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Effects of Elevated Temperature on Lightweight Concrete: Flexural Behaviour of Reinforced Concrete Beams and Performance Against Impact and Abrasion

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Abstract: This research investigates the effects of elevated temperature on lightweight concrete, the flexural behaviour of reinforced concrete (RCC) beams, and the performance of lightweight concrete against impact and abrasion. Elevated temperatures can significantly influence the mechanical properties and durability of lightweight concrete, leading to strength reduction, thermal stresses, changes in microstructure, and potential loss of structural integrity. The flexural behaviour of RCC beams under loading involves nonlinear responses, crack formation, moment-curvature relationships, reinforcement yielding, and shear effects, all of which play crucial roles in beam performance and failure mechanisms. Lightweight concrete, while offering advantages such as reduced weight, may exhibit lower impact resistance and abrasion resistance compared to conventional concrete. However, proper mix design, material selection, and surface treatments can mitigate these drawbacks. This study emphasizes the importance of understanding the behaviour of lightweight concrete under various conditions and highlights strategies to enhance its performance in practical applications. Experimental investigations and standardized testing methods are essential for evaluating the response of lightweight concrete to elevated temperature, flexural loading, impact, and abrasion, providing valuable insights for design and construction practices.

Keywords: *Lightweight concrete, elevated temperature, Flexural behaviour, Reinforced concrete beams, Impact resistance, Abrasion resistance, Mechanical properties, Structural integrity, Thermal stress, Crack formation*.

1. Introduction

Lightweight concrete, characterized by its reduced density and enhanced thermal insulation properties, has garnered considerable attention in the construction industry due to its potential for sustainable and efficient building solutions. As a key component of modern infrastructure projects, lightweight concrete offers advantages such as improved energy efficiency, reduced dead loads, and increased fire resistance. However, the performance of lightweight concrete under various environmental conditions remains a subject of ongoing research and development. One significant factor affecting the performance of lightweight concrete is elevated temperature. Elevated temperatures can induce complex physical and chemical changes within the concrete matrix, leading to alterations in mechanical properties, microstructure, and overall durability. Studies have shown that lightweight concrete may exhibit reduced compressive strength, increased permeability, and susceptibility to thermal spalling at elevated temperatures [1]. The detrimental effects of elevated temperature on lightweight concrete underscore the importance of understanding its behaviour and implementing appropriate measures to mitigate potential risks in structural applications.

Furthermore, the flexural behaviour of reinforced concrete (RCC) beams is crucial for assessing the structural integrity and load-carrying capacity of concrete structures. Flexural loading induces complex stress distributions within RCC beams, resulting in phenomena such as crack formation, plastic deformation, and ultimately, structural failure. Understanding the flexural behaviour of RCC beams is essential for optimizing design parameters, such as reinforcement detailing and section geometry, to enhance structural performance and durability [2]. In addition to mechanical considerations, the resistance of lightweight concrete to impact and abrasion is of practical importance, especially in high-traffic areas or industrial settings. Lightweight concrete may exhibit lower impact resistance and abrasion resistance compared to conventional concrete due to its reduced density and inherent material properties. However, various strategies, including the incorporation of durable aggregates, surface treatments, and specialized additives, can enhance the impact and abrasion resistance of lightweight concrete [3]. This study aims to investigate the effects of elevated temperature on lightweight concrete, analyse the flexural behaviour of RCC beams under different loading conditions, and evaluate the performance of

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lightweight concrete against impact and abrasion. Through experimental investigations and numerical simulations, we seek to gain insights into the mechanical response and durability characteristics of lightweight concrete in diverse environmental conditions. By elucidating the underlying mechanisms governing the behaviour of lightweight concrete, this research aims to inform the development of sustainable and resilient concrete structures for future construction projects.

1.1 Effect of elevated temperature on Light weight concrete

Lightweight concrete, known for its reduced density and enhanced thermal insulation properties, has gained popularity in various construction applications. However, understanding its behaviour under extreme conditions, such as elevated temperatures, is crucial for ensuring structural integrity and safety. Elevated temperatures can induce complex physical and chemical changes within lightweight concrete, affecting its mechanical properties and overall performance. Studies have shown that exposure to elevated temperatures can lead to significant alterations in the microstructure and mechanical behaviour of lightweight concrete. For instance, Li et al. (2018) [4] investigated the mechanical properties of lightweight aggregate concrete after exposure to elevated temperatures and found that the compressive strength and elastic modulus decreased with increasing temperature. Additionally, the researchers observed changes in the pore structure and hydration products, highlighting the complex nature of lightweight concrete's response to elevated temperatures. The detrimental effects of elevated temperature on lightweight concrete extend beyond mechanical properties. Thermal spalling, a phenomenon characterized by explosive spalling of concrete due to rapid heating, is a common concern in fire-exposed structures. Studies by Kodur et al. (2013) [5] emphasized the importance of understanding the factors influencing thermal spalling in lightweight concrete and proposed strategies to mitigate this risk, such as incorporating polypropylene fibres or using supplementary cementitious materials. Furthermore, the durability of lightweight concrete can be compromised at elevated temperatures, leading to increased permeability and susceptibility to environmental degradation. Research by Wu et al. (2017) [6] investigated the pore structure and permeability of lightweight aggregate concrete after exposure to elevated temperatures and demonstrated that pore refinement and increased permeability occurred due to thermal damage. These findings underscore the need for comprehensive assessment and mitigation measures to address the effects of elevated temperature on lightweight concrete's durability.

Lightweight concrete (LWC) is a popular construction material valued for its lower density and weight compared to normal-weight concrete. However, its performance under high temperatures becomes a crucial factor in ensuring structural integrity during fire events or in environments with extreme heat.

Detrimental effects:

- Dehydration: As temperature rises, the free and chemically bound water within the LWC evaporates. This moisture loss weakens the binding capacity of the cement paste, leading to microcrack formation and reduced strength [7, 8].
- Thermal expansion: Different components of LWC (aggregate and cement paste) expand at varying rates when heated. This differential expansion can induce internal stresses, potentially causing cracking and distortions [9].
- Loss of durability: High temperatures can accelerate chemical reactions within the LWC, such as carbonation and the alkali-silica reaction. These reactions can lead to long-term deterioration and compromise the service life of the structure [9].
- Strength reduction: Studies have shown a general decrease in compressive and flexural strength of LWC after exposure to elevated temperatures. This strength loss becomes more significant above specific thresholds (around 400°C).

Factors influencing performance:

- Type of lightweight aggregate: LWC incorporating lightweight aggregates like expanded clay exhibit better performance at high temperatures compared to those with natural aggregates this is because expanded clay aggregates possess inherent fire resistance.
- Cement type: Calcium aluminate cement (CAC) offers superior performance at high temperatures compared to Ordinary Portland Cement (OPC) used in standard LWC.
- Water-cement ratio (w/c ratio): Lower w/c ratios generally result in denser and stronger concrete with improved resistance to high temperatures.
- Cooling regime: The rate of cooling after heat exposure can also impact the residual strength of LWC. Slower cooling allows for a more gradual release of internal stresses, minimizing strength loss.

1.2 Flexural behaviour of RCC beams

Flexural behaviour of Reinforced Concrete (RC) beams is a fundamental aspect of structural engineering, crucial for designing safe and efficient concrete structures [10]. When subjected to bending loads, such as those experienced in beams, RC members undergo complex deformation and stress distributions, leading to various failure modes and behaviours. Initially, under low bending moments, RC beams behave elastically, following Hooke's Law. This phase is characterized by linear stress-strain relationships, where the beam deforms proportionally to the applied load. As the applied bending moment increases, tensile stresses develop at the bottom of the beam. These stresses exceed the tensile strength of concrete, leading to crack initiation and propagation along the span of the beam. The formation of cracks is a critical aspect of flexural behaviour and influences factors such as stiffness, durability, and ultimate strength.

The behaviour of RC beams is governed by strain compatibility between concrete and reinforcing steel. Steel reinforcement carries tensile forces and helps control crack widths, enhancing the ductility and load-carrying capacity of the beam. As loading continues, plastic hinges form near the supports of the beam. In these regions, concrete undergoes significant deformation, and steel reinforcement yields, redistributing moments and allowing for additional load-carrying capacity beyond the elastic limit [11]. Eventually, as the bending moment exceeds the capacity of the beam, progressive failure occurs. This failure may manifest as concrete crushing, yielding of reinforcement, or a combination of both, leading to collapse. Shear forces also influence the flexural behaviour of RC beams, especially in slender members or those subjected to concentrated loads. Adequate shear reinforcement is essential to prevent sudden shear failures. Ductile behaviour, characterized by the ability to undergo significant deformation before failure, is desirable in RC beams [12]. Redundancy, provided by multiple load paths within the structure, enhances safety and allows for graceful failure modes. Reinforced Concrete (RCC) beams are workhorses in construction, used extensively for supporting floors, roofs, and bridges. Understanding their flexural behaviour, which is how they bend under load, is crucial for designing safe and efficient structures.

Stages of Loading:

- Untracked Stage: Under low loads, the entire concrete section resists bending. The concrete is in compression on the top and tension on the bottom. The beam behaves linearly, with deflection proportional to the applied load.
- Cracked Stage: As the load increases, the tensile capacity of concrete is exceeded, leading to hairline cracks developing at the bottom of the tension zone. Steel reinforcement takes over resisting the tension, while concrete in compression continues to contribute.
- Yielding Stage: With further loading, the steel reinforcement reaches its yield point, experiencing significant plastic deformation. The deflection rate increases rapidly.
- Ultimate Failure: Beyond the yielding point, the concrete in compression crushes, and the beam fails in flexure.

Factors Affecting Flexural Behaviour:

- Material Properties: The strength and elasticity of concrete and steel reinforcement significantly influence the flexural capacity and crack patterns.
- Geometry: The beam's cross-sectional dimensions (width, depth) and the location of the reinforcement within the section affect the moment of inertia, which governs stiffness and deflection.
- Amount of Reinforcement: The quantity and arrangement of steel bars determine the beam's tensile capacity and influence its failure mode (under-reinforced, balanced, or over-reinforced).
- Loading Conditions: The type of load (point load, distributed load), its magnitude, and the support conditions (simply supported, fixed) all affect the bending moment distribution and influence the flexural behaviour.

Analysis Methods:

There are various methods to analyze the flexural behaviour of RCC beams, ranging from simple hand calculations to sophisticated finite element analysis software. Common approaches include:

- Flexure Formula: This simplified method provides an initial estimate of the beam's moment capacity based on material properties and section geometry.
- Limit State Design (LSD): This codified approach ensures structural safety by checking the beam's capacity against design loads under serviceability and ultimate limit states.
- Advanced Analysis: Software tools can model complex loading scenarios and provide detailed information on stress distribution, crack patterns, and deflections.

1.3 Behaviour of Light weight concrete against Impact and Abrasion

The behaviour of lightweight concrete against impact and abrasion is an important aspect to consider in various construction applications, especially in structures subjected to heavy traffic, dynamic loads, or abrasive environments [13].

Impact Resistance: Lightweight concrete typically exhibits lower impact resistance compared to conventional concrete due to its reduced density. However, the impact resistance can be improved through proper mix design and reinforcement strategies.

- Factors Affecting Impact Resistance: Impact resistance of lightweight concrete is influenced by various factors such as aggregate type, size, shape, and strength, as well as the presence of any additives or reinforcements.
- Mitigation Strategies: To enhance impact resistance, lightweight concrete can be designed with higher strength aggregates, such as expanded shale or clay, or

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incorporating synthetic fibres or steel fibres to provide additional toughness and ductility.

- Testing Methods: Standardized testing methods such as the ASTM C1231/C1231M Standard Practice for Lightweight Aggregate Concrete for Structural Purposes or impact testing apparatus can be used to evaluate the impact resistance of lightweight concrete specimens.

Abrasion Resistance: Abrasion resistance refers to the ability of lightweight concrete to withstand surface wear and degradation when subjected to abrasive forces, such as foot traffic, vehicle traffic, or erosion [14].

- Aggregate Selection: The choice of lightweight aggregates can significantly impact the abrasion resistance of concrete. Aggregates with higher hardness and durability, such as natural or manufactured lightweight aggregates, can improve abrasion resistance.
- Surface Treatments: Applying surface treatments such as coatings, sealants, or epoxy overlays can enhance the abrasion resistance of lightweight concrete by providing a protective barrier against wear and tear.
- Testing Methods: Abrasion resistance of lightweight concrete can be evaluated using standardized tests such as the ASTM C944/C944M Standard Test Method for Abrasion Resistance of Concrete or Mortar Surfaces by the Rotating-Cutter Method, which simulates abrasive forces encountered in real-world conditions.

Field Performance: The performance of lightweight concrete against impact and abrasion can also be assessed through field observations and case studies in various construction projects. Monitoring the condition of lightweight concrete structures over time provides valuable insights into its long-term durability and resistance to wear and tear [15].

2. Literature Review

2.1 Effect of Elevated Temperature on Lightweight Concrete:

Lightweight concrete (LWC) is increasingly used in various construction applications due to its advantageous properties, including reduced density and enhanced thermal insulation. However, the behaviour of lightweight concrete under elevated temperature conditions is a critical aspect for structural safety and durability. Several studies have investigated the effects of elevated temperature on lightweight concrete, highlighting its mechanical response, microstructural changes, and durability characteristics. Li et al. (2018) conducted a study on the mechanical properties of lightweight aggregate concrete after exposure to elevated temperatures. The researchers observed reductions in compressive strength and elastic modulus with increasing temperature, along with changes in the pore structure and hydration products [16]. Kodur et al. (2013) focused on the performance-based design of fire-resistant concrete structures, emphasizing the importance of understanding factors influencing thermal spalling in lightweight concrete. The study proposed strategies to mitigate thermal spalling risks, such as incorporating polypropylene fibers or supplementary cementitious materials [17]. Wu et al. (2017) investigated the effects of high temperature on the pore structure and permeability of lightweight aggregate concrete. Their findings revealed pore refinement and increased permeability due to thermal damage, highlighting the implications for durability and environmental degradation [18]. These studies collectively underscore the complex nature of lightweight concrete's response to elevated temperatures and the need for comprehensive assessment and mitigation measures to ensure structural resilience and fire safety.

2.2 Flexural Behaviour of RCC Beams:

Reinforced concrete beams are commonly used in structural systems to support loads and resist bending moments. Understanding the flexural behaviour of RCC beams is essential for designing safe and efficient concrete structures. Numerous studies have investigated various aspects of flexural behaviour in RCC beams, focusing on factors such as crack formation, load-deflection responses, and ultimate failure modes. Nilson et al. (2015) provided comprehensive insights into the design of concrete structures, including flexural behavior analysis. The authors discussed the principles of flexural design, reinforcement detailing, and code provisions for ensuring structural integrity and ductility [19]. Park and Paulay (1975) conducted seminal research on reinforced concrete structures, emphasizing flexural behavior analysis and plastic hinge formation in beams. The study highlighted the importance of strain compatibility between concrete and reinforcing steel for predicting structural response and ultimate failure modes [20]. ACI Committee 318 (2014) developed building code requirements for structural concrete, providing guidelines for flexural design and analysis. The code provisions address factors such as load combinations, minimum reinforcement requirements, and detailing for enhancing structural performance and durability [21]. These studies collectively contribute to the understanding of flexural behaviour in RCC beams and provide valuable insights for optimizing design parameters and ensuring structural safety in concrete construction.

2.3 Behaviour of Lightweight Concrete against Impact and Abrasion: Lightweight concrete may exhibit lower impact resistance and abrasion resistance compared to

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conventional concrete due to its reduced density. However, several studies have investigated strategies to enhance the impact and abrasion resistance of lightweight concrete, focusing on material selection, surface treatments, and reinforcement techniques. Mindess et al. (2003) provided a comprehensive overview of concrete technology, including discussions on lightweight concrete properties and performance characteristics. The authors discussed methods for improving impact and abrasion resistance through aggregate selection, surface treatments, and fiber reinforcement [22]. ASTM International developed standardized test methods for evaluating the abrasion resistance of concrete surfaces. ASTM C944/C944M provides guidelines for conducting abrasion tests using rotating-cutter apparatus, allowing for quantitative assessment of wear resistance and surface durability [23]. Monteiro and Miller (2014) investigated the abrasion resistance of lightweight concrete containing synthetic lightweight aggregates. The study evaluated mass loss, surface roughness, and wear patterns to assess the effectiveness of different aggregate types and surface treatments in enhancing abrasion resistance [24]. These studies offer valuable insights into the behaviour of lightweight concrete against impact and abrasion and provide guidance for selecting appropriate materials and design strategies to ensure durability and performance in demanding environments.

3. Methodology

3.1 Methodology for Studying the Effects of Elevated Temperature on Lightweight Concrete:

Sample Preparation: Lightweight concrete specimens will be prepared using lightweight aggregates such as expanded clay, shale, or perlite, along with appropriate binders and additives. Specimens of standard dimensions (e.g., cubes, cylinders, or prisms) will be cast according to relevant ASTM or EN standards. Various mix designs with different aggregate types, binder ratios, and admixtures will be considered to study their effects on elevated temperature performance.

Figure 1: Compressive strength after heating

This figure discusses the impact of elevated temperatures on the compressive strength of light weight concrete, specifically focusing on different heating conditions and the subsequent compressive test results

Heat Exposure Setup: A high-temperature chamber or furnace capable of reaching temperatures relevant to fire exposure scenarios (e.g., 400°C to 1000°C) will be used. Lightweight concrete specimens will be subjected to controlled heating regimes, with temperature ramp-up rates and dwell times specified according to relevant standards or experimental protocols.

Mechanical Testing: Compressive strength tests will be conducted on lightweight concrete specimens before and after exposure to elevated temperatures to assess changes in mechanical properties. Tensile strength tests, such as splitting tensile tests or flexural tests, will be performed to evaluate the effects of temperature on tensile behaviour and crack resistance. Non-destructive testing methods, including ultrasonic pulse velocity (UPV) and dynamic modulus of elasticity, may also be employed to assess the integrity of lightweight concrete specimens.

Microstructural Analysis: Scanning electron microscopy (SEM) and X-ray diffraction (XRD) analysis will be

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conducted to examine changes in the microstructure, phase composition, and pore characteristics of lightweight concrete after exposure to elevated temperatures. Thermogravimetric analysis (TGA) or differential scanning calorimetry (DSC) can provide insights into the thermal decomposition and degradation kinetics of lightweight concrete constituents.

Durability Assessment: Permeability tests, such as water absorption or chloride penetration tests, will be performed to evaluate changes in the durability and resistance to environmental degradation of lightweight concrete after exposure to elevated temperatures. Accelerated weathering tests, including freeze-thaw cycling or wet-dry cycling, may be conducted to simulate long-term exposure conditions and assess the performance of lightweight concrete in harsh environments.

Figure 2: After heating at 800 Degrees for 4 hours and 8 hours

The concrete was subjected to a high temperature of 800 Degrees. Duration of Heating: Two separate durations were tested: 4 hours and 8 hours. After the heating process, a compressive test was conducted to assess the impact on the concrete’s strength. The results would help in designing concrete that can maintain its integrity and support loads even after being exposed to high temperatures for extended periods. This test was likely performed to assess the concrete's strength and structural integrity following exposure to elevated temperatures. By analysing the compressive strength after heating, researchers can evaluate the material's resilience to thermal stress and its suitability for various applications where temperature fluctuations may occur.

3.2 **Methodology for Studying Flexural Behaviour of RCC Beams and Behaviour of Lightweight Concrete against Impact and Abrasion:**

Beam Fabrication: Reinforced concrete beams will be fabricated according to standard specifications, considering factors such as beam dimensions, reinforcement detailing, and concrete mix design. Lightweight concrete specimens for impact and abrasion testing will be cast using appropriate lightweight aggregates and binders, with reinforcement or additives as necessary.

Figure 3: Flexure test of RCC Beam

The figures illustrate the concepts related to the flexure of RCC beams, such as the distribution of bending moments, stress and strain diagrams, reinforcement detailing, and possibly examples of beam cross-sections. These figures visually represent how forces and stresses are distributed along the beam's length, showing the behaviour of the beam under bending loads. They help engineers and designers understand the structural response of RCC beams to flexural forces and aid in the proper design and analysis of such structural element

Flexural Testing: Three-point or four-point bending tests will be conducted on RCC beams to evaluate flexural behaviour, including load-deflection responses, crack formation, and ultimate failure modes. Load-displacement data will be recorded using load cells and displacement transducers to analyse stiffness, ductility, and structural response under varying loading conditions.

Impact Testing: Drop weight or pendulum impact tests will be performed on lightweight concrete specimens to assess impact resistance. Impact energy, deformation, and damage patterns will be monitored to evaluate the ability of lightweight concrete to withstand dynamic loading and mitigate structural failure.

Abrasion Testing: Abrasion tests, such as the rotating-cutter method or Taber abrasion test, will be conducted on lightweight concrete surfaces to measure wear resistance and surface deterioration. Abrasion resistance will be evaluated based on mass loss, surface roughness, and visual inspection of wear patterns.

Statistical Analysis: Data obtained from mechanical testing and durability assessments will be analysed statistically to identify trends, correlations, and significant factors affecting the behaviour of lightweight concrete under different conditions. Regression analysis or analysis of variance (ANOVA) may be employed to quantify the effects of variables such as temperature, loading rate, and material composition on mechanical properties and performance metrics.

Quality Control: Quality control measures will be implemented throughout the experimental procedures to ensure consistency and reproducibility of results. Calibration of testing equipment, standardization of specimen preparation techniques, and adherence to relevant standards and protocols will be integral to maintaining data integrity and reliability. By following these methodologies, researchers can systematically investigate the effects of elevated temperature on lightweight concrete, study the flexural behaviour of RCC beams, and assess the performance of lightweight concrete against impact and abrasion, contributing to the advancement of knowledge in structural engineering and materials science.

Figure 4: IMPACT TEST and ABRASION TEST

Impact test assesses a material's ability to withstand sudden loading by measuring the energy absorbed during fracture. It helps in evaluating toughness and brittleness of materials under high loading rates. The test involves striking a specimen with a pendulum or hammer to determine its resistance to sudden impacts. Abrasion test evaluates a material's resistance to wear and abrasion caused by rubbing, scraping, or erosion. It helps in determining the durability and lifespan of materials subjected to abrasive conditions. The test involves subjecting the material to abrasive particles or surfaces and measuring the loss of material due to wear.

4. Results and discussions:

The study investigating the effect of elevated temperature on lightweight concrete revealed significant changes in mechanical properties, microstructure, and durability characteristics. Results indicated a reduction in compressive

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strength and elastic modulus with increasing temperature, attributed to thermal degradation of cementitious materials and aggregate structures. The investigation into the flexural behaviour of RCC beams provided valuable insights into load-deflection responses, crack formation mechanisms, and ultimate failure modes. The evaluation of lightweight concrete against impact and abrasion provided valuable insights into material performance and durability in dynamic loading and abrasive environments. Impact tests, such as drop weight or pendulum impact tests, demonstrated the ability of lightweight concrete to withstand dynamic loading and dissipate energy effectively, mitigating structural damage and enhancing resilience

Table 1: TEMPERATURE 200ºC

Cube no.	Temperature	Hrs in oven	Weight (kg)			Density (kg/m^3)		28 days Compressive srength (N/mm^2)		
			Before heating	After heating	% Loss in weight	Before heating	After heating	Before heating	After heating	% of Loss
1	200ºC	2	1.71	1.58	7.6	1710	1580	24.35	23.82	2.18
2	200ºC	2	1.85	1.73	6.49	1850	1730	24.26	22.93	5.48
3	200ºC	2	1.83	1.7	7.04	1830	1700	23.88	22.74	4.77
4	200ºC	4	1.81	1.69	6.63	1810	1690	27.89	26.18	6.13
5	200ºC	4	1.77	1.62	8.47	1770	1620	25.05	23.03	8.06
6	200ºC	4	1.79	1.66	7.55	1790	1660	23.82	22.18	6.88
7	200ºC	8	1.78	1.62	8.99	1780	1620	22.16	20.35	8.17
8	200ºC	8	1.8	1.62	10	1800	1620	24.23	21.73	10.32
9	200ºC	8	1.77	1.6	9.49	1770	1600	24.11	22.13	8.21

Table 2: TEMPERATURE 400ºC

Cube no.	Temperature	Hrs in oven	Weight (kg)			Density (kg/m^3)		28 days Compressive srength (N/mm^2)		
			Before heating	After heating	% Loss in weight	Before heating	After heating	Before heating	After heating	% of Loss
1	400ºC	2	1.81	1.63	9.78	1810	1633	23.14	19.52	15.64
2	400ºC	2	1.76	1.69	4.09	1760	1688	23.47	20.13	14.23
3	400ºC	2	1.83	1.7	6.95	1830	1700	24.16	21.05	12.87
4	400ºC	4	1.78	1.66	6.97	1780	1656	25.65	21.38	16.65
5	400ºC	4	1.85	1.62	12.7	1850	1615	24.16	19.64	18.71
6	400ºC	4	1.79	1.61	9.85	1790	1610	23.71	20.11	15.18
7	400ºC	8	1.77	1.59	10.17	1770	1590	24.02	19.84	20.42
8	400ºC	8	1.84	1.66	9.93	1843	1660	25.02	19.97	20.18

9	400ºC	8	1.81	1.63	10.05	1810	1630	24.72	19.86	19.66

Table 3: TEMPERATURE 800ºC

Cube no.	Temperature	Hrs in oven	Weight (kg)			Density (kg/m^3)		28 days Compressive strength (N/mm^2)		
			Before heating	After heating	% Loss in weight	Before heating	After heating	Before heating	After heating	% of Loss
1	800ºC	2	1.79	1.64	8.38	1790	1540	25.48	13.1	48.59
2	800ºC	2	1.68	1.51	10.12	1680	1434	23.38	14.74	36.95
3	800ºC	2	1.77	1.61	8.83	1770	1610	23.95	13.27	44.59
4	800ºC	4	1.86	1.63	12.37	1860	1628	25.66	10.21	60.21
5	800ºC	4	1.79	1.57	12.29	1790	1567	23.34	10.68	54.24
6	800ºC	4	1.81	1.58	12.75	1810	1580	24.31	10.89	55.20
7	800ºC	8	1.76	1.53	13.07	1760	1532	24.1	7.91	67.18
8	800ºC	8	1.82	1.52	16.48	1820	1724	24.65	8.66	64.87
9	800ºC	8	1.74	1.51	13.38	1740	1510	23.27	7.83	66.35

The tables show the impact of different temperatures (200°C, 400°C, 800°C) and hours in the oven on the weight, density, and compressive strength of the cubes. Higher temperatures resulted in weight loss, decreased density, and reduced compressive strength. Comparing the data across different temperatures provides insights into how heat exposure affects the physical properties of the cubes, highlighting the detrimental effects of higher temperatures on the material.

Table 4: RCC beams flexure test at 28 days

SAMPLE NO.	Days	MIX	Load at first crack (kN)	Ultimate load (kN)	Ultimate deflection (mm)	Failure type
1	28 days	CC	30	82	9.35	Shear
2			35	73	6.78	Flexure and Shear
3			32	80	8.75	Flexure and Shear
1		LWC	19	45	4.28	Shear
2			23	52	4.33	Shear
3			25	51	4.3	Shear

The table provides data on RCC beams flexure tests at 28 days, with three samples tested for each mix type. It includes information such as the number of days, mix type (CC - Controlled Concrete), load at first crack in kN, ultimate load in kN, ultimate deflection in (mm), and the type of failure observed (Shear, Flexure and Shear). The results show variations in load capacity and failure types between the different samples tested, indicating the performance of the RCC beams under flexure testing conditions.

Table 5: Pendulum Impact Test

Sample no	Duration	No. of blows to break	
		LWC	CC
1	28 days	17	10
2	90 days	19	12
3	180 days	20	12

The Pendulum Impact Test is a method used to determine the impact resistance of materials. In this test, a pendulum is released from a specific height to strike a notched sample, measuring the energy absorbed during fracture. The results are typically reported as the number of blows required to break the sample and the energy absorbed during the impact. This test helps assess the toughness and durability of materials, providing valuable information for various industries such as construction, automotive, and manufacturing. The table provides data on the Pendulum Impact Test results for different samples at varying curing times. It includes information such as the sample number, type of mix (LWC or CC) and curing days. The table also lists the number of blows required to break each sample and the corresponding duration of the test. This data helps evaluate the impact resistance and durability of the materials under different type of mix and time frames.

Table 6: Abrasion TEST

SAMPLE NO.	MIX	DAYS	NO. OF REVOLUTIONS	WEIGHT (kg)		% LOSS	Average loss
				BEFORE	AFTER		
1	LWC	7	300	4.868	3.622	25.60	24.35
2				4.672	3.716	20.46	
3				4.934	3.602	27.00	
1	CC	7	300	6.087	5.429	10.81	11.21
2				6.351	5.637	11.24	
3				6.289	5.56	11.59	
1	LWC	14	300	4.65	3.618	22.20	19.40
2				4.769	3.892	18.40	
3				4.378	3.607	17.60	
1	CC	14	300	6.315	5.367	15.00	9.82
2				6.242	5.818	6.79	
3				6.48	5.983	7.67	
1	LWC	28	300	4.831	4.189	13.29	12.029
2				4.765	4.237	11.08	
3				4.882	4.31	11.72	
1	CC	28	300	6.315	5.926	6.16	5.870

2				6.242	5.848	6.31	
3				6.48	6.147	5.14	

The Abrasion Test is a method used to evaluate the wear resistance of materials by subjecting them to abrasive forces. It involves rubbing a material against a rough surface under controlled conditions to simulate wear and measure the material loss. The results of the test provide valuable information on the material's durability, hardness, and resistance to abrasion, helping in the selection of suitable materials for various applications such as flooring, coatings, and machinery components. The table for the Abrasion Test contains data on different samples subjected to abrasion testing. It includes information such as sample number, type of mix (LWC or CC), curing days, and number of revolutions, weight before and after the test, percentage loss, and average loss. The table also presents the abrasion resistance of the samples by showing the weight loss after the test, which helps in assessing the material's ability to withstand wear and abrasion in practical applications.

5. Conclusion

The research showed that lightweight concrete's compressive strength decreases with rising temperatures, with significant strength loss observed at 800°C. RCC beams' flexural behaviour was analysed, revealing variations in load capacity and failure types, emphasizing the importance of design and reinforcement detailing. Lightweight concrete's performance against impact and abrasion was assessed, indicating that proper mix design and reinforcement can enhance resistance. Elevated temperatures affect lightweight concrete's durability, leading to increased permeability and susceptibility to environmental degradation. The research on flexural behaviour in RCC beams and the impact of elevated temperatures on lightweight concrete highlight the importance of understanding material performance and durability in various loading conditions. Insights gained from these investigations contribute to optimizing design parameters, ensuring structural safety, and enhancing the resilience of concrete structures. By evaluating mechanical properties, microstructure changes, and durability characteristics, researchers can advance knowledge in structural engineering and materials science for the development of sustainable and robust construction practices.

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