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STUDY ON PERFORMANCE OF SELF-COMPACTING CONCRETE USING SCBA AND GGBS FOR SUSTAINABLE CONSTRUCTION: A REVIEW

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Abstract - *The intent of this investigation is to look into the use of ash from sugarcane bagasse (SCBA) and blast furnace slag in self-consolidating concrete (SCC), as well as to look into the existing research on their usage in cementitious materials. This study looks at previous research on SCBA and GGBS concrete and focuses on the major components of SCBA and GGBS material, the hydraulic reaction of SCBA and GGBS in concrete, and the toughness properties of SCBA as well as GGBS concrete. According to the literature review, using SCBA and GGBS in concrete buildings will be both cost-effective and ecologically friendly. The second commonest material in the world, after water, is cement, which is the most essential element of the concrete mix for buildings. However, we are aware that it causes significant environmental damage due to the production of carbon dioxide during the cement-making process. According to the study, every ton of cement manufactured releases half a ton of pollutants, which is a significant amount of carbon dioxide; hence, immediate intervention is required. Because cement demand and usage are increasing on a daily basis, it is critical to find a substitute binding substance that can replace cement. Mineral admixtures such as industrial and agricultural wastes can be utilized in concrete composites since they have comparable chemical characteristics to cement and the same pozzolanic activity. The study concentrated on the fundamental characteristics of self-consolidating concrete (SCC) made using additives such as blast furnace slag and bagasse ash. Many research studies have been conducted on the fundamental precepts of self-consolidating concrete (SCC), which was created by incorporating blast furnace slag and bagasse ash as extra cementitious components.*

Key Words: Self-compacting concrete (SCC), Sugarcane bagasse ash (SCBA), Ground-granulated blast furnace slag (GGBS), Sustainable constructions.

1. INTRODUCTION

In place of cement, fine aggregates, coarse aggregates, and reinforcing elements, several industrial and agricultural waste products are already employed in concrete. This review study illustrates the partial substitution of SCBA and GGBS for cement and sand in concrete. The durability of various qualities of freshly formed and cured concrete when combined with SCBA and GGBS will be discussed [7].

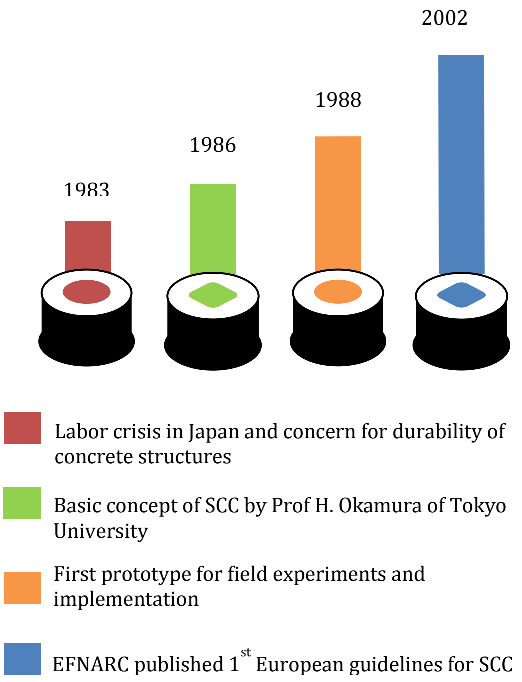
Reusing industrial and agricultural waste in concrete composites as a sustainable alternative to traditional disposal methods like composting, incineration, and landfill dumping helps to alleviate the pollution issue that results from these methods. By increasing the amount of SCBA and GGBS, cement can be substituted for SCBA and GGBS to achieve the best compressive strength [10]. The W/C ratio can be decreased by adding mineral admixtures like SCBA and GGBS, and the workability can be improved by adding the superplasticizer dosage. In applications involving civil infrastructure, SCBA and GGBS may be the best options. Due to advantages in durability, sustainability, appearance, and strength gained by partially replacing with cement, the scopes of SCBA and GGBS are favourable, because it has qualities similar to cement, we may use industrial and agricultural waste in concrete composites.

The utilization of industrial byproducts as supplementary cementitious materials (SCMs) is gaining widespread attention due to its potential for sustainable development in the construction industry. Blast furnace slag and bagasse ash (SCBA) have emerged as viable alternatives due to their capacity to improve concrete durability as well as strength. GGBS is a powder-form byproduct of the metals sector that can partially replace Portland cement in concrete manufacture. SCBA, a byproduct of the sugarcane industry, on the reverse side, is a cementitious substance that may be utilized as a partial substitute for concrete.

In conclusion, the utilization of GGBS and SCBA as SCMs in concrete production has the potential to offer sustainable solutions to the construction industry by improving the strength and durability of concrete while reducing its carbon footprint. The synergy between these two materials, along with their pozzolanic and hydraulic properties, can lead to the production of denser, more durable, and sustainable concrete. Therefore, the use of GGBS and SCBA in concrete production should be encouraged as an environmentally friendly approach to construction.

2. THE BEGINNINGS OF SCC

Prof. Okamura first put up the concept of the SCC in 1986. To maintain homogeneity and compaction of cast-in-situ concrete within thin structural parts, however, and consequently increase the longevity of concrete structures, Prof. Dr. Hajime Okamuara at the University of Tokyo invented SCC in Japan in 1988. Japanese contractors embraced the concept fast [15].

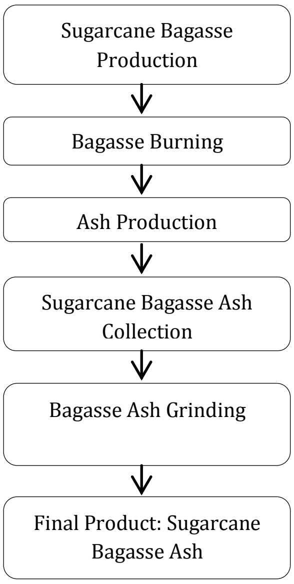


SCC, which does not require vibration to accomplish complete compaction, was utilized and developed in Japan in the early 1990s. The SCC became increasingly well-known in Japan for ready-mixed concrete and prefabricated items around the year 2000. Some European countries emphasized the value and promise of the SCC's expansion in Japan. In 1989, they established the European Federation of Natural Trade Associations to represent manufacturers and consumers of specialty construction materials.

3. SUGARCANE BAGASSE ASH (SCBA)

By replacing some of the cement with SCBA, the amount of cement required in concrete production can be reduced, thereby lowering the overall carbon footprint of the concrete.

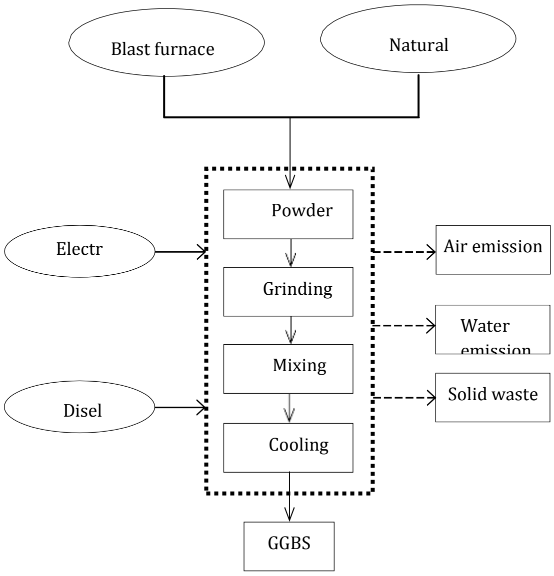
SCBA can enhance the characteristics of the resultant concrete in addition to its environmental benefits. SCBA is rich in silica and alumina, two substances that are key components of cement. When used as a partial substitute for cement, SCBA reacts with water to form supplementary cementing components such as calcium silicate hydrate (C-S-H) and calcium aluminate hydrate (C-A-H). These additions improve the finished concrete's strength and durability, as well as its resistance to chemical attack and other types of degradation.



Flowchart -1: Process of SCBA

4. Ground-granulated blast furnace slag (GGBS)

When utilized as a cement alternative, GGBS can give various advantages to the final concrete. For one, it can help to reduce the amount of heat generated during the curing process, which can be particularly beneficial in large pours or in hot climates. Additionally, GGBS can help to increase the durability of the concrete, making it more resistant to chemical attack, abrasion, and cracking over time.



Flowchart – 2: Process of GGBS

One of the most significant advantages of utilizing GGBS as a cement substitute is that it can assist to minimize the carbon footprint of the final concrete. Since the production of cement is a significant source of greenhouse gas emissions, using GGBS can help to offset some of these emissions by reducing the amount of cement needed in the concrete mix.

5. LITERATURE REVIEW

Because of its numerous advantages, including better durability and a lower ecological footprint, SCBA and GGBS have gained popularity as an alternative to regular cement in recent years. However, a comprehensive review of the existing literature on SCBA and GGBS is needed to better understand its properties, applications, and limitations.

Amaresh Tripathy et al. (2022) [1] provided study summaries of the taken proactive procedures and methodologies utilized for SCBA property enhancement, as well as their consequences in light of the tests done and the findings acquired, in order to establish the feasibility of SCBA in the construction sector. According to this study, processed SCBA performs better than its untreated version when employed as an additional binder and filler material, with a 20% ideal substitute.

S.S. Vivek (2021) [2] researched to employ metakaolin and blast furnace slag as cement replacements in various combinations to enhance the performance of SCC. Using laboratory testing, the study established the ideal superplasticizer dose of 1.25% of the weight of cement and the water-to-powder proportion of 0.40. The fresh properties of the ternary SCC mixtures met the EFNARC guidelines. Substituting 5% metakaolin and 30% GGBS for cement increased compressive strengths by 6.64% and 2.22%, respectively, while the axial compressive strength increased by 7.71% and 5.23%, respectively. Flexural strength increased by 45.11% and 12.84% with 15% metakaolin and 30% GGBS, respectively. C-S-H and CA-S-H compounds may be responsible for the improvement in mechanical properties. However, exceeding 30% GGBS in the ternary SCC mix may reduce mechanical properties.

Hugo A.A. Diniz et al. (2021) [3] examined the effects of four different substances (MK, SCBA, RHA, and HL) on the physical properties, mechanical properties, and long-term durability behaviours of SCC. The carbonation test findings showed that SCBA performed badly when compared to the other supplemental cementitious materials, except for the exception of concrete RH30 (SCMs). The primary reason for this is believed to be the poor particle size distribution of SCBA, which increased the porosity of the concrete. Additionally, SCBA exhibited lower pozzolanic reactivity than RHA at the same substitution levels, likely due to a lower carbonation depth.

B. Selvarani et al. (2021) [4] demonstrated the properties of SCC when coupled with various kinds of additives, as well as percentages of substituting GGBS (5%, 10%, 15%, 20%, 25%, 30%) and Polypropylene filaments (0, 0.5, 1.0, 1.5, 2, 2.50 Kg/m3) for cement. At a 25% substitution of GGBS, the maximum compressive and flexural strengths were attained. The split tensile strength at 28 days is increased by GGBS (25% + fiber, 1.00 kg/m3). It was decided that 25% and 1.00 kg/m3 of GGBS and polypropylene filaments, which were discovered to be strong and environmentally friendly cement, respectively, are the optimal substitute levels for self-compacting concrete.

Ather Ali et al. (2021) [5] examined the characteristics of self-compacting concrete made by mixing RHA and SCBA. Partial replacement of sand with a mixture containing 0, 10, 20, and 30% RHA and SCBA, respectively. The results show that flow ability declines with increasing ash replacement amount and that flow is present in all mix formulations within standard limits. The mix compositions' capacity for passing and filling has met EFNARC requirements. The compressive strength of concrete mixes enhanced from 35 to 49 MPa between 28 and 90 days of curing age, demonstrating enhanced pozzolanic activity with a 20% substitution of SCBA. Concrete mixes are cured in both damp and dry circumstances, with water-cementitious material ratios ranging from 0.40. A 20 percent replacement of SCBA between 28 and 90 days of curing age resulted in an increase in compressive strength from 35 to 49 MPa, indicating improved pozzolanic activity. The use of RHA and SCBA as sand replacements introduces air into the cement paste matrix due to the increased surface area and adsorptive qualities of ashes. The average water absorption measured on 91-day samples of SCBA mix groups 10, 20, and 30% was reduced by 34%, 30%, and 42%, respectively, when compared to 28-day samples. When the SCBA substitution level was raised by 20% and 30% during sulfate resistance testing, the resistivity dropped by 10% and 34%, respectively, as assessed on specimens with 30% BFS at 91 days.

Amreen Khatun et al. (2018) [6] explores the incorporation of sugarcane bagasse ash (SCBA), an agricultural residue, into self-compacting concrete at different levels, ranging from 0% up to 25% in increments of 5%. Self-compacting concrete that has been treated and undergone control is assessed for its fresh, mechanical, long-lasting, and microstructural qualities. For each percentage of SCBA replacement with cement, the fresh qualities of concrete were examined, and the findings indicate that 10% SCBA replacement with cement yields the best outcomes. Cement replacement with SCBA at a rate of 10% results in the highest flow ability of the concrete, proving that 10% is the ideal percentage for getting the best outcomes from self-compacting concrete. Rest all tests conducted on newly-poured concrete within the range allowed by European rules when 10% of the SCBA is replaced with cement. Similar proportions of substances including zeolite H-ZSM-5, carbon sulphate, Hannebachite, and calcium carbonate were observed. These substances are a sign that silica and calcium oxides, which improve self-compacting concrete's effectiveness, are present in the concrete.

Duc-Hien Le et al. (2018) [7] focuses on the combined utilisation of agricultural and industrial wastes in the production of environmentally friendly concrete. He also researched the qualities of fresh and hardened self-compacting concrete (SCC) made from blended cement, such as SCBA, GGBS, and OPC. Cement was replaced with SCBA and GGBS by a proportion of 0-30%. At 28 days, the SCBA 20% had the best compressive strength, whereas the SCBA 30% had the highest strength after 91 days. Water absorption was decreased by 34%, 30%, and 42% on average when 91-day samples were compared to 28-day samples for SCBA mix groups 10, 20, and 30%, respectively. When the SCBA substitution level was increased by 20% and 30%, the resistivity of the specimen decreased by 10% and 34%, respectively, with 30% GGBS at 91 days.

Ardra Mohan et al.(2017) [8] utilized silica fume and ultra-fine GGBS with SCC in various ratios as replacements for regular Portland cement, including 0%, 5%, 10%, and 15%. (OPC). He looked into the mechanical and fresh characteristics of self-compacted concrete made with GGBS that was extremely fine and silica fume. 10% of GGBS added has a strong chance of working. The compressive strength (72.44 MPa at day 90) and split tensile strength (4.46 MPa at day 28) increase with a 10% replacement of ultrafine GGBS by the addition of various mineral admixtures. All of the combinations met EFNARC requirements and had good workability characteristics. When compared to SCC alone, SCC plus SCM increase mechanical properties. When compared to other mixes, 10% silica fume offers the greatest compressive strength and split tensile strength. Ultra-fine GGBS and SCC with silica fumes reached their peak strengths at 10% replacement. Concrete can be infused with SCM, a byproduct of numerous industries, to decrease the environmental impact of waste disposal.

V.Murali Krishnan et al. (2017) [9] focuses on the effects of mineral admixtures, especially fly ash and blast furnace slag, on self-compacting concrete flow capacity and segregation resistance (SCC). Several weight percentages of GGBS were utilised to replace cement in the M-30 mix, including 0%, 25%, 30%, 35%, and 40%. The strength of the SCC concrete was determined to be 47.56 MPa after 28 days and 25% GGBS. The split tensile and flexural strength were also measured after 28 days and a 25% increase in GGBS concentration. For all mixtures, the rate of chloride penetration is moderate. The strength of the concrete rapidly decreased as the GGBS portion climbed over 40%.

Rachael Challagalli et al. (2017) [10] carried out research on creating an SCC, testing its fresh characteristics, and replacing cement in all combinations. The fineness of the particles affects the concrete's ability to flow, and alccofine and GGBS include finer particles, which enhance the cement paste's lubricating properties and improve workability. Because of its high calcium oxide concentration, concrete performs better. The strength of concrete is increased by increasing the particle packing by adding fillers like alccofine and GGBS. GGBS outperformed fly ash and bagasse ash in terms of strength. For SCC, ternary and quaternary mix mixes can be created using these mineral admixtures. It can be inferred that alccofine should be added to high-strength concrete instead of bagasse ash as the strength attained when sugarcane bagasse ash was used was lower.

S.Saranya (2017) [11] investigated the use of GGBS and fly ash in self-compacting concrete (SCC) in various proportions was explored, with OPC substituted by 25%, 35%, or 45% fly ash and 40%, 50%, or 60% GGBS. The presence of GGBS resulted in a 60% drop in the compressive and flexural strengths of the resulting concrete, according to an analysis of its strength properties. The ideal amount for concrete has been determined to be 40% GGBS. The inclusion of GGBS reduced the split tensile strength test results for concrete by up to 50%. While mineral admixtures have a direct effect on flow, removing admixtures has an inverse connection with strength.

TS Kumar et al. (2017) [12] determined the concrete was made by substituting locally sourced agricultural waste ash (BA) for cement, in varying proportions of 5%, 10%, 15%, 20%, and 25% by weight. The experiment showed that replacing cement with both BA and silica fume resulted in decreased drying shrinkage values for Ternary Bagasse Ash Silica Fume (TBASF) Concrete.

Shafiq N et al. (2016) [13] confirmed that SCBA has been shown to have promise as a cement alternative in concrete. SCBA's chemical composition, fineness, and well-controlled combustion process were discovered to let it serve as a cement substitute material. The SCBA concentration in concrete was changed from 5 to 50% to partially substitute cement during the investigation, and the effect on workability, compressive strength, splitting tensile strength, and bond strength was assessed. According to the findings, integrating SCBA (at 5-50% content) boosted the slump value of fresh concrete. When compared to cement-only concrete, concrete with 5-30% SCBA improved in mechanical parameters such as compressive strength, splitting tensile strength, and bond strength.

Ganesh Babu et al. (2015) [14] discovered that SCBA can be used to replace cement up to a maximum of 10%, however 1% is the ideal degree of replacement. When SCBA is used to partially replace cement, it improves the workability of fresh concrete and reduces the requirement for superplasticizers. The density of the concrete reduces as the amount of SCBA rises, resulting in a lower weight material generated from waste resources.

Prashant O Modani et al. (2013) [15] analyzed the properties of untreated bagasse ash when used as a substitute in concrete, at varying percentages of 0%, 10%, 20%, 30%, and 40% by volume of FA, while maintaining a constant superplasticizer dosage of 0.8% and a w/c ratio of 0.40. The findings demonstrated that specimens with 10% SCBA replacement had concrete strength greater than those of specimens with 0% SCBA replacement. However, as the SCBA replacement percentage increased, the development of mix tensile strength decreased. The sorptivity coefficient was also found to increase as the percentage of SCBA increased and the concrete compressive strength decreased.

Table – 1: Literature study of SCBA and GGBS

Author(s)	Mineral admixture	Replacement percentage	Utilized as	W/C ratio	Curing days	Maximum replacement (%)
S.S. Vivek [2](2021)	GGBS & MK	30%, 40% & 50% by weight of cement	SCM	0.3, 0.40	28	30%
B. Selvarani et al.[4] (2021)	GGBS & PF	5%, 10%, 15%, 20%, 25% & 30% by weight of cement	SCM	0.4	7 & 28	25%
Muhammad Hamza Hasnain et al. [5] (2020)	RHA & SCBA	10%, 20%, & 30% by weight of cement	SCM	0.4	7, 28, 56 & 90	20%
Amreen Khatun et al. [6] (2018)	SCBA	5%, 10%, 15%, 20% & 25% by weight of cement	SCM	Varied	7, 28, & 56	10%
Duc-Hien Le et al. [7] (2018)	SCBA, GGBS & FA	10%, 20%, & 30% by weight of cement	SCM	0.45	7, 28, 56, & 91	10% (SCBA) & 30% (BFS)
Ardra Mohan et al. [8] (2018)	SF & GGBS	5%, 10% & 15% by weight of cement	SCM	0.34	7, 28, 56 & 90	10%
J.Vengadesh Marshall Raman et al. [9] (2017)	GGBS	25%, 30%, 35%, & 40% by weight of cement	SCM	0.4	7, 14 & 28	25%
Rachael Challagalli et al. [10] (2017)	GGBS, SCBA, FA & Alcofine	Various mixes	SCM	0.45	7 & 28	-
S.saranya [11] (2017)	GGBS & FA	40%, 50% & 60% by weight of cement	SCM	Varied	7 & 28	40%
T. Santhosh Kumar et al. [12](2017)	SCBA & SF	5%, 10%, 15%, 20% and 25% by weight of cement	SCM	0.35	7, 28, 56 & 90	5% & 10%
M.Ganesh Babu et al. [14] (2015)	SCBA	5%, 15% and 25% by weight of cement	SCM	0.48	7, 28, 56 & 90	10%
Prashant O Modani et al. [15] (2013)	SCBA	10%, 20%, 30% and 40% by volume of FA	SFM	0.4	7 & 28	10-20%
Othmane Boukendakdji et al. [17] (2011)	GGBS	10%, 15%, 20%, and 25% by weight of cement	SCM	0.40	7, 28, 56 & 90	15% & 20%
Mucteba Uysal et al. [18] (2011)	GGBS, FA, BP, MP	20%, 40% & 60% by weight of cement	SCM	0.33	7, 28, 90 & 400	40%
M.A. Megat Johari et al. [19] (2011)	GGBS, FA, SF, MK	Various mixes	SCM	0.28	1, 3, 7, 14, 28, 90, 180 &365	40%
N.B. Singh et al. [31] (2000)	SCBA	10%, 20% & 30% by weight of cement	SCM	0.5	1, 3, 7, 15 & 28	10%
Ganesan et al. [32] (2008)	SCBA	5%, 10%, 15%, 20%, 25% & 30% by weight of cement	SCM	0.53	7, 14, 28 & 90	10%
T. Akram et al [33] (2009)	SCBA	5%, 10%, 15% & 20% by weight of cement	SCM	0.37-0.43	7 & 28	15%
Chusilp et al. [34] (2009)	SCBA	10%, 20% & 30% by weight of cement	SCM	0.71-1.03	3, 7, 28 & 90	10%
Sua-Iam, G et al. [35] (2013)	SCBA	10%, 20%, 40%, 60%, 80% & 100% by volume of FA	SFM	Varied	3,7,28 & 91	10%
Rajasekar, A et al. [36] (2018)	SCBA	5%, 10%, 15% & 20% by weight of cement	SCM	0.18	7, 28 & 91	15%
Akkarapongtrakul A et al. [37] (2017)	SCBA	5%, 10%, 15% & 20% by weight of cement	SCM	0.5	7,28 & 90	15%
Kazmi, S.M.S et al. [38] (2017)	SCBA	10%, 20%, 30% & 40% by weight of cement	SCM	Varied	7, 14, 28 & 56	10%
Sua-Iam, G et al. [35] (2013)	SCBA	10%, 20%, 40%, 60%, 80% & 100% by volume of FA	SFM	Varied	3,7,28 & 91	10%

UC Sahoo et al. (2013) [16] suggested a novel approach for formulating self-compacting concrete with GGBS, in which the slag proportion was determined by taking into account strength needs and efficacy. The efficacy of the proposed mix design was evaluated via experimental research, revealing that the optimal replacement percentage was necessary for high strength, whereas a higher replacement percentage resulted in weaker concrete.

Said Kenai et al. (2012) [17] discovered that utilizing a Polycarboxilates-based superplasticizer, it was revealed that replacing cement with slag in self-compacting concrete is favourable. Although the initial strength of slag concrete is lower, the integration of slag in the concrete results in greater workability and strength. The yield stress and plastic viscosity decrease as the amount of slag in the mixture increases.

Mucteba Uysal et al. (2011) [18] focused the properties of self-consolidating concrete by replacing increasing quantities of mineral admixtures for Portland cement (PC), such as fly ash, blast furnace slag, limestone powder, basalt powder, and marble powder. The effects of these admixtures on self-compacted concrete flowability, strength, ultrasonic testing, specific gravity, and sulphate resistance were investigated. Sulfate resistance tests were also performed, which entailed immersing the material in 10% sodium sulphate and 10% magnesium sulphate solutions for 400 days. The studies revealed that fly ash and blast furnace slag significantly increased the flexibility and compressive strength of SCC combinations.

MA Megat et al. (2011) [19] examine the effect of various materials on attributes such as flexural strength, compressive strength, elastic modulus, porosity, and pore size distribution, such as silica fume, metakaolin, fly ash, ground granulated blast furnace slag (GGBS), and rice husk ash. The results showed that including GGBS into the concrete mix increased its workability, while the early strength was lowered due to the dilution effect, especially at high levels of replacement. The GGBS specimens had the greatest strength between 28 and 90 days following first setup.

M Liu et al. (2010) [20] conducted in order to produce a Self-Compacting Concrete (SCC) with a maximum of 80% cement substitution in all mixtures and assess its fresh qualities. The results show that fly ash acts as a lubricant and does not react with superplasticizer, which results in a repulsive force. As a result, superplasticizer has no effect on the cement. As a result, the more fly ash present, the less superplasticizer is required.

Paratibha Aggarwal et al. (2008) [21] developed a technique for testing self-compacting concrete mix designs. The workability test results: L-Box, J-ring, and V-funnel tests for self-consolidating concrete acceptance characteristics such as slump flow are shown. Strength properties tests were also performed as part of the study at 7, 28, and 90 days in order to gather additional data.

DK Panesar et al. (2008) [22] examined the use of GGBS as a replacement for cement in concrete revealed that three parameters impacted the conventional characteristics of the material: the water content, the amount of GGBS, and the period of cure. Due to greater extensive evaporation, the compressive strength of the concrete rose as the water-binder ratio increased. Throughout the 28-day to 120-day period, the compressive strength increased by 10% to 20%. Also, the scaling resistance of GGBS concrete was not as excellent as that of OPC concrete.

Zoran et al. (2008) [23] discussed the characteristics of self-compacting concrete (SCC) combined with two distinct fillers, silica fume, and fly ash. The L-box examination was performed to evaluate SCC's capacity to flow through tight areas between reinforcing bars and other barriers without segregation or obstruction. The L-box has a unique design and proportions that permit the average depth of concrete (h2 mm) to be measured by considering the elevation of the horizontal section of the box into account. The depth of concrete directly beyond the barrier was determined using the same procedure (h1 mm). SCC's passage capability was estimated using the formula Pa=h2/h1, where Pa denotes passage capability and has a value ranging from 2 to 10 mm. The near and far ends of the passing ability are measured by h1 and h2, respectively.

S Akyuz et al. (2007) [24] carried out an experimental study to determine the ideal proportion of GGBS to achieve optimal compressive strength in cement concrete. After testing 32 different mixes, they discovered that substituting upwards of 55% of the cement with GGBS had no impact on compressive strength.

Liberato et al. (2006) [25] evaluated the HLSCC was assessed to determine its basic characteristics such as its ability to flow, resist segregation, and fill spaces when it is still fresh. The tests for flowability involved measuring the slump flow; while the segregation resistance ability was assessed by determining the time it takes to reach a 500 mm slump flow. The HLSCC performed satisfactorily in all mixes for these tests. However, the V-funnel test, which also measures segregation resistance ability, showed that only mix no. 2-4 and mix no. 6 of LC mixed concrete met the expected capacity level. The time required for complete flow through the V-funnel was noted during this test.

P Kumar (2006) [26] presented information about the development of SCC and its fundamental principle, as well as various testing methods to evaluate its high flowability, segregation resistance, and passing ability. It also explored different mix design approaches that utilize a variety of materials, taking into account how material characteristics and mix proportions greatly influence the ability of SCC to self-compact. The paper further discussed the practical applications of SCC, its acceptance at job sites, and future prospects. An Orimet test was performed, which is more indicative of SCC behavior in real-world conditions than the Slump-flow variety. In examining the filling capacity, passage ability, and resistance to segregation of SCC, the Orimet / J-ring combo test yielded good results.

Lachemi at el (2004) [27] presented research on using four different types of Viscosity Modifying Agents (VMA) to create Self-Compacting Concrete (SCC). The researchers investigated the characteristics of the SCC in both its fresh and hardened forms by incorporating various VMAs into it. The v-funnel test was developed to evaluate the elastic properties of concrete in confined locations. Filling the funnel with cement and then opening the bottom exit to permit the concrete to flow out was required. The duration required for the concrete to flow out was measured, and a flow time of fewer than 6 seconds indicated limited deformability due to high paste viscosity, increased inter-particle friction, or flow obstruction.

VK Bui et al. (2002) [28] discussed about the self-consolidating concrete's resistance to segregation. They conducted extensive experimentation on SCC with different types of water ratios, slurry proportions, fine and coarse aggregate blends, and varied types and quantities of pozzolanic materials. The test findings were useful in identifying the method and equipment utilized to investigate the horizontal as well as vertical segregated tolerance of SCC.

Babu et al. (2000) [29] indicated that the activity of the slag is affected by both the amount of glass present and the fineness of the GGBS. The researchers analyzed the effectiveness of GGBS in cement at different levels of substitution. They suggested that the overall efficiency of strength is reliant on the age of the material and the proportion of slag used in replacement.

K. H. Khayat (1999) [30] focuses on investigating the advantages of casting strongly reinforced portions with SCC to enhance productivity and working conditions on-site. In addition to the conventional flow test for slump for deformability, the filling capacity or V-funnel flow test should be carried out to assess the concrete's capacity to move effectively through tight gaps. Symmetric or mixed adhesives incorporating cementitious or non-cementitious fillers such as limestone powder can be utilized to reduce cement quantity, and the heat of hydration as well as contraction.

6. DISCUSSION

The use of agro-industrial waste in SCC has various advantages. One advantage is that it can assist in lessening the environmental impact of concrete manufacturing, as these components are frequently regarded as trash and would otherwise be wasted. One way to decrease greenhouse gas emissions is by using these materials as partial replacements for cement, thus reducing the amount of cement required. Using agro-industrial wastes in SCC can also improve its mechanical as well as physical characteristics. Concrete's compressive, flexural, and durability can be improved by incorporating appropriate percentages of SCBA and GGBS. An ideal combination of 10% SCBA and 40% GGBS has been suggested. Therefore, the use of agro-industrial wastes in SCC can be a sustainable and effective approach to creating concrete while also aiding in the reduction of the construction industry's ecological consequences.

SUMMARY

This report presents the findings of numerous GGBS and SCBA research investigations. Based on the research,

- ➢ Is also possible to infer that combining SCBA and GGBS in concrete has various advantages. Lower heat generation during hydration, higher ductility, smaller pore size in the concrete, considerably enhanced at later phases, fewer primary energy use as well as greenhouse gas emissions, light color, and better visual appeal are some of the benefits.

- ➢ Moreover, substituting 20-40% of the cement with GGBS and 10-20% of the cement with SCBA resulted in increased durability, including higher resistance to sulfate attack, alkali-silica reactivity, and chloride ion infiltration, leading to better resistance to corrosion.

- ➢ Additionally, employing SCBA and GGBS can improve both durability and strength. The reaction between cement and water can trigger the activation of GGBS and SCBA, which can improve strength.

- ➢ Lastly, the best proportion of cement substitution by SCBA and GGBS may be used on all major parts of a structure, such as bridges and pre-stressed components.

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