JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

A STUDY ON HIGH PERFORMANCE CONCRETE BY REPLACING RAW MATERIALS WITH RECYCLED AGGREGATES, BAGASSE ASH AND SILICA FUMES

Gaurav Kumar Jatav[1], Dr. Sanjay Sharma[2]
[1](M.E. Student, Civil Engineering Department, N.I.T.T.T.R. Chandigarh,) [2](Professor, Civil Engineering Department, N.I.T.T.T.R. Chandigarh)

ABSTRACT

The present experimental research work involves the partial substitution of cement & coarse aggregates at different content levels with recycled coarse aggregates (15%, 30% and 45%) and bagasse ash (5%, 10% and 15%) and silica fumes (5%, 10% and 15%) respectively to produce green concrete. After performing experiments, it was concluded in the end that up to 14% increase in compressive strength and up to 17% increase in split tensile strength was observed. Water absorption at 0% replacements was found out to be 2.98%, whereas for the other design mixes i.e. ARC1, ARC2, ARC3, BRC1, BRC2, BRC3, CRC1, CRC2 and CRC3 the water absorptions was 2.58%, 2.52%, 2.54%, 2.37%, 2.32%, 2.29%, 2.35%, 2.30% and 2.23% respectively. Therefore, it is suggested in the gist that the BRC2 i.e. concrete having 10% of bagasse ash, 10% of silica fumes and 30% of recycled aggregates is the optimum concrete mix.

Keywords: Recycled Coarse Aggregates, Bagasse Ash, Silica Fumes.

INTRODUCTION

Concrete structures, the most common structures, are being constructed with cement, aggregates, water, reinforcing bars (steel bars) with the addition of an external enhancing agent. This material in the fresh stage shows different behavior than the behavior of hardened concrete. millions of raw cement, sand (both coarse and fine), water, and steel bars are being excavated or produced in different parts of the world to meet the high demand of construction industries. The study and investigation of the properties at different stages of concrete and its application comes under the field of concrete technology. all the load-bearing structures are being with concrete as they can easily withstand heavy loads. Different kinds of cement such as OPC, PPC, Rapid hardening cement, etc are being used in daily constructional work.

In modern world, thousands of researchers play an impeccable role and without all these researches and researchers, the enormous and complicated structures would not have been possible to construct. The work of such an industry continues even in times of pandemic and becomes essential after calamities. Thousands of companies are operating different small scale and large scale projects throughout the world and millions of people are working in such companies with different skill sets and different academics. Each year for the construction industry is much more innovative and focused than the previous year.

MATERIAL USED:

Recycled Aggregates

Recycling substances is a pretty traditional idea as Romans practiced reusing the materials of the destroyed art to create brand-new ones. After the Second World War, reusing elements from wrecked structures displayed an alternative low-cost solution. For a more sustainable society, the infrastructure sector and various companies are presently embedding sustainability into their raw material having different strategies, and recycling is one of the environmental control methods for obtaining a sustainable building industry. The construction sector produces enormous quantities of rubble which can be easily reused and recycled for future sustainable production of concrete. The modern construction industry obtains millions of debris throughout the world which is being thrown away as disposal. The utilization of such waste rubble material in concrete as an aggregate has great significance and can solve the disposal problem of such material.

Table: 1. Physical Properties of Graded Recycled Aggregates

Test	Results
Specific Gravity	2.35
Water Absorption	3.09 %

Bagasse Ash

Bagasse is the trash from a sugarcane plant, fruit plants or seeds when the juice of such plants has been extracted. this end product which was considered as a waste in primitive times is now considered a very useful material and can be utilized in many industries which replace raw material. Bagasse is abundant in fibers which helps in good binding. There are many applications of this bagasse which entails soil improvement, used as a fertilizes in many materials, animal diet, combustible fuel, or in concrete.

Table: 2. Chemical Composition of BA.

S. No.	Composition	Proportion (%)
1.	SiO2	66.48
2	Al2O3	28.65
3	Fe2O3	29.11
4	CaO	1.95
5	MgO	0.83
6	SO3	0.54
7	Loss of ignition	0.75

Silica Fumes

Silica fume is a result of electrostatic seizing and soothing of silica dust with gasses emitted from electric arcs or alloys in the generation method of silicon metal, especially ferrosilicon alloys. This substance has more than eighty percent non-crystalline silica with a dia ranging between 0.01 and 0.3 microns, which is approximately 50 to 100 times finer than particles of cement. This material is ‘super pozzolan’ that can be used to improve ordinary cement properties. It transforms the physical properties of fresh cement paste and the microstructural features of hardened cement. Previous researches have done the by replacing cement with silica fumes, concrete shows more strength than the conventional concrete which is a result of improves fresh and hardened properties.

Table: 3. Chemical Composition of Silica Fume.

S. No.	Composition	Proportion (%)
1.	SiO2	93.15
2	Al2O3	0.82
3	Fe2O3	1.45
4	CaO	0.81
5	MgO	0.24
6	SO3	-
7	Na2O	0.70
8	K2O	0.70

CONCRETE MIX PROPORTION

Mix Designation: Cement is replaced with silica fumes and bagasse ash at proportion of 5%+5%, 10%+10%, 15%+15% and this replacement levels are denoted as A, B and C respectively. In addition to this, coarse aggregates were replaced by recycles aggregates at proportion of 15%, 30% and 45% which shall be denoted as RC1, RC2 and RC3.

Table: 4. Designation of Various Concrete Mix

Mix Designation	Partial replacement of cement with bagasse ash and silica fume	Partial replacement of Raw coarse Aggregates with RCA
CM	0%	0%
ARC1	5%+5%	15%
ARC2	5%+5%	30%
ARC3	5%+5%	45%
BRC1	10%+10%	15%
BRC2	10%+10%	30%
BRC3	10%+10%	45%
CRC1	15%+15%	15%
CRC2	15%+15%	30%
CRC3	15%+15%	45%

RESULTS AND DISCUSSION

Slump test results:

From fig. 1, it can be revealed that with an increment in the percentage of replacement material in concrete mix, concrete slump value was decreased. Therefore, it can be concluded in the gist that some difficulty was faced while producing workable concrete when concrete is having higher proportions of bagasse ash, silica fumes and recycled aggregates. However, workable mix was produced when low proportions of replacement materials were added in concrete mix.

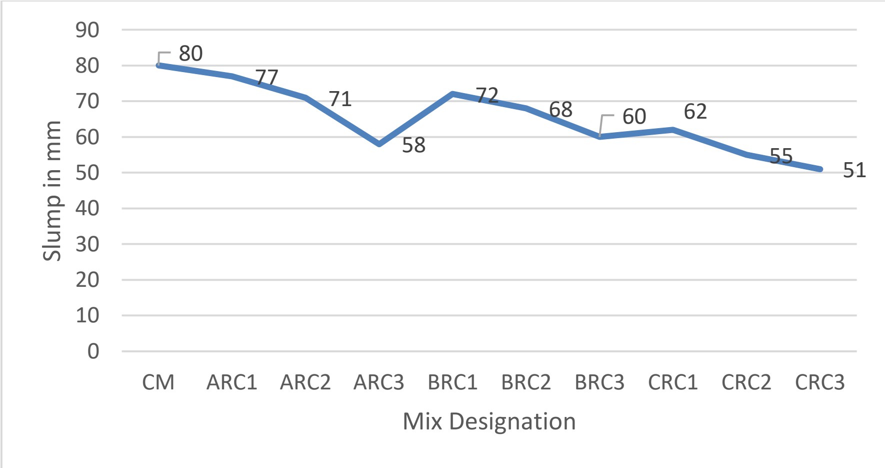

Figure 1. Effect of Replacement of raw material on Workability.

Compressive Strength:
From fig. 2, it is observed that with the replacement of raw materials with bagasse ash, silica fumes and recycled aggregates, the compressive strength is increases up to some extent when compared with control concrete mix. The maximum compressive strength was attained by BRC2 concrete mix i.e. 23.1 MPa at 7 days and 32.2 MPa at 28 days, whereas, the compressive strength of control mix was 21.4 MPa at 7 days and 30.6 MPa at 28 days. An almost of 8% increase in compressive strength at 7 days and 6% at 28 days was seen in BRC2 with respect to control mix (CM). It was also observed from the results that the maximum decrease in compressive strength was seen in CRC3 of about 13% at 7 days and 14% at 28 days with respect to control mix concrete.

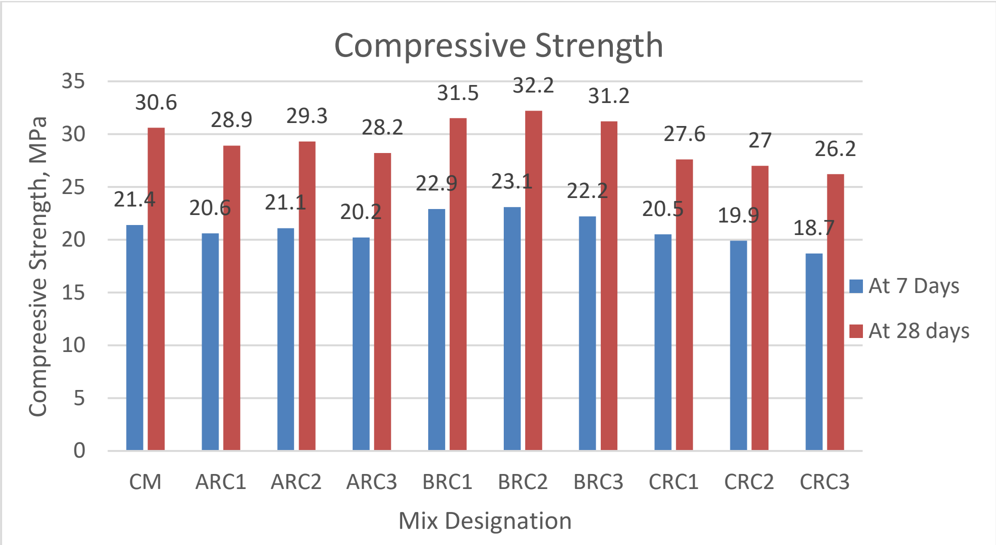

Figure 2. Effect of Replacement of raw material on Compressive Strength.

Split Tensile Strength:
From fig. 3, it is observed that with the replacement of raw materials with bagasse ash, silica fumes and recycled aggregates, the split tensile strength is increases up to some extent when compared with control concrete mix. The maximum split tensile strength was attained by BRC2 concrete mix i.e. 2.13 MPa at 7 days and 3.02 MPa at 28 days, whereas, the split tensile strength of control mix was 2.1 MPa at 7 days and 2.85 MPa at 28 days. An almost of 2% increase in split tensile strength at 7 days and 6% increases at 28 days was seen in BRC2 with respect to control mix CM. However, the maximum decrease in split tensile strength was seen in CRC3 of about 17% at 7 days and 12% at 28 days with respect to control mix concrete.

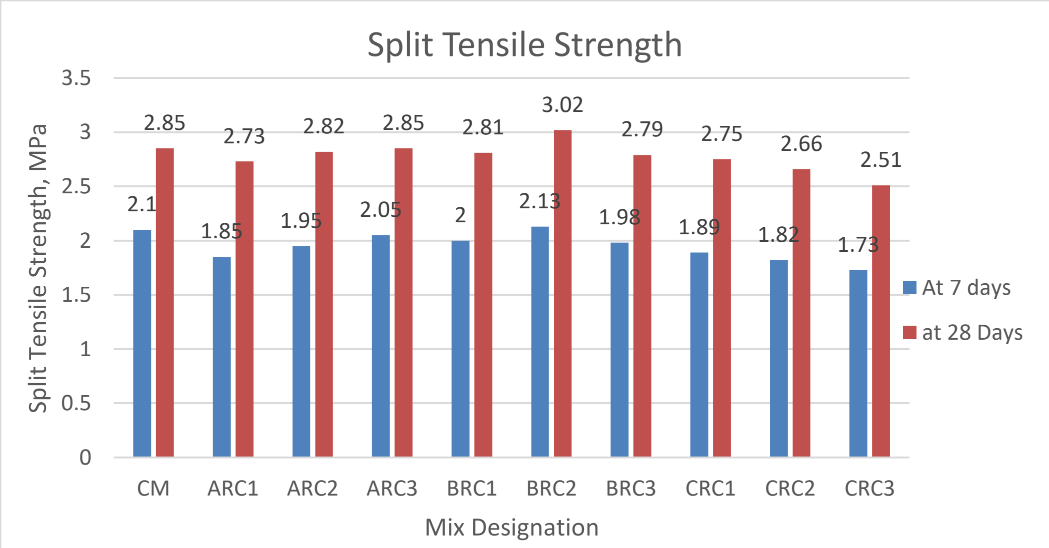

Figure 3. Effect of Replacement of raw material on Split Tensile Strength.

Split Tensile Strength:

From fig. 4, it can be concluded that the water absorption of various concrete samples was low which reveals less porosity of the concrete mix. Water absorption at 0% replacements was found out to be 2.98%, whereas for the other design mixes i.e. ARC1, ARC2, ARC3, BRC1, BRC2, BRC3, CRC1, CRC2 and CRC3 the water absorptions was 2.58%, 2.52%, 2.54%, 2.37%, 2.32%, 2.29%, 2.35%, 2.30% and 2.23% respectively.

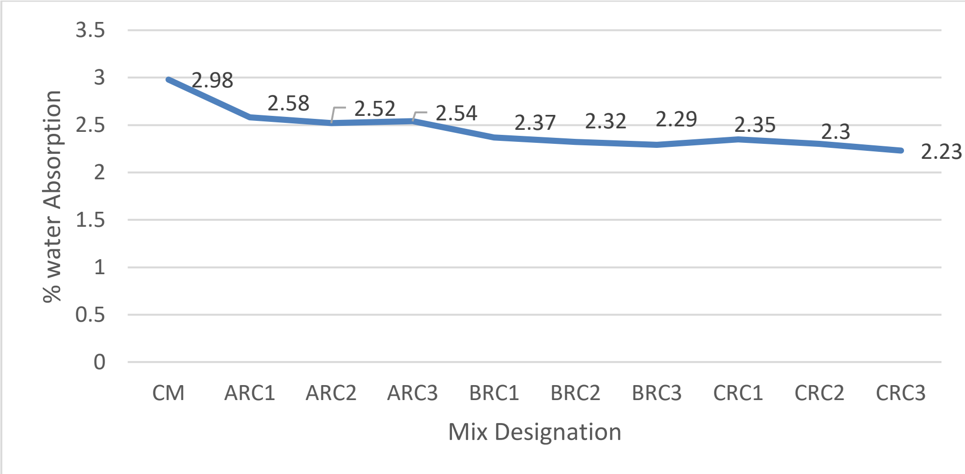

Figure 4. Effect of Replacement of raw material on Water Absorption.

CONCLUSION

i. With an increment in the percentage of replacement material in concrete mix, concrete slump value was decreased. Therefore, it can be concluded in the gist that some difficulty was faced while producing workable concrete when concrete is having higher proportions of bagasse ash, silica fumes and recycled aggregates. However, workable mix was produced when low proportions of replacement materials were added in concrete mix.

ii. The replacement of raw materials with bagasse ash, silica fumes and recycled aggregates increases the compressive strength up to some extent when compared with control concrete mix. The maximum compressive strength was attained by BRC2 concrete mix i.e. 23.1 MPa at 7 days and 32.2 MPa at 28 days, whereas, the compressive strength of control mix was 21.4 MPa at 7 days and 30.6 MPa at 28 days. An almost of 8% increase in compressive strength at 7 days and 6% at 28 days was seen in BRC2 with respect to control mix (CM). It was also observed from the results that the maximum decrease in compressive strength was seen in CRC3 of about 13% at 7 days and 14% at 28 days with respect to control mix concrete.

iii. The replacement of raw materials with bagasse ash, silica fumes and recycled aggregates increases the split tensile strength up to some extent when compared with control concrete mix. The maximum split tensile strength was attained by BRC2 concrete mix i.e. 2.13 MPa at 7 days and 3.02 MPa at 28 days, whereas, the split tensile strength of control mix was 2.1 MPa at 7 days and 2.85 MPa at 28 days. An almost of 2% increase in split tensile strength at 7 days and 6% increases at 28 days was seen in BRC2 with respect to control mix CM. However, the maximum decrease in split tensile strength was seen in CRC3 of about 17% at 7 days and 12% at 28 days with respect to control mix concrete.

iv. The water absorption of various concrete samples was low which reveals less porosity of the concrete mixes. Water absorption at 0% replacements was found out to be 2.98%, whereas for the other design mixes i.e. ARC1, ARC2, ARC3, BRC1, BRC2, BRC3, CRC1, CRC2 and CRC3 the water absorptions was 2.58%, 2.52%, 2.54%, 2.37%, 2.32%, 2.29%, 2.35%, 2.30% and 2.23% respectively.

v. Therefore, it is suggested in the gist that the BRC2 i.e. concrete having 10% of bagasse ash, 10% of silica fumes and 30% of recycled aggregates is the optimum concrete mix.

REFERENCES

1. Corinaldesi Valeria, Moriconi Giacomo, (2009) “Influence of mineral additions on the performance of 100% recycled aggregate concrete” Construction and Building Materials, pp: 2869–2876.
2. Amin Noor-ul, (2011) “Use of Bagasse Ash in Concrete and Its Impact on the Strength and Chloride Resistivity” Journal of Materials in Civil Engineering, pp: 717-720.
3. Singha Roy Dilip K., Sil Amitava, (2012) “Effect of Partial Replacement of Cement by Silica Fume on Hardened Concrete”, International Journal of Emerging Technology and Advanced Engineering, Volume 2, Issue 8, pp: 472-475.
4. Alsanusi S., (2013) “Influence of silica fume on the properties of self-compacting concrete”, World academy of Science, Engineering and Technology, Vol. 7, pp 399-403.
5. Butler L., West J.S., Tighe S.L. (2013). “Effect of recycled concrete coarse aggregate from multiple sources on the hardened properties of concrete with equivalent compressive strength.” Construction and Building Materials Vol. 47 pp 1292-1301.
6. Folino Paula, Xargay Hernán, (2014) “Recycled aggregate concrete – Mechanical behavior under uniaxial and triaxial compression”, Construction and Building Materials, pp: 21-31.
7. Duan Z.H., Poon C.S. (2014). “Properties of recycled aggregate concrete made with recycled aggregates with different amounts of old adhered mortars.” Materials and Design Vol. 58 pp 19-29.
8. Rowland Otoko George (2014) “Use of Bagasse Ash as Partial Replacement of Cement in Concrete”, International Journal of Innovative Research & Development, pp: 285-289.
9. Dilbas H., Simsek M., Cakir O. (2014). “An investigation on mechanical and physical properties of recycled aggregate concrete (RAC) with and without silica fume.” Construction and Building Materials Vol. 61 pp 50-59.
10. Andreu G., Miren E. (2014). “Experimental analysis of properties of high performance recycled aggregate concrete.” Construction and Building Materials Vol. 52 pp 227-235.
11. Muller A, Scrivener K.L., Skibsted J., Gajewicz A.M. and McDonald P.J., (2015) “Influence of silica fume on the microstructure of cement pastes: New insights from H-NMR relaxometry”, Cement and Concrete Research, pp: 116-125.
12. Singh Lakhbir, Kumar Arjun, Singh Anil, (2016) “Study Of Partial Replacement Of Cement By Silica Fume”, International Journal of Advanced Research (2016), Volume 4, Issue 7, pp: 104-120.
13. Mangi Sajjad Ali, Jamaluddin N, (2017) “Utilization of sugarcane bagasse ash in concrete as partial replacement of cement” Materials Science and Engineering, pp: 1-8.
14. Amin Muhammad Nasir, Ashraf Muhammad and Kumar Rabinder, (2020) “Role of Sugarcane Bagasse Ash in Developing Sustainable Engineered Cementitious Composites”, Frontiers in materials, Volume 7, pp: 1-12.
15. S. Loganayagan, N. Chandra Mohan, S. Dhivyabharathi, (2019) “Sugarcane bagasse ash as alternate supplementary cementitious material in concrete”, Materials Today: Proceedings-ELSEVIER.
16. Javed Ahmad Bhat, (2021) “Effect of strength of parent concrete on the mechanical properties of recycled aggregate concrete”, Materials Today: Proceedings-ELSEVIER.
17. IS 10262:1982 (Reaffirmed 2019), Recommended guidelines for concrete mix design, Bureau of Indian Standards, New Delhi. 111
18. IS 4031:1988 (Part XI), Methods of tests for specific gravity of cement, Bureau of Indian Standards, New Delhi.
19. IS 4031:1988 (Part VI), Methods of tests for compressive strength of cement, Bureau of Indian Standards, New Delhi.
20. IS 4031:1988 (Part V), Methods of tests for determination of initial and final setting time of cement, Bureau of Indian Standards, New Delhi.
21. IS 4031:1988 (Part IV), Methods of tests for standard consistency of cement, Bureau of Indian Standards, New Delhi.
22. IS 2386:1963 (Part III), Methods of tests for sieve analysis of coarse and fine aggregates, Bureau of Indian Standards, New Delhi.
23. IS 456:2000, Code of practice Plain and Reinforced Concrete, Bureau of Indian Standards, New Delhi.