Increasing Profits of Ready-Mix Concrete by Using Cutting-Edge New Additive

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**Abstract**

A new revolutionary patented additive for concrete was used in series of trials to check for its suitability to Ready-mix Concrete industry. Commercial production of Concrete was also taken up to check the fresh and hardened properties of additive incorporated concrete. The study showed that additive (commercially known as ICRETE) showed impressive results in concretes as it demonstrated comparable strengths even at reduced Cement contents. In addition the striking feature of the product is to improve the profits for Ready-mix Concrete producer, without affecting the quality & durability.

**Keywords:** Ready-Mix Concrete, Profits, Quality, Durability, Additive.

**Introduction**

The recent times showed that Covid19 had almost irreversible effects on lives of not only individuals but also many organizations. The Ready-mix Concrete industry is an abused child in the construction industry, whose growth was further crippled by Covid 19 lock down. In such testing times, ICRETE was extensively tested to check its benefits for the Ready-mix Concrete. Initially both fresh and hardened properties were studied in reputed 3rd party laboratory. The fresh properties and hardened properties were found to be satisfactory. At this stage authors took the next step of exploring the possibilities of measuring the Cost benefits/savings on the material cost for each m3. This exercise was basically aimed to quantify the savings both in laboratory and field conditions in Ready-mix Concrete industry. The product in question is in powder form, a grayish color powder.
Materials
For the study 53 GRADE cement conforming to IS 269 was selected. GGBS was taken from JSW. The crushed aggregates and manufactured sands were used after checking all properties. The novel additive ICRETE properties have also been given. All the trails were conducted with a pre-selected PC based Hyperplasticiser. All the trials and production was repeated with same sources of ingredients.

Table 1: Chemical & Physical Properties of Cement

| S.No | Particulars                          | Test Results | Specifications as per IS: 269:2015 |
|------|--------------------------------------|--------------|------------------------------------|
| A    | Chemical Requirements                |              |                                    |
| 1    | LSF (Lime Saturation factor)         | 0.89         | 0.8-1.02                           |
| 2    | Alumina Modulus                      | 0.82         | Min 0.66                           |
| 3    | Insoluble residue (%)                | 4.19         | Max 5.0                            |
| 4    | Magnesia (%)                         | 1.76         | Max 6.0                            |
| 5    | Sulphuric Anhydride (%)              | 2.67         | Max 3.5                            |
| 6    | Loss on Ignition (%)                 | 3.41         | Max 4.0                            |
| 7    | Chloride Content (%)                 | 0.021        | Max 0.1                            |
| 8    | Tricalcium Aluminate                 | 4.08         |                                    |
| B    | Physical Requirements                |              |                                    |
| 1    | Specific Surface Area (M$^2$/Kg)     | 311          | Min 225                            |
| 2    | Normal Consistency (%)               | 25           |                                    |
| 3    | Soundness (a) Le Chatelier (mm)      | 1            | Max 10                             |
|      | (b) Autoclave (%)                    | 0.04         | Max 0.8                            |
| 4    | Setting Time (Minutes)               |              |                                    |
|      | (a) Initial                          | 150          | Min 30                             |
|      | (b) Final                            | 210          | Max 600                            |
| 5    | Compressive Strength (Mpa)           |              |                                    |
|      | (a) 72±1h                            | 33           | Min 27                             |
|      | (b) 168 ± 2h                         | 43           | Min 37                             |
|      | (c) 672 ± 4 h                        | 56           | Min 53                             |

Table 2: Chemical & Physical Properties of GGBS

| S.No | Characteristics                  | Test Results | Specifications as per IS: 269:2015 |
|------|----------------------------------|--------------|------------------------------------|
| A    | Chemical Requirements            |              |                                    |
| 1    | Manganese Oxide (MnO) %          | 0.1          | 5.5 Max                            |
| 2    | Magnesium Oxide (MgO) %          | 7.69         | 17.0 Max                           |
| 3    | Sulphide Sulphur (S) %           | 0.44         | 2.0 Max                            |
| 4    | Sulphate (as SO3) %              | 0.22         | 3.0 Max                            |
| 5    | Insoluble residue (I R) %        | 0.39         | 3.0 Max                            |
| 6    | Chloride Content (CI) %          | 0.009        | 0.1 Max                            |
| 7    | Glass Content %                  | 92           | 85 Min                             |
### Table 3: Aggregate Properties

| IS Sieve Designation | Cumulative % Passing 20mm | Cumulative % passing 12.5 mm | Crushed Stone Sand | Cumulative % passing when 20mm & 12.5mm are mixed in 35:35:30 Ratio | Requirements as per IS:383-2016 (Table 10) |
|----------------------|--------------------------|-----------------------------|--------------------|-------------------------------------------------|------------------------------------------|
| 80 mm                | 100                      | 100                         | 100.00             | 100.00                                          | -                                       |
| 40 mm                | 100                      | 100                         | 100.00             | 100.00                                          | 100                                     |
| 20 mm                | 89.7                     | 100                         | 100.00             | 96.40                                           | 95-100                                  |
| 4.75 mm              | 0                        | 1.2                         | 100.00             | 30.40                                           | 30-50                                   |
| 0.6 mm               | 0                        | 0                           | 47.70              | 14.30                                           | 10.0-35.0                              |
| 0.15mm               | 0                        | 0                           | 17.70              | 5.30                                            | 0-6                                    |

![Figure 1: All in aggregate grading Curve](image)

### Table 4: Properties of ICRETE

| SL No. | Parameters                                             | Testing Protocol | Results | ASTM C1797 |
|--------|--------------------------------------------------------|------------------|---------|-------------|
| 1      | Particle size % by mass passing in 45 micron Test sieve by wet sieving method | ASTM C117        | 90.5    | 90 Min      |
| 2      | Bulk density (Loosed) gm/cc                            | -                | 0.75    | -           |
| 3      | PH in 10% Solution at 28 deg. C                        | -                | 9.9     | -           |
Experiments

The lab experiments and later Real Time Ready-mix Concrete production were done to examine the efficacy of Novel additive for concrete against bench mark Ready-mix concrete mixes. Series of Trials were done in Laboratories of many ready-mix Concrete companies in Bangalore, Mangalore, Cochin. The production of concrete using same mixes was done later. The mixes are given as below. The mixes with coding IC, means mixes incorporated with ICRETE. In general the net profit per m3 of Ready-mix Concrete in a professionally managed Ready-mix Concrete company is said to be 125 to 200Rs/m3.

Table 5: Mix Design

| Mix Design | Unit | OPC 1 | OPC (IC) 1 | OPC 2 | OPC (IC) 2 | GG 3 | GG (IC) 3 | GG (IC) 4 | GG (IC) 5 |
|------------|------|-------|------------|-------|------------|------|-----------|-----------|-----------|
| Opc        | Kg   | 340   | 300        | 370   | 330        | 160  | 140       | 108       | 120       |
| GGBS       | Kg   | 0     | 0          | 0     | 0          | 160  | 140       | 162       | 180       |
| 20mm       | Kg   | 583   | 597        | 598   | 613        | 589  | 599       | 595       | 591       |
| 12.5mm     | Kg   | 467   | 478        | 485   | 497        | 472  | 480       | 487       | 474       |
| M Sand     | Kg   | 852   | 875        | 810   | 830        | 862  | 880       | 890       | 868       |
| Water      | Kg   | 155   | 150        | 150   | 145        | 148  | 148       | 145       | 150       |
| Admixture  | Kg   | 1.53  | 1.5        | 1.85  | 1.65       | 1.44 | 1.12      | 1.08      | 1.2       |
| Icrete     | Kg   | 0     | 3          | 0     | 3.3        | 0    | 2.8       | 4.05      | 2.1       |
| Slump at 2 Hrs | mm | 140 | 135 | 130 | 145 | 140 | 130 | 150 | 135 |
| 7 Days Compressive Strength | Mpa | 25.1 | 26.7 | 30.6 | 30.2 | 20.79 | 20.9 | 19.4 | 20.7 |
| 28 Days Compressive Strength | Mpa | 32.8 | 33.7 | 41.6 | 43.8 | 32.84 | 33.19 | 32.76 | 31.7 |

Table 6: Savings

| Mix Design | Unit | Rate/ Kg | OPC 1 | OPC (IC) 1 | OPC 2 | OPC (IC) 2 | GG 3 | GG (IC) 3 | GG (IC) 4 | GG (IC) 5 |
|------------|------|----------|-------|------------|-------|------------|------|-----------|-----------|-----------|
| Opc        | Kg   | 4.5      | 340   | 300        | 370   | 330        | 160  | 140       | 108       | 120       |
| GGBS       | Kg   | 3.75     | 0     | 0          | 0     | 0          | 160  | 140       | 162       | 180       |
| 20mm       | Kg   | 0.7      | 583   | 597        | 598   | 613        | 589  | 599       | 595       | 591       |
| 12.5mm     | Kg   | 0.7      | 467   | 478        | 485   | 497        | 472  | 480       | 487       | 474       |
| M Sand     | Kg   | 0.7      | 852   | 875        | 810   | 830        | 862  | 880       | 890       | 868       |
| Water      | Kg   | 0.05     | 155   | 150        | 150   | 145        | 148  | 148       | 145       | 150       |
| Admixture  | Kg   | 46       | 1.53  | 1.5        | 1.85  | 1.65       | 1.44 | 1.12      | 1.08      | 1.2       |
| Icrete     | Kg   | 33       | 0     | 3          | 0     | 3.3        | 0    | 2.8       | 4.05      | 2.1       |
| Mix Cost   |      | 2940     | 2891  | 3083       | 3035  | 2740       | 2678 | 2664      | 2700      |
| Savings    |      | 49       | 48    | 62         | 75    | 40         |      |           |           |           |
Results

OPC1, OPC2, GG3 (Bench mark mixes) showed similar slumps to that of Cement Reduced ICRETE incorporated mixes. The novel additive did not change the workability and those mixes were found to be fit for pumpable mixes. Even at a reduced Cement content of 40kg/m3, the OPC(IC) mixes showed almost similar strengths. Table VI gives savings per m3 due to use of ICRETE.

Conclusions

• Based on both lab trials and Production results, we can see a saving of Rs 40 to 75Rs in various low to medium strength concretes. This translates to 32% to 60% increase in Net profit on lower end of Net profit and 20% to 37.5% increase on the higher end of net profit, when a normal 125 to 200Rs/m3 net profit is considered. Based on this even a worst case scenario of 20% jump in net profit is a big boost to a cash starved Ready-mixOrganization or any Readymix company.
• The Cement (Cementitious)Reduced Icreteincorporated mixes have equally performed in terms of both slump& strength compared to reference Concrete.
• As any cement(Cementitious) reductions, means lesser OPC usage, the concretes become more sustainable by using ICRETE.
• The 3RD PARTY reports (which are not added part of this article) also depicted the said additive reduces permeability and all other durability properties are improved.
• The Ready-mixCompanies after using ICRETE reported reduced plastic shrinkage cracks, which is another benefit of using the product.

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References

1. IS: 10262-2009, “Concrete Mix Design - Guidelines”, Bureau of India Standard, New Delhi.
2. A Oner, S Akyuz, An experimental study on optimum usage of GGBS for the compressive strength of concrete, www.sciencedirect.com, Cement and concrete composites 29 (2007) 515-514
3. IS 16714:2018: Ground Granulated Blast-Furnace Slag for Use in cement, concrete and Concrete and Mortars -specification, Bureau of Indian Standards, New Delhi, India.
4. ASTM: C 989-04, “Standard Specification for Ground Granulated Blast-Furnace Slag for use in Concrete and Mortars”, ASTM, America.
5. Manjunatha, L. R., & Anvekar, S. R.(2015) Transition of Concrete Industry From Cement to Eco Friendly Industrial by-Products for Sustainable Green Growth in the Indian Construction Industry. https://www.researchgate.net/publication/283350119
6. L.R. Manjunatha, Sandhya. R. Anvekar, M.V. Yogananda (2014). Recent Developments in the Indian Concrete Industry in the Use of GGBS in Concrete at RMC Batching Plants as Partial Replacement to OPC Cement and its Effects on Concrete Durability and Sustainabilty In the Indian Context. December 2014. Conference: International congress on durability of Concrete. Volume: 1. DOI:10.13140/2.1.3123.3609
7. Raghavendra Y. B, Y. Ramalinga Reddy (2019) “Optimum usage of GGBS in Ready Mix Concrete Industry”. International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-8 Issue-6, August 2019 .pages 4542 -4553. Retrieval Number F8861088619/2019©BEIESP DOI: 10.35940/ijeat.F8861.088619
8. Manu Mohan, Dr. Elson John (2020) Study on Slump Retention of Ready-Mix Concrete: A Review. pages 1784-1789, International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 07 Issue: 07 | July 2020 www.irjet.net p-ISSN: 2395-0072

9. Kanta Naga Rajesh, Ponnada Markandeya Raju, Kapileswar Mishra, Pavan Kumar Madisetti (2019) A review on sustainable concrete mix proportions. Pages 1-10, International Conference on Sustainable Systems and Structures (ICSSS 2019) IOP Conf. Series: Materials Science and Engineering 1025 (2021) 012019 IOP Publishing doi:10.1088/1757-899X/1025/1/012019

10. IS: 516-1959, “Methods of Tests for Strength of Concrete”, Bureau of India Standards, New Delhi.