Topic:

“Advancements in integral Waterproofing Systems”

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Self Healing Concrete

- *God*

Heals anything real or virtual through Time, Space and Energy

Concrete Cracks

- Two major Types
- Cracks in plastic state
- Cracks in Hardened state.

- Both cracks cause problems if left unattended affecting directly

DURABILITY of Concrete structure.

Deterioration will be more damaging if cracks occur in RCC structures.

Limitations of Waterproofing systems

- Most of the waterproofing systems (whether integral or applied post construction) give way over a period of time leading to water penetration and penetration of other contaminants like chlorides, sulphates etc into Concrete through CRACKS causing huge durability problems

- No matter how carefully it is mixed or reinforced, and then placed ,all concrete eventually cracks, and under some conditions, those cracks can lead to collapse.
- It is almost impossible today to ensure 100% crack free concrete both just after placing and during its service life.
- Cracks lead to leakage and eventually damage concrete structures

- All concretes especially Reinforced concrete if have to survive the test of time against weathering agents need to be

CRACK FREE and made IMPERMEABLE.

While somehow you can achieve IMPERMEABILITY , making crack free concrete /mortar is out of question.

- Dr Henk Jonkers worked on the concept of Self healing….that is as and when concrete cracks it will heal by itself.
- This is Biomimicry ie imitating life like a wound on a living organism or a cut on our skin heals by natural process(gets stiched by natural process)

- Dr Henk Jonkers, a microbiologist, began working on it in 2006, when a concrete technologist asked him if it would be possible to use bacteria to make self-healing concrete.
- It took Dr Henk Jonkers three years to crack the problem -- but there were some tricky challenges to overcome.

- "You need bacteria that can survive the harsh environment of concrete," says Jonkers. "It's a rock-like, stone-like material, very dry."
- Concrete is extremely alkaline and the "healing" bacteria must wait dormant for years before being activated by water.

Principle

- The bioconcrete is mixed just like regular concrete, but with an extra ingredient -- the "healing agent." It remains intact during mixing, only dissolving and becoming active if the concrete cracks and water gets in.

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- "The next challenge was not only to have the bacteria active in concrete, but also to make them produce repair material for the concrete -- and that is limestone," Dr Henk Jonkers explains.
- In order to produce limestone the bacilli need a food source. Sugar was one option, but adding sugar to the mix would create soft, weak, concrete.
- In the end, Jonkers chose calcium lactate, setting the bacteria and calcium lactate into capsules made from biodegradable plastic and adding the capsules to the wet concrete mix

- When cracks eventually begin to form in the concrete, water enters and open the capsules.
- The bacteria then germinate, multiply and feed on the lactate, and in doing so they combine the calcium with carbonate ions to form calcite, or limestone, which closes up the cracks.

Applications

- Important public structures like Flyovers, Bridges, Metro , water storage tanks , Nuclear power plants, defence infrastructure buildings, marine structures ,Tunnels and all other concrete structures wherever DURABILITY is of NUMERO UNO importance.

SELF HEALING CONCRETE

-Durable
- -40 %Longer Life Span
- -30 to 40 %Less Maintenance
- -Increase Water tightness

-Sustainable
- -Reduction of raw materials (cement, gravel, sand and steel)
- -Reduction of CO2 Emission

Self-Healing Concrete

- Technology Invented at TU Delft (2006)
- Award winning Technology
- Established in 2014, > 6 years ahead of competition
- 4 Patents World-Wide, trademark registered in EU & Asia
- Right of first refusal new self-healing technology TU Delft

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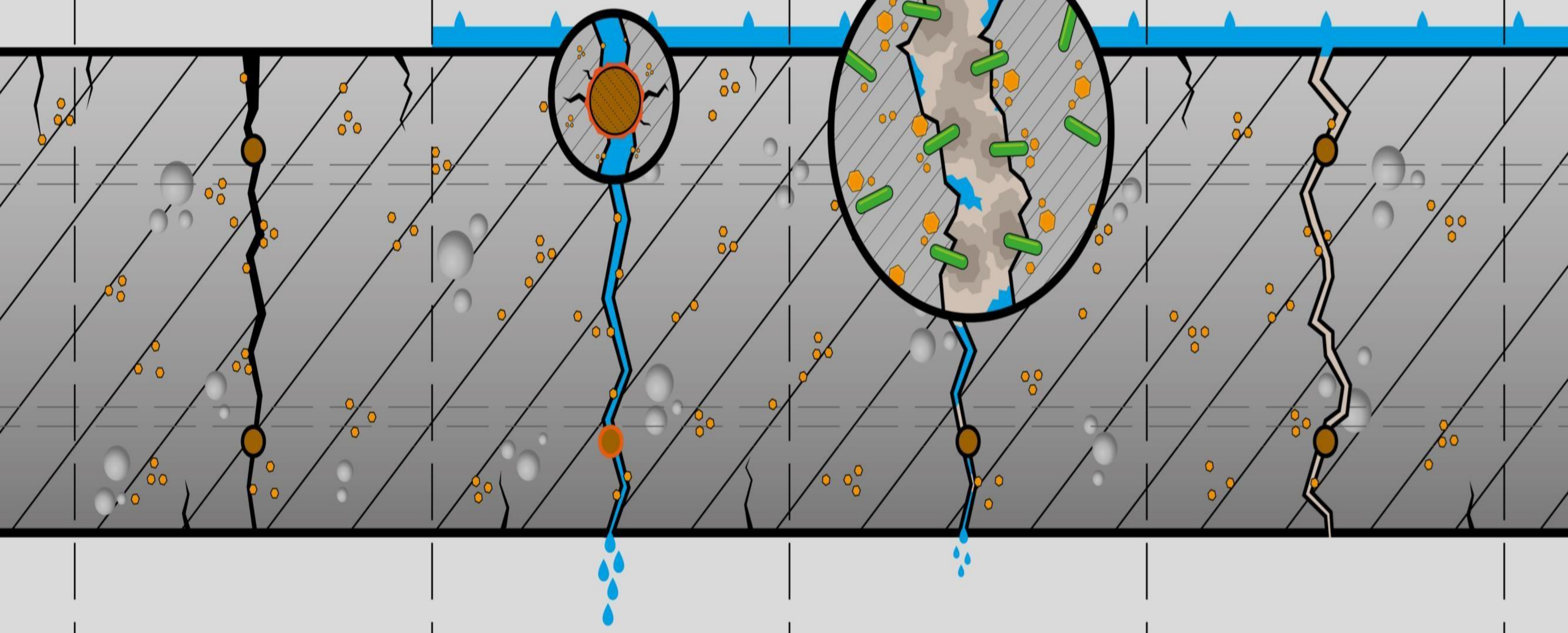

1. CONCRETE CRACKS

Cracking is an accepted and common phenomenon in concrete structures.

2. LEAKAGE & CORROSION

However, cracked concrete may result in serious leakage and reinforcement corrosion issues.

3. AUTONOMOUS REPAIR

When in contact with water, the bacteria will multiply and starts to produce limestone.

4. CRACKS ARE SEALED

Due to the formation of limestone, cracks are autonomously repaired, preventing leakage and protecting the reinforcement.

HOW DOES IT WORK?

Bacteria heal cracks by limestone precipitation!

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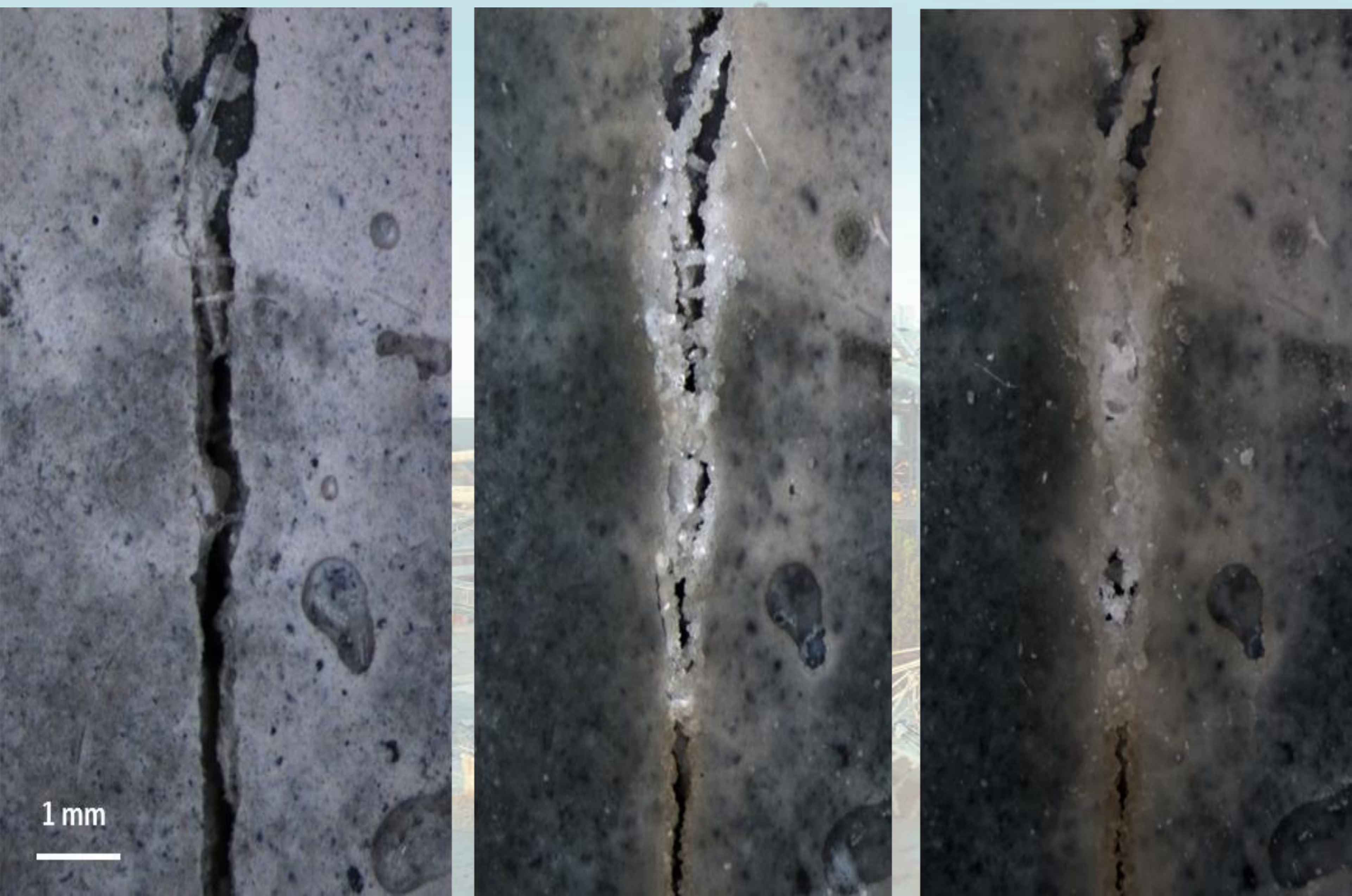

Value Propositions

Extended Life-span

Watertight Concrete

Decrease Failure Costs

Reduce steel rebar

Reduce labor costs

Reduce maintenance

Huge Impact on Carbon footprint;

- **Worldwide: 70 Megaton**

Is there still space for concrete?

Solution:
Reduce the reinforcement

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Reduction of the reinforcement case study

Original Design crack width :0.15 mm

New design with Healing Agent :6 kg/m3

New tolerable crack width :0.25 mm

Potential reduction reinforcement :35%

Potential reinforcement saving :32 kg/m7

Potential CO2 reduction (5000 m3) :320 Mt

Benefits of reducing shrinkage reinforcement by using Healing Agent

- More space for concrete, less risk of defects
- Low Life Cycle Costs
- Easier to apply and therefore lower costs
- Easier to recycle because of less reinforcement
- You have to accept a crack, but relax...it will heal.

Field of application

- Tunnels & Bridges
- Liquid-containing reservoirs
- Basements & Parking garages
- Harbors & Airports
- Marine structures
- Flooring & Parking decks

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Port of Rotterdam

PILOT Virgin Concrete: Marine structures

PILOT Precast Concrete: Waste water tanks

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WATERSCHAPSBEDRIJF
LIMBURG


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evides
industriewater


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evides
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VANDEZANDE
LIEBHERR

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16-11-2020	01-12-2020	14-12-2020	06-01-2021


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BEFORE
AFTER


Have a coffee! That crack will repair itself!
POING!
SUVAAL -2016-

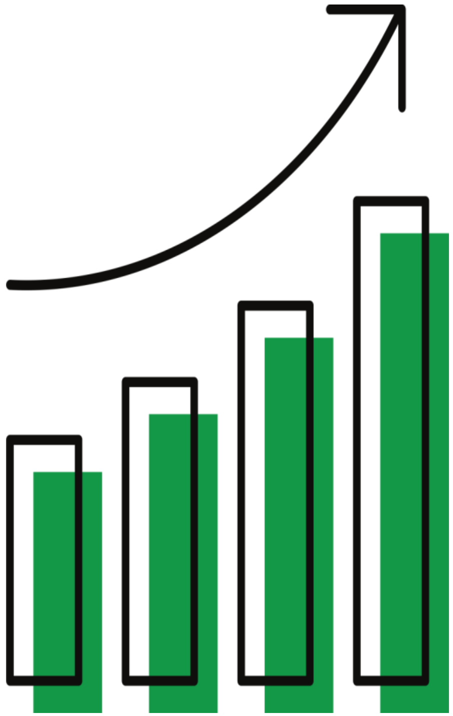
I-CRETE

Next Generation Concrete Additive for enhancing performance and durability

ICRETE - Technology Overview

- Patented concrete additive – Added to the concrete during mixing
- Blend of micro-minerals and activators – Available in powder form
- Chemically reacts with intermediate phases of cement to increase the strength and durability
- Confirms to ASTM C 1797
- Not a Super Plasticizer
- Helps to maximize Strength and Durability

ICRETE - How It Works?



- ✓ By promoting the dissolution of Alumina and Iron present in the supplementary cementitous materials
- ✓ Accelerating the hydration of intermediate phases present in cement
- ✓ Increasing the rate of silicate reaction
- ✓ Forming additional binding phases other than C-S-H

Advantages of Using ICRETE

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1 Increased Strength

2 Decreased permeability
Enhanced Durability

3 Reduced Shrinkage

4 Better economics.

Economically Durable

M25 Grade Concrete Costing (OPC/Fly Ash Mix)

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	Cost/ Tonne	Control Kg/m3	Cost (INR)	With I crete Kg/m3	Cost (INR)
Cement	6000	220	1320	180	1080
Fly Ash	1500	100	150	120	180
I-Crete (0.7%)	36000	0	0	2.1	75.6
20 mm	750	630	472.5	667	500.25
12.5 mm	750	440	330	444	333
Sand	1000	870	870	862	862
Water	0	170	0	171	0
			3142.5		3030.85
Compressive Strength					
7 Days		21.1		20.55	
28 Days		37.05		36.7	
Cost Savings per m3		111.65			

M 30 Grade Concrete Costing (OPC/GGBFS Mix)

	Cost/ Tonne	Control Kg/m3	Cost (INR)	With I crete Kg/m3	Cost (INR)
Cement	6000	180	1080	150	900
GGBFS	3500	180	630	150	525
I-Crete (1.5%)	36000	0	0	4.5	162
20 mm	750	695	521.25	707	530.25
12.5 mm	750	464	348	471	353.25
Sand	1000	773	773	786	786
			3352.25		3256.5
Compressive Strength					
7 Days		30.9		28.4	
28 Days		40.1		41.2	
Cost Savings per m3		95.75			

M 35 Grade Concrete Costing (OPC/Fly ash Mix)

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	Cost/ Tonne	Control Kg/m3	Cost (INR)	With I crete Kg/m3	Cost (INR)
Cement	6000	315	1890	265	1590
Fly Ash	1500	125	187.5	125	187.5
I-Crete (1.3%)	36000	0	0	5.07	182.52
20 mm	750	670	502.5	704	528
12.5 mm	750	359	269.25	359	269.25
Sand	1000	845	845	887	887
Water	0	149.6	0	140.4	0
			3694.25		3644.27
Compressive Strength					
7 Days		32.66		31.03	
28 Days		53.36		56.02	
Cost Savings per m3		Rs. 49.98			

M 50 Grade Concrete Costing (OPC/Fly ash Mix)

	Cost/ Tonne	Control Kg/m3	Cost (INR)	With I crete Kg/m3	Cost (INR)
Cement	6000	424	2544	350	2100
Fly Ash	1500	106	159	150	225
I-Crete (1.5%)	36000	0	0	7.5	270
20 mm	750	766	574.5	789	591.75
12.5 mm	750	326	244.5	336	252
Sand	1000	702	702	722	722
Water	0	153.7	0	140	0
			4224		4160.75
Compressive Strength					
7 Days		49.69		49.46	
28 Days		64.89		66.8	
Cost Savings per m3		63.25			

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Permeability Results of ICrete – As per IS 2645

Water Permeability test as per IS 2645

With 2% BWOC I-Crete

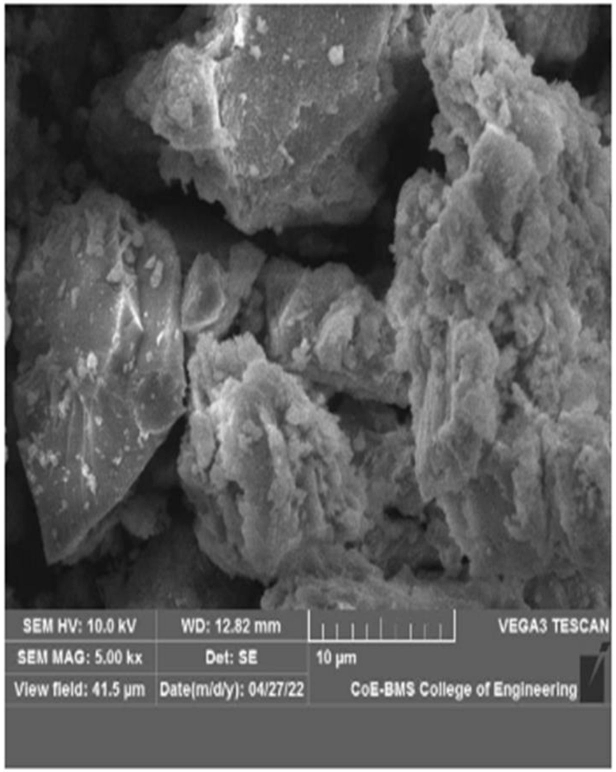
Without I-Crete

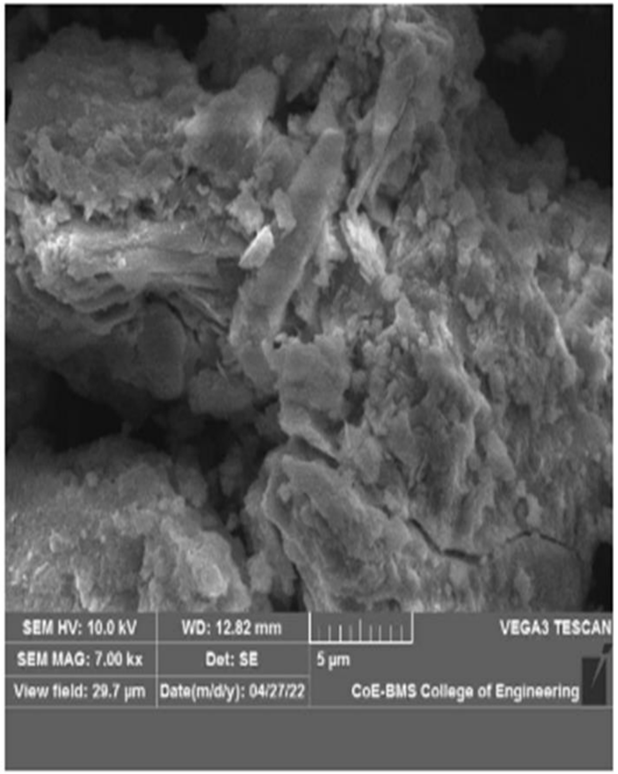
Average water percolation

18%

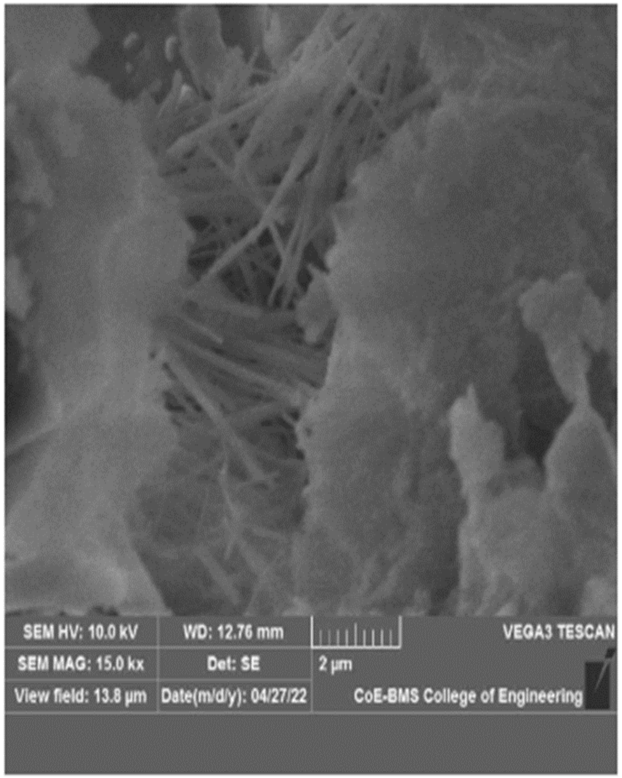
100%

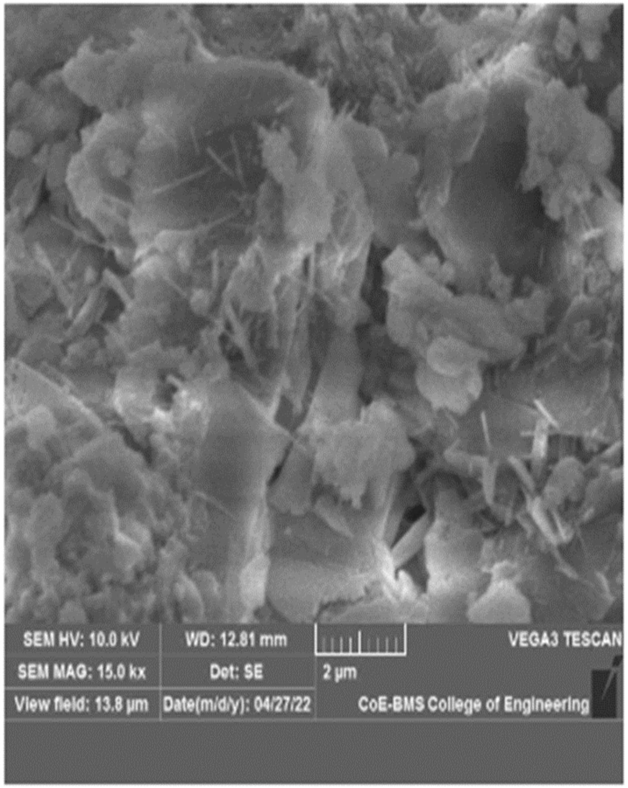
SEM PICTURES – OPC + GGBFS after 28 Days of Hydration





SEM PICTURES OF OPC + GGBFS + 2% I crete





SEM Pictures showing additional crystal growth with I crete, a reason for decreased permeability and improved strength.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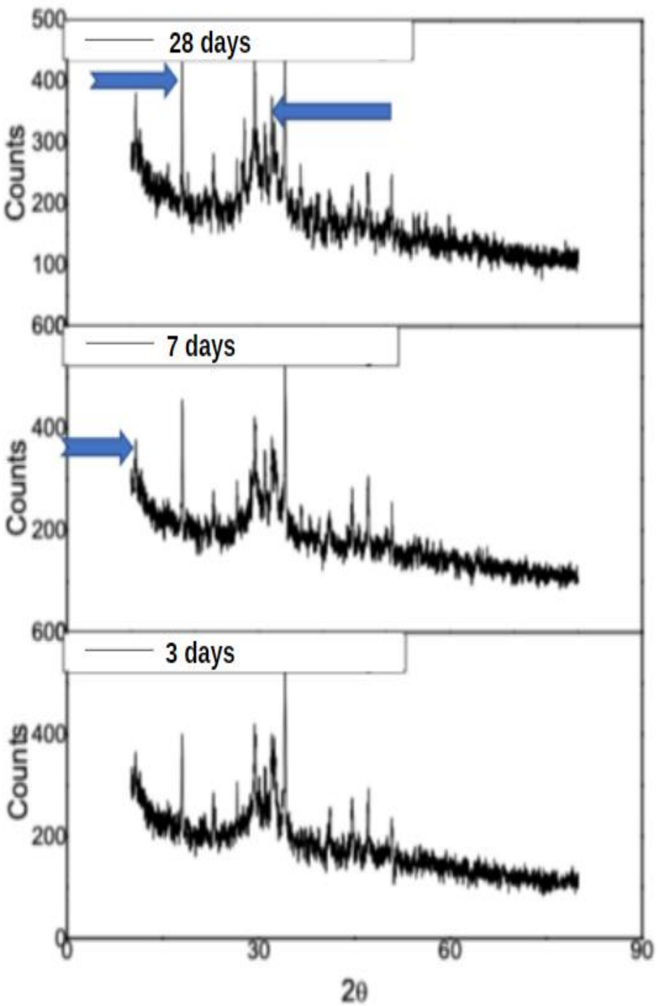
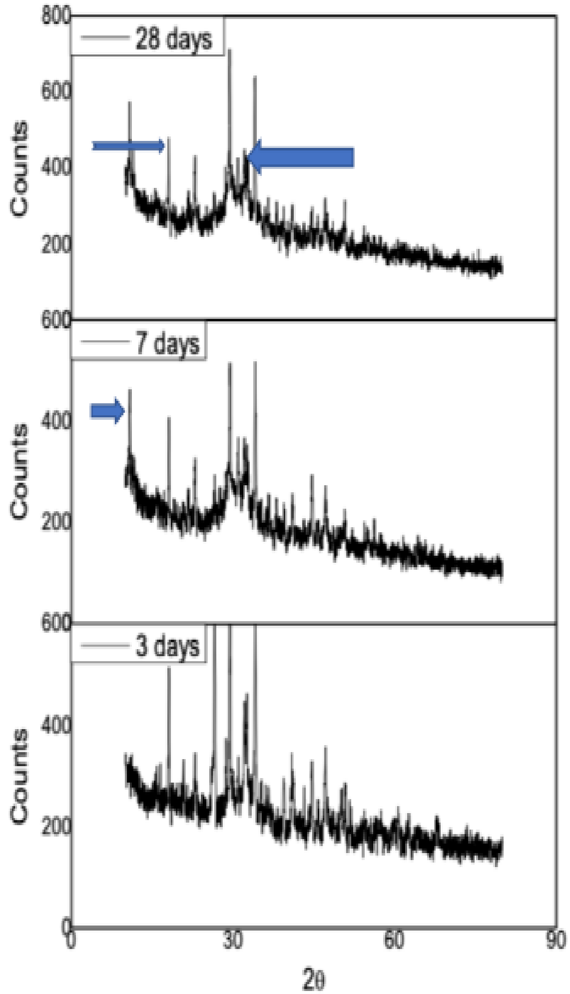
200 nm
EHT = 15.00 kV
WD = 4.7 mm
Signal A = InLens
Mag = 50.00 K X
Date :4 Jan 2023
ZEISS

XRD

OPC + GGBFS



OPC + GGBFS + 2% I crete



- Intensity of Ca(OH)2 peaks are reduced with addition of I- Crete after 28 days.
- At 7 days calcium sulfo-aluminate and C-S-H peaks are more pronounced with I-Crete addition.

THANK YOU

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