НАУЧНЫЙ ЖУРНАЛ
НАУКА И МИРОВОЗЗРЕНИЕ

УДК- 666.973

PRODUCTION TECHNOLOGY OF NANOSILICA AND STEEL FIBER CONCRETE

Ovezdurdyyeva Gulnar
Supervisor: Lecturer of Oguz han Engineering and Technology University of Turkmenistan
Ashgabat, Turkmenistan

Ovezsahedov Saparmyrat
Supervisor: Lecturer of Oguz han Engineering and Technology University of Turkmenistan
Ashgabat, Turkmenistan

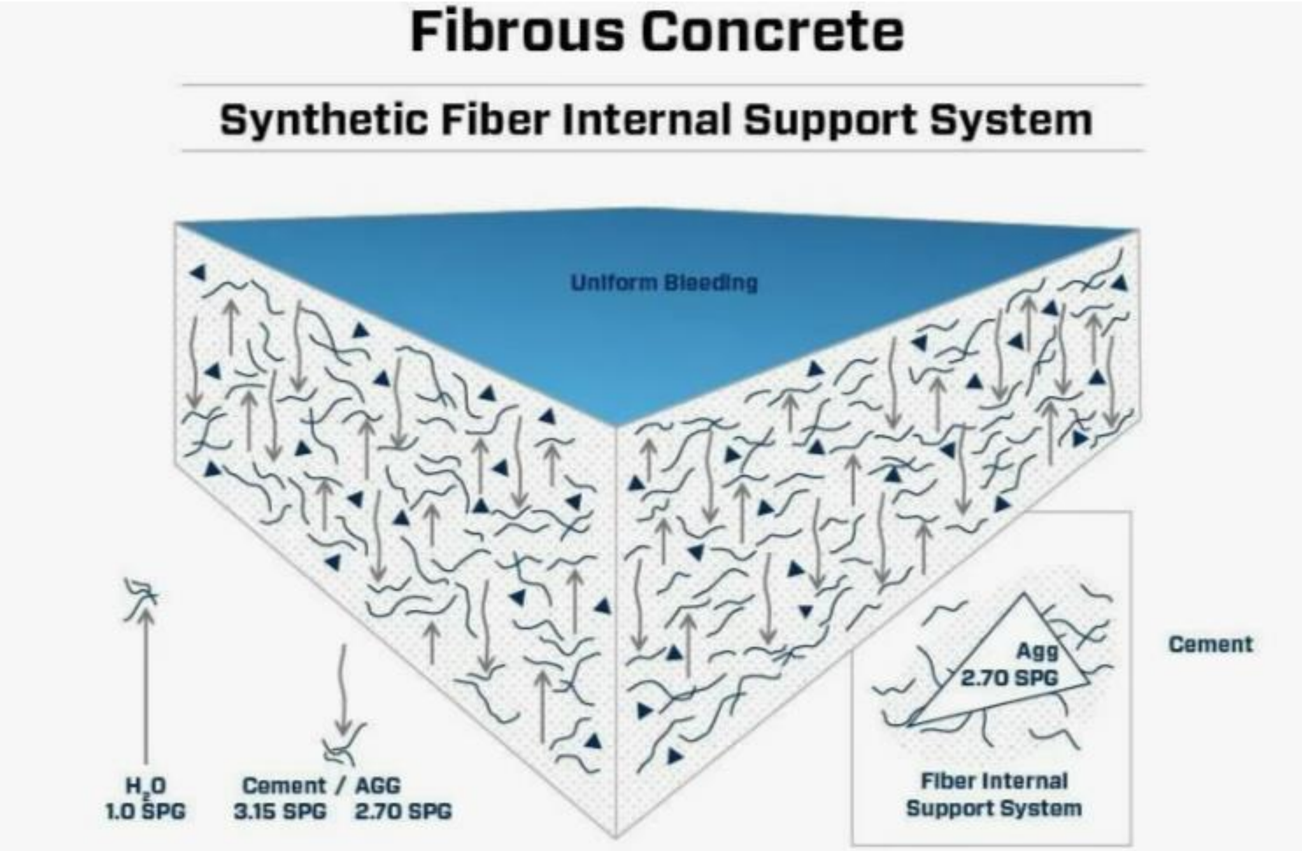
Begmyradov Hojamyrat
Student of Oguz han Engineering and Technology University of Turkmenistan
Ashgabat, Turkmenistan

Abstract: The development of advanced concrete technologies has led to significant improvements in the strength, durability, and versatility of construction materials. Two such innovations are nanosilica and steel fiber, both of which have been incorporated into concrete to enhance its mechanical properties and resistance to environmental degradation. This article discusses the production technology of nanosilica and steel fiber concrete, focusing on their synthesis, incorporation into the concrete matrix, and the resulting benefits for various construction applications. The article also highlights the challenges associated with the production process, the economic implications, and the future potential of these materials in the construction industry.

1. Introduction Concrete is one of the most widely used construction materials due to its versatility, affordability, and strength. However, conventional concrete often faces limitations in terms of tensile strength, crack resistance, and long-term durability. Recent advancements in concrete technology have introduced new materials, such as nanosilica and steel fibers, which address these limitations and significantly improve the overall performance of concrete structures.

Nanosilica, a highly reactive form of silicon dioxide with particle sizes in the nanometer range, has been used to enhance the strength, workability, and durability of concrete. Steel fibers, on the other hand, are added to improve the concrete's tensile strength and crack resistance. Together, nanosilica and steel fibers offer a promising solution for producing high-performance concrete with superior mechanical and durability properties.

This article provides an overview of the production technologies for nanosilica and steel fiber concrete, the role these materials play in enhancing concrete properties, and their applications in modern construction.



2. Nanosilica: Properties and Production Technology Nanosilica, also known as nano-sized silica or silica nanoparticles, is a fine powder with a particle size typically ranging from 1 to 100 nanometers. Its small size and high surface area make it highly reactive, enabling it to enhance the chemical interactions within the concrete mix.

- **Synthesis of Nanosilica**: Nanosilica can be produced through various methods, such as the sol-gel process, flame pyrolysis, and hydrothermal synthesis. The sol-gel process is one of the most common techniques for producing nanosilica due to its low cost and ability to control particle size. This process involves the hydrolysis and condensation of silicon alkoxides (such as tetraethyl orthosilicate, TEOS) in an aqueous solution. The resulting silica nanoparticles are then dried and calcined to obtain nanosilica powder.
- **Incorporation into Concrete**: Nanosilica is typically added to concrete as a supplementary cementitious material (SCM) to improve its properties. It reacts with calcium hydroxide (CH), a byproduct of cement hydration, to form additional calcium silicate hydrate (C-S-H), the primary binding phase in concrete. This reaction improves the hydration process, resulting in stronger and denser concrete with improved resistance to cracking and shrinkage. Nanosilica also enhances the durability of concrete by reducing the permeability and improving the resistance to chemical attacks such as sulfate and chloride penetration.

- **Effects on Concrete Properties**: The incorporation of nanosilica in concrete leads to several notable improvements, including:
  - **Increased compressive strength**: Nanosilica enhances the density of the concrete matrix, resulting in higher compressive strength.
  - **Improved workability**: Nanosilica helps in reducing the water-cement ratio, improving the workability of the mix.
  - **Enhanced durability**: Concrete with nanosilica exhibits superior resistance to water penetration, chemical attack, and abrasion.

3. Steel Fibers: Properties and Production Technology Steel fibers are short, thin strands of steel that are added to concrete to improve its tensile strength, crack resistance, and ductility. Steel fibers are typically made from cold-drawn wire and are available in various shapes, sizes, and aspect ratios. They are used to reinforce concrete in applications where high strength and resistance to cracking are required.

- **Manufacture of Steel Fibers**: Steel fibers are typically manufactured by cutting steel wires or rods into small lengths, often using a process known as cold drawing. This process involves pulling steel wire through a die to achieve the desired diameter. The fibers can be produced in a range of sizes, from 0.5 mm to 2.0 mm in diameter, and lengths from 10 mm to 50 mm.
- **Incorporation into Concrete**: Steel fibers are usually added to the concrete mix at a rate of 0.5% to 3% by volume. The fibers are evenly distributed throughout the mix to ensure uniform reinforcement. The addition of steel fibers to concrete enhances its performance by bridging microcracks, reducing crack propagation, and improving overall fracture toughness.
- **Effects on Concrete Properties**: The addition of steel fibers to concrete provides several advantages, such as:
  - **Improved crack resistance**: Steel fibers help prevent the formation and propagation of cracks in concrete, particularly under tensile and flexural stresses.
  - **Increased tensile strength**: Steel fibers significantly improve the tensile strength of concrete, making it more resistant to pulling forces.
  - **Enhanced post-cracking behavior**: Steel fibers improve the post-cracking behavior of concrete, allowing it to carry loads even after the formation of cracks.

4. Production Technology of Nanosilica and Steel Fiber Concrete The production of nanosilica and steel fiber concrete involves a carefully controlled process to ensure optimal performance of both materials. The typical production steps include:

- **Mix Design**: The first step in producing nanosilica and steel fiber concrete is the development of an appropriate mix design. The proportion of nanosilica and steel fibers in the mix is carefully calculated based on the desired properties of the final concrete. The nanosilica is typically added as a supplementary cementitious material, while the steel fibers are incorporated as reinforcement.

- **Batching**: Once the mix design is finalized, the ingredients are batched in the appropriate proportions. The cement, aggregates, and other admixtures are mixed together in a concrete mixer. Nanosilica is typically added to the mix in a fine powder form, and it is dispersed evenly throughout the mix to ensure consistent reactivity. Steel fibers are added at the appropriate rate, ensuring they are evenly distributed within the concrete matrix.
- **Mixing**: After batching, the ingredients are thoroughly mixed to ensure uniform distribution of both nanosilica and steel fibers. The mixing process must be carefully controlled to avoid agglomeration of the nanosilica particles or clumping of the steel fibers. This step is crucial to achieving the desired properties of the concrete.
- **Curing**: The concrete is then poured into molds and allowed to cure. Proper curing is essential for the development of strength and durability in concrete. The curing process for nanosilica and steel fiber concrete is similar to conventional concrete but may require slightly adjusted curing times or conditions due to the presence of nanosilica.

5. Applications of Nanosilica and Steel Fiber Concrete Nanosilica and steel fiber concrete is ideal for high-performance applications in construction, where enhanced mechanical properties and durability are required. Some key applications include:

- **High-strength concrete structures**: The enhanced compressive and tensile strength of nanosilica and steel fiber concrete makes it ideal for use in high-strength applications such as bridges, high-rise buildings, and industrial floors.
- **Seismic-resistant structures**: The crack resistance and improved ductility of steel fiber concrete make it suitable for seismic-resistant designs, as it can absorb energy and prevent failure during earthquakes.
- **Durable pavements and roads**: Nanosilica concrete exhibits superior resistance to wear and tear, making it an excellent choice for roads, pavements, and airport runways.
- **Marine structures**: Due to its improved resistance to chemical attack and water penetration, nanosilica and steel fiber concrete is ideal for use in marine environments, such as piers, jetties, and coastal infrastructure.

6. Conclusion Nanosilica and steel fiber concrete represents a significant advancement in concrete technology, offering improved mechanical properties, crack resistance, and durability. The production of this high-performance concrete involves careful mix design, precise batching, and effective curing methods to ensure optimal results. The applications of nanosilica and steel fiber concrete span a wide range of industries, from construction and infrastructure to energy and manufacturing. As the demand for stronger, more durable, and sustainable building materials increases, the use of nanosilica and steel fiber concrete is expected to play a critical role in meeting these challenges.

Literature:

1. Malhotra, V. M., & Carino, N. J. (2004). *Handbook on Nondestructive Testing of Concrete*. CRC Press.
2. Bui, Q. B., & Hassan, R. (2018). "Effect of nanosilica on the properties of cement-based materials." *Construction and Building Materials*, 162, 354-364.
3. Pandey, A. K., & Jha, A. K. (2019). "Steel fiber reinforced concrete: A review." *Construction Materials Journal*, 54(3), 213-224.
4. Zhang, Z., & Zhou, S. (2017). "Nanosilica and its application in concrete." *Materials Science Forum*, 892, 71-82.
5. Zhang, L., & Yu, J. (2016). "Performance of steel fiber reinforced concrete: A review." *Construction and Building Materials*, 125, 1-11.