KeSEBAE NEWS

Newsletter of the Kenya Society of Environmental, Biological and Agricultural Engineers

Volume 4. No. 8 **14 September 2022**

Innovative Construction Materials

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Over the years, the construction industry has continuously gone through a series of innovations. The innovations have seen a shift from the use of conventional construction materials to innovative construction materials. The technological advancements used in innovative construction materials have been employed to solve the problems and inadequacies faced by the use of conventional construction materials such as waste a lot of natural resources, pollution, environmental degradation, heaviness of the materials, bulkiness and the irregular shapes of the material. With the high demand for housing, rise in disasters and increased cost of construction, the innovative construction materials come in handy. Some materials have evolved over time and some are new innovative solutions.

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A fortnightly Newsletter touching on topical issues affecting our environment.

KeSEBAE NEWS is a Newsletter of the Kenya Society of Environmental, Biological and Agricultural Engineers (KeSEBAE)

Inside this Issue!

DEAR READER

1.0.What Is Innovation in Construction Materials?

Innovation in construction materials implies the development of the quality and properties characteristics of the building material. The reform can be brought in the previous material keeping the useful properties the same or a new material i.e alternative to the previous one can be introduced. Innovation in construction materials also implies improvements in processes, products, or services of construction.

Innovative materials came into existence when engineers and scientists saw there is need to improve on the widely used existing construction materials which have drawbacks, particularly on their impact on the environment.

Example of this is cement, despite it being versatile, low cost and practicality. Production of cement globally amounts to 5% CO2 emissions every year, according to 2017 study.

2.0.What Are Innovative Construction Materials?

Some of the innovative ideas about construction materials are listed below,

i. Self-healing Concrete
ii. Bioplastic and 3D printed bioplastic
iii. 3D-printed Graphene
iv. 'Programmable' Cement
v. Aerograhite
vi. Transparent Aluminium
vii. Hardwood Cross-Laminated Timber
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ix. Wool Brick
x. Bio-coal Lining
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2.1. Self-Healing Concrete

Concrete is commonly used construction around the world. Concrete's ubiquity is perhaps only matched by the frequency with which it cracks. Researchers around the world are coming up with different types of self-healing concrete. A concrete with the capabilities to patch over its own fractures it is undoubtedly a boon to the building industry, eliminating cracks, repairs, and leaks, along with damp-proofing.

Its self-healing abilities come in the form of Bacillus bacteria, which is mixed with concrete before pouring. When a rupture is formed, limestone is created which fills in the crack. Since the bacteria within can lay dormant for up to 200 years, it's a relatively long-term solution.

Although, the idea of a self-healing concrete has been around since ancient Rome, where it was used underwater, the modern approaches are comparatively more sophisticated.

Figure 1: Self-healing concrete

2.2. Bioplastic and 3D-Printed Bioplastics

Bioplastic is a strong and long-lasting made from renewable biomass resources such as algae, marine chitins, plethora, cellulose, or other materials which can degrade faster once they're disposed of.

In construction, bioplastic can be used for cladding, structural elements, water pipes, bridges, or piers.

3D-printed bioplastics which were introduced by Dutch firm Aectual, the were invented to deal with the problem of waste in construction materials that contribute to increase in environmental and economic costs.

The firm uses 3D printers with bioplastics materials to build a variety of designs from floors, stairs, facades and even entire buildings. The firm state to be using 100% renewable plant-based polymers and can also deploy recycle plastics, these plastics can be shredded if the printer makes mistakes thus resulting into low-waste.

2.3. A 3D-printed Graphene

Graphene, considered to be one of the strongest artificial materials in the world, contains physical properties that render its applications near-limitless. However, since it physically manifests itself as sheets or flakes, it becomes difficult when used on construction.

However, recently, the possibility of using 3D-printed graphene in construction was strengthened by a paper published by three MIT engineers, which mentioned a three-dimensional structure that potentially had the ability to be 10 times as strong as steel, and 5% the weight of it too, if built with 3D-printed graphene. Further research and development are certainly needed, but the current results look promising for the future of construction.

2.4.Hydro Ceramics (Passive Cooling)

This is a composite facade material made of clay and hydrogel which is capable of cooling the interiors of buildings by up to 6 °C. Hydro ceramics use the hydrogel's ability to absorb 500 times more water than its own weight to create a building system that "becomes a living being as part of nature, not beyond it." The technology was developed by Spanish students at the Institute for Advanced Architecture of Catalonia back in 2014. Since that time, this innovative material that enables self-cooling systems are in great demand in the construction industry and among architects. It is especially popular for eco-construction as it can save up to 28% of the total energy consumption of traditional cooling devices.

Figure 2: Hydrogel-filled ceramic

2.5.'Programmable' Cement

This innovative cement is to curb the issue of concrete porosity. This is because, on a molecular level, concrete particles form randomly thus allowing space for liquid and chemicals through which in turn degrades concrete, leading to rusting of steel supports enclosed in it. The scientists at Rice university, Texas came up with the discovery of programming the molecular structure of concrete as it sets, meaning builders could tell the cement to form into more tightly packed cubes, spheres or diamond-shaped structures for instance. The team discovered that by adding negatively and positively charged surfactants to the cement mix they could control the form that cement particles take as the cement set. Practically, this means that concrete that sets harder is significantly less porous and stronger and in turn less concrete would be needed to form strong structures as suggested by the scientists.

2.6.Aerographite

Aerographite is an artificial material made by researchers at the Hamburg University of Technology in 2012, aerographite is made from networks of hollow carbon tubes, which makes it 75 times lighter than Styrofoam.

The following characteristics makes this material great for construction purposes

- Bendable
- Strong
- Stable at room temperature
- Conducts electricity
- Withstands a lot of vibration
- It's so flexible and malleable, it can be compressed into a space 95% its normal area, and then restored to its original form, free from damage.

Amazingly, the scrunching up of aerographite actually serves to make it stronger, which isn't true of most lightweight materials subjected to compression. Since it can also withstand vibrations, it's regularly used in aeroplanes, satellites, purification systems, and electric cars. It's bound to find its further purpose in construction due to its excellent physical properties.

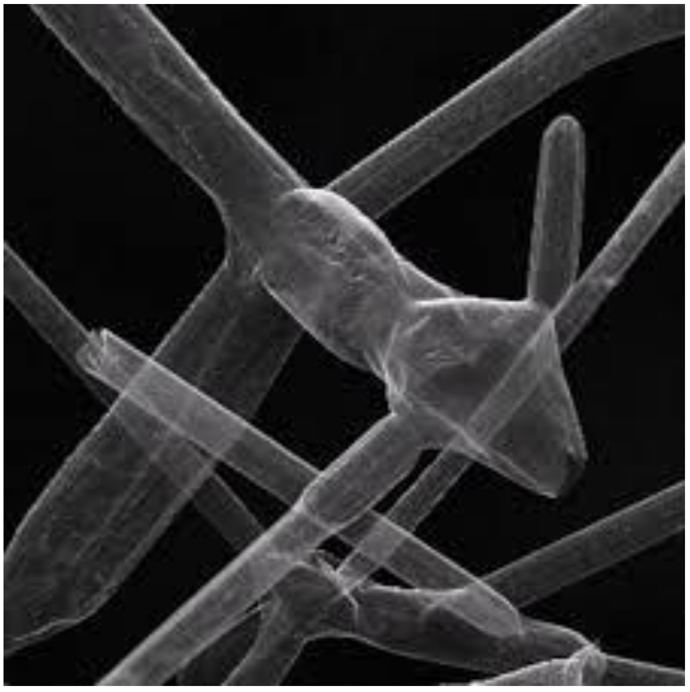

Figure 3:Aerographite

2.7.Transparent Aluminum

It is a transparent ceramic based on aluminium oxynitride (AlON). The main features of this material are scratch resistance and durability. Transparent aluminium is much more durable than aluminosilicate glass (quartz) and it's also 85% harder than sapphire. In addition, it can withstand heat up to 2,100ºC. It is resistant to radiation, acids, alkalis and water. Naturally, the material was immediately adopted by the military and optics industries. But in construction, it is used for impact-resistant windows, domes and other elements that require transparency and strength.

2.8. Hardwood Cross-Laminated Timber

Engineers have created cross-laminated timber. It has a layered design, with small pieces of softwood that are laminated together. These layers are glued together under high pressure in opposing directions, resulting in a strong structure.

A great benefit of cross-laminated timber is better water resistance than traditional wood. It also boasts a reduced carbon footprint. It's already being used in the US in the construction of roofs, floors, beams, and columns, but it could potentially replace reinforced concrete or structural steel for building skyscrapers due to its strength.

Figure 4:Hard Wood Cross-laminated Timber

2.9. Precast Concrete

Precast concrete is not a new material. It has already been used in structures like the Sydney Opera house, but its sustainability and cost-effectiveness make it an increasingly popular choice among contractors.

It takes less energy and materials to produce precast concrete than pouring and curing concrete on site, which is a great advantage. Typically, precast concrete will be cured in an off-site facility and shipped to the construction site. Then these precast concrete slabs can be placed and affixed together.

For projects that require a lot of identical components, this can be a cost-effective way to finish buildings faster. You won't have to worry about the weather or wait a long time for the concrete to reach its full strength before you start a new task.

Figure 5:Precast Concrete

2.10. Wool Brick

This wool brick is made up of clay, combines wool, and natural polymer, and uses naturally available materials, manufacturing wool brick is an excellent step towards sustainable construction, because it has a zero-carbon product.

2.11. Bio-Coal Lining

Berlin-based start-up Made of Air has developed a special non-toxic bioplastic made of biochar from forest and agricultural waste. It captures carbon and can be used for everything from building facades, furniture, interiors, transport and urban infrastructure.

The recycled material consists of 90% carbon and is able to absorb CO2 from the atmosphere, and is itself a carbon-negative material

2.12. BioMASON bricks

Trillions of bricks are made every year, and the majority are heated to extremely high temperatures in kilns as part of the process – all of which requires large amounts of energy. BioMASON, North Carolina business hopes to make has discovered a way of growing concrete bricks in ambient temperatures – which eliminates the need for firing them. Inspired by the formation of coral – a natural yet hard substance – the firm has created a method of 'growing' cement bricks. The company places sand in rectangular moulds and then injects bacteria that wrap around the grains of sand. They then 'feed' this mix with nutrient-rich water over the course of a few days.

The result is calcium carbonate crystals that 'grow' around each grain of sand and form a hard, stone-like substance in just a few days. BioMASON says its products are equal to standard bricks, yet require significantly less energy to create, meaning they're much more environmentally friendly.

Figure 6: BioMason bricks

2.13. Alusion Panels

The variety of materials used for ceilings, floors and cladding is often limited to brick, sheet metal, concrete or painted plaster. ALUSION, a product of Canadian firm Cymat Technologies, aims to provide architects and designers with something more.

The material is claimed to be uniquely versatile, and suitable for covering buildings, doors, floors and more. The Toronto-based business discovered a way of injecting air into molten aluminium which forms bubbles thanks to the dispersion of ceramic particles in the mix – not unlike how air bubbles form in a chocolate bar.

Besides making for a striking design material, ALUSION offers noise reduction benefits, is 100 per cent recyclable and is strong and non-combustible.

While it's certain that many of today's leading building materials will continue being used for decades – if not centuries – to come, the development of alternatives is certainly promising.

If nothing else, having access to a wider variety of source materials will ensure the construction sector is built on solid foundations.

Figure 7: Alusion panels

2.14. Other innovative construction materials include:

- Homeostatic Facades
- Artificial Spider Silk
- Modular Bamboo
- Memory Steel
- Mycelium Insulation
- Zero-Carbon Cement
- Air-Purifying Facade
- Bendable Concrete
- Conductive Paint
- Carbon Fiber Rope
- Invisible Solar Cells
- 3d Printed Concrete
- Cigarette Butt Bricks
- Carbon Fibre
- Sensitiles — Decorative Acrylic Tile
- Aerogel
- Richlite
- Liquid Granite
- Bending Concrete
- Laminated Wood
- Cabkoma — Hydrocarbon Threads, String Support
- Flexicomb
- For Passive Cooling
- Passive Cooling Paint
- Hemp Rebar
- Low-E Glass / Films
- Pigmented Concrete
- Light-Generating Cement
- Pollution Absorbing Brick
- Biologically Produce Furniture

3. Conclusion

Most of the materials described are still in development, they are well on their way to becoming a staple of the construction industry.

Construction companies that want to be competitive need to stay up-to-date with the latest innovations in construction materials. Creating stronger, more sustainable buildings will give their clients more value, improve their bottom line and protect the environment.


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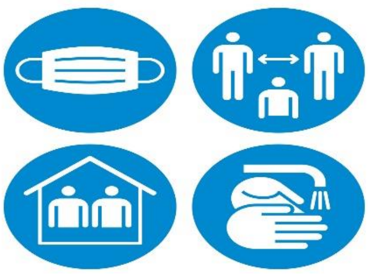

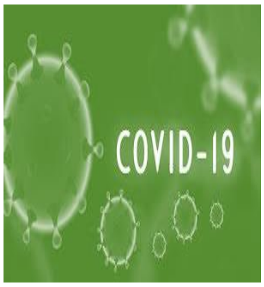

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