IJARETY


# International Journal of Advanced Research in Education and TechnologY (IJARETY)

**Volume 11, Issue 6, November-December 2024**

**Impact Factor: 7.394**

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

INNO SPACE SJIF Scientific Journal Impact Factor

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International Journal of Advanced Research in Education and TechnologY(IJARETY)

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 7.394| A Bi-Monthly, Double-Blind Peer Reviewed & Referred Journal |

|| Volume 11, Issue 6, November-December 2024 ||

DOI:10.15680/IJARETY.2024.1106063

# High Strength Concrete - A Literature Review

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**ABSTRACT:** Concrete is the most widely used building material. India uses more than 100 million cubic meters of concrete per year, making it the most common building material there. Numerous varieties come in a variety of uses. High performance special concrete is one such variety that has greater durability and strength than regular special concrete with a lower water-cement ratio. A large number of mineral admixtures, which are waste products of other industries, are being beneficially used in making quality concrete. This type of concrete type is used in special and complex construction structures such as bridges and tunnels. High-performance concrete also helps in reducing the duration of the project. High performance concrete has several advantages over traditional Portland cement concrete. High-strength concrete having more than 60MPA comprehensive strength with improved properties is generally known as high performance concrete.

**KEY WORDS**: High-performance concrete, Water cement ratio, Plasticizers, Fly ash, Compressive strength, Portland cement, Applications of high-performance concrete.

## I. INTRODUCTION

In the present phase, concrete has proved to be the most important element inconstruction. Concrete is a composite construction material whose majorconstituents are aggregate, cement, and water. The concrete has the same basicingredients but has a different microstructure than ordinary concrete. Highperformance concrete (HPC) incorporates additional cementitious materials suchas fly ash, blast furnace slag, silica fume, and superplasticizer. HPC has highcompressive strength and high strength adequate workability and a high modulusof elasticity also. The continuous global demand for concrete implies that moreaggregate and cement would be required in the production of concrete, therebyleading to more extraction and depletion of deposits of natural gravel, andincreased CO2 emission from quarrying activities. The continuous of concrete isharmful to environmental conditions and a reduction in water cement ratio thequality of high-performance concrete is increased. The curing is most important inconstruction to reduce the heat but in summer the heat is more In this situation,more water is required for the curing of the concrete. High performance is meantto distinguish structural materials from conventional ones, as well as to optimize acombination of properties in terms of final application in civil engineering. Ultra-high-performance concrete will help to minimize the overall cost of the project.

## II. LITERATURE

Kmita A (2000): Concrete is the most widely used constructionmaterial in India with annual consumption exceeding 100million cubicmeters. Also, the recent earthquakes in different parts of the worldhave once again revealed the importance of designing structureswith high ductility. The attribute “High Performance” implies anoptimized combination of structural properties such as strength, toughness, energy absorption, capacity, stiffness, durability, multiple, cracking, and corrosion resistance, taking into account the final costof the material. Admixtures play a key role in the production of HighPerformance Concrete. Both Chemical and MineralAdmixtures form apart of the High-PerformanceConcrete mix. The major differencebetween Conventional Cement Concrete and High-PerformanceConcrete is essentially the use of Mineral Admixtures in the latter.The cost of civil infrastructure constitutes the major portion of thenational wealth. Its rapid deterioration has created an urgent needfor the development of novel, long-lasting &cost-effective methodsfor new construction, repair, and retrofit. Many efforts have beenapplied toward developing high-performance concrete for buildingstructures with enhanced performance and safety. In a rapidlychanging global world, the adverse consequences of naturaldisasters on society, economy, and environment cannot be overemphasized. Recent experiences of Jammu & Kashmir and Bhujearthquakes, and also the North India Flood that struck Uttrakhand,once again exposed poor quality construction methods, lack ofpreparedness in rescue and rehabilitation, etc.

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S.M. Mousavi (2012): Metakaolin is one of the most quality enhancing SCM sin both high-strength and high-performanceconcretes, and its capacity to turn portlandite into C-S-H gel viapozzolanic reaction can improve concrete strength. At 28 and 90days, employing 15% MK as the only mineral admixture wasdetermined to be ideal, resulting in compressive strength increasesof 21.88 percent and 21.95 percent (relative to the referencespecimen), respectively. Another study found that increasing MKcontent decreased HPC's mechanical and durability qualities, butlowering the w/c ratio to 0.34 enhanced compressive strength,particularly for 10% and 15% MK replacements, with the bestcompressive strength seen at 10% MK replacement with w/b = 0.35.Many other investigations have concluded that 10% of cement is thebest proportion of MK for improving concrete characteristics. Ricehusk ash (RHA) is made by burning rice husks, and because thesehusks are agricultural waste, using RHA as a mineral additive hasenvironmental and economic benefits. Furthermore, RHA has apozzolanic reactivity that is comparable to that of SF. This makes itan excellent SF alternative in HPC, owing to its similar chemicalcompositions and large specific surface areas, and their ability toaffect compressive strength and durability qualities equally. RHA hasalso been shown to boost compressive strength considerably. RHAwas discovered to be able to absorb free water in RHA-blendedPortland cement paste, resulting in increased compressive strength.By incorporating 20% RHA, compressive strength increased by13.41percent, and splitting tensile strength increased by 11.84 percent, butreplacing more than 20% RHA lowered the strength of Bamboo Leafas AddictiveBLA can be used as a pozzolan in High-PerformanceConcrete if the percentage composition of $SiO_2$, $Al_2O_3$, and $Fe_2O_3$is greater than 70%, as stipulated by ASTM C-618, 2001. Thepercentage of OPC that should be replaced by BLA is 5%. Whencompared to the control sample, this replacement level resulted inHPC having higher compressive and breaking tensile strengths. Incomparison to other percentages, the concrete with 5% BLAreplacement had superior interlocking of concrete grains in themicrograph. High-performance concrete is a type of concrete withspecific properties tailored to a certain purpose and environment,ensuring that it performs well in the structure in which it is installed.In other words, high-performance concrete is a type of concrete thatis meant to provide several advantages in the constitution of concrete structures.HPC involves the use of supplemental cementitious materials such as fly ash and blast furnace slag, as wellas chemical admixtures such as superplasticizers, in addition to thethree main constituents in ordinary concrete. Microfilters andadditional cementing chemicals are increasingly being used inconcrete as partial substitutes for Portland cement. The majority ofthese blending ingredients are either industrial by-products or rawmaterials. They help the environment by recycling industrial waste,minimizing harmful emissions discharged into the atmosphere as aresult of cement manufacturing, protecting raw materials, andconserving. Several investigations have shown that the quantity ofextra materials in the mix affects concrete strength development inaddition to the w/c ratio. The more we learn about the relationshipbetween concrete Composition and strength, the better we'll be ableto understand the nature of concrete and how to make the bestconcrete mixture. FEATURES OF HIGH-PERFORMANCE CONCRETEA High-Performance concrete element is that which is designed togive optimized performance characteristics for a given set of load,usage, and exposure conditions, consistent with requirements ofcost, service life, and durability. High-performance concrete has verylow porosity through a tight and refined pore structure of the cementpaste, very low permeability of the concrete, high resistance tochemical attack, low heat of hydration, High early strength andcontinued strength development, high workability and control ofslump, low water binder ratio and low bleeding and plastic shrinkage. The basic features of high-performance concrete are its strength, ductility, and durability. These parameters are the mostimportant features that a construction material should possess fromits performance point of view. Strength In practice, concrete with acompressive strength of less than 50MPa is regarded as NSC, while high-strength concrete (HSC) may be defined as having a compressive strength of about 50MPa. Recently, concrete with acompressive strength of more than 200MPa has been achieved.Such concrete is defined as ultra-high strength concrete. Thecompressive strength of concrete has been steadily increasing withample experimental validation made by adding fibers in HPC exhibitssubstantial strain-hardening type of response which leads to a largeimprovement in both strength and toughness compared with theplain matrix. The improvement in terms of ductility, and highperformance FRC is referred to as ultra ductile concrete as well.Durability Given the durability characteristic of high-performanceconcrete, it is proposed that to achieve durable concrete, threecriteria may need to be considered in concrete mix design. The threecriteria are strength, permeability, and crack resistance. A strengthcriterion ensures that concrete can resist the design stress withoutfailure. A permeability criterion ensures that concrete has a limitedflow penetration rate to minimize vulnerability to water and chemicalion attacks during the design period of service life. A crack resistance criterion ensures that concrete has a minimum capabilityto resist cracking due to environmental conditions, such as thermaland moisture shrinkage. The permeability of concrete is a key factorinfluencing the durability of concrete. Concrete permeability isdependent on the permeability of each constituent material and itsgeometric arrangement. The permeability of cement paste isprimarily related to pore structure, which includes porosity, pore size,and connectivity; while pore structure is a function of the water-tocement ratio and the degree of hydration. Methods for achievingHigh Performance In general, better durability performance has beenachieved by using high-strength, low w/c ratio concrete. Though inthis approach the design is based on strength and the result is betterdurability, it is desirable that the high performance, namely, thedurability, is addressed

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directly by optimizing critical parameterssuch as the practical size of the required materials. Two approachesto achieve durability through different techniques.

P. Dinakar (2013): studied that Using MK as a partialreplacement for cement decreased the plastic density of themixtures By utilizing local MK and cement designed for a lowwater/binder ratio of 0.3, high strength and high-performanceconcretes can be developed and compressive strengths of morethan 100MPa can be realized. These concrete also exhibited a 28-day splitting tensile strength of the order of 5.15 % of theircompressive strength and showed relatively high values of modulusof elasticity. Splitting tensile strengths and elastic modulus resultshave also followed the same trend as that of compressive strengthresults showing the highest values at 10%replacement. The tensilestrength also has increased marginally. The results for the testagainst acid attack show that silica fume-contained concretepossesses greater acid resistance as compared to normal concrete.In high-strength concrete mix design as the water-cement ratioadopted is low, superplasticizers are necessary to maintain therequired workability as the percentage of mineral admixtures isincreased in the mix, the percentage of superplasticizers should alsobe increased, for thorough mixing and for obtaining the desiredstrength. The maximum compressive strength achieved for M80grade concrete is 88.8MPa with the mineral admixtures' replacementcombinations of 15%Flyash and 10% Metakaolin.

Fouad, F. H. (2014): The literature review shows that water cement ratio, silica fume, and plasticizers accelerate the strength ofthe concrete. Concrete is the most versatile material in theconstruction industry. Concrete admixture can be made usingseveral ingredients of which ordinary Portland cement is the basicingredient. High-performance concrete is one of the special types ofconcrete admixture used in recent construction to increase thestrength of the structure. The special parameters used in highperformance concrete are plasticizers, fly ash, and silica fumes inaddition to regular water-cement ratio, aggregates, and sand. Theuse of fly ash fills the voids between the cement particles and helps itto make admixture more strength resistant. The particles of fly ashare smaller than Portland cement because they occupy space and fillthe voids. Special admixtures like fly ash and silica fume can be usedto replace the mineral admixtures to increase the workability andstrength of the concrete to create high-performance concrete. Highpercentage use of fly.

W. Micah Hale (2017): Studied the effect of sand gradation, binder type and content, and curing regimes on concrete'scompressive strength. The use of finer sand increases thecompressive strength when compared to natural gradation sand. Afly ash content of more than 20% decreased the concrete'scompressive strengths at early ages but increased the strengths at later ages. The curing regimens influenced the concrete's compressive strength. Curing regime C, which was 2 days at 60 °Cfollowed by 3 days at 90 °C, resulted in the highest compressivestrengths. The material efficiency in the design of ultra-highperformance concrete is influenced by flowability, mechanicalperformance, durability, and cost. A reduction in the amount of themost expensive material and an increase in the amount of the leastexpensive material might lead to an improvement in performanceversus cost. Potential health concerns can arise due to repeatedinhalation of crystalline silica powder during production. Limestonepowder had a positive effect on the fresh properties of the compositeincluding mixing time and workability. The limestone powder is usedas a partial replacement of cement and partial or full columnjunctions strengthened with Ultra high steel Fiber reinforcedConcrete (UFC). It was concluded that UFC displayed excellentperformance in terms of mechanical and durability behavior. Thepossibilities to use high-performance concrete for the design ofseismic resistant cost-effective and durable buildings. The cost ofcivil infrastructure constitutes the major portion of the nationalwealth. Its rapid deterioration has created an urgent need for thedevelopment of novel, long & cost-effective methods for newconstruction, repair, and retrofit. A promising way of resolving thisproblem is to selectively develop advanced composites such asHPRC. The use of structural high-performance lightweight concretereduces the dead load by about 25 to 35 percent as compared tonormal weight concrete thereby offering substantial cost savings byproviding less dead load Improved seismic response, longer span,thinner sections, less reinforcing steel and lower foundation cost,reduced trucking and placement cost, further make this materialmore versatile for its application. In a rapidly changing global world, the adverse.

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ISSN: 2394-2975 Impact Factor: 7.394

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