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An Experimental Study of Composite Cements with Icrete

(*Icrete Impact on CC1 Vs CC2*)

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Abstract:- This Concrete is the Key building material innovated and upgraded daily basis. Today we consume concrete as the highest material next to the water in terms of volume. The rapid growth of Modernised Urbanisation keeps the demand very high always. No Construction can move forward without modern concrete. Concrete has blended into our daily life. The darker side is the toxic impact it creates on the surroundings. Every ton of cement produced liberates an equal amount of Co2 back into the atmosphere. In terms of percentage, it is about 20 percent of overall carbon dioxide emissions. The global rise in temperature increasing the sea level make the earth a tough place to live. It also causes diseases to human fertility etc. To reduce the negative impacts, we need to move towards sustainable development. The minor contribution of reduction from construction industries can result in a significant reduction overall.

The combination of today's supplementary cementitious materials with triple blend binder (Composite Cement) makes us an Eco-friendly, durable, and cost-effective concrete. The triple blend binders standardize the concrete performance, easing the application of multiple blended concrete. Adding confidence among the engineers, Structural consultants, and end users makes it a fool proof system. The real challenge is the knowledge transfer of the multi-blended concrete.

The myth of making multiple blended concrete fixed. The overall acceptance after the innovative invention of supplementary cementitious materials. Both fresh concrete and hardened concrete properties uplifted to a great level. Today effective utilization is achieved by easing through the stand products. The trend moved toward the performance and durability of structures by increasing the SCM percentage from 15% to 40%. The ideal range of blending is about 40%.

The Ultrafine SCM (Icrete) enables and uplifts the performance of Multi blend binder much better than Ordinary Portland cement performance. This experimental study helps to have a clear understanding. Finally, the concrete was studied using the multi-blend binder and Icrete.

- **The standard single component Multi blend binder makes us easier to use.**
- **The Multi blend binder improves the fresh concrete and hardened concrete properties.**
- **The multi-blend binder with Icrete makes the concrete suitable for all major applications.**

Keywords:- *Compostie cement; triple blend concrete,Early strength,Icrete impact; Durable concrete structures, Modern blended concrete.*

I. INTRODUCTION (AN EXPERIMENTAL STUDY OF COMPOSITE CEMENTS WITH ICRETE)

This Cement, SCM, CSS (Crushed stone sand), CA (Coarse aggregate), Chemical admixture, and water make modern concrete. The concrete performance depends on the Binder performance. The novel concrete binder helps improve the performance of Concrete structures. Today all the aspects (design to execution) of novel concrete properties are analysed. This multi-blend modern concrete makes the complex design simple and possible. The success is to take innovation even to the general site.

The modern multi-blend cement composite cement will act as the key to making multi-blend concrete at sites. The Tertiary Concrete Mixtures using Composite cement consist of fly ash, slag, or Silica. CC1 (CEM, GGBS & Slag) & CC2 (CEM, GGBS & Micro silica) has been used. This multi-blending in binder helps to improve the fresh and harden concrete properties. The additional properties like early compressive strength and durability are reinforced in structure drastically through the addition of Supplementary cementitious material (SCM (Icrete)). The concrete performance has been studied both in CC1 & CC2. M60 Grade has been taken as a reference grade, as it is across projects. The lower concrete will satisfy its acceptance parameters.

II. EASE TO USE

A. Handling multiple Supplementary cementiitous materials (SCM0

First, the single-component composite cement enables standardizing the properties of multiple blend cementitious materials. In addition, the handling of three different materials becomes stress-free at the site and more standardized way. The standardized composite cement gives

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a measurable uniform performance of multiple SCM binders, enabling better control of concrete properties.

As the basic concrete properties are controllable while using composite cement, it becomes a base to get better durability and advanced properties of concrete. The concrete trial using Composite cement CC1 and CC2 were taken along with Icrete. The impact in concrete while using Icrete was verified, The Icrete is the new SCM to improve concrete properties. Icrete is a **Ground calcium carbonate GCC a type of ground limestone ASTM C1797-17.** Icrete reacts during the early age of cement hydration to increase its strength by suspension the impact of Alumina and Iron present in the supplementary cementitious materials.

- Silicate reaction improves drastically.
- Making additional binding phases along with C-S-H.

The reactivity takes place in optimized content and economizes the cost of concrete. The sustainability and durability are much better due to particle size distribution. **The recommended dosage is 0.7 to 2.25% based on its application requirements.**

III. EXPERIMENTAL WORK

Two different Composite Cements (Triple blend cement) has been taken for the initial study. The concrete behaviour with respective workability (Slump & Flow), Compressive, Flexural strength and durability (RCPT & Water absorption) was studied.

The composite cement confirming to IS 16415: 2015. The above listed 2 detailed cases has been studied and compared. The combination of CC1 vs. CC2 along with Icrete proportion such as 2.5 and 5 has been studied.

Case 1) Composite cement CC1 M60 Grade of concrete with high Icrete. 3 Mixes (0%, 2.5% & 5%)
CC1 (OPC 60 +Slag 22 +PFA 18)

Case 2) Composite cement CC2 M60 Grade of concrete with high Icrete. 3 Mixes (0%, 2.5% & 5%)
CC2 (OPC 60 +Silica 20 +PFA 20)

A. Workability & Flow

Workable concrete means the concrete which can be placed and can be Workability means the easiness of handling concrete. Workability properties involve the initial stage of mixing, producing, transporting, pumping, and placing concrete. In conventional construction structures, the ideal workability is 130 +/-20 Slump. Modern construction methods call for higher workability, which is otherwise known as the flow of concrete. Say 550 MM flow during the placing period. The closed-form work system has been the trend of the modern era because of its commercial and technical advantage. The speed and finishing with minimal labor expenses encourage such a system of construction. The slump is measured in MM.

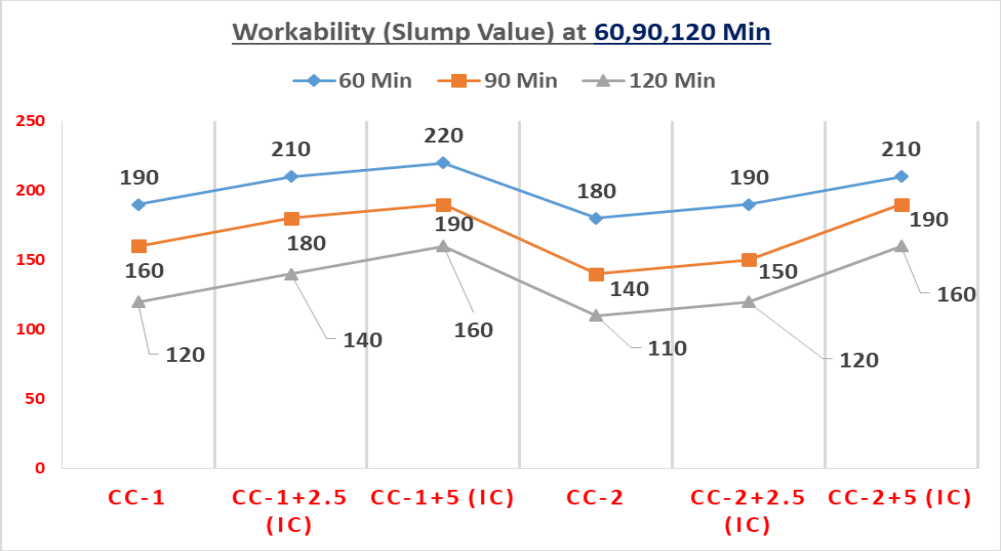

Fig. 1: Workability (Slump Value) at 60, 90, 120 Min

Retention was observed for 120 Min from the time of mix of water. The CC 1 Cement showed better workability than the CC-2 cement initially. However both the cement behavior was same at 120 Min.

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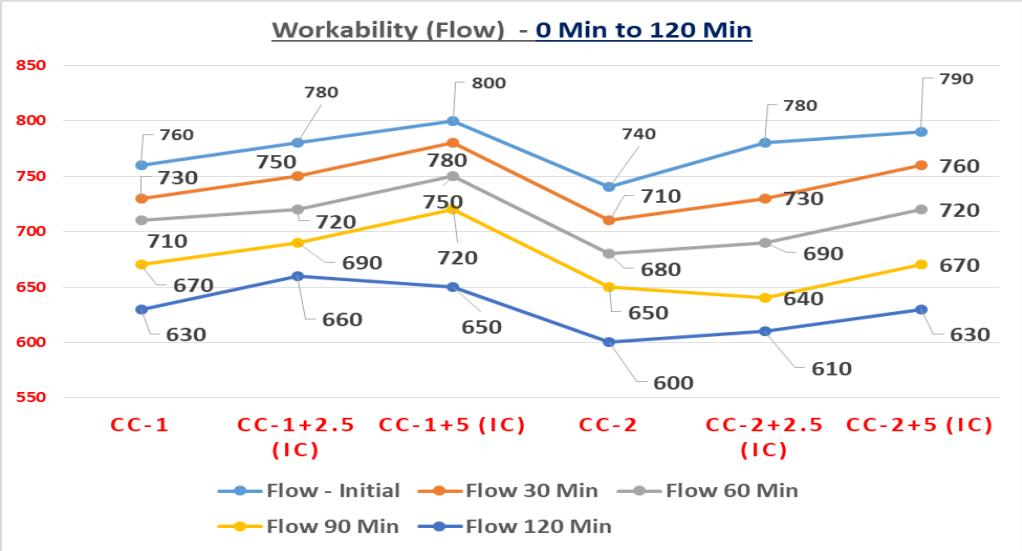

Fig. 2: Workability (Flow) – 0 Min to 120 Min

In terms of flow and Retention at 120 Min from the time of mix of water. The CC 1 Cement showed better workability and retention.

B. Compressie Strength

The ability of the concrete to take the compressive load without any fracture or failure is known as compressive strength. The CS varies from 5 – 100 Mpa etc., based on the structural load. This capacity shows how well the concrete has been produced and placed. CS is the ratio between the cross-section of the member and the load applied. Generally, Compressive strength is a sample using a cube specimen of dimension 150 MM or 100 MM height or a cylindrical specimen of height 300 MM. Compressive Strength = Load / Cross-sectional Area.

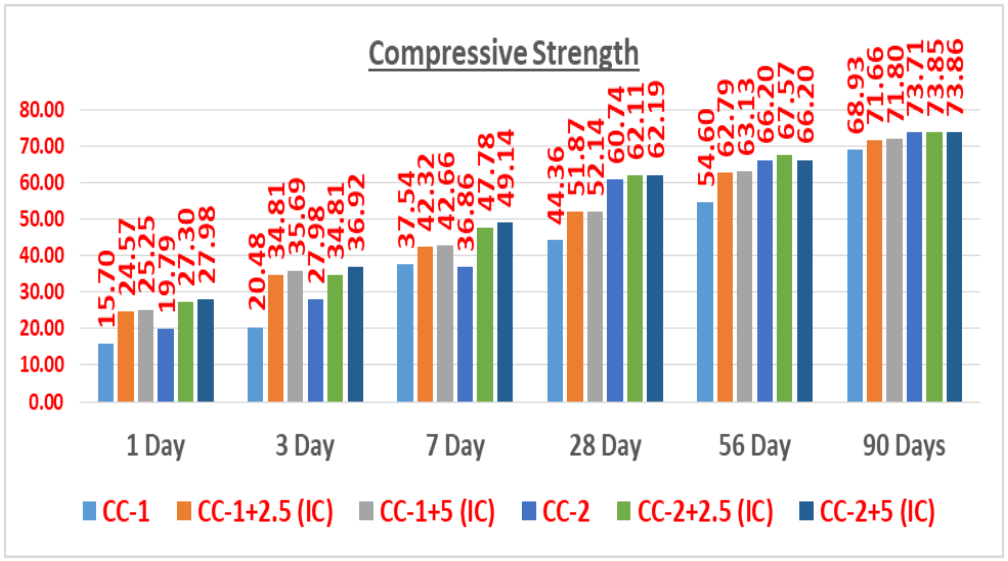

Fig. 3: Compressive Strenght

- CC2 Cement had better results than CC1 cement. This is due to the addition of silica fume as a 3rd supplementary cementitious material in cement.
- Icrete improves the initial strength at early age 1, 3 & 7.
- The compressive strength at 1 days is significantly improved by using the mineral additive (Icrete).
- CC 1 or CC 2 can be used up to M 30 grade. CC2 is ideal for concrete M 35 and higher grade.
- CC 2 can be worked as a replacement of OPC 53 cement.

C. Flexural strength

The flexural strength of concrete is one measure of the tensile strength of unreinforced concrete. It refers to the ability of the concrete beam or slab to resist bending while testing. The Modulus of Rupture (MR) gives flexural strength. As with compressive strength, the flexural strength of concrete is another crucial property of concrete. The flexural strength of concrete is usually a lot lower than its compressive strength (between 8-10% of the compressive strength).

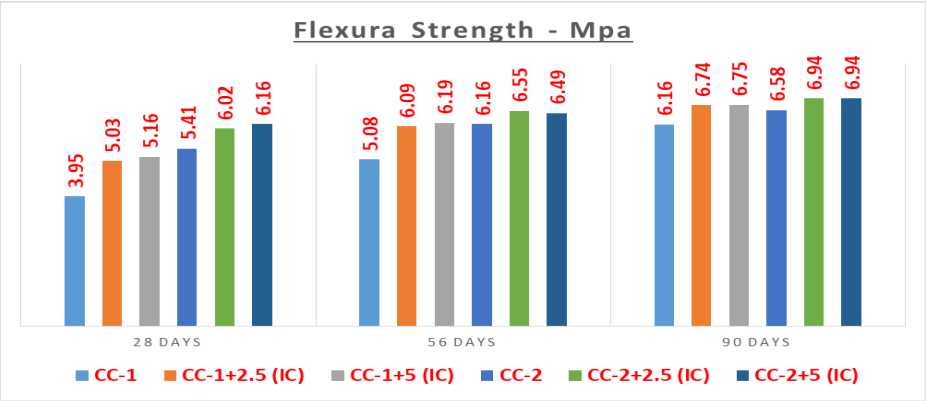

Fig. 4: Flexura Strenght – Mpa

D. Durability (Waterperability & RCPT)

- The tightness of concrete can be determined by the Water absorption test that is far the concrete is denser. This test is done as per the guideline BS 1881 concrete testing. The amount of penetrated water into the concrete while is kept submerged in water. The lower the value of absorption, the better the denseness and durability.
- *Water absorption test has its limitation as it depends on the hydration of cement rather that any reactive process.* Hydration depends on various factors such as Cement, SCM type, cementitious quantity content, W/C ratio, Workability, Voids and ambient, etc. To narrow down the variation it is ideal to take the long-term testing for acceptance, such as 56 and 90 days gives accurate results as compared to 28 days. In the end, we try to get absolute results in this process. The prominence of concrete durability cannot be misjudged, especially when trusting to build a sustainable concrete structure that will last well into the future.

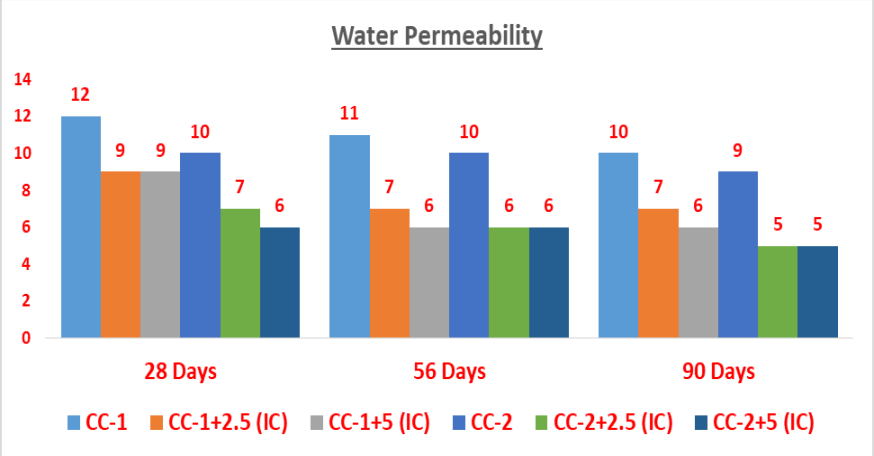

Fig. 5: Water Permeability

- Icrete incorporation make the concrete denser and durable. In later stage i.e. above 56 days.
- Both Composite cement shows better durability properties by the addition of Icrete.

E. Rapid chloride penetration test

- The RCPT test guided through the code ASTM C 1202. The unit of measurement is Coulomb. Ampere is the unit for measuring the current, so Coulomb (ampere/second). The higher the coulomb, the permeability or voids is higher and vice versa.
- This test requires RCPT Test equipment with two reservoirs. One reservoir with NaCl solution of 3.0% and the other with NaOH 0.3M solution. The Concrete Specimen dimension shall be with a thickness of 50mm with a dia of 90-100mm.
- The ability to resist the Chloride ions penetration is the RCPT value. The voids in the concrete surface or core determine the life of the concrete structure. The dense concrete voltage that passes through would be lower. That means the concrete has high durability. The current passed for 6 hours.
- CC1 Composite cement shows slightly better reading as compared with RCPT.

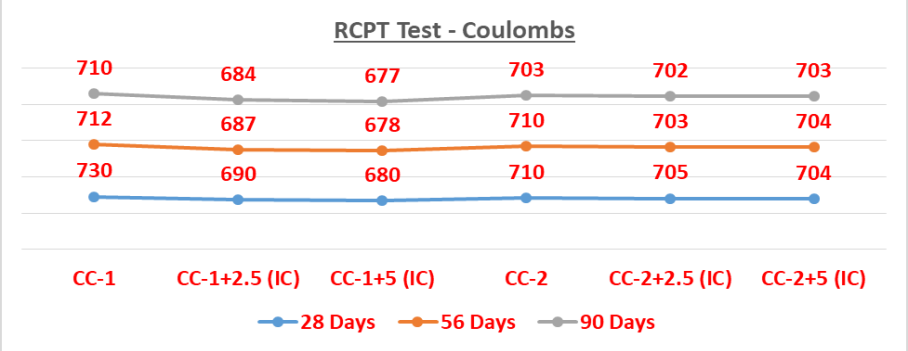

Fig. 6: RCPT TEST – Coulombs

IV. RESULT AND CONCLUSION

The modern composite cement are going to be the key future factor for making durable structure. The incorporation of new generation ultra-fine materials helps to improve the properties of concrete in the initial stage. This booster will encourage the designer to think of using the multi blend concrete. The initial parameters of composite cement shall be uplifted in future by seeing the more field results.

Our study reveals that the triple blend cement shall be used for structural concrete application without any hesitation. The knowledge about the application of multi blend concrete needs to be spread among the designer, engineer and end-users. The multi blend concrete has multiple advantage of technical (high flow, self-levelling, high strength, Durable), and functional (Less pores, Smooth finish, low heat, less shrinkage) etc.

The workability in terms of flow CC1 is better. In terms of compressive strength and flexural strength CC2 is better than CC1. CC2 can be the ideal replacement of OPC 53. As the multi blend cement are durable both are equally better in durability aspect.

The CC2 showed the slight better performance as expected because of higher mortar strength over CC1 cement. Both the cement shall be used for concrete application. The choice of CC2 would be preferred when the grade of concrete is higher.

Further multi blend cement's study and ultra-fine inclusion guide will definitely give us the knowledge to improve the application of multi blend cement. There by the structure shall be more durable at optimal cost. The future wide range of scope is available to arrive the guide line using modern additives with the combination of multi blend concrete. The durability aspects are taking its importance at present, this has to be expanded widely across all projects and applications. This also support to upgrade the future trends like precast and pre stress by reducing the shrinkage and increasing the life span of the element. The costing can also greatly reduced when it is used in large scale. This eco-friendly development will help the construction to be more suitable.

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