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REPLACEMENT OF QUARRY WASTE AS FINE AGGREGATE IN THE PREPARATION OF SELF COMPACTING CONCRETE

Mr. DHARAVATH VENKATESH, Head Of Department,
MOHAMMED UWAIS, M.Tech Student,
Ms. K.VEDA SAMHITHA Assistant Professor
DEPARTMENT OF CIVIL ENGINEERING, SIDDHARTHA INSTITUTE OF TECHNOLOGY AND SCIENCES (UGC-AUTONOMOUS), Narapally (V),Korremulla road, Ghatkesar (M), Medchal Malkajgiri (Dist), 500088 E_MAIL:vpersonal114@gmail.com,abduluwais007@gmail.com.

ABSTRACT
The increased emphasis on the life-cycle cost analysis for building project requires that new attention to be focused on service life and durability of concrete structures. Durability is the ability to resist weathering action, chemical attack or any other process of deterioration. Concrete's great versatility and relative economy in filling wide range needs has made it a competitive building material. This high demand for concrete in construction lead to the increase in the release of carbon dioxide in cement production and also to the scarcity of natural river sand. So there is an urge to replace the conventional self-compacting concrete materials. Materials like Fly-ash and Quarry dust (QD) are chosen based on the criteria of cost and mechanical properties. This project is concerned with the evaluation of changes in compressive strength and split tensile strength in different mixes of M40 Grade self-compacting concrete which include conventional aggregate self-compacting concrete, concrete with replacement of cement by fly ash and fine aggregates with varying percentages of 0%, 10%, 20%, 30%, 40%, by Quarry Dust (QD). We can conclude that concretes made by Fly ash and Quarry Sand Dust have given good strength and durable properties when compared to conventional self-compacting concrete in severe environment.

Keywords: Fly ash, Quarry dust (QD), M40 Grade concrete.

I.INTRODUCTION

1.1 Self-compacting concrete

Self-Compacting Concrete was first developed in 1986 in Japan to achieve durable concrete structures since then, various investigations have been carried out and mainly large construction companies have been used this type of concrete in practical structures in Japan. SCC is a new kind of high-performance concrete (HPC) with excellent deformability and segregation resistance. It is a special kind of concrete that can flow through and fill the gaps of reinforcement and corners of moulds without any need for vibration and compacting during the placing process. Though showing good performance, SCC is different from HPC developed in North America and Europe, which emphasizes on high strength and durability of concrete. In terms of workability, HPC may improve fluidity of concrete to facilitate to placing. However, it cannot flow freely by itself to pack in every corner of moulds and all gaps among reinforcement. In other words, HPC steel requires vibration and compaction in the compaction process. Comparatively, SCC has more favorable characteristics such as high fluidity, good segregation resistance and the distinctive self-compacting ability without any need for vibration during the placing process. To produce SCC, the major work involves designing an appropriate mix proportion and evaluating the properties of concrete thus obtained. In practice, SCC in its fresh state high fluidity, self- compacting ability and segregation resistance, all of which contributing to reducing the risk of honey combing of concrete. With these good properties, the SCC shows good performance in compressive strength test and can fulfill other construction needs because its production has taken into consideration the requirements in the structural design.

Compared with conventional concrete of similar mechanical properties, the greater material cost of SCC is due to the relatively high demand of cementitious materials and chemical admixtures, including high-range water reducing admixtures and viscosity enhancing admixtures. Typically, content in cementitious material can vary between 350 to 450 kg/m3 for SCC targeted for the filling of high-restricted areas and for repair applications. Such applications require low aggregate volume to facilitate flow among restricted spacing without any blockage and ensure the filling the form work without consolidation i.e. incorporation of high volumes of fine ground powder materials is necessary to enhance cohesiveness and increase paste volume required for successful casting of SCC.

Development of SCC

For several years beginning in 1983, the problem of the durability of concrete structure was a major topic of interest in Japan. The creation of durable concrete structures requires adequate compaction by skilled workers. The design of modern reinforced structures becomes more and more advanced, the designed shapes of structures are becoming increasingly complicated and heavy reinforcing is no longer unusual. Furthermore the gradual reduction in the number of skilled workers in Japan's construction industry has led to a similar reduction in the quality of construction work one solution for the achievement of durable concrete independent of the quality of construction work in the employment of SCC, which can be compacted into every corner of a form work, purely by means of its own weight without need for vibrating compaction. The necessity of this type of concrete was proposed by okamura in 1986. Studies to develop SCC, including a fundamental study on the workability of concrete, have been carried out by "Ozawa and Maekawa" at the university of Tokyo.

The prototype of SCC was first completed in 1998 using materials already on the market. The prototype performed satisfactorily with regard to drying and hardening shrinkage, heat of hydration, and denseness after hardening and other properties.

At almost the same time, "HPC" was defined as a concrete with high durability due to low water-cement ratio by professor AITCIN (Gagneetal 1989). Since then the term high performance concrete has been used around the world to refer to high durability of concrete. Therefore, H.okamura and M.ouchi, the orders of an invited paper on SCC for JACT2003 have changed the term for the proposed concrete, for their work, to "Self-Compacting High-Performance Concrete".

How does it work

- A consolidating must have a fluidity that allows self-consolidation without external energy.
- Remain homogenous in a form during and allow the placing process and flow easily through reinforcement.
- To achieve these performances, okamura redesigned the concrete mix design process. How mix design procedure focused on these different aspects.
- Reduction of the coarse aggregate content in order to reduce friction or the frequently of collision between them, increasing the overall concrete fluidity.
- Increasing the paste content to further increase fluidity.
- Managing the paste viscosity to reduce the risk of aggregate blocking when the concrete flow through obstacles.

In technological terms, even though a significant amount of research tends to show that SCC's viscosity varies with the shear rate and acts as a pseudo plastic material, SCC is often described as Bingham fluid (viscoelastic) where the stress shear ratio is linear and characterized by two constants viscosities and yield stress.

Back to the performances-based definition of SCC; the self-consolidation is mainly governed by riled stress, while the viscosity will affect the homogeneity and the ability to flow through reinforcement. As the SCC viscosity can be adjusted depending on the applications the yield stress must remain significantly lower than other types of coarse in order to achieve self-consolidation.

Applications

After the development of the prototype of SCC at the University of Tokyo, intensive research was begun in many places, especially in the research institutes of large construction companies. As a result, SCC has been used in many practical structures. The first application of SCC was in a building in June 1990. SCC was then used in towers of a prestressed concrete cable-stayed bridge in 1992. Since then, the use of SCC in actual structures has gradually increased. Currently, the main reasons for the employment of SCC can be summarized as follows

- To shorten construction period.
- To assure compaction in the structure; especially in confined zones where vibrating compaction is difficult.
- To eliminate noise due to vibration effective especially at concrete products plants.

a) Large scale constructions

SCC is currently being employed in various practical structures in order to shorten the construction period of large-scale constructions. The anchorage of Akashi-kalikyo (Akashi strains) bridge opened in April 1998, a suspension bridge with the longest span in the world (1,991mt), is a typical example (kashima 1999). SCC was used in the construction of the two anchorages of the bridge. A new construction system that makes full use of the performance of SCC was introduced for this purpose. The concrete was mixed at the batcher plant next to the site and then pumped to the plant. It was transported 200 meters through pipe to the casting site, where the pipes are arranged in rows 3 to 5 meters apart. The concrete was cast from gate valves located at 5-meter intervals along the pipes. These valves were automatically controlled so that the surface level of the cast of the cast concrete could be maintained. The maximum size of the coarse aggregate in the SCC used at this site was 40mm. the concrete fell as much as 3mt. but segregation did not occur, despite the large size of coarse aggregate. In the final analysis, the use of SCC shortened the anchorage construction period by 20% from 2.5 to 5 years.

b) Concrete products

SCC is often employed in concrete products to eliminate vibration noise. This improves the working environment at plants and makes the location of concrete products plants in urban areas possible. In addition, the use of SCC extends the lifetime of mould for concrete products. The production of concrete products using SCC has been gradually increasing.

1.2 Fly ash

Coal is the main ingredient in major industries worldwide. Coal has been used as a fuel for generating electricity, manufacturing of steel and in operating few automotive. On the burning of coal, ash is produced in small dark flecks known as "fly ash". This fly ash is driven out through boilers together with flue gases. As it consists of fine particulate matter, it is also known as "pulverized flue ash". While this fly ash is driven out from hot boilers, electrostatic precipitators quickly capture the fine particulate matter of ash pile up with some energy and the charged particles as the walls of precipitator are oppositely charged to the particles. In previous years for many industries, fly ash imposed a challenge in its disposal. They accustomed to dispose of it in a landfill far away from the industry. It created consequential environmental pollution as these lightweight particles of ash get muddled up with surrounding atmosphere causing dust or air pollution. And also, when it is disposed of in the landfill, it clogs the soil pores making the soil stale and unfit for use by causing soil pollution. Even it mix-up with groundwater by penetrating deep into soil pores causing water pollution. Therefore, the fly ash became a huge obstacle to either dispose or recycle.

In India, coal/lignite based thermal power stations account for more than 55% of the electricity-installed capacity and 65% of electricity generation. The proximate and ultimate analysis of coal mined from India show that the content of ash in coal is around 40-50%. Disposal of solid wastes from power plant industries that uses coal for production poses great environmental problem.

As per the estimation of Government of India, power plants are going to use 1800 million tons of coal that may result in 600 million tons of fly ash by 2031-2032 (Singh 2011). Coupled with this, the deteriorating quality (increasing ash quantity) of coal is expected to aggravate the situation (Swamy, 1961 and Bhattacharjee et al., 2002). Approximately 80% of the coal ashes and metallurgical slags produced today end up either in low –value applications such as landfills and base course for roads, or are simply disposed off by ponding and stock piling. Disposal in this manner contributes to land, air and ground water pollution. Also these industrial by-products generally contain small amounts of toxic metals. The concrete construction industry should be a preferred vehicle for their disposal because most of the harmful metals can be immobilized and safely incorporated into the hydration products of cement. Owing to large size, the concrete industry is logically the ideal home for safe and economic disposal of millions of tons of available coal ash (Kumar 2001).

Dry fly ash

This is currently the most commonly used method of supplying fly ash. Dry fly ash is handled in a similar manner to Portland cement. Storage is in sealed silos with the associated filtration and desiccation equipment or in bags.

Conditioned fly ash

In this method, water is added to the fly ash to facilitate compaction and handling. The amount of water added being determined by the end use of the fly ash. Conditioned fly ash is widely used in aerated concrete blocks; grout and specialist fill applications.

Stockpiled fly ash

Conditioned fly ashes, which are not sold immediately, is stockpiled and used later. The moisture content of stockpiled fly ash is typically 10% to 15%. This is used mainly in large fill and bulk grouting applications (Behera, 2004).

Lagoon

Some power stations pump fly ash as slurry to large lagoons. These are drained and when the moisture content of deposited fly ash has reached a safe level, it may be recovered. Because of the nature of the disposal technique, the moisture content can vary from around 5% to over 30%. Lagoon fly ash can be used in similar applications to stockpiled conditioned fly ash.

As per estimates, the annual fly ash generation in the country in 2007-08 (data of 2008-09 under compilation, expected to be 150 million tonnes) was about 125 million tonnes; fly ash recycled is about 30 per cent, that is about 40 million tonnes. Out of this the cement industry consumes around 28-30 million tonnes which is above 70 per cent of the recycled ash. Hence, there is still a huge surplus of 85 million tonnes, which is being disposed off as slurry in the ponds. Another approximately 78,000 mw of new power generation capacity is expected to come up in the country within three-four years. Out of this major portion of around 60 per cent would come in form of thermal power. Estimated generation of fly ash till 2012 would be 175 million tonnes, which again would pose a serious problem of disposal.

The major consumer of fly ash is the cement industry, while some small quantities are used for making fly ash bricks, landfill etc. As per the table, the utilization of fly ash in the cement industry in manufacturing PPC cement is increasing on yearly basis. Further motivation and freight equalization to cement industry can result into 100 per cent fly ash disposal in a most eco-friendly manner.

1.3 Generation of fly ash globally

In 2010, worldwide, the production of fly ash was approximately 780 Million Tonnes (MT). China ranks first in the production of fly ash of 395 MT, North America of 115 MT, India of 105 MT, Europe of 52.6MT and Australia contributes to 2% of worldwide fly ash production. In this only 53% of fly ash is utilized and Africa has reported the lowest utilization of 10.5%, and Japan reported the highest utilization of 96.4%. India is one of the largest coal producing country, and China ranks first in its coal production (https://yearbook.enerdata.net/coal-lignite/coal-production-data.html). In India, the average coal production ranges to an average of 764 million tonnes (MT) 8 every year. The coal produced in India is of low grade and contains 30-45% of ash content when burnt, whereas higher grade coal possesses 10-15% of ash content. Therefore, the generation of fly ash is also more when compared with higher-grade coal. About 71% of the electricity in India is generated through thermal power plants.

1.4 Current utilization of fly ash

Fly ash is resource material used for the different application during day-by day activities. The fly ash mainly used in cement making due to pozzolanic characteristics. The engineering properties of fly ash can create so many geo-technical applications. The nature of fly ash is interred in nature that is why the fly ash material is used for filling applications. The morphological properties of the fly ash support the production of different kinds of ceramic material. The physical and chemical properties of fly ash help to improve the quality of agricultural soil. Fly ash content is help full in the reclamation of agricultural soil. The fly ash is rich in micronutrient as soil. The micronutrient present in fly ash help in plant growth because different plant needs micronutrient for their growth. As Indian scenario of fly ash generation and utilization is concern, on 2012, the fly ash generation rate is reaches up to 170 million tons per year and the expected target rate of utilization is 100%.

1.5 Use of fly ash in building construction

The main use of fly ash in building construction is the brick and block making. The produced blocks and bricks are better furnished, high in strength, less water absorption capacity, less environmental influences, lower unit weight and fewer loads on foundation. The construction of fly ash bricks and blocks is economic because it consumes less energy during manufacturing which automatically reduce the cost. The most and vital role of fly ash bricks and blocks reduce the use of good quality soil. The manufactured bricks and blocks are lower in cost when compared with clay bricks and cement blocks. The number of bricks required per unit area is also reduced.

1.6 Use of fly ash in cement and concrete

The ordinary or high performance concrete contains 20 to 40% fly ash and high. The roller compacted concrete contains 60 to 70% fly ash, the cellular light weight concrete contains 20 to 40% fly ash and the high volume fly ash concrete contains 50 to 70% of fly ash. The properties of fly ash mixed cement possess long term strength, better workability, higher impermeability, less heat of hydration, corrosion resistance, high resistance to aggressive environment and more durability. The fly ash mixed cement is economical as it reduces the cost of clinkering, the energy consumption during manufacturing, the cost of raw material i.e. amount of lime stone, iron ore etc and overall consumption of cement.

1.7 Physical properties of fly ash

Fly ash consists of fine, powdery particles that are predominantly spherical particles, which differs in size and shape significantly due to differences in degree of pulverization of coal, impurities in the coal, boiler type, powder load and efficiency of 10 collection systems. In general, the Blaine's fineness of Indian fly ash varies between 300 to 600 m3/kg except in few stray causes where it is coarser. One of the most important parameter, which governs the use of fly ash as a general, rule that increase with its fitness. Lime reactivity of Indian fly ash samples generally varies between 3.5 to 6.5 N/nm2 (Moreno et al., 2005). The fly ash particles are either solid or hollow, and mostly glassy (amorphous) in nature. The carbonaceous material in fly ash is composed of angular particles. The particle size distribution of most bituminous coal fly ashes is generally similar to that of silt (less than a 0.075 mm) although sub bituminous coal fly ashes are also silt-sized; they are generally slightly coarser than bituminous coal fly ashes (Ahmaruzzaman, 2009). The specific gravity of fly ash usually ranges from 2.1 to 3.0, while its specific surface area (measured by the Blaine air permeability method) may range from 170 to 1000 m2 /kg (Ahmaruzzaman, 2009). The color of fly ash can vary from tan to gray to black, depending on the amount of unburnt carbon in the ash. Lighter the color, lower the carbon content. Lignite or sub bituminous fly ashes are usually of light tan to buff in color, indicating relatively low amounts of carbon as well as the presence of some lime or calcium. Bituminous fly ashes are usually some shade of gray, with the lighter shades of gray generally indicating a higher quality of ash.

1.8 Chemical properties of fly ash

Those of the coal burned and the techniques used for handling and storage influence the chemical properties of fly ash to a great extent. The chemical composition of fly ash depends largely on the geological and geographic factors related to coal deposits. There are basically four types of coal, each of which varies in terms of its heating value, its chemical composition, ash content and geological origin. The four types of coal are anthracite, bituminous, sub bituminous and lignite. In addition to being handled in a dry, conditioned or wet form, fly ash is also sometimes classified according to the type of coal from which the ash was derived. The principal components of bituminous coal fly ash are silica, alumina, iron oxide, and calcium, varying amounts of carbon as measured by the loss on ignition (LOI) (Ahmaruzzaman, 2009). Lignite and sub bituminous coal fly ash may have a higher concentration of sulphate compounds than bituminous coal fly ash.

1.9 Composition and classification of fly ash

Fly ash is also known as coal ash. It is a heterogeneous material and has diverse mineralogy. Depending on the grade of coal and state of burning, the chemical composition varies in fly ash. All types of fly ash include some common chemical constituents like silicon dioxide (SiO2) available in both amorphous and crystalline form, Aluminium Oxide (Al2O3) and Calcium Oxide (CaO). Heavy metals such as arsenic, beryllium, boron, chromium, cobalt, lead, cadmium, manganese, mercury are also found in traces in fly ash.

Class F

On burning of anthracite, bituminous coal or harder coal, Class F fly ash is produced. It contains less than 7% of lime (CaO) and posses pozzolanic properties. Due to this, Class F fly ash should be mixed with hydrated of quick lime to produce cementitious properties. This type of fly ash when mixed with sodium silicate (chemical activator) forms geopolymer and extends its properties to use it in numerous fields.

Fig.1: Class ‘F’ type of fly ash

Class C

On the burning of sub-bituminous coal or lignite, Class C fly ash is produced. This makes the fly ash posses self-cementing properties and pozzolanic properties. When water is mixed up with this type of fly ash, it becomes stronger over time.

Fig.2: Class ‘C’ type of fly ash

Class C fly ash contains more than 20% of lime (CaO). Hence, no addition of lime is required. It contains alkalis and sulphate as addition chemical constituents. Class C fly ash can be used in the manufacturing of fly ash bricks.

1.11 Quarry dust

Igneous and metamorphic rocks cover about 90-95% of the earth’s surface. In earth’s crust, most abundantly available type of rock is igneous and due to its wide range of physical and chemical properties, enables its use in all different sectors of construction purposes. Most of the high rise mountains, hills, plateaus and surface of the earth, even in oceanic crust consist of igneous rock. The leading manner of extracting rock or stone is through digging, quarrying and blasting. In India, most of the rocks are extracted through quarrying. Quarrying is the process of extracting rock using explosives. 15 The pieces of rock or stone obtained in quarrying are used in either stone masonry or aggregate in building or road construction. In this blasting process of rock, numerous small or fine particles of stones are transformed into dust particles in the atmosphere. These dust particles surround the environment throughout the quarry and get settled on the leaves and bark of trees, thereby killing the tissues of the tree. Hence to reduce air pollution, this quarry dust is used for construction purposes. It is used as a substitute for fine aggregate in concrete either partially or fully. As it is originated from rock, it offers better strength when compared with sand as fine aggregate in concrete. It can also be used in road construction and manufacturing of bricks and tiles. It is the cheap and best material available in the market for construction purposes.

Properties and chemical composition of quarry dust

Even though the quarry dust is the product obtained from rock, it consists of different chemical components in it, which is helpful to use in aggregate. The chemical composition of quarry dust includes Silicon dioxide (SiO2), Aluminium Oxide (Al2O3), Ferrous oxide (Fe2O3), Calcium oxide (CaO), Magnesium Oxide (MgO), Sodium oxide (Na2O), Potassium oxide (K2O), Titanium (TiO2). As this is the product obtained from a rock, the shape of the particles is irregular when used in concrete as fine aggregate provides better bonding. The specific gravity of the quarry dust ranges between 2.4 to 2.8, and maximum size of the particle is 4.75 mm and absorption of quarry dust ranges between 0.4 to 0.8% depending upon the type of rock from which the quarry dust is produced.

Applications of quarry dust

There are many applications of quarry dust. Discussed below are applications in construction, processing, and landscaping and recreational applications: Application of quarry dust in construction In the construction industry, quarry dust is used as an aggregate substitute especially for sand in a concrete mixture. The application of quarry dust can reduce the cost of construction. In the Centre for Housing Planning and Building built a number of low cost houses using quarry dust. The research done for the cost of construction proved that using quarry dust is cheaper than sand. Quarry dust is also used in the construction of sub base in highways. Application of quarry dust in processing In India, quarry dust is used to produce concrete blocks. It is mixed with chalk and gypsum to produce blocks. The used of quarry dust in producing concrete blocks is also applied in South Africa. Quarry dust is also used to produce tiles.

II.LITERATURE REVIEW

2.1 SSC

Hajime Okamura in his paper entitled "Self Compacting High-Performance Concrete" has discussed about self compacting concrete as a mix that can be compacted into every corner of a formwork, purely by means of its own weight and without the need for vibrating compaction. Inspite of its high flowability, the coarse aggregate in not segregated. A model formwork was used to observe how well self-compacting concrete can flow through obstacles. Concrete is placed into the right-hand tower, flows through the obstacles and rises in the left-hand tower. The obstacles were chosen to simulate the confined zones of an actual structure. The self-compacting concrete on the left can rise to almost the same level as on the right. It is realized that the development of self compacting concrete would be necessary to guarantee durable concrete structures in the future. When concrete flow between reinforcing bars, the relative location of the coarse aggregate is changed. The relative displacement causes shear stress in the paste between the coarse aggregate, in addition to compressive stress. Shear force required for relative displacement largely depends upon water cement ratio. Increasing water cement ratio leads to improved flowability of cement paste and decreases viscosity. Therefore, superplaticizer is indispensible. Coarse aggregate is limited to 50 percent of solid volume and fine aggregate content is 40 percent of mortar volume. U type test is most appropriate for evaluating self compactability.

Naveen Kumar C., Kiran V. John, Jagadish Vengala and Ranganath R. V. in their paper entitled "Self Compacting Concrete with Fly Ash and Metakaolin", have studied the properties of SCC containing flyash and metakaolin. From their study they have concluded that mixes with different fillers like silica fume and metakaolin help in attaining a high early strength of around 50-70 MPa which is very useful in pre-cast applications. They also can provide high durability when used along with fly ash, The experimental study reported in this paper showed that fly ash can be used in large quantities in SCC and cement content can be reduced to as low as 200kg/cum without losing the requisite characteristics of SCC, blends of metakaolin and fly ash used as filler performed better than the use of fly ash or metakalin as individual filler in SCC. Good compressive and tensile strengths, good flowability and adequate self compactability were obtainable with only marginal increase in the 1superplasticizer dosage. The visual assessment of mixes containing metakaolin showed that VMAis not necessary for metakaolin incorporated SCC.

III.OBJECTIVE AND METHODOLOGY

3.1 Objective

The present study deals with the replacement of cement by Fly ash and replacement of fine aggregates with varying percentages (0, 10, 20, 30, 40%) by Quarry stone Dust for M40 grade of Self-compacting concrete.

i) To study the effect of replacement of different percentages (0, 10, 20, 30, 40%) in fine aggregates by quarry dust and cement by Fly ash in the concrete.

ii) To determine the workability of freshly prepared concrete by Slump test & T50 test.

iii) To determine the compressive strength of cubes at 7, 14, 28 days curing

iv) To determine the split tensile strength of beams at 28 days curing.

3.2 Methodology

1. The flyash and quarry dust were collected from different sources.
2. Sieved the quarry dust with IS Sieve 4.75mm to IS Sieve 75microns. The passed from 4.75mm and retained on 75microns was used for this study.
3. Physical properties of all materials was tested (mentioned in chapter4).
4. Design mic design of M40 grade concrete was for this study. The partial replacement of cement with fly ash and 10%, 20%, 30%, 40% & 50% of river sand with quarry dust.
5. The fresh properties of self compacting concrete are tested by using slump and T50 test.
6. The harden properties of self compacting concrete is tested by using compressive and split tensile strength test.
7. Based on the tes

IV.EXPERIMENTAL WORK

4.1 General

This chapter describes about the materials used and their properties, experimental methods and setups in this investigation.

4.2 Materials used

Ordinary Portland Cement of 53 grade with specific gravity 3.15 available in local market, fine aggregate which is chemically inert, clean conforming to grade zone II with specific gravity 2.6 were used. Coarse aggregate of 20 mm size uniform quality with respect to shape and grading conforming to IS standards was used for control concrete and 10 to 12.5 mm size aggregates were used for SCC. Fly ash obtained from NTPC Thermal Power Station (Class F) was used in this investigation to improve workability and durability of SCC. Ceramic waste obtained from 4.75mm IS Sieved passed aggregates are using for partial replacement of fine aggregates. Potable water available in the laboratory was used to cast concrete specimens and for curing.

4.3 PROPERTIES OF MATERIALS

Cement

In this investigation, 53 grade OPC conforming to IS 12269–1987 was used. The cement sample was tested as per the procedure given in IS 4031-1988 and 4032-

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1985. The physical properties satisfy the requirements of respective codes are listed in Table 4.1.

Table 4.1 Physical Properties of OPC 53 Grade Cement

Property	Value	Code recommendations
Specific gravity	3.15	3.10 – 3.15
Consistency	29%	25 – 35
Initial setting time	45mint	Not less than 30mint
Final setting time	6hours 35mint	Not greater than 10hours
fineness	4%	Not greater than 10%

Figure. 3 Cement

Fine Aggregate

Locally available river sand was used as fine aggregate conforming to grade zone II in this investigation. The sand was cleaned and screened at laboratory to remove deleterious materials and tested according to IS: 383-1970. The results of fine aggregate water absorption was 0.75% and specific gravity was 2.68.

Figure. 4: Fine aggregate

Coarse Aggregate

The coarse aggregate occupies more than 85% of the volume of concrete and their impact on various properties of the concrete is predominant. The maximum size of the coarse aggregate was limited to 20 mm for control concrete and 12.5 mm for SCC. The results of coarse aggregate water absorption was 0.5% and specific gravity was 2.72.

Figure. 5: Coarse aggregate

Quarry dust

Quarry dust is a result of crushers while doing quarrying activities. Quarry dust was obtained from nearby quarries at the Ghatkeshar. The specific gravity of quarry dust we got 2.7.

Figure. 6: Quarry dust

Water

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement in concrete. Drinking water available in the laboratory conforming to IS 456-2000 was used to cast concrete specimens and for curing in this investigation.

Mix design

The concrete mix was designed for M40 grade concrete to study the various properties of the concrete as per IS 10262:2009.

Mix proportions for SCC

To produce SCC, the major work involves designing an appropriate mix proportion and evaluating the properties of the concrete thus obtained. 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 honey combing of concrete. With these good properties, the SCC produced can greatly improve the reliability and durability of the reinforced concrete structures. In addition SCC shows good performance in compressive strength test and can fulfill other construction needs because its proportion has taken into consideration the requirements in the structural design. The mix proportion for self compacting concrete is obtained by trial and error method. using EFNARC regulations. The mix proportion for 1 m3 of SCC is presented in Table

4.1.

Table 4.1 Mix design

Material	Kg/m3
Cement	450
Flyash	150
Water	210
Fine aggregate	746
Coarse aggregate	737 20 – 10 mm = 442 10 – 4.75mm = 295

Volume of cube = (0.15)3 x 1.1 = 0.0037125
Volume of cylinder = 1.1 X 5.3014 x 10-3 = 0.005831

Table 4.2 FOR SINGLE CUBE

MIX %	CEMENT	FLYASH	FA	QD	CA	WATER
0	1.67	0.556	2.77	0	2.736	780
10			2.63	0.1385		
20			2.5	0.277		
30			2.35	0.4155		
40			2.216	0.554		

Table 4.3 FOR SINGLE CYLINDERS

MIX %	CEMENT	FLYASH	FA	QD	CA	WATER
0	2.62	0.87	4.35	0	4.3	1.225
10			4.1325	0.2175		
20			3.915	0.435		
30			3.7	0.6525		
40			3.48	0.87		

Figure. 7: Mixing of SSC

V.RESULTS AND DISCUSSIONS

5.1 Test Results and Graphs

Fresh concrete properties of SCC

Table 5.1 Fresh properties of SCC test results

Tile waste (%)	Slump value (mm)	T_{50} (sec)	J- ring value (mm)
0	600	4.6	550
10	610	3.4	558
20	615	3.2	560
30	620	3.0	564
40	622	2.6	568

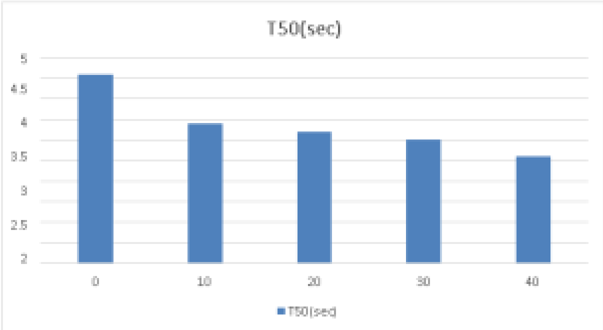

Figure 8: T50 values graphs

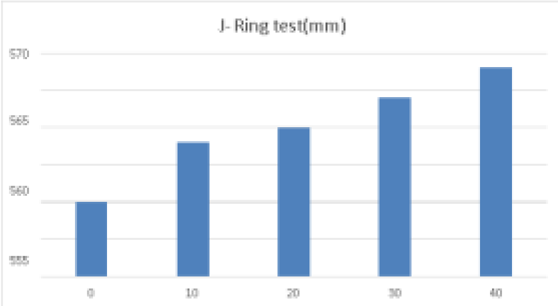

Figure 9 : J-ring test values graphs

Harden concrete properties of SCC

Compressive strength

Table-5.2 Compressive Strength at 7, 14 and 28 days for SCC

QD (%)	Compressive strength in (Mpa)		
	7 DAYS	14 DAYS	28 DAYS
0	26.8	37.2	41.1
10	27.5	38.5	43.2
20	30.1	39.2	44.5
30	**32.3**	**40.89**	**45.8**
40	29.4	38.8	43.4

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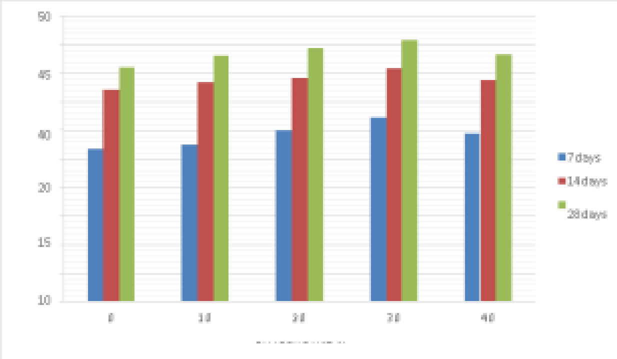

Figure :10

Tensile strength

Table-5.3 Tensile Strength at 28 days for SCC

QD (%)	28 Days Tensile strength (Mpa)
0	6.98
10	7.3
20	7.35
30	**7.39**
40	7.37

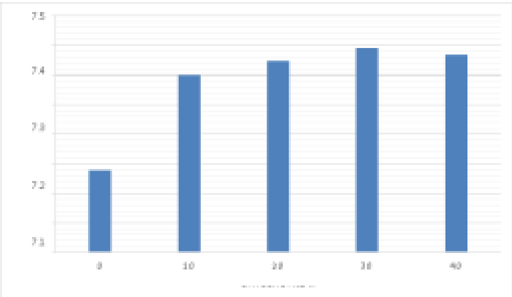

Fig -11 : Compressive strength test result graph for SCC

5.2 DISCUSSION

Strength Characteristics

The compressive strength values obtained by testing standard cubes for SCC (with partial replacement of fine aggregate with quarry waste) samples. The average value is taken as final output. The SCC mix has strength above 40 MPa in compression. The compressive strength of quarry dust based SSC, replacement of 30% gains higher strength compare to conventional SSC. The strength for Quarry dust based SSC gains 10% more than Conventional SSC.

The Split tensile strength values obtained by testing standard cylinders for SCC (with partial replacement of fine aggregate with quarry waste) samples. The average value is taken as final output. The tensile strength of quarry waste based SSC, replacement of 30% gains higher strength compare to conventional SSC. The strength for GGBS based SSC gains 5.5% more than Conventional SSC.

Workability

The workability properties those are T50, J-ring and Slump value was good. The T50 and Slump value and J-ring values are more for quarry waste based SSC as compare to the conventional SSC.

VI.CONCLUSIONS

In this project work, elaborate testing was carried out and the obtained results were analyzed critically based on the previous research works available in literatures. The project outcomes are summarized as conclusions for the prime properties of concrete, such as, compressive strength, split tensile strength and workability properties.

1. Based upon its properties quarry dust aggregates are appropriate concrete material which is used as an alternative material to fine aggregates in concrete.
2. This study was carried to obtain the results, test conducted on the quarry dust modified fine aggregate SSC concrete mix, in order to ascertain the influence of quarry dust on the characteristic strength of SSC concrete. The higher compressive and tensile strength of SSC concrete, when the quarry dust replacing of 30% in the fine aggregate content. The results show if around 10% of compressive and 5.5% of tensile strength as more than the conventional SSC.
3. For all types of mixes considered always an increase in strength up to a certain level is seen for both 7, 14 & 28days curing.
4. Also, they reduce the cost of construction when compared to conventional aggregate based concrete.

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