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Strength and Durability Studies on Concrete by Replacing Cement with GGBS and Fine Aggregates with Plastic Waste

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Abstract: *There is no doubt concrete is most useful thing in construction industry but it has a negative impact also, just like a coin has two faces. Raw materials used in manufacturing of concrete affects the environment in one or the another negative way. Like manufacturing of cement produce carbon dioxide whereas the production of aggregates adds dust to the environment. Production of fine aggregates also impact the geology of the area from they were extracted. A step taken in this direction is the use of waste products along with or in replacement of cement. Many of these materials are already in use, like silica fume, fly ash etc. In this study, plastic fine aggregates were used in place of natural fine aggregates. Plastic aggregates were produced by little processing of waste plastic. Plastic is the biggest threat to the environment, and it is affecting the environment rapidly. Some recent studies show that it can be used construction industry due to some of its properties like inert behavior, resistance to degradation etc. Also use of waste plastic can help in reducing plastic waste. Various experiments were performed to test the mechanical properties of the concrete with plastic fine aggregates. Concrete was prepared using plastic fine aggregates in varying proportions of 0, 5, 10,and 15%. opc is replaced by ggbs in 0, 10, 20, 30% proportion.*

Keywords: fine aggregate, ggbs, plastic wastes, resistance to degradation

I. INTRODUCTION

During the 1970's, central and state environmental agencies began to pay increasing attention to industrial pollution, safety and waste management control. However, environmental sustainability is at stake both in terms of damage caused by the extraction of raw material and CO2 emission during cement manufacture. This brought pressures on researchers for the reduction of cement consumption by partial replacement of cement by supplementary materials. These materials may be naturally occurring, industrial wastes or byproducts that are less energy intensive. Researchers all over the world are focusing on ways of utilizing either industrial or agricultural waste, as a source of raw materials for industry. This waste, utilization would not only be economical, but may also the result in foreign exchange earnings and environmental pollution control. Industrial wastes, such as blast furnace slag, fly ash and silica fume, metakaolin, ground granulated blast furnace slag (GGBS). are being used as Supplementary cement replacement materials.

Concrete is probably the most extensively used construction material in the world with about six billion tones being produced every year. Based on this report it was decided to replace 10 % fine aggregates by used plastic waste to determine the effect of different levels of replacements.

The present paper focuses on investigating characteristics of M20 and M40 grade concrete with partial replacement of cement with GGBS by replacing cement via 30%, 40%, 50%. The cubes, cylinders and prisms are tested for compressive strength, split tensile strength, flexural strength. Durability studies with sulphuric acid and hydro chloric acid were also conducted.

Ground Granulated Blast Furnace Slag (GGBS) is obtained during the steel making process, when the slag is unshed to form granules. Granulated Blast furnace Slag (GGBS) is the by product obtained in the manufacture of pig Iron in blast furnaces at around 1400° to 1500°C in the molten form. The slag is obtained by rapidly chilling the molten ash from the

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furnace by means of chilled water and is ground about 400 m²/kg of fineness by using state of the art grinding mill to make GGBS. It is a non-metallic product consisting essential of glass containing silicates and alumina Silicates of lime. GSR is one of the largest GGBS exporter in India.

GGBS Furnace Slag Owing to immense domain knowledge, we have become a prominent manufacturer, supplier and exporter of GGBS Furnace Slag. Complying with the industry standards, these slags are made using latest techniques and optimum-grade materials. Our offerings find their wide application in the construction industry for making concrete durable structures in combination with cement. Prior the dispatch, these slags undergo quick thorough checks for quality assurance. Also, GGBS Slags are packed in special and secure packaging material so as to ensure safety during transportation. Products Features: Excellent Hardening Properties No Additives Compositional Accuracy Moisture-Free Commendable Hardening Properties Increases Durability Of Structures Zero Impurity High Hardening Strength No Moisture Content Temperature Resistant Other Details: We offer GGBS as the name suggests is granulated blast furnace slag, ground to very high fineness. It is obtained during the manufacturing process of pig iron in blast furnace. Test Certificate Ground Granulated Blast Furnace Slag Characteristics Requirement as per BS: 6699 Test Result Fineness(M2/Kg) 275 (min) 400 Soundness Le-Chatelier Expansion (mm)

10.0 (max) Nil Initial Setting Time(min) Not less than OPC Min. 30 Minutes 220 Insoluble Residue(%) 1.5 (max) 0.05 Magnesia content(%) 14.0 (max) 9.5 Sulphide sulphar(%) 2.00(max) 0.6 Sulphite content(%) 2.50(max) 0.1 Loss on Ignition(%) 3.00(max) 0.3 Manganese Content(%) 2.00(max) 0.06 Chloride content(%) 0.10 (max) 0.003 Moisture content(%) 1.00 (max) 0.005 Glass content(%) 67 (min) 94 Compressive strength (N/mm2)After 7 days After 28 days 12.0 (min)32.5(min) 3453 Chemical ModuliCaO+MgO+SiO2CaO+MgO+SiO2CaO/SiO2 66.66 (min)>1.0<1.40 841.31.05 Note: Compressive strength soundness and initial setting time on blend of 70% GGBS: 30% OPC, All tests performed as per IS4031 & 4032.

1.1 Objectives:

- Determination of compressive strength of concrete for 28days curing period and 56 days (i.e., 56 days for curing and other 56 days exposed to atmosphere).
- Effect of accelerated curing on compressive strength.
- Determination of porosity and water absorption.
- Permeability test.
- Determination of strength after heating and cooling.
- Determination of strength after alternate wetting and drying.
- Acid attack test (sulphate attack test).

II. LITERATURE REVIEW

Raghatate Atul M. in 2012 performed study on use of plastic bags in form of fiber in concrete and test it properties. He adds fiber in proportion of 0.2%, 0.4%, 0.6%, 0.8% and 1% by weight of concrete. He found that there was reduction of compressive strength with increase in plastic content, but there was increase in tensile strength with optimum strength at 0.8% addition.

Praveen Mathew et. al. in 2013 study the use of Recycled Plastics as Coarse Aggregate for Structural Concrete. They performed test on concrete with various proportions of plastic aggregates in replacement of coarse aggregates and found the optimum result at 22% replacement of coarse aggregates with plastic aggregates. They further performed the test for other properties on concrete with 22% plastic aggregates and found that concrete with plastic aggregates was weaker in fire resistance.

Yogendra O. Patil et. al. [2013] researched on the effects on compressive strength and flexural strength of concrete with partial replacement of cement with various percentages of GGBS. The tests were conducted at 7, 28 and 90 days with replacement ranging from 10 % to 40 %. It was observed that the strength of concrete is inversely proportional to the percentage of replacement of cement with GGBS. The replacement of OPC by GGBS up to 20% shows the marginal reduction of 4 – 6 % in compressive and flexural strength for 90 days curing and beyond that of more that 15%. He concluded that, GGBS as replacement of OPC by 20% results in reduction in cost

S. Arivalagan (2014) investigated the effects on concrete by partially replacing the cement with GGBS at 20%, 30% and 40% replacement levels. Test results showed increase in compressive strength at 7 and 28 days at 20% replacement level of cement by GGBS. Split tensile strength and flexural strength of concrete also increased at 20% cement replacement. The increasing strength is due to filler effect of GGBS. In fresh concrete degree of workability of concrete also increased with increased GGBS percentage.

T. Vijaya Gowri et. al. [2014] investigated the effects of partial replacement of cement with GGBFS on compressive strength, split tensile strength and flexural strength of concrete at 28, 90, 180 and 360 days. He used 50% GGBFS as replacement material of cement for various water/binder ratios i.e. 0.55, 0.50, 0.45, 0.40, 0.36, 0.32, 0.30 and 0.27. He observed that the High Volumes of slag concrete gains appreciable amount of strength at later ages (90 days onwards) and it increases with decrease in water/binder ratios. He found out that the strength of high volume of slag concrete is more at later ages because of slower hydration of slag with $Ca(OH)_2$ and water. He concluded that on replacement of cement by 50% GGBFS helps to reduce the cement content of concrete, thereby reducing the cost of concrete and also protecting the environment from pollution.

M. Ramalekshmi et. al. [2014] discussed the results of partial replacement of cement with 50% - 80% of GGBFS on compressive strength of concrete at 7, 14 and 28 days. She concluded that slag replacement decreases the strength of concrete in short term when compared to control OPC. However, in long term it exhibits greater final strength. Thus 50% GGBFS as replacement showed maximum compressive strength at 28 days. Experiments were also conducted on beam-column with and without GGBFS with 50% replacement. The specimen were tested at 28 days under constant axial load and varying lateral load which showed increase in load carrying capacity of the specimen by 6.6 %. Thus 50% GGBFS as replacement can be used in RC specimens.

S. Arivalagan [2014] investigated the strength and strength efficiency factors of hardened concrete, by partially replacing cement with 20% , 30% and 40% GGBS at different ages. The specimens when tested at 7 and 28 days, showed increase in compressive strength for 20% replacement of cement. Split tensile strength and flexural strength of concrete also increased at 20% cement replacement. The increasing strength is due to filler effect of GGBS. It was also found that the degree of workability of concrete was normal and it increased with the addition of GGBS.

Reshma Rughooputh and Jaylina Rana [2014] studied the effects of partial replacement of OPC by GGBFS on various properties of concrete including compressive strength, tensile strength, splitting strength, flexure strength, modulus of elasticity, drying shrinkage and initial surface absorption. Cement was partially replaced by 30 % and 50 % of GGBFS by weight and test was performed at 7 and 28 days. It was found that GGBFS in concrete leads to lower early compressive strength gain but higher later compressive strength gain. Flexural strength of test specimens increased by 22% and 24%, tensile strength increased by 12% and 17% for 30% and 50% replacement respectively. Drying shrinkage increased by 3% and 4%. Static modulus of elasticity increases by 5% and 13%. She also observed that the initial surface absorption decreases as the GGBFS content increases because GGBFS decreases the permeability of concrete. Based on the results the optimum mix was the one with 50% GGBFS.

S. Vanitha et al. in 2015 performed studies on use of waste plastic in Concrete Blocks. Paver Blocks and Solid Blocks of size 200 mm X 150 mm X 60 mm and 200 mm X 100mm X 65 mm were casted for M20 grade of concrete and tested for 7, 14 and 28 days strength. Plastic was added to a proportion of 2%, 4%, 6%, 8% and 10% in equal replacement of aggregates. They found the optimum result for paver block at 4% replacement of aggregates with plastic aggregates. And 2% of plastic in case of solid blocks.

Santosh Kumar Karri et. al. (2015) investigated characteristics of M20 and M40 grade concrete with partial replacement of cement with ground granulated blast furnace slag (GGBS) by replacing cement at 30%, 40%, 50% replacement levels. It was observed that the concrete achieved maximum compressive strength at 40% replacement level. But as the percentage replacement exceeded 40% replacement level, the values of compressive strength were found to be descended. Compressive strength at 30% replacement was found to be higher than that of 50% replacement in concrete. Split tensile strength and flexural strength results were also found to be highest at 40% replacement level for both M20 and M40 grades.

Thejaskumar HM and Dr V. Ramesh [2015] studied the effects of partial replacement of cement with BFS on various properties of concrete. Compressive strength of concrete mixtures that were kept in water, 10% HCl and 15% H_2SO_4 solutions were determined at the ages of 7, 28 and 56 days with cement replacement ranging between 40 –

60%. It showed that as the ages goes up, the compressive strength, split tensile strength and flexural strength soars up but it decreases with the increase in percentage of BFS. However, replacement up to 55% does not affect the strength negatively. After 56 days the samples having 53% of BFS, didn't face a decrease in resistance, gained more compressive resistance in the solution of HCl and H2SO4.

Magandeep et. al. [2015] in there paper observed that the Slump values of various mix proportions of GGBFS concretes increased when replacement of GGBFS increases from 10 to 40 %. Compressive strength and flexural strength decreases as the percentage of GGBFS increases at the age of 7 and 28 days but it increases with the increase in percentage of GGBFS at the age of 56 days. He also observed that the split tensile strength of the mix with 20% and 30% cement replacement better performed than control mix at 56 days where as the mix with 40% cement replacement showed a decrease in strength at 56 days. The sulfate resistance and chloride resistance increased in the specimens with 30% GGBFS content than the specimens without GGBFS.

Santosh Kumar Karri, G.V.Rama Rao, P.Markandeya Raju (2015), Concrete is probably the most extensively used construction material in the world with about six billion tones being produced every year. It is only next to water in terms of per-capita consumption. However, environmental sustainability is at stake both in terms of damage caused by the extraction of raw material and CO2 emission during cement manufacture. This brought pressures on researchers for the reduction of cement consumption by partial replacement of cement by supplementary materials. These materials may be naturally occurring, industrial wastes or byproducts that are less energy intensive. These materials (called pozzalonas) when combined with calcium hydroxide, exhibits cementetious properties. Most commonly used pozzalonas are fly ash, silica fume, metakaolin, ground granulated blast furnace slag (GGBS). This needs to examine the admixtures performance when blended with concrete so as to ensure a reduced life cycle cost. The present paper focuses on investigating characteristics of M20 and M40 grade concrete with partial replacement of cement with ground granulated blast furnace slag (GGBS) by replacing cement via 30%, 40%, 50%. The cubes, cylinders and prisms are tested for compressive strength, split tensile strength, flexural strength. Durability studies with sulphuric acid and hydrochloric acid were also conducted.

Prabhat kumar et al[2] (2016)presented a review of existing literature work for understanding thoroughly about RCA and the concluded from various studies that Natural aggregate can be used with recycle aggregate with a ratio of 80:20 and 70:30. Higher ratio of Recycle aggregate can worsen the properties and strength of mix and due to use of recycled aggregate in construction industry it can slow the impact of waste on environment. Also it will promote sustainable growth

MB Hossain et. al. in 2016 performed work on Use of waste plastic in concrete as a constituent material. They replace coarse aggregates in proportion of 5%, 10% and 20. They found that the concrete was lighter in weight. But the compressive strength was lesser than that of conventional concrete. They also found that the concrete with 10% plastic aggregates shows strength nearly similar to the conventional concrete. So, the optimum result was 10% plastic aggregates.

Lhakpa Wangmo Thingh Tamanget. al. in 2017 performed experiment on Plastics in Concrete as Coarse Aggregate. They performed the testing of mechanical properties of concrete containing Plastic aggregates They use plastic aggregates in proportion of 10%, 15%, and 20%. They found marginal reduction in strength and suggested the optimum result as 15% replacement.

B Jaivignesh and A Sofi in 2017 performed Study Properties of Concrete with Plastic Waste as Aggregate. They used the plastic place of fine aggregates as well as coarse aggregates in proportion of 10%, 15 % and 20%. They also added steel fibre to the concrete. Their research concludes to the reduction in strength but suggested its use in favor of reduction of waste material and eco friendly materials.

Elango A and Ashok Kumar A in 2018 performed study concrete with plastic fine aggregates. They used OPC 53 grade, River sand and crushed aggregates. They used plastic in place of fine aggregates in proportion of 10%, 20% and 30%. They test mechanical and durability properties on their concrete samples. They found the decrease in strength of concrete. But found that the concrete shows good results against acid attacks and increase in elasticity. So they concluded that the plastic aggregate concrete can be used in place where we need less compressive strength but more durability

III. METHODOLOGY

A. Experimental Work:

Plan of Experimentation

The Experimental investigation is planned as follows.

- To find the properties of the materials such as cement, sand, coarse aggregate, water and GGBS.
- To obtain Mix proportions of OPC concrete for M25 by IS method (10262-2009).
- To calculate the mix proportion with partial replacement of cement with GGBS such as 0%, 10%, 20%, and 30% of GGBS with OPC.
- To calculate the mix proportion with partial replacement of sand with Plastic Granule such as 0%, 5%, 10%, and 15%.
- To prepare the concrete specimens such as cubes for compressive strength, cylinders for split tensile test, prisms for flexural strength and also cubes for durability studies in laboratory with 0%, 10%, 20% and 30% replacement of GGBS with OPC for M25 grade concrete.
- To cure the specimens for 7 days, 28 days and 56 days.
- To evaluate the mechanical characteristics of concrete such as compressive strength, split tensile test, flexural strength.
- To evaluate the durability studies of M25 grade GGBS replacement concrete, with 1% and 5% concentrations of Hydro chloric acid (HCl) and Sulphuric acid (H2So4).
- To evaluate and compare the results.
- To check the economic viability of the usage of GGBS, Keeping in view of the safety measures.

1. **Material Collection:**

- Cement: The choice of the cement content depends on the strength requirements, exposure classes for durability and the minimum amount of fine aggregate requires in the mix. The cement used for this study is ordinary Portland cement of 43 -grade.
- Fine Aggregate: The sand is of river sand screened and washed to remove all the organic and inorganic components that are likely to present in it. Sand is taken from local construction material suppliers and sieved in 4.75mm sieve.
- Coarse Aggregate: The coarse aggregates that are used for the concrete are 20mm of maximum size angular and well graded.
- GGBS: It is a by-product of iron manufacturing industry obtained through quenching of molten slag. The molten slag rapidly solidifies in a glassy granulate on cooling. The glassy granulate is further dried and altered into fine powder through grinding to achieve the required particle size. This fine powder is called ground granulated blast furnace slag (GGBS). It is a supplementary cementing material which can be partially replaced with cement in concrete, resulting in cost savings and energy savings as well. GGBS produces low carbon concrete by replacing cement, reducing the CO2 emissions as well as improving properties of concrete. Therefore, use of GGBS is also a greener approach. Concrete is enormously adopted in construction practices because of its long service life. The durability of concrete plays an important role in achieving such a long service life, as it is responsible for keeping the concrete away from any kind of deterioration. Durability of concrete can be reduced by some degradation mechanisms such as freeze-thaw damage, alkali-aggregate reactions, sulphate attack, abrasion etc. GGBS improves the durability of concrete, as it reduces the permeability, lowers the rate of heat evolution, refines the pore structure and gives more resistance to sulphate attack. Molten slag is being generated in large quantities from iron and steel industries. It becomes a solid waste on cooling and the disposal of such waste can cause dire environmental problems. So it's a much greener approach to convert this solid waste into powdered form and utilise it by partially replacing cement.
- Plastic Waste : Plastic wastes are increasing profusely in landfills. Disposed plastic wastes are further treated with incineration which leads to emission of harmful pollutants in the atmosphere. So it becomes a matter of concern to find ways to recycle and reuse waste plastic. Poly-ethylene Terephthalate (PET) bottles are mostly

used for storing carbonated and non-carbonated drinks. These bottles can be reused in terms of PET fibers as a partial replacement of fine aggregate. Hence reducing the amount of plastic waste to be disposed which is responsible for environmental pollution. Concrete is weak in tension and liable to crack due to shrinkage. The PET fibers act as light weight aggregates and help reducing the unit weight of concrete. Addition of fibers to concrete would act as crack inhibitors and substantially increase the tensile strength, cracking resistance, impact strength, wear & tear, fatigue resistance and ductility of concrete (M. Sulyman et. al. 2016, Bon-Min Koo et. al. (1996-1944). Thus, use of PET fibers help in enhancing the durability characteristics of concrete.

2. Material Tests

Properties cement determined by the following tests in Table 3.1

Particulars	Results Obtained	Requirements As Per Is 12269-1970
Fineness of cement (%)	4.3	3-7
Specific gravity	3.1	3.1-3.15
Normal consistency (%)	32	30-35
Initial setting time (min)	31	30
Final setting time (hrs)	8 hours	10 hours

Properties GGBS determined by the following tests in Table 3.2

CHEMICAL COMPOSITION		PHYSICAL PROPERTIES	
Calcium oxide	40%	Colour	white
Silica	35%	Specific gravity	2.9
Alumina	13%	Bulk density	1200 kg/m^3
Magnesia	8%	Fineness	>350m^2/kg

Properties fine aggregate determined by the following tests in Table 3.3

Particulars	Results Obtained	Requirements As Per Is 12269- 1970
Specific gravity	2.55	2.60-2.90
Fineness modulus	2.65	2.80-2.90
Water absorption (%)	0.9 %	1%
Sieve Analysis	Zone III	IS 383

Properties Course aggregate determined by the following tests in Table 3.4

Particulars	Results Obtained	Requirements As Per Is 12269- 1970
Specific gravity	2.62	2.60-2.90
Fineness modulus (20mm)	5.77	6.10-6.90
Water absorption (%)	0.7 %	1%
Sieve Analysis	Zone II	IS 383

Properties of fresh concrete Workability by slump test Table 3.5

Replacement level	Value	Degree of Workability
0 % GGBS	48	Low
10 % GGBS	50	Low
20 % GGBS	53	Low
30 % GGBS	57	Medium

B. Methodology:

Materials which are used to conduct the above tests are Cement, Locally available sand, GGBS, Plastic, Basalt Aggregates and Water.

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Casting and Curing:

Cube specimen of size 15cm×15cm×15cm were cast using the mix proportion given in Table3.6 as per IS:516- 1959. The cubes were de-moulded after 24 hours of casting. The cubes were kept for curing under water immersion at laboratory temperature 27±2˚C. Water is being changed at regular intervals. In all 120 specimens the cement was replaced by GGBS by (0%, 10%, 20% and 30%) with M25 case mix case were cast for 7days, 28 days and 56 days curing. In all 120 specimens the fine aggregate was replaced by plastic by (0%, 5%, 10% and 15%) with M25 case mix case were cast for 7days, 28 days and 56 days curing.

Table 3.6: Mix proportions for Cement, GGBS, Natural Sand, and Plastic for M25 (1:1:2) grade concrete

Sr. No.	Mix Combination	Cement	Fine Aggregate	Course Aggregate (20 mm)	W/C ratio
1	Conventional Concrete	1	1	1.32	0.56
2	10 % GGBS	1	1.2	1.36	0.56
3	20 % GGBS	1	1.5	2	0.56
4	30 % GGBS	1	1.8	2.2	0.56

Curing for Durability test: 24 hours after casting the test specimens, cubes, cylinders and prisms are de-moulded and immediately immersed in clean and fresh water tank and allow it for curing for 7 days, 28 days and for 56 days in potable water. Specimens were also cured in 1% H2SO4 acid and 1% HCl acid for 56 days and 5% H2So4 acid curing, 5% HCl acid curing for 28 days.

C. Test

Compressive strength test on Concrete:

The compressive strength test was carried out using IS: 516-1979. CTM of 2000 kN capacity was used with load rate of approximately 140 kg/cm /min until failure for Compressive strength test. At the end of curing period i.e., 7days, 28 days and at 56 days (exposed to environment for a period of 7days, 28 days and at 56 days curing period), compressive strength test was conducted. The test results for compressive strength are presented in Tables
4.1 (0%, 30%, 40% and 50% of GGBS concrete) for M20 grades of concrete at room temperature for 7days, 28 days and at 56 days respectively.

Table 3.7: The compressive strength test result of M25 (1:1:2) grade concrete block

	compressive strength (N/mm^2)		
% of GGBS	**7 days**	**28 days**	**56 days**
Conventional Concrete	14.35	28.58	33.60
10 % GGBS	15.40	30.50	36.36
20 % GGBS	16.30	32.85	38.22
30 % GGBS	16.60	33.33	38.45

Figure 4.1: Compressive Strength (Mpa) of Concrete with Various Levels of Replacement of GGBS

Split tensile strength of concrete

For split tensile strength, the load was applied without shock and increased continuously at a nominal rate within the range 1.2 N/mm2/min to 2.4 N/mm2/min until failure of the specimen. The test results for split tensile strength are presented in Tables 7 and Table 8 (0%,

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10%, 20% and 30% of GGBS concrete) for M25 grades of concrete at room temperature for 28 and 90 days respectively.

Table 3.8: The split tensile strength test result of M25 (1:1:2) grade concrete block

	Split tensile strength (N/mm^2)		
% of GGBS	**7 days**	**28 days**	**56 days**
Conventional Concrete	1.72	2.69	3.45
10 % GGBS	1.78	2.85	3.65
20 % GGBS	2.01	3.02	3.90
30 % GGBS	2.03	2.98	3.95

Durability Studies with H2SO4 and HCl

Concrete cubes of 150 x 150 x 150 mm3 size were cast for durability studies for 2 grades (M25) of concrete 1% H2SO4, 1% HCl concentration for 90 days curing and 5% H2SO4, 5% HCl concentration for 28 days curing were considered for durability studies. Each grade consists of 4 series 0%, 10%, 20% and 30% and hence each grade contains 96 cubes placed in individual tubs for each concentration. The normality of the solution was checked for every 2 days. The Compressive strength of cubes exposed to H2SO4 and HCl are tested for compressive strength and results were presented from Tables 13.9 and 3.10 for 0%, 10%, 20% and 30% of GGBS concrete for M25 grades of concrete at room temperature for 7 day, 28 and 56 days respectively. Figure 4.3 shows acid affected concrete cubes.

Table 3.9: Compressive strength for M25 grade concrete after H2SO4Acid curing

	compressive strength (N/mm^2)		
% of GGBS	**7 days (5% H_2SO_4)**	**28 days (5% H_2SO_4)**	**56 days (1% H_2SO_4)**
Conventional Concrete	12.35	25.58	31.60
10 % GGBS	13.40	27.50	32.36
20 % GGBS	14.30	29.85	34.22
30 % GGBS	14.60	30.33	34.45

Table 3.10: Compressive strength for M25 grade concrete after HCl Acid curing

% of GGBS	**7 days (5% HCl)**	**28 days (5% HCl)**	**56 days (1% HCl)**
Conventional Concrete	12.17	25.29	31.36
10 % GGBS	13.20	27.31	32.19
20 % GGBS	14.16	29.47	34.09
30 % GGBS	14.32	30.17	34.23

Water absorption test:

The test was carried out as per IS code.

% water absorption=[(Ww-Dw)/Dw]x100 Where, Ww=wet weight of the cube, Dw=dry weight of the cube.

Permeability Test:
The test was carried out according to German Standard DIN 1048 on concrete specimens of size 150x150x150 mm ,and the depth of penetration in specimen is noted down by breaking them equally under UTM.

Alternate heating and cooling:
The specimens are cast and cured for 28 days, after curing the specimens are subjected to heating and cooling for a period of 20days (20cycles) to check the durability. The specimens are heated at normal atmospheric temperature in day time and cooled during the night time. This process is continued for 20 days and after that strength of the specimens is checked.

Alternate wetting and drying:
The specimens are cast and cured for 28 days, after curing the specimens are subjected to alternate wetting and drying for a period of 20 days to check the durability. The specimens are kept for wetting in curing tank for 1 day and next day it is allowed to dry, again the procedure is repeated, after 20 days cycle the strength of specimens are tested to check the effect of alternate heating and cooling on concrete.

IV. FUTURE WORK

- Corrosion of reinforcement embedded in RCC member using GGBS and plastic is to be carried out.
- For higher grade concrete effect of acid attack fill be future work.
- Also to test same block for 84 day is need to be consider.
- Other levels of replacement with GGBS can be researched.
- Combination of GGBS with different other admixture can be carried out.
- Studies on replacements levels of high grade concrete can be carried out.

V. CONCLUSION

- Based on the analysis of experimental results and discussion there upon the following conclusions can be drawn.
- Workability of concrete increases with the increase in GGBS replacement level.
- The compressive strength of concrete increased when cement is replaced by GGBS for both M25 grade of concrete. At 30% replacement of cement by GGBS the concrete attained maximum compressive strength for both M25 grade of concrete.
- The split tensile strength of concrete is increased when cement is replaced with GGBS. The split tensile strength is maximum at 30% of replacement.
- The flexural strength of concrete is also increased when the cement is replaced by GGBS. At 30% replacement, the flexural strength is maximum.
- The compressive strength values of acid effected concrete decreases on comparison with of normal concrete, but the effect of acid on concrete decreases with the increase of percentage of GGBS. At 30% replacement of GGBS the resistance power of concrete is more.
- Concrete containing 30% GGBS and 10% plastic waste has resulted in higher strength at 56 days of curing i.e., 38.22 N/mm2 and 38.45 N/mm2 respectively compared to control mix of strength 42.292N/mm2 , this is due to higher water absorption of foundry waste sand. At 56 days age of concrete control concrete (33.60N/mm2) and concrete containing GGBS (36.36 N/mm2) has recorded nearly the same strength.
- Concrete containing weathered has recorded lower strength of 33.94N/mm2 compared to control mix, this is due to higher water absorption of weathered sand.
- Permeability is measured in terms of depth of penetration of water in concrete, concrete containing weathered sand, control mix and concrete containing burnt black sand recorded depth of penetration 4.38cm, 2.86cm, 1.85cm respectively.

- The compressive strength results show that the mixtures containing used GGBS showed higher strengths at all test ages. The compressive strength of concrete containing 30% used GGBS is 23% higher than control mix at 28 -day age.
- However, the decrease in the compressive strength of 25% and 35% as compared to the design strength of 38 Mpa is 11% and 19%, respectively at 28 days. But concrete containing 30% GGBS and 10% plastic replacements of regular concrete sand showed almost the same compressive strength as control mix at all ages.

REFERENCES

[1]. Elango A and Ashok Kumar A " Study on Partial Replacement of plastic waste as fine aggregate in concrete" International Journal of Current Engineering And Scientific Research, Volume 5, Issue 5, 2018, ISSN (Print):2393-8374, ISSN (Online): 2394-0697

[2]. Lhakpa Wangmo Thingh Tamang, Tshering Wangmo, Karma Tshering Darjay, Karma Sangay Phuntsho, Phuntsho Namgyal, Ugyen Wangchuk "Use of Plastics in Concrete as Coarse Aggregate" International Journal of Education and Applied Research, Volume 7, Issue 5, 2017, ISSN (Print) 2249-4944, ISSN(Online) 2348-0033.

[3]. B Jaivignesh and A Sofi, " Study on mechanical properties of concrete using Plastic Waste as an Aggregate", IOP Conference Series: Earth and Environmental Science, 2016.

[4]. MB Hossain, P Bhowmik, KM Shaad, " Use of waste plastic aggregates in concrete as a constitutional material" Progressive Aggriculture Journal, 2016, ISSN 1017-8139.

[5]. Raghatate Atul M., " Use of plastic in concrete to improve its properties", International Journal of Advanced Engineering Research and Studies, Volume 1, Issue 3, 2012, ISSN 2249-8947.

[6]. Praveen Mathew, Shibi Varghase, Thomas Paul ,Eldho Varghase, " Recycled Plastic as coarse aggregates for structural concrete", International Journal for Innovative Research in Science, Engineering and Technology, Volume 2, Issue 3, 2013, ISSN 2319-8753.

[7]. S. Vanitha, V. Natrajan and M Praba" utilization of waste plastic as a partial replacement of coarse aggregates in concrete Blocks" Indian Journal of Science and Technology, Volume 8, Issue 12, 2015, ISSN (Print) 0974-6846, ISSN (Online) 0974-5645.

[8]. Ms. K.Ramadevi1, Ms. R. Manju, Experimental investigation on the properties of concrete with plastic PET (Bottle) fibres as fine aggregates, International Journal of Emerging Technology and Advanced Engineering, (ISSN 2250-2459, Volume 2, Issue 6, June 2012).

[9]. Santosh Kumar Karri, G.V.Rama Rao, P.Markandeya Raju "Strength and Durability Studies on GGBS Concrete" SSRG International Journal of Civil Engineering (SSRG-IJCE) – volume 2 Issue 10 October 2015 ISSN: 2348 – 8352 www.internationaljournalssrg.org Page 34.

[10]. Thejaskumar HM and Dr. V. Ramesh, "Experimental Study on Strength and Durability of Concrete with Partial Replacement of Blast Furnace Slag", Vol. 3, Issue 1, Sep. 2015, pp. 134-140, e-ISSN: 2348-7607

[11]. Magandeep, Ravi Kant Pareek and Varinder Singh, "Utilization of Ground Granulated Blast Furnace Slag to Improve Properties of Concrete", International Journal on Emerging Technologies, Vol. 6, Issue 2, Aug. 2015, pp. 72-79, e-ISSN: 2249-3255

[12]. T. Vijaya Gowri, P. Sravana and P. Srinivasa Rao, "Studies on Strength Behaviour of High Volumes of Slag Concrete", International Journal of Research in Engineering and Technology(IJRET), Vol. 3, Issue 4, Apr. 2014, pp. 227-238, e-ISSN: 2319-1163

[13]. M. Ramalekshmi, R. Sheeja and R. Gopinath, "Experimental Behaviour of Reinforced Concrete with Partial Replacement of Cement with Ground Granulated Blast Furnace Slag", International Journal of Engineering Research & Technology(IJERT), Vol. 3, Issue 3, Mar. 2014, pp. 525-534, ISSN: 2278-0181

[14]. S. Arivalagan, "Sustainable Studies on Concrete with GGBS as a Replacement Material in Cement", Jordan Journal of Civil Engineering, Vol. 8, Issue 3, Feb 2014, pp. 263-270

[15]. Reshma Rughooputh and Jaylina Rana, "Partial Replacement of Cement by Ground Granulated Blast Furnace Slag in Concrete", Journal of Emerging Trends in Engineering and Applied Sciences(JETEAS), Vol. 5, Issue 5, 2014, pp. 340-343, ISSN: 2141-7016

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[16]. Yogendra O. Patil, Prof. P.N. Patil and Dr. Arun Kumar Dwivedi, "GGBS as Partial Replacement of OPC in Cement Concrete – An Experimental Study", International Journal of Scientific Research(IJSR), Vol. 2,
[17]. IS: 5816-1999, Indian standard code for splitting tensile strength of concrete–method of test, Bureau of Indian Standards, New Delhi, India.
[18]. IS 10262:2009," Concrete mix proportioning- guidelines", Buereau of Indian Standards
[19]. IS 383:1970," Specifications for coarse and fine aggregates from natural resources", Buereau of Indian Standards
[20]. IS 456:2000, " Code of practice for plain and reinforced concrete", Buereau of Indian Standards