Impact Factor (SJIF): 4.542

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 4, Issue 12, December-2017

GREEN CONCRETE BY USING GGBS, RECYCLED AGGREGATE, RECYCLED WATER TO BUILD ECO ENVIRONMENT

NAYANA A Y[1],

[1]*Assistant Professor, Department of civil engineering, BTLIT, Bangalore*

Abstract — ***Manufacture and using of Ordinary Portland cement used in concrete industry produces 2.5 billion tons of CO_2. Hence several researches are focused on use of waste materials which is having cementing properties, which can be added as a partial replacement of cement in concrete without compromising strength and durability of concrete. This decreases the consumption of cement thus reduction in carbon emission. GGBS is a byproduct, which is obtained by manufacturing of iron, which may be used as partial replacement of cement in concrete. In response to the global warming issues, green concrete for construction is an essential requirement. In the present project, an attempt is made to produce the green concrete by using the by-product GGBS , recycled aggregates and recycled water to reduce the carbon footprints. Firstly, cement is replaced by GGBFS 60%, 70%, 80% by weight and 100% recycled aggregate and 100% recycled water is used. Grade of the concrete is M25. As water is the primary requirement in the world, by using recycled water scarcity of water may be reduced and also Disposal of demolished material is a big issue. Hence recycled aggregate in concrete can be useful for environment protection. This paper provides mechanical properties of concrete prepared with ordinary Portland cement and green concrete.***

Keywords- GGBS; recycled aggregate; recycled water; carbon footprints; green concrete.

I. INTRODUCTION

A. General

Green concrete is defined as the concrete with material as a partial or complete replacement for cement, fine aggregate, coarse aggregate and the substitution materials should be waste material. In order to produce a green concrete coarse aggregate is replaced with recycled aggregate and water is replaced with recycled water. Concrete which uses waste material as at least one of its components and production process does not lead to negative environmental impacts.

After water, concrete is the second most consumed substance on earth. By every person on the planet, 3 tons of concrete are consumed in each year.

Ground granulated blast furnace slag is a by-product which is obtained during the quenching of molten iron. The main advantage of concrete which consist of GGBS is which enhances lower heat of hydration, durability, workability, resistance against chloride and sulphate attack along with these it also contributes to the environment by reducing the usage of cement during the manufacture of concrete. Replacement of cement by slag is best way to produce green concrete, reduces the CO2 emission. By using the recycled aggregate and recycled water we save the environment.

Due to modernization, demolished materials are dumped in land. It is not used for any purpose, this effects the fertility of land. As per CPCB, in India, 48 million tons of solid waste is generated, out of which 14.5 million tons from construction sector. Only 3% of these wastes is utilized for embankment. Hence by using these recycled aggregates in concrete leads to environmental protection.

B. Advantages of green concrete

- The main advantage of "Green concrete" is eco friendly in nature.
- By using mineral admixture such as GGBFS, it reduces the quantity of cement, by reducing cement $C0_2$ emission also reduces.
- Due to less crushing, less emission of $C0_2$
- Now a day's scarcity of water is a big problem. Hence instead of portable water, recycled water is used.

C. Disadvantages of green concrete

- Since recycled aggregate is used there may be a less in compressive strength compared to normal concrete.
- It is difficult to get recycled aggregate.
- Recycled aggregate in concrete leads to increase in drying, shrinkage, creeps, porosity of water and high water absorption.
- Recycled water is used hence proper care is taken; otherwise it may cause skin diseases.

D. **Research objectives**

- In response to the global warming issues, green concrete for construction is an essential requirement. This may reduces the green house gases.
- To produce a green concrete by replacing the cement by waste material Ground Granulated Blast Furnace Slag (GGBS)
- To Use recycled aggregate and recycled water
- To evaluate the carbon footprint of the proposed green concrete and comparing with the conventional concrete.

E. **Scope of the work**

- Due to increased activity of construction followed by demolition leads to lot damage to the environment because of dumping the C&D waste in low lying areas and free spaces.
- To reduce this hazard to environment the only possible solution is to recycle and reuse the materials which has been used for construction activities and it is essential to develop an interest towards alternative aggregates in various applications of construction.
- Various types of waste produced in environment among those in present study only C&D waste, GGB S , recycled water has been selected for preparation of specimens.
- In present research work the alternative material GGBS recycled water and recycled aggregate isuse d From this research work intends to contribute to the waste management in preservation of enviro nment and exhausting resources.
- Various types of waste produced in environment among those in present study, GGBS, recycled water, C&D waste has been selected for preparation of cubes, cylinders and beams.

II. EXEPRIMENTAL INVESTIGATIONS

Constituents of green concrete

The basic components of "Green Concrete" is

A. Cement,
B. GGBFS,
C. M sand,
D. Recycled aggregate,
E. Recycled water
F. Super plasticizer

A. Cement

Cement is the main constituents of concrete and it act as a binding material. For the manufacturing of cement, the raw materials used are calcareous and argillaceous materials. Ordinary Portland cement confirming to the specifications of IS: 12269-1987 was used. Grade of the cement is 53 and the cement required for the experiments are collected from single source and stored with care.

Table 1. Physical properties of Ordinary Portland Cement 53grade

Sl no	Properties	Test methods	Test values	Limitation as per Is 12269-2004
1	Specific gravity	Specific gravity bottle (IS 4031 Part-4)	3.12	$\leq$3.15
2	Fineness of cement	Sieve test on 90µ sieve (IS : 4031 Part-1)	4%	<10%

3	Initial setting time	Vicat Apparatus (IS : 4031 Part-5)	35min	>30
4	Final setting time		220 min	<600

B. GGBFS

GGBFS means ground granulated blast furnace slag is a byproduct of pig iron which is obtained by rapid quenching of slag. The chemical composition of blast furnace slag is same as cement clinker. The main advantage of using GGBS is to reduce the unit water content necessary to obtain same slump in fresh concrete. In hardened concrete GGBS reduces the heat of hydration and increase the resistance against chemical attack.

Table 2. Properties of GGBS

Sl no	Properties	Test values
1	Specific gravity	2.8
2	Fineness of GGBS	2.2%

C. Fine aggregate

Concrete consists of 30-40% fine aggregates. Aggregate which passes through 4.75mm sieve are called fine aggregate. The aggregates used were confirming to zone II according to IS: 383-1970.

Table 3 Physical properties of fine aggregates

Sl no	Properties	Code of reference	Results
1	Specific gravity	IS : 2386-1963 (Part-3)	2.6
2	Fineness modulus	IS : 383-1970	3.1
3	Bulking of sand	IS : 2386-1963 (Part-3)	7%

D. Coarse aggregate

Aggregate which passes through 20mm sieve and retained on 4.75mm sieve are used. The aggregates used were confirming IS 383:1970.

Table 4 Properties of coarse aggregate

Sl no	Properties	Code of reference	Results
1	Specific gravity	IS : 2386-1986 (Part-3)	2.65
2	Water absorption	IS : 2386-1986 (Part-3)	0.29%
3	Fineness modulus	IS : 2386-1963 (Part 1)	2.7
4	Impact value	IS : 2386-1986 (Part 3)	13.7
5	Los angle abrasion	IS : 2386-1986 (Part 3)	22.94

E. Recycled aggregate

Table 5 Physical properties of recycled aggregate

Sl no	Properties	Code of reference	Results
1	Specific gravity	IS : 2386-1986 (Part-3)	2.45
2	Water absorption	IS : 2386-1986 (Part-3)	0.31%
3	Impact value	IS : 2386-1986 (Part 3)	33.2%
4	Los angle abrasion	IS : 2386-1986 (Part 3)	35.5%

F. Super plasticizer

Super plasticizer are the new version of plasticizer, now a days super plasticizers are most commonly used admixtures, chemical composition is different from normal plasticizer. in the resent investigations GLENIUM B233 is used

G. Mix proportions for different mix for 1m^3 concrete

Table 6 Mix proportions for different mix for 1m3 concrete

Sl No	Materials	Normal Concrete	60% GGBS, 100% RA 100% RW	70% GGBS 100% RA 100% RW	80% GGBS 100% RA 100% RW
1	Cement	311	124	93	62
2	GGBS	0	187	218	249
3	Coarse aggregate	1220	1220	1220	1220
4	Fine aggregate	766	766	766	766
5	Water	140	140	140	140
6	Super plasticizer	6.22	5.22	5.22	5.22

III. RESULTS

A. Compressive strength

The compressive test were carried to the specimen of 150mm X 150 mm X 150 mm after 7, 14, 28 days of curing with Compressive Testing Machine of 2000 kN capacity.A test result is average of three specimens and the maximum strength is average of 28 days curing.

Table 7 Compressive Strength test for different mix proportions

S1 No	Mix designation	Content	Compressive strength			Average Compressive Strength for 28 days (MPa)
			7 days	14 days	28days	
1	Mix 1	Normal concrete	19.11	27.60	30.85	30.27
			18.88	26.50	30.21	
			18.44	26.90	29.75	
2	Mix 2	60% GGBS, 100% RA 100% RW	18.97	22.80	26.97	26.17
			18.08	22.10	26.25	
			17.55	21.90	25.31	
3	Mix 3	70% GGBS 100% RA 100% RW	14.89	19.62	20.76	20.42
			15.91	18.97	20.53	
			15.51	19.12	19.99	
4	Mix 4	80% GGBS 100% RA 100% RW	10.40	16.12	17.83	17.32
			10.75	15.02	17.14	
			11.01	15.16	17.00	

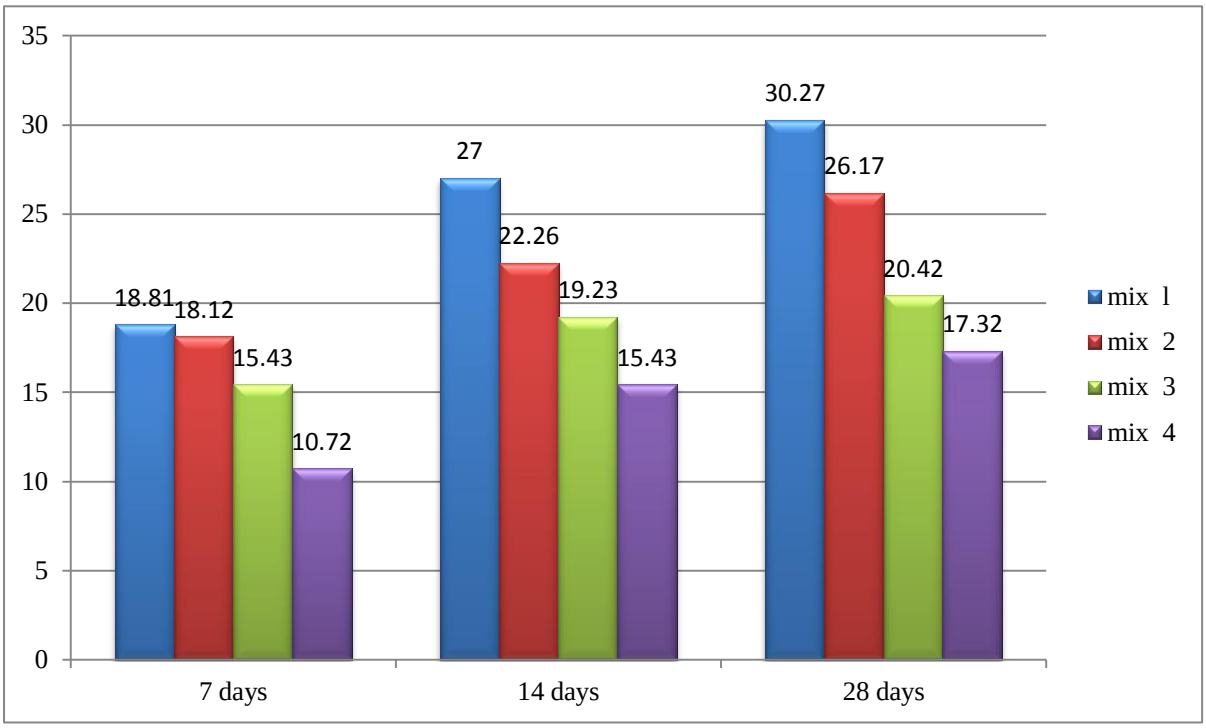

Fig 1 Compressive Strength for different mix proportions

B. Tensile strength

Concrete is strong in compression and weak in tension. Tension will creates crack in concrete. Tensile strength of concrete is measured by following formula.

$$ft = 2P/\pi DL$$

Table 8 Tensi1e strength test for different mix proportions

S1 No	Mix designation	Content	Tensi1e strength			Average Tensi1e strength Strength for 28 days (MPa)
			7 days	14 days	28days	
1	Mix 1	Normal concrete	2.39	3.12	3.43	3.01
			2.36	2.76	2.59	
			2.30	2.13	3.02	
2	Mix 2	60% GGBS, 100% RA 100% RW	2.23	2.76	2.97	2.77
			2.19	2.54	2.74	
			1.99	2.08	2.59	
3	Mix 3	70% GGBS 100% RA 100% RW	2.0	2.43	2.68	2.44
			1.91	2.09	2.53	
			1.75	1.94	2.12	
4	Mix 4	80% GGBS 100% RA 100% RW	1.29	2.13	2.46	2.23
			1.31	1.88	2.25	
			1.42	1.96	2.00	

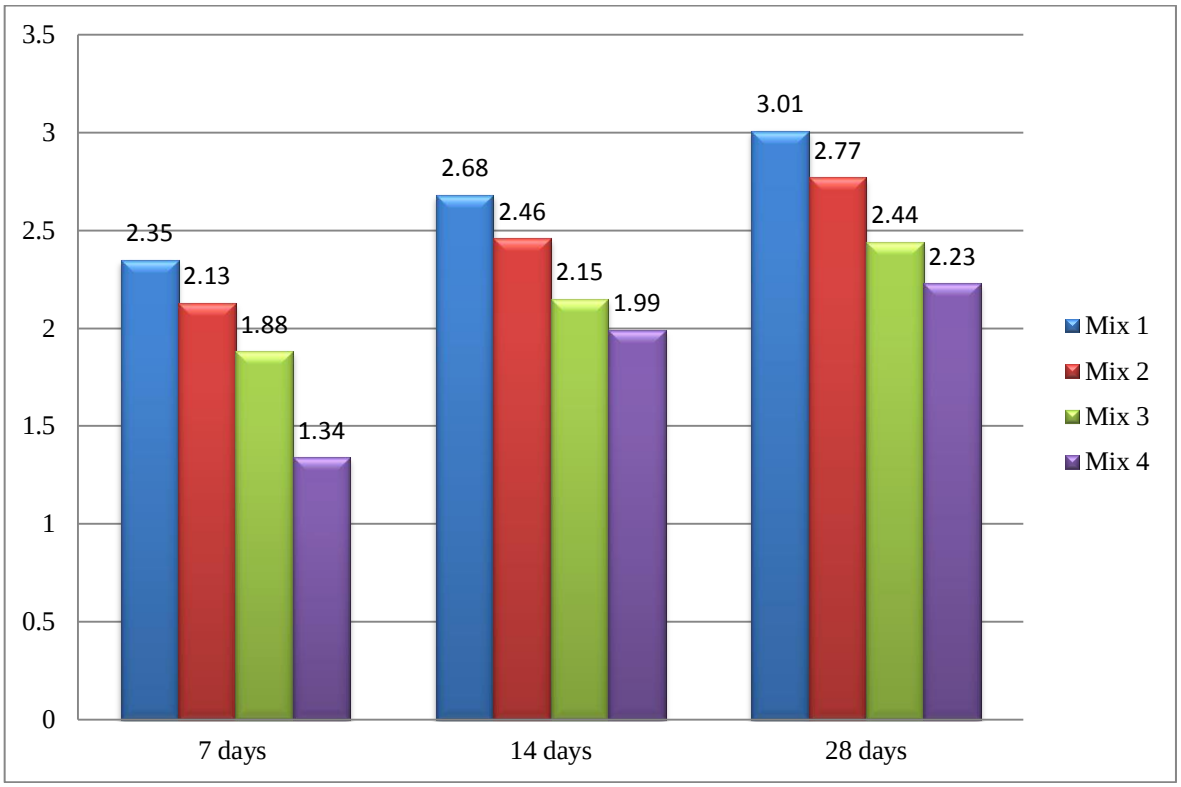

Fig 2 Tensile strength for different mix proportions

C. Flexural strength

Table 9 F1exural Strength test for different mix proportions

S1 No	Mix designation	Content	Flexural strength			Average Flexural Strength for 28 days (MPa)
			7 days	14 days	28days	
1	Mix 1	Normal concrete	4.19	4.94	4.97	5.02
			4.11	4.03	5.15	
			4.06	4.43	4.95	
2	Mix 2	60% GGBS, 100% RA 100% RW	4.01	4.33	4.65	4.69
			3.65	4.19	5.01	
			3.93	3.85	4.42	
3	Mix 3	70% GGBS 100% RA 100% RW	3.11	3.99	4.52	4.15
			3.26	3.75	4.12	
			3.42	3.81	3.79	
4	Mix 4	80% GGBS 100% RA 100% RW	2.89	3.61	4.05	3.86
			2.98	3.49	3.83	
			3.09	3.11	3.69	

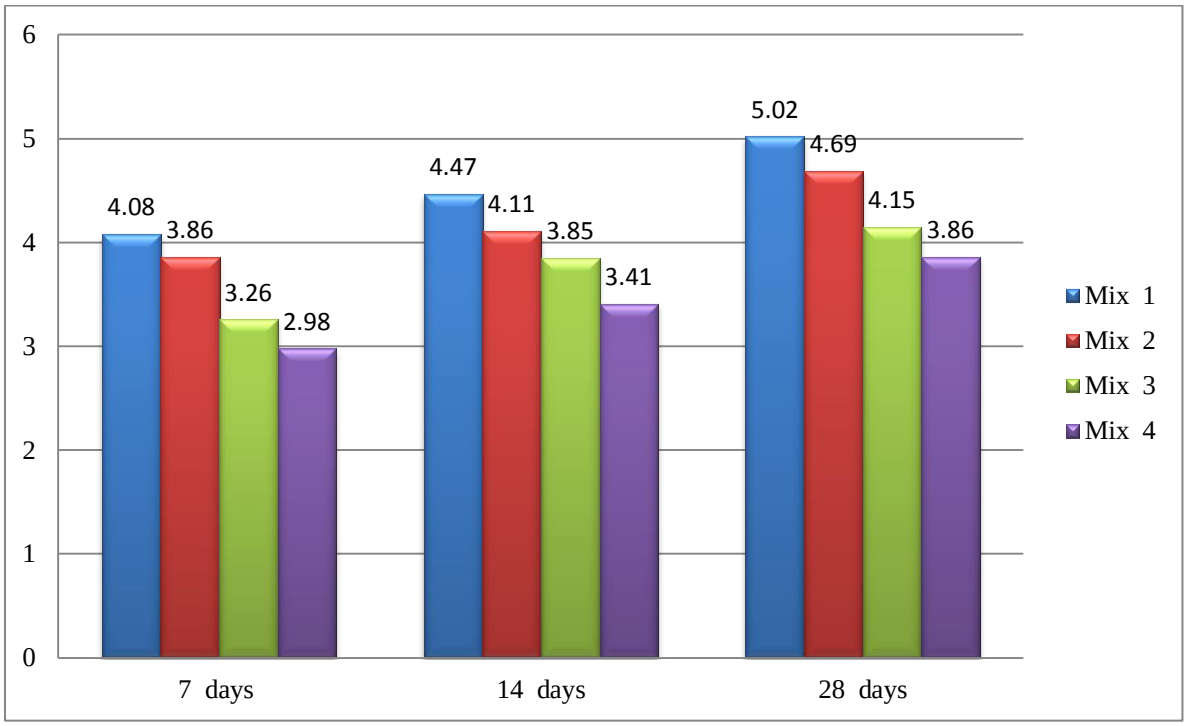

Fig 3 Flexural strength for different mix proportions

IV. CONCLUSION

- Considering the resent global warming issues, need for eco materials is revolutionary requirement. Hence, in the resent investigation Cement is replaced with 60% GGBS, 70% GGBS and 80% GGBS and coarse aggregate is replaced with recycled aggregate and water is replaced with recycled water to produce the green concrete.
- The compressive strength of green concrete for 60% replacement is 13.51 % less, 70% replacement is 32.6% less, 80% replacement is 42.6 % less when compared to Normal concrete.
- The tensile strength of green concrete for 60% replacement is 7.9 % less, 70% replacement is 18.9% less, 80% replacement is 25.9% less when compared to Normal concrete.
- The flexural strength of green concrete for 60% replacement is 6.6 % less, 70% replacement is 17.3% less, 80% replacement is 23.10 % less when compared to Normal concrete.

REFERENCES

[1] Asokan Pappu, Mohini Saxena, Shyam R. Asolekar, " Solid Wastes Generation In India And Their Recycling Potential In Building Materials", Building and environment Vol 5, issue 11, (2014)
[2] Gupta. S ,"Effect Of Content And Fineness Of Slag As High Volume Cement Replacement On Strength And Durability Of Ultra – High Performance Mortar", (2016) , pp.43-54
[3] H.K. Kim and H.K. Lee, "Effects Of High Volume Of Fly Ash, Blast Furnace Slag And Bottom Slag On Flow Characteristics , Density, And Compressive Strength Of High-Strength Mortar", journal of materials in civil engineering, Vol 25, (2013) , pp.662-665
[4] IS 10262:2009 "Concrete Mix Proportion -Guidelines"
[5] IS 2386-1963 (1) "Indian Standard For Methods Of Test For Aggregate For Concrete" Part 1 particle size and shape
[6] IS 2386-1963(3) "Indian Standard For Methods Of Test For Aggregate For Concrete" Part 3 specific gravity , absorption, density
[7] IS 2386-1963(4) "Indian Standard For Methods Of Test For Aggregate For Concrete" Part 4 mechanical properties
[8] IS 383-1970 "Indian Standard Specifications For Coarse And Fine Aggregate From Natural Sources For Concrete"
[9] IS 456:2000 "Indian Standard For Plain And Reinforced Concrete"
[10] IS 12269:2013 "Indian Standard for Ordinary Portland Cement 53 grade"

[11] Jagmeet Singh, Harpreet Singh, Rajindervir Singh, " Portland Slag Cement Using Ground Granulated Blast Furnace Slag(GGBFS)" ", IJREAS, Vol 5, issue 11, (2015), pp.47-53
[12] M. Etxeberria, E. Vazquez, A. Mari, M Barra, "Influence Of Amount Of Recycled Coarse Aggregates And Production Process On Properties Of Recycled Aggregate Concrete", cement and concrete research 37, (2007) , pp.735-742
[13] Mette Glavind, Christian Munch-Peterson, Jesperr S.Damtoft, Anette Berrig, "Green Conscrete in Denmark"
[14] Mr. Tushar R Sonawane, Prof. Dr. Sunil S. Pimplikar, "Use of recycled aggregate concrete", IOSR-JMCE, pp.52-59.
[15] Peter Duxson, John L Provis, Grant C. Luckey, Jannie S.J van Deventer, "The role of inorganic polymer technology in development of green concrete", cement and concrete research, Vol 37, 2007, pp.1590-1597
[16] S Kavitha and Dr T Felix Kala, "Evaluation of strength behavior of SCC using alccofine and GGBS as partial replacement of cement", Indian journal of science and technology,vol.9 (22),june 2016.
[17] Silva And Tarun R. Naik, " Sustainable Use Of Resources- Recycling Sewage Treatment Plant Water In Concrete" (2010)
[18] T.Vijaya Gowri, P. Sravana, P. Srinivasa Rao, "Studies On Strength Behaviour Of High Volume Of Slag Concrete", IJRET, Vol 3, issue 4, (2014) , pp.227-238