Emperor Journal of Civil Engineering

Received : March 2022
Accepted : March 2022
Published : April 2022

www.ejceng.mayas.info

Volume - I Issue – 4 April - 2022

Strength And Durability Test on Partial Replacement of Cement by Glass Powder in self Compacting Concrete

Aravindan K

Research Scholar, Department of Civil Engineering,
Mahendra Engineering College,Mallasamudram.

ABSTRACT

Self Compacting Concrete that is able to flow under its own weight and completely fill the form work, even in the presence of dense reinforcement, without the need of any vibration, whilst maintaining homogeneity.). SCC can also be used in situations where it is difficult or impossible to use mechanical compaction for fresh concrete, such as underwater concreting, cast in-situ pile foundations, machine bases and columns or walls with congested reinforcement The composition of SCC is similar to that of normal concrete but to attain self flow ability admixtures, such as fly ash, glass filler, limestone powder, silica fume, Super-pozzolonas, etc; with some superplasticizer is mixed The addition of glass fibers can improve ductility,post crack resistance,energy absorption capacity and bleeding resistance. .

The various properties of the materials to be used in the experimental programme were determined. The specifications of glass Powders and the advantages of using them along with concrete were studied. A detailed review of literature on glass powder concrete was also done.

Cement will be replaced with Glass Powder by 5%, 10%, 15%, 20%, 25%, to the weight of cement. The cubes, cylinders and prisms were casted of size 150x150x150mm, 150mm diameter x 300mmhigh, 700x150x150mm. Superplasticizer will be added for better workability and optimum dosage was determined by using marsh cone test. Thus various strength and durability test will be conducted.

I.INTRODUCTION

SELF COMPACTING CONCRETE

Self compacting concrete (SCC) represents one of the most significant advances in concrete technology for decades. Inadequate homogeneity of the cast concrete due to poor compaction or segregation may drastically lower the performance of mature concrete in-situ. SCC has been developed to ensure adequate compaction and facilitate placement of concrete in structures with congested reinforcement and in restrictedareas.

SCC was developed first in Japan in the late 1980s to be mainly used for highly congested reinforced structures in seismic regions (Bouzoubaa and Lachemi, 2001). As the durability of concrete structures became an important issue in Japan, an adequate compaction by skilled labors was required to obtain durable concrete structures. This requirement led to the development of SCC and its development was first reported in 1989 (Okamura and Ouchi,1999).

SCC can be described as a high performance material which flows under its own weight without requiring vibrators to achieve consolidation by complete filling of formworks even when access is hindered by narrow gaps between reinforcement bars (Zhu et al., 2001). SCC can also be used in situations where it is difficult or impossible to use mechanical compaction for fresh concrete, such as underwater concreting, cast in-situ pile foundations, machine bases and columns or walls with congested reinforcement. The high flowability of SCC makes it possible to fill the formwork without vibration (Khayat et al., 2004). Since its inception, it has been widely used in large construction in Japan (Okamura and Ouchi, 2003). Recently, this concrete has gained wide use in many countries for different applications and structural configurations (Bouzoubaa and Lachemi,2001).

It can also be regarded as "the most revolutionary development in concrete construction for several decades". Originally developed to offset a growing shortage of skilled labor, it is now taken up with enthusiasm across European countries for both site and precast concrete work. It has proved beneficial economically because of a number of factors as noted below (Krieg, 2003 and ENFARC,2002):

- Faster construction
- Reduction in sitemanpower
- Easierplacing
- Uniform and completeconsolidation
- Better surfacefinishes
- Improveddurability
- Increased bond strength
- Freedom indesign
- Reduced noise levels, due to absence ofvibration
- Safe workingenvironment

The method for achieving self-compactability involves not only high deformability of paste or mortar, but also resistance to segregation between coarse aggregate and mortar when the concrete flows through the confined zone of reinforcing bars (Okamura and Ouchi, 2003). Homogeneity of SCC is its ability to remain unsegregated during transport and placing. Highflowability and high segregation resistance of SCC are obtainedby:

- A larger quantity of fine particles, i.e., a limited coarse aggregatecontent.
- Alowwater/powderratio,(powderisdefinedascementplusthefillersuchasfly ash, silica fume etc.)and
- The use ofsuperplasticizer.

Because of the addition of a high quantity of fine particles, the internal material structure of SCC shows some resemblance with high performance concrete having self-compactibility in fresh stage, no initial defects in early stage and protection against external factors after hardening. Due to the lower content of coarse aggregate, however, there is some concern that: (1) SCC may have a lower modulus of elasticity, which may affect deformation characteristics of prestressed concrete members and (2) Creep and shrinkage will be higher, affecting prestress loss and long-term deflection (Mata,2004).

Self compacting concrete can be produced using standard cements and additives. It consists mainly of cement, coarse and fine aggregates, and a filler, such as fly ash or Super-pozz, water, super plasticizer andstabilizer.

The composition of SCC is similar to that of normal concrete but to attain self flow ability admixtures, such as fly ash, glass filler, limestone powder, silica fume, Super-pozz, etc; with some superplasticizer is mixed. Since Super-pozz is a new emerging admixture and is a highly reactive alumino – silicate pozzolanic material, its fineness and spherical particle shape improves the workability of SCC. Thus, it can be used as a suitable admixture inSCC.

The composition of SCC is similar to that of normal concrete but to attain self flow ability admixtures, such as fly ash, glass filler, limestone powder, silica fume, Super-pozz, etc; with some superplasticizer is mixed. Since Super-pozz is a new emerging admixture and is a highly reactive alumino – silicate pozzolanic material, its fineness and spherical particle shape improves the workability of SCC. Thus, it can be used as a suitable admixture inSCC

POWDERED GLASS

Powdered glass

Clear **glass powder** made from leaded crystal **glass** and ground into fine **powder** can be used in all media to give colors added luminosity or to create textural effects on the surface of paintings. Colored and clear **glass powder** can be used in all media, such as oil, acrylic dispersions, lime and all kinds of glues.

This glass powder was prepared from transparent glass waste. It was grounded and then passed through the sieve of 0.6 mm (N°30) where more than 95% passed through the sieve of 0.25 mm (N°60). The physical and mechanical tests gave a value of 2,500 kg/m^3 of specific density and 2,850 cm^2/g for the specific surface area; the value of the dry internal angle was varied between 24° and 26° and 18° to 20° for the saturated friction angle. The chemical composition analysis gave a value of 65% by weight of $SiO_2$and 15% for the sum of CaO and Na_2O.

An additional test showed a zero value for the absorption rate, and a strong capillary action, which helped to build a column of 60 cm for a section of 3 × 3 cm.

The capillarity phenomenon of the glasspowder.

II. LITERATURE REVIEW

J.m. Khatib, The influence of including fly ash on the properties of self compacting concrete is investigated.Portland cement was partially replaced with 0-80% FA.The water to binder ratio was maintained at 0.36 for all mixes.Properties included workability,compressivestrength,ultrasonic pulse velocity,absorption and shrinkage.The results indicate that high volume of FA can be used in SCC to produce high strength and low shrinkage.Replacing 40% of PC with FA resulted in a strength of more than 65N/mm^2 at 56 days.There is a systematic reduction in shrinkage as the FA content increases and at 80% FA content,the shrinkage at 56 days reduced by two third compared with the control.Increasing the admixture content beyond a certain level leads to reduction in strength and increase in absorption.The correlation between strength and absorption indicate that there is sharp decrease in strength as absorption increases from 1 to 2%.After 2% absorption,the strength reduces at a much slower rate.

ZoranJure,Goradana A., In the paper potential usage of coarse recycled aggregate obtained from crushed concrete for making of self compacting concrete was researched.On the other hand the issue of the waste disposal sites created by the demolition of old structures is solved.In the experiment three types of concrete mixtures were made,where the substitution of coarse aggregate by the recycled aggregate was 0%,50% and 100%.In the process of mixing,equal consistence of all concrete mixtures was achieved.The obtained results indicate that the properties of these concretes have only a slight difference and the recycled coarse aggregate can successfully be used for making of self compacting concrete.

TESTING METHODS FOR SCC

The guideline for testing the fresh Self Compacting Concrete has not been standardized to date. So far no single method or combination of methods has achieved universal approval and most of them have their adherents. The constant search for finding more appropriate field testing methods has led to the emergence of few empirical methods in the past few years.

The filling ability, passing ability and resistance to segregation are the distinguished properties of SCC which is not common to conventional concrete and, therefore the tests for SCC are handled through special tests.

EFNARC, making use of broad practical experiences of all members of European federation with SCC, has drawn up specification and guidelines for testing the SCC and also specified the limiting values to obtain SCC. It also provides a framework for design and use of high quality SCC.

WORKABILITY TEST RESULTS

Mix	Slump flow	L-Box	J-Box
SCC	695	0.82	9.8
CG 1%	680	0.84	10.1
CG 2%	710	0.89	10.2
CG 3%	740	0.92	10.7
CG 4%	715	0.88	10.5
CG 5%	690	0.85	10.4

HARDENED CONCRETE PROPERTIES AND TEST RESULTS

Compressive strength of cube at 7 days

Mix	% of Glass	Spe I	Spe II	Spe III	Avg.
SCC	0	22.22	21.77	22.44	22.14
SCC1	1	29.3	29.68	29.06	29.35
SCC2	2	29.5	29.78	29.86	29.71
SCC3	3	37.33	37.24	37.57	37.38
SCC4	4	32.89	33.16	33.33	33.13
SCC5	5	31.11	31.29	30.84	31.08

Compressive strength of cube at 14 days

Mix	% of Glass	Spe I	Spe II	Spe III	Avg.
SCC	0	29.55	29.7	30/04	29.7
SCC1	1	31.1	31.28	30/60	30.9
SCC2	2	31.56	31.91	32.0	31.8
SCC3	3	39.56	40.0	40.18	39.9
SCC4	4	37.33	37.2	37.42	37.3
SCC5	5	35.56	35.61	35.20	35.4

Compressive strength of cube at days

Mix	% of Glass	Spe I	Spe II	Spe III	Avg.
SCC	0	39.5	36	34.9	35.47
SCC1	1	33.77	33.42	33.51	33.57
SCC2	2	33.86	34.04	34.13	34.01
SCC3	3	42.67	42.4	42.04	42.37
SCC4	4	40.44	40.71	41.16	40.77
SCC5	5	39.56	39.2	39.29	39.35

Discussion

In this investigation, the compressive strength test of self compacting concrete is carried out with addition of glass fibres in various percentages. The tests were carried out at 7 days, 14 days and 28 days. It is found that the compressive strength at 28 days has increased upto 16.28% with 3% of glass fibres.

Split tensile strength of cylinder at 7 days

Mix	% of Glass	Spe I	Spe II	Spe III	Avg.
SCC	0	0.63	0.70	0.75	0.69
SCC1	1	0.54	0.55	0.58	0.56
SCC2	2	0.59	0.59	0.61	0.60
SCC3	3	0.78	0.81	0.87	0.82
SCC4	4	0.74	0.72	0.78	0.74
SCC5	5	0.69	0.65	0.64	0.64

Split tensile strength of cylinder at 14 days

Mix	% of Glass	Spe I	Spe II	Spe III	Avg.
SCC	0	0.91	0.99	0.97	0.96
SCC1	1	0.87	0.84	0.91	0.87
SCC2	2	0.93	0.96	0.99	0.96
SCC3	3	1.27	1.21	1.20	1.23
SCC4	4	1.20	1.24	1.22	1.22
SCC5	5	1.13	1.08	1.11	1.11

Split tensile strength of cylinder at 28 days

Mix	% of Glass	Spe I	Spe II	Spe III	Avg.
SCC	0	1.48	1.51	1.54	1.51
SCC1	1	1.41	1.34	1.39	1.38
SCC2	2	1.49	1.50	1.53	1.51
SCC3	3	1.70	1.78	1.75	1.74
SCC4	4	1.63	1.61	1.66	1.63
SCC5	5	1.54	1.57	1.59	1.56

Discussion

In this investigation, the split tensile strength test of self compacting concrete is carried out with addition of glass fibres in various percentages. The tests were carried out at 7 days, 14 days and 28 days. It is found that the split tensile strength at 28 days has increased upto 13.21% with 3% of glass fibres.

Flexural strength of beam at 28 days

Mix	% of Glass	Spe I	Spe II	Spe III	Avg.
SCC	0	5.77	5.33	5.11	5.40
SCC1	1	5.56	5.56	5.33	5.48
SCC2	2	6.67	6.22	6.01	6.30
SCC3	3	7.78	7.56	7.61	7.63
SCC4	4	7.11	6.89	6.86	6.95
SCC5	5	6.67	6.44	6.44	6.52

Discussion

In this investigation, the flexural strength test of self compacting concrete is carried out with addition of glass fibres in various percentages. The tests were carried out at 28 days. It is found that the flexural strength at 28 days has increased upto 41.29% with 3% of glass fibres.

III. CONCLUSION

In this experimental study on self compacting concrete using crushed glass fibres, the following conclusions have been made.

- The maximum compressive strength of 42.37 N/mm^2 was obtaining at addition of fibers 3% of concrete, The percentage improvement of the compressive strength over thereference concrete is 16.28 %.
- The maximum split tensile strength of 1.51 N/mm^2 was obtaining at addition of fibers 3% of concrete, The percentage improvement of the split tensile strength over the reference concrete is 13.21 %
- The maximum flexural strength of 7.63 N/mm^2 was obtaining at addition of fibers 3% of concrete, The percentage improvement of the flexural strength over the reference concrete is 41.29 %
- Difficulties observed in this project are quick initial setting of concrete due to the effect of Poly Carboxylic Ether (PCE) based super plasticizer.
- Based on Marsh cone test the effect of super plasticizer dosage find out. The result reducing while, increasing percentage of super plasticizer.
- The increasing percentage of fly ash, result will be reducing compare than initial stage, because of the fly ash property.
- The addition of VMA Glenium stream -2 , (.1%) give exact workability.

IV. OBSERVATIONS

In this experimental study the following observations are made

- The addition of glass fibres in concrete gives a reduction in bleeding.
- The setting time of concrete has taken more than 24 hours
- The addition of super plasticizer has given the easy workability of concrete
- Development of cracks are prevented with the use of glass fibres
- Workability of concrete decreases respectively by the increase in volume of fibers.

V.REFERENCES

1. Jin Tao, Yong Yuan and Luc Taerwe, Compressive Strength of Self Compacting Concrete during High Temperature Exposure ASCE
2. M.A Hossain and M.Lachemi,||Bond Behaviour of SCC with Mineral and Chemical Admixtures|| Cement and ConcreteResearch
3. Sudharsan, N, & Saravanaganesh, S. (2019). Feasibility studies on waste glass powder. International Journal of Innovative Technology and Exploring Engineering, 8(8), 1644–1647.
4. M.Valcuendeand C.parra-Natural Carbonation of Self Compacting ConcreteConstruction and BuildingMaterials
5. MariaC,BryanEandRaulPlacingConditions,MesostructuralcharacteristicsandPost cracking response of fibre reinforced Self Compacting Concrete Constructionand BuildingMaterials
6. Philippe Turcry, Ahmed and Khalil, Cracking Tendency of Self Compacting Concrete Subjected to Restrained Shrinkage ASCE
7. YoungHoonKimandMaryBeth,||ShearCharacteristicsandDesignforHighStrength Self CompactingConcrete-ASCE
8. J.MKhatib-PerformanceofSelfCompactingConcretecontainingFlyashConstruction and BuildingMaterials
9. Vidhya, K., & Kandasamy, S. (2013). Study on properties of bricks manufactured using fly ash and pond ash. Pollution Research, 32(2), 405–409.
10. Sudharsan, N., & Palanisamy, T. (2018). A comprehensive study on potential use of waste materials in brick for sustainable development. Ecology, Environment and Conservation, 24, S339–S343.
11. Vidhya, K., & Kandasamy, S. (2014). Study on the flexural strength of coal ash brick masonry wall elements. Journal of Structural Engineering (India), 41(4), 410–419.
12. Sudharsan, N,& Sivalingam, K. (2019). Potential utilization of waste material for sustainable development in construction industry. International Journal of Recent Technology and Engineering, 8(3), 3435–3438.
13. Vidhya, K., & Kandasamy, S. (2016). Experimental Investigations on the Properties of Coal-Ash Brick Units as Green Building Materials. International Journal of Coal Preparation and Utilization, 36(6), 318–325.
14. N. Sudharsan, T. Palanisamy, S. C. Yaragal, (2018), Environmental sustainability of waste glass as a valuable construction material - A critical review. Ecology, Environment and Conservation, 24 pp. S331–S338.