A Review of The Behaviour of High-Performance Concrete Utilizing Graphite Powder and Natural Fibres

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Abstract - High-performance concrete is a type of concrete that is more durable, stiffer, and more insulating than regular concrete. It also dries faster and resists damage in a variety of climatic situations. High-performance concrete is composed of resins, binders, and aggregates that have been tuned to fulfill stringent strength and durability criteria. a paper that provides an outline of the materials utilized in the manufacture of high-performance concrete. The purpose of this research is to identify potential novel materials for use in the creation of these unique concretes. While searching bibliographic databases for information on OPC (ordinary Portland cement), mineral additions, aggregates, and chemical additives used in the manufacturing of HPC and UHPC, many parameters were considered (ultra-high-performance concrete). The review paper also discusses key features of potential materials utilized in the manufacturing of HPC and UHPC, such as whether synthetic or natural fibers may be combined with cement to make UHPC composites that outperform ordinary concretes used in civil construction. Overall, the paragraph presents an overview of high-performance concrete and the materials utilized in its manufacture, as well as the possibility for future materials to be employed.

Index Terms - High-Performance Concrete, Graphite powder, Walnut shell, Natural fiber, Durability

I. INTRODUCTION

A high-performance concrete system is intended to provide long-term durability and performance. This is accomplished by employing procedures like curing the concrete at low temperatures with low water content, inserting steel or twisted rods for structural support, or utilizing precast brickwork. High-performance concrete is frequently employed in contemporary construction designs because it has more endurance than traditional materials that are not designed to survive for decades. It is also thought to be a more ecologically friendly technique.

Graphite is a substance that is mostly comprised of carbon and has a highly distinctive set of features. It has a porous structure and is lightweight and soft. Carbonization of plant matter, such as charcoal, coal, or molten tar, is used in the manufacturing of graphite. Graphite is commonly utilized as a filler in numerous applications such as tubes, electrical contacts, and connector pins in the electronics sector due to its high electrical conductivity. This is due to its high electrical conductivity, making it a suitable material for use in electrical applications.

Fig.1 Materials which are used in HPC concrete

The outer coating of a walnut fruit is used to make walnut shell powder. Walnut trees produce a hard, woody shell or pit that covers the seed or nutlet. The shell forms by enclosing and encircling the pericarp, which is the husk or outer coat of the ovule or seed. To acquire the shell, the fleshy outer covering of the nut is removed, which is then crushed and ground into a fine powder. This powder has a wide range of uses, including cosmetics, abrasives in polishing and cleaning goods, and fillers in industrial materials.

High-performance concrete (HPC) is a type of concrete that has been particularly constructed to suit certain needs such as high strength, durability, and environmental resistance. HPC is composed of a blend of resins, binders, and aggregates that have been designed for these qualities. The British government invented it in the late 1970s, and its use has expanded across the construction sector since then. The American Society of Testing Materials (ASTM) developed a design guide for HPC in 1980, which includes Portland cement and a variety of additives. High-rise structures, bridges, and tunnels are just a few of the uses for HPC. The theoretical elements of HPC were reviewed in the review study, including theories for its creation and bearing capacity. It also covered ultra-high-performance concrete (UHPC), a kind of HPC with even greater strength and durability.

The technological aspects of this concrete are described, giving details on the binder, reinforcing action, Young's modulus, and other properties that can be used for construction analysis. Also reviewed are pre-commercialization efforts as well as technological difficulties that still need to be overcome if this type of concrete will become commercially viable.

TABLE 1. Properties of Different Types of Concrete:

Concrete	**Abbreviation**	**Compressive Strength (Mpa)**	**w/b Ratio**	**Workability (mm)**	**Cement Consumption (kg/m^3)**
Conventional	CC	20-50	0.45-0.65	NA	260-380
High Strength	HSC	55-100	NA	NA	400-700
High Performance	HPC	55-100 50-100	<0.4	455-810 (slump flow)	400-700
Ultra-High Performance	UHPC	>100 >120 >150	0.2-0.3	> 260 (flow table without drops)	800-1000

CLASSIC COMPONENTS USED FOR HPC AND UHPC PRODUCTION

The primary materials that make up the construction of HPC and UHPC will be explained in this section. These materials are referred to as classics since they are also utilized in CC manufacture. Ordinary Portland cement (OPC), mineral additions, aggregates, and chemical additives are samples.

Ordinary Portland Cement (OPC). The OPC that is used to produce HPC and UHPC may also be utilized to produce CC. Therefore, a few experts advise using OPC with greater clinker concentrations and lesser mineral additives. This is important because the manufacture of HPC/UHPC requires the use of mineral additives, such as fly ash and blast furnace slag, that are more reactive than those typically taken into account in the manufacture of commercial cement [1]. These unique OPCs have different denominations. These types of cement are referred to as CP-I cement and as CP-V-ARI cement by Brazilian standards NBR 16697 [2] by the major international standards and cement as OPC-43, and OPC-53 by Indian standards.

TABLE 2. Physical Properties of Ordinary Portland Cement (OPC) Used for HPC And UHPC.

Density (g/cm^3)	Blaine Fineness (cm2/g)	Retained in Sieve #200 (%)	Reference
-	3600	-	[55]
3.1	3600	-	[29]
3.12	4430	0.2	[1]
3.15	3500	-	[17]
-	-	2	[56]
3.06	-	1.38	[57]
3.09	4070	-	[58]
3.15	-	1.8	[25]

Mineral additions. Researchers have proposed the replacement of clinker with agro-industrial residues or by-products. This is the case with blast furnace slag, fly ash, silica fume, and other pozzolans such as agricultural ashes. It was observed a reduction in production costs, due to the reduction in the consumption of clinker, which generally has a higher cost than aggregates. For example, Li and Jiang (2020) [3] observed a 21% cost reduction when using 60% slag and 10% limestone in OPC replacement for the same concrete strength class. Zhang et al. (2021) [4] demonstrated that concrete mix design can be optimized simultaneously for environmental, economic, and mechanical objectives with silica fume incorporation. In addition, there is a contribution to sustainable development, and the achievement of concrete with greater mechanical strength, especially with the use of pozzolanic materials [5,6,7]

Aggregate. As for their weight, aggregates are classified as light, such as expanded clay, conventional, such as crushed stone, or heavy, such as hematite aggregates [8,9]. From a granulometric point of view, they are classified into carse, those whose grains pass through the 152 mm opening sieve and are retained in the 4.75 mm sieve, and in giblets, those whose grains pass through the 4.75 mm opening sieve and remain retained in the 0.075 mm aperture sieve [10,11]. The particle size distribution of the materials plays a major role in the fresh and hardened performance of HPC and UHPC. While the aggregates correspond to the macroscale components, the binder materials (i.e., OPC and mineral additions) correspond to the microscale fraction of concrete. In addition, the very small silica fume particles can improve the particle packing of the binder fraction, leading to higher compactness due to physical effects besides the pozzolanic contribution [12]. By optimizing the particle size distribution and mix proportions, one can achieve maximum particle packing, therefore improving the fresh and hardened properties of concrete. This strategy has been widely used for HPC and UHPC design over the last few years [13,14,15].

Chemical Additi*ves.* As examples of some additives used in HPC, the following works stand out. Ibragimov and Fediuk (2019) [16]. evaluated the influence of different types of superplasticizers on the mechanical properties of concrete. The authors used five different superplasticizer additives: the first is a copolymer based on polyethylene derived from unsaturated carboxylic acids (1st generation); the second is based on sodium salts of polyethylene naphthalene sulfonic acids (2nd generation); the third is a polyfunctional consisting of naphthalene sulfonate and an organic accelerator; the fourth additive used is a superplasticizer based on polyoxymethylene derivatives of polymath acrylic acid (PAA); finally a copolymer based on polyether carboxylates (PCE). The strength results obtained by the authors are shown in given table below. It is observed that the additives that contributed the most to the compressive strength were the PAA and PCE, which is why they are the most used in the literature.

TABLE 3. Compressive strength results obtained with the use of various water-reducing additives:

Composition	Compressive Strength after 1 Day (MPa)	Compressive Strength after 3 Days (MPa)	Compressive Strength after 28 Days (MPa)
Reference	7.1 (100%)	19.57(100%)	40.53 (100%)
1st generation	12.32 (174%)	31.89 (163%)	57.55 (142%)
1st generation (naphthalene)	12.81 (18%)	32.42 (166%)	51.70 (128%)
Polyfunctional	13.76 (194%)	29.01 (148%)	46.15 (114%)
Polyoxyethylene derivatives of polymethacrylic acid (PAA)	22.53 (331%)	46.38 (237%)	62.81 (155%)
Copolymer based on polyether carboxylates (PCE)	19.62 (276%)	45.01 (230%)	65.72 (162%)

HPC and UHPC Containing Fibres: Composite Material

Steel Fibres. Through the consulted database, it is observed that the majority of research carried out with HPC and UHPC, mainly use steel fibres, produced through essentially ferrous metallic alloys, containing between 0.008 and 2.11% of carbon. These fibres present positive properties, such as high ductility and tensile strength, in addition to compatibility with concrete, which is typically observed in the use of steel bars in reinforced concrete [17,18,19,20]. However, they are prone to corrosion, which is why several authors have studied the effects of this pathology on the behavior of HPC. According to Shin and Yoo (2020) [21], Yoo et al. (2020) [22], Lv et al. (2021) [23], and Ngo et al. (2021) [24], corrosion reduces the strength of the cementitious composite and decreases its ductility to levels even worse than its behavior without reinforcement. Therefore, corrosion must be severely avoided.

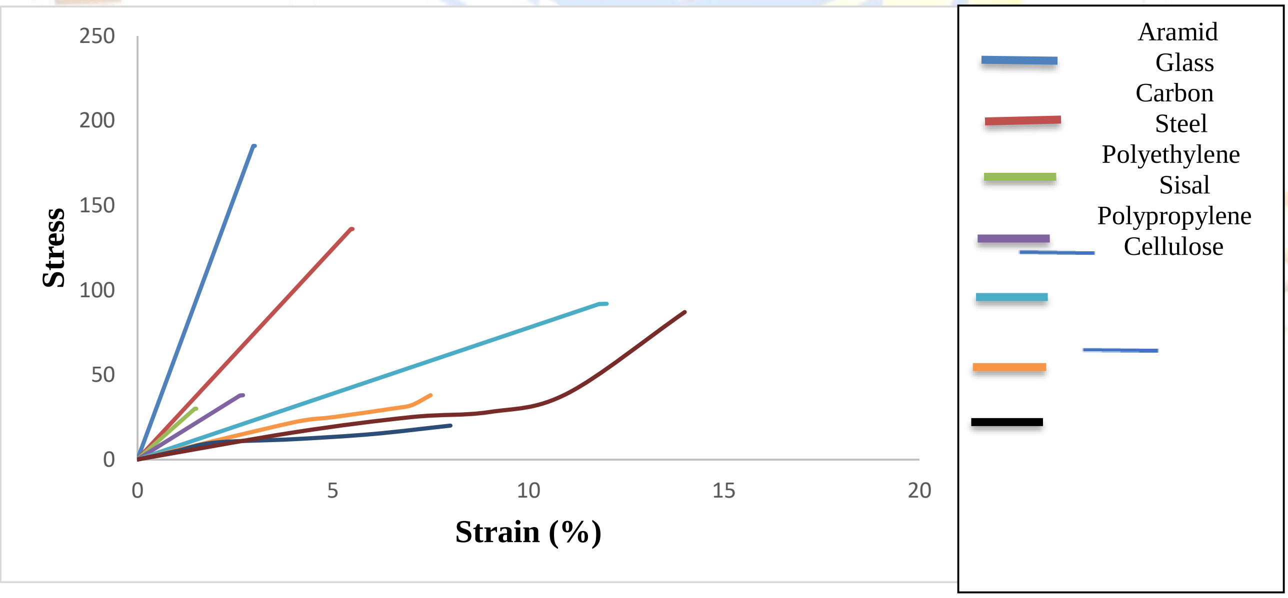

fig 2. Stress-strain diagram of fibers used in HPC and UHPC

Other Synthetic Fibres. Other synthetic fibers used for HPC and UHPC applications are carbon, glass, and polymeric materials such as polypropylene and polyethylene. Carbon fibers, composed of thousands of unified filaments, have the advantage of greater adhesion to the cement matrix due to their high specific area.

Natural Fibers. Natural fibers, such as fibers of mineral origin like basalt [25,26,27,28], and fibers of plant origin, like sisal [29,30], as well as banana [31,32], can also be used as reinforcement of HPC and UHPC. Their main advantages are the fact that they are renewable and eco-friendly resources. The main disadvantages are the great variability of properties and the possibility of degradation in an alkaline environment, especially in the case of fibers of vegetable origin that need previous treatments to be applied in cementitious matrices [29,30,33]. Another important advantage of natural fibers, especially vegetable fibers, is related to the *fiber's* high adherence to the OPC matrix. The adhesion mechanisms of this type of *fiber* are related to the fibrous structure of cellulose [29]. Some authors have carried out studies on the improvement of the adhesion properties of these fibers through treatments with alkaline materials, which attack the *fibre* surface, increasing the roughness and adhesion with the matrix [30,33].

II. LITERATURE SURVEY

Venkatesh Kodur and Wasim Khaliq was investigated the effects of steel, polypropylene, and hybrid fibres on HSC and SCC, as well as how temperature influences the thermal characteristics of several high-strength concrete (HSC) types, including self-consolidating concrete (SCC) and fly ash concrete (FAC). In the 20 to 800 °C temperature range, the researchers investigated specific heat, thermal conductivity, and thermal expansion. In the 20–800 °C temperature range, the results indicated that SCC had greater thermal conductivity, specific heat, and thermal expansion than HSC and FAC. Simplified equations that represent different thermal qualities as a function of temperature were developed using the test results. The performance of concrete buildings in the presence of fire may be assessed using these equations.

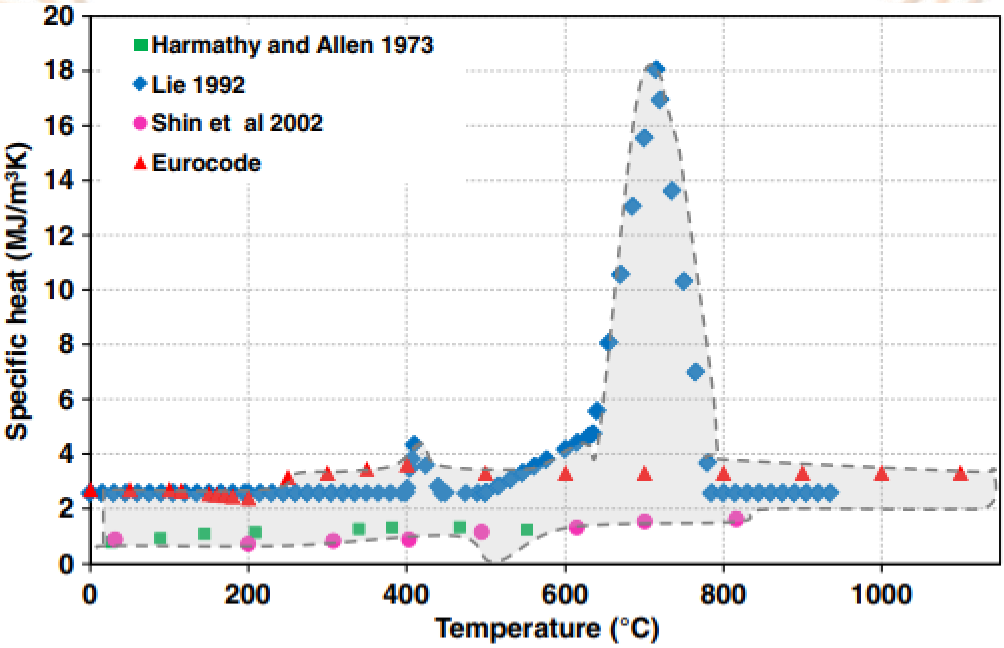

Fig. 3 Variation of specific heat of NSC as a function of temperature

Liu Xiaoming and Wu Shaopeng assessed how adding conductive materials, such as graphite and carbon fibre, might affect the mechanical and electrical characteristics of asphalt concrete. The inclusion of carbon fibre boosted these qualities, but the addition of graphite lowered the Marshall stability, residual stability, and rutting dynamic stability of the asphalt mixture. The mechanical and electrical qualities of the asphalt concrete were enhanced when the two fillers were added. With a value of 90% for 30 vol.% graphite and 70% for 45 vol.% graphite, the robust modulus was similarly impacted by the addition of graphite. They proposed that modified asphalt concrete made with graphite and carbon fibre can be beneficial for self-monitoring of strain in a variety of applications, including border and traffic monitoring and vibration control.

Waqas Ahmad and others had investigated the impact of coconut fibre reinforcement on the mechanical characteristics of high strength concrete (HSC) containing silica fume and a superplasticizer. SEM was used to examine the microstructure when the fibres' lengths (25mm, 50mm, and 75mm) and mass contents (0.5%, 1%, 1.5%, and 2%) were altered (SEM). In comparison to HSC without fibres, the study discovered that adding coconut fibres increased the compressive, splitting-tensile, and flexural strengths as well as energy absorption and toughness indices. The 50mm long fibres and 1.5% cement mass content produced the greatest overall results.

Alireza Naji Givi, and Suraya Abdul Rashid was evaluated the effect of SiO2 nanoparticles on the physical and mechanical characteristics of binary mixed concrete. Water permeability, workability, and setting time were among the physical parameters examined; the mechanical qualities examined were compressive, split-tensile, and flexural strength. As a partial replacement for cement, the researchers introduced SiO2 nanoparticles at varied concentrations (0.5%, 1.0%, 1.5%, and 2.0%). The samples were cured in a water and lime solution for 7, 28, and 90 days. The best replacement level for cement with SiO2 nanoparticles, according to the study's findings, was 1.0% for specimens that were cured in water, increasing the strength of the cement. Nevertheless, Portland cement might be efficiently substituted with 2.0% of SiO2 nanoparticles for specimens curing in a lime solution to produce the same effect. In conclusion, the researchers hypothesised that the ideal replacement level depended on the curing circumstances and that adding SiO2 nanoparticles to binary mixed concrete might enhance its physical and mechanical qualities. The results could have an impact on the future design of stronger and more resilient concrete.

Khaled Abdelsami, Ibrahim Saad Agwa, Bassam Tayeh, and Radwa Defalla Abdel Hafez was investigation on the use of natural materials like chicken feather fibres (CFFs) in reinforced concrete composites. When a structure is built to its maximum capacity, high-strength concrete (HSC) is brittle and is prone to a sudden collapse. As a result, the study's goal was to determine whether employing CFFs may make HSC behave more brittlely. To determine the effects of using CFFs, two situations were looked at. Several CFF volumes (0% as the control, 0.5%, 1%, 1.5%, 2%, and 3%) were added to HSC in the first scenario. The second scenario substituted glass fibres (GF) for CFFs. Testing was done on the concrete's morphological, hardened, and fresh qualities. Also, they discovered that employing both types of fibres increased HSC's brittleness, with 1% serving as the ideal volume ratio for each type of fibre. Flexural strength increased by 44.9% and splitting tensile strength increased by 42.65% in the combinations containing 0.1% GF. The same attributes were improved by around 21.6% and 21.16%, respectively, in the mixes containing 0.1% CFF. In conclusion, the researchers hypothesised that using CFFs and GF can increase HSC's brittleness, with 1% serving as the ideal volume ratio for both types of fibres. Using GF in HSC led to larger improvements in flexural and splitting tensile strengths than CFF.

Baomin Wang was evaluated the effect of adding nano-SiO2 (NS) to high-performance concrete with varied water-to-binder (W/B) ratios (0.24, 0.29, and 0.34) on its strength. The compressive strengths of the concrete were measured early on and later on by the researchers. They discovered that NS enhanced the compressive strength of the concrete mix, and that the impact was greater in the first stages than in the last stages. The best mixing ratio for NS was determined to be between 3% and 5%. The tests employed X-ray diffraction, scanning electron microscopy (SEM), and mercury injection to better understand the action principle of NS at the microscopic level. The findings demonstrated that NS greatly enhanced the microscopic properties of the concrete and had a filling effect, which increased the concrete's performance. The researchers conclude that adding NS can increase the strength of high-performance concrete, and the ideal mixing ratio is between 3% and 5%. The microscopic examination revealed that NS has an interfacial and filling impact that enhances the microscopic properties of the concrete and enhances performance.

Ali Khoshakhlagh, Ali Nazari, and Gholamreza Khalaj was researched at how adding various concentrations of Fe2O3 nanoparticles to high-performance self-compacting concrete might affect it. The specimens' compressive, flexural, and split tensile strengths as well as their water absorption coefficient were assessed by the researchers. They discovered that including Fe2O3 nanoparticles into the cement paste up to 4.0 weight percent enhanced the concrete specimens' strength and water permeability. The development of C-S-H gel was aided by the higher concentration of crystalline Ca(OH)2, especially in the early stages of hydration, which boosted the specimens' strength. The Fe2O3 nanoparticles also served as foreign nucleation sites, hastening the production of C-S-H gel and boosting the durability of the concrete. Also, the nanoparticles served as nanofillers, filling up unwanted voids and re-establishing the specimens' pore structure, which decreased their capacity to retain water. In conclusion, they proposed that the addition of Fe2O3 nanoparticles to high-performance self-compacting concrete might increase the material's strength and water permeability and might be a technique to improve the performance of concrete structures.

Morteza H. Beigi, Javad Berenjian, Omid Lotfi Omran, Aref Sadeghi Nik, and Iman M. Nikbin assessed the effects of nano silica and reinforcing fibers on the mechanical, rheological, and durability of self-compacting concrete. The rheological characteristics of the concrete were assessed by the researchers using a variety of testing techniques, including L-Box, slump flow, and T50. RCPT and water absorption tests were also utilized to evaluate the concrete's durability. To assess the microstructural qualities of the concrete, they also employed atomic force microscopy and X-ray diffraction techniques. 40 distinct concrete mixes, labeled A, B, C, and D, were used in the study. The cement's nano silica concentration ranged from 0 to 6 weight percent (wt%), and three types of reinforcing fibers—steel, polypropylene, and glass—were added in varying volume percentages (0.1 to 0.5 v%). The finding of the study demonstrated that self-compacting concrete's mechanical characteristics and durability may be considerably increased by adding the optimum proportions of both nano silica and reinforcing fibers.

Marawan Saad, Ibrahim Saad Agwa, Bassam Abdelsalam Abdelsalam & Mohamed Amin did that the investigation about impacts of employing natural fibre waste to improve the brittleness of high-strength concrete was explored (HSC). Banana fibre (BF) and palm leaf sheath fibre (PLSF), which were employed as natural fibres, were processed chemically before being added to the concrete mixes. Using fibre volume fractions of 1%, 2%, and 3% and an aspect ratio of 100, the researchers created three HSC mixes including BF, and three additional mixes containing PLSF. The slump, compressive strength, tensile strength, flexural strength, and elastic modulus of HSC with natural fibres were all examined by the researchers. SEM was also used to examine the microstructures of natural fibres and HSC made with natural fibre. The outcomes demonstrated that the inclusion of natural fibres did not considerably increase the compressive strength of HSC. Nevertheless, the tensile strength of HSC improved when up to 2% PLSF was applied. In terms of enhancing the characteristics of HSC, PLSF was discovered to be superior to BF. Both fibres were shown to be beneficial in improving the brittleness of HSC.

Libya Ahmed Sbia, Amirpasha Peyvandi, Parviz Soroushian, and Anagi M. Balachandra were carried out in order to assess the impact of adding nano and microscale reinforcement to ultra-high-performance concrete (UHPC). The optimum reinforcing system, which combined PVA fibre and CNF at certain volume fractions, enhanced the flexural strength, maximum deflection, energy absorption capacity, impact resistance, abrasion weight loss, and compressive strength of UHPC by certain percentages, according to the study. Their research also discovered that while modified CNF had no effect on the workability of fresh UHPC blends, PVA fibre had an undesirable effect. The authors found that the ideal discrete reinforcing systems discovered in the study are influenced by a variety of criteria, including concrete materials, mix designs, manufacturing circumstances, and fibre and nanofiber qualities. Lastly, the authors indicate that the study's results can be enhanced further by fine-tuning these parameters and determining the related optimal discrete reinforcement systems. Overall, the study shows that nano and microscale reinforcement have the ability to improve the mechanical characteristics and performance of UHPC.

Rabinder Kumar1 & Nasir Shafiq2 & Aneel Kumar1 & Ashfaque Ahmed Jhatial did their experiments were carried out to assess the benefits of incorporating nano-silica (NS) and metakaolin (MK) into fly ash (FA)-blended cement for increasing the mechanical and durability qualities of concrete. Ternary and quaternary material blends were employed, and cost-benefit analysis and environmental evaluation were performed. At 91 days, a mix with 10% MK substituting ordinary Portland cement (OPC) and 1% NS as an addition in FA-blended OPC concrete had a compressive strength of 94-MPa, which was more than 25% greater than the control mix. Also, the ultrasonic pulse velocity and dynamic modulus of elasticity were significantly enhanced, while chloride migration was decreased by 50%. Their research also discovered that MS100, a blend of 30% FA and 10% MK, had the lowest embodied CO2 emissions, while MS101 had the highest eco-strength efficiency for 28-day compressive strength, at 0.268 MPa/kgCO2m3. MS00 was determined to have the best cost-benefit ratio, but the inclusion of MK and NS increased the cost. As compared to MS00, MS01 had the lowest cost of producing 1 MPa, saving just 0.04-$/MPa/m3.

Salomaa, Amrinsyah Nasutionb, Iswandi Imranb, and Mikrajuddin Abdullahb performed this to assess the feasibility of employing green concrete in sustainable development, especially by integrating nanomaterials into the concrete mixture. The study employed Polishing Liquid Milling Technology to process fly ash with nanotechnology, resulting in nanoscale grain-size concrete, also known as nanomaterial concrete. The materials employed in the investigation were cement type I, nano silica, quartz powder, fine sand, coarse aggregate, and superplasticizer. The study looked at how adding nanoparticles to concrete might improve its resistance to sulfate attack, which can boost concrete's durability while lowering the environmental pollution. Overall, the study implies that integrating nanoparticles into concrete might be a potential strategy for sustainable development.

N Aina Misnon, M S Jaafar, Abdulrahman Alhozaimy, and Siti Khadijah investigated how Saudi Arabian powdered red sand may substitute partially for cement in the creation of concrete. The researchers tested the material's activation using various curing techniques and heat treatment to look into its possibilities. High-performance concrete frequently uses well-known pozzolanic ingredients like silica fume and fly ash, but their high cost is a considerable disadvantage. Due to its high silica concentration, powder red sand was discovered by the researchers to be a viable natural pozzolana. After performing a compressive strength test, they discovered that 10% powder red sand added to concrete that had been dried out using low-pressure steam produced the sample's required strength.

George Uwadiegwu Alaneme and Elvis M. Mbadike looked into the usage of Bambara nut shell ash (BNSA) in the production of concrete. The researchers utilized a 1:3:6 mix ratio and a 0.55 water-cement ratio. Various amounts of cement (0%, 5%, 10%, 20%, 30%, and 40%) were substituted with BNSA, and concrete cubes of 150 mm x 150 mm x 150 mm were cast and left to cure for varying amounts of time (3, 7, 28, 60, and 90 days). The results revealed that when the BNSA replacement ratio grew from 5 to 40%, the percentage difference in compressive strength increased from 20.69% to 46.53%. The concrete density response showed a slight rise in percent difference ranging from 0.85% to 3.47%. According to the Poisson ratio test, as the BNSA ratio went from 5% to 40%, the percentage differences increased from 5.17% to 11.14%. Young's modulus of elasticity experiment revealed that when the BNSA ratio climbed from 10.81% to 29.412% and from 5% to 40%, the percentage difference increased from 9.4% to 14.17%. The researchers discovered that the concrete with 5% BNSA substitution performed well.

R. Palla, S.R. Karade, G. Mishra, U. Sharma, and L.P. Singh studied the impacts of incorporating silica nanoparticles (SNPs) into high-volume fly ash concrete, mortar, and cement paste, which accounts for 40% of the cement's volume. The w/b ratio and SNP concentration were changed to see how they affected the material's qualities. Adding SNPs hastened the hydration process, with 2% SNPs shortening the inactive time by 4 hours. The research looked at a 0.25 w/b ratio and discovered that adding the appropriate quantity of SNPs enhanced the mechanical and durability aspects of the concrete. When compared to the control, the compressive strength of mixtures containing SNPs improved by 61% after 3 days and 25% after 28 days. SNPs were also shown to affect the porosity, sorptivity, and water absorption of the interfacial transition zone by up to 25-40%, according to the study.

Amirpasha Peyvandi, Parviz Soroushian, Nafiseh Farhadi, and Anagi M. Balachandra investigated the use of low-cost nanomaterials including graphite nanoplatelets and carbon nanofibers, which have mechanical, physical, and geometric, and stability feature similar to carbon nanotubes but at a far lower cost. They developed high-performance concrete by combining low-cost graphite nanoparticles with micro-scale polyvinyl alcohol fibres and performed studies to assess the impacts of the combination. The results demonstrated that adding graphite nanoparticles into high-performance concrete improved its different technical qualities significantly. The desired levels of micro- and nano-scale reinforcement systems were identified by the researchers. The study's findings demonstrated that nano- and micro-scale reinforcing in concrete exhibited synergistic effects, which might be attributed to the varied sizes at which they work. The researchers also revealed that graphite nanoparticles influenced the pace and degree of moisture absorption in concrete. Additionally, graphite nanoplatelets were shown to be more efficient than carbon nanofibers in improving the moisture barrier qualities of concrete due to their planar structure.

Syed Mazharul Islam, Raja Rizwan Hussain and Md. Abu Zakir Morshed They compared the quality of composite concrete reinforced with natural fibres (coconut coir) to composite concrete reinforced with straight, rounded steel fibres (HSC). To analyze the mechanical properties of the composite concrete, many tests were performed, including workability, compressive strength, indirect tensile strength, and flexural strength. Ten batches of NSC and HSC with 0%, 0.5%, and 1.0% fibre volume dosing rates on coir and steel fibres were studied to identify how to improve the mechanical characteristics of composite concrete. When the fibre dose rate rose, the workability of both NSC and HSC decreased. Compressive strength testing found that both types of fibres were weaker than conventional concrete. In NSC, steel fibre compressive strength improved with increasing fibre volume dosage rate, however, coir fibre compressive strength fell compared to plain concrete and declined with increasing fibre volume dosage rate. Split tensile testing in NSC revealed that adding 0.5% coir and 0.5% steel lowered tensile strength when compared to ordinary concrete. Strength improved as compared to 0.5% steel in ordinary concrete and 0.5% coir in HSC. In HSC, 0.5% coir outperformed 0.5% steel and unreinforced concrete. Both types of fibres enhanced the flexural strength and toughness of composite concrete in NSC, although the flexural strength of concrete including coir fibres remained constant at 0.5% and 1% fibre volume dosages, whereas it increased with steel fibres. In HSC, 0.5% coir enhanced flexural strength as compared to conventional concrete. The study discovered that 0.5% and 1.0% coir fibres increased NSC flexural strength and 0.5% coir fibre improved HSC flexural and tensile strength. Coir fibres enhanced the ductility and toughness of both types of concrete but decreased the workability of fresh concrete and the compressive strength of hardened concrete. At the post-cracking stage, the fibres were fully exploited, increasing the ductility and toughness of both types of concrete.

Roja A. Nambiar and M.K. Haridharan investigated the properties of High-Performance Concrete (HPC) by introducing 10% silica fume and 20% fly ash into the concrete mix. The compressive strength of the concrete was tested for different trial mix ratios on the 7th, 14th, and 28th days of the study, with material proportions selected based on the compressive strength of the trial mixes. After the collection of these results, samples were cast with a constant water-to-cement ratio (w/c = 0.28) and cured to explore and identify the best superplasticizer dose. The study also examined the mechanical qualities of HPC with Silica Fume and Fly Ash, such as compressive and split tensile strength, as well as the durability properties, such as sorptivity, acid attack, and so on, by adding natural fibre (jute) in various ratios. When compared to other concrete samples, the concrete with 1% jute performed better in terms of mechanical and durability properties.

III. CONCLUSIONS

The purpose of a review study, as discussed in this chapter, is to assess theories regarding the components utilized to create HPC (high-performance concrete) and UHPC (ultra-high-performance concrete). Although these forms of concrete have no set definition, they are typically regarded as having great strength, superb workability, and high durability. Based on the literature and research, the review study set a limit of 50 MPa for HPC and 100 MPa for UHPC for these concretes' compressive strengths at 28 days.

The principal form of Ordinary Portland Cement (OPC) utilized in the creation of traditional HPC and UHPC is distinct from that used in ordinary concrete. The OPC used in HPC and UHPC is richer in clinker and has fewer mineral additives, ensuring that the pozzolans used to make HPC and UHPC are of greater quality and reactivity than those used to create OPC. From a chemical and mineralogical viewpoint, it is preferable to employ OPCs that are high in C3S and C2S or have low levels of Al2O3 and Fe2O3 oxides. This information is based on the conclusions of a review study that assessed the precursor materials utilized in the development of HPC and UHPC.

The significance of utilizing chemical additives, especially shrinkage mitigators and superplasticizers, in the manufacturing of HPC and UHPC (ultra-high-performance concrete). These additives aid in lowering the water-to-cement ratio (w/c) without compromising the concrete's workability. The third generation of superplasticizers is the most often employed in these applications. These superplasticizers function by leveraging both electrical repulsion and steric processes to scatter the cement particles in the mix and boost workability. Overall, the utilization of these chemical additions is critical in producing the necessary HPC and UHPC qualities.

Producing HPC and UHPC with OPC and mineral admixtures is often easier since it does not entail handling very alkaline materials. Using alkali-activated materials to make HPC and UHPC, on the other hand, has a lesser environmental effect.

This article gives a thorough examination of how nanomaterials impact the various characteristics of UHPC. Following an analysis of data from past investigations, the following results were reached:

- The addition of nanoparticles to UHPC influences the fluidity of the mixture largely through the specific surface area's water absorption rate and the filling effect. At low doses, CNFs and CNTs have no influence on fluidity, whereas other materials impair the fluidity of UHPC due to their water absorption effect. Admixture-modified nanoparticles are a reliable answer to this problem.
- CNTs and CNFs primarily increase UHPC mechanical characteristics, whereas other nanomaterials improve pore structure via the seeding, filling, and reactivity with hydration products. These effects improve the toughness, impermeability, and bending strength of UHPC.

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