Glass & translucent materials

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Special reports

Comment

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Glass & Translucent materials supplement

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Editor's letter

I am delighted to bring you this 2016 edition of ADF's Glass & Translucent Materials Supplement in which we take a close look at new product technology and its relevance for specifiers. We also report on inspiring projects, pioneering research and development initiatives, plus we gain the news and views of some of those involved in this industry sector.

In this issue, we feature three diverse projects which showcase the innovative and challenging use of glass materials in different ways. Glass was the material of choice when relatively new architect's firm, 1004arquitectos, designed two transparent buildings, one angular one oval, to provide the Caligrama School for adult learning with classrooms and a children's playground. In responding to the brief to create a new landmark building that would integrate a run-down part of town with a new urban space, the glazed structure illuminates – quite literally at night – a town in northern Spain. No other building material could have produced the exact effect that the architect and its client, the Town Council of Torrelavega, wanted to achieve.

From Spain to an international visitor attraction in the UK and winner of the BBC's public vote on the entries in the 2015 RIBA Sterling Prize for Architecture, the Whitworth Gallery. Again, glazing plays a pivotal role in the University of Manchester's ambitious extension to its arts gallery, especially in the first floor cafe and Promenade Gallery facing the park.

As we were interested to learn more about a pioneering development project based on the water spider's web making process, Stephen Cousins reports for us on a project that was masterminded by a research team at the University of Stuttgart. The creation of a Research Pavilion, using advanced carbon-fibre construction without moulds, has resulted in a fascinating, semi-transparent structure with exciting implications for architectural design of the future.

We are also grateful to our contributors who have provided us with topical comment. This includes the National Association of Rooflight Manufacturers (NARM) who shed light on rooflight systems and corresponding regulations, while the Glass & Glazing Federation (GGF) gives an update on fire-resistant glass legal compliance and CE marking.

And last but not least, manufacturers, Vetrotech, ESG and Rodeca tell us about the latest product developments in their respective fields of expertise and Schott discusses new glass materials and the merits of traditional production processes for the restoration of historic buildings.

I hope you find it both an enjoyable and informative read!

Sarah Johnson

AWARDS

Double win for Arup at FACADE2015 Awards

© Iwan Baan

Arup celebrated success at the Society of Facade Engineering's annual interntional awards FACADE2015, celebrating facade engineering excellence.

The Bombay Sapphire Distillery in Hampshire, UK, was presented with 'Outstanding Facade Innovation' and Guy's Hospital Tower in London was crowned 'Facade of the Year' in the Refurbishment category.

The Arup team supported Heatherwick Studio with geometrical optimisation, structural and detail design of the glass facade of the Bombay Sapphire Distillery. The greenhouse-style structures demonstrate a unique and innovative approach of employing curved glass as a structural component. The award was given jointly to Arup and the contractor, Bellapart, because the project stood out for the tight integration of the design team as well as the structural glass innovation.

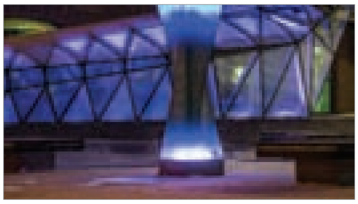
On Guy's Hospital Tower, Arup was appointed to deliver a high quality, energy- efficient solution that would go on to secure the future of the tower for the next 30 years. A once in a generation opportunity was taken to improve the performance of the building using the best current facade technologies and the finished scheme exceeds current building regulation requirements. Key to the success of the project, the judges highlighted that the hospital was able to remain operational throughout the refurbishment works.

Dave Richards, UK facade engineering leader, Arup said:"These awards celebrate the best in international facade engineering and we are delighted that all our hard work has been recognised by our peers. The two winning projects couldn't be more different, yet they both showcase the extraordinary vision of our clients, outstanding engineering and design, and collaboration between all involved."

The Society of Facade Engineering was formed in 2004 as a joint initiative of CIBSE, IStructE and the RIBA. It brings together architects, facade engineers, building services engineers, structural engineers and contractors in a forum where they can work together to advance knowledge and promote good practice in facade engineering.

300TH ANNIVERSARY

Steel & glass features for Omsk's 300th anniversary

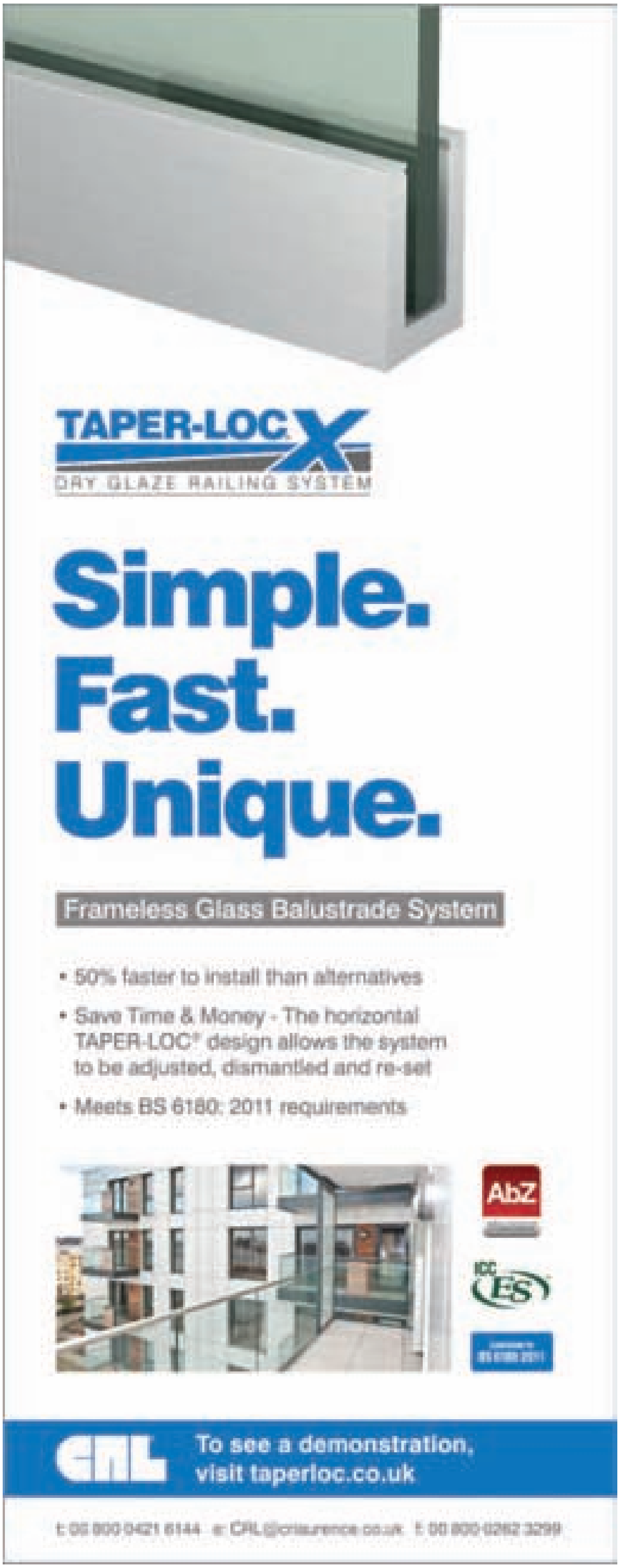


As part of the forthcoming 300th anniversary celebrations of the Siberian city of Omsk in 2016, the city administration decided to refurbish and renovate the existing Valikhanov street in the city centre, which cuts through historic parts of the town, connecting it to the river Irtysh. The refurbishment project of this street, which is nearly 1km long, involved major work to existing infrastructure (change of all existing mains, refurbishment of existing facades, complete repaving of the whole street with solid granite stone, etc.) as well as the design and construction of several steel and glass features ('crystals') to be scattered along the street as if by an imaginary "wizard". Due to complex and geometric form the client invited Gennady Vasilchenko Malishev and his team to help, based on their experience with unusual structures in the country previously. In total there were 11 'crystals':

- Three canopies to the major road crossing, each measuring approximately 5.5m wide by 12m long
- Five information kiosks, each measuring approximately 3m wide by 3m long and 3m tall
- Two fountains, one small (2.5mx 4m tall), and one large (12m wide, 9m tall), which became de facto local "arcs de triomphe"
- Stacked glass sculpture

Once again, in their work Malishev Engineers had to cut deep into the essence of the consulting engineering profession where they believe they were a vital link between the architects (based in St Petersburg), the manufacturers/suppliers (based in Finland, Belarus, Russia, Bulgaria, UK, Germany, China), and the project site based in Omsk, Siberia. Malishev Engineers not only designed the structure to fulfil the architectural vision (and sometimes beyond) but also closely followed production process assisting with fabrication drawings, working out assembly method as well as finding suitable manufacturers capable of delivering the project on time and within the budget without compromising the design.

The company feel that with this project they have grown further with their experience of handling complex projects and also feel that they have contributed however small to the promotion of engineering excellence internationally. The project has been awarded the Institution of Structural Engineers award.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INDUSTRY GROWTH

Cautious optimism across the industry as firms anticipate growth

The UK's glass and glazing industry looks set to experience a period of expansion over the next two years, with firms upping headcounts and planning further investment in order to take advantage of a number of opportunities in the market, according to research from Pilkington United Kingdom Limited. The study, which surveyed 318 customers across the supply chain – including fabricators, installers and architects – found that two thirds (66 per cent) plan to recruit more staff over the next two years. A conservative estimate for the average number of jobs firms are hoping to create in the next two years is three per organisation. If replicated across the industry, this could mean thousands of new roles across the sector. The expected uplift in job creation appears to be underpinned by a forecast increase in turnover for many businesses, with the average firm forecasting growth of at least 10 per cent over the next two years.

Investing in the future

The survey also shows businesses are planning to invest in developing new products and improving their infrastructure to capitalise on opportunities. Almost two fifths (37 per cent) said they plan to develop their product range while nearly a third (32 per cent) are planning to upgrade their premises or machinery.

Opportunities on the horizon

The research also highlighted that firms are anticipating an uplift in the number of new houses being built, something that was confirmed by the last Autumn Statement, in which the Chancellor announced the biggest house building initiative since the 1970s. A third of businesses (32 per cent) said an upturn in the construction of new homes would allow them to grow, while a quarter (24 per cent) cited increased spend by property owners on energy-efficiency improvements and other retro-fits as a growth driver. Nearly a quarter (23 per cent) said that the relaxation of the planning laws – a proposal introduced by the Government in the summer budget – was an important step in helping their firm pursue a more ambitious expansion strategy. Andy McDowell, commercial director at Pilkington United Kingdom Limited, said: "There has been no shortage of pessimistic forecasts for the performance of the glazing market in recent years, and while many firms are still operating with caution, this survey shows clear signs of growing confidence in some parts of the industry. The commercial sector in particular is a buoyant market, with many of our customers citing healthy order books."

Challenges ahead

When questioned about the greatest obstacle currently facing their business, the rising cost of materials came out on top with more than half of respondents (52 per cent) highlighting it as the biggest challenge in the two years ahead. One in three respondents (33 per cent) said that low spend in the domestic market as a result of tough economic conditions would be the biggest challenge, while just over a quarter (27 per cent) named the cost of employment as the main hurdle. Other challenges included lack of skills in the labour market (25 per cent) and sluggish spending in the commercial sector (23 per cent). Overseas competition was named as a threat by just five per cent of firms, compared to 22 per cent that flagged domestic competition.

COMMENT

Rooflighting: a compliance checklist for busy specifiers

The huge variety of rooflight systems available in the UK today, plus evolving regulations for their application, can make specifying rooflights a complex subject. In this article NARM, the National Association of Rooflight Manufacturers, provides a brief overview of the factors you need to consider

Building use

With any rooflighting specification, the first point to consider is the use of the building. This will determine the amount of light required.

For example, in many educational, engineering or design environments where precise, detailed work is carried out, the required light level will be much higher than for a storage facility or reception area.

The type of light is also critical. In the applications mentioned above, direct, un-diffused light is not desirable as it will create uneven lighting conditions, glare and the potential for unwanted localised heat build-up. Therefore, it's important that a light-diffusing glazing material is specified for these applications.

However, diffusing glazing materials are translucent (not transparent) and will therefore obscure the view out. Therefore, where this is a requirement, such as in some domestic applications, the effects of direct light must be balanced against the preference for a view. This in turn, has a bearing on the glazing material specification.

Glazing material

Rooflights for the UK market fall into three broad material categories:

Glass is often the preferred material for domestic, commercial and retail applications, where aesthetics, high performance and long working life are key considerations.

Polycarbonate offers exceptional impact resistance, high levels of light transmission, formability/curvability and good fire rating. It is often specified for commercial, educational and industrial buildings.

GRP (Glass Reinforced Polyester) is the material of choice for factory and warehouse rooflights and offers excellent light diffusion and performance properties.

Roof construction

Whatever the design of the roof or materials used, there is a compliant rooflighting solution available:

For pitched slate or tiled roofs, a variety of fixed or opening roof windows are available, for in-plane installation i.e. flush with the pitch of the roof. These are generally glass units and often the preferred solution for domestic dwellings or smaller commercial buildings.

A huge variety of rooflight designs are available for flat roof constructions – from individual, modular rooflights in glass or polycarbonate, to continuous pitched or barrel vault rooflights, pyramids, lantern lights and other structures.

For profiled metal or asbestos cement roofs, profiled GRP or polycarbonate rooflights are available to match virtually any sheet profile, allowing rooflights to be installed in-plane with the roof.

Energy efficiency

Compliance with Part L of the Building Regulations for conservation of fuel and power (Technical Handbooks Section 6 for Scotland), is one of the most contentious and widely discussed topics for rooflight specifiers.

It is now well documented that rooflights make a positive contribution to compliance, by reducing dependence on fossil fuels for artificial lighting. However, a recent member company survey by NARM has revealed that there is still some confusion amongst specifiers regarding the relative contribution of thermal insulation (U-value) and overall light transmission. Put simply, specifying roof lighting with a compliant U-value is important, but much more so is the rooflight area and subsequent amount of daylight introduced.

The amount of energy needed to light a building artificially is often much greater than the amount of energy used to heat it, and may be the greatest single energy use in operating the building.

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CO_2 emissions are approximately 40 per cent higher on a building with no rooflights than a building with 10 per cent rooflights or more. This demonstrates that for some buildings, regulatory compliance is impossible without rooflights.

Roof safety

The Health & Safety Executive has approved a test procedure and classification for roofing assemblies including rooflights. Developed by the ACR – Advisory Committee for Roofsafety, the test provides a clear classification of rooflights, allowing peace of mind for specifiers.

The term 'non-fragile' can be applied to a wide range of rooflight types offering varying degrees of durability and impact resistance. However, a non-fragile rooflight is NOT designed to be walked upon. It's designed to save lives by preventing people or objects falling through it accidentally, when accessing roof areas not designed for regular foot traffic.

This should not be confused with what have become known as 'walk-on' or 'traversible' rooflights which are designed to floor loadings for regular and deliberate foot traffic.

Fire performance

In England & Wales, rooflights are subject to fire performance regulations covered in Approved Document B of the Building Regulations. In Scotland, it's Section 2 of the Technical Handbooks.

For general areas, all three roof glazing materials outlined in this article can be specified to meet the main requirements of the standards without restriction. For specific applications such as positioning adjacent to fire walls or escape routes, seek advice from your rooflight manufacturer.

Security

Rooflights in accessible locations on new build domestic properties are also subject to regulations in Approved Document Q of the Building Regulations.

Quality standards

With an increasing number of construction products coming into the UK from all over the world, it's important to recognise the appropriate UK quality standards for rooflights.

Your rooflight supplier should be an ISO9001 accredited company – or be working toward this accreditation.

Rooflights should be CE marked where the appropriate standard exists for the specific rooflight type. Information is available on the NARM website in respect of this.

Independent accreditation schemes such as those operated by the British Board of Agrément and the British Standards Institution also provide evidence of quality standards compliance, although these are only appropriate to high volume, standard products, not bespoke designed items – as many rooflights are.

Other factors

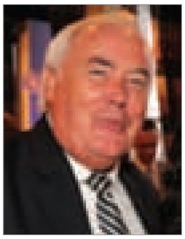
Other factors which may need to be taken into consideration, depending upon the application, are aesthetics, working lifespan and, of course, budget.

A condition of NARM membership for roof lighting suppliers is that their products and services must be within UK regulations, so for many, selecting a NARM member company will be a reliable 'short cut' to regulatory compliance.

COMMENT

Legal Compliance for fire-resistant glazing

Steve Rice, director of technical affairs for the Glass and Glazing Federation (GGF), outlines the compliances and CE marking issues that impact all those responsible for making the glazing in a building fire-resistant



Making Insulating Glass Units (IGUs) with a fire-resistance characteristic requires special processes to verify performance. Architects and specifiers should be aware that manufacturers cannot simply use a fire-resistant glass component such as a pane of fire-resistant glass (that has already been CE marked) in their production and assume it covers all other properties. The GGF has guided and advised all glass manufacturers and installers, responsible for putting a fire-resistant glazed unit on the market, that they need to make a separate Declaration of Performance (DoP) backed by fire-resistance testing of their complete IGU product.

Demonstrating fire-resistance

The manufacturer has to show that the IGU they produce conforms with the requirements of product standard BS EN 1279-5:2005 +A2:2010 Glass in Building – Insulating Glass Units, part 5: Evaluation of conformity. System 1 for the attestation and verification of constancy of performance applies.

Under that system, Factory Production Control (FPC) applicable to the fire-resistance characteristic is required, which includes testing of samples taken at the factory to a prescribed test plant. A notified product certification body has to provide a certificate of constancy of performance for the product, based on:

- type testing of fire-resistance to BS EN 1364-1 of a representative product sample taken by the notified body
- initial inspection of the manufacturing plant and the FPC
- follow up assessment and evaluation of the FPC

Following testing, the fire-resistance performance needs to be classified according to standard BS EN 13501-2, Fire classification of construction products and building elements – Part 2: Classification using data from fire-resistance tests, excluding ventilation services. Testing to BS 476 part 22 is not acceptable. And testing to BS EN 1364, when the product has not been formally sampled, can only be used as supporting data.

Further requirements

When the product certificate has been received, the manufacturer can draw up a formal DoP and prepare the CE marking label. However they have to ensure that the declared performance is maintained. That requires recording relevant technical documentation and steps taken to monitor the product. The keeping of a complaints register of product non-conformance and recalls is also required. The technical records and DoP have to be held for at least ten years after placing the product on the market. Product traceability is important, and there are therefore requirements for product labelling and identification of production units with unique batch or serial numbers.

There is also an obligation to ensure that the product is accompanied by appropriate instructions and safety information concerning its use. That would be expected to include guidance for handling, glazing and installation, including naming of the components of the required glazing system as established by fire-resistance testing.

Cascaded evidence (or sharing Initial Type Testing)

There is an alternative approach. The manufacturer can choose a path already followed by another where an IGU product has already been successfully CE marked. But the manufacturer must follow the associated product system and process description for the CE marked IGU. The associated fire-resistance test results and product classification may be used with agreement from the owner of the original type testing. However the manufacturer has to separately achieve certification by a notified inspection body for their FPC. Placing the product on the market still requires a DoP under the name of the manufacturer.

To read the full GGF Guidance Document on sharing cascaded evidence or initial type testing, please see:
www.ggf.org.uk/publication/guidance_on_sharing_itt

Getting it right

There is a great deal for an IGU manufacturer to get right in claiming fire-resistance and those responsible for fire safety and fire-resistance in a building should also take not that:

1. Formal classification is essential
2. Product performance has to be established by rigorous procedures
3. The steps in the process cannot be sidestepped
4. And if not careful, manufacturers could easily breach CE marking rules and the Construction Products Regulation (CPR). Such breaches can mean heavy fines and in extreme cases, imprisonment

If you are responsible for making the glazing in a building, fire-resistant, make sure your supplier and installer are doing it correctly otherwise it can defeat the point of installation.

A study in glass

A landmark educational building featuring an innovative use of glazing has lit up a run-down part of the Spanish town of Torrelavega, writes Steve Menary

A mix of squares, circles and an innovative use of glazing has been used to create a striking new educational facility in northern Spain.

Until last summer, the Caligrama adult learning school at Torrelavega in Cantabria lacked its own headquarters. The town council set out to change that and also to make a regional statement with a landmark building.

Although Torrelavega only has a population of 56,000, the town dates back to the thirteenth century and is the capital of the surrounding county, Valle del Besaya.

The council wanted to create a "new iconic building" that would be a "reference for the future of the region" and achieved that with a heavy reliance on glass and glazing that shone light on a previously neglected area of the town.

The project is located in the run-down eastern part of Torrelavega. The council wanted to use the new building to integrate this part of the town with a new proposed urban space adjoining the site, to be known as Miravalles Park.

Torrelavega Council awarded the commission for this high profile project to an architectural practice that had only been formed the previous year.

The Madrid-based studio 1004arquitectos was founded by Coral Álvarez de Miguel, Jaime Lamúa Chueca, Pedro López Quintas and Sergio Soria to focus on architecture and urban design.

The group's founding principles are described as to produce "a perspective that integrates the user, urban transformation, the development of public space and the environment in which it is inserted."

This appealed to Torrelavega Council and in November 2009 the commission for the new adult learning school was awarded to 1004arquitectos. The founders oversaw the design,

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'Glazing was a central part to the design that 1004arquitectos produced in response to the client's brief'

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with Juan Pablo Prieto working as project technical architect in the studio.

Glazing was a central part to the design that 1004arquitectos produced in response to the client's brief.

The studio spokesperson added: "The project is the result of a reflection on educational architecture and the conventional way of understanding the educational programme.

"Instead of a repetition of isolated spatial elements, we proposed a transparent materiality that manifests how far architecture can influence the educational model and its development: a transparency that turns the classrooms into open educational spaces, showing the teaching inside, reducing noise in the areas of transit and creating a common atmosphere that enhances the willingness of students, as has been demonstrated in numerous works."

At the heart of the design are two translucent glass buildings, one angular and one oval that provide the central teaching space for adults and a children's playroom respectively.

1004arquitectos specified very different types of building to define their different purposes. The school building has two main modules that responded to the size of the classrooms that were required by the Caligrama School for Adult Learning.

The height of the main building was the maximum permitted by the planners in the town to maximize the impact and the attempt to create an iconic structure. The box shape is based on a 25 square metre module that can be used to create classrooms, offices, workshops or a library.

The five-metre by five-metre modules were specified by

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'In total, 1,700 square metres of glazing was used to meet the specifications'

1004arquitectos specifically to form a "glass box". The top two floors of the building contain the 13 classrooms clustered together to form a central core and are separated from the surrounding circulation by glass partitions.

The studio's spokesperson adds: "The circulation spaces and the relationship areas form a ring that surrounds the compact core, simplifying the transit inside the school and improving accessibility and use. This way the building enhances its inclusiveness potential allowing the centre's activity to be manifested outside and improving the necessary interaction between the school and the city."

On the ground floor the building features administrative buildings plus laboratories and workshop spaces that are partly embedded in the side of the sloping plot.

The design includes a section removed from one side of the first floor to indicate the position of the main entrance. Glazing is again a central part of the design solution as the main entrance is flanked by clear glass walls on either side that allow for a view into the offices.

"The abstract appearance is broken at the main entrance where the outer skin has a spacious cut and therefore offers a direct view of the office areas through a fully transparent glass façade," adds the company spokesperson.

"To improve the thermal conditions the south and east sides have frameless projecting openings. The children's playground building features the same translucent glass facades but its shape is softer to reflect its function as a leisure space, and to help integrate it into the gently landscaped park."

The outer surfaces of the double-glazed facade panels are a silk-screened pattern of vertical lines. This produces a

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'The outer surfaces of the double-glazed facade panels are a silk-screened pattern of vertical lines'

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translucent effect and also, crucially, prevents direct sunlight from overheating the interior.

The children's playground building had fewer educational and planning constraints but also features the same translucent glass facades.

Here, the shape is softer. The architects produced this design to reflect the building's role as a leisure space. 1004arquitectos also wanted the children's playground building to be smaller and to blend into the proposed new park.

"Versus the geometric rationality of the school, the playground building integrates in the park as a curved shape that refers to its leisure function," added the 1004arquitectos spokesperson.

Glass and glazing are also vital to the internal design with glazing allowing for a view into the teaching spaces.

After nearly four years in the design, planning and development pipeline, work started on site in October 2013. Antonio J García then took over as site architect for 1004arquitectos.

UTE Vías-Codelse was appointed as main contractor to build out the designs proposed by 1004arquitectos. On site, Jefe de Obra took charge of the project for the contractor along with site manager, Rafael Ariño.

A6ingeniería were also recruited as the main engineers on the project with Elías Martínez working on the structural elements and Juan Carlos Fernández on installations.

In total, 1,700 square metres of glazing was used to meet the specifications of 1004arquitectos. This was the first occasion that the studio had used this particular glazing system. Instead of looking overseas for materials, all the glazing was sourced in

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'Glass and glazing are also vital to the internal design with glazing allowing for a view into the teaching spaces.'

Spain from Cortizo, which has offices in Cantabria and also across Europe.

The structural glazing facade is a high performance curtain wall with a visible grid of flat cover cap and a double-glazing solution. The external is a silk-screened extra-clear glass and the internal is low emissivity coated.

Both are made of tempered glasses to prevent breakages associated with thermal stress. The aluminium structure is made of regular cut mullions, placed following an alternate rhythm of 80 and 160 cm, and transoms separated by the whole storey height to avoid the appearance of a glass partition facing each floor slab.

The 1004arquitectos spokesperson explains: "The building envelope can be understood as a double skin facade with a distance between both layers big enough to contain the common spaces and the circulation areas, the inner layer encloses the teaching programme. The external layer consists of a double-glazed curtain wall facade with a strong vertical rhythmical modulation and the inner one is formed by a laminated glass with a special acoustic treatment.

"The outer surfaces of the double-glazed facade panels feature a white pattern of vertical lines that produces a translucent effect and prevents direct sunlight from overheating the interior.

"At the same time, the pattern turns the facade into a white-silk skin that gives the building an abstract shape and offers a frosted and light appearance. In the daylight, the motif of the print provides a filtered view from inside to outside, and allows a vaguely transparent view when looking from the

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outside in. At night the effect is reversed and the building turns into a lantern that reveals the inside."

Miravalles Park will be created in the future but the design of the project also includes landscaped grounds that will blend into this parkland.

This landscaping emulates the existing sloping topography and also features a pathway from the street at the front to Miravalles Park in readiness for completion of this scheme.

UTE Vías-Codelse successfully finished on site in May 2015 and the project was handed over to Torrelavega Council. For 1004arquitectos, the project has been an unprecedented success for a practice in its own early period of development.

"The building responds to the social demand of the city of Torrelavega," said a spokesperson for 1004arquitectos.

"At its urban planning level, the project is understood as an access to the future Miravalles Park. This premise defines the building location and ground occupation, in an attempt to release most of the plot as a public space for the city."

For 1004arquitectos, the Caligrama School for Adult Learning headquarters is quite literally a window into a new future both for mature students in Torrelavega but also the practice itself.

Project details

Project: Caligrama School for Adult Learning headquarters (Centro de educación de Personas adultas y ludoteca en Torrelavega)

Location: Torrelavega, Cantabria, northern Spain

Client: Torrelavega Council

Architect: 1004arquitectos

Structural engineer: A6ingeniería

Contractor: UTE Vías-Codelse

Glazing: Cortizo


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Arachnitecture

A reinforced ETFE dome, inspired by the bubble-shaped nest of the water spider, demonstrates the feasibility of virtually formwork-free carbon fibre construction. Stephen Cousins reports

Carbon fibre–reinforced polymers are an extremely strong, rigid and light form of reinforced plastic, commonly used for high-performance engineering applications in the aerospace, automotive and civil engineering sectors.

Their unique properties offer many benefits for architectural design, but applications in the construction sector have so far been limited by the cost of manufacture, using moulds to form repeat elements.

But what if a carbon-fibre building could be created without the need for moulds, using the external structure itself as formwork? If that were possible it could open up entirely new and exciting possibilities for architecture and construction.

That was the question posed by a multidisciplinary research team from the University of Stuttgart's Institute for Computational Design (ICD) and Institute of Building Structures and Structural Design (ITKE), when designing the University's innovative 2014-2015 Research Pavilion.

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The prototype structure, a semi-transparent ETFE dome criss-crossed with lines of carbon fibre reinforcement, is the result of a one-and-a-half year development project by the team of researchers and students in architecture, engineering and natural sciences. The 7.5m-wide, 4.1m-high dome covers an area of about 40m^2 and is one of several prototype structures that have been developed by ICD/ITKE to explore the application of novel computational design, simulation and fabrication processes in architecture.

The design for the Pavilion has its roots in the natural world, where many robust and material-efficient construction processes for fibre-reinforced structures have been observed.

Marshall Prado, research associate at the ICD explains: “Our team of Masters students was exploring biological role models that utilise natural fibrous materials and the web building process of the diving bell water spider (Agyroneda Aquatica) emerged as particularly interesting. We wanted to integrate an enclosure layer as formwork for the structure and the spider’s unique behaviour showed how it could be done.”

Bubble building

The water spider is found in freshwater ponds and streams in northern and central Europe and northern Asia and spends most of its life under water, for which it constructs a

reinforced air bubble to survive. The creature extrudes a horizontal sheet web, under which the air bubble is placed, then it sequentially reinforces the bubble by laying a hierarchical arrangement of fibres from within. The result is a stable construction able to withstand mechanical stresses, such as changing water currents, providing a safe and stable habitat for the spider.

The ICD/ITKE team analysed web construction processes and underlying behavioral patterns of different water spiders to form a set of design rules, which were then abstracted and transferred into a human-scale technological fabrication process.

The spider took the form of a KUKA six-axis industrial robot, fitted with a custom end effector (a custom-designed robot "wrist" designed to interact with the environment) designed to lay the carbon fibre material and perform various other functions. The robot was placed within an inflated membrane envelope, made of ETFE. The soft ETFE was initially only supported by air pressure, but by robotically reinforcing the interior surface with strips of carbon fibre, it was gradually stiffened to form a self-supporting monocoque structure.

Thus, the ETFE acts simultaneously as pneumatic formwork for construction and becomes part of the building

Continued overleaf...

skin, resulting in a highly resource efficient construction process requiring no moulds or temporary support during fabrication.

Creepy behaviour

Devising the fabrication method was extremely complex, involving advanced computer-aided design and sensor data gathering.

A computational agent-based design method was developed to determine and adjust the specific layouts and orientations of carbon fibre bundles needed to structurally reinforce the shell. The digital agent's behaviour was programmed to mirror the movements of a real spider, navigating the surface shell geometry to generate a proposed robot path for carbon fibre placement.

"There were several constraints on how the fibres could be laid; structural analysis of the form revealed how it would perform under a compression load and the related structural requirements, such as the density of fibres needed in different areas," said Prado. "In addition, buckling analysis helped

determine the directions the fibres should be aligned."

The pneumatic ETFE formwork was inherently flexible and deformations during fibre placement posed a particular challenge to controlling the robot. To help it adapt to surface movements during production, a sensor system embedded into the end of the robot's effector, and integrated into the robot control system, recorded its current position and contact force in real time.

This adaptive "cyber-physical" system enabled constant feedback between the actual production conditions and the digital generation of robot control codes.

Prado comments: "The sensor measured the force of the robot against the membrane, which allowed the computer to control the level of force it applied by feeding that information back to the robot control system (if it was pushing too hard, the robot could back off a little, if it was not pushing hard enough, the robot could move forward). By slowly tweaking the system along the way it could autonomously adapt its movements."

Working out how to stick the carbon fibre bundles to the

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ETFE posed another challenge. The robot's extrusion system was fitted with a motor to sync extrusion precisely to the speed of the robot's movement. However, the surface of the membrane was so delicate that any additional tension on the system, caused by using too strong adhesive, would have pulled the fibre off. In addition, ETFE is commonly used in roofing or cladding applications and as such has self cleaning properties, making it harder to stick to.

"We explored different glue products and activation techniques that would allow the fibres to stick without causing too much tension or interfere with the fibre matrix, eventually settling on a composite spray adhesive," says Prado. "The robot's end effector incorporates a spray gun that sprayed the adhesive in sync with the speed of the robot's movement."

Testing different types of glue, the amount of time they took to become tacky, and calibrating the robot's path and movement, took several months of trial and error.

Spinning the 'web'

When the project went into production nine carbon fibre rovings (a long and narrow bundle of fibre) were placed by the robot in parallel. As successive fibres were set in place, the dome became gradually stiffer until the team was satisfied that the structure could support itself. A total 45km of roving was laid to complete the structure at an average speed of 0.6 metres per minute.

"We ended up with a very strong, light and weatherproof structure," said Prado. "It is the most structurally efficient fibre structure among the three pavilions the University has completed so far. It is also the largest and lightest, weighing just 260kg, or 6.5kg / m^2, light enough for the students to carry by hand from the fabrication facility to the site."

According to ICD/ITKE, the high degree of functional integration achieved by using ETFE film as both pneumatic formwork and building envelope, helped reduce materials consumption, compared to conventional formwork techniques, and eliminated the need for an additional facade installation.

It also showed how additive construction can be used to create efficient fibre-reinforced structures, simultaneously minimising construction waste compared to subtractive construction. And by mimicking a natural production process, the Pavilion exhibits several unique architectural qualities.

But the innovations don't stop there, Prado says the project resulted in an unexpected application when the structure was later adapted to function as a giant speaker cone: "The ETFE membrane is tightly stretched and held in tension. One of our partner institutes had the idea of attaching magnetic resonators to the surface to transform the entire structure into a speaker. They demonstrated how to turn a building into a speaker, sound fills the whole space, making it impossible to tell where a sound is coming from because the venue IS the sound." It's another feat of engineering inspired by the humble water spider and its spherical sub-aquatic home.

Throwing open the Temple: Remodelling the Whitworth Gallery

What does it take to get 38 per cent of a BBC vote seeking the nation's favourite 2015 Sterling Prize nominee? Michael Willoughby travelled to Manchester to look around the Whitworth Gallery, which received thousands of votes

In the Victorian and Edwardian eras, civic museums were conceived as temples of art. The idea was that, starved of improving culture, visitors would flock to see the collections of the benevolent entrepreneurs. The historical construction of galleries expressed this idea, with collections housed in neoclassical brick, stone and terracotta castles.

Today things are different. These same museums are facing an unprecedented fight for public funding, and need to make sure that they can maintain or increase visitor numbers or otherwise they risk losing out on a slice of the shrinking Arts Council pie. In the case of the Whitworth Gallery, part of the University of Manchester, the limitations of the existing structure were obvious. The sole access to the site was the elaborate, symmetrical Edwardian frontage facing the busy Oxford Road, which declared: in here is culture.

And while the museum, built in 1889 and extended in 1908 for "people of all social classes" to "counteract the malaises of inner city life" was created in a park, the structure failed to show its welcoming side to the gardened area (bounded to the west by the large and infamous housing estate, Moss Side) Instead, the Whitworth proffered a lack of proper landscaping. A fence met would-be visitors. The gallery needed a rethink.

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Reconnections

The idea, says head of collections care and access, Nicola Walker, was to reconnect the gallery with the parkland, both in practice, by adding pathways, sculptures and entrances into the rear of the gallery, and visually by creating a glazed promenade gallery with exhibition space and cafe overlooking the park.

A further aim was to double the exhibition space to around 4,300 square feet. The so-called "V&A of the North" contains 60,000 artworks, mostly on paper, as well as flat textiles and wallpapers, but also a small collection of oil paintings and sculpture. The Whitworth continues to collect and has recently benefitted from a large gift from the local Karpidas Foundation.

"The programmes were getting more and more ambitious," says Walker; "It just wasn't big enough anymore." There were already two big galleries and the idea was to make three by bringing back into use a space that had been turned into a lecture theatre in the 1960s. The lecture theatre and event space was moved into the hammer-beamed Grand Hall, which had hitherto been used for storage. A brand-new Study Centre and Clore Learning Studio have been built opening onto the art garden.

The main galleries were improved by stripping out the 1960s-era suspended ceilings to take them back to the original Edwardian substructure. The three galleries were also refurbished with no services on display, leaving pure clean walls.

However, not all of the interiors were stripped out. John Bickerdike's Loliondo floors and Norwegian stone are added to by materials including oak panelling on the walls and Purbeck stone floors. The idea – and the impact – is that it should be difficult to tell when one is moving from one of the old to the new area.

The retooled interior space is accessed by a brand-new grand staircase with carved stone handles and a wonderful shadow-casting sculpture, Plato's Disco by David Batchelor, hanging above.

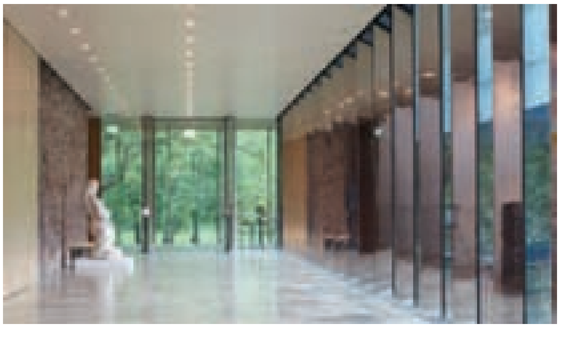
Wrap around

Work on the gallery involved far more than a usual extension. Instead, the new work, designed by architecture firm, MUMA, and carried out by ISG, involved construction of a two-storey extension to the rear which wrapped around the side-elevations of the building. In fact, the expansion is much like the 1908 efforts, which grew around and encased the original Grove House, trapping a cobbled street within the development as it did so.

By far the most impressive aspect of the new Whitworth is the cafe, which one floor up, extends into the canopy of trees. The ultra-modernist space makes a great contrast with the brick facade and its angled stainless steel mullions which have the effect of reflecting the light away on all sides.

"Every seat is a window seat," says Walker, "but the leaves of the trees protect you from the sun."

'By far the most impressive aspect of the new Whitworth is the cafe, which one floor up extends into the canopy of trees'



Just in case some sun peeps through, however, the glazing is protected with UV filtration, laminated for strength and shatter-proofing and fritted at the top for extra exclusion. The Glass is either created by German glass maker, MBM or local Sheffield manufacture, Arkoni.

Glass also makes an impressive appearance in the Promenade Gallery which faces out into the park where it is protected by a huge brise soleil that shields both people and artworks from the sun.

On the north side, MUMA created a facade from solid red brick using up to 14 different styles of brickwork as homage to the 1908 structure.

The Whitworth Mix

The architects were keen to find a colour that matched the weathering on the original and so worked with Northcot Brick to create a new purplish colour, called the Whitworth Blend.

The intricate brickwork pattern drew inspiration from the

Continued overleaf...

Whitworth's extensive textile collection. The "level of finesse in the brick detailing, coursing, jointing and patterning demonstrating a resurgent craft approach to building" together with "extraordinary architectural quality" won the redevelopment the 2015 Brick Development Association's Supreme Award.

The Study Centre, meanwhile, benefits from a visual connection to the park, with new ribbon windows looking out onto the orchard garden, featuring cobbles and York stone reclaimed from the original site in a design by Sarah Price. The other side looks into the park.

It was previously housed in a very large area to the back of house, accessed by a keypad with no lift access. Visitors had to make an appointment to study. The visibility of the centre offers an invitation to gallery-goers to engage with the staff.

The Collections Centre was designed as a "halfway house" between the public galleries and the Study Centre, with a series of exhibitions mounted in collaboration with the public to get people used to the idea of interacting with researchers and curators. So, for example, the first exhibition was organised by online voting through Facebook and Twitter. 250 items were chosen from the Museum's collection and the public whittled it down to 40. The current show was chosen by toddlers, who stuck yellow stickers by the images they liked.

"It's a through space to invite people into the Study Centre," says Walker.

For example, they might see a particular artist they like and decide to pursue it further. Access to the collection on computers is also available. The idea is to constantly turn towards the visitor.

The final part of the jigsaw was improving the green credentials of the building. The museum previously had a green roof. The next phase of the development called for an energy-efficient 'passive first' mechanical and electrical services installation, including closed-loop ground-source heat pump with energy-efficient boilers and earth tubes providing ventilation to the lower ground floor.

The natural lighting system in the galleries is complemented by LEDs throughout and louvres at the windows.

'While the aim was for 240,000 visitors in the first year, the results are more than double. In actual fact the Whitworth will have hit 440,000 by Feb 14 2016, a year since it reopened'

All in all, the strategy allowed the team to get rid of air-conditioning and chillers and opt for a much more passive approach whereby the new building wraps around the old creating rooms within rooms. The museum is aiming for BREEAM "Excellent" rating.

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A Spot of Luck

Funding for the project was £3 million from the University of Manchester, which owns the gallery. £1.5 million came from Arts Council England. A further £8 million came from the Heritage Lottery Fund – in fact additional funds were forthcoming because other projects did not stack up that year.

The extra money made sure that the forecourt of the Whitworth was properly landscaped in preparation for the closure of the Oxford Road to private traffic. This will create another area for events.

While the aim was for 240,000 visitors in the first year, the results are more than double.

In actual fact the Whitworth will have hit 440,000 by Feb 14 2016, a year since it reopened.

"I can't tell you much about where the audience is coming from," says Walker, "but from personal observation, we are getting more diverse including international visitors, young people, school children, families... we're getting all these and more."

With visitor growth like that, other arts institutions should surely follow the Whitworth's lead.

Aesthetics and functionality in glazing for historical buildings

Preservation efforts are primarily orientated towards maintaining historical structures and, if possible, cautious restoration. However, when material loss or irreparable damage threatens to halt the effort, alternative options need to be considered explains Ulrich Huber, sales manager EMEA, SCHOTT AG

The same is true when the preservation of an entire building, which – from an economic point of view – can only be achieved by converting it for a use other than its original purpose. In this process, driven primarily by economic considerations, building owners and occupants formulate the general requirements for construction components, as is the case with glazing: winter and summer heat protection, safety aspects, and photometric parameters, to name just a few. When taking historic preservation aspects into consideration, not only are the new material's optical appearance and similar characteristics to the original material important, but also the use of an authentic production process, which, at any rate, must be based on historic technologies.

Historical Context of Glass Making

It was not until the early 20th Century, with the rolling table process, that the manufacturing of flat glass could be accomplished in a continuing process. In 1902, Belgian Emile Fourcault (1862–1919) patented a process for manufacturing flat glass utilising drawing nozzles and a vertical drawing shaft. By 1904, he had achieved technical implementation of the process. The first industrial plants were launched in spring 1914 when eight casting machines were commissioned in Dampremy, Belgium. In the 1920s the Fourcault process became the first fully mechanised process for the continual manufacture of sheet glass and was gradually implemented globally. In Germany, due to provisions in the Treaty of Versailles, the Fourcault process could not be implemented for manufacturing until 1925. The first German plant locations were in Witten (North Rhine – Westphalia) and Torgau (Saxony) where production began in 1925 and continued until 1990. Thus, machine-drawn glass was the prevailing material for window panes and facade glazing for the construction era of 1920 to 1960 and to some extent beyond that. The use of the Fourcault process heavily declined in the 1960s with the implementation of the float process.

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1. Looking through machine-drawn glass

2. Looking through float glass

Characteristics of machine-drawn glass

Drawing the molten glass through the Fourcault nozzle produces more or less pronounced draw marks in the final product. Thickness variations within the defined tolerance are what give machine-drawn glass its distinctive characteristic. Thus, the manufacturing process can result in certain warping. In contrast to float glass, machine-drawn glass possesses a higher plies difference. Features stemming from the smelting phase, including blisters, knots or tiny pebbles, are acceptable as long as their size and frequency do not exceed the specifications within the predetermined values. All of these characteristics give machine-drawn glass its distinctive appearance and make for an authentic production process. In its top view (reflection) uneven surfaces can be seen in machine-drawn glass.

When looking through the glass (transmission), straight lines often appear wavy (Image 1). In contrast, float glass, due to its plano-parallel surfaces, gives optically undistorted impressions in its reflection as well as its transmission (Image 2).The features of machine-drawn glass can be influenced by specific product technologies. Thus, for structures of different design eras, several types of restoration glass are available to match the original glass used on historic buildings.

These include, for example, 4.5 mm thick, sturdy, colourless glass with irregular surfaces full of character, which is also suitable for use as outdoor glazing and restoration glass and that resembles window panes manufactured at the turn of the 20th century. A minimal thickness of 2.75 mm ensures that it can be easily installed in historic window frames and window profiles. Or for a more lightly structured surface version glass, resembling hand-blown glass, or in contrast, a glass with a more dominant structure, are also available. Whereas for Bauhaus style buildings, a 4-mm thick restoration glass with a slightly irregular surface to form harmony with buildings of Classical Modernism is ideal.

Depending on the glass static necessities of the project, such as solar protection coatings, this glass can be produced with a 6 mm thickness and up to 3,000 mm in length.

Machine-drawn glass is generally low iron glass. Thus, as monolithic glass, it has a colour rendition index of 100 and it is ideal for glazing in museums, which present increased lighting technology challenges.

Additional process possibilities

In May 2012 the Deutsche Institut für Bautechnik (DIBt) – or the German Institute for Civil Engineering – issued the European Technical Approval, ETA-12/0159, for glass made using the Fourcault process. This means that these glass types are considered authorised construction products which can be used within the scope of an approved construction project.

In general, all restoration glass can be processed as insulation glass. When it comes to thermal restorations in historical buildings, insulation glass with a low overall thickness is often requested so that it can be integrated into frames worth preserving provided that they have the required load capacity and appropriate seam width. Restoration glass with a thickness of at least 2.75 mm makes it possible to have an insulated glass structure with an overall thickness of approximately 10 mm. The weight of units with a second pane made of 3 mm float glass is roughly 15 kg/m^2. When krypton is used as a gas filling for the space between the panes and a heat protective coating at Level 3 is applied, a glazing U-value of 1.9 W/m^{2}K can be achieved. A selection of restoration glass types can be used if a solar protection coating at Level 2 is mandated in a refurbishing project. This is especially true when it comes to providing protection from the summer heat in buildings with large-area glazing from the Bauhaus era as well as for modern ones.

The processing of laminated glass using PVB films allows for a glazed/glass structure in accordance with a resistance class per EN 356. When it comes to user-specific lighting technology requirements, transmission values of specific spectrums for solar radiation can be adjusted. Thus, it is possible to reduce the transmission of light in the UV range of 280nm to 420nm from normally 57 per cent to 8 per cent – an important aspect to prevent the damage of assorted materials caused by solar radiation. Thermal tempering with the appropriate machine-drawn glass increases their mechanical and thermal capacities and produces fracture patterns similar to tempered safety glass.

When scale, safety & style collide

For large scale, modern constructions, virtually anything is achievable in glass. Andrew Lake, Vetrotech UK general manager explains why selecting the right fire-rated glass system is therefore critical to the specifying process

From the dizzying heights of the Burj Khalifa to the architectural feat of the Louvre Pyramid, architects and specifiers have consistently pushed the boundaries when it comes to delivering projects that are both visually stunning and defy the laws of what would have historically been deemed architecturally possible.

Where historic buildings such as the Ancient Egyptian pyramids would have taken 100,000 men to build over the course of 20 years, modern day architects are faced with a very different set of challenges in the form of building regulations and health and safety restrictions.

Though glassmaking reputedly dates back to 4000BC, the unique properties of glass were only first explored in the 1930s, and it was not until the 1960s that glass started to be used as a structural material. Today, architects are constantly challenging engineers to produce glass that is on a larger scale and that covers more complicated and diverse settings than ever before.

The number of building surfaces that are now covered with glass is rapidly evolving, with glass selection a critical stage of the specifying process. Glass characteristics and properties have to be evaluated, as well as structural and architectural capabilities. The Key Properties are:

- Strength
- Fire resistance
- Solar performance
- Acoustic insulation
- Thermal control
- Aesthetics

While sustainability is high on the agenda of both domestic and commercial developments, it is fire resistance that is becoming more widely specified in the commercial arena, and fire-rated glass plays a vital role.

From an aesthetics point of view, fire-rated glass may on the face of it look like many forms of non-rated glass; however most types of non-rated glass offer very little or no fire protection whatsoever. When subjected to fire, standard glazing is liable to shatter within seconds.

Fire-rated glass, which is rated based on a range of standard test times (minutes) of 15, 30, 60, 90, 120 and 180, is put through rigorous testing before being launched to market and can survive even in extreme temperatures. The higher the rating, the longer it will provide sustained resilience. It is designed to help prevent fire spreading from room to room, or to use the official term, limits fire damage via compartmentation to sustain the integrity of a building.

Due to technological advances in glass manufacturing it is also important to note that fire-rated glass comes in multiple forms, with each fire-resistant product offering differing characteristics and contrasting levels of fire protection. To ensure that the right fire-rated system is specified for the respective location it is imperative that you familiarise yourself with each available option and have evidence that any performance based testing that has been conducted demonstrates its compatibility for the chosen application.

The transparency of fire-rated glass also means that any smoke or flames can be quickly identified if fire breaks out and a suitable and safe evacuation of occupants within the building can be plotted out.

'For large scale, modern constructions, virtually anything is achievable when specifying the glass'

With the ravages of fire potentially endangering life and property, it is essential that each element of fire-rated glass is specified, selected and installed correctly to ensure that it does the job that it is intended to. Failure to do so can have severe repercussions due to inadequate product performance.

Wherever glass is specified within a commercial development, it must be used as part of a fire resistant glazed system including the glass, beading, fixings, seal and frame. Each of these products must have been fire tested and approved as compatible for use with each component within the system.

For large scale, modern constructions, virtually anything is achievable when specifying the glass. Where bespoke glass pane sizes are specified, manufacturers and suppliers are the first port of call to either confirm they have the appropriate test evidence to support the size and system specified, or to run the tests on the new size requested. Architects now have more freedom and flexibility than ever before when integrating large-scale glass within projects.

Recent landmark glazing installations, such as Forbury Place in Reading, have seen steel fabricators and glass manufacturers work together to develop systems that allow projects to cover more sides and storeys than ever before.

Fire-resistant glass panes on these new scales can also be butt jointed and concealed for the ultimate clean and crisp aesthetic finish. Structural support steelwork is often hidden beneath bespoke facades to complete the look and the introduction of robotic glass lifting machines allows further flexibility for glass of scale (size and tonnage) to be used within these modern buildings.

The sky really is the limit for today's architects, with scale, style and safety all working together to deliver architecturally stunning and structurally sound buildings that, like the Ancient Pyramids, will be enjoyed for years to come.

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Smarter glass

Russell Shipton, marketing manager, ESG, explains why smart glass has come of age and why it has clearly got a bright future

'With advances in technology over the same period, it was only a matter of time before a more technical solution was to be found in products that could be adhered to the glass'

The past 20 years has seen a dramatic increase in the use of glass as both an external and internal building material. It's a wonderful material that gives a building exterior a modern and sleek look, while allowing the interior to be a light and airy environment, far removed from the dark and enclosed spaces of the 70s and 80s. That said, its most positive characteristic can also be a major disadvantage – it is transparent and at times lets in unwanted bright light and heat. The installation of blinds and curtains to block light are traditional solutions but comparatively old fashioned in today's technology-lead world. While using power-hungry air conditioning to combat solar heat is costly and has an environmental impact.

With advances in technology over the same period, it was only a matter of time before a more technical solution was to be found in products that could be adhered to the glass. These products were known by the term 'smart glass'. However smart glass has now come of age as advances in glass lamination (the bonding together of two or more pieces of glass using an adhesive interlayer) has allowed the inclusion of other products into the construction of the glass to solve the problems associated with excess heat and light.

There are three main types of smart glass: SPD (Suspended Particle Device), Electrochromic and PDLC (Polymer Dispersed Liquid Crystal). The first two are primarily used as climate and light controls, whilst the unique properties of PDLC allow it to also be used as a privacy glass. SPD is a thin film laminate that contains rod shaped nanoparticles, which, when there is no electrical current applied, are randomly aligned throughout the film preventing the infiltration of light and heat. With current applied, the nanoparticles align and both light and heat can pass through. The user can tune the tint levels to the required level by varying the voltage applied, the lower the voltage the less the particles are aligned. The tint colour is typically clear to dark blue, however the glass is never totally opaque and can therefore never be used as a privacy glass option.

Electrochromic glass is the only one of the three types that does not need a continual current to maintain its 'switched' state. The interlayer is made up of two electrodes, with a separator in between. Lithium ions migrate between the two electrodes – moving to the other when a voltage is applied to it. As it is a gradual migration the switching can take up to 15 minutes, while tint levels can be selected by turning off the current and halting the ion migration. The glass is returned to clear by applying the current to the opposite electrode. Again, electrochromic glass never turns totally opaque, going from clear, with a very subtle light blue, to a deep blue colour.

PDLC works in much the same way as SPD, except using liquid crystals. Without voltage the crystals are dispersed and light cannot pass through, with voltage they align allowing the light through the film and glass. The big difference with PDLC is that when the crystals are dispersed they turn the glass

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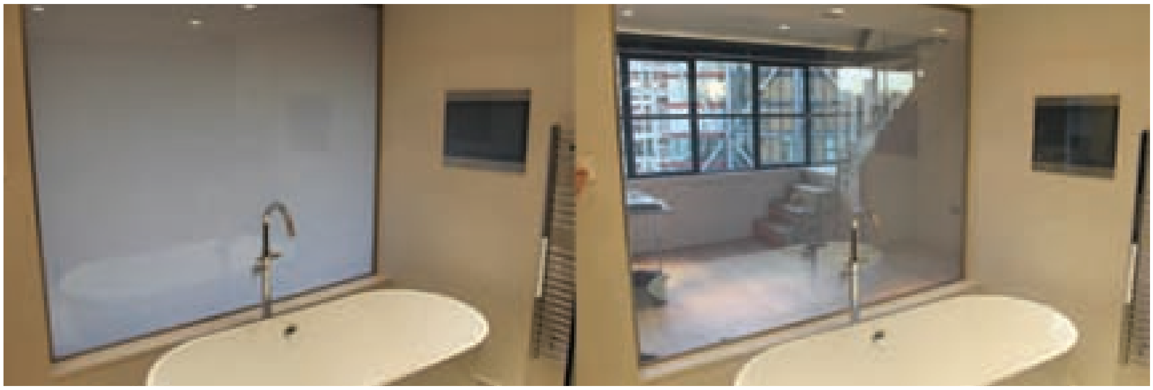

opaque. Although they don't give total blackout by blocking all of the light transmission, they cannot be seen through, meaning that PDLC can be used as a privacy glass option. Switchable LCD privacy glass is a PDLC based product.

Both SPD and electrochromic products can block up to 99 per cent of the sun's UV light and claim to be able to save the user up to 40 per cent on their energy bills by reducing the need for climate control within buildings. However, it has been suggested that of the two, it is the electrochromic that has the greener credentials as it does not require a constant electrical current to stay in its 'switched' state.

Despite market forecasts that predict the use of smart glass products will increase massively by 2017, their market penetration has so far been limited. It has been widely suggested that this has been due to poor market awareness and high costs. Like any new technology, the fall in price comes through volume sales and at present the adoption of these products into the building industry has been slow. However, the future of this market looks very bright. Year-on-year sales of switchable LCD privacy glass has been on the increase, while the price has been steadily dropping. With sales of climate control glass around the world on the increase, the traditional UK weather may have led people to question the need for it here in Britain, but as our average yearly temperature increases, so have the amount of enquiries made to manufacturers. Like other smart products, TV's for example, it's a question of how long before they are seen as a main stream everyday item, rather than one that is something out of a James Bond film.

Translucent polycarbonate rains on other cladding systems' parades

Paul Jackson, technical director at Rodeca, explains why translucent polycarbonate panels are now being specified as rainscreen systems

A completed image of the AMRC at Sheffield

It is a popular misconception that rainscreen cladding systems are something of a modern-day wonder product but they actually date back hundreds of years. Their design principles can be found in the timber weather boarded houses of Essex and clay tile or wooden-shingle cladded properties of Kent and Sussex, to name just a couple.

A wide range of rainscreen cladding systems is now available in the UK, from aluminium and aluminium composite materials or steel cassettes to fibre cement and glass fibre reinforced polyester composite panels. These are complemented by an equally wide choice of fixing systems, ranging from wood and aluminium to steel stud.

Whatever the cladding or fixing system, the principles of ventilated rainscreen systems are the same, with the cladding fixed back to the main support structure, forming a relatively lightweight, colourful weather-resistant overcoat. The benefit of this system is that any moisture, either ingress or humidity, is ventilated out of the cavity, ensuring the insulation and the inner leaf of the building are not affected by condensation.

Over the decades architectural trends have changed, with traditional brick facades losing out to an ever-growing palette of contemporary rainscreen finishes. And translucent polycarbonate, which has long been specified for its ability to allow natural daylight (up to 66 per cent transmittance) into a building through the walls or roof, is now making its mark in this type of application. So why this evolvement?

Well, translucent buildings naturally look very different by day and by night, particularly with innovative use of back lighting within the rainscreen cavity. They are also available in almost any colour and translucency level, from opal finishes through to colours throughout the panel and different colours in the front or rear of the panel to achieve a 3D-type effect.

In line with the current trend for all things industrial, they can be used to express or conceal the structure, enabling designers to show what is happening behind. In addition, polycarbonate-glazed openings, sitting behind the exterior

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Rainscreen cladding on a new sports and music building at Mandeville School in Aylesbury, Buckinghamshire

double-wall polycarbonate rainscreen, allow designers to introduce daylight into areas without breaks in the external facade. At night this can work in reverse, changing the building's appearance externally from the ambient light within, allowing designers to experiment with coloured panels and/or lighting such as LED.

In addition, unlike traditional rainscreen finishes such as rigid boards or sheet materials which tend to have a black shadow line effect around the panel edges, polycarbonate materials can achieve large seamless facades with just a perimeter frame only. Panels are possible up to 23m in height/length with the only limitation on facade length being the building's expansion joints.

The material's light weight – approx 8kg/m^2 – means the structure can be kept lean and save costs.

Panels can be lifted and installed by hand from access platforms without the aid of cranes or lifting plant and through their tongue and groove system they are quickly secret fixed as standard rather than reliant on complex mechanically-undercut anchors or structurally adhesive systems or trays.

Architects of rainscreen cladding schemes have several considerations at the design stage to ensure the system is optimised.

For example, a refurbishment project may require a fully-adjustable carrier to even out the tolerances of the existing building whereas a new-build project backed onto a lightweight steel framing system or insulated composite panels, may not have the same tolerance issues and simple top-hat arrangements that can be provided at the fastener location.

Panels can be cut on site to accommodate building irregularities and tolerances and window and door penetrations can be flush or recessed as with other rainscreen systems. A wide range of perimeter aluminium sections allows designers to overcome interfacing and building height issues such as vertical/horizontal breaks and compartmentation.

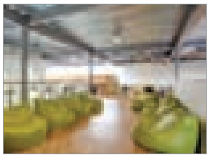
With a lighting strategy, horizontal rails may block light and therefore will need to run vertically projected via isolated top-hat sections or cavity sizes that should be increased to accommodate the lighting. Consideration also needs to be given to accessing the lighting system for maintenance.

The amount and type of insulation also requires careful consideration as its branding will be on display if the panel is fully translucent. Dark membranes and foil-faced insulations should be avoided as they reflect heat onto the rear of the panels.

Sufficient airflow from the base of the cladding out through the head should be considered, along with factored wind loads that the cladding needs to be designed to withstand. This can sometimes be optimised by the use of a thicker panel, although there is a balance to be struck between the savings of a thinner panel and the additional framework, fixings and labour it requires due to much closer fixing centres. This requires value-engineering to get the optimum structural span and costs. For example, a 10m high facade with a windload of 1.0kN/m^2 and a 40mm thick panel would require five intermediate cladding rails, whereas a 50mm panel requires only three.

Through thick and thin, it seems translucent polycarbonate as a rainscreen system is here to stay!

Space with natural lighting and raw materials



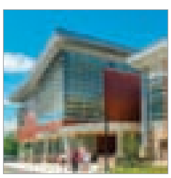
Ashton 6th Form College, in Lancashire, has recently been awarded 'Best Commercial Build' at the Northern Design Awards for the design of their student centre. **Glazing Vision's** modular fixed Flushglaze rooflight system was installed to harness large amounts of natural daylight; this was situated above the stairwell leading to the mezzanine level on the north side of the building. The large glazing product sits within the void, casting daylight into an area that would typically have been shadowed, providing a view of the sky while simultaneously creating an internal flow of space between floor levels. Each individual glazed section is supported structurally by aluminium back to back angles.

01379 658 300 www.glazing-vision.co.uk

Glazing helps Land Rover bar lead the pack

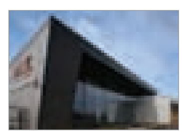
Pilkington United Kingdom Limited has worked with Land Rover BAR to supply the glass for its America's Cup team headquarters. The building incorporates 2,005 sq ft of glazing and has been awarded the BREEAM Excellent standard. To help it achieve this high sustainability standard, Pilkington Suncool™ was used for the areas exposed to direct sunlight and unshaded by the semi-transparent skin that surrounds much of the building. To enhance the building's safety, Pilkington Optilam™ laminated glass was also specified for the inner pane of all units.

Making the grade in the USA



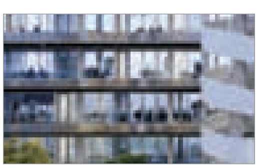
The new Essex Technical High School in Massachusetts, USA harnesses the latest building technology, including a striking external Infiniti Fin solar shading solution from **Levolux**, to deliver a first class environment for students and teachers alike. To create the optimum environment for occupants, balancing light and shade, Levolux was approached to design and supply a custom solar shading solution for the new school. The Infiniti Fin solution comprises horizontal aerofoil-shaped aluminium fins that are secured above and across glazed areas. A 400mm wide Fin has been used on the largest of four school buildings, which incorporates the school's main entrance. The Fins are fixed into a series of vertical stacks comprising up to 9 Fins, set at 600mm centres.

Senior's class act



Senior Architectural Systems has helped deliver a dramatic new design scheme for a new performing arts centre in Newcastle-under-Lyme. The new state of the art centre, which is part of Newcastle-under-Lyme College, features various glazing solutions from Senior that have been installed by Aire Valley Architectural Ltd for main contractor Bardsley Construction. The slim sightlines and aesthetic flexibility of Senior's SMR800 curtain walling made it the ideal choice to create the modern entrance to the building and the system has been used throughout to maximise the flow of natural light into the dance studios and communal areas. The centre's bright and spacious design has been further complemented by Senior's SPW600e windows and the use of Senior's SD automatic doors.

Leading aesthetics & solar control performance



SGG COOL-LITE XTREME 70/33 II is the latest product from **Saint-Gobain Glass** to target the premium commercial market, offering specifiers and glass processing companies a thermally efficient 'to be toughened' option that features high light transmission, a low solar factor and excellent neutrality. SGG COOL-LITE XTREME 70/33 II features a unique market leading performance band by combining a high light transmission of 70 per cent with an extremely low Solar Factor of 0.33. The light transmission ensures a high level of natural light floods any open space and the low solar factor blocks 67 per cent of solar heat gain.

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Architectural glazing from Cambs glass

Cambs Glass is one of the UK's leading specialists in architectural glazing, offering products ranging from bespoke rooflights to large commercial curtain walling projects both for the private and commercial sectors. The company believes it is important to keep up to date with the latest glazing technology and trends within the market. Located in Suffolk within the East of England, Cambs Glass cover the whole of the UK and Channel Islands. It is a company that focuses on customer satisfaction at the forefront. Cambs Glass' sales team are happy to help on info@cambsglass.co.uk with your future glazing requirements.

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