



International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

New and Advanced Construction

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DOI: <https://doi.org/10.55248/gengpi.5.0324.0768>

ABSTRACT:

The chapter provides an overview on the most advanced construction materials available today on the market, able to substantially increase the productivity of the sector, to ensure more safe and comfortable buildings, and to improve energy and environmental efficiency of the built environment. After a review on Nanomaterials, smart materials and bio-based materials for architecture, an in depth presentation of some of the most innovation building products is given, illustrating their properties, their main applications, their role in digital fabrication, and the benefits archived along the entire building process. Advanced products treated in this chapter include advanced concrete, engineered mass timber, high-performance insulators, dynamic windows, smart coatings, and mimetic photovoltaics.

INTRODUCTION:

Advanced construction materials are the materials that are designed to improve the performance of a structure. These materials are often used in the construction of buildings, bridges and other structures they can be used increase the strength and durability of a structure.

Advanced construction materials can also be used to reduce the cost of construction as they are often more cost effective than traditional materials.

In the ever-evolving field of construction, advancements in materials play a pivotal role in shaping the future of infrastructure. The quest for innovative and sustainable solutions has led to the development of new and advanced construction materials, marking a significant departure from traditional approaches. These materials not only aim to enhance structural integrity but also address environmental concerns, durability, and efficiency in construction processes.

The advent of cutting-edge technologies, coupled with a growing emphasis on sustainable practices, has spurred a wave of research and development in the realm of construction materials. Engineers and scientists are continually exploring novel formulations and manufacturing techniques to create materials that surpass the limitations of conventional options.

New and advanced construction materials encompass a wide array of substances, including but not limited to high-performance concrete, smart materials, nanomaterials, composites, and bio-based materials. Each of these categories brings unique properties and characteristics, contributing to the overall improvement of construction methodologies and the longevity of structures.

Sustainability is a key driver in the development of these materials, with an increasing focus on reducing carbon footprints, energy consumption, and waste generation. Many advanced materials aim to enhance energy efficiency, providing insulation, and promoting ecofriendly construction practices.

As the construction industry grapples with the challenges of population growth, urbanization, and climate change, the adoption of new and advanced construction materials becomes imperative. This introduction sets the stage for exploring the multifaceted world of materials engineering, showcasing the innovations that promise to revolutionize the way we conceive, design, and build structures in the 21st century.

CONTENTS USED:

- BREATHING BRICK
- SELF HEALING CONCRETE
- GRAPHENE
- TRANSPARENT WOOD
- CARBON FIBRE

- ARTIFICIAL SAND

BREATHING BRICK:

- The breath brick is designed to form a part of a building regular ventilation system at the center of the brick it functions as a cyclonic filtration .
- An idea is board from the modern vacuum cleaners which separates out the heavy polluted particles from the air.

In a broad sense, the term "breathing brick" could refer to a type of building material designed to allow controlled airflow or ventilation. This could be particularly relevant for improving indoor air quality and regulating temperature within a structure. Some potential features of a "breathing brick" might include:

- 1.Porosity:The brick may have a porous structure that allows air to pass through, facilitating natural ventilation.
- 2.Absorption and release:The material may have the ability to absorb moisture and release it over time, helping to regulate humidity levels within a building
- 3.Permeability: The brick may be designed to be permeable to certain gases or air, promoting a continuous exchange of fresh air.
- 4.Sustainable Materials: It could be made from sustainable or ecofriendly materials to align with modern construction practices focused on environmental considerations.

If "breathing brick" is a specific product or concept, I recommend checking with recent sources or the company/organization associated with its development for detailed information on its composition of properties and applications.



SELF HEALING CONCRETE:

- Self healing of cracks or self-filling of cracks by the help of bacterial process after hardening is known as self healing concrete .it is also known as bacterial concrete.
- It can be observed that small cracks that occur in a structure of width in the range of 0.05 to 0.1 mm gets completely sealed in repetitive dry and wet cycles.

Self-healing concrete is an innovative material designed to automatically repair cracks that develop in the concrete over time. This technology has the potential to enhance the durability and longevity of concrete structures, reducing the need for frequent maintenance and repairs. Here are key aspects of self-healing concrete:

1.Microcapsules or Vascular System:

Microcapsules:Self-healing concrete often incorporates microcapsules filled with healing agents, such as bacteria, minerals, or polymers.

When a crack forms in the concrete, these capsules rupture, releasing the healing agent into the crack.

Vascular System: In some cases, self-healing concrete utilizes a vascular system containing a liquid healing agent. When a crack occurs, the vascular system delivers the healing agent to the damaged area.

2. Bacteria Healing:

Certain self-healing concrete formulations involve bacteria, typically spore-forming bacteria, embedded in the concrete. When cracks expose the bacteria to moisture, they become active and produce minerals like calcite to fill the cracks, restoring the material's integrity.

3. Mineral Precipitation:

The healing agents in self-healing concrete often facilitate the precipitation of minerals, like calcium carbonate, which helps to seal the cracks. This process mimics the natural healing ability of some minerals found in concrete.

4. Polymer Based Systems:

Some self-healing concrete solutions use polymers that react with water or other substances to form a gel-like material, sealing the cracks and preventing further damage.

5. Application Areas:

Self-healing concrete is particularly beneficial in infrastructure exposed to harsh environmental conditions, such as bridges, tunnels, and buildings. It can help reduce maintenance costs and extend the service life of structures.

6. Advantages:

Extended lifespan: Self-healing concrete has the potential to significantly increase the lifespan of structures.

Reduced Maintenance: The automatic repair mechanism minimizes the need for frequent repairs and maintenance, saving time and resources.

7. Challenges:

Cost: The production of self-healing concrete can be more expensive than traditional concrete, mainly due to the incorporation of specialized materials.

Effectiveness Over Time: The long-term effectiveness of self-healing concrete is an ongoing area of research and development.



Graphene:

GRAPHENE is a single layer of carbon atoms. holds immense potential to revolutionize the construction industry.

1. Structure:

Graphene is a remarkable material with unique properties, composed of a single layer of carbon atoms arranged in a hexagonal lattice. It is often considered a "wonder material" due to its exceptional electrical, thermal, and mechanical properties. Here are key aspects of graphene:

Graphene is a two-dimensional material, essentially a single layer of carbon atoms arranged in a hexagonal lattice, similar to the structure of graphite. The carbon-carbon bonds in graphene are extremely strong.

2.Electrical Conductivity:

Graphene exhibits exceptional electrical conductivity, making it an excellent conductor of electricity. Electrons move through graphene with minimal resistance, making it a potential material for use in electronic devices.

3.Thermal Conductivity:

It also possesses high thermal conductivity, allowing heat to be conducted efficiently. This property makes graphene attractive for applications in thermal management.

4.Mechanical Strength:

Despite its thinness, graphene is incredibly strong. It has a tensile strength several times higher than that of steel, making it one of the strongest materials known.

5.Transparency:

Graphene is transparent, allowing light to pass through. This property makes it suitable for applications in transparent conductive films for electronic devices, like touchscreens.

6.Flexibility:

Graphene is flexible and can be bent or stretched without losing its properties. This flexibility opens up possibilities for flexible electronics and wearable technologies.

7.Applications:

Graphene is considered a potential replacement for silicon in electronic devices due to its excellent electrical properties.

It has applications in batteries and supercapacitors, enhancing energy storage capabilities.

Graphene can be integrated into composite materials to enhance their mechanical and electrical properties.

Potential applications include drug delivery systems and biosensors.

Graphene-based films can be used in displays and solar cells.

8.Challenges:

Production:While the properties of graphene are well-established, scalable and cost-effective methods for its production are still being developed.

Integration:Incorporating graphene into practical applications can pose challenges due to issues like uniformity, scalability, and cost.



TRANSPARENT WOOD:

Transparent wood treated with special allow light transmission while maintaining structural integrity.

Transparent wood is a novel and innovative material that is derived from natural wood sources. The process involves removing the lignin— a component that gives wood its characteristic opacity—from the wood fibers. The resulting material retains the strength and durability of wood while becoming transparent. Here are key aspects of transparent wood:

1.Production Process:

Lignin Removal:The key step in producing transparent wood involves removing lignin, a polymer that scatters and absorbs light, from the wood structure. This is typically done through a chemical process.

Impregnation:After lignin removal, the wood is often impregnated with a transparent polymer to enhance its optical properties and strength.

2.Properties:

Lignin Removal:Transparent wood is characterized by its ability to allow light to pass through, making it translucent or transparent. The degree of transparency can be controlled during the production process.

Strength:Despite the removal of lignin, transparent wood retains much of its structural strength, making it a viable material for construction and other applications.

Thermal Insulation:Transparent wood has been found to possess good thermal insulation properties, potentially providing a combination of transparency and energy efficiency.

3.Applications:

Building Materials: Transparent wood can be used as a building material for windows, walls, and other structural elements, allowing natural light to enter while maintaining privacy.

Design and Décor: It has applications in interior design and furniture, providing a unique and aesthetically pleasing alternative to traditional materials.

Solar Cells: Transparent wood has been explored for use in solar cells, where it could serve as a transparent substrate for photovoltaic cells.

4. Advantages:

Renewable: Transparent wood is sourced from renewable materials, making it an environmentally friendly alternative.

Biodegradable: It is biodegradable, reducing environmental impact at the end of its life cycle.

Aesthetics: The unique visual appeal of transparent wood makes it suitable for various design and architectural applications.

5. Challenges:

Scalability: Large-scale production and cost-effectiveness are challenges that need to be addressed to make transparent wood more widely available.

Moisture Stability: Transparent wood may be sensitive to changes in humidity, affecting its optical properties.

CARBON FIBRE:

It is a composite material and having diameter of about 4.5 to 6.5 microns. It is lightweight and weighs 2/3 the weight of steel. It has tensile strength of about 5.9 Gpa and tensile modulus of 300 Gpa.

Carbon fiber is a high-strength, low-weight material known for its excellent mechanical properties and versatility. It is composed of thin, strong crystalline filaments of carbon, typically bound together with a polymer resin. Here are some key aspects of carbon fiber:

1. Composition:

Raw Materials: Carbon fibers are made from organic polymers, such as polyacrylonitrile (PAN), rayon, or petroleum pitch.

Carbonization: The precursor material undergoes a high-temperature process called carbonization, which removes non-carbon elements and leaves behind a high carbon content.

2. Properties:

Strength and Stiffness: Carbon fiber is renowned for its high strength-to-weight ratio, making it incredibly strong and stiff while being lightweight.

Low Thermal Expansion: It has low thermal expansion properties, making it resistant to changes in temperature.

Chemical Resistance: Carbon fiber is generally resistant to chemicals and corrosion.

Electrical Conductivity: Carbon fibers are electrically conductive.

3. Applications:

Aerospace: Carbon fiber is widely used in the aerospace industry for components such as aircraft wings, fuselages, and interior components due to its strength and lightweight properties.

Automotive: Carbon fiber is used in the automotive sector for components like body panels, chassis, and interior parts to reduce weight and improve fuel efficiency.

Sports and Recreation: It is popular in sports equipment like bicycles, golf clubs, tennis rackets, and even in high-performance cars and boats.

Industrial Applications: Carbon fiber is used in various industrial applications where a combination of strength and low weight is crucial. 4. Challenges:

Cost: Carbon fiber production can be expensive compared to traditional materials.

Brittleness: While strong, carbon fiber can be brittle and may not perform well under certain types of impact.

Artificial sand:

The main natural and cheapest resource of sand is river. Natural sand is the outcome of weathering of rocks producing different grades or sizes. Artificial sand, also known as manufactured sand or crushed sand, is a type of sand that is produced by crushing rocks, quarry stones, or larger aggregates into smaller particles. Artificial sand, also known as manufactured sand or crushed sand, is a type of sand that is produced by crushing rocks, quarry stones, or larger aggregates into smaller particles.

Now a days, in construction of roads, buildings, dams, canals, etc., cement concrete plays an important role. Concrete is an artificial stone resulting from hardening of rationally chosen mixture of binding material, water and aggregate (Sand and crushed stone or gravel). The mixture of these materials, before it hardens, is called concrete mix. Particles of sand and crushed stone from a stone are car-cass in concrete. Cement paste resulting from the

interaction of concrete mix with water coating on the grains of sand and crushed stone, fills the voids between them, lubricates the aggregate and imparts mobility (fluidity) to the concrete mix. When the cement paste hardens, it binds the aggregate into an artificial stone or concrete.

High quality concrete mixture may be produced only with deep knowledge of all manufacturing procedures, a proper choice of quality constituents and their optimum ratio, suitable procedures for preparing concrete mixes, for placing, compacting and hardening them in order to obtain concrete structure of high quality, high strength, durability and low cost.

Concrete is one of the major building materials in all branches of modern construction. Possibility of controlling the properties of concrete within a wide range by using appropriate in gradients. the concrete mix should possess adequate plasticity and can readily be shaped in to durable structural items of various sizes and shapes at no considerable labour expenditure.

The proper sand with requisite fineness module can achieve the above requisite. The natural river sand is a cheapest resources of sand. Natural sand is weathered and worn out particles of rocks and is of various grades or of size. Depending on the account of wearing. But now a days these resources are erasing very fast. Due to dams constructed on every river the natural sand producing capacity reduce to a considerable extent. Due to fast development of the country the consumption of the sand is also increased.

The sand available in the riverbed is very coarse and contains very much percentage of silt and clay. The silt and the clay presents in the sand reduces the strength of the concrete and holds dampness. Fine particles below 600 microns must be up to at least 30% to 50% for good results. At present these particles are not present in river sand up to the required quantity.

Digging the sand, from riverbed in access quantity, is hazardous to environment. The deep pits dug in the riverbed, effects on ground water level. Erosion of the nearby land is also due excess sand lifting. Government has banned for lifting Sand from riverbed in many areas. The sand available and allowed to lift, is of inferior quality.

Conclusion:-

Glimpsing a bright future Construction industry stands for a pivotal role, driven by innovation and fueled by emergence for new advanced materials. These materials possess a potential to transform the way we build. Advanced construction materials are materials that are designed to improve the performance of a structure. These materials are often used in the construction of buildings, bridges, and other structures. They can be used to increase the strength and durability of a structure, reduce its weight, or improve its energy efficiency.

Advanced construction materials can also be used to reduce the cost of construction, as they are often more cost-effective than traditional materials. Examples of advanced construction materials include steel, concrete, composites, and glass. Steel is often used in the construction of bridges and buildings, as it is strong and durable. Concrete is used for foundations and walls, as it is strong and can be formed into any shape. Composites are a combination of materials that are used to create a stronger and more durable material. Glass is often used in the construction of windows and skylights, as it is transparent and can be used to let in natural light.