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Smart Dynamic Concrete-Rapid Economical Sustainable Construction

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Abstract – The innovative Self Compacting Concrete (SCC) was first introduced in Japan in early 1980's. The use of SCC was spreaded all over the world for precast and ready mix concrete industry. Although, there is limited use of SCC because of its initial higher cost of production. To prevent bleeding and segregation, SCC mixes need high amount of cementatious material. Then only it can deliver self-compacting properties. To overcome this high fines content a new concept was introduced in Asian market, named as "Smart Dynamic Concrete". With the SDC it is possible to reduce high fines content without losing self-compacting property. The production of SDC made possible by using an innovative new family member of viscosity modifying agent admixture (VMA) in the combination with super-plasticizer.

Keywords: - Smart Dynamic Concrete, Viscosity Modifying Agent, Super-plasticizer, Self Compacting Concrete.

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I. INTRODUCTION

In today's advanced concrete technology in civil engineering self-compacting concrete is able to consolidate and fill formwork under its own weight without any vibration. Self-compacting concrete is highly flow able, homogeneous and stable concrete because of its higher performance and excellent self-compaction.

Self-compacting concrete is a typical high binder content in mixer than conventional concrete which is resulting into high construction cost high amount of cementitious material resulting in large amount of co2 emission and environmental pollution. The new mix design method of self-compacting concrete with low cement and low total binder content can be a great interest as it can meet the requirement of both self-compacting and environmental friendly.

However a typical self-compacting concrete mix require 400 to 600 kg/m^3 of cement content for recommended self-compacting property. Smart dynamic concrete is a special invented concrete which is significantly flow able and non-segregating and it is spread into the place of formwork by its own weight and completely fill the form work even in the presence of dense reinforcement. Smart dynamic concrete offer several ecological economical.

The production of smart dynamic concrete is possible by using innovative viscosity modifying agent with superplasticizer. This viscosity modifying agent is produced by Chemical company BASF.

Various sites using BASF Master Glenium Sky 8600 series viscosity modifying agent to produce self-compacting concrete with low cement content that is smart dynamic concrete. This VMA is enables to achieve self-compacting properties with lower files and paste content without risk of excessive bleeding and tendency to segregate. The viscosity modifying agent plays a important role in maintaining the homogeneity of smart dynamic concrete and increase its robustness without affecting the flows significantly and enhances plastic viscosity.

Smart dynamic concrete getting popular rapidly because of its potential to deliver considerable saving to all parties concerned moreover these saving are achieved without compromising the plastic and ultimate properties of concrete making is SDC an attractive proposition.

II. LITERATURE REVIEW

[1] In this paper, the application of SCC in Japan for last decade is described. SCC is defined in terms of the common scale for the workability of fresh concrete by the Japan Society of Civil Engineers. Technologies of cementitious material and chemical admixtures for achieving SCC are described against high cement content and low water to cement ratio in SCC. Technological

development for promoting SCC is described.

[2] In this paper author said that Low fines SCC satisfy all the needs of RMC industry where 80% of the concrete produced is between M 20 - M 40. Low fines SCC can be used as everyday concrete. Low Fines SCC reduced cost due to extra fines. Viscosity Modifying Agent (VMA) is the key for low cement content.

[3] In this paper author conclude that, the yield point and plastic viscosity of the SCC mixes were found to be increased as the quantity of VMA was increased. VMA prevent segregation of concrete and make it more cohesive. SCC with VMA can also be used in under water construction. The optimum VMA dose is found to be 0.4% of weight of binder.

III. ADVANTAGES OF SDC:

- Smart dynamic concrete has Rapid rate of placement.
- Faster construction can be achieved by using smart dynamic concrete.
- SDC is useful for congested reinforcement
- smart dynamic concrete is highly flow able than self-compacting concrete
- Smart dynamic concrete gives superior level of finish surface without segregation, minimum voids content and homogeneous concrete.
- Smart dynamic concrete has low water cement ratio.
- Smart dynamic concrete can be used in both precast and cast in situ construction work.
- Smart dynamic concrete has less heat of hydration and thermal shrinkage.
- Smart dynamic concrete requires minimal to no vibration due to its self-compacting property thereby resulting in lower energy and manpower utilization.
- Demoulding can be done in just 16 hours and faster rotation of formwork or in other words shorter cycle times resulted in overall cost Savings and more importantly earlier completion times.
- Smart dynamic concrete reduces carbon footprint of concrete and the construction processes because of the lower cement content less energy lower in place cost better finish ability and enhanced durability.

IV. INGREDIENTS OF SDC:

In the beginning of the concrete manufacturing trials were taking out for a different grades of concrete with various combination of ordinary Portland cement, coarse aggregate, fine aggregate. By keeping cement is content and water cement ratio as constant in order to improve workability of concrete chemical admixture of different family were tried such as superplasticizer and poly carboxyl ether.

Cement: Ordinary Portland cement 53 grade which meets all the requirements is used.

Additions: Inert and pozzolanic or hydraulic additions are commonly used to improve and maintain the cohesion and segregation resistance. Fly ash is used as replacement to the cement.

Chemical admixture: Master Glenium Sky 8654 is used as new generation based polycarboxylate Ether polymer in combination with superplasticizer.

Coarse aggregate: Combination of 20 mm and 10 mm down size aggregate is used.

Crushed sand as fine aggregate: Manufactured sand which satisfies the requirements of IS 383-1970 is used to make smart dynamic concrete and not river sand.

Water: Portable water free from chloride, oil acids, alkalis, organic matter, sugar is used to make smart dynamic concrete and for curing. Above ingredients are used to make smart dynamic concrete of well-proportioned and non-segregating concrete.

V. MIX PROPORTION

In order to achieve all the parameters and to overcome the problems arrived in traditional self-compacting concrete smart dynamic concrete were designed. Mix design M30 and M 40 SDC mix design given in following table:

Mix design of M30 grade SDC

Material	Proportion in Kg/m^3
Cement	345
Fly Ash	115
20 mm	330
10 mm	598
Crush sand	952
Admixture %	0.8
Water	170
W/C ratio	0.37

Mix design of M40 grade SDC

Material	Proportion in Kg/m^3
Cement	375
Fly Ash	125
20 mm	323
10 mm	604
Crush sand	913
Admixture %	0.94
Water	170
W/C ratio	0.34

VI. SLUMP FLOW OF SDC

Slum flow and retention at initial stage and after 1 hour is given in following table:

Slump flow(mm)	Initial	After 1 Hr.
M30	680	540
M40	650	580

VII. LONG TERM STRENGTH OF SDC

After 28 days of curing, cubes were kept to study long term strength at 3 days, 7 days and 28 days.
Long term strength of M30 and M40 grade SDC is given in following table:

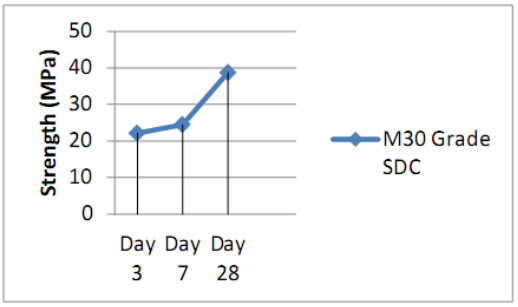
Long term strength of M30 grade SDC

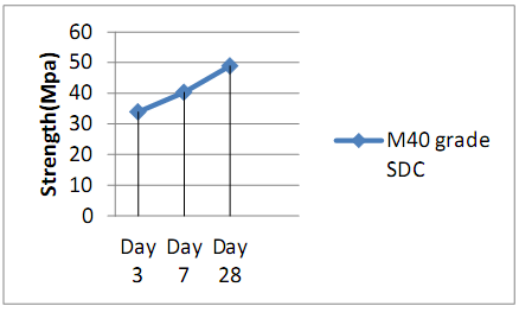
Age in days	3	7	28
Strength (Mpa)	22.13	24.48	38.75

Long term strength of M40 grade SDC

Age in days	3	7	28
Strength (Mpa)	33.88	40.28	48.88

The graph of compressive strength and age in days as follows:





VIII. CONCLUSION

- An innovative concept of utilizing viscosity modifying agent facilitate the production of smart dynamic concrete with self-compacting properties despite a relatively low find content and cost.
- The Rheology anti segregation Cohesion and table properties shown by the unique admixture provide SDC with sufficient robustness even with minor variations in material and mix design composition.
- The use of Smart dynamic concrete can be extended to everyday concrete in the ready mix and precast concrete industry.
- As smart dynamic concrete required low cementitious material it reduces carbon footprint of the concrete.
- Smart dynamic concrete is an attractive proposition for designers contractors and owners because of its a economically viable without compromising aspect such as durability of structure.

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