Experimental Study on the Replacement of Coarse and Fine Aggregates with Silico-Manganese Slag in Concrete

1BASKE RAMESH, 2GODISHALA MANASA, 3SAFIUDDIN NEHAL, 4O.Nikhil
123Assistant professor,4Student
Dep of Civil Engineering
Vaagdevi College of Engineering, Warangal, India

ABSTRACT

This study explores the feasibility of using silico-manganese (SiMn) slag as a partial or complete replacement for coarse and fine aggregates in concrete. Silico-manganese slag, a by-product of the steel industry, offers potential environmental and economic benefits by reducing natural aggregate consumption and promoting waste utilization. A series of concrete mixes were prepared with varying percentages of SiMn slag as a substitute for traditional aggregates. The performance of the modified concrete was evaluated through mechanical properties such as compressive strength, tensile strength, and flexural strength, along with durability tests.

The results demonstrate that the inclusion of SiMn slag enhances certain mechanical properties, particularly compressive strength, at optimal replacement levels. However, higher substitution ratios showed a slight decline in performance, indicating a need for careful mix design. Additionally, the use of SiMn slag improved the concrete's resistance to chemical attack, promoting durability. This study suggests that SiMn slag can serve as a sustainable alternative to conventional aggregates, contributing to eco-friendly construction practices and circular economy initiatives.

I.INTRODUCTION:

1.1. Introduction to concrete:

Concrete is the most widely used construction material globally, owing to its versatility, durability, and cost-effectiveness. However, the increasing demand for concrete has led to the over-extraction of natural aggregates, resulting in environmental challenges such as depletion of natural resources, ecological imbalance, and land degradation. To address these concerns, the construction industry has been actively exploring sustainable alternatives to reduce the use of natural aggregates. One promising approach is the utilization of industrial by-products as substitutes, promoting waste management and reducing the environmental impact of construction activities.

Silico-manganese (SiMn) slag is an industrial by-product generated during the production of silico-manganese alloy, widely used in the steel industry. Traditionally, SiMn slag is considered waste and disposed of in landfills, contributing to environmental pollution. However, recent research suggests that SiMn slag possesses suitable physical and chemical properties that make it a potential replacement for coarse and fine aggregates in concrete. By incorporating SiMn slag in concrete, both resource conservation and waste management can be achieved, aligning with sustainable development goals and circular economy principles.

This study focuses on evaluating the mechanical and durability performance of concrete incorporating silico-manganese slag as a partial or complete replacement for conventional aggregates. The primary objectives are to (i) determine the optimal replacement levels of SiMn slag for improved strength and durability, (ii) assess the impact of SiMn slag on key properties such as compressive, tensile, and flexural strength, and (iii) analyze the potential challenges and benefits associated with its use in construction.

The findings of this research contribute to the ongoing efforts to develop eco-friendly construction materials while promoting the efficient utilization of industrial waste. If proven effective, the use of SiMn slag in concrete can reduce dependency on natural aggregates, minimize waste disposal issues, and enhance the sustainability of the construction sector.

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%

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 colorof 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 anylump inside.

c) Take a couple of cement and feel between the fingers. It should provides a smooth and not a grittyfeeling.

d) Take a handful of cement and throw it on a bucket filled with water, the particles should float for a few timebefore 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 ofboth 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 duringthe 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'. The corresponding concrete features a bulk density less than 1800.

Normal weight aggregate- The aggregate mixture has unit weight of 1520-1680 kg/m2. The concrete made with this kind of aggregate features a bulk d 2300-2400 kg/m2.

Heavy weight aggregate- The unit weight is larger than 2100 kg/m. The major density of the corresponding concrete is larger than 3200 kg/m2.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 subsequents 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 retainedon 75 micron sieve.

Fine aggregate from rivers or may be obtained from crushing stone (Manufactured sand). Fine aggregatecan 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 steel plants 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 MANGANESE 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 improvesits 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-lessening 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 a necessary 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 toconcrete 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 dispersionand optimum performance.

2.6. Mixing of Concrete:

Thorough mixing of the materials is crusial 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 timeFinal 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 conductedas per IS specification.

PRINCIPLE:

The slump test result's a slump of the behaviour of a compacted inverted cone of concrete under the action ofgravity. 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 damped 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 wall 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 mouldexactly 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 theheight 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 intovessel 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 foundW2.

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

= **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/cm2 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/cm2 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 2 3	0%	0%	320 170 320	270	27
2	1 2 3	5%	5%	220 180 170	190	19
3	1 2 3	10%	10%	220 200 260	227	22.7
4	1 2 3	15%	15%	250 210 260	240	24
5	1 2 3	20%	20%	290 220 220	243.3	24.33

FIG 3.2..a- CUBES

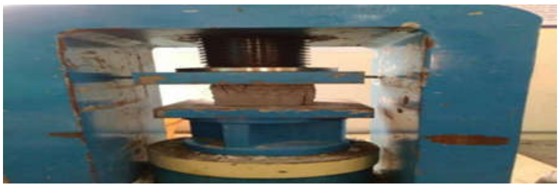
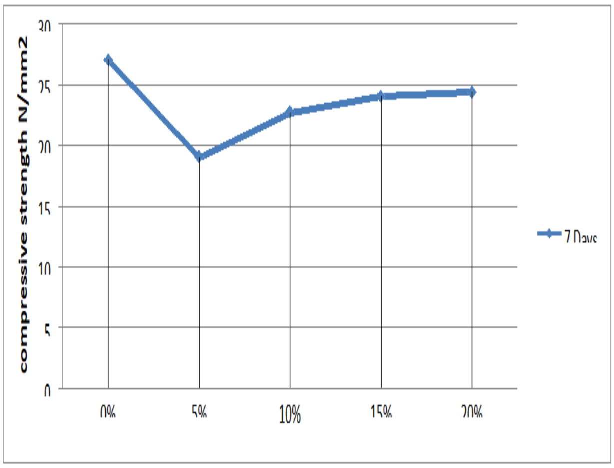


FIG 3.2.b- COMPRESSION TESTING MACHINE

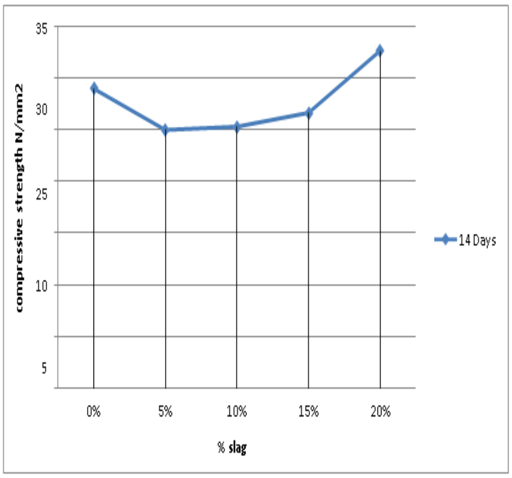
GRAPH 3.2- SHOWING COMPRESSIVE STRENGTH FOR 7 DAYS



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 2 3	0%	0%	360 170 340	290	29
2	1 2 3	5%	5%	270 230 250	250	25
3	1 2 3	10%	10%	255 250 255	253.3	25.33
4	1 2 3	15%	15%	250 260 290	266.67	26.67
5	1 2 3	20%	20%	320 310 350	326.67	32.67

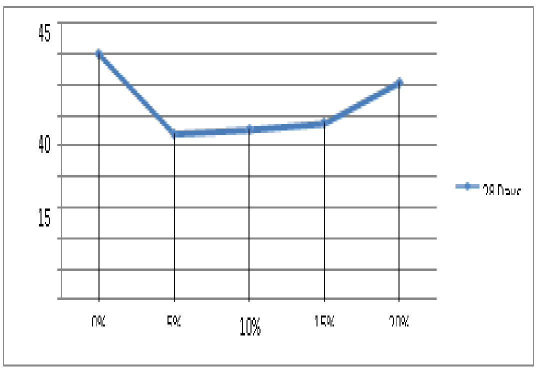
GRAPH 3.3.-SHOWING COMPRESSIVE STRENGTH FOR 14 DAYS



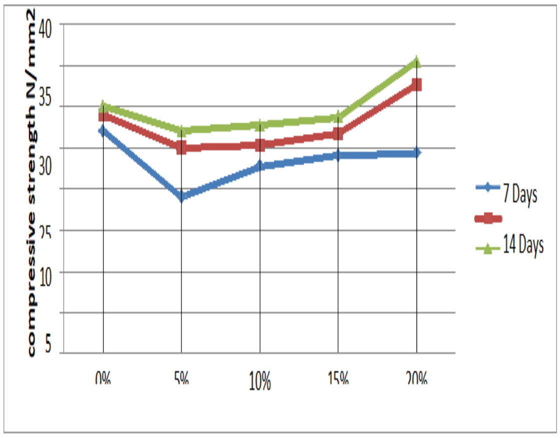
3.4. Compressive strength of concrete for 28 days:

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 2 3	0%	0%	370 430 400	400	40
2	1 2 3	5%	5%	270 265 275	270	27
3	1 2 3	10%	10%	280 280 270	276.67	27.67
4	1 2 3	15%	15%	320 220 320	286.67	28.67
5	1 2 3	20%	20%	350 350 360	353.33	35.33

GRAPH 3.4.SHOWING COMPRESSIVE STRENGTH FOR 28DAYS



GRAPH .3.5.COMPARISON OF COMPRESSIVE STRENGTH



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 o 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 o 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 o 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 o 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 o Si.Mn slag i.e., 0%, 5%, 10%, 15%, 20% for 28 days.

V. Conclusion

This study demonstrates the potential of silico-manganese (SiMn) slag as a viable substitute for coarse and fine aggregates in concrete. The experimental investigation reveals that, at optimal replacement levels, SiMn slag enhances the mechanical properties of concrete, particularly compressive strength. The material also contributes to improved durability by increasing resistance to chemical attacks and reducing permeability. However, excessive substitution can lead to a decline in performance, indicating the importance of optimizing mix proportions.

The incorporation of SiMn slag offers several advantages, including:

Environmental benefits, such as reduced exploitation of natural aggregates and lower landfill requirements for industrial waste.

Economic benefits, through the utilization of a waste by-product that lowers material costs.

Despite these benefits, some challenges remain, such as achieving consistent quality in SiMn slag and addressing potential variations in particle shape and chemical composition. Therefore, further studies are recommended to fine-tune the mix design and explore the long-term durability of SiMn slag concrete under different environmental conditions.

In conclusion, SiMn slag has the potential to replace conventional aggregates in concrete, contributing to sustainable construction practices. Its use promotes resource conservation, waste reduction, and the development of greener building materials, aligning with global efforts toward a circular economy. With appropriate mix design and quality control, SiMn slag can play a significant role in advancing eco-friendly construction solutions.

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