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Optimization of Ready Mix Concrete Wastage by Using Accelerator Admixture

Mahesh Babu Sompalli[1], Ramya Ramakrishna[2]
[1]*Officer-Technical, Ex-employee of RDC Concrete India Pvt. Ltd., Bangalore, India.*
[2]*Officer-Technical, RDC Concrete India Pvt. Ltd., Bangalore, India.*

***Abstract*: An estimated 60 percent of all the Ordinary Portland cement concrete consumed by the construction industry is currently supplied by ready mixed concrete plants. The popularity of ready mixed concrete continuously growing while the in-situ concrete preparation declines rapidly due to many reasons like insufficient space for material storage, lack of quality control and greater cost of production. The biggest difficulty faced in ready mix concrete plant is the wastage accumulated due to rejection and diversion of concrete either from plant or site level. Rejection at plant level occurs due to over admixture dosage, operational failures of equipment, or human negligence (E.g Transit mixer drum having water while batching etc.) At site level either due to slump issue (High/low slump), or Segregation/bleeding in concrete, cohesiveness (too harsh/fines) or delay in time of transport to site. An attempt had been made to reduce the Rejection & diversion of concrete due to segregation /bleeding. This study concern with use of Accelerator admixture of liquid form to recover the concrete properties. An experimental investigation has been carried out on a concrete sample with segregation and bleeding. Its performance was observed both at plant and at site accordingly after re-dosing with accelerator admixture to the segregated concrete at different stages. Tests were conducted and it shows a considerable increase in compressive strength on 3rd day, 7th day and 28th day after adding the accelerator admixture to the concrete mix.**

***Keywords*: Accelerator admixture, Batching plant, Bleeding, Segregation**

1. Introduction

Concrete is the most widely used building material which is a mixture of cement, fine aggregate, coarse aggregate, water and admixtures. It may include supplementary cementitous material like Fly ash, Ground granulated blast furnace slag, and micro silica. It can be used for construction of multi-storey buildings, dams, road pavements, tanks, offshore structures, canal lining, and the process of selecting suitable ingredients of concrete and determining their relative amount with the objective of producing a concrete of required strength durability and workability as economically as possible is termed the concrete mix design. The compressive strength of hard concrete is generally considered to be an index of its other properties depends on many factors e.g. quality control, quantity of cement, water cement ratio, placing, compaction and curing. To achieve better quality control and considering the economy factor people now a days are choosing concrete from ready mix concrete plants.

Ready mix concrete plays as vital role in construction industry. Batching plants are classified into four types based on productivity rate, some of them are mentioned below.

- Truck mounted plant having productivity rate 18m3/hr.
- Compact plant having 30-45m3/hr productivity rate.
- Mobile plants having 60-150m3/hr.
- Horizontal plants having 180-240 m3/hr.

These plants are operated either by manual, automatic, or semi-automatic modes. The heart of batching plant is the mixer, and there are many types of mixer such as tilting /non- tilting, pan mixer, single shaft and twin shaft mixer. The twin shaft mixer can ensure an even mixing of concrete having the advantage of high capacity motors. As per IS 4925:2004 minimum mixing time of concrete in a mixer is 30 sec. The operation involved in the concrete batching starts with raw materials which are first poured into large hoppers, there after precisely weighed before getting transferred to the mixer via conveyor belt. Some of the plants are equipped with the control system connected with a software installation which will enable us to pre-fix the concrete slsump, productivity, formula number and concrete grade. When all the material reaches the mixer, the motor revolves for a specified time and then concrete will be released to the Transit mixer. Initial concrete quality check was carried out at plant, then it will be transported to site. As per IS 4926:2003 the concrete shall be discharged from the truck mixer within 2h of the time of batching. In case of Segregation/ bleeding observed in the concrete batched at plant, analyse the root cause which may due to over dosage of admixture, or improper moisture correction, or admixture dispenser failure, or water leakages into transit mixture drum. Once it observed either we can reject & dump the concrete, which will be a huge loss. Hence we need to derive a solution to convert rejected concrete by adding dry mix (cement + aggregates) to the segregated/bleeding concrete.

This method can be followed only if the original concrete is being catered to its lower grade for optional use. The main aim of ready mix concrete industry, is to supply concrete to site with customer specified grade, and slump. In many cases variation is observed in concrete after reaching the site due to improper checking at plant, water leakages in transit mixer and as result the concrete will be rejected. This will also create huge loss to

the producer.

2. Material

The materials used in design of M25 grade concrete are cement, Ground granulated blast furnace slag (GGBS), fine aggregate, coarse aggregate, water, super plasticizer and accelerator. Corresponding physical properties are mentioned below.

A. Cement

Cement used was OPC53 grade. All properties of cement were in accordance with IS 269: 2015. The physical properties of the cement used are as listed in the table.

Table 1
Physical properties of cement

Properties	**Test values**
Specific gravity	3.15
Consistency	27.5
Initial setting time	140
Final setting time	290

B. GGBS

It is a by-product of iron ore. All physical properties of GGBS used were in accordance with the IS 16714:2018, the properties are listed below table.

Table 2
Physical properties of GGBS

Properties	Test values
Insoluble residue	0.36
Glass content	94.5%
Loss of ignition	-0.26
Moisture content	0.09

C. Fine aggregates

The Manufactured sand which was locally available and passing through 4.75 mm IS sieve size used as a fine aggregates. The physical properties of M. Sand are listed below table.

Table 3
Physical properties of fine aggregate

Properties	**Test values**
Specific gravity	2.57
Water absorption	3.3%
Finess modulus	2.63
Silt content	5%

D. Coarse aggregates

The coarse aggregates with nominal maximum size as 20mm single grade (60%) and 10mm graded size (40%) as per IS used. The physical properties of coarse aggregate are listed below table.

Table 4
Physical properties of coarse aggregate

Properties	**CA20mm**	**CA10mm**
Specific gravity	2.64	2.67
Water absorption	0.41%	0.53%
Finess modulus	7.14	6.59

E. Water

Portable water was used for experiment, all properties of water in accordance with the IS 456:2000.these are listed below table.

Table 5
Physical properties of water

Properties	**Test value**
Ph	7.44
Organic solids mg/L	196
Inorganic solids mg/L	720.2
Chlorides mg/L	396.1

F. Super plasticiser Admixture

The properties of used admixture for concrete making was in accordance to the IS 9103:1999. The brand of admixture was used CAC Hyper Fluid H3 plus, and properties are listed below.

Table 6
Physical properties of super plasticiser

Properties	**Test value**
Product name	CAC Hyper fluid H3 Plus
Specific gravity	1.1
Chloride content	Nill
Ph	6.6

G. Accelerator Admixture

CAC SETPLAST admixture was used in concrete as an accelerator. It will reduce the setting time of concrete depends upon dosage and ambient temperature, it can be also used to improve the high early strength. The properties of admixture was listed below.

Table 7
Physical properties of accelerator

Properties	**Test values**
Product name	CAC SETPLAST
Appearance	Colourless flowing liquid
Specific Gravity	1.26
Chloride content	Nill

3. Method

The aim of this experimental study is to reduce the cost of production in ready mix concrete industry due to rejection of concrete. It can be achieved by adding accelerator to the rejected concrete at two different stages as per the site conditions.

Case 1. Addition at plant:

Assume that the batched vehicle is containing full of segregated concrete at plant, then instead of dry mix we can add accelerator admixture of specified dosage, to make a workable concrete.

Case 2: Addition at site:

Assume that, the segregation and bleeding was found at site, then instead of rejection we can make the concrete workable by adding of accelerator. By this we can avoid the delay of concreting process.

"Accelerator admixture is the one which increase the rate of hydration of Tri calcium silicate (C3S) and Tri calcium aluminate (C3A) phases of cement. Therefore by providing earlier heat evolution and strength development. It act as a catalyst in the hydration of C3S and C3A."

4. Experimental investigation

The concrete mix of M25 grade was prepared as per IS 10262:2009 having mix design proportions per cum as follows,

To support our experiment we conducted the trails based on time criteria by adding accelerator admixture.

Table 8
Concrete mix design

Material	Quantity per cum (kg)	
	Accelerator addition at initial	Accelerator addition after 2hrs
Cement	165	165
GGBS	165	165
20mm	701	701
10mm	377	377
M.Sand	821	821
Water	160	160
Admixture – CAC H3 PLUS	1.3	1.3
Admixture – CAC SETPLAST	3	1.5

Case 1 Accelerator addition at initial:

Initially Concrete was segregated at plant by adding excess dosage of CAC Hyper fluid H3 plus admixture. After ten minutes of water adding time, accelerators admixture (CAC Setplast) added to the mix and slump was reduced to 200mm. After 2 hours retention the slump observed was 100mm then cube samples of 150mm size cubes casted.

Case 2 Accelerator addition at after 2 hrs:

In this case, Concrete was segregated at plant by adding excess dosage of CAC Hyper fluid H3 plus admixture. But still it was transported to site and left undisturbed for two hours. After two hours accelerator was added and slump was brought down to 100mm and then cubes samples were casted.

From these cube samples, compressive strength of concrete was determined at 3days, 7 days and 28 days of curing. Compression testing machine of 2000KN capacity was used.

5. Results

Each set of 3 cubes of M25 grade of concrete were tested in compression testing machine. Average of these 3 readings gives the average compressive strength of concrete as given below.

Table 9
Compressive strength of concrete

Description	Average compressive strength(MPa)		
	3 days	7 days	28 days
Accelerator addition at initial	11.79	22.78	33.64
Accelerator addition after 2hrs	13.66	23.89	37.13

A. Cost analysis

Following data consists of average cost of material taken as per market price. It may vary from region to region.

Table 10
Raw material cost

Raw material	Cost per Kg (Rs)
Cement	6
GGBS	3
Coarse Aggregate	0.6
Fine aggregate	0.6
CAC Hyper fluid H3 plus	60
CAC Setplast	50

Once the dry mix is added to the segregated concrete, then on an average cost of additional raw materials will be,

Cement (100kg)+M.Sand(400kg) = Rs 840 for every 6m^3

Instead of dry mix if we can add maximum of 3 litres of accelerator admixture as per the mix condition, then the Cost incurred will be = Rs 150

Overall savings = Rs 690 for every 6m^3

[Note: The above savings are excluded from TM fuel cost. If once vehicle rejected from the site due to high slump, it may be diverted or sent for dry mix, hence we need to include TM Fuel Cost also].

6. Conclusion

From this experimental work carried out for M25 grade of concrete, the following conclusion were drawn

- Addition of accelerator admixture, will not have any impact on strength and serviceability of the concrete, Even though it may increase the rate of hydration and strength.
- Concrete for which accelerator added after 2hrs of batching was observed more strength.
- In both cases strength of concrete was achieved more than the target strength.
- This process is proved to be economical than the dry Mix addition or rejection.

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