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Graphene nanotechnology in composites for a challenging architectural design



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Gazechim Composites Ibérica, S.A. (Spain) was a finalist at JEC's World Innovation Awards 2019 in Paris and a winner at the JEC Innovation Awards 2019 in Chicago in the Building category, for an avant-garde building composition especially-designed for a new logistic centre in Valencia (Spain).

The project was created with the purpose of showing architects, civil engineers and designers the capabilities of composites applied to architecture. It consolidates the technology of graphene nanohybrid composites in the construction sector. In the execution of the building, avant-garde naval engineering know-how is implemented by Graphenano Composites, establishing a differ-

ential factor with respect to standards set by traditional materials in architecture.

The main goal of Gazechim Composites Ibérica, a subsidiary of Gazechim Group with a strong presence in the composite industry, was to promote the project with a commitment to show the advantages and possibilities of composites in a market still to be exploited through its new logistics platform in Valencia (Spain).

In cooperation with Graphenano Composites, the company designed, developed and implement-



Fig. 2: Infusion process for one of the 240 sqm composite canopy's sections

ed different GRP architectural elements, such as a large, avant-garde design-inspired canopy: This self-supported structure, together with the other elements implemented, leverages graphene-based nanotechnology in composites with a high future potential.

Development, manufacturing and installation

One of the many challenges in this project was to manage and coordinate a wide range of major players in the composite value chain as partners to bring the project from blueprint to reality. With its team at the centre, Gazechim Composites Ibérica partnered with nine material suppliers (Chem-Trend,

Chomarar, Euromere, Gurit, Nouryon, Obo, Owens Corning, Omar Coatings and Polynt), a composites and a civil engineering office (Graphenano Composites and Grupotec), four industrial customers (Graphenano Composites, Look Composites, Polymec and Xúquer), a building company (Construcciones Eliseo Pla), an architectural and interior design office (Onside) and the project's general contracting team. Different manufacturing processes were used, such as vacuum infusion, pultrusion and hand lay-up.

The flagship element in the building is a huge self-supported canopy. With a total surface area of 340 m²,

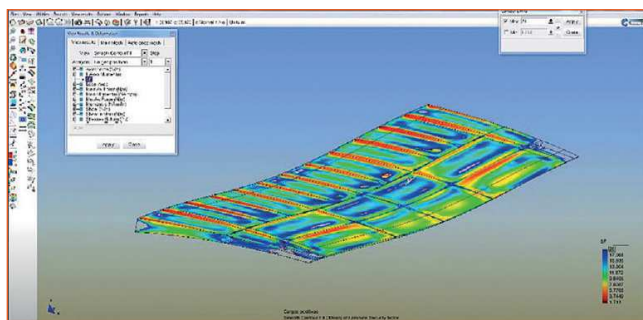


Fig. 1: Screenshot of the FEA performed for the 340 m² canopy



Fig. 3: General view of the office block, showing The White Bow



Fig. 4: General view of the installed composite elements in the building

this structure leverages graphene-based nanotechnology and resembles the hard top of a boat, transferring concepts from naval architecture to civil architecture. This effort marks the first construction application featuring nanotechnology in a polymeric matrix to enhance composite performance. The matrix was nanomodified with graphene to enhance the material's flexural modulus and tensile strength properties, while reducing the overall weight of the structure. The total surface of the other composite elements is 275 m² in the office's façade and 880 linear metres of profiles for shade slats. In addition, around 3,000 linear metres of graphene-modified composite rebars were used to reinforce concrete in some areas of the project. The canopy over the loading dock of the logistics centre is, to date, the largest part in the world manufactured with the latest generation of hybrid composites using graphene nanotechnology, with the aim of

improving the final performance of the composite. The dynamic pressure of the wind, possible overloads and rainwater evacuation were taken into consideration for the calculation. Figure 1 shows a screenshot of this process. Manufacturing the part with composites offered the following advantages:

- Less than half the weight of an equivalent steel part;
- No need for a heavy and bulky auxiliary supporting structure;
- As the canopy is a self-supporting structure with no pillars, the risks associated with truck collisions in the loading area are completely eliminated;
- Lower transport and handling costs as this element was manufactured by companies close to the commissioning location.

This challenging design was only possible due to the high strength-to-weight ratio of composites, maximized by the use of a Kerdyn™ Green recycled PET core sandwich structure through the infusion pro-

cess (see Figure 2). In addition, this core contributes to excellent mechanical properties and reduces the carbon footprint of the global project, contributing to the current circular economy and sustainability policies.

Other architectural elements to be highlighted in this project are present in the office block, developed in collaboration with the Onside architecture office (Valencia). The façade is protected by a skin of slats arranged in a wave shape, emulating the waves of the sea surface. Above it, The White Bow, a protruding geometry that stands out in an almost impossible way at its vertex, evoking the hull of a ship (see Figures 3 & 4), is floating and sailing over the building. The thermal insulation provided by the 880 linear metres of composite slats contributes to energy savings and well-being in the building. The architects designed the slat layout in order to optimize the building's energy response to solar radiation. Thermal insulation is important in a warm climate with many hours of direct sunlight like Valencia's. The thermal efficiency of composites allows considerable energy savings compared to conventional materials such as aluminium. Around 3,000 metres of composite rebars with a graphene nanohybrid matrix were also used to reinforce the concrete in different exterior areas of the project. These rebars improve both the strength of concrete and its resistance to humidity and atmospheric agents.

Contributing to a more sustainable solution

Several key aspects of this project speak of the positive impacts made and enabled by Gazechim Composites Ibérica: a more positive LCA (life cycle analysis) and LCCA (life cycle cost analysis) competitiveness versus traditional

materials used in the building sector. From an LCA point of view, the embodied energy per square metre is lower for fibreglass composites compared to traditional materials such as brick, aluminium and steel in terms of surface (a critical point for buildings). The project made a massive use of an up to 100% recycled PET foam core, Kerdyn Green® from Gurit. From an LCCA point of view, the positive contributions are driven by energy savings through the reduction of overall material quantities and a reduced transportation weight. Through the implementation of the graphene-modified Compograph® polymer matrix and the designed sandwich structures, these mechanical properties were increased along with long-term durability, resulting in reduced maintenance costs versus traditional materials.

Conclusion

The project's main overall objective is to create a real-life and full-scale application that sends a clear message to designers, engineers and the global building market. Introducing this level of advanced, next-generation composites incorporating nanotechnology has reset the competitive landscape and created new performance gaps with respect to structures made with traditional materials. While clearly demonstrating the competitive advantages of composites, this shows the great synergies and market potential that exist when integrating them with traditional materials within the same project. As an influential leader in the distribution of composite materials, Gazechim Composites Ibérica is committed to going one step further in the adoption of advanced materials and communicating the advantages, possibilities and future opportunities still to be explored and converted. □

More information:
www.gazechim.es