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EXPERIMENTAL INVESTIGATION OF CONCRETE BY PARTIAL REPLACEMENT OF FINE AGGREGATE BY GGBS AND SGP

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Abstract - *In our modern world, concrete is one of the most widely used construction materials. One of the main ingredient of concrete is Sand. Recycling of waste materials like steel waste (GGBS) and glass cuttings waste (SGP) are used partial in fine aggregate to make the concrete durable and leads to greener environment. This is an effort to quantify the effect on properties of GGBS and SGP and to evaluate its efficiencies in concrete. The aim of this project is to minimize cost of project and to utilize the GGBS and SGP in concrete and minimize the disposal risk to nature. This is to indicate that it is possible to manufacture concrete containing GGBS and SGP with characteristics similar to those of natural sand or M-sand. Here, GGBS and SGP are partially replaced to fine aggregate in concrete of various levels 10%, 15%, 20% and 25%.*

Key Words **:** Sand replacement, GGBS, SGP, Properties.

1. INTRODUCTION :

Concrete is an assemblage of cement, aggregates and water. The most commonly used fine aggregate is sand which is derived from the river banks. Therefore, the consumption of natural sand is very high, that is due to the extensive use of concrete. Concrete is an artificial conglomerate stone made essentially of Portland Cement, water, sand and coarse aggregates. The mixture of the materials results in a chemical reaction called hydration and a change in the mixture from plastic to a solid state. Concrete is the main part of any construction work which is composed of gravels or crushed stones, sand and hydrated cement etc. It has been used over a century in all construction work. Concrete is a composite material. All of its constituents contributes to its properties like fresh and harden properties. Concrete has attained the status of a major building material in all the branches of modern construction. It is difficult to point out another material of construction which is as variable as concrete. Concrete is the best material of choice where strength, durability. Permeability, fire resistance and
absorption resistance are required. Compressive strength is considered as an index to assess the overall quality of concrete and it is generally assumed that an improvement of all other properties. Hence, strength investigations are generally centered on compressive strength. There are also other strengths such as flexural strength, split tensile strength etc. Even though concrete mixes are proportioned on the basis of achieving the desired compressive strength at the specified age, flexural strength often play a vital role in concrete making.

The aim of this project is to minimize cost of the project and to utilize the GGBS and SGP in concrete and to minimize the disposal risk to nature. Here, Ground Granulated Blast Furnace Slag and Sheet Glass Powder are partially replaced to sand in concrete of various levels of 10%,15% , 20% and 25%. The mechanical properties (compressive, split tensile and flexural strength) of concrete and durability properties are determined at different curing periods and were compared with control M20 mix.

2. MATERIALS AND PROPERTIES :

➢ CEMENT :

Cement is one of the most important building materials, is a binding agent that sets and hardens to adhere to building units such as stones, bricks, tiles, etc. The properties such as consistency, strength, setting time, bulk density .,etc

PROPERTIES	RESULTS
Consistency	35%
Specific gravity	3.2
Initial setting time	55 mins
Final setting time	355 mins

Table – 1 : Cement

➢ FINE AGGREGATE :

Fine aggregate is the essential ingredient in concrete that consists of natural sand or crushed stone. The quality of fine aggregate strongly influence the hardened properties of concrete such as bulk density, moisture content, specific gravity, durability, etc

PROPERTIES	RESULTS
Specific gravity	2.65
Fineness Modulus	2.75
Bulk density	1.73 Kg/m3
Water absorption	0.6

Table – 2 : Fine aggregate

- **COARSE AGGREGATE :**

Coarse aggregate is stone which are **broken into small sizes** and **irregular in shape**. The **coarse aggregate** has a major effect on **concrete properties** such as Specific gravity, hardness, elastic modulus, and another**.**

PROPERTIES	RESULTS
Specific gravity	2.75
Bulk density	1540 Kg/m3
Water absorption	1.2
Fineness modulus	7.56

Table – 3 : Coarse aggregate

- **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, ground into a fine powder. There are some properties such as specific gravity, bulk density, moisture content, etc.

PROPERTIES	RESULTS
Specific gravity	2.8
Bulk density	1000-1100 Kg/m3
Moisture content	0.089
Fineness modulus	350m2

Table – 4 : Ground granulated blast slag (GGBS)

- **SGP :**

Sheet glass powder (SGP) **used in concrete making leads to greener environment**. In shops, many sheet glass cuttings go to waste, which are not recycled at present and usually delivered to landfills for disposal. There are some properties such as specific gravity, bulk density, moisture content .,etc.

PROPERTIES	RESULTS
Fineness modulus	2.24
Specific gravity	3.25
Bulk density	1610 Kg/m3
Moisture content	2.55%

Table – 5 : Sheet glass powder (SGP)

3. RESULTS AND DISCUSSION :

3.1 COMPRESSIVE STRENGTH TEST ;

The compressive strength of hardened concrete was performed on standard compression testing machine. For this study, experimental work involves casting of concrete cubes size 150mm x 150mm x 150mm for determination of compressive strength for 7 days, 14 days and 28 days. Totally 15 cubes of M20 grade concrete were casted. Cubes were casted for various percentage for addition for GGBS and SGP in concrete. The concrete cubes after casting is allowed for 7 days, 14 days and 28 days curing. After curing, cubes are tested in compression testing machine to determine the Ultimate Compressive Load. From the ultimate load, the compressive test is obtained by the following formula,

Compressive strength = Ultimate Load / area

Fig – 1: Compressive strength Test

	7 DAYS (N/mm^2)	14 DAYS ($N/mm^{2)}$)	28 DAYS (N/mm^2)
Conventional concrete	13.5	18	20
10%	16	20.44	21.33
15%	16.88	20.66	23.55
20%	16.45	20.88	29.78
25%	14.22	19.11	27.55

Table – 1: Compressive strength Attained

3.2 SPLIT TENSILE STRENGTH TEST :

For this study, experimental work involves casting of concrete cylinders of size 150mm diameter and 300mm length for determination of split tensile strength for 7 days, 14 days and 28 days. Totally 15 cylinders of M20 grade concrete were casted. Cylinders were casted for various percentage of GGBS and SGP in concrete. Adding 10%, 15%, 20% and 25% of GGBS and SGP to the concrete, the calculation for split tensile strength is obtained. The concrete cylinder after casting is allowed for 7 days, 14 days and 28 days of curing. After curing, concrete cylinders are tested in Compression Testing Machine (CTM) of capacity of 2000 KN to determine the Ultimate Split Tensile load.

From the ultimate load, the tensile strength is obtained by the following formula,

Split Tensile Strength = $2P / (\pi DL)$ (N/mm^2)

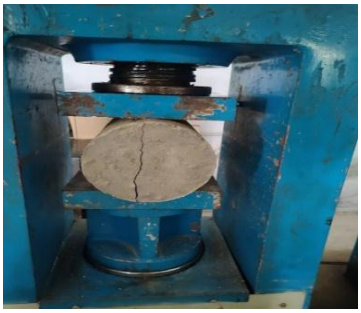

Fig – 2 : Split Tensile Strength Test

Where,

D = diameter of the cylindrical specimen (mm)
P = ultimate load
L = length of the cylindrical specimen (mm)

	7 DAYS (N/mm^2)	14 DAYS (N/mm^2)	28 DAYS (N/mm^2)
Conventional concrete	1.00	1.62	2.23
10%	1.69	1.98	2.4
15%	1.83	2.12	2.54
20%	1.98	2.26	2.8
25%	1.9	2.19	2.7

Table – 2 : Split Tensile Strength Attained

3.3 FLEXURAL STRENGTH :

For this study, experimental work involves casting of concrete beams of size 500mm x 100mm x 100mm for determination of flexural strength for 7 days, 14 days and 28 days curing. The concrete for designed mix is mixed homogeneously by means of hand mixing. Before casting the beam, the entire mould is greased. So, the beam can be easily removed from the mould after the desired period. The concrete is filled in the beam in three layers and each layer is compacted evenly tamping rod. The concrete beam after casting is allowed for 7 days, 14 days and 28 days curing. After curing, the prism were allowed for curing. After this process, beams are tested in Flexural Testing Machine (FTM) to determine the flexural strength.

Flexural strength = Pl / bd^2

Fig – 3 : Flexural strength Test

	7 DAYS (N/mm^2)	14 DAYS (N/mm^2)	28 DAYS (N/mm^2)
Conventional concrete	1.97	2.7	3.13
10%	3.00	6.00	8.75
15%	2.7	4.8	7.85
20%	2.00	3.75	6.5
25%	1.2	1.65	6

Table – 3 : Flexural strength Attained

4. CONCLUSIONS :

- From the above experimental investigation, we are about to conclude that partially replacement GGBS and SGP in fine aggregate, the hardened strengths such as Compressive strength, split tensile strength and flexural strength are obtained in laboratory.
- Compressive strength – The compressive strength increases in the minimal replacement of GGBS and SGP (10%,15%) in the concrete for 7 days, 14 days and 28 days. Attains the maximum strength at 20% of replacement, it starts to decrease at 25% of replacement.

- Split tensile strength – The split tensile strength increases in the minimal replacement of GGBS and SGP (10%, 15%) in the concrete for 7 days, 14 days and 28 days. Attains the maximum strength at 20% of replacement, it starts to decrease at 25% of replacement.

- Flexural strength – The flexural strength of concrete attains the maximum strength at minimal replacement at 10% for 7 days, 14days and 28 days. And gradually starts to decrease from 15% to 25% for 7 days, 14 days and 28 days. The result of flexural strength is not satisfied.

- By this, we conclude that the above strengths compressive strength and split tensile strength tends to show the rapid increase by increasing the percentage of replacement and at certain percentage of replacement, it starts to decrease. The flexural strength of the concrete attains the maximum strength at the minimal replacement and starts to decrease for the further percentages of the replacement.

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