TEC THIN ENVIRONMENTAL CLADDING

Innovation by Permasteelisa Group
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Figure 1: TEC external view in day time

Industry Reports: A World of Talent

In the last decade building regulations have become more stringent and are paying closer attention to the environmental impact of building construction, building energy consumption and renewable energy integration. They are paying more attention to material embodied energy and recyclability as well as environmental depletion and pollution. These are topics which have to be carefully considered in the design phase of any construction, with a direct impact on the façade market in which continuous innovation and rational design are essential to provide adequate green solutions.

Over the next few pages the Permasteelisa Group will introduce you to one of the most innovative recent technologies developed with the environment and nature in mind.

TEC - THIN ENVIRONMENTAL CLADDING

TEC, Thin Environmental Cladding is the latest technological development completed by the Permasteelisa Group R&D department. This is part of Permasteelisa's Alter Technology which looks at innovative design systems and materials. More specifically, TEC represents a curtain wall system entirely composed of pultruded composite material. The expert knowledge of pultruding techniques and GFRP (Glass Fibre Reinforced Polymer) properties was provided by Fiberline Composites with a common and challenging objective: the development of a high performing, top quality product characterized by a unique architectural appearance.

With regards to performance and quality levels, Permasteelisa set the full list of requirements which would also allow the product to be applied on high rise buildings. The idea behind it is to obtain a façade system which covers (and often exceeds) the typical performance of standard glass-and-metal curtain wall systems, i.e. performance intended as a whole, so from building energy consumption through to structural and safety "constraints", with particular sensitivity to fire security.

Concerning the aesthetics, it was clear from the early stages of development that the composite material itself, if properly exploited by a dedicated design, would provide a unique solution for architects to create buildings with their own identities. The particular matrix used to produce the profiles, a thermosetting

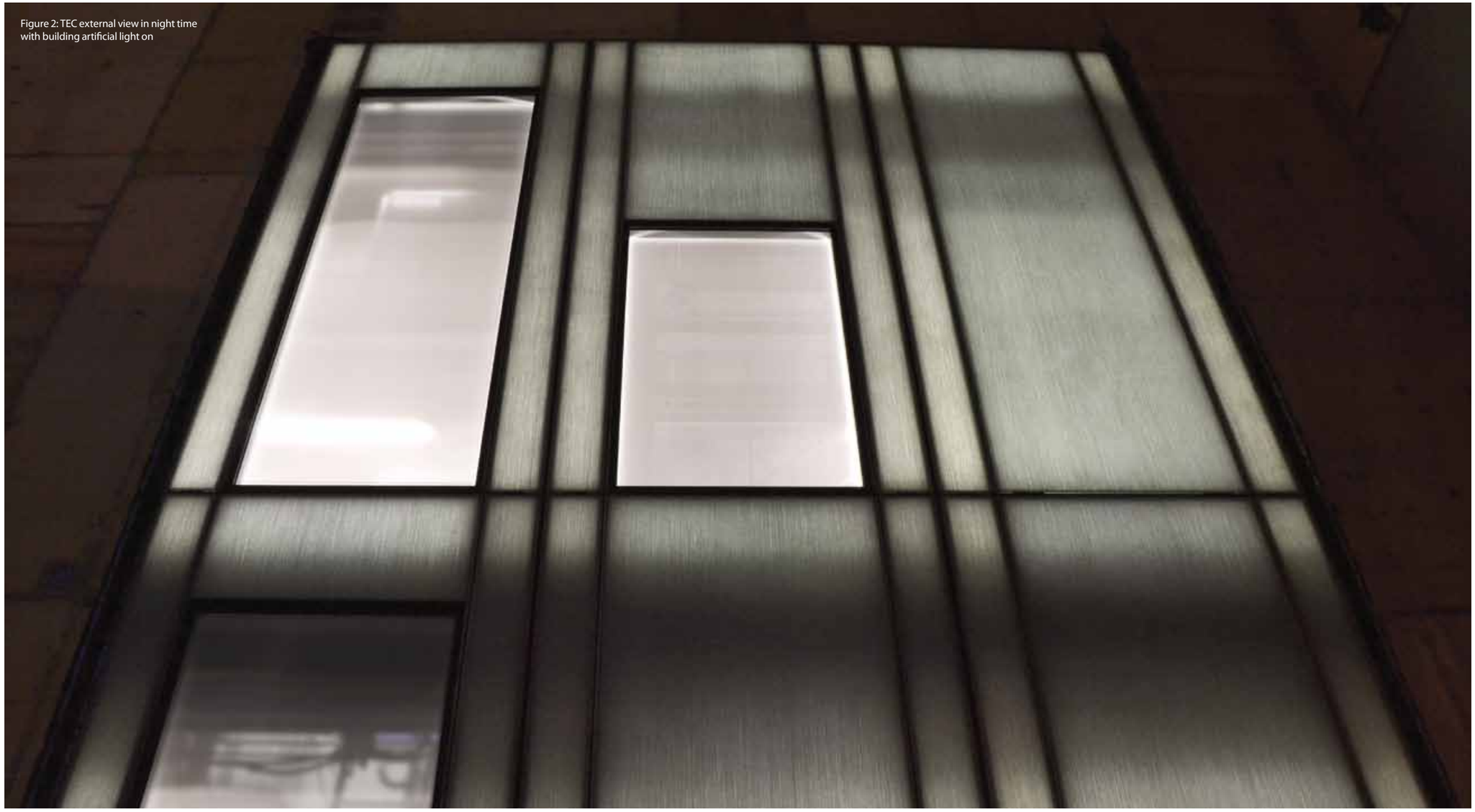

Figure 2: TEC external view in night time with building artificial light on

polyester based resin, beyond providing well balanced thermal, structural, fire and durability performances, is indeed characterized by a transparent appearance. Once it is "merged" with the glass fibre reinforcement during the pultrusion process, it produces profiles with finishes characterized by the following two main peculiarities:

Firstly, the glass fibre pattern is visible even if it is protected by a thin resin layer. This allows to play with glass fibre patterns to obtain different, three-dimensional finishes;

Secondly, profiles are characterized by a translucent appearance; in other words, they allow a degree of light to pass through them diffusely and, equally important, they capture small quantities of light to illuminate themselves.

These pure material related features drove the design of the TEC, leading the R&D team to the façade solution revealed to you here.
The concept behind the TEC design is to increase the building occupants comfort level, optimizing at the same time the building energy demand.
How?

Large green areas present on TEC panel correspond to those parts of the façade (mullion profiles and spandrel panel) which provide thermal insulation and, at the same time, allow natural light to pass through them, illuminating the buildings internal environment.

This allows a reduction of building energy consumption for artificial lighting because of two effects:
Direct effect: the natural light passing through the translucent wall decreases the energy demand for artificial lighting;

Indirect effect: the translucent wall, illuminated from the external side allows the blind control system (BCS) of the building to be set to a different threshold, thereby permitting a greater amount of natural light to pass through the walls, consequently eliminating unfavourable contrast values. The end result is enhanced well-being and comfort of the occupant.

Care of the overall building energy consumption is not the only measure to reduce environmental impact of a building. The choice of the material itself is also important.

Energy consumed to produce the material (or component), energy stored in the material at the end of its life, water and air pollution and recyclable properties are even more important factors that have to be considered in the product design phase as soon as there is a need (or possibility) for material choice.

Production of pultruded glass fibre reinforced polyester profiles requires low energy consumption in comparison to equivalent extruded aluminium profiles, especially if those aluminium profiles are not made from recycled

Figure 3: TEC performance test: dynamic water penetration test (left) and thermal cycle test (right)

material (usual request for top quality façade products). This comparison is in favour of GFRP material, both considering pure values per unit mass of base material and also considering the façade surface (square metre) as reference unit.

The latter is important because it allows you to compare "apples with apples", considering equivalent façade systems (in this case, by weighting environmental performances to structural and thermal ones).

Pultruded GFRP is also well placed in terms of air pollution (resin injection happens in a closed mould with very low emission) and water pollution.

End of life properties of glass fibre reinforced polyester have recently been improved: once the façade would be dismantled, all the GFRP parts can be recycled in order to produce high quality cement. The energy stored in the material (the so called embodied energy) is re-used, replacing the use of fossil fuels (1000 tonnes of GFRP profiles in cement production saves around 450 tonnes of coal, 200 tonnes of chalk, 200 tonnes of sand and 150 tonnes of aluminium oxide).

Thin Environmental Cladding: We have spent a few words describing why TEC is environmentally benign. But why is it called Thin Cladding? TEC has been designed with an overall façade depth of 100mm, that is about half of the standard aluminium façade systems with similar structural and safety performance. This lower façade depth is made possible thanks to the performance of the GFRP material which has a well-balanced structural and thermal performance. It doesn't mean that GFRP is stiffer than aluminium (elasticity modulus is about one third of the aluminium one), but it achieves good stiffness in combination with a high thermal insulation. Indeed, thanks to its low lambda value (approximately 0.35 W/(m·K) in cross-fibre direction – aluminium is 160 W/(m·K)), no thermal breaks are required (with obvious advantages in terms of profile stiffness) and

the edge effects on insulating panels are low. Moreover, the translucent appearance of the profile allows wider panel mullions without the effect of a heavy and dark façade bearing structure.

Furthermore, the reduced thickness of the structure of the GFRP façade has also a positive cost impact: the increased net rentable area of the interior building space. This aspect is equivalent to a yearly income for the building owner, reducing the payback time of the initial façade investment.

TEC - PERFORMANCES AND TESTING

The TEC is translucent, environmentally friendly and cost-efficient. There are additional façade performances which have been optimized by means of holistic design of the facade:

Wind load resistance: 2.4 kPa;
U-value: between 1.1÷1.2 W/(m·K), depending on façade configuration;
Direct sound insulation: Rw+Ctr = 36dB;
Fire reaction performance: class B-s3-d0 according to EN 13501.

All these performances are evaluated for the nominal panel dimensions (1.8 m wide by 4 m high) and for any designed façade configuration (e.g. one or two glazed areas, fully spandrel panel)

The most challenging performance to be achieved during the design and development phase of this technology was the combination of high acoustic insulation together with the demands of structural resistance and the translucent appearance. Acoustic solutions in curtain walling typically require heavyweight surfaces (e.g. steel plates), however an innovative design solution of decoupling internal and external GFRP façade skins resulted in high acoustic performances which can be tuned specifically to each project requirements.

A full performance test cycle according to CWCT standards was performed on a 6-full size-panel mock-up. Test cycle includes impact tests (hard and soft body), dynamic water penetration resistance tests (both according to AAMA and EN standards) and thermal cycling. Structural behaviour of the façade during testing correlated very well with the predictions/simulation tool during design phases (modelling composite material

Figure 4: Examples of TEC potential colours and related actual translucent effect

is delicate due to the anisotropic material properties).

The result achieved in the static water penetration resistance test, where TEC reached the classification RE.1200 (i.e. water tight till 1200 Pa), confirms the excellent quality and robustness of the systems design.

Also, impact properties of the TEC have been tested with good results. Soft body impacts (tested with both double-tyre and glass-sphere filled bag) show that the façade is able to absorb the energy coming from the impact without any damage to profile connections, (aspect that may be critical for relatively "fragile" materials such as GFRP). The same results were obtained during the hard body impact tests (1 kg steel sphere): no denting on the GFRP can be measured. Impact resistance classification for both hard and soft bodies results class B according to CWCT TN 52 – appendix B.

To complete the façade performance testing, SBI (Single Burning Item) fire tests were carried out. The design optimisation followed during the TEC development resulted in class B-s3-d0 classification according to EN 13501, which complies with national requirements in most European Countries.

TEC - CREATIVITY FREEDOM

TEC offers design opportunities which are innovative and unique. It also offers common shape variations and the possibility to play with the glass fibres to obtain 3-dimensional effects. Additionally TEC is available in any colour simply by using coloured coatings.

Coloured coating, when properly set-up maintains the translucent effect on the curtain wall whether it's painted on the front or the rear side. The results give different effects if exposed to direct sunlight or if the system is back lit.