ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785
(ISRA), Journal Impact Factor: 2.114

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

STUDY ON DURABILITY PROPERTIES OF RECYCLED AGGREGATE CONCRETE INCORPORATED WITH SILICA FUME AND MINERAL QUARTZ

Anand K. Darji*, Dr. Indrajit N Patel, Mrs. Jagruti Shah
[1]Structural Engineering Dept., BVM Engg. College, V.V. Nagar, Gujarat, India.

ABSTRACT

Disposal of construction waste is now new challenge for the construction industry in this era. This is peak time to use Construction waste as recycled aggregate (RA) in concrete manufacturing for sustainable development. Recycled aggregate concrete (RAC) is the future to save environment from the waste. Supplementary Cementing Materials (SCMs) are widely used these days to improve the durability of concrete. Silica fume has gained worldwide acceptance due to its high pozzolanic reactivity compared to other SCMs. Using mineral admixtures as cement replacement substance in concrete has a tendency to increase by the future in order to provide greater sustainability in construction industry. On the other hand Quartz is the second most abundant mineral in the Earth's continental crust, after feldspar. It is used as SCM in concrete. In this study, replacements of cement with silica fume 4%, 8% and12% & mineral quartz 5% for concrete mix ofM35 and M40 grade. The natural aggregate is replaced by recycled aggregate (RA) with 30%. This paper study conducted on water absorption and sorptivity test on recycled aggregate concrete (RAC). The experiment result analysis shows that durability of 8% SF and 5% Quartz are better than other replacements.

KEYWORDS: Silica Fume (SF), Mineral Quartz, Recycled Aggregate Concrete (RAC), Supplementary cementing materials (SCMs)

INTRODUCTION

RA is derived from the processing of materials previously used in a product and/or in construction. Examples include recycled concrete from construction and demolition waste material (C&D). In order to reduce the usage of natural aggregate, RA can be used as the replacement materials. RA is comprised of crushed, graded inorganic particles processed from the materials that have been used in the constructions and demolition debris. These materials are generally from buildings, roads, bridges, and sometimes even from catastrophes, such as wars and earthquakes. RA concrete is generally reported to be between 15% and 40% weaker than natural aggregate concrete.as the replacement of RA with natural aggregate increases the strength of concrete will decreases but at the same time if we are add the SCMs like silica fume and mineral quartz the strength will increases.

Silica fume is an amorphous type of silica dust collected in bughouse filters as a by-product from manufacturing silicon metal or ferrosilicon alloys. The smoke that results from furnace operation is collected and sold as silica fume, rather than being land filled. Silica fume is widely used in concrete and refractory application. One of the most beneficial uses for silica fume is in concrete. Due to its unique chemical and physical properties, silica fume has become a versatile mineral admixture for a multitude of applications. Silica fume consists primarily of amorphous (non-crystalline) silicon dioxide (SiO2). Silica fume is an ultrafine material with spherical particles less than 1 μm in diameter, the average being about 0.15 μm. The individual particles are extremely small, approximately 1/100th the size of an average cement particle silica fume. Because of its chemical & physical properties, like high silica content & extreme fineness, silica fume is a very effective pozzolanic material.it has High early compressive strength, High tensile flexural strength, low permeability to chloride and water intrusion, Enhanced durability, Increased toughness, Higher bond strength.

Quartz is the second most abundant mineral in the Earth's continental crust, after feldspar. It is made up of a continuous framework of SiO4 silicon–oxygen tetrahedral, with each oxygen being shared between two tetrahedral, giving an overall formula SiO2. There are many different varieties of quartz, several of which are semi-precious gemstones. Especially in Europe and the Middle East, varieties of quartz have been since antiquity the most commonly used minerals in the making of jewelry and hard stone carvings. Quartz is an essential constituent of granite and other felsic igneous rocks. It is very common in sedimentary rocks such as sandstone and shale and is also present in variable amounts as an accessory mineral in most carbonate rocks. It is also a common constituent of schist, gneiss, quartzite and other metamorphic rocks. Because of its resistance

ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785
(ISRA), Journal Impact Factor: 2.114

to weathering it is very common in stream sediments and in residual soils. Naturally occurring quartz crystals of extremely high purity, necessary for the crucibles and other equipment used for growing silicon wafers in the semiconductor industry, are expensive and rare.

MATERIALS

(1) Silica Fume

Table 1 Physical & chemical properties of SF

Chemical & Physical Characteristics	Units	Micro Silica
SiO2	%	85+
CaO	%	0.94
AL2O3	%	0.61
Fe2O3	%	0.31
Loss on Ignition	%	2.00
Moisture	%	1
Bulk Density	Kg/m3	450-600
Pozzolanic Activity Index (7 days)	%	105+
Coarse Particles > 45 Microns	%	09%
Coarse Particles < 45 Microns	%	91%
Specific Surface Area	M2/gm	16

(2) Mineral Quartz

Table 2 Properties of Mineral Quartz

Chemical Characteristics	Units	Micro Silica
Mineral quartz	%	99%
SiO2	%	< 1
Specific Surface Area	Micron	400

(3) Cement

Brand Name: Hati
Grade of cement: 53 Grades (IS12269:1987)
Type of cement: Ordinary Portland cement

Table 3 Physical properties of cement

Sr. No	Test Name	Method of Test	Test Results	Specification Requirement
1	Consistency (%)	IS 4031: Part-4	30%	--
2	Initial Setting Time	IS 4031: Part-5	90min	Shall not < 30 Min
3	Final Setting Time (min)	IS 4031: Part-5	178min	Shall not >600 Minutes
4	Specific Gravity	IS 4031 : Part-11	3.15	--

ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785
(ISRA), Journal Impact Factor: 2.114

(4) Fine Aggregate

Locally available river sand was used as fine aggregate. The properties of fine aggregate, confirming to IS: 383 – 1970, are shown in table.2

Table 4 Physical properties of fine aggregate

Sr. No.	Particulars	Sand
1	Source	Bodeli, Gujarat
2	Zone	Zone II (IS: 383-1970)
3	Sp. gravity	2.6
4	Fineness modulus	3.05

(5) Coarse aggregate

Natural aggregate of maximum size 20 mm are taken in the study. The physical properties of course aggregate are shown in table. The sieve analysis of coarse aggregate is shown in Table. The aggregate were tested as per IS 2386 (Part: 1, 2, 3) – 1963 and IS: 383– 1970.

Table 5 Properties of Natural Aggregate and RA

Sr. No.	Particulars	Natural Aggregate	RA
1	Source	Sevalia, Gujarat	Anand, Gujarat
2	Max. aggregate	20mm	20mm
3	Specific gravity	2.86	2.75
4	Fineness modulus	6.94	7.31

(6) Water

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Since it helps to from the strength giving cement gel, the quantity and quality of water is required to be looked into very carefully. Water cement ratio used is 0.37 for M35 and 0.35 for M40 concrete.

(7) Chemical Admixture

To decide the chemical dosage in the concrete Mix it is require doing the Marsh Cone test.

Table 6 Properties of Chemical Admixture

Admixture	FF-T (VC)
Produced by	Sikament
Physical state	liquid
Colour	Transparent
Density (kg/l)	1.03
Compatibility	Use for all cement
Dosage	0.5%-3% of cement weight

ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785
(ISRA), Journal Impact Factor: 2.114

Experiment Methodology

(a) Mix design

Based on is 10262:2009 concrete mix proportioning – guidelines trial mix design with different proportion of ingredients has been designed. Table 3.1 presents the design mix proportion for M35 and M40 grade

Table 7 Mix Design

Mix	w/c Ratio	Cement	Fine aggregate	Coarse aggregate(CA)	RA	Admixture
		Kg/m^3	Kg/m^3	Kg/m^3	30% of (CA)	liter
M35	0.37	399.65	757.31	869.74	372.74	5.994
M40	0.35	422.48	742.04	857.05	367.30	6.297

RESULTS ANALYSIS

Water absorption

For water Absorption 100mm X 100mm X 100mm cube is used to find out water absorption result, test result shows with different grade of concrete with different Percentage of silica fume and mineral quartz are as in Figure:2 and Figure:3.

Figure: 1 water absorption

ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785
(ISRA), Journal Impact Factor: 2.114

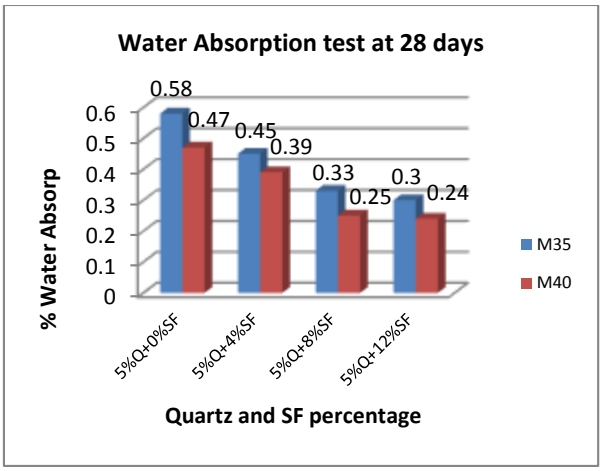

Figure: 2 Grade v/s water absorption for 28 days

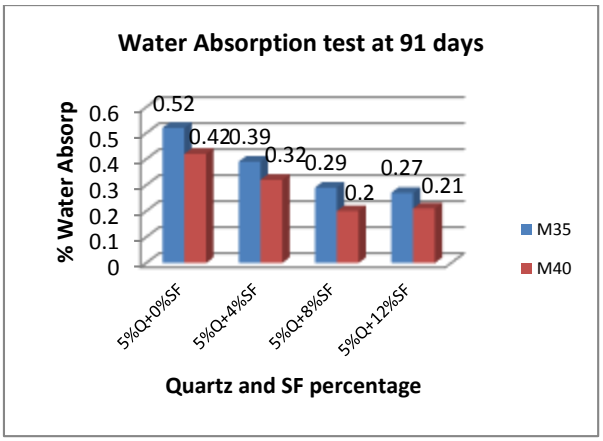

Figure: 3 Grade v/s water absorption for 91 days

ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785
(ISRA), Journal Impact Factor: 2.114

Sorptivity Test

In sorptivity test 100mm x 100mm x 100mm cube is used. Test results of the Sorptivity test for the different grade of concrete with the different proportion of silica fume and mineral quartz at 28, 91 days are as in Figure:4 and Figure:5.

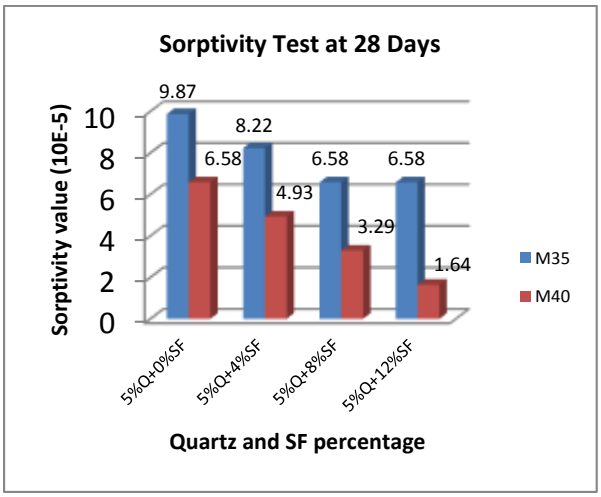

Figure: 4 Grade v/s water absorption for 28 days

ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785
(ISRA), Journal Impact Factor: 2.114

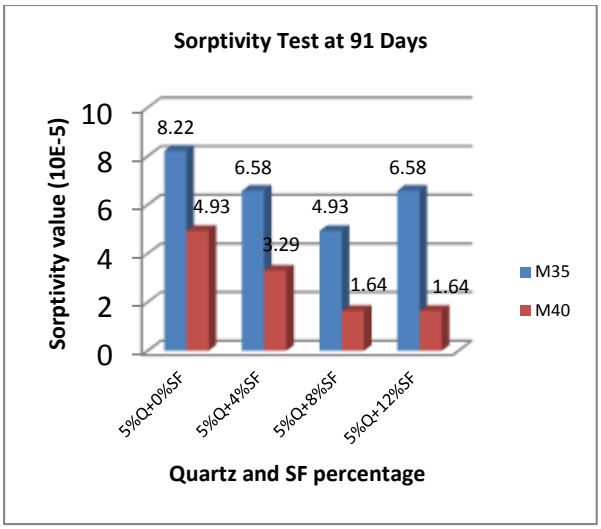

Figure: 5 Grade v/s water absorption for 28 days

CONCLUSION

Based on experimental investigation concerning the water absorption and sorptivity of concrete, the following observations are made regarding the resistance of partially replacement of SF and Mineral quartz for M35 and M40 grade concrete:

- All the specimen shows an ideal property of impervious concrete with minimum water absorption.
- The water absorption and sorptivity of RAC concrete shows lower water absorption and sorptivity at replacement of SF with 8% and 5% with Mineral quartz for M35 and M40 grade concrete.
- For 28 days strength, where percentage decrease in water absorption is found to be 0.3% for M35 and 0.24 for M40 and sorptivity is found to be 6.58 mm/min0.5 for M35 and 1.64 mm/min0.5 for M40 with respect to reference mix.
- For 91 days strength, where percentage decrease in water absorption is found to be 0.27% for M35 and 0.21 for M40 and sorptivity is found to be 4.93 mm/min0.5 for M35 and 1.64 mm/min0.5 for M40 with respect to reference mix.
- The percentage water absorption decreases as the grade of concrete increases.
- The water absorption and sorptivity at 12% SF and 5% Mineral quartz shows higher than the 8% SF and 5% Mineral quartz
- The water absorption and sorptivity of M40 grade concrete is lower water absorption and sorptivity than M35 grade concrete.

REFERENCES

[1] Al-Amoudi, M. Maslehuddin" Shrinkage of plain and silica fume cement concrete under hot weather" Cement & Concrete Composites 29 (2007) 690–699 23 May 2007
[2] Deepa A Sinha, Dr.A.K.Verma, Dr.K.B.Prakash (2012) "Sorptivity and waste absorption of steel fibers reinforced ternary blended concrete". International journal: global research analysis (GRA),volume:1,issue:5,oct2012,issn no:2277-8160.
[3] Gonen, T. and Yazicioglu, S. (2007). "The influence of compactionpores on sorptivity and carbonation of concrete." Construction andBuilding Materials, Vol. 21, No. 5, pp. 1040-1045.
[4] Jayeshkumar Pitroda" Evaluation of Sorptivity and Water Absorption of Concrete with Partial Replacement of Cement by Thermal Industry Waste (Fly Ash)" International Journal of Engineering and Innovative Technology (IJEIT)
[5] Jianzhuang Xiao" Mechanical properties of confined recycled aggregate concrete under axial compression" Construction and Building Materials 26 (2012) 591–603
[6] L. Evangelista, J. de Brito, " Mechanical behavior of concrete made with fine recycled concrete aggregates" Cement & Concrete Composites 29 (2007) 397–401.
Volume 2, Issue 7, January 2013

ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785
(ISRA), Journal Impact Factor: 2.114

AUTHOR BIBLIOGRAPHY

	**Author -Anand K.Darji** perusing his Master's Degree in Structural Engineering from Birla Vishvakarma Mahavidyalaya Vallabh vidhyanagar. He completed Bachelor of Engineering in Civil Engineering from the Bharati Vidhyapeeth (University), Pune in 2013. Currently he is doing research work in the field of RAC with SCMs for sustainable development in the concrete field.
	**Prof. (Dr.) Indrajit Patel** He has over two and half decades of academic & Professional experience in the field of Civil & Structural Engineering & Technology. He has successfully worked on many national and international projects and activities in context to academic excellence, quality assurance and improvement, exchange program, department and institute development program. To his credit there are more than 40 research publication at national and international level conference and journals. He is recipient of young designer's award, Best Teacher Award and Promising Engineering Teacher award. Currently He is associated with S.P. University, Gujarat Technological University (GTU) and Indian Society for Technical Education in various capacities.
	**Mrs. Jagruti Shah** an Urban Planner (Gold Medalist), currently holds the position of Project coordinator in Gujarat Technological University (GTU), Gujarat for the Project initiated by Government of Gujarat "Vishwakarma Yojana: an approach towards Rurbanization" under which she is preparing Village development Plan for scaling up village life with Urban amenities with the help of young Technocrats. She hails five years of teaching and research experience in multi-disciplinary field of Urban and Regional planning, Building Planning, concrete technology and AHP based Urban Modelling. To her credit more than 30 research publication at national and international level. She is instrumental in preparation of Different research project related to Urban Infrastructure Planning and Management, Affordable Housing, Building and Town Planning, Urban Development Plan and Village development Plan. Email: jagruti@gtu.edu.in