



STEEL

Architecturally
Exposed Structural
Steel

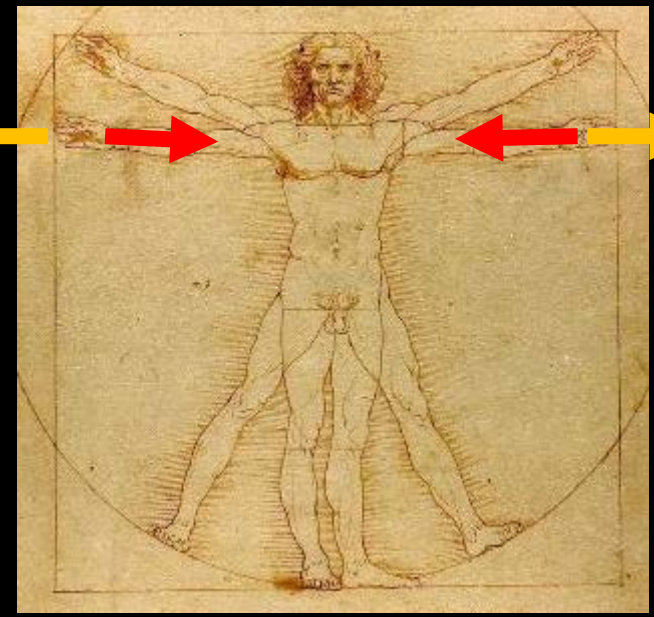
TENSION

Part 1



Tension
i.e.

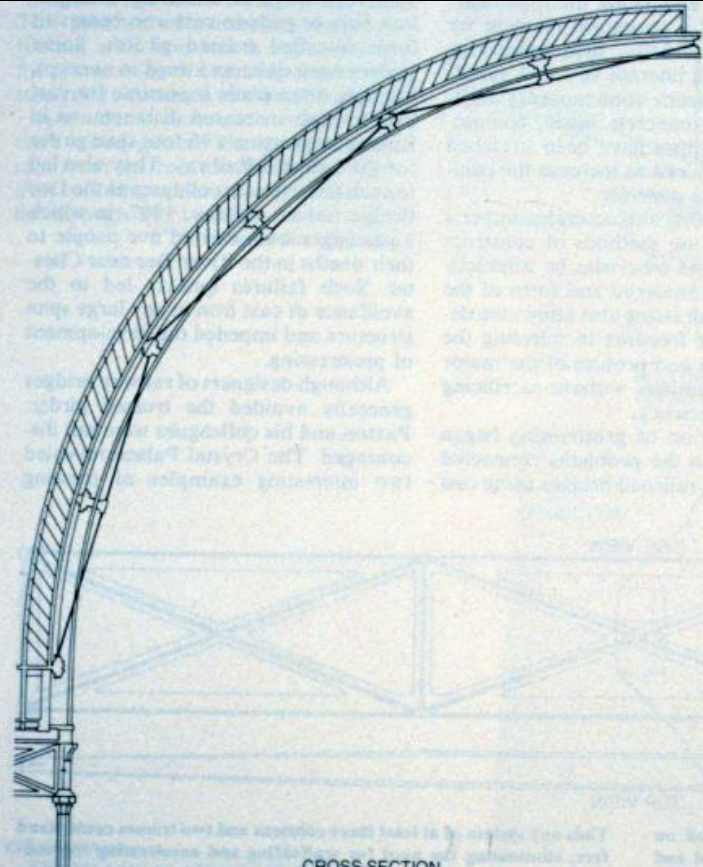
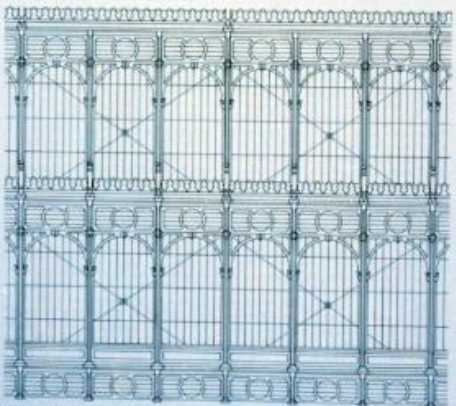
STRETCHING



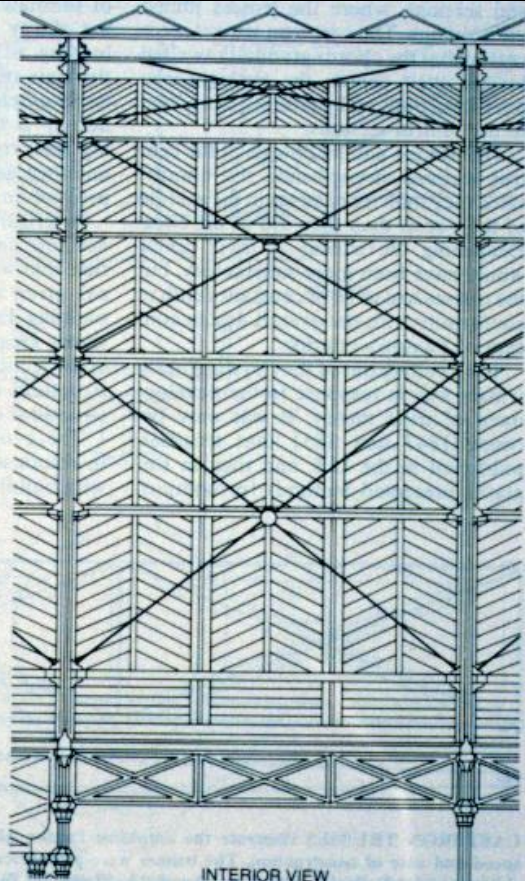




WROUGHT-IRON RODS provided a rigid support for the exterior walls of the Crystal Palace, which had an internal wall to stiffen it. Visible from inside and out (the interior view is shown here), these cross braces added to the building's strikingly contemporary appearance.

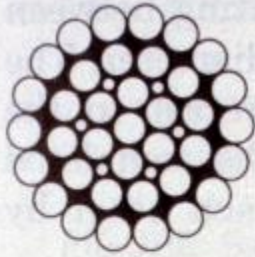


CROSS SECTION

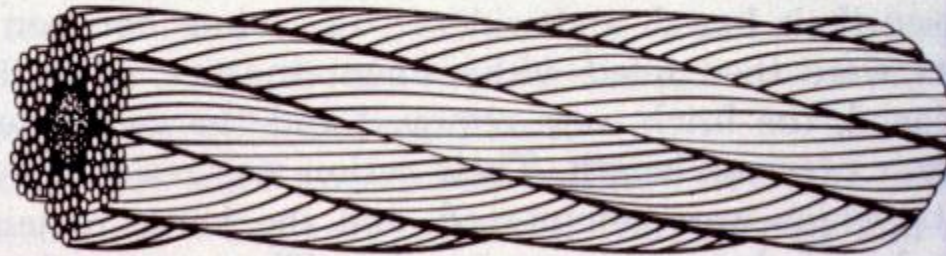
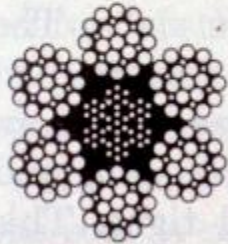


INTERIOR VIEW

cables = steel "rope"



(a) Galvanized Bridge Strand



(b) Galvanized Bridge Rope

FIGURE 6.43 Wire strand and rope.

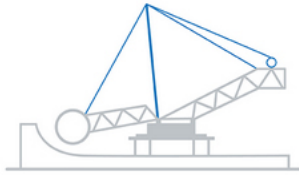


Brooklyn Bridge
New York City, USA
John A. Roebling
1893

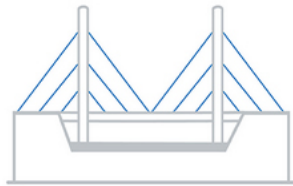
- For Tension structures there is a choice between using **cables** or **rods**.
- If the intended in situ is one of suspension (curved final form) then it will usually be cables
- For X bracing, we usually use rods as they will be stiffer when being installed.
- For exterior use cables must be given a weather proof casing to prevent corrosion
- End connectors are normally clevis type.
- Must include the ability to tighten the members as they need to be installed loose, connected, then tightened.

Do I use a cable or a rod?

- Cables can be extremely long and so are used where length is an issue
- Rods are limited to shipping lengths and are never spliced, so must fit on the bed of a standard long transport truck



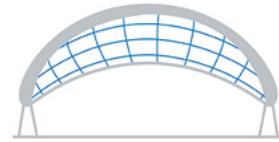
**Bucket Wheel Excavators
and Spreaders**



Cable Stayed Bridges



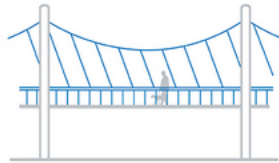
Giant Observation Wheels



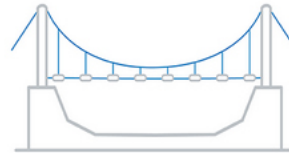
Glass & Membrane Roofs



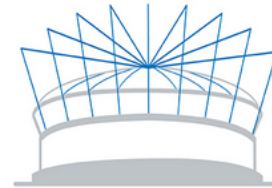
Glass Facades Systems



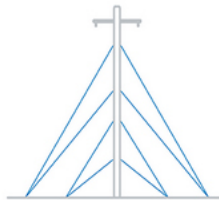
Pedestrian & Cycling Bridges



Pipeline Bridges & Suspension



Stadium & Arena Roofs



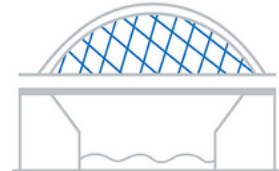
Stayed Masts & Towers



**Stayed Windturbine, Transmission
Towers and Offshore Platforms**

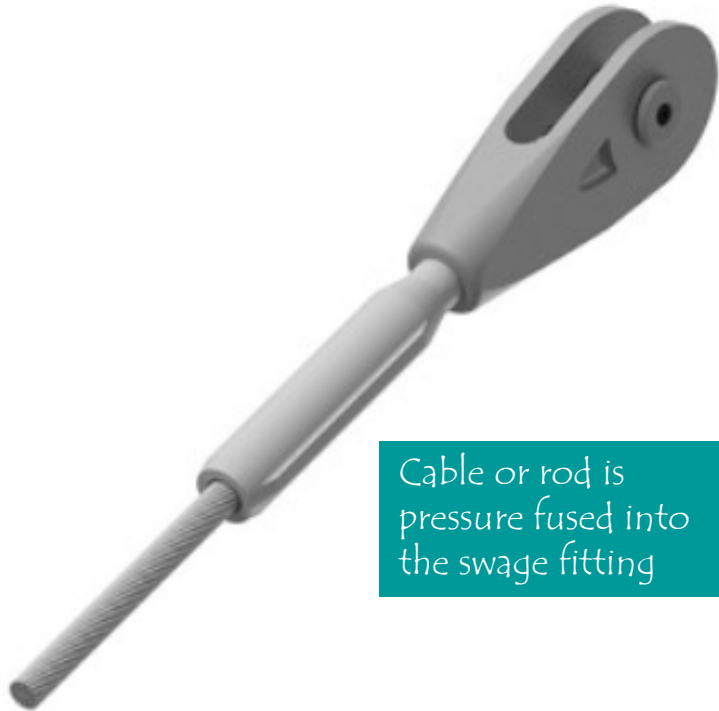


Suspension Bridges

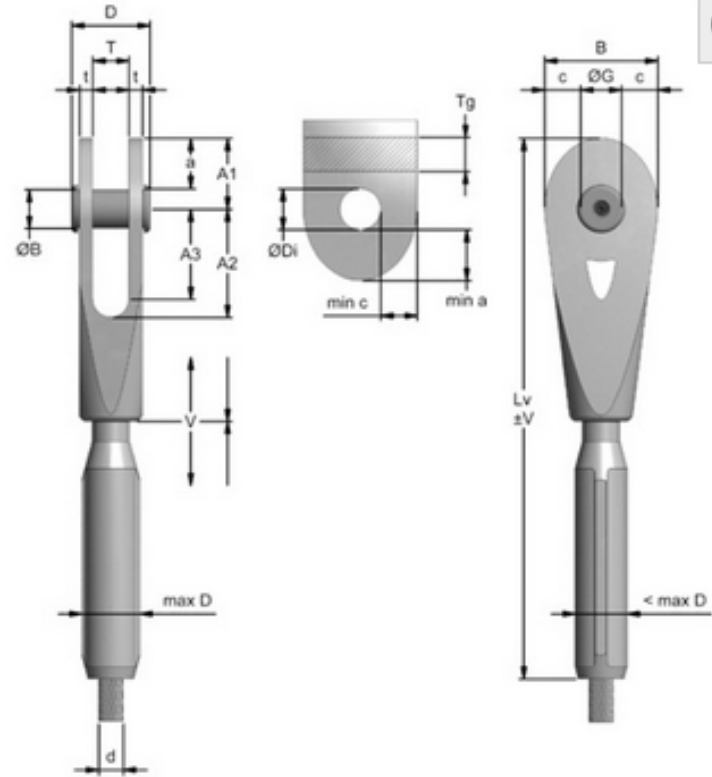


Tied Arch Bridges

Open Socket



Cable or rod is
pressure fused into
the swage fitting



Types we will look at include:

- Simple X bracing applications
- Suspension structures
- Fabric structures
- Mast and Cable support systems
- Force differentiated structures (trusses, tensegrity)
- More innovative use of tension members to create large roof spans

- Cable based glazing systems will be looked at in our steel and glazing lecture

SUSPENSION SYSTEMS

A wide-angle photograph of a pedestrian suspension bridge in Yufuin, Japan. The bridge features a prominent white A-frame tower on the left, with cables extending to the bridge deck. The bridge spans a deep valley with a steep, grassy hillside in the foreground. In the background, there are rolling hills and mountains under a clear blue sky with light clouds. Several people are visible walking on the bridge and in the paved area below. The overall scene is bright and scenic.

Pedestrian Suspension Bridge
Yufuin, Japan



九重大吊橋









安全
注意
気圧に
かけください
※この器具は高圧電気で

















Pedestrian Suspension Bridge
Miyazaki, Japan



Pedestrian Bridge
Miyazaki, Japan

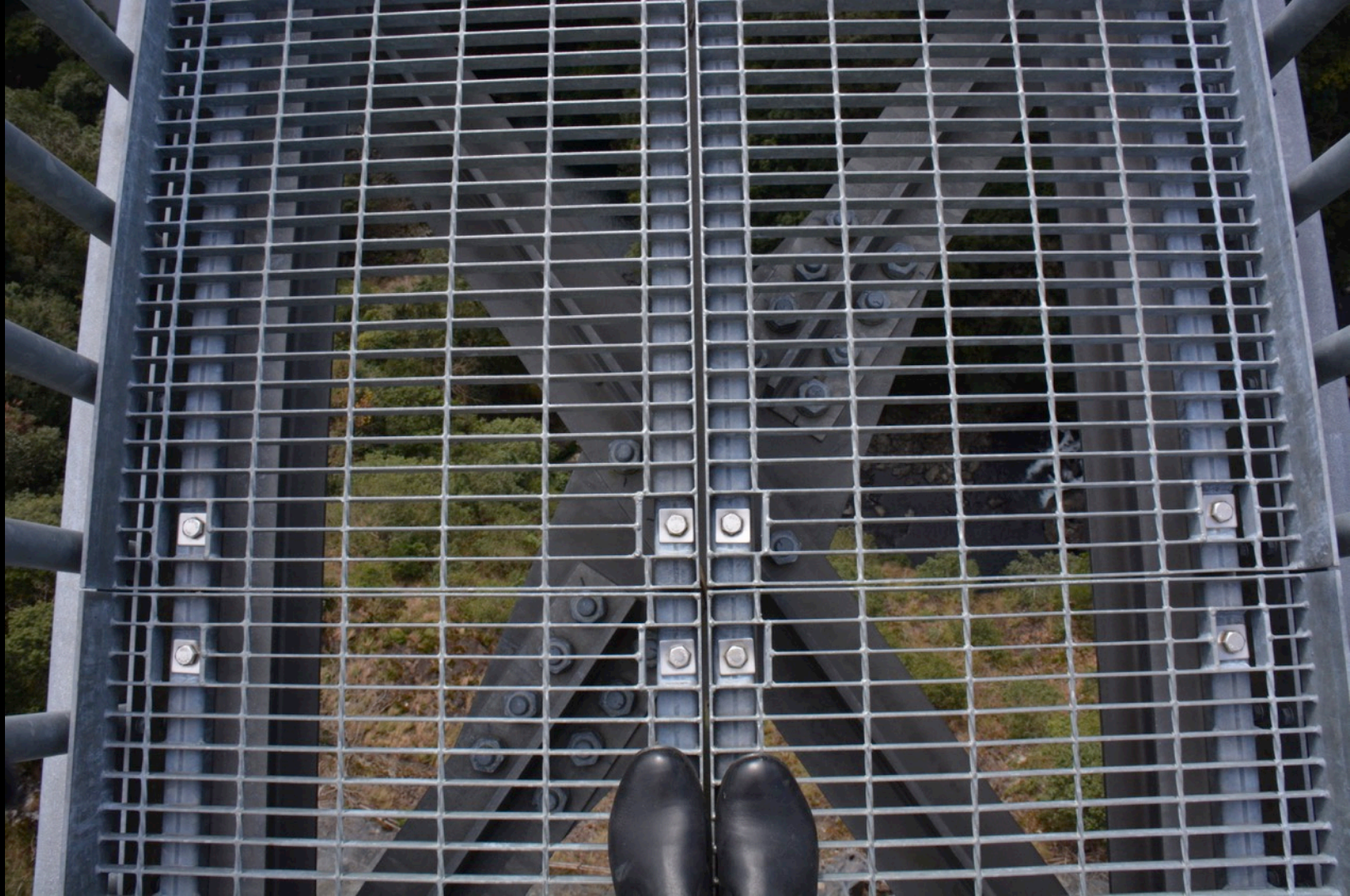






























Capilano Cliff Walk
Vancouver, B.C.
Morrison Hershfield Engineers
Solid Rock Steel Fabricators
2011















Reichstag Dome
Berlin, Germany
Foster and Partners
2004















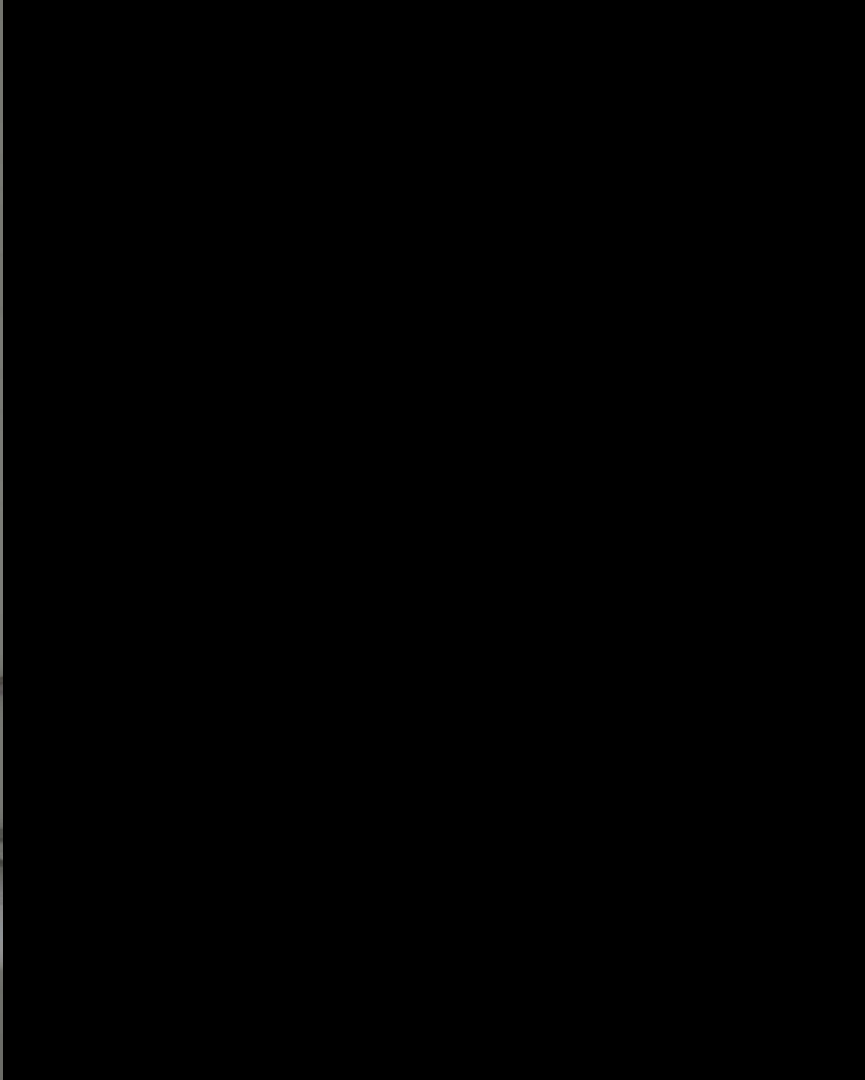




Shanghai, China
Wil Alsop branch firm









Gardens by the Bay
Singapore
Wilkinson Eyre Architects
Grant Associates
2012







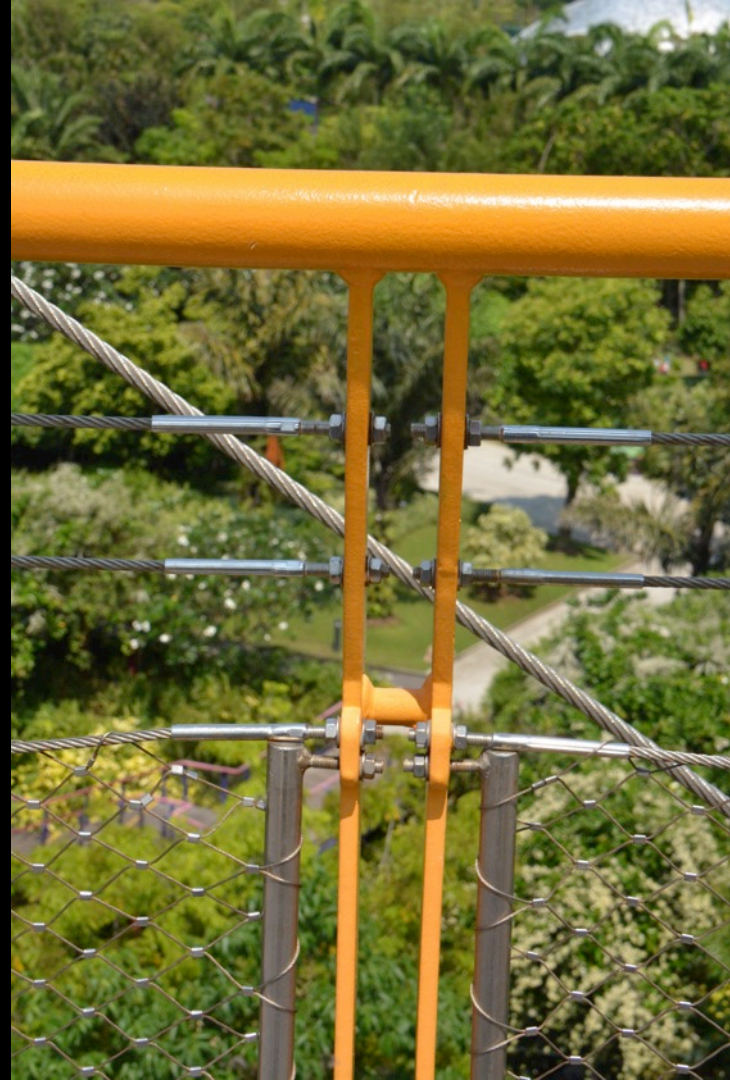














































Zubizuri Bridge
Tied Arch, 75m span
Bilbao, Spain
Santiago Calarava
1997

























X BRACING SYSTEMS



TSK Design Studio
Henderson, Nevada
TSK Architects
1994

















Munich Airport
Munich, Germany
1994





A photograph of the Northumbria University School of Design building in Newcastle-upon-Tyne, U.K. The building features a prominent cylindrical tower with blue vertical cladding and a curved facade with a complex, multi-level structure of glass and metal. The Northumbria University logo is visible on the upper part of the building. The sky is clear blue, and there are some trees and a street lamp in the foreground.

Northumbria University
School of Design
Newcastle-upon-Tyne, U.K.
Atkins
2008















APEGBC Headquarters
Vancouver, B.C.
Peter Busby and Associates
2002











Kant-Dreieck Office Building
Berlin, Germany
Josef Paul Kleihues







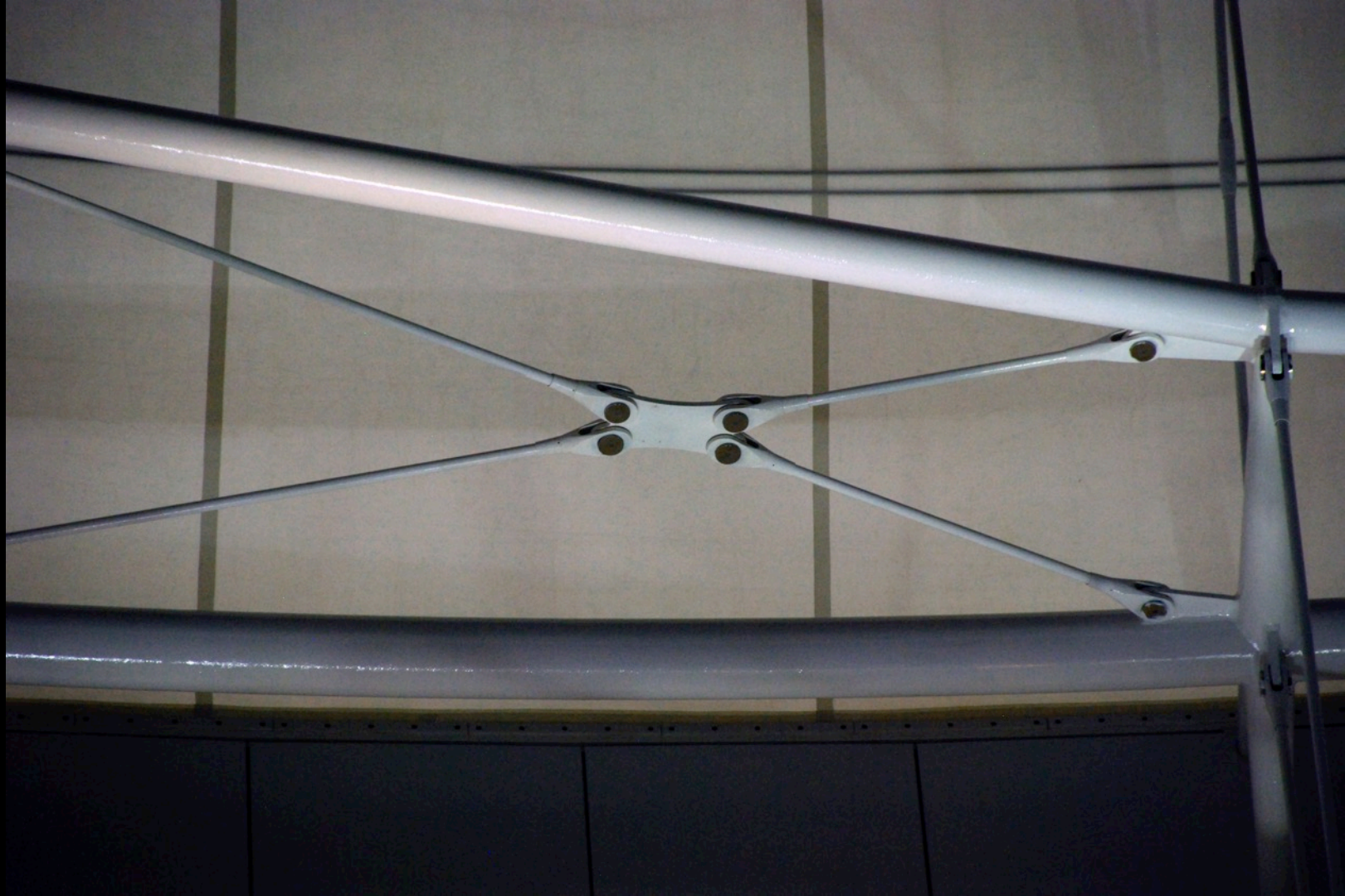


Burj Al Arab
Dubai, UAE
WS Atkins Architects
1999





















FORCE DIFFERENTIATED STRUCTURES

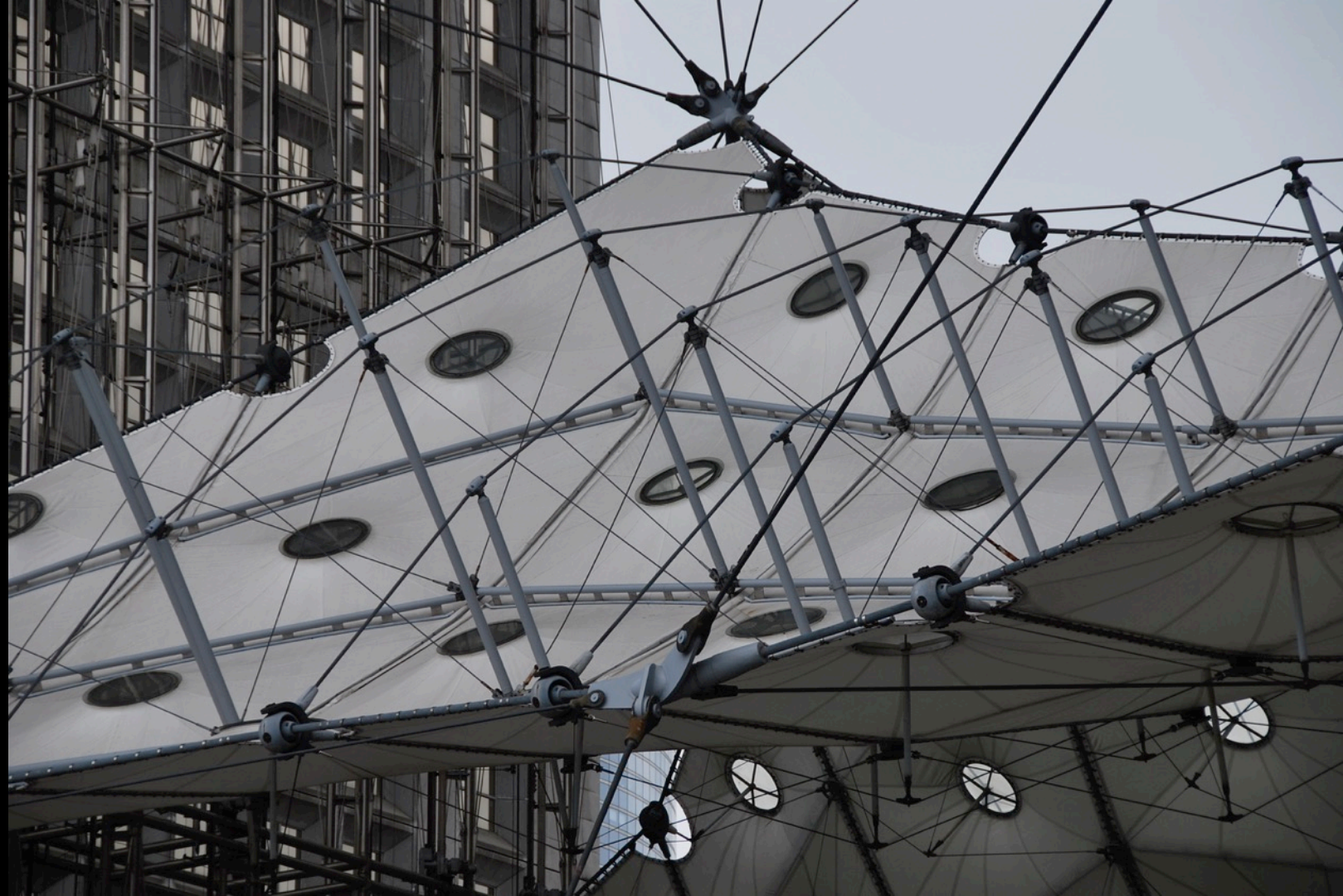


Grand Arch La Defense
Paris, France
Paul Andreu
1985





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MIT Department of Brain and Cognitive
Sciences Building
Cambridge, Massachusetts
Charles Correa and Associates
2006













Luzern Station Hall
Luzern, Switzerland
Santiago Calatrava
1989









RESTAURANTS



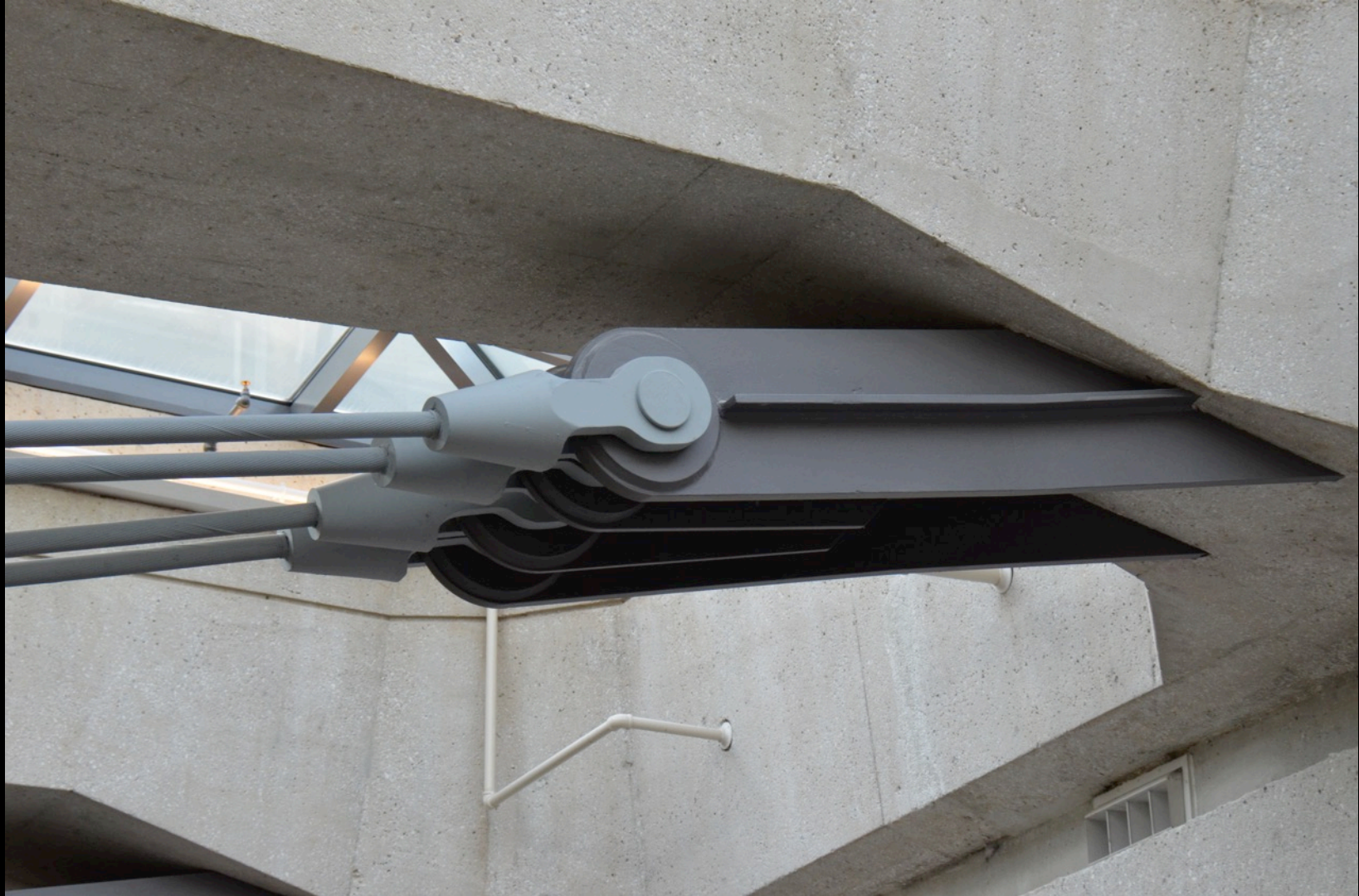


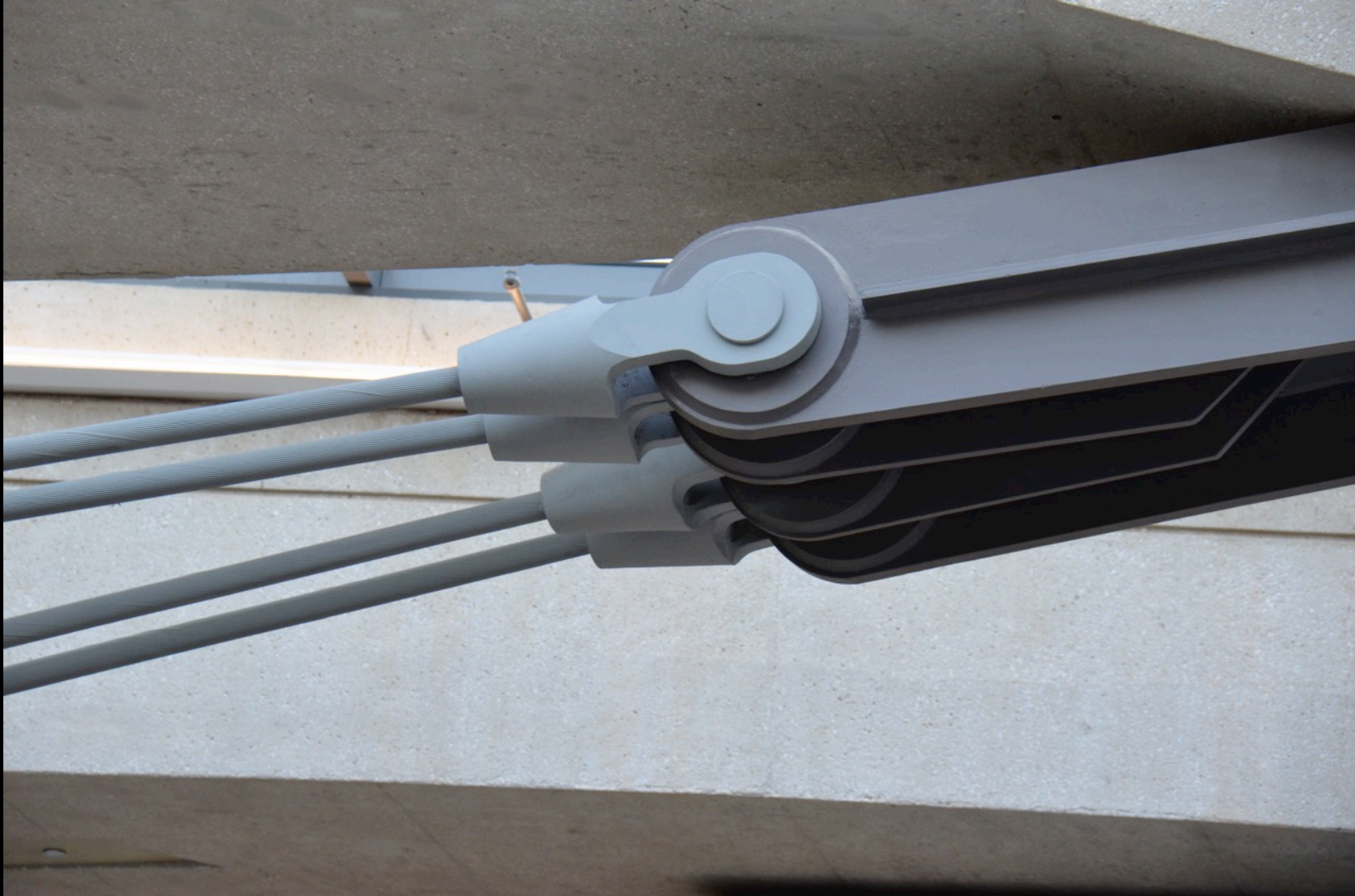




Dulles Airport Renovation
Washington, D.C.









Pavilion at Canary Wharf
London, U.K.



The image shows the interior of a large, modern airport terminal. The ceiling is a complex, white, ribbed structure with a curved, vaulted design. The floor is highly reflective, showing the silhouettes of people and the ceiling. In the foreground, there are several blue directional signs with white text and icons. The signs provide information in both Chinese and English for various services like buses, hotels, and parking. People are seen walking through the terminal, some with luggage. A large blue sculpture is visible in the background on the right side. The overall atmosphere is bright and spacious.

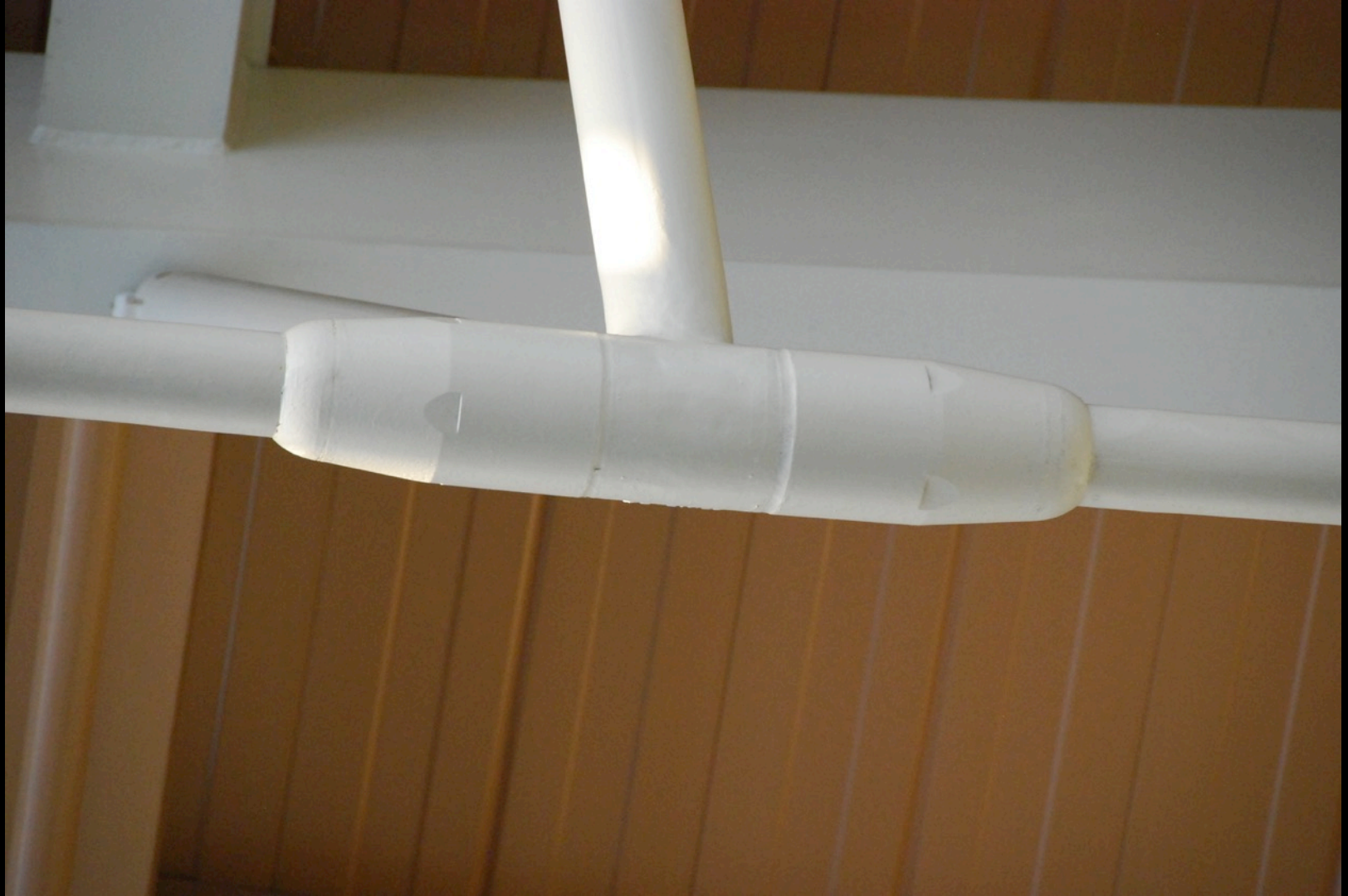
Shanghai Pudong International Airport
Terminal 2
Shanghai, China
Rogers Stirk Harbour and Partners
2008













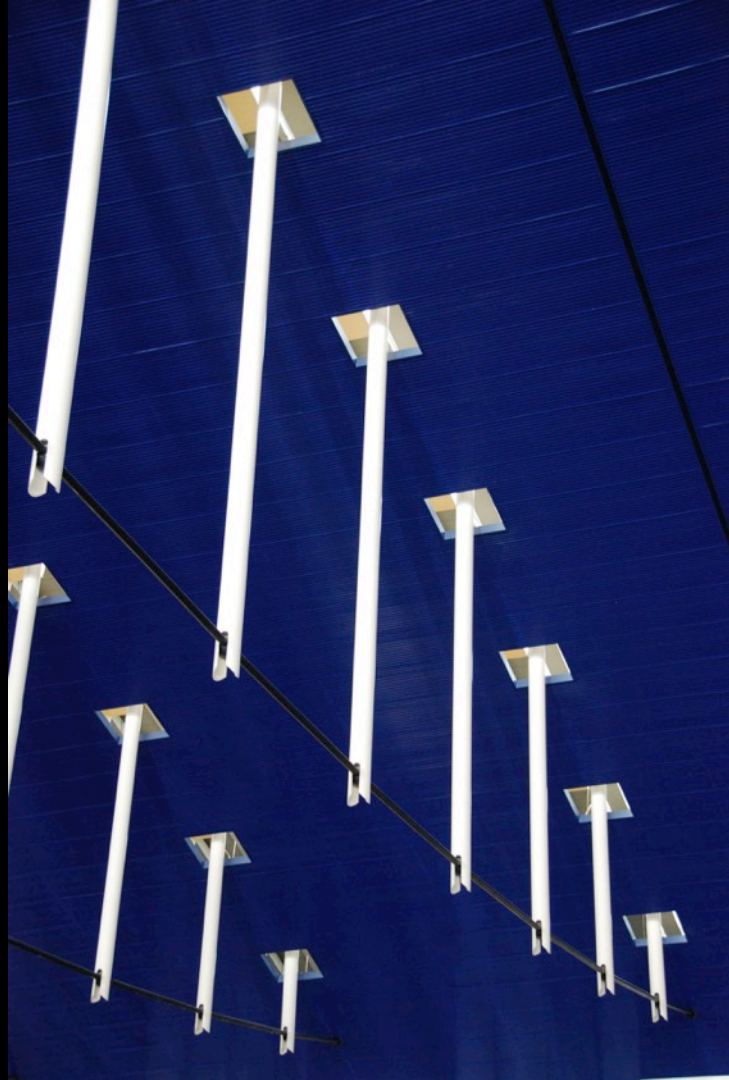


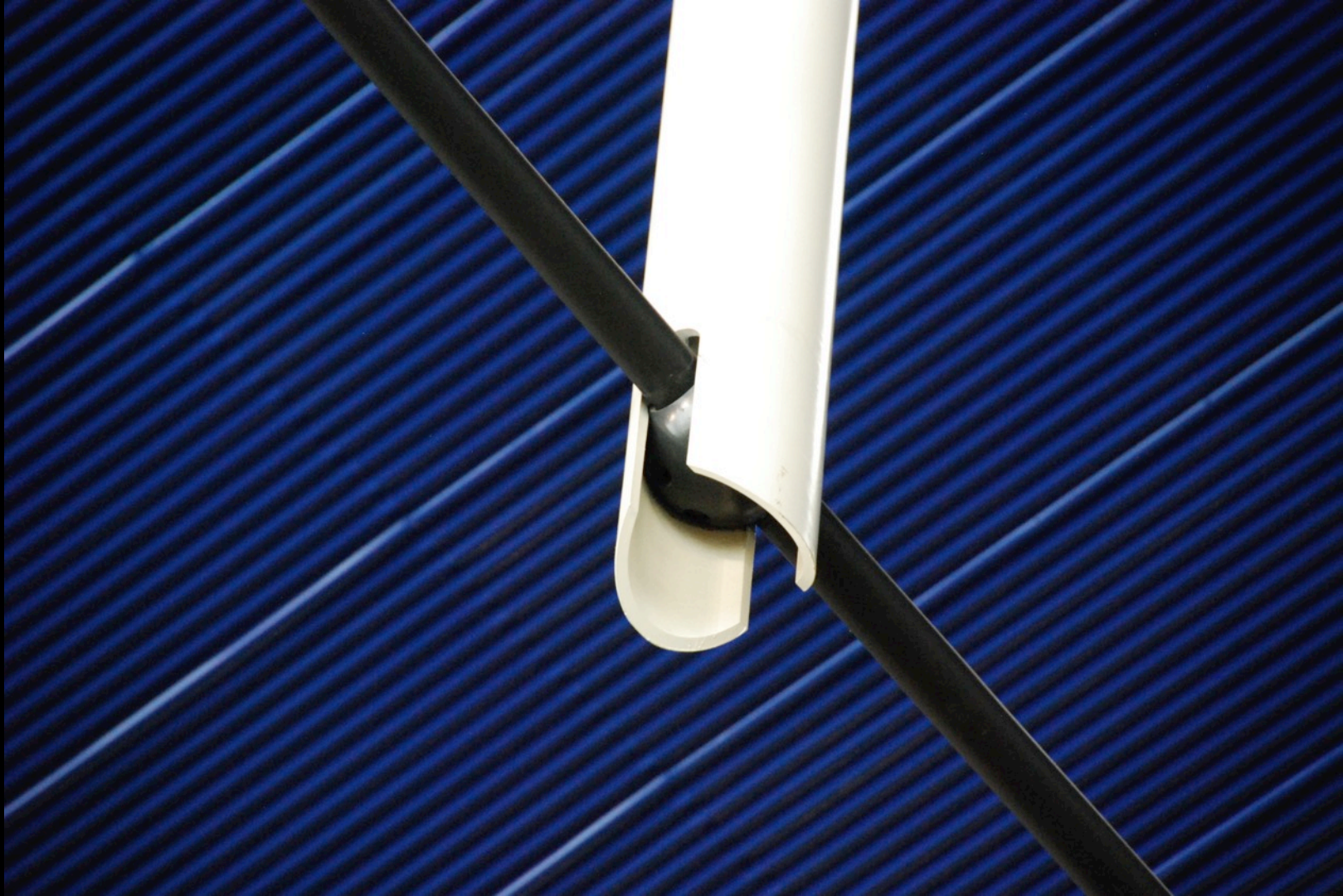
A photograph of the Shanghai Pudong International Airport Terminal 1, showcasing its iconic white, ribbed, cantilevered roof structure supported by a dense network of white steel columns. The terminal's facade is a long, continuous glass wall. In the foreground, a white, ribbed roof structure is visible, likely part of an adjacent building or a lower level of the terminal. The sky is overcast and grey.

Shanghai Pudong International Airport
Terminal 1
Shanghai, China
Paul Andreu
1999

















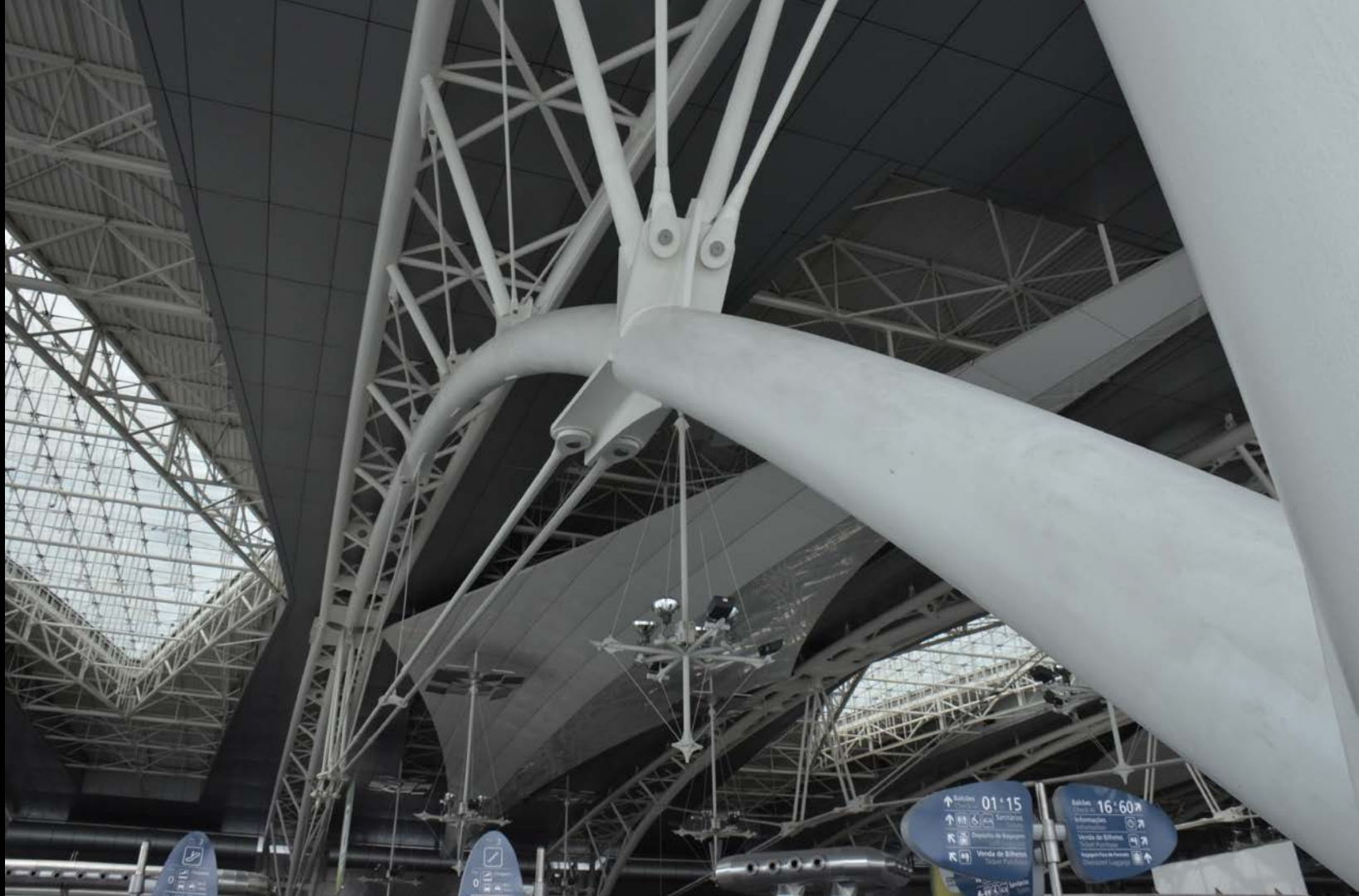




Porto International Airport
Porto, Portugal







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Sydney Olympic Park Aquatic
Centre
Sydney, Australia
Cox Architecture
1994













Humberto Delgado Airport
Lisbon, Portugal









Taikou Place Bridge
Hong Kong











Shanghai Oriental Sports Complex
Shanghai, China
Gerkan, Marg and Partners (GMP)
2011













戲水池
Children's Pool
水深 0.4米
Water Depth 0.4m

戲水池
Children's Pool
水深 0.4米
Water Depth 0.4m

小心台階
Caution Steps
小心地漏
Caution Floor







