iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 Issue: I Month of publication: January 2022

DOI: https://doi.org/10.22214/ijraset.2022.39777

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue I Jan 2022- Available at www.ijraset.com

Effect of GGBS, Metakaolin and Colloidal Nano-Silica on Mechanical Properties of Concrete

Pranav Andraskar[1], Swapnil Dhanage[2], Sachin Darade[3], Prem Macharla[4], Sachin Kudale[5]
[1]T.E Department of Civil Engineering, Trinity Academy of Engineering, kondhwa, Maharashtra, India
[2]Assistant Professor, Department of Civil Engineering, Trinity Academy of Engineering, kondhwa, Maharashtra, India

Abstract: Concrete is the most common used material for construction &their design consumes almost the total cement production in the world. The use of large quantities of cement produces increasing CO2 emission and as a consequence the greenhouse effect. A method to reduce the cement content in the concrete mixes is the use of GGBS, Metakaolin Nano-Silica. This project aims to present the state of GGBS, Metakaolin& Nano-Silica's effect on the workability and mechanical properties of concrete and to find out the economy of the experiment as compared to convential concrete. Concrete has occupied an important place in construction industry in the past few decades and it is used widely in all types of constructions ranging from small buildings to large infrastructural dams or reservoirs..

Keywords: GGBFS, Mechanical Properties, Workability, Economy.

I. INTRODUCTION

Concrete is perhaps the formest extensively used construction material within the world with about six billion tones being produced per annual. With the continuous growth of industries in the world, CO_2 emissions continue to rise. Manufacturing of cement contributes about 5-7% of CO_2 emissions. A lot of studies have been done in the past which examine the greenhouse emissions from concrete and how they affect the atmosphere. The manufacturing of construction materials requires a lot of fuel and so, in turn, consumes a lot of energy. There are competing reasons, within the future, to increase the practice of partially replacing cement with waste by-products and processed materials possessing pozzolanicproperties. Lately, some attention has been given to the utilization of natural pozzolans like GGBS as a possible partial replacement for cement. As seen in lots of studies the GGBS (Ground Granulated Blast Furnace Slag), Metakaolin & Colloidal Nano-Silica exhibits cementitious properties.

The Main Ingredients of Mixture Are As Follows

1) Cement.
2) Fine aggregates (i.e. sand).
3) Course aggregate.
4) Water.
5) GGBS.

A. Material Properties

1) *Cement:* Cement consists of four major compounds Tri-calcium Silicate (C3S), Dicalcium Silicate (C2S), Tri-calcium Aluminates (C3A) & Tetra calcium Alumino ferrite (C4AF). Tri-calcium silicate (C3S) and Di-calcium silicates (C2S) are the most important compound responsible for strength. Together they constitute 70 to 80 % of cement. The average C3S content in modern cement is about 45 % and that of C2S is about 25%.
2) *Fine Aggregate (Sand):* Concrete is an assemblage of individual pieces of aggregate bound together by cementing material, its properties are based primarily on the quality of cement paste. This strength is independent also on the bond between the cement paste and aggregate. If either the strength of the paste or the bond between the paste and aggregate is low a concrete of poor quality will be obtained irrespective of strength of the aggregate, for making strong concrete, strong aggregate is an essential requirement.
3) *Coarse Aggregate:* Coarse aggregate plays an important role in case of high strength concrete, because as the grade of concrete increases the mix of concrete becomes more cohesive and the fine aggregate play an important role of only particle packing.
4) *Water:* Water is an important ingredient of concrete as it actively participates in the mix design consideration. It is generally stated in the concrete codes and also in the literature that the water chemically reacts with cement.

©IJRASET: All Rights are Reserved

5) *Ground Granulated Blast Furnace Slag (GGBS):* Ground-granulated blast-furnace slag (GGBS or GGBFS) is obtained by quenching molten iron slag (a by-product of iron and steel-making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder. Concrete containing GGBS cement has a higher ultimate strength than concrete made with Portland cement. It has a higher proportion of the strengthenhancing calcium silicate hydrates (CSH) than concrete made with Portland cement only, and a reduced content of free lime, which does not contribute to concrete strength. Concrete made with GGBS continues to gain strength over time, and has been shown to double its 28-day strength over periods of 10 to 12 years.

Table -1:

Observations	Calculataions
Characteristics of compressivestrength	40 N/mm^2
Standard Deviation	5
Target mean compressive strength, $F_t = f_{ck} + 1.65xS$	48.25 N/mm^2
W/C ratio	0.36
Type of cement	OPC (53 Grade)
Water content per m^3 of concrete	151 Kg/m^3
Cement content for W/C = 0.36	420 Kg/m^3
Total fine aggregate per m^3 of concrete, F_a	768 Kg/m^3
Total coarse aggregate per m^3 of concrete, C_a	1111 Kg/m^3
Final Proportion	**1:1.83:2.65**

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue I Jan 2022- Available at www.ijraset.com

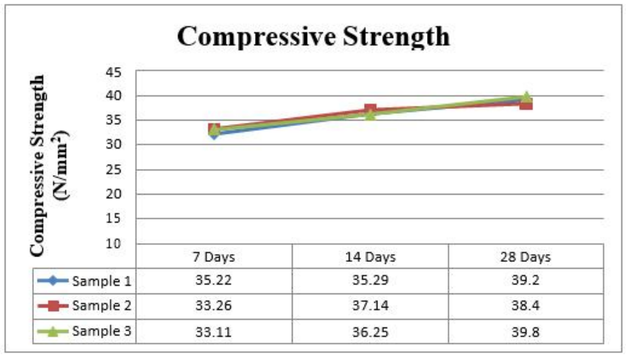
II. MIX PROPORTION

SR. NO.	Cement	GGBS	MK	CNS
Cube M	58	30	10	2
Cube N	52	30	15	3
Cube O	46	30	20	4
Cube P	60	40	0	0
Cube Q	54	40	5	1
Cube R	48	40	10	2
Cube S	42	40	15	3
Cube T	36	40	20	4

SR. NO.	**Cement**	**GGBS**	**MK**	**CNS**
Cube 0	100	0	0	0
Cube A	90	10	0	0
Cube B	84	10	5	1
Cube C	78	10	10	2
Cube D	72	10	15	3
Cube E	66	10	20	4
Cube F	80	20	0	0
Cube G	74	20	5	1
Cube H	68	20	10	2
Cube I	62	20	15	3
Cube J	56	20	20	4
Cube K	70	30	0	0
Cube L	64	30	5	1

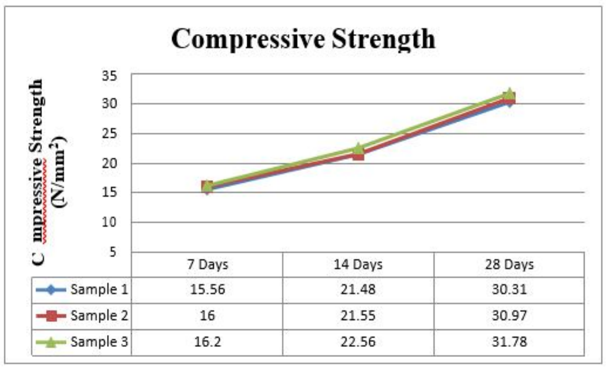
International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue I Jan 2022- Available at www.ijraset.com

III. RESULT



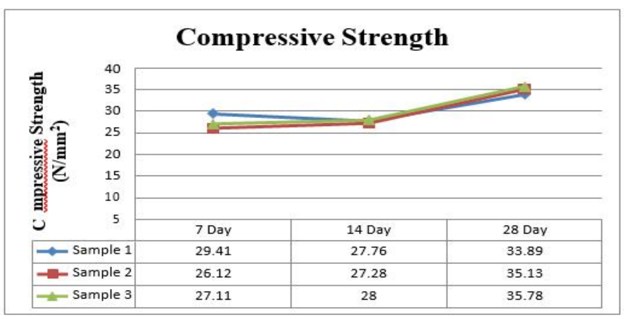
	7 Days	14 Days	28 Days
Sample 1	35.22	35.29	39.2
Sample 2	33.26	37.14	38.4
Sample 3	33.11	36.25	39.8

Compressive strength at 100% cement



	7 Days	14 Days	28 Days
Sample 1	15.56	21.48	30.31
Sample 2	16	21.55	30.97
Sample 3	16.2	22.56	31.78

Compressive Strength at 90% cement and 10%GGBFS



	7 Day	14 Day	28 Day
Sample 1	29.41	27.76	33.89
Sample 2	26.12	27.28	35.13
Sample 3	27.11	28	35.78

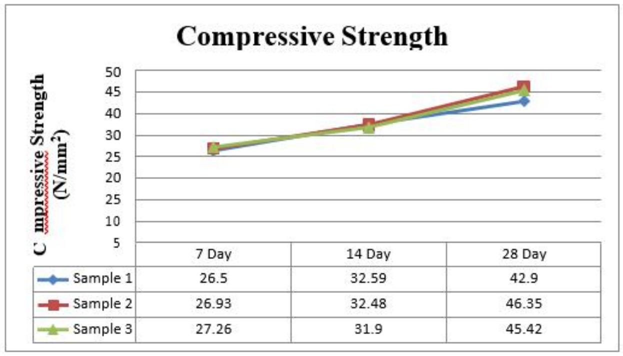
Compressive strength at 66% cement, 10% GGBFS, 20% MK & 4% CNS

	7 Day	14 Day	28 Day
Sample 1	22.44	27.23	32.19
Sample 2	24.48	28.34	32.56
Sample 3	22.65	28.2	33.78

Compressive Strenghth at 80% cement & 20%GGBFS

©IJRASET: All Rights are Reserved |

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue I Jan 2022- Available at www.ijraset.com



Compressive Strength at 36% cement, 40% GGBFS, 20% MK & 4% CNC

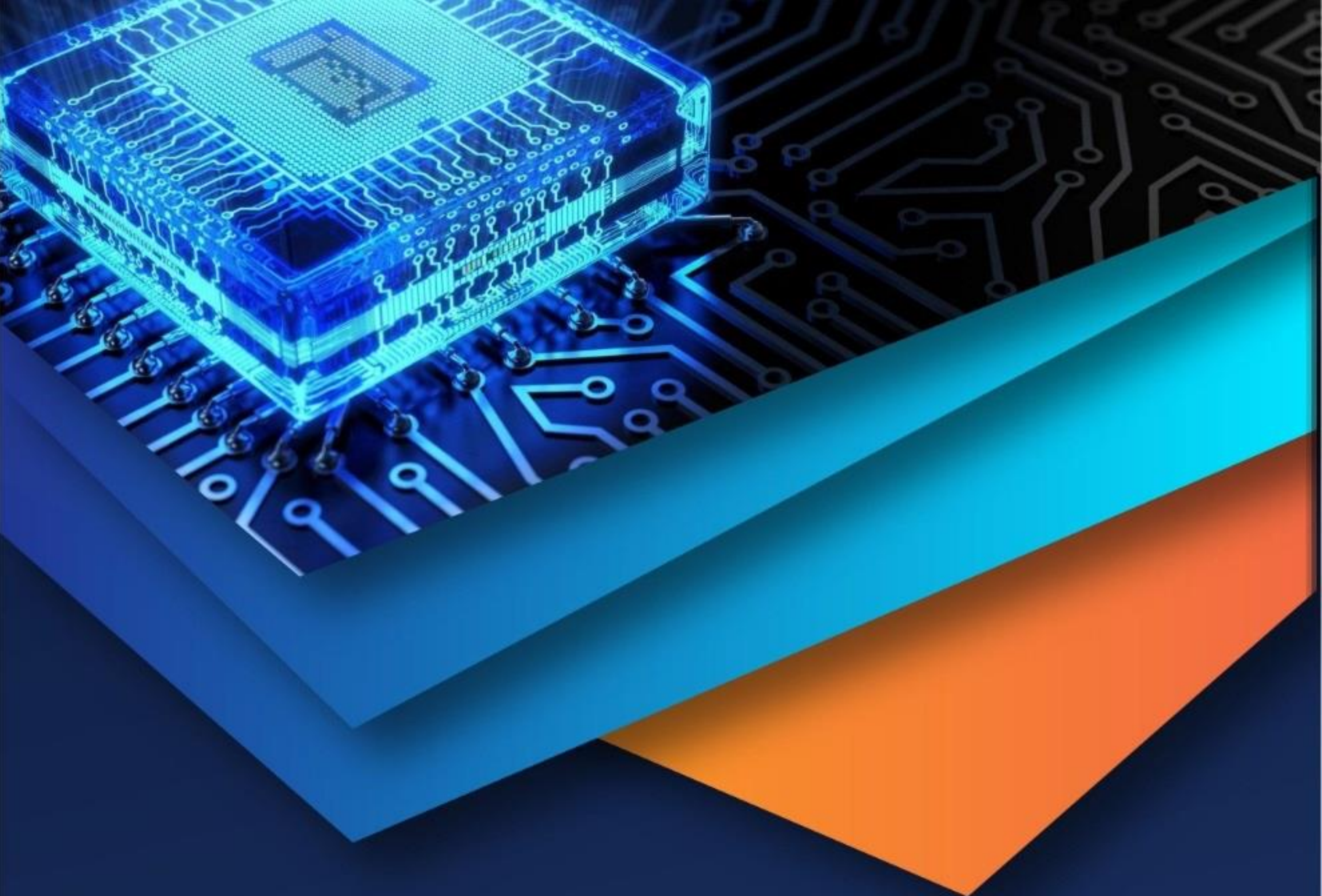
IV. CONCLUSIONS

From the results tabulated in the earlier chapter the following statements can be derived:-

1) The desired compressive strength is achieved in designed M40 mix proportions.
2) The replacement of Cement with Colloidal Nano-Silica & Metakaolin decreases the fluidity of M40 grade concrete even in the presence of significant dosage of superplasticizer.
3) The early strength of designed M40 grade concrete is less as compared with Standard M40 grade concrete due to the slow rate of pozzolanic reaction of GGBS.
4) It is observed that the early strength of designed M40 grade of concrete is slightly increased due to addition of Metakaolin and Colloidal Nano-Silica with GGBS
5) It is observed that the highest compressive strength of concrete is achieved at Cement replaced with 40% GGBS, 20% MK & 4% CNS

REFERENCES

[1] GGBS as Partial Replacement of OPC in Cement Concrete – An Experimental Study
[2] Sustainable studies on concrete with GGBS as a replacement material in cement
[3] Eco-friendly GGBS Concrete: A State-of-The-Art Review
[4] Fresh and Hardened Properties of Ground Granulated Blast Furnace Slag Made Concrete
[5] Effect of Ground Granulated Blast Furnace Slag as Partial Cement Replacement on Strength and Durability of Concrete
[6] Strength and Durability Studies on GGBS Concrete
[7] Effect of Temperature on Durability of High Volumes of Slag Concrete
[8] Properties of concrete containing ground granulated blast furnace slag (GGBFS) at elevated temperatures
[9] An overview on the Influence of Pozzolanic Materials Properties of concrete
[10] Effect of GGBFS on time dependent compressive strength of concrete



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)