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Experimental Investigation on Strength Properties of Concrete using Foundry waste (silica and Quartz)

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Abstract- **Production and consumption of cement is increasing day by day as a result in the massive development in the construction field. This leads to the depletion in the limestone which is a natural resource. In order to conserve the limestone in nature the reduction of cement production is essential. This project deals with the utilization of an alternative material, silica and quartz as partial replacement of cement. The main objective of this project is to study the effects of silica and quartz from the steel industry as foundry waste for the partial replacement of cement in the manufacturing of concrete. Silica and quartz are the foundry waste obtained from the steel industry. Silica and quartz replace 50%, 30%, 20% by weight of the cement.**

Index Terms- Concrete, Silica, Quartz, Compressive Strength, Spilt Tensile Strength.

I. INTRODUCTION

Concrete, usually Portland cement concrete, is a composite material composed of fine and coarse aggregate bonded together with a fluid cement (cement paste) that hardens over time—most frequently a lime-based cement binder, such as Portland cement, but sometimes with other hydraulic cements, such as a calcium aluminate cement. Worldwide, concrete has overtaken in the construction industry, concrete is most commonly used as the foundation for most structures. When constructing with concrete, it is vital to properly understand the reinforcing requirements, accessory requirements, desired and achievable strengths, historical data relative to materials being used, proper placement of materials, and tracking of periodic trending strengths to design parameters are being met.

Design mix of M 20 grade concrete with replacement of 0%, 20%, 30% and 50% of quarry dust organized as M1, M 2, M 3, M 4 and M 5 respectively have been considered for laboratory analysis viz. slump test, compaction factor test, compressive strength (cube, cylindrical sample), split tensile strength, flexural strength, modulus of elasticity, water absorption of hardened concrete. The durability of concrete was studied by immersing the concrete cube in 5% solution of MgSo4, 5% solution of NaCl and 2N solution of HCl for 28 days and 91 days and results were compared with the standards to achieve the desired.(T.K. Lohani1, M. Padhi1, K.P. Dash). Mixes prepared by replacing 40, 50 and 60% of natural aggregates with recycled aggregates. Then its fresh and mechanical properties were determined along with control mix. From test results concrete with 50% replacement of aggregate with recycled aggregates shows adequate strength compared to control mix. Mixes were prepared by replacing 40, 50 and 60% of cement with GGBS together with 50% replacement of recycled aggregates. From test results concrete with 40% and 50% replacement of cement with GGBS together with 50% replacement of recycled aggregates shows adequate strength compared to control mix (Relangi Sai Krishna Supretha, D. Venkateswarlu, Divya Anusha Naidu). The test results of concrete were obtained by adding CS and FS to sand in various percentages ranging from 0%, 20%. 40%, 60%, 80% and 100%. All specimens were cured for 7, 28, 60 & 90 days before compression strength test and splitting tensile test. The results indicate that workability increases with increase in CS and FS percentage. The highest compressive strength obtained was 46MPa (for 100% replacement) and the corresponding strength for control mix was 30MPa (S Meenakshi Sudarvizhi and R Ilangovan).

In this work we are replacing cement partially with foundry waste (silica and quartz) which are obtained from steel industry

II. MATERIALS

1. Cement:

FIG.1.CEMENT

Cement is one of the major constituent in the manufacture of concrete. It act as a binding material. Ordinary Portland Cement 20 grade purchased from SIDCO was used for this study. This is one of the most widely used one in the construction industry in India. The properties of cement are shown in Table 1.

TABLE 1. PROPERTIES OF CEMENT

PROPERTIES OF CEMENT	EQUIPMENT	VALUES
Initial Setting Time	Vicat Apparatus (Is 4031 Part 5)	42minute
Normal Consistency	Vicat Appartus Is4031 Part 4	33%
Fineness	Sieve Test On Sieve On 9 Cis 4031- Part Ii	7% Reside
Specific Gravity	Specific Gravity Bottle	3.05
Final Setting Time	Vicat Apparatus	308 Minute

2. Coarse aggregate:

FIG.2.COARSE AGGREGATE

The particle shape of the aggregate contributes to the effectiveness of producing a high performance concrete. Crushed rock creates a much better bond between the paste and the aggregate than a gravel does. However, the aggregate mortar bond may be more important in flexure tests than in compression tests. Coarse aggregates of 12mm and 16mm size is used in this work. The properties of coarse aggregates used in this work is given in the Table 2.

TABLE 2. PROPERTIES OF COARSE AGGREGATEOARSE AGGREGATE 2. PROPERTIES OF COARSE AGGREGATE

PROPERTIES OF COARSE AGGREGATE	EQUIPMENT	VALUES
Fineness Properties	Sieve Analysis Is (2386-1963) Part 2	4.23
Specific Gravity	Pycnometer IS (2386-1963) Part 3	2.73
BULK DENSITY Kg/m^3	IS(2386 – 1963) Part 3	1340

3. Fine aggregate (M Sand):

FIG.3. FINE AGGREGATE

M-Sand is, it can be dust free, the sizes of m-sand can be controlled easily so that it meets the required grading for the given construction. Since usage of M-Sand has increased durability, higher strength, reduction in segregation, permeability, increased workability, decreased post-concrete defects, it proves to be economical as a construction material replacing river sand. It can also save transportation cost of river sand in many cases. The properties of M sand is given in the Table 3.

TABLE 3. PROPERTIES OF FINE AGGREGATE

PROPERTIESOF FINE AGGREGATE		VALUES
Fineness Modulus	Sieve Analysis Is (2386-1963) Psrt Ii	3.13
Specific Gravity	Pycnometer 2386-1963 Part 3	2.6
Bulk Density	Is 2386-1963 Part 3	1830
Water Absorption	Is 2386 – 1963 Part 3	1.02%

4. Silica:

FIG.4.SILICA

Silica is another name for the chemical compound silicon dioxide. Each unit of silica includes one atom of silicon and two atoms of oxygen. The properties of silica include both chemical and physical properties such as hardness, colour, melting and boiling point and reactivity. Silica under normal conditions of temperature and pressure is a solid, crystallised mineral. It is relatively hard, rating 7 on the Mohr Scale, a scale used to measure the hardness of minerals relative to each other. Silica reacts with hydrofluoric acid. The properties of silica are given in Table 4.

TABLE 4. PROPERTIES OF SILICA

PROPERTIES	OBSERVATION
Colour	Brown
Specific Gravity	1.20 To 0.035
Chloride Content	Nil To B8 5075 To Is 456-78
Nitrate Content	Nil
Freezing Point	0^0c
Air Entrainment	Maximum 0.5%

5. Quartz:

FIG.5.QUARTZ

It is an abundant mineral in the earth's continental crust. It is made up of a continuous framework of SiO4 silicon- oxygen tetrahedral. Each oxygen atom is shared between two tetrahedral giving an overall formula of SiO2. Owing to its abundance and high thermal and chemical stability, quartz is widely used in many large – scale applications – abrasives, foundry materials, ceramics and cement. The properties of quartz used in this work is given in Table 5.

TABLE 5. PROPERTIES OF QUARTZ

PROPERTIES	VALUES
Specific Gravity	2.53
Bulk Density	1340kg/m^3
Percentage Of Void	46.58%
Fineness Modulus	3.38

III. METHODOLOGY

Mix Design: M20 concrete is used in this work with ratio of 1:1.5:3. 8 bag of cement is required for 1m3 of M 20 concrete. The total quantity of the sand required for 1m3 of M20 concrete is 0.472m3.The quantity of coarse aggregate required for 1m3 of M20 concrete is 0.853m3.

IV. CASTING

1. Compression test: The concrete with respective percentage of foundry waste are casted into cubes with the help of moulds 150mm X 150mm.These cubes had put for curing for 7 days, 14 days and 28 days.
2. Split tensile test: The concrete with respective percentage of foundry waste are casted into cylinders with the help of moulds. These cylindrers had put for curing for 7 days, 14 days and 28 days.
3. Flexure test: The concrete with respective percentage of foundry waste are casted into beam with the help of moulds. These beams had put for curing for 7 days, 14 days and 28 days.

V.RESULT

1. Compression test

TABLE 6. COMPRESSION TEST OBSERVATION

Cement content In (%)	Foundry Waste Content (%)		Compressive strength after respective curing periods(N/mm^2)		
	Silica	Quartz	7 days	14 days	28 days
100	0	0	13.5	18	20
50	25	25	4.31	9.26	14.29
70	15	15	7.86	12.86	17.9
80	10	10	10.08	15.08	20.4

FIG 6. COMPRESSION TEST

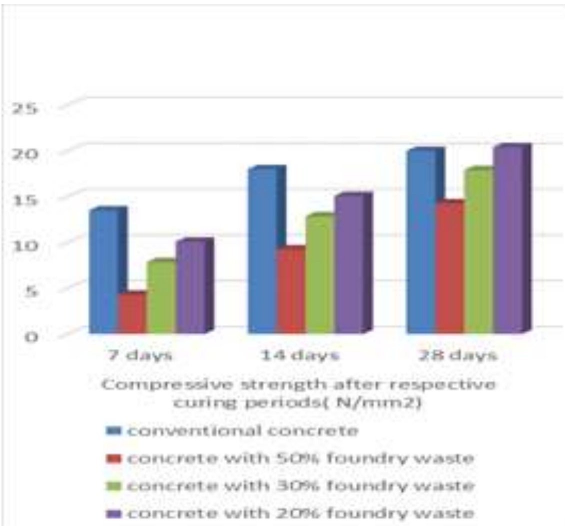

FIG.7. COMPRESSIVE STRENGTH OF CONCRETE

In fig.7 the compression strength of 20%of foundry waste concrete is almost equal to conventional concrete. So the use of foundry waste in concrete give better result when compared to conventional concrete.

2. Split tensile test

FIG.8.SPILT TENSILE TEST

Cement content In (%)	Foundry Waste Content (%)		Tensile strength after respective curing periods(N/mm^2)		
	Silica	Quartz	7 days	14 days	28 days
100	0	0	1.755	2.83	4.7
50	25	25	0.283	0.42	0.63
70	15	15	0.9054	1.416	3.9
80	10	10	1.415	2.79	4.2

TABLE 7. TENSILE TEST OBSERVATION

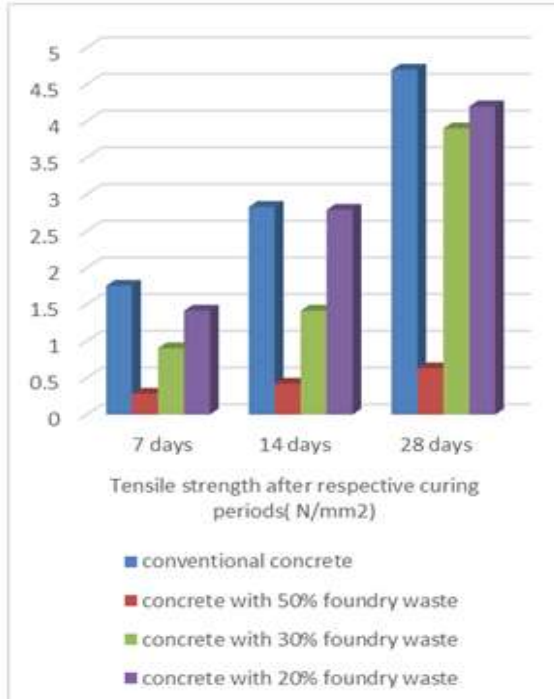

FIG.9. TENSILE STRENGTH OF CONCRETE

In fig.8 the tensile strength of 20%of foundry waste concrete is almost equal to conventional concrete. So the use of foundry waste in concrete give better result than conventional concrete.

3. Flexure test

FIG.10.FLEXURE TEST

TABLE 8. FLEXURE TEST OBSERVATION

Cement content In (%)	Foundry Waste Content (%)		Flexural strength after respective curing periods(N/mm²)		
	Silica	Quartz	7 days	14 days	28 days
100	0	0	2.57	2.97	3.13
50	25	25	1.45	2.13	2.65
70	15	15	1.96	2.51	2.9
80	10	10	2.22	2.72	3.2

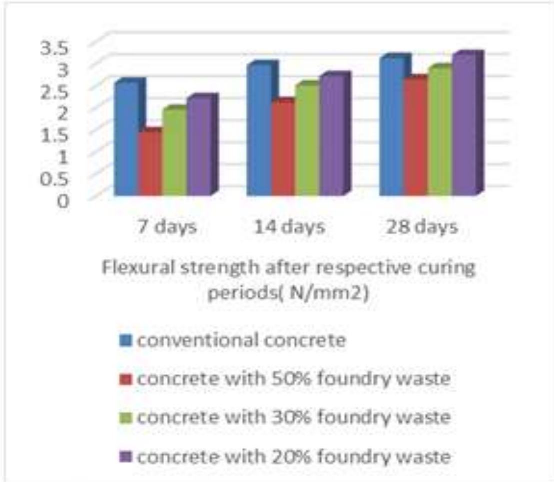

FIG .11. FLEXURAL STRENGTH OF CONCRETE

In fig.9 the flexural strength of 20%of foundry waste concrete is almost equal to conventional concrete. So the use of foundry waste in concrete give better result when conventional concrete.

VI. CONCLUSION

- The concrete in which the cement is partially replaced with foundry waste (i.e. silica and quartz replace 50% of the cement content) gives compressive strength less than that of conventional concrete. So it is not advisable to replace cement content in concrete by 50% of foundry waste.
- The concrete in which 30% of the cement content is replaced with foundry waste gives compressive strength which is near to the compressive strength of conventional concrete. So it is advisable to replace cement content in concrete by 30% of foundry waste.
- The concrete in which 20% of the cement content is replaced with foundry waste gives compressive strength which is more than the compressive strength of conventional concrete. . So it is advisable to replace cement content in concrete by 20% of foundry waste

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