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EXTRACT BEETROOT AS ADMIXTURE FOR INTERNAL CURING FOR CEMENT MORTAR

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Abstract. . Concrete's qualities, such as those attained by cement hydration and the microstructure of hydrated cement, make it the most flexible building material. The curing process is slower and more water is needed for this kind of hydration. While water is scarce or while working at great heights, this becomes a serious problem. Self-curing, also known as internal curing, is a solution developed by scientists to deal with this problem. Cement that cures on its own, internally, requires the use of special curing chemicals known as self-curing agents. During the chemical interaction between the cement and water, these substances serve to minimize the loss of water from the mortar. In our studies, we employ a biomaterial like beetroot extract to evaluate the efficacy of internally cured mortar to that of externally cured mortar. Beetroot, the self-curing agent, was tested at concentrations of 0.0 and 0.10% and shown to be effective ratios of 0.2%, 0.3%, 0.4%, 0.5%, 0.6%, 0.7%, 0.8%, 0.9%, and 1.0% by weight of cement. In all, 150 cubes were produced for use in the experiments. Using Beetroot extract as a self-curing agent, this article aims to measure the compressive strength of 1:3 cement mortar after 3, 7, 14, 28, 45, and 56 days and compare it to that of conventional and air-cured cement mortar. The findings reveal that after 3, 7, 28, 45, and 56 days, the optimal compressive strength of mortar with a dose of 0.50% of self-curing agent is 86%, 88%, 102%, 108%, 104% and 76%, 30%, 27%, 25.50%, 13%, respectively, which is greater than the air-cured and conventionally cured mortar. Compared to air-cured mortar, conventionally cured mortar has a greater compressive strength after 3 and 56 days (6% and 81%, respectively), while self-curing agent dose of 0.50% results in a 27% increase in compressive strength after 28 days. The findings are promising for the development of bio-self-cured cement mortar that is sustainable, cost-effective, and increases hydration.

Keywords— Biomaterial, Beetroot Extract, Cement Mortar, Ecofriendly, Self-curing agents.

INTRODUCTION

Curing concrete involves keeping the material at just the right level of wetness and temperature for a certain period of time so that the aggregate may develop its intended characteristics. There are a wide variety of mechanical properties that can be achieved through ideal concrete curing, including strength, elasticity, shrinkage, and creep-like properties; and there are a wide variety of features with respect to durability, including resistance to freezing and thawing, scaling, abrasion, chloride penetration, sulfate attack, and alkali-silica reaction. There are two main types of cure, exterior and internal. By combining water and cement, the internal curing process may begin. A chemical reaction known as hydration is set in motion by this combination. The concrete's strength, durability, and other attributes are all determined by the quality of this chemical process. Superior curing allows for the production of a material that is less porous, considerably stronger, and resistant to stress and abrasion. Wet coating, membrane curing, heat absorption curing, electrical curing, and infrared curing are all examples of external curing methods. Spraying water on the concrete, covering it with wet means, curing with formwork techniques, curing with a membrane-like structure, curing by covering a sheet, curing with high-temperature exposure techniques, curing with a high-temperature liquid like water, curing with a method in which high temperature is generated using the alternating current or infra-red technique, and curing by covering the concrete with a membranous structure are all examples of external curing. The goal of curing is to keep the concrete at a consistent temperature and moisture level throughout its whole volume, not only on the top. The choice of procedure, however, depends on the nature of the materials, the building strategy, and the intended use of the concrete. Concrete that cures internally does so by holding its moisture content for an extended period of time. Saturated porous lightweight aggregate or polyethylene glycol may be used for the self-curing. Both methods significantly cut down on water evaporation from the top of the concrete and keep it damp for longer. When comparing the processes involved in curing, it becomes clear that exterior curing requires a lot of water to be effective, whereas internal curing requires less water but is more expensive. Because of this, I've been working on a cheap curing agent for the internal curing process in mortar as a method of producing high-quality mortar.

LITERATURE REVIEW

Concrete is well known as an adaptable construction material worldwide. The functional characteristics of the concrete greatly depend upon the microstructure of the hydrated cement and the hydration of the cement. The friendly environment would support the evaporation of the contents from the concrete hence strengthening concrete through possible curing technique becomes necessary, till a most important section of the evaporation of necessary contents so called the procedure, is accomplished. The main problem that occurs in the curing process are regions having water insufficiency and construction works at considerable heights. One of the smart solutions to overcome this problem is Internal curing or Self-curing. It provides superfluous water contents excessively adequate evaporation of water contents of cement and reduces self-aridness. The internal curing agent preserves the water level in concrete and bring down the evaporation through the hydration of the concrete. In this paper, the authors focused on the study of the effect of several internal curing agents like Super absorbent polymer, Polyethylene glycol and Polyvinyl alcohol on concrete material. The impacts of the mentioned agents on characteristics such as compressive concentration, gash tensile concentration and flexural concentration were observed and it was found that polyethylene glycol was the most helpful among all the agents[1]. In another citation, the authors [2] discloses the effect of internal curing accelerators such as polyethylene glycol and polyacrylamide on water preservation, water incorporation, level of evaporation of water contents, penetrable pores and microstructural functions of cement composites including and excluding the silica fume as cement alternative. The cement mixture that contains internal curing agents gives improved water preservation, reliable on extended evaporation of water contents, less water intake and penetrable pores in comparison with cement mixtures that don't contain internal strengthening accelerator. For the mixtures excluding the silica fume, the utilization of a mixture of polyethylene glycol and polyacrylamide was more effective than the utilization of poly ethylene glycol alone. It was found that the rate of strengthening of cement concrete on completion of one month of hardening for mixtures containing 7% silica fume was higher when the combination of polyethylene glycol and polyacrylamide was utilized than the rate of similar mixtures with polyethylene glycol exclusively. Internal curing agents can be utilized according to different requirements and objectives. Internal curing agents help if there are limited water resources available near the construction sites or with a costly expenditure of capital can give water for curing. Internal curing agents provide speed in construction work. The authors [3] found that many new research scholars are developing different techniques with different materials like super absorbent polymer, wood powder, polyethylene, lightweight aggregate and other shrinkage reducing mixtures for having good results. The present investigation engages the utilization of contraction reducing mixture polyethylene glycol in concrete which helps in internal curing and provides better evaporation and hence strengthening. The comparative study shows that polyethylene glycol can help in internal curing by giving strength to equality with traditional curing techniques. It was also observed that 2% of polyethylene glycol by weight of cement was best possible for M30 without compromising workability. It is also observed that, the authors [4] have studied two internal curing agent materials in different compositions level and the accumulation of silica fume. The internal curing agent used was polyethylene glycol. The functional characteristics are estimated while the concrete samples are based on air curing administration during the testing. The output of the experiment shows utilization of internal curing accelerators in concrete materials effectively enhanced its functional characteristics. It was also observed that the cement concrete utilized polyethylene glycol as an internal curing accelerator reached higher values of functional characteristics than concrete with saturated Leca. Comparatively large value of the cement and lower water proportion lead to the additional proficient performance of internal curing agents in concrete materials. The incorporation of silica fume into internal curing concrete material improved its functional characteristics because of its capability to preserve water inside concrete. Internal curing of cement concrete material using pre-saturated insubstantial polyethylene glycol is reknown technique of offsetting self-dehydration and autogenous reduction. The authors [5] have compared concrete materials with or without silica fume including the chemical category of reduction shrinking combination, polyethylene glycol, and Leca as internal curing accelerator for water preservation even at prominent temperature and their permanence. Several physical characteristics are determined up to one month, for the cases in which acquaintance to air in two different temperatures and up to six months of exposure to 5% of carbon dioxide and dry or wet cycles in 8% of sodium chloride for toughness evaluation. To calculate the water preservation of the examined concretes, the volumetric water absorption and concrete mass losses are considered. Silica fume concrete materials with or without polyethylene glycol provide the best outputs under all curing conditions and good permanence characteristics. Self-curing agent containing cement offers a simpler experimental function over traditional resin cement but it releases higher amounts of unrelated monomers that disturb its biocompatibility. In paper authors [6] concentrated on the comparison impact of internal curing multiple resin cement in additional to traditional resin cement. Samples of four resin cement, two internal curing dual resign cement and two traditional resin cement are prepared with the same assumptions and situations & kept in water. For every material, 20 samples are utilized and cell cultures of human periodontal ligament cells are added under suitable situations. One of the experimental groups was left untouched as a control. A cell performance evaluation is done in groups. In addition to this, microscopic evaluation of microstructure is performed utilizing cell viability staining. Further, the authors have explored the curing modes of the concrete on its polymerization reduction and degree of conversion over a particular post-establishment time [7]. The authors have analyzed five different types of self-adhesive and three traditional dual heal resin cement. Fourier transform infrared technique was employed to determine the actual instant degree of conversion over a day. Polymerization reduction was measured by the bonded disk technique for one hour. It was observed that after one hour of post-activation, the degree of conversion of light healed samples ranged between 65.7% and 76.9%, whereas for self-cured samples the degree of conversion ranged between 44.8% and 72.3%. After one hour of post-activation, polymerization reduction ranged between 5.7% and 8.4% for light healed and ranged between 4.7% and 8.2% for the degree of conversion samples. Finally, the authors concluded that on every occasion when light access is achievable efficiency of their conversion. The traditional internal healing techniques needed a tremendous amount of water. This becomes the most challenging task in the region where limited water is available and for the case of work where construction is going on at high latitude. In this paper[8] the authors have presented a novel solution for the requirement of concrete which doesn't need additional water for healing. In new concrete materials, calcium lignosulfonate with various proportions is employed as an internal healing agent. The toughened concrete with calcium is healed under ambient circumstances while the toughened concrete excluding limestone is waterlogged for healing. The characteristics of new and toughened concrete without and with limestone are contrasted. The experimental outputs discloses that a unceasing enhancement in a nose dive with the increase in calcium lignosulfonate, though 0.4% calcium lignosulfonate is recognized as the best possible proportion for desired mechanical characteristics. In the paper [9], the authors have proposed high concentration metakaolin-based concave hub microspheres organized by the permutation of high temperature sintering and converse suspension polymerization. The key intention was designed to use high concentration metakaolin-based concave hub microspheres in the concrete slurry to decrease autogenous reduction, without unconstructively having an effect on other characteristics of concrete slurry. The high concentration metakaolin-based concave hub microspheres are built and the liquid incorporation and strength performance of high concentration metakaolin-based concave hub microspheres are examined. The microsystem of toughened concrete with high concentration metakaolin-based concave hub microspheres is investigated. Alleviation of autogenous reduction of well concrete with high concentration metakaolin-based concave hub microspheres is tested. Outputs showed that high concentration metakaolin-based concave hub microspheres with numerous apertures on the shell has the capability to soak up water and the water absorption capability is steady in concrete slurry. High concentration metakaolin-based concave hub microspheres decrease the cut-off rate of the concrete slurry at high angular speed and accordingly rises the shear number at low angular speed. To examine the trouble of long period reduction in compressive strength in application of oil well cement structures, exposed to high temperature and high pressure healing situations, several influencing aspects, including concrete sources, particle dimension of silica flour, and addition of silica fume, alumina and nano-graphene are examined. To evaluate the surroundings of cementing deep wells and geothermal wells, concrete slurries are directly exposed at 200°C. To compute the qualities of the set concrete, Young's modulus, compressive strength, water permeability and mineral compositions are used. Short period healing experimental output shows that the utilization of crystalline silica plays an important function in stabilizing the mechanical characteristics of oil well concrete structures, while the accumulation of silica fume has an unfavorable consequence on strength permanence. Long-period healing experimental output shows that the nano-graphene can stabilize the Youngs modulus of oil well concrete structures. [10]. In fibre post cementation, self-etching bonding structures are mostly employed. On the other hand, no proper procedures are mentioned for selecting pre-healing measures. In the paper, the authors in [11] have studied the bonding tightness of fibre after application of cement, utilizing pre-healing techniques in self-etching bonding structures and contrasting them as a self-adhesive structure. The fibre posts are cemented in three different ways by utilizing a concurrent pre-healing course of action or a self-etching bonding structure and utilizing a self-adhesive structure. Every sample is surrounded and segmented upright along the axis into three thick portions. The comparison outputs showed that the bond strength in the overall root is not considerably dissimilar between the three sections. When every section is separately analysed, group self-etching demonstrated considerably lower coronal bond strength. In the investigation [12], the comparison between two self-healing agents is done for enhancing the performance of the cement-concrete materials. The first self-healing agent employed is pre-soaked lightweight cumulative with several proportions of sand and the second agent used is polyethylene glycol with various proportions of mass of cement. At different stages, the physical characteristics of the concrete materials are calculated. The outputs show that the utilization of the internal healing agent of polyethylene glycol in concrete materials efficiently enhances the physical characteristics contrast with traditional concrete. Internal healing agent polyethylene glycol is found to be more efficient than the lightweight aggregate internal healing agent. Advanced cement substance and lesser water cement proportion guide to more effectual outputs of internal healing agents in concrete. Due to the complication of multi physics procedures, cemented adhesive backfill materials commence the black box healing time after being positioned into underground stapes. Furthermore, due to restricted intervention in the thermal procedure, cemented adhesive backfill materials may go through isothermal healing situations in underground excavations. To find the best possible design for cemented adhesive backfill materials, it is essential to study the isothermal multi physics procedure in cemented adhesive backfill. In the paper [13], the authors have studied the advancement and functions of isothermal multi physics procedures of cemented adhesive backfill materials under several types of cement to tailings proportions. An isothermal multi-physics supervision program is executed to quantitatively study the advancement of volumetric liquid content, electrical conductivity, and matric suction in different healing situations. The conclusion has the ability to enhance the understanding of the multifaceted area performance of cemented adhesive backfill materials and contribute to its best possible design. In cement mixture, the applicability of kenaf cellulose microfibers as a self-healing accelerator is examined. The assessment variables are mass fraction and length of kenaf cellulose microfibers. Pulverizing kernaf strand fibres are employed to prepare two different types of kenaf cellulose microfibers. The amount of kenaf cellulose microfibers varies from 0 to 3% to the weight of the cement. Further, self-healing of cement-mixtures is evaluated by autogenous reduction and inner comparative humidity tests. Despite, the cellulose microfibers type, the utilization of a higher kenaf cellulose microfibers proportion caused nearly 65% shrinkage in autogenic reduction, further, 32% rise in comparative waeter contents. Out of the two kenaf cellulose microfiber types, the shorter kenaf cellulose microfibers are more efficient in sinking autogenous reduction due to their improved scattering and preventive consequence[14]. The paper [15] presented the internal curing functioning of cracks in strain hardening concrete-based mixtures restraining various quantities of magnesia extensive agents with several reactivates. The prepared samples are loaded for a bending characteristics evaluation and then it is exposed to fluid for curative performance analysis. The variations in the fracture during the curing process are determined using microscopic analysis using modern digital tools. Further fluid soaking examination is also executed to determine the sealing capability of the cracks. The outputs show that three reactive manganese oxide extensive agents can considerably enhance the crack curing effectiveness of strain hardening concrete-based trues under liquid fog healing situations. Moreover, the internal curing effect of the 12% dosage is not good as that of the 6% dosage when the reactivity of the magnesia extensive agents and the manganese oxide accelerator with a reliable reactivity value shows most promising effect on crack curing.

Few of the conclusions which can be drawn from the above literature survey are like, author have discussed the use of internal curing agents to reduce the water evaporation during the hydration of concrete to address the problem where curing is problematic in the regions of water inadequacy and construction at significant heights. Further, it is also evident from the literature that, the period assigned for healing is stagnation of construction time increasing expenses and efforts, one of the main troubles with concrete technology is its increased propensity to suffer initial stage cracking. In another case, it is estimated that resin cement that shows high reduction might be more prone to dimensional volatility and condensed bond strength, resulting in minor leakage, and it is also disclosed that, traditional curing techniques needed a large amount of water. Further, considering different hurdles and downsides mentioned through the literature survey, the research work is concentrated and discussed in depth through the subsequent sections.

EXPERIMENTATION

Experimental Setup

Cement mortar (1:3) is the subject of this paper's experiments, which are the emphasis of the investigation. The experimental procedure calls for the casting of 150 cubes of cement mortar (1:3). This prefix specifies the percentage of self-curing agent applied to the cement (in parts per thousand): 0.10, 0.20, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80, 0.90, and 1.0. Compressive strength is evaluated at 3, 7, 28, 45, and 56 days to compare results with those for conventionally cured mortars.

Method of Mixing

Cement Mortar (1:3) Methodology: It is crucial to ensure that the chosen components are thoroughly combined in order to get the desired outcomes. The best outcomes come from using a mortar cement mass in which the nominated components have been well mixed. If cement paste coats the mortar, it guarantees that all of the chosen ingredients will be well mixed. When doing experiments, it is customary to use a waterproof platform for mixing materials. Sand and cement are the fine aggregate and binding material, respectively, and they are fully combined in an absolutely dry state. The procedure consists of three rounds. The self-curing mortar is then appropriately mixed with the chosen proportion of biomaterial extract in liquid form.

Figure 1 Mixing of beetroot extract (self-curing agent) in a dry mortar (1:3)

Compressive strength for hardened cement mortar (1:3)

The compressive strength of a cement mortar (1:3) was tested, both with and without the addition of a self-curing agent. The 7.06 mm cubes were put through a compression test using 2000 KN testing equipment. The use of a vibrating machine helped ensure even compaction. By dividing the highest force endured by the specimen throughout the test by the average cross-sectional area of the specimen, the compressive strength of the cement mortar cube can be calculated. After 24 hours of curing (1:3) mortar at room temperature (25 to 27 0C) and 90% relative humidity, the specimen is removed and subjected to three different curing methods: air curing with and without a self-curing agent, and conventional curing (the specimen is completely immersed in water) for three, seven, 28, 45, and 56 days. Each compressive strength was determined by averaging the results from three separate samples.

Figure 2 Compressive Testing Machine

Materials and Their Properties

The mortar's durability is determined by the components employed as admixtures. The focus of this study is on cement mortar (1:3) and its variations (air-cured, conventionally-cured, and self-cured). All of the materials used in the experiments are hand-picked from the same batch, carefully stored, and put through rigorous testing in accordance with Indian Standard Specifications to establish a wide range of critical characteristics. The Concrete Technology Lab at Government Polytechnic in Washim, Maharashtra, is where all the rigorous testing that's needed to determine the compressive strength of cement mortar (1:3) takes place. The following experimental materials have reached their ultimate form

Cement

Specifically, UltraTech Ordinary Portland Cement 53 grade compliant with IS: 12269-2015 is recommended. The prospective cement is stored in a temperature- and humidity-controlled plastic container. Cement meets the standards for fineness (4.697) and standard consistency (32.0%) as defined by IS:4031 (Part 4) - 1998; specific gravity (3.15) as defined by IS:269; and initial setting time (117) and ultimate setting time (185 minutes) as defined by Vicat's technique and IS:12269-1987.

Sand

As per IS:383-1970 standard, the river sand passing through the 4.75 mm sieve confirming to the zone-I is used as fine aggregate. The weight of the sample is 1000gm.

Water

The chemical reaction known as hydration requires water as its principal element. The mortar's strength is enhanced by the addition of water. According to standard IS 456-2000, water is utilized in the composition for both mixing and curing the specimen. The pH of the water being utilized is 6.8.

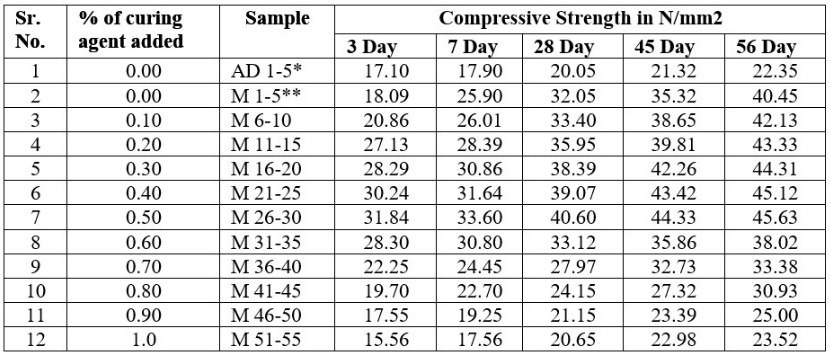
Self-curing agent

In the proposed self-curing procedure, the biomaterial itself serves as the curing agent. As the facility conducting these experiments is located in Washim, the necessary biomaterial is sourced from the communities around the Washim District of Maharashtra State. The method begins with harvesting the biomaterial from the ground and washing it to remove the sticky dirt. The materials have been expertly sliced and crushed into little bits. The extracted material is collected in a container before being incorporated into the mortar. The extract biomaterial has a pH of 5.8. It is feasible to extract between 70 and 75 milliliters from 100 grams of biomaterial. After extracting of biomaterial remaining material is used as cattle feed.

Result and Discussion

The surface of newly applied cement mortar constantly loses moisture. Because the admixtures added to the cement mortar mix include hydrogen, they are able to establish bonds with the water molecule, increasing the mortar's ability to retain water and decreasing its susceptibility to drying out. The strength of mortar is increased because of the availability of more water, which enhances the hydration level and generates a thick microstructure. The tests' results are summed up by measuring the mortar's compressive strength. Table no.1 shows the results of a statistical analysis of one-third cement-to-three-quarters sand mortar.

Table 1 The Compressive strength of cement mortar (1:3)



Sr. No.	% of curing agent added	Sample	Compressive Strength in N/mm2				
			3 Day	7 Day	28 Day	45 Day	56 Day
1	0.00	AD 1-5*	17.10	17.90	20.05	21.32	22.35
2	0.00	M 1-5**	18.09	25.90	32.05	35.32	40.45
3	0.10	M 6-10	20.86	26.01	33.40	38.65	42.13
4	0.20	M 11-15	27.13	28.39	35.95	39.81	43.33
5	0.30	M 16-20	28.29	30.86	38.39	42.26	44.31
6	0.40	M 21-25	30.24	31.64	39.07	43.42	45.12
7	0.50	M 26-30	31.84	33.60	40.60	44.33	45.63
8	0.60	M 31-35	28.30	30.80	33.12	35.86	38.02
9	0.70	M 36-40	22.25	24.45	27.97	32.73	33.38
10	0.80	M 41-45	19.70	22.70	24.15	27.32	30.93
11	0.90	M 46-50	17.55	19.25	21.15	23.39	25.00
12	1.0	M 51-55	15.56	17.56	20.65	22.98	23.52

Note: * indicate air-cured mortar and ** indicate conventional cured mortar.

Table 2 The Comparison of compressive strength of air-cured with different dosages of Self-curing mortar (1:3)

Sr. No.	**% of curing agent added**	**Sample**	**Compressive Strength for CM (1:3) with different dosages of Self-curing agent.**
1	0.10	M 6-10	22.0 to 89.0% - Higher
2	0.20	M 11-15	59.0 to 94.0% - Higher
3	0.30	M 16-20	65.0 to 98.0% - Higher
4	0.40	M 21-25	77.0 to 102.0% - Higher
5	0.50	M 26-30	86.0 to 104.0% - Higher
6	0.60	M 31-35	65.0 to 89.0% - Higher
7	0.70	M 36-40	30.0 to 49.0% - Higher
8	0.80	M 41-45	15.0 to 38.0% - Higher
9	0.90	M 46-50	3.0 to 12.0% - Higher
10	1.0	M 51-55	9.0% Lower at 3 days and 5.0% Higher at 56 days

Table 3 The Comparison of compressive strength of conventional curing with different dosages of Self-curing mortar (1:3)

Sr. No.	**% of curing agent added**	**Sample**	**Compressive Strength for CM (1:3) with different dosages of Self-curing agent.**
1	0.10	M 6-10	4.0 to 15.0% - Higher
2	0.20	M 11-15	7.0 to 50.0% - Higher
3	0.30	M 16-20	10.0 to 56.0% - Higher
4	0.40	M 21-25	12.0 to 67.0% - Higher
5	0.50	M 26-30	13.0 to 76.0% - Higher
6	0.60	M 31-35	56.0% Higher at 3 days and 6.0% Lowe at 56 days
7	0.70	M 36-40	23.0% Higher at 3 days and 17.0% Lowe at 56 days
8	0.80	M 41-45	9.0% Higher at 3 days and 24.0% Lowe at 56 days
9	0.90	M 46-50	9.0 to 38.0% Lower
10	1.0	M 51-55	14.0 to 42.0% Lower

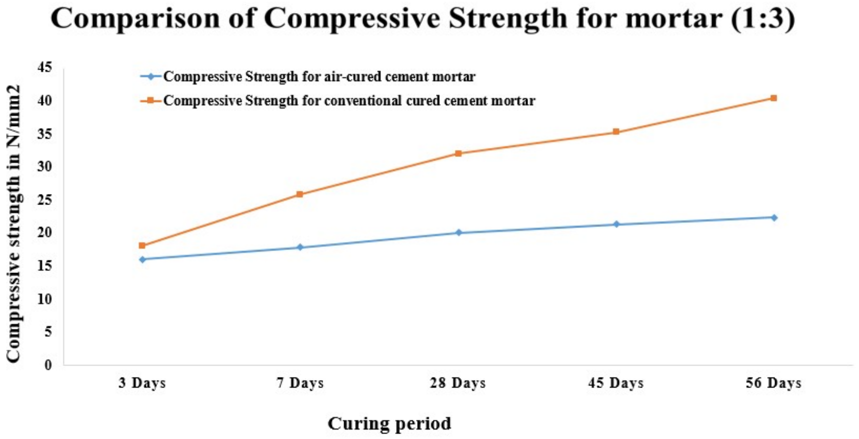


Figure 3 Comparison of compressive strength of cement mortar (1:3) of air-cured with conventional cured mortar.

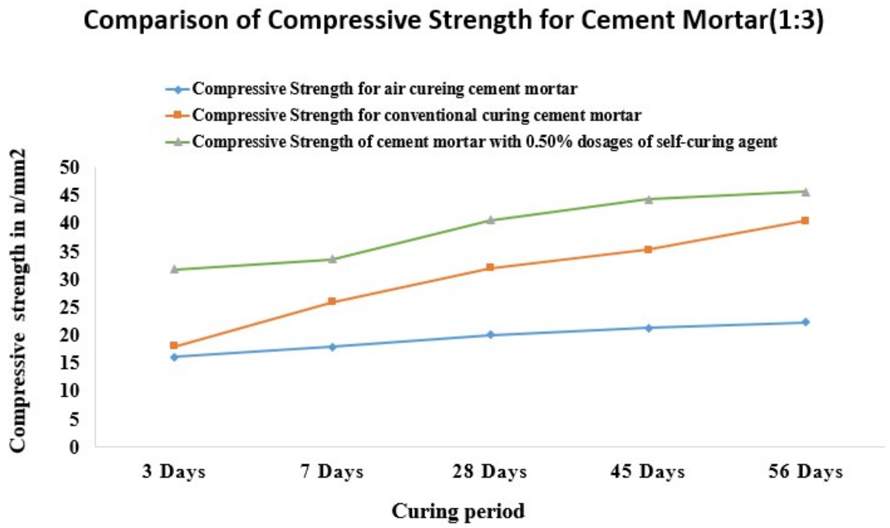


Figure 4 Comparison of compressive strength of cement mortar (1:3) of air-cured, conventional cured, and different dosages of self-curing agent mortar.

From figure no.4 it was observed that with a dosage of 0.50% of self-curing agent, the optimum compressive strength of mortar was found to be 86%,88%,102% ,108%, 104% and 76%,30%,27%,25.50%,13% which is higher than the air-cured and conventional cured mortar at 3,7,28,45, and 56 days respectively. The compressive strength of conventional cured mortar at 3 and 56 days is found to be 6 % and 81% respectively which is higher than air-cured mortar. With the dosage of the self-curing agent 0.50%, compressive strength at 28 days is found to be 27% higher than conventional cured mortar.

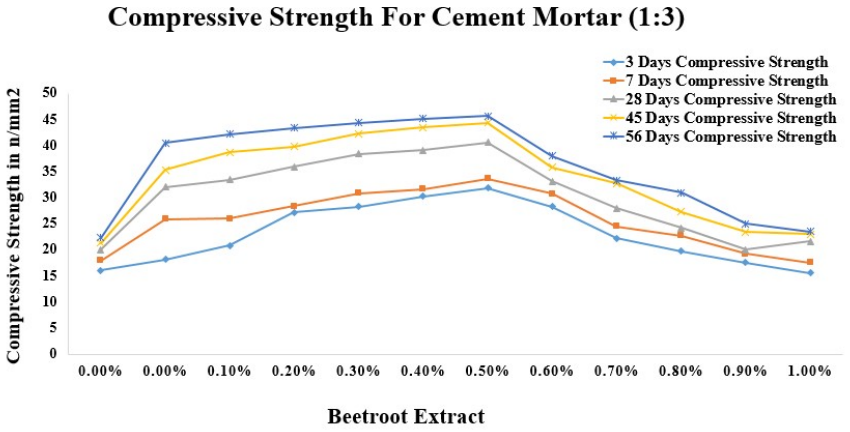


Figure 5 Comparison of compressive strength of cement mortar (1:3) with different dosages of the self-curing agent.

Compressive strength of cement mortar improves from 22% to 86% at 3 days and from 89% to 104% after 56 days when self-curing agent is added (0.10 to 0.50%). Compressive strength drops from 65% to 3% after 3 days and 70% to 5% after 7 days if self-curing doses are increased above 0.50%, however this is still better than air-cured mortar.

The compressive strength of cement mortar improves from 15% at 3 days to 76% at 56 days when using a self-curing agent at a dose of 0.10 to 0.50%, and from 4% to 13% at 56 days when using a conventional curing agent.

Compressive strength reduced from 56 to 9 percent in 3 days, which is greater than conventionally cured mortar, while self-curing doses rose from 0.60 to 0.80 percent. Compressive strength is lower than conventionally cured mortar by 3–14% after 3 days if the self-curing agent dose is raised from 0.90 to 1.0%. The compressive strength of cement mortar reduces from 6% to 42% after 56 days when the dose of the self-curing agent is increased from 0.90 to 1.0%, compared to conventionally cured mortar.

Based on the above experimental findings, increasing the cement dosage up to 0.50% by weight enhances the compressive strength of cement mortar (1:3), however increasing the dosage beyond 0.50% reduces the compressive strength. Although the strength of cement mortar rises up to a dosage of 0.50% of the self-curing agent because of the availability of extra internal sources of water for the full hydration of cement, the strength decreases when the dosage of the self-curing agent is increased.

Conclusion

After going through the in-depth research work following things can be concluded:

1. For maximum compressive strength of cement mortar (1:3), the appropriate dosage of the self-curing agent as beetroot extract was found to be 0.50% by weight of cement.

2. The optimum compressive strength was observed with a 0.50% dosage of a self-curing agent which is higher than that of air-cured and conventional cured mortar.

3. With the dosage of the self-curing agent from 0.10 to 0.50%, the compressive strength of cement mortar increases from 22 to 86 % at 3 days and 89 to 104% at 56 days which is higher than the air-cured mortar.

4. Further increases the dosage of the self-curing agent beyond 0.50% the compressive strength decreases from 65 to 3.0% at 3 days and 70 to 5.0% at 56 days but which is higher than air-cured mortar.

5. The compressive strength of cement mortar increases with a dosage of the self-curing agent from 0.10 to 0.50%, at 3 days 15 to 76%, and at 56 days 4 to 13% which is higher than conventional cure.

6. The dosage of the self-curing agent increased from 0.60 to 0.80% and 0.90 to 1.0% the compressive strength decreased from 56 to 9% at 3 days which is higher and 3 to 14% lower than the conventional cured mortar.

7. The dosage of the self-curing agent increased from 0.60 to 1.0% the compressive strength decreased from 6 to 42% at 56 days which is lower than the conventional cured mortar.

8. To check for surface cracks, we visually inspected the cast cubes. It was observed that there were no hair

cracks on the cubes' surfaces despite constant inspection. Because of this, the mortar will not crumble or

develop hair cracks as time goes on.

9. No extra curing is needed for the mortar prepared with the use of the extract of beetroot as a self-curing agent

and the material is eco-friendly and cost-effective.

10. Self-curing mortar is utilized in situations where the quality of mortar would be badly impacted by the presence

of fluoride in the water, where water is scarce due to drought, or where access to challenging buildings is

limited..

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