ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

High Strength Self-Compacting Material for Stone Dust and Fine

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ABSTRACT

Self-compacting concrete (SCC) represents a milestone in concrete research. SCC is a highly flow-able, non-segregating concrete that can spread in to place, fill the formwork and encapsulate the reinforcement without any mechanical vibration for consolidation. SCC was originally developed at the University of Tokyo, Japan during the year 1986 by Prof. Okamura and his team to improve the quality of construction and also to overcome the problems of defective workmanship. Concrete technology has made significant advances in recent years which results in economical improvement of the strength of concrete. This economical development depends upon the intelligent use of the locally available materials. Important constituent of self-compacting concrete (SCC) is natural sand and filler material which is expensive and scarce.

This necessitates that a suitable substitute be found. The cheapest substitute for natural sand is quarry dust and for filler material is fly ash. Quarry dust, a by-product from the crushing process during quarrying activities is one of the materials being studied and fly ash is an artificial pozzolanic material, a finely divided pozzolana form compounds which have cementitious properties, when mixed with hydrated lime andalkalis. In this work, the fresh and compressive strength properties of self compacting concrete when the sand is partially replaced with stone dust , when the filler materials is increased by adding fly ash in % of the total powder content and when both substituent's are implemented simultaneously . Optimization of stone dust and fly ash is alsoobtained.

The results indicated that the incorporation of quarry dust into the self compacting Concrete mix as partial replacement material to natural sand resulted in higher compressive strength and optimization of sand replacement is 40%. Optimization of addition of fly ash in total powder content is 30%.

Key words:
Formwork, Consolidation, Self-compacting concrete, Filler material, Quarry dust, Pozzolanic.

I. INTRODUCTION

Self-compacting concrete was initially created in 1988 keeping in mind the end goal to enhance solidness of concrete structures. From that point forward, different examinations have been completed and this concrete is initially utilized as a part of commonsense structures in Japan, mostly by huge development organizations. To make this a standard concrete a few objective blend plan strategies and self compatibility testing techniques have been completed. Improvement of self compacting concrete is an attractive accomplishment in the development business keeping in mind the end goal to overcome issues connected with cast set up concrete. Contrasted with ordinarily vibrated concrete (NC), self-compacting concrete (SCC) has upgraded qualities and enhances profitability and working conditions because of the end of compaction. Keeping in mind the end goal to accomplish ideal quality and sturdy concrete structures compaction is the key.

Cite this article as: MD Ilyas Ahmed & Dr.S.VijayMohanrao, "High Strength Self-Compacting Material for Stone Dust and Fine", International Journal & Magazine of Engineering, Technology, Management and Research, Volume 6, Issue 4, 2019, Page 140-144.

In any case, full compaction was hard to get or judge in view of expanding in support volumes with littler bar measurements and a lessening in gifted development laborers, prompting low quality concrete. Self compacting concrete is not influenced by the abilities of specialists, the shape and measure of strengthening bars or the course of action of a structure furthermore because of its high ease and imperviousness to isolation it can be pumped longer separations. Superior concrete having similarity in first stage and no underlying imperfections in early stage.

The idea of self compacting concrete was initially proposed in 1986 by educator Hajime Okamura (1997), however the model was initially created in 1988 in Japan, by teacher Ozawa (1989) at the college of Tokyo. Suggestions on the configuration and uses of SCC in development have been created by numerous expert social orders, including the American Concrete Establishment (ACI), the American Culture for Testing and Materials (ASTM), Place for Cutting edge Bond Based Materials (ACBM), Precast Counseling Administrations (PCI) and Get-together Internationalizes Research centres et Specialists des Matériaux, systèmes de development et offends (RILEM) and soforth.

Self compacting concrete is thrown so that no of extra internal or external vibration is fundamental for the compaction. It streams like nectar and has an extremely smooth surface level in the wake of setting. The arrangement of SCC is like that of typical concrete yet to achieve self stream capacity some substance and mineral admixtures are utilized. More often than not, the concoction admixtures utilized are high range water reducers (super plasticizers) and thick altering specialists (VMA), which change the rheological properties of concrete.

II. SCOPE OF WORK

Whatever may be the type of concrete it is very important to design the mix of the concrete. The same is the case with self compacting concrete also.

It is difficult to get proper mix for self compacting concrete The major work involved in getting self compacting concrete is to get appropriate mix proportion .In practice, SCC in its fresh state shows high fluidity, self-compacting ability and segregation resistance, all of which contribute to reducing the risk of honeycombing of concrete. If the normal concrete is not compacted well honey combs may occur in which durability of the structure is reduced. But because of the flow ability property of self compacting concrete compaction is not necessary. Because of this property the SCC produced can greatly improve the reliability and durability of the reinforced concrete structure.

Self- compactability can be largely affected by the characteristics of materials and the mix-proportion. To ensure its high filling ability, flow without blockage and to maintain homogeneity SCC requires more powder content. But it is not possible to increase cement as powder content .So a filler material is required which can be fly ash, Biogases ashetc. Compressive strength tests were conducted to know the strength properties of the mixes. Initially a simple mix design was followed and modifications were made accordingly while arriving at trial mixes to get an optimized mix which satisfies both fresh, hardened properties and economy. Finally a simple mix design for OPC based SCC was arrived on the lines of Nan su mix design.

After required mix proportion is achieved, fine aggregate is replaced with Stone dust by 10%, 20%, 30%, 40%, 50%, in each case nine cubes were cast and the compressive strength was determined. The optimum % of stone dust replacement is found by observing the compressive strength after the optimum percent of sand replacement was found now the fly ash is added at an amount of 40%, 50%, 60% of the total powder content to the optimum stone-dust mix and tested for compressive strength. The optimum fly ash content in the total powder content is determined by observing the compressive strength.

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III. MATERIALSUSED

The materials used in this work are

a. 53 Grade ordinary Portlandcement
b. FineAggregate
c. CoarseAggregate
d. Super Plasticizer (CONPLAST SP430)
e. Viscosity modifying agent VMA (GLINIUM STREAM-2)
f. Microsilica
g. Water

Cement

Cement used in the investigation was 53 Grade ordinary Portland cements (fly ash free) confirming to IS: 1489(part-1).The cement was obtained from a single consignment and of the same grade and same source. Procuring the cement it was stored properly.

Fine Aggregate

The fine aggregate conforming to Zone-II according to IS: 383 were used. The fine aggregate used was obtained from a nearby river source.

Coarse Aggregate

Crushed granite Aggregate was used as coarse aggregate. The coarse aggregate was obtained from a local crushing unit and only 12.5mm aggregates according to IS: 383 are used in this project. In order to do corrosion test small cubes have to be casted. According to IS: 383 the maximum size of the aggregate used should be 5 times the aggregate size.

Super Plasticizer

High range water reducing admixture called as super plasticizers are used for improving the flow or workability for decreased water-cement ratio without sacrifice in the compressive strength. These admixtures when they disperse in cement agglomerates significantly decrease a viscosity of the paste by forming a thin film around the cement particles. In the present work water-reducing admixture Conplast SP430 complies with BS 5075 Part 3 and with ASTM C494 as Type A and Type F. SP 430 is an admixture of a new generation based on aqueous solution of sulphonated naphthalene formaldehyde condensates. The product has been primarily developed for applications in high performance concrete where the highest durability and performance is required.

Viscosity Modifying Agent (VMA)

A concrete in fluid state tends to yield to segregation, which can be prevented by rendering cohesion. VMAs are used to render cohesiveness to such fluid concrete .When VMA is added to concrete viscosity of the mix is changed by which shear resistance is influenced. These modifications help in controlling the bleeding of the concrete .Any minor fluctuations in the quality of the concrete making materials seem to overcome through the functionality of VMA. In the present work Glinium stream2 VMA isused.

Fly ash

SCC is produced with high quantity of fine powder/fine material .so in addition to cement some other fine materials ,either reactive or inert is used .There is a general thinking that inert materials such as limestone powder can be added. However it is not true as per authors experience because inert fillers do not participate in cement chemistry that results in poor engineering properties and durability. This is where fly ash has a striking contribution for sustainably cost – effective and durable SCC. Fly ash renders not only workability but also contributes for strength.

IV. TESTS CONDUCTED

Compressive Strength

In order to find compressive strength cubes of dimensions 150X150X150mm^3 were casted. For that purpose moulds of required dimensions are used. Care should be taken that there should not be any gap .If there are any gaps they should be filled with plaster of pairs. After 24hrs of casting the cubes are removed from the mould. Then they are placed in water for curing for a period of 28 days. After 28days of curing the cubes are removed from the curing tank. the cube should be kept outside to dry.

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After drying cubes are ready for testing. They are tested in compression testing machine of capacity 200 tones .The example was set in the machine in such a way, to the point that the heap was connected to inverse sides of the blocks as station that may be, not top and base. The pivot of the example was deliberately adjusted at the focal point of the stacking outline. The heap connected was expanded persistently at a steady rate until the resistance of the example to the expanding load separates and didn't really can be managed. The greatest burden connected on the example wasrecorded.

V. MIXPROPORTIONS

After getting trial mixes by Nansu method, the mixes were modified accordingly as per EFNARC to achieve optimum mix proportions satisfying fresh properties, hardened properties and also economy. The proportions arrived for M60Mpa of SCC and are given in the table as follows. All the values are in kg/m^3.

Table 1 Mix Proportions of 60 MPa for Stone Dust Replacement

Stone Replacement Dust	0%	10%	20%	30%	40%	50%
UNITS	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)
Cement	680	680	680	680	680	680
Fine aggregate	850.3	765.27	680.24	595.21	510.19	425.15
Stone dust	0	85.03	170.06	255.09	340.12	425.15
Coarse aggragate	803.17	803.17	803.17	803.17	803.17	803.17
Sp	16.85	16.85	16.85	16.85	16.85	16.85
Flyash	289.26	289.26	289.26	289.26	289.26	289.26
Micro silica	35	35	35	35	35	35
VMA	1.75	1.75	1.75	1.75	1.75	1.75
Water	249.86	249.86	249.86	249.86	249.86	249.86

Table 2 Mix Proportions of 60 MPa for Fly Ash Replacement

Addition of Fly ash	0%	40%	50%	60%
UNITS	(Kg/m3)	(Kg/m3)	(Kg/m3)	(Kg/m3)
Cement	680	680	680	680
Fine aggregate	510.19	510.19	510.19	510.19
Stone dust	340.12	340.12	340.12	340.12
Coarse aggragate	803.17	803.17	803.17	803.17
Sp	16.85	16.85	16.85	16.85
Flyash	289.26	453.33	680	1020
Micro sillica	35	35	35	35
VMA	1.75	1.75	1.75	1.75
Water	249.86	249.86	249.86	249.86

VI. RESULTS

From the below table we can observe that by increase in replacement of fine aggregate with stone dust. The sharp edges of the particles in stone dust provide better bond with cement than the rounded particles of natural sand resulting in higher strength. After the optimum dosage flow ability decreases hence strength is reduced.

Table 3 Variation of Strength of the cubes due to % replacement of the fine aggregate with stone dust

% of fine aggregate replaced with stone dust	Strength (N/mm2)		
	3 days	7 days	28 days
0%	17	19.1	61
10%	18	20	62
20%	21	23	64
30%`	25	28	68
40%	28	34	72
50%	23.5	30	60

Table 4 Variation of Strength of the cubes with addition of fly ash in % of powder content

% fly ash added in the powder content	3 days	7 days	28 days
10	20.5	27.5	37
20	23.5	32	47
30	28	34	72
40	22	28	57
50	18	22	46
60	14	19	36

From the above results optimum fly ash content in powder quantity is 30%.

VII. CONCLUSION

The following are the conclusions obtained after performing the above experiments

a. The optimum fine aggregate replacement with stone dust quantity is40%.
b. Increase in the fly ash content in the total powder in the optimized stone dust mix the slump flow v-funnel values areincreases.
c. With increase in fly ash content in the total powder the rate of increase in strength is not affected at 3days, 7days but affected at 28 days due to pozzalanicaction.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

d. The optimum fly ash content in 60Mpa SCC is 30% in total powdercontent.

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