RESEARCH ARTICLE OPEN ACCESS

A Study on Influene of Quarry Dust on Behaviour of Self Compacting Concrete

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ABSTRACT
The study has conducted to determine the workability and compressive strength of the self –compacting concrete. Concrete that flows and settles due to its own weight without segregation and bleeding is called self-compacting concrete. SCC is a type of concrete that can be placed in the form work and it passes through any obstruction by its own weight and does not require any vibration Modern application of SCC is focused on high performance, better and more reliable and uniform quantity. Japan, started in late 1980's to develop SCC. By the year 2000, the SCC has become popular in Japan for prefabrication products and ready mixed concrete. Fly ash contains the basic ingredients of cement like silica, magnesium and calcium. Cement industries use fly ash to improve the volume. Quarry dust also contains a similar property of river sand. Quarry dust is used in concrete to minimize the demand of river sand . Slump flow, L-box, V- funnel tests were carried out to determine the workability of self-compacting concrete and compressive strength, flexural strength & split tensile strength was conducted on 7 days and 28th days of curing period. NDT tests like rebound hammer ,ultrasonic pulse velocity tests were adopted for finding strength without loading the specimen The results were encouraging in that they revealed that concrete of the required compressive strength can be produced. It is concluded that a new construction material with low cost can be made available
Keywords – SCC, Quarry dust, Fly ash, NDT tests, Flow Properties.

Date Of Submission: 02-08-2019 Date Of Acceptance: 13-08-2019

I. INTRODUCTION

Self-compacting concrete is a concrete mix which has high deformability, good segregation resistance (prevents separation of particles in the mix), and moderate viscosity which is necessary to ensure uniform suspension of solid particles during transportation, placement (without external compaction), and thereafter until the concrete sets.

The growth of Self Compacting Concrete by Prof. H.Okamura in 1986 has caused a significant impact on the construction industry by overcoming some of the difficulties related to freshly prepared concrete. The SCC in fresh form reports numerous difficulties related to the skill of workers, density of reinforcement, type and configuration of a structural section, pump-ability, segregation resistance and, mostly compaction. Though, the Bureau of Indian Standards (BIS) has not taken out a standard mix method while number of construction systems and researchers carried out a widespread research to find proper mix design trials and self-compact ability testing approaches. The work of Self Compacting Concrete is like to that of conventional concrete, comprising, binder, fine aggregate and coarse aggregates, water, fines and admixtures. To adjust the rheological properties of SCC from conventional concrete which is a remarkable difference, SCC should have more fines content, super plasticizers with viscosity modifying agents to some extent. As compared to conventional concrete the benefits of SCC comprising more strength like non SCC, may be higher due to better compaction, similar tensile strength like non SCC, modulus of elasticity may be slightly lower because of higher paste, slightly higher creep due to paste, shrinkage as normal concrete, better bond strength, fire resistance similar as non SCC, durability better for better surface concrete.

Addition of more fines content and high water reducing admixtures make SCC more sensitive with reduced toughness and it is designed and designated by concrete society that is why the use of SCC is a considerable way in making of pre-cast products, bridges, wall panels etc. also in some countries.

However, various investigations are carried out to explore various characteristics and structural applications of SCC. SCC has established to be effective material, so there is aneed to guide on the normalization of self-consolidating characteristics and its behaviour to Apply on different structural construction, and its usage in all perilous and inaccessible project zones for superior quality control.

"Self-compacting concrete (scc) is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement

II. REQUIREMENTS FOR SCC

SCC has to exhibit following properties in its plastic state

Filling Ability

It is the ability of SCC to flow into and fill completely all spaces in the formwork and encapsulate reinforcement while maintaining homogeneity.

Passing Ability

It is the ability of concrete mix to pass through obstacles like narrow sections in form work, closely spaced reinforcement bars without getting blocked by interlocking of aggregate particles.

Resistance to segregation

Segregation resistance of self compacting concrete is its capability to retain homogeneity in the distribution of ingredient in fresh state during both static and moving condition i.e., during mixing, transportation and placing. It is dependent on viscosity of mix in fresh state.

III. ADVANTAGES OF SCC

At present self-compacting concrete (SCC) can be classified as an advanced construction material. The SCC as the name suggests, does not require to be vibrated to achieve full compaction. This offers benefits and advantages over conventional concrete.

- Faster construction times.
- Better surface finishes
- Easier placing
- Thinner concrete sections.
- Improved durability and reliability of concrete structures.
- Improvement of health and safety is also achieved through elimination of handling of vibrators
- Ease of placement results in cost savings through reduced equipment and labour requirement.
- Lower overall costs.
- Substantial reduction of environmental noise loading on and around a site.

IV. LITERATURE REVIEW

1) **Celik et al., 1996 .** observes crusher dust formed during the process of comminution of rock into crushed stone or crushed sand. They investigated the effects of varying dust content from 0 to 30% of fine aggregates on the physical and mechanical properties of fresh and hardened concrete. They reported an increase in compressive strength and flexure strength upto 10% dust content, followed by a gradual decrease with increasing dust content.
2) **Nan Sua, Kung-Chung Hsu et al.2001.** proposes a new mix design method for self-compacting concrete (SCC). The results indicate that the proposed method could produce successfully SCC of high quality. Compared to the method developed by the Japanese Ready- Mixed Concrete Association (JRMCA), this method is simpler, easier for implementation and less time-consuming, requires a smaller amount of binders and saves cost.
3) **M.Rame Gowda, M.C.Narasimhan, et al .2009 .**proposes quarry dust in normal concrete increases the water demand,in scc it has been increasd deformability and passing ability of fresh concrete,and also noted that increasing pouring height of scc does not effect the strength parameters of concrete .
4) **H.A.F. Dehwah,2011.** evaluate the mechanical properties of self-compactingconcrete (SCC) prepared using quarry dust powder (QDP), silica fume (SF) plus QDP or only fly ash(FA). Trials were conducted to assess the proportions of QDP, SF + QDP or FA required for producing SCC meeting the flow criteria. SCC specimens were prepared and tested for compressive strength, pulse velocity , split tensile strength and flexural strength. The use of QDP alone results in a significant cost saving in regions where SF and FA haveto be imported from other countries.
5) **K.S. Johnsirani, Dr. A. Jagannathan, R. Dinesh Kumar,2013**. make investigation on self-compacting concrete (SCC) with fine aggregate (sand) replacement of a Quarry Dust (QD) (0%, 25%, 50%, 75%, 100%) and addition of mineral admixtures like Fly Ash (FA) and Silica Fume (SF) & chemical admixtures like super plasticizers (SP). The slump, V-funnel and L-Box test are carried out on the fresh SCC and in harden concrete compressive strength and split tensile strength values are determined. Attempts have been made to study the

properties of such SCCs and to investigate the suitability of Quarry Dust to be used as partial replacement materials for sand in SCC.

6) **Anzar Hamid Mir,2015**.proposes The reduction in the sources of natural sand and the requirement for reduction in the cost of concrete production has resulted in the increased need to find new alternative materials to replace river sand so that excess river erosion is prevented and high strength concrete is obtained at lower cost. One such material is Quarry stone dust: a by-product obtained during quarrying process. Attempts have been made to study the suitability of Quarry dust as sand replacing material and it has been found that Quarry dust improves the mechanical properties of concrete as well as elastic modulus.
7) **sumit L. Chauhan, Raju A.Bondre 2015.** It describe the role of quarry dust In the construction of buildings and other structures to eliminate the demand of natural sand by using quarry waste to replace the use of natural sand. We are investigating the potential of using quarry waste and its effect on the strength and workability of concrete
8) **K.S. Johnsirani, Dr. A. Jagannathan 2015** .experimental investigation on self compacting concrete (SCC) with various partial replacements of fly ash, silica fume and combination of both fly ash and silica fume. Also the study made with fully replacement of natural sand by quarry dust. The slump, V-funnel and L-Box test are carried out on the fresh SCC and in harden concrete compressive strength and split tensile strength values are determined
9) **Baboo Rai, Sanjay Kumar, and Kumar Satish 2016.** the experimental work conducted to study the effect of quarry waste on self-compacting concrete containing binary cementitious blends of fly ash and cement. For all trial mixes the fly ash percentage replacement to cement was kept constant at 30%. Based on the standard flow ability test a visual stability index has been provided to all the trial mixes. Quarry waste replacement showed the desirable results that can suggest the usage in self-compacting concrete as well as in normally vibrated concrete .
10) **K. Shyam Prakash and Ch. Hanumantha Rao 2016 .** By replacement of quarry dust, the requirement of land fill area can be reduced and can also solve the problem of natural sand scarcity. Quarry dust satisfies the reason behind the alternative material as a substitute for sand at very low cost. It even causes burden to dump the crusher dust at one place which causes environmental pollution .It is found that 40% replacement of fine aggregate by quarry dust gives maximum result in strength than normal concrete and then decreases from 50%. The compressive strength is quantified for varying percentage and grades of concrete by replacement of sand with quarry dust.

V. OBJECTIVEAND METHODOLOGY

1. Objective

The main objective of this project is to study the properties of Influence of mineral admixtures on self compacting concrete .These properties includes flow and strength properties of blended fiber reinforced self compacting concrete.

The flow properties includes

- Filling ability.(V-Funnel)
- Passing ability.(L-Box)
- Resistance to segregation.(Flow table)

The strength properties includes

- Compressive strength.
- Split tensile strength.
- Flexural strength.
- Rebound hammer test.
- Ultrasonic pulse velocity.

2. Methodology

Self compacting concrete mix of M30 grade is adopted from past researchers .The fiber reinforced self compacting concrete and blended fiber reinforced self compacting concrete mixes are obtained by adding fibers to SCC mix.

Flow properties are studied through

- Flow table test
- V-Funnel test
- L-Box test

Strength properties are studied through

- Compressive strength of cube specimens of size 150mm x 150mm x150mm.
- Split tensile strength of cylinder specimens of size 150mm dia. x 300mm height.
- Flexural strength of beam specimens of size 150mm x 150mm x700mm.

VI. MATERIALS&THAIR PROPERTIES

CEMENT

It is generally well known for its impeccable physical properties, which are: Fineness: The uniform size among the particles in the cement is the main reason for their un deterrable strength. ...

High fineness denotes that there is more area available for water reaction in the cement. It is always desirable to use the best cement in constructions. Therefore, the properties of a cement must be investigated. Although desirable cement properties may vary depending on the type of construction, generally a good cement possesses following properties

S.NO	PROPERTY	VALUE
1	Specific Gravity	3.15
2	Initial Setting Time	105 min
3	Final Setting Time	360 min
4	Consistency	33%

Table 1

FLYASH

Fly ash is a by-product from coal-fired electricity generating power plants. The coal used in these power plants is mainly composed of combustible elements such as carbon, hydrogen and oxygen (nitrogen and sulphur being minor elements), and non-combustible impurities (10% to 40%) usually present in the form of clay, shale, quartz, feldspar and limestone.

S,NO	PROPERTY	VALUE
1	Specific Gravity	3.2
2	Fineness	3.3
3	Initial Setting Time	32 min
4	Final Setting Time	350 min

Table 2

SAND

Sand is a granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Sand is a non-renewable resource over human timescales, and sand suitable for making concrete is in high demand.

S.NO	PROPERTY	VALUE
1	Specific Gravity	2.606
2	Grading Zone	Zone-III
3	Fineness Modulus	2.54

Table 3

COARSE AGGREGATE

coarse aggregate is gravel which has been crushed, washed and sieved so that the particles vary from 5 up to 50 mm in size. Coarse aggregates have a wide variety of construction applications because they resemble standard rock particles, as opposed to fine aggregate, which more closely resembles sand . Coarse aggregates are an integral part of many construction applications, sometimes used on their own, such as a granular base placed under a slab or pavement, or as a component in a mixture, such as asphalt or concrete mixtures. Coarse aggregates are generally categorized as rock larger than a 4.75 mm and less than 2 inches.

S.NO	PROPERTY	VALUE
1	Aggregate Size	10-12 mm
2	Specific Gravity	2.71
3	Water Absorption	0.45%
4	Unit Weight(kg/m^3)	1420
5	Fineness Modulus	6.74

Table 4

QUARRY DUST

Quarry dust is a byproduct of the crushing process which is a concentrated material to use as aggregates for concreting purpose, especially as fine aggregates. In quarrying activities, the rock has been crushed into various sizes; during the process the dust generated is called quarry dust and it is formed as waste.

S.NO	PROPERTY	VALUE
1	Specific Gravity	2.56
2	Grading Zone	Zone-III
3	Fineness Modulus	2.74

Table 5

SUPER PLASTICIZER

Hi-forza 245 type super plasticizer was used in mixes. Having density of 1.03 kg/l It provides necessary workability. The product has been primarily developed for applications in high performance concrete where the highest durability and performance is required. This type of superplasticizer is free of chloride & low alkali. It is compatible with all types of cements.

Table 6

S.NO	PROPERTY	VALUE
1	Chloride ion Content	<2%
2	PH	>6
3	Relative Density	1.03kg/l

VII. TEST PROCEDURE

Required self compacting concrete Mix proportion was taken from past literature. After casting various trial mixes final mix was arrived as below.

MIX TABLE

C (Kg)	F.A (Kg)	C.A (Kg)	S.P (Lit)	FLYASH (Kg)	WATER (Lit)
450	988	667.5	5.34	74.95	237
1	2.19	1.48	0.01187	0.166	0.525

Table 7

Control mix is designated as SCC0 i.e. SCC without any fiber QD.The QD is added to control mix in different percentages by weight of Sand.QD content as 5% by weight of sand and Grading Zone-III added. Similarly different percentages of 15%, 25% 35%,45%.were added in the SCC mix. Mixes were designated as below

- SCC0-self compacting concrete without any QD
- SCC 5%QD -self compacting concrete with 5% QD by weight of sand
- SCC15% QD-self compacting concrete with 15% QD by weight of sand
- SCC25% QD-self compacting concrete with 25% QD by weight of sand
- SCC35%QD-self compacting concrete with 35% QD by weight of sand
- SCC45%QD -self compacting concrete with 45% QD by by weight of sand

After preparing every SCC mix, following flow tests were conducted to study the flow properties.

- Slump flow test
- V-funnel test
- L-box test

SLUMP FLOW TEST

Slump flow test was conducted to assess the horizontal flow of the concrete in absence of obstruction. The slump flow mean of two measurements of the spread flow diameter at right angle to the nearest 10 mm. It is commonly used test and gives good assessment of filling ability. The test also indicates the resistance of segregation. Slump flow test is a method to get flow- ability characteristics of self-compacting concrete without any segregation.

Fig 1 Flow Table, Abram's Cone and Spirit Instrument

Fig 2 Measuring the slump flow of D1and D2

V-FUNNEL TEST

The V-funnel test is used to assess the viscosity and filling ability (flow ability) of self- compacting concrete with a maximum size of aggregate 20 mm size. The funnel is filled about 12 liters of concrete.

Fig 3 preapred V-funnel as per EFNARC guide lines

L-BOX TEST

This test was developed in Japan. The L-box test is used to assess the passing ability of self-compacting concrete to flow through tight openings including spaces between reinforcing bars and other obstructions without segregation or blocking. There are two variations; the two bar test and the three bar test. The three bar test simulates more congested reinforcement.

Fig 4 Shows the flowing concrete through reinforced bars in L-box after lifting gate

TESTS ON HARDENED CONCRETE

- Test on cubes for compression strength
- Test on cubes for compression strength
- Test on cylinder for split tensile strength
- NDT tests

Fig 5 shows prepared mix cubes

Fig 6 Flexural strength test for different SCC mixes beams using UTM

VIII. RESULTS

NDT Test Results

%Replacement of sand by QD	UPS V(Km/s)	Feed back	Rebound number
0%QD	4.9	Excellent	32
5%QD	4.7	Excellent	34
15%QD	4.9	Excellent	31
25%QD	5.1	Excellent	35
35%QD	4.8	Excellent	34
45%QD	4.8	Excellent	38

Table 8

Results For Hardened Concrete

% Replacement of sand with QD	Strength			
	Compressive Strength (N/mm^2) 7 days	Compressive Strength (N/mm^2) 28 days	TensileStrength (N/mm^2) 28 days	Flexural Strength (N/mm^2) 28 days
0 %QD	**22.75**	**32.63**	**2.045**	**4.84**
5 %QD	**23.61**	**34.37**	**2.162**	**5.28**
15 %QD	**23.89**	**37.69**	**2.486**	**5.96**
25 %QD	**24.26**	**39.82**	**2.895**	**7.51**
35 %QD	**24.92**	**36.54**	**2.582**	**5.39**
45 %QD	**25.45**	**38.26**	**2.618**	**6.21**

Table 9

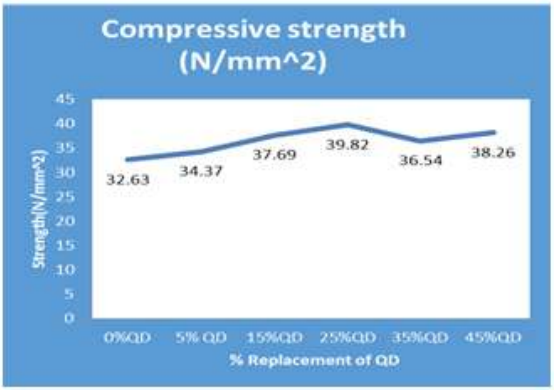

Fig 6 Shows variation of compressive strength (28days) at different % ges of QD in SCC

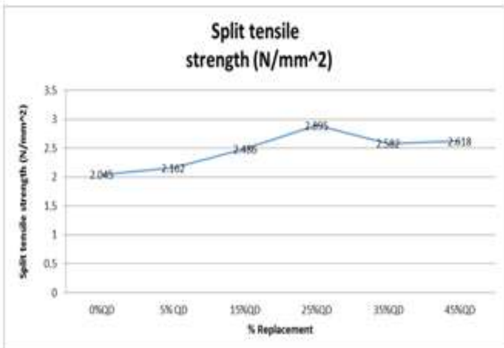

Fig 7 Shows variation of split tensile strength (28days) at different %ges of QD in SCC

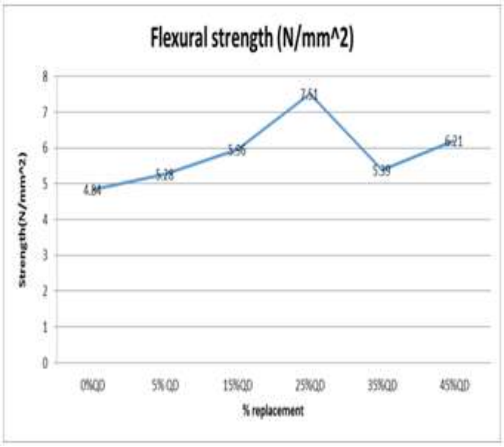

Fig 8 Shows variation of flexural strength (28days) at different %ges of QD in SCC

Results For Fresh Concrete

% Replacement of sand with QD	Flow Table		VFunnel	L-Box Test	
	Time (t50)	D avg	Time (tsec)	Time sec	H2/H1
0%QD	4.83	640	10.7	6.09	0.85
5%QD	4.86	684	6.94	6.56	0.89
15%QD	5.20	657	7.16	6.81	0.76
25%QD	6.54	638	8.31	6.98	0.65
35%QD	5.92	651	9.39	7.10	0.76
45%QD	6.11	653	9.85	7.19	0.72

Table 9

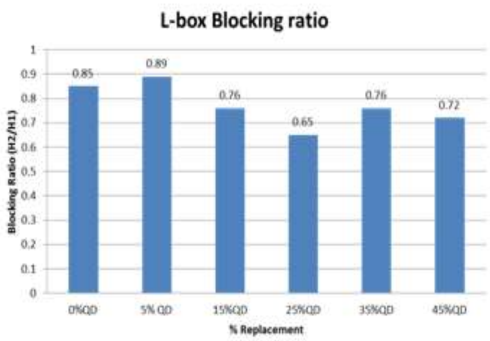

Fig 9 Shows variation of blocking ratio at different %ges of QD in SCC mix

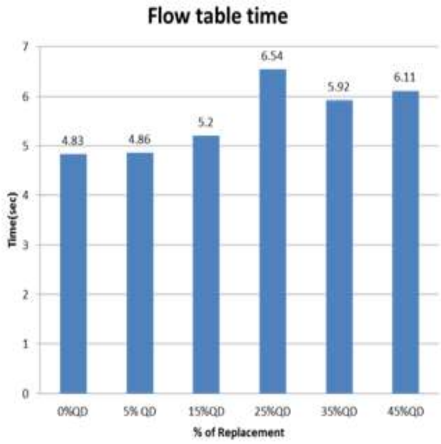

Fig 10 Shows variation of flow time at different %ges of QD in SCC mix

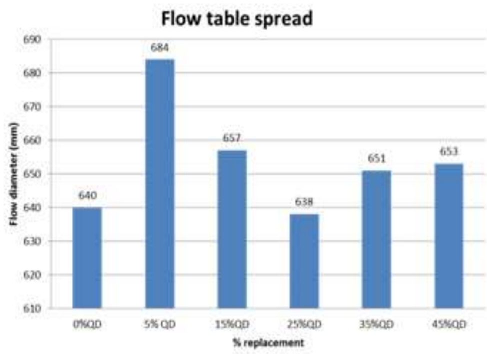

Fig 11 Shows variation of flow diameter at different percentages of QD in SCC mix

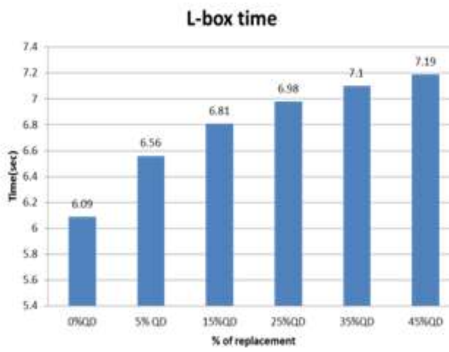

Fig 12 Shows variation of passing time at different %ges of QD in SCC mix

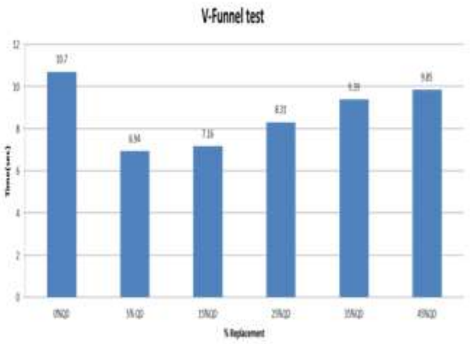

Fig 13 Shows variation of filling time at different %ges of QD in SCC mix

IX. CONCLUSIONS

Following are the conclusions from the study:

All the experimental data shows that the addition of the industrial wastes improves the physical and mechanical properties. These results are of great importance because this kind of innovative concrete requires large amount of fine particles (Aitcin, 1990). Due to its high fines of quarry dust it provided to be very effective in assuring very good cohesiveness of concrete. From the above study it is concluded that the quarry dust may be used as a replacement material for fine aggregate. Quarry dust has been used for different activities in the construction industry such as for road construction and manufacture of building materials such as light weight aggregates, bricks and tiles. From the various laboratory investigations made for characteristics study of quarry dust concrete and based on the studies conducted as explained in following conclusions are drawn.

1. Non availability of sand at reasonable cost as finer aggregate in cement concrete for various reasons, search for alternative material stone crusher dust qualifies itself as a suitable substitute for sand at very low cost.
2. Aggregates with higher surface area are requiring more water in the mixture to wet the particle surfaces adequately and to maintain a specific workability. Obviously increasing in water content in the mixture will adversely affect the quality of concrete.
3. The compressive strength of cubes at 28 days curing for control mix increases for 53 grade concrete but strength reduces with the control mixture. The increase in dust content up to 25% increases compressive strength of concrete, if the dust content is more than 25% the compressive strength decreases gradually. But the compressive strength of quarry dust concrete continues to increase with age for all the percentage of quarry dust contents.
4. The splite Tensile Strength & Flexural Strength is Max for 25%QD Replaced mix After 28 Days Curing .Later On it Will Decreases.
5. Increase In QD Effects The Workability .Flow Table spread Is Decreases compared To Nominal Mix.

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Kakarla Gopinadh" A Study on Influene of Quarry Dust on Behaviour of Self Compacting Concrete" International Journal of Engineering Research and Applications (IJERA), Vol. 09, No.08, 2019, pp. 32-40