

# PEDESTRIAN BRIDGES OF EXPRESSIVE STEEL

## Architecturally Reconnecting the Urban Fabric



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# Overview

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- The presentation will address:
- Structural bridge types
- Benefits of AESS for pedestrian bridges
- Pedestrian Bridge as Public Art
- Erection and fabrication issues and potential
- Corrosion protection systems and application
- AESS based detailing



# Structural Bridge Types

There are 7 main types of structural forms for bridges:

## ARCH BRIDGE



EXAMPLE: PONT-SAINT-MARTIN, ITALY

WWW.BIGRENTZ.COM



## BEAM BRIDGE

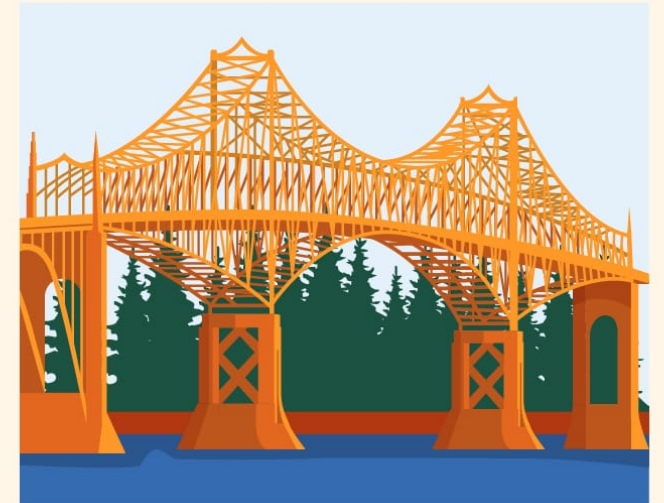


EXAMPLE: LAKE PONTCHARTRAIN CAUSEWAY, LOUISIANA

WWW.BIGRENTZ.COM



## CANTILEVER BRIDGE



EXAMPLE: McCULLOUGH MEMORIAL BRIDGE, OREGON

WWW.BIGRENTZ.COM



<https://www.bigrentz.com/blog/types-of-bridges>

# Structural Bridge Types

There are 7 main types of structural forms for bridges:

## SUSPENSION BRIDGE



EXAMPLE: GOLDEN GATE BRIDGE, CALIFORNIA

[WWW.BIGRENTZ.COM](http://WWW.BIGRENTZ.COM)

**BIG  
RENTZ**

## CABLE-STAYED BRIDGE



EXAMPLE: STRÖMSUND BRIDGE, SWEDEN

[WWW.BIGRENTZ.COM](http://WWW.BIGRENTZ.COM)

**BIG  
RENTZ**

# Structural Bridge Types

There are 7 main types of structural forms for bridges:

## TIED ARCH BRIDGE (BOWSTRING)



**EXAMPLE:** FORT PITT BRIDGE, PENNSYLVANIA

[WWW.BIGRENTZ.COM](http://WWW.BIGRENTZ.COM)



## TRUSS BRIDGE



**EXAMPLE:** COTTONWOOD RIVER  
PRATT TRUSS BRIDGE, KANSAS

[WWW.BIGRENTZ.COM](http://WWW.BIGRENTZ.COM)







Arch Bridge





Cantilever Bridge





Cable Stayed Bridge





Suspension Bridge





Beam Bridge Variation





Truss Bridge





Tied Arch Bridge

# Design Issues:

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- Span – how far?
- Over what?
- Clear span or intermediate supports?
- Access to get on the bridge
- Edge support conditions
- Any height restrictions?
- Support overhead
- Support under deck
- Does any transportation need to go under the bridge?
- How do you transport it to location?

**Outside:** materials, durability, corrosion

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## To Combine or to separate?

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- Pedestrian access has typically been included alongside existing vehicular bridges
- Pedestrians have been completely excluded from vehicular and rail bridges
- Pedestrian precincts that parallel high traffic on bridges are non ideal
- Recent increase in dedicated pedestrian bridges can be seen as good





Guangzhou, China





San Francisco, USA



Toronto, Canada





Winnipeg, Manitoba

## Selecting Your AESS Category

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- Choices are most often **AESS 3** – Viewing Distance < 6m or **AESS 4**
- High degree of welded prefabrication
  - Often no need to grind or remediate welds
- High degree of custom sections for very artistic bridges
- Numerous curved elements, including cones and tapers
- Stainless steel fittings for railings and guards
- Higher level finishes on tensile elements than might be found in regular suspension type bridges



# Benefits of AESS for Pedestrian Bridges

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- Artistic potential
- Urban activation
- Prefabrication of near complete elements prior to erection/installation
- Transportation to site of large bridge elements
- Minimization of disruption to normal traffic flows during erection
- Durability and ease of inspection for maintenance

## Artistic Potential – Bridge as Public Art

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- Securing funding
- Many municipalities are developing dedicated funds for public art
- Possible to add budget to the bridge if it is also seen as “public art”
- Pedestrian/cycle bridges can be used “as” art
- The improvement of the human condition by design





Peace Bridge | Calgary, Canada





Arganzuela Bridge | Madrid, Spain





Simone Beauvoir Footbridge | Paris, France





London, UK





Toronto, Canada

## Urban Activation

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- Encourage public use if the bridge is an attraction
  - Entails designing the spaces of the bridge for activities
  - May necessitate more width or points of overview or for lingering
  - May require the separation of cyclists from slower moving pedestrians to avoid accidents
  - Some bridges will preclude cyclists for this reason
  - Must ponder bridge access for the disabled and cyclists (ramps)
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Millennium Footbridge | London, UK





Gateshead Millennium Bridge | Newcastle, UK





Simone de Beauvoir Footbridge | Paris, France





Brooklyn Bridge | New York City, USA





Cycle access ramp to bridge | Guangzhou, China





Peace Bridge | Calgary, Canada





# Prefabrication

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- AESS/steel is easily shop fabricated
- Steel can come to site prefinished
- Able to reduce the time spent on the site
  
- POSSIBLE to reduce/eliminate site welding
- POSSIBLE to promote quicker bolted connections on site
- Depends on aesthetics, member types, span
  
- Greatly impacts decisions in transportation:
  - Component size
  - Access to site for installation





Auckland, New Zealand

# Minimized Disruption to Traffic

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- Erection is quicker so traffic is less disrupted than for work that requires extensive scaffolding and formwork
- Need to understand implications of span
  - Clear span versus multiple spans
  - Over water, clear span or supports possible?
  - Over streets, highways or rail lines, stoppage of traffic
    - Lift in segments and join or launch entire bridge?
    - Premiums paid for stoppage can be reduced





Skytrain Bridge | Vancouver, Canada

Image: George Third & Son





Image: George Third & Son



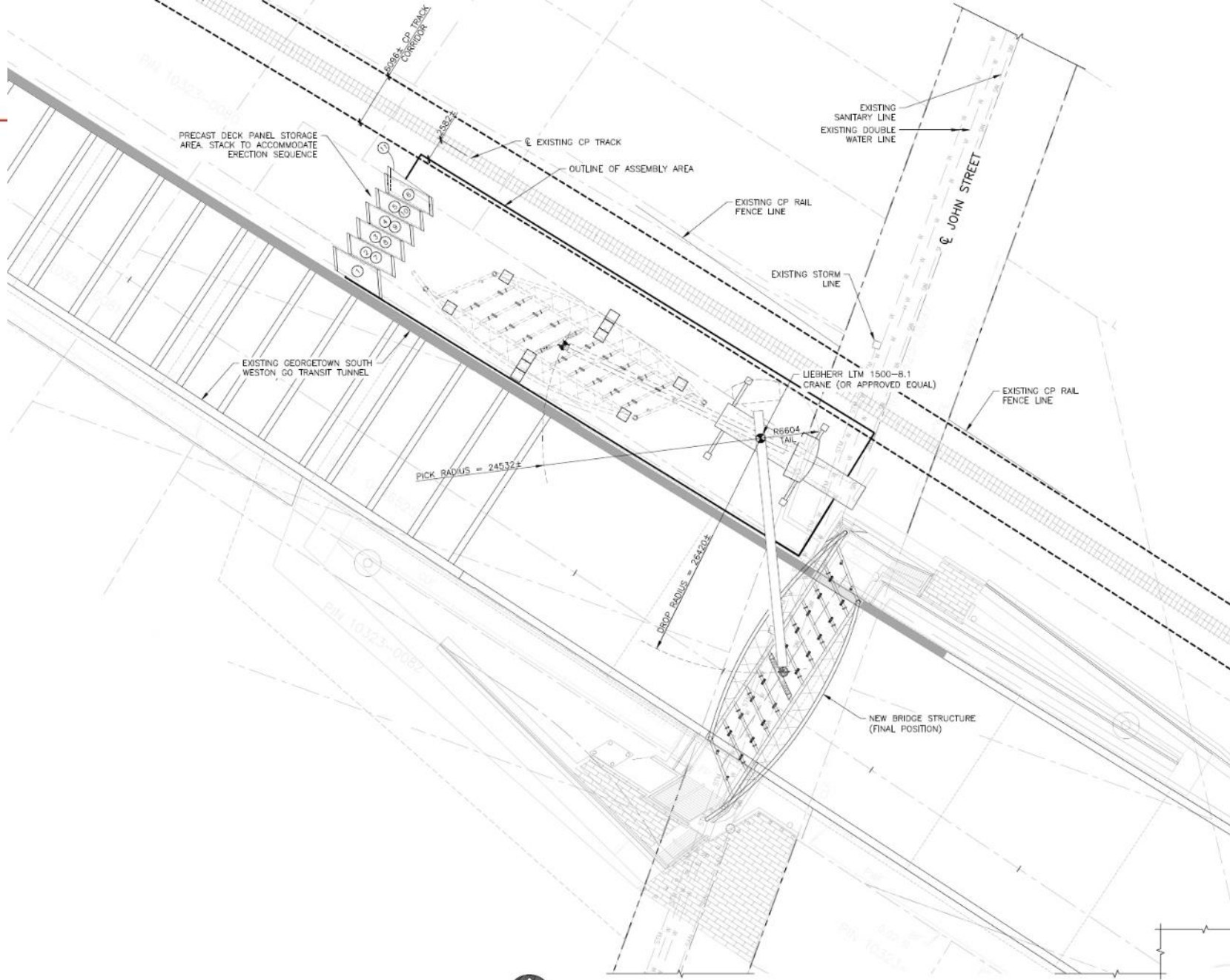


John Street Bridge | Toronto, Canada









NORTH



**SITE PLAN**

(PHASE 5)

1:250

FINAL POSITIONING

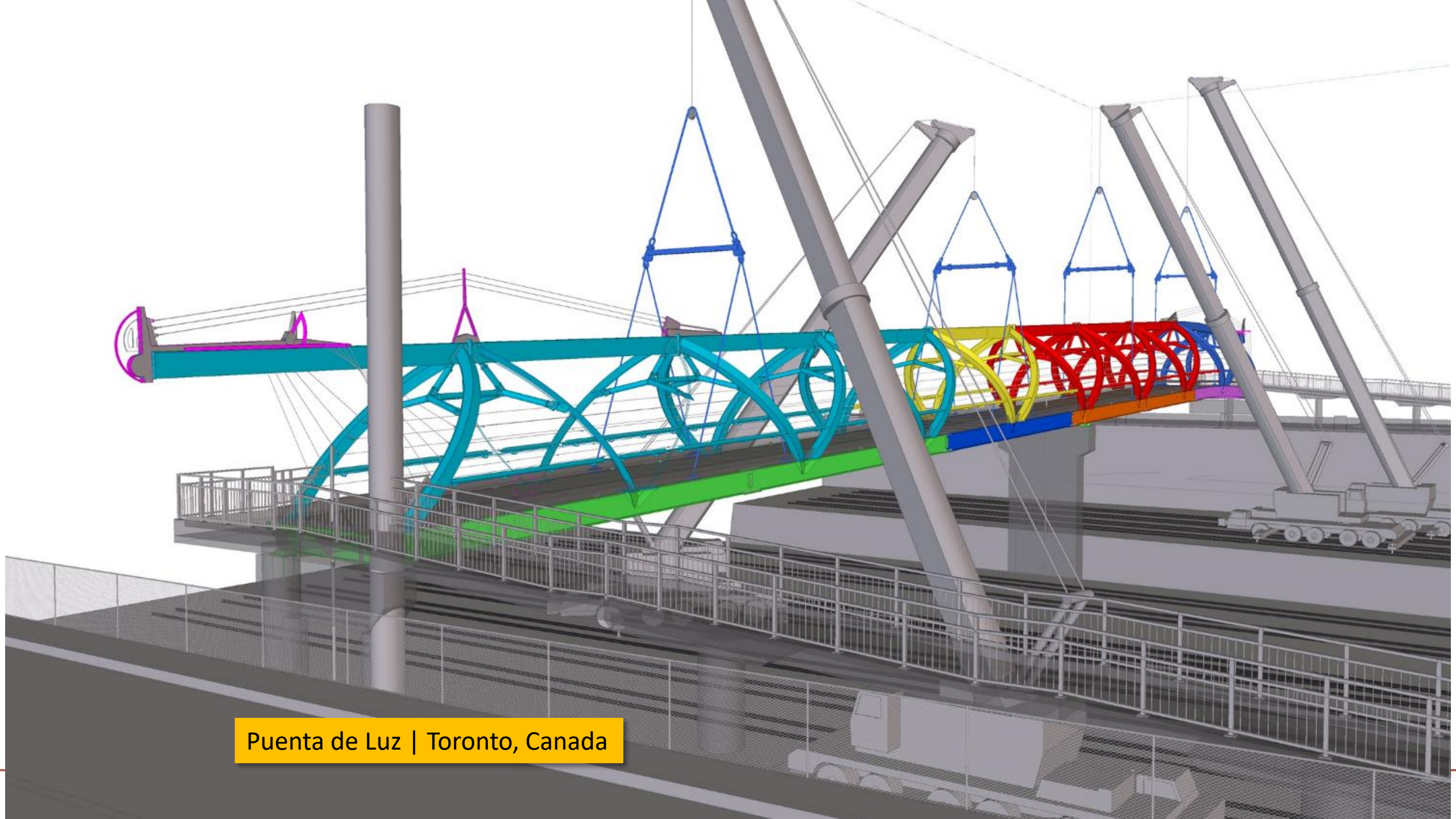












Puerta de Luz | Toronto, Canada









ROGERS CENTRE





Fabrication of the Gateshead Millennium Bridge takes place offsite: Bridge completely prefabricated and shipped to site.



alamy stock photo

D2EKME  
www.alamy.com





[http://www.picturesofgateshead.co.uk/millennium\\_bridge/index.html](http://www.picturesofgateshead.co.uk/millennium_bridge/index.html)





Kurilpa Bridge Construction  
<https://www.arup.com/projects/kurilpa-bridge>











# Durability

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- Extremely important to understand the atmospheric conditions and risk of corrosion
- Ascertain type of de-icing agents as some are far more corrosive than others
- Need to obtain higher up front spending on corrosion system to prevent longer term repairs
- Ensure maintenance schedule
- Detailing for drainage and against pigeons, etc.





Denver, USA





Amgen Bridge | Seattle, USA





Mimico Creek | Toronto, ON



# Galvanization

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- Likely the most popular and cost effective solution for corrosion resistance
- Need to understand limits of size of galvanizing bath as may mean constructing of smaller elements
- Need to ensure drainage holes and coating hollow sections on inside (more \$)
- Complex shapes and thin steel not well suited to galvanizing
- Hot process so can cause deformations
- Presence of SO<sub>2</sub> will accelerate corrosion







# 1.1 Surface preparation to SSPC-SP 6

SP 3 : Power Tool Cleaning

SP 6 : Commercial Blast Cleaning

**S.S.P.C. Steel Surface Preparation Standards** (click a picture for more details)

				
Bare Metal	SP-5	SP-6	SP-7	SP-10



**SP-6  
Commercial Blast Cleaning**

Complete removal of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products and other foreign matter, except for spots and discolorations.

Spots and discolorations shall be limited to no more than 33% of each area of nine square inches.

Usual methods for cleaning: compressed air nuzzle blasting or equipment with centrifugal wheels.

Equivalence: NACE 3# • Swedish Standard # SA-2

→ SP 15

SSPC-SP 6 for complete removal of visible oil, mill scale, rust, paint.





Miyazaki, Japan







London, UK







Toronto, Canada

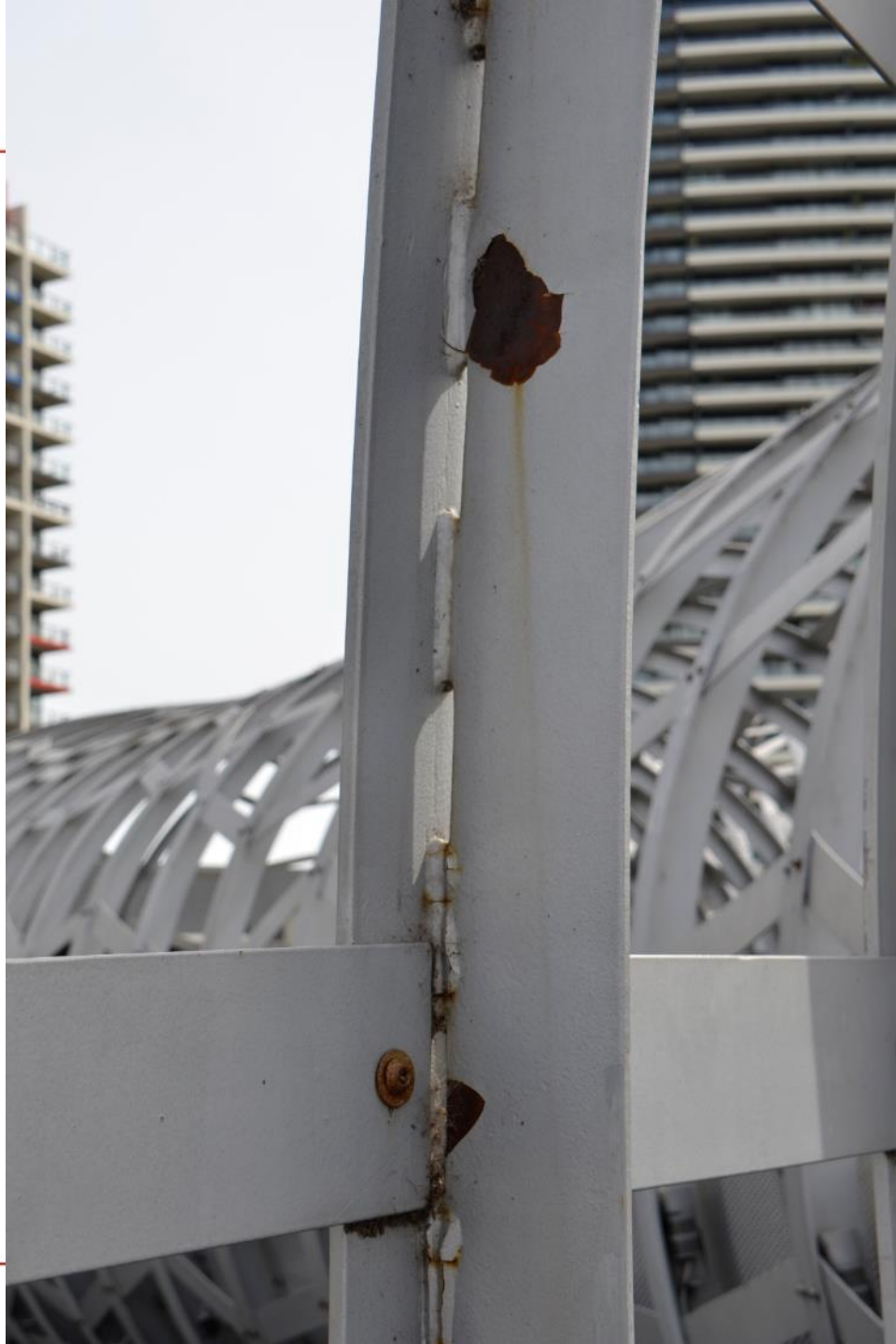




Polysiloxane coating

Webb Bridge | Melbourne, Australia










Olympia, Greece





Make sure that the fasteners are also durable, galvanized!



# Metallization

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- Zinc / aluminum wire is melted and sprayed
- Usually shop applied
- No limits on member sizes
- Relatively cold process (150C) so no issues of deformation for thin members
- Need to verify applied thicknesses
- Aluminum better for high SO<sub>2</sub> levels (industrial pollutants)





Auckland, New Zealand















# Weathering Steel

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- Material most commonly sourced as plate good
  - Involves a high level of custom fabrication
  - Achieves patina through cycles of wet/dry
  - Need to ensure good detailing and drainage
  - Keep debris and leaves away as these will trap moisture and accelerate corrosion
  - Not suited to harsh marine climates as salt spray will accelerate corrosion
  - Concern for staining of surfaces below the steel
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Melbourne, Australia









Glass Bridge | Perth, Australia





















Stratford Town Centre Link | London, UK












A close-up photograph of a weathered steel weld joint. The steel is heavily rusted, showing a dark brown, textured surface. The weld joint is visible as a raised, textured area where two steel plates meet. In the background, out of focus, is a building structure with a metal railing and a concrete surface.

Special weathering steel weld material used on this product. Often left unremediated as grinding would rather mess up adjacent finishes.







# Stainless Steel

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- Not all stainless steels are equal
- Rough finishes will rust faster
- Must also be cleaned on a regular basis to prevent staining and pitting
- Marine climates and presence of de-icing agents will require higher level of steel
- Use at least 316 for basic corrosion prevention
- Severe marine climates will need Duplex 2205





Helix Bridge | Singapore





















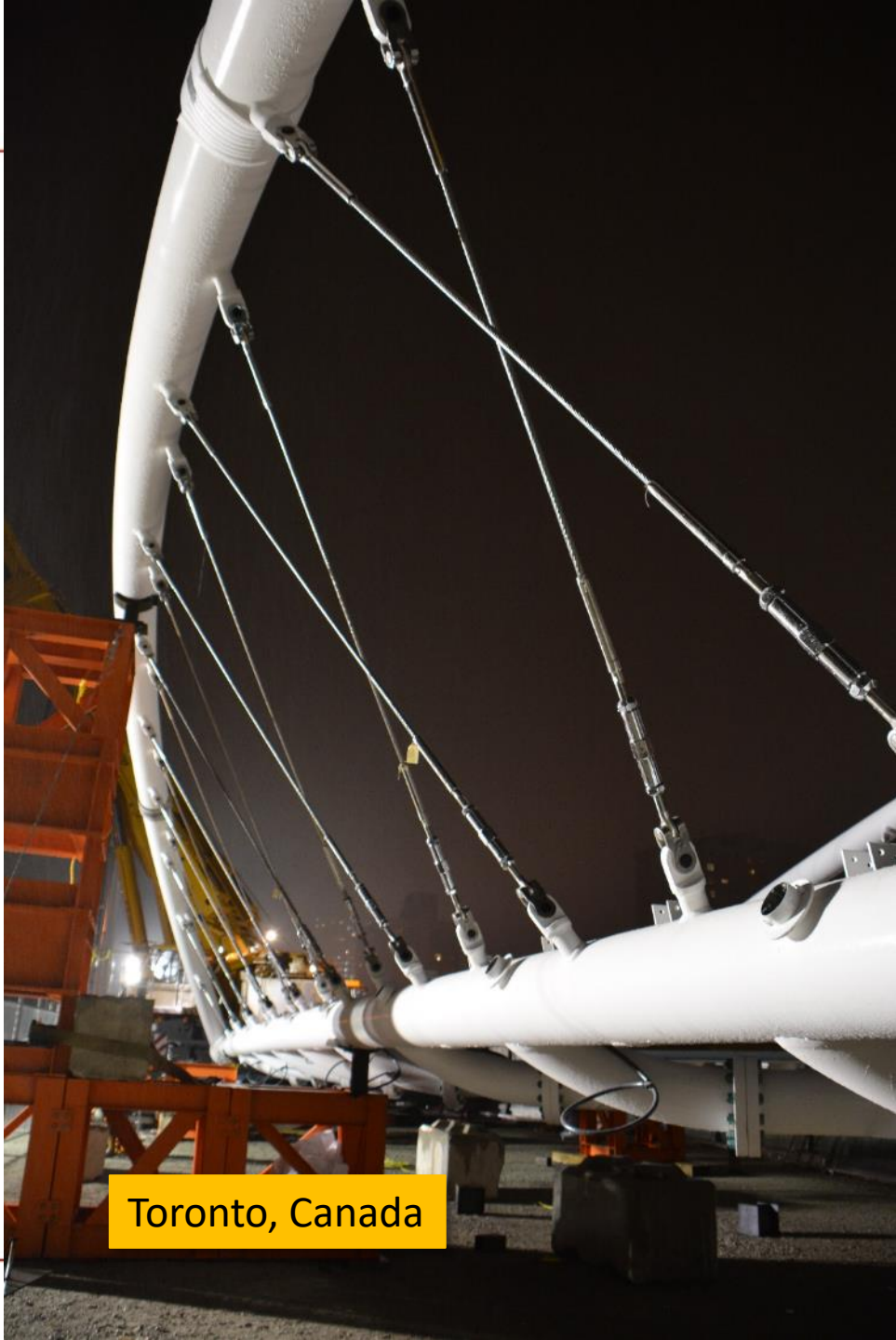
Paddington Basin | London, UK





Vancouver, Canada





Toronto, Canada





# Maintenance and Staining

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- Understanding the environment cannot be stressed enough
- Impacts the ultimate choice of corrosion system
- Bridges are not easy to clean due to their locations
- Consider colour choice as you understand the potential cleaning and finishing schedule, particularly when using a painted type finish
  
- *White might not be the greatest colour choice....*





Vancouver, Canada











## Support Type

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- The abutment conditions will influence the type of bridge
  - Mast types need clearances
  - Arch supports need good abutments
  - Long low bridges require special foundations/support
  - Similar considerations to larger vehicular bridges but the supports may need to be more aesthetically integrated into the overall design
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Skytrain Bridge | Vancouver, Canada









TransCanada Overpass | Vancouver, Canada









Amgen Helix Bridge | Seattle, USA













Pedro e Ines Bridge | Coimbra, Portugal





Solferino Footbridge | Paris, France









St. Patrick's Bridge | Calgary, Canada









Peace Bridge | Calgary, Canada









Millennium Bridge | London, UK













Jubilee Bridge | London, UK









Canary Wharf Footbridge | London, UK













Dalian, China













Yufuin, Japan











# Span Length and Clearances

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- Span length important
- Ability to include mid span supports
- Clearance below the deck for traffic
- Height limitations
- Clearances for transportation to the site
- Type of transportation to the site





Museum of Flight | Seattle, USA









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Fourteenth Avenue Bridge Reach

Duwamish Waterway

Hydro 4 Less - Hydro Shop Seattle

Metal Shorts

Raisbeck Aviation High School

S 94th Pl  
E Marginal Way S

The Museum of Flight

Boeing

S 96th Pl

Boeing Military Flight Center

E Marginal Way S

Airport Way S

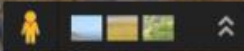
Airport Way S

Airport Way S

Google



3D











Simone de Beauvoir Footbridge | Paris, France





<http://www.linternaute.com/savoir/grands-chantiers/06/dossier/passerelle-bercy-tolbiac-simone-de-beauvoir/3.shtml>





Gateshead Millennium Bridge | Newcastle, UK















## Section Types and Detailing

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- Most bridges will use either hollow structural sections or custom fabricated plate
- Budget usually will determine
- You can actually make a pretty interesting bridge with minimal custom work





Skytrain Bridge | Vancouver, Canada









Prefectural Art Museum | Oita, Japan









Canoe Bridge | Vancouver, Canada

















Kurilpa Bridge | Brisbane, Australia

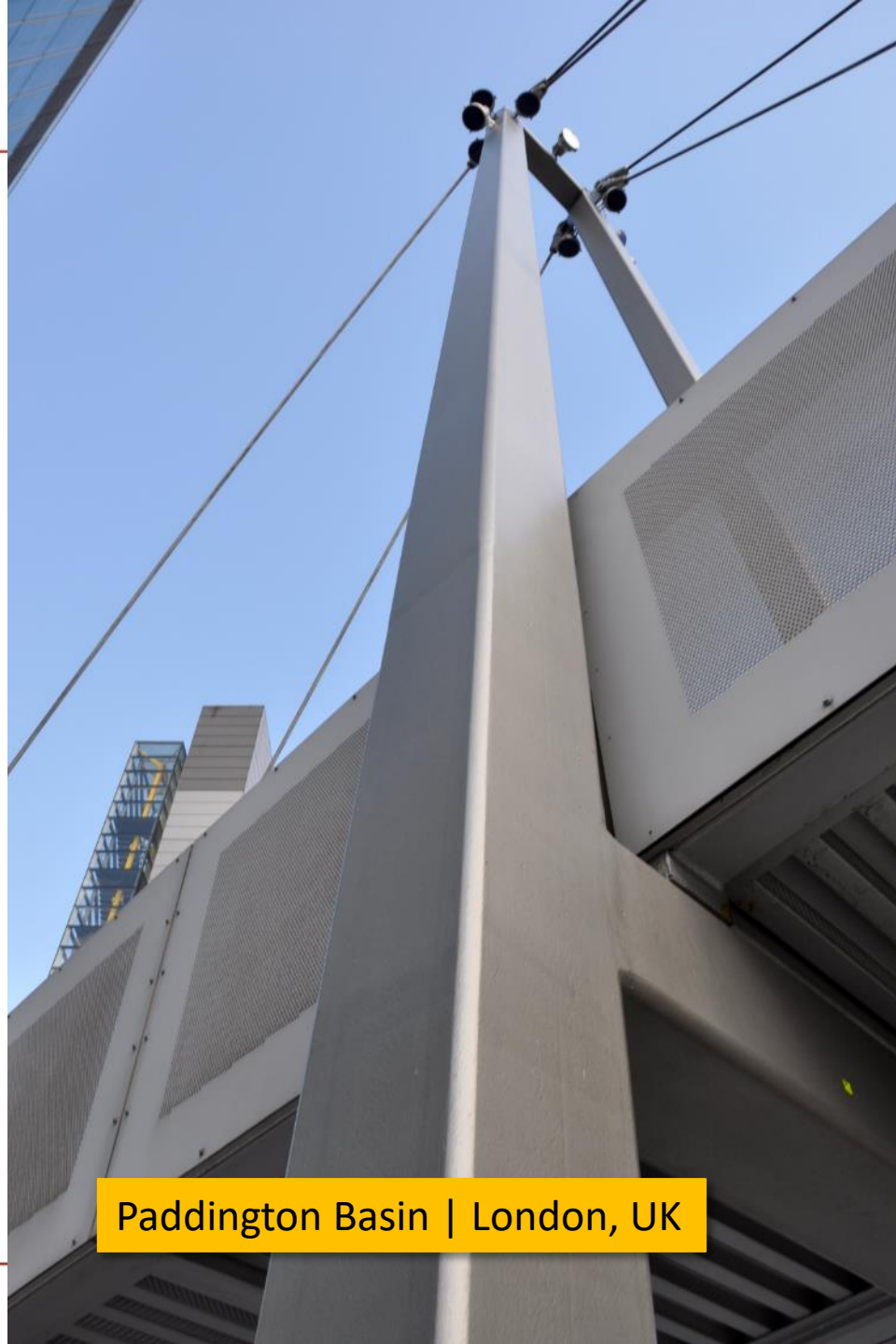




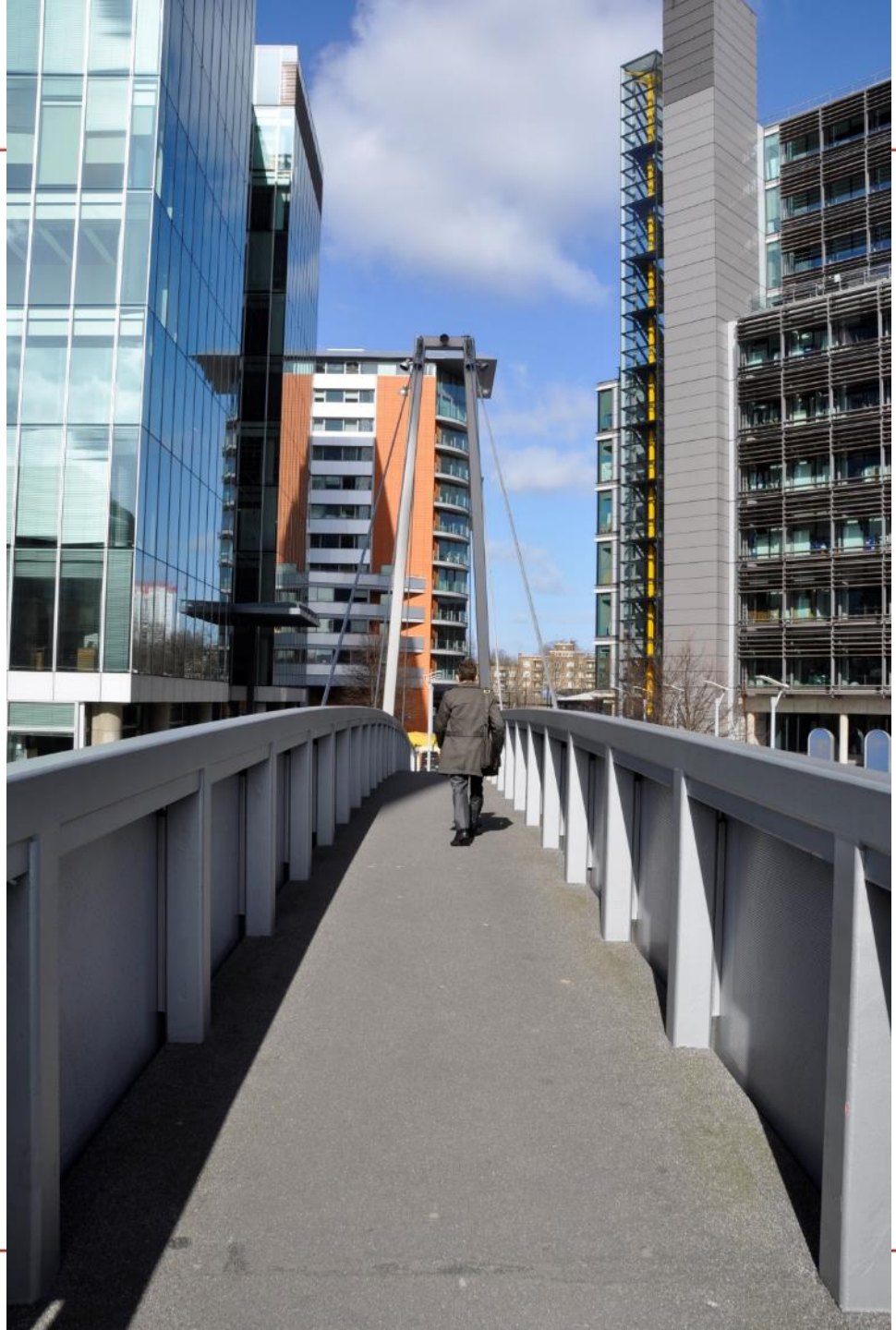








Paddington Basin | London, UK







Wells Fargo Bridge | Salt Lake City, USA





Humber River Bridge | Toronto, Canada



A low-angle photograph of the Amgen Helix Bridge in Seattle, USA. The bridge features a prominent, curved, metallic structure with a series of parallel, slightly curved beams that create a helical pattern. The bridge is supported by a complex network of dark, cylindrical steel columns. In the background, a multi-story brick building with large windows is visible under a clear blue sky with a few wispy clouds. The overall scene is brightly lit, suggesting a sunny day.

Amgen Helix Bridge | Seattle, USA



# Custom Fabrication

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Or, how to create a corner using plate steel...

Three options:

- Brake form the steel (corners will be rounded)
- Butt weld the corners (corners will be crisper)
- Inset the plates as they meet and fillet weld (corners will be crisp with a shadow line)





Peace Bridge | Calgary, Canada





Arganzuela Bridge | Madrid, Spain









Pedro e Ines Bridge | Coimbra, Portugal









Puente de Luz | Toronto, Canada



# Specialized Detailing

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- Many other details will require custom fabrication
- All tapers are created using brake forming
- Clevis attachments required for tensile components
- Railings and guards must be designed for views as well as safety





Paddington Basin Lift Bridge | London, UK













Bridge | London, UK









Amgen Bridge | Seattle, USA





Jubilee Bridge | London, UK







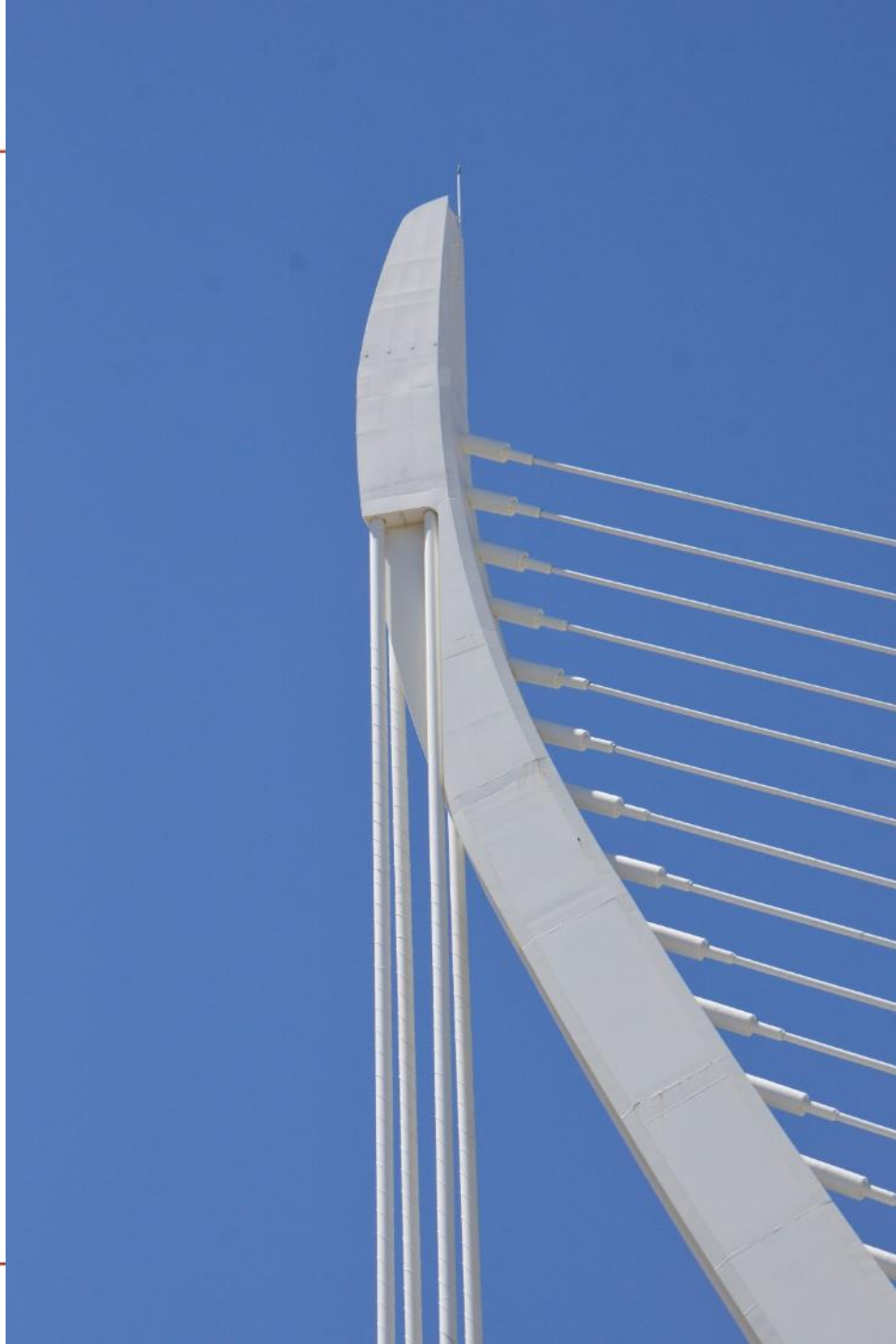






Valencia, Spain

















Wisconsin Art Museum Bridge | Milwaukee, USA







# Design of Guards and Railings

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- Style and height will depend on the risk of fall
- Taller and more dense (non climbable) guards are required over highways and rail corridors
- Lower guards possible over landscaped areas and rivers
- Important to preserve the sense of view as not to make pedestrians feel imprisoned
- Possible to use stainless steel meshes and glass where falling must be safely restricted
- Much will depend on checking the local codes. Important in many areas to have it non-climbable (so no horizontal rails or large meshes).





Puente de Luz | Toronto, Canada





TransCanada Overpass | Vancouver, Canada





Amgen Bridge | Seattle, USA





Suicide Prevention Barrier | Toronto





Arganzuela Bridge | Madrid, Spain





Simone de Beauvoir Footbridge | Paris, France









Pedro e Ines Bridge | Coimbra, Portugal









Prefectural Museum | Oita, Japan





Lift Bridge | Auckland, New Zealand



## The Solution is in the AESS

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*Architecturally Exposed Steel can be used to create vital pedestrian bridges that are capable of reconnecting the disparate parts of our urban centers.*



*Take care to choose and detail for your correct AESS Category, for durability, and a fantastic user experience.*

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