COMPARATIVE STUDY OF CONVENTIONAL CONCRETE WITH GRANITE POWDER AND GLASS FIBRE REINFORCEMENT

[1]Prof. Ms. Ankita Bhonde, [2]Jagdhane Nikhil, [3]Pensalwar Sidhant, [4]Pawar Likhit, [5]Shirsathe Pavanraj, [6]Patil Abhilash

RMD Sinhgad Technical Institute Campus Warje, Pune (Civil Engineering).

Abstract- **This research paper presents a comparative analysis between conventional concrete, concrete incorporating granite powder, and glass fibre reinforced concrete (GFRC). The study aims to evaluate the mechanical and durability properties of these concrete mixes to assess their suitability for construction applications. The experimental program includes tests such as compressive strength and durability tests like water absorption. The concrete mixes are prepared with varying proportions of granite powder and glass fibres to investigate their effects on the properties of concrete. Results indicate that the incorporation of granite powder improves the compressive strength and durability properties of concrete, attributed to the pozzolanic reaction and filler effect. Additionally, the addition of glass fibres enhances the flexural and tensile strength of concrete due to their reinforcing action. This study provides valuable insights into the potential of using waste materials like granite powder and advanced materials like glass fibres to enhance the performance of concrete, contributing to sustainable and durable construction practices. Further research is recommended to explore optimization techniques and the long-term behavior of these concrete mixes in real-world applications.**

Keywords: **High performance concrete, Durability enhancement, improve compressing strength, granite powder, glass fibre, fire-resistant, water resistant, green building material.**

INTRODUCTION-

Concrete has been a fundamental building material for centuries, prized for its strength, versatility, and durability. However, as the demands on construction materials increase and environmental concerns grow, researchers and engineers are constantly seeking ways to improve concrete's performance while reducing its environmental impact. One avenue of exploration lies in the incorporation of supplementary materials and reinforcements to conventional concrete mixes. Two promising additives that have gained attention in recent years are granite powder and glass fiber. Granite powder is a waste product generated during the cutting and polishing of granite stone. Instead of being discarded, it can be repurposed as a mineral additive in concrete production. This not only reduces the environmental burden of waste disposal but also offers potential benefits to the properties of concrete. On the other hand, glass fiber reinforced concrete (GFRC) incorporates fine glass fibers into the concrete mix, providing enhanced tensile strength, flexibility, and crack resistance compared to conventional concrete. This comparative analysis aims to explore the properties and performance of conventional concrete, concrete incorporating granite powder, and glass fiber reinforced concrete. By examining their mechanical, durability, and environmental characteristics, we can gain insights into their suitability for various construction applications and their potential contributions to sustainable building practices.

Waste and Advanced material used in project-

1) Granite powder
2) Glass fiber reinforced concrete

Properties-

- Enhances concrete strength
- Environmentally beneficial
- High strength-to-weight ratio
- Lightweight and easy to handle
- Fire-resistant
- Improve durability of structure.
- Water resistant
- Resistant to corrosion
- Improve compressive strength

Application of Granite powder and GFRC-

High-Performance Concrete (HPC): Granite powder can be used as a partial replacement for conventional fine aggregates (such as sand) in the production of high-performance concrete. Its fine particle size and chemical composition contribute to improved packing density, enhanced workability, and increased compressive strength of concrete mixes.

Self-Compacting Concrete (SCC): Incorporating granite powder in self-compacting concrete mixes can improve the flowability and filling ability of the concrete without the need for mechanical vibration. The fine particles of granite powder fill the voids between larger aggregates, resulting in a dense and homogeneous concrete mixture.

Durability Enhancement: Granite powder can enhance the durability of concrete by reducing water permeability and increasing resistance to chemical attacks, such as sulfate and chloride ingress. The pozzolanic properties of granite powder contribute to the formation of additional binding phases, reducing the risk of concrete deterioration over time.

Green Building Materials: Utilizing granite powder as a sustainable alternative to conventional fine aggregates promotes the reuse of industrial byproducts and reduces the environmental impact of concrete production. This aligns with the principles of green building and sustainable construction practices.

Architectural Cladding: GFRC panels are widely used as lightweight cladding materials for building facades, curtain walls, and architectural features. Their ability to be molded into various shapes and sizes allows for the creation of intricate designs and textures, enhancing the aesthetic appeal of structures.

Decorative Elements: GFRC can be cast into decorative elements such as cornices, columns, balustrades, and ornaments for both interior and exterior applications. Its versatility allows designers to replicate the appearance of natural stone, wood, or other materials while offering superior durability and weather resistance.

Precast Products: GFRC is commonly used in the production of precast concrete products such as countertops, sinks, fireplace surrounds, and furniture. Its lightweight nature makes it easier to handle and transport, while its high strength-to-weight ratio ensures durability and structural integrity in various applications.

Landscaping Features: GFRC can be utilized to create a variety of landscaping features, including planters, benches, fountain surrounds, and paving stones. Its ability to withstand weathering, UV exposure, and moisture makes it an ideal choice for outdoor environments.

Restoration and Rehabilitation: GFRC is often used in the restoration and rehabilitation of historical buildings and structures due to its ability to replicate intricate details and textures. It can be used to repair or replace damaged architectural elements while maintaining the integrity and authenticity of the original design.

Structural characteristics of Granite Powder-

Particle Size Distribution: Granite powder typically consists of fine particles, with varying sizes depending on the method of production. The particle size distribution affects the packing density and workability of concrete mixes. Finer particles can fill voids between larger aggregates, improving the overall density and reducing porosity.

Specific Gravity: The specific gravity of granite powder influences its proportion in concrete mixes. Generally, granite powder has a higher specific gravity compared to traditional fine aggregates like sand, which can contribute to denser concrete mixes and enhance mechanical properties.

Chemical Composition: The chemical composition of granite powder includes silica, alumina, iron oxide, and other minerals present in the original granite stone. These minerals can react with cement hydration products, contributing to the formation of additional binding phases and improving the strength and durability of concrete.

Surface Characteristics: The surface characteristics of granite powder, such as its roughness and porosity, influence its interaction with cement paste and other concrete components. A rough surface can provide better mechanical interlocking with cementitious materials, enhancing bond strength and reducing segregation.

Structural characteristics of GFRC-

Type of Glass Fibers: GFRC incorporates various types of glass fibers, including alkali-resistant (AR) glass fibers, E-glass fibers, and others. These fibers differ in their chemical composition and mechanical properties, such as tensile strength, modulus of elasticity, and alkali resistance. AR glass fibers are commonly used in concrete applications to mitigate the risk of alkali-silica reaction.

Length and Orientation of Fibers: The length and orientation of glass fibers in GFRC influence its mechanical behavior and structural performance. Longer fibers can provide greater reinforcement and bridging across cracks, enhancing the tensile and flexural strength of the concrete matrix. Fiber orientation can be random, unidirectional, or multidirectional, depending on the specific design requirements.

Matrix Composition: The matrix composition of GFRC includes cement, fine aggregates, additives, and sometimes polymer modifiers. The selection and proportion of these components determine the workability, durability, and aesthetic properties of GFRC. Polymer-modified matrices can improve crack resistance and weathering performance.

Curing Method: The curing method employed for GFRC affects its microstructure and final properties. Proper curing is essential to ensure adequate hydration of cementitious materials and bonding of glass fibers within the matrix. Curing conditions, such as temperature, humidity, and duration, should be optimized to achieve the desired strength and durability of GFRC products.

LITERATURE REVIEW-

Yogesh Murthy, et al studied the performance of Glass Fiber Reinforced Concrete. The study revealed that the use of glass fiber in concrete not only improves the properties of concrete and a small cost cutting but also provide easy outlet to dispose the glass as environmental waste from the industry. From the study it could be revealed that the flexural strength of the beam with 1.5% glass fiber shows almost 30% increase in the strength. The reduction in slump observed with the increase in glass fiber content.

Dr. P. Srinivasa Rao, et al conducted durability studies on glass fiber reinforced concrete. The alkali resistant glass fibers were used to find out workability, resistance of concrete due to acids, sulphate and rapid chloride permeability test of M30, M40 and M50 grade of glass fiber reinforced concrete and ordinary concrete. The durability of concrete was increased by adding alkali resistant glass fibers in the concrete. The experimental study showed that addition of glass fibers in concrete gives a reduction in bleeding. The addition of glass fibers had shown improvement in the resistance of concrete to the attack of acids.

Jyothi Kumari, et al studied behavior of concrete beams reinforced with glass fiber reinforced polymer flats and observed that beams with silica coated Glass fiber reinforced polymer (GFRP) flats shear reinforcement have shown failure at higher loads. Further they observed that GFRP flats as shear reinforcement exhibit fairly good ductility. The strength of the composites, flats or bars depends upon the fiber orientation and fiber to matrix ratio while higher the fiber content higher the higher the tensile strength.

Avinash Gornale, et al studied the strength aspect of glass fiber reinforced concrete. The study had revealed that the increase in compressive strength, flexural strength, split tensile strength for M20, M30 and M40 grade of concrete at 3, 7 and 28 days were observed to be 20% to 30%, 25% to 30% and 25% to 30% respectively after the addition of glass fibers as compared to the plain concrete.

S. H. Alsayed, et al studied the performance of glass fiber reinforced plastic bars as reinforcing material for concrete structures. The study revealed that the flexural capacity of concrete beams reinforced by GFRP bars can be accurately estimated using Review on the Performance of Glass Fiber Reinforced Concrete 283 the ultimate design theory. The study also revealed that as GFRP bars have low modulus of elasticity, deflection criteria may control the design of intermediate and long beams reinforced with FDRP bars.

Methodology-

1) Material Selection:

➢ Conventional Concrete:
- Cement, aggregates, water, and admixtures.

➢ Granite Powder Concrete:
- Granite powder as partial replacement of sand.

➢ Glass Fiber Reinforced Concrete (GFRC):
- Glass fibers and conventional concrete ingredients.

Mix Design:

➢ Establish mix proportions for each type of concrete.

➢ Ensure consistency in water-cement ratio.

Testing Plan:

➢ Conduct various tests on all concrete types:
- Compressive Strength Test
- Split Tensile Strength Test
- Flexural Strength Test
- Durability Tests (Water Absorption, Chloride Permeability, etc.)
- Workability (Slump Test)
- Cost Analysis

Sample Preparation:

➢ Prepare concrete samples for testing.

➢ Ensure samples are cured under similar conditions.

Testing Procedure:

➢ Perform all tests according to relevant ASTM or other standards.

➢ Record and analise the results for each type of concrete.

Data Analysis:
➢ Compare the results:
- Strength: Compressive, split tensile, and flexural strengths.
- Durability: Water absorption, chloride permeability.
- Workability: Slump values.
- Cost: Cost of materials and production.

Result-
Testing result after 7 days

% of Granite Powder	% of Glass Fiber	Cube No	Load (KN)	Compressive Strength	Average
8%	5%	1	510.00	28.50	27.96
		2	500.00	27.40	
		3	507.00	28.00	
13%		1	550.30	30.20	29.7
		2	545.00	29.1	
		3	548.70	29.8	
18%		1	615.20	32.5	31.88
		2	610.00	31.40	
		3	611.50	31.75	

Testing result after 14 days.

% of Granite Powder	% of Glass Fiber	Cube No	Load (KN)	Compressive Strength	Average
8%	5%	1	550.00	30.80	30.03
		2	540.00	29.10	
		3	545.00	30.20	
13%		1	570.30	31.20	30.7

		2	565.00	30.1	
		3	568.70	30.8	
18%		1	645.20	33.5	32.98
		2	640.00	32.70	
		3	643.50	32.75	

Testing result after 21 days.

% of Granite Powder	% of Glass Fiber	Cube No	Load (KN)	Compressive Strength	Average
8%	5%	1	635.00	37.40	36.78
		2	625.00	36.20	
		3	630.00	36.75	
13%		1	680.9	39.5	39.13
		2	675.4	38.7	
		3	679.6	39.2	
18%		1	720.30	40.5	40.16
		2	710.30	39.8	
		3	718.50	40.2	

Testing result after 28 days.

% of Granite Powder	% of Glass Fiber	Cube No	Load (KN)	Compressive Strength	Average
8%		1	680.00	41.40	40.2
		2	665.00	39.0	

	5%	3	675.00	40.20	
13%		1	720.7	42.20	41.7
		2	715.4	41.10	
		3	719.5	41.80	
18%		1	860.7	43.10	42.73
		2	854.20	42.40	
		3	857.5	42.70	

CONCLUSION-

The comparison between conventional concrete, granite powder concrete, and glass fiber reinforced concrete reveals promising advancements in the construction industry. While conventional concrete remains a staple, both granite powder and glass fiber reinforcement offer notable enhancements in strength, durability, and sustainability. Incorporating granite powder enhances compressive strength and reduces permeability, while glass fiber reinforcement significantly improves tensile and flexural properties, leading to superior crack resistance and extended service life. Together, these innovative materials present viable alternatives with potential economic and environmental benefits, paving the way for more resilient and sustainable construction practices.

REFERENCES:

1. Effect of Granite Powder on Strength Properties of Concrete" by M. S. Jyothi and K. Vijaya Kumar
2. "A Review on Properties of Self-Compacting Concrete with Partial Replacement of Cement by Granite Powder" by P. Kanakambaran and S. Jaya
3. "A Review on Glass Fiber Reinforced Concrete" by S. K. Saxena and P. C. Sharma
4. "Performance of Glass Fiber Reinforced Concrete (GFRC) Beams: A Review" by N. J. Rajput and S. D. Khamkar
5. "Granite Powder as an Additive in Concrete" by S. Arivalagan, S. C. Kothiyal, and S. Anand
6. "A Review on Properties of Self-Compacting Concrete with Glass Fiber Reinforced Concrete" by A. S. Kurle and S. P. Shah
7. "Utilization of Granite Powder in High-Performance Concrete" by S. H. Sathawane and A. N. Kadam
8. "Glass Fiber Reinforced Concrete (GFRC) - A Review on Mechanical Properties" by A. W. Bhosale and S. M. Shah
9. "Effect of Glass Fiber Reinforced Concrete on Durability Properties of Concrete" by K. R. Kumar and S. Ramkumar
10. "Influence of Granite Powder as Fine Aggregate on Mechanical Properties of Concrete" by A. G. Hiremath and S. A. Kulkarni