PRELIMINARY INVESTIGATION ON SELF-COMPACTING CONCRETE USING STONE DUST AND FLY ASH AS PARTIAL REPLACEMENT OF FINE AGGREGATE

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Abstract - *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* [1]. *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 a artificial pozzolanic material, a finely divided pozzolana form compounds which have cementitious properties, when mixed with hydrated lime and alkalies* [4].. *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 also obtained. 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*: Self-compacting concrete (SCC), Fly ash, Fresh properties, Compressive Strength**

1.INTRODUCTION

Self-compacting concrete was first developed in 1988 in order to improve durability of concrete structures. Since then, various investigations have been carried out and this concrete is first used in practical structures in Japan, mainly by large construction companies. To make this a standard concrete several rational mix-design methods and self-comp -actability testing methods have been carried out. Development of self-compacting concrete is a desirable achievement in the construction industry in order to overcome problems associated with cast in place concrete. Compared to normally vibrated concrete (NC), self-compacting concrete (SCC) possesses enhanced qualities and improves productivity and working conditions due to the elimination of compaction. In order to achieve optimum strength and durable concrete structures compaction is the key. But full compaction was difficult to obtain or judge because of increasing in reinforcement volumes with smaller bar diameters and a reduction in skilled construction workers, leading to poor quality concrete. Self-compacting concrete is not affected by the skills of workers, the shape and amount of reinforcing bars or the arrangement of a structure and also due to its high fluidity and resistance to segregation it can be pumped longer distances. Self-compacting concrete is cast so that no of additional inner or outer vibration is necessary for the compaction. It flows like honey and has a very smooth surface level after placing. The composition of SCC is similar to that of normal concrete but to attain self-flow ability some chemical and mineral admixtures are used. Usually, the chemical admixtures used are high range water reducers (super plasticizers) and viscous modifying agents (VMA), which change the rheological properties of concrete .Mineral admixtures, are used as an extra fine material, besides cement, and in some cases, they replace cement. Because of the addition of a high quantity of fine particles, the internal material structure of SCC shows some resemblance with high

2. EXPERIMENTAL STUDY

The program consisted of arriving at mix proportions ,weighing the ingredients of concrete accordingly, mixing them in a standard concrete mixer of rotating drum type of half bag capacity and then testing for the fresh properties of SCC. If fresh properties satisfy EFNARC specifications, 6 Standard cubes of dimensions

150mmx150mmx150mm were caste to check whether the target compressive strength is achieved at 7- days and 28days curing. If either the fresh properties or the strength properties are not satisfied, the mix is modified accordingly. Standard cube moulds of 150X150X150mm made of cast iron were used for casting standard cubes. The standards moulds were fitted such that there are no gaps between the plates of the moulds. If there small gaps they were fitted with plaster of Paris. The moulds then oiled and kept ready for casting. After 24 hours of casting, the specimen were demoulded and transferred to curing tank wherein they were immersed in water for the desired period of curing.For optimization of stone dust After required mix proportion is achieved fine aggregate is replaced with Stone dust by 10%, 20%, 30%, 40% and 50%, in each case nine cubes were casted, the compressive strength was determined and the optimum % of stone dust replacement is found. After the optimum percent of sand replacement was found now the fly ash is added to the optimum stone dust mix in 40%, 50% and 60% of the total powder content in each % of fly ash content nine cubes are prepared and tested for compressive strength and the optimum fly ash content in the powder is determined.

3. MIX DESIGN

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 M_{60} of SCC and are given in the table as follows. All the values are in kg/m^3 [11 & 12].

Table 1: Mix Design of M_{60} grade of concrete

Grade of concrete	M_{60}
Cement	680 Kg/m^3
Fine aggregate	850.3 Kg/m^3
Coarse aggregate	803.17 Kg/m^3
Super plasticizer	16.85 Kg/m^3
fly ash	289.26 Kg/m^3
Micro silica	35 Kg/m^3
VMA	1.75 Kg/m^3
Water	249.86 Kg/m^3

Table 2: Mix Proportions for Stone dust replacement

STONE DUST REPLACEMENT	0%	10%	20%	30%	40%	50%
UNITS	(Kg/m^3)	(Kg/m^3)	(Kg/m^3)	(Kg/m^3)	(Kg/m^3)	(Kg/m^3)
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 aggregate	803.17	803.17	803.17	803.17	803.17	803.17
Super plasticizer	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 sillica	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 3: Mix Proportions for Fly ash replacement

ADDITION OF FLYASH	30%	40%	50%	60%
UNITS	(Kg/m^3)	(Kg/m^3)	(Kg/m^3)	(Kg/m^3)
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 aggregate	803.17	803.17	803.17	803.17
Super plasticizer	16.85	16.85	16.85	16.85
fly ash	289.26	453.33	680	1020
Micro silica	35	35	35	35
VMA	1.75	1.75	1.75	1.75
Water	249.86	249.86	249.86	249.86

4. RESULTS AND DISCUSSIONS

Table 4: Fresh properties for M_{60} mix

TEST	RANE OF VALUES	UNITS	VALUE
Slump flow test	650-800	mm	735
T_{50}cm slump flow	2-5	Sec	5
V-funnel test	6-12	Sec	9
V-funnel at T_5 minutes	6-15	Sec	11
L-box test	0.8-1	h_2/h_1	1
J-ring	0-10	mm	7

Table 5: Variation of Strength of the cubes due to % replacement of the fine aggregate with stone dust

% of fine aggregate replaced with stone dust	Compressive Strength (N/mm2)		
	3 days	7 days	28days
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

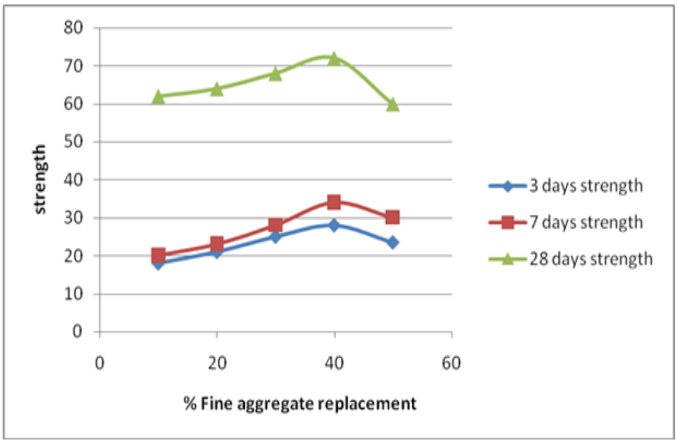

Figure 1. Variation of Strength due to % of fine aggregate replacement with stone dust

From the above graph 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 6: Fresh properties of self-compacting concrete when fine aggregate is replaced with stone dust

% of fine aggregate replaced with stone dust	Slump (mm)	T_{50} (sec)	V Funnel (sec)	V-Funnel(T_5 Minute) (sec)	Box H1 /H2
10%	735	5	9	11	1
20%	728	5	8	10	1
30%	720	5	7	9	1
40%	710	4	6	7	1
50%	690	4	5	6.5	1

Table 7: Fresh properties of self compacting concrete when flyash is added in % of powder content to the optimized stonedust mix proportion

% fly ash added in the powder content	Slump (mm)	T_{50} (sec)	V Funnel (sec)	V-Funnel(T_5 Minute) (sec)	Box H1 /H2
40	720	5.15	5	5	1
50	720	5.62	6.5	7	1
60	730	4.06	4.5	6.7	1

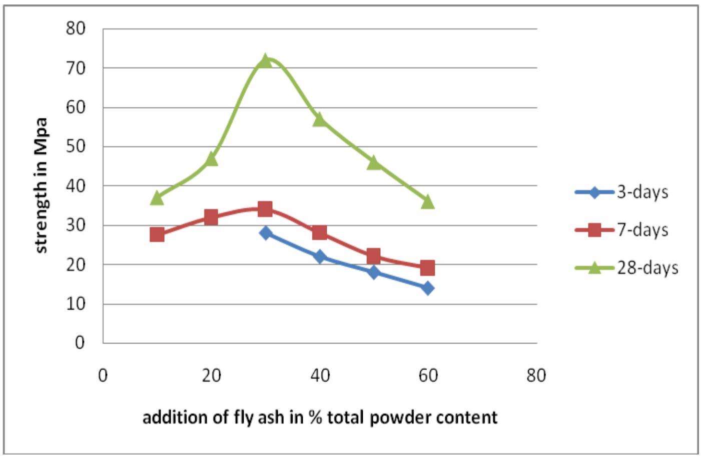

Figure 2. Variation of Strength with addition of fly ash in % of total powder content

5. CONCLUSIONS

The following are the conclusions obtained after performing the above experiments

1. From the above study concluded that increasing stone dust slump flow value, v-funnel value and T_{50} value is decreases. Due to the irregular shape and flakiness of stone dust.
2. The optimum fine aggregate replacement with stone dust quantity is 40%.
3. Increase in the fly ash content in the total powder in the optimized stone dust mix the slump flow v-funnel values are increases
4. 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 pozzalanic action.
5. The optimum fly ash content in 60Mpa SCC is 30% in total powder content.

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