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M-SAND AND SELF COMPACTING CONCRETE: DETERMINING IT'S MORPHOLOGICAL AND CHEMICAL PROPERTIES

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ABSTRACT

Slag materials used in the production of iron and steel are not harmful to human health or the environment, according to the National Slag Association (NSA) of the United States of America, which provides evidence to support this claim. Construction aggregates made from slag have been used in a variety of applications, including asphaltic concrete, Portland cement concrete, highway embankment and shoulders, as well as on unpaved roads, parking lots, walkways, and driveways. The establishment of SCC was done with the intention of addressing the shortage of unskilled workers in the Japanese construction sector. There were a lot of challenges faced throughout the process of compaction since standard concrete was being poured into reinforcements that were already congested. This problem was addressed by the development of a material known as self-compacting concrete. It is possible for it to compress on its own whether it is weighted down or under the effect of gravity, provided that there is no vibration, bleeding, or segregation. Without segregation, SCC has a substantially higher fluidity than ordinary concrete. This is in comparison to regular concrete. Its weight is capable of entirely filling every corner of the formwork..

Keywords: *M-Sand , Self Compacting Concrete , Morphological , Chemical , Properties*

INTRODUCTION

Steel Slag

The natural resources of natural mineral aggregates of excellent engineering grade that are capable of being used would eventually run out if they were to be exploited. Slag materials used in the production of iron and steel are not harmful to human health or the environment, according to the National Slag Association (NSA) of the United States of America, which provides evidence to support this claim. Construction aggregates made from slag have been used in a variety of applications, including asphaltic concrete, Portland cement concrete, highway embankment and shoulders, as well as on unpaved roads, parking lots, walkways, and driveways. These applications have been carried out in a secure and successful manner. Steel slag is collected from steel melting furnaces for the purpose of this study. The most common compounds found in steel slag are dicalcium silicate, tricalcium silicate, dicalcium ferrite, merwinite, calcium aluminate, calcium-magnesium iron oxide, and a little amount of free lime and free magnesia material.

Manufacturing Sand (M-Sand) :Effective For Lowering Pollution Levels

Sudden and significant decline in the amount of building sand that is available In addition, the M-Sand has been given a new incarnation as a result of the environmental movement's efforts to reduce the amount of river sand that is dredged. The crushing and screening procedures that are carried out in the quarries result in the production of M-Sand as a secondary product. In point of fact, M-Sand is a commendable alternative in the building industry since it is the most effective for lowering pollution levels while maintaining a desirable level of efficiency. In the process of proportioning concrete, M-Sand has shown to be an obviously useful and appropriate additive. When it comes to satisfying the requirements of the civil engineering industries, the manufacturing of M-Sand is an essential requirement that must be met.

In order to produce manufactured sand, also known as M-sand, rock deposits are crushed. Similar to fine aggregate in both fresh and hardened concrete, this alternative material may be produced in huge numbers and possesses properties that are equivalent to those of fine aggregate. A significant amount of natural sand is necessary in order to accomplish rapid expansion in infrastructure. Because of this circumstance, emerging countries like India have a difficult time locating natural sand of a relatively good grade. Across India, natural sand supplies are being depleted, which is having a significant negative impact on the ecology. According to a number of studies, the utilization of alternative materials that are readily available and inexpensive might be of assistance in addressing the issue of the scarcity of natural resources and the conservation of the environment. As a result of the limited availability of river sand in India, several other materials are utilized in its place. These resources include manufactured sand, copper slag, fly ash, slag, limestone, and siliceous stone powder. According to Shanmugapriya et al. (2014), Raju and Dharmar 2020, and Nanthagopalan and Santhanam (2010), they can be used in concrete mixes as a partial replacement for fine aggregate.

According to the findings of a number of studies, M-sand, which is one of these materials, has been demonstrated to be an effective substitute for actual river stones. An appropriate alternative to river sand has been demonstrated to be M-sand, which has a greater paste volume than river sand (Nanthagopalan & Santhanam, 2010). This has been demonstrated via a number of experiments that conducted on alternative materials. The production of concrete of an exceptional grade may be accomplished with the use of M-sand that contains a high concentration of micro fines. In general, the proportions of microfines have a tendency to improve the compressive strength, flexural strength, bond strength, water permeability, impact resistance, sulphate resistance, and abrasion resistance of the material up to a certain degree. As soon as the limit is reached, the strength begins to decrease since there is not enough paste to appropriately cover the aggregate. In addition, M-sand did not fulfill the requirements of the existing sand criterion since it had a greater percentage of tiny particles. In a research that was conducted by Hameed and Sekar in 2009 and Jadhav and Kulkarni in 2012, it was found that the compressive, split tensile, and flexural strengths of the material improved when M-sand was used to replace between 40 and 60 percent of the Natural Sand. Despite the fact that the presence of an excessive amount of microfines causes the strength of concrete to decrease, the form and structure of crushed sand particles improves the interlocking between the particles, which in turn increases the strength and durability of the concrete.

Self Compacting Concrete: Decreased Amount of Time Requirements

Okamura & Ouchi (2016) They were the pioneers in the concrete business in the 1980s when they introduced self-compacting concrete, also known as SCC. The establishment of SCC was done with the intention of addressing the shortage of unskilled workers in the Japanese construction sector. There were a lot of challenges faced throughout the process of compaction since standard concrete was being poured into reinforcements that were already congested. This problem was addressed by the development of a material known as self-compacting concrete. The term "self-compacting concrete" refers to a specific variety of concrete. It is possible for it to compress on its own whether it is weighted down or under the effect of gravity, provided that there is no vibration, bleeding, or segregation. Without segregation, SCC has a substantially higher fluidity than ordinary concrete. This is in comparison to regular concrete. Its weight is capable of entirely filling every corner of the formwork. The primary factors that are contributing to the rise in interest in SCC are the decreased amount of time requirements and the reduced amount of work that is necessary to complete particular casting operations.

The SCC material is able to cover the reinforcement while effectively assuming the form of any delicate formwork required. In order to manufacture SCC, it is necessary to take the following steps: reducing the amount of water to cement, using a powerful plasticizer, increasing the ratio of sand to aggregate, and incorporating certain viscosity modifying agents. The elimination of the usage of vibrators and the huge reduction in the amount of ambient noise loading on the site both contribute to a major improvement in the health and safety of the employed individuals. Due to the existence of fine-grained inorganic components, mineral admixtures are allowed to be used in the SCC mix. It would be beneficial to perform more research on the utilization of waste materials as mineral admixtures in SCC, some of which have previously been utilized in practical applications.

OBJECTIVES OF THE STUDY

1. To study on Self Compacting Concrete: Decreased Amount of Time Requirements
2. To study on utilization of alternative materials that are readily available and addressing the issue of the scarcity of natural resources and the conservation of the environment.

RESEARCH METHOD

The characteristics of the material are the primary focus of research since they have the ability to either facilitate or produce changes that improve the outcomes of all studies. Whenever they are present in solid or almost solid forms, they are usually very concentrated and constantly quantitative. This is especially true of the former. These quantitative properties, in point of fact, serve as a benchmark for assessing the advantages offered by a variety of materials. Consequently, these qualities are very important when selecting materials for the purpose of conducting experiments. The direction and potentiality of the materials being evaluated often lead the attributes of a material to vary to some degree during the course of the testing process. The purpose of these experiments is to clearly identify the features of these materials. A demonstration of how to construct an SCC mix design that includes steel slag and M-Sand is also provided in this section. The unique mix design of SCC makes use of concrete grades M20, M30, and M40 as fine aggregates in lieu of steel slag and M-Sand. The addition of these concrete grades is done at varied amounts that correspond to the physical qualities of the concrete grades.

Cement

Cement of the OPC-43 grade is the preferable alternative, and the choice is mostly influenced by the specific needs of the concrete. The cement that is used in SCC proportioning is subjected to testing in accordance with IS: 4031 - 1988 and IS 40032 - 1988; the results of these tests are shown in Table 1.

Table 1 The physical characteristics of cement grade OPC 43

Properties	Results	Requirements as per IS:81112 - 1989
Specific gravity	3.15	---
Fineness (m^2 / kg)	310	Minimum 225
Soundness (in mm)	1.20	Maximum 10
Initial setting time	125 minutes	Minimum 30
Final setting time	215 minutes	Maximum 600

High-quality Aggregate

The rating of the various SCC potentialities is a characteristic that is shared by all of them. Clay, silt content, and chloride contamination are some of the detrimental materials that are protected against by fine aggregate used in SCC. Additionally, the fine aggregate is graded appropriately to prevent the void ratio from occurring. Due to the fact that SCC contains a significant quantity of cement as well as micro silica, which are minute particles, it is essential to grade sand in the appropriate manner. When trying to make a thick SCC mix with the least amount of water required for mixing and the optimal cement %, it is vital to evaluate features such as bulk density, gradation, specific surface, and void ratio. Naturally occurring river sand that has been graded, screened through a 4.75 mm screen, and then retained on a 600 micron filter is the raw material that is used to produce fine aggregate. A series of tests were performed on the fine aggregate in accordance with the International Standard 2386-1963.

Steel Slag Vitality

It is necessary for steel slag to be exposed to open weather during the treatment process in order for it to naturally disintegrate to a substantial degree before it can be used. This decomposition process is what determines the lifespan of steel slag. Because of this, slag is an appropriate component for usage as a phosphate fertilizer, aggregate for roads, and counterweight in concrete and other construction materials. As a consequence of this, it is believed that this byproduct of the metal and alloy production sectors may serve as a dependable raw resource in the strategic quality enhancement of the SCC that is being investigated in the present study.

DATA ANALYSIS

Analysis using Scanning Electron Microscopy (SEM)

It is possible to assess the morphological characteristics of the steel slag by using a scanning electron microscope (SEM). The scanning electron micrograph (SEM) image of the steel slag sample is shown in Figure 1 at magnifications of 10000x and 20000x. The lengths of the major and minor axes are equal to 1.87 and 0.55 micrometers, respectively, according to the measurements that are shown in the figures. The elongation is calculated to be 3.4 units of length. This leads one to believe that there are particles that are elongated. The area of the particle is measured to be 1.03 square microns, while the perimeter of the particle is calculated to be 4.84 microns using software. The roundness of the particles, as determined by the computation, is 0.55, which indicates that their shape is angular. In addition to reducing porosity, they enhance the packing between the particles, which in turn results in an improvement in the qualities of strength and durability.

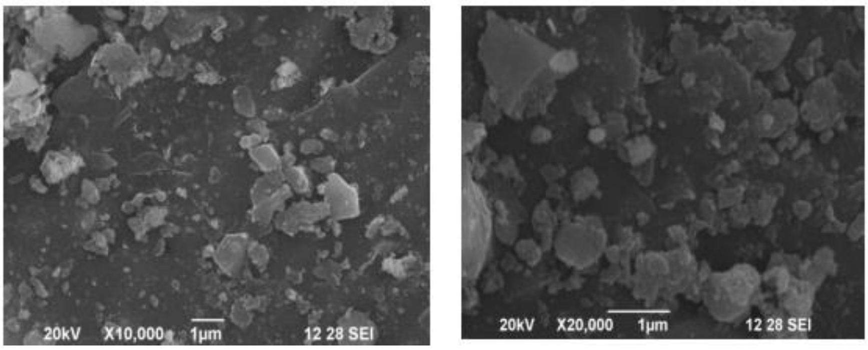


Figure 1 SEM photos of the slag steel

M-Sand

In Zone II Table 2, M-sand, which is employed as fine aggregate, is comparable to the material described there. A list of the physical parameters of M-Sand that are in accordance with IS 2386 (Part III) 1963 may be found in Table 3.

Table 3 The physical characteristics of synthetic sand

Properties	Results
Specific gravity	2.59
Fineness modulus	2.67

Bulk density (kg/m^3)	17665
Water absorption	1.4%

Table 4 presents the results of the sieve analysis test that was performed on M-sand particles. In addition, the specific gravity of the combined steel slag and fine aggregate is shown in Table 4.

T able 4 M-sand sieve analysis

IS Sieve size	% of Passing	IS Recommended limit
4.75 mm	99	90– 100
2.36 mm	91	75– 100
1.18 mm	72	55–90
600 Micron	46	35–59
300 Micron	21	8– 30
150 Micron	5	0– 10
80 Micron	1	-

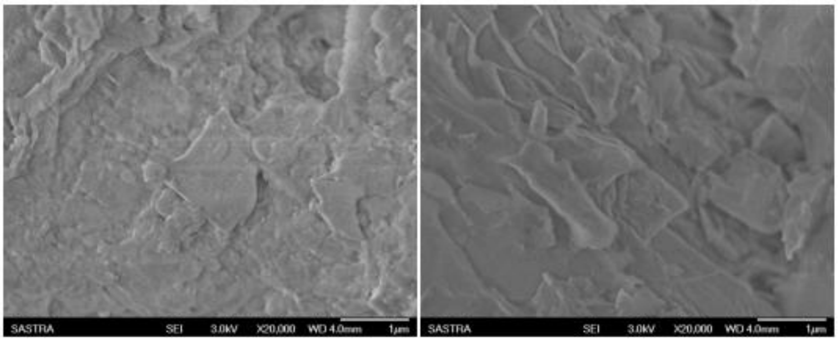
Table 5 Specific gravity of fine aggregate and M-sand mixed

M – sand (in %)	Fine Aggregate (in %)	Specific Gravity
0	100	2.60
10	90	2.60
20	80	2.60
30	70	2.60
40	60	2.60
50	50	2.60
60	40	2.59

70	30	2.59
80	20	2.59
90	10	2.59
100	0	2.59

Analysis Using Scanning Electron Microscopy (SEM)

At a magnification of 20,000 times, the scanning electron micrograph (SEM) of a concrete sample that contains both M-Sand and natural sand is shown in Figure 2



(a) Concrete with N-sand (b) Concrete with M-sand

Figure 2 Concrete samples with N and M sand captured in SEM photos

Based on the information, the length of the major axis is 1.55 micrometers, while the length of the minor axis is 1.5 micrometers. The elongation may be calculated by dividing the length of the main axis by the length of the minor axis, which results in a value of two hundred. Both the length of the main axis and the length of the minor axis are almost similar. Given this information, it seems that the particles have a spherical shape. In terms of measurements, the particle has a surface area of 1.88 square microns, and its perimeter is calculated to be 4.87 microns. The roundness of the particles has been measured and found to be 0.99, which indicates that the particles close to having a spherical shape. Dealing with the concrete is simplified as a result of this.

Using the same 20000x magnification, the scanning electron micrograph (SEM) image of the sample that contains M-sand is Within the context of the figure, the lengths of the major axes are 1.87 micrometers, while the lengths of the minor axes are 0.55 micrometers.

The elongation is calculated to be 3.4 units of length. This leads one to believe that there are particles that are elongated. The area of the particle is measured to be 1.03 square microns, while the perimeter of the particle is calculated to be 4.84 microns using software. The roundness of the particles, as determined by the computation, is 0.55, which indicates that their shape is angular. By reducing the amount of porosity and increasing the amount of packing that exists between the particles, they enhance the qualities of strength and durability significantly.

When steel slag and M-sand are used in place of fine aggregate in concrete, grades M20, M30, and M40 are investigated for their potential efficacy. When substituting proportions that vary from 10% to 100%, 10% increments are used to make the replacement. In accordance with the marsh cone test, the dosage of Complots

SP 430 is 1.78 percent by total binder content. This concentration is in accordance with the guidelines set out by the JSCE's SCC. The reference mixes (SCCNS) that include N-Sand for M20, M330, and M40 respectively.

As the reference mix and trial mix proportions for concrete with M-sand partly substituting fine aggregate are shown. These proportions range from 0% to 100% with a 10% increase in M20, M30, and M40 grade.

Table 6 Combine pro component for SCC-M20, M30, and M40 Grade, using M-sand in lieu of some of the N-sand.

MIX	% of Replacement in FA	Water kg/m3	Cement kg/m3	Fly Ash kg/m3	FA (kg/ m3)		CA kg/m3
					N-sand	M-sand	
20SCCNS	0	189	350	174	859	0	765
20SCCMS1	10	189	350	174	744	83	765
20SCCMS2	20	189	350	174	661	165	765
20SCCMS3	30	189	350	174	578	248	765
20SCCMS4	40	189	350	174	496	331	765
20SCCMS5	50	189	350	174	415	415	765
20SCCMS6	60	189	350	174	345	518	765
20SCCMS7	70	189	350	174	258	602	765
20SCCMS8	80	189	350	174	171	685	765
20SCCMS9	90	189	350	174	83	750	765
20SCCMS10	100	189	350	174	0.00	846	765

Variations in the trial mix proportions for SCC with partial replacement of fine aggregate with M-sand at 10% increase in M20 graded These variations are demonstrated to be present. The trial mixes for M20 are referred to as 20SCCMS11, 20SCCMS2, and so on up to 20SSCCMS10, and their objective is to serve as a replacement for fine aggregate. M-sand is utilized to substitute ten percent of the fine aggregate, as shown by the mix identifier of 20SCCCMS1, which shows that mix. In a similar vein, mix 20SCCMS10 demonstrates that M-sand has totally replaced the fine aggregate, although to a lesser level than before.

CONCLUSION

River sand is a natural resource that is depleting at an alarming rate, it is of the utmost importance to reduce the amount of river sand that is employed by making efficient use of industrial by-products such as fly ash, M-Sand, and steel slag. In the event that fine aggregate is not accessible, M-sand and steel slag are used as an alternative in order to reduce the amount of natural resources that are needed and the amount of environmental damage that is created. According to the results that were published in the past, M-sand and steel slag have the potential to be employed as fine aggregates in the building of SCC as a partial replacement. When M-Sand and steel slag are used as fine aggregate in SCC, there is a reduction in the amount of resources that are depleted, the amount of money spent on construction, and the impact on the environment. The findings of this research will make it possible for the building and construction industries to focus on the use of M-Sand and steel slag as a partial replacement for fine aggregate. This will result in SCC that is comparable to or even better to that of fine aggregate.

REFERENCES

[1] Liu M (2011) Incorporating ground glass in self-compacting concrete. Constr Build Mater 25(2):919–925

[2] Ali EE, Al-Tersawy SH (2012) Recycled glass as a partial replacement for fne aggregate in self compacting concrete. Constr Build Mater 35:785–791

[3] Soliman NA, Tagnit-Hamou A (2016) Development of ultra-highperformance concrete using glass powder–towards ecofriendly concrete.Constr Build Mater 125:600–612

[4] Sheen YN, Le DH, Sun TH (2015) Innovative usages of stainless steel slags in developing self-compacting concrete.Constr Build Mater 101:268–276

[5] Qasrawi H (2014)The use of steel slag aggregate to enhance the mechanical properties of recycled aggregate concrete and retain the environment.Constr Build Mater 54:298–304

[6] Guo Y, Xie J, Zheng W, Li J (2018) Efects of steel slag as fne aggregate on static and impact behaviours of concrete.Constr Build Mater 192:194–201

[7] Anastasiou E, Georgiadis Filikas K, Stefanidou M (2014) Utilization of fne recycled aggregates in concrete with fy ash and steel slag. Constr Build Mater 50:154–161

[8] Sosa I, Thomas C, Polanco JA, Setién J, Sainz-Aja JA, Tamayo P (2022) Mar Durability of high-performance self-compacted concrete using electric arc furnace slag aggregate and cupola slag powder.Cement Concrete Compos 1:127

[9] Ali-Boucetta T, Behim M, Cassagnabere F, Mouret M, Ayat A, Laifa W (2021) Durability of self-compacting concrete containing waste bottle glass and granulated slag.Constr Build Mater 270

[10] Tariq S, Scott AN, Mackechnie JR, Shah V (2021) Glass powder replacement in self-compacting concrete and its efect on rheological and mechanical properties.J Sustain Cement Based Mater

[11] The European guidelines for self-compacting concrete specifcation, production and use Europe (2005) May. Available from www.efnarc.org IS:516–1959

[12] Singh G, Siddique R (2016) Strength properties and microstructural analysis of self-compacting concrete made with iron slag as partial replacement of fne aggregates.Constr Build Mater 127:144–152