STEEL

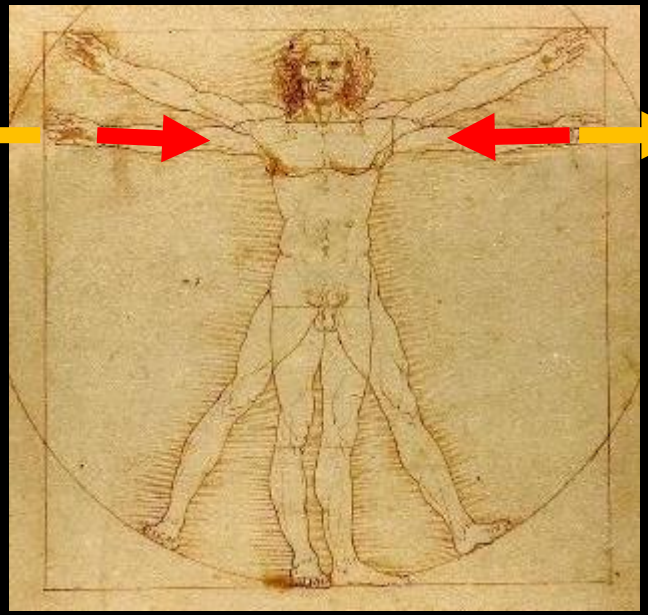
Architecturally Exposed Structural Steel

TENSION

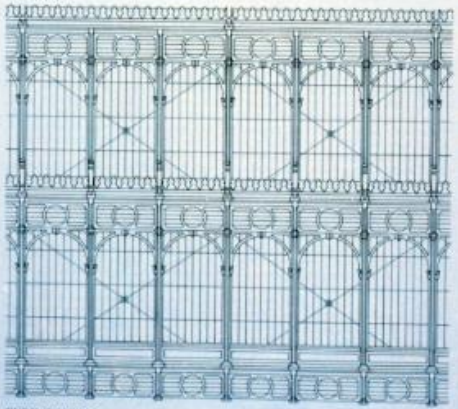
Part 1

Tension
i.e.

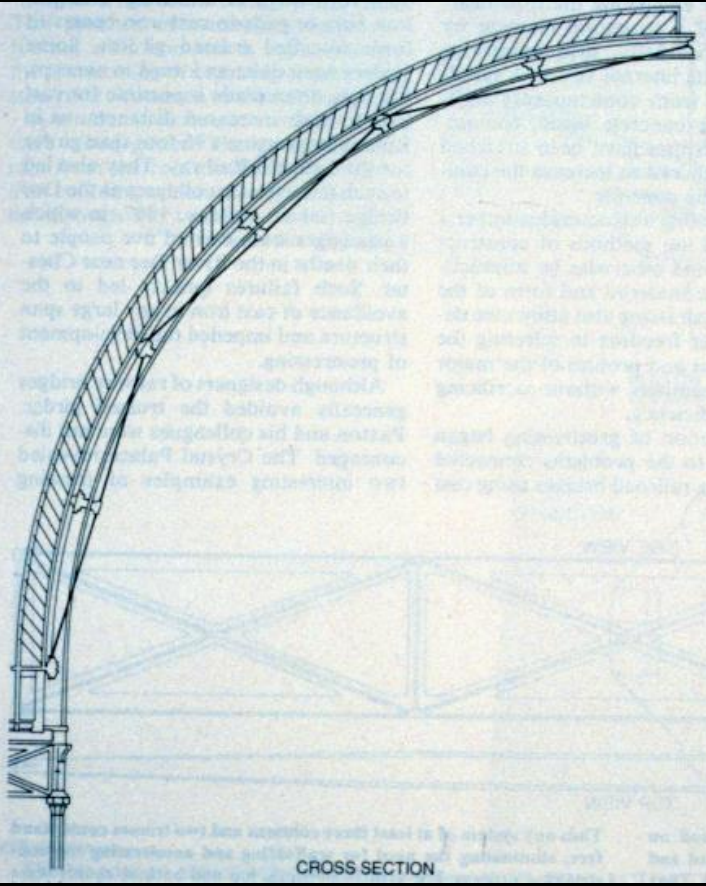
STRETCHING



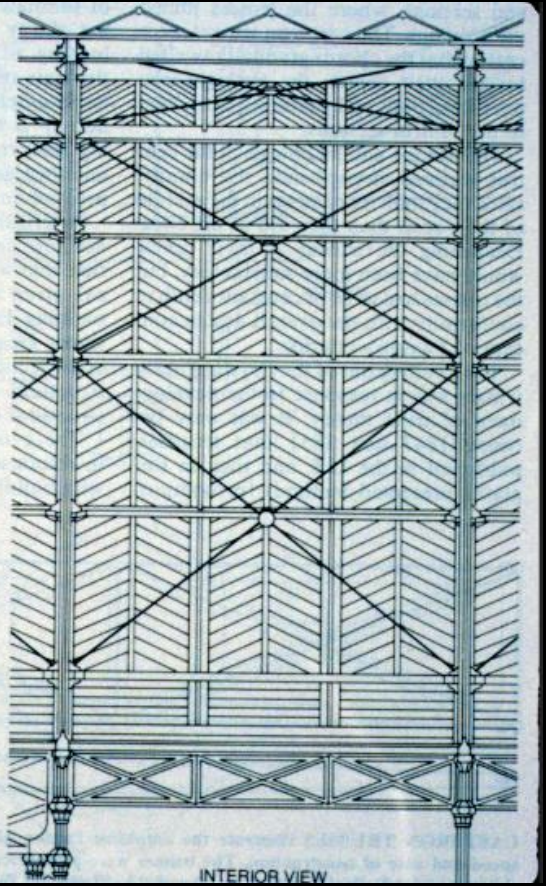
WROUGHT-IRON RODS provided a rigid support for the exterior walls of the Crystal Palace, which had no internal walls to stiffen it. Visible from inside and out (the interior view is shown here), these cross braces added to the building's strikingly contemporary appearance.



CURTAIN WALLS

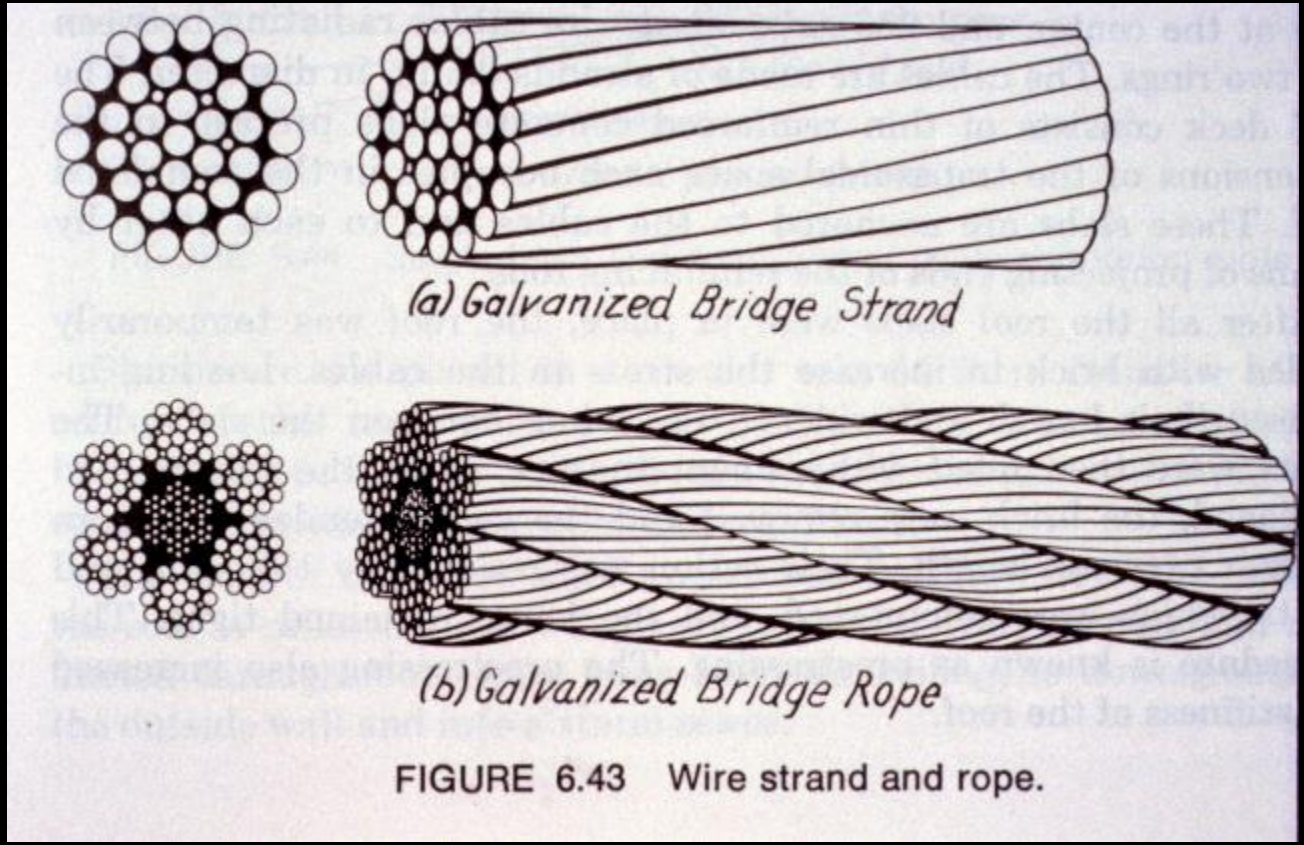


CROSS SECTION



INTERIOR VIEW

cables = steel "rope"



(a) Galvanized Bridge Strand

(b) Galvanized Bridge Rope

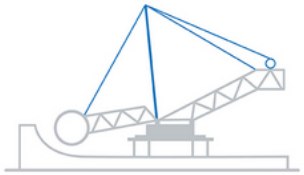
FIGURE 6.43 Wire strand and rope.

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.

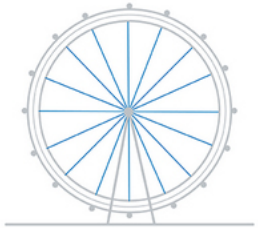
Do I use a cable or a rod?

- 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

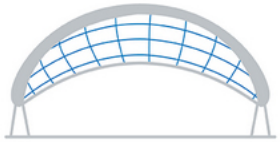


Bucket Wheel Excavators and Spreaders

Cable Stayed Bridges

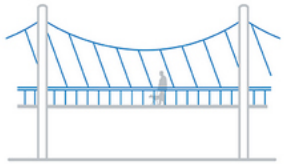


Giant Observation Wheels

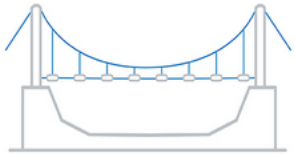


Glass & Membrane Roofs

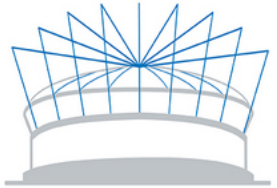
Glass Facades Systems



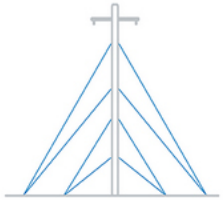
Pedestrian & Cycling Bridges



Pipeline Bridges & Suspension

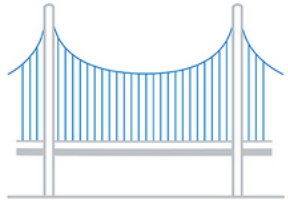


Stadium & Arena Roofs

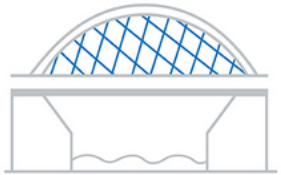


Stayed Masts & Towers

Stayed Windturbine, Transmission Towers and Offshore Platforms

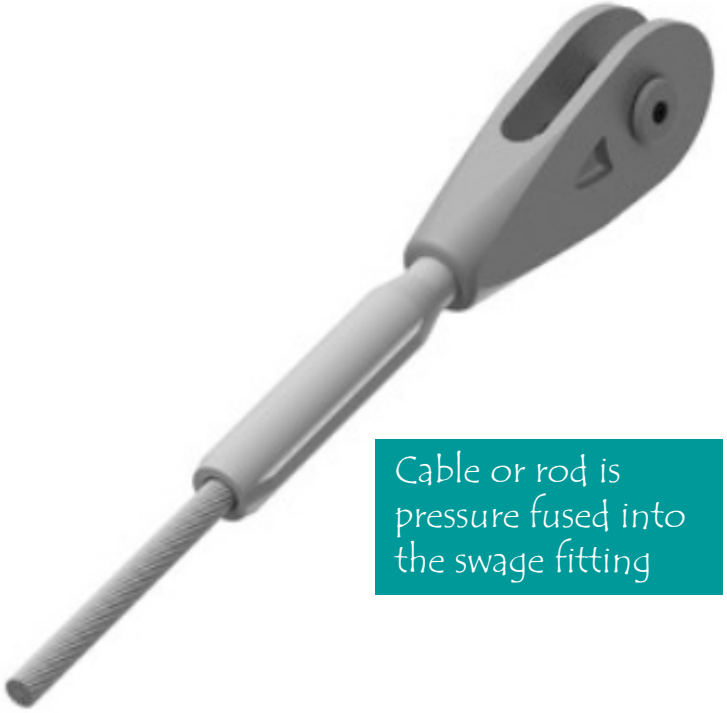


Suspension Bridges

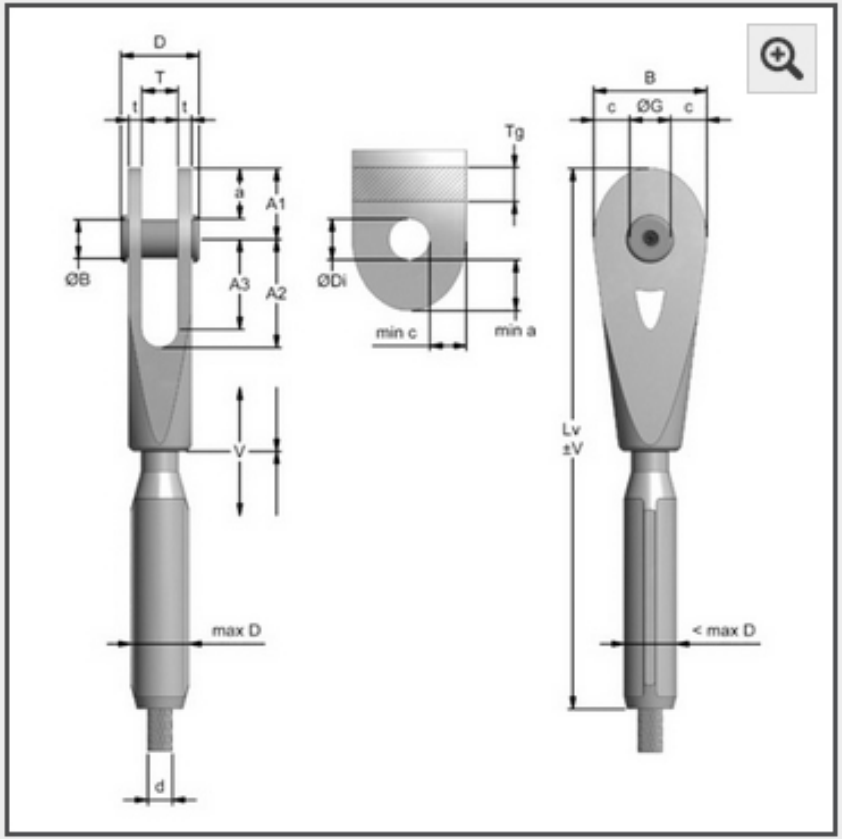


Tied Arch Bridges

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

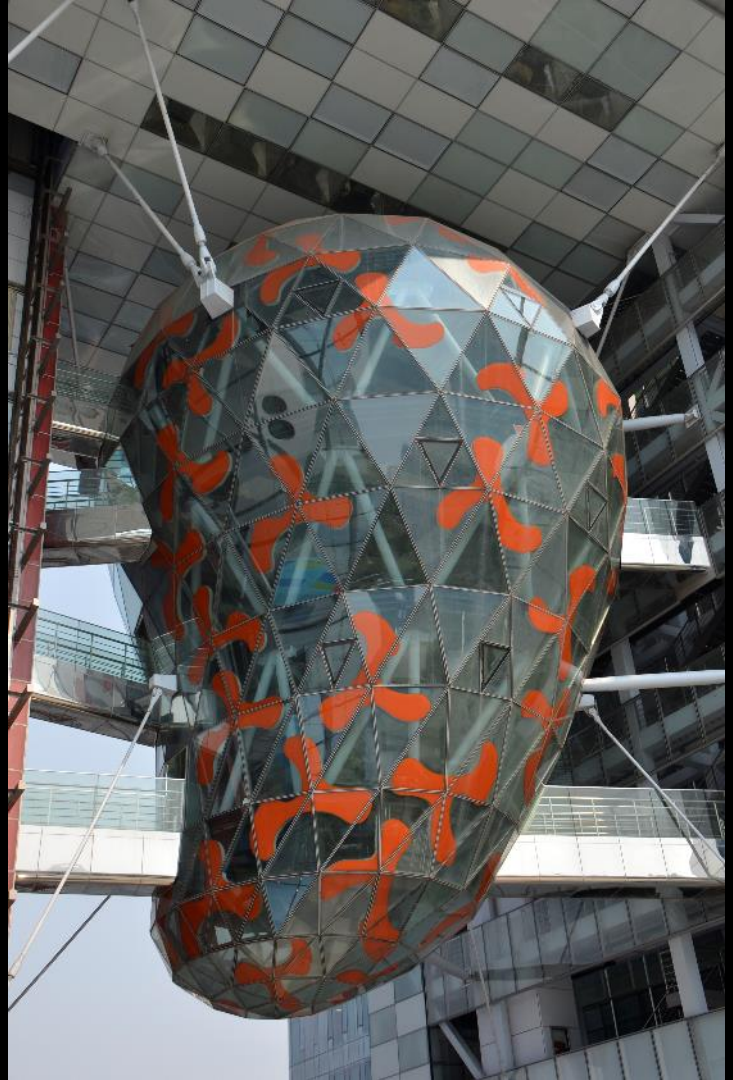
- Cable based glazing systems will be looked at in our steel and glazing lecture

SUSPENSION SYSTEMS

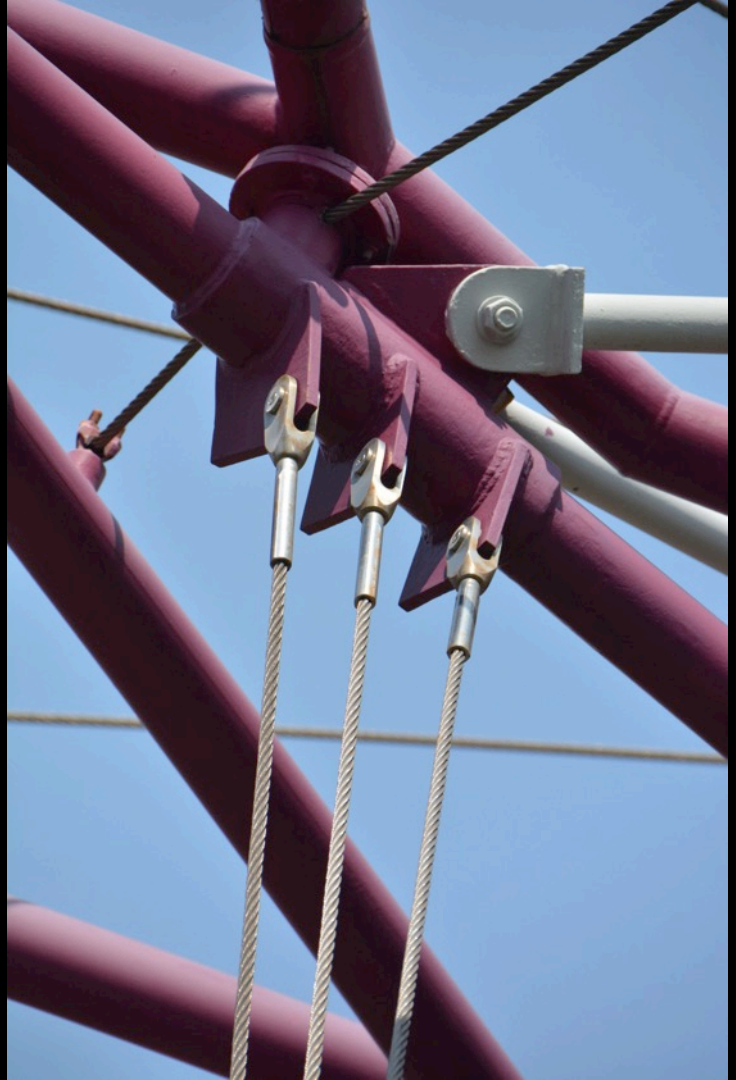
Capilano Cliff Walk
Vancouver, B.C.
Morrison Hershfield Engineers
Solid Rock Steel Fabricators
2011

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



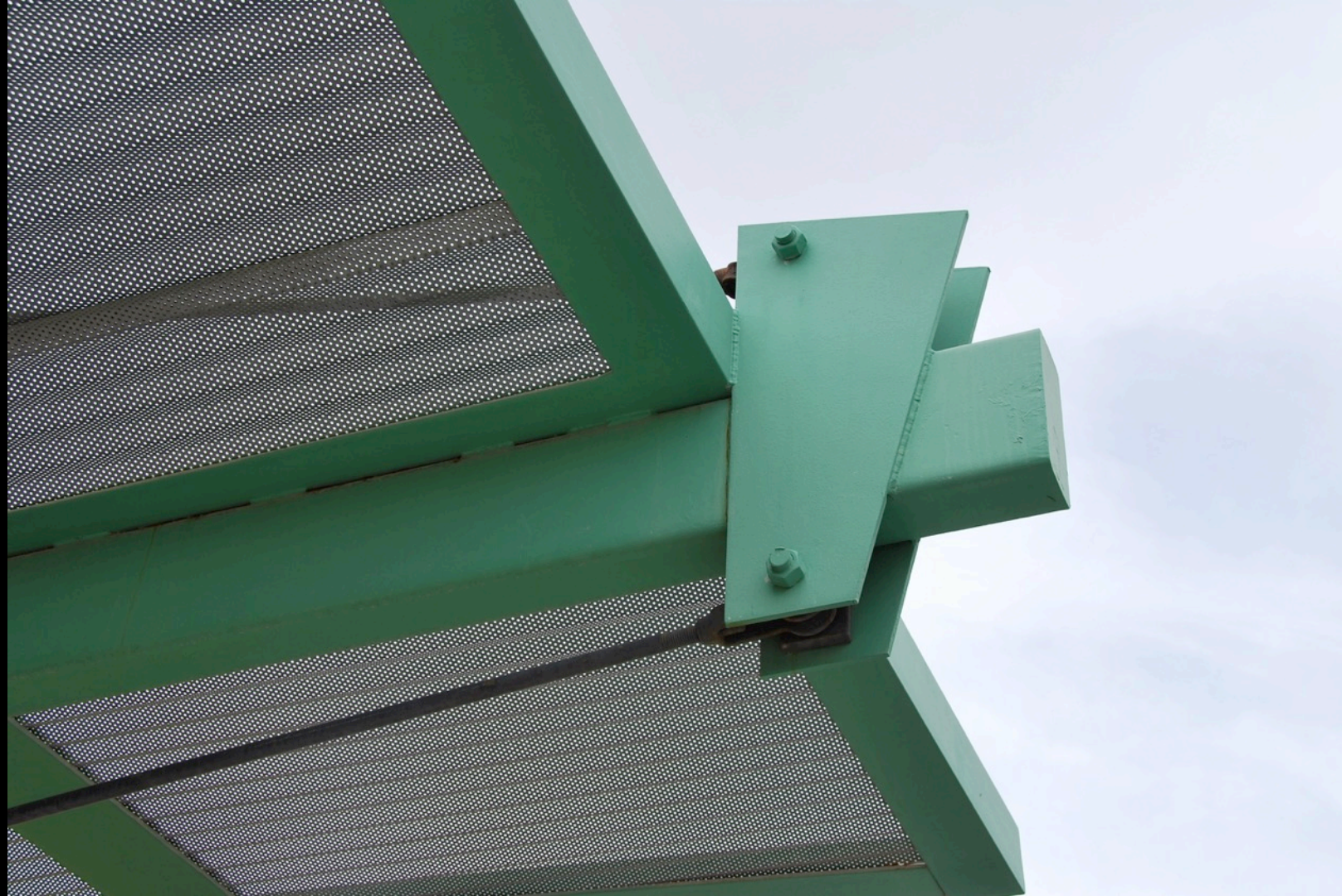
Zubizuri Bridge
Tied Arch, 75m span
Bilbao, Spain
Santiago Calarava
1997


RESTAURAN
CAFETER

X BRACING SYSTEMS

TSK Design Studio
Henderson, Nevada
TSK Architects
1994


709




CCSN

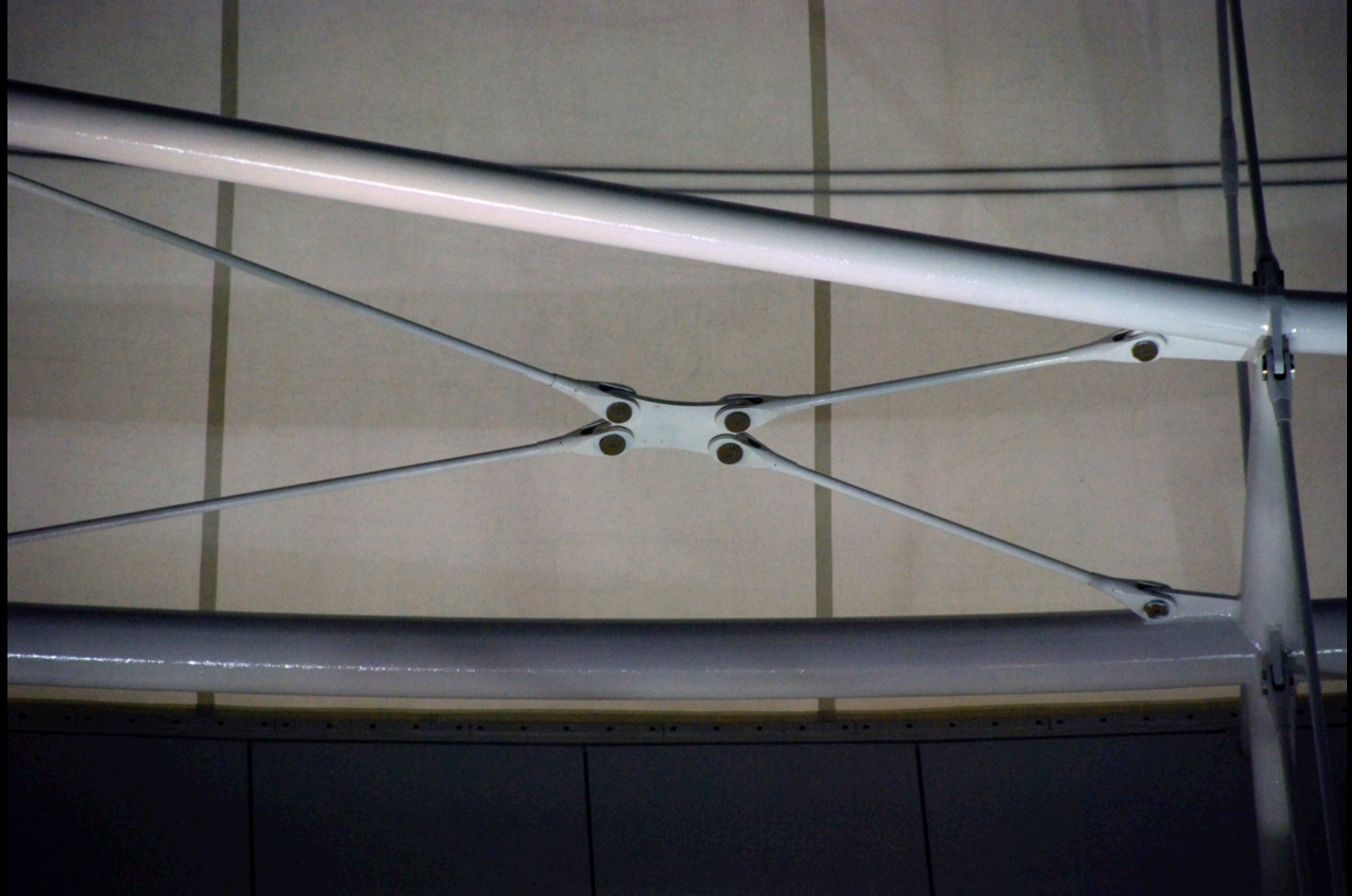
Munich Airport
Munich, Germany
1994

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



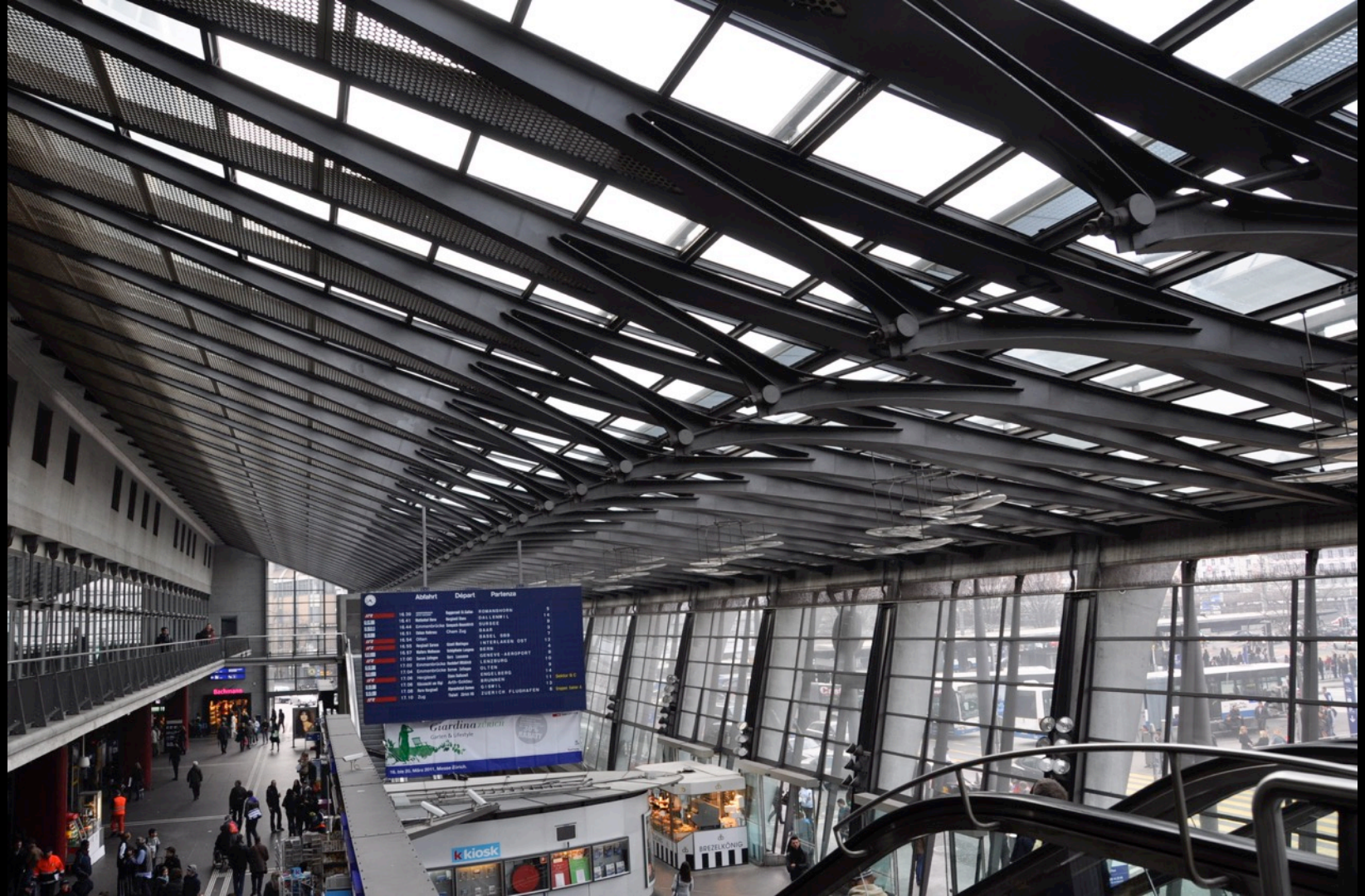
FORCE DIFFERENTIATED STRUCTURES

Grand Arch La Defense
Paris, France
Paul Andreu
1985


VISITE

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

Luzern Station Hall
Luzern, Switzerland
Santiago Calatrava
1989

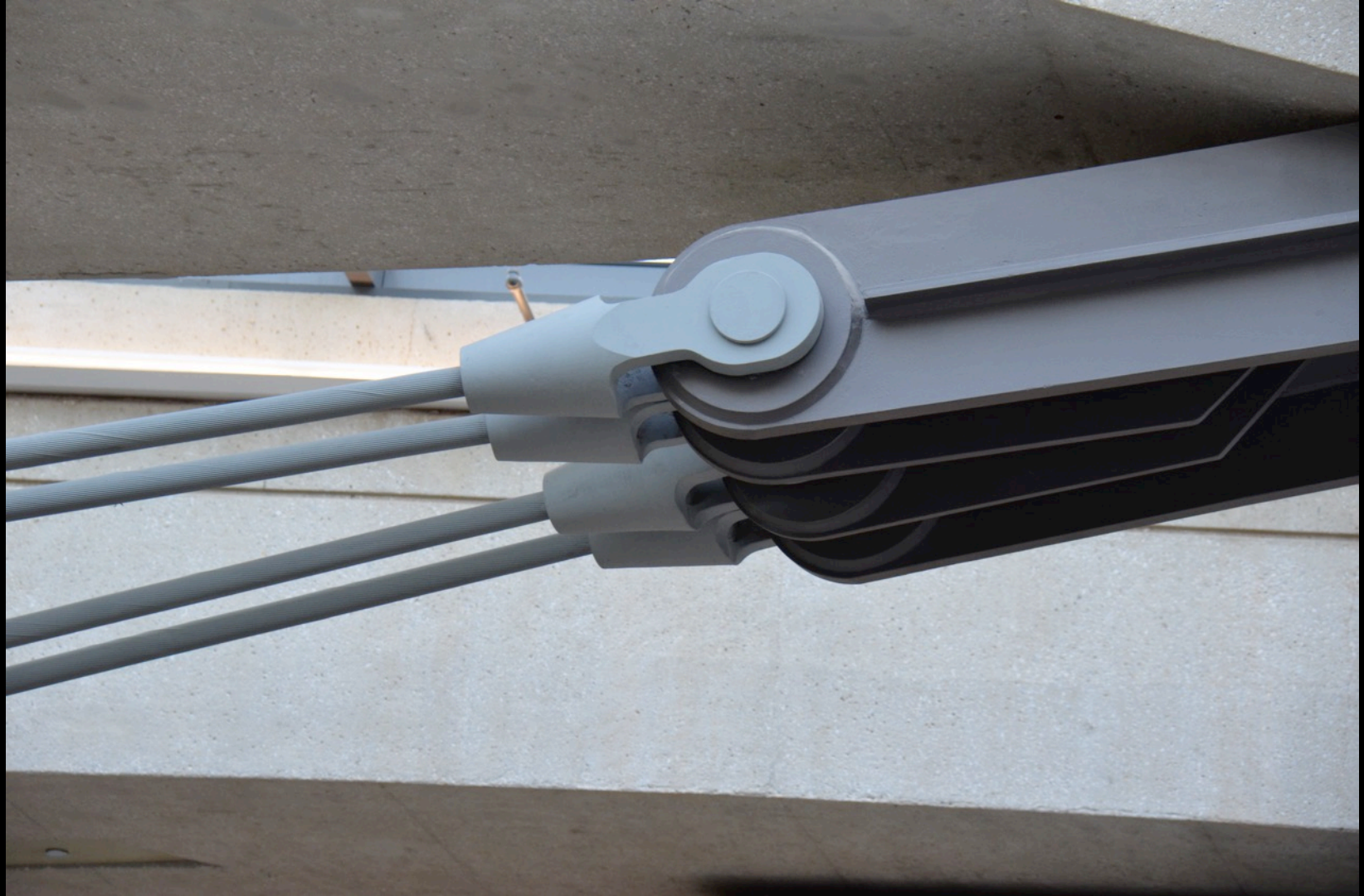

Abfahrt Départ Partenza
kiosk
PRETZELKÖNIG


Pulsations


RES URANTS

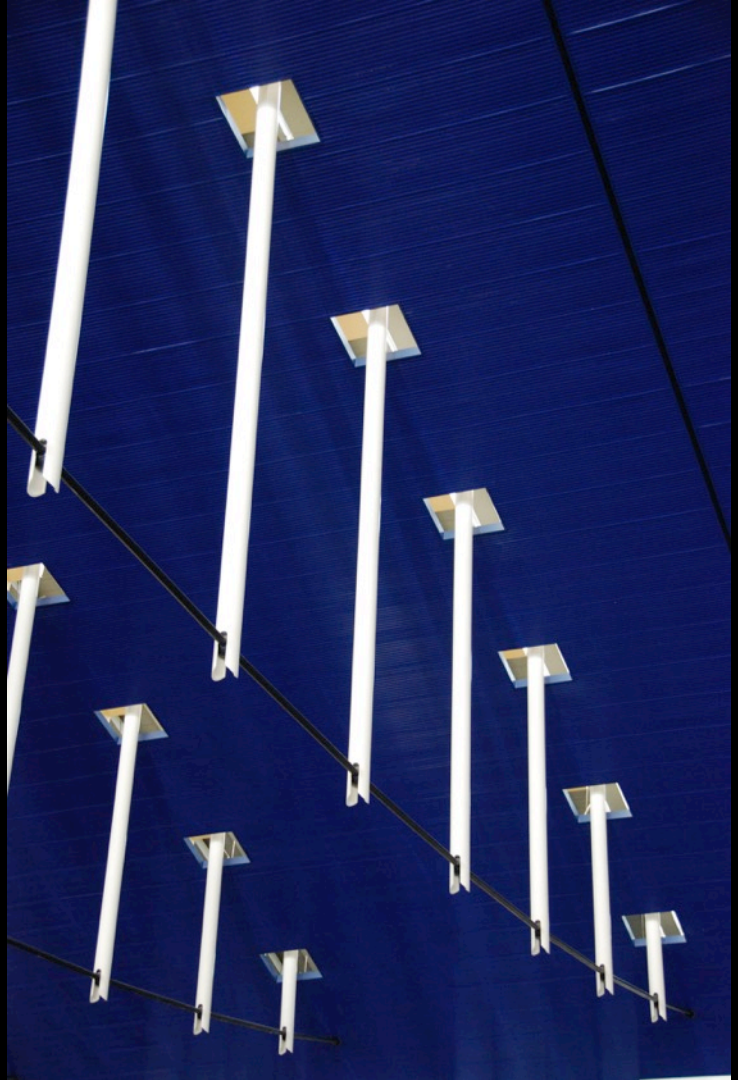

P
Max. 48 Std.
Länger oder ausserhalb der Halterungssysteme abgestellte Velos werden auf Ausweichplätze verschoben.
Auskunft:
Velostation Bahnhof Lu
Tel. 041 210 05 20
VELOS

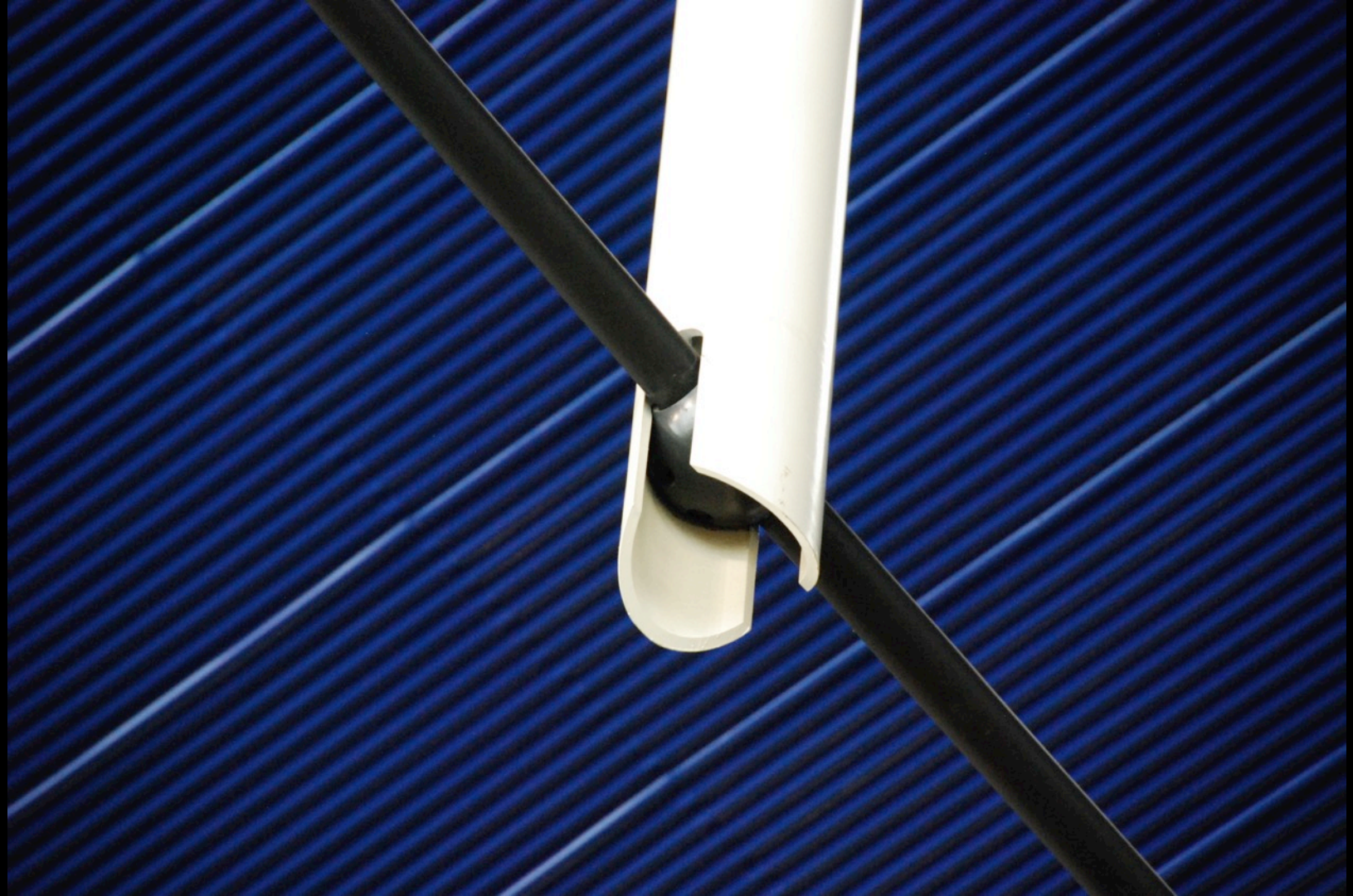
Dulles Airport Renovation
Washington, D.C.



Pavilion at Canary Wharf
London, U.K.

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

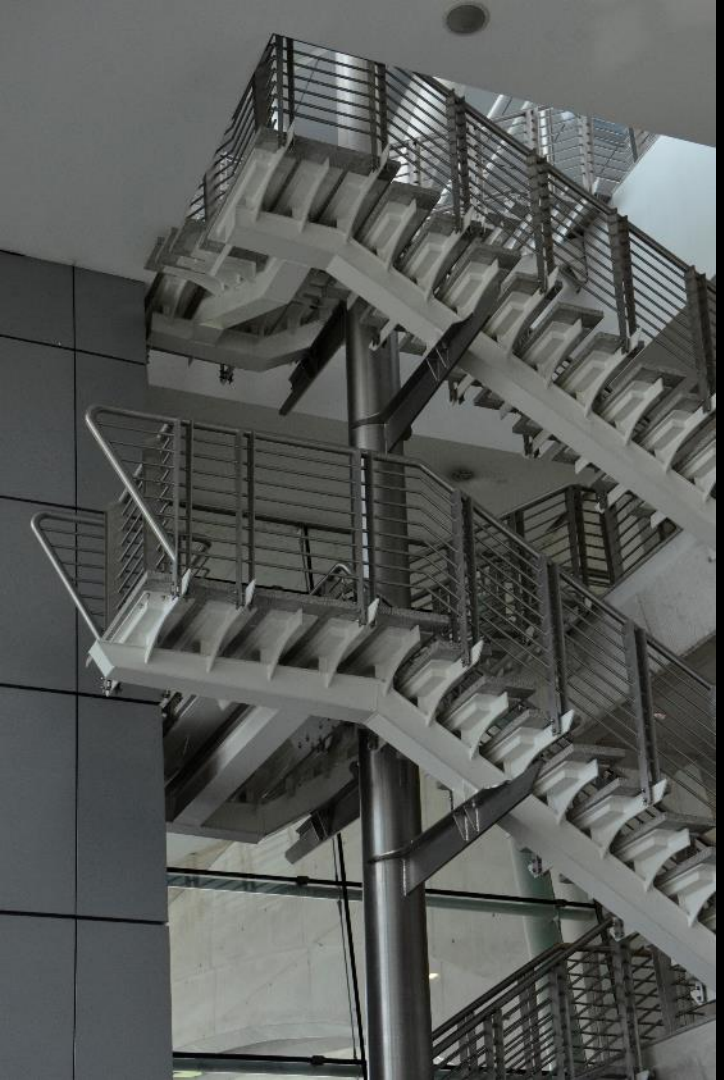


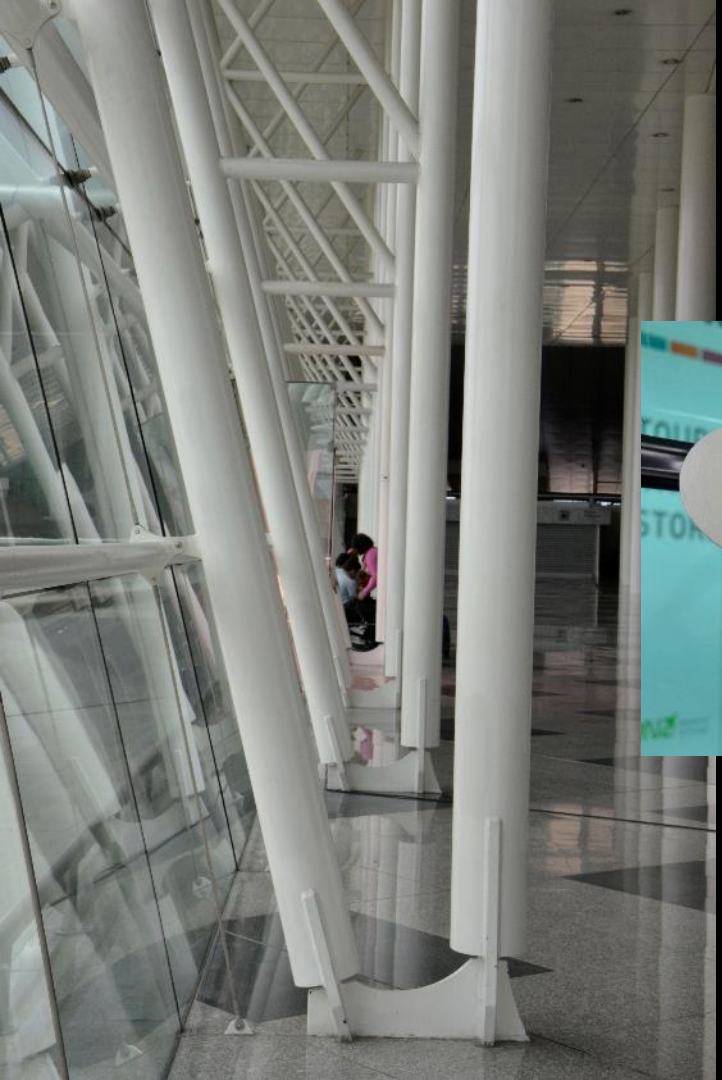



1
9–10
沪F 96540
PD 08605

Porto International Airport
Porto, Portugal


Balcões
01 15
Balcões
16 60





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 Parnters (GMP)
2011



3
2
55:58


娃娃池
Children's Pool
水深 0.4米
小心台阶
Careful Steps
小心跑滑
Careful Fall