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EXPERIMENTAL STUDY ON MECHANICAL PROPERTIES OF INTERNAL CURING AGENT IN CEMENT MORTAR

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ABSTRACT
Investigation study is made on spinach also termed as spinach oleracea stem is a leafy green vegetable plant and the stem is suns dried and taken as powder and used as a natural self curing agent in cement mortar. Its pH value is 7.48. The design grade of concrete was fixed at M40. The main notion behind the usage of spinach as self curing agent is to find out the presence of hydroxyl group in the chemical structure of spinach family. The chemical structure shows that it contains OH functional group. As such, the Spinacia oleracea stem powder selected as internal curing agent possesses hydroxyl group, which is also find out by using Fourier transform infrared spectroscopy (FTIR), x-ray diffraction (XRD). From the above test results molecular structure for the spinach oleracea stem was derived. Spinach is also an effective curing agent and improves the cement hydration, compressive strength, diminishes shrinkage and accelerates the durability of concrete whereas the conventional method needs improvement.

KEYWORDS: Self Curing Agent, Spinach, FTIR, XRD, Durability, Hydration

INTRODUCTION

Concrete is a composite material that comprises of cement, aggregate, and water. It needs a proper curing and moisture contents at a minimum of 28 days for the good heat of hydration and to the desired strength. So that the properties of hardened concrete greatly influenced with the effect of curing and water is one of the most important elements of the earth for the human being and with time potable water quantity is decreasing day by day [1].Over this construction industry demand, a large amount of water for curing purposes to minimize this demand, a concept of self-curing is introduced. The requirement of internal curing initiates directly from the fundamental nature of cement hydration process [2]. The mixture of cement and water reacts to form crystalline and gel hydration products in which water combines into these hydration product generally inhabited less space than water in its bulk form [3]. Because of this low water cement ratio internal curing becomes beneficial as permeability of concrete, rapidly vanishes, which discontinue the percolation of external water from the surface to the interior concrete [4]Curing permits continuous hydration of cement and consequently continues gain in strength, once curing stops strength gain of the concrete also stops[6].Different variables for example wind velocity, relative humidity, atmospheric temperature, ratio of water/cement of the mixture and cement type. Currently a large number of technicalities are introduced with rapid improvement in the mortar technology [7].The utilisation of self curing admixtures is extremely imperative from the view point of water provision needed daily. Addition of polymers in the mixing mainly form hydrogen bond with water particles and decreases the chemical potential of the atoms which thus diminishes the vapour pressure, thus lessening rate of evaporation from the surface[10].

LITERATURE REVIEW

Sarita et al. (2018), have investigated the comparison of the mechanical properties of high volume flyash concrete when it is self cured by synthetic polymer polyethylene glycol and biopolymer spinacia oleracea. The criterion includes the percentage of flyash and dosage of polyethylene glycol and spinacia oleracea and age in curing. Workability, compressive strength and durability were determined as performance specification for this investigation. It was found that spinacia oleracea shows the best results compared to polyethylene glycol.[2]
Anbhazhagan et al. (2017), have investigate the self curing concrete is one of the special concrete in mitigating insufficient curing due to human negligence, paucity of water areas, inaccessibility of structure in difficult terrains and in areas where the presence of fluorides in water will badly affect the characteristics of concrete. This study involves the addition of polyethylene glycol (PEG 400, with weight of cement in different ratios) in concrete and compared with that of conventional cured concrete. The optimum dosage of PEG for maximum strength was found to be 2% for M25 grade and it was found that as the percentage of polyethylene glycol increases, the workability of self curing concrete [3].
Packialakshmi et al. (2014), caralluma fimbriyata an edible succulent cactus belong to the family Apocynacea. Caralluma have found medicinal uses in the treatment of rheumatism, diabetes, leprosy, antiseptics and Disinfectants. The main objective of the study is to observe the salient features exhibited by the Fourier transform infrared spectroscopy the vibration assignments, intensities and wave number of dominant peak were obtained from absorption spectra. Various functional groups like halogen, alkanes, carboxylic acid, aldehydes etc were identified by the various solvent extraction of caralluma fimbriyata [9]

OBJECTIVE

The main objective of this study is to determine the hydration behavior and self desiccation effect of spinach oleracea stem as natural self curing agent in cement mortar and further to the study the strength parameters of self curing concrete by conducting hardened concrete test which helps in the effective hydration resulting in better durability properties.

RESEARCH METHODOLOGY

The methodology is framed according to the goal of the project. Here the methodology is started with reviewing the literatures followed by material collection, material study was analysed through FTIR, HPTLC, and XRD analysis. Based on the analysis reports, molecular structure for the material is framed. From that temperature study, evaporation study for the cement mortar is identified with various mix proportions.

MATERIALS USED

1. OPC Cement
2. Fine aggregate
3. Coarse aggregate
4. Spinach powder
5. Water

1) Cement

Ordinary Portland Cement **(**OPC) of 53 Grade confirming to the specifications given in IS: 12269–1987 is used in this investigation. The properties of cement are found out using various tests carried out as per IS: 4031–1988 and they are listed out in the Table 1

Table 1 .Properties of cement

S.No	Property	Value
1	Type	OPC
2	Grade	53
3	Specific gravity	3.1

2) Coarse Aggregates

Coarse aggregate are the crushed stone used for making concrete **.**Coarse aggregate used in this investigation of size 20mm and specific aggregate of coarse is 2.78.

3) Fine Aggregate

Manufacture sand or M sand is a fine aggregate which is ecofriendly and economical alternative to the river sand. It is manufactured by crushing suitable stones and are finely graded to match the IS standards requirement .The specific gravity of M sand is 2.622.

4) Spinach Powder

Spinach oleracea plant was collected from the perundurai market and the spinach oleracea stem was taken separately and was sun dried and powdered, was used as natural self curing agents in cement mortar with various replacement % by weight of cement and shown in the fig.1

Fig.1 Spinach Powder

5) Water

Water to be used for mixing and curing of mortar should be free from injurious or deleterious materials as per the standards prescribed in IS 3025: Part (1987). Potable water is generally considered satisfactory. In the present investigation, locally available tap water is used for both mixing and curing purposes.

MATERIAL INVESTIGATON AND ANALYSIS
HYDROXYL ANALYSIS

The material study involves in finding out the hydroxyl groups present in the spinach powder which includes the following test are;

1. FTIR
2. XRD

1) FTIR Analysis

The FTIR analysis was carried out in PSG COLLEGE OF PHARMACY, Coimbatore and the fresh plant samples were collected in perundurai market, erode district. Then, the powdered plant material was stored in an airtight container and kept for further studies. 50 g of powdered stem were weighed and extracted with 250 ml of ethanol and water. Then it is kept in an orbital shaker at 190-220 rpm for 48 hours. The supernatant was collected, concentrated and dried. The extracts of spinach oleracea stem were mixed with KBr salt, using a mortar and pestle, and compressed into a thin pellet. The samples were loaded onto FTIR spectroscope and the spectroscopic results were recorded on a Shimadzu FTIR Spectrometer 8000 series, the scan range was between 4,000–400 cm^{-1}.The results of FT-IR spectroscopy confirm the presence of various chemical constituents such as alcohol, alkanes, aromatic carboxylic acid, and halogen compound and alkyl halide in the ethanolic extract of spinach oleracea stem. The peak at the strong instance peaks are identified at 3348.42 and 1643.35 cm-1 which are assigned to the H-bonded and O-H stretching vibration. The peaks at 2090.84, 1990.54 and 1851.66 cm-1 which are assigned to the carbonyl compound frequency vibration is shown. It means that some carbonyl compounds are existed in the ethanolic extract of leaves. The peak at 2854.65 cm-1attributes to symmetric stretching of –CH (CH2) vibration (lipids) and some other groups such as carboxylic acids, nitrile, terminal alkynes, ketone compound, aromatic Compound, phenol or tertiary alcohol, acid, phosphate ions are observed. The results of FTIR analysis confirm the presence of functional groups is shown in table.2

Fig. 2 FTIR instrument

Table 2: Test results for FTIR analysis

S.No	Wave number cm^{-1}	Wave number cm^{-1}	Functional group assignment	Expected Phytochemical indentified
1	2345.44	2248-2376	C=N(stretch)	Nitrile
2	1618.33	1650-1600	C=O Stretching	Ketone
3	1379.15	1410-1310	O-H bond alcoholic compound	Phenol, tertiary alcohol
4	1272.1	1250-1310	C-O stretching	Acid

2) XRD Analysis

The sample has been tested in PSG COLLEGE OF TECHNOLOGY, Coimbatore for evaluating its chemical composition by x-ray diffraction with graphite monochromator. The sample is taken about 5-8gm and the sample is scanned from 2q of 0±80º.The test results confirm the presence of chemicals in the sample is shown in table.3

Table.3 Test results for XRD analysis

COMPOUND NAME	CHEMICAL FORMULA
Calcium Silicate	$Ca_3 (Si_3 O_9)$
Silicon Oxide	$Si O_2$
Calcium Silicate Hydroxide	$Ca_5 Si_6 O_{16} (O H)_2$

MOLECULAR STRUCTURE

A molecular geometry refers to the spatial arrangements of atoms in a molecule and th chemical bond that hold the atoms together, and can be represented using structural formula and by molecular models; complete electronic structure descriptions include specifying the occupation of a molecule's molecular orbital's.Based on the analysis of FTIR, HPTLC and XRD the extract of spinach oleracea stem are rich in bio active compounds such as:

1) p-Coumaric Acid
2) Anthraquinones
3) Flavonoids

1) Molecular Structure for Coumarins

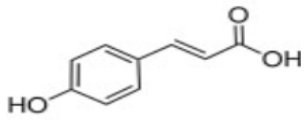

Fig 3: Coumaric Acid

MOLECUALR FORMULA=$C_9H_8O_3$

2) Molecular Structure for Anthraquinones

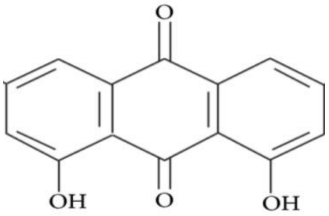

Fig 4: Anthraquinones

MOLECULAR FORMULA=$C_{14}H_8O_2$

3) Molecular Structure for Flavonoids

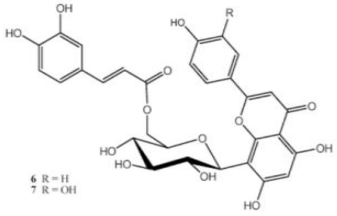

Fig 5: Flavonoids

MOLECULAR FORMULA=$C_{22}H_{19}O_{13}$

MIX PROPORTION

Mix proportion for concrete

The mix proportion for the concrete is made for the mix ratio of M40. Mix design is the process of determining the relative proportions of various ingredients of concrete with the object of producing concrete of certain minimum strength and durability as economically as possible.

Table 4: Material Quantities

MATERIALS	QUANTITY (kg/m3)
Cement	385
Fine Aggregate	862
Coarse Aggregate	1097.096
Water	140

CASTING OF SPECIMEN

Polyethylene mould was fabricated with size of 100mm x 100mm x 100mm and size of the bolt used in the fabrication is 6mm is shown in Fig .7

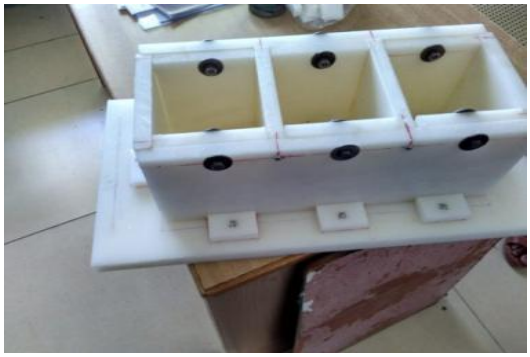

Fig 6: Polyethylene Mould

Fig 7: Mixing & Casting of specimens

COMPRESSIVE STRENGTH TEST& RESULTS

Compressive strength of concrete mixes made with spinach was determined. The specimens (cube) of size 100 mm x 100 mm x 100 mm were kept in oven for 1 day and on removal were tested in dry condition and grit present on the surface.

The load was applied without shock and increased continuously until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained. Testing and failure pattern of cube is shown in fig.8

Fig 8: Testing and failure pattern of cube

Table 5: Compressive strength test results

S.NO	MIX PROPORTIONS	COMPRESSIVE STRENGTH OBTAINED ($N/mm^{2)}$
1	3% spinach97% cement	41
2	5% spinach 95% cement	32
3	7% spinach 93% cement	24
4	9% spinach 91% cement	18

CONCLUSION

1. From the above analysis results such as FTIR, HPTLC, XRD which confirms the presence of hydroxyl ions present in the spinach powder was verified.And here Spinach powder used as a natural self curing agent in concrete.
2. By the various replacement of spinach powder by weight of cement 3%, 5% the compressive strength obtained is $41N/mm^2$, $32N/mm^2$ respectively.

REFERENCE

1) Rajeswari Unnithan, S., Sarah Anil (2017), 'Review on Self Curing Concrete', International Research of Engineering and Technology, Vol.04, No 05,
2)Sarita Sharma, Devesh Jaysawal (2018),'Mechanical Properties Investigation Of High Volume Flyash Concrete Cured With Synthetic And Bio Polymer As Self Curing Agent', International Journal For Research In Engineering Application & Management',Vol 04, No-02.
3) Anbhazhagan., Jagadeesh, B N., Parthiban, G., Thamothiran, R & Devi, S., (2017) 'Experimental Analysis Of Self Curing Concrete By Using Polyethylene Glycol', International Research Journal Of Engineering And Technology, Vol.04, No 10.
4) Aston Jeremiah Richard, N & Freeda Christy, C.,(2013) ,'Experimental Work On Analysis Of Samples Containing Self Curing Agent', Engineering Science And Technology An International Journal, Vol 3,No 2,pp 2250-3498.
5) Daliya, J., Belarmin, G., (2016), 'Effect Of Self Curing Agent On Mechanical Properties Of Concrete', International Journal Of Engineering Research & Technology, Vol 5, No 09, pp 2278-3181.
6) Subashini, S & Sathish Kumar, K., (2017), 'Physiochemical Characteristics of Calcium Oxalate Crystals in Spinacia Oleracea L', Indian Journal of Biochemistry & Biophysics, Vol 54, pp 156-163.
7) Persson, B.,(1999), 'Chemical Shrinkage And Self Desiccation In Portland Cement Based Mortars', Concrete Science And Engineering, Vol 1,pp 228-237.
8) Awham, M., Rawdhan, R., & Mishhadani, A.,(2017), 'Effect Of Self Curing Agents On The Different Properties Of Cement And Mortar', International Journal Of Current Research, Vol 9,No 07,pp 54586-54594 .
9) Packialakshmi, N., & Naziya, S., (2014), 'Fourier Transform Infrared Spectroscopy Analysis Of Various Solvent Extracts Of Caralluma Fimbriyata', Asian Journal Of Biomedical And Pharmaceutical Sciences, Vol 04, No 36, pp 20-25.
10) Persson, B., (2000),'Self Desiccation And Its Importance In Concrete Technology', Vol 30, pp 293-305.