Strength and durability of concrrete by using sillica fume and GGBS

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ABSTRACT

The most fundamental part of cement, Portland concrete, is a flexible and rather costly substance. Concrete assembling for a huge scope is creating ecological issues and exhaustion of regular assets from one perspective, and consumption of normal assets on the other. Because of the danger to the climate, specialists have started to utilize mechanical waste as a supplemental cementation fixing in the creation of cement. With the utilization of fundamental materials like concrete, coarse totals, and fine totals, the present structure costs are at a record-breaking high. Leaving waste materials in nature, in particular, can cause environmental problems. Cement manufacturing releases a large amount of greenhouse gases into the atmosphere, which contribute to global warming. Subsequently, scientists are presently zeroing in on the utilization of waste materials with cementing properties that can be added to cement concrete as a fractional replacement for cement without undermining its solidarity or durability, bringing about a decline in cement creation and consequently a decrease in ozone depleting substance outflows, just as economical waste administration. Silica smolder and powdered granulated impact heater slag are side-effects from the iron business that, due to their characteristic cementing characteristics, can be utilized as a halfway replacement for cement in concrete. The reason for this review was to examine the workability, compressive strength, split rigidity, flexural strength, and durability of cement by subbing Silica seethe (SF) and ground granulated impact heater slag for cement (GGBS). The different replacement levels 0%SF+0%GGBS, 10%SF+0%GGBS, 10%SF+10%GGBS, 10%SF+20%GGBS, 10%SF+30%GGBS, 10%SF+40%GGBS, 10%SF+50%GGBS for M40, M60 and M80 Grade of concrete.

1.INTRODUCTION

Historically, only concrete strength was considered when designing the concrete mix, with the expectation that concrete strength would be the determining factor for all other desired concrete properties, including toughness. One of the topics discussed, considered and modified in the continuous update of the 2000 IS 456 standard is the strength of concrete elements according to the training regulations of different countries with more experience in checking the strength of concrete buildings.One of the main purposes of concrete weakening in the past was to overemphasize the compressive strength of concrete. In fact, the progress in concrete innovation is highly dependent on the strength of the concrete.

1.1 CHEMICAL PROPERTIES

Impurities such as calcium oxide (CaO) and magnesium oxide (MgO) may be found in trace amounts (MgO). C3A is the first to respond when water is introduced to cement, causing initial set. It produces a significant quantity of heat. In the first 28 days, C3S hydrates and gains strength. It also produces heat. The next to hydrate is C2S. It takes a long time to hydrate and is responsible for increased ultimate strength. C4AF is a chemical that is relatively inactive. When the solid parts of the concrete are laid, the attack of the substance that causes the weight loss, the cracking of the concrete, and then the disintegration of the concrete becomes an important study. Conventional Portland cement generally does not provide good protection against corrosion. The expansion of FA improves the miniaturized auxiliary properties of the concrete, such as porosity, permeability and absorption. Reduced porosity and penetration indicate improved synthetic attachment and erosive obstruction.The exploratory study of this corner aims to discover the compressive strength and compactness of concrete by partially replacing the cement with quarry dust

2.LITERATURE REVIEW

Basher Taha1 He made concrete objects that include built-in shading drops and glass as a substitute for concrete. In this study, no significant difference in concrete compressive strength was observed when using recycled glass sand (RGS), but there was a typical loss of 16% when 205 Portland cement was replaced with glass pozzolana (PGP). Due to the inherently smooth surface and low water absorption of glass particles, we concluded that using RGS in concrete would reduce the texture and adhesion of mortar in the concrete mix.

Ali Ergun2 estudied the effect of pumping concrete with diatomaceous earth and marble dust waste on the mechanical properties of cement. The shreds of marble dust are created when the objects are cut, shaped and cleaned. According to the test results, significant samples containing 10% kieselguhr, 5% WPM and 5% WPM + 10% kieselguhr for concrete had the most obvious compressive and flexural strengths. Diatomite and WPM can be used in place of concrete to improve the mechanical properties of , either alone or in combination with an added superplasticizer.

Ganesha Mogaver.G. Sarangapani and Anand studied the effects of partial replacement of sand with quarry dust in ordinary cement concrete for different mix percentages. They believe quarry dust can replace sand 20-25% of the time. Roz-Ud-Din Nassar4 et al., (2012) Tested the strength of whole recycled concrete containing recycled glass as an incomplete replacement for cement. Changing the treated glass leads to positive changes in the structure of the hydrated cement adhesive. It is believed that this split concrete substitute successfully overcomes the limitations of set reuse by advancing as the residue of the adhesive mortar bonded to the surface of the reused set. The strength improvement in 56 days is a round trip of pozzolana treated waste glass.

Fad Dehwah11 studied the mechanical properties of self-compacting concrete made from fumed silica, fumed silica and fly ash. SCC is a self-treating concrete with no vibration. Even in deep-seated reinforced concrete people, it fills all cracks, crevices and holes. The mechanical properties of self-consolidating concrete (SCC) consisting of fumed silica (QDP), fumed silica (SF) + QDP or simply fly ash (FA) were tested. Augustine Uche Elinwa12 et al., (2006) This article examines the use of waste wood ash as a partial replacement for cement.The pozzolanic properties of the ash obtained from sawdust were confirmed with a pozzolanic content of 75.9%. Substituting 10% SDA cement has been shown to give excellent results and promote optimal function, and Ti also noted that the SDA he uses has a mass of 73.55% Sio2 + Al2O3 + Fe2O3 and a pH had a value of 10%.At the 5%, 10%, and 15 degrees of substitution, the 28 day compressive strength of SDA/OPC concrete is approximately 93%, 78%, and 68% of the control mix, respectively. Felix F. Udoeyo13 et al., (2002)

3.EXPERIMENTAL

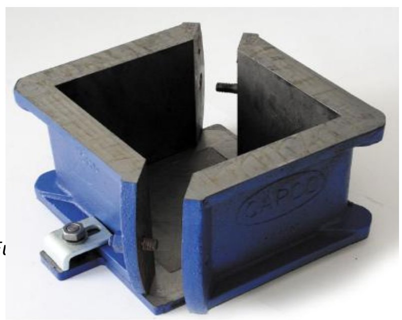
PROGRAM3.1 SCHEME OF EXPERIMENTAL PROGRAM:

The following table lists the number of blocks that will be tried during the experimental

S. No	Mix ID	Compressive strength	Split tensile strength	Flexural strength	Durability
		7, 14, 28, 56, 90 and 180 days	28, 56, 90 and 180 days	28, 56, 90 and 180 days	90 days
1	Conventional Concrete	3+3+3+3+3+3	3+3+3+3	3+3+3+3	3
2	10%SF+0%GGBS	3+3+3+3+3+3	3+3+3+3	3+3+3+3	3
3	10%SF+10%GGBS	3+3+3+3+3+3	3+3+3+3	3+3+3+3	3
4	10%SF+20%GGBS	3+3+3+3+3+3	3+3+3+3	3+3+3+3	3
5	10%SF+30%GGBS	3+3+3+3+3+3	3+3+3+3	3+3+3+3	3
6	10%SF+40%GGBS	3+3+3+3+3+3	3+3+3+3	3+3+3+3	3
7	10%SF+50%GGBS	3+3+3+3+3+3	3+3+3+3	3+3+3+3	3
Total		126 cubes	84 cylinders	84 prisms	21 cubes

process:

3.2 Mould shapes



Cube mould Cylinder mould Beam mould

Shape and Dimensions of the Blocks

Table 1: Shape and Dimensions of Blocks

Type of test	Shape of block	Length(m)	Breadth(m)	Height(m)	Diameter(m)	Volume of block (m^3)
Compressive strength	Cube	0.15	0.15	0.15	--	0.00375
Split tensile strength	Cylinder	--	--	0.30	0.15	0.00530
Flexural strength	Square prism	0.1	0.1	0.7	--	0.00700

MATERIALS USED

CEMENT

Cement is a folio, a synthetic utilized in assembling to join together and solidify parts and to bond them together. The main kinds of cement are utilized as a part in the production of mortar in brick work and cement, which is a cement total blended in with a folio to deliver a solid development material.

Ordinary Portland cement 53 grade

COARSE AGGREGATE

A 20mm crushed stone combination is added from a local quarry. Sieving is used to separate aggregates with a length larger than 20mm.


FINE AGGREGATE:

Locally available glitter sand is used which is detachable from the natural number. The result of the screening confirms this up to zone II (in phase with IS: 383-1970). Studies are ongoing and the results are presented below.

Fine Aggregates

SILICA FUME

Silica fume (CAS number 69012-64-2, Einecs number 273-761-1) is an opaque (amorphous) polymorph of silica (CAS variant 69012-64-2, Einecs variant 273-761-1). It is an ultra-fine powder of spherical particles with a regular molecular spacing of 150 nanometers, created by combining silicon and ferrosilicon compounds. The introduction strategy, particle properties and soft regions of fumed silica are generally different from those of fumed silica.

Silica Fume

GGBS

Granulated blast furnace slag is formed by rapidly quenching (quenching) liquid particles from the preheater with water. During this cycle the slag is decomposed and transformed into undefined granules (glass) that meet the requirements of IS 12089:1 . (an ingredient in Portland cement that produces granular slag) Granular slag is the basis for the introduction of GGBS.

GGBS

GGBS

WATER:

Basically, only tap water should be used. This is to ensure the water is free of toxins such as airborne particles, natural substances and particulate salts that can affect substance properties including but not limited to distribution, coagulation, energy, cavity life and cost.

ADMIXTURE

In order to maintain the workability of the neat concrete geopolymer, an excellent plasticizer based on the naphthalene sulfonated polymer Conplast SP430 was used in the form of a brown liquid which is immediately soluble in water.

Conplast SP430

BASIC TESTS ON MATERIALS

FINENESS OF CEMENT

The fineness of cement altogether impacts the tempo of hydration and, subsequently, the tempo of ascend in fortitude. The fineness of the cement builds the tempo of warming. Better cement

Fineness of cement test results.

Trial no.	1	2	3
Weight of cement in gms	100	100	100
Wt. Of residue on sieve in gms.	2.5	2.3	2.4
Amount retained (%)	2.5%	2.3%	2.4%

Fineness of cement = 2.4%

SPECIFIC GRAVITY OF CEMENT

Explicit gravity is controlled by estimating the heaviness of a cement test and its volume by estimating the fluid dislodged by the cement test. The fluid which is to be utilized ought to be with the end goal that it doesn't have any compound responses.

S. No.	Initial residing	Final reading	Volume Of cement (v)	Specific gravity G=W/V
1	0	19.75	20.32	3.15

Calculations:

Specific gravity of cement = 3.15 . NORMAL CONSISTENCY OF CEMENT

The ordinary consistency is described as the cement glue's charge of water need, with a thickness that lets in the Vicat plunger to penetrate to a most of 5 to 7mm from the Vicat form's base. When water is introduced to cement, the ensuing adhesive starts to harden and obtain quality, whilst concurrently dropping its consistency.

Fig 4. 1 : Normal consistency of cement

% of water	Initial reading	Final reading	Height not penetrated (mm)
26%	50	32	18
28%	50	20	30
30%	50	12	38
32%	50	7	43

Normal consistency of cement =32%

INITIAL SETTING TIME

The primary placement time is defined as the time it takes for the paste to dry to the point when the vicat needle cannot slip through the glue within 5mm of the structure's base.

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Fig 4. 2 : vicat apparatusInitial setting time of cement test results

Time(minutes)	10	20	30	40	50	60
Initial reading	50	50	50	50	50	50
Final reading	0	1	2	2.5	3.5	5
Height not penetrated	50	49	48	47.5	46.5	45

Initial setting time of cement = 60 minutes.

SPECIFIC GRAVITY OF COARSE AGGREGATE

The express gravity of totals is utilized in the primary calculation of cement blends in substantial development. With each fixing's specific gravity known, its weight may be converted to solid volume, and a hypothetical significant yield for each unit volume can be calculated. Specific Gravity of 20 mm coarse aggregate results

Observations	Trial-1	Trial-2
Weight of empty specific gravity bottle(gms)(W1)	460	460
Weight of bottle + aggregate(gms)(W2)	1235	1230
Weight of bottle + aggregate + water(gms)(W3)	1718	1705
Weight of bottle + water(gms)(W4)	1215	1215
Specific gravity	2.85	2.75

Specific gravity of 20mm coarse aggregate = 2.80

Specific Gravity of 12 mm of coarse aggregate

Observations	Trial-1	Trial-2
Weight of empty specific gravity bottle(gms)	460	460
Weight of bottle + aggregate(gms)	1220	1210
Weight of bottle + aggregate + water(gms)	1695	1695
Weight of bottle + water(gms)	1215	1215
Specific gravity	2.714	2.77

Specific gravity of 12mm of coarse aggregate =2.74

SPECIFIC GRAVITY OF FINE AGGREGATE

Specific gravity is characterized as the heaviness of an absolute comparative with the heaviness of an identical volume of water.

Specific gravity of Fine aggregate

Observations	Trial-1	Trail-2
Weight of empty specific gravity bottle(gms)	460	460
Weight of bottle + aggregate(gms)	1230	1230
Weight of bottle + aggregate + water(gms)	1695	1705
Weight of bottle + water(gms)	1215	1215
Specific gravity	2.65	2.75

Specific gravity of fine aggregate = 2.70

SIEVE ANALYSIS OF FINE AGGREGATE

The entirety of the all out rates held on sifters of standard sizes parceled by 100 is characterized as the fineness modulus of an aggregate. It's generally considered as a weighted standard size of sifter on which the material is kept, with sifters chose from the best (for the explanation 150 micron sifter is taken as the least).

Perceptions and estimations:

Weight of fine aggregate = 1000gm.

Sieve analysis of fine aggregate test results

S. No.	Sieve sizes Mm	Weight retained	%age weight retained	Cumulative % of weight retained(F)	%age weight passing	Cumulative %age weight passing
1	4.75	0	0	0	100	100
2	2.36	95	9.5	9.5	90.5	190.5
3	1.18	271	27.1	36.6	63.4	253.9
4	600µ	295	29.5	66.1	33.9	287.8
5	300µ	309	30.9	97	3	290.8
6	150µ	30	3.0	100	0	290.8

Fineness modulus $= \frac{309.2}{100} = 3.092$

The fineness modulus of fine aggregate = 3.09

4.4 MIX DESIGN AND SAMPLE PREPARATION

Mix Design of M40 Grade Concrete

Step 1: Choosing the Right Mix Target Strength Proportioning

$$Fck = fck + 1.65 \times S$$
$$= 40 + 1.65 \times 5.0 = 48.25 \text{ N/mm}^2$$

Assumed standard deviation

Sl. No	Grade of concrete	Assumed std deviation N/mm²
1	M10	3.5
2	M15	
3	M20	4
4	M25	
5	M30	5
6	M35	
7	M40	
8	M45	
9	M50	
10	M55	

Step 2 The water-to-cement ratio is chosen.According to IS 456, Table 5, the maximum water-cement ratio is 0.45.

Sl. No	Exposure	Plain concrete			Reinforced concrete		
		Maximum cement content kg/m³	Maximum free water cement ratio	Minimum grade of concrete	Maximum cement content kg/m³	Maximum free water cement ratio	Minimum grade of concrete
1	Mild	220	0.6	-	300	0.55	M20
2	Moderate	240	0.6	M15	300	0.50	M25
3	Severe	250	0.5	M20	320	0.45	M30
4	Very severe	260	0.45	M20	340	0.45	M35
5	Extreme	280	0.40	M25	360	0.40	M40

Step 3 Selection of Water Content The maximum amount of water in a 20 mm aggregate is 186 kg (for 25 to 50 slump)

SL. No	Normal maximum size of aggregates	Maximum water content
1	10	208
2	20	186
3	40	165

STEP 4: Concrete Mix Calculations Estimation

Sl. No	Nominal maximum size of aggregates	Volume of coarse aggregate per unit volume of total aggregate for different zones of fine aggregates			
		Zone IV	Zone III	Zone II	Zone I
1	10	0.50	0.48	0.46	0.44
2	20	0.66	0.64	0.62	0.60
3	40	0.75	0.73	0.71	0.69

STEP-5: Final trial mix

MATERIAL	**CEMENT**	**FINE AGGREGATES**	**COARSE AGGREGATES**	**WATER**
Density	438 kg/m3	717.12 kg/m3	1115 kg/m3	197 kg/m3
Proportions	1	1.63	2.54	0.45

4.EXPERIMENTAL INVESTIGATION

Workability testing of concrete (Slump cone test)

Compaction factor test

The fabric load in the chamber was not determined to the nearest tenth of a kilogram. A mound of a certain grade of compacted concrete is referred to as something. 6. The cylinder is replaced by layers of concrete from the previous model and has been broken in all its aspects to achieve full compaction

Compaction factor apparatus

Casting of cubes and cylinders

Square design and 3D chamber made of M40 concrete, full range, we design 3D molds for ordinary concrete, partial replacement of concrete

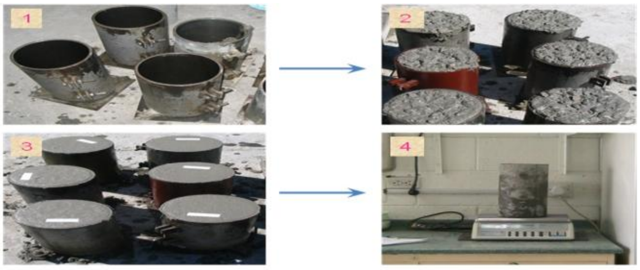
Compaction: Filling the Cube Moulds and Compacting the Concrete

Fill in the block shapes as shown in the example, at this point reduce them significantly by hand or by vibrating. Any air trapped in the material reduces the strength of the solid. The 3D squares must therefore be fully compressed. However, care must be taken not to over-compact the substance as this would completely isolate the mortar in the mix. The ultimate compressive strength can also be reduced accordingly.

Filling the mould (for 150 mm cube 3 equal layers)

Compacting with compacting bar

The 150 mm formwork must be squeezed in three starting layers (50 mm deep). A tamper bar is provided to compact the material. It consists of a 1.80 kg and 380 mm long metal rod with a 25 mm long rectangular stop. Impacts should be evenly distributed over the soil as each layer will be compacted with the ram and each layer should be compacted to its maximum depth.When compacting the first layer, the press beam must not hit the smallest part of the mold hard. For later layers,



cylindrical moulds

Curing

After a long period of 7, 28 days and 56 days, the solid samples were cured by six methods until their compressive properties were determined. The following hardening methods were used:Water Immersion Hardening (WSC): These are examples of 3D solids that are immersed in water.Spray Cure (SC): Water was sprayed onto the solid samples twice a day.

Curing of cubes and cylinders.

The compression test

To determine the quality of Portland bond concrete, two fundamental tests are conducted. Solid clearing is usually tested using flexural quality tests, whereas buildings are usually tested using compressive quality testing.The strength of the cement is measured in megapascals (MPa) and is frequently mentioned as a cement trademark characteristic measured 28 days after mixing. A solid's compressive quality is a measure of its capacity to endure stresses that would fracture it.

Compression testing machine testing sample specimen

Split tensile strength test

One of the most fundamental and fundamental features of concrete is its inflexibility. A part versatility test in a strong chamber is a technique for determining the bond's unbending nature.Because of its delicate nature, the strong is extremely feeble under stress and cannot be relied upon to oppose the immediate weight.

To analyze the tension of SFRC, barrel of size 150mmX300mm has been applied as part of this trial paintings. 30-40 chambers had been threw. The chamber molds had been demoulded following 24 hours and exchanged to curing tank for 14 days, 28 days 56 days and 90 days. After that chambers were attempted on a level plane beneath stress trying out machine (CTM)

Split tensile machine test specimen sample

Flexural strength test

Equipment & apparatus

- **Beam mould** of size 15 x 15 x 70 cm (when aggregate size is less than 38 mm) or size 10 x 10 x 50 cm (when aggregate size is less than 38 mm) (when size of aggregate is less than 19 mm)
- **Tamping bar** (40 cm length, 2 kg in weight, with a tamping portion of 25 mm x 25 mm)

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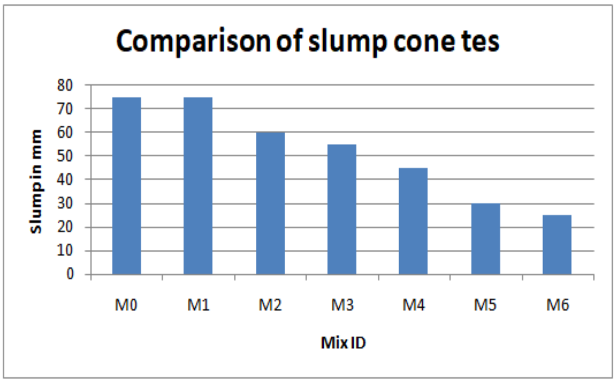
5. RESULTS

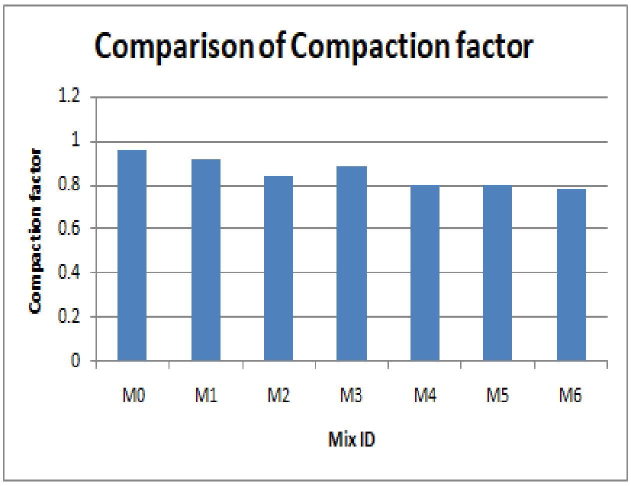
CONCRETE TESTS

S. No	% Replacement	Mix ID	Slump in mm
1	0%SF+0%GGBS	M0	75
2	10%SF+0%GGBS	M1	75
3	10%SF+10%GGBS	M2	60
4	10%SF+20%GGBS	M3	55
5	10%SF+30%GGBS	M4	45
6	10%SF+40%GGBS	M5	30
7	10%SF+50%GGBS	M6	25

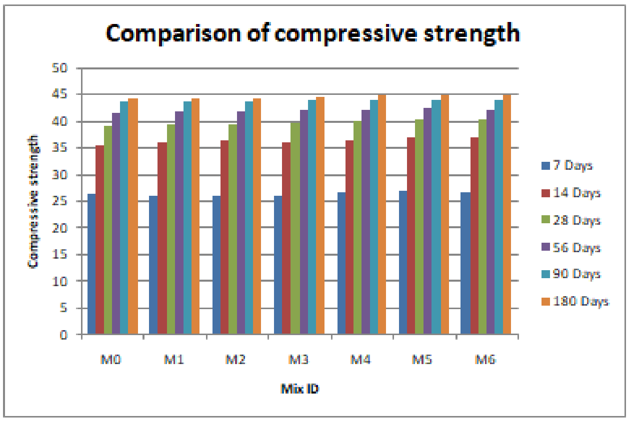


Compaction factor test

S. No	% Replacement	Mix ID	Compaction factor
1	0%SF+0%GGBS	M0	0.96
2	10%SF+0%GGBS	M1	0.92
3	10%SF+10%GGBS	M2	0.84
4	10%SF+20%GGBS	M3	0.88
5	10%SF+30%GGBS	M4	0.80
6	10%SF+40%GGBS	M5	0.80
7	10%SF+50%GGBS	M6	0.78

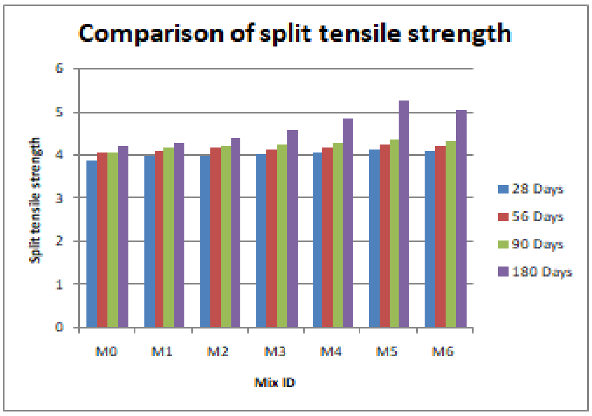


S. No	% Replacement	Mix ID	7 Days	14 Days	28 Days	56 Days	90 Days	180 Days
1	0%SF+0%GGBS	M0	26.3	35.6	39.2	41.6	43.56	44.1
2	10%SF+0%GGBS	M1	26	36	39.4	41.8	43.64	44.24
3	10%SF+10%GGBS	M2	26.2	36.24	39.52	41.92	43.76	44.38
4	10%SF+20%GGBS	M3	26.1	36.16	39.82	42.06	43.82	44.54
5	10%SF+30%GGBS	M4	26.54	36.42	40.12	42.14	43.9	44.72
6	10%SF+40%GGBS	M5	26.86	36.9	40.22	42.32	44.06	44.92
7	10%SF+50%GGBS	M6	26.78	36.84	40.16	42.24	43.96	44.86



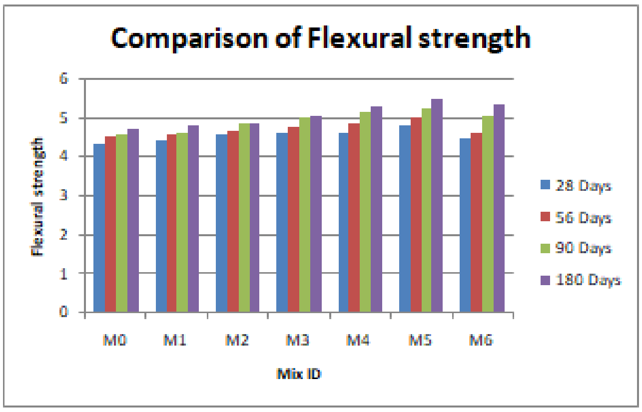
FLEXURAL STRENGTH OF CONCRETE

S. No	% replacement	Mix ID	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	Compressiv e strength of cube after 28days curing	Compressiv e strength of cubes after 90days curing	% loss of compressiv e strength for 90days curing due to acid attack
1	0%SF+0%GGBS	M0	2420	2280	5.78	39.2	36.34	7.3
2	10%SF+0%GGBS	M1	2355	2248	4.54	39.4	36.02	8.58
3	10%SF+10%GGBS	M2	2335	2206	5.52	39.52	36.1	8.65
4	10%SF+20%GGBS	M3	2265	2124	6.22	39.82	36.16	9.2
5	10%SF+30%GGBS	M4	2230	2096	6	40.12	36.48	9.07
6	10%SF+40%GGBS	M5	2394	2244	6.26	40.22	36.38	9.3
	10%SF+50%GGBS	M6	2425	2260	6.8	40.16	36.36	9.46



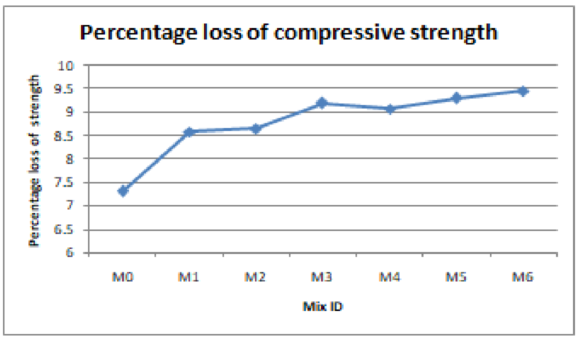
Flexural Strength

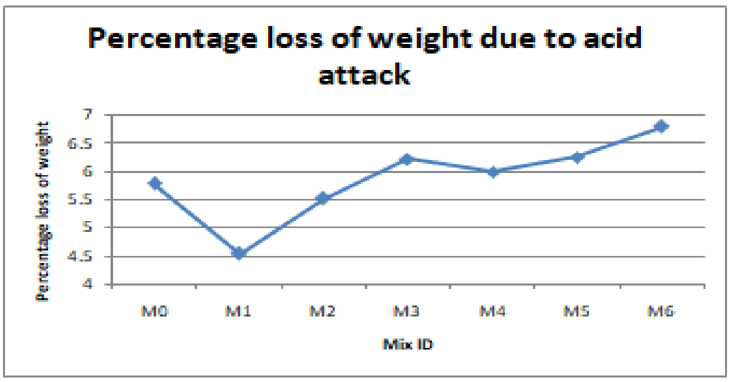
S. No	% Replacement	Mix ID	28 Days	56 Days	90 Days	180 Days
1	0%SF+0%GGBS	M0	4.3	4.5	4.56	4.7
2	10%SF+0%GGBS	M1	4.4	4.54	4.62	4.78
3	10%SF+10%GGBS	M2	4.54	4.66	4.82	4.84
4	10%SF+20%GGBS	M3	4.58	4.72	4.98	5.04
5	10%SF+30%GGBS	M4	4.62	4.84	5.12	5.28
6	10%SF+40%GGBS	M5	4.78	4.96	5.24	5.48
7	10%SF+50%GGBS	M6	4.44	4.6	5.02	5.34



DURABILITY OF CONCRETE

Acid Attack

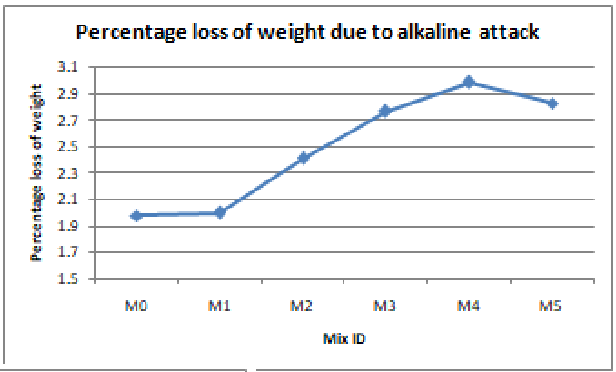


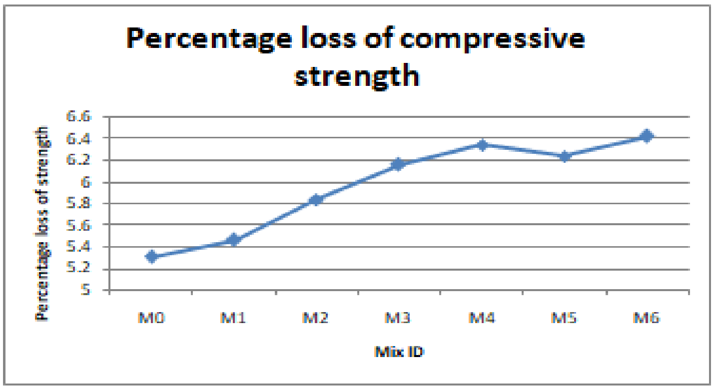


Alkaline attack:

M40 Grade concrete

Alkaline attack 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	% loss of compressive strength due to alkaline attack for 90days curing
1	0%SF+0%GGBS	2280	2235	1.98	39.2	37.12	5.3
2	10%SF+0%GGBS	2245	2200	2	39.4	37.24	5.46
3	10%SF+10%GGBS	2365	2308	2.41	39.52	37.22	5.84
4	10%SF+20%GGBS	2458	2390	2.766	39.82	37.36	6.16
5	10%SF+30%GGBS	2468	2394	2.99	40.12	37.58	6.34
6	10%SF+40%GGBS	2538	2466	2.83	40.22	37.72	6.24
7	10%SF+50%GGBS	2680	2598	3.06	40.16	37.58	6.42





6.CONCLUSIONS

1. Fall cone value for a combination of fumed silica and GGBS concrete As the range increases, the material becomes more functional.
2. The value of the compaction coefficient of silica fume and GGBS of concrete changes as the range of silica fume and GGBS increases.
3. The most remarkable concrete compressive strength is 10% SF + 40% GGBS, which is the best incentive for 7 days discharging, 28 days accumulation, 56 days accumulation, 90 days discharging and 180 days. - Day of dismissal.
4. 4th round and hollow models have a maximum part stiffness of 10% SF + 40% GGBS. The recovery times are 28 days, 56 days, 90 days and 180 days.
5. The flexural strength of copper slag concrete is also maximum at 10% SF + 40% GBS 28 days curing, 56 days curing, 90 days curing and 180 days curing.
6. Mass deficiency rate and increase rate of compressive strength loss with elongation resistance indicators are in concrete 10% SF + 40% GGBS focused. In this sense the substance is solid at 10% SF + 40% GGBS

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