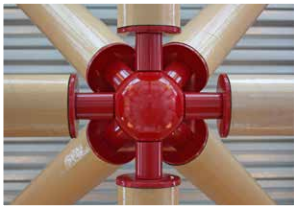
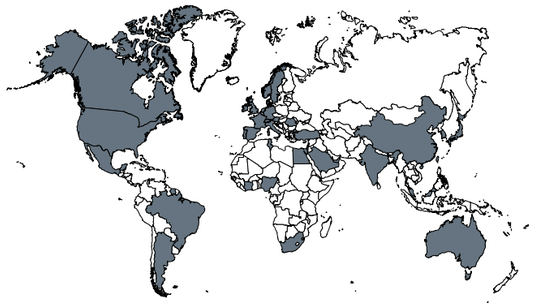


octatube

REALIZING CHALLENGING ARCHITECTURE



octatube

Octatube designs, develops and constructs challenging architectural structures, with an emphasis on advanced applications of glass and steel.

Company

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realizing challenging architecture.

Company

Besides a high-class design, engineering and manufacturing company, we also play a role as a specialised contractor. Octatube is unique in the Netherlands, carrying out projects in-house from design to completion.

Octatube is a family-owned company based in Delft. The founder is Mick Eekhout, who also holds a position as Professor Emeritus at the Delft University of Technology. Mick and his son Nils Eekhout are the two company directors.

Octatube has a workforce of over 80 people, divided over our Design & Engineering, Production, Installation and Project Management departments. All our departments are situated in one building where collaboration is tight. We believe this is essential in our delivery of innovative and dependable results.

Octatube together with Queen Máxima & Mona Keijzer, State Secretary for Economic Affairs and Climate Policy, November 2017, Factory Octatube, Delft

Design & Engineering

Octatube's designers and engineers come from a wide range of backgrounds in structural, civil and mechanical engineering and architectural & industrial design. They are the backbone of the company and our inventiveness, innovation and engineering excellence. The Design & Engineering department has a broad expertise in the design of materials, details, elements and components.

The main activities of the Design & Engineering department are designing, engineering, structural calculations, estimating, shop drawings and work planning.

Octatube is certified in accordance with ISO 9001:2008, the internationally accepted standard for quality management and quality control.

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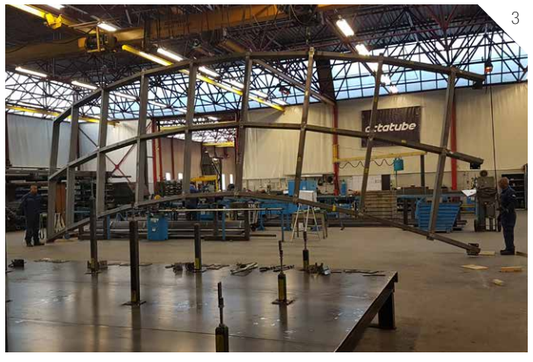
Production

The Production & Installation department manufactures (stainless) steel and aluminium sections and components. Our factory is also ideally equipped for (pre)assembly, prototyping, fabrication, testing of prototypes and mock-ups and the mechanical testing of structural elements and complete products. Some architects even compare our production facilities to an oversized model workshop. The Design & Engineering department is frequently involved in this work. The Production department is also responsible for all other components manufactured by our suppliers and subcontractors such as glass panels and GRP elements.
Octatube has been certified in accordance with NEN-EN 1090 and complies with the conformity of structural steel works (CE-marking), execution class EXC3.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1: Visit by Queen Máxima to Octatube, 2017, Delft
2: Mock-up Capital C (De Diamantbeurs), Octatube factory, Delft
3: Fabrication Capital C (De Diamantbeurs), Octatube factory, Delft
4: Transport for Yithzak Rabin Center, Tel Aviv

Installation & Supervision

Components and structural elements are transported from the factory to the site, where the installation department takes responsibility for further surveying, installation and fitting. Within the Netherlands most of the installation and supervision work is carried out by our own staff, while further afield the work is usually carried out by a local qualified subcontractor under Octatube's supervision. Octatube is SCC** certified.

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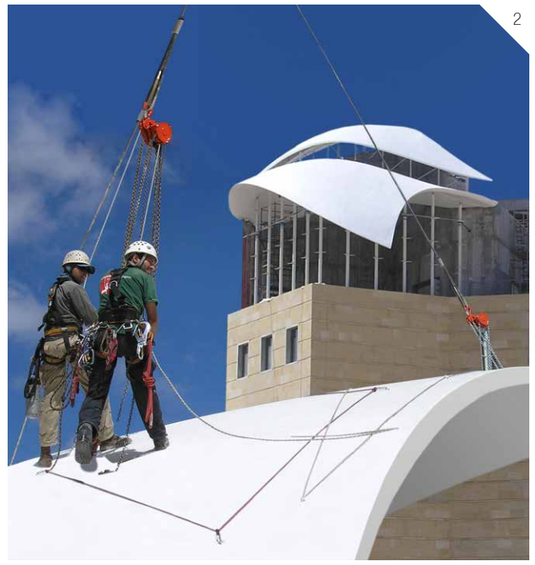
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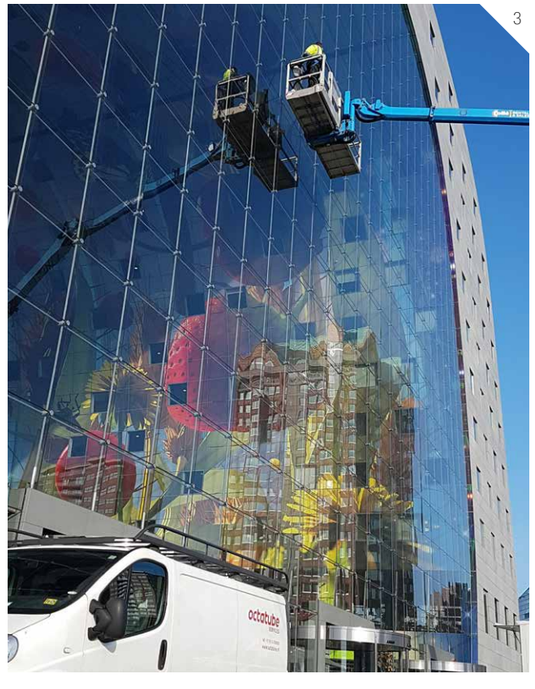
Services

Octatube Services conducts various activities after completion of the project. Examples include maintenance, repairs and renovations. Octatube Services can rely on years of accumulated knowledge of Octatube. As a result there is always a suitable solution to be found without compromising on quality and aesthetics. You are assured of fast service and reliable solutions.

The staff of Octatube Services knows the designs and products of Octatube through and through. By carrying out a maintenance program we can keep buildings in good condition and prolong the performance, safety and representativeness of façades and roofs.

Clients of Octatube Services mainly consist of building owners, management companies, contractors, government agencies and individuals.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1: Installation of steel structure Van Gogh Museum, Amsterdam
2: Alpine installation Yithzak Rabin Center, Tel Aviv
3: Yearly maintenance work Markthal by Services, Rotterdam

History

Octatube has over 30 years of ‘design & build’ experience with complex architectural structures which contributes to a solid reputation at home and abroad. Mick Eekhout launched his architecture practice in the 1970s. This agency expanded in 1978 with the creation of the engineering consultancy Octatube Engineering BV, followed by the “design & build” business Octatube Space Structures BV in 1983. The Octatube group now takes the form of a holding company with a number of subsidiaries. In the Netherlands we trade as Octatube Nederland BV, and abroad under the titles Octatube International BV, Octatube Europe BV, Octatube Deutschland BV and Octatube Qatar BV. Octatube led the field in the technical developments of the high-tech architecture era between 1980 and 1995 and in the consecutive freeform and ‘Blob’ architecture period. In the first decade of our existence the emphasis was on spaceframes and tent structures. This naturally led to an expansion into the field of structural glazing. Nowadays Octatube is a specialist for complex glazed facades and roofs.

1: Veronica Music Tent, demountable, 1984
2: Spaceframe Air Cargo, Dubai, 1990
3: Prinsenhof Delft, 1997

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Philosophy

Octatube's business philosophy focuses on the development of new products, the synergy between different design disciplines and the integration of the design, engineering, production and installation processes. This ‘Design & Build’ concept results in a single responsible and approachable party: Octatube. There are major benefits for the client here, particularly where highly specialised, new or experimental components are concerned.
For the diverse group of designers and engineers within Octatube, the presence of the production facilities brings them into close contact with the materials, the numerous processing techniques and the resulting products.

1: Market Hall, Rotterdam, 2014 (MVRDV)
2: Entrance to the Victoria & Albert Museum, London, 2017 (AL_A)

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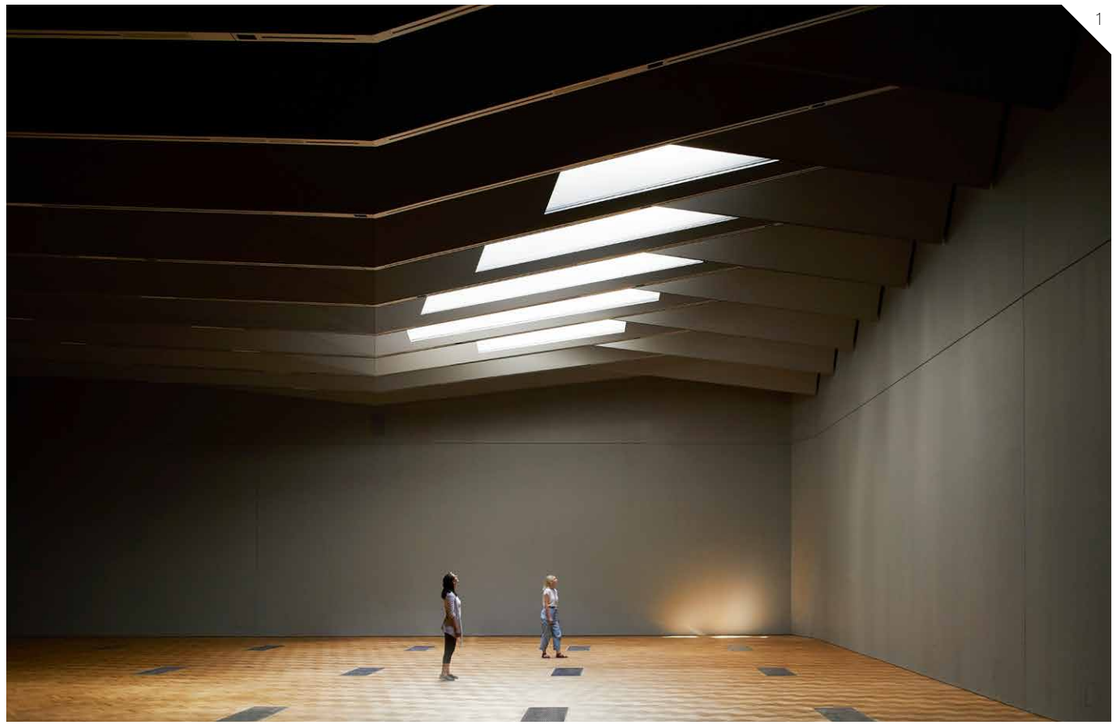
All-glass

Glass can have all the compressive strength of concrete, provided the forces are appropriately applied to the glass surface. It makes glass extremely interesting as a structural material, but it does call for an absolute mastery of the associated theory and practice.
One useful property of glass is its capacity to take up compressive forces, but against that is its' poor resistance to tensile force. Glass is brittle and may break without warning. The use of glass as a structural material therefore imposes high demands on the design. Architects are more and more choosing for fully transparent and all-glass structures. Glass fins, self-stabilizing glass structures and glass units with diaphragm action are important features to achieve this ambition.

Victoria & Albert Museum, London, 2017 (AL_A)



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The Victoria and Albert Museum (V&A) is the largest design & craftsmanship museum in the world. The museum's most recent renovation project includes a skylight (see page 9) featuring double-glass panels supported by laminated low-iron glass beams varying in height. It is a unique example of the use of structural glass in combination with free glass design and a monumental context.

For New Atrium, an office building in Amsterdam, winter gardens of approximately 12 metres in height had to be realised. In order to make the structure as transparent as possible, the design team opted for structural glass fins that would transfer the weight to the building's main structure. The corners of the winter gardens have been realized in large, hot bend glass panes.

The all-glass exterior elevator shaft of Mauritshuis is a self-supporting glass structure in which the shape of the glass structure stabalizes itself.

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left: Glass elevator shaft Mauritshuis, The Hague, 2014 (Hans van Heeswijk Architecten)
1: Victoria & Albert Museum, Exhibition area, London, 2017 (AL_A)
2: New Atrium, Amsterdam, 2017 (MVSA)
3: Gemeentemuseum, The Hague, 2014 (Braaksma & Roos Architecten)

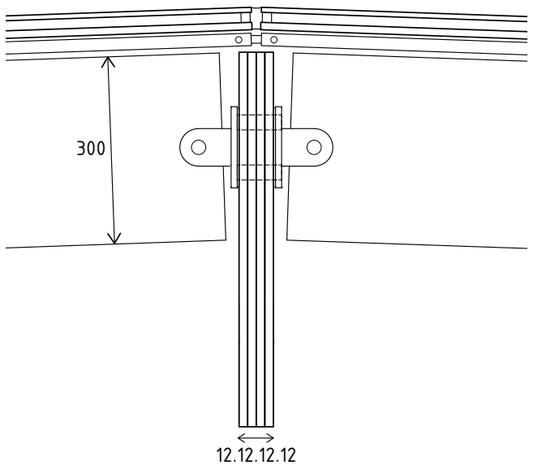
Glass fins

When it comes to all-glass structures, the most commonly used elements are glass fins. These building components utilize the full potential of glass as a structural material, and at the same time yield maximum transparency and an unobstructed view.

Glass fins eliminate the need for conventional metal mullions and beams. In facades and roofs the glass fins can be structurally used to transfer horizontal and vertical loads from e.g. wind and snow to the structure.
Various connections can be used to transfer loads from the façade or rooflight to the glass fins, such as (hidden) clamping nodes, and bonded connections.

As a leading design & build party in structural glass technologies, Octatube has long been able to translate architectural concepts for transparent rooflights and facades into bespoke and high-end projects.

Currently it is possible to make glass fins up to 18 meters long. Usually glass fins are composed of a combination of 2 or more layers of tempered glass. In combination with a wide array of glass types such as low-iron or colored glass and the application of frit patterns and translucent interlayers, architects have numerous possibilities.



drawing (1:10): Detail roof Gemeentemuseum, The Hague

1: Glass Elevator Shaft Mauritshuis, The Hague, 2014 (Hans van Heeswijk Architecten)

2: Gemeentemuseum, The Hague, 2014 (Braaksma & Roos Architecten)

3: Van Gogh Museum, Amsterdam, 2015 (Hans van Heeswijk Architecten)

Free Form Architecture

Since the rise of 3D Computer Aided Design (CAD) design in the eighties and nineties Octatube has been at the front of the developments. Nowadays, all Octatube's projects are designed, engineered, calculated and drawn completely in 3D. This provides complete freedom in the geometrical possibilities. Furthermore, the feasibility can directly be tested with the application of many different materials and production methods.

One of the first substantial projects with a complete free form language, was the Town Hall in Alphen aan den Rijn in the Netherlands in 2003.

In the last years the possibilities in production like CNC laser cutting, CNC milling and 3D printing has also been employed by Octatube to deal with large quantities of unique elements.

Van Gogh Museum, Amsterdam, 2015 (Hans van Heeswijk Architecten)

Cold bent glass

Traditionally shaping of glass sheets is done in hot bending processes. Alternatively, cold bending of glass sheets has also been developed providing important advantages. It is also possible to twist double gazed panels in a frame.

Octatube has been realizing projects with cold bent glass since 2001. Flat glass sheets are bent and kept in that shape using mechanical pressure at the construction site. Both in single and double curved applications. Cold bending of framed glass has been used for some time in cylindrical roofs, but it is also possible to cold bent glass with point fixings. This technique was used by Octatube on the Floriade Pavilion (photo 1). During bending, half of the tension applied was used for bending and the other half to take up the wind loading.

We have thoroughly investigated the theory behind the bending and twisting of glass, allowing us to model and predict the material's bending and breaking properties. The knowledge we have developed allows us to make superb use of cold-bent single and insulated glass units. A recent example is the Van Gogh Museum in Amsterdam where double glass units in the cold bent glass facade are only fixed by means of a few clamping nodes.

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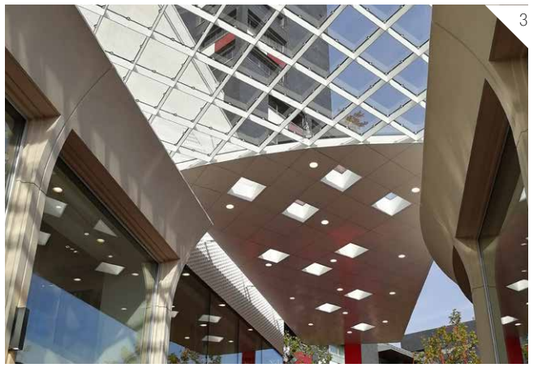

1: Floriade Pavilion, Haarlemmermeer, 2002 (Asymptote Architects)
2: Canopy Zonnehuisgroep, Amstelveen, 2012 (Thijs Asselbergs)
3: Passage Tilburg, 2018 (Rijnboutt)
right: Van Gogh Museum, Amsterdam, 2015 (Hans van Heeswijk Architecten)

Hot bent glass

In hot bending, a single or double curvature in a glass panel is normally achieved by heating the glass and allowing it to cool in a mould. This process is particularly expensive given that a separate mould needs to be made for each glass shape. However, hot bent glass panels are very suitable for projects with a lot of repetition.

An example are the glass panels of the Fletcher Hotel's second skin, a project near the A2 highway in Amsterdam (photo 1). Despite the fact that 10 different screens have been developed for the creation of the blue circle pattern on the glass, all glass panels have the same cylindrical curvature, enabling an efficient glass production method by means of hot bending techniques.

1: A2 Fletcher Hotel, Amsterdam, 2013 (Benthem & Crouwel Architecten)
2: New Atrium, Amsterdam, 2017 (MVSA)
3: Teahouse Garden Hermitage, Amsterdam, 2014 (Friso ten Holt)

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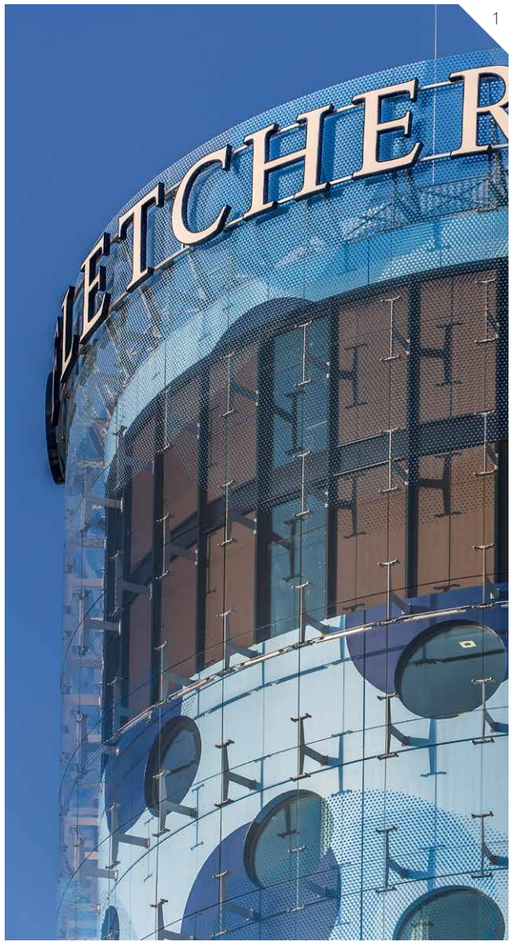

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Gridshells

A gridshell is a form- and cross-section-active, lightweight structure, composed of discrete members following a curved free-form shape. Through its shape, a gridshell is designed to carry loads as efficiently as possible, resulting in an efficient, self-supporting structure that can span large distances using relatively little material. They strength of a gridshell is derived from its single or double curvature. Usually gridshells are applied to create freeform, geometric or geodesic building skins.

A gridshell is usually based on a grid of many triangles or rectangles. The repetition of the individual elements often creates a homogeneous appearance. Through its form, the gridshell offers support for a wide variety of cladding materials such as glass, cladding and membranes, while the slender elements allow for light to enter.

Octatube has ample experience with clad-shells and transparent gridshells.

1: Artist impression Capital C, De Diamantbeurs, 2018, Amsterdam (ZJA Zwarts & Jansma Architecten)
2-3: Rokin 49, Amsterdam, 2016 (Rijnboutt)

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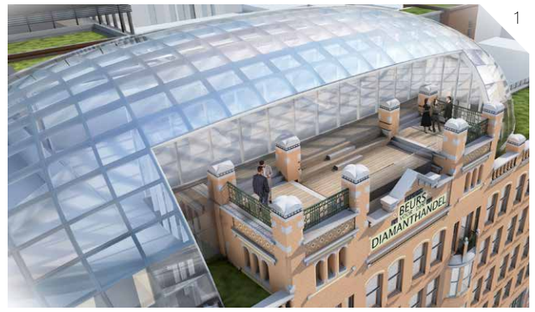

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Structural Glazing

The architectonic aim of structural glass is to deliver surfaces with maximum transparency, preferably by maximizing the self-supporting capabilities of glass, creating slender and elegant structures. Our structural glazing techniques are primarily found in roofs and facades, but other applications are possible, including internal walls, floors, balustrades and elevators.

The composition of the glass panels used in frameless applications depend on project-specific requirements. Important choices need to be made between single or insulated glazing, heat-strengthened or fully tempered glazing, and laminated or single pane glazing. There are also variations in the transparency and heat transmission properties of the glass sheets used to make up the panels. There are also options for clear glass, tinted glass, low-iron glazing, (toughened) reflective coatings on the external or internal face, toughened or un-toughened coatings and hard or soft low emission coatings (low E) on the internal faces of cavity constructions, as well as screen printing (fritting).

Octatube is a front runner in glass market that is always developing. We are also very familiar with triple glazing, fire proof glazing, solar glazing, media glass and glazing with LED lighting.

The Curve, IJsselstein, 2017 (EVA Architecten)

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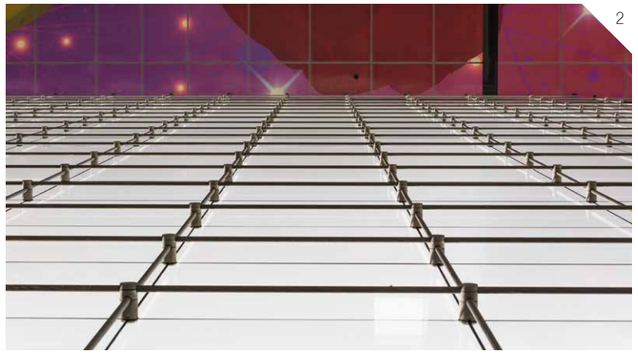

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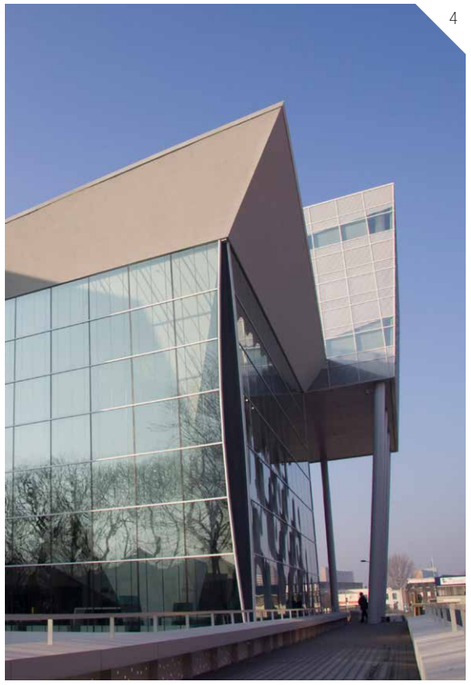

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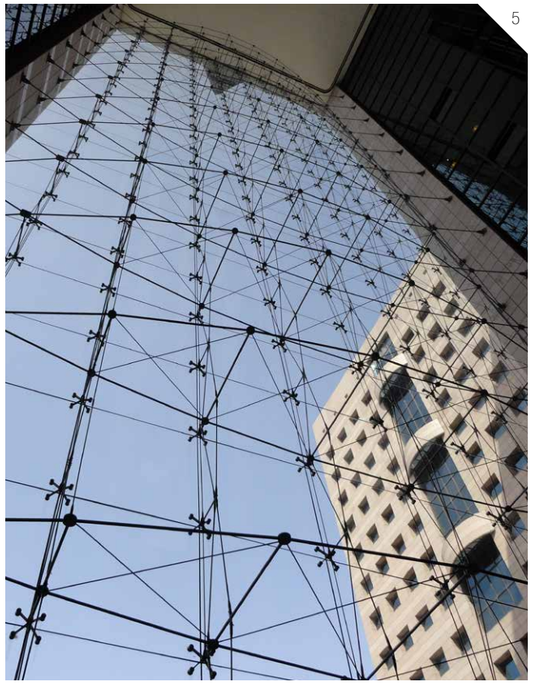

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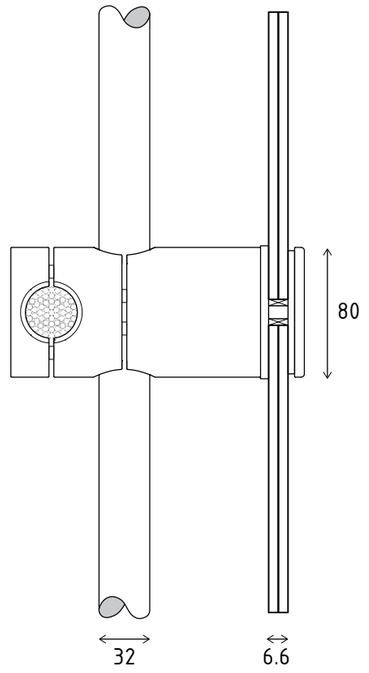
Cable facades

Cable structures and flat tensioned cable net glazed are an emerging trend in architecture. The underlying concept involves pre-stressed cables running between the surrounding structure of the facade surface. Glass units are usually fixed to the cables by means of clamping nodes. The cables must be able to take both the weight of the glass and the wind load, transferring these forces to the surrounding structure.

Cable facades are always flexible systems. Allowing deflections in the facade surface increases the structural depth essential for taking up the wind load. This is one of the characteristiscs of cablenet facades. The cables in the facade must be carefully pre-tensioned to prevent too much deflection in case of very strong winds.



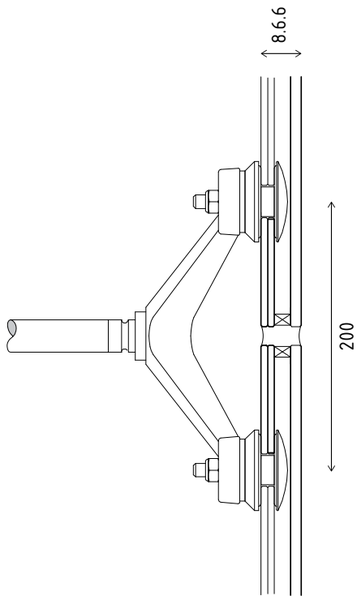
drawing (1:5): Market Hall, Rotterdam, 2014 (MVRDV)
1-2: Market Hall, Rotterdam, 2014 (MVRDV)
3-4: INHolland University, Delft, 2009 (Rietveld Architects)
5: OZ Building, Tel Aviv, 1995 (Avram Yaski)

Point fixed glazing systems

Quattro nodes provide the interface between the glass sheet and the stabilising support structure. The form of the nodes is derived from the shortest distance between the holes in the glass sheet and the central placement of the support structure, which normally runs along the axis between two glass panels. With four holes in the corners of each of four glass panels, the typical resulting form is a diagonal cross.

While our Quattro systems are named after this most common format, Trio, Duo and Mono nodes are also possible. For example, two adjacent holes with a straight connection crossing a central support result in a Duo node. At Octatube we distinguish between standard, system and special nodes.

The cast stainless steel Quattro node is an example of a standard format. The nodes are in metal: cast aluminium, modular cast iron, welded or pressed steel or cast, welded or pressed stainless steel. These elements can be treated and finished in many different ways.



drawing (1:5): semi mechanical glass connection

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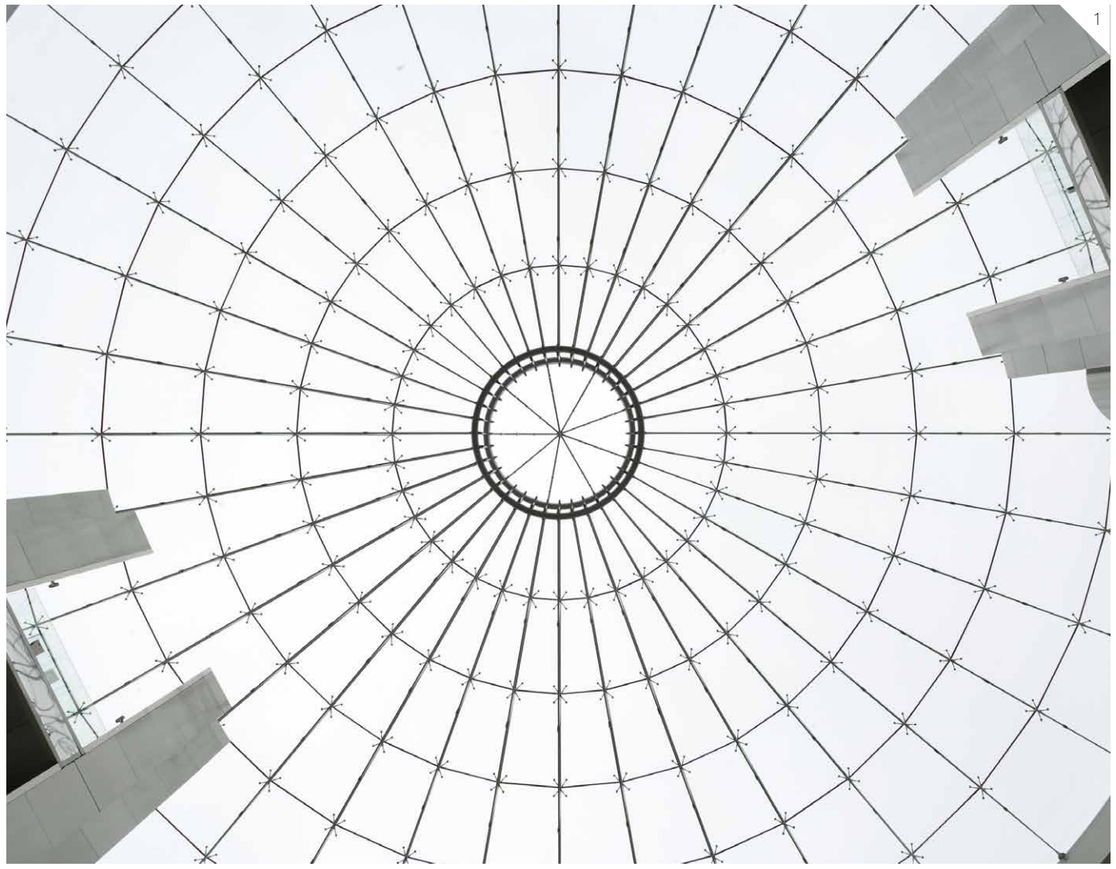
1: Quattro node at Airport Manises, Valencia, 2011 (Francisco Benitez)
2: Audi Böllinger Höfe, Heilbronn, 2015 (Kohlbecker)
3: Datacenter Digital Realty, Amsterdam, 2017 (AGS Architects & Rosbach Architects)



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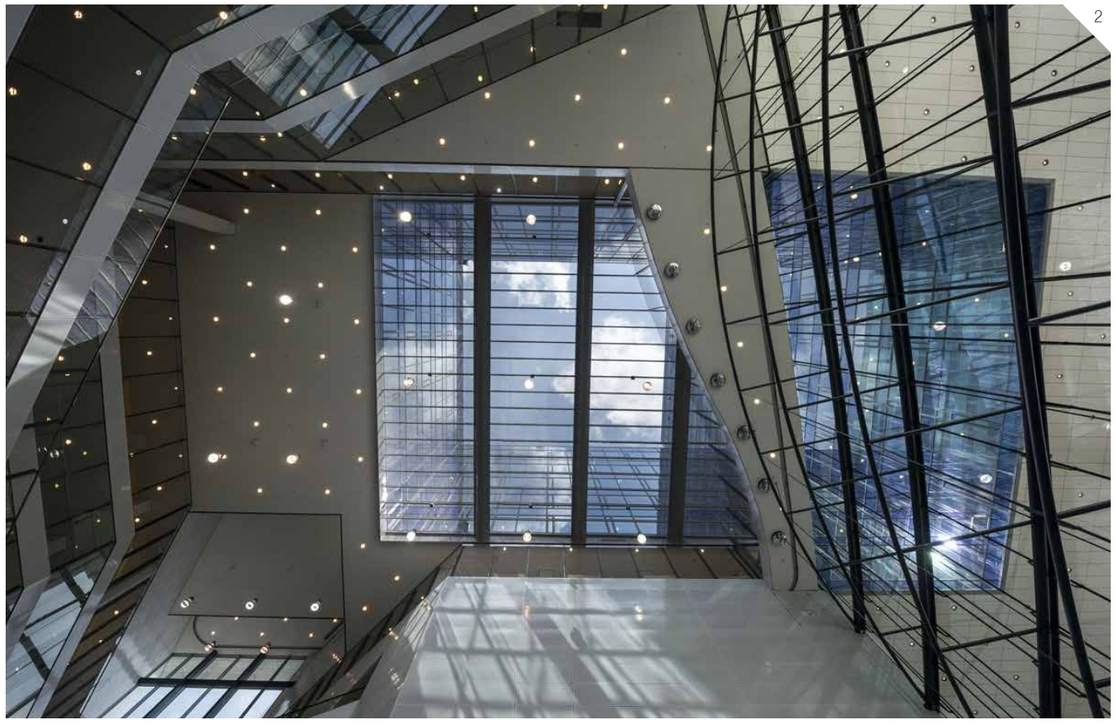

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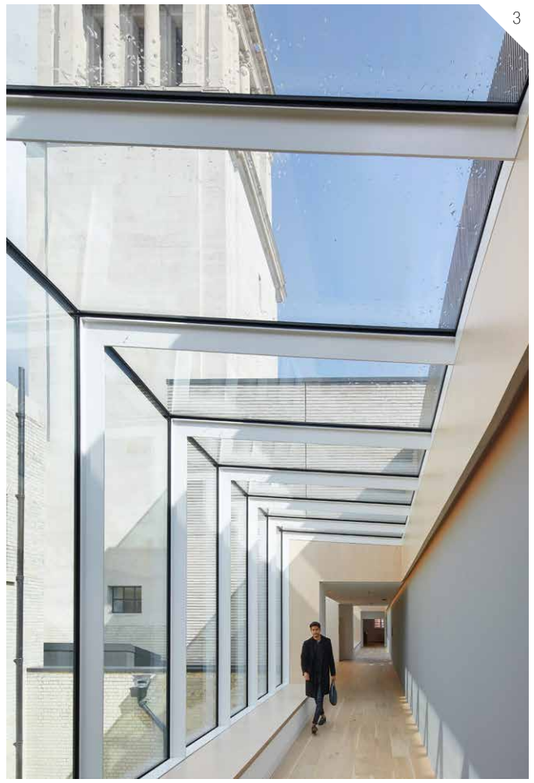

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Linear glazing systems

In some applications it it not feasible to use an entirely frameless construction.

Linear glazing systems are characterized by a span in one direction. An important consideration in the application of linear profiles is the safety of the resulting structure. The linear design and the creation of visual tensions make the linear profiles a focus of interest.

1: Bancopolis, Madrid, 2005 (Kevin Roche)
2: City Offices, Utrecht, 2014 (Kraaijvanger)
3: Victoria & Albert Museum, London, 2017 (AL_A)
4: City Canopy 'The Diagonal', Almere, 2014 (DunnetCraven)

Steel Structures

Transparent glass facades are at their best when combined with a customized elegant supporting structure. Octatube is a specialist in the application of these minimum and light-weight structures.

Load bearing structures may consist of existing structural elements, a steel structure fabricated by others or metal components supplied by Octatube. Octatube will set down strength, stiffness and stability requirements for the supporting structure. Glass facades are generally combined with slender supporting structures, on aesthetic considerations. We make a distinction between super slender structures (for example pre-tensioned trusses), slender structures (circular, elliptical or rectangular tubes, rectangular or lattice beams) and regular structures (such as open steel profiles).

In the past 32 years many steel structures have been realised in the form of spaceframes, domes and tensegrities.

Atrium roof Ten Thirty, Amstelveen, 2015 (OeverZaaijer architectuur en stedebouw)

Spaceframes

Spaceframes are lattice structures which work in three dimensions. They are manufactured on an industrial scale. The space frame concept was first applied by Alexander Graham Bell in 1907, with the company Mero popularising the technique during the 1960s. Mick Eekhout invented and patented the Octatube space frame system during his thesis in 1973. This development marks the beginning of Octatube's history.

Octatube generally produces their space frames in circular steel tubes, but aluminium, solid timber and even cardboard and bamboo have been successfully used on occasion. The shift in construction philosophy away from a manufacturer-centred and towards a consumer-centred approach has moved the focus from industrial spaceframe manufacturing to special, project-related design. The consequence is that many spaceframe designs do not fit in with an existing system. Projects often use a derivative of one of the available basic systems. Traditionally, Octatube designs and supplies three different spaceframe systems: the Octatube system, the Tuball system and the Streamline system.

1: The Bubble, Eindhoven, 2013 (Tarra architectuur & stedenbouw)
2: Faculty of Architecture TU Delft, 2009 (BK City)
3: Cotroceni Shopping Centre Dome, Bucharest, 2009 (M.Y.S. Architects)

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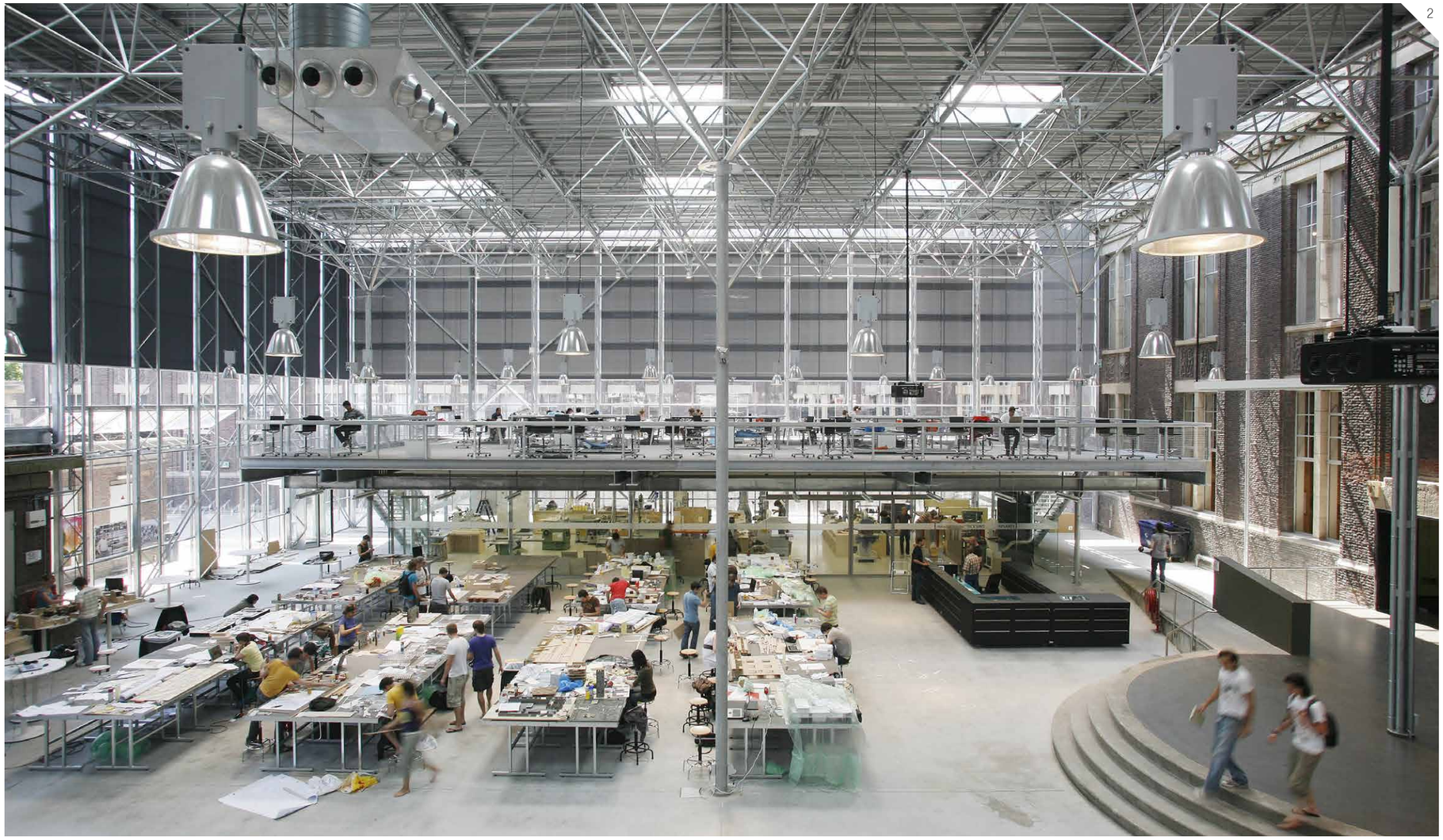

Domes

The structural functioning of a dome is highly efficient. The form - generally half a sphere with a cylindrical ground surface - is ideal for spanning large areas without the need for additional columns or walls. Since ancient times all kind of domes have been built. The typical geometrical language always forms a distinct architectural element. Octatube has extensive experience in the design and realisation of challenging domes in both traditional single layered systems, spaceframes and gridshells.

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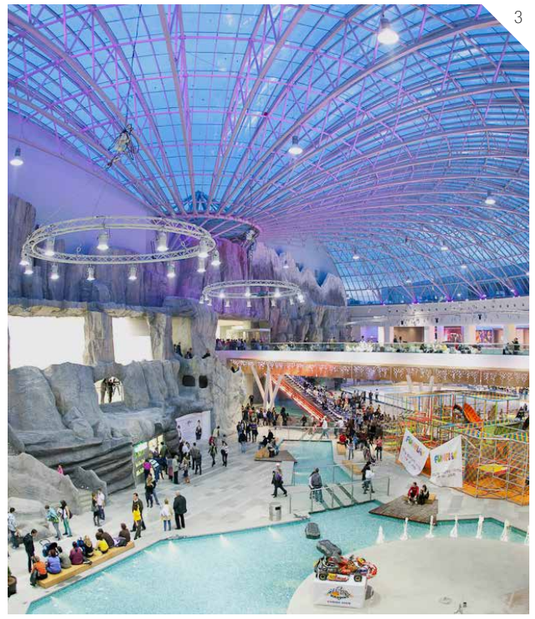

Renovation

The contrast between the visual transparency of glazed constructions and massive masonry is a source of great dynamism in the design of architectonic applications in monumental works.

Monumental buildings are often expanded to meet contemporary needs using glazed elevator shafts, staircases and roofs. Renovation projects are often complex, with limited space and the requirement to tie in with existing structures which may have subsided in irregular ways over the course of time. The keys to a successful project include not only the selection of a suitable system but also the painstaking design and detailing of numerous features and connections.

Sammy Ofer Centre (London Business School), London, 2017 (Sheppard Robson)

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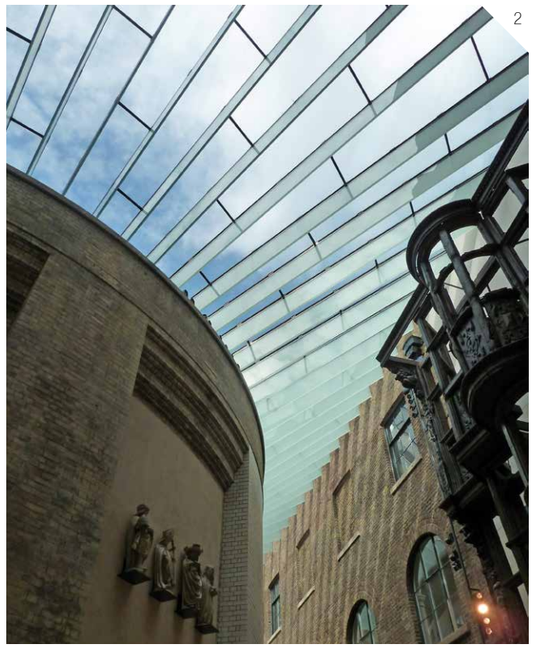

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The detailing of glass structures may clearly bear the signature of an individual architect. Whether it is finesse and suppleness or crisp lines and strength, the lightweight supporting structures can be tailored to match. Sensitive designs such as the work of Braaksma & Roos Architecten in the Gemeentemuseum of The Hague win the approval of the local authorities, simply because of the careful and respectful treatment of the existing monument.

Highly exceptional detailing can be seen at London's Victoria & Albert Museum. The glass fins seem to 'slice' through the existing 19th century cornice (photo 2). The supports for the fins are concealed from view in a niche behind the masonry.
The tension between transparent glass structures and a historical context also plays a major role at two recent projects of Octatube: the Sammy Ofer Centre for the London Business School and the Victoria & Albert Museum Exhibition Road Entrance.

left: Sammy Ofer Centre (London Business School), London, 2017 (Sheppard Robson)
1: Gemeentemuseum, The Hague, 2014 (Braaksma & Roos)
2: Victoria & Albert Museum Daylit Gallery, London, 2009 (MUMA)
3: Victoria & Albert Museum Exhibition Road Entrance, London, 2017 (AL_A)

Miscellaneous

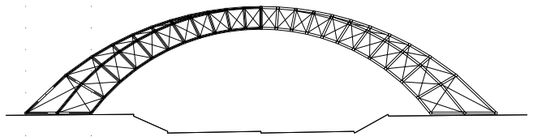
Because of the experience with the development of new components, products and systems, Octatube is always interested to apply its ‘Design & Build’ expertise in special projects and structures. An external query is often the inducement for an important role in a building team, where the aim is always to translate complex architectural structures into a technically feasible design.

Traditionally, membrane structures have been applied, and later Octatube has also realized many projects with composites, cardboard and cladding materials.

A2 Fletcher Hotel, Amsterdam, 2013 (Benthem & Crouwel Architecten)

Cardboard structures

Architect Shigeru Ban is internationally recognized for his cardboard structures. Octatube has collaborated with Ban on several occasions in the creation of his cardboard tube buildings. Varying from the building of a membrane covered geodesic theatre to a cardboard bridge. Despite the temporary nature of these projects, they continue to be rebuilt and reused at different locations.
Octatube has made great steps in the development of cardboard tube construction in recent years, and we now see a bright future for standardized space frame structures as well as free forms using this material. In both cases it is clear that cardboard must be both more environmentally friendly as well as more economical than steel.



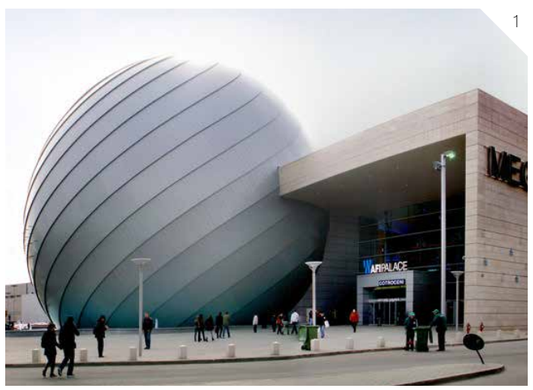
drawing: Paper Bridge, Vers-Pont-du-Gard, 2007 (Shigeru Ban Architects)
1: Paper Bridge, Vers-Pont-du-Gard, 2007 (Shigeru Ban Architects)

1

Cladding

When realizing complex geometries, architectural, building technical or financial considerations sometimes lead to the application of sheet material.
An example is the Imax theatre in Bucharest, where Octatube had been invited in an early stage of the design process to join the design team. The goal was to design a perfect sphere out of sheet metal. While engineers worked on developing potential surfaces, grid optimization, and double-bending, the designers took the opportunity to further exploit the properties and boundaries of the material. The outcome of this combined research was pitched to the architect as a free-form solution, minimizing the chance of disruptive oil-canning.
For the Floriade Pavilion in 2002 three-dimensional corners have been developed for an aluminium roof, in collaboration with Karel Vollers. An extensive process of computer modelling, testing and the development of (adjustable) moulds was necessary in order to achieve the desired accuracy of the shape. The process of producing the explosion panels with a small TNT ring was very experimental.

1: Imax Theatre, Bucharest, 2009 (M.Y.S. Architects)
2: Installation of the Oculus, Victoria & Albert Museum, 2017 (AL_A)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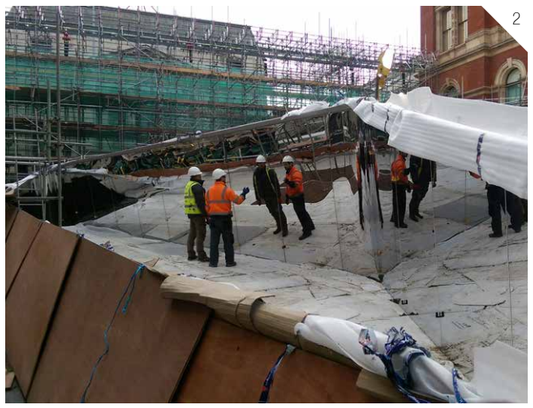
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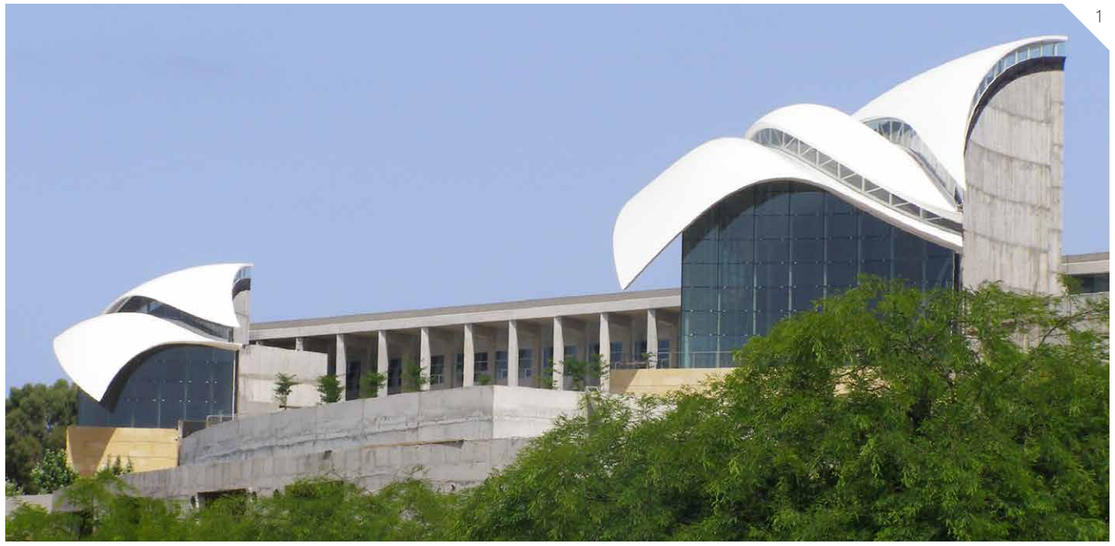
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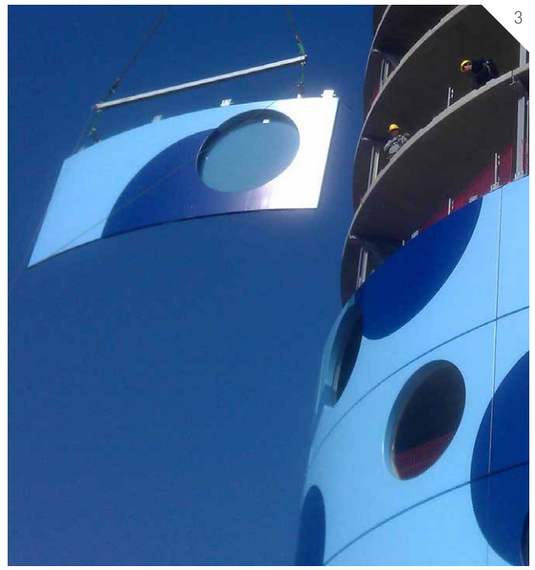
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Membrane structures

Since the 1980s Octatube has been realizing membrane structures for a wide variety of projects. Tensioned membrane structures or ‘tents’ in their architectonic and sculptural manifestations have been familiar since the works of Frei Otto in the sixties. The main use of the tent in the Netherlands has been as an ‘urban umbrella’, where the tent functions as a canopy, a shelter from the rain/sun or a freestanding roof, for example over a shopping centre. The most common form is a roof surface combining convex and concave curves. This arrangement allows the fibres in the reinforcement woven into the cloth to support one another as the wind loading fluctuates.

In the Netherlands the smaller membranes generally use polyester-reinforced PVC fabric with a lifetime of 15 to 20 years. In addition, there are applications with the Teflon-based PTFE and ETFE: almost transparent materials which often are applied with air pressured cushions as a building skin. Compared to glass they are less transparent, but they are recyclable and many times lighter.

Composite structures

A composite is a material that consists of different components. For building materials they often refer to fiber-reinforced plastics like glassfiber reinforced polyester (GRP). But it could also refer to i.e. bullet proof glass that consists of polycarbonate interlayers, or cables made of aramide. GRP is an ideal material for realizing light-weight, isolated and free form roofs and facades. In 2005 Octatube has realized the Yitzhak Rabin Center, with two double curved GRP shells cantilevering 12 meters.

1: Yithzak Rabin Center, Tel Aviv, 2005 (Moshe Safdie Architects)
2: Paperdome, Utrecht, 2004-2012 (Shigeru Ban Architects)
3: A2 Fletcher Hotel, Amsterdam, 2013 (Benthem & Crouwel Architecten)

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Most recent awards & commendations:

2015 Dutch Construction Award
2015 Benelux Award for Galvanizing
2015 Smart People Award, Metal Construction Association
2015 Octatube winner Orange Trade Mission Fund
2016 Special commendation at the Facade Of The Year Awards with the Van Gogh Museum project
2017 Winner Facade of the year, in the category refurbishment with the Victoria & Albert Museum, Exhibition Road Quarter

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