

Supporting presentation for
lecturers of Architecture/Civil
Engineering

Module 02A:

Applications - Architecture

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1. Facades



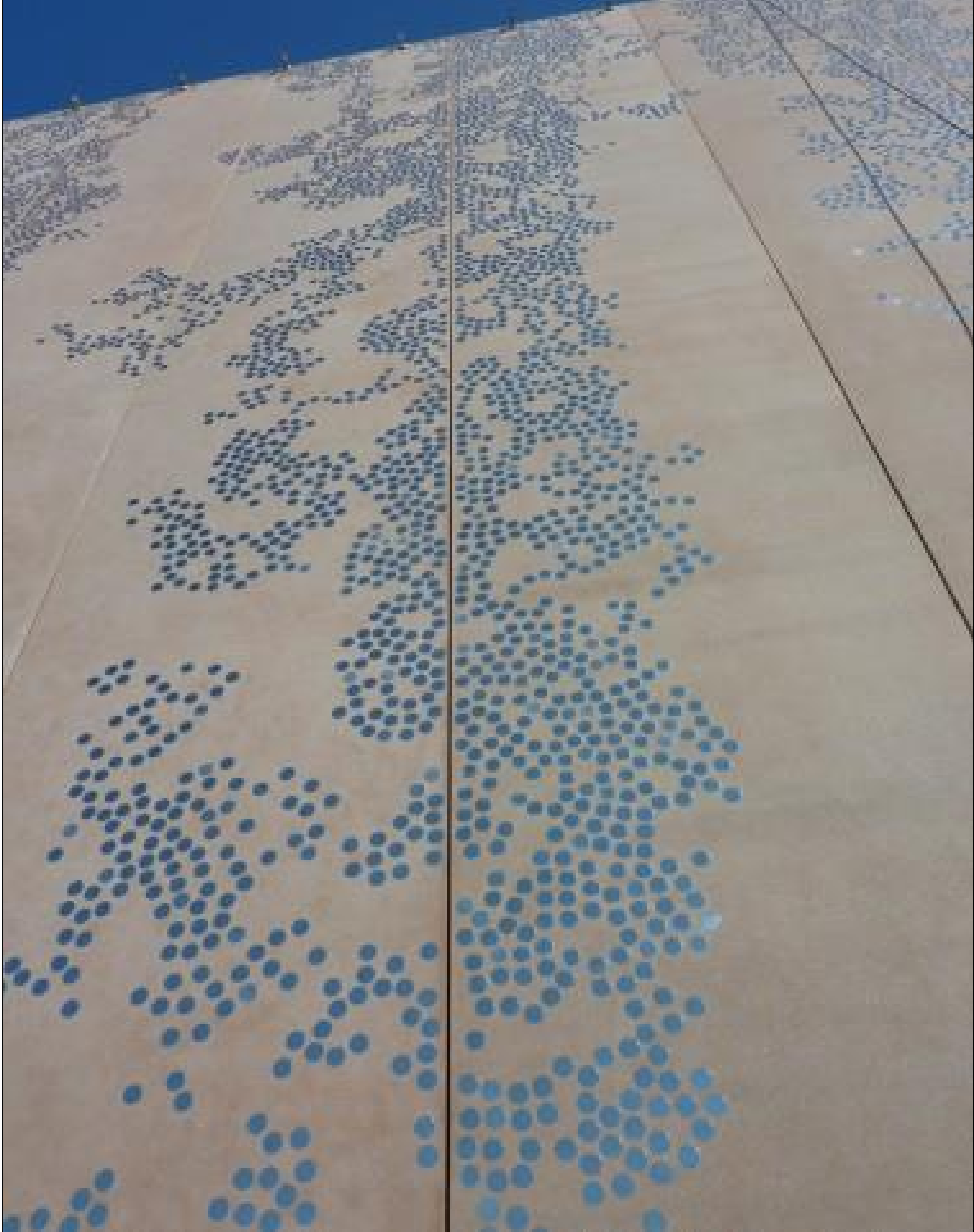
Clockwise, from top left:

1. Westfield Doncaster shopping center facade in Victoria, Australia ⁴
2. Sunbreaker Stainless mesh ion a school facade near Whashington, DC, USA. Reduces glare,saves energy offers good visibility⁶
3. Stainless mesh canopy over courtyard, Arizona, USA. Maximizes sun blockage while allowing air flow⁶
4. Lou Ruvo medical Research Center designed by Frank Gehry, Las Vegas, USA ⁵

Stainless facade of 285m-high apartment building, New York, USA.
Architect: Frank Gehry⁷



Reflective stainless steel inserts in a concrete wall for an archive building, Bure-Saudron (51), France⁸





F. R. Weismann Art Museum, Minneapolis, USA (1993)

Architect: Frank Gehry⁹

Gehry: "I always have felt that architecture was about materials. Watching my artist friends work directly with materials – the right product is something that seems right and real and acceptable and not contrived."

For the Weisman, Gehry chose stainless steel... Its shiny, reflective, but extremely durable surface has given the building its unique identity.



Kauffman Center of Performing Arts, Kansas City, ISA (2011)

Architect: Moshe Safdie; Engineering: Arup¹⁰

The north elevation of the building, which faces downtown Kansas City, features a series of arched walls sheathed in stainless steel that rise from the ground like a wave. From its crest a curved glass roof sweeps down towards the low-rise Crossroads neighborhood to the south and cascades into a 65-foot high by 330-foot wide glass wall, which provides the Kauffman Center's Brandmeyer Great Hall with panoramic views of Kansas City. This dramatic glass facade and roof are anchored by 27 high-tension steel cables, reminiscent of a stringed instrument.



Len Lye Centre, New Plymouth, NZ

Architect: A. Patterson¹¹

14 m high facade made of 32 tons of highly polished grade 316 stainless steel



Delhi Metro Rail Corporation Headquarters, India
Architect: Raj Rewal & Associates¹²

Architect Raj Rewal & Associates designed stainless steel cladding for the building in New Delhi, involving stainless steel tubular truss with stainless steel panels interspersed with toughened glass panels.



District heating facility, Torino,Italy

Architect: JP Buffi¹³

The heating facility has been clothed by curved screens.

The copper-coloured stainless strips are arranged to provide gaps for a glimpse through to the facility.



Capital gate Tower (2010), Abu Dhabi RMJM, Architects¹⁴⁻¹⁶

The distinctive stainless steel 'splash' that descends from the 19th floor, is a design element and a shading device that eliminates over 30 percent of the sun's heat before it reaches the Capital Gate building. The splash also twists around the building towards the south to shield the tower as much as possible from direct sunlight.

The 'splash' is made of 580 panels for a total of ~5000 m² of stainless steel mesh



Glass facade¹⁷

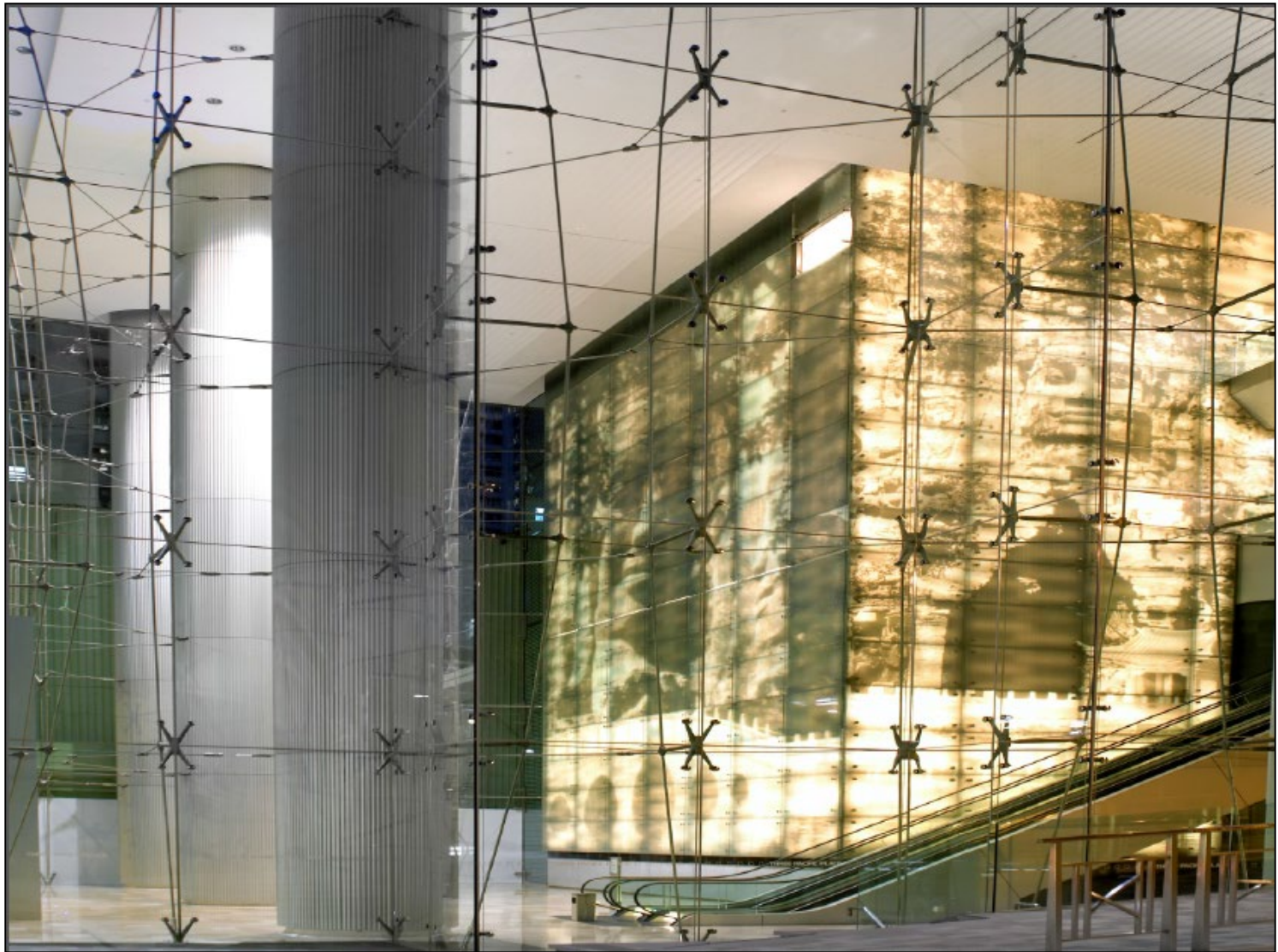
A web of stainless steel tie-bars linked by nodes holds the glass facade, maximizing open light area, including corners



Glass facade, Paris ¹⁸

The glass facade is supported by a light, high strength stainless steel structure

The sphere in the background is the «Geode», a unique stainless steel clad 360° movie theater, part of the «Cité des Sciences et de l'industrie»



Glass facade, Paris¹⁹



Office building mesh facade, Utrecht, Netherlands²⁰

Architects: Cepezed

This 3000 m² stainless steel mesh facade holds transparent plastic disks.

Wind causes the mesh to vibrate and the disks to move, resulting in ripples and light effects.



Energy saving building, Nantes, France²¹
Architects: FORMA 6 & B. Dacher

Intricate laser cut shapes of the stainless steel facade give this building an outstanding look.



McGowan Academic center, Washington, DC, USA Sunshade mesh⁶

McGowan Academic Center is a classroom building community college.

The building design provided for an atrium area integrated with an exterior ventilated façade, in the center of the building that faced directly east in the morning hours.

The stainless sunshade reduces the daytime glare and the amount of air conditioning required to cool the space in the summer months. Typical metal sunshade products could not be used for this application as visibility was crucial. They simply didn't offer enough open area.

Rehab of Château de Rentilly, France²²⁻²³



Left: Before
Below: After

A contemporary art building in the park of a château.
The facade has been clad with mirror-finish stainless steel plates

Xavier Veilhan, architect:
*«... the building was a shadow of what it was...
I wanted walls that would reflect the surrounding park... »*





St Guy Hospital , London²⁴
Architect: T. Heartherwick

The Boiler Suit, a unique façade designed to encase the boiler house which powers Guy's Hospital. It is made up of 108 undulating tiles of woven stainless steel braid and is illuminated at night to provide a distinctive welcoming beacon for staff and visitors arriving at hospital in the dark.



American Airlines Arena, Miami, USA

Made from 3,400 square feet of a high-grade architectural woven stainless steel mesh fabric with interwoven LED profiles, Miami's Mediamesh® screen, provides visitors to the Arena with unobstructed viewing from the interior and visually engaging digital media content on the exterior. Standing three-stories tall (42 feet high by 80 feet wide), Miami's Mediamesh façade is four times the size of an average billboard. The arena host more than 1.3 million guests per year for concerts, family and sporting events.

Facades References (1/2):

UPDATED
2019!

1. https://www.worldstainless.org/Files/issf/non-image-files/PDF/Euro_Inox/Facades_EN.pdf
2. https://www.worldstainless.org/Files/issf/non-image-files/PDF/Euro_Inox/Innovative_facades_EN.pdf
3. <http://www.archiexpo.com/architecture-design-manufacturer/stainless-steel-facade-cladding-2964.html> more examples here!
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11. <http://pattersons.com/civic/len-lye-contemporary-art-museum/>
12. http://www.stainlessindia.org/UploadPdf/SI_Mar08.pdf
13. <http://www.archilovers.com/projects/30432/centrale-termica-teleriscaldamento-iride-energia.html>
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Facades References (2/2):

UPDATED
2019!

15. <http://www.dailymail.co.uk/travel/article-1284591/Abu-Dhabi-Capital-Gate-skyscraper-leans-times-Tower-Pisa.html>
16. <http://www.e-architect.co.uk/dubai/capital-gate-abu-dhabi>
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2. Green Walls

About Green Walls

Green Facades are an emerging architectural element, providing an enormous amount of benefits to a building through occupant amenity, thermal control and improving air quality.

Using stainless steel cables, rods and mesh to train climbing plants up a building facade provides an alternative to the traditional planted green wall.

Retro-fitting a green facade to existing structures is easily achieved.



Green facade¹

Electric transformer building, Barcelona. Stainless fasteners and cables support the plants.



Green walls for apartment buildings² (affordable everywhere!)



Advantages :

- Improved insulation
- Noise damping
- Cooler micro-climate
- Enhanced biodiversity
- Better air quality (pollutants filtration)
- Aesthetics
- Psychological well-being
- Positive social and economic fallout

Stainless cables and anchors



Green walls for apartment buildings²

The benefits of re-introducing Mother Nature to an increasingly unnatural environment are so apparent that the Australian Government has established the Green Building Council of Australia (GBA) to advocate sustainable property development.



Vertical Landscaping

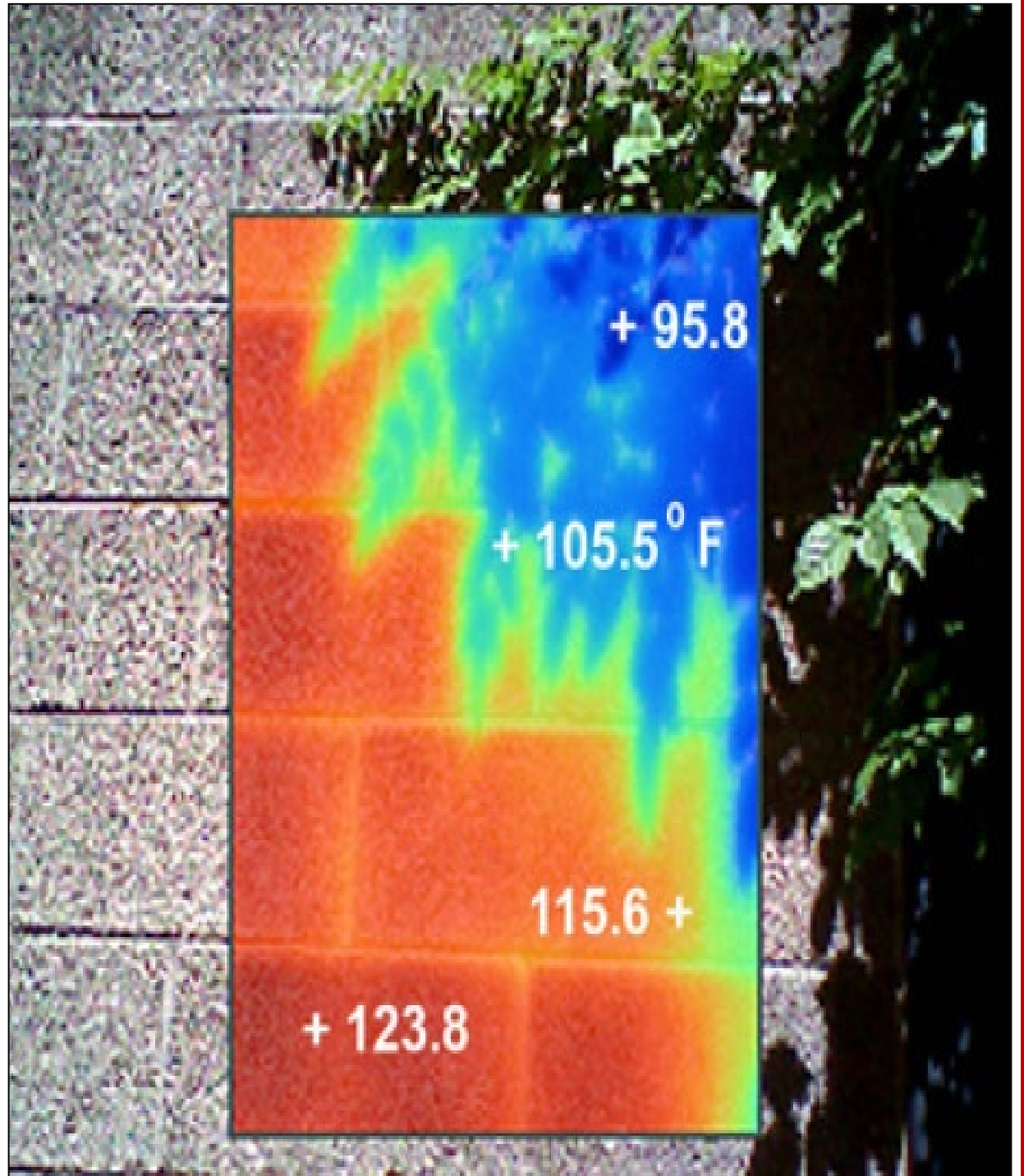
Melbourne City Council Chambers: The stainless steel trellising systems and components provide essential climbing structure for the plant life, and transform the hard heat retaining surfaces into vibrant vertical gardens.





Green wall³

Infrared photography demonstrating temperatures of the building surface, Tampa, AZ.
°F, from ref. 4.





Anchors and cables

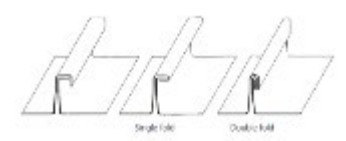
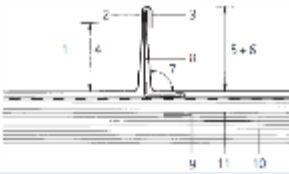
Stainless steel systems are easy to install

Green Walls References

1. [https://www.worldstainless.org/Files/issf/non-image-files/PDF/Euro Inox/VertGardens EN.pdf](https://www.worldstainless.org/Files/issf/non-image-files/PDF/Euro%20Inox/VertGardens%20EN.pdf)
2. <http://www.ronstantensilearch.com/melbourne-city-council-chambers-northern-green-facade/>
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4. [http://drum.lib.umd.edu/bitstream/1903/11291/1/Price umd 0117N 1 1876.pdf](http://drum.lib.umd.edu/bitstream/1903/11291/1/Price%20umd%200117N%201876.pdf)
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3. Roofs

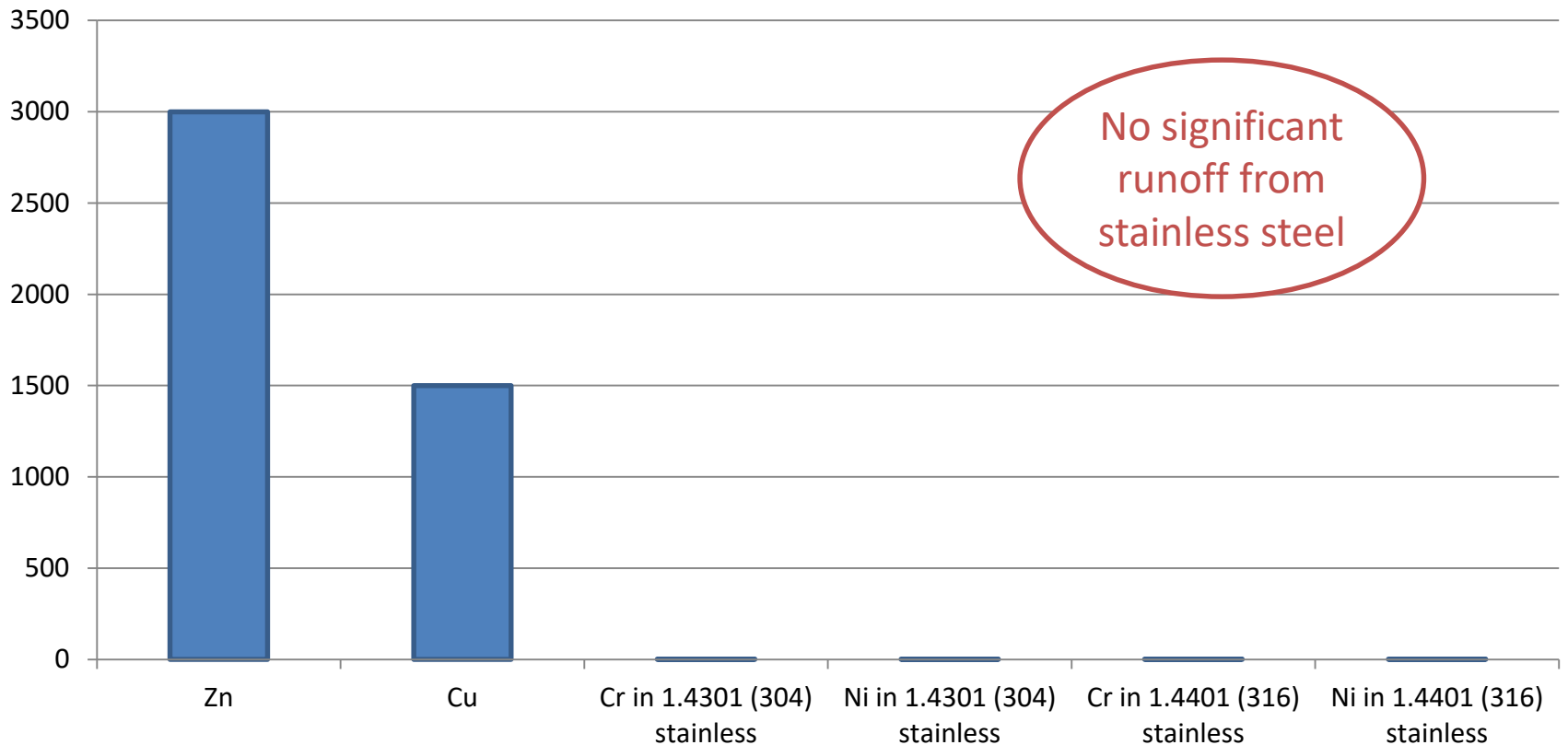
Usual characteristics of stainless steel roofs¹⁻⁴

	Inclined (>3%)	Flat
Material	Ferritics 1.4509 1.4510	Austenitics 1.4301 1.4401
Joining	Mechanical	Welding (for water tightness)
		 <ul style="list-style-type: none"> 1 Stainless steel strip 2 Continuous seam weld 3 Folded top of standing joint 4 Height to seamweld about 16 mm 5 Height of joint before folding about 30 mm 6 Height of joint after folding about 20 mm 7 Angle of about 92° 8 Sliding cleat 9 Stainless fastener 10 Acoustic/protective membrane 11 Supporting structure
Surface Finish	Matte or terne coating (Sn)*	Matte or 2B (when there is a top layer)
Thickness	0.5mm; 0.4 mm for rainwater goods Allows a lightweight structure	
Life expectancy	Will last the life of the building	
Other	Suitable for green roofs In renovation can be placed directly on the bitumen roof	

* In some areas Cu or Zn are restricted as being eco-toxic and leaching into the rainwater

A new concern, metal runoff in rainwater⁵

Mostly in northern Europe ... Stems from demands on water quality, availability and re-use



The Delhi Parliament Library⁶⁻⁷

Architect: Raj Rewal Associates



1. Left: Overview, with the Parliament in the back.

2. Right: View of central focal dome

The library, $\sim 55,000 \text{ m}^2$, had its height restricted to avoid obstructing the Parliament House. The central focal dome comprises a lattice of stainless steel tubular members and cables converging at key tension cast nodes. The second dome containing stainless steel tubes, known as the VIP dome, has a diameter of 16 m and a height of 2.5 m.

Clockwise, from top left:¹

1. Stainless church roof, Leicester, UK
2. School restaurant, Oyonnax, France
3. Universum Science centre, Bremen, Germany





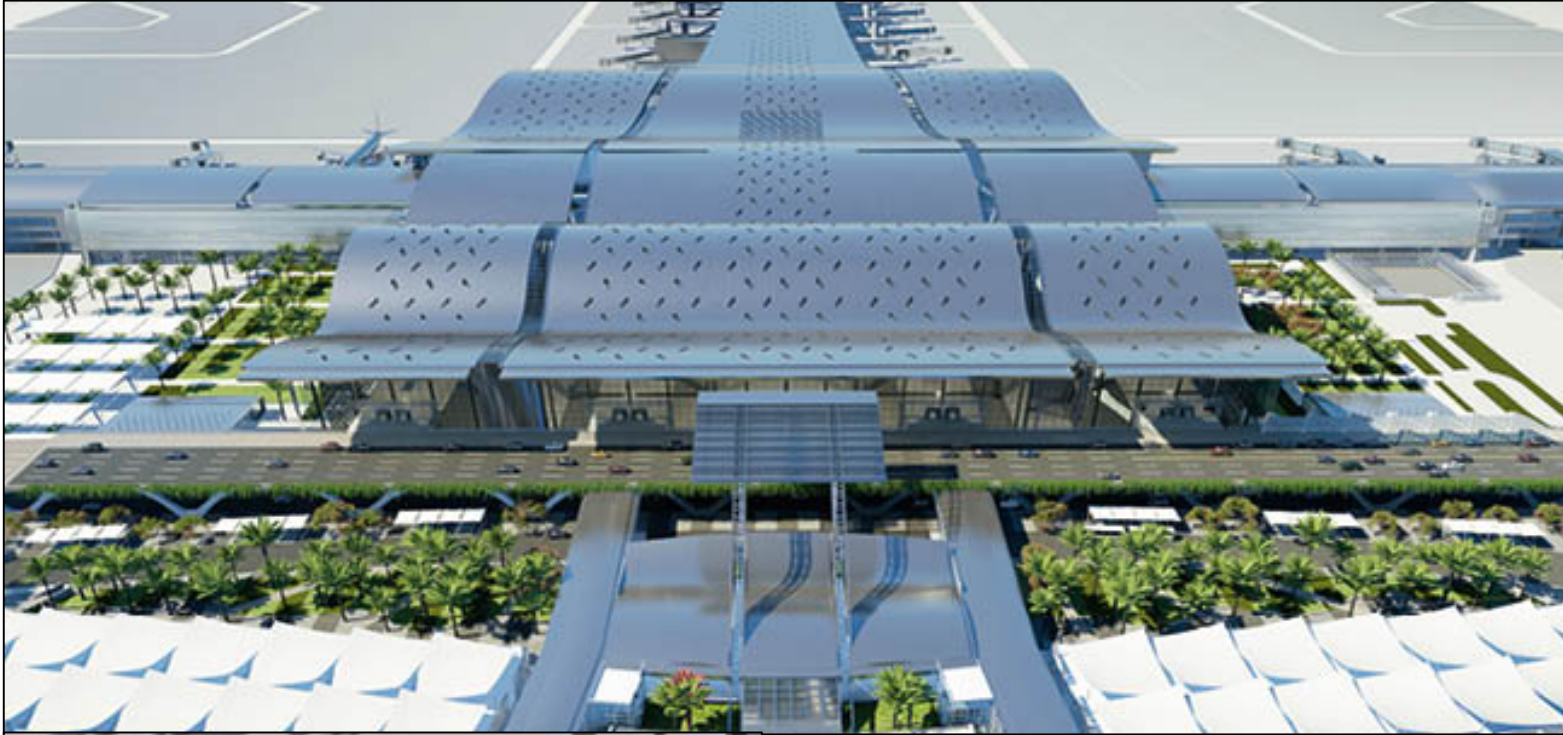
UAE Pavilion at the Shanghai Expo⁸

Architects: Foster & Partners

The dune-like structure is made of triangulated lattice covered with flat stainless steel panels. It has been designed to be demounted.

New Doha airport, Qatar⁹⁻¹⁰

Architects: HOK



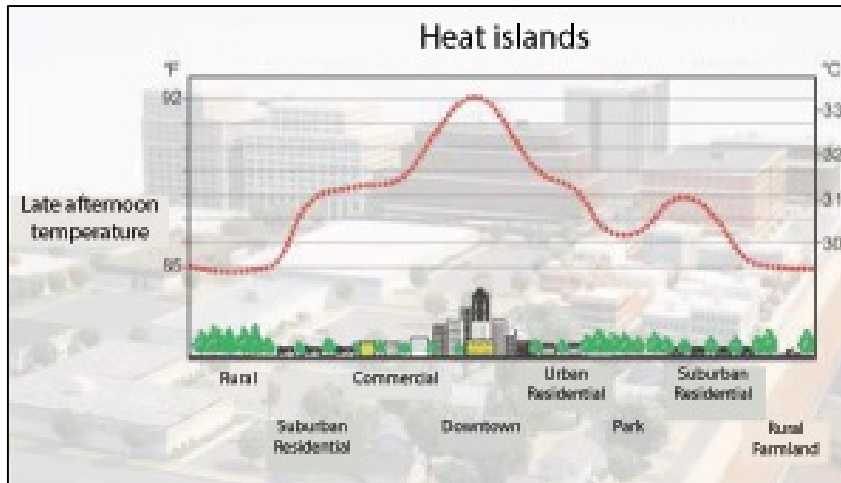
The undulating roof is said to be the largest stainless steel roof in the world (195000m²).

It features a non-directional, low gloss, uniformly textured stainless steel finish.

A lean duplex grade was selected.

No maintenance is required.

Green Roofs^{1-4, 11-12}



Advantages

- Mitigate heat islands
- Reduce dust
- Promote biodiversity
- Provide insulation
- Reduce flood risks
- Reduce noise
- Absorb CO₂
- Aesthetics
- Psychological well-being
- Positive social and economic fallout

Limits

- Requires a sturdy structure
- Needs a proper know-how
- May need watering in summer
- Some maintenance is required
- More expensive

High Reflectance Roof

Austin Hall Sam Houston State University Huntsville, Tx, USA (1851)

Low glare*, high reflectance stainless steel roof ^{11,13}

High Reflectance (Albedo) roofs mitigate heat islands in cities.

Solar Reflectance is now included in LEED (Leadership in Energy and Environmental Design)

SRI of Proprietary finishes > 100



Product	Temperature Rise, at C (F)	Solar Reflective Index
Stainless Steel, bare	27 (48 F)	39-60
Galvanized steel, bare	30 (55 F)	46
Aluminum, bare	27 (48 F)	56
Any metal, white coating	9 (16 F)	107
Clay tile, red	32 (5 8F)	36
Concrete tile, red	39 (71 F)	17
Concrete tile, white	12 (21 F)	90
Asphalt, generic white	36 (64 F)	26
Asphalt, generic black	46 (82 F)	1
Wood shingle, brown	37 (67 F)	22
Wood shingle, white	6 (10 F)	106

* The surface must provide a diffuse light reflection (i.e. avoid mirror-like reflection). Highly polished surfaces are not suitable.



Sunbreakers¹⁵

University of Arizona Medical Research Building & Thomas Keating Bioresearch Building

Canopy-type shading

Mesh with 43% open area: maximises sun blockage while allowing air to pass between the panels.

Roofs References

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2. http://ssina.com/download_a_file/roofing.pdf
3. <https://youtu.be/ZQledV2QFRY>
4. <http://www.bssa.org.uk/cms/File/The%20Growing%20Market%20for%20Stainless%20Steel%20Roofing.pdf>
5. O. Wallinder and C. Leygraf ASTM Special Technical Publication N°1421, « Outdoor Atmospheric Corrosion » pp 185-199
6. https://www.worldstainless.org/Files/issf/non-image-files/PDF/Structural/Parliament_Library_Building_Domes.pdf
7. http://www.architectureweek.com/2003/1022/design_1-3.html
8. <http://www.fosterandpartners.com/projects/uae-pavilion-shanghai-expo-2010/>
9. <http://www.hok.com/design/service/engineering/hamad-international-airport/>
10. <https://www.rigidized.com/exteriorscmt.php>
11. a) <http://www.stainlessindia.org/UploadPdf/Dec%202011%20wshop%20Part-I.pdf>
b) <http://www.wbdg.org/resources/cool-metal-roofing>
12. http://www.constructalia.com/repository/transfer/en/01921518ENLACE_PDF.pdf
13. <http://www.rigidized.com/saveenergy.php>
14. <http://www.stainlessindia.org/UploadPdf/Dec%202011%20wshop%20Part-I.pdf>
15. www.cambridgearchitectural.com/

4. Decoration

Clockwise, from top left:

1. Wood and stainless stairs (unspecified location)
2. Curved wire mesh ceiling (Louisiana State University)
3. Restaurant in Finland with transparent room divider
4. Door handle





Banque de France, Paris, France⁴

Architects: Moati -Rivière

Mirror finish EN 1.4301 (AISI 304)



Metro station L5 El Carmel, Barcelona, Spain⁵

Woven stainless steel mesh wall panels



Mosteiro da Batalha, Portugal⁶

Stainless steel mesh curtain

Open Area 36 %

Weight 0.25 kg/m²

Rod diameter 0.05 mm.

Wire pitch 0.13 x 0.13 mm.



Home curtain/safety banister⁷

Stainless steel

Open area 44 %

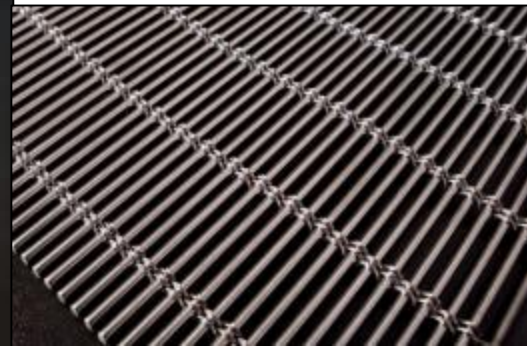
Weight 5,2 kg/m²

Cable diameter 4 x 0.75 mm.

Rod diameter 1.5 mm.

Cables pitch 26.4 mm.

Wire pitch 3 mm.





Museum of contemporary art & planning exhibition, Shenzhen, China (under construction)

Architect: CoopHimmelblau⁸

Decoration References

1. http://www.seoic.com/cable_railing.htm
2. <http://cambridgearchitectural.com/projects/louisiana-state-university-lsu-student-union-theater>
3. <http://www.twentinox.com/projects/item/36/Transparent+stainless+steel+curtain+panels>
4. <http://www.uginox.com/fr/node/180>
5. <http://www.cedinox.es>
6. <http://www.archilovers.com/projects/58425/mosteiro-da-batalha.html>
7. http://www.theinoxincolor.com/portfolio_category/decorative-mesh-projects/
8. <http://www.coop-himmelblau.at/architecture/projects/museum-of-contemporary-art-planning-exhibition>

5. Stainless Steel Plumbing



Clockwise, from top left:

1. Sanitary piping
2. Press-fitted tubes
3. Kitchen faucet
4. Shower head with light



Stainless piping system

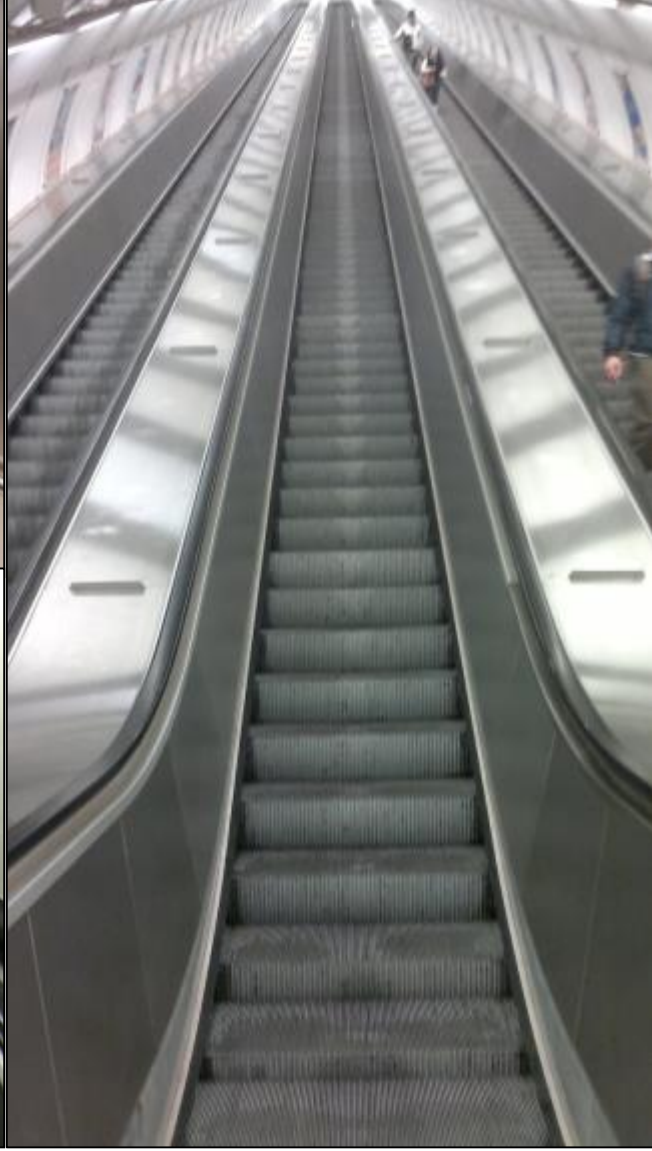
Stainless Steel Plumbing References

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3. https://nickelinstitute.org/library/?opt_perpage=20&opt_layout=grid&searchTerm=pipes%20for%20buildings&page=1
4. <http://www.bssa.org.uk/cms/File/BSSA%20PLUMBING%20P.1-4.pdf>
5. [https://www.grohe.de/de de/badezimmer.html](https://www.grohe.de/de_de/badezimmer.html)

6. Escalators and elevators

Clockwise, from top left:

1. Elevator (unspecified location)
2. Escalator (Prague Metro)
3. Moving sidewalk (Brussels Metro)





Mesh-clad elevator³



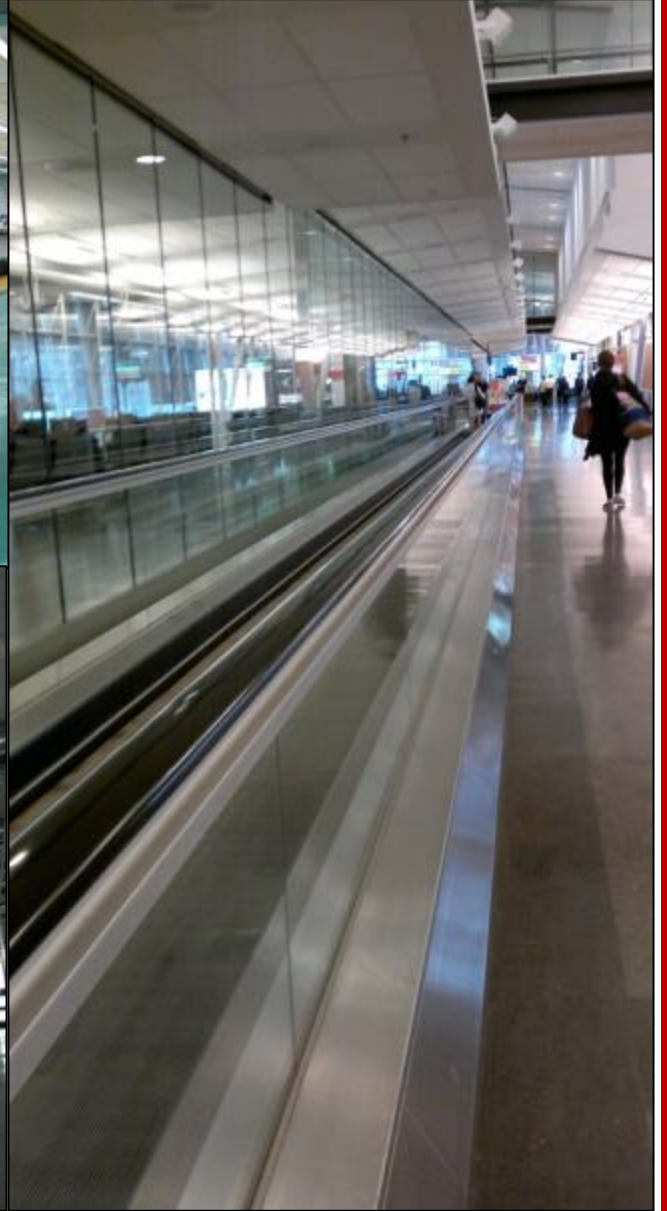
Kraaiennest metro station entrance, Amsterdam, NL⁴

References:

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2. [http://commons.wikimedia.org/wiki/File:Metro bruxelles la uftand.jpg](http://commons.wikimedia.org/wiki/File:Metro_bruzelles_la_uftand.jpg)
3. <http://cambridgearchitectural.com/projects/ft-lauderdale-hollywood-international-airport-rental-car-center>
4. <http://www.cabworks.com/>

7. Airports





Airports References

Stainless steels are used everywhere, as the requirements are materials are expected to be used by the public 365 days a year while retaining an excellent aesthetic appearance:

- roofs,
- urban furniture,
- counters,
- drinking fountains,
- partitions,
- ventilation equipment
- handrails
- elevators, escalators, moving sidewalks
- baggage delivery carousels
- pushcarts
- fasteners
- etc...

8. Urban furniture



Clockwise, from top left:

1. Fence near school in Budang, Korea. Grades: STS439 / STS304 Finish: 2B / HL / polishing
2. Handrail in Gijón, Spain. Grade: 316L Finish: Polished
3. Handrail, India
4. Lower Manhattan's South Ferry Subway Terminal "See it split, see it change" by by Doug and Mike Starn



Clockwise, from top left:

1. Bench in Paulinia (SP), Brazil. Grade: 304 STS304 Satin Finish
2. Butterfly bench in San Luis Potosi, Mexico
3. Bench with woven mesh, France
4. Lamp post, Seoul, Korea Grades: STS439 / STS304 / STS304N1 Finish: 2B / BA / Polishing



Clockwise, from top left:

1. Bus Stop, Istanbul, Turkey. Grades: AISI 304 and AISI 316 Finish: 2B / BA / Brushed / Scotch Brite
2. Bicycle rack, Albenga, Italy. Grade: EN 1.4301 (AISI 304)
3. Sculpture, « Invisible City », Wellington, New Zealand
4. Joana Vasconcelos's sculpture entitled « Marylin » and made of stainless pots



Urban Furniture References

1. <https://www.worldstainless.org/applications/architecture-building-and-construction-applications/street-furniture/>
2. http://norcor.free.fr/piazza_superbe_inox.jpg
3. <http://listraveltips.com/wellington-street-art-stainless-steel-braille-sculpture/>

9. Restoration



Left: Stainless steel entrance pavilion to the the crypt of the St Martin-in-the-Field Church, London

Right: Stainless and Glass Pyramide du Louvre, Paris



Opera theatre in Verona, Italy

The great Roman monument, dates back to the first half of the 1st Century AD and has been known as the most important open air opera theatre. Recent restoration work involved the construction of new covering for the central pit, where the orchestra sits, the underground room and the underground sewage tunnels. The new covering slab is supported by a system of roof struts and post tension tie rods. The post tension system used, comprising stainless steel bars, guarantees structural safety, quality and durability.



Roman Theater, Frejus, France

Restoration of the open air roman theater with teck and perforated 3 mm thick EN 1.4571 stainless steel sheet



Restoration References

1. [https://www.worldstainless.org/Files/issf/non-image-files/PDF/Euro Inox/New meets Old EN.pdf](https://www.worldstainless.org/Files/issf/non-image-files/PDF/Euro%20Inox/New%20meets%20Old%20EN.pdf)

10. Arenas

1-3
Clockwise, from top left:

1. Handrail in VIP entrance staircase, Wembley, UK;
2. Turnstile; 3. Lockers;
4. Stainless canopy and handrail on Bourke St pedestrian bridge to Melbourne's Colonial stadium, Australia





Yamuna Stadium, Delhi, India ⁴

Architects: Peddle Thorb

On the occasion of the Commonwealth Games 2010, a multifunctional stadium was created in New Delhi. With its shining façade made of stainless steel mesh, the stadium symbolises sport as a means for modern and sustainable human interaction. The stainless steel cladding with an open area of 53 percent shields spectators from the fierce subtropical climate and provides effective sun protection.



Castelão Stadium, Fortaleza, Brazil^{5,6}

Architect: Vigliecca & Associados

The façade was entirely made of stainless steel expanded sheets. In addition to the external frame, stainless steel was used on railings, handrails at VIP areas, lavatories and locks of the stadium. “We have made an option for the durability stainless steel provides, which is essential to areas like the façade that required a corrosion-resistant material, and for its noble appearance, required in the hospitality sector”, says architect Ronald Fiedler, responsible for the Project.



Allianz Park Palmeiras Stadium, Sao Paulo, Brazil⁷

Architect: Edo Rocha Arquitetura

This is one of the most beautiful arenas in the world. Stainless Steel is intensively used in its façade. Stainless Steel is intensively used in its façade. The sheets of stainless steel have holes in them to facilitate the circulation of air.



Media Facade, Lille stadium, France⁸
Architects: Valode Pistre and Ferret

Stainless steel mesh media facade.

The mesh supports a high power, versatile LED system which permits individually programmable lighting effects, ranging from simple graphics to video content.

Arenas References

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2. <http://www.assda.asn.au/blog/223-stainless-welcome-for-sports-fans>
3. <http://www.controlledaccess.com/>
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6. <http://www.copa2014.gov.br/en/noticia/see-details-castelaos-architecture-project>
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8. <https://www.osram.com/ls/projects/grand-stade-lille/index.jsp>

11. Swimming Pools

Clockwise, from top left:

1. Olympic-size, stainless steel-lined swimming pool, Vichy, France
2. Custom stainless steel roof spa
3. Stainless steel handrail





Stainless Waterslide

Made from a single streamlined curve shape, the foot of the curve constitutes the steps that take the user to the top of the slide. The slide itself then loosens and turns in on itself. To create a contrast, the designers used a mirror-polished finish on the interior while the exterior is brushed

"Polished stainless steel doesn't get too hot to touch, even in sunny climates," the UK-based designers explained. "In fact, it actually reflects sunlight and thermal energy as it doesn't oxidise like other metals."

Swimming Pools References

1. <http://www.imoa.info/molybdenum-uses/molybdenum-grade-stainless-steels/architecture/french-pool-liner-article.php>
2. http://www.constructalia.com/repository/transfer/fr/02163065ENLACE_PDF.pdf
3. <http://www.awt-eisleben.de/en/swimming-pools-136.html>

Thank you

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<https://www.surveymonkey.com/r/3BVK2X6>