



Creating Smart Living With Advanced Building Materials

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The Need

The construction sector has been impacted dramatically by the global downturn and is currently moving to a more innovative and cross-sectoral model. Advanced building materials are a subsector of the construction sector. This subsector represents a new generation of construction materials which demonstrate exceptional properties. Through advanced building materials, new technologies are integrated into both residential and commercial buildings and infrastructures to make them smarter, more sustainable, energy efficient and secure, thereby addressing environmental and social challenges globally.

The Problem

According to the International Energy Agency, buildings account for 30 to 40% of energy use in Europe with a supplement of 5 to 10% being used in processing and transport of construction products and components. This gives rise to around one third of the region's CO₂ emissions. Moreover, the onsite construction industry and the manufacturing of construction materials also consume billions of tons of natural resources, while producing a large amount of non-recyclable waste. Therefore, over the past few decades, this sector has been under increasing pressure to improve its cost efficiency, sustainability, and capacity, pushed by the

endeavor and need to face consequences of global warming and climate change. Radical improvements are needed and these have lately also been encouraged by governments. Increased awareness of climate change and other environmental concerns is changing priorities as people transform the way they live to limit the impacts of their daily life on environment. In fact, customers are seeking innovative solutions that would improve their quality of life while being environmentally-friendly. The willingness to use greener building materials for home construction has become a fast growing trend over the last few years, mainly motivated by growing environmental consciousness and cost saving opportunities through better energy management.

The Solution

The design, height, characteristics, and energy performance of buildings have been deeply impacted by the development of new technologies for new building materials demonstrating particular properties. Traditional building materials such as concrete, steel and plastics have been improved and/or replaced by more advanced materials allowing for unusual and sophisticated architecture and design while assuring energy efficiency, sustainability and security. The development of technologies and new materials to improve building energy efficiency is an important instrument for reducing greenhouse gas emissions and for preserving the limited natural resources in the short to midterm.

About Advanced Building Materials



(Figure : Propagate Skyscraper converts harmful greenhouse gases into usable building materials! It is a self-propagating structure whose growth is dependant only on the weather conditions and the quality of air surrounding it. Carbon dioxide is turned into a solid material that builds upon an existing scaffolding structure

Advanced building materials range from new forms of concrete (lower carbon, with fibres that alter its resistance and durability or with air purifying capabilities), and innovative wooden structures, glass with enhanced qualities (electro chromic glass, photovoltaic embedded construction glass), to automated infrastructure. Green building materials such as cork, bamboo and woven flooring can also be considered part of advanced construction materials. Concrete production from recycled materials is also a dynamic growth area within the industry, along with wood from sustainable forests, energy-efficient lighting fixtures and water-efficient plumbing fixtures. Increasing urbanisation around the world will continue to drive the construction of innovative buildings, where materials play a key role. Developing advanced building materials for sustainable construction has become not only a vital necessity, but a moral imperative for the next generations. These new materials and construction technologies incorporate cutting-edge and economically viable sustainable solutions thereby increasing profitability, decreasing construction time and overall favourably impacting the

environment. The potential for application of these innovations is therefore wide, and can feed vitality and diversification into an industry sector which so far accounts for a large proportion of the European economy added value.

Various innovative solutions in advanced building materials

Construction industry is transforming, pushed by new societal, economic and energy challenges. In this context, the construction industry and its related sectors such as the building materials sector are moving towards a more innovative model. Indeed, the part of R&D and innovation is increasing in the building materials sector that is nowadays looking for offering more innovative solutions integrating new technologies. Various companies are aiming to provide innovative solutions to increase the sustainability, the security, and the energy efficiency of residential and nonresidential infrastructures. Companies have found niches in the advanced building materials market and are providing innovative solutions and products to respond to customer needs and governments' political priorities. In this study, various innovative materials & techniques are discussed which are developed to counter various existing problems.

Spray On Coating

This material is being developed by Pro-Teq Surfacing Ltd. to reduce the public expenditure related to energy consumption (street lighting) and infrastructure maintenance as this cost is constantly increasing in all countries. Spray-on coating that makes ordinary pathways glow in the dark. This innovative coat can be applied onto any solid surface including tarmac, concrete and wood. During the day, it absorbs UV rays and releases them at night as a soft blue glow. This solution could replace the need for bright light, not on busy streets, but on pedestrian or cycling pathways where it could be possible to cut costs by eliminating lights. This product would be perfect for reducing the risk of collision between cyclists and pedestrians at night. Besides, thanks to its anti-slip properties, this new coating is safer for cyclists and enhances access for disabled people. The Starpath is a cost effective solution as it allows to turn off the light at night to realise energy savings; and also because it doesn't require resurfacing thereby eliminating the substantial cost of removal and disposal of the existing surface. This product can be applied quickly and makes the surface anti-slippery, and water-resistant. Starpath can be applied both in public and private areas. Refer Figure below for spray on coating application and its path illumination phenomena.





Figure : Spray On Coating & it's Effect (Picture Courtesy <http://www.pro-techno-surfacing.com/>)

Integrated Solution of Photovoltaic & Thermal Insulated Roofing

Designergy has developed an innovative building construction material combining both solar exploitation through photovoltaic modules, and energy saving functions through thermal insulation roof materials into a single piece system mounted in one step. This new innovation is making the roof construction process much less complex. The roof is not only a cost centre but it becomes an income source while producing renewable energy and also saving energy by providing the right thermal insulation. The system designed by the company is more advanced than the traditional system consisting in two separate components (roof and solar PV system) or the standard BIPV (Building Integrated PV) system, having only the most external roof layer (e.g. tiles) substituted by a PV module arrangement. This new and innovative concept allows the customer to reduce the investment cost of the roof, to considerably reduce the pay-back time of the PV system, and to simplify the roofing assembly. This system does not require special structural adjustments between the photovoltaic part and the other insulating layers of the roof, so optimize installation time and damage risks are

reduced. Fast installation and reduced cost of TCR elements make this solution interesting also on the economical point of view for either a new pitched roof or a renewed one. Refer Figure below for this innovative roofing product.

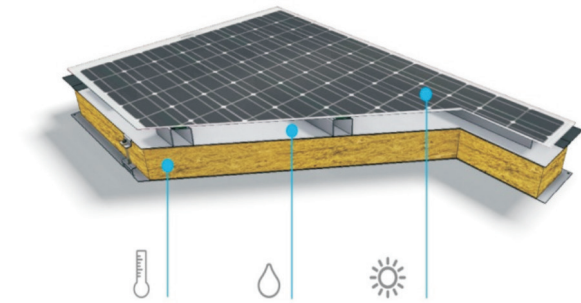


Figure : Integrated Solution of Photovoltaic & Thermal Insulated Roofing

Kebonization of Soft Wood to Yield Hard Wood

The demand for tropical hardwood is increasing worldwide due to its quality, durability and solidity. However, one third of the world's rainforests have already been disappeared within the last 50 years, corresponding to a loss of around 6 million hectares a year. The global demand for tropical hardwood cannot be met through sustainable means, constituting a major environmental and climate issue. Kebony has come up with a patented sustainable alternative to tropical hardwood when beauty and performance are essential. Developed in Norway, the Kebony technology is an environmentally friendly patented process, which enhances the properties of non-durable softwoods with a bio-based liquid. As a result the wood's cell structure is permanently modified adopting premium characteristics. Kebony is a highly durable, sustainable wood with the aesthetics and performance of the best tropical hardwood, which requires minimum maintenance and brings low life cycle costs. Suitable for internal and external applications that demand high performance and great aesthetics, Kebony is available in clear and character grade pines. All Kebony woods acquire a silver patina after exposure to the elements. Kebony has named this innovative wood transformation process as "Kebonization". This transforms the wood into sustainable species so that they acquire the same aesthetical and physical properties of hardwood, making them more durable, attractive, low maintenance, environmentally friendly, and suitable for use in construction. Refer Figure below for various applications of Kebony products.



Figure : Various applications of Wood Produced by Kebony

Passive Fire Protection System of Buildings

Security is a crucial requirement in building construction. Over recent decades public and private buildings have become larger and more complex. Each year, hundreds of fatal fires occurred across Europe. Smoking, candles, cookers, chemicals, etc. are the causes of at least 60 % of all fire deaths, leading also to important economic losses. Currently, there is a clear need to increase the fire safety in the near future. IFS produces and installs innovative insulation systems. It offers a complete range of solutions on passive fire protection products & services to protect lives and industrial assets against fire. The solutions developed by IFS allow contributing to save lives by offering more time for people to escape when fire occurs and protecting industrial & buildings assets by destruction delay. By combining nanoparticles with refractory cement, the IFS technology demonstrates two key characteristics:

- The technology is less intensive in material consumption
- The technology offers thinner and lighter material with higher thermal insulation and longer fire protection rating.

IFS is also providing services for the maintenance of the products. The company is currently operating in traditional markets such as the construction market (residential and non-residential buildings) and targets two other markets: Tunnels infrastructure & oil and gas industry. Refer Figure below for IFS fire protection systems in various buildings, tunnels and steel structures.



Figure : Various applications of Innovative Fire Protection Systems & Production System

ThermaSteel Panel System

The ThermaSteel Building System is a unique patented process utilizing the power of composite technology consisting of structural grade steel and Expanded Polystyrene (EPS). The ThermaSteel System is panelized composite structure of modified expanded polystyrene (EPS), bonded to a light-gauge, galvanized steel frame. The panels are produced in a single step to provide a light-weight, energy efficient, load bearing construction system. The panels can be installed vertically as bearing walls and horizontally as floors and roofs in addition to the panels; top and bottom tracks, connectors, reinforcements, king and additional studs, lintels, columns, beams, channels, and blocking also conform to the system. Light gauge steel is an excellent alternative for these components to be built with. ThermaSteel is completely recyclable, it can still survive earthquakes and hurricanes and elude the ravages of termites, rot, and decay while remaining for decades in exactly the same condition as the day it was installed. ThermaSteel components may be used for exterior and interior walls, partitions, floors, and roofs. Combinations of pre-insulated components are screwed together to form a unique high performance energy shell that is fast, lightweight and extremely strong with superior thermal properties. Rough openings for doors and windows are formed during the manufacturing process. Refer Figure below for ThermaSteel applications.



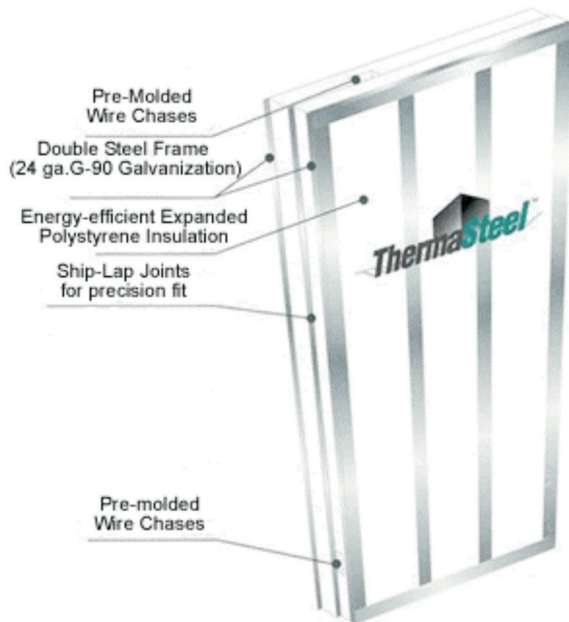


Figure : ThermaSteel panel and its Applications

Slippery Liquid-Infused Porous Surfaces

SLIPS is a slippery surface that can repel almost everything. A simple, inexpensive, and robust material that repels a variety of liquids and solids has immediate relevance to applications ranging from biomedical devices to architecture and fuel transport. Unwanted interactions between liquids and surfaces are currently a limiting factor nearly everywhere liquids are handled or encountered: they create drag in transport systems, trigger fouling in medical tubing, nucleate icing on power lines, promote growth of bacteria, and interfere with sensing devices. Most state-of-the-art liquid repellent surfaces are modeled after lotus leaves, which, due to their rough, waxy surface and contact angle characteristics, are known to exhibit superhydrophobicity and self-cleaning as water droplets remove contaminants from their surfaces when they roll-off. Despite over a decade of intense research, these surfaces are, however, still plagued with problems that restrict their practical applications: they show limited repellency to oils; they fail under pressure and upon any physical stress; they cannot self-heal; and they are expensive to produce. SLIPS technology is inspired by the Nepenthes pitcher plant, provides unique capabilities that are unmatched by any other liquid-repellent surface technologies. SLIPS surfaces function under extreme high pressure conditions, instantly self-heal imperfections, provide optical transparency, and are ultra-repellent to pure and complex fluids such as blood, crude oil, and brine. They also repel solids such as ice and wax. Probable application can be hospitals etc. Stopping the spread of disease in a confined space such as a hospital is no easy task, involving continuous disinfecting and even the occasional architectural reorganization. SLIP would let bacteria slip right off. In addition, the material could ward off dust, ice, and graffiti, making it a tantalizing prospect to industries outside of just health care. Refer Figure below for operational principle of SLIPS.

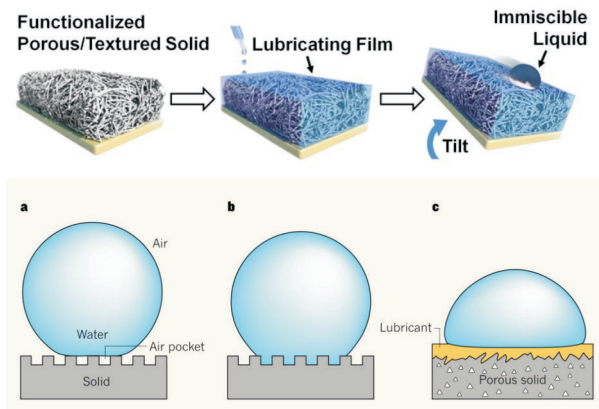


Figure : Operational Principle of SLIP

Impacts of the development of advanced building materials in The Construction Industry

Advanced building materials are the result of intensive R&D activities that have been considerably reinforced within big construction companies, and developed as a core activity by start-ups. The necessity to create new types of building materials has transformed the industrial base of the construction sector. Companies have shifted their business model towards a more innovative system, encouraging the collaboration between multiple disciplines: civil engineers, designers, architects, scientific researchers especially on material sciences, new materials, KETs, etc.

Challenges to Adopt the advanced building materials

Consumer attitude and awareness towards greening and energy consumption has been changing over the last decades. Awareness on environmental issues has increased with higher recognition of climate change, and the influence of human activities on it. This new way of thinking leads to a shared consensus on taking actions on saving the environment and ecological balance. Consumers are more convinced that individual lifestyles have to be changed. As reported by a UK National Regulatory Authority recognized by EU Directives, 70% of the European consumers agree to do a lot to reduce energy consumption at home. The increase in energy costs, on top of the economic crisis, encourages people to seek solutions for energy saving. Indeed, across Europe, average electricity cost for households and industries have increased by 29% between 2005-2011, while it was only 5% and 1% in USA and Japan, respectively over the same period of time. This new way of thinking had considerable influence on customer's interest towards the use of advanced building materials. Convenient solutions for low maintenance, automation, flexibility, health improving features, and optimal environmental integration in the short, medium and long terms are in demand. Customers represent not only households but also companies and governments who are willing to implement solutions for energy saving within commercial buildings and public infrastructures.

One more challenge to adopt any new building materials is that a country's construction sector is subject to various national and international regulatory requirements and standards concerning energy consumption, environmental



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risks and impact, health and safety, quality of products, etc. These surplus and mismatch of regulations and standards at national and international level are quite hard for the companies to comply, as they are responsible of high administrative burdens and costs. Such complex regulatory framework can deeply impact the competitiveness of companies in the construction sector and its related markets such as advanced buildings materials. Indeed, the large amount of administration and documentation to prove the conformity of the product to local regulatory requirements and standards; and the different level of transposition of international regulation and standards on the national markets make the situation very confusing and complex for the small companies.

Conclusion

Advanced building materials are innovative products that

may find difficulty to get into markets because of client's reluctance. Policy makers should encourage the multiplication of public demonstrators. The trial of the product into public infrastructure could prove the qualities and the reliability of the concept thereby encourage clients to adopt the new products. Companies in the advanced building materials sector need more transversal competences. Technology is an integral part of this new generation of building materials. Designers, architects and engineers have to shift their traditional thinking and their way to work to include cutting-edge technologies.

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