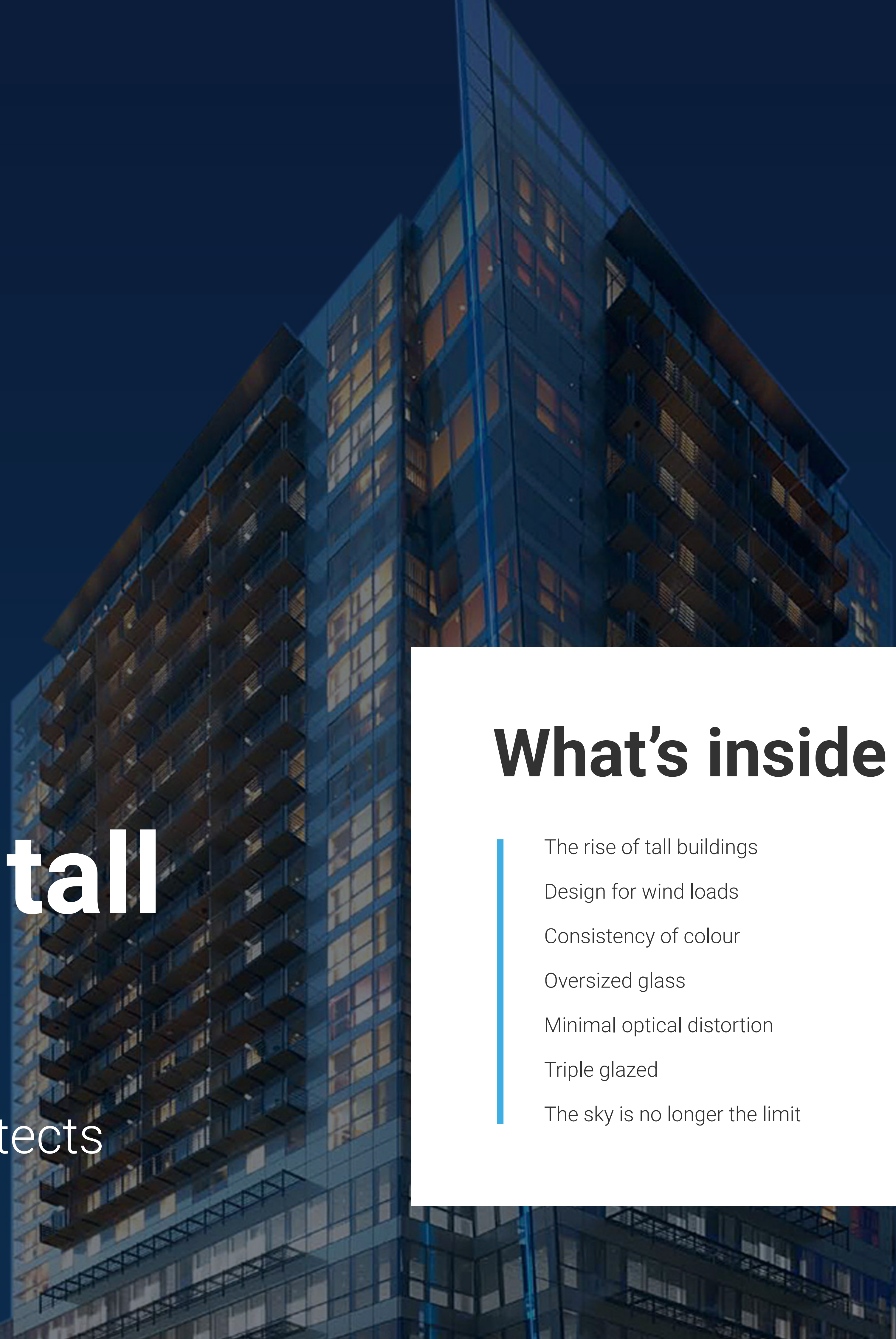
CareyGlass



The rise of tall buildings

A Glazing Guide for Architects

What's inside

The rise of tall buildings

With 70% of the world's population set to live in urban areas by 2050, it's not surprising that supertall buildings are becoming more common in our cities. However, increasing building height isn't the only challenge facing the modern architect. In addition to taller buildings, architects are now required to produce progressively more complicated and multifaceted building designs, compared with the traditional 'glass box' designs of years passed.

The facade of tall buildings presents the most significant risk during construction and typically accounts for the highest proportion of the project costs. Architects face a difficult balancing act, determining the right combination of aesthetics and performance, while creating an economically viable solution that can be safely constructed, and that will qualify for the applicable environmental ratings (LEED or Energy Star rating in the US, BREEAM rating in the UK or Green Star rating in Australia). Added to this is the challenge of convincing clients to try something new and innovative, which may not have already been attempted in their country before.

Fortunately, glass not only offers flexible aesthetic options, it's also a less expensive alternative to steel and masonry. Moreover, glass weighs significantly less than other building materials, while still providing the required strength and protective qualities. This is why high quality glazing is the primary choice for architects looking to produce innovative tall building designs, while limiting risks for the building contractor in terms of cost, time and safety.

In this guide, we outline some of the essential attributes high-rise glass facades should possess, covering wind load, colouring, thermal and solar properties and the size of the glass panels, using innovative projects from around the globe to illustrate the different points.

Image Source: UNStudio Architects

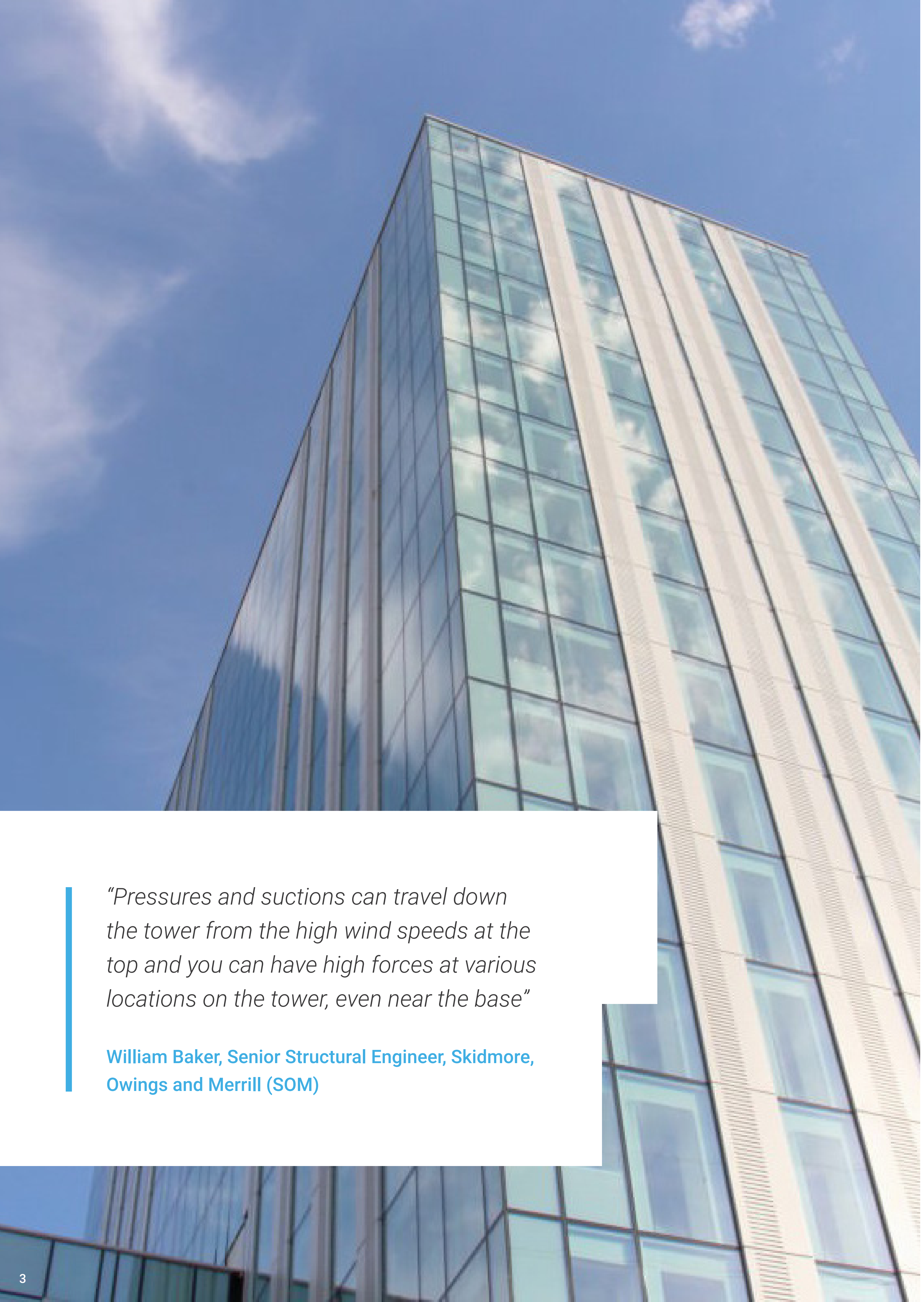
The Canaletto Tower, London, UK

Architect: UNStudio | Contractor: Ardmore Group | Glass Processor: Carey Glass

This 31 storey architectural masterpiece created by internationally-lauded UNStudio does more than propose an eye-catching and contemporary living space both inside and out. The Canaletto Tower succeeds in drawing in and reflecting the best of its environment through innovative design. The apartments have floor-to-ceiling glass for which solar control glass was specified due to its neutral appearance, solar control and thermal insulation properties, as well as its suitability for curved glazing.

INTERNATIONAL PROPERTY AWARDS

THE BEST RESIDENTIAL HIGH RISE ARCHITECTURE, UK, 2016



> *“Pressures and suctions can travel down the tower from the high wind speeds at the top and you can have high forces at various locations on the tower, even near the base”*
>
> **William Baker, Senior Structural Engineer, Skidmore, Owings and Merrill (SOM)**

Design for wind loads

The taller the building, the greater the wind pressure

One of the main concerns for supertall buildings is wind. Closer to the ground, there are trees, hills and other buildings providing shelter. The higher a building goes, the fewer of those obstructions are present, meaning tall buildings take the full force of the wind. Not only that, wind speed, and therefore wind pressure, increases with the height above ground level. The wind loads a building is subjected to will also be affected by the height, shape and orientation of a building.

Head on wind pressure, which pushes the glass in, is only half of the problem. When wind whips around the side of a building, eddies of low pressure are created that can suck the glass out – and these suction forces can be stronger than the head on wind pressure. These wind loads then dictate the span and thickness of glazing that must be used to remain compliant - higher wind loads will generally require shorter spans or thicker glass.

Wind currents are sometimes mapped out using scale models of buildings that are placed into a wind tunnel, while inbuilt pressure sensors record the changes in levels. The levels recorded can then be used to determine the appropriate glass strength and shape to handle and control the wind pressures a building will be subjected to.

Different glazing options offer varying capacities to withstand wind loads; float glass, tempered glass and annealed laminated glass being some of the more popular options. The best way for architects and engineers to ensure they are compliant with wind load requirements, and to achieve optimum results, is to work with a glazing manufacturer or processor directly. They will advise on the most appropriate glazing options for your designs, and ensure your proposed specifications can withstand the relevant wind loads.

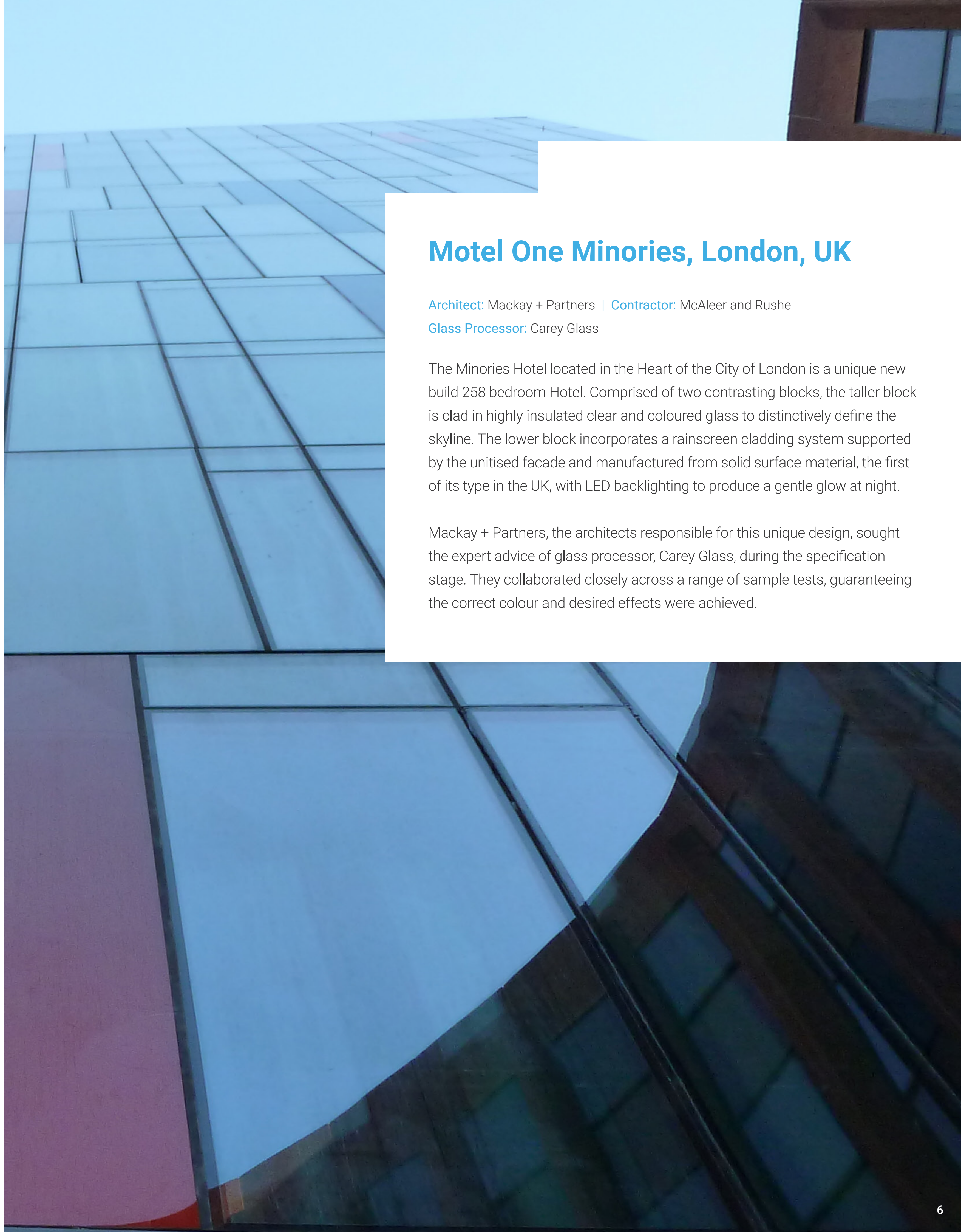
Consistency of colour

Check for colour changes in all conditions

The consistency of colour in glass (or lack of, rather) has plagued architects ever since ancient Rome. It is a problem that persists today in the 21st Century, despite the move from cylinder and spun glass production to modern day float glass. This is because the evolution of glass and the treatments it is subjected to, combined with the increased demands being placed on it once installed, making things more complicated.

A good example of a treatment would be laminated coatings, which are added for sun protection. There is a noticeable colour change when the coating is applied facing the interlayer material. This basically means the colour reflected on the outside will change based on the angle it is being viewed from. The problem being that an architect might not realise this before the building has been completed, if the glass samples weren't viewed under the correct conditions prior to installation.

Due to the increased coating thickness, solar control glasses are more prone to exhibiting variation between batches. Therefore, if the glass is to be used on a single project, it is advised that the glass for that project is produced from a single source.



Motel One Minories, London, UK

Architect: Mackay + Partners | Contractor: McAleer and Rushe
Glass Processor: Carey Glass

The Minories Hotel located in the Heart of the City of London is a unique new build 258 bedroom Hotel. Comprised of two contrasting blocks, the taller block is clad in highly insulated clear and coloured glass to distinctively define the skyline. The lower block incorporates a rainscreen cladding system supported by the unitised facade and manufactured from solid surface material, the first of its type in the UK, with LED backlighting to produce a gentle glow at night.

Mackay + Partners, the architects responsible for this unique design, sought the expert advice of glass processor, Carey Glass, during the specification stage. They collaborated closely across a range of sample tests, guaranteeing the correct colour and desired effects were achieved.

National Arts Centre, Ottawa, Canada

Architect: Diamond Schmitt Architects
Contractor: PCL Constructors Canada Inc.
Glass Processor: Carey Glass

GLASS	
IGU Make Up	17.5mm Laminate (5/16" laminated to (5/16")
10mm (3/8" solar control)	Largest IGU: 8 x 19 feet
12mm (1/2") Air space	Bird friendly frit pattern on surface #3

Oversized glass

Harnessing the benefits of natural light

Current architectural trends are in favour of oversized glass as it increases the transparency of a building and can completely change its look. The problem is that the standard glass sizes produced by most glass manufacturers and processors are maximum of 8 x 12 feet. This means sourcing larger glass panel sizes is difficult for glazing contractors, as most US glass manufacturers and processors don't produce them.

For architects, specifications including IGUs over 12' are often returned with the glass sections broken down into smaller panels, completely changing the aesthetics of the building. This ends up being frustrating for both the architect whose vision cannot be realised, and for the glazing contractor who has to deal with the associated delays to the project.

Using a glazing supplier with proven experience in oversized glass projects makes a huge difference and can really extend the design possibilities for architects. Glass processor, Carey Glass, can supply high performing low-E IGUs, up to 10 x 19 feet, allowing for entire walls to be glazed using a minimal number of panels, to create more open designs.

Through consulting with a glass processor who specialises in big glass, architects can put together a well-thought-out specification, based on readily available materials. The result is best use of glazing to maximise effect and no delays resulting from lack of supply.

> *"In recent years, we've seen a growing number of true landmarks in transparent design. Large glass sheets and new fixing systems are enabling designs with almost full transparency"*
>
> **Jorma Vitkala, Glastory.net**

Minimal optical distortion

Keeping roller wave & edge dip to acceptable levels

The most common optical defect afflicting high-end facades is a condition known as 'roller wave'; an optical distortion, caused by the heating and cooling process when making tempered float and coated glass. During processing, the glass tends to sag very slightly between the carrier rollers that move the glass through the furnace. After heating, the glass then moves through the 'quench', rapidly cooling it down, which freezes the compressive stresses to withhold the tensile stresses. This process is required for classification as heat strengthened or fully tempered glass.

The same process can also cause a phenomenon called anisotropy/iridescence. This anomaly can be seen under low reflective or polarized light. The effect can be reduced with uniformed heating and cooling during the heat treatment phase.

Strictly controlling the temperature at the start of the heating process is an effective method of reducing roller wave. By heating the glass for a longer time period and at a slightly lower temperature, the effects can be reduced significantly. As with unexpected variations in colour already discussed, coatings for heat insulation and sun reflection applied to glazing can also cause roller wave. This is due to the metallic silver oxides used in the coating application, thus meaning the side of glass with the coating reflects the heat of the furnace, whilst the non-coated contact surface absorbs the heat.

Edge dip is another optical distortion that occurs during the glass toughening process. The ends of each piece of glass sag to a greater degree, due to the cantilever effect that's caused by the two ends being unsupported. This distortion can cause both structural and aesthetic problems for architects, though most modern frames can generally accommodate minor levels of edge dip. As with roller wave, edge dip can be reduced by modifying the parameters within the furnace. Acceptable levels of edge dip are around ± 0.006", while roller wave levels should only be ± 0.003".

In the end, it comes down to selecting a glazing supplier who processes glass with the required due care and attention, and who can advise on any potential roller wave or edge dip issues arising from treatments.

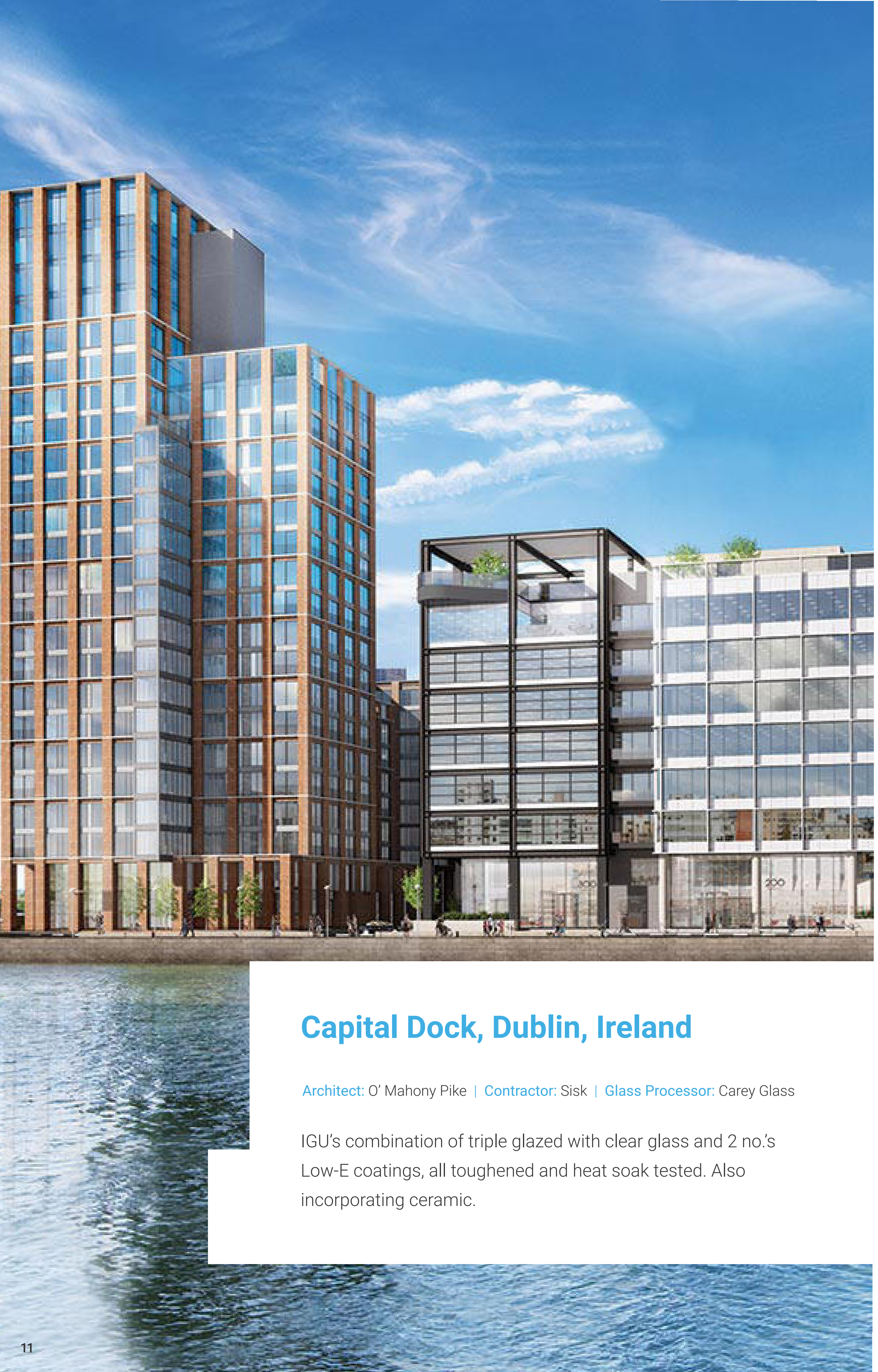
Zurich, North American HQ, Illinois, U.S

Architect: Goettsch Partners | Contractor: Clayco | Glass Processor: Carey Glass

Zurich North America's stunning 783,800-square-foot headquarters in Schaumburg bucks the trend of corporations abandoning suburban campuses for city centers. The curtain wall facade wraps outboard of three super scale trusses that are set 60 feet on center, achieving an 180-foot span over the middle of the campus, and a 30-foot cantilever at the perimeter.

The three primary "bars" stacked and arranged to maximize views of the surrounding landscape and optimize solar orientation. Glass processor Carey Glass achieved an impressive .002" roller wave with an edge dip of .007", crucial to maintaining design integrity.

BUILDING DESIGN +CONSTRUCTION BUILDING DESIGN+ CONSTRUCTION 2017 BUILDING - SILVER AWARD



Capital Dock, Dublin, Ireland

Architect: O' Mahony Pike | Contractor: Sisk | Glass Processor: Carey Glass

IGU's combination of triple glazed with clear glass and 2 no.'s Low-E coatings, all toughened and heat soak tested. Also incorporating ceramic.

Triple glazed

Realising the fifth generation of the high-rise

Looking to the future, it will not be the extravagant heights that will prove the most significant trend for supertall buildings, but rather their energy efficiency. Architects refer to these future skyscrapers as 'fifth generation'; their primary aim is to have an entirely carbon-neutral footprint and this has already been realised in landmark developments such as Melbourne's CH2, 1 Bligh Street, Sydney. This tower includes a variety of eco-friendly innovations, like renewable energy generation, solar shading and double-skin facades with natural ventilation.

Future glass facades will merge sustainable architecture and energy efficiency, while incorporating the slimline look of laminate glass facades. Optimising heat efficiency has traditionally been at odds with design aesthetics, as triple glazed panels were often too large for highly creative usage; but technological advances are making it easier to find equilibrium. There are three critical measures of performance that must be chosen in architects' designs, and specified in the resulting contracts. These are the U-Value (1/R-value), the Solar Heat Gain Coefficient (SHGC) and Visible Transmittance (VT).

A low U-Value is important for both energy savings and comfort in very hot and cold climates. To achieve required U-Values, select a glass processor with expertise in triple glazed units for facade design. Generally, they comprise of an outer pane of 10mm, 12mm, 15mm or 19mm thick glass, two airspace widths of 16mm, and 6mm thick glass for thermal insulation.

The Solar Heat Gain Coefficient (SHGC) is the fraction of solar radiation that passes through the glazing and becomes heat inside the room – the lower the SHGC, the greater its shading ability.
Visible transmittance (VT) details the percentage of visible light that is transmitted through the glazing. Modern spectrally selective (SS) windows offer a high VT with a low SHGC, as well as lower U-values than uncoated glass. SS windows allow significant daylight into buildings without overheating on sunny days, meaning the psychological benefits of natural light can be enjoyed without the associated additional energy usage.

Even with advances in glass performance and capabilities, architects must still find a balance between their desires for thermal comfort and energy efficiency – which are easier to achieve with smaller window areas – and their desires for views, daylight, and connectivity with the outdoors – all of which demand large glass areas. Carefully choosing, and then specifying the overall system U-value, SHGC, and VT with your glazing processor, is the best way to start.

The sky is no longer the limit

While the ongoing spirit of one-upmanship in designing the tallest skyscraper in the world isn't set to end anytime soon, the real future of architectural design is to be found in the more versatile and energy efficient high-rise developments, which will be essential to cope with projected urban population growth and keep cities running.

There is an increasing array of new and innovative glazing possibilities for high-rise facades. The most successful outcomes tend to be achieved by architects who work directly with progressive glazing suppliers during the 'design assist' stage. Innovative glass processors like Carey Glass, are helping architects realise their visions, by helping them understand all of the possibilities and limitations early on in the process. This upfront collaboration leads to more groundbreaking designs that are also safe, economical and constructible from the glazing contractor's perspective, meaning better buildings can be built faster.

CareyGlass

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North America

+1 917 979 6135
northamerica@careyglass.com

United Kingdom

+44 161 848 8090
salesch@careyglass.com

Europe

+353 67 50700
sales@careyglass.com