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STRENGTH AND DURABILITY OF CONCRETE BY USING SILICAFUME AND GGBS

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ABSTRACT:

This thesis presents a study conducted on mechanical and durability properties of concrete. The investigation covered concrete mixes at water cementitious material with ratio of 0.4. Ordinary Portland cement of 53-grade was used in this study. The percentage of cement that partially replaced by weight were Silica Flume is 10% and varying the GGBS replacement from 0% to 50%. Concrete cubes and cylinders were casted and tested in laboratories. The optimum proportion of replacement was found by conducting tests on mechanical properties like Compressive strength test and Split tensile strength test.

The results show that the optimum replacement of cement with silica flume 10% and 40% GGBS, it is possible to gain the same strength as conventional concrete. The durability of concrete was done by curing with 5% Hydrochloric acid (HCL) and 5% Sulphuric acid (H2SO4). The effect of acids on compressive strength, Split tensile strength and durability characteristic property was determined for 7, 28, 60, 90 and 180Days.

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1. INTRODUCTION

1.1 GENERAL:

For a long time concrete was considered to be very For a long time concrete was considered to be very durable material requiring. We build concrete structures in highly polluted urban and industrial areas, aggressive marine environments, harmful sub-soil water in area and many other hostile conditions where other materials of construction are found be non –durable. Since the use of concrete in recent years have spread to highly harsh and hostile conditions, the earlier impression that concrete is a very durable material is being threatened, particularly on account of premature failures of number of structures.

In the past only strength of concrete was considered in the concrete mix design procedure assuming strength of concrete in all pervading factor for all other desirable properties of concrete including durability. In the recent revision of IS 456 of 2000, one of the points discussed, deliberated and revised is the durability aspects of concrete, in line with codes of practice of other countries, which have better experiences in dealing with durability of concrete structures. One of the main reasons for deterioration of concrete in the past is that too much emphasis is placed on concrete compressive strength. As a matter of fact advancement in concrete technology has been generally on the strength of concrete. It is now recognized that strength of concrete alone is not sufficient, the degree of harshness of the environment condition to which concrete is exposed over its entire life is equally important. Therefore, both strength and durability have to be considered explicitly at the design state. It is interesting to consider yet another view point regarding strength and durability relationship. Durability of concrete is its Resistance to deteriorating agencies to which the concrete may be exposed during its service life. When one deals with the durability aspects of concrete, the chemical attack, which results in loss of weight, cracking of concrete and the consequent deterioration of concrete, becomes an important part of investigation. Ordinary Portland cement concrete usually does not have good resistance to acid attack. The addition of FA improves the micro structural properties of concrete like porosity, permeability and sorptivity. The reduction of porosity and permeability implies the improvement in chemical attack and corrosion resistance. The experimental investigation of this aspect is to find compressive strength and durability of concrete by partial replacement of cement with quarry dust.

Durability is an important engineering property of concrete, which determines the service life of concrete structures significantly. Due to the interactions of concrete with external influences, the mechanical and physical properties of concrete may be threatened and lost. ACI Committee Report 201(2001) has classified chemical attacks into several types that include acidic attack, alkali attack, carbonation, chloride attack, and leaching and sulfate attack. Acidic attack usually originates from industrial processes, but it can even be due to urban activity. Even natural exposure conditions may cause acid attacks. Free acids in natural waters are rare. Exceptions are carbonic waters and sulfurous and sulfuric acids in peat waters. Soils may contain huminous acids. Several organic and inorganic acids may occur in shallow regions of sea-water as a consequence of bacteriological activity. Significant quantities of free acids in plants and factories may be found. In these cases, the concentration of acid, which comes in contact with concrete structures, may reach to high value. The degree of aggressive of an acid is dependent on the chemical character of anions present. The strength of acid, its dissociation degree in solutions and, mainly, the solubility of the calcium salts formed are dependent on the chemical character of anion. The acidic attack is affected by the processes of decomposition and leaching of the constituent of cement matrix.

The objective of the present project work is to study the behavior of concrete in partial replacement for cement with quarry dust in proportions. It includes a brief description of the materials used in the concrete mix, mix proportions, the preparation of the test specimens and the parameters studied. In order to achieve the stated objectives, this study is carried out in different stages. In the initial stage, all the materials and equipment needed must be gathered or checked for availability. Once the characteristics of the materials selected have been studied through appropriate tests, the applicable standards of specification are referred. The properties of hardened concrete are important as it is retained for the remainder of the concrete life. In general, the important properties of hardened concrete are strength and durability. An experimental program is held to measure strength of hardened concrete.

1.2 AIM AND OBJECTIVES:

The main objectives of the present study are as mentioned below:

- To study the effect of silica fume and GGBS on the compressive strength of concrete.
- To study the microstructure of the hardened cement concrete.
- To explain the change in properties of concrete, if any, by explaining the microstructure.
- Investigations were carried out on OPC mixes for M40, M60, M80 grade using 20mm maximum size of aggregates to ascertain the workability and durability properties of concrete made with partial replacement of cement with Silica fume from H_2So_4, HCL immersion test the effect of acids on design concrete is same as the effect for ordinary Portland cement concrete.
- Hence in the present investigation more emphasis is given to study the OPC using silica fume so as to achieve better concrete composites and also to encourage the increased use of byproducts to maintain ecology.

2. REVIEW OF LITERATURE

He has conducted properties of concrete contains mixed colour waste recycled glass as cement replacement. In this study no significant differences were observed in compressive strength of concrete with presence of recycled glass sand(RGS) in concrete while an average reduction of 16% was occurred when 205 of Portland cement was replaced by pozzolanic glass powder(PGP). In this we studied that due to inherent smooth surface and negligible water absorption of glass particles, the presence of RGS in concrete will reduce the consistency and adhesive bond of ingredients inside concrete mix.

The smooth and plane surface of large recycled glass particles can significantly weaken the bond between cement paste and glass particles. The inherent cracks are source of weakness and can reduce the strength of concrete.

Ali Ergun[2] et al,(2011) He has studied effects of usage of diatomite and waste marble powder as partial replacement of cement on the mechanical properties of concrete. Waste marble powder is obtained by product during sawing, shaping, and polishing. Test results indicated that the concrete specimens containing 10% diatomite, 5% WPM and 5% WPM + 10% diatomite replacement by weight for cement had the best compressive and flexural strength. The replacement of cement with diatomite and WPM separately or together using super plasticizing admixture could be used to improve mechanical properties.

Ganesha Mogaveera. G.Sarangapani and Anand V.R.[3] (2011) They have studied the effect of Partial Replacement of Sand by Quarry dust in Plain Cement Concrete for different mix proportions. They have concluded that sand can be replaced effectively by means of quarry dust up to 20% to 25%

Roz-Ud-Din Nassar[4] et al,He examined the strength of recycled aggregate concrete containing milled glass as partial replacement for cement. The replacement of milled glass brings favorable changes in the structure of hydrated cement paste. This partial replacement for cement is estimated effectively overcomes the limitations of recycled aggregate through improvement in quality of remnant mortar paste attached to surface of recycled aggregate. Improvement in 56 days strength provides an indirect measure of pozzolanic activity of milled glass waste.

Roz-Ud-Din Nassar[5] et al,This paper studies the durability of recycled aggregate. concrete containing milled glass as partial replacement for cement. The use of milled waste glass, as partial replacement of cement is estimated to produce significant gains in durability of recycled aggregate concrete. Milled glass was found to suppress alkali-silica reactions. By use of milled waste glass as partial replacement of cement in recycled aggregate concrete results in enhanced durability characteristic such as sorption, chloride permeability and freeze-thaw resistance through improvement in pore system characteristics.

Mud fadhil[6] et al, This paper studied Workability and Compressive strength of ductile self compacting concrete (DSCC) with various cement replacement materials. It was studied that DSCC with various cement replacement materials was conducted. up to 20% of cement in DSCC was replaced by microwave incinerated rice husk ash(MIRHA), silica fume(SF) and fly ash(FA) in certain ratio. DSCC with replacement 10% MIHRA and 10%fly ash has higher compressive strength without scarifying the self compacting abilities.

3. EXPERIMENTAL PROGRAM

To achieve the objectives discussed earlier, experimental program is planned to study the effect of replacement of cement by nano silica on strength properties of concrete.

3.1 SCHEME OF EXPERIMENTAL PROGRAM:

The details of number of blocks to be tested while the experimentation process is given in the below table:

3.3 MATERIALS:

3.3.1 CEMENT:

Cement is a binder, a substance utilized in production that units and hardens and can bind other materials together. The maximum vital forms of cement are used as a issue inside the production of mortar in masonry, and of concrete- that is a aggregate of cement and an mixture to form a sturdy building material.

Figure 1 : Ordinary Portland cement 53 grade

The normal Portland cement of 53 grade is used in accordance with IS: 12269-1987.

Properties of this cement had been tested and listed below.

1. Fineness of cement = five%
2. Specific gravity if cement = 3.02

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3. Standard Consistency of cement = 33%

4. Initial placing time = 50mins

5. Final putting time = Not extra than 10 hours.

3.3.2 AGGREGATES:

Construction aggregate, or absolutely "aggregate", is a huge class of coarse particulate fabric used in production, including sand, gravel, beaten stone, slag, recycled concrete and geo-artificial aggregates. Aggregates are the most mined materials within the world.

COARSE AGGREGATE:

Crushed stone mixture of 20mm size is added from nearby quarry. Aggregates of length greater than 20mm size are separated by using sieving. Tests are carried which will find out the

• Specific gravity = 2.98

• Fineness modulus = 7.5

Figure 2: Coarse Aggregates

FINE AGGREGATE:

Locally available sparkling sand, unfastened from natural count number is used. The result of sieve evaluation confirms it to Zone-II (in step with IS: 383-1970).The tests are carried out and results are shown below.

• Specific gravity = 2.3

• Fineness modulus = 3.06

Figure3: Fine Aggregates

3.3.3 SILICA FUME

Silica fume, also known as microsilica, (CAS number 69012-64-2, and EINECS number 273-761-1) is an amorphous (non-crystalline) polymorph of silicon dioxide, silica. It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production and consists of spherical particles with an average particle diameter of 150 nm. The main field of application is as pozzolanic material for high performance concrete.

It is sometimes confused with fumed silica (also known as pyrogenic silica, CAS number 112945-52-5). However, the production process, particle characteristics and fields of application of fumed silica are all different from those of silica fume.

Silicon dioxide nanoparticles, also known as silica nanoparticles or nanosilica, are the basis for a great deal of biomedical research due to their stability, low toxicity and ability to be functionalized with a range of molecules and polymers.

Silica Fume

3.3.4 GGBS

Granulated Blast Furnace Slag is obtained by rapidly chilling (quenching) the molten ash from the furnace with the help of water. During this process, the slag gets fragmented and transformed into amorphous granules (glass), meeting the requirement of IS 12089:1987 (manufacturing specification for granulated slag used in Portland Slag Cement). The granulated slag is ground to desired fineness for producing GGBS.

The chemical composition of JSW's GGBS contributes to the production of superior cement. Over the period of time, its load-bearing properties continue to increase as it absorbs surplus lime released during hydration to form more calcium silicate hydrates. These hydrates add to the strength of the cement.

GGBS

3.3.5 WATER:

Generally potable water ought to be used. This is to make sure that the water is cheap unfastened from such impurities as suspended solids, organic depend and dissolved salts, which may additionally adversely affect the residences of the concrete, especially the placing, hardening, energy, sturdiness, pit fee, and many others.

3.3.6 ADMIXTURE

To acquire workability of clean Geopolymer Concrete, Sulphonated napthalene polymer based totally wonderful plasticizer Conplast SP430 in the shape of a brown liquid right away dispersible in water, Use of superplasticizer lets in the discount of water to the quantity up to 30 percentage without lowering the workability, in assessment to the feasible reduction up to fifteen percentage in case of plasticizers. The use of superplasticizer is practiced for production of flowing, self leveling, self compacting, and for production of excessive strength and high performance concrete.

Figure 6 : Conplast SP430

MIX DESIGN

W	C	FA	CA
180	450	606.86	1191.52
0.40	1	1.35	2.65

Material	Cement	Sand	12.5mm aggregates	Water
Density	450	837.45	1023.55	140
Proportions	1	1.861	2.275	0.31

4. RESULTS AND DISCUSSION

4.1 MATERIAL PROPERTIES:

4.1.1 PHYSICAL PROPERTIES OF CEMENT:

TABLE 4.1.1: Test results on the cement

Sl.no	Test	Results	IS code used	Acceptable limit
1	Specific gravity of cement	3.160	IS:2386:1963	3 to 3.2
2	Standard consistency of cement	6mm at 34% w/c	IS:4031:1996	w/c ratio 28%-35%
3	Initial and final setting time	45 mins and 10 hours	IS:4031:1988	Minimum 30mins and should not more than 10 hours
4	Fineness of cement	3.00%	IS:4031:1988	<10%

4.1.2 PHYSICAL PROPERTIES OF COARSE AGGREGATES:

Table 4.1.2: test results on coarse aggregates

Sl.no	Test	Results	Is code used	Acceptable limit
1	Fineness modulus	6.5	IS:2386:1963	6.0 to 8.0mm
2	Specific gravity	2.90	IS:2386:1963	2 to 3.1mm
3	Porosity	46.83%	IS:2386:1963	Not greater than 100%
4	Voids ratio	0.8855	IS:2386:1963	Any value
5	Bulk density	1.50g/cc	IS:2386:1963	-
6	Aggregate impact value	37.5	IS:2386:1963	Less than 45%
7	Aggregate crushing value	26.6%	IS:2386:1963	Less than 45%

4.1.3 PHYSICAL PROPERTIES OF FINE AGGREGATES:

Table 4.1.3: Test results on the fine aggregates

Sl.no	Test	Result	Is code used	Acceptable limits
1	Fineness modulus	4.305	IS:2386:1963	Not more than 3.2 mm
2	Specific gravity	2.43	IS:2386:1963	2.0 to 3.1
3	Porosity	36.6%	IS:2386:1963	Not greater than 100%
4	Voids ratio	0.577	IS:2386:1963	Any value
5	Bulk density	1.5424	IS:2386:1963	-
6	Bulking of sand	3.0%	IS:2386:1963	Less than 10%

4.2 CONCRETE TESTS

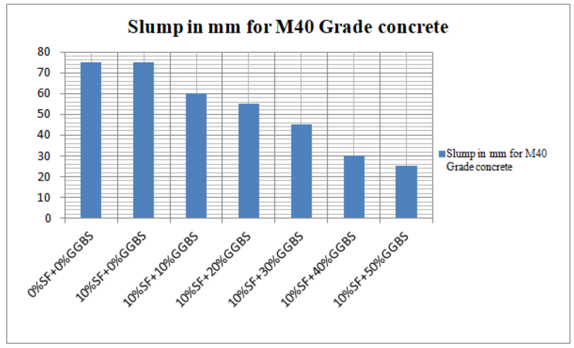
4.2.1 FRESH CONCRETE TESTS

4.2.1.1 SLUMP CONE TEST

M40 Grade concrete

Table 4.2.1.1.1 Slump cone test for M40 Grade

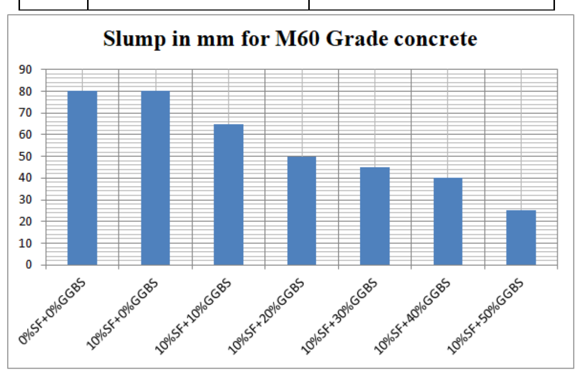
s.no	% Replacemet	Slump in mm for M40
1	0%SF+0%GGBS	75
2	10%SF+0%GGBS	75
3	10%SF+10%GGBS	60
4	10%SF+20%GGBS	55
5	10%SF+30%GGBS	45
6	10%SF+40%GGBS	30
7	10%SF+50%GGBS	25



M60 Grade of concrete

Table 5.2.1.1.2 Slump cone test for M60 Grade

s.no	% Replacemet	Slump in mm for M60
1	0%SF+0%GGBS	80
2	10%SF+0%GGBS	80
3	10%SF+10%GGBS	65
4	10%SF+20%GGBS	50
5	10%SF+30%GGBS	45
6	10%SF+40%GGBS	40
7	10%SF+50%GGBS	25

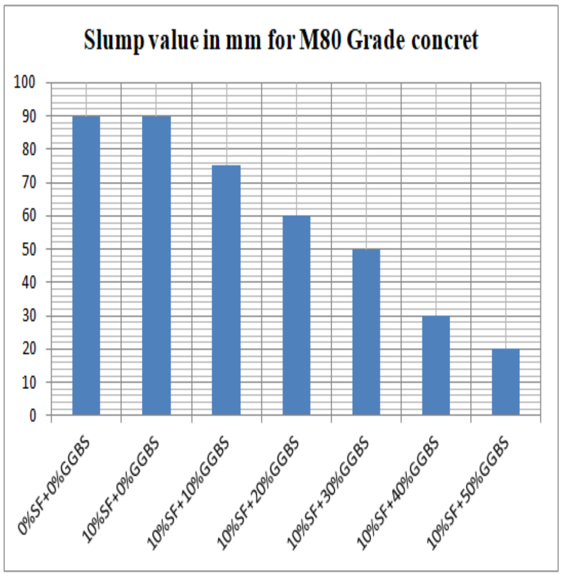


M80 Grade of concrete

Table 4.2.1.1.3 Slump cone test for M80 Grade

s.no	% Replacemet	Slump in mm for M80
1	0%SF+0%GGBS	90
2	10%SF+0%GGBS	90

3	10%SF+10%GGBS	75
4	10%SF+20%GGBS	60
5	10%SF+30%GGBS	50
6	10%SF+40%GGBS	30
7	10%SF+50%GGBS	20



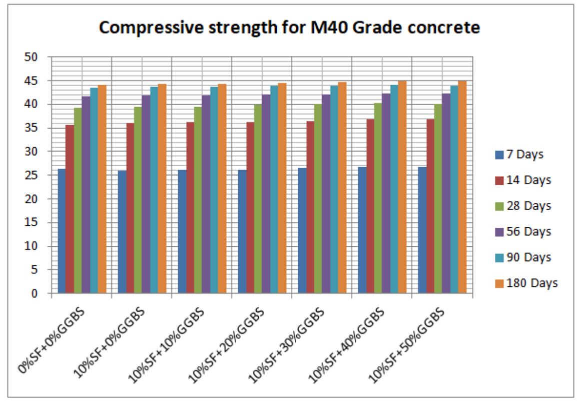
4.2.2 HARDEN CONCRETE TESTS

4.2.2.1 COMPRESSIVE STRENGTH OF CONCRETE

M40 Grade concrete

Table 4.2.2.1.1 Compressive strength for M40 Grade

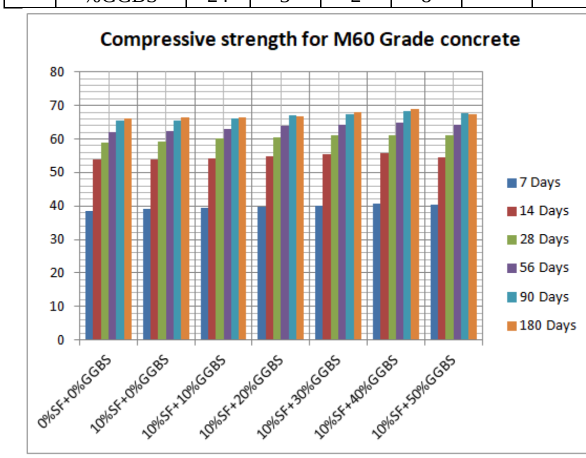
S. no	% Replacement	7 Days	14 Days	28 Days	56 Days	90 Days	180 Days
1	0%SF+0% GGBS	26.3	35.6	39.2	41.6	43.56	44.1
2	10%SF+0 %GGBS	26	36	39.4	41.8	43.64	44.24
3	10%SF+10 %GGBS	26.2	36.24	39.52	41.92	43.76	44.38
4	10%SF+20 %GGBS	26.1	36.16	39.82	42.06	43.82	44.54
5	10%SF+30 %GGBS	26.54	36.42	40.12	42.14	43.9	44.72
6	10%SF+40 %GGBS	26.86	36.9	40.22	42.32	44.06	44.92
7	10%SF+50 %GGBS	26.78	36.84	40.16	42.24	43.96	44.86



M60 GRADE OF CONCRETE

Table 4.2.2.1.2: Compressive strength for M60 Grade

S. no	% Replacement	7 Days	14 Days	28 Days	56 Days	90 Days	180 Days
1	0%SF+0% GGBS	38.6	53.8	59.04	62.1	65.4	66.12
2	10%SF+0 %GGBS	39	54	59.2	62.4	65.52	66.32
3	10%SF+10 %GGBS	39.42	54.26	60.14	63.08	66.22	66.46
4	10%SF+20 %GGBS	39.86	54.68	60.48	63.78	66.96	66.74
5	10%SF+30 %GGBS	40.16	55.32	60.96	64.26	67.47	67.88
6	10%SF+40 %GGBS	40.58	55.86	61.24	64.94	68.18	68.94
7	10%SF+50 %GGBS	40.24	54.63	61.02	64.38	67.6	67.52

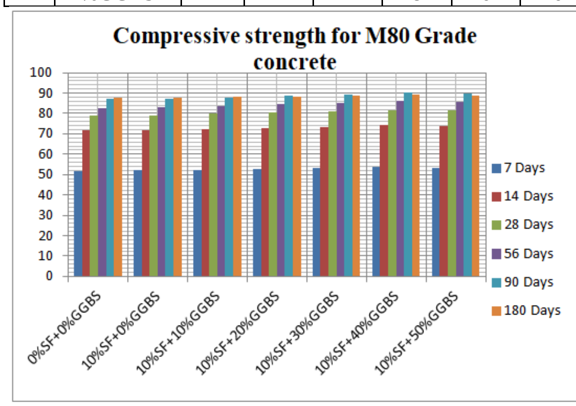


M80 GRADE OF CONCRETE

Table 4.2.2.1.3: Compressive strength for M80 Grade

S. no	% Replacement	7 Days	14 Days	28 Days	56 Days	90 Days	180 Days

1	0%SF+0% GGBS	51.6	71.8	78.8	82.8	87.2	87.8
2	10%SF+0 %GGBS	52	72	79.2	83.2	87.36	87.88
3	10%SF+10 %GGBS	52.26	72.3	80.14	83.62	87.7	88.12
4	10%SF+20 %GGBS	52.88	72.94	80.56	84.6	88.84	88.34
5	10%SF+30 %GGBS	53.2	73.46	81.04	85.12	89.38	88.62
6	10%SF+40 %GGBS	53.74	74.1	81.68	86.02	90.28	89.2
7	10%SF+50 %GGBS	53.42	73.8	81.32	85.48	89.76	88.96

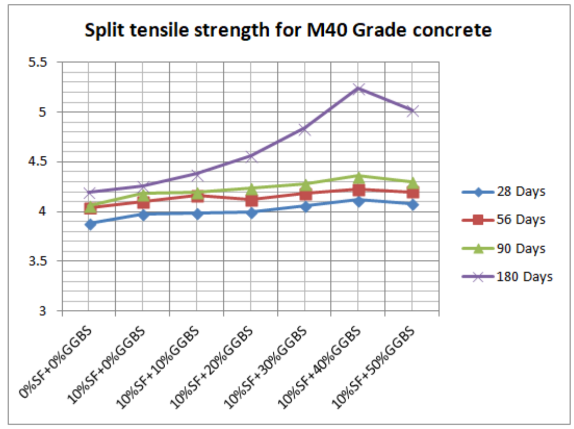


4.2.2.2 SPLIT TENSILE STRENGTH OF CONCRETE

M40 Grade concrete

Table 4.2.2.2.1 Split tensile strength for M40 Grade

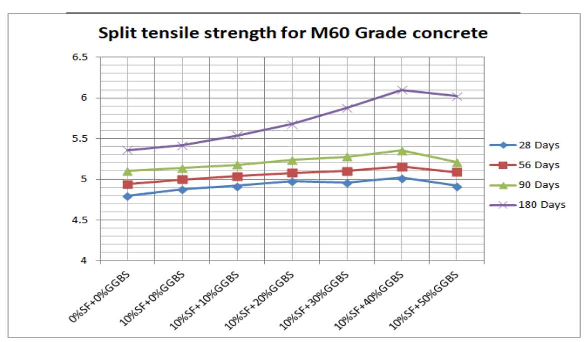
S.no	% Replacement	28 Days	56 Days	90 Days	180 Days
1	0%SF+0%GGBS	3.88	4.04	4.06	4.2
2	10%SF+0%GGBS	3.98	4.1	4.18	4.26
3	10%SF+10%GGBS	3.99	4.16	4.2	4.38
4	10%SF+20%GGBS	4	4.12	4.24	4.56
5	10%SF+30%GGBS	4.06	4.18	4.28	4.84
6	10%SF+40%GGBS	4.12	4.23	4.36	5.24
7	10%SF+50%GGBS	4.08	4.2	4.3	5.02



M60 Grade of concrete

Table 4.2.2.2.2 Split tensile strength for M60 Grade concrete

S.no	% Replacement	28 Days	56 Days	90 Days	180 Days
1	0%SF+0%GGBS	4.8	4.94	5.1	5.36
2	10%SF+0%GGBS	4.88	5	5.14	5.42
3	10%SF+10%GGBS	4.92	5.04	5.18	5.54
4	10%SF+20%GGBS	4.98	5.08	5.24	5.68
5	10%SF+30%GGBS	4.96	5.1	5.28	5.88
6	10%SF+40%GGBS	5.02	5.16	5.36	6.1
7	10%SF+50%GGBS	4.92	5.09	5.21	6.02



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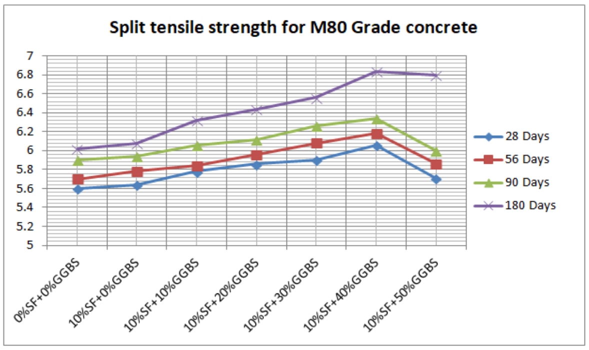
M80 Grade of concrete

Table 4.2.2.2.3 Split tensile strength for M80 Grade concrete

S.no	% Replacement	28 Days	56 Days	90 Days	180 Days
1	0%SF+0%GGBS	5.6	5.7	5.9	6.02
2	10%SF+0%GGBS	5.64	5.78	5.94	6.08
3	10%SF+10%GGBS	5.78	5.84	6.06	6.32
4	10%SF+20%GGBS	5.86	5.96	6.12	6.44
5	10%SF+30%GGBS	5.9	6.08	6.26	6.56
6	10%SF+40%GGBS	6.06	6.18	6.34	6.84
7	10%SF+50%GGBS	5.71	5.86	6	6.8



4.2.5.1 Acid Attack

M40 Grade Concrete

Table 4.2.5.1.1 Acid attack for M40 Grade

Sl.no	% replacement	Initial weight of cube after 28days curing in grams	Final weight of cubes after 90days curing in grams	% loss of weight due to acid attack	Compressive strength of cube after 28days curing	Compressive strength of cubes after 90days curing	Compressive strength of cubes after 180days curing	% loss of compressive strength for 90days curing due to acid attack	% loss of compressive strength for 180days curing due to acid attack
1	10%SF+0%GGBS	2355	2248	4.54	39.4	36.02	32.84	8.58	8.84
2	10%SF+10%GGBS	2335	2206	5.52	39.52	36.1	32.82	8.65	9.05
3	10%SF+20%GGBS	2265	2124	6.22	39.82	36.16	32.78	9.2	9.36
4	10%SF+30%GGBS	2230	2096	6	40.12	36.48	33	9.07	9.56
5	10%SF+40%GGBS	2394	2244	6.26	40.22	36.38	32.92	9.3	9.48
6	10%SF+50%GGBS	2425	2260	6.8	40.16	36.36	32.9	9.46	9.5

M60 Grade concrete

Sl.no	% replacement	Initial weight of cube after 28days curing in grams	Final weight of cubes after 90days curing in grams	% loss of weight due to acid attack	Compressive strength of cube after 28days curing	Compressive strength of cubes after 90days curing	Compressive strength of cubes after 180days curing	% loss of compressive strength for 90days curing due to acid attack	% loss of compressive strength for 180days curing due to acid attack
1	0%SF+0%GGBS	2390	2268	5.1	59.04	53.7	53.6	9.04	9.2
2	10%SF+0%GGBS	2370	2248	5.14	59.2	53.8	53.68	9.12	9.32
3	10%SF+10%GGBS	2320	2190	5.84	60.14	54.46	54.46	9.44	9.54
4	10%SF+20%GGBS	2225	2094	5.89	60.48	54.56	54.5	9.78	9.88
5	10%SF+30%GGBS	2280	2154	5.53	60.96	55.15	54.82	9.52	10.06
6	10%SF+40%GGBS	2334	2196	5.91	61.24	55.19	55.14	9.88	9.94
7	10%SF+50%GGBS	2325	2184	6.06	61.02	54.88	55.02	10.06	9.82

M80 Grade concrete

Sl.no	% replacement	Initial weight of cube after 28days curing in grams	Final weight of cubes after 90days curing in grams	% loss of weight due to acid attack	Compressive strength of cube after 28days curing	Compressive strength of cubes after 90days curing	Compressive strength of cubes after 180days curing	% loss of compressive strength for 90days curing due to acid attack	% loss of compressive strength for 180days curing due to acid attack
1	0%SF+0%GGBS	2290	2160	5.64	78.64	70.92	71.24	9.8	9.4
2	10%SF+0%GGBS	2284	2154	5.74	79.2	71.5	71.34	9.72	9.92
3	10%SF+10%GGBS	2528	2378	5.96	80.14	71.16	72.38	9.96	10.16
4	10%SF+20%GGBS	2286	2146	6.12	80.56	72.4	72.24	10.12	10.34
5	10%SF+30%GGBS	2356	2206	6.36	81.04	72.92	72.5	10.02	10.54
6	10%SF+40%GGBS	2456	2302	6.3	81.68	73.38	73.02	10.16	10.6
7	10%SF+50%GGBS	2388	2236	6.4	81.32	72.96	72.3	10.28	10.44

4.2.5.2 Alkaline attack:

M40 Grade concrete

Table 4.2.5.2.1 Alkaline attack for M40 Grade concrete

Sl. No	% replacement	Initial weight of cube after 28days curing in grams	Final weight of cubes after 90days curing in grams	% loss of weight due to alkaline attack	Compressive strength of cube after 28days curing	Compressive strength of cubes after 90days curing	Compressive strength of cubes after 180days curing	% loss of compressive strength due to alkaline attack for 90days curing	% loss of compressive strength due to alkaline attack for 180days curing
1	0%SF+0%GGBS	2280	2235	1.98	39.2	37.12	37	5.3	5.62
2	10%SF+0%GGBS	2245	2200	2	39.4	37.24	37.14	5.46	5.74
3	10%SF+10%GGBS	2365	2308	2.41	39.52	37.22	37.18	5.84	5.94
4	10%SF+20%GGBS	2458	2390	2.766	39.82	37.36	37.32	6.16	6.28
5	10%SF+30%GGBS	2468	2394	2.99	40.12	37.58	37.52	6.34	6.48
6	10%SF+40%GGBS	2538	2466	2.83	40.22	37.72	37.64	6.24	6.4
7	10%SF+50%GGBS	2680	2598	3.06	40.16	37.58	37.58	6.42	6.44

M60 Grade concrete

Table 5.2.5.2.2 Alkaline attack for M60 Grade

Sl. No	% replacement	Initial weight of cube after 28days curing in grams	Final weight of cubes after 90days curing in grams	% loss of weight due to alkaline attack	Compressive strength of cube after 28days curing	Compressive strength of cubes after 90days curing	Compressive strength of cubes after 180days curing	% loss of compressive strength due to alkaline attack for 90days curing	% loss of compressive strength due to alkaline attack for 180days curing
1	0%SF+0%GGBS	2320	2272	2.1	59.04	55.5	55.42	5.98	6.12
2	10%SF+0%GGBS	2248	2198	2.24	59.2	55.6	55.5	6.08	6.26
3	10%SF+10%GGBS	2316	2254	2.64	60.14	56.38	56.34	6.24	6.32
4	10%SF+20%GGBS	2456	2382	2.98	60.48	56.56	56.54	6.48	6.5
5	10%SF+30%GGBS	2688	2606	3.08	60.96	56.44	56.86	6.68	6.74
6	10%SF+40%GGBS	2468	2390	3.2	61.24	57.2	57.26	6.6	6.5
7	10%SF+50%GGBS	2546	2466	3.16	61.02	57.02	57.06	6.54	6.48

M80 Grade concrete

Table 4.2.5.2.3 Alkaline attack for M80 Grade

Sl. No	% replacement	Initial weight of cube after 28days curing in grams	Final weight of cubes after 90days curing in grams	% loss of weight due to alkaline attack	Compressive strength of cube after 28days curing	Compressive strength of cubes after 90days curing	Compressive strength of cubes after 180days curing	% loss of compressive strength due to alkaline attack for 90days curing	% loss of compressive strength due to alkaline attack for 180days curing
1	0%SF+0%GGBS	2340	2286	2.3	78.8	74.04	73.7	6.04	6.46
2	10%SF+0%GGBS	2364	2306	2.44	79.2	74.36	73.98	6.12	6.58
3	10%SF+10%GGBS	2584	2514	2.68	80.14	75.14	74.6	6.24	6.92
4	10%SF+20%GGBS	2684	2606	2.92	80.56	75.34	74.72	6.48	7.25
5	10%SF+30%GGBS	2568	2366	3.16	81.04	75.6	69.98	6.72	7.43
6	10%SF+40%GGBS	2444	2362	3.36	81.68	76.3	75.66	6.58	7.36
7	10%SF+50%GGBS	2458	2380	3.2	81.32	75.94	75.44	6.64	7.24

V CONCLUSION

From the above study the following conclusions were made

1. The material properties of the cement, fine aggregates and coarse aggregates are within the acceptable limits as per IS code recommendations so we will use the materials for research.
2. Slump cone value for the combination of silica fume and GGBS concrete Decreases with increasing in the percentage so the concrete is workable.
3. Compaction factor value for the combination of silica fume and GGBS concrete increases with increase in the percentage of Silica fume and GGBS.
4. The compressive strength of concrete is maximum at 10%SF+40%GGBS and is the optimum value for 7days curing, 28days curing, 56days curing, 90days curing and 180days curing.

5. Split tensile strength for the cylindrical specimens is maximum at 10%Ssf+40%GGBS 28days curing, 56days curing, 90days curing and 180 days curing.
6. The flexural strength of copper slag concrete is also maximum at at 10%Ssf+40%GGBS 28days curing, 56days curing, 90days curing and 180 days curing
7. The percentage loss of weight and percentage loss of compressive strength is increases with in increasing the percentages in all cases in durability studies in 10%SF+40%GGBS concrete. So, the concrete is durable up to 10%SF+40%GGBS.

   So the replacement of 10%SF+40%GGBS concrete is generally useful for better strength values in, M40, M60, M80 grades of concrete.

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