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DURABILITY STUDY ON BEHAVIOUR OF INTEGRAL CRYSTALLINE WATER PROOFING CONCRETE

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ABSTRACT:- *Concrete is most commonly used building materials. Concrete is considered as a micro porous and permeable material. Porosity refers to the amount of voids present in concrete, is expressed in terms of percentage of the total volume of a material. Therefore, these qualities result pathways to form that allow the ingress and movement of water into, and through, along with the cracking that occurs due to shrinkage.*

Integral Crystalline Waterproofing blocks the movement of water through the concrete by plugging or blocking the natural pores, capillaries and micro cracks, and concrete its own waterproofing barrier. This stands in contrast to more conventional means of waterproofing, which usually involves applying a coating or coated to the concrete surface. The process is sometimes also attempted through densification of the concrete Crystalline waterproofing systems rely on a technology that turns porous concrete in to an impermeable barrier.

The result of these technology the structure with reduced cracking, self-sealing and waterproofing abilities which provides a powerful defense against water and resist corrosion of reinforcing steel. In this paper the water crystalline formation is arrested by the partial replacements of cement by GGBS (20%), Silica Fume (10%), Fly Ash(10%) and Rice Husk ash (25%) with addition of CWP agent. This characteristic strength is analyzed by compressive strength of concrete where the replacement is compared with Conventional concrete.

The use of integral waterproofing agent deals with determining how much amount of chemical resistance, moisture penetration and Co_2 absorption by conducting durability test on 14 days.

Key words*: Crystalline Waterproofing Agent CWA, Durability, Co_2 absorption*

1. INTRODUCTION

1.1 Waterproofing

Concrete is currently the most used human made material in the world, used twice as much as all other materials combined. The concrete degradation is the root cause of the issue in the presence of moisture or water within the concrete. The ingress of deleterious substances into concrete takes place through the pore system in the concrete matrix, or through micro cracks.

To ensure a concrete structure's durability, which leads to a longer lifespan and a more sustainable building, the concrete must be waterproofed.

1.2 Integral Crystalline Water Proofing

Integral Crystalline Waterproofing (ICW)technology is based on principles that are very similar to the processes that occur during concrete hydration. These admixtures are added or applied to concrete, crystalline chemicals facilitate a reaction with cement to form long, narrow crystals and filling the pores, capillaries and hairline cracks of the concrete mass. The moisture content remains present, till the crystals continue to grow throughout the concrete. Once the concrete has dried, the crystalline chemicals sit dormant until another dose of water (such as through a new crack) causes the chemical reaction known as crystallization to begin again. The ability to reactivate in the presence of water gives crystalline-treated concrete the ability to improve self-sealing. When cracks form due to drying shrinkage, settling, seismic activity, etc., water entering through them causes new crystals to form and grow, blocking and filling the cracks. Improving the self-sealing ability of concrete is one of crystalline technology's most unique and useful features, and can help to dramatically reduce the long-term maintenance and repair costs of a concrete structure.

Fig :1 Crystalline Water Proofing Agent

1.3Partial Replacement of Cement in Concrete

Concrete is a family of different material like binding material (cement+ fly ash), fine aggregate, coarse aggregate and water. Nowadays, cost of construction is very high with usage of conventional materials due to unavailability of natural

materials. To overcome this, by total replacement of concrete with different material which is not convenient in terms of required properties. The limitation of unavailability of material which plays the vital role of concrete. So we have only choice of partial replacement of concrete ingredients by waste materials. The partial replacement of cement with desirable properties that we can save natural material and reduce emission of CO2 in the atmosphere. The industrial wastes dumping to the nearest site which spoils the land and atmosphere. It also affects the aesthetics of urban environment and so the use of this waste material in concrete is cost effective as well as environment friendly.

2. MATERIAL USED

2.1 Fly Ash

Fly Ash is a fine powder obtained from thermal power plant. It is a coal combustion product and it is also known as Pulverized Fuel Ash as a by-product. The shape of the particles is spherical and the size ranges from 0.5 µm to 300 µm. Fly ash consists of substantial amount of SiO_2, Al_2O_3, CaO. Fly ash as a partial replacement of cement up to 30 % of mass of the cement. It improves the workability of concrete and reduce the emission of Co_2 in concrete.

2.2 Ground Granulated Blast Furnace Slag (GGBS)

Ground-Granulated Blast-Furnace Slag (GGBS) is a cementitious material and it is a by-product of furnaces making iron. It contains a maximum amount of calcium oxide and silica. The physical appearance of GGBS is fine powder and colour is of off - white. GGBS as a partial replacement of cement up to 30-50 %. It increases the durability of concrete. It sets very slowly. It produces the low heat of hydration.

2.3 Silica Fume

Silica fume is an ultra-fine powder collected from by-product of making silicon and ferrosilicon. It consists of spherical particles and the average diameter of particle is 150 µm. It consists of 85 – 95 % of Silicon di-oxide. It increases the compressive strength, bond strength and abrasion resistance.

2.4 Rice Husk Ash

The optimized RHA, by controlled burn and/or grinding, has been used as a pozzoloanic material in cement and concrete. It improves the strength and durability properties, and environmental benefits to disposal of waste materials and to reduced carbon dioxide emissions. The optimum level of RHA added to the cement up to 25% to increase the strength and durability.

2.5 Super Plasticizer (Poly Carboxylate)

Superplasticizers is a chemical admixture and it also high range water reducer. It used in low dosage up to 0.15 % to 3% and they allow to reduce the water up to 40%.it increase the fluidity properties of concrete in low w/c ratio. It improves the compressive strength and flexural strength of concrete.

3.Tests

Compressive strength of concrete is depending on the water-cement ratio, grade of cement, quality of aggregates, and quality control during production of concrete. We carried out the compressive test on cube by various standard codes recommend concrete concrete cube as the standard specimen for the test.

3.1 PARTIALLY REPLACEMENT OF FLY ASH IN CEMENT WITH CRYSTALLINE WATER PROOFING AGENT

Grade of Concrete – M30

Type of Cement – OPC 53

Crystalline Water Proofing Agent – 2 %

Fly Ash – 10 %

Superplasticizer – 1 %

W/C Ratio – 0.4

Consistency of OPC with Fly Ash - 45 %

Initial setting time –110 mins

Slump value –21 mm

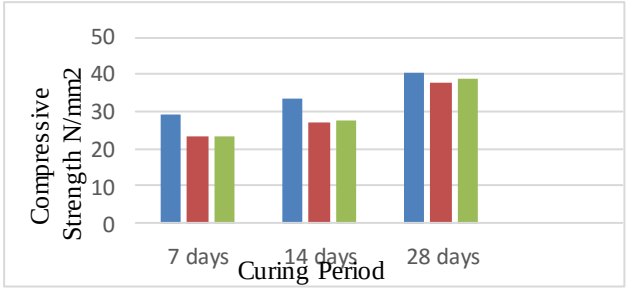
Compaction factor - 0.875

Flow table value – 7.2 %

Vee Bee time - 12 sec

Table 1: Fly Ash with CWA

Days	1	2	3	Average
7 daysN/mm2	29.33	23.55	23.11	25.33
14daysN/mm2	33.725	27.08	27.68	29.49
28daysN/mm2	40.44	37.78	38.65	38.96



Graph 1: Fly Ash with CWA

3.2PARTIALLY REPLACEMENT OF SILICA FUME IN CEMENT WITH CRYSTALLINE WATER PROOFING AGENT

Grade of concrete – M30

Type of cement – OPC 53

Crystalline water proofing agent – 2 %

Silica fume – 10 %

Superplasticizer – 1 %

w/c ratio – 0.4

Consistency of OPC with silica fume – 35 %

Initial setting time – 95 mins

Slump value – 113 mm

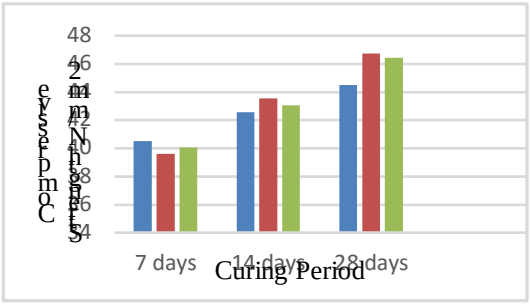
Compaction factor - 0.755

Flow table value – 10.2 %

Vee Bee time - 7 sec

Table 2: Silica Fume with CWA

Days	1	2	3	Average
7 days N/mm2	40.44	39.55	40	40
14days N/mm2	42.50	43.48	43	43
28days N/mm2	44.44	46.67	46.36	45.82



Graph 2: Silica Fume with CWA

3.3PARTIALLY REPLACEMENT OF GGBS IN CEMENT WITH CRYSTALLINE WATER PROOFING AGENT

Grade of concrete – M30

Type of cement – OPC 53

Crystalline water proofing agent – 2 %

GGBS – 20 %

Superplasticizer – 1 %

w/c ratio – 0.4

Consistency of OPC with GGBS – 35 %

Initial setting time –120 mins

Slump value – 96 mm

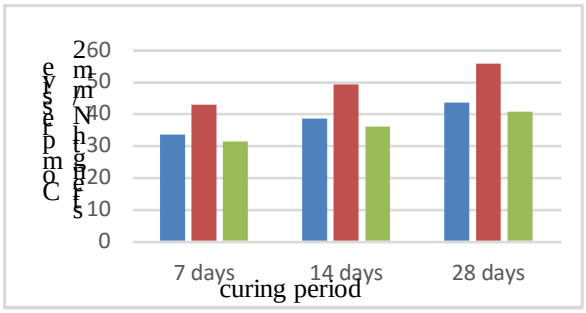
Compaction factor - 0.715

Flow table value – 11.6 %

Vee Bee time - 6 sec

Table 3: GGBS with CWA

Days	1	2	3	Average
7 days N/mm2	33.33	42.67	31.11	35.70
14 days N/mm2	38.33	49.07	35.77	41.06
28 days N/mm2	43.33	55.47	40.44	46.41



Graph 3: GGBS with CWA

3.4 PARTIALLY REPLACEMENT OF RICE HUSK ASH IN CEMENT WITH CRYSTALLINE WATER PROOFING GENT

Grade of concrete – M30

Type of cement – OPC 53

Crystalline water proofing agent – 2 %

Rice Husk Ash – 25 %

Superplasticizer – 1 %

w/c ratio – 0.4

Consistency of OPC with RHA – 55 %

Initial setting time –195 mins

Slump value – 40 mm

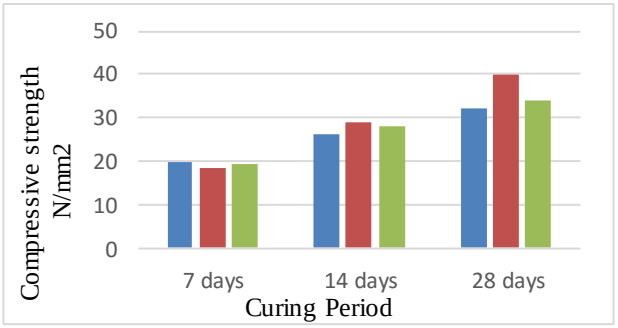
Compaction factor - 0.715

Flow table value – 6.6 %

Vee Bee time - 19 sec

Table 4: RHA with CWA

Days	1	2	3	Average
7 days N/mm2	20	18.22	20	19.4
14 days N/mm2	26.3	28.95	27.94	27.73
28 days N/mm2	32	40	34.2	35.4



Graph 4: RHA with CWA

4. COMPARATIVE STUDY

Four admixtures were taken out (i.e.) Fly ash, GGBS, Silica fume, Rice husk ash and it will be added as a partial replacement in cement. It also includes the addition of Crystalline Waterproofing agent. It will be added to each of the replacement. The replacement is determined by referringjournals and fixed its percentage. (i.e.),

Fly Ash – 10%

GGBS – 20%

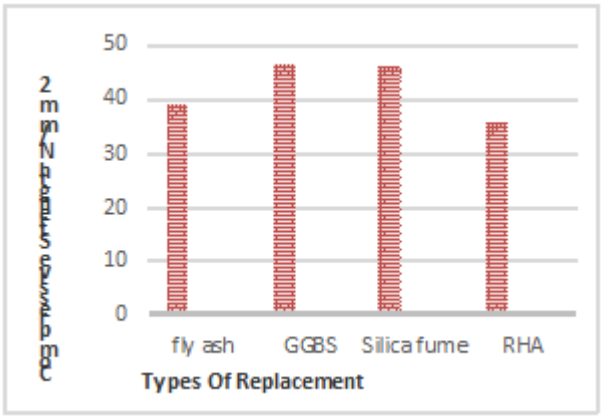
Silica fume – 10%

Rice Husk Ash – 25%

Crystalline Waterproofing agent – 2%

Each replacement, 3 Cubes were casted and tested on 7, 14, 28 days respectively. The addition of crystalline waterproofing agent determines whether the concrete is attaining to reduce its moisture content (i.e.) (filling the voids by growing crystals

in it). It also acts as a self-sealing agent. compressive strength of Fly ash, GGBS, Silica Fume, Rice Husk Ash is computed on following graph.



Graph 5: Comparative Study

5. Durability Test

5.1 Water Absorption Test

In this test, the specimens are dried in an oven for a specified time and temperature and the specimens are weighed W1. The material is then emerged in water at agreed upon conditions, often 23°C for 24 hours or until equilibrium. Specimens are removed, patted dry with a lint free cloth, and weighed W2

Table 5 water absorption test.

S.NO	Type of concrete	WATER ABSORPTION $((W_2 - W_1) / W_1) \times 100$
1	Fly ash	0.34 %
2	GGBS	0.74 %
3	Silica Fume	0.56 %
4	RHA	1.45 %

5.2 Acid Attack Test

Concentration of HCL = 5 % of diluted water

The sample specimen after 28 days moist curing that samples are weighted and immersed in the 5% concentration of HCL solution. After 14 days the samples are weighted and tested on compressive test.

Table 6Acid Attack Test

S.no	Type of concrete	14 days strength N/mm^2	Efflorescence formation
1	Fly Ash	46.22	Moderate
2	GGBS	55.55	Low
3	Silica Fume	44.44	Moderate
4	Rice Husk Ash	35.11	Low

5.3 Carbonation Test

The sample specimens are split and the carbonation indicator sprayed inside of the specimen. The colour change indicates the penetration of co_2.The depth of co_2 penetration is carbonation depth of concrete.

Indicator = phenolphthalein solution

Carbonation Depth On Silica Fume concrete = 13.5 cm

Carbonation Depth OnRice Husk Ash concrete = 15 cm

Carbonation Depth On Fly Ash concrete = 15 cm

Carbonation Depth OnGGBS Concrete = 10 cm

6. CONCLUSION

In this Research paper, Concrete Specimens are tested under Compressive Strength test of concrete, Durability test and Particle size growth of crystal was analyzed by Scanning Electron Microscope(SEM) with various replacements.In this paper, various replacements were done by the partial replacement of Fly ash, GGBS, Silica Fume, Rice Husk Ash with addition of Water Crystalline agent 2%.For each replacement materials were tested by the compressive strength test and the results were shown the graph readings.From this result, the individual replacement is done by three various stages of curing periods and the testing result were compared with conventional concrete cubes.Test results given the optimum strength of compressive strength in all replacement and the Ultimate Strength GGBS with water strength is obtained from crystalline agent of 2%.Durability tests such as Water absorption, Acid attack and Carbonation test conducted on Concrete Specimen and the results indicates the reaction with CWA agent.The tests will be extended to check the duration period with long lasting workability is done by the test of durability. From this, it gives higher value of strength in GGBS replacement compare to another replacement.

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