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The Effect of Manufactured Sand on Self Compacting Concrete with Partially Replace by Industrial Waste: A Review

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ABSTRACT:

Concrete is a versatile construction material of this century. Concrete has several problems as a result of bad construction procedures and poor constituents in the concrete mix, but it is nevertheless a commonly used material. Poor compaction during construction is the primary cause of concrete deterioration. Honeycomb formations are the result of inadequately compacted concrete. This difficulty is solved with Self-Compacting Concrete (SCC) constructions since no external compaction or vibration is required. The labour required for compaction is also minimised by the development of SCC. SCC is one of the special concrete. It can compact by itself under the action of gravity or by its self-weight without vibration, bleeding, and segregation.

A large amount of industrial waste has been generated as a result of industrialization. Wastes are produced as a result of a variety of industrial activities. They have a wide range of properties and chemical compositions, and they have an impact on human health and the environment. As a result, waste management and disposal must be done safely in order to preserve a sustainable environment. The cement industry consumes much amount of the natural resources for the production of cement, in addition pollutes the atmosphere with the emission of CO2. Hence the waste materials from the industries, having pozzolonic nature can be used along with cement. Because of the rising shortage of river sand and natural aggregates across the country, the construction sector in India is under immense pressure to find alternatives for basic construction materials in order to fulfil the growing demand for infrastructure. Sand mining in rivers has been prohibited in several parts of our country due to its negative environmental impact.

Keyword: industrial waste, pozzolonic nature, Self-Compacting Concrete, Honeycomb formations, bleeding

INTODUCTION:

The foundation of human development is socioeconomic development. Industrial growth benefits society, but it also causes garbage to contaminate the environment. Waste disposal pollutes the environment, poisoning the water as a result. The majority of industrial processes generate waste products, as well as both helpful and harmful contaminants. With 4% of particle emissions, the building industry contributes significantly to pollution of the air, water, and noise. Carbon dioxide (CO2) is released when calcium carbonate is heated to extremely high temperatures for the production of lime, especially in the cement industry. This emission directly contributes to greenhouse gases. On the other hand, the sector also uses fossil fuels and other non-renewable energy sources to produce commodities. Once concrete production uses the least amount of energy possible, it will be a sustainable material. In addition, recyclable and ecologically friendly materials must be used to create sustainable materials. Cement use can be reduced by utilising industrial byproducts that directly lower carbon emissions, such as copper slag, rice husk ash, fly ash, and ground granulated blast furnace slag (GGBS). The purpose of the concrete industry's ongoing research into additional cementitious materials is to lessen the problem of disposing of solid waste. When industrial byproducts are used as a partial replacement for portland cement, significant energy and cost reductions are possible. The need for building resources like river sand and natural aggregates has increased significantly throughout India, placing tremendous pressure on the construction sector to find substitutes. Due to its detrimental effects on the ecology, sand mining in rivers has been outlawed in some areas of our nation. Conservation of natural resources is crucial to any modern development. Due to the dearth of natural resources, it is also important to handle alternative building materials well in order to create a comfortable environment.

SELF COMPACTING CONCRETE:

Okamura & Ouchi (1995) were the first to offer self-compacting concrete (SCC) to the concrete industry in the 1980s. To solve the lack of unskilled employees in the Japanese construction industry, SCC was established. When pouring regular concrete into crowded reinforcements, a number of difficulties in the compaction process were encountered. Self-Compacting Concrete was developed as a solution to this issue. One type of unique concrete is self-compacting concrete. Without vibration, bleeding, or segregation, it can compact on its own when weighted down or under the influence of gravity. Compared to regular concrete, SCC has a significantly higher fluidity without segregation. Its weight can completely fill any formwork corner. Less effort required to execute specific casting tasks and decreased time consumption are the main drivers of the increase in interest in SCC. SCC efficiently assumes the form of any intricate formwork and covers the reinforcement. Limiting the water-cement ratio, adding a potent plasticizer, raising the sand-aggregate ratio, and adding certain viscosity modifying agents are the steps required to produce SCC. The workers' health and safety significantly improve as a result of the removal of vibrator use and a large reduction in environmental noise loading on the site. Mineral admixtures are permitted in the SCC mix due to the presence of fine-grained inorganic components. Let's conduct more study using waste materials as mineral admixtures in SCC, some of which have already found use in actual applications**.**

MANUFACTURED SAND:

Rock deposits are crushed to make manufactured sand (M-sand). This alternative material can be generated in large quantities and has qualities that are comparable to fine aggregate in fresh and hardened concrete. To achieve quick infrastructure growth, a lot of natural sand is required. Due to this condition, developing nations like India struggle to find high-quality natural sand. Natural sand reserves are being depleted in India, greatly deteriorating the ecosystem. The scarcity of natural resources and environmental protection may be aided, according to many studies, by the use of widely available and cheaply priced substitute materials.

River sand is in scarce supply in India, so to meet demand, numerous alternative materials are used instead, including manufactured sand, copper slag, fly ash, slag, limestone, and siliceous stone powder. They serve as a partial substitute for fine aggregate in concrete mixtures (Shanmugapriya et al. 2014; Raju & Dharmar 2020; Nanthagopalan & Santhanam 2010). According to numerous investigations, M-sand among these materials proven to be an effective replacement for genuine river sand. Due to its higher paste volume, M-sand has been shown through numerous studies on alternative materials to be an acceptable substitute for river sand (Nanthagopalan & Santhanam, 2010). M-sand with a high concentration of micro fines can be used to produce concrete of excellent grade. Up to a certain point, the proportions of microfines generally tend to increase the compressive strength, flexural strength, bond strength, water permeability, impact resistance, sulphate resistance, and abrasion resistance. Insufficient paste to coat the aggregate causes the strength to decline once the limit is reached (Li et al. 2011; Amnon Katz & Hadassa Baum 2006; Li et al. 2009; and Celik & Marar 1996). Due to its higher fine content, M-sand also failed to meet the requirements of the current sand criteria. According to a study (Hameed & Sekar 2009 and Jadhav & Kulkarni 2012), the compressive, split tensile, and flexural strengths increased when 40 to 60 percent of the natural sand was replaced by M-sand. The shape and structure of crushed sand particles enhance the strength and durability of concrete due to improved interlocking between particles, even when the excess micro fines lower the strength of concrete.

GROUND GRANULATED BLAST FURNACE SLAG:

Adding additional cementitious components is suggested to enhance the qualities of concrete and make it more affordable and environmentally friendly. SCC mixes often contain a lot more fine fillers. (2012) Boukendakdji and others. blast furnace crushed into granules Slag is a material waste that comes from blast furnaces used to make iron. It is an eco-friendly material that ensures green building techniques and reduces environmental pollution. issues. GGBS is frequently used as a substitute for 35–65 percent Portland cement in concrete. By substituting 50% Portland cement for every tonne of cement, around 500,000 t of CO2 can be saved. Due to its advantages in terms of enhancing workability and making the mix more mobile and cohesive, GGBS is utilised successfully as a cement substitute in the construction industry all over the world. By forming a denser matrix with GGBS as a partial replacement for regular Portland cement, concrete increases strength and durability and increases the service life of concrete structures. Self-Compacting Concrete has also been successfully used with GGBS. The addition of GGBS to self-compacting concrete has various advantages, including improving its capacity to compact, consistency, and retention for a longer period of time. Dadsetan and others, 2017. The greater strengths of self-compacting concretes including GGBS at different replacement levels ranged from 30 to 100 MPa. (2013) Dinakar et al. The service life of concrete structures is extended and concrete durability is improved by GGBS. To achieve the goal of sustainable development in the production of concrete, this study examines the viability of employing ground granulated blast furnace slag as a partial replacement for cement in concrete.

FLY ASH:

A waste by-product of coal-fired power stations is called fly ash. Class C fly ash and Class F fly ash are the two types of fly ash often employed in the building sector. The proportion of calcium, silica, alumina, and iron in the ash makes a significant distinction between these two classes. To enhance the flow characteristics, fly ash is employed. Fly ash lowers the cement's hydration heat, which considerably reduces concrete's propensity for cracking. Fly ash can be added to self-compacting concrete to increase its fresh and hardened qualities. 2019; Karmegam et al. When fly ash is replaced by up to 35%, the rheological characteristics of SCC significantly improve, with good flow ability and Due to the spherical form of the particles, fly ash is the preferred additive for SCC. Fly ash is also added to the powder content to increase the workability of SCC to its fullest potential. Fly ash performs well in concrete because it has the right physical, chemical, and mineralogical characteristics.

OBJECTIVES OF THE THESIS:

This study uses an environmentally friendly additional cementitious material to examine the mechanical and durability characteristics of SCC.

- In order to create the SCC, GGBS, fly ash, and M-sand are used. The findings of tests on the effects of GGBS and M-sand on the SCC's fresh and hardened properties are presented in this dissertation. The following were the subjects of a thorough investigation using GGBS and M-sand.

- To research the rheological characteristics of SCC replacement with GGBS admixture.
- To assess the SCC's splitting tensile strength and compressive strength.
- To determine the ideal ratio of M-sand and GGBS in the SCC mixtures.
- This research offers a solution to the environmental issues caused by the disposal of GGBS and cement manufacture.
- This study intends to examine the mechanical and durability characteristics of SCC made from manufactured sand and ground granulated blast furnace slag.

LITERATURE REVIEW:

Okamura & Ouchi (1995) In terms of flow and passability, the SCC test approaches were investigated. It was also recommended to use the sensible mix design for SCC. It was researched how mortar behaved as a solid and a fluid under the impact of fine and coarse aggregate. Investigated were a number of on-site acceptability tests. In this investigation, a novel additive type and a segregation inhibitor were used. Additionally, some recommendations for self-compacting concrete applications were provided.

Manu Santhanam *et al*. (2004), SCC, or self-compacting concrete, has been extensively studied. More SCC usage-related topics, such as the design of the materials and mixtures, test procedures, construction-related issues, and properties, were covered in this paper.

Schutter *et al.* (2008) outlined the key elements of SCC, experimental techniques for determining fresh characteristics, mix design techniques, construction procedures, microstructures, and hydration. Engineering properties of SCC like creep, shrinkage, elastic modulus, compressive strength, and binding with reinforcements were also discussed, along with durability characteristics, deterioration mechanisms, and applications.

Girish *et al.* (2010) used fly ash as a filler to conduct an experimental study on the impact of paste and powder on self-compacting concrete mixtures. For each series of trials, water was kept constant among the various water contents w/c ratios investigated. Slump flow, V funnel, and J-ring tests were used to evaluate SCC performance. The results demonstrate that as paste volume increases, SCC's flow characteristics also increase.

Gowda *et al.* (2011) In order to create Self-Compacting Mortar (SCM) mixes, an attempt was made to partially substitute cement and sand with quarry dust (QD) and rice husk ash (RHA), respectively. Instead of cement, RHA substitution ranges from 5 to 20%. In place of natural sand, 40% QD was the ideal amount. To determine whether adding RHA and QD to SCM mixtures would be practical, the results of the compressive strengths tests were compared.

Uysal *et al*. (2012) tried to make SCCs by adding different mineral admixtures, including Fly Ash (FA), Marble Powder (MP), Limestone Powder (LP), Basalt Powder (BP), and Granulated Blast Furnace Slag (GBFS). To assess the viability of SCC, the slump flow, T50 time, L-box, and V-funnel tests were used. Compressive strength and ultrasonic pulse velocity were used to determine the toughened characteristics. The workability of the SCC mixes was significantly improved by the inclusion of FA and GBSF. After 28 days, GBFS replaced 20% of the cement, yielding strength greater than 78 MPa.

Studies on durability, including water and chloride ion permeability, were also conducted. According to test results, SCC might be produced using any filler substance. Additionally, a blend of 60% GBFS and 40% PC offered the highest defence against chloride ion permeability. On the other hand, the results of the impermeability depth tests ranged from 4.42 to 12.58 mm. Ramanathan *et al*. (2013) investigated the workability tests (slump, L-box, U-box, and T50), as well as the strength characteristics of self-compacting concrete containing various mineral admixtures, such as compressive, flexural, and split tensile strength. The performance of mineral admixtures replaced for cement by 30%, 40%, and 50% is compared. Silica fume, fly ash, and powdered granulated blast furnace slag were employed as mineral admixtures. Particle size distribution, particle shape, and surface characteristics all play a significant role in how mineral admixtures affect admixture requirements. Thus, a cost-effective self-compacting concrete can be made by combining silica fume, fly ash, and powdered granulated blast furnace slag in the proper quantities.

Dadsetan *et al*. (2017) Three self-compacting mortars, meta kaolin, ground granulated blast-furnace slag, and fly ash were used in place of cement in the SCC combinations. They investigated SCC's mechanical and microstructural characteristics. By using SCMs, compressive strengths were improved. In contrast to other materials, metakaolin was recommended as an efficient SCM replacement material. With the exception of 10% GGBS, MK and GGBS were able to improve cement replacement levels' modulus of elasticity.

Karmegam *et al.* (2019) The potential for recycling Granite Sawing Waste (GSW) in Fibre Reinforced Self Compacting Concrete (FRSCC) utilising Polypropylene (PP) fibres was experimentally studied. Investigated was the efficacy of GSW at 5, 10, 15, and 20% of weight in place of cement. At volume fractions of 0.05, 0.1, and 0.15%, PP fibres were used. As an extra mineral additive, fly ash was employed. The GSW and PP fibres improve the FRSCC's compressive strength and splitting tensile strength, it is determined.

Celik & Marar (1996) have investigated the effects of different crusher dust content ratios on the characteristics of both fresh and hardened concrete.

Sahu *et al.* (2003) utilised fine aggregate made of crushed stone dust. In this investigation, natural sand was used to partially replace stone dust. M20 and M30 grades of concrete were made and tested. The experiments demonstrate that discarded crushed stone can be used successfully as fine aggregate.

Prakash Rao & Gindar Kumar (2004) used river sand and stone crusher dust to research the characteristics of concrete. The studies revealed that stone crusher dust had a positive impact on concrete's compressive strengths and RC beams' flexural behaviour. Additionally, the failure loads and fracture patterns of concrete containing river sand were compared.

Katz & Baum (2006) The impact of fines in aggregates on the creation of concrete has been experimentally explored. The impact of adding particles to concrete with normal strength was investigated. The concrete compositions were made to always be workable. As long as the admixture is added in the proper amounts to maintain workability, fines can increase concrete strength by up to 30%, lower carbonation rate, and slightly increase volume changes of both fresh and cured concrete. Due to the existence of significant numbers of ultra-fine particles, the properties of the concrete were significantly affected when sufficient admixture dosages were added to maintain workability.

Gonçalves *et al.* (2007) studied how various manufactured fine aggregates produced by impact or cone crushing and natural sand affected the performance of cement mortars. Also performed was an examination of particle shape. The mortars were distinguished by the largest porosities, absorptivities, and lowest unconfined compressive strength, which were most likely caused by their poor particle morphologies. The categorised product from cone crushing also had a low packing density.

Ilangovan *et al*. (2008) investigated if it would be possible to use quarry rock dust as a complete replacement for natural sand in concrete. Studies on mechanical performance and durability were done. The findings indicated that concrete constructed of quarry rock dust had almost 10% greater compressive, flexural, and durability studies than regular concrete.

George *et al*. (2008) utilised synthetic sand and quarry dust in place of river sand while creating concrete. The M30 concrete mix was created. There were four mix ratios created. Both types of replacements increased the concrete's tensile strength.

Kou *et al.* (2009) tested SCC's durability and freshness qualities. Recycled concrete aggregates were used to replace the coarse and fine aggregates. The findings demonstrate that there were minimal changes in the qualities of SCCs formed from crushed fine recycled aggregates and river sand.

Malagavelli *et al.* (2010) We tested the qualities of M30 grade concrete and partially substituted river sand with ROBO sand (crushing dust) and cement with GGBS. The findings showed that the concrete's strength was significantly higher than that of regular mix concrete.

Li *et al*. (2011) investigated the effects of manufactured sands' Los Angeles abrasion value, Los Angeles crushing value, surface roughness, parent rock types, and micro fines content on the strengths and abrasion resistance of MS-PCC. When the surface roughness of the sand particles is more noticeable and the crushing value is lower, the MS-PCC has higher compressive and flexural strengths.

Nanthagopalan *et al.* (2011) investigated the use of M-sand in SCC. Using M-sand, researchers looked at the impact of paste volume and w/p ratio (water to powder ratio) on SCC characteristics. The powder and aggregate combinations were optimised using the particle packing method. Fresh concrete tests, including slump flow, T500, J-ring, and hardened concrete compressive strength tests, were performed on SCC. Using M-sand, SCCs with low and medium strengths (25–60 MPa) were produced.

Corinaldesi *et al.* (2011) examined the use of mineral additives like recycled aggregate powder (a powder made from the rubble recycling process), fly ash, or limestone powder in the SCC. The characteristics of freshly laid concrete were evaluated using the Slump Flow, L-box test, and Segregation Resistance. When coarse recycled aggregate and rubble powder are used together with increased fresh concrete performance, the SCC mixture can be optimised.

Jadhav *et al.* (2012) examined how the water-to-cement ratio affected M20 grade concrete that contained synthetic sand rather than natural sand. The results of the tests on the qualities of the concrete when it was fresh and after it had cured showed that it had good strength even with the replacement of 60% natural sand.

Elavenil & Vijaya (2013) discovered that M-sand's particle size distribution contributes to better packing density, improving the concrete's durability. In comparison to river sand-based concrete, M-sand-produced concrete has stronger flexural strength, increased abrasion resistance, higher unit weight, and lower permeability because the pores are filled with microfines.

Tao Ji *et al.* (2013) Based on the minimum paste hypothesis, the mix percentage for manufactured sand concrete (MSC) was designed. The addition of the micro particles replaced some of the cement. It was investigated how the workability and mechanical properties of MSC were impacted by the presence of microfines. The study found that MSC can contain micro fines as a component and that adding micro fines in moderation can increase MSC's workability, compressive strength, axial compressive strength, splitting tensile strength, and elasticity modulus.. More micro fines can reduce the mechanical characteristics of MSC, though, when added to concrete. By applying the minimal paste theory, the volume stability and cracking-resistant performance of MSC were enhanced.

Tuljaramsa *et al.* (2015) The use of M-sand in powder-based SCC was looked into. Both newly developed and toughened qualities underwent testing. The findings indicated that 30% M-sand replenishment was the ideal amount.

Ganesh Babu *et al*. (2000) have examined the effectiveness of GGBS in concrete and come to the conclusion that GGBS concretes can be designed for a desired proportion of replacement.

Rafat Siddique (2001) studied SCC constructed from Class F fly ash for its self-compactability (fresh characteristics), strength, and durability. The range of class F fly ash used in the five percentages was between 15% and 35%. After 28 days, SCC mixes had compressive strengths between 30 and 35 MPa and splitting tensile strengths between 1.5 and 2.4 MPa. The findings demonstrated that the properties of SCC were enhanced with the addition of fly ash, including an increase in carbonation depth at 20% fly ash content, pH values greater than 11 for all mixes, increased weight loss from deicing salt surface scaling, and very low chloride permeability resistance (less than 700 and 400 Coulomb) at ages of 90 and 365 days, respectively.

Li *et al.* (2003) studied how the additives FA and GGBS affected the characteristics of high-strength concrete. The microstructure of the concretes was examined using a scanning electron microscope at 7 and 360 days. The findings demonstrate that the use of both FA and GGBS improved the short- and long-term characteristics of concrete.

Nehdi *et al.* (2004) examined SCC's durability characteristics. Measurements were made of the SCC mixes' fresh concrete characteristics and compressive strength at 1, 7, 28, and 91 days. The results show that SCC can be produced using high-volume replacement composite cement and has good workability, long-term strength, resistance to surface scaling by deicing salt, low sulphate expansion, and very low chloride ion penetrability.

Gao *et al.* (2005) have examined the morphology of hydrates in concrete containing GGBS as as well as the aggregate-cement paste's Interfacial Transition Zone (ITZ). Microhardness measurements, scanning electron microscopy, and X-ray diffraction were all used in the investigation. The experimental results demonstrated that GGBS significantly lowers both the quantity and orienting direction of CH crystals at the ITZ. The authors come to the conclusion that the pozzolanic reaction of GGBS enhanced the weak ITZ between aggregate and cement paste. With GGBS particle sizes getting smaller, the aforementioned gains become significantly more significant.

Boukendakdji (2009) had measured how Algerian slag affected the characteristics of newly-poured and hardened self-compacting concrete. In general, SCC mixes contain a much more fine fillers. The use of additional cementitious ingredients is well known for improving the properties of concrete while being economical and environmentally beneficial. SCC's workability and toughened characteristics were noted. The optimal slag content among the various Algerian slags was found to be 15%. Increased slag content resulted in a decrease in compressive strength, but this decrease in compressive strength becomes less pronounced at later ages (56 and 90 days after mixing).

Nazari *et al*. (2011) have tested SCC for strength and the proportion of water absorption. Different ratios of powdered granulated blast furnace slag and TiO2 nanoparticles were employed in place of Portland cement, including 45 percent of the former and up to 4 percent of the latter. Since the TiO2 nanoparticles accelerated the development of C-S-H gel, the compressive strength and water resistance of concrete specimens were improved. For predicting the concrete specimens' flexural and split tensile strengths, the researchers proposed a number of empirical connections.

MATERIALS:

Following is a quick discussion of the materials employed in the current experiment to produce SCC and their properties.

CEMENT: The well-known building ingredient cement has long played a crucial role in construction projects. varying cement brands have varying strength development characteristics and rheological behaviour as a result of variations in compound composition and fineness. As per IS code IS: 12269-2013, ordinary Portland cement of grade 53 was used in this study. The cement was ultra-tech. In Table 3.1, the physical characteristics are displayed. By using a 90 micron screen, the cement was found to be 1% fine.

Cement properties

Properties	**Value**
Fineness	1 % /330 m^2/kg
Specific gravity	3.14
Initial setting time	35 min
Final setting time	10 hrs
Consistency	38 %

COURSE AGGREGATE: For constructions with crowded reinforcement, 10mm CA is the ideal size. The recommended aggregate should also be well-graded and spherical or cubical in shape. In order to lessen the challenges of making, mixing, and putting concrete as well as to prevent aggregate segregation in new concrete, the maximum size of CA chosen in this study was 15mm. Used as coarse aggregate was crushed granite stone that passed 12.5 mm and retained 10 mm. The physical characteristics of the coarse aggregate material are displayed in Table

Table Coarse aggregate properties

Properties	**Value**
Bulk Density	1463 kg/m^3
Specific gravity	2.73
Fineness modulus	6.89

FINE AGGREGATE: The fine aggregates used were Ordinary river sand and M-sand, obtained from nearby quarries as shown in Figure 5.1. Both materials were tested as per Indian Standard specification IS 383-1970.

Figure Manufactured sand

Table Properties of river sand

Properties	**Values**
Bulk Density	1600 kg/m^3
Specific gravity	2.56
Fineness modulus	2.72

Table Results of sieve analysis: River sand

Sieve size in mm	**Weight retained in grams**	**Cumulative Weight retained in grams**	**Cumulative Percentage retained in grams**	**Percentage passing**	**Grading for Zone II Conforming to IS: 383,1970**
4.75	21	21	2.1	97.9	90-100
2.36	35	56	5.6	95.7	75-100
1.18	191	247	24.7	78.3	55-90
0.6	309	556	55.6	44.4	35-39
0.3	282	838	83.8	16.2	8-30
0.15	162	1000	100	0	0-20

The most popular choice for fine aggregate is natural sand, however sand mining has had terrible effects on the ecology. Use of M-sand as a fine aggregate in concrete manufacturing can lessen these effects. M-sand is created by crushing rock and gravel to the desired grain size. The M-sand utilised has a specific gravity of 2.53. Figures 3.2 and 3.3, which depict the particle size distribution of the natural sand and M-sand samples used in this investigation, respectively.

Table Properties of M-sand

Properties	**Value**
Bulk Density	1665 kg/m^3
Specific gravity	2.53
fineness modulus	2.62

Table Results of sieve analysis: M-sand

Sieve size in mm	**Weight retained in grams**	**Cumulative Weight retained in grams**	**Cumulative Percentage retained in grams**	**Percentage passing**	**Grading for Zone II Conforming to IS: 383,1970**
4.75	0	0	0	100	90-100
2.36	43	43	4.3	95.7	75-100
1.18	174	217	21.7	78.3	55-90
0.6	314	531	53.1	46.9	35-39
0.3	304	835	83.5	16.5	8-30
0.15	165	1000	100	0	0-20

FLY ASH: One of the most often used industrial waste materials in the manufacturing of concrete worldwide is fly ash. It possesses outstanding pozzolanic characteristics. An unwanted byproduct of coal-fired power plants is called fly ash. In these power plants, coal is ground to the consistency of fine powder before burning. Fly ash is a mineral byproduct of coal combustion that is used and is collected from the exhaust gases of power plants. The

IS3812 (part1): 2003 standard was satisfied by the Class F fly ash that was obtained from the "Mettur Thermal Power Plant" next to Mettur Dam in Salem, Tamilnadu, India. In Figure the Fly ash sample is displayed.

Table Properties of Fly ash

Properties	Value
Fineness	325 m^2/kg
Specific gravity	2.16

GROUND GRANULATED BLAST FURNACE SLAG (GGBS): In this research, GGBS, a waste product from blast furnaces acquired from the iron industry, was employed as cement's replacement material. In the building industry all around the world, GGBS is used as an effective substitute for cement. Self-compacting concrete has been made with success using GGBS. A non-metallic substance called GGBS contains silicates and aluminates of calcium as well as other bases. A non-metallic material made of calcium and other basic silicates and aluminates is known as ground granulated blast furnace slag. In terms of improving its compatibility consistency and retaining it for a longer period of time, the addition of GGBS to self-compacting concrete offers several advantages. According to studies done with a scanning electron microscope, the GGBS is made up of dense, abrasive micro-sized angular particles. The range of particle sizes is roughly between 1 and 60 microns. By volume, 40–50% of the particles have a size close to one micron. Utilised GGBS was purchased from Astra Chemicals in Chennai, India. Slag quality meets the specifications of IS 12089-1987.In Figure 3.5, the GGBS sample is displayed.

Figure Ground granulated blast-furnace slag

Table Properties of ground granulated blast-furnace slag

Properties	Values
Fineness	390 m^2/kg
Specific gravity	2.85

SUPER PLASTICIZER: The flow properties were obtained using the Superplasticizer (SP). The essential elements of SCC are superplasticizers or high-range water-reducing admixtures. It is the responsibility of SP to offer a high level of flow ability and deformability. The chosen sulphonated naphthalene polymers serve as its foundation. The brand name of the item is Conplast SP430. Table provides a list of the Superplasticizer's physical characteristics.

Table Superplasticizer properties

Properties	Values
Specific Gravity	1.1
Appearance	Brown Liquid
Chloride Content	Nil

WATER: The most necessary and affordable component of concrete is water. The hydration of cement uses a portion of the water used for mixing. As a lubricant between the fine and coarse aggregates, the residual water is helpful. Concrete may typically be poured with water that is safe for drinking. Concrete mixing and curing require clean water devoid of contaminants like oil, acids, alkalis, vegetable matter, etc. If not, it can damage the concrete and cause the reinforcement to corrode. In this investigation, the common potable water that was accessible in the lab was used. Table 3.10 provides a list of the characteristics of water.

Table Water properties

Test conducted	Value	Permissible value as per IS 456 – 2000
Chloride content	114.0 mg/l	500 mg/l
pH value	7	Not less than 6.0
Total Dissolved Solids	460 mg/l	500 mg/l (as per IS 10500-2012)
Total hardness	80 mg/l	200 mg/l

SUMMARY:

It was investigated how well GGBS and M-Sand were used in self-compacting concrete. Both of the substances can be utilised as acceptable substitutes for cement and fine aggregate. This study proved that GGBS and M-sand can be used to create environmentally friendly self-compacting concrete. Researchers looked at how GGBS and M-sand affected self-compacting concrete. According to the findings, adding M-sand to GGBS boosts SCC's compressive strength. The cement substituted with a 20% GGBS content in the accepted concrete mixes is the best content compared to other Proportions. G20 MS40 has a higher compressive strength than the other mixtures overall. Investigations were made into the SCRCC beam's flexural behaviour.

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