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# Effect of Elevated Temperature on the Lightweight Aggregate Fibre Reinforced Self-Consolidating Concrete

N. Ramanjaneyulu[1], M.V. Seshagiri Rao[2] V. Bhaskar Desai[3]
[2]Research Scholar, JNTUA College of Engineering/Anantapuram and Sr. Asst. Professor, CVR College of Engineering/Civil Engg. Department, Hyderabad, India
Email: rams.613@gmail.com
[3]Professor, CVR College of Engineering/Civil Engg. Department, Hyderabad, India
Email: rao_vs_meduri@yahoo.com
[3]Retd. Professor & Rector, JNTU Anantapur, Civil Engg. Department, Anantapur, A.P, India
Email: vbdesaijntu@gmail.com

***Abstract:*** **This study comprehensively investigates fiber-reinforced self-compacting concrete (FRSCC) behavior across multiple grade variations, namely M20, M30, and M40. The study encompasses substituting conventional natural aggregate with sintered fly ash, exploring replacement percentages of 10%, 20%, and 30%. The primary objective of this study is to identify the optimum Strength achieved through a 20% replacement ratio. The assessment of fresh properties of FRSCC was undertaken through rigorous testing protocols involving the L box, J ring, and V funnel tests, following the guidelines stipulated by the European Guidelines for Self-Compacting Concrete (EFNARC). Furthermore, the research extensively analyzed vital mechanical properties, including compressive Strength, split tensile Strength, and flexural Strength. These evaluations provided insights into the influence of sintered fly ash incorporation on the structural performance of FRSCC. The investigation extended to a post-curing temperature study, subjecting the concrete specimens to varying temperatures of 100 °C, 300 °C, 600 °C, and 900 °C, followed by exposure to a 1000 °C heating furnace for 3 hours at each designated temperature. The outcomes of this research yield valuable insights into the potential improvements in the mechanical and thermal properties of FRSCC by integrating sintered fly ash. This study is pertinent for professionals and researchers engaged in optimizing the formulation and utilization of fiber-reinforced self-compacting concrete, with implications for sustainable construction practices and enhanced resilience in diverse thermal conditions.**

***Index Terms:*** **Fibre reinforced lightweight self-compacting concrete, Fly Ash, Sintered fly ash Aggregate, Lightweight Sintered fly ash aggregate concrete, lightweight self-consolidating concrete, Crimped steel fiber.**

## I. INTRODUCTION

To provide engineers greater freedom during creating concrete structures that are both affordable and quick to create, lightweight self-compacting concrete aims to integrate the benefits of both lightweight concrete (LWC) and self-compacting concrete (SCC). Self-compacting concrete (SCC) does not require vibration for installation or compaction. Fiber-reinforced lightweight Aggregate Concrete (FRLWAC) focuses on its mechanical Strength, durability, and thermal behavior. The study contributes to optimizing FRLWAC's applications in construction and engineering. [1-4] Even amid packed reinforcement, it can pour with its weight, filling formwork and reaching full compaction without separating material components. Microcracks in the motor-aggregate interface cause plain concrete to be weak. In the concrete technology industry, self-compacting concrete (SCC) has become a groundbreaking substance because it provides remarkable flowability and self-consolidation without needing external compaction. Characteristics of Lightweight Expanded Clay Aggregate (LECA) used instead of some of the coarse aggregate in Lightweight Self-Compacting Concrete (LWSCC) regarding Strength and durability. The research aims to assess the feasibility and performance of LWSCC in various construction applications. [5-8]. To further enhance its mechanical properties and performance, researchers have investigated the potential of incorporating steel fibers as reinforcement within SCC Self-Compacting Concrete (SCC) by partially replacing coarse aggregate with Pumice Lightweight Aggregate (PLA). The research aims to evaluate the mechanical and structural properties of SCC with PLA, exploring its potential as a sustainable construction material. [9-12] The strength characteristics of concrete incorporating Sintered Fly Ash Aggregate (SFAA) as a partial replacement for conventional coarse aggregate. The study explores the viability and performance of SFAA-based concrete for sustainable construction applications. [13]. The fresh and hardened behavior of lightweight self-consolidating concrete (LWSCC) was made with sintered fly ash aggregate (SFAA). The research aims to assess the workability and mechanical properties of LWSCC with SFAA for potential structural applications. [14]. Steel fibers can be added to the mixture to minimize this weakness. To make concrete more durable or capable of resisting the development of cracks, composite materials can also be made from different fibers, such as glass, polymer, etc., which presents valuable insights into the properties and performance of this novel composite material. [15] The experimental study delves into the effects of steel fiber reinforcement on the properties and behavior of SCC, providing crucial knowledge for optimizing the mix design and harnessing the full potential of this advanced concrete material in construction applications. The combination of SFAA and LWSCC presents an exciting avenue for sustainable construction. The lightweight nature of SFAA reduces the overall dead load of structures, which is especially beneficial in applications like high-rise buildings and bridges. Additionally, LWSCC offers increased construction efficiency by eliminating the need for manual


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compaction, resulting in reduced labor costs and faster construction cycles. [16] This paper explores the effects of fiber reinforcement on lightweight aggregate concrete, providing crucial knowledge for advancing sustainable and high-performance construction practices.

## II. Literature Review

**Hajime Okamura, Masahiro Ouchi (9999):** Concrete that compacts by itself was created in 1988 to prevent vibrational compaction. Such that the author established a logical approach mix design before beginning the inquiry. At the work site, the rational mix design technique is determined to be suitable for SCC. With this method, we may investigate and suggest novel approaches to structural design.

**Thomas Paul, Habung Bida, Bini Kiron (2016)**. The study aimed to identify and contrast the differences in the properties of regular concrete, or SCC, when steel fibers are added in various amounts. The experimental examination aimed to determine the compressive strength, flexural Strength, and split tensile Strength of concrete reinforced with steel fibers and containing fibers with volume fractions of 0%, 0.4%, 0.8%, and 1.2% end-hooked steel fibers. The aspect ratio of the steel fiber was 75. The data from the results has been examined and contrasted with a specimen that contains no steel fiber. As the fiber dosage rate rises, the workability of SCC is considerably diminished. The research article suggests that because of these characteristics, steel fiber-reinforced self-compacting concrete can be utilized to build curved forms and in locations where compaction is not feasible.

**Siddharth Anand, Mohammad Afaque Khan, Abhishek Kumar (2016)**. At a certain point, adding steel fiber increases compressive Strength, preventing cracks from forming and giving greater Strength. The hardened condition has steel fibers added to it. Fiber-reinforced concrete is required when restricted durability, narrow fracture widths, or safety considerations are design criteria. With each additional steel fiber added to the SFR-SCC, compressive Strength rises. Workability in SFR-SCC significantly declines as steel fiber content rises. Flexural Strength in SFR-SCC rises as steel fiber content rises. As the amount of steel fiber in SFR-SCC grows, the tensile Strength also rises. 5. Self-compacting concrete is easy to use and straightforward.

**S. Ramesh Reddy, I.Krisharchana, Dr. V. Bhaskar Desai (2017)**. An effort is made to create lightweight concrete made of ions by substituting sintered fly ash for 100% of the natural aggregate and using three different pozzolanic materials to replace a portion of the cement (11%), including equal amounts of slag, fly ash, and silica fume, as well as varying amounts of Nano Aluminium Oxide. M20 concrete is intended to have a mean strength of 26.6N/mm2. When Nano Al2O3 is raised by up to 1%, the altered concrete rises to 42.80N/mm2, enhancing its flexural Strength and Young's modulus. Sintered fly ash aggregate can be utilized as coarse aggregate, cutting down on cement usage by 11%.

**Dilip Kumar, Arvind Kumar, Ashish Gupta (2014)**. In the current study, a mix design for concrete of the M25 grade was finished utilizing the IS technique. Sintered fly ash aggregates, a waste product of coal-firing thermal power plants (TPPs) and their accumulation near power plants, were formed by combining sintered fly ash with cement and water. Ordinary Portland cement of 43 Grades was used in the process. The Compressive Strength and Flexural Strength Test results of the concrete at ages 3, 7, 14, 28, 56, and 90 days are examined by the author in this study. Replace 10%, 20%, 30%, 40%, and 50% of the fly ash aggregate with coarse aggregate. Using it as a raw material to make cubes or bricks will benefit our economy and environment. 30% replacement of sintered fly ash aggregate in concrete resulted in the most value gain, whereas 50% replacement of sintered fly ash aggregate in concrete resulted in the lowest increase. At 30% replacement, the highest compressive Strength measured was 43.12 N/mm, while the lowest Strength was 26.24 N/mm. When concrete was used with a 30% less sintered fly ash aggregate, a maximum flexural strength of 11.16 N/mm was found.

Concrete reached a minimum strength of 2.10 N/mm at 50% substitution of sintered fly ash aggregate. Using lightweight concrete can expedite construction while enhancing the green construction environment. By partially replacing coarse aggregate with sintered fly ash aggregate, thermal power stations can produce waste materials.

## III. Experimental Study

### *Materials*

This section provides information about the different materials used in experimental investigation.

### *A. Cement:*

In this investigation, ordinary Portland cement of grade 53 cement is used. This cement is found to various specifications. The physical properties are tested according to IS 4031-1998, and results are tabulated in Table 1.

TABLE I.
Physical Properties of Cement

| Test | Result |
|---|---|
| Specific gravity | 3.14 |
| Standard consistency | 33% |
| Initial setting time | 45 min |
| Final setting time | 680 min |
| Bulk density | 1440 kg/ $m^3$ |
| Fineness of cement | 2.14 % |

### *B. Fly-Ash*

The non-combustible, finely divided waste called fly ash collected from the exhaust gases of industrial furnaces is one of the most expensive by-products used in the construction industry. Simple concrete has a flaw because the mortar-aggregate interface has tiny cracks. Steel fibers can be added to the mixture to eliminate or significantly lessen this weakness. Fibers are typically utilized in concrete to prevent shrinkage cracking caused by plastic. Additionally, they lessen the concrete's permeability, lessening water leaking. The number of fibers added to a concrete mix is expressed as a percentage of the composite's overall volume (concrete plus fibers), or volume fraction; this percentage usually falls between 0.1 and 3%. Concrete's ability to withstand cracks increases by adding steel fibers (or ductility). While steel fibers are beneficial for multidirectional reinforcement, traditional rebars are typically employed to increase the tensile Strength of the concrete in a specific direction.

### C. Coarse Aggregate

This investigation uses aggregates passed 12mm and retained on 10 mm aggregates. The properties of coarse aggregates are tabulated in Table 2

TABLE II.
COARSE AGGREGATES PHYSICAL PROPERTIES

| Property | Coarse aggregate |
|---|---|
| Fineness modulus | 6.39 |
| Water absorption | 0.58 % |
| Specific gravity | 2.21 |
| Bulk density | 1419 kg/ m$^3$ |

### D. Fine Aggregate

In this investigation, fine aggregate, which is locally available river sand free from all impurities, is used. The requirements of sand are confirming 'IS: 383-1970', and the properties of fine aggregate are tested, and results are tabulated in Table 3

TABLE III.
FINE AGGREGATE PHYSICAL PROPERTIES

| Test | Results |
|---|---|
| Fineness modulus | 2.91 |
| Water absorption | 1.1% |
| Specific gravity | 2.61 |
| Bulk density | 1569 kg/ m3 |
| | |

### E. 'Sintered Fly Ash' Aggregate

Concrete's dead weight decreases of natural stone aggregate. The concrete with sintered fly ash aggregate is spherical, with a 5–20 mm size range and a light grey hue. Bulk density is 640-750 kg/m3, aggregate crushing Strength is 5-8.5 t, and water absorption is 15-20% in uncrushed material and 40-50% in crushed material.

### F. Water

The most crucial component of concrete is water, which aids in the binding of the aggregates and cement.

### G. Super Plasticizer

In this investigation, CONPLAST SP430 is used to improve the workability of concrete.

### H. Crimped Steel Fibre

Short, irregular steel fibers, termed crimped steel fibers, can be utilized in concrete to improve the mechanical qualities of the material. These fibers, generally constructed of low-carbon steel, are intended to boost the tensile Strength of concrete to enhance its performance.

**CRIMPED STEEL FIBRE**

Physical Properties
Diameter (d) - 0. 4 mm
Length of Fibre (l)- 12 mm
Aspect ratios (l/d) - 30

Figure 1. Crimped steel fibers

### I. Mix Design

In this investigation, the mix design of SCC lightweight aggregates was finished using the rational mix design method. Pumice aggregate is replaced partially by coarse aggregate in concrete with different percentages such as 10%, 20%,30%, and 40%.

### J. Curing of Specimens

All the specimens of pumice self-compacted lightweight aggregates were cast and cured by placing the specimens in a curing tank for 7 and 28 days.

## IV. EXPERIMENTAL METHODOLOGY

### A. Compressive Strength

Cubes size of 100*100*100mm specimens were cast, cured for 7 and 28 days, and tested below an automatic testing machine. In compressive strength tests, cylindrical or cubical samples are subjected to axial loads until failure, measuring their ability to withstand compression.

Figure 2. Compressive testing machine

### B. Split Tensile Strength

The split tensile test, carried out per IS 5816-1999, is an indirect test used to measure the tensile strength of concrete. The average split tensile strengths of M40 grade lightweight self-consolidating concrete, with varying levels of sintered fly ash aggregate replacement (0%, 10%, 20%, and 30%), show an interesting trend. As the percentage of replacement increases, there will be a gradual decrease in split tensile Strength (6.06 MPa for 0% replacement, 6.31 MPa for 10% replacement, 5.12 MPa for 20% replacement, and 4.05 MPa for 30% replacement) as shown in figure 10. Cylinder size of the 150*300mm specimens was cast, cured, and tested under a CTM machine for 7 and 28 days. Measure the diameter of the cylinder or cube at the midpoint of its height using a measuring tape or digital calipers. This is the average diameter, denoted as 'D.'Calculate the split tensile Strength using the formula:

Split Tensile Strength (fsp) = (2 * Load at Fracture)/

(π *D* L)Where L is the length of the cylinder or cube.

Figure 3. Split Tensile testing machine.

TABLE IV.
RESULTS OF HARDENED PROPERTIES OF SCC SINTERED FLY ASH AGGREGATE REPLACED CONCRETE.

| GRADE | % | CEMENT | FA | CA | SFA | FLY-ASH | SP | WATER |
|---|---|---|---|---|---|---|---|---|
| M20 | 10% | 263 | 960 | 594 | 17.5 | 316 | 17.3 | 238 |
| | 20% | 263 | 96 | 528 | 35 | 316 | 17.3 | 238 |
| | 30% | 263 | 960 | 462 | 52 | 316 | 17.3 | 238 |
| M30 | 10% | 374 | 942 | 617 | 18 | 383 | 22.7 | 206 |
| | 20% | 374 | 942 | 549 | 36 | 383 | 22.7 | 206 |
| | 30% | 374 | 942 | 480 | 54 | 383 | 22 | 206 |
| M40 | 10% | 432 | 942 | 617 | 18 | 349 | 11 | 228 |
| | 20% | 432 | 942 | 549 | 36 | 349 | 11 | 228 |
| | 30% | 432 | 942 | 480 | 54 | 349 | 11 | 228 |

### *C. Flexure Strength*

Flexural test specimens are determined using flexural Strength by IS 516-1959. Prism size of 150*100*100mm samples were cast and cured for 7 and 28 days under a testing machine. Flexural strength tests assess the resistance of prismatic concrete beams to bending forces.

Figure 4. Flexure testing Machine

**IV Tests on Temperatures up to 900˚C:** The cubes underwent tests for compressive Strength and weight after a 28-day curing period. The lightweight sintered fly ash has been self-compacted and cured. Temperatures ranging from 100˚ to 1000˚c were experienced by classes M20, M30, and M40 to ascertain how resistant concrete specimens are to external factors, including heat generated during a volcanic eruption.

## V. EXPERIMENTAL RESULTS

TABLE V.
QUANTITIES OF MATERIALS FOR CASTING PUMICE

| Grade of concrete | Designation | Compressive Strength Mpa | | flexural Strength Mpa | | split tensile strength Mpa | |
|---|---|---|---|---|---|---|---|
| | | 7 Days | 28 Days | 7 Days | 28 Days | 7 Days | 28 Days |
| 20 | NWSCC | 25.6 | 37.8 | 5.12 | 7.4 | 5.92 | 8.06 |
| | 10% | 22.83 | 36.76 | 4.96 | 6.37 | 4.84 | 6.37 |
| | 20% | 21.73 | 33.2 | 4.28 | 5.84 | 4.26 | 5.12 |
| | 30% | 14.79 | 25.6 | 3.01 | 4.01 | 3.14 | 4.05 |
| 30 | NSCC | 36.3 | 39.6 | 5.73 | 9.5 | 5.98 | 8.62 |
| | 10% | 28 | 38.33 | 5.12 | 8.92 | 5.02 | 7.05 |
| | 20% | 37.06 | 32.12 | 5.07 | 7.02 | 4.92 | 5.22 |
| | 30% | 31.26 | 25.9 | 3.48 | 6.12 | 3.91 | 4.28 |
| | 40% | 30.3 | 25.16 | 3.12 | 6.12 | 3.11 | 4.14 |
| 40 | NSCC | 46.8 | 44.9 | 6.20 | 9.7 | 6.12 | 8.69 |
| | 10% | 47.56 | 42.96 | 6.18 | 9.26 | 5.18 | 7.58 |
| | 20% | 48.62 | 44.8 | 5.23 | 9.73 | 6.26 | 8.73 |
| | 30% | 42.7 | 38.2 | 5.01 | 8.68 | 4.98 | 5.27 |

TABLE VI.
FRESH PROPERTIES OF SCC

| Grade of concrete | % of Replacement | Fresh Properties | | |
|---|---|---|---|---|
| | | Slump flow T50cm Test Sec | V Funnel Test Sec | L-Box Test H2/H1 |
| 20 | 10% | 4 | 4 | 0.82 |
| | 20% | 4.3 | 5.94 | 0.85 |
| | 30% | 4.8 | 9.78 | 0.87 |
| 30 | 10% | 5 | 6.8 | 0.78 |
| | 20% | 5.2 | 7.4 | 0.84 |
| | 30% | 5.7 | 8 | 0.87 |
| 40 | 10% | 4.8 | 5.8 | 0.81 |
| | 20% | 5 | 6 | 0.87 |
| | 30% | 5.5 | 6.4 | 0.9 |

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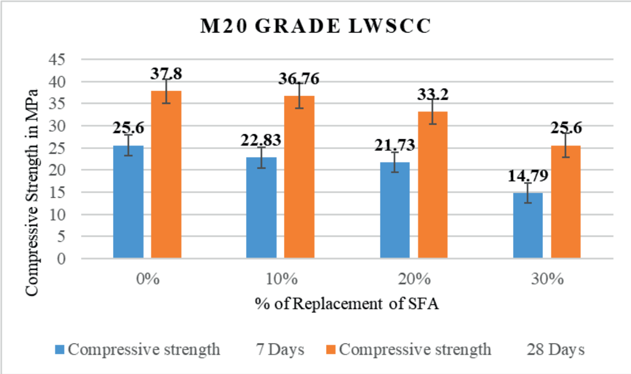


Figure 5. Compressive Strength for 7 and 28 days of M20 grade

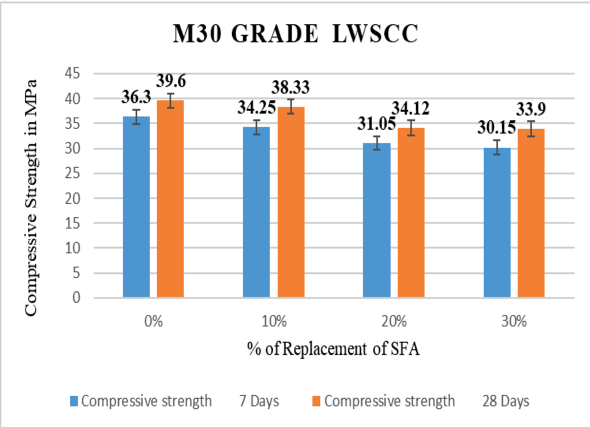


Figure 6. Compressive Strength for 7 and 28 days of M30

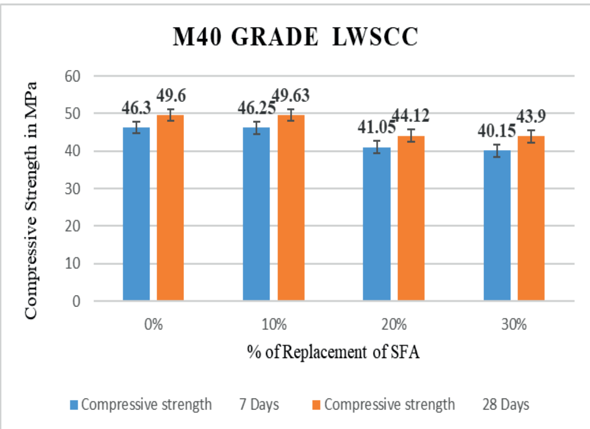


Figure 7. Compressive Strength for 7 and 28 days of M30

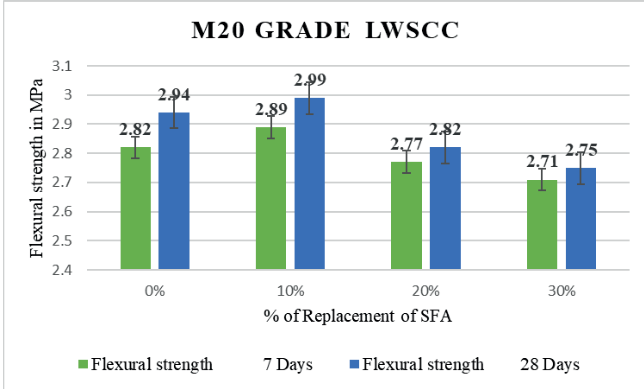


Figure 8. Flexural Strength for 7 and 28 days of M20

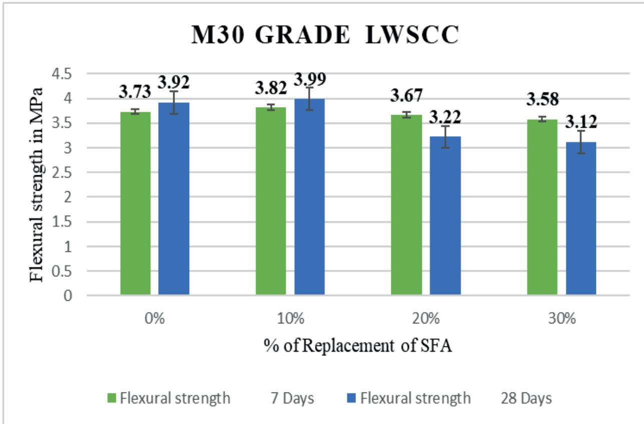


Figure 9. Flexural Strength for 7 and 28 days of M30

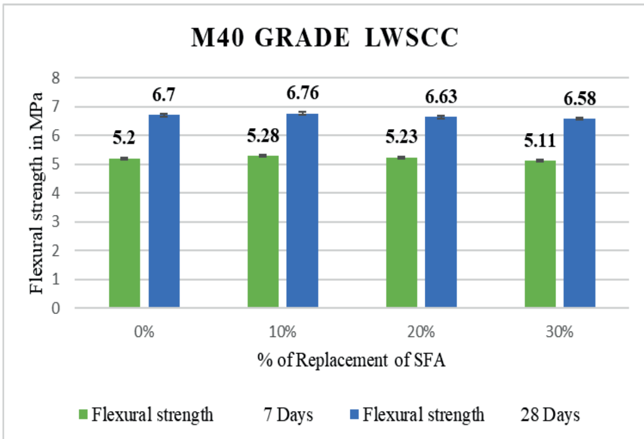


Figure 10. Flexural Strength for 7 and 28 days of M40

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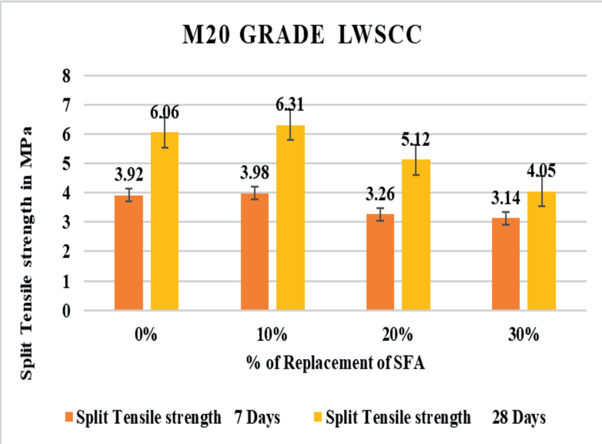


Figure 11. Flexural Strength for 7 and 28 days of M30 grade

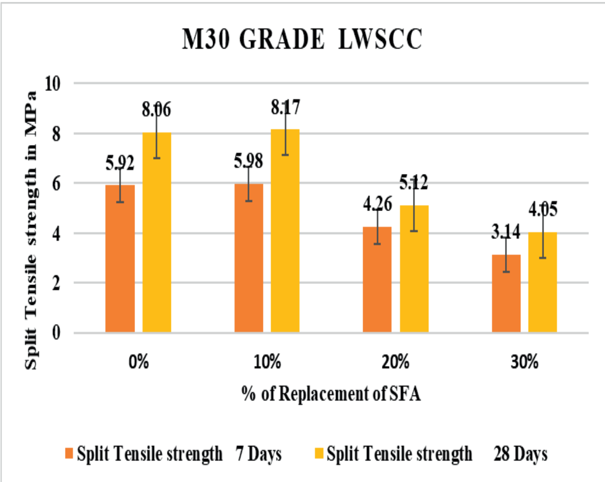


Figure 12. Flexural Strength for 7 and 28 days of M40

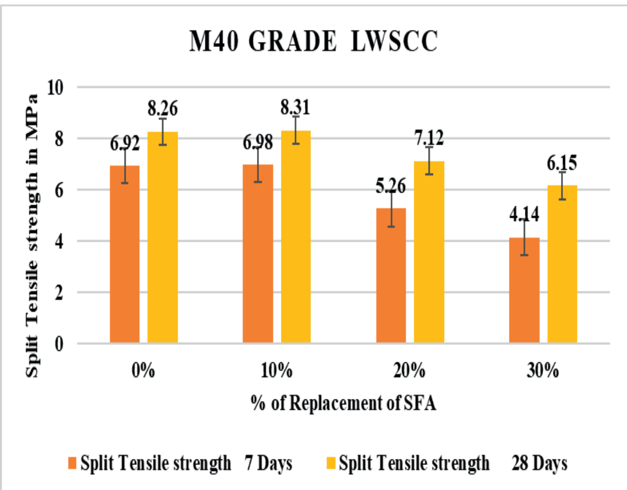


Figure 13. Tensile Strength for 7 and 28 days of M20

TABLE VII.
COMPRESSIVE STRENGTH OF LWSCC FOR 28 DAYS AT 100°C

| Grade of Concrete | Coarse Aggregate % | | Hardened properties |
|---|---|---|---|
| | Gravel % | SFA % | Compressive Strength |
| | | | 28 days (MPa) |
| M20 | 100 | - | 27.2 |
| | 90 | 10 | 25 |
| | 80 | 20 | 26.3 |
| | 70 | 30 | 24.7 |
| M30 | 100 | 0 | 38.9 |
| | 90 | 10 | 35 |
| | 80 | 20 | 36.1 |
| | 70 | 30 | 34.5 |
| M40 | 100 | - | 49.5 |
| | 90 | 10 | 46.2 |
| | 80 | 20 | 45.1 |
| | 70 | 30 | 41.6 |

TABLE VIII.
COMPRESSIVE STRENGTH OF LWSCC FOR 28 DAYS AT 300°C

| Grade of Concrete | Coarse Aggregate % | | Hardened properties |
|---|---|---|---|
| | Gravel % | SFA % | Compressive Strength |
| | | | 28 days (MPa) |
| M20 | 100 | 0 | 27.2 |
| | 90 | 10 | 26.3 |
| | 80 | 20 | 25 |
| | 70 | 30 | 24.7 |
| M30 | 100 | 0 | 38.9 |
| | 90 | 10 | 35 |
| | 80 | 20 | 36.1 |
| | 70 | 30 | 34.5 |
| M40 | 100 | 0 | 49.5 |
| | 90 | 10 | 46.2 |
| | 80 | 20 | 45.1 |
| | 70 | 30 | 41.6 |

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TABLE IX.
COMPRESSIVE STRENGTH OF LWSCC FOR 28 DAYS AT 600˚

| Grade of Concrete | Coarse Aggregate % | | Hardened properties |
|---|---|---|---|
| | Gravel % | SFA % | Compressive Strength 28 days (MPa) |
| M20 | 100 | 0 | 27.2 |
| | 90 | 10 | 23.1 |
| | 80 | 20 | 24.0 |
| | 70 | 30 | 23.3 |
| M30 | 100 | 0 | 38.9 |
| | 90 | 10 | 29.1 |
| | 80 | 20 | 29.5 |
| | 70 | 30 | 20.8 |
| M40 | 100 | 0 | 49.5 |
| | 90 | 10 | 35.4 |
| | 80 | 20 | 38.7 |
| | 70 | 30 | 30.4 |

TABLE. X.
COMPRESSIVE STRENGTH OF LWSCC FOR 28 DAYS AT 900˚C

| Grade of Concrete | Coarse Aggregate % | | Hardened properties |
|---|---|---|---|
| | Gravel % | SFA % | Compressive Strength 28 days (MPa) |
| M20 | 100 | 0 | 27.2 |
| | 90 | 10 | Failed |
| | 80 | 20 | Failed |
| | 70 | 30 | 11.8 |
| M30 | 100 | 0 | 38.9 |
| | 90 | 10 | Failed |
| | 80 | 20 | 21.4 |
| | 70 | 30 | 17.9 |
| M40 | 100 | 0 | 49.5 |
| | 90 | 10 | Failed |
| | 80 | 20 | Failed |
| | 70 | 30 | 28.5 |

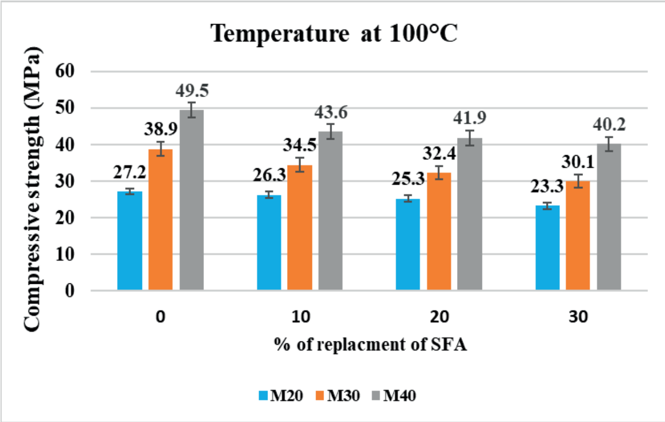


Figure 14. compressive strength subjected to different temperatures and replaced with 10% M40 grade of concrete.

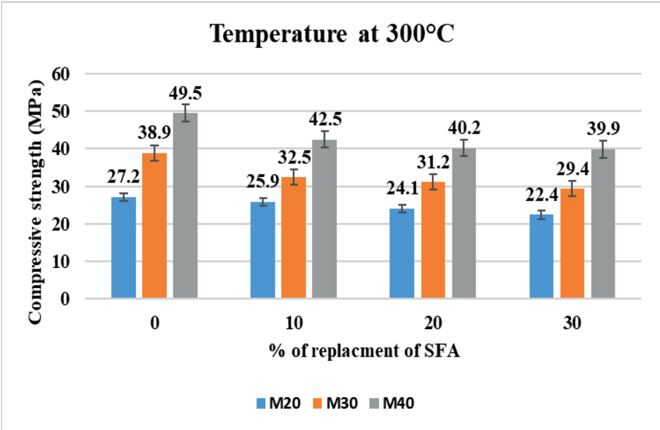


Figure 15. compressive Strength subjected to different temperatures replaced with 10%,20%, and 30% SFA of M20

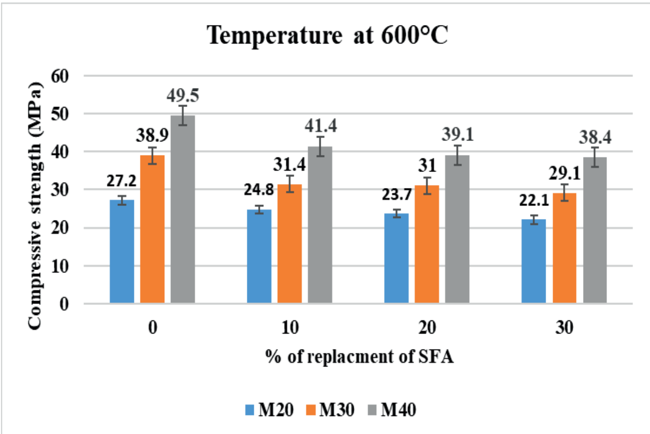


Figure 16. compressive strength subjected to different temperatures replaced with 10%,20%, and 30% SFA of M30 grade of concrete.

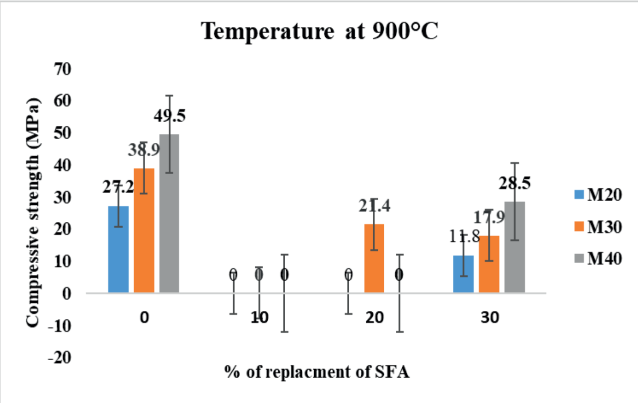


Figure 17. compressive strength subjected to different temperatures replaced with 10%,20%, and 30% SFA of M20, M30 and M40 grade of concrete.

## VI. Results and Discussions

Table 6 displays the new characteristics of FRSCLWC made with sintered fly ash aggregates. The test results demonstrate that every blend complies with the specifications (EFNARC 2005). "A 20% substitution of SFA aggregate in the M20 grade of concrete led to an increase in split tensile Strength of 3.7%, flexural Strength of 1.4%, and compressive Strength of 11.4%. A 20% substitution of Sintered Fly Ash aggregate in the M30 grade of concrete increased its compressive Strength by 2.27%, flexural Strength by 2.3%, and split tensile Strength by 3.2%. A 30% substitution of SFA aggregate in the M40 grade of concrete increased the flexural Strength, split tensile Strength, and compressive Strength by 2.11%, 2.26%, and 1.41%, respectively. When 20% of the concrete aggregate in the M20 grade was replaced with sintered fly ash, the compressive Strength improved 6.6% at 100˚C and declined steadily as the temperature rose. When 20% of the Sintered Fly Ash aggregate in the M30 grade of concrete was substituted, the compressive Strength increased by 1.28% at 100˚C and declined gradually as the temperature rose. When 10% of the Sintered Fly Ash aggregate in the M40 grade of concrete was substituted, the compressive Strength increased 2.8% at 100˚C and declined gradually as the temperature rose. Because self-compacting concrete offers a number of advantages over regular conventional concrete, steel fibers are used to reinforce it.

## VII. Conclusions

The conclusions and suggestions that may be drawn from this experimental investigation are outlined below.

1. Increased Strength with SFA Aggregate Replacement: The results indicate that including SFA (sintered fly ash Aggregate) in concrete mixes led to overall improvements in compressive, flexural, and split tensile strengths across different grades of concrete. Notably, a 20% replacement of conventional aggregate with SFA resulted in significant strength enhancements, particularly in the M20 grade.
2. Grade-Specific Response: The effect of SFA aggregate replacement on concrete Strength varied with different concrete grades. While the M20 grade exhibited the most significant improvements in Strength with a 20% replacement, the M30 and M40 grades showed more minor but still notable enhancements with 20% and 30% replacements, respectively.
3. Temperature-Dependent Behavior: The study also explored the behavior of SFA-reinforced concrete at elevated temperatures (100 The findings revealed that the compressive Strength initially increased with SFA replacement in all grades but gradually decreased as the temperature rose. This observation suggests that the performance of SFA-reinforced concrete may be sensitive to high-temperature conditions.
4. Superior Performance of SCC with Steel Fiber: The discussion highlights the advantages of Self-Compacting Concrete (SCC) over conventional concrete, particularly when reinforced with steel fiber. Although the specific benefits of SCC are not explicitly mentioned, it implies that SCC with steel fiber reinforcement offers superior properties to regular concrete mixes.
5. Optimal SFA Replacement Ratios: Based on the results, replacing 20% of conventional aggregate with SFA is a good choice for M20 and M30 grades, leading to significant strength improvements without affecting other properties. For the M40 grade, a 30% SFA aggregate replacement may be preferred, as it provides a reasonable strength enhancement while avoiding potential diminishing returns on Strength with higher SFA content.
6. The results of this study show that adding SFA aggregate, especially in the best replacement ratios, can improve the mechanical properties of different grades of concrete. This is an excellent way to improve concrete performance in various settings, including those with high temperatures. Additionally, the study highlights the suitability of SCC reinforced with steel fiber, further supporting its use in concrete construction where self-compaction and enhanced mechanical properties are desired.

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