

## REPLACEMENT OF COARSE AND FINE AGGREGATE WITH SILICO MANGANESE SLAG IN CONCRETE: AN EXPERIMENTAL STUDY

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### ABSTRACT

In recent years, climate change and the deterioration of the environment have risen to the status of the single most important concern. Due to globalisation, there is an ever-increasing shortage of raw resources that are necessary for the building industry. The most difficult task for scientists and engineers is to devise methods to extend the useful life of waste materials while simultaneously avoiding the depletion of natural resources. Slag is the most important waste product generated by industry.

The purpose of this work is to conduct an experiment to investigate the impact that using silicomanganese slag in lieu of coarse aggregate and fine aggregate would have on the characteristics of concrete. During the course of this research, the M30 grade of concrete served as the basis for the mix design under consideration. In this investigation, natural fine aggregate and coarse aggregate were both subjected to silica-manganese slag replacement at percentages of 0%, 5%, 10%, and 15% respectively.

### 1. INTRODUCTION:

#### 1.1. Introduction to concrete:

Concrete is widely used structural material consisting essentially of binder and material filler. It's unique distinction of being only construction material actually manufactured on the site, whereas the other materials are merely shaped to use at worksite. Good or bad concrete is made from some discrete materials like grains of sand, gravel or pieces of gravel and therefore the innumerable fine particles of cement powder mixed with water.

Concrete is composite material composed mainly of water, aggregate and cement. Often, additives and reinforcements are included with in the mixture to attained the required physical properties of the finished material. When these ingredients are mixed together, they form a fluid mass that's easily moulded into shape. Overtime, the cement forms a tough matrix which binds the remainder of the ingredients together into a durable stone like material with many uses.

The rapid rate of growth in population in

India as forced the development industry to use the building materials at rapid rate and leading to depletion of natural resources and also has the severe impact on the environment causing many hazards either directly or indirectly like depletion of river due to sand mining being done at alarming rate etc. On the other hand industrialization, ascent of industries in India gave birth to numerous kinds of waste matter.

Fortunately, a waste stuff are often added to concrete to significantly improve its environment al characteristics. The best challenge before the development industry is of two folds. One is to serve the infrastructural requirements of growing population.

#### 1.2. Introduction to Silico Manganese slag:

Basic slag is co-product of steel making and commonly produced either through the furnace or oxygen converter route or the electrical arc furnace route.

Steel making slag may be a product resulting from the economic process distributed to supply first Fe and second steel silicomanganese slag is generated in the steel making processes resulting from the transformation of Fe to liquid steel.

The towns in Austria where the method was invented. The generation of silico manganese slag in Indian steel plants is about 20 kg/ton of hot metal produced. Out of this only 25% is being reutilized in India whereas 70% in other countries.

In other words, current total productions of Silico manganese slag in India is about 12 million tonnes every year which is a way behind the developed countries.

Slag production data for the planet is unavailable, but it's estimated that global steel slag output in 2016 was about 160 to 240 million tonnes. Amount of slag produced in A.P is about 1.44 million tonnes/annum. Steel slag could be a by-product obtained either from conversion of iron in an exceeding Basic oxygen furnace (BOF) or by the melting of scrap to create steel with in the Electric arc furnace (EAF).

Bangladesh has very limited availability of natural stones. Because of this reason, brick aggregate is that the main building material for the countries construction industry. But brick

industries are related with to plenty of negative environmental impacts. Therefore, it's necessary to find out possible alternative resources which will be used as coarse aggregate in construction works. An in depth study on the recycling of demolished brick concrete as coarse aggregate was meted out for the sustainable use of construction materials in Bangladesh. Investigations on other possible alternatives, like steel slag could also be conducted.

The demand of steel in Bangladesh is estimated at about 3 million metric ton with 2.5% growth annually. During production of steel, a large portion of by-product is produced and these are classified as furnace steel slag(produced during melting of scrap and sponge iron and it becomes in lumped form after cooling during a slag pot, it's rich in silicon oxide, iron oxide and manganese oxide), process slag (produced in ladle refining furnace where CaO and other necessary production) is produced and these are classified as furnace steel slag(produced during melting of scrap and sponge iron and it becomes in lumped form after cooling in a very slag pot, it's rich in silicon oxide, iron oxide and manganese oxide),process slag, it is produced in finer form and rich in calcium oxide, silicon oxide, magnesium oxide and iron oxide) and flue dust. Ground granulated furnace slag(GGBFS) will be used as a mineral admixture in cement. Also furnace slag are often used as coarse aggregate for creating concrete also as aggregate in asphalt paving roads. Flue dust may be employed in many industrial products because the source of carbon and zinc and also in fertilizer production. The utilization of slag as aggregate will reduce the necessity for virgin aggregate, energy required and pollutant emissions during mining, processing, and transportation of materials. Investigations on the use of furnace slag as coarse aggregate in concrete are conducted by many researchers as partial replacement or full replacement of stone coarse aggregate by slag aggregate. No investigation on utilization of this material as coarse aggregate in concrete has been applied yet in Bangladesh as a replacement of brick coarse aggregate. Therefore, this study has been planned to search out the suitability of utilization of the slag aggregates in concrete. Partial replacement of brick aggregate wasn't conducted during this study. Also, studies on utilization of processed slag as fine aggregate in concrete and flue dust for creating controlled low strength materials are conducted later.

### 1.3. PHYSICAL PROPERTIES

Property	Value
Specific gravity	3.4
Fineness modulus	3.1
Water absorption	0.65%
Crushing value	29%
Impact value	17.3%
Bulk density	1999 kg/cum
Volume voids	0.245%
Abrasion test	28%

### 1.4. CHEMICAL COMPOSITION OF MANGANESE SLAG

Constituents	Composition
Aluminum oxide	1-4
Calcium oxide	40-57
Magnesium oxide	10-14
Manganese oxide	5-10
Silica	20-35

#### 1.4.1. ADVANTAGES OF SILICO MANGANESE SLAG :

##### Greater hardness:

Slag incorporates a greater resistance to wear. This can be a results of its mineral composition. The results are less wear, longer road lifetimes. Roads constructed using silico manganese slag demonstrates reduced rutting (potholes).

##### Better adhesion:

Silico manganese slag has micro pores and thus, it retains its own adhesiveness wear. In contrast, natural rock becomes smooth with wear its surface becomes polished and slippery. As a result, tyres can grip better on surfaces constructed using silico manganese slag and this is often particularly important highways and in curves.

##### Wear resistance:

- Silico manganese slag is hard and internally

bound. Natural gravel doesn't have some stability and load bearing capacity. As slag is difficult and more compact than natural rock. Roads lasts longer .As there's less wear, particulate pollution is reduced.

- but this, slag is effectively employed in preparation of Asphalt. USES OF MANGANESE SLAG
- Manganese is comparable to iron in its chemical and physical properties, but it's harder and more brittle. It's present in several significant deposits, and most major ores include manganese dioxide within the form of romanechite, pyrolisite and wad. Among these, manganese dioxide is the most vital compound.
- Manganese is acquired either through the electrolysis of manganese sulphate, or by reducing the oxide with aluminium, magnesium or sodium. Over 95% of the manganese created is used with in the type of ferromanganese and silico manganese alloys for the assembly of steel and iron.

#### 1.4.2. DISADVANTAGES OF SILICO MANGANESE SLAG

- The major disadvantage of manganese slag is its greater weight compared to natural rock, this has an impression on logistics and transport costs.
- It's a hazardous waste which could be a greater threat to mankind and animal life.
- The disposal of manganese slag ends up in pollution of soil.
- Concrete prepared from manganese slag emits about 7% of total carbon dioxide into the atmosphere.

#### 1.4.3. ENVIRONMENTAL ASPECT

- 1 No substantial leaching of the slag metal content to underground or surface water representing little or no concern regarding potable water quality.
- 2 Slag has no impact on animals or other forms of life in the areas of use or areas nearby. There is no bioaccumulation of metals present in the slag in the soil.
- 3 Slag used in cement manufacturing has partially replaced the use of clinker reducing energy consumption and , therefore Co2 emissions.
- 4 Environmental impacts caused by mineral extraction can be eliminated with the use of slag

#### 1.4.4. OBJECTIVES:

- To check the workability of concrete with partial replacement of manganese slag as fine aggregate and coarse aggregate.
- To review the compressive strength of concrete with partial replacement of coarse and fine aggregate with manganese metal slag and its powder.
- To review the flexural strength of concrete with partial replacement of coarse and fine aggregate with manganese slag.
- To get the optimum percentage of manganese slag and granular slag to induce desired workability.
- To check results of non-conventional concrete to the traditional concrete

## II.METHODOLOGY

### 2.1.MATERIAL SURVEY

#### 2.1.1.Cement

Cement may be a binder, a substance that sets and hardens and might bind other materials together. The word "cement" traces to the Romans, who used the term opus caementicium to explain masonry resembling modern concrete that was made of crushed rock with calx as binder. The volcanic ash and pulverized brick supplements that were added to the calcined lime, to get a hydraulic binder, were later sited as cement.



FIG-2.1. CEMENT

**Ordinary Portland cement (OPC):** It's manufactured within the form of different grades, the foremost common in India being Grade-53, Grade-43, and Grade-33. OPC is manufactured.

**Ordinary Portland Cement-Grade 43:-** Having been certified with IS 8112:1989 standards, Grade 43 is in

**Ordinary Portland cement-Grade 53:-** Having been certified with IS 12269:1987 standards, Grade 53 is understood for its rich quality and is extremely durable. Expert opinions from technicians and engineers are a requirement during this regard.

**Basic composition**

Contents	Percentage
Cao	60-67
Sio2	17-25
Al2o3	3-8
Fe2o3	0.5-0.6
7Mgo	0.5-4.0
Alkalis	0.3-1.2
So3	2.0-3.5

**2.1.2. COMPOSITION OF OPC****Testing of cement**

Testing of cement is brought under two categories.

- 1) Field tests
- 2) Laboratory tests

**1) Field testing:-**

It's sufficient to subject the cement to field tests when it's used for minor works. The following are the fieldtests:

- a) Open the bag and take an honest have a look at the cement. There mustn't be any visible lumps. The color of cement should normally be greenish grey.
- b) Thrust your hand into the cement bag. It should provide you with a cool felling. There shouldn't be any lump inside.
- c) Take a couple of cement and feel between the fingers. It should provides a smooth and not a gritty feeling.
- d) Take a handful of cement and throw it on a bucket filled with water, the particles should float for a few time before they sink.
- e) Take about 100 grams of cement and a tiny low quantity of water and make a stiff paste. From the stiff paste, pat a cake with sharp edges. Put it on a glass plate and slowly take it under water during a bucket. See that the form of the cake isn't disturbed while taking it all the way down to the underside of the bucket. After 24 hours the cake should retain its original shape and at the identical time it should also set and attain some strength.

If a sample of cement satisfies the above field tests it's going to be concluded that the cement

isn't bad. The above tests don't really indicate that the cement is absolutely good for important works.

**2) Laboratory tests**

For using cement in important and major works it's obligatory the a part of the user to check the cement within the laboratory to verify the necessities of the Indian standard specifications with reference to its physical and chemical properties.

**Given below are the laboratory tests of cement.**

1. Standard consistency of cement.
2. Compressive strength of cement.
3. Setting times of cement.
4. Relative density of cement.
5. Fineness of cement.

**2.2. AGGREGATES****2.2.1. Introduction of aggregates**

Totals are characterized as latent, granular, and inorganic materials that ordinarily contains stone or stone- like solids. Totals are regularly utilized alone (in street bases and different kinds of fill) or will be utilized with solidifying materials, (for example, Portland concrete or black-top concrete) to make composite materials or cement. The chief well known utilization of totals structure concrete cement. Around three- fourths of the measure of Portland concrete cement is involved by total. It's unavoidable that a constituent involving a particularly larger than usual level of the mass ought to have a vital impact on the properties of both the new and solidified items.

**2.2.2. Classification of aggregate**

Aggregates will be divided into several categories according to different criteria. In accordance with size

**Coarse aggregate-**Aggregates retained on the 4.75 mm sieve. For mass concrete, the most size are often as large as 150 mm. Fine aggregate (sand) Aggregates passing 4.75 mm sieve and predominately retained on the 75 um sieve. In accordance with sources

**Natural aggregates-** This sort of aggregate is taken from natural deposits without changing their nature during the method of production like crushing. Some examples are sand, crushed limestone and gravel.

**Manufactured aggregates-** This can be a form of artificial materials produced as a main product or an industrial by-product. Some examples are furnace slag, lightweight

aggregate and heavy weight aggregates (e.g. ore or crushed steel).

In accordance with unit weight

**Light weight aggregate-** The unit weight of aggregate is a smaller amount than 1120 kg/m<sup>3</sup>. The corresponding concrete features a bulk density less than 1800.

**Normal weight aggregate-** The aggregate mixture has unit weight of 1520-1680 kg/m<sup>3</sup>. The concrete made with this kind of aggregate features a bulk d 2300-2400 kg/m<sup>3</sup>.

**Heavy weight aggregate-** The unit weight is larger than 2100 kg/m<sup>3</sup>. The major density of the corresponding concrete is larger than 3200 kg/m<sup>3</sup>. A typical example is magnetite, limonite, a heavy iron ore. Heavy weight concrete is employed in special structures like radiation shields.

### 2.2.3. Coarse Aggregate

Aggregate that's retained on 4.75 mm sieve after passing through 80mm sieve are referred to as coarse aggregates. It's going to be crushed gravels or hard stones uncrushed gravels or stone. These aggregates commonly obtained from stream deposits, glacial deposits and alluvial fans.

They derive many of the properties from their parent rocks like chemical and mineral composition, petrographic classification, relative density, hardness strength, physical and chemical stability, pore structure, colour, etc Other properties of those aggregates which don't seems to be derived from the parent rocks are particle size, shape, surface texture and absorption. of these properties may have considerable effect on the standard of concrete in fresh as well as in hardened state.



**FIG- 2.1. COARSE AGGREGATE**

#### Tests on coarse aggregate

The subsequent are the tests conducted on coarse aggregate.

1. Sieve analysis of coarse aggregate.
2. Specific gravity and water absorption of coarse aggregate.
3. Bulk density of coarse aggregate.

4. Aggregate crushing value.
5. Aggregate impact value.
6. Aggregate abrasion value.

### 2.2.4. Fine Aggregate :

Fine aggregate are often defined because the aggregate which pass through 4.75mm sieve and retained on 75 micron sieve.

Fine aggregate from rivers or may be obtained from crushing stone (Manufactured sand). Fine aggregate can even be divided supported their particle size.

- 2.2.4.1. Coarse sand
- 2.2.4.2. Medium sand
- 2.2.4.3. Fine sand



**FIG- 2.2. FINE AGGREGATE**

#### Tests on fine aggregate

The following are the tests conducted on fine aggregate

1. Sieve analysis of fine aggregate.
2. Specific gravity and water absorption of fine aggregate.
3. Bulk density of fine aggregate.

### 2.3. SilicoMangansese slag:

Basic slag is co product of steel making and is usually produced either through the blast furnace or oxygen converter route or the electrical arc furnace route.

The qualitative and quantitative elemental analysis of the underside ash and weld slag was recognised by the energy dispersive x-ray analysis and morphology was studied by scanning microscope. The compressive strength of concrete with replacement of manganese slag metal and its powder as coarse aggregate and fine aggregate to the commercial waste shows concrete and hence industrial waste may be used as aggregate in concrete.

Steel making slag could be a product resulting from the commercial process disburbed to supply first pig iron and second steel silico manganese slag is generated with in the steel making processes resulting from the transformation of pig iron to liquid steel.

The towns in Austria where the method was invented. The generation of silico manganese slag in Indian steelplants is about 20 kg/ton of hot metal produced. Out of this only 25% is being reutilised in India whereas 70% in other countries.



FIG .2.3. – SILICO MANGENESE



FIG-2.4. SILICO MANGENESE SLAG

**2.4. Water concrete work should have following properties.**

1. It should be free from injurious amount of soils.
2. It should be free from injurious amount of acids, alkalis or other organic or inorganic impurities.
3. It should be free from iron, substance or any other style of substances, which are likely to own adverse effect on concrete or reinforcement.
4. It should be suitable for drinking purposes.

**The function of water in concrete**

1. It acts as lubricant.

2. It reacts chemically with cement to create the binding paste for coarse aggregate and reinforcement.
3. It enables the concrete mix to flow into formwork.

**2.4.1. PROPERTIES OF WATER**

Water is a vital ingredient of concrete because it actively participates within the chemical reactions with cement. The strength concrete comes mainly from the binding action of the hydration of cement get the need of water should be reduced to the desired reaction of un-hydrated cement because the excess water would find yourself in barely formation undesirable voids with in the hardened cement paste in concrete.

**2.5. Chemical admixtures**

**2.5.1. Plasticizers**

Plasticizers increase the workability of plastic or "fresh" concrete, allowing or not it's placed more easily, with less compaction effort. Plasticizers will be accustomed to reduce the water content of a concrete while maintaining workability and are sometimes called water reducers because of this use. Such treatment improves its strength and sturdiness characteristics. Super plasticizers (of so called highrange water-reducers) are a category of plasticizers that have fewer deleterious effects and might be accustomed increase workability over is practical with traditional plasticizers.



FIG 2.5.-SUPER PLASTICIZER

Water-lesening admixtures ordinarily diminish the ideal water content for a substantial blend by around 5 to 10 percent. Subsequently, concrete containing a water-decreasing admixture needs less water to accomplish anecessary droop than untreated cement. The treated cement can have a lower water-concrete proportion. This generally demonstrates that a superior strength substantial will be delivered without intersection the measure of concrete. Ongoing headways in

admixture innovation have prompted the occasion of mid-range water reducers. These admixtures decrease water content by at least 8% and tend to be more steady on a wider range of temperatures. Mid-range water reducers provide more consistent setting times than standard water reducers.

Super plasticizers likewise alluded to as plasticizers or high-range water reducers (HRWR), lessen water content by 12 to 30 and might be added to concrete with low-to-ordinary droop and water-concrete proportion to frame high droop streaming cement. Streaming cement could be a profoundly liquid however functional substantial which will be set with next to zero vibration of compaction. The impact of super plasticizers endures simply 30 to an hour, contingent upon the brand and measurements rate and is trailed by a quick misfortune in usefulness. As a consequences of the droop misfortune super plasticizers are normally added to concrete at the place of work percent.

**1. ECMAS HP 890** is state of the art Super plasticizers supported specially selected and modified Poly carboxylic ethers, to supply Exceptional performance.

**2. ECMAS HP 990** provides good water reduction in addition to good workability, retention allowing production and placing of prime quality concrete with none problems of set time retardations.

**3. ECMAS HP 990** is employed generally at a dosage of range 0.3% to 1.5% by weight of cement.

**4. ECMAS HP 990** is usually to be added on to wet mix and mixed for 2-3 minutes to urge proper dispersion and optimum performance.

**2.6. Mixing of Concrete:**

Thorough mixing of the materials is crucial for the assembly of uniform concrete. The blending should make sure that the mass becomes homogeneous, uniform in colour and consistency. There are two methods adopted for mixing concrete



**FIG-2.6. MIXING OF CONCRETE**

**1. Hand mixing**

**2. Machine mixing**

In the present investigation machine mixing was employed. With in the case of silico manganese slag. Silico manganese slag was mined rather than coarse and fine aggregates.

**2.7 Tests on Materials**

**CEMENT**

**2.7.1. Physical properties of Portland cement**

Properties	Test results
Normal consistency	30%
Specific gravity	3.08
Setting time Initial setting time/Final setting time	32 minutes
Fineness of cement	4.44%
Bulk density	1.44 m/cc

**FINE AGGREGATE**

**2.7.2. Physical properties of fine aggregate**

Properties	Test results
Fineness modulus	2.89
Specific gravity	2.6
Bulk density	1.7

**COARSE AGGREGATE**

**2.7.3. Physical properties of coarse aggregate**

Properties	Test results
Fineness modulus	7.57
Specific gravity	2.6
Bulk density	1.52

**2.7.4. MIX DESIGN(As per IS 10262:2009)**

Property	Value
Grade description	M30
Type of cement	OPC 53
Workability Exposure	0.9
Exposure	Moderate
Specific gravity of F.A	2.63
Specific gravity of C.A	2.81
W/c	0.55
Minimum cement Content	290 kg/cum
Standard deviation	Very good

**MIX PROPORTIONS (Normal concrete)**

Mix proportions of M30 grade concrete as per IS 10262-2009 per 1cu.m

w/c ratio	Cement	FA	CA	Water
0.45	1	1.67	2.44	1.67
0.45	370.51	734.77	1073.02	197.16

**2.7.5. Batching proportions for M30 grade concrete**

**2.7.6. Batching proportions for M30 grade concrete for 9**

**cubes (10\*10\*10) cm and 9 beams(10\*10\*50) cm.**

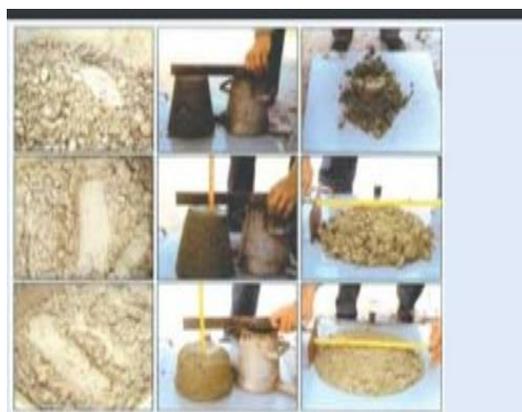
Sl. No	% of Si.M n slag	Cement (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	Water (l)	Si.M n Meta l slag	Si.Mn. Granula r slag
1	0%	370.51	734.77	1073.02	197.16	-	-
2	5%	370.51	698.03	1012.369	197.16	36.74	60.651
3	10%	370.51	661.293	965.718	197.16	73.477	107.302
4	15%	370.51	624.554	912.067	197.16	110.216	160.953
5	20%	370.51	587.816	858.416	197.16	146.954	214.604

**2.8. WORKABILITY:**

It is defined because the property of concrete which determines the quantity of useful internal work necessary to provide full compaction. Another definition which envelops a wider meaning is that, it's defined because the ease with which concrete may be compacted 100% having regard to mode of compaction and place of deposition.

**2.9. SLUMP TEST:**

More specifically, it measures the consistency of the concrete therein specific batch. This test is performed to test the consistency of freshly made concrete. Consistency may be a term closely associated with workability. It's a term which describes the state of fresh concrete. It refers to the benefit with which the concrete flows. It's accustomed to indicate the degree of wetness. Workability of concrete is principally laid low with consistency i.e. wetter mixes are more workable than drier mixes but concrete of the identical consistency may vary in workability. It's also accustomed to determine consistency between individual batches.



**FIG 2.7.– DEGREE OF WORKABILITY**

The test is popular because of simplicity of apparatus used and easy procedure. In India this test is conducted as per IS specification.

**PRINCIPLE:**

The slump test result's a slump of the behaviour of a compacted inverted cone of concrete under the action of gravity. It measures the consistency or the wetness of the concrete.

**APPARATUS**

1. Weight and weighing device
2. Tools and containers for mixing or concrete mixer.
3. Tamper (16 mm in diameter and 600 mm in length)
4. Ruler
5. Slump cone which has the form of the frustum of a cone with the following dimensions:
  - a) Base diameter-20 cm
  - b) Top diameter-10 cm
  - c) Height -30 cm
  - d) Materials thickness a minimum of 1.6 mm.

**Procedure:**

1. Prepare a clean, wide, flat mixing pan.
2. Place the dampened slump cone on one side of the pan. It shall be held firmly in situ during filling by the operator standing on the two foot pieces.
3. Place the newly mixed concrete in three layers, each approximately one third the quantity of the mould.
4. In placing each scoopful of concrete, move the news around the top fringe of the mould because the concrete slides from it, so as to confirm symmetrical distribution of concrete within the mould.
5. Rod each layer with 25 strokes of the tamper, distribute the strokes in a very uniform manner over the cross-section of the mould, each stroke just penetrating into the underlying layer.
6. For the underside layer this will necessitates inclining the rod slightly and making approximately half of the strokes spirally toward the centre.
7. In filling and rodding the highest layer, heap the concrete above the mould before rodding is started.
8. After rodding the highest layer, take away the surface of the concrete with a trowel, leaving the mould exactly filled.
9. While filling and rodding make sure that the mould is firmly fixed by feet and can't move.
10. Clean the surface of the bottom outside the cone of any excess concrete. Then

immediately removes the mould from the concrete by raising it slowly in an exceedingly vertical direction.

11. Measure the slump immediately by determining the difference between the peak of the mould and also the height of the vertical axis of the specimen.

12. Clean the mould and therefore the container thoroughly immediately after using.

13. If the pile topples sideways, it indicates that the materials haven't been uniformly distributed within the mould and also the test should be remade.

**INTERPRETATION OF RESULTS:**

The slumped concrete takes various shapes, and in step with the profile of slumped concrete, the slump is termed as true slump, shear slump or collapse slump.

After the slump is achieved, a fresh sample should be taken and also the test is repeated. A collapse slump is a sign of too wet a mixture. Only a true slump is of any use within the test. A collapse slump will generally mean that the combination is just too wet or that it's a high workability mix, that slump test isn't appropriate.

Very dry mixes; having slump 10-40 mm are used for foundations with light reinforcement. Medium workability mixes 50-90 for normal reinforced concrete placed with vibration.

High workability concrete >100 mm. Result: The slump value is 5 cm

The obtained slump is true slump.



**FIG 2.8.SLUMP TEST**

**2.10. Compacting Factor Test**

**Aim:** To workout the workability of concrete.

**Specification**

1. Compaction factor apparatus.
2. Tray.
3. Balance.
4. Tampering rod.

### 5. Weights.

#### Procedure

The apparatus consists of two hopper vessels and with hinged bottoms and a cylinder of internal diameter 15cm and height 30cm. With fastenings in spite of appearance to forestall it from moving.

The fresh concrete is filled into vessel A. The hinged door is let receptive make the concrete fall into vessel B.

Next, the hinged door of vessel B is opened to let the concrete fall into cylinder. After striking level at the highest of the cylinder is weighed W1.

The cylinder is emptied and therefore the fresh concrete filled within the cylinder in layers compacting each layer 25 times with compacting rod. After levelling the highest, the weight of the compacted concrete is found W2.

compacting factor is  $W1/W2$



**FIG. 2 . 9 . - COMPACTION FACTOR PROCEDURE**

#### Result:

Compaction factor = weight of partially compacted concrete kgs/ weight of fully compacted concrete kgs

$$= \frac{14.20}{15.720} = 0.903$$

### III.RESULTS AND DISCUSSIONS

#### 3.1 Compressive strength of concrete:

Out of the many test applied to the substantial, his is that the most extreme significant which supplies an idea pretty much every one of the qualities of cement. By this single test one adjudicator that if Concreting has been done appropriately. For block test two kinds of example either 3D shapes 15 cm\*15 cm or 10 cm\*10 cm relying on the elements of totals are utilized.

This substantial is poured inside the form and furthermore the altered appropriately so as not to have any voids.Following 24 hours these molds are taken out and test examples are placed in water for relieving. The most elevated surface of those examples ought to be made even and smooth. This should be possible by putting concrete glue and spreading easily on entire space of example.

These examples are tried by pressure

testing machine following 7 days relieving or 28 days restoring. Burdenought to be applied step by step at the speed of 140 kg/cm<sup>2</sup> each moment till the examples comes up short. Burden at the disappointment separated by space of example gives the compressive strength of cement.

#### Sampling:

1. Fill the concrete within the moulds in layers approximately 5cm thick.
2. Compact each layer with not less than 25 strokes per layer employing a tampering rod
3. Level the highest surface and smoothen it with a trowel.

#### Curing:

Precautions: The water for curing should be tested every 7 days and also the temperature of water must be at 27+-20 C.



**FIG 3.1.- CURING TANK**

#### Procedure:

1. Take the size of the specimen to the closest 0.2 m
2. Place the specimen within the machine in such a fashion that the load shall be applied to the alternativesides of the cube coast.
3. Align the specimen centrally on the bottom plate of the machine.
4. Rotate the movable portion gently by hand so it touch the highest surface of the specimen.
5. Apply the load gradually without shock and continuously at the speed of 140kg/cm<sup>2</sup> per minute till thespecimen fails.
6. Record the utmost load and note any unusual features within the sort of failure.

**3.2. Observations of compressive strength**

**Compressive strength of concrete for 7 days:**

Sl.No	Specimen size 100*100*100 Mm	% of Si.Mn metal slag	% of Si.Mn powder	Load (Kn)	Avg.load (Kn)	Comp.strength N/mm2
1	1	0%	0%	320	270	27
	2			170		
	3			320		
2	1	5%	5%	220	190	19
	2			180		
	3			170		
3	1	10%	10%	220	227	22.7
	2			200		
	3			260		
4	1	15%	15%	250	240	24
	2			210		
	3			260		
5	1	20%	20%	290	243.3	24.33
	2			220		
	3			220		

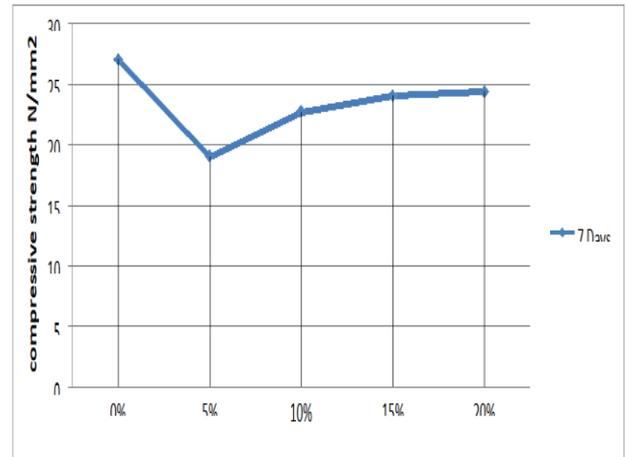


**FIG 3.2..a- CUBES**



**FIG 3.2.b- COMPRESSION TESTING MACHINE**

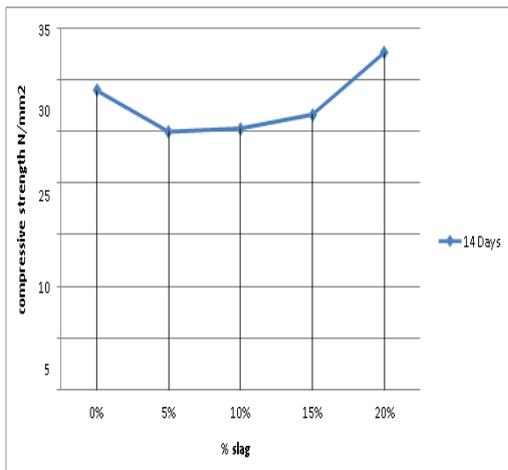
**GRAPH 3.2- SHOWING COMPRESSIVE STRENGTH FOR 7 DAYS**



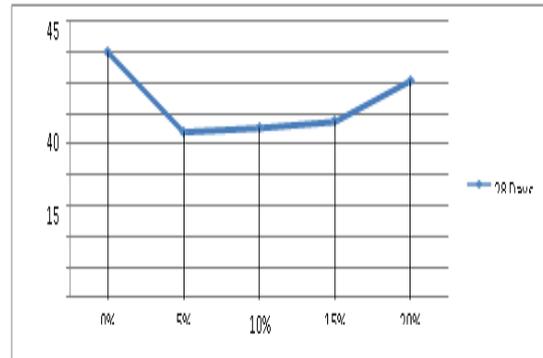
**3.3. Compressive strength of concrete for 14 days:**

Sl.No	Specimen size 100*100*100 Mm	% of Si.Mn metal slag	% of Si.Mn powder	Load (Kn)	Avg.load (Kn)	Compressive.strength N/mm2
1	1	0%	0%	360	290	29
	2			170		
	3			340		
2	1	5%	5%	270	250	25
	2			230		
	3			250		
3	1	10%	10%	255	253.3	25.33
	2			250		
	3			255		
4	1	15%	15%	250	266.67	26.67
	2			260		
	3			290		
5	1	20%	20%	320	326.67	32.67
	2			310		
	3			350		

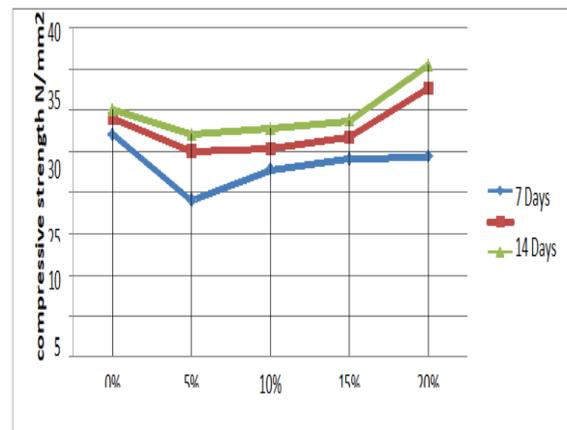
**GRAPH 3.3.-SHOWING COMPRESSIVE STRENGTH FOR 14 DAYS**



GRAPH 3.4.SHOWING COMPRESSIVE STRENGTH FOR 28DAYS



GRAPH 3.5.COMPARISON OF COMPRESSIVE STRENGTH



3.4. Compressive strength of concrete for 28 days:

Sl.No	Specimen size 100*100*100 Mm	% of Si.Mn metal slag	% of Si.Mn powder	Load (Kn)	Avg.load (Kn)	Comp.strength N/mm2
1	1	0%	0%	370	400	40
	2			430		
	3			400		
2	1	5%	5%	270	270	27
	2			265		
	3			275		
3	1	10%	10%	280	276.67	27.67
	2			280		
	3			270		
4	1	15%	15%	320	286.67	28.67
	2			220		
	3			320		
5	1	20%	20%	350	353.33	35.33
	2			350		
	3			360		

IV. Result:

Average compressive strength of the concrete cube = 27N/mm2 (7 days) Average compressive strength of the concrete cube = 29 N/mm2 (14 days) Average compressive strength of the concrete cube=37N/mm2 (28 days)

Discussion of test results:

In the present investigation 100\*100\*100 mm size cubes and 100\*100\*500 mm size beams are used. Compressive strength and flexural strength of concrete is determined on these specimens, which were cured in clean water until the date of test. 3 cubes and 3 beams are tested and average value is taken in accessing compressive strength and flexural strength at different percentages of silico manganese slag for 7days, 14 days,28 days respectively.

3.4.1.1. Table 4.2.1. gives the results of compressive strength of cubes at different percentages o Si.Mn slag i.e.,

0%, 5%, 10%, 15%, 20% for 7 days.

3.4.1.2. Table 4.2.2. Gives the results of compressive strength of cubes at different percentages of Si.Mn slag i.e., 0%, 5%, 10%, 15%, 20% for 14 days.

3.4.1.3. Table 4.2.3. gives the results of compressive strength of cubes at different percentages of Si.Mn slag i.e., 0%, 5%, 10%, 15%, 20% for 28 days.

3.4.1.4. Table 4.3.1. gives the results of flexural strength of cubes at different percentages of Si.Mn slag i.e., 0%, 5%, 10%, 15%, 20% for 7 days

3.4.1.5. Table 4.3.2.gives the results of flexural strength of cubes at different percentages of Si.Mn slag i.e., 0%, 5%, 10%, 15%, 20% for 14 days.

3.4.1.6. Table 4.3.3. gives the results of flexural strength of cubes at different percentages of Si.Mn slag i.e., 0%, 5%, 10%, 15%, 20% for 28 days.

#### Scope for further study

1. The present study may be further applied out on other grades of concrete.
2. The effect of fresh properties of the concrete because of the usage of various proportions is also studied.
3. In present investigation the replacement of fine and coarse aggregate was up to 20%.
4. Further investigation may be carried out at different percentages and adding admixtures, with small changes that may increase or reach the strength of Conventional concrete.
5. The study may be extended to help the sturdiness aspects of the concrete with varying replacement proportions.

#### V. Conclusion

1. The specific gravity of Silico manganese slag is high compared to the fine aggregate.
2. Manganese slag resulted that the compressive strength is increased when compared with the standard concrete.
3. Compacting factor, bulk density has increased as the percentage replacement of fine and coarse aggregate with silico manganese slag increased.
4. Cost and weight is reduced as compared to the conventional concrete.
5. There exists a high potential for the employment of silico manganese slag as coarse aggregate and silico manganese granular slag as fine aggregate within the production of lightly reinforced.

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