volume less than that of bulk water. While this water can and frequently is provided by external (surface) curing in concretes with higher water content, in low w/c concretes, the permeability of the concrete quickly falls below the threshold required to effectively move water from the concrete's exterior to its interior. Hence, internal curing is justified. If more water can be spread reasonably evenly all through concrete, it will be easy to move to the adjacent cement paste and take part in the cement hydration as desired.

SCC produced a continuous and progressive curing process, making it commonly more appropriate to locations wherever accessibility is problematic after construction. Extremely relevant in areas with a lack of water, such as desert areas worldwide. Furthermore, slope surface concreting can be used for rigid pavement road construction, where water curing is challenging to sustain for a long time. SCC is primarily used for the development of high-performance and high-strength megastructures, such as towering skyscrapers, tunnels, bridges, and shotcrete structures that are essential for avoiding the need to build unstable slopes. Compared with oven-dry porous aggregate, prewetted porous aggregate can decrease plastic shrinkage cracking more efficiently. This is due to the dry porous aggregate's inadequacy to sufficiently absorb extra water from concrete during plastic stage. If dry porous aggregate can absorb the necessary quantity of excess water from the concrete mixture, it can produce results that are almost identical to those of prewetted porous aggregate. Prewetted porous aggregate slowly released internal curing water, prolonging the period that internal RH stays at 100%. As a result, autogenous shrinkage is decreased, which improves hydration and refines pore structure. Also, the effectiveness of LWA may differ depending on their type.

Utilizing Supplementary Cementitious Materials (SCMs) to replace OPC partially or completely in concrete is just an effective way to conserve Mother Nature's resources while also minimizing environmental impact. Because the majority of SCMs were pozzolanic in nature, they play a supporting role in augmenting the concrete's later strength. Materializing SCMs with cement offers several advantages, including keeping the SCMs in the cement, utilizing commercial by-products, improving the microstructural characteristics of concrete, and reducing environmental impact by reducing greenhouse gas emissions. The majority of SCMs were industrial by-products that, when abandoned on land or discharged into dihydrogen monoxide bodies, were considered waste but also contaminants. As a result, encasing them within concrete is really a safe way to dispose of them. Fly Ash (FA), Ground Granulated Furnace Slag (GGBFS), Micro Silica (MS), and Silica Fume (SF) are examples of SCMs. Concrete is made up of cement, aggregates, and water, together with or without admixtures. Curing is necessary to attain desired strength as well as other qualities. Poor curing practices have a negative impact on cement's promising qualities.

Due to the obvious inadequate curing, this surface zone will be really drained by greater penetrability. Unexpected thermal and shrinkage cracks can reduce the solid's strength, strength, and workability. The rate of substantial shrinkage within concrete is proportional to the rate of moisture distress. SCMs have either been included within concrete mixtures as a partial substitution for Portland cement as well as mixed with the cement during production to validate the effectiveness of ordinary Portland cement (OPC) hydration processes in concrete. Papadakis and Tsimas [1] addressed the different kinds between natural and synthetic materials that can be used as SCM. The purpose of this study was to look at the performances of SF and FA with blended concrete. SF particles were incredibly tiny, with over 95 percent of spherical particles being less than 1 m in diameter. The purpose of this study was to look at the behavior of SF and FA into blended concrete.

SCMs work in conjunction with cement to optimize the properties of fresh concrete, boost the properties of hardened concrete, and lower the cost of raw materials [2,3]. FA seems to be a pozzolanic SCM as well as a combustion of coal by-product [2][3]. Coal-fired power stations are perhaps the most common source of it. FA is classified as Class C and Class F, depending entirely on the composition of the coal through which it comes, according to ASTM C618.2. The FA particles interact with CH generated during hydration process in the presence of moisture and water content, converting it to the stronger, highly acceptable CSH [4,7]. More CSH and CH are created while cement hydration progresses [8]. FA would be continuing to react with CH to produce more CSH, increasing strength towards the concrete matrix, as long as the reactants are accessible in sufficient amounts as well as other characteristics of the environment remain appropriate [9,10].

1.1. Significance of the study

Concrete materials were fully combined in a drum mixer for about 10 min in conformance with ASTM C192. For each mix, 150 mm × 150 mm × 150 mm cubes were formed to evaluate the strength test properties. Specimens with a cube mould were densely packed on a concrete vibrating machine. The specimens have all been adequately covered for 24 h while submerged in a curing tank for the required curing period. The distribution of particle size, the effect of particle filling, and open spaces within the solid system constitute the initial factors that have a substantial impact on the environmental demand and flow capacity. According to ASTM C 494 [22], it was discovered that raising the SP doses from 100 to 150 mm produced the necessary slump.

The use of utilizable Class F Fly ash (FA) varied up to 30% with Silica Fume (SF) from 5% to 15% has now been substituted with cement at a rate of Polyethylene Glycol (PEG 400) up to 1%, according to current study on blended SCC. To compare the effects of SF and FA on Self Curing Concrete (SCC) and conventional concrete for the Mix M30 grade, the research involves mechanical characteristics like compressive and split tensile strength as well as durability parameters like sulphate and acid resistance. The physical and chemical properties of FA and SF have been included in Table 1 and the SEM images of FA and SF have been figured out in Figs. 1 and 2. Also properties of Polyethylene Glycol (PEG 400) have been tabulated in Table 2. The Mix proportions of blended SCC with SF and Fa with different ratios in replacement with cement were summarized in Table 4.

2. Experimental investigation

2.1. Materials and characterization

Throughout the investigation, low molecular weight polyethylene glycols 400 (PEGs) were used. Before adding water to the concrete, the chemicals and water were properly combined [11,12]. "A polycarboxylate-type, new-generation, high range water reducing admixture affirming to ASTM C494 was used as super plasticizer (SP) for enhancing the mobility or workability of mix with

Table 1
Physical and Chemical Characteristics OPC, FA and SF.

Properties		OPC	FA	SF
Physical	Relative Density	3.19	2.6	2.22
	Particle size	24 µm	2.5 µm	7 µm
	Surface area m^2/kg	330	325	380
	Colour of Material	Grey	Grey	White
	pH	11.8	5.5	8
Chemical	SiO_2	21.54	58.65	92.44
	Al_2O_3	4.68	22.86	1.1
	Fe_2O_3	2.46	4.39	1.45
	TiO_2	–	0.94	1.66
	CaO	62.58	3.12	1.45
	MgO	1.08	1.49	0.64
	Na_2O	0.24	0.59	1.82
	K_2O	0.87	2.44	3.21
	Loss on Ignition	2.58	3.24	≤ 4%

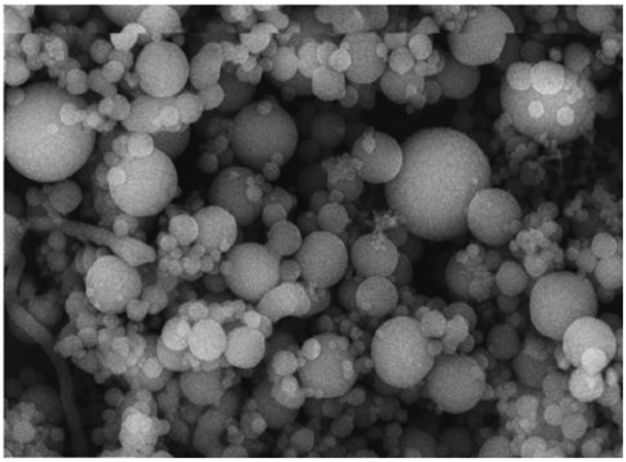

Fig. 1. SEM image for SF.

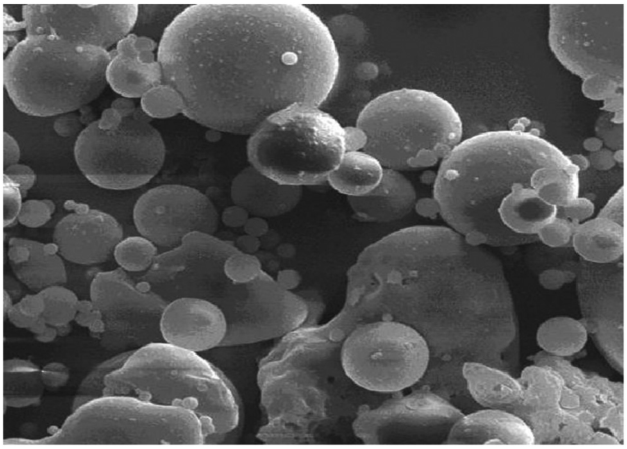

Fig. 2. SEM image for FA.

Table 2
Properties of Polyethylene Glycol 400.

Properties	Values
Molecular weight	400
Appearance	Clear liquid
Specific gravity and pH	2.25 and 5–7
Density	1.128 g/cm^3
Melting point	4 to 8° c

decreased w/c ratio [13,14]. These admixtures, when they dissipate in cement, substantially coagulate and minimize the viscosity of the paste, formulating a thin film all around cement particles [15,16].” Different range of dosages of “Flyash, and Silica fume with PEG 400 of different mixture proportions were determined, in which the optimal dosage of blended materials will be arrived at for M30 grade of concrete with super plasticizer and PEG 400 as 1% of the weight of the cement content” are used. Although the concrete specimens of M30 grade blended concrete cubes were cast, were manufactured with the appropriate amount of Flyash as well as Silica fume replacements.

Industrial waste has now become a more appealing alternative to disposal as people have become much more aware of the ecosystem’s real hazards [18,19]. SF is a by end-product of both the silicon and ferrosilicon industries’ smelting processes. SF is extremely useful in the research and development of HSC, HPC mixes [20,21]. Great improvements have been made in enhancing the performance of construction material during the past three decades. SF and FA are essential in the creation of high-strength concrete with practical use, either independently or in combination [23,24]. The use of SF in a limited period seemed to have among the most dramatic effects on the industry’s ability to routinely and competitively produce SF modified concrete that was flowable but still cohesive, with high early and late-age strengths, as well as resistance to severe environments [25,26].

Utilizing X-ray powder diffraction, a significant spike centred at around 4.4 may be seen in silica fume, which is essentially an amorphous silica structure. The silica fume particles are spherical in form, with an average diameter approximately 0.1 and 0.2 mm, as determined by microscopic examination shown in Fig. 1. SF has a relative density of approximately 2.2 g/cm^3 and a relatively high surface area of roughly 20–22 m^2/g, have been assessed. The hydration reactions of the clinker phases were supplemented in blended Portland cements mostly by pozzolanic reactions of the additional SCM. Even though clinker hydration processes follow distinct mechanisms as well as rates than the pozzolanic reactivity of the SCM, the existence of SCMs influences hydration in blended cements. Both the SCM’s characteristics and the mix design are decisive elements that have the potential to influence all stages of hydration and pozzolanic reactions in blended cement.

Fig. 2 shows an analysis using a scanning electron microscope (SEM) to analyze the particle morphology of FA. The variation in structure and components between class C and class F fly ashes is noticeable. FA particles have a nearly amorphous sphere shape and are streamlined, with over 50% chemical compositions of aluminum (Al), silica (Si), and oxygen (O) in strong signal intensities. As a result, it’s known as an amorphous alumina silicate sphere. Magnesium, potassium, calcium, titanium, and iron produce remarkably low signal intensities means that the particle concentration in such elements is lower. Patel et al. [2] investigated the features of self-compacting concrete for waste material utilization. The study used GGBFS as a concrete substitute in 9 percent, 14 percent, and 18 percent of the cases to determine its impact on new characteristics and Compressive Strength of SCC.

Mohammed et al, [3] studies the mixes varying the different percentages of FA (FA), differing percentages with SF (SF), as well as a third with a combination of FA and SF. Nan Su and Miao [4] proposed a mix design method that included a low cement concentration to produce a medium-strength, flowing concrete. To generate medium strength concretes, the packing factor had first been determined, and then the workability was obtained by filling the void between both the aggregate using GGBFS and FA. Numerous experimental mixtures containing FA, SF, polycarboxylate-based superplasticizer (SP), and iron slag have been made using slump cone testing, L box, and V funnel mostly with purpose of exploring the optimum SCC combinations with pass ability, fill ability, viscosity, and resistance to segregation as described by Raharjo et al. [5]. The properties of OPC, FAand SF as mentioned in Table 1.

Khan et al. [6] discusses the physical and chemical aspects of SF, as well as the mechanisms of its interaction. It investigates how SF affects concrete's porosity, freeze–thaw resistance, corrosive environmental resistance, sulphate resistance, carbonation, and alkali-aggregate resistance. In a binary blend, Vivek et al. [7] attempted to generate SCC using three distinct supplemental cementitious materials as just a partial cement replacement. GGBFS, Metakaolin (MK), and SF with various proportions were used to substitute cement. The adequacy of mineral admixtures was evaluated using durability tests also including resistant to acid attack, sulphate attack, water permeability, and sorpitivity. Rao [8] investigated the various strength properties of Ternary Blended Concrete (TBC) for the M40 grade and coming up with the greatest TBC mix. With the addition of pozzolans into concrete at various percentages of FA and SF, all material characteristics have been seen to enhance. The carbonation phenomena has been investigated for these mixes, revealing the temperatures where the substantial carbonation attacks can occur with ternary cementitious mixtures. Ahmed [9] outlined the important components of these mixtures that influence this carbonation process over time.

Mavoori et al. [10] conducted an empirical study on the use of SF and FA used as a cement substitute, with a small fraction of steel fibres incorporated by concrete volume. In a drum mixer, these concrete materials being thoroughly mixed according to ASTM C192 for around 10 min. Every combination was moulded into 150 mm × 150 mm × 150 mm cubes for mechanical properties and durability tests. Over a concrete vibrating machine, mould specimens have been compacted. The samples had been submerged in the curing tank for the specified curing period after being covered approximately 24 hours. According to Bashandy [17], research was done to investigate whether sulphates affected the performance of self-curing concrete in comparison to the conventional concrete. To test compressive and tensile strength, and percentage weight loss, samples were submerged in a Na_2S0_4 solutions with a 4% concentration.

3. Material properties and mix proportioning

To acquire the specific experimental data which ropes to understand the mechanical behaviour and consequence of utilization of FA and SF as partial replacement for accomplishing the parameters of Ternary Blended Concrete (TBC) with the optimum dosage of Polyethylene Glycol PEG 400, the experimental programme was held up. This investigation employed cement 53-grade OPC that conformed to IS: 12269-1987 and with a specific gravity of 3.227, also specific surface area of 235 m^2/g, and initial setting and as well as the final setting period of 33 and 520 min, respectively. Fine aggregates were utilized, which was locally accessible river sand that conformed to Zone 2 and according to the Indian Standards IS: 383-1970. Sand had a relative density of 2.62 as well as bulk density with 1.5 g/cm^3 correspondingly. Pulverized rocky angular aggregate passed through the 20 mm sieve but were kept on a 4.75 mm sieve as coarse aggregate. The CA used complies with IS 383-1970 and is evaluated for physical characteristics according to IS 2386-1963, with a relative density of 2.67, a bulk density of 1425 kg/m^3 in the loose state, and 1518 kg/m^3 in the compacted condition. The experiments employed potable water both for mixing and curing SCM specimens. The FA derived from Ramagundam thermal power station seems to have a specific gravity of 2.17. The property parameters of PEG 400 have been specified in Table 2.

The study utilized low-molecular-weight polyethylene glycols (PEGs) with a molecular weight of 400. Prior to combining water into concrete, these chemicals have been completely combined with water. "A polycarboxylate-type, new-generation high range water reducing admixture affirming to ASTM C494 would be used as a super plasticizer for helping to improve the flow or workability of mix to significantly reduced water–cement ratio (w/c), these admixtures when dispersed in cement composite substantially decrease the viscosity of the paste constituting a thin film all around cement particles, these admixtures when dispersed in cement agglomerate dramatically reduce the viscosity. Numerous different dosages of FA and SF have M2 to M9 of varied mix proportions have been determined, wherein the optimum number of blended elements will really be showed up for Mix M30 grade of concrete with SP and PEG 400 as 1% of the weight of its cement content. Specimens of M30 grade blended concrete specimens were decided to cast well with appropriate amount of FA and SF replacement levels. The mix ratio for M30 grade of concrete was tabulated in Table 3. The Mix proportions of blended SCC with SF and Fa with different ratios in replacement with cement were summarized in Table 4.

These materials were swamped in a Na_2SO_4 concentration of sodium sulphate. Total dissolving sulphate ions in a 4 percent concentration have been calculated using the quantities of added sulphates. To speed up the sulphate attack process, the chosen sulphate ion concentration became ten times greater than that recommended. After being submerged in the solutions where these samples were evaluated. Standard specimens have been used to compare performance. The evaporation rate of these solutions showed visible over the surface of samples. Temperature and relative humidity have both been recorded once a week throughout this experiment. When Portland cement and sulphate salts interact widely to generate crystals of ettringite, concrete constructed with Portland cement is susceptible to deterioration. When given considerable space to grow, ettringite crystallizes into needle-like structures, but when placed in a small area, it reacts expansively. Concretes were chemically attacked by being submerged in an acid solution to study their resistance to chemical attack. The samples were taken out of the curing period only after 90 days and their

Table 3
Mix Ratio of Concrete – M30 (kg/m^3).

Water (Litres)	Cement (kg/m^3)	Fine aggregate (kg/m^3)	Coarse Aggregate (kg/m^3)	Super plasticizer (kg/m^3)
140	350	744.255	1314.18	3.5
0.4	1	2.126	3.75	0.01

Table 4
Mix Proportions of Self -curing Concrete (kg/m^3).

Mix	Cement (kg/m^3)	FA (kg/m^3)	SF (kg/m^3)	C.A (kg/m^3)	F.A (kg/m^3)	S.P (kg/m^3)	Water (litres)
M1 (100)	350	–	–	1315	745	3.5	140
M2 (65 + 25 + 10)	228	87.5	35				
M3 (65 + 20 + 15)		70	52.5				
M4 (65 + 10 + 25)		35	87.5				
M5 (65 + 15 + 20)		52.5	70				
M6 (70 + 10 + 20)	245	35	70				
M7 (70 + 20 + 10)		70	35				
M8 (80 + 10 + 10)	280	35	35				
M9 (90 + 5 + 5)	315	17.5	17.5				

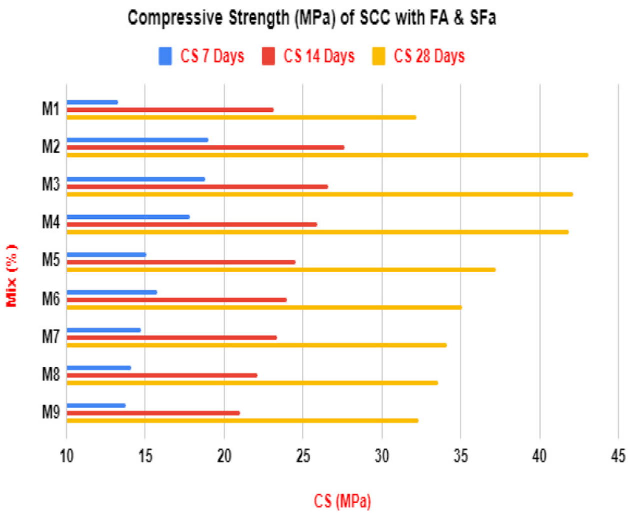

Fig. 3. CS of Blended SCC for 7, 14 and 28 days.

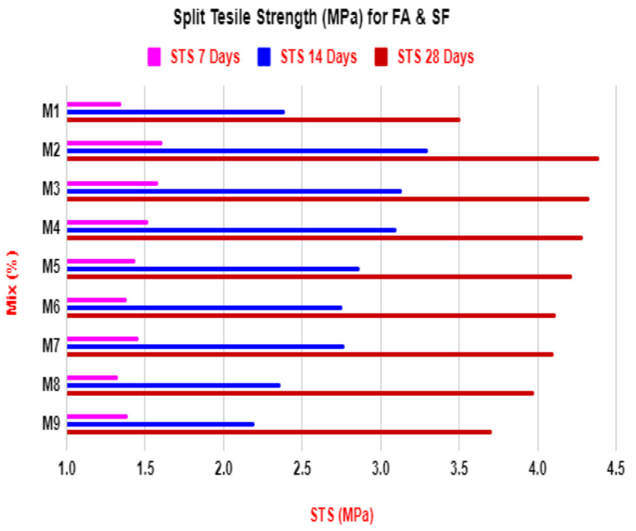

Fig. 4. STS of Blended SCC for 7, 14 and 28 days.

surfaces were cleaned with a soft nylon brush to get rid of any weak reaction products but also loose materials. Initial weights were calculated, and specimens were coded plastic covers attached over them to serve as identification. The pH (4) of the solution in which the specimens were submerged was kept constant at 3% H_2SO_4.

4. Results and discussions

The optimal dosage of PEG 400 based upon weight reduction and retention capacity of water over SCC mixtures prepared with SCMs was determined in grammes as 23, 31, and 42, correspondingly, for curing times of 7th,14th, and 28th days. In comparison to a traditional cured concrete mix, it weighs 65, 82, and 102 grammes, respectively, after 7th, 14th, and 28th days of curing. Regarding higher grades of SCC mixtures, the effective dosage of PEG 400 could be lowered to 0.5 percent. The addition of PEG to concrete minimizes water evaporation, resulting in an improvement inside the concrete water retention capacity and, ultimately, enhanced compressive strength. While 45 kg/m^3 water is incorporated in processes for 1 kg/m^3 SCC, the efficacy of internal curing through procedures for PEG 400 implemented to concrete is

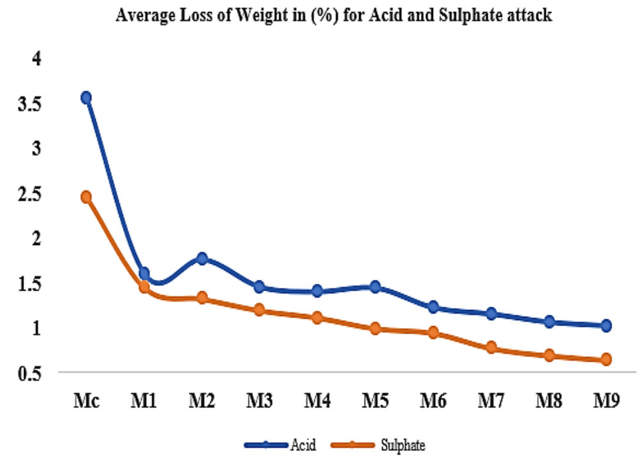

Fig. 5. Percentage Average loss in weight for acid and sulphate attack.

Table 5
Strength parameters of Ternary SCC blended with SF and FA in different proportions.

Mix (%)	Days	M1	M2	M3	M4	M5	M6	M7	M8	M9
Compressive Strength (N/mm^2)	7	13.29	19.04	18.79	17.82	15.06	15.77	14.72	14.10	13.79
	14	23.15	27.67	26.6	25.89	24.52	24.0	23.33	22.10	21.0
	28	32.21	43.12	37.16	41.85	37.21	35.12	34.12	33.55	32.31
Split Tensile Strength (N/mm^2)	7	1.35	1.61	1.58	1.52	1.44	1.38	1.46	1.33	1.39
	14	2.39	3.3	3.14	3.1	2.87	2.76	2.77	2.36	2.20
	28	3.51	4.39	4.33	4.29	4.22	4.12	4.1	3.98	3.71

Table 6
Average Loss of Weight in (%) for Acid and sulphate Resistance.

Mix	Acid Resistance		Sulphate resistance	
	Average loss of weight (%)	Average loss of CS (%)	Average loss of weight (%)	Average loss of CS (%)
Mc	3.55	12.96	2.44	11.35
M1	1.59	6.02	1.44	4.96
M2	1.76	5.49	1.32	4.45
M3	1.45	5.33	1.19	4.27
M4	1.4	4.44	1.11	4.18
M5	1.44	4.22	0.99	4.09
M6	1.22	4.15	0.94	3.44
M7	1.15	4.01	0.77	3.24
M8	1.06	3.49	0.69	2.89
M9	1.02	3.12	0.64	2.75

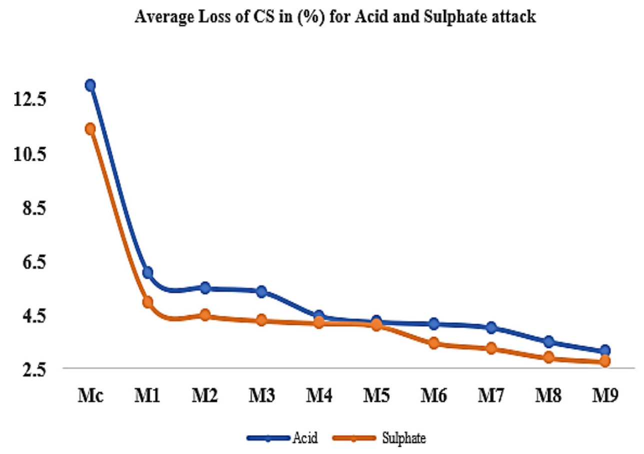

Fig. 6. STS of Blended SCC for 7, 14 and 28 days.

greater. PEG 400 was much more effective than conventional concrete curing. The concrete composition as well as the w/c proportion have a significant impact on the SCC performance (Figs. 3 and 4).

The CS and STS values tested in CTM for Ternary SCC Blended concrete with various proportions of SF and FA was tabulated in Table 5 and shown in Fig. 5. The average loss in weight and loss in CS due to acid and sulphate attack have been tested for 28 days and it was tabulated in Table 6 and demonstrated in Fig. 6.

5. Conclusions

When the proportion of FA in SCC is increased, the compressive strength of the concrete improves at first, then declines. Since FA really has a strong ability effect, the active components can interact with hydration products of cement to generate a pozzolanic reaction, resulting in CSH gels, that boosts interfacial bonding intensity. This pozzolanic reactions is substantially aided by the continual development of hydration products as in later phase, that supports and accelerates its development of the later strength of the FA-based concrete. The proportion of FA used; therefore, it should not be excessive. Obviously, a percentage of ten percent seems to have a greater effect on strength properties of concrete. Therefore, FA proportion was taken for Ternary SCC is varying from 5% to 25%. Finally, after testing the SCC specimens in CTM, M2 (65 + 25 + 10) mix having higher CS of 43.12 N/mm^2 and it is observed that from M3 it has been gradually decreasing up to M9. Similarly in STS M2 mix has the higher value and gradually declining towards from M3 to M9.

Whenever the proportion of SF is continued to increase further, the surplus SF absorbs a huge quantity of water, leading to an increase in water demand, as well as the excess water of the hydration reaction remains in the confined pore spaces of the concrete, causing a reduction in specific gravity and affecting the concrete strength. Lower sulphate exposure times did not result in any noticeable visual damage. Although they were usually limited to the specimen surface, losses were slightly moderate the longer the exposure time. Visual inspection reveals degradation to the specimen surface, which has no impact on the primary mechanical properties relating to the specimen's entire mass. The mass loss from the control mixture, that lowered the mass at the curing tank at several cycles of exposure, reached its maximum. In addition to SCMs, that induces mass loss for all mixes in the drying test is the development of gypsum on the surface of the concrete, which leads to increased shrinkage and, as a result, with a decrease in mass. It is identified that the maximum loss in weight and CS have seen in the conventional mix of SCC mix FA and SF.

CRediT authorship contribution statement

The First author, P Magudeaswaran, was responsible for conducting experiments related to materials characterization and analysing the parameters of Flyash (FA) and Silica Fume (SF) for the Resistance to Self-Curing Concrete of M30 Grade over Acid and Sulphate Resistance. The Second author 'Vivek Kumar C' was responsible for assisting and supporting for conducting experiments to the manuscript and, also written the original draft of the manuscript and responsible for making the final revisions and getting approval from co-authors. The Third author 'K Vamsi Krishna' and Fourth Author' Akella Naga Saibaba' was responsible for Conception, Methodology and Design of study and revising the manuscript analytically for valuable intellectual content for guiding to complete this manuscript. The Fifth author ' Rathod Ravinder' was responsible for conducting technical assist for tests, writing, editing support, general support, etc.

Data availability

Data will be made available on request.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Further reading

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