ANALYSIS OF M60 GRADE CONCRETE USING SILICO-MANGANESE SLAG AS THE PARTIAL REPLACEMENT OF COARSE AND FINE AGGREGATES

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Abstract
India, in recent years is witnessing a rapid growth and innovative development in construction industry. The extended use of concrete and its materials involve use of available natural resources. Natural resources in India are depleting, contrastingly, there is substantial increase in generation of wastes from the industries. The sustainable development in concrete technology and construction involves the use of waste and innovative materials in order to replace the depletion of natural resources and find alternative ways for conserving the environment. The materials like - slags, quarry dust, manufactured sand, municipal incineration waste ash, bottom ash, recycled sands from construction and demolished waste, etc are used as alternative materials for replacement or full substitution of sand. Aggregates are considered as one of the main filler constituents of concrete as they occupy 50 – 80% of concrete volume. The concrete industry globally consume over 8-12 billion tons of natural aggregates annually. Recently natural sand is becoming scarce in availability and costly, because of its demand by the construction industries. Increase in industrial waste, increases threat to our society. It is very essential to dispose these wastes safely without effecting the sustainable environment. A manganese manufacturing industry produces a large amount of waste. This nondegradable refusal creates problem to our environment. We use this waste for casting solid blocks. This report deals with the partial replacement of coarse and fine aggregates by coarse Silico Manganese and its dust, respectively, in various percentages of high strength concrete (M60) and finding that solid concrete blocks' Flexure strength, Compressive strength which are studied.

INTRODUCTION

Concrete is widely used construction material consistent essentially of a distinction of being the only construction material actually manufactured on the site, whereas other materials like grains of sand, gravel or pieces of crushed rock and the innumerable fine particles of cement powder mixed with water.

Concrete is a composite material composed mainly of water, aggregate, cement. Often, additives and reinforcements are included in the mixture to achieve the desired physical properties of the finished material. When these ingredients are mixed together, they form a fluid mass that is easily molded into shape. Over time, the cement forms a hard matrix which binds the rest 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 construction industry to use the building materials at rapid rate and resulting in depletion of natural resources and also has a severe impact on the sand mining being done at alarming rate etc. on the other hand, industrialization, rapid growth of industries in India gave birth to numerous kinds of waste products.

The steady increase in demands due to population growth as also resulted in increase in production and as the production rate increases to match the consumption rate the waste produced by the process during production also increases proportionality. But the waste products generated by these industries is causing environmental hazards as their disposal being a major problem, due to this over

the period of time waste management has become one of the most complex challenging problem in India. Fortunately, a waste product can be added to concrete to significantly improve its physical properties and environmental characteristics. The greatest challenge before the construction industry is of two folds. One is to serve the infrastructure requirements of growing population and the other protection of environment.

INTRODUCTION TO SIMN SLAG

Silico Manganese

A ferroalloy composed chiefly of silicon and manganese; it is smelted by the carbon reduction in one heat-treating furnaces. Silicon with 10-26 percent Si (the remainder is Mn, Fe, and impurities) is obtained from manganese ore, manganese slag and quartzite and is used as deoxidizer and alloying additive in the smelting of steel, as well as in smelting of ferromanganese with reduced carbon content by the silico-thermic process. Silico manganese with 28-30 percent Si, for which specially prepared high-manganese low phosphorus slag serves as raw material, is used in the production of metallic manganese.

SiMn slag in cement

SiMn is used as cement making for replacement of clinker. Although SiMn-slag usage in cement cement making is commercialized in China, Indian cement manufacturers are still unwilling to take advantage of the low-cost raw material for cement manufacture.

SiMn-slag has higher Cao content in comparison to BF-slag, which acts as an activator and gives better strength. However, presence of p205 results in corrosion of reinforced materials in concrete structure. If only 10% SiMn slag is used in cement, the P2O5 content will be around 0.3% which is not so harmful in Portland slag cement (PSC), because low in P2O5PSC react, with alkali on slag contributing little strength of cement. Therefore, more than 10 % SiMn slag use in PSC is not possible.

Iron oxide present in SiMn slag forms a phase, tetra calcium alumino-ferrite (C4AF) which has an adverse effect on the quality of cement. The total iron oxide should not be 5%. The ferruginous portion of SiMn slag can be separated by magnetic separation technique. However, for magnetic separation , crushing and grinding are required which are very costly. After crushing and grinding to suitable size SiMn-slag is used as a flux material in sinter making.

At the end of original processing of silico manganese ore to remove as much of the remaining metal as possible until further processing is no longer economically viable. The remaining ore is then screened and sold for use in cement manufacture as an ingredient, and concrete production as a cementitious, reactive aggregate. About 93% of all manganese produced is in the form of manganese ferroalloys. The FeMn grades are high carbon (HC), medium carbon (MC), low carbon (LC) and very low carbon (VLC). Whereas the SiMn grades are medium carbon(MC) and low carbon (LC).

Material survey

Cement is a binder, a substance that sets and hardens and can bind other materials together. The word cement traces to the romans, who used the term opus cementitious to describe masonry resembling modern concrete that was made form crushed rock with burnt lime as binder. The volcanic ash and pulverized brick supplements that were added to the burnt lime, to obtain a hydraulic binder were later referred to as cementum, cementum, cement, and cement.

Fig1 OPC Cement

Ordinary Portland Cement (OPC)

Cement can be defined as the bonding material having cohesive and adhesive properties which makes it capable to unite the different construction materials and form the compacted assembly. Ordinary/normal Portland cement is one of the most widely used type of Portland cement. The name Portland cement was given by joseph asp din in 1824 due its similarity in color and its quality when it hardens like Portland stone. Portland stone is white grey limestone in island of Portland desert.

Properties of cement.

- It is an excellent binding material
- It is easily workable.
- It gives good strength to masonry 12
- It offer good resistance to moisture.
- It possesses good plasticity.
- It can take more loads on hardening.
- It attains homogeneity quickly during mixing.

Composition of OPC

The chief chemical components of Portland pozzolana cement are:

- Calcium
- Silica
- Alumina
- Iron

Ingredients	Concentration (%)
CaO	66.67
SiO_2	18.91
Fe_2O_3	4.94
Al_2O_3	4.51
SO_3	2.5
MgO	0.87
K_2O	0.43
Na_2O	0.12
Loss of ignition	1.05

FINE AGGREGATE

Fine aggregate can be defined as the aggregate which pass through 4.75 mm IS sieve and retained on 75-micron sieve . fine aggregate is available from rivers or can be obtained from crushing stone (manufactured stand).

Fine aggregate can also be divided based on their particle size.

1. Coarse sand.
2. Medium sand.

3. Fine sand.

Test in fine aggregate

The following are the test conducted on fine aggregate.

• Sieve analysis of fine aggregate.
• Specific gravity and water absorption of fine aggregate.
• Bulk density of fine aggregate.

Fig 2 Sieve Analysis

Silico Manganese Slag

Since the natural manganese oxide concentrates are becoming low grade and complex and the use of manganese continues to increase in the special steel industry, the amount of the slag generated in the silico-manganese alloy smelting processes will rise concurrently. Silico manganese is an essential allow in the manufacture of steel which impart hardness and strength and performs as an oxidizing agent. Large amount of non-bio-degradable slag is produced during the manufacture of alloy which was thought of being used in the construction industry as aggregates in flexible and rigid pavements as well as ballast for rail track construction.

Silicon manganese slag

Fig3:Silicon magnisium alloy extracted from silica magnise alloy slag

Water

Water to be used in the concrete work have following properties:

• It should be free from injurious amount of soils.
• It should be free from injurious amount of acids, alkalis or other organic or inorganic impurities.

• It should be free from iron, vegetable matter or any other type of substances, which are likely to have adverse effect on concrete or reinforcement.
• It should be fit for drinking purposes. 19 The function of water in concrete:
• It acts as lubricant.
• It acts as a chemically with cement to form the binding paste for coarse aggregate and reinforcement.
• It enables the concrete mix to flow into formwork.

Admixture

Introduction admixtures are materials other than cement, aggregate and water that are added to concrete either before or during its mixture to alter its properties, such as workability, curing temperature range, set time or color. Some admixtures have been in use for a very long time, such as calcium chloride to provide a cold weather wetting concrete. Others are more recent and represent an area of expanding possibilities for increased performance. Not all admixtures are economical to employ on a particular project, also, some characteristics of concrete, such as low absorption can be achieved simple by consistently adhering to high quality concreting practices. Concrete should be workable, finish able, strong, durable, watertight and wear resistant. These qualities can often be obtained easily and economically by the selection of suitable materials rather than by resorting to admixtures (except air-entraining admixtures when needed).

Experimental Investigations and Mix Design

Cement Ordinary Portland cement 53 grade has been used. The physical properties of the cement obtained on conducting appropriate tests.

Fine aggregate

In the present investigation fine aggregate is of natural sand obtained locally. The physical properties of fine aggregates like specific gravity, bulk density, and fineness modulus are tested.

Coarse aggregate

The crushed coarse aggregate of 20mm maximum sizes are obtain from the local crushing plants is used in the present study. The physical properties of coarse aggregates such as specific gravity, bulk density, flakiness and elongation index and fineness modulus are tested.

Simn slag

SiMn slag used in the present investigation was collected from Navabarath Ferro Alloys Limited Near Palwancha, Kothagudem, Telanaga. The test on SiMn slag were carried out as per IS: 383-1970.

Water

Clean portable water is used for casting and curing operation for the work. The water supplied in the campus is of the portable standard of pH value=7.50 is used.

Super plasticizer

To improve the workability of fresh concrete a dark brown liquid based on lignosulphonate based super plasticizer i.e., ROOF LAST WL was used supplied by FOSROC Construction Chemical Distributors. Dosage of 20ml is used per 50kg of cement.

Slump test

Fig 4 Slump cone test

Test Result

compaction factor= weight of partially compacted concrete/ Weight of fully compacted concrete = 15.20/ 16.58 = 0.91

Compressive strength of concrete

Fig 5 Compressive strength

Table1: Compressive Strength Of concrete Cubes

Sl no	days	% of SiMn slag	Compressive strength
1	7	0%	45
2	14		53
3	28		68
1	7	10%	6.7
2	14		1.31
3	28		2.94

Flexural strength

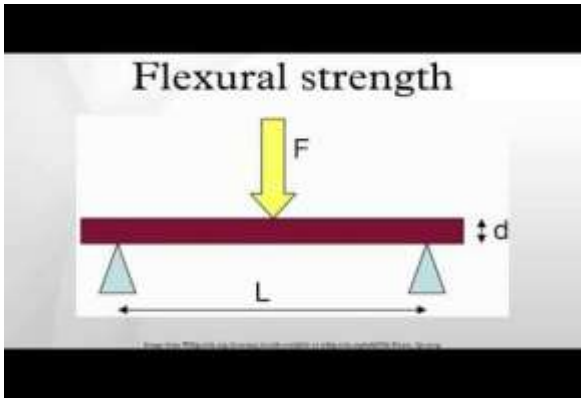

Fig 6 Flexural Strength

Table2:Flexural strength of beams

S no	Specimen size 100*100*500	% of SiMn slag	Span (mm)	Distance of fracture	Load (KN)	Avg Load (KN)	Flexural strength (N/mm2)
1	1 2 3	0	500 500 500	170 165 190	18.5 21 15	18.5	8.2
2	1 2 3	10	500 500 500	180 160 175	17 16 18	17	9

Results and Discussion

Flexural strength

• In the present investigation of 100x100x500mm beams are used. Flexural strength of concrete was determined on these specimens, which were cured in clean water until the date of test. Three beams were tested in every case at different % of SiMn slag for 7days, 14days, 28 days respectively. • Table 5.5 gives the results of flexural strength of beams at different % of SiMn slag i.e, 0%, 10%, 20%, 30%, 40%, for 7days to 28 days.

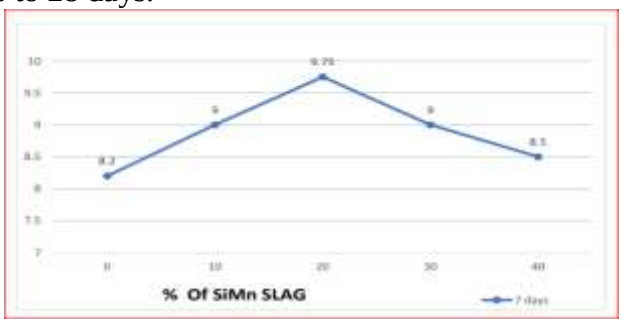

Fig 6: Flexural strength of 7 days

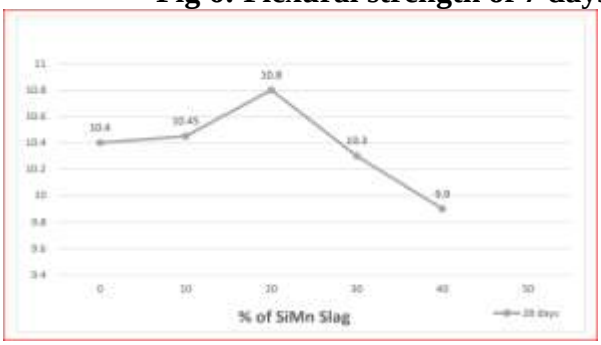

Fig 7: Flexural strength of 28 days

Compressive strength

In the present investigation 100x100x100mm cubes are used. Compressive strength of concrete was determined on these specimens, which were cured in clean water until the date of test. Three cubes were tested in every case at different % of SiMn slag for 7 days, 14 days, 28 days respectively

• The compressive strength of beams at different % of SiMn slag i.e; 0%, 10%, 20%, 30%, 40% for 7 days to 28 days.

Fig8: Flexural strength for 7 days

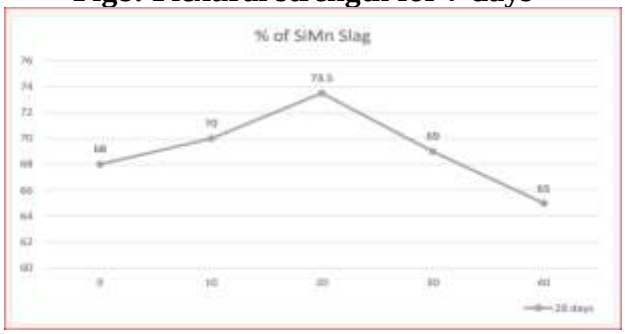

Fig9: Flexural strength for 28 days

Conclusion

Based on the experimental results following conclusion were made:

• The specific gravity of SiMn slag is more than that of coarse aggregate.

• 10%, 20%, 30%, 40% of both coarse aggregate and fine aggregate was replaced by the silico manganese slag resulted in increase of flexural and compressive strength compared to conventional concrete.

• The flexural strength of SiMn replaced concrete was found to increasing with all the percentages of replacement.

• The compressive strength SiMn replaced concrete was found to increase with all the percentages of replacement.

• The flexural strength at 7, 14, 28 days for 20% SiMn slag replacement was observed to be very high.

• The compressive strength at 7,14,28 days for 20% SiMn slag replacement was observed to very high.

• The maximum flexural strength was achieved at 20% replacement for 28 days i.e 10.8N/mm2 and 3.85% more strength than conventional concrete.

• The maximum compressive strength was achieved at 20% replacement for 28 days i.e 73.5N/mm2 and 8.08% more strength than conventional concrete.

• The flexural strength was found to be increasing for 10% and 20% and then decreased for 30% and 40%.

• The compressive strength was found to be increasing for 10% and 20% then decreased for 30% and 40%.

• The SiMn slag replaced concrete can be used for construction of road pavements, footpaths, foundation etc.

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