THE STRENGTH PROPERTIES OF CONCRETE BY PARTIAL REPLACEMENT OF FINE AGGREGATE WITH QUARRY DUST AND CEMENT WITH GGBS AND NANO-SILICA

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Abstract : Concrete is the most widely used construction material in civil engineering fields because of its high structural strength and stability. The concrete industry is constantly looking for supplementary cementations material with objective of reducing the solid waste disposal problem. Ground granulated blast furnace slage (GGBS) and Quarry dust are among the solid waste generated by industry. Natural sand is most commonly used fine aggregate in concrete increasing construction activities requires production of more and more quality of concrete, which needs more and more natural sand and coarse aggregate. A recent survey shows that for production of every tone of Cement, around one tone of Carbon dioxide is liberated. So, in the present scenario it has become a matter of prime importance, to reduce the cement production and increase the use of substitute materials to the save the environment. In the present study Quarry Dust is used as partial replacement of fine aggregate by weight at varying percentage of 25%, 50%, 75% and 100% respectively. Cement is used as replacement of GGBS by weight at varying percentages of 20%, 40% and 60%, and Nano silica by weight at varying percentages of 3 %. The combined influence of quarry dust and GGBS, Nano Silica on Compressive strength, Split Tensile Strength of M40 grade of concrete investigation. The test results of concrete prepared using different combinations of quarry dust and GGBS, Nano-Silica are compared with that of controlled concrete. Based on the experimental investigation, the increase in the strength properties of the materials has been observed and the optimum replacement percentages of GGBS and Quarry Dust are 40% and 50% respectively.

Key Words: Ground granulated blast furnace slage, Quarry Dust, Nano silica, Compressive strength, SplitTensile Strength.

I. INTRODUCTION

Concrete is the most commonly used material in various types of construction. Concrete is widely used for making architectural structures, foundations, pavements, bridges, motorways, runways, parking structures, dams, reservoirs, pipes, fences and poles. The present day concrete demands high performance with economy. Concrete is a material with which any shape can be cast. It is the material choice where strength, performance, durability, impermeability, fire resistance and abrasion resistance are required. It is difficult to find out other material of construction which is as versatile as concrete. Concrete is one of the materials which seems simple but actually complex materials. The properties of concrete mainly depends on its constituents. The main important materials used in making concrete are Cement, Fine Aggregate, Coarse Aggregate and Water. The properties of Cement, Sand, crushed stone and water influences the quality of concrete. In addition to this, workmanship, quality control and method of placing also play the leading role on the properties of concrete.

II.LITERATURE REVIEW

An overview of literature on the various experiments conducted by many authors on the partial replacement of cement with GGBS , Nano Silica and fine aggregate with Quarry Dust(QD) by and the results there of highlighting the significance of using the GGBS for partial replacing in Cement and Quarry Dust for replacing the Natural Sand in concrete. It includes the literature about mix design, fresh concrete properties, strength, durability aspects, micro structures and the structural behavior of concrete with the replacement of cement with GGBS, NS and fine aggregate by Quarry Dust.

Patel and Pitroda (2013) reported that every year 200-400 tons of CRUSHED FINE AGGREGATE is generated by the stone cutting plants, and is dumped as waste. This leads to serious environmental and dust pollution. So it is necessary to dispose the CRUSHED FINE AGGREGATE waste quickly and efficiently.

Pofale and Quadri (2013) reported that Compressive Strength of concrete (M25 & M30) made using crusher dust increased at all the replacement level between 30 to 60% at a interval of 10%. However maximum increased in strength is observed at a replacement level of 40%.

ReshmaRughooputh and JayalinaRana(2014) did experiment on Partial Replacement of cement by ground granulated blast furnace slag. The experiment is carried out by replacing cement with GGBS by 30% and 50%. Grade of concrete considered as M30. The results showed thatCompression strength,Flexural Strength and split tensile strength were maximum for mix with 50% GGBS and 50% ordinary Portland cement (OPC). Secondly the results also indicate that increase in GGBS content increases workability as well as strength properties. The drying shrinkage results were 3% and 4% for 30% and 50% GGBS respectively.

K. Prakash (2016), Research work on effect if supplementary cementations materials on strength of recycled aggregates concrete. The study was based on reference concrete mix of grade M20 using natural aggregates and partially replacement of coarse aggregates by recycled aggregates. In this study supplementary materials evaluated are silica fume (SF), metakaolin (MK) and ground granulated blast furnace slag (GGBS) at 10% partial replacement to cement. The maximum compressive strength of 28 days cubes is 28.37 N/mm2 for 0% recycled aggregates used and 10% GGBS replacement of cement. Praveen Mathew, Jeevan Jacob, Leni Stephen, Thomas Paul (2014). In this research work of the behavior of concrete under various percentage Replacements for natural aggregate (NA) (both fine and coarse) with recycled aggregate (RA) is examined for its structural property. Properties of recycled aggregate concrete (RAC) such as compressive strength, splitting tensile strength, flexural strength and modulus of elasticity were examined.

III. MATERIALS

The main constituents of the Concrete are Cement, Fine Aggregate, Coarse Aggregate and Water. Quarry Dust is procured from Chandragiri Quarry, in Tirupati. Local drinking water is used for mixing and curing. The properties of Cement, Fine Aggregate, Coarse Aggregate, Water, Quarry Dust used in the investigation were obtained based on standard experimental procedures laid down in IS codes.

The materials used in experimental investigation include

1. Ordinary Portland Cement (OPC)
2. Fine aggregate
3. Coarse aggregate
4. Ground Granulated Blast Furnace Slag
5. Quarry Dust
6. Nano Silica
7. Water

Cement:

In the present investigation Ultra Tech Ordinary Portland Cement (OPC) of 53 grade confirming to IS: 12269-1987 specifications was used. All the tests are carried out in accordance with procedures described in IS: 4031-1985. Tests were conducted for the determination of physical properties of the cement.

- Fineness is 7.6%
- Specific Gravity is 3.15
- Normal Consistency is 30%

Fine Aggregate:

The locally available Natural Sand is procured and is found to be conformed to Grading Zone-II of IS 383-1970. Various tests have been carried out as per the procedure given in IS 383-1970 from them it is found that,

- ✓ Specific Gravity of Fine Aggregate is 2.52
- ✓ Fineness Modulus of Fine Aggregate is 3.76

Natural Coarse Aggregate:

Machine crushed granite aggregate conforming to IS 383-1970 consisting 20mm and 12mm below has been obtained from the local quarry. It has been tested for physical and mechanical properties such as Specific Gravity, Water Absorption and Sieve Analysis and the results are as follows:

- ❖ Specific Gravity of Coarse Aggregate is 2.67
- ❖ Water Absorption of Coarse Aggregate is 0.4%
- ❖ Fineness Modulus of Coarse Aggregate is 6.52

Ground Granulated Blast Furnace Slag

GGBS used in this present experimental study is obtained from ASTRRA chemicals, Chennai Theproperties of GGBS as given by the supplier are

- Fineness is 3.9
- Specific Gravity is 2.85
- Insolble Residue is 0

Quarry Dust

Quarry Dust is collected from local stone crushing units of Chandragiri near, Tirupati, Andhra Pradesh. The particle sizedistribution of Quarry Dust was determined and the results obtained are

- Specific gravity observed for Quarry Dust is 2.3
- Water absorption of Quarry Dust is 3.5%
- Fineness Modulus of Quarry Dust is 2.18

Nano Silica (NS)

Nano materials have atleast one dimension of the order of a nano which is 10-9m. For example one strand of DNA is 2nm wide andhuman hair has a diameter of nearly 10-4m. A nano particle becomes a quantum dot with dimension of the order of 10nm andthis size is so small that jumps in energy levels occur. Nano silica particles are of the same size.

Water:

As per IS 456:2000, water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salt, sugar, organic materials or other substances that may be deleterious to concrete or steel . If these are present can adversely affect the strength of concrete Potable water is generally considered satisfactory for mixing and curing of concrete

IV. Results And Discussion

The results of the experimental investigation are presented in this chapter. In order to facilitate the interpretation of the result, the analysis was carried out at each phase of experimental work. The significance of the results were assessed with the reference to relevant IS codes.

Compressive Strength

Compressive Strength of concrete is commonly considered as the most reliable property because the strength is usually reliable measure of the quality of concrete.The Compressive Strength values of both Control Concrete along with different combinations of GGBS, NS and Quarry Dust are shown in Figure 6.1. when compared to Controlled Concrete, It is observed that the Compressive Strength of Concrete increases up to 18% when cement is replaced with 40% of GGBS and 50% of Quarry Dust at 28 days.

Table 1. Compressive Strength Test Results of M_{40} Grade Concrete

Concrete Mix	Compressive Strength of Concrete (MPa)				
	3 Days	7 Days	28 Days	56 Days	90 Days
Control Concrete	18.14	28.5	38.8	39.1	42.2
3%NS +GGBS 20%+QD25%	26.2	33.6	43.4	46.2	48.8
3%NS +GGBS 20%+QD50%	27.8	34.2	44.8	48.4	49.5
3%NS +GGBS20%+QD75%	24.7	31.4	43.2	45.5	44.2
3%NS +GGBS20%+QD100%	22.1	30.3	41.5	43.1	42.3
3%NS +GGBS 40%+QD25%	34.6	38.2	47.8	51.2	53.8
3%NS +GGBS 40%+QD50%	36.5	44	52.6	54.8	56.4
3%NS +GGBS 40%+QD75%	35.4	41.8	47.5	50.2	53.2
3%NS +GGBS40%+QD100%	33.3	36.2	44.8	49.4	51.5
3%NS +GGBS 60%+QD25%	28.7	36.4	43.6	46.6	48.5
3%NS +GGBS 60%+QD50%	29.5	38.8	46.5	49.4	51.2
3%NS +GGBS 60%+QD75%	28.4	39.4	44.7	45.6	50.6
3%NS +GGBS 60%+QD100%	26.3	35.3	42.2	43.2	48.6

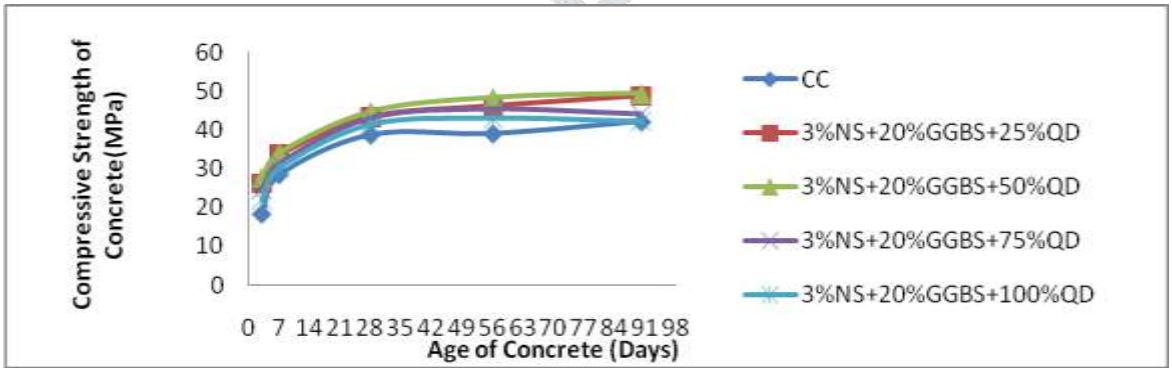

Fig. Variation of Cube Compressive Strength of M_{40} Grade Concrete with Different Percentages of 20%GGBS+ 3%NS and at 25% to 100% Quarry Dust

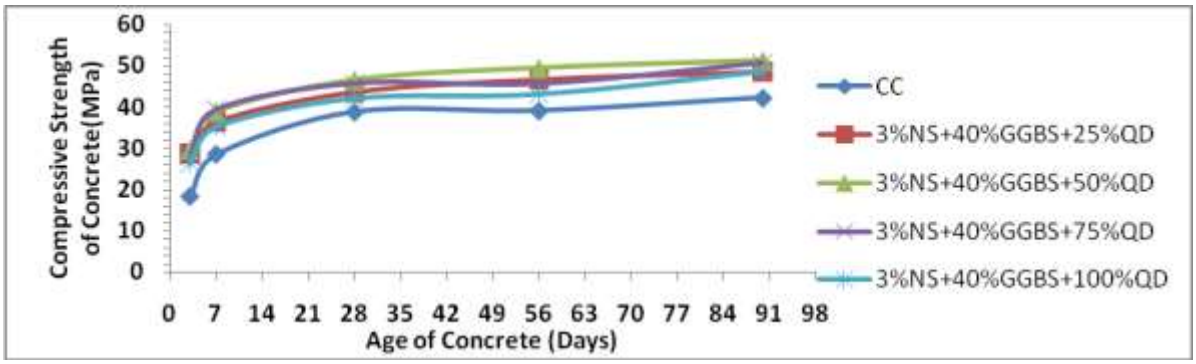

Fig. Variation of Cube Compressive Strength of M_{40} Grade Concrete with Different Percentages of 60%GGBS+3%NS and at 25% to 100% Quarry Dust

Split Tensile Strength

The Split Tensile Strength test was carried according to IS 5816-1999. The results of Split Tensile strength of Concrete with different percentages of GGBS and Quarry Dust are

Table. Split Tensile Strength Test Results of M40 Grade Concrete(28days)

Concrete Mix	GGBS (%)	QD (%)	Split Tensile Strength(MPa)
Control Concrete	0	0	3.73
0%NS+ GGBS0%+QD25%	0	25	3.82
0%NS+ GGBS0%+QD50%	0	50	3.91
0%NS+ GGBS0%+QD75%	0	75	3.63
3%NS+ GGBS0%+QD100%	0	100	2.83
3%NS+ GGBS20%+QDS25%	20	25	3.79
3%NS+ GGBS20%+QD50%	20	50	4.1
3%NS+ GGBS20%+QD75%	20	75	3.83
3%NS+ GGBS20%+QD100%	20	100	2.96
3%NS+ GGBS40%+QD25%	40	25	3.85
3%NS+ GGBS40%+QD50%	40	50	4.30
3%NS+ GGBS40%+QD75%	40	75	3.58
3%NS+ GGBS40%+QD100%	40	100	3.20
3%NS+ GGBS60%+QD25%	60	25	3.48
3%NS+ GGBS60%+QD50%	60	50	3.80
3%NS+ GGBS60%+QD75%	60	75	3.40
3%NS+ GGBS60%+QD100%	60	100	2.50

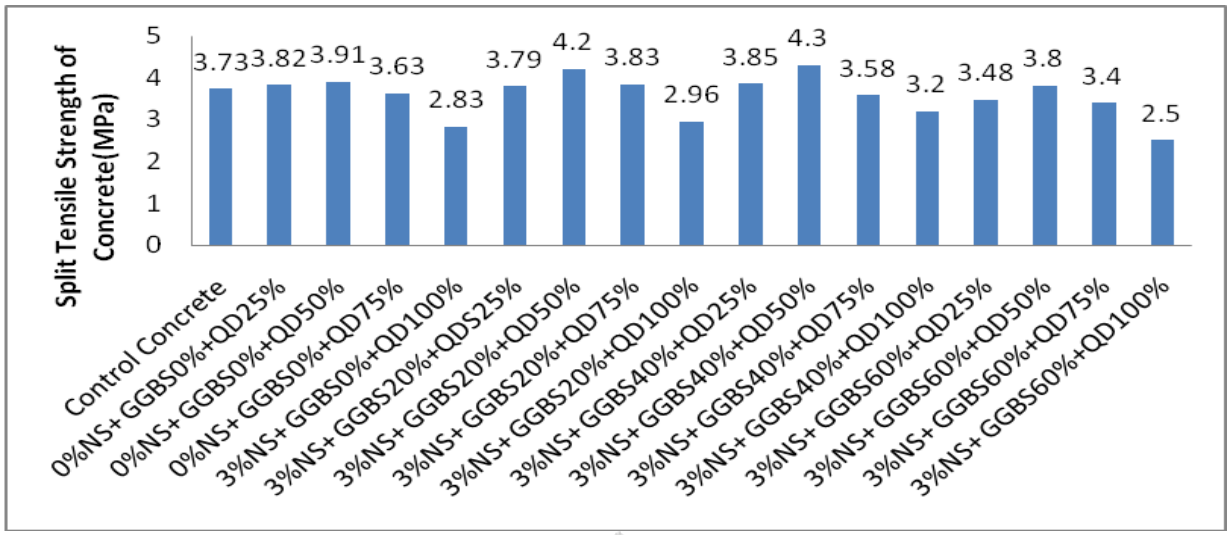

Fig. Variation of Split Tensile Strength of M40 Grade Concrete at Different Percentages of GGBS ,NS and Quarry Dust

V. CONCLUSIONS:

Based on the test results of the present investigation, the following conclusions are drawn

- While using the nano silica solution in concrete the original water cement ratio of concrete mix is to be corrected by the amount of water available in nano silica solution. An increase of 18% in Cube Compressive Strength at 28 days is observed with 40% GGBS, Nano Silica and 55% Quarry Dust.The maximum percentage increase of 18.4% in Split Tensile Strength compared to Control Concrete and it is obtained at 40% GGBS,3%Nano Silica and 50% Quarry Dust replacement. At a replacement percentage of 40% cement with GGBS and 3% cement with Nano Silica and Fine aggregate with 50% Quarry Dust , the Water Absorption test results has the minimum value of 3.5%.Finally it is very interesting to note that the variation of various test results followed the similar trend

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