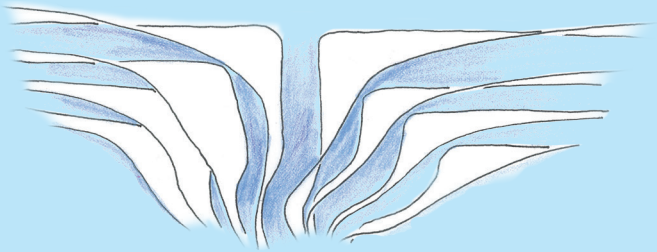


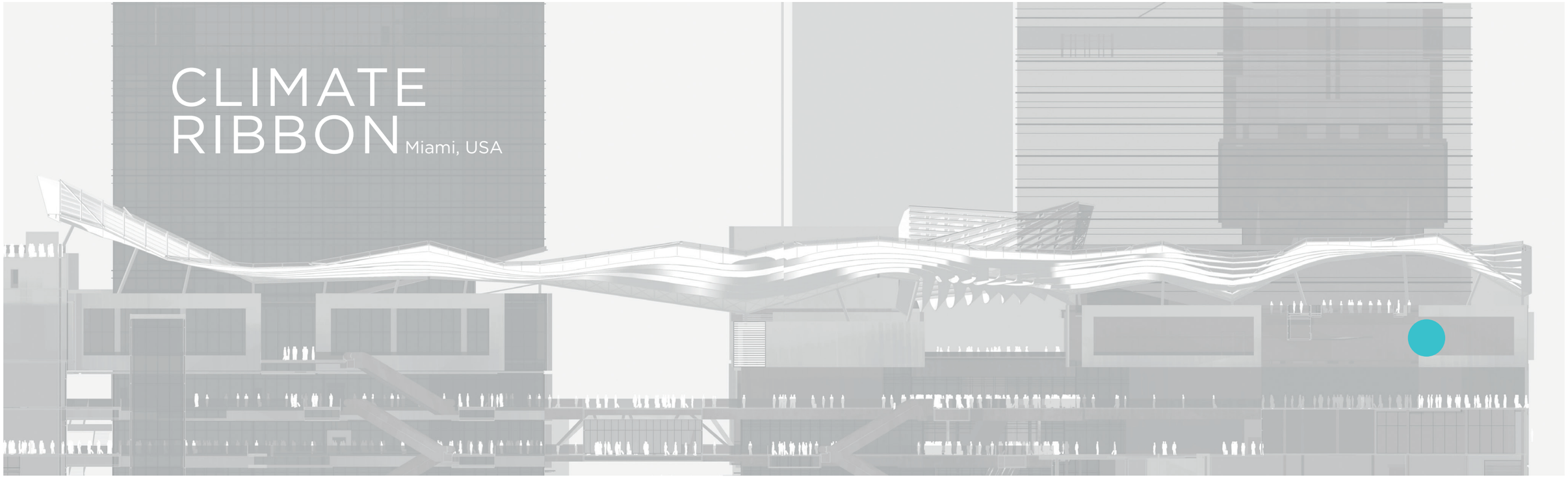
CLIMATE RIBBON™

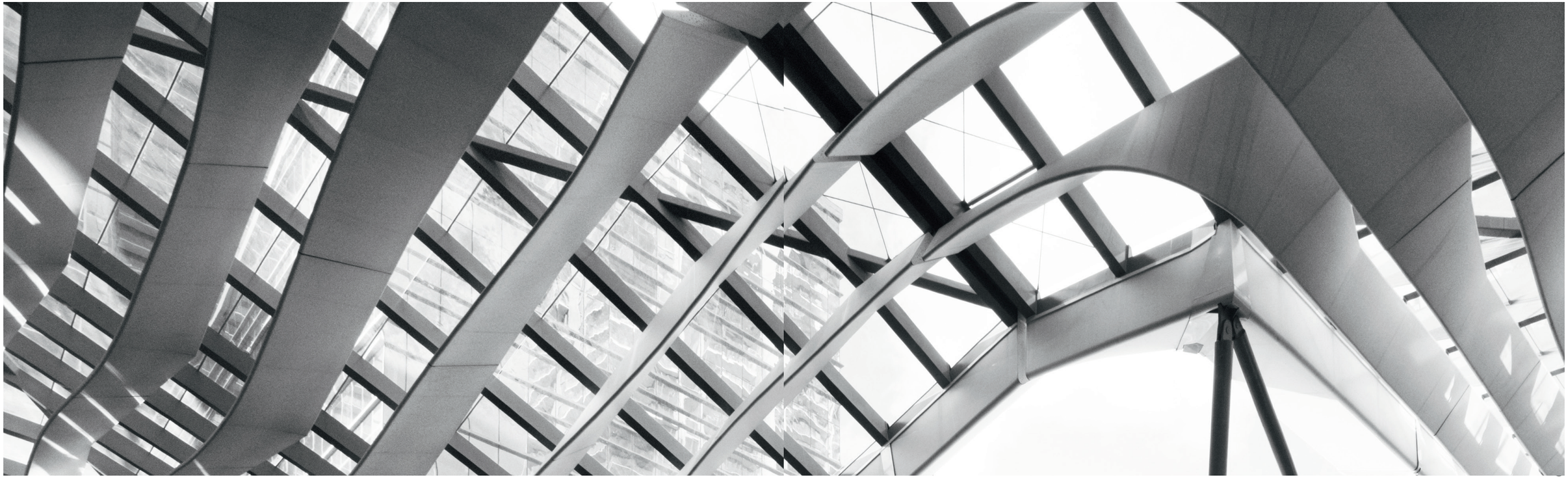
Miami, USA

HDA

HUGH DUTTON ASSOCIÉS

CLIMATE RIBBON Miami, USA





SUMMARY
CLIMATE RIBBON

“Four years ago, I was honoured and flattered when Steve Owens of Swire and Bernardo Fort Brescia of Arquitectonica invited me to join them in the realisation of the CLIMATE RIBBON™. I am particularly pleased that the public unveiling of this project coincides with the Miami Art Basel event, because I consider that all of our work is a synthesis of art and science. Art is about communication for me, and the message I have to say here is that we have an obligation to mankind and the environment to make our designs beautiful and in harmony with nature.

To do this we must understand her forces. We must work with nature and not against her. We must understand and respect her energy in the sun, wind, rain, and gravity. We must design with these forces in mind, show we can appreciate them and live with them in harmony.

Having grown up in Jamaica, my own background made me aware of the tropical climate that is the context for this project. My father was a planter and our home was a rambling house on a hill surrounded by verandas with jalousie windows. This was already true sustainable design without air-conditioning.

He was a keen sailor and we spent countless hours on the sea. As any sailor knows, the sea has no time for hubris and you learn to submit to her forces very quickly. I understood notably the nature of the trade winds that are the basis of this design. The CLIMATE RIBBON™ is a technical exercise of advanced computational design. The computer is used to manage complex geometries by handling masses of three dimensional data. Sophisticated engineering computation processes use non-linear analysis methods to best simulate how forces are resolved in the different parts of the whole. Parametric design processes simulate natural processes such as the sun exposure, the wind and rainwater. The parametric processing brings fascinating power and shapes to design, but these need to be sculpted and formed to achieve a desired aesthetic.

The climate ribbon is a static piece but is designed to create a dynamic in light. It expresses the movement of the sun and how light changes every moment of the day. It is all about light. The blades allow glimpses of Miami’s blue skies and pick up the crisp light in a composition of translucent, reflective and indirect light that varies throughout the day, highlighting the fluidity of the CLIMATE RIBBON™. By night - and tonight is the first night it is lit - the blades express the same fluidity, but in a different perspective.

In our world of chaos and pretentiousness, of arrogance and, these days, of fear, I feel the climate ribbon is also much more than a technical exercise. As an icon of the symbiosis of man and nature, it is also a statement of calm and of humility, of peace and harmony. I am very comfortable with it...

The CLIMATE RIBBON™ is an idea that took shape thanks to the efforts of many people. We have listed the principal participating companies, but countless others have assisted or simply supported the idea. Without this enthusiastic collaboration, what you see today would not have been possible. On behalf of HDA I take this opportunity to thank everyone for their support.”

HUGH DUTTON

I. NOTES ON THE CLIMATE RIBBON™

THE CLIMATE RIBBON™
IS AN ARTISTIC EXPRESSION
OF NATURAL FORCES,
OF SUN, WIND AND RAIN IN LIGHT,
TELLING A STORY ABOUT MAN
AND NATURE IN SYMBIOSIS.

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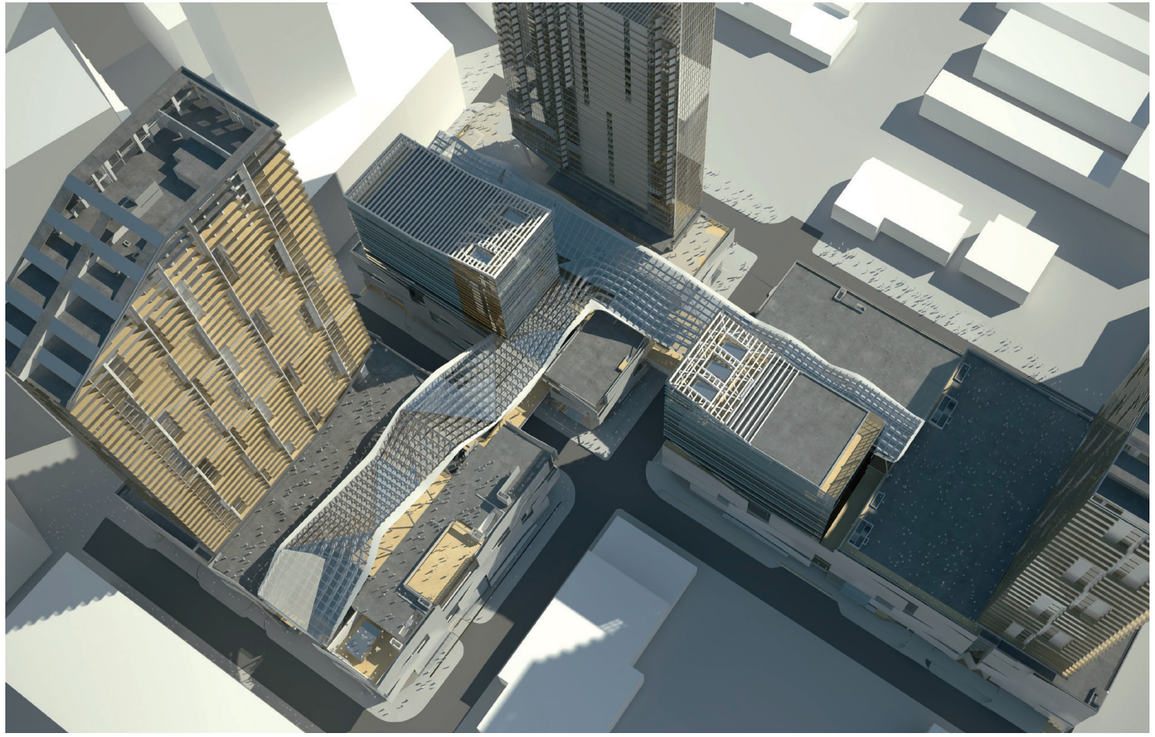
TECHNICAL NOTES

The CLIMATE RIBBON™ began as an architectural feature of the new Brickell City Centre development in Miami by Swire Properties by architects Arquitectonica. It shelters a pedestrian street at the heart of the development and improves the micro- climate of the public spaces through shading and natural ventilation.

A 100 000 sq. ft. facetted canopy of steel and glass above the pedestrian street undulates between the hotel, office and residential towers with a fluid ceiling beneath of sinuous blades of architectural fabric shading.



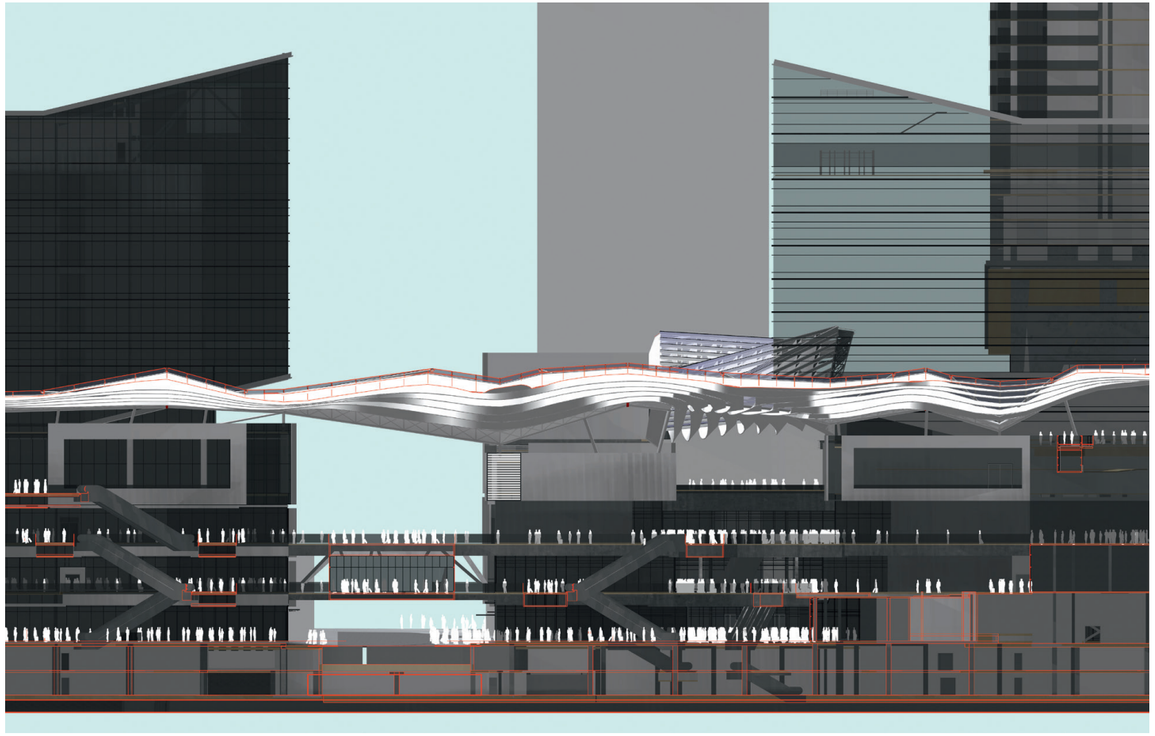
INTENT

Brickell City Centre comprises a retail plinth on several distinct city blocks in downtown Miami's Brickell district, topped with several towers for condominium apartments, offices, and a hotel.

The CLIMATE RIBBON™ ties these blocks together, forming a shelter to improve the microclimate for the public in the pedestrian circulation streets using purely passive energy design strategies.

A SYMBOL OF SUSTAINABILITY

Beyond this functional performance, CLIMATE RIBBON™ is a unique sculptural icon for the Brickell City Centre that expresses Swire Properties' commitment to sustainable development.



A SUN SHADE

Shop fronts that would normally be exposed to direct sun radiation are protected from the majority of the sun's rays. Priority has been given to midday and evening sun in the hotter seasons as these moments are most associated with higher temperatures. Circulation routes, restaurant and café areas have also been provided with protection.

A BREEZE PATH

Though air conditioning would be a means of ensuring a predictable air temperature inside the shopping centre, it would not be considered ecological an being built over CLIMATE RIBBON™ strives to improve the perceived temperature conditions for the public in the shopping centre by encouraging a breeze flow in the public spaces through harnessing the summer trade winds.

A RAINWATER COLLECTOR

CLIMATE RIBBON™ surfaces are inclined and sloped to channel rainwater to specific collection points where the water is stored and re-used for planting irrigation and other purposes.

II. INSPIRATION

THE CLIMATE RIBBON™ WAS INSPIRED BY...

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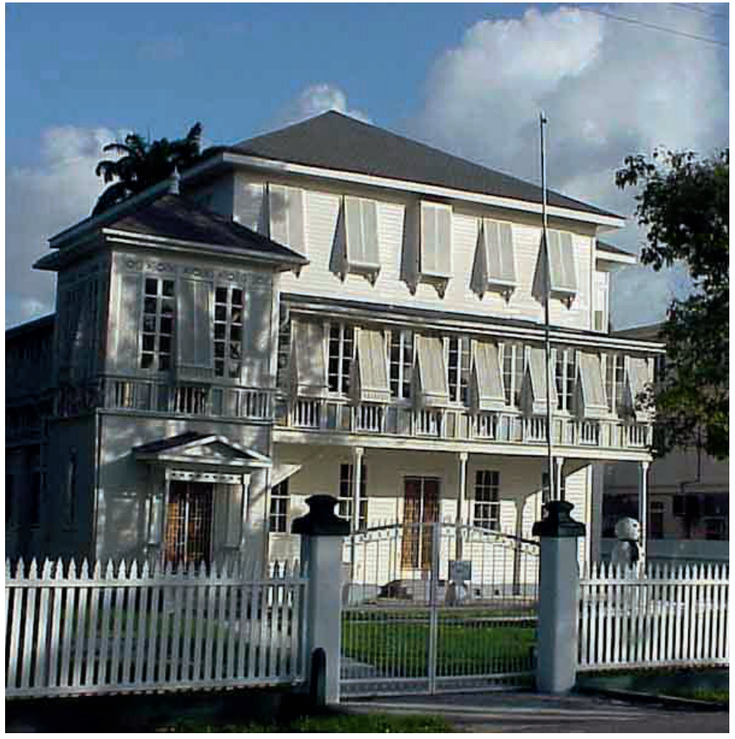
TRADE WINDS

The trade winds are very predictable and consistently blow from the East South East inland. S.E.8th st provides an optimal wind corridor for the summertime trade winds directly from the sea toward the Brickell City Centre development. Summertime is when natural cooling is most usefully exploited.

SAILS

Sails, as an expression of wind, are an appropriate image for the climate ribbon. Also in terms of design, the context of the sea, tropical weather and sails have a big in unfluence on one’s consciousness of maritime forces and the practical technical thinking that the nautical environment demands.

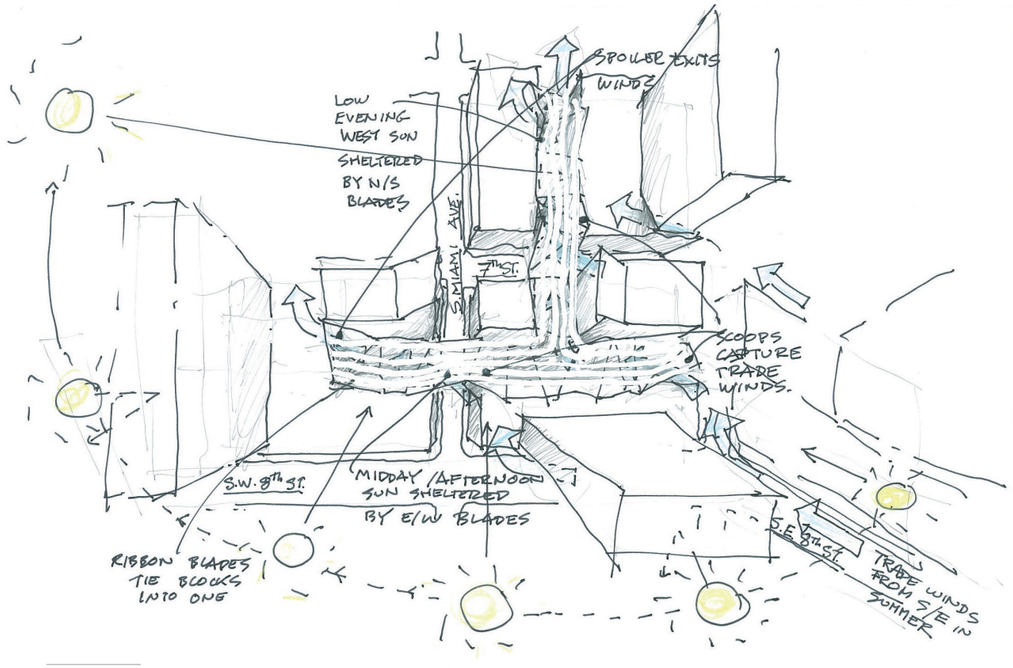


JALOUSIES

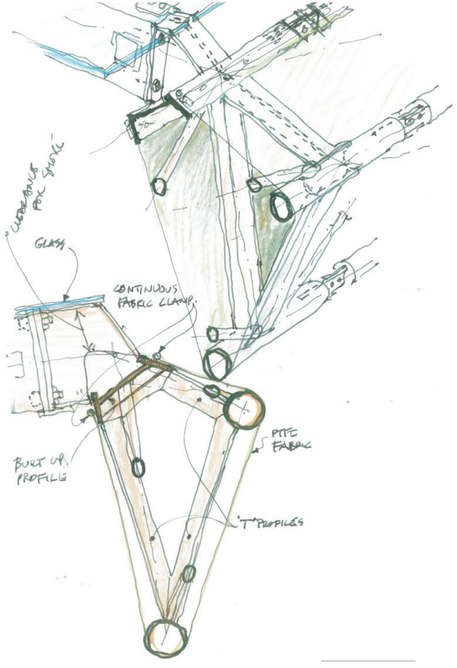
Traditional tropical architecture does not use air conditioning. Buildings are naturally cooled by shading and the breeze. Generous verandas or boxes with white louver slats protect windows and provide shade whilst ensuring natural ventilation. Houses were built on hill tops or places that favoured breezes and their jalousies have become a distinctive characteristic of colonial architecture.

- THE CLIMATE RIBBON™ BLADES WERE DIRECTLY INSPIRED BY THESE PRECEDENTS.

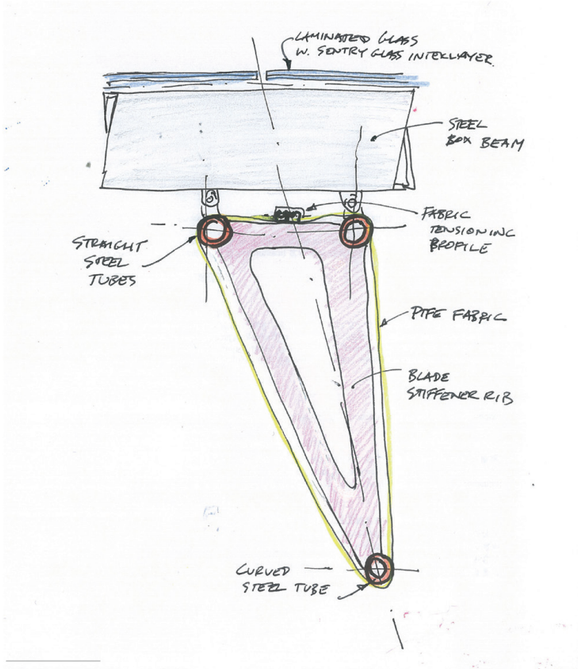
III. EARLY STUDIES & SKETCHES



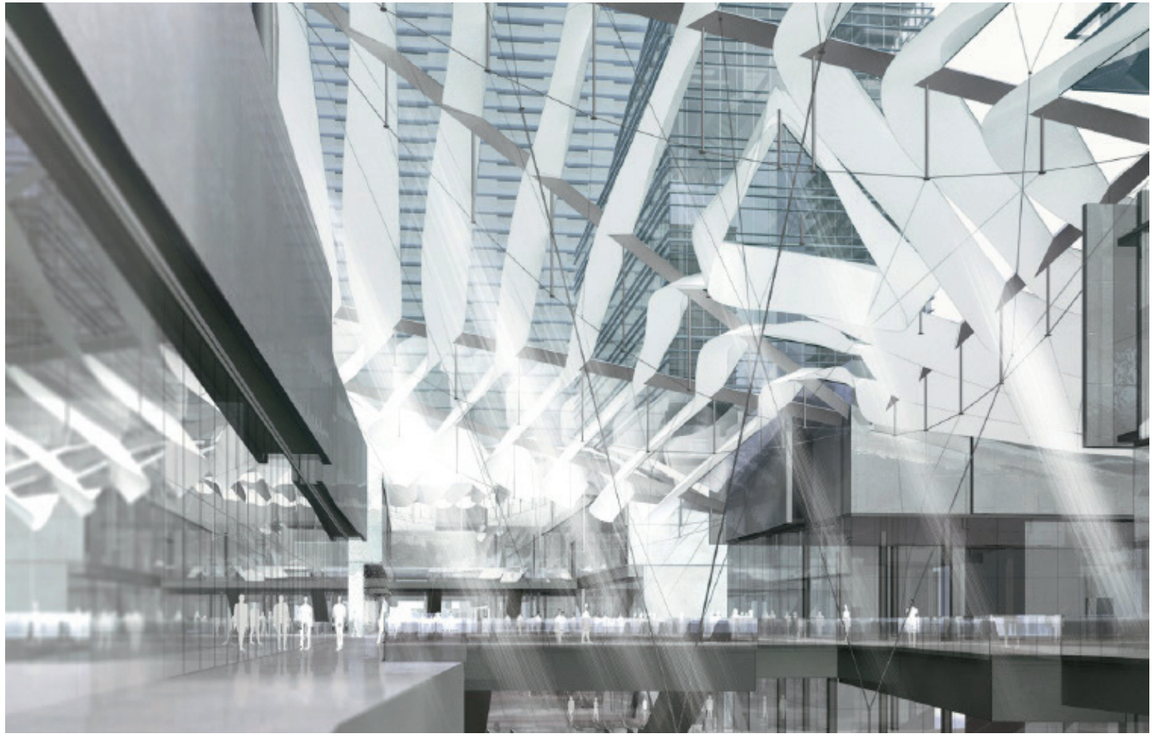
WIND AND SUN IMPACT
ON B.C.C

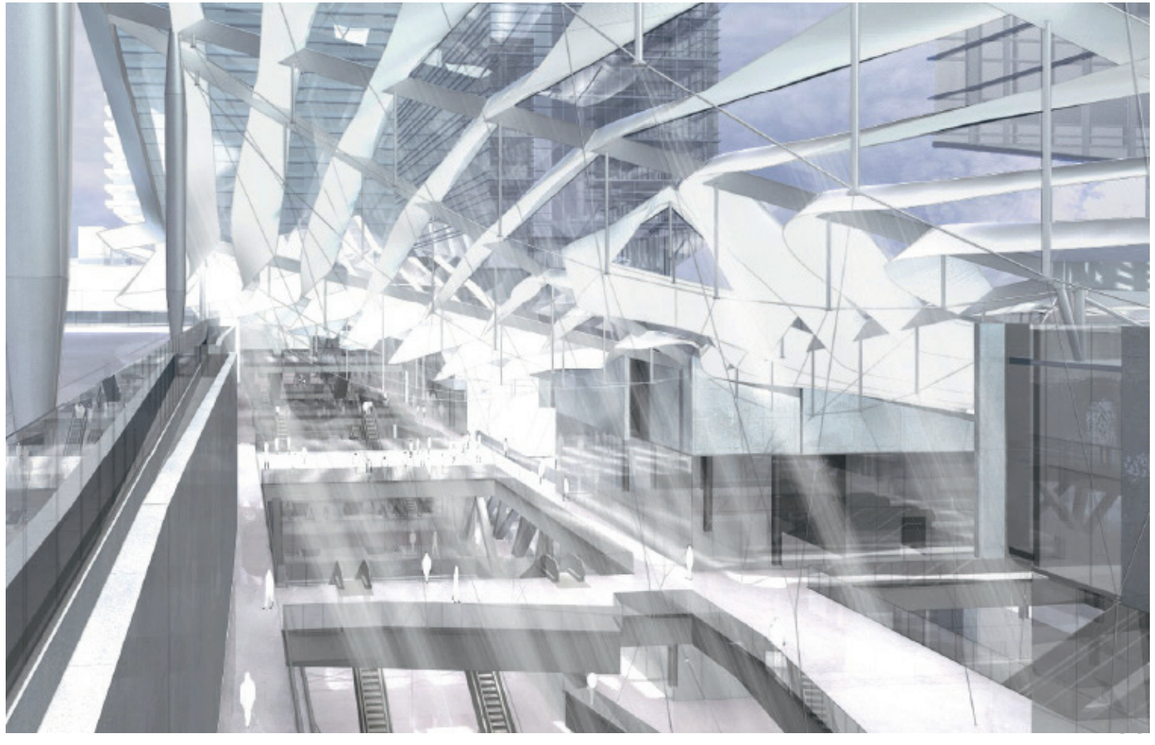


EDGE BEAM CONSTRUCTION
FABRIC STRECHED ON STEEL FRAME



TYPICAL BLADE
IN FABRIC ON STEEL





IV. SIMULATION & ANALYSES

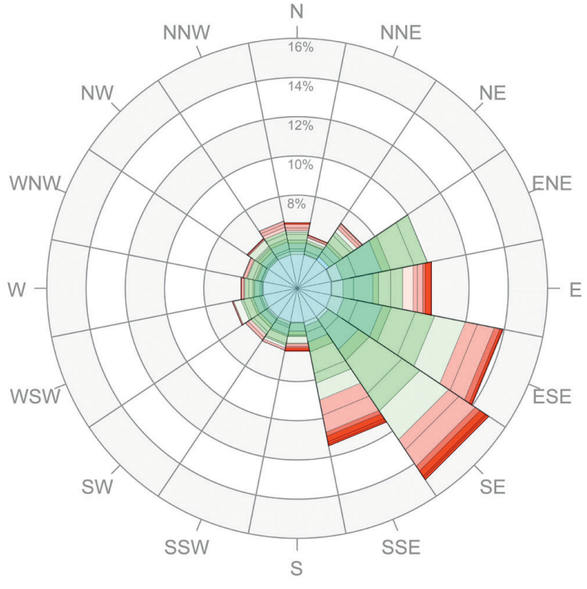
SCIENCE

Intuitive experience about natural cooling, shading and ventilation requires validation by scientific analysis. **Firstly**, studio digital and model-based quantitative and qualitative simulations were combined to develop a performance-based foundation for a comprehensive approach to the design. Virtual simulations of airflow, annual sun paths and rain- water were carried out. **Secondly**, physical testing in a wind tunnel was used to confirm the airflow predictions. Independent fluid dynamic simulations were made to measure airspeed, temperature and comfort conditions. Once the global topography for the Ribbon had been validated, the structure was tested against extreme wind forces in the wind tunnel laboratory. **Finally**, a fluid dynamic study of thermal comfort measured expected temperatures inside and outside the internal street.

WIND SIMULATION

Two very distinct aspect of wind were considered in the CILIMATE RIBON™ design.

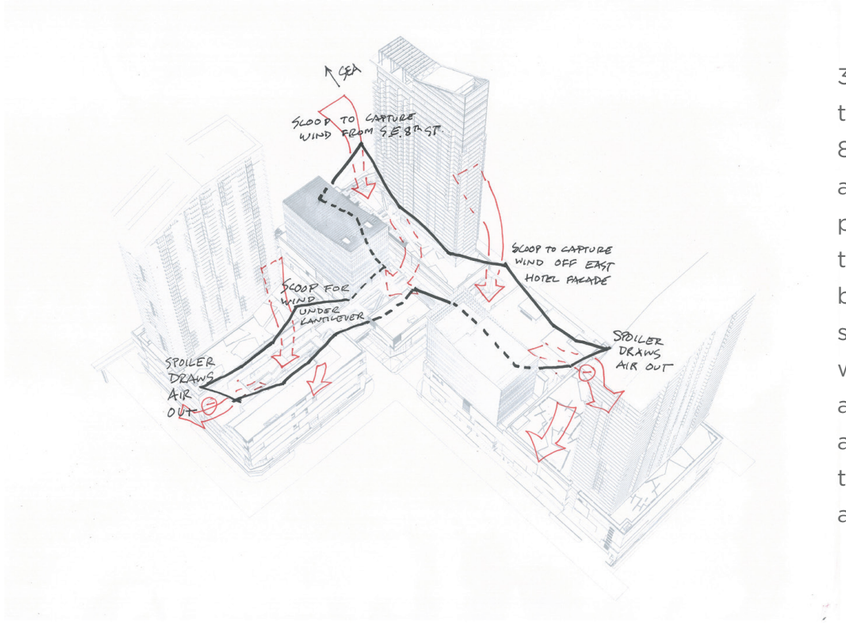
- HURRICANE STORM WINDS ARE THE PRIMARY FORCE THAT THE STRUCTURE MUST WITHSTAND WHILE AT THE SAME TIME BREEZES ARE DESIRED AND ENCOURAGED.



WIND ROSE FOR MIAMI
SHOWING DOMINANCE OF E.S.E TRADE WINDS

COMFORT BREEZE

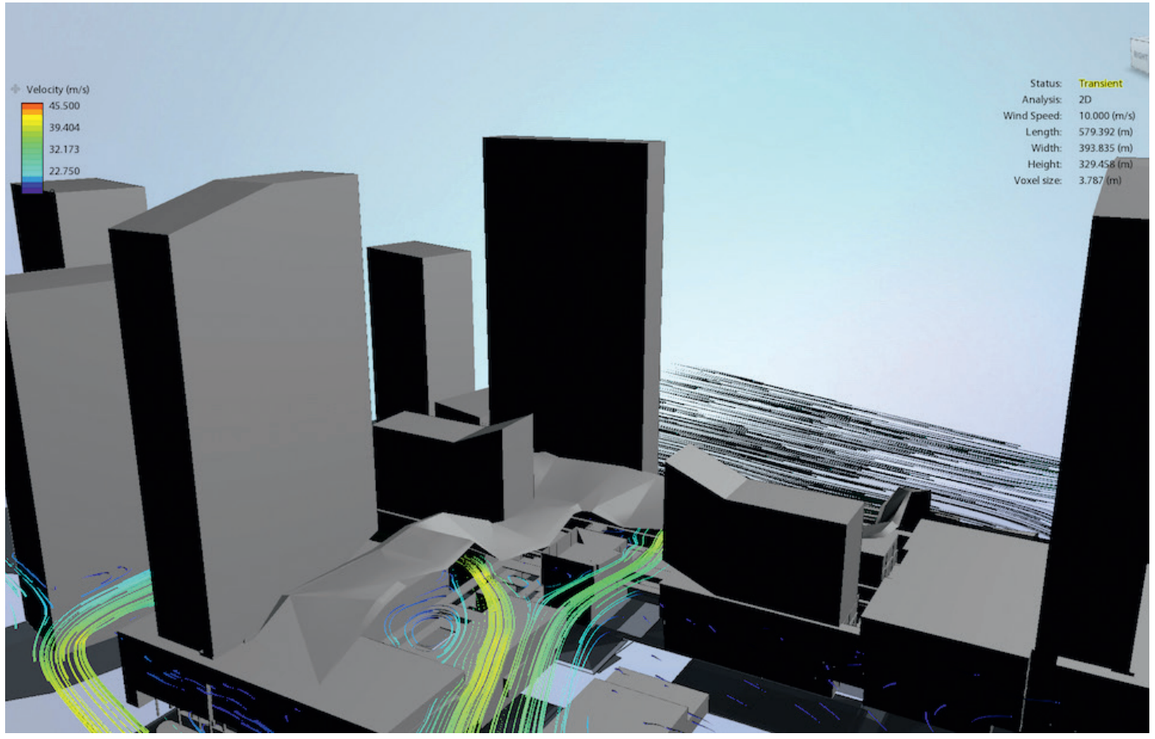
People feel cooler in a hot environment when they sense air movement over their skin. The CLIMATE RIBBON™ intends to improve the sensation of comfort in the hot seasons by generating this air flow in the main pedestrian street. Statistical data and comfort research produced by the wind and energy consultants affirm this fact. Benchmarks for comfort thresholds were determined and measured on thermal dynamic simulation models. These analyses confirmed the improvement that the Climate Ribbon provides to the protected areas of the public realm of the Brickell City Centre.



BREEZE FLOW CONCEPTS

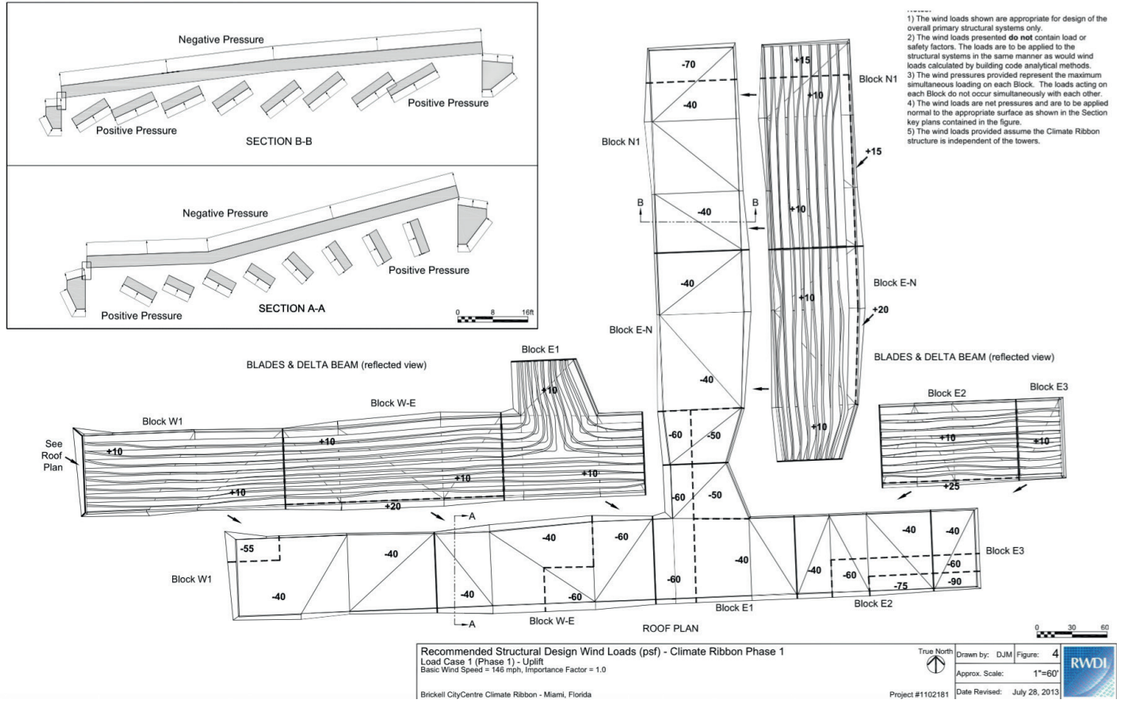
3D desk modelling shows that trade breezes flow up S.E. 8th street from Brickell key and wind their way into the pedestrian street of BCCE, then split and flow up the north branch or west to BCCW. The sectional diagram shows how the wind is collected by the ‘scoop’ at the eastern entrance and accelerated towards the exits by the ‘spoiler’ raised up portions at the West ends.

SIMULATION OF TRADE WINDS
ON B.C.C DEVELOPMENT



SEA BREEZES FUNNELED THROUGH STREETSCAPE

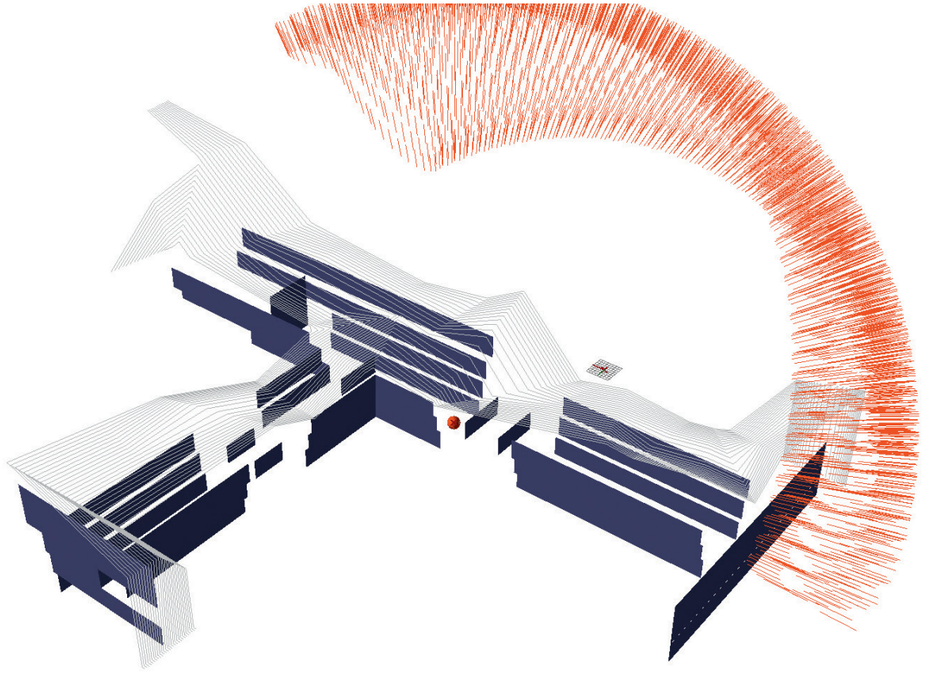
SECTIONAL VIEW SHOWING WIND ACCELERATION UNDER CLIMATE RIBBON



STRUCTURAL WIND

Once the final topography of the CLIMATE RIBBON™ is fixed as a function of the comfort and architectural design parameters, the structural forces on the surfaces are analysed through laboratory testing. A physical replica model of BCC with surrounding buildings is created and wind forces are measured on all surfaces taking into account high pressure points and dynamic buffeting considerations.

WIND PRESSURE MAP ON CLIMATE RIBBON SURFACES FROM TEST LABORATORY

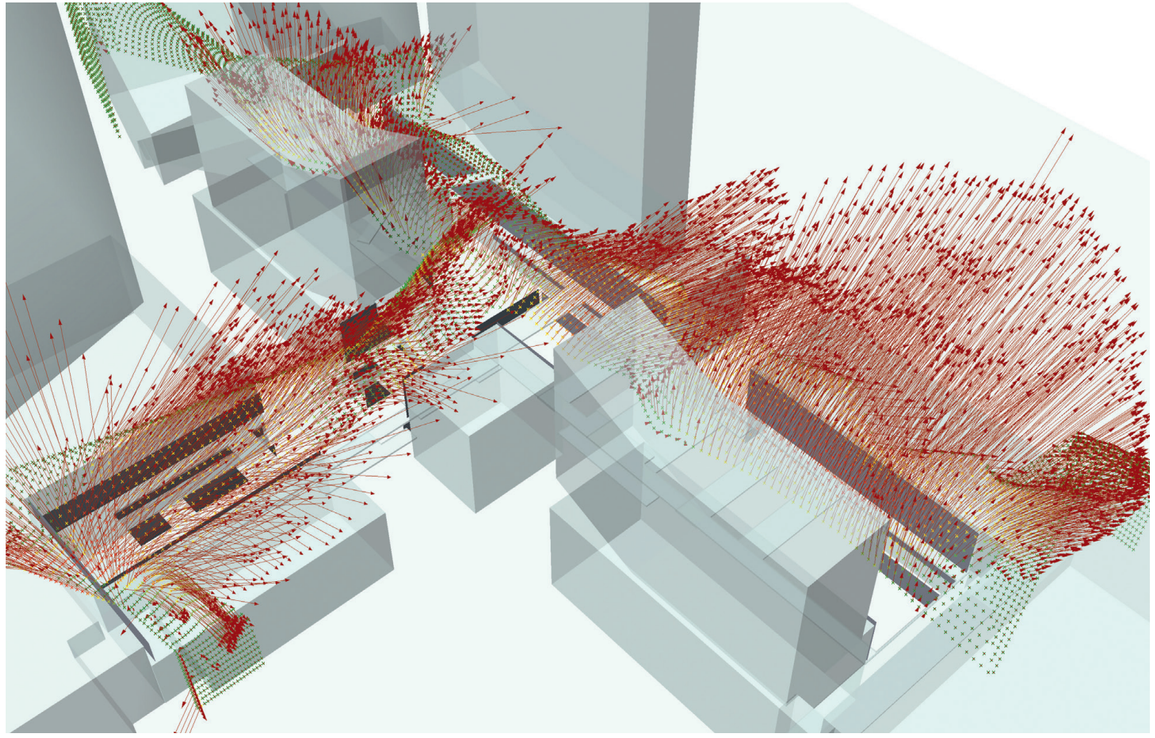


SUN & DAYLIGHT

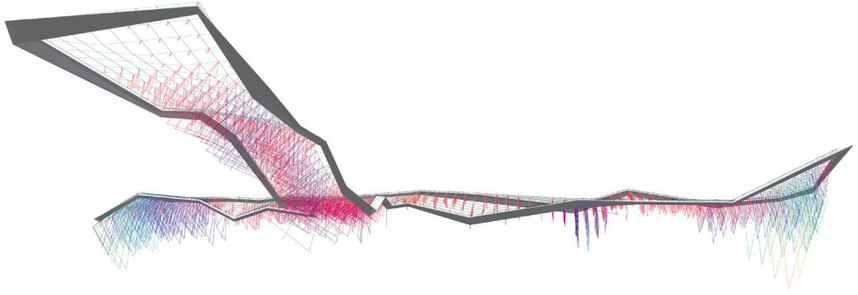
Optimal comfort conditions for the public realm require a balance of shade and natural light. Shading is necessary for comfort while indirect light and views of the sky are desirable. The CLIMATE RIBBON™ provides direct sun-shading for people and reduces solar radiation on the public realm areas. It is also designed to limit the amount of sun projecting directly into shopfronts.

ANNUAL SUN PATH IN RED,
SHOP FRONTS IN BLUE

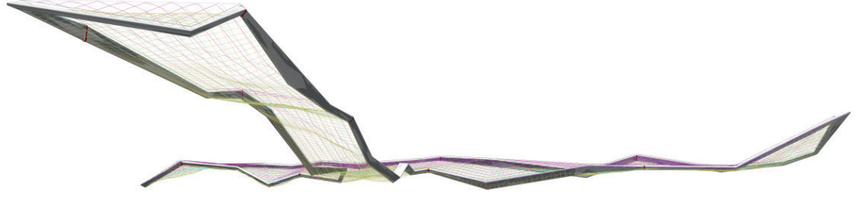
The annual sun path for the site is simulated in a 3D model that takes into account the BCC towers. It demonstrates how the Hotel East protects the North South street from noonday sun and how the West BCCW condominium tower protects the East/West street from late afternoon sun. It also shows that protection is required from mid-afternoon sun and evening sun, for the North South street.



SUN VECTORS FOR ANNUAL SUN



PARAMETRIC PROCESS :
SUN VECTORS DETERMINE BLADE ANGLES

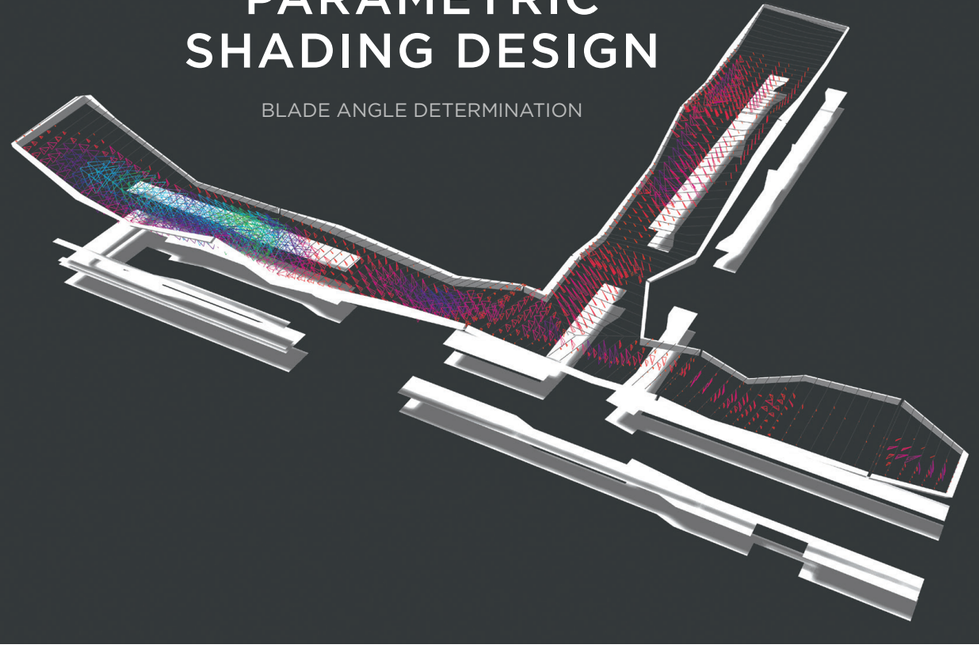


PARAMETRIC PROCESS :
BLADE PROFILE CURVING

The diagram shows a mapping of annual direction and intensity of sun exposure for the pedestrian street and shopfronts. It suggests that longitudinal blades in both North/South and East/West pedestrian streets, perpendicular to the sun angles shown on the graphic plots, give optimal alignment for sun protection. A computer model was developed to plot the blade inclination for optimal parametric design. The computer worked long hours calculating the inclination of each blade at points along the lengths.

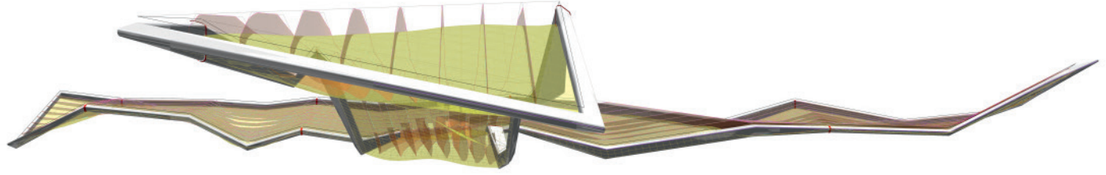
PARAMETRIC SHADING DESIGN

BLADE ANGLE DETERMINATION

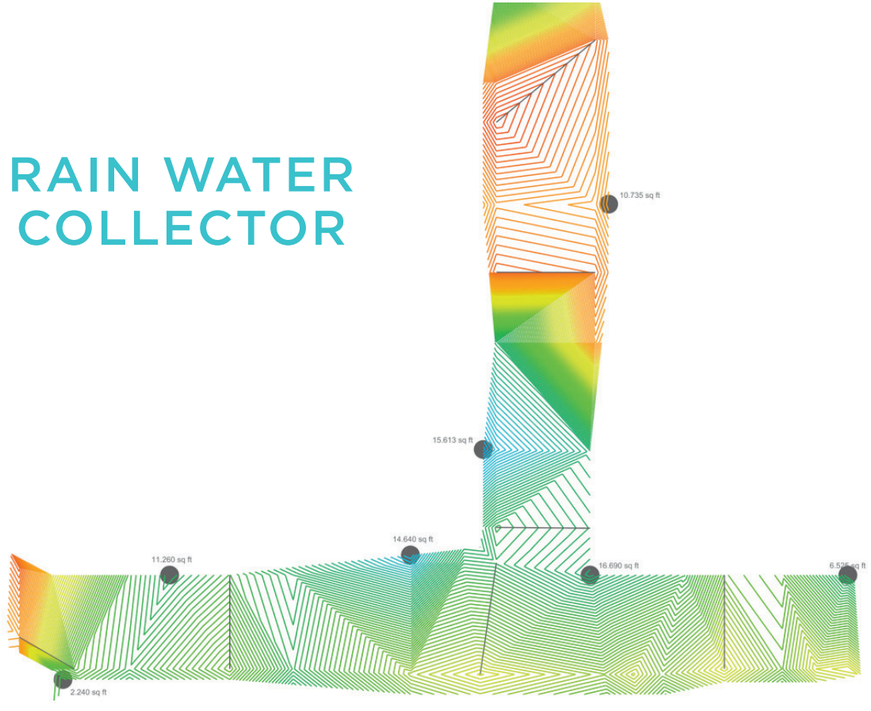


BLADE FLOW

BLADE EDGE TUBE MODELLING TO CONTROL SMOOTHNESS



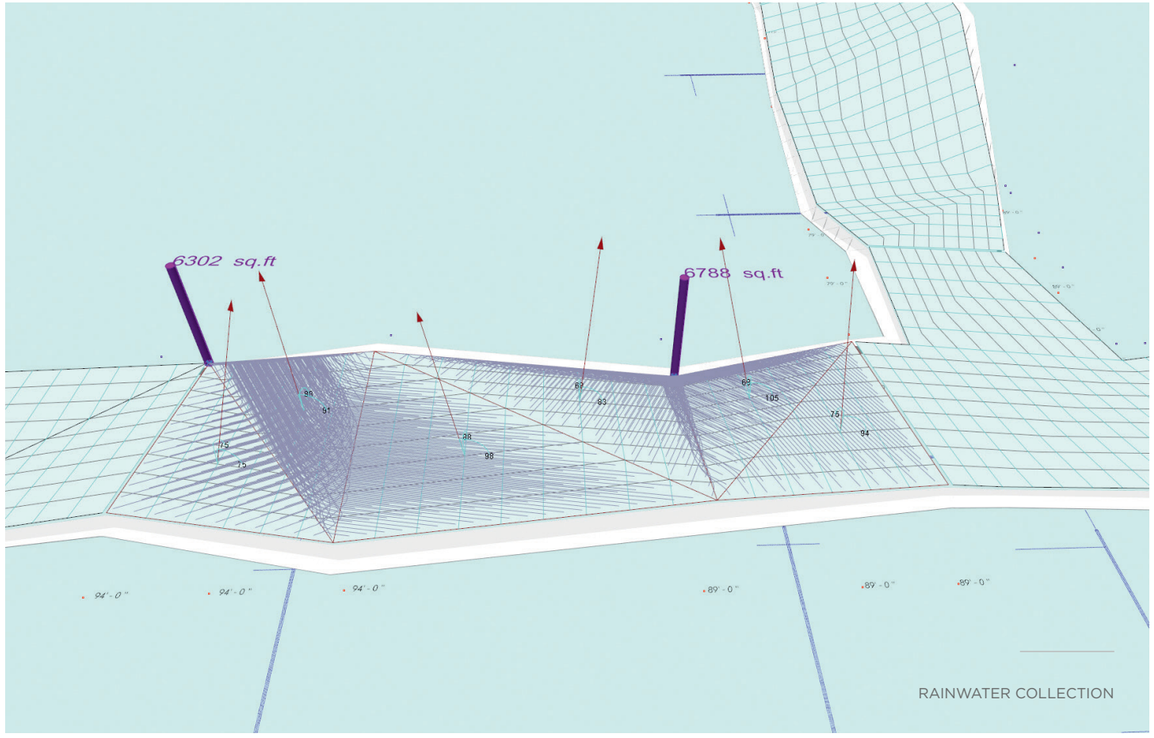
RAIN WATER COLLECTOR



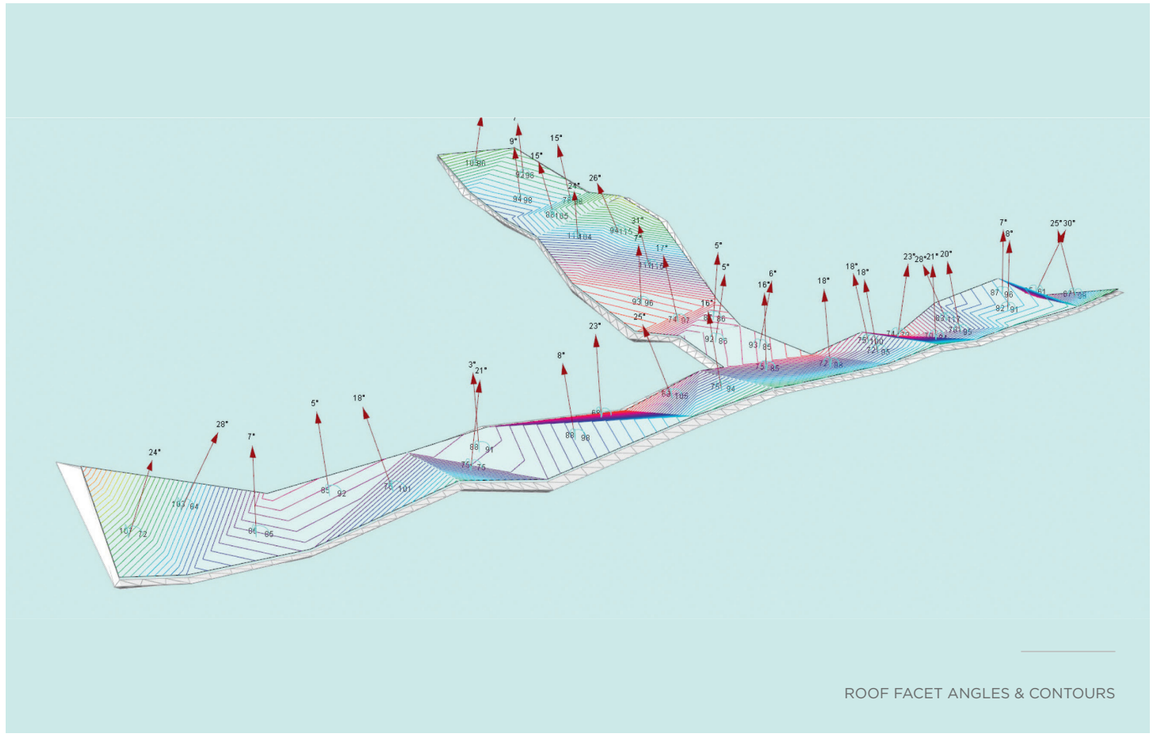
RAIN SIMULATION

After Sun and Wind, rainwater is another important parameter of the CLIMATE RIBBON™ design. The topography of the surface directs rainwater to cisterns on the roofs of the parent building blocks for diverse uses such as irrigation of the landscape. 3D modelling simulations show contours of the surfaces of the ribbon and predict quantities of water at each collection point.

ROOF CONTOURS AND
WATER COLLECTION POINTS

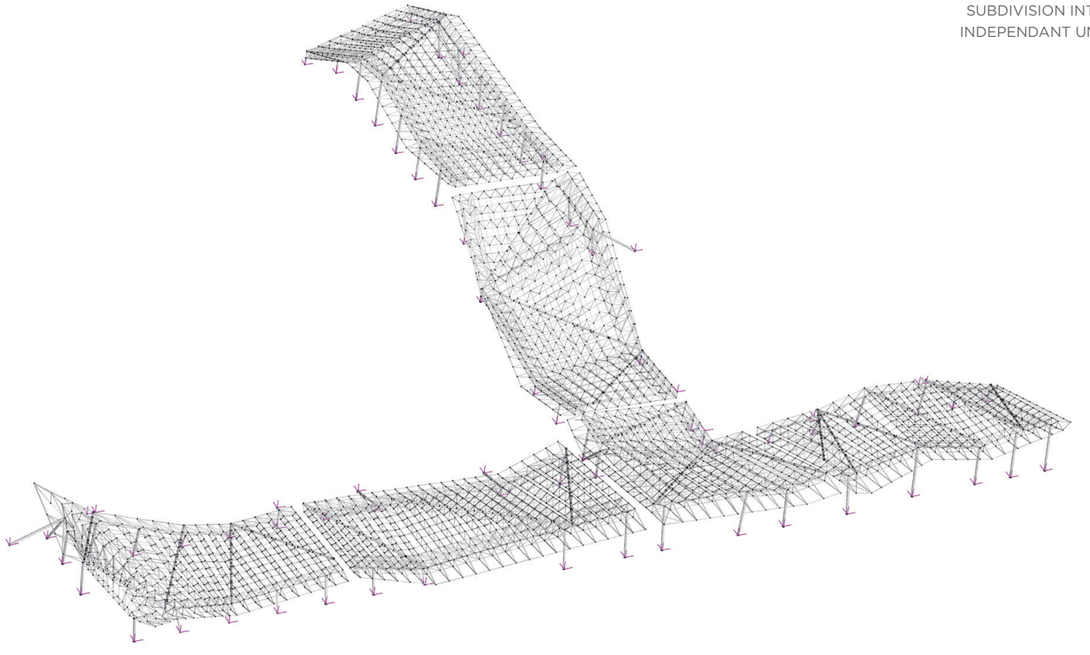


RAINWATER COLLECTION



ROOF FACET ANGLES & CONTOURS

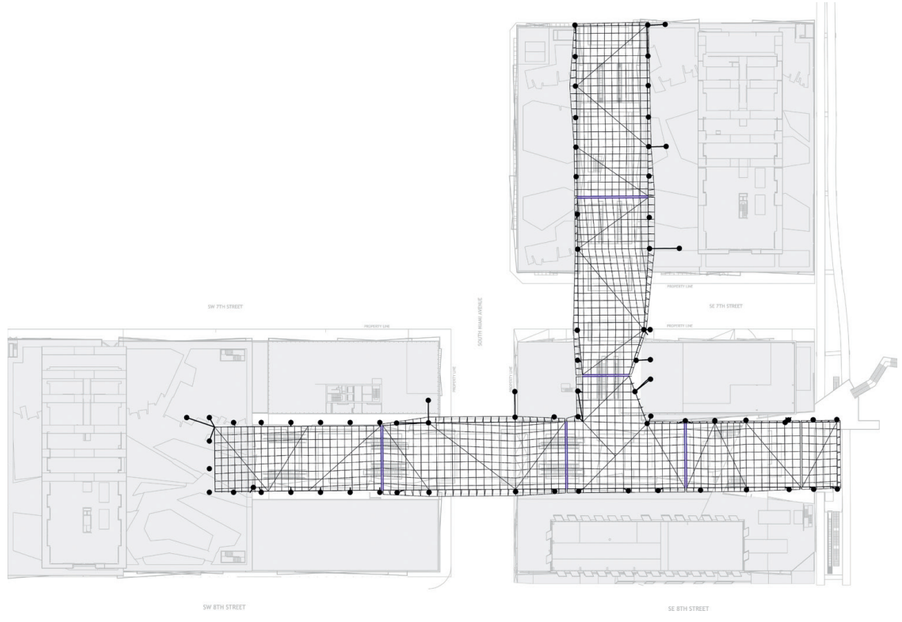
V. STRUCTURE



SUBDIVISION INTO 6
INDEPENDANT UNITS

Given that the CLIMATE RIBBON™ jumps between the different buildings on distinct city blocks, the design has to take into account that the blocks move differentially between each other. It must float above them without locking in structurally to all of them at the same time. This is achieved by subdividing the ribbon into a series of independent units minimally connected to the retail plinth in a 'statically determinate' manner, like a series of tectonic plates that move relative to each other. The gaps in the blades show the lines where the movement occurs. The ribbon surface itself is made in stiff planes and supported on multiple pinned legs. Each unit has one braced point firmly linked to a single building, where the legs are triangulated, and other support points where the legs are articulated to allow separate buildings to shift beneath the ribbon.

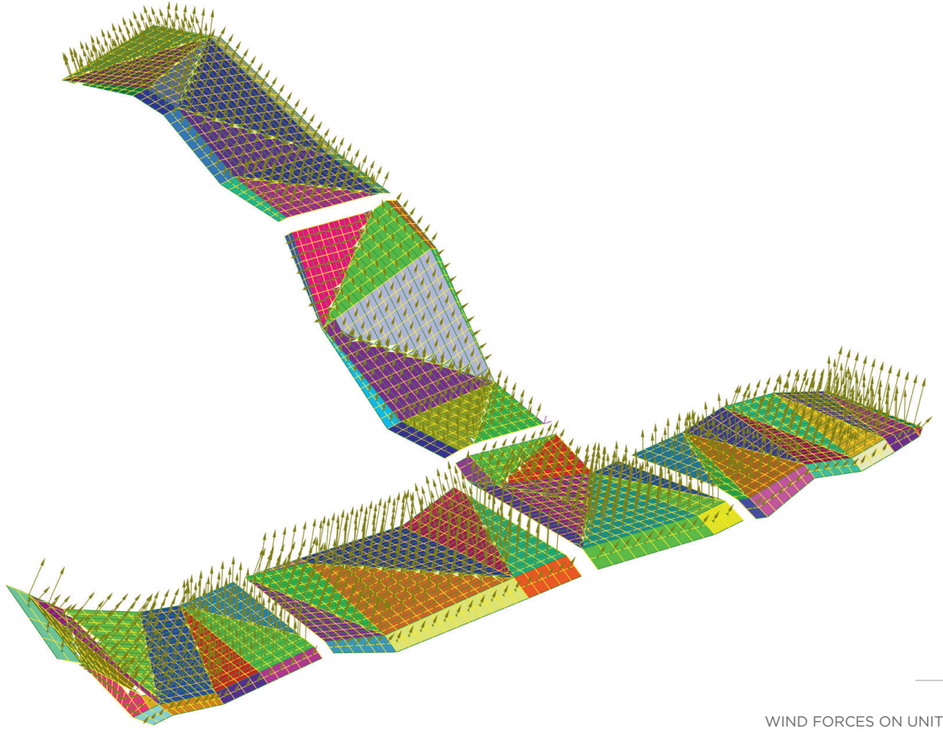
- THE 'PARENT' BUILDINGS BENEATH THE CLIMATE RIBBON™ ARE DESIGNED TO WITHSTAND THE HORIZONTAL FORCES FROM THE RIBBON AT THESE STIFF POINTS AND THE VERTICAL FORCES AT ALL OF THE OTHER POINTS.



FOOTPRINT SHOWING SUPPORT
LEGS AND BRACING

FOOTPRINT

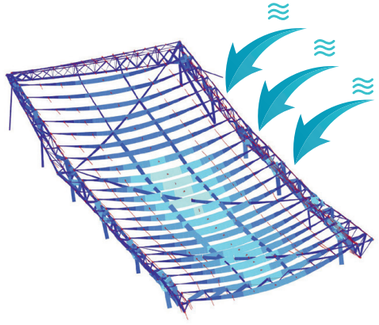
The footprint drawing shows the legs and the stiff points while the blue lines show the movement joints between the climate ribbon plates.



WIND FORCES ON UNIT BLOCKS

STRUCTURAL ANALYSIS

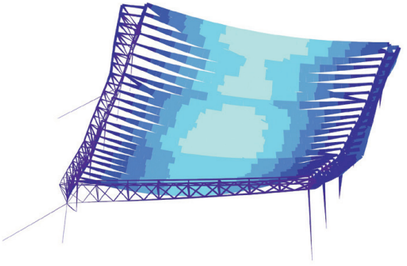
The biggest forces the CLIMATE RIBBON™ must withstand are hurricane wind loads. Wind forces on the whole surface are determined by combining wind tunnel laboratory data with Florida building code calculation methods. The structural analysis shows the theoretical wind forces determined in the wind tunnel.



The wind is applied as a force that is perpendicular to each glass plane and the cumulative forces are calculated for all the members and the support columns.

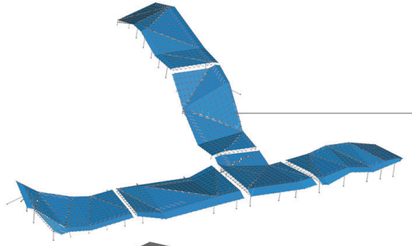
WIND LOADING CALCULATION

Each element is then engineered and all of the detailed connections verified as a function of these wind forces. The fabric and glass surfaces are calculated to withstand the maximal winds and tested for flying debris.

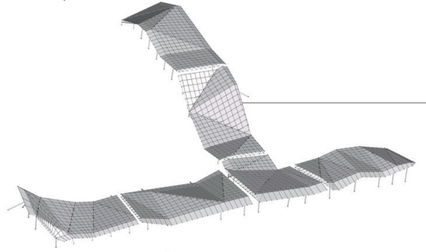


WIND LOAD DEFLECTIONS

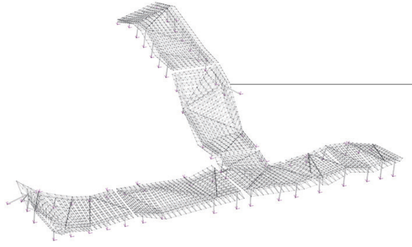
VI. MATERIAL & FABRIC



GLASS



STEEL

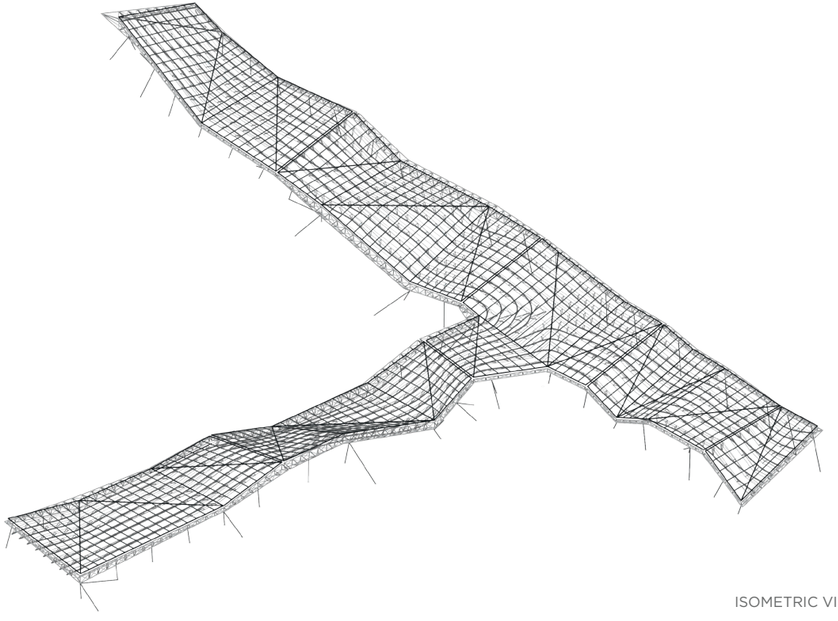


BLADES

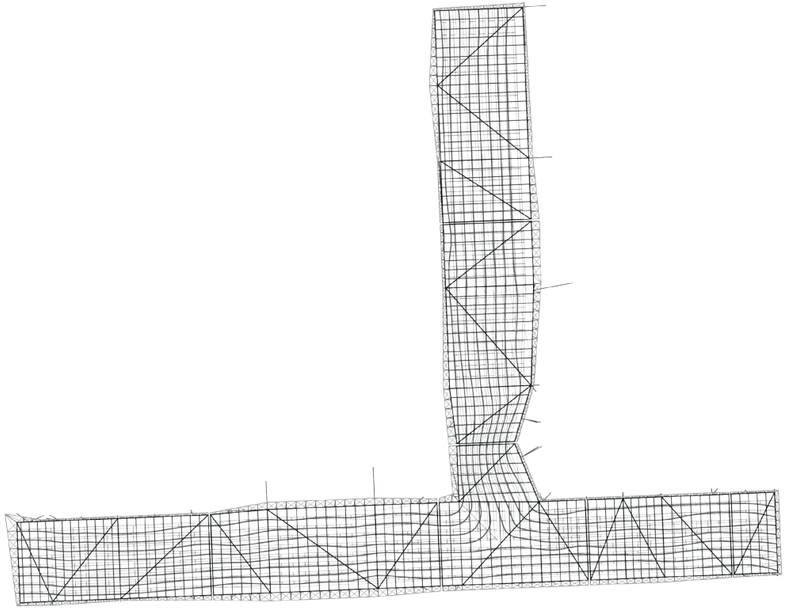
LAYERS & GEOMETRY

There are 3 layers to the Climate Ribbon: Steel framing, a Glass covering and the Fabric blades suspended beneath. Three basic materials.

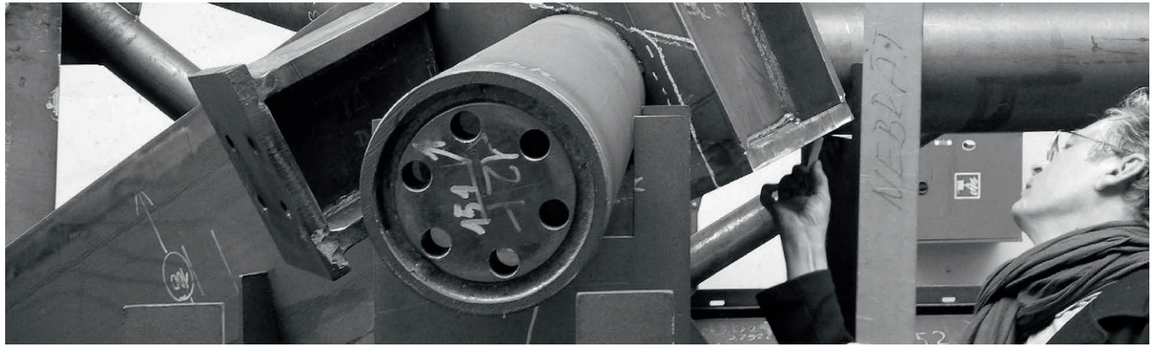
CLIMATE RIBBON COMPONENTS



ISOMETRIC VIEW FROM BELOW



PLAN VIEW



STEEL

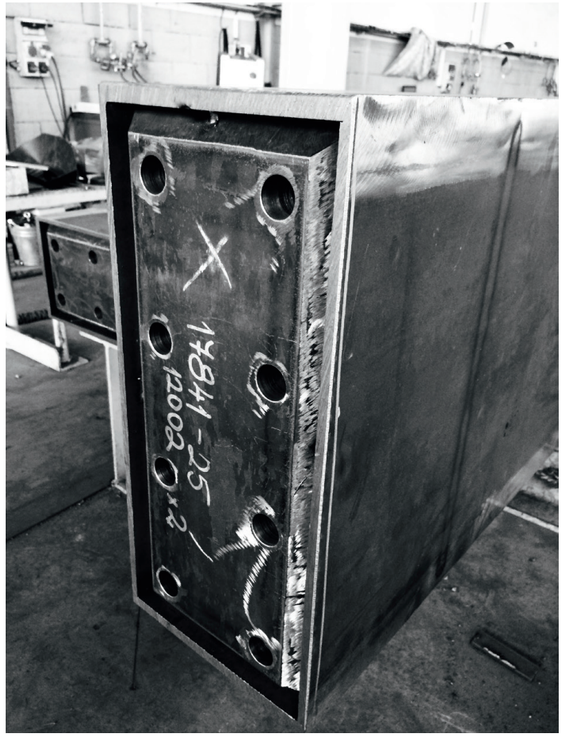
Steel is the primary structural material, not only of the Climate Ribbon but also of the main Parent Buildings of BCC retail podium and towers. It is durable, predictable and structurally the most efficient and economically optimal material available for the project. Initiated in Miami, conceived in Paris, engineered in Germany and fabricated in the Czech Republic, the CLIMATE RIBBON™ steel was shipped back to Miami across the Atlantic ocean.

A primary ‘Delta beam’ triangular truss provides a frame around the perimeter of the ribbon, resting on the inclined support legs. Repetitive box beams span across the space between the Delta beam frames.

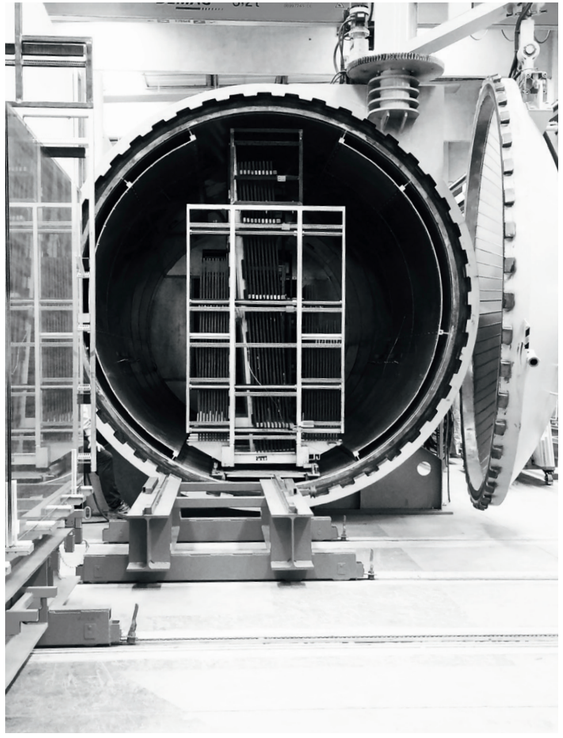
STEEL FABRICATION FACTORY

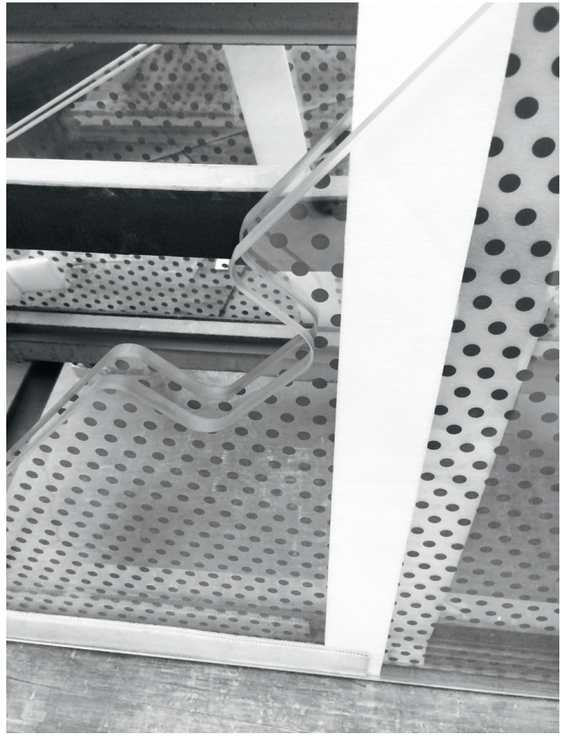
The box beams are welded-up from steel plates whose thicknesses vary as a function of the forces in them, to optimise tonnage. Connection plates, bolt splices, glazing support surfaces and threaded studs are all factory-prepared to allow simple site assembly.

All welds are quality tested by Miami-qualified inspectors to ensure that weld integrity is to the required structural standards. The steel is then rust-protected and finished with a light grey paint to diminish its visual impact against the blades.



BOX BEAM SPLICE
AND SITE ERECTION JAN 2015





GLASS

The glass skin, resting directly on the steel beams, provides the rain shelter protection. Two sheets of heat strengthened glass are laminated together to make safety glass. The glass has a ‘frit’ printed in a dot pattern to provide further solar protection to the blades.

To comply with Florida hurricane safety parameters, the glass is tested to ‘missile impact’ standards where a 2x4 is projected against it at high speed while the surface is subjected to hurricane wind pressures.

All glass was pre-cut and treated in Austria, and, like the steel, transported by ship across the Atlantic.

GLASS LAMINATION AUTOCLAVE
AND FRIT PATTERN FOR SHADING

STUDY MODEL OF BLADE IN HDA STUDIO

FABRIC BLADES

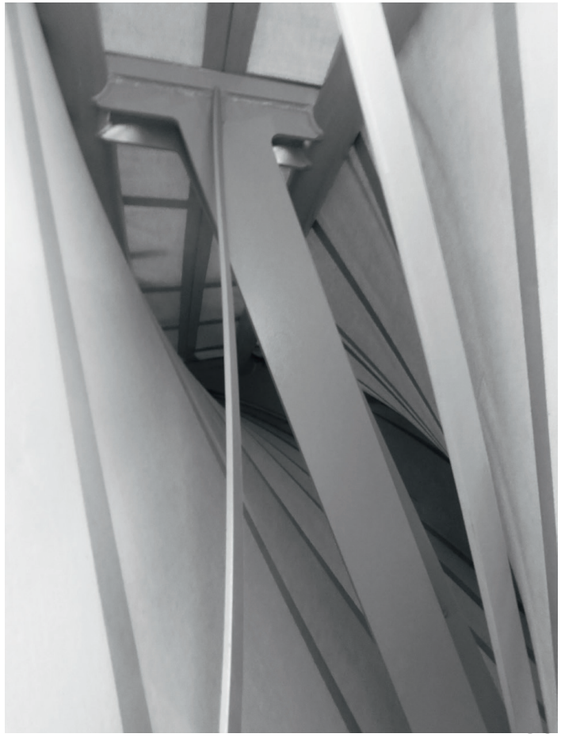
The blades are a fluid warped surface that can only be made in a tailorable and supple material. Architectural fabric, a building equivalent of sailcloth, was chosen. It is a fibre-glass mesh coated with PTFE (a durable polymer called Polytetrafluoroethylene), more commonly known as Teflon for its non-stick characteristics and inertness.

The material is often used for large span applications such as football stadiums or fair event canopies. Its longevity and durability is critical to the success of the blades.

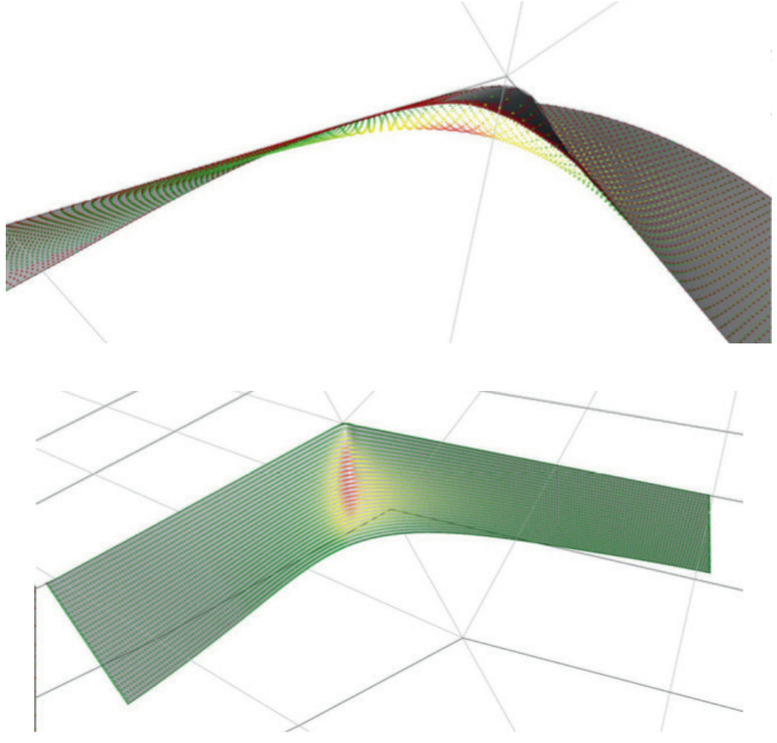
In addition to the formability of the material, the translucency of the material is an important factor to give the climate ribbon its feel of lightness.

The fabric is tailored to form-found shapes, using patterning software, similar to that used in dressmaking and the fashion industry. It is cut and heat-welded and then stretched onto steel frames. The steel frames, consist of tubular edge profiles with spacing diaphragms.

The fabric is fixed to these frames at preassembly facilities in Miami near the site. Each blade is then lifted into place and pinned to the supporting steel frame.



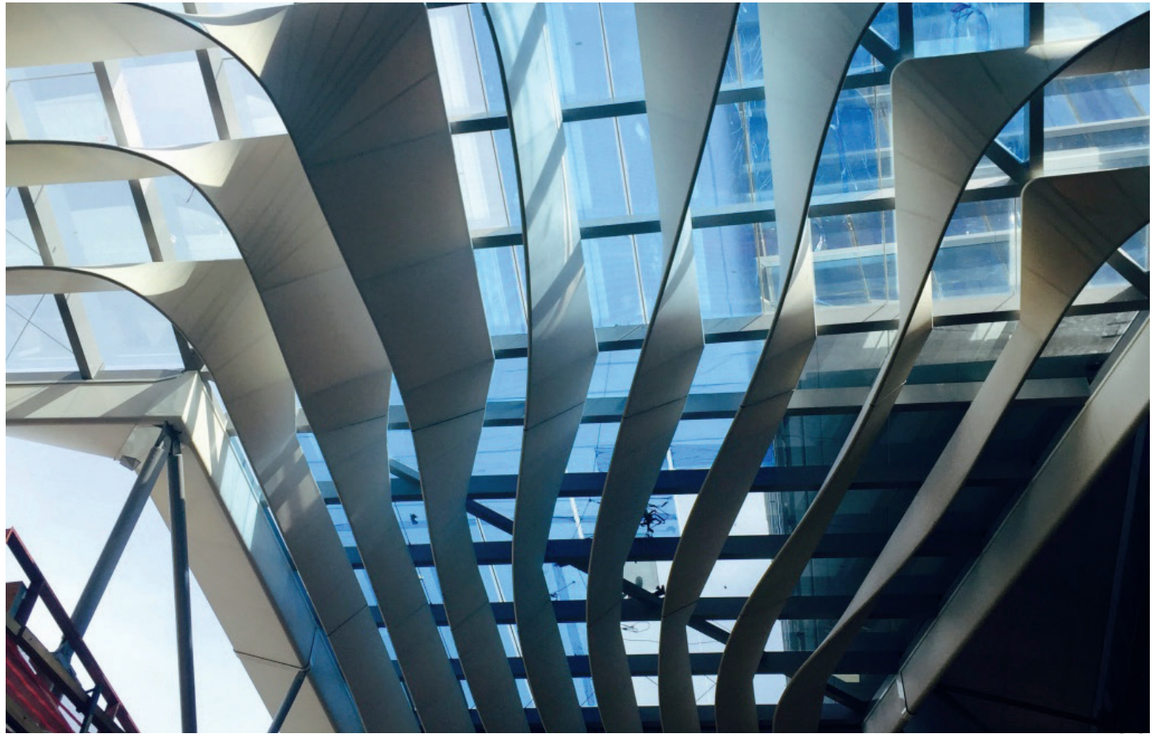
BLADE ASSEMBLY AND FABRIC TENSIONING
IN MIAMI SUMMER 2015

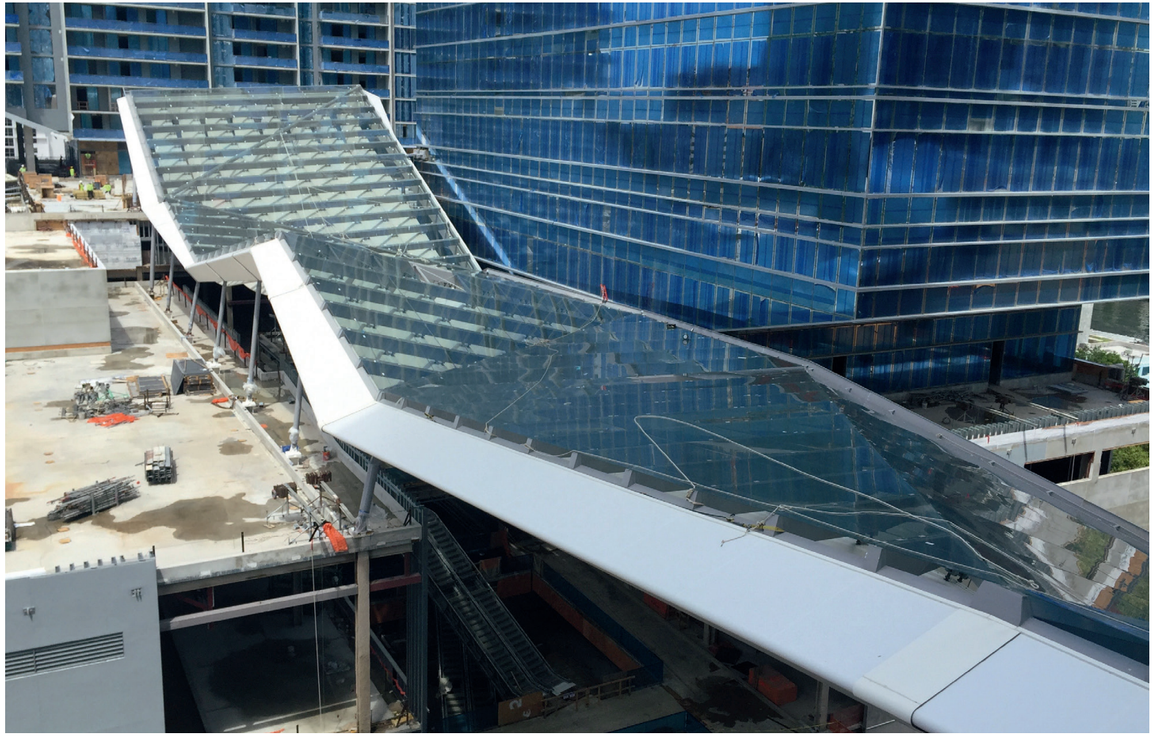


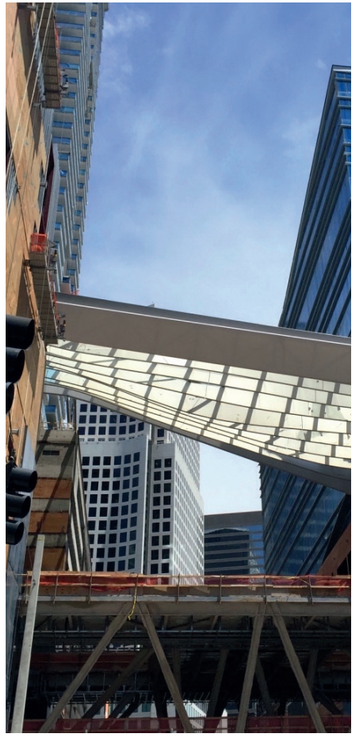
Though the CLIMATE RIBBON™ is an entirely static composition of over a thousand tons of steel, two and a half acres of glass and three and a half acres of fabric, it gives the feeling of movement - expressing nature, climate and our commitment to the environment.

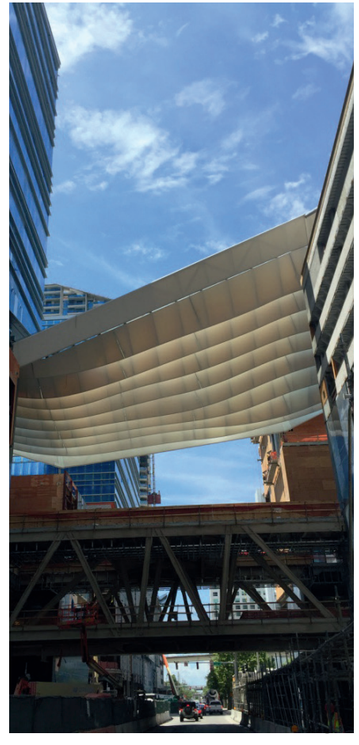
FABRIC SURFACE DESIGN TENSION SIMULATION

VII. CONSTRUCTION










Tyvek
Tyvek
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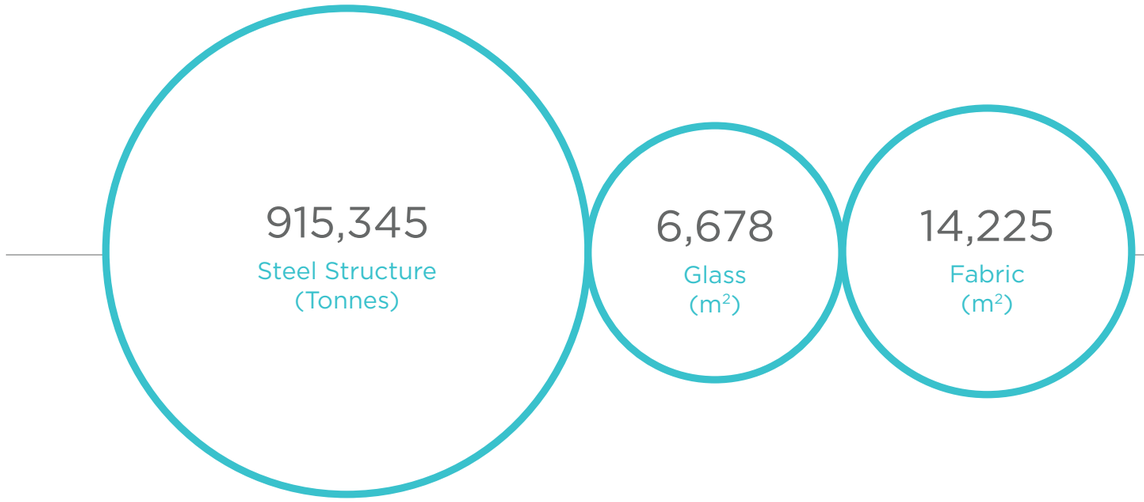
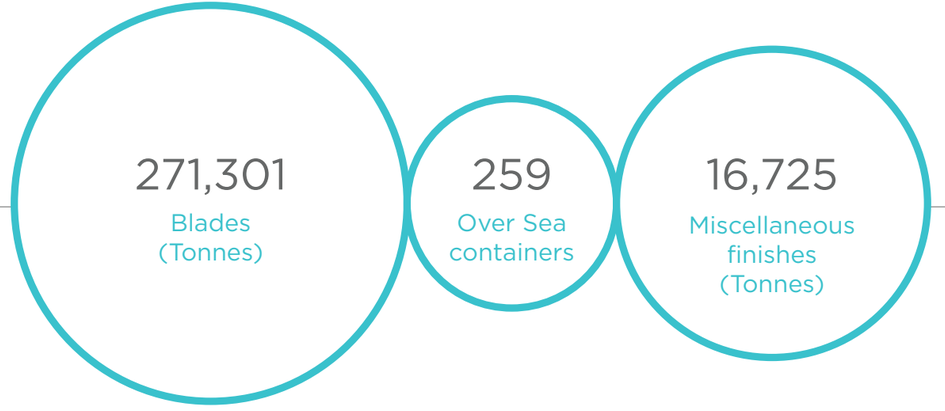
Tyvek

VIII. VITAL STATISTICS


915,345
Steel Structure
(Tonnes)
6,678
Glass
(m²)
14,225
Fabric
(m²)


271,301
Blades
(Tonnes)
259
Over Sea
containers
16,725
Miscellaneous
finishes
(Tonnes)

IX. PEOPLE

CLIMATE RIBBON ™

Miami, USA

Client: Swire Properties, Hong Kong and Miami

Architects: Arquitectonica, Miami, Florida

Climate Ribbon Designer: Hugh Dutton Associés, Paris

Sustainability peer reviews: University of Carnegie Melon and Cardiff University

Wind tunnel consultants and testing: RWDI, Guelph, Ontario Canada

General Contractor: Americaribe Morarity Joint Venture

Climate Ribbon Design Build contractor: Gartner, Wurzburg, Germany

Steel Subcontractor: Signum SPOL, Czech Republic

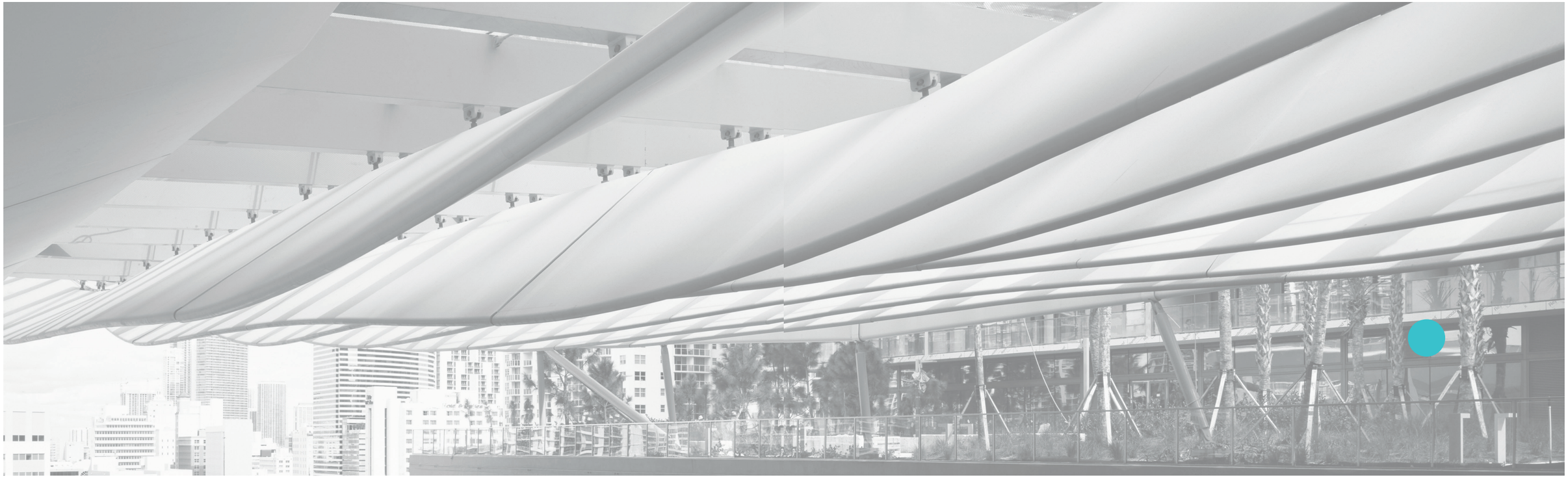
Glazing supplier: Eckelt, Austria

Fabric engineering: FTL Stuttgart

Fabric Manufacturer: Cannobio Italy

BRICKELL CITY CENTRE

SWIRE PROPERTIES



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