An Experimental Study on Self-Compacting M-30 Grade Concrete Using PEG

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Abstract— **In general concrete is a man-made material, most widely used building material in the construction industry. It consists of a rationally chosen mixture of binding material such as cement, well-graded fine and coarse aggregate, water and additives (to make specimen with required characteristics). Self-curing is done in order to fulfill the water requirements of concrete whereas self-compacting concrete is prepared so that it can be placed in difficult positions and congested reinforcements. This investigation is aimed to utilize the benefits of both self-curing as well as self-compacting. The present investigation involves self-compacting self-curing concrete is achieved by using polyethylene glycol at a rate of 0%, 1%, and 2%. The various mechanical properties like compressive strength and tensile strength is considered. The test results were analyzed at different temperatures both inside and outside the laboratory for air curing. It is analyzed that the optimum dosage of 1% of PEG contributes higher strength. Workability tests i.e. slump flow, T50, V-funnel, , L-box were conducted on the fresh concrete whereas water retention and compressive strength were evaluated to determine the properties of hardened concrete. Comparative studies were carried out for water retention and compressive strength for conventional SCC and self-cured SCC. The compressive strength of self-cured SCC is comparable with old-fashioned cured specimens at lower w/c ratio whereas does not provide satisfactory results at higher w/c ratio.**

Index Terms— **self compacting, PEG , mix design.**

I. INTRODUCTION

Self-Compacting Concrete (SCC) delivers one of the most important advancement in concrete technology from long time. Inadequacy of mixture of the casted concrete, due to poor compaction or segregation and need of high deformability may lower the performance of concrete at site. SCC has been developed to guarantee adequate compaction and to give finished placement of concrete in those structures also where congestion of reinforcement create problem and also in difficult areas. As we know SCC was developed first in Japan nearly in 1980s to be mainly focused to use for highly congested reinforced structures in seismic regions

(Bouzoubaa and Lachemi, 2001). As the durability of concrete is main and important concern of structures became an important issue in Japan, and need of an adequate compacting skill by labors was required to obtain required durable concrete structures. Finally, this requirement led to the formation of SCC and its development was initially reported in 1989 (Okamura and Ouchi, 1999). SCC can be termed as a high performance material which flows by its own without requiring of compacting vibrators or tamping to achieve required compaction with the complete filling of formworks even when there is problem occur by congestion among reinforcement bars. Bridges, box-culverts, retrofitting and also for underwater concreting, cast in-situ, pile foundations, machine bases and columns or walls with congested reinforcement. The concept for achieving self-compatibility involves not only high deformability of paste or mortar, but also resistance to segregation amongst coarse aggregate and mortar. Similarity of SCC is its ability to remain unsegregated during transport and placing. High flow ability and high discrimination resistance of SCC are obtained by:

1. A lower quantity of fine particles, i.e., a limited coarse aggregate content.
2. A low water-powder ratio, (powder generally defined as cement with the addition of fly ash, Silica fumes etc.) And
3. The employment of super plasticizer Because of the addition of a high amount of fine particles, the internal material Structure of self-compacting concrete shows some similarity with high performance concrete having self compatibility in fresh stage, no initial deficiencies in early stage and guard against external aspects after hardening. Because of the Lower content of coarse aggregate, however, there is some concern that:
    - SCC may have a lesser modulus of elasticity, which may affect warp characteristics of prestressed concrete members and
    - Creep & shrinkage will be higher, disturbing prestress loss and long-term deflection.

II. APPLICATIONS OF SCC

After the development of the various type of model of SCC at the University of Tokyo, a concentrated research was begun in many places for various research regarding SCC , specifically in the various research organization of various construction related industry . As a result, SCC has been used in many buildings, structures and any other part.

In 1991 Self-compacting concrete was then used in the various towers of a prestressed concrete cable-stayed bridge in japan. In 1992 Lightweight self-compacting concrete was

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used in the main girder of a cable-stayed bridge. Since then, the use of SCC in actual structures has progressively increased.

- Currently, we are using SCC for the main basic reason of construction industry
- To shorten period of construction
- To promise compaction in the structure: particularly in restrained zones where vibrating compaction is tough.
- To remove noise due to vibration: effective particularly at concrete products plants.

A. *Necessity of Self-Compacting Concrete*

Self-compacting concrete decreases labor cost of vibration and consolidation and SCC main use in free from vibration of concrete and confirms the compaction of the concrete in the imprisonment. However, total cost of construction cannot always be reduced just by the use of SCC, except that of where construction project is too large. This is because that general construction field system is fundamentally designed based on the theory that mechanical vibrating compaction of concrete is compulsory and without compaction there will be no construction happen.

Self-Compacting Concrete readily increase the quality of construction as well as reduce the cost of construction on stages that formerly based on conservative concrete which shows necessity of vibration compaction. This type of work, which can easily cause segregation, has been an always a point of worry in different different construction work. Once such complication is excluded, concrete construction can be modernized and a new construction system including support and structural design, form work, reinforcement.

One example of SCC based construction is the so called sandwich structure, where concrete is filled into a steel shell. Such a construction has already been finalized in Kobe, and could not have been completed without the development of SCC (Shishido et al, 1999).

III. METHODOLOGY

A self-consolidating must:

- Have a High-fluidity/Less-Viscous that allows self - compaction without extra efforts.
- Maintain its homogeneity in a form during and after the placing and
- Maintain its fluidity in highly congestion confinement.

In many terms, even with the effective researches, it has been seen SCCs viscosity varies with the rate of shear and behave as a false material which possess high-plasticity; SCC is often described as Bingham fluid (viscous elastic) where the stress/shear rate ratio is linear and characterized by two constants – viscosity and yield stress.

Back to the performance based definition of SCC, the self – consolidation is mainly governed by yield stress, on the other hand viscosity affects its homogeneity and the ability to flowing through confinement. As the SCC viscosity can be adjusted depending on the application, the yield stress remains significantly lower than other types of concrete in order to achieve self – consolidation.

s. c. c. tests

- test for slump &t50 test
- l-box test
- v-funnel test and–funnel test at t5 minutes

A. *Compressive Strength of Concrete*

Compressive strength of concrete is defined as the load, which causes the failure of a standard specimen. (Ex 100 mm cube according to ISI) divided by the area of cross section in uniaxial compression under a given rate of loading. The test of compressive strength should be made on 150mm size cubes.

Place the cube in the compression-testing machine. The green button is pressed to start the electric motor. When the load is applied gradually, the piston is lifted up along with the lower plate and thus the specimen application of the load should be 300 KN per minute and can be controlled by load rate control knob. Ultimate load is noted for each specimen. The release valve is operated and the piston is allowed to go down. The values are tabulated and calculations are done.

B. *Mix Design and Trail Proportions*

The components of self-compacting concrete are similar to conservative concrete. It consists of chemical admixtures cement, fine aggregates, coarse and, water, mineral and. Similar to conservative concrete; SCC can also be affected by their appearances of materials and mixture proportioning. A rational mix design method for self-compacting concrete using a variety of materials is necessary. The coarse and fine aggregate contents are stable so that self-compact ability can be attained easily by adjusting water-powder ratio, super plasticizer dosage. In the mix proportioning of conventional concrete, from the view point of obtaining the required strength the W/C ratio is fixed. With SCC, however, the water powder ratio has to be decided by taking into account self-compact capability because self-compact ability is very complex to this ratio. In most case, the required strength of structure does not manage the water cement ratio because the water powder ratio very for gain in the strength of conventional structures unless most of the powder materials in use not reactive.

The characteristics of the powder, super plasticizer and VMA largely affect the mortar property and so the proper water powder ratio and super plasticizer and VMA dosage cannot be fixed without trial mixing at this stage. Therefore, once the mix proportion is decided, self-compact ability has to be tested by slump flow, l-box test and v-funnel test.

IV. TEST ON SELF COMPACTING CONCRETE

There are various types of the test methods for SCC specimen has not been yet standardized and such test discussed are not yet perfect. The Test methods discussed here are the procedures and descriptions rather than that of such detailed procedures.

S.C.C Tests which shows relevant procedural methods are considered here and discussed.

- Various properties such as Flow ability, Segregation and Compactibilty are mainly considered for relevant test procedure.
- Effect of consistency is considered

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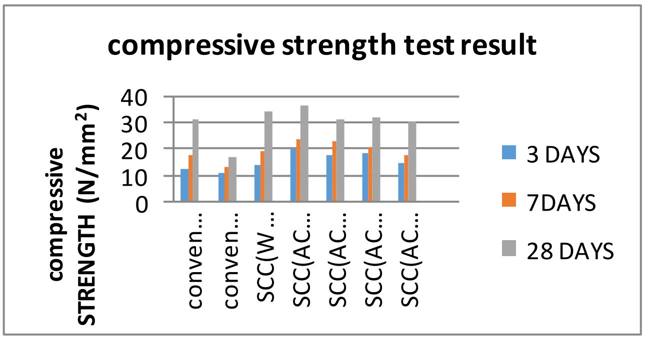
- Blockage issues and various characteristics of concrete is considered
- Test for slump &t50 test
- L-box test
- V-funnel test and–funnel test at t5 minutes
- Compressive strength of concrete
- Tensile strength of concrete

V. COMPRESSIVE STRENGTH OF CONCRETE

Compressive strength of concrete specimen is considered as the load, which causes the crack in specimens and failure of mould and a standard specimen divided by the area area of the cross section of use standard specimens in a compressive testing machine

The procedure of compressive testing of cube include that first we place the specimen in a CTM machine and after it we gradually applied load on it and then note the load where first crack are seen, first crack mean failure of specimen is started After the we note the load for various mould and arrange in a tabulated form

Specimen Details		**Compressive strength(N/mm²)**		
		3 Days	**7 Days**	**28 Days**
PEG 0%	Conventional (WC)	12.8	18	31
PEG 0%	Conventional (AC)	11	13.7	17
PEG 0%	SCC(WC)	14.4	19.5	34
PEG 1%	SCC(AC-IS)	20	23.7	36
PEG 1%	SCC(AC-ES)	18	22.7	31
PEG 2%	SCC(AC-IS)	18.6	21	32



A. L-Box Test

The L-box Test is nothing but experimental value which gives values in the ratio of different levels of concrete at different end. The L-box mainly includes of a "chimney section" and "trough section" after completion of experiment, the level of concrete in the chimney section are measured as H1,the level of concrete in the trough section are measured as H2.The "L-box value" or "L-box ratio" or "blocking value" is simply represent the ratio H2/H1.General acceptable range of values for the L-box value are in the range of 0.8- 1.0.If the test concrete was perfectly leveled after completion of test, the L-box value will be equal to 1.0. On the other hand, if the concrete was too stiff to flow or highly viscous to the end of the trough the L-box value would be equal to zero.

B. Procedure

- Initially all the surface of L-Box (both section) get dampen.
- For restraining pre-amateur flow of concrete make sure that all the gates are fully blocked.
- Now fill the Chimney portion of L-Box with a studied sample of concrete from a bucket.
- Finish of the surface of Box and make sure appropriate quantity of concrete in it.
- Promptly open or lift the gate to allowing flow of concrete through the L-Box.
- Once concrete got stuck or freeze to flow (allowable time to open the gates is 1min), measure and record the height of concrete at the Other section and named as H2 and at the chimney section named as H1 of the L-Box.
- The L-Box value is measured as the ratio of H2/H1.

C. Standard beam test

Modulus of rupture test is also known as a standard beam test for that test a special size of beam 100mmX100mmX500mm and in that test the one most of the important thing which keep in mind that material should be homogeneous. The beam should be tested over the span of 400 mm for 100mm specimen by applying two loads of equal magnitude placed at third points.

To find out these two loads, a central point load is applied on a beam supported on a rolling steel rollers placed at third point. The load is applied on the rate of loading shall be 1.8KN/minute for 100 mm specimens the load should be raised until the beam failed. Note down the type of failure, appearance of fracture and fracture load.

VI. CONCLUSIONS

Based on the detailed procedural investigation as conducted for the study of behavior of Self-Compacting Concrete we have reached to following conclusion: -

It was observed that 2% PEG gives lower compressive strength and compared to 1% PEG. Thus it is found that addition of PEG in high dose over 1% of cement would not give expected results in strength and those cannot be used practically.

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