AESS APPLIED

Terri Meyer Boake Professor School of Architecture University of Waterloo



Owner

Calgary International Airport

Architect

DIALOG

Structural Engineers

Read Jones Christoffersen Ltd.

Construction Manager

Ellis Don Construction Management Services

Steel Fabricator / Detailer / Erector

Supermétal

Project Profile

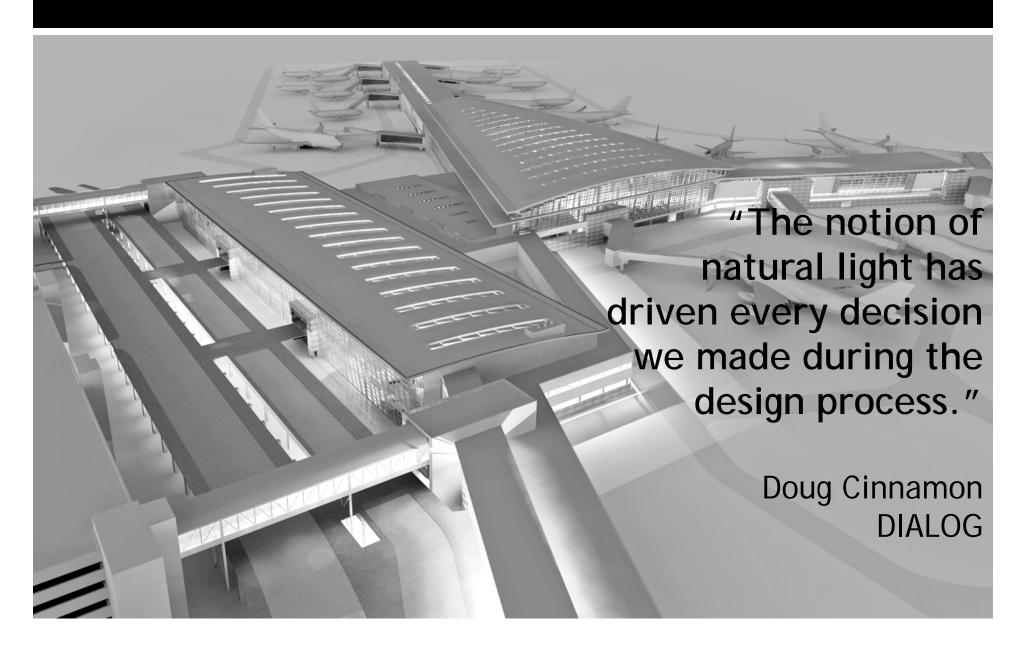
CALGARY INTERNATIONAL AIRPORT International Facilities Project



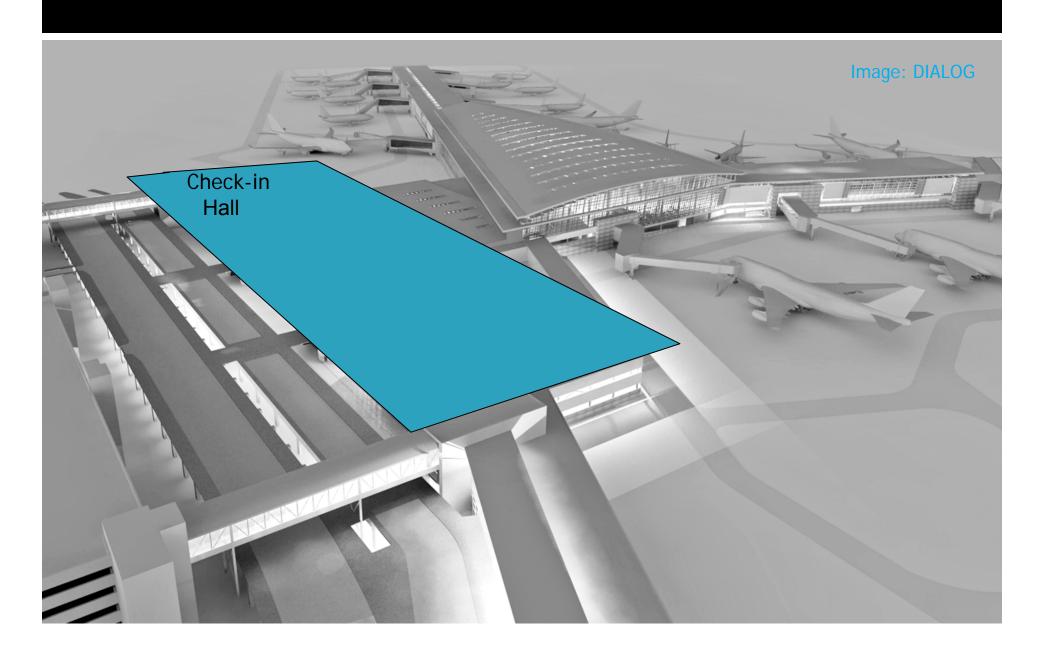
Photo credits this section: Supermétal

Content: Sylvie Boulanger, Vice President, Technical Marketing

Calgary Airport International Facilities Project



Calgary Airport International Facilities Project



Check-in Hall

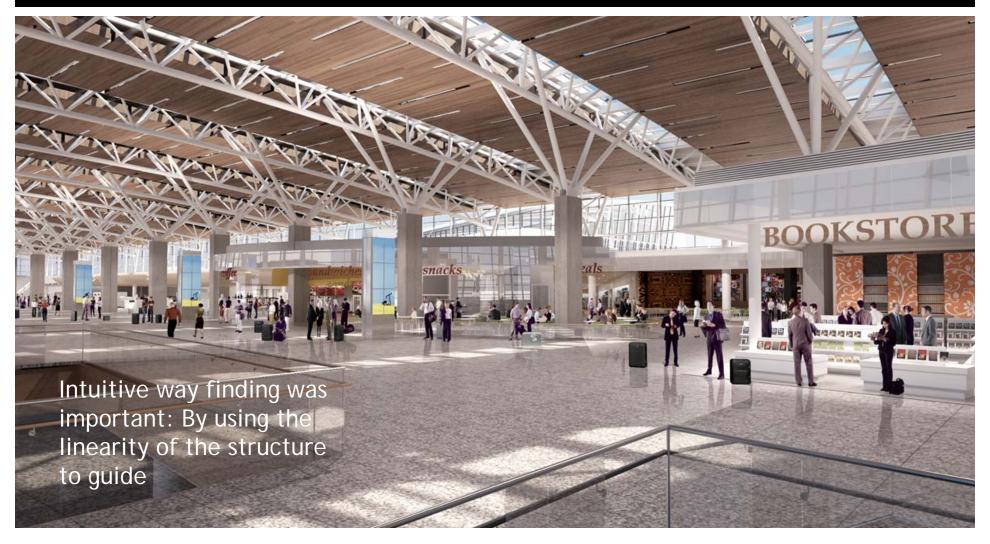
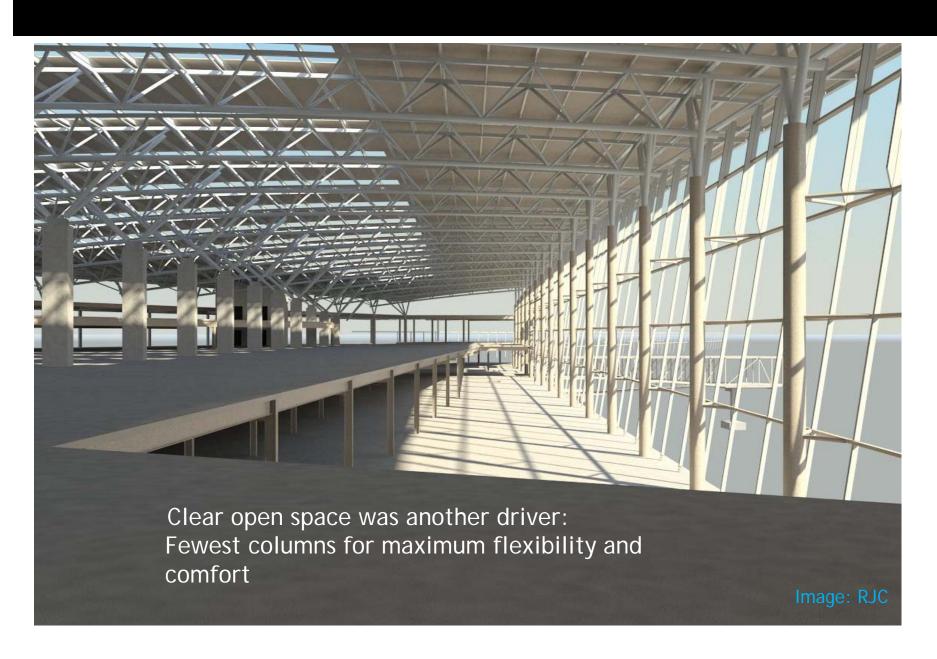


Image: DIALOG

Calgary Airport International Facilities Project



Quick Facts

International Facilities Project

\$1.4 billion investment In-service October 2015 Five levels and 183,500 m² 22 new aircraft gates Green building features

Structural Steel

8000 tons, including 2000 tons of AESS in Check-in and Departures Halls

Check-in Hall

Area of 48,100 m² 17 x 58m triangulated trusses Weight per truss: 22.5 tons Heaviest segment: 9 tons

Typical truss

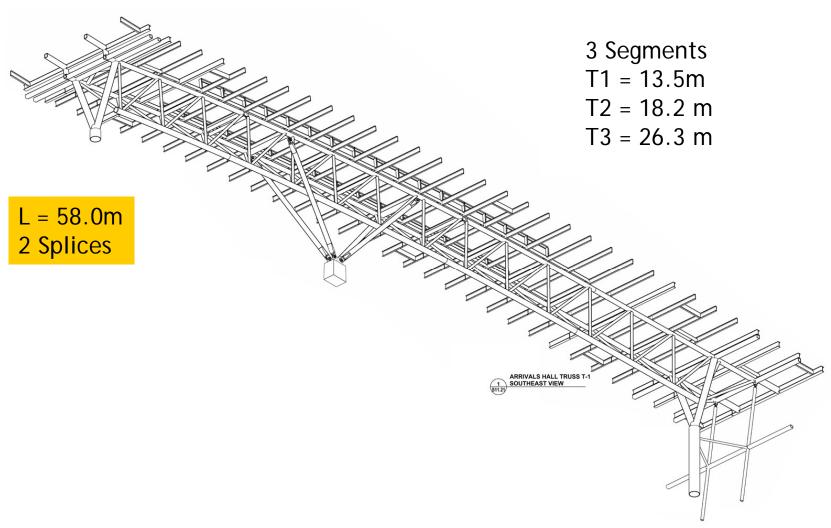
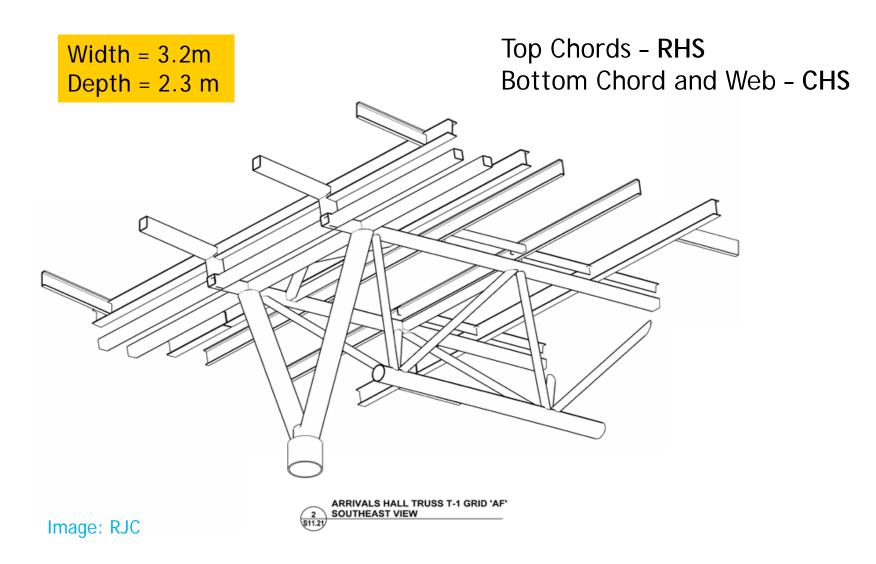


Image: RJC

Typical Truss



Sample AESS Specification

KINDS ISSUED FOR THE PRINTED FOR THE

ARCHITECTURALLY EXPOSED STUCTURAL STEEL (ABSS)

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

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 - t. Procles emotion argining death beloating which numbers are conducted as 65% sentence are thefactuages;

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21 MATERIALS

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- 22 SPECIAL SURFACE PREPARATION

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- 25 ARCHITECTURAL REVIEW
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15 ARCHITECTURAL REVIEW

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Subdvision in Structural Steel Division of Engineer's Specification

Sample AESS Specification

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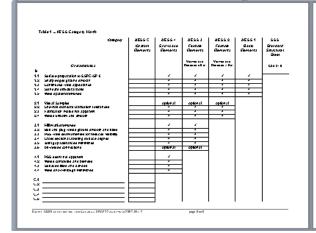
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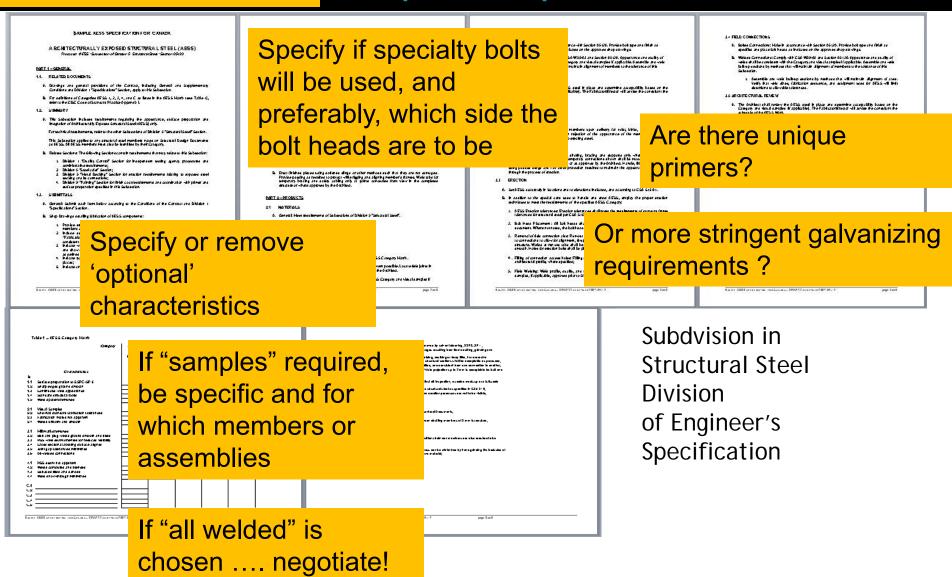


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Subdvision in Structural Steel Division of Engineer's Specification

Sample AESS Specification



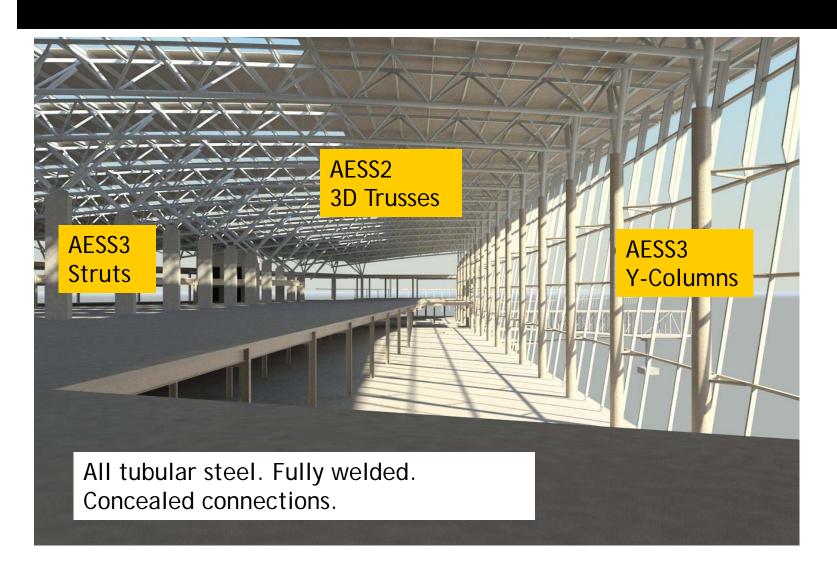
Sample AESS2 / AESS3 Table

Contract Area(s)	Element (Members and Associated Connections)	AESS Category (Refer to TABLE 1)
Hotel	Canopies	-
Terminal		
Hotel	Glazing Supports (Interior)	AESS 3
Terminal		
Piers		
Terminal	Glazing Supports (Exterior	AESS 3
Piers		
Hotel	Glazing Support Pin Connections at Floor Level	AESS 3
Terminal		
Piers		
Hotel	Columns	AESS 3
Terminal		
Piers		
Hote	Column Struts to Glazing	AESS 3
Terminal		
Piers		
Terminal	Column Struts to Trusses	AESS 3
Terminal	Roof Trusses	AESS 2
Hotel	Braces	AESS 3
Terminal		
Hotel	Moment Frames	AESS 2
Terminal		
Piers		

Sample AESS2 / AESS3 Table

Contract Area(s)	Element (Members and Associated Connections)	AESS Category (Refer to TABLE 1)
Hotel Terminal	Canopies	-
Hotel Terminal Piers	Glazing Supports (Interior)	AESS 3
Terminal Piers	Glazing Supports (Exterior	AESS 3
Hotel Terminal Piers	Glazing Support Pin Connections at Floor Level	AESS 3
_ Hotel	Columns	AESS 3
Piers		
Hotel Terminal Piers	Column Struts to Glazing	AESS 3
Terminal	Column Struts to Trusses	AESS 3
Terminal	Roof Trusses	AESS 2
Hotel Terminal	Braces	AESS 3
Hotel Terminal Piers	Moment Frames	AESS 2

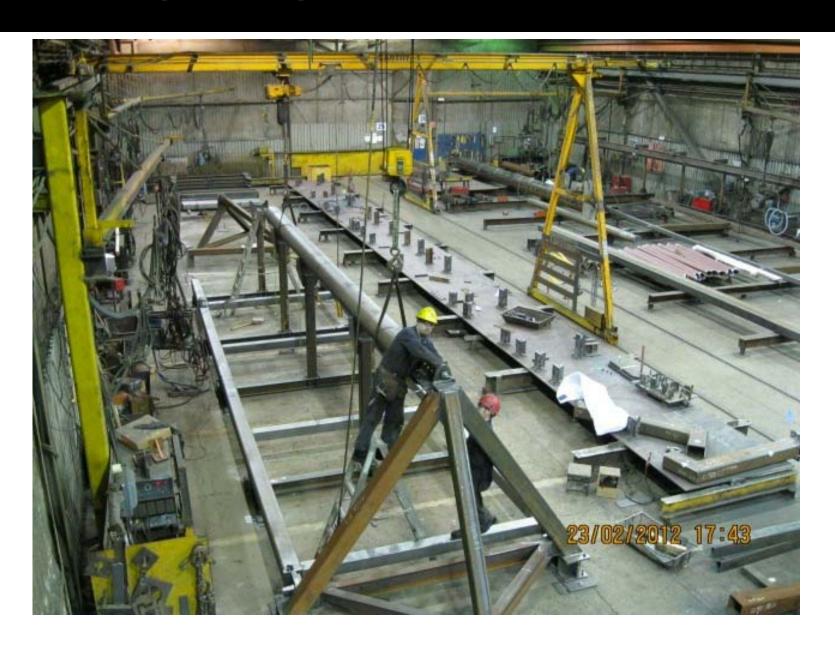
AESS 2 and 3 Combination 1



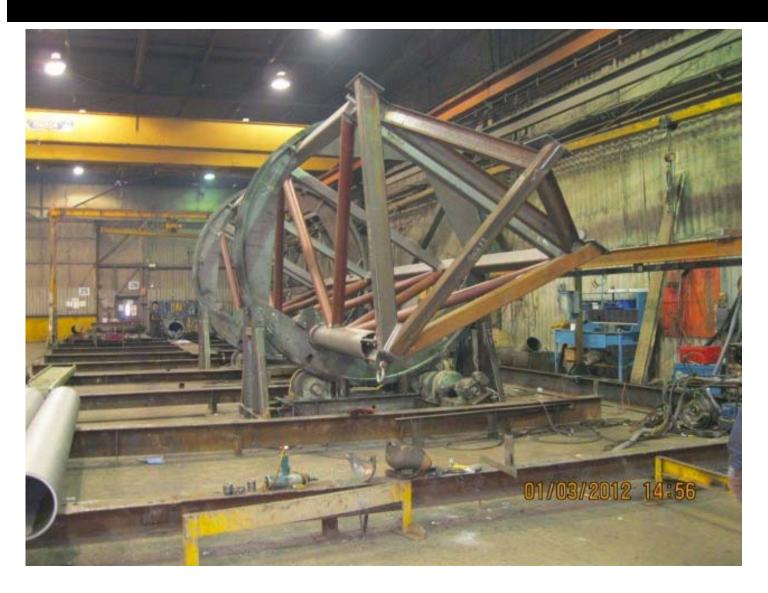
Cost impact items

- Custom "shapes"
- Use of welded plate in lieu of W, C and L sections
- Connection details
- Transportation restrictions
- Staging area restrictions
- Bending the steel
- Custom castings
- General level of complexity of the elements or structure
- Eccentric elements

Mockups at Supermétal Plant

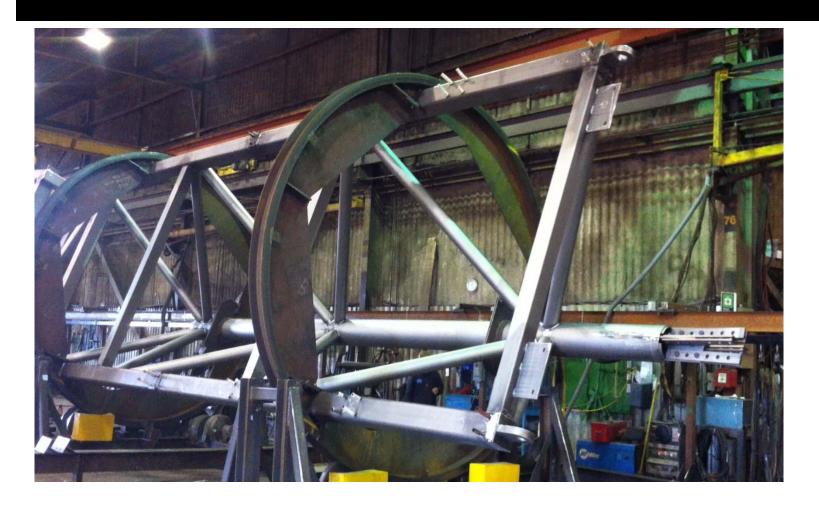


Mockups at Supermétal Plant



During fabrication it is essential that elements provide good access for operations.

The "Rotator"!



The main truss elements were placed in a jig that rotated to permit access for operations.



Avoiding confusion







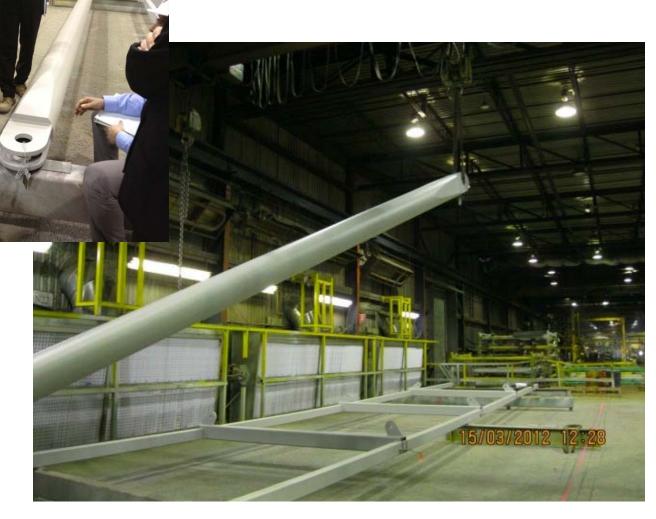


When a Mockup is required ...

Remember that the shop conditions are different than the final conditions, with respect to:

- Distance
- Position
- Lighting







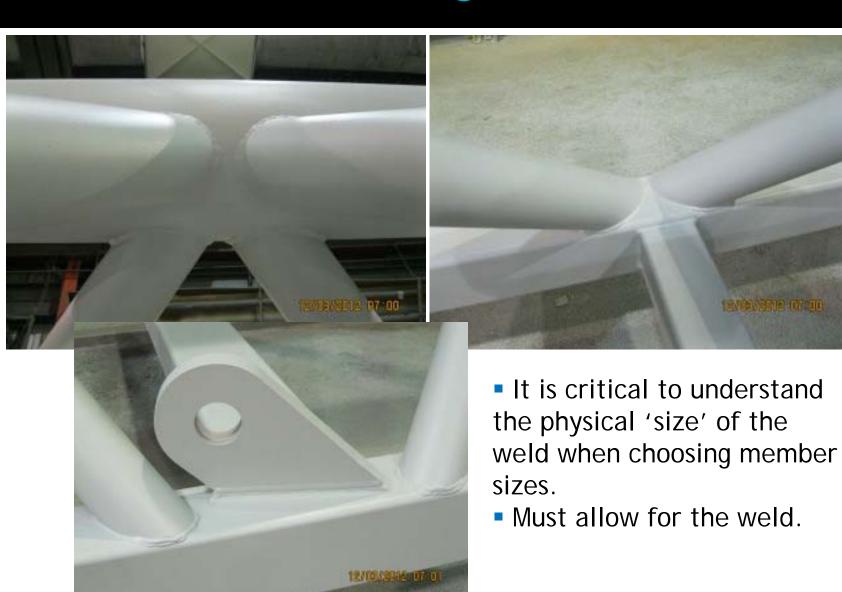


Replicating the view angle

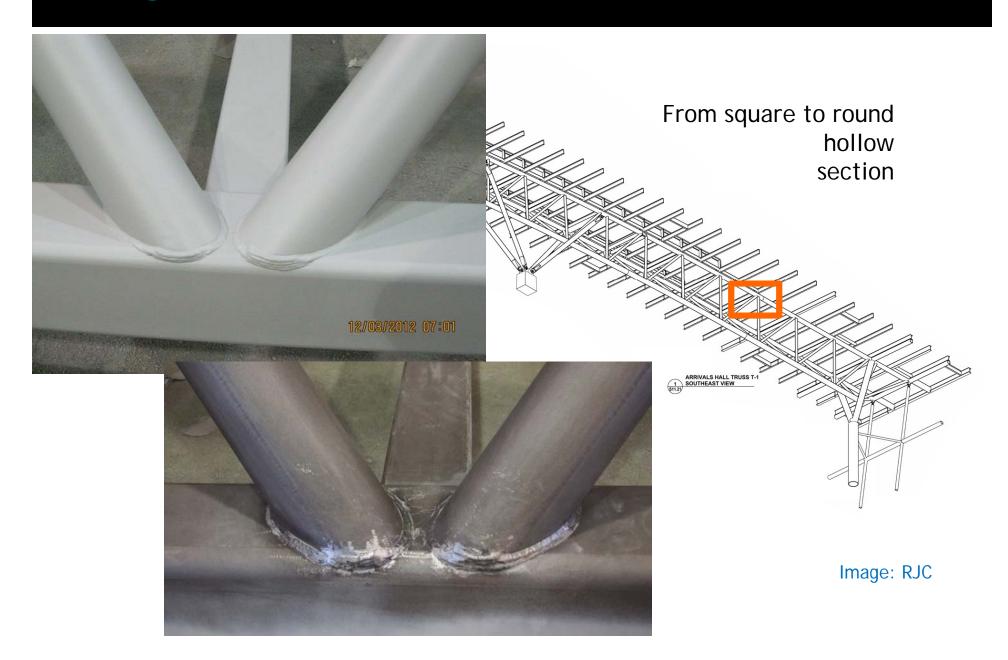




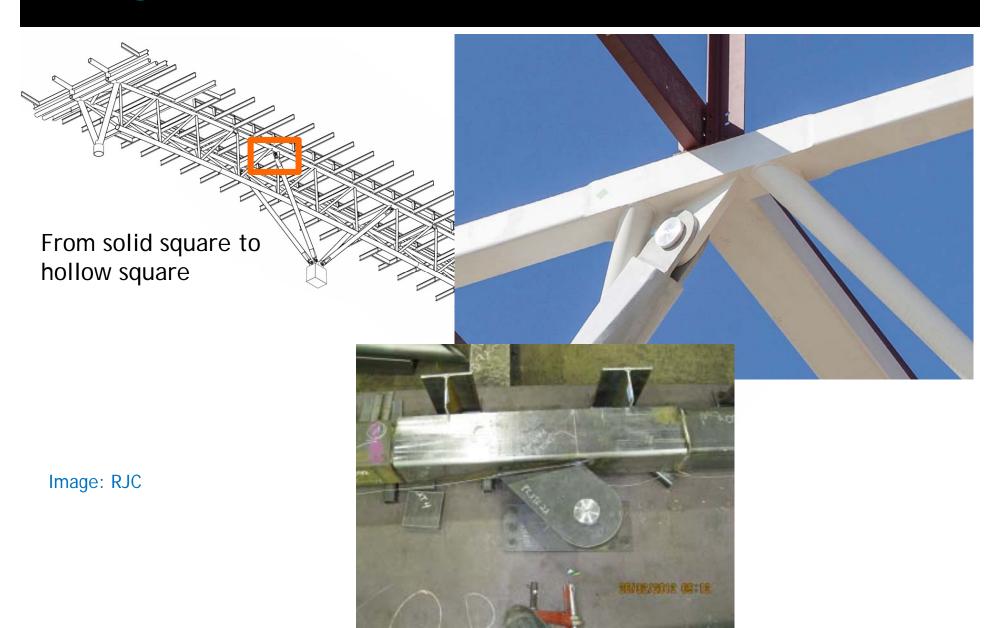
Member sizes and alignment issues



Alignment issues



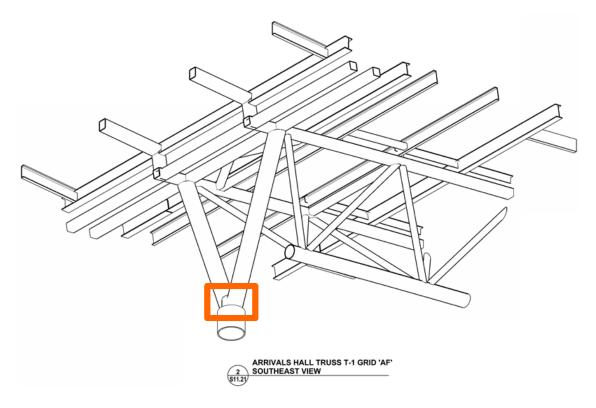
Alignment issues



Hidden splices



How round is round?



From round column to round plate

Image: RJC

How round is round?

FACT: A round plate is not the same shape as a round tube!





Plate either goes on top of

Care in transportation and handling



Panoramic view

Calgary Airport Panorama - Terminal / Hotel - From North side at Grid 10

28 AOÛt 2012



30 SEPTEMBRE 2012



26 OCTOBRE 2012



Flip, Rotate and Lift

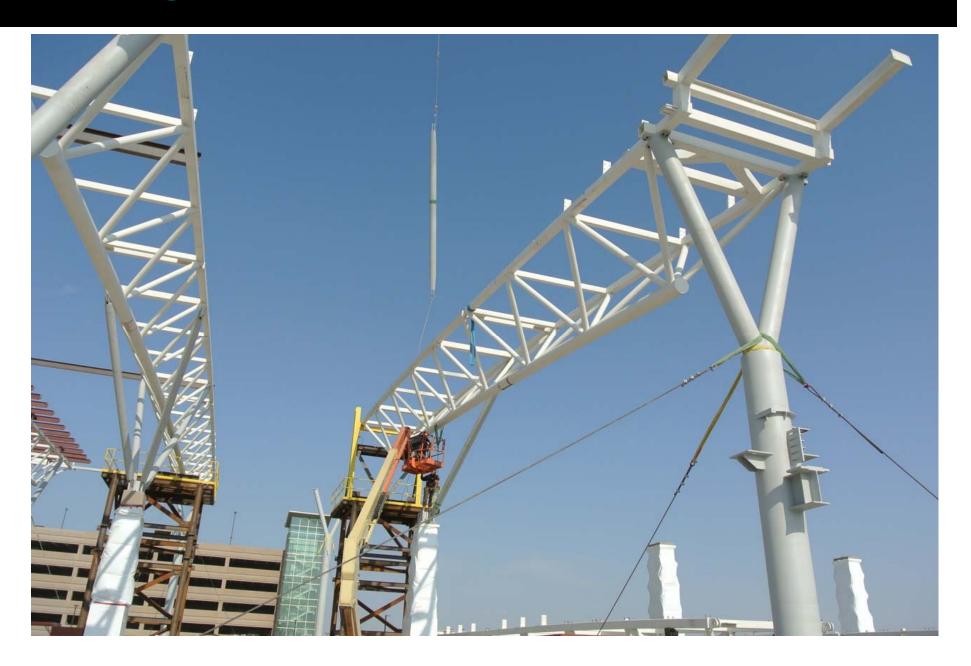




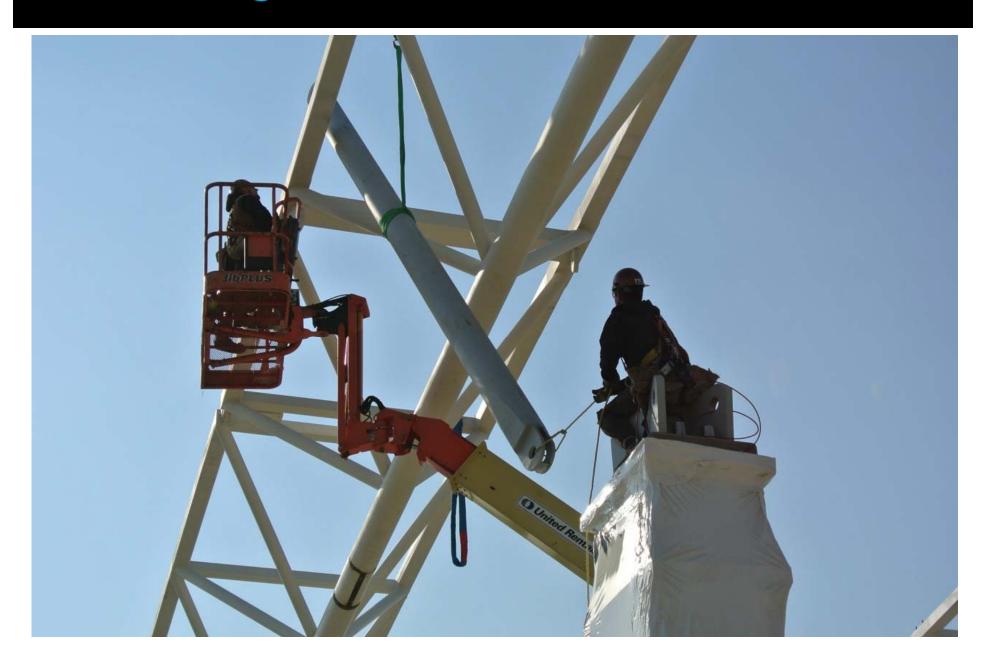




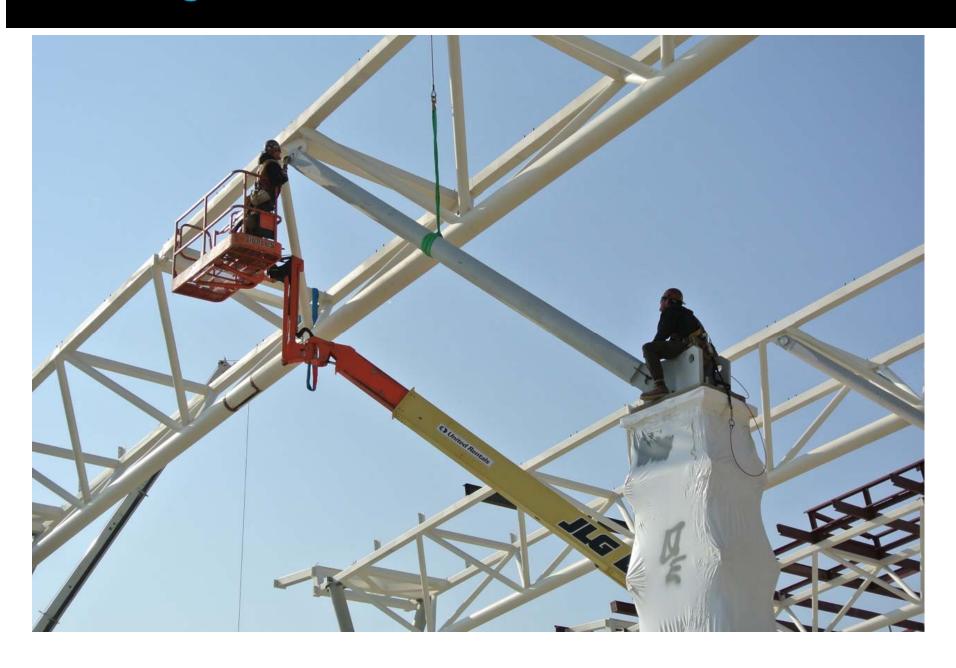
Lifting a truss element



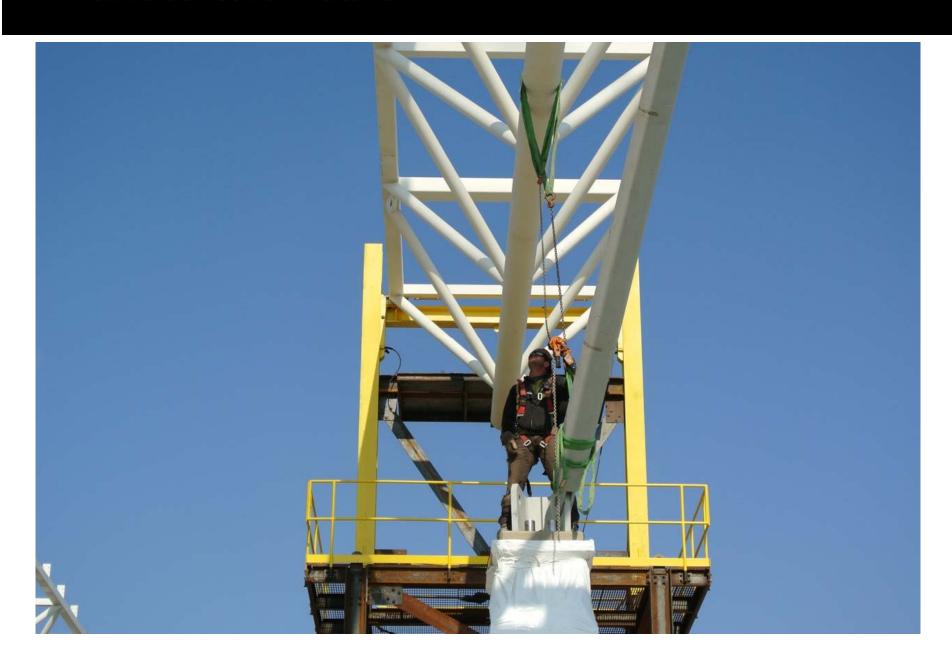
Threading the struts



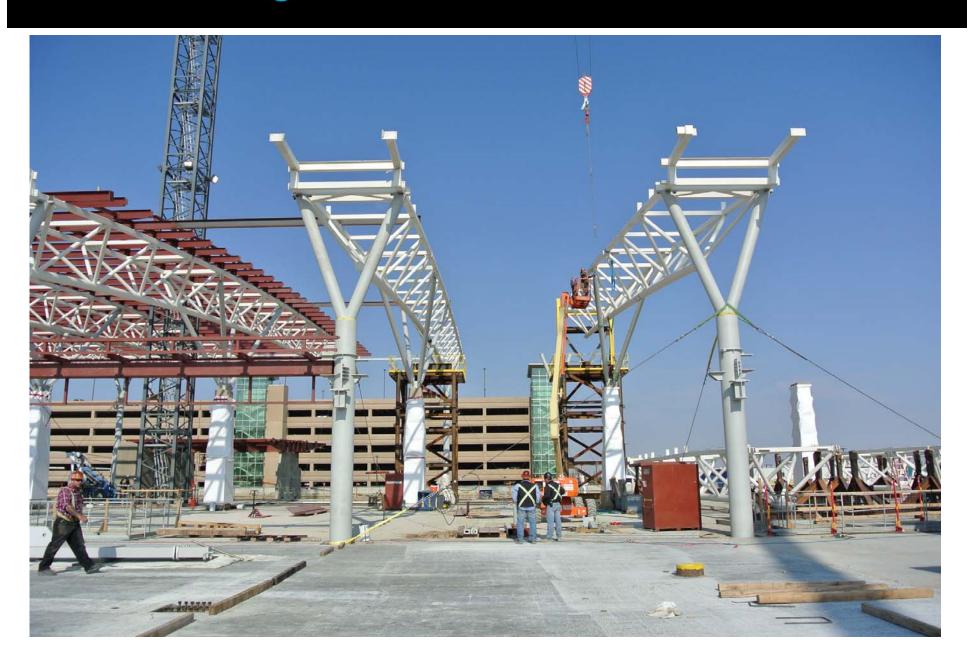
Bolting the strut



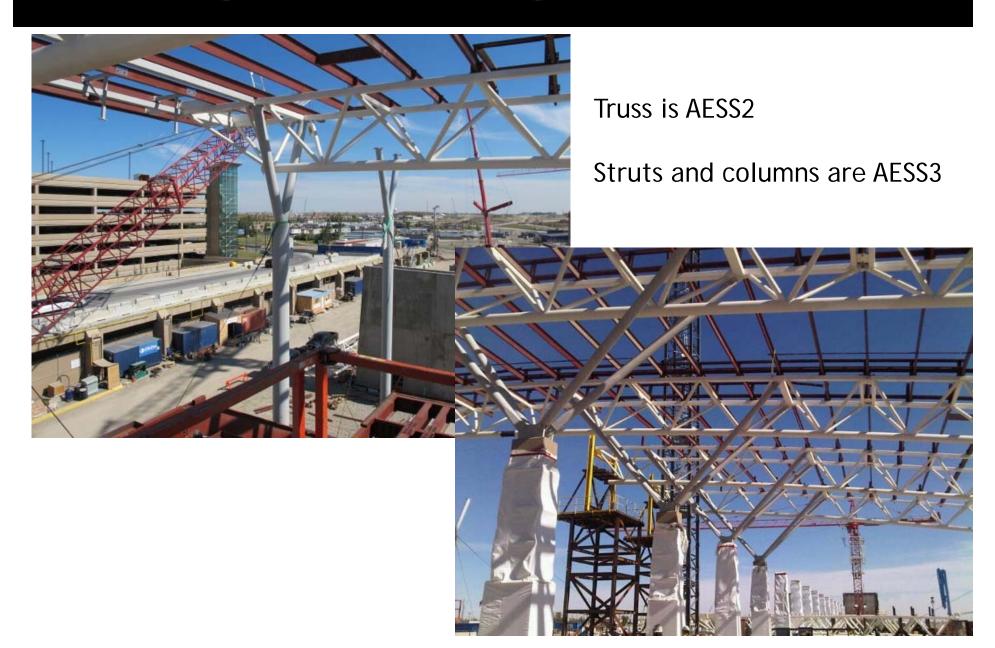
Handle with care



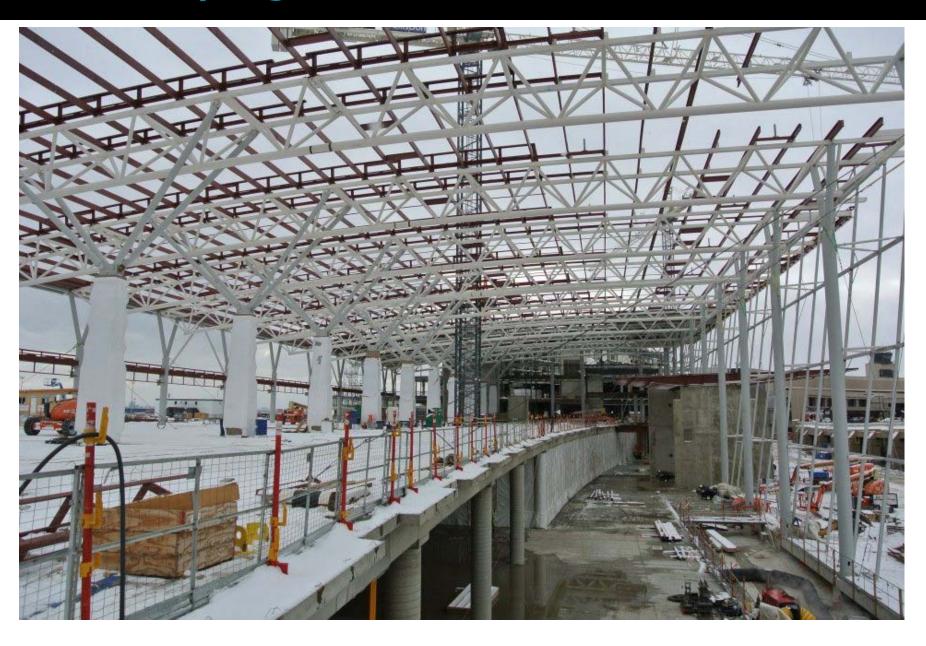
Site strategies



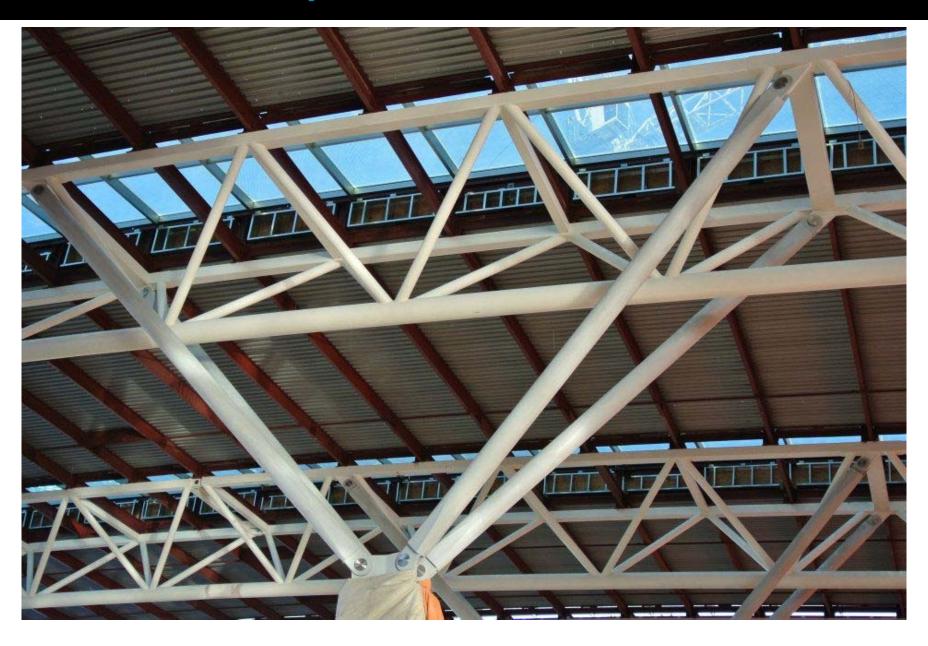
Selecting the AESS Categories



Overall progress



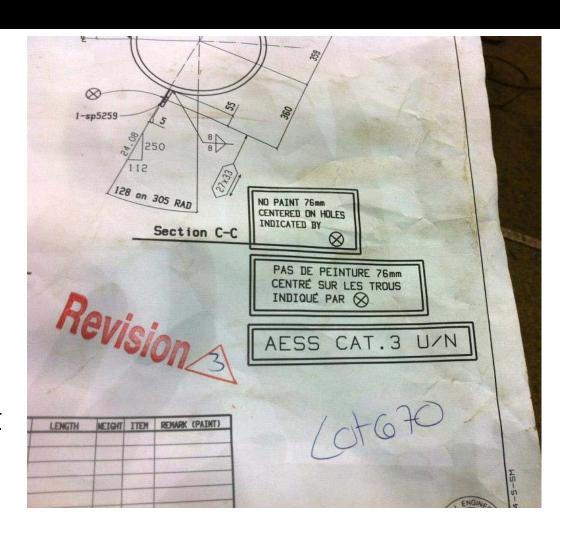
Construction proceeds



Lessons Learned

- Better bids
- More productive plant visits
- Expectations more aligned

- Smooth weld still subject to interpretation
- Identical vs equivalent reproduction
- Inspection consistency

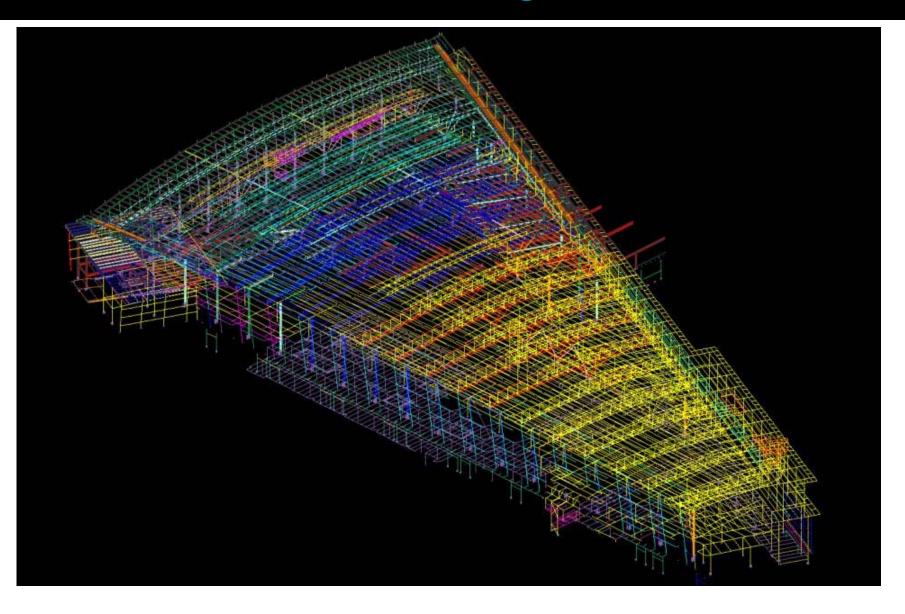


Next phase!

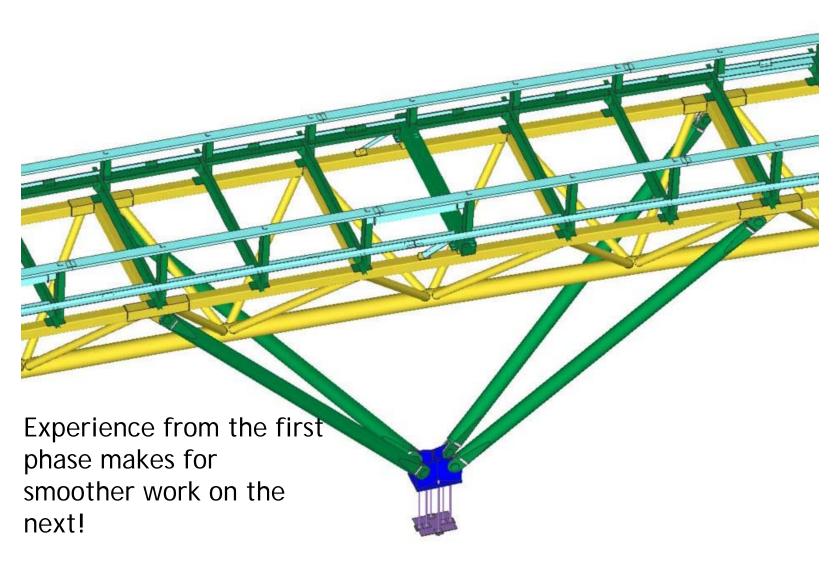


Image: DIALOG

Overall structural drawing



Detail



https://www.facebook.com/media/set/?set=a.280522345386864.54021.194585130647253&type=3



Owner

Brookfield

Architects

Pelli Clarke Pelli Architects

Construction Manager

Plaza Construction

Steel Fabricator / Detailer / Erector

Walters Inc. Hamilton/Metropolitan Walters

Project Profile

WORLD FINANCIAL CENTRE ENTRY PAVILION New York City, New York

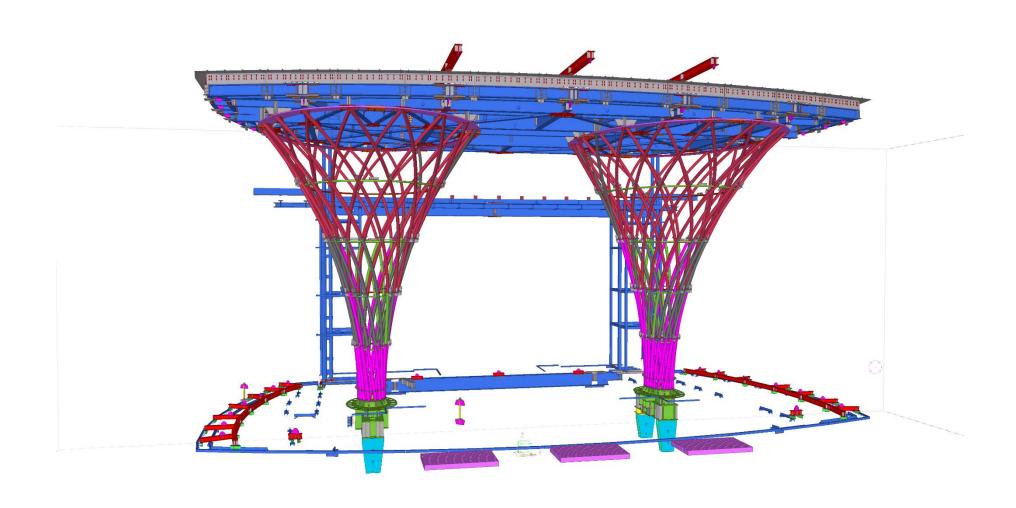


Site access courtesy: Walters Inc.

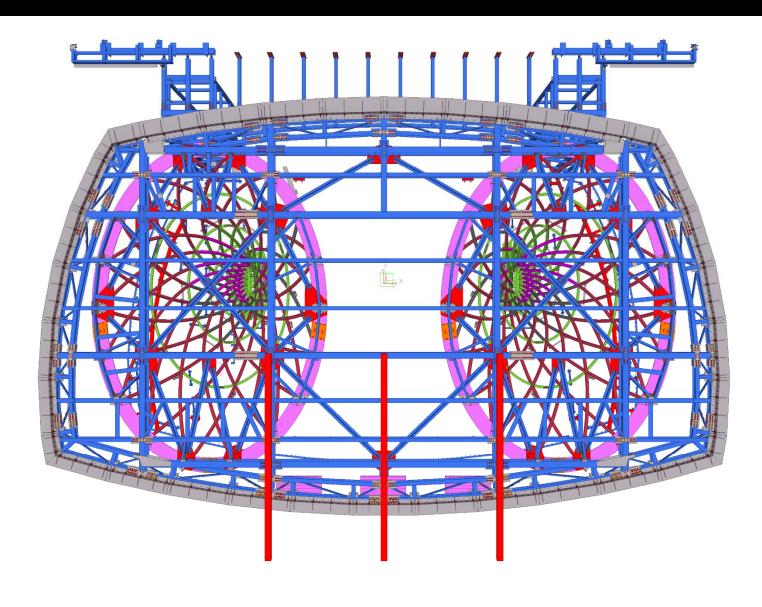
The Architect's Concept



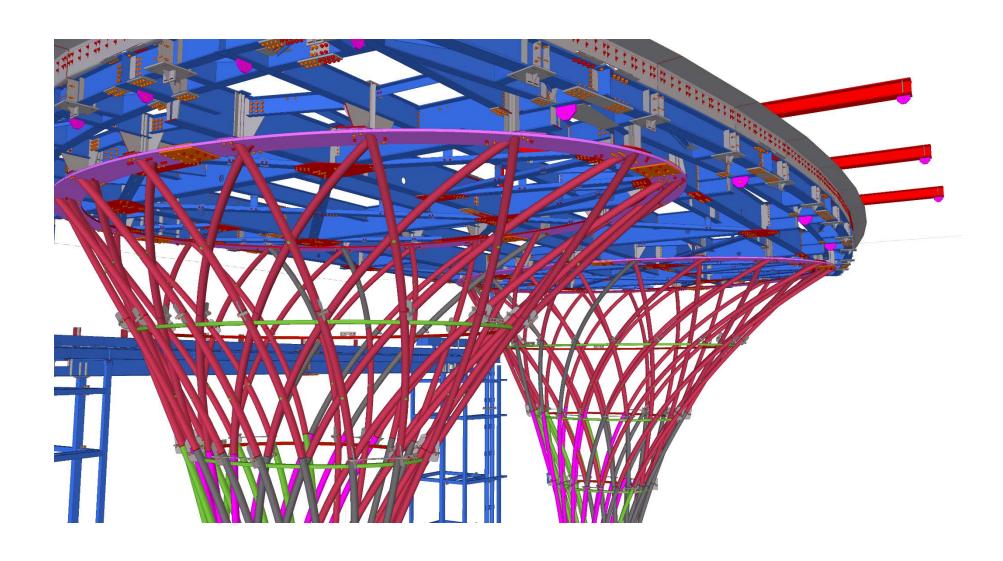
Complex steel uses digital methods



Top view of plan



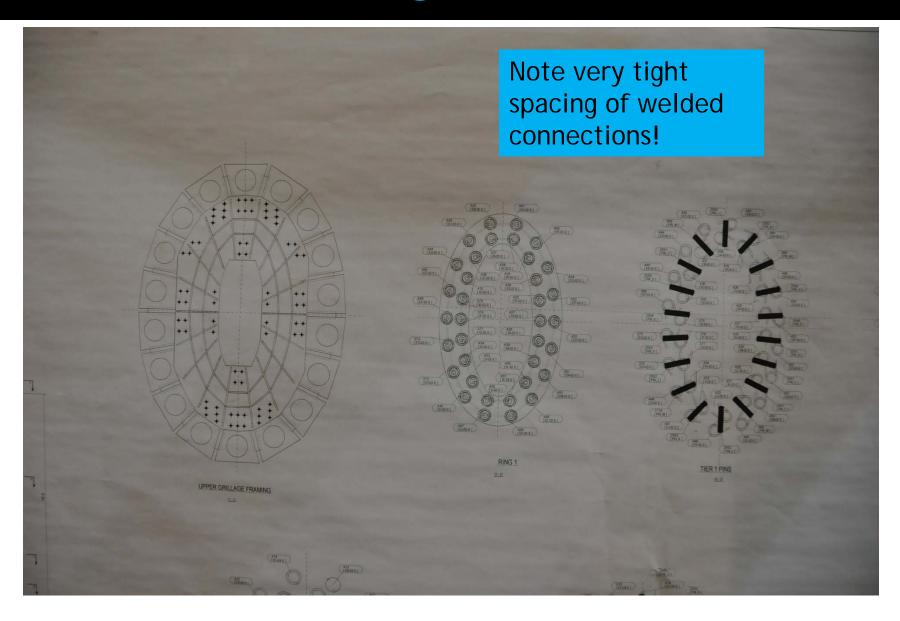
Detailed view



The 3D Model



Planimetric drawings



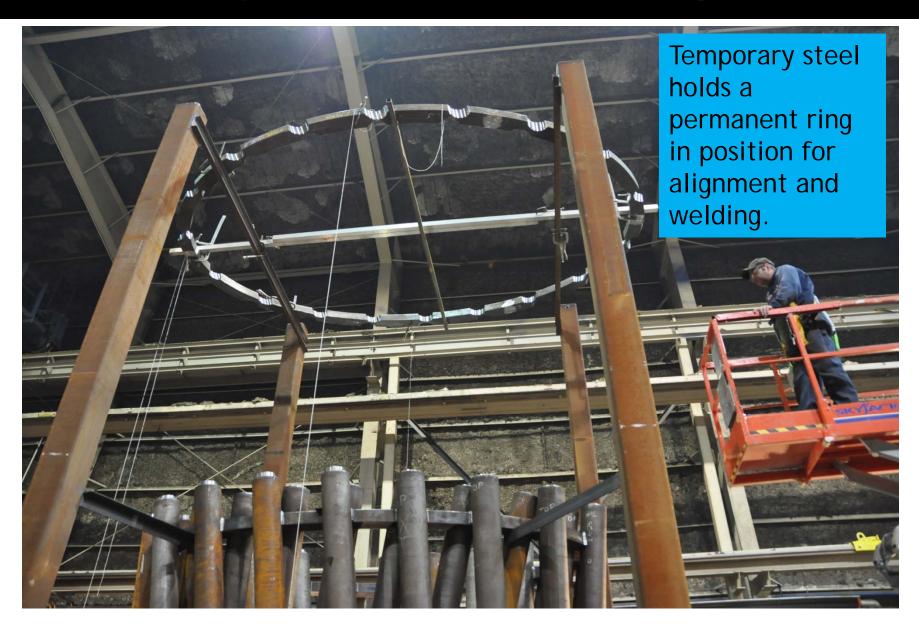
Setting the jigs



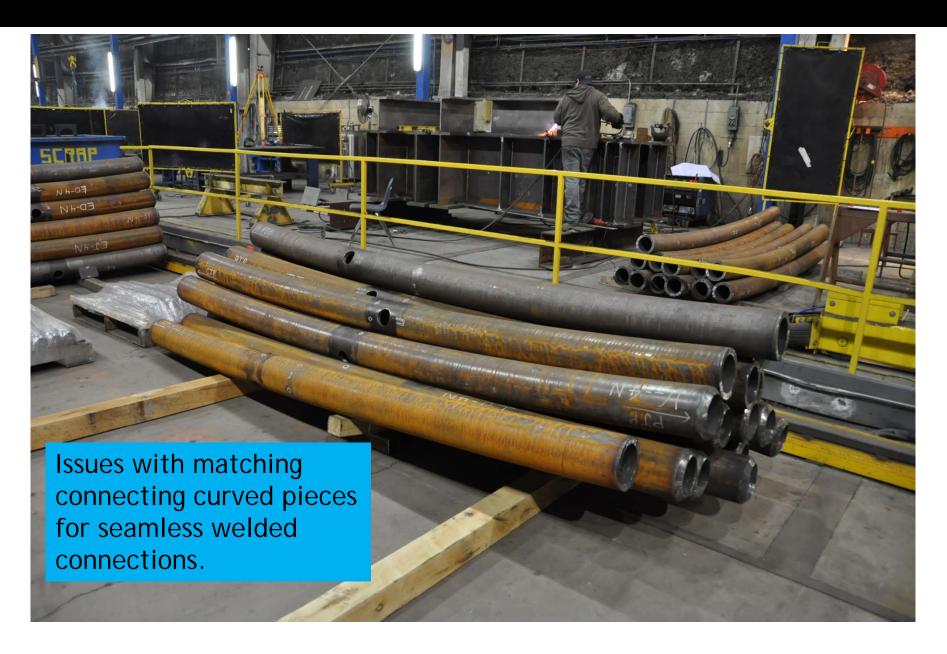
- Two "baskets"
- 5 tiers each
- Fully welded AESS4
- Understand truck limitations
- Minimize site connections
- Transport to NYC from Hamilton



Maximizing the fabrication in shop



Curved tubular steel

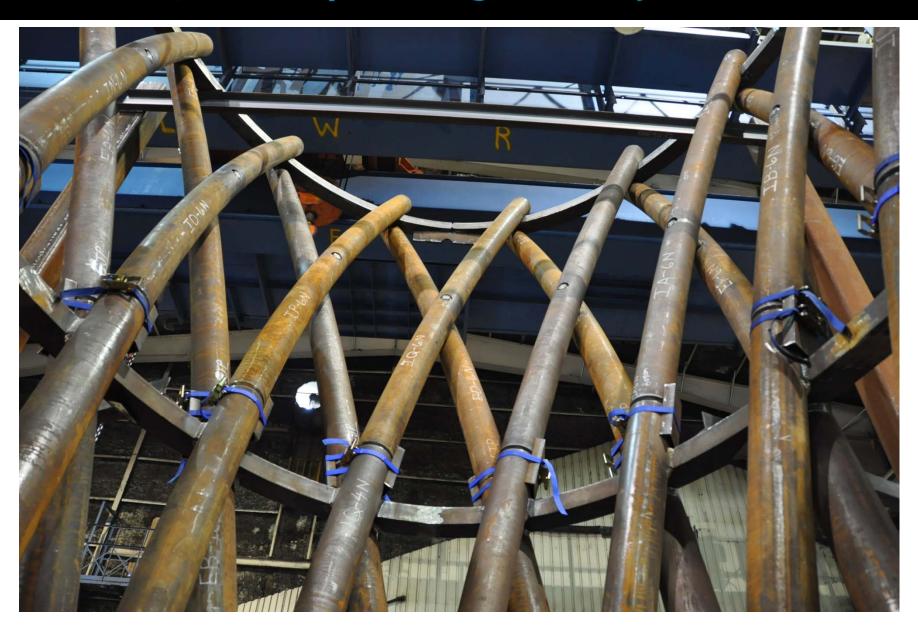


Solid connecting steel rods

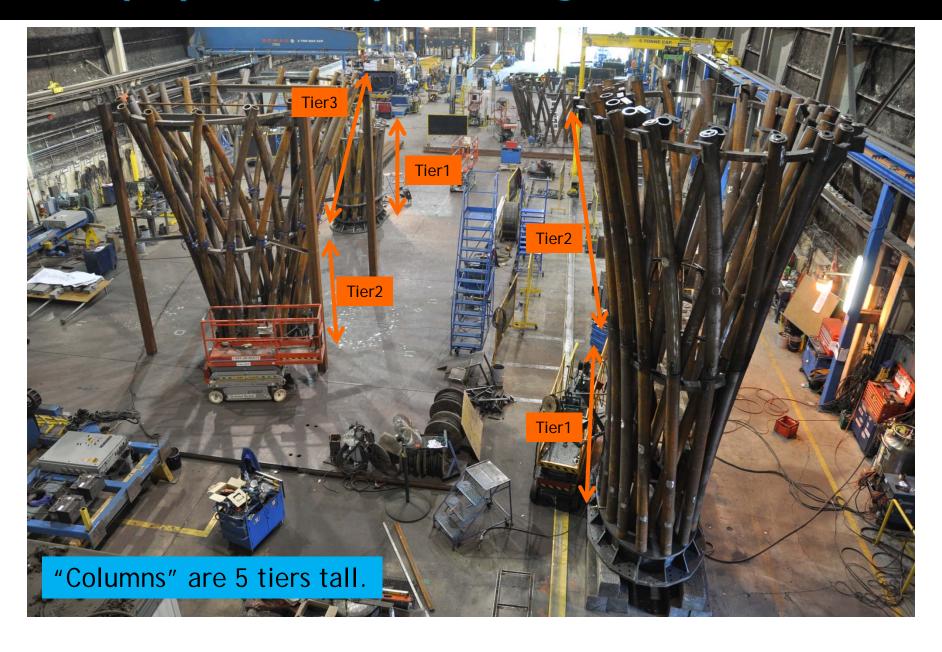


For AESS4 these connections must be ground and filled and 'made to disappear'

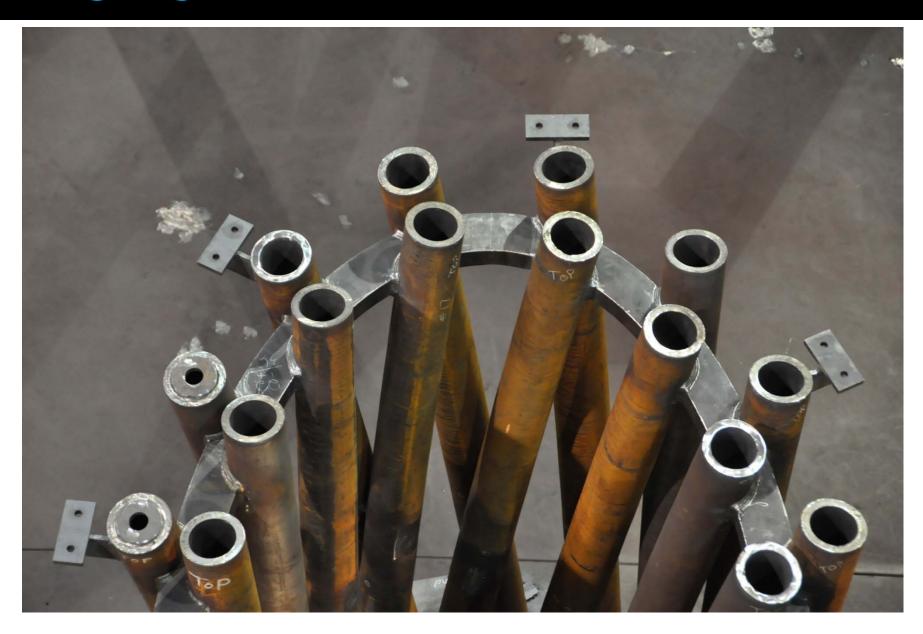
Curves, overlaps and geometry



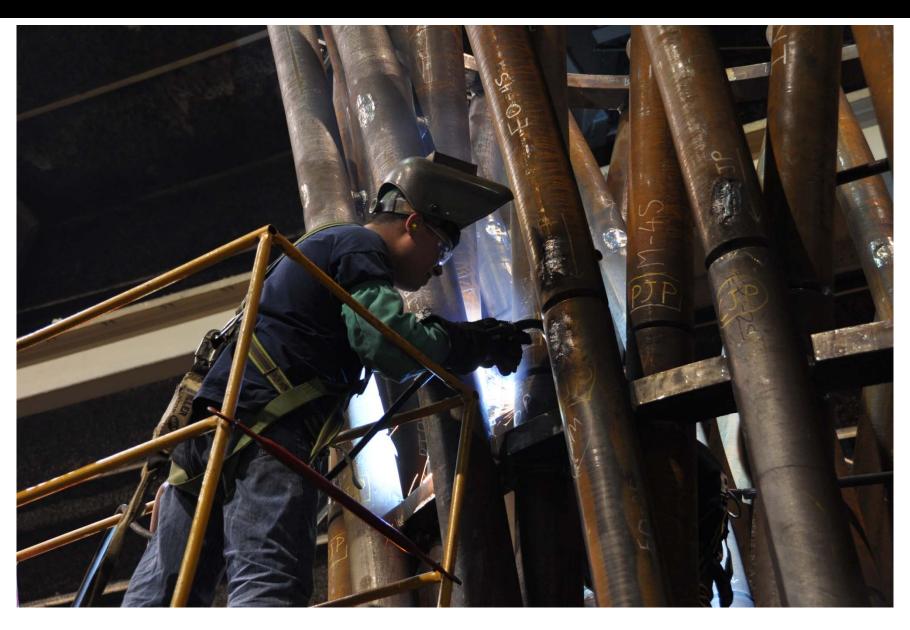
Shop space and pre-fitting



Aligning future site connections



Why shop weld?



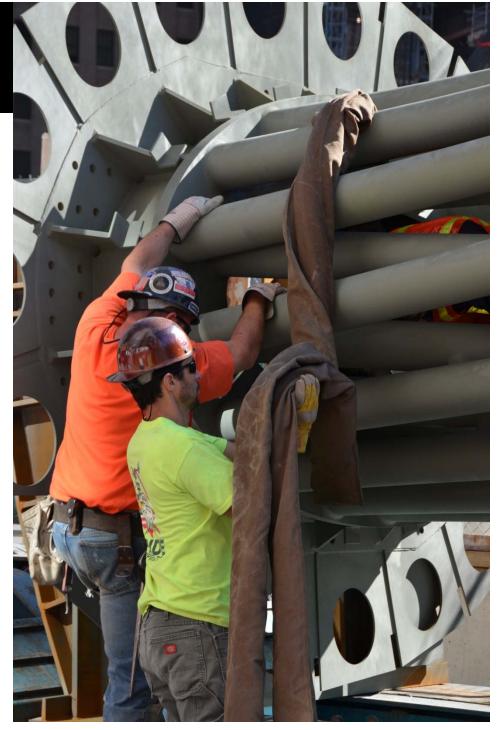
Transportation



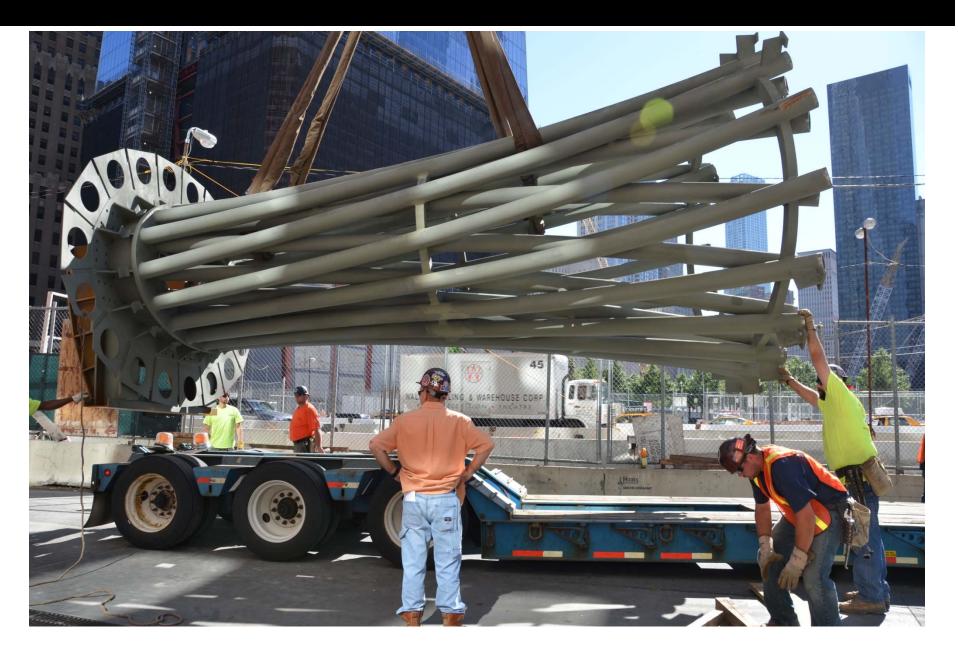
Handle with care



- Erection crew different from fabrication crew
- Lifting odd shapes difficult
- Steel is primed
- Surfaces must not be damaged



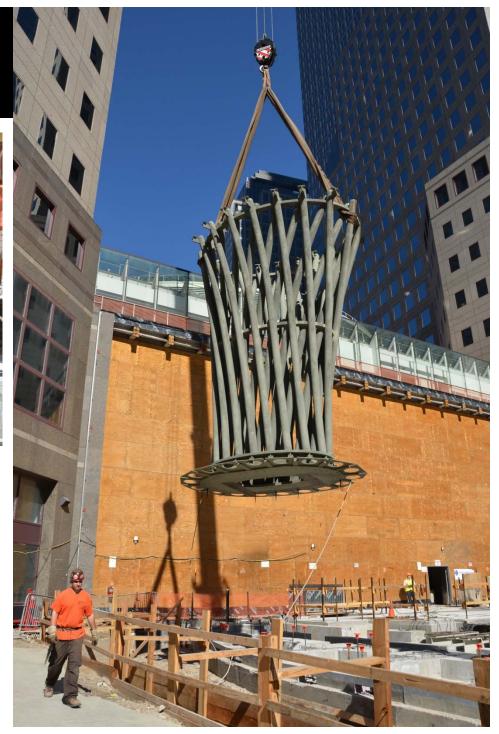
Lift off of the truck



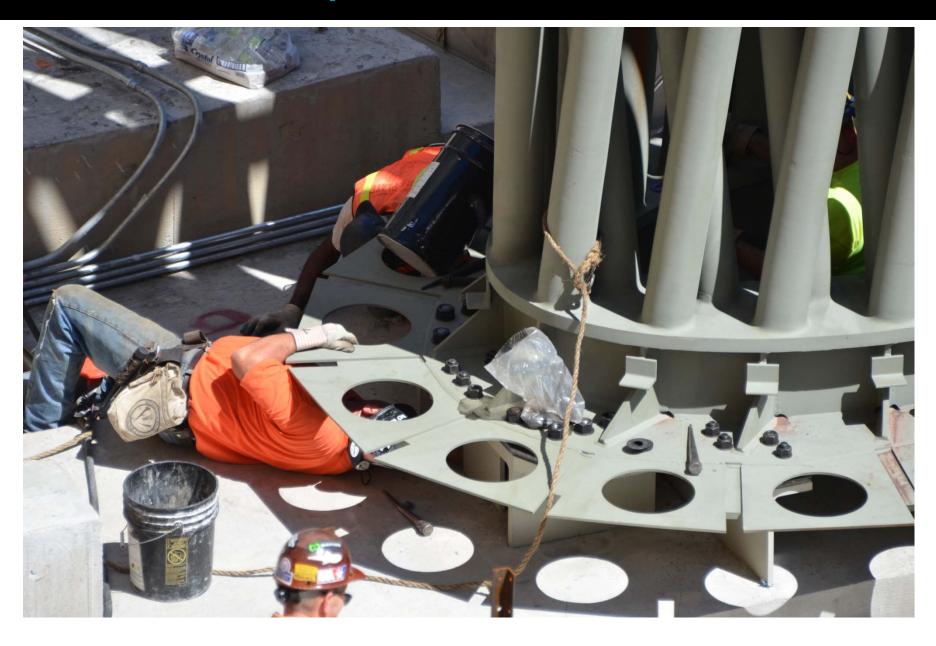
Lift into place



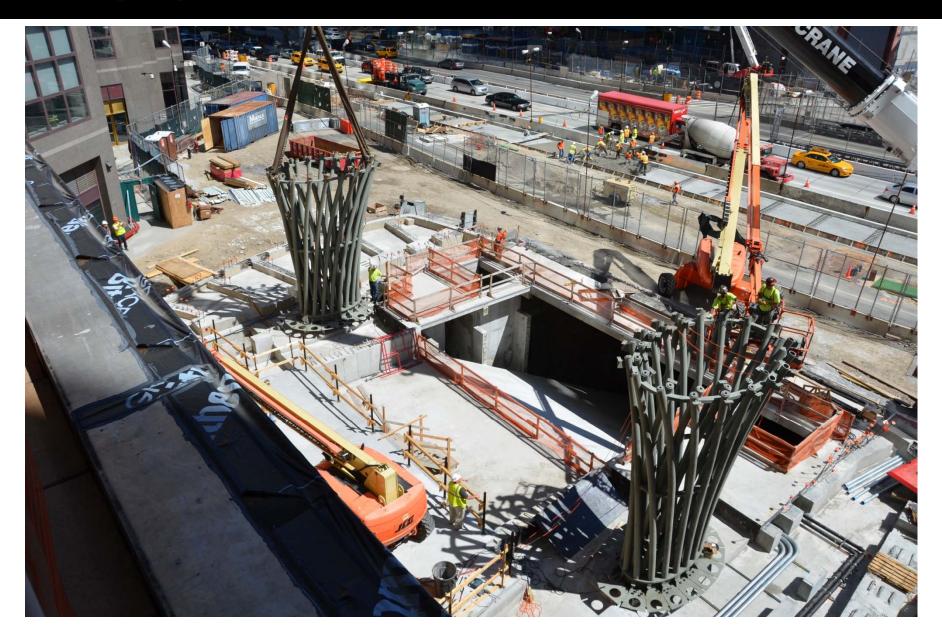
- Site preparations must be accurate
- AESS requires precision
- Plumb element
- Remember this is structural steel



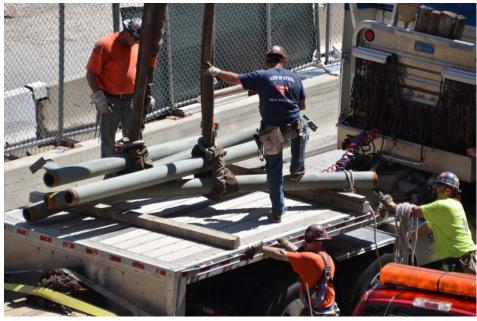
Access to complete connections



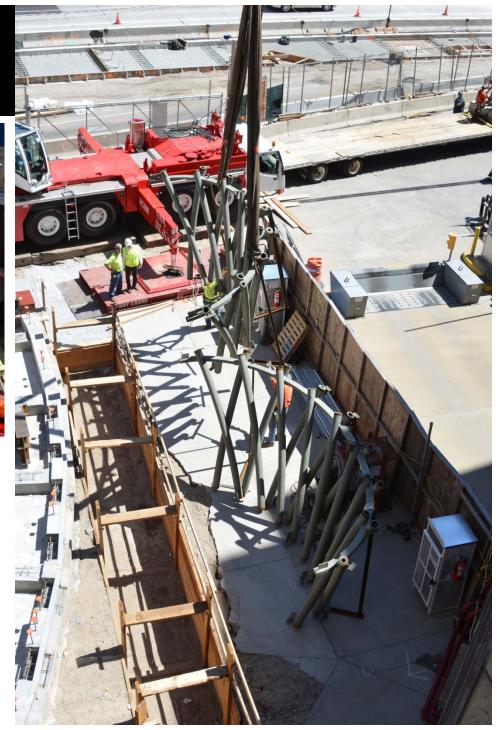
Staging and site issues



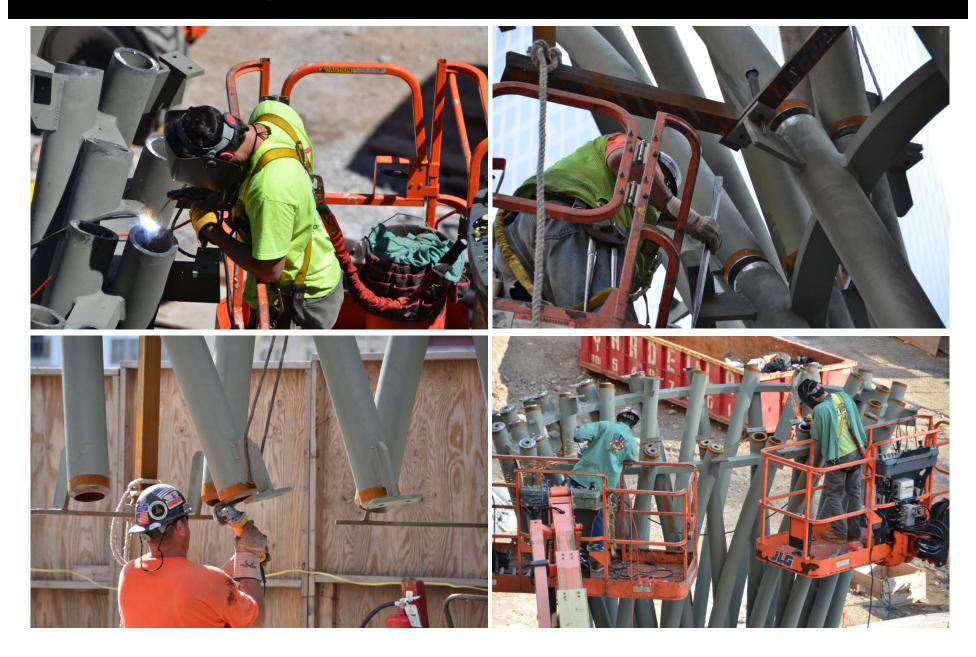
Sorting pieces



- Many pieces for a complex project
- Need to ensure adequate labeling to avoid confusion
- Upper tiers too large to be shipped assembled
- Subdivided into sections to fit shipping limitations



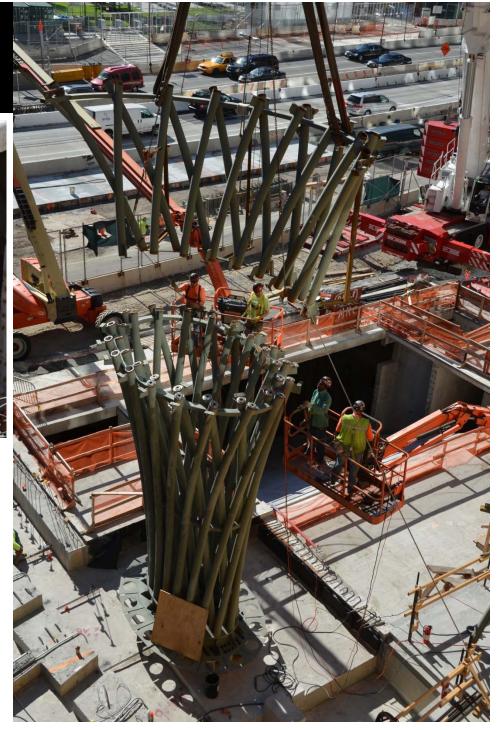
Access to perform work



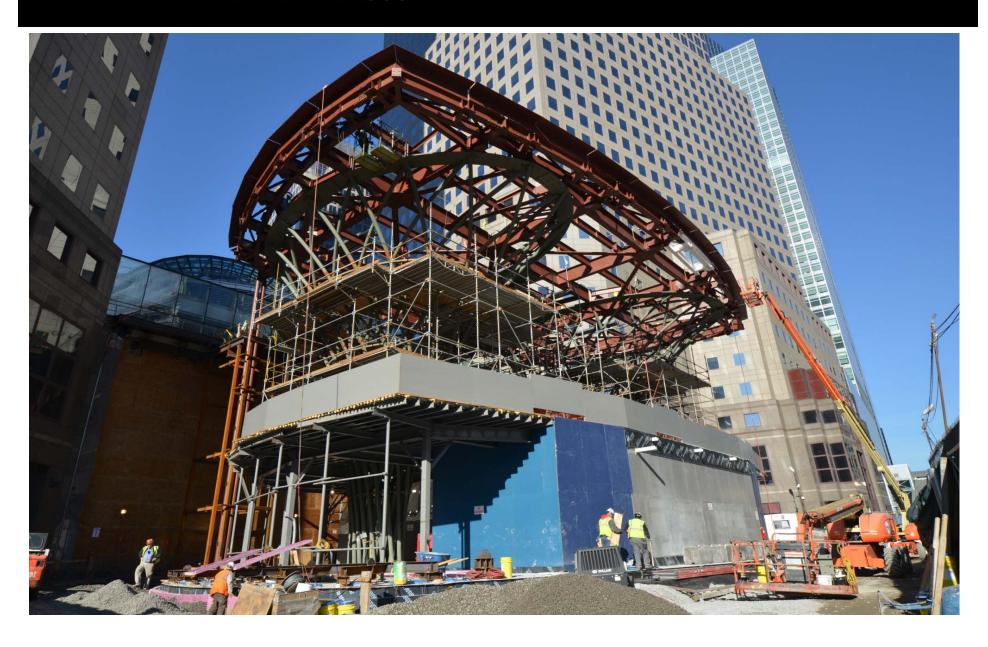
Complex fit



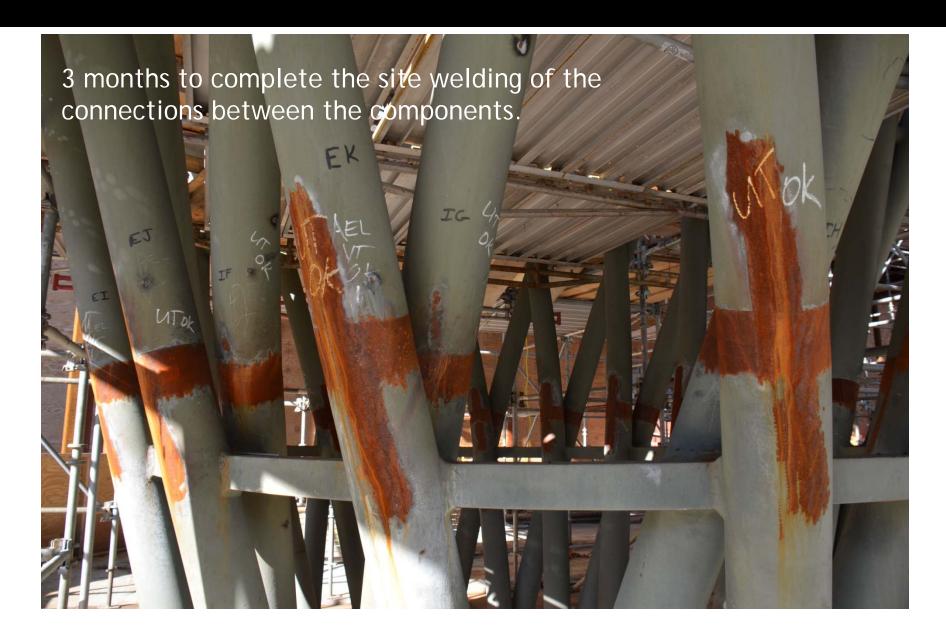
- If it does not fit, it is a HUGE problem
- Precision at the shop AND precision at the site



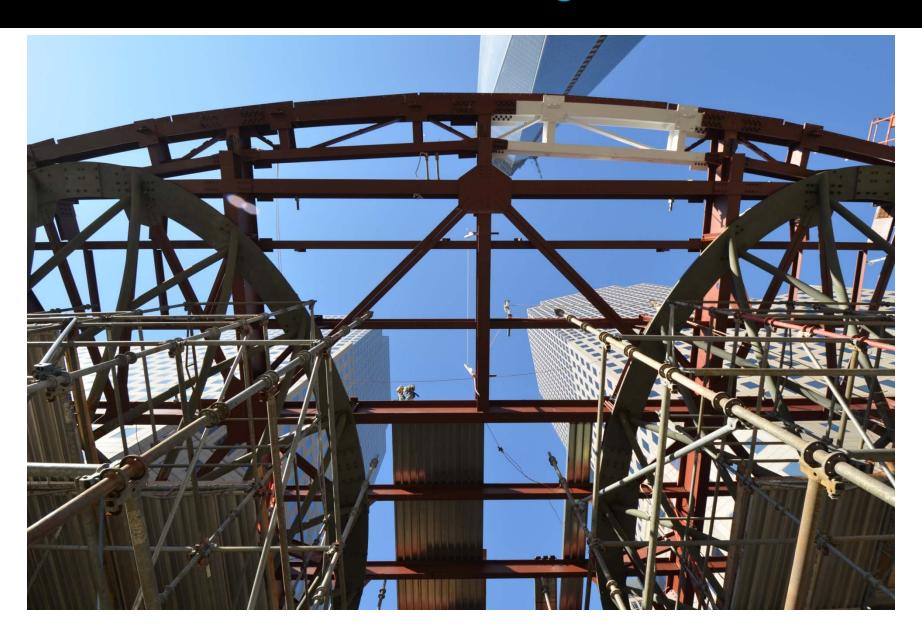
3 months later...



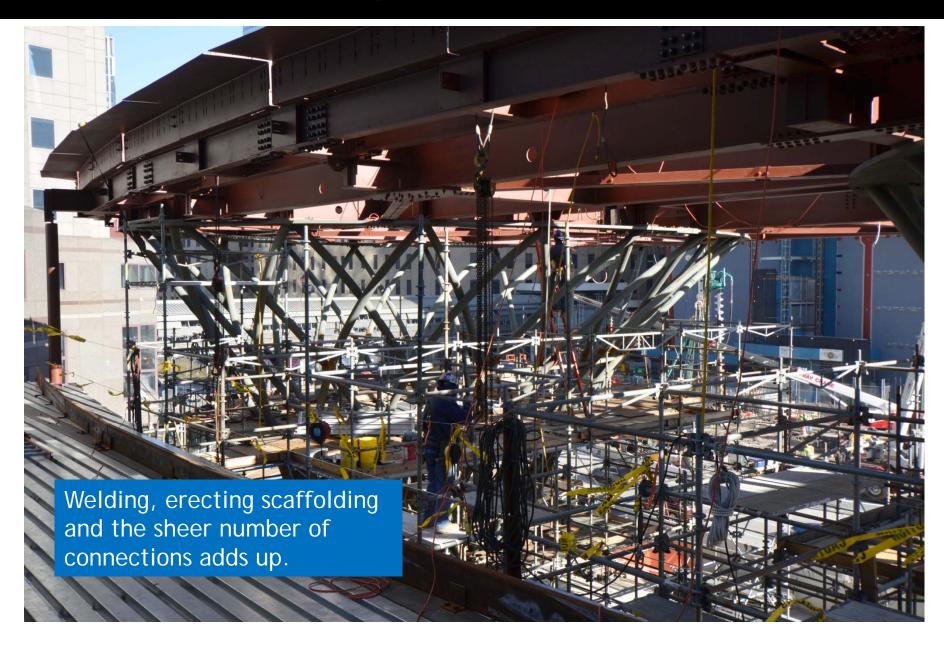
Weld remediation



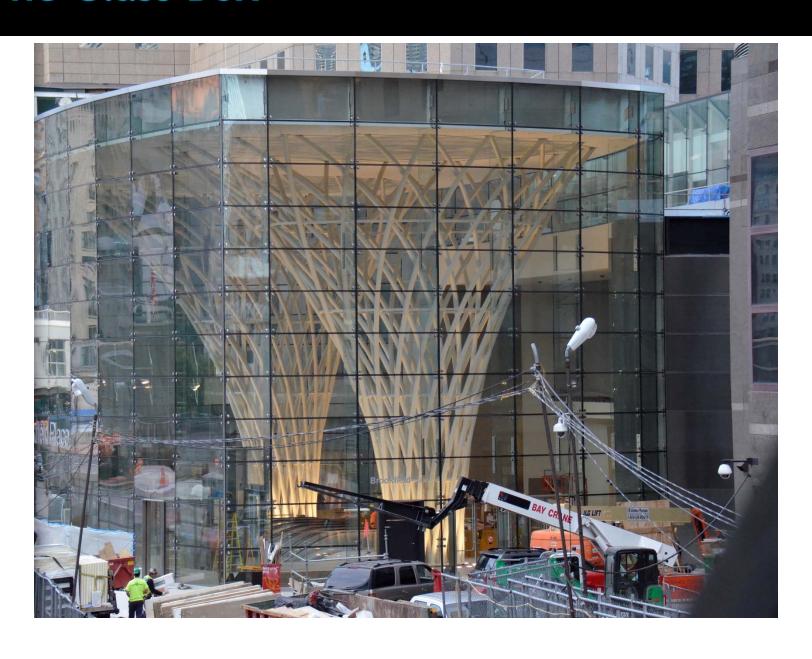
Installation of roof decking



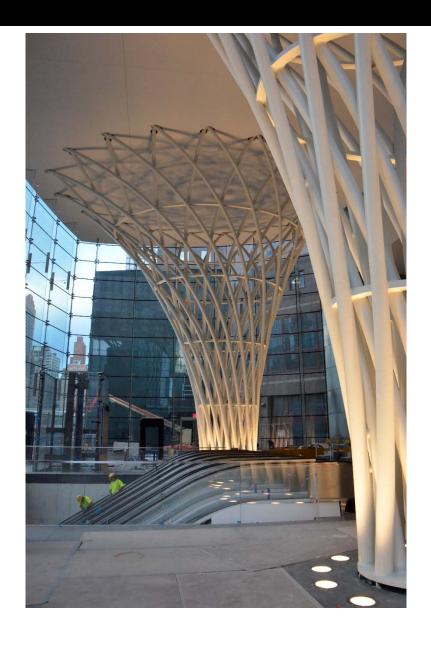
This takes a long time...

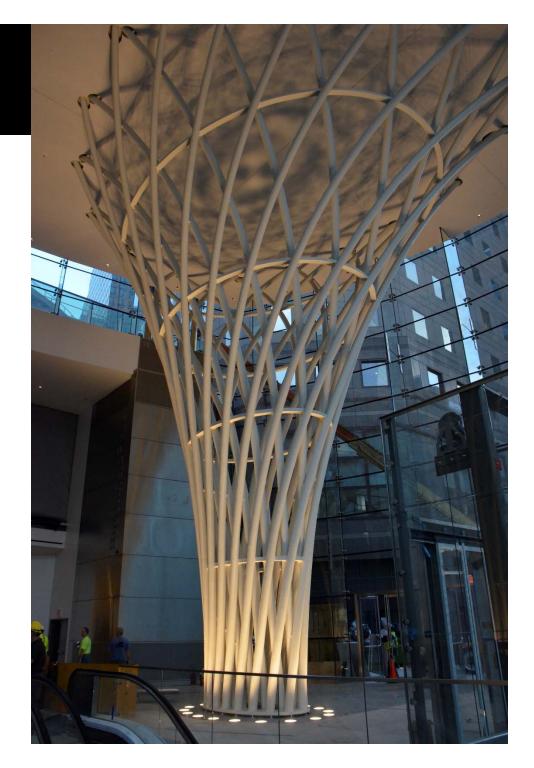


The Glass Box

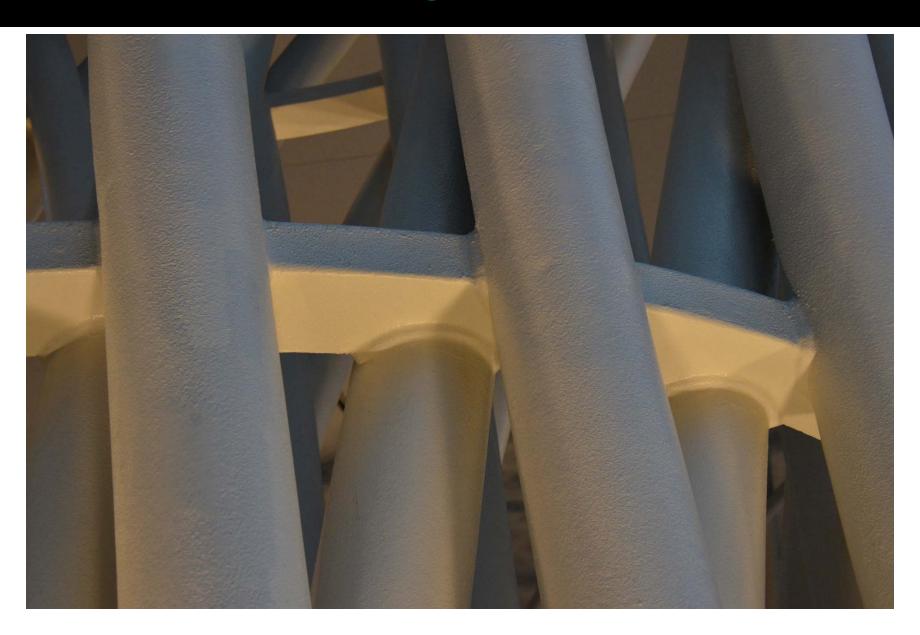


Finished steel

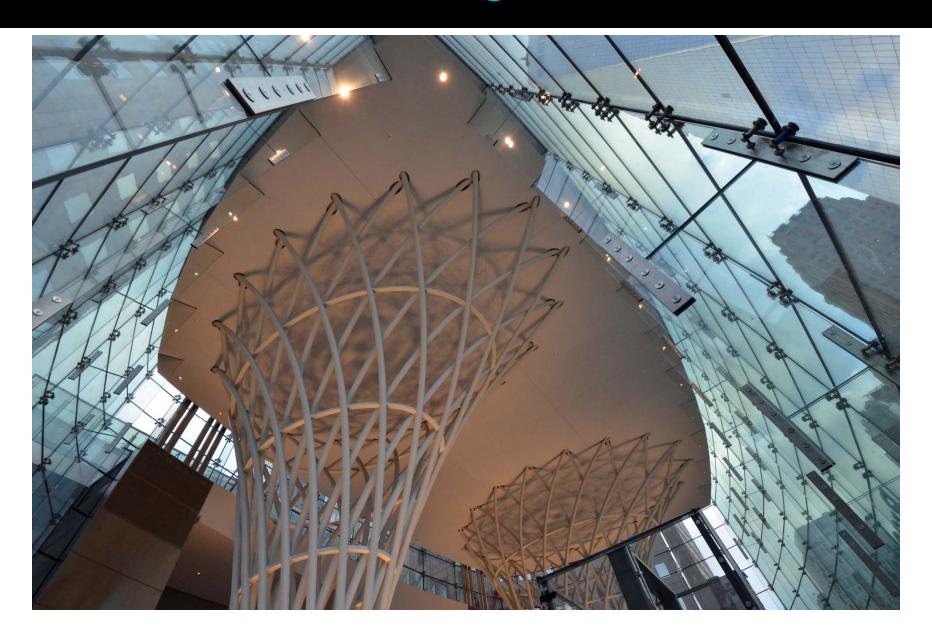




Intumescent coating



Structural columns in glass box





Project Profile

EIGHTH AVENUE PLACE WINTERGARDEN Calgary, Alberta

Owner

Penny Lane II Limited Partnership

Development Manager

Hines Canada Management Co., ULC

Architects

Pickard Chilton International Design architect Gibbs Gage Architects AOR Kendall/Heaton Associates Inc. Production architect

Structural Engineers

Dr. P.V. Banavalkar, CBM Design engineer Read Jones Christoffersen Ltd. EOR

Construction Manager

Ellis Don Construction Management Services

Steel Fabricator / Detailer / Erector Supermétal



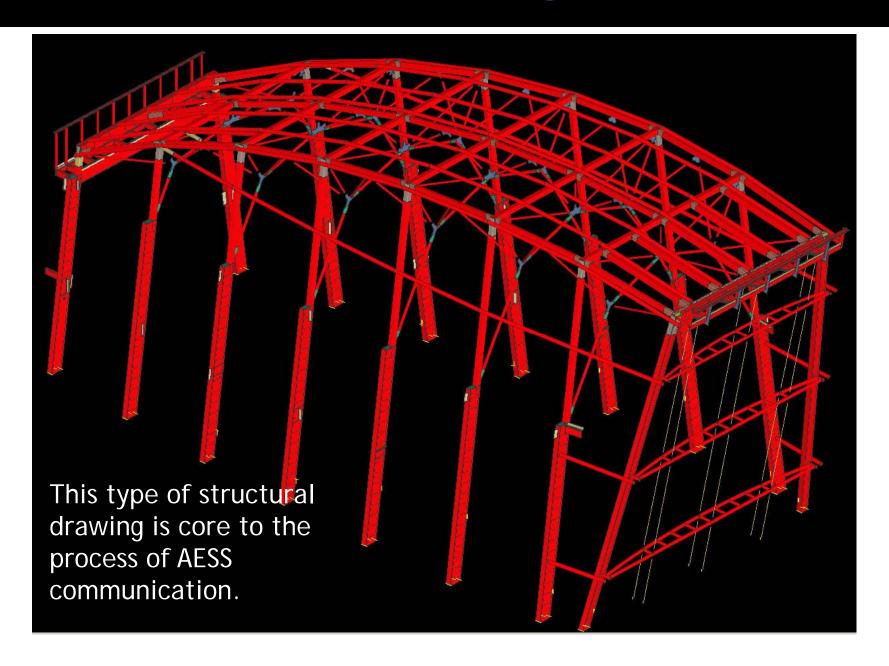
Photo credits this section: Supermétal

Content: Sylvie Boulanger, Vice President, Technical Marketing

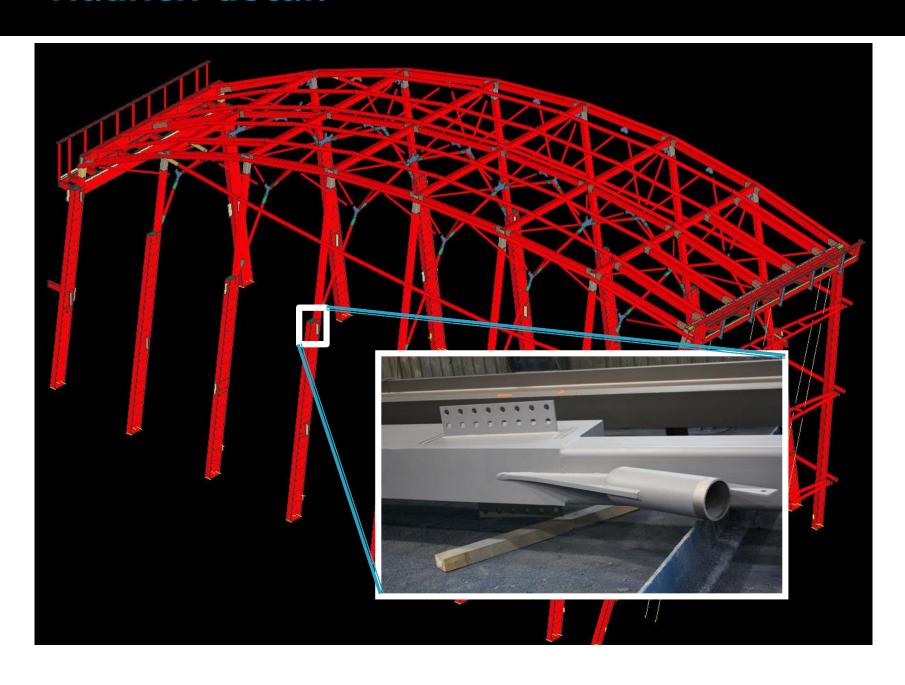
Concept

- The main structure comprises eight large trapezoidal arches connected by a web of smaller steel tubes, which form an interconnected three dimensional trussframe.
- All of the complex structural connections between the steel arches and tubes were architecturally designed and engineered
- Specification approaches CISC's AESS2 and AESS3
 Categories, for 'far from view' and 'close to view' steel

Overall structural drawing



Haunch detail



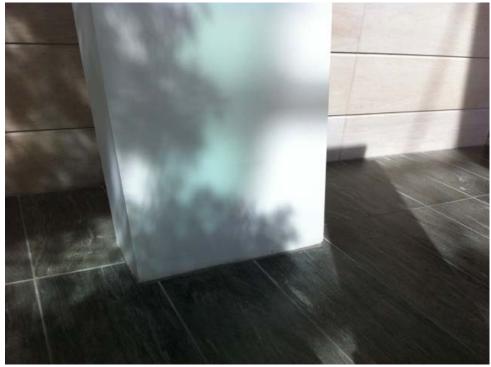
Column fabrication



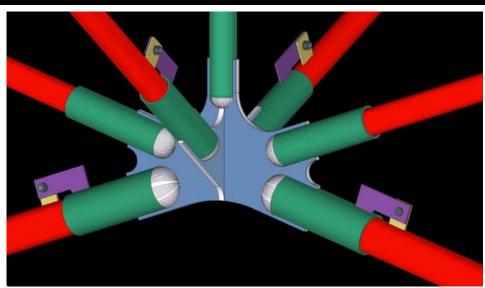


Custom plate columns with sharp corners are typical of high level AESS





Node connection







Steel erection

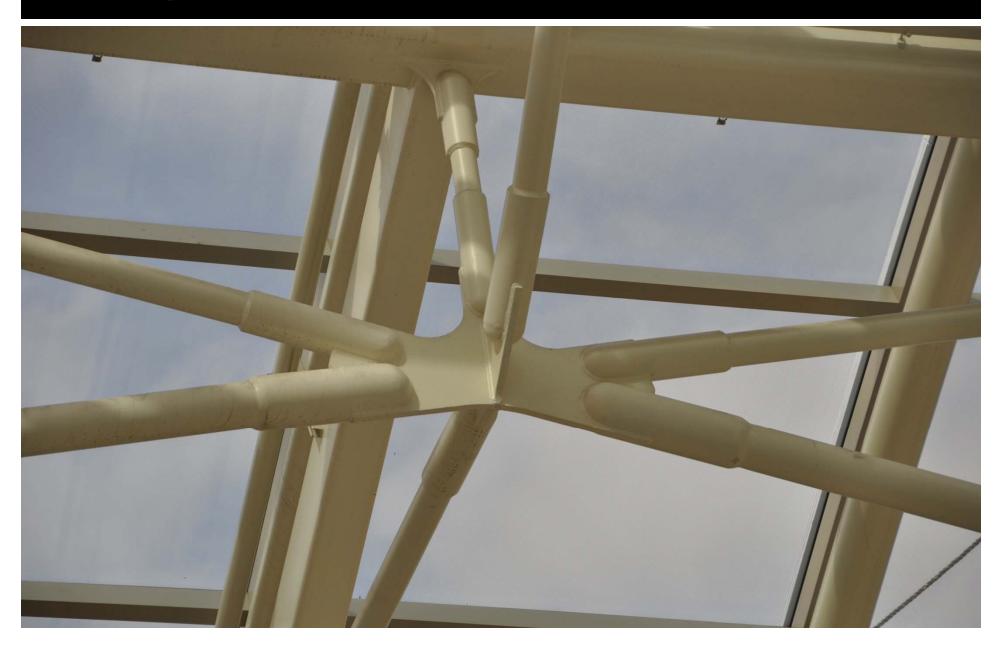




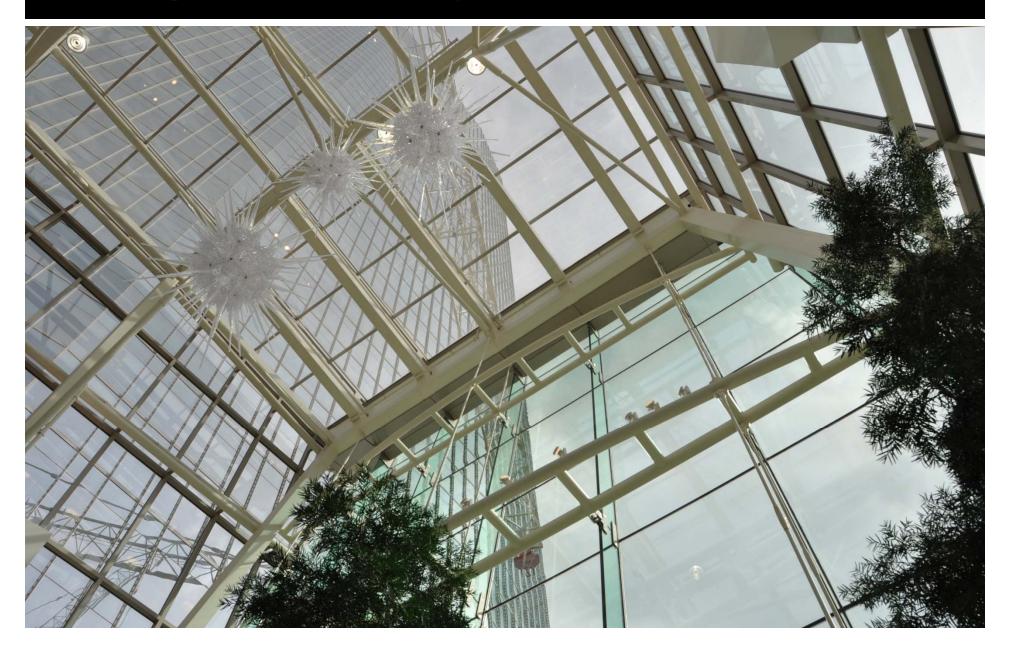
Last Arch erection

2nd Arch erection

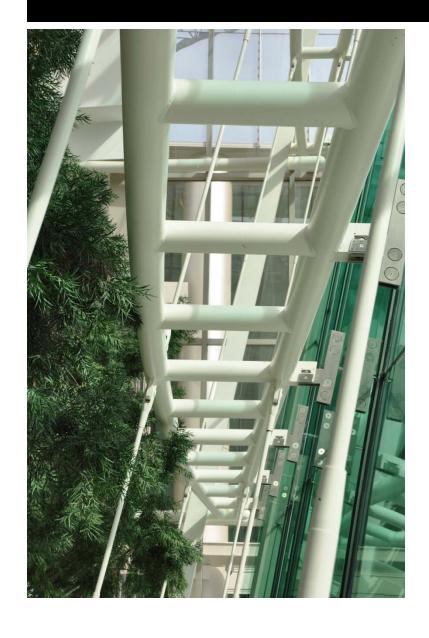
Completed node



Completed Wintergarden



Details







Owner

Cityzen, Fernbrook Homes

Architects architects Alliance

Construction Manager

Steel Fabricator / Detailer / Erector
Walters Inc. Hamilton/Metropolitan Walters

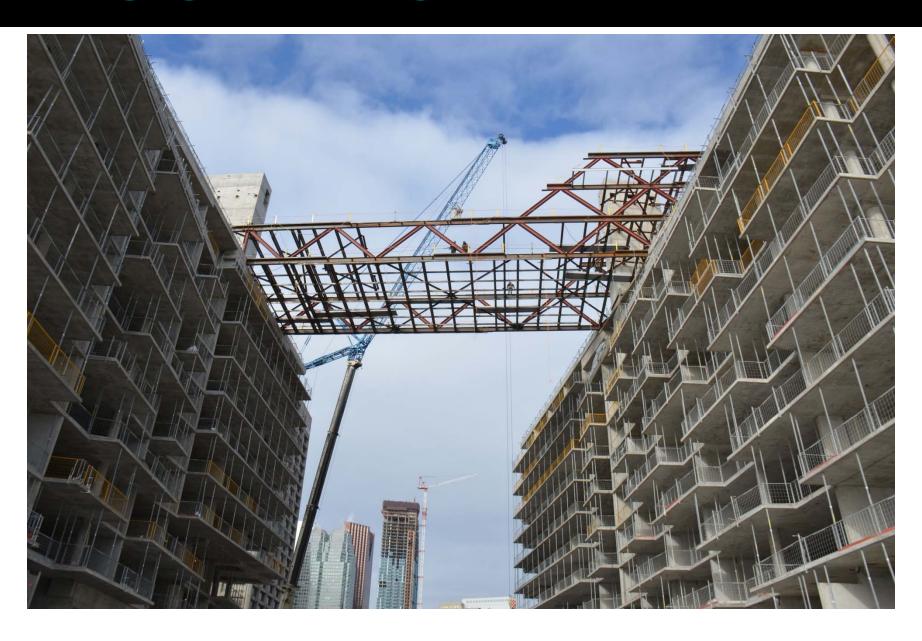
Project Profile

PIER 27 RESIDENCES Toronto, Ontario

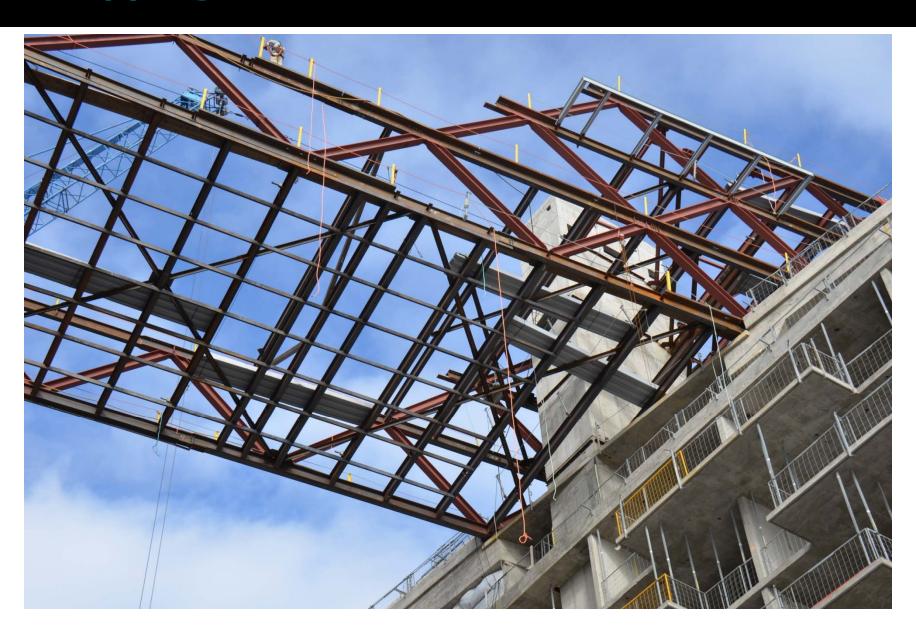


Site access courtesy: Walters Inc.

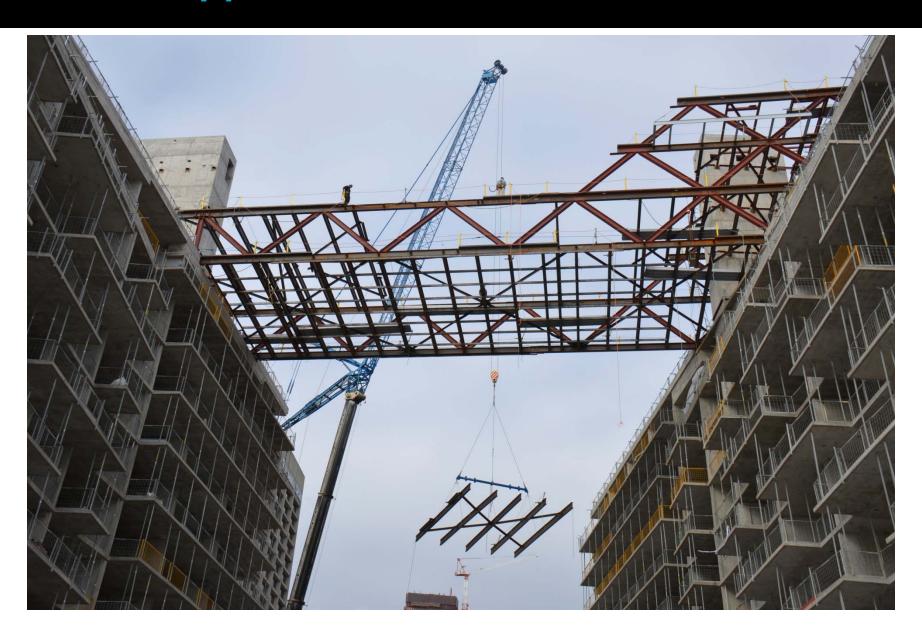
Bridging with a diagrid 'truss'



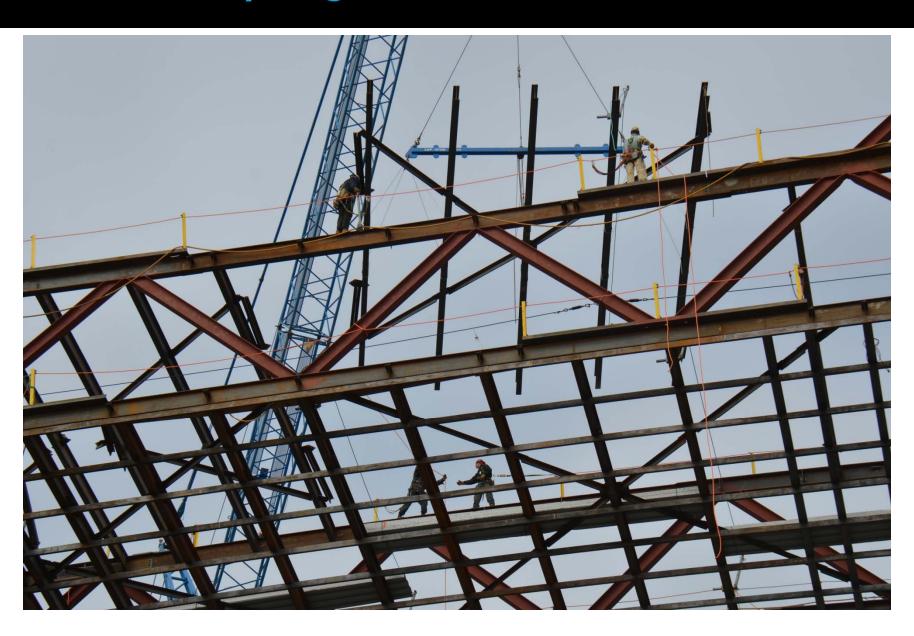
Prepping for a lift



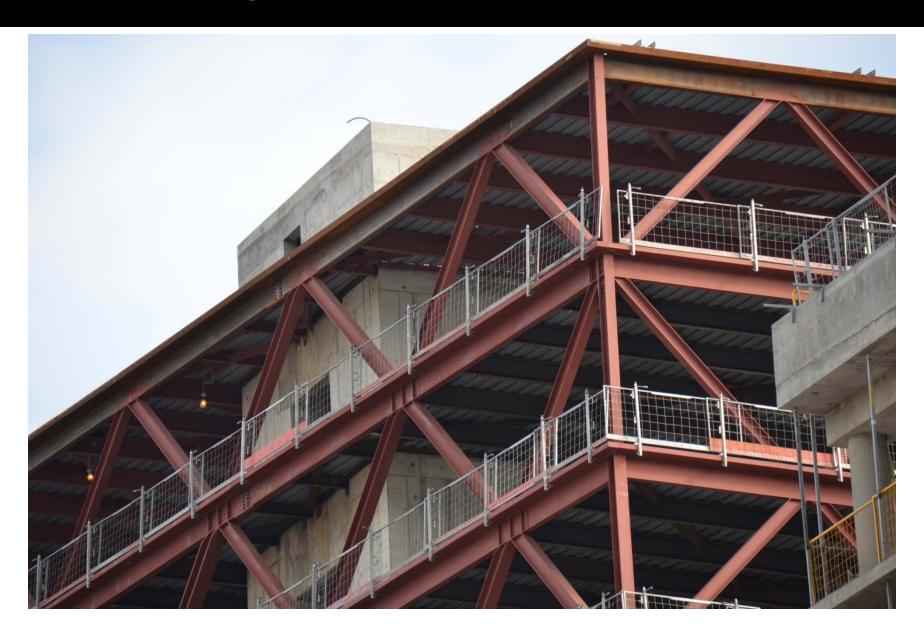
Floor support element erected



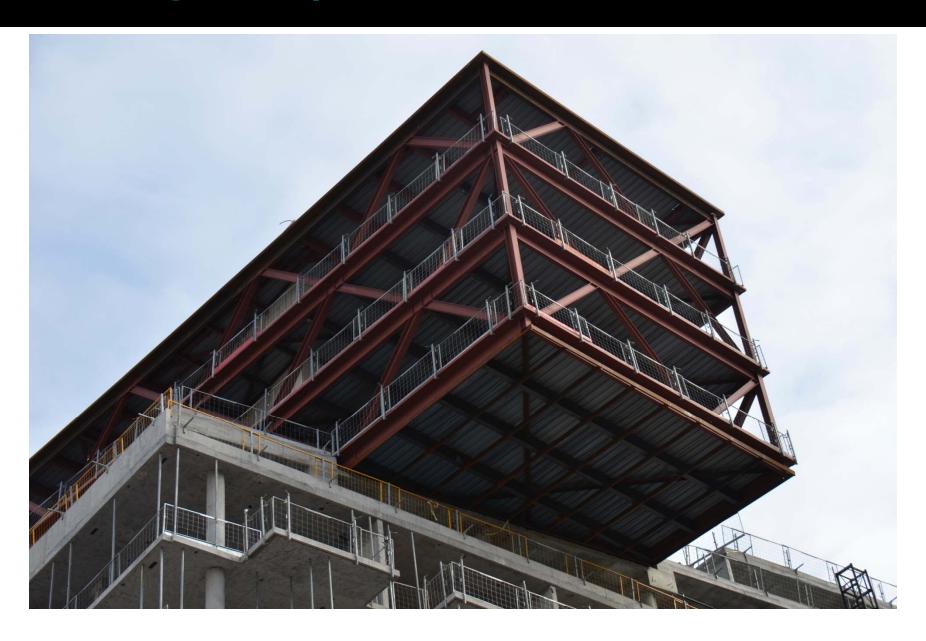
Team accepting element



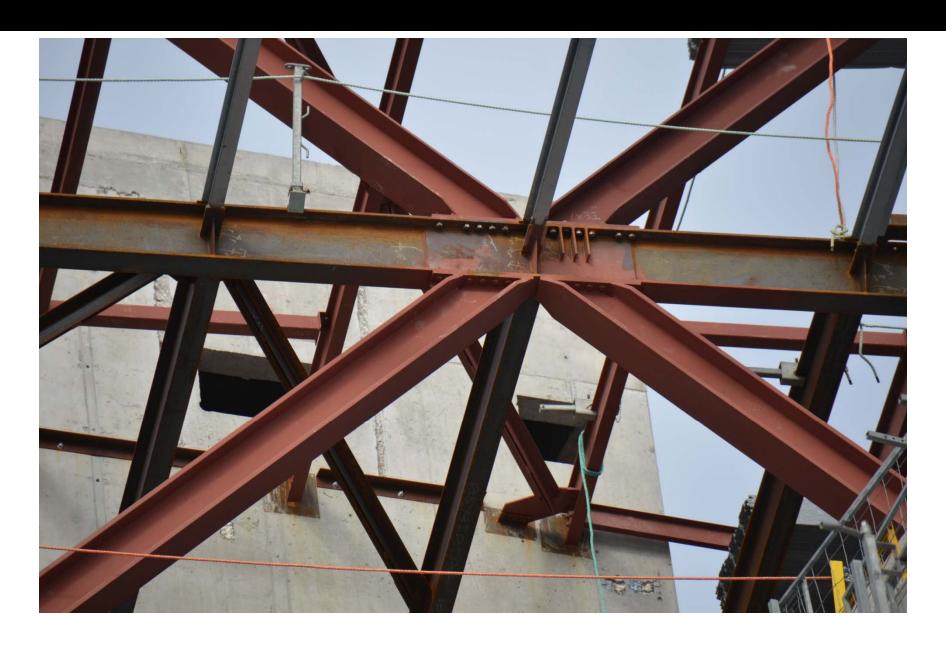
What is exposed? What is not?



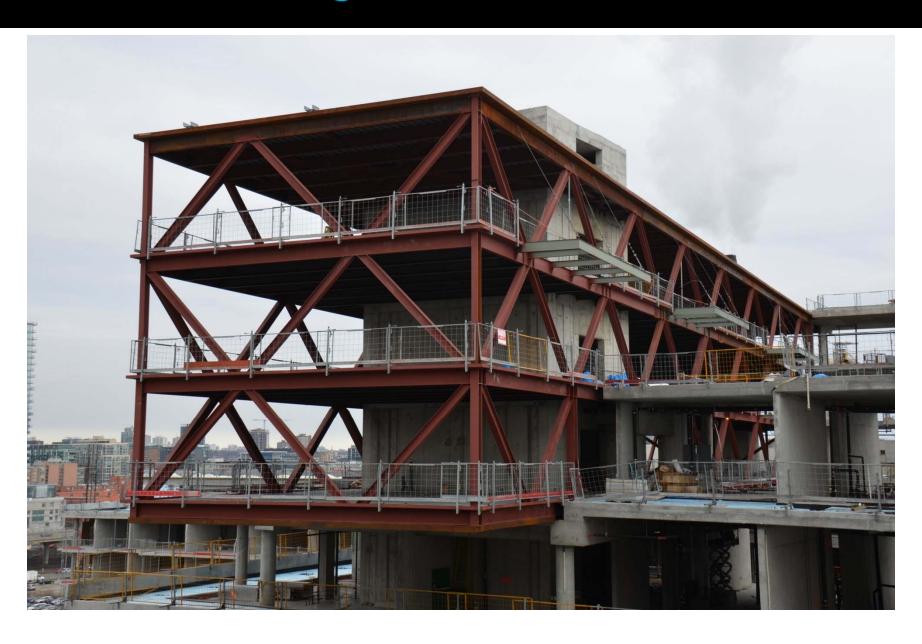
Bracing in all planes



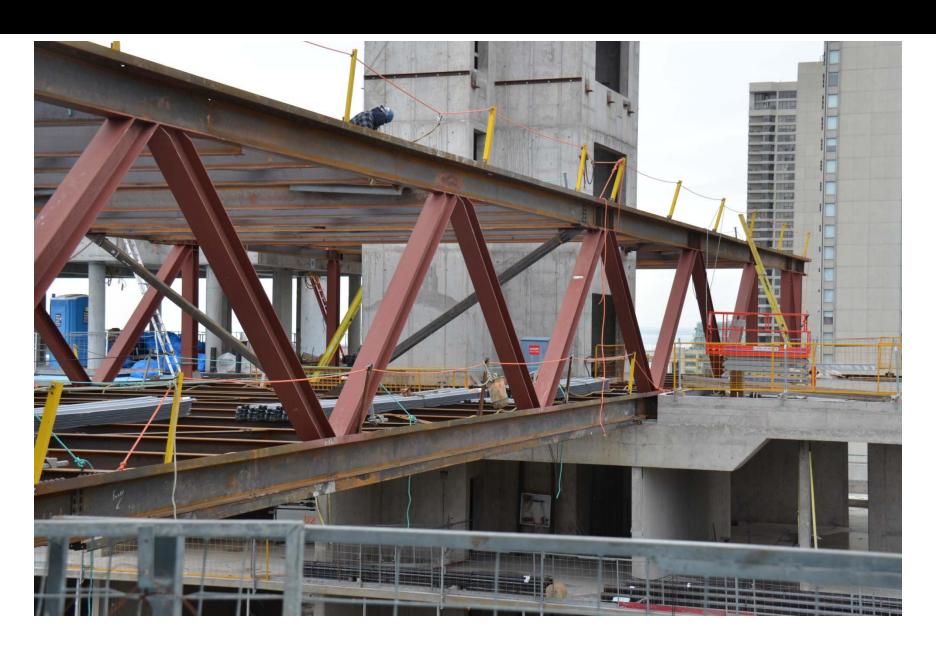
Intersections



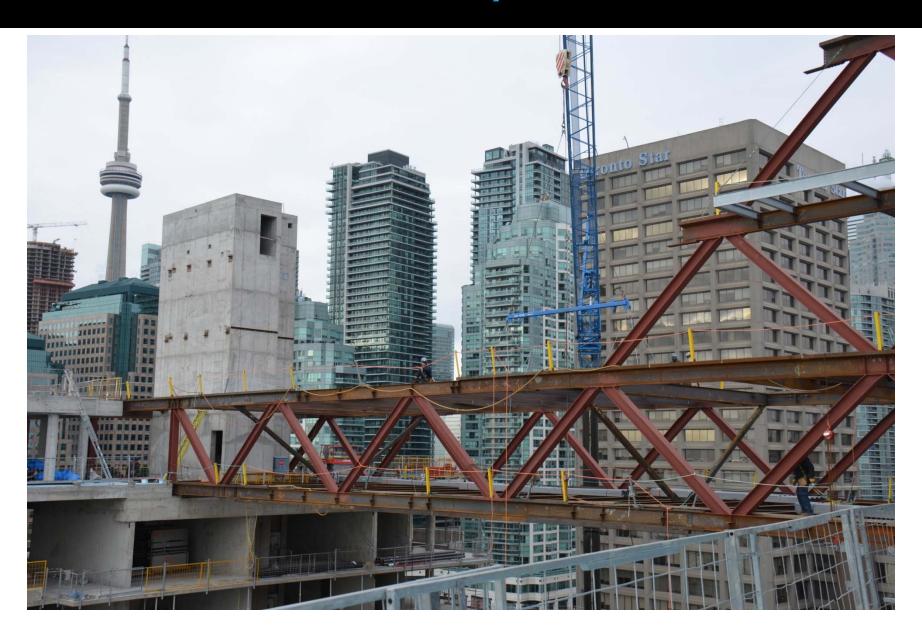
Stiffness through structural choices



Steel to concrete issues



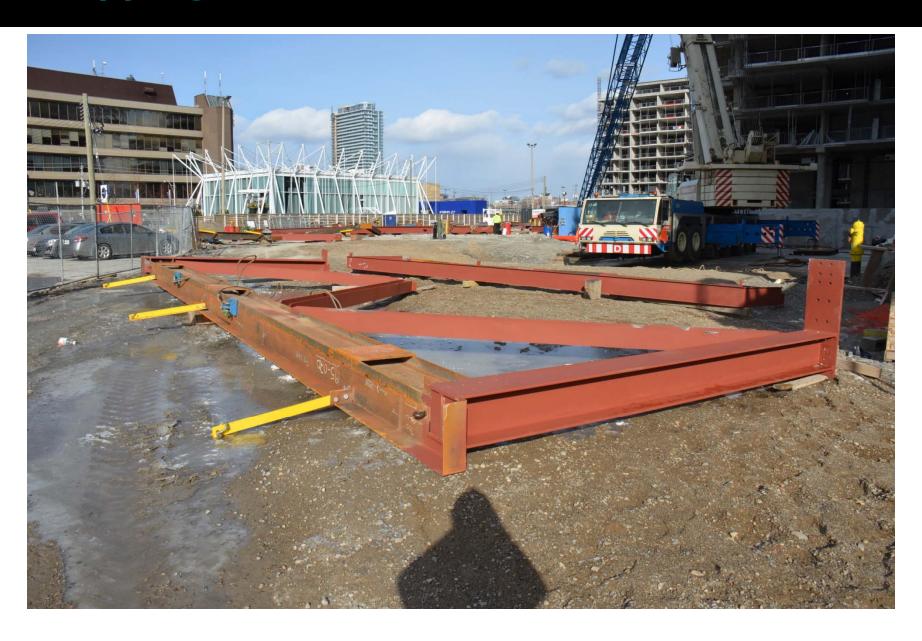
AESS vs structural components



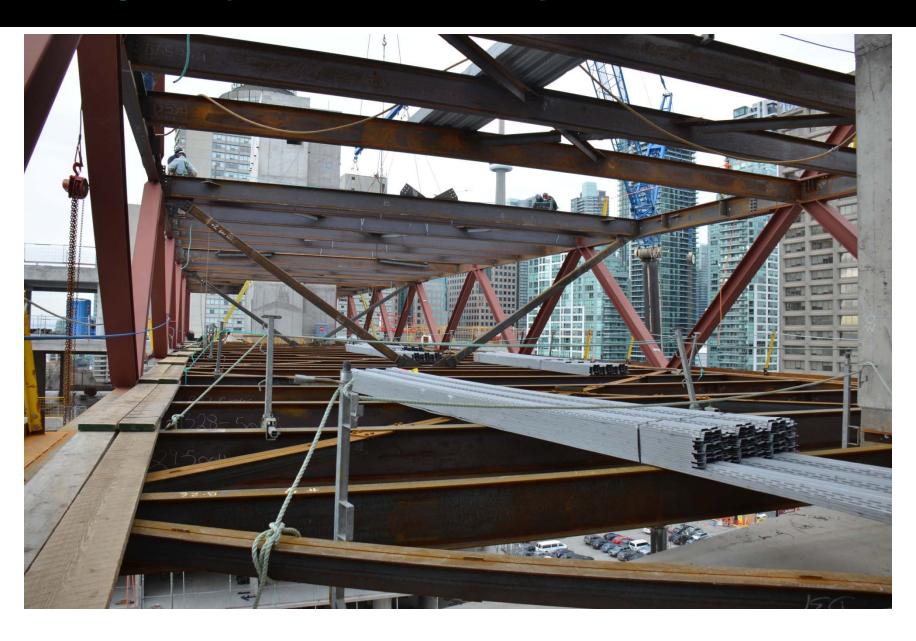
Splice locations



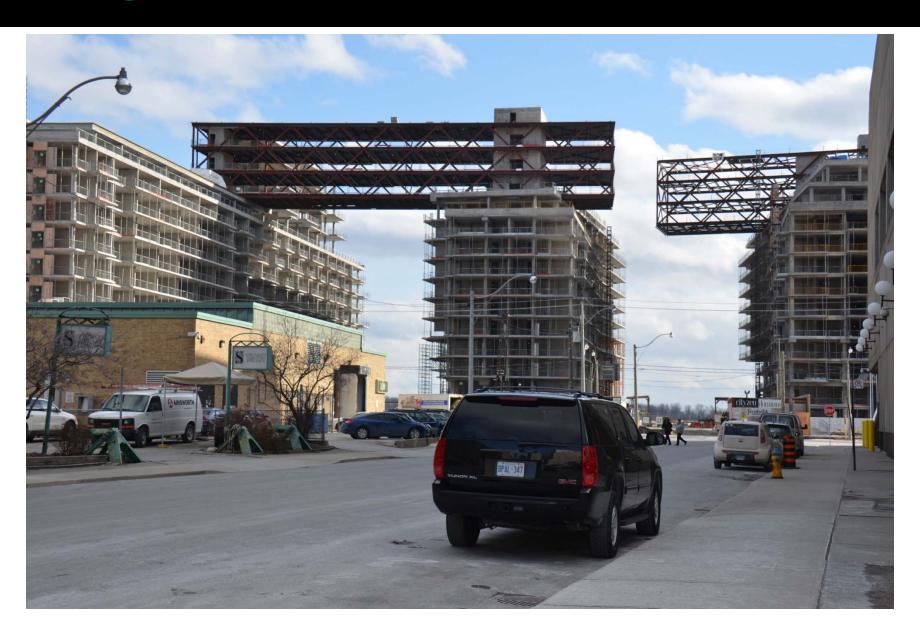
Shipping restrictions



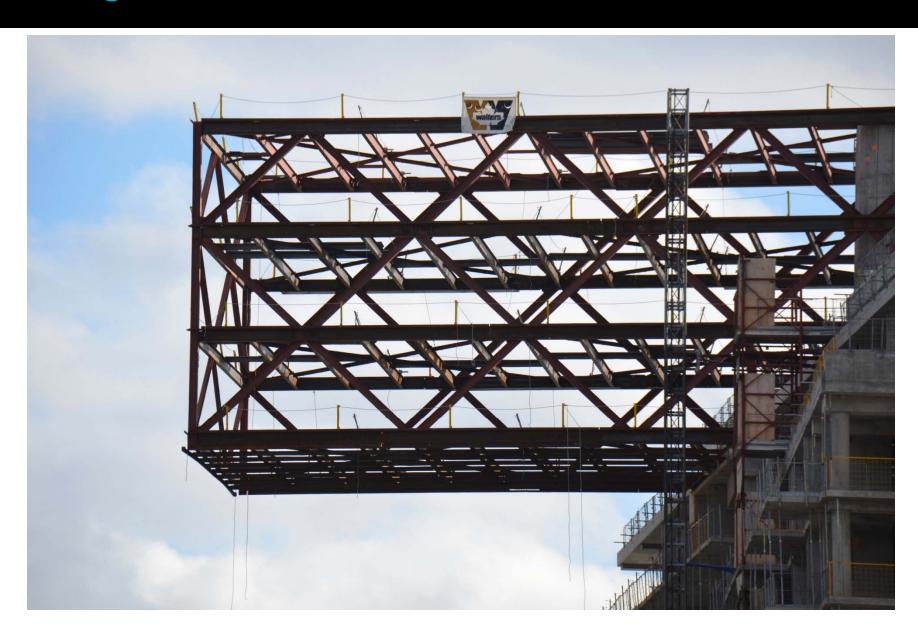
Temporary stabilization systems



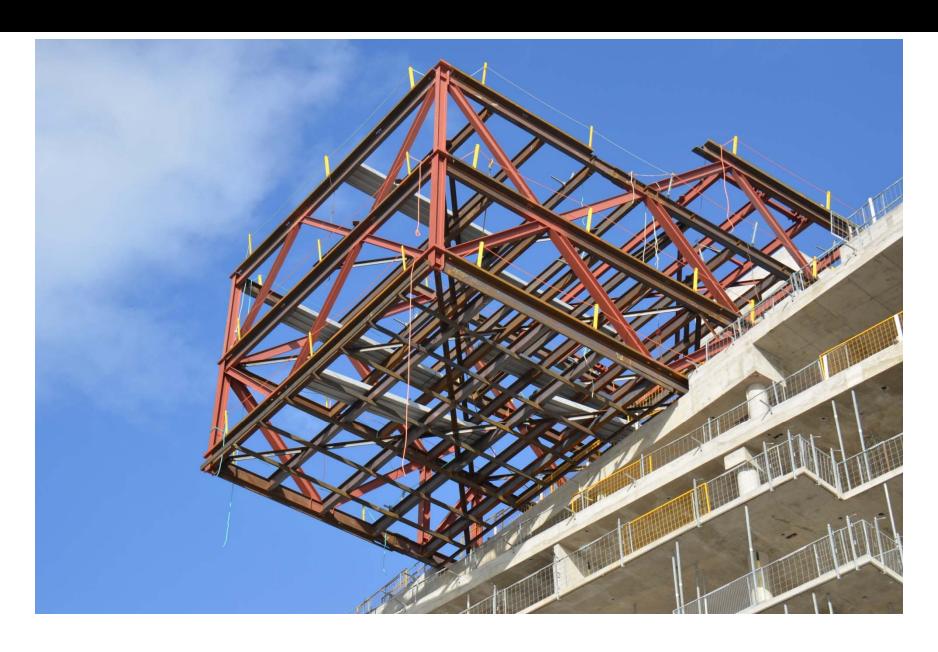
Bridges and cantilevers



Diagrid as result



Subtle differentiation





Project Profile

PEMBINA HALL University of Manitoba Winnipeg, Manitoba

Owner

The University of Manitoba

Architects

Raymond S.C. Wan Architect

Structural Engineers

Crosier Kilgour & Partners Ltd.

SMS Engineering Ltd.

McGowan Russell Group

Stantec Engineering

Dyregrov Robinson Inc.

Construction Manager

Bird Construction Company Ltd.

Steel Fabricator / Detailer / Erector

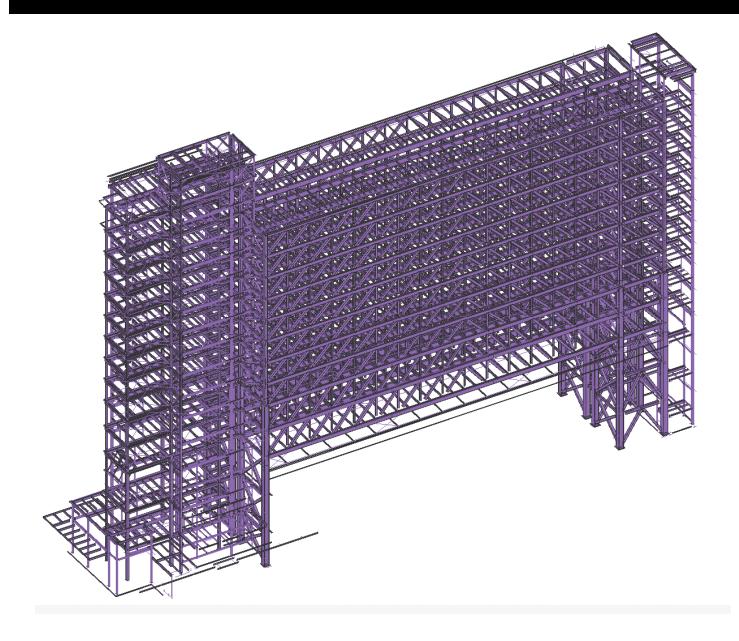
Supermétal



Photo credits this section: Supermétal

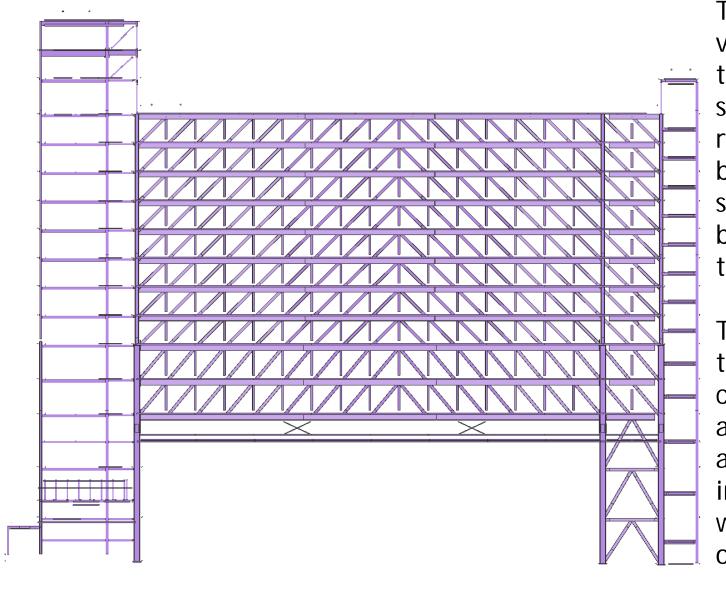
Content: Sylvie Boulanger, Vice President, Technical Marketing

Structural Isometric



This drawing type is useful for showing the extent of the steel in the project as it excludes other materials such as reinforced concrete from the view.

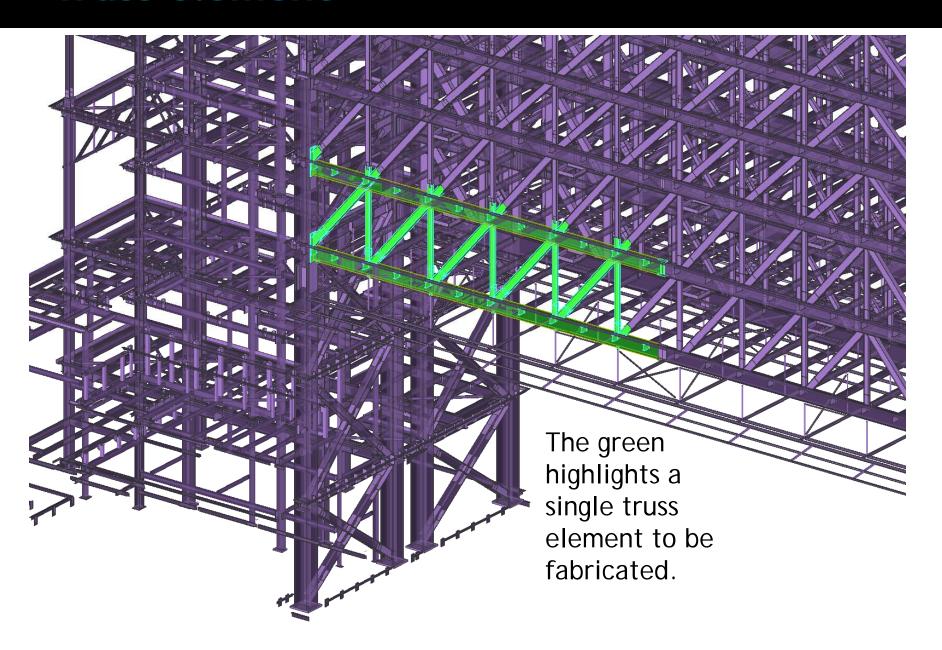
Elevation view of steel



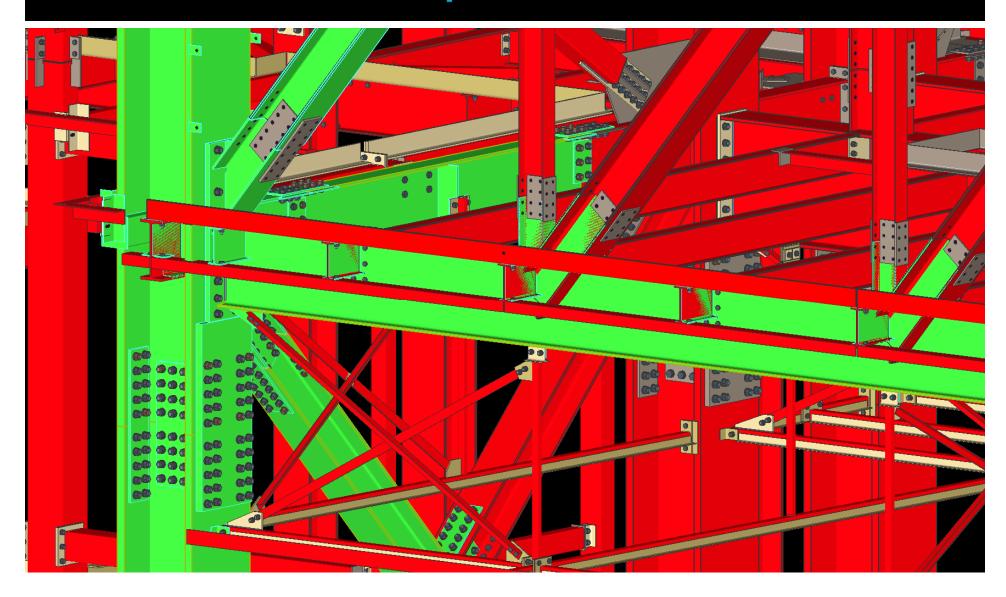
The elevation view highlights that the main slab of student residences will be clear spanning between the tower elements.

The direction of the diagonal chords was an aesthetic choice as it puts them in compression which is not optimal loading.

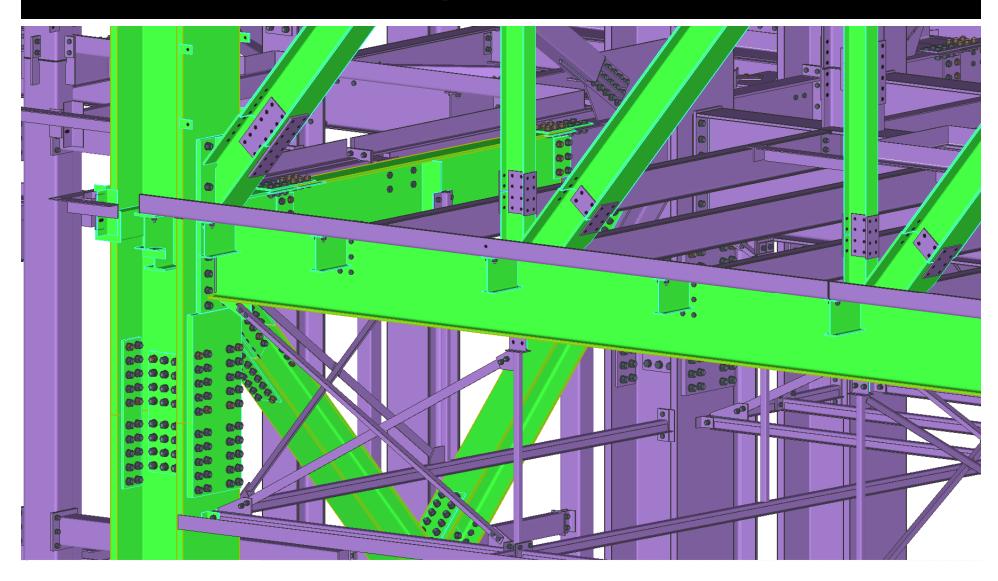
Truss element



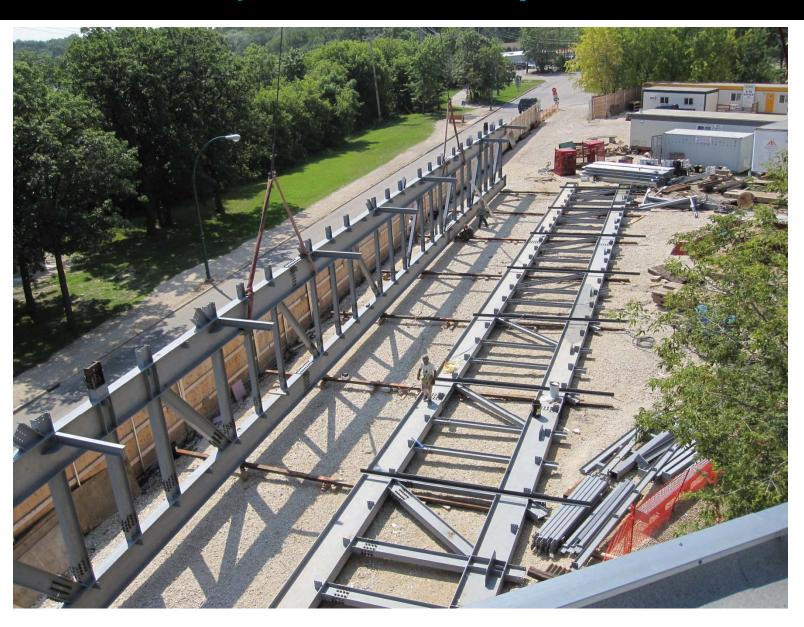
Connections and splices



Connections and splices



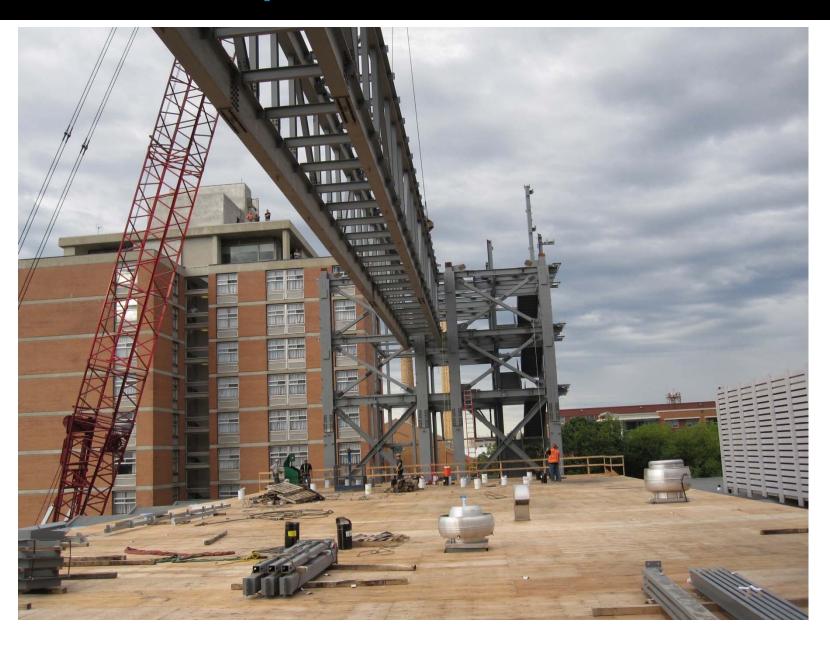
Site assembly of truss components



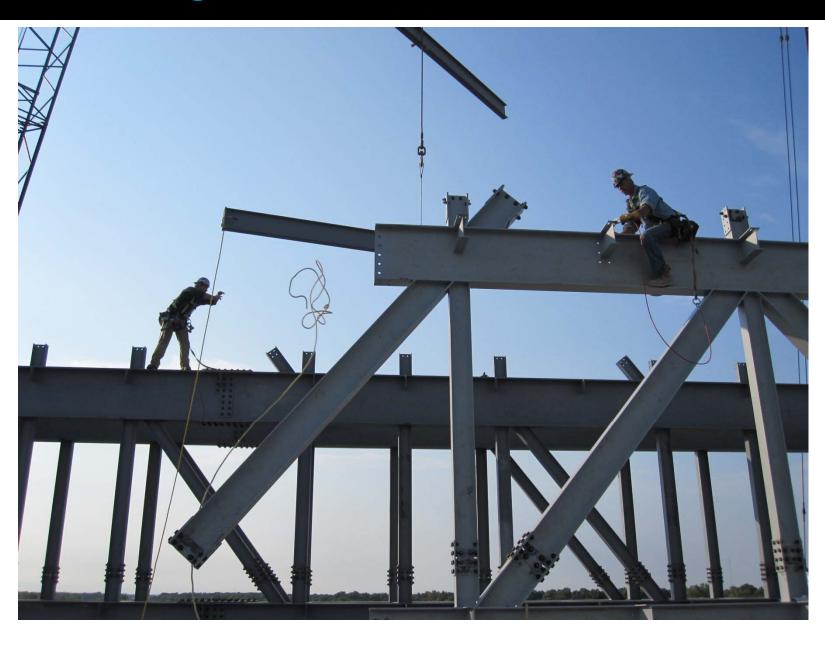
Lifting an assembled truss section



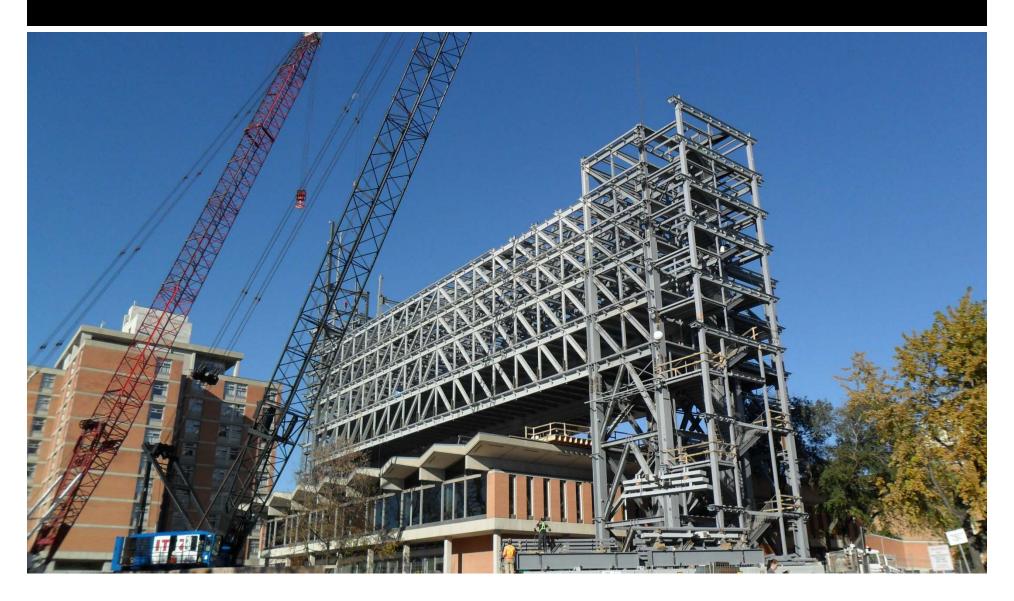
First truss in place

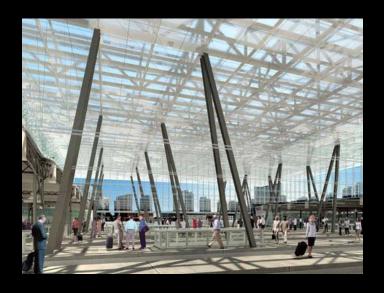


Site bolting



Semi finished structural frame





Project Profile

UNION STATION ATRIUM Toronto, Ontario

Owner

Yolles (CH2M HILL) - lead for GO Transit / Metrolinx

Architects

Zeidler Partnership

Construction Manager

Aecon

Structural Engineer

Yolles

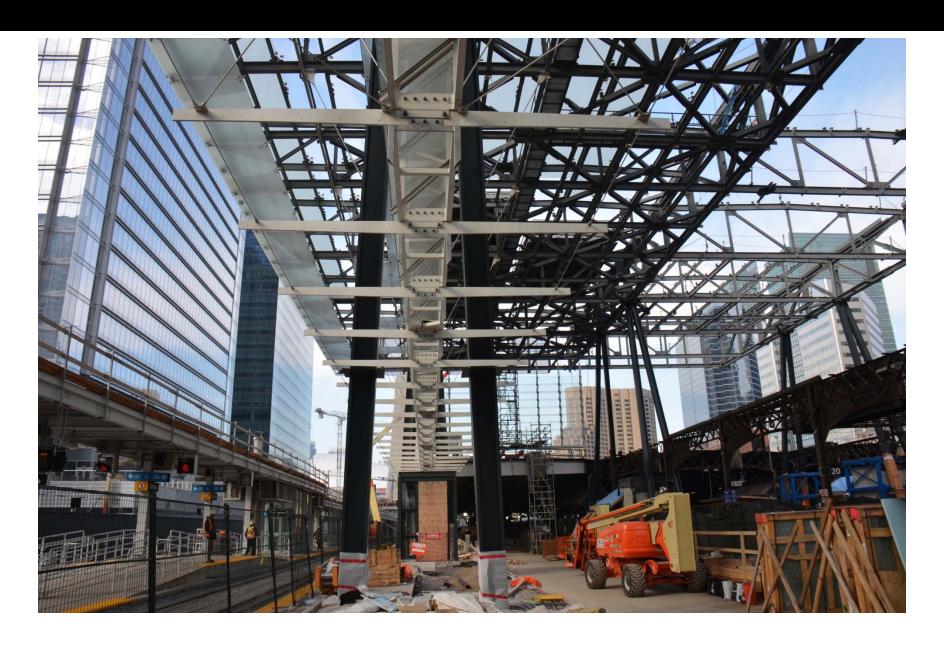
Steel Fabricator / Detailer / Erector

Walters Inc.

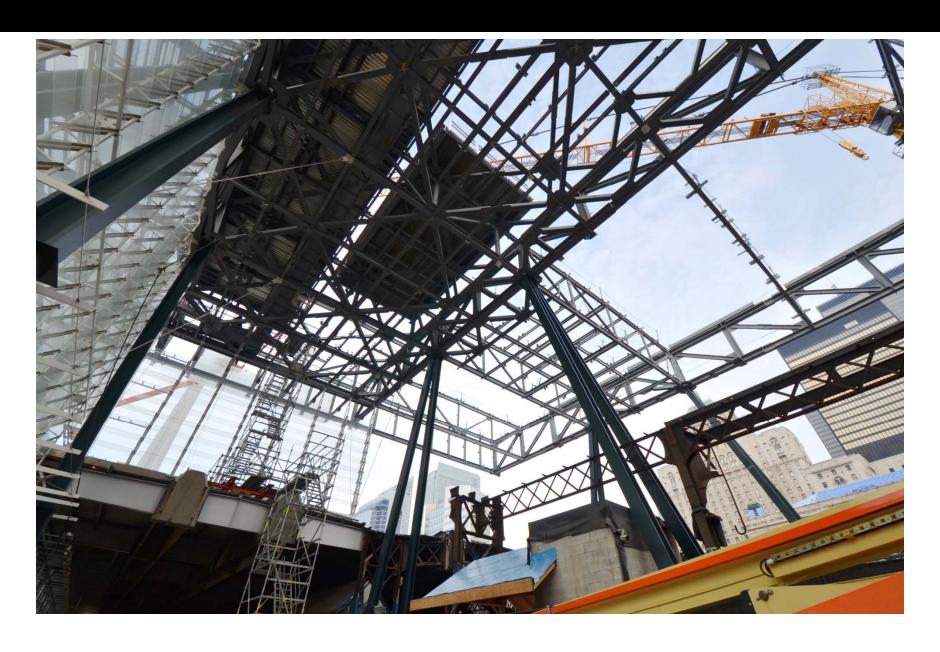


Site access courtesy: Walters Inc.

Union Station Train Shed

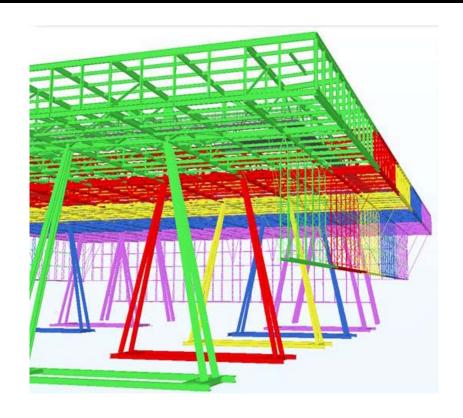


View towards roof

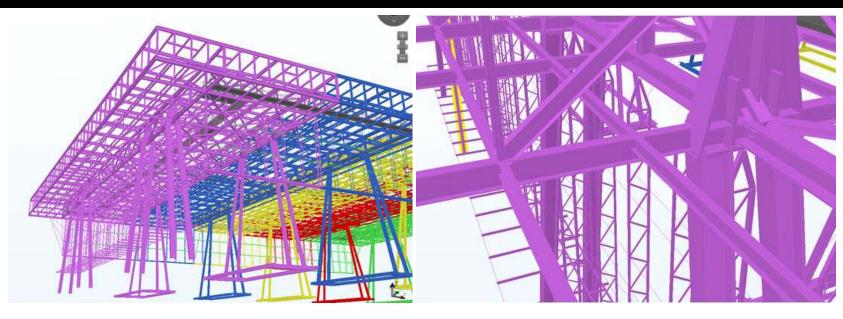


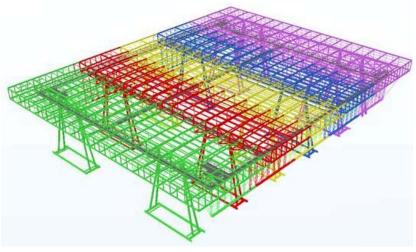
Construction phasing

- The location provides many 'issues'
- The tracks have to be kept open and operational
- The work has to be sequenced
- Major lifting that does require track closure can only occur at night
- This costs 'extra' given the time of day issues



Drawings

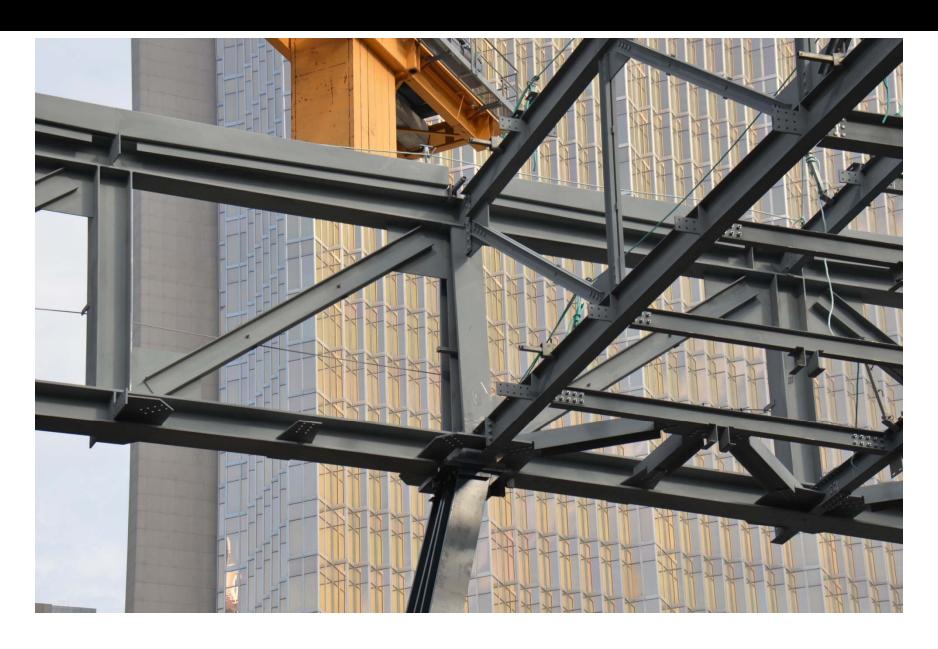




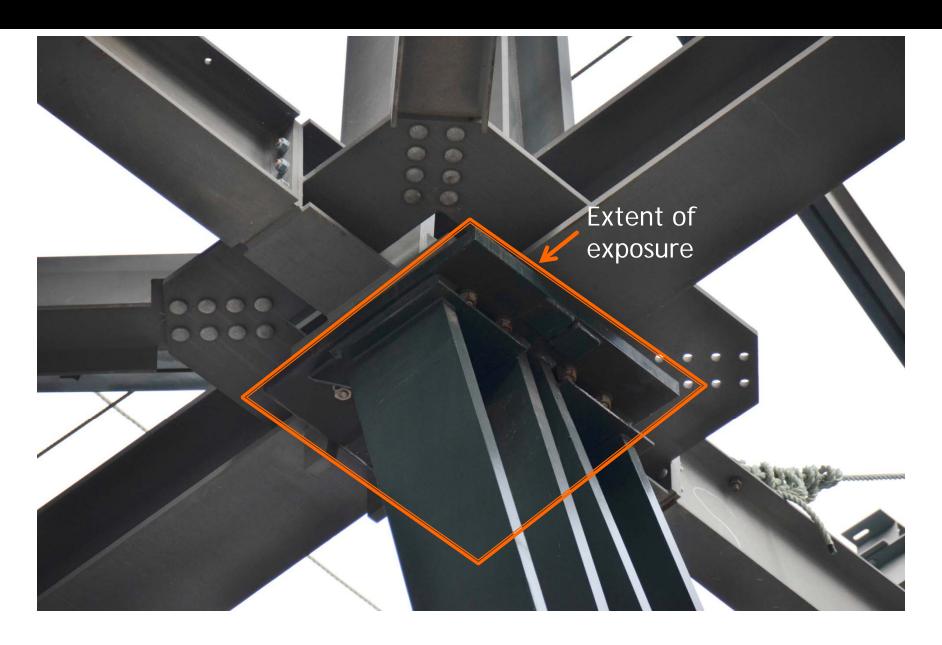
Images: Walters Inc.

Detailing software allows the fabricator to design all of the connections as well as produce drawings for each element and for erection sequencing.

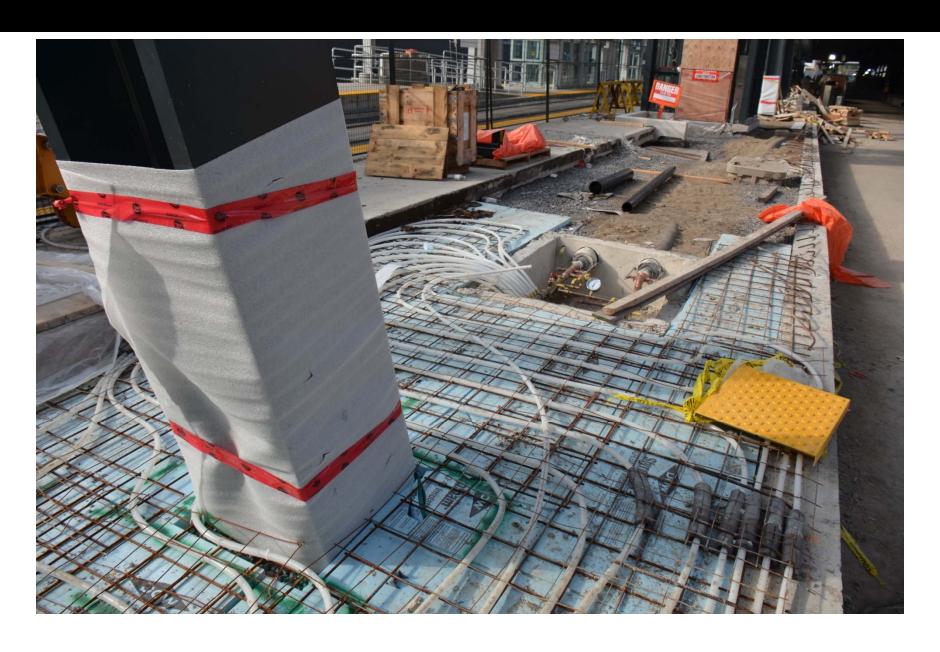
Truss construction



Truss connecton

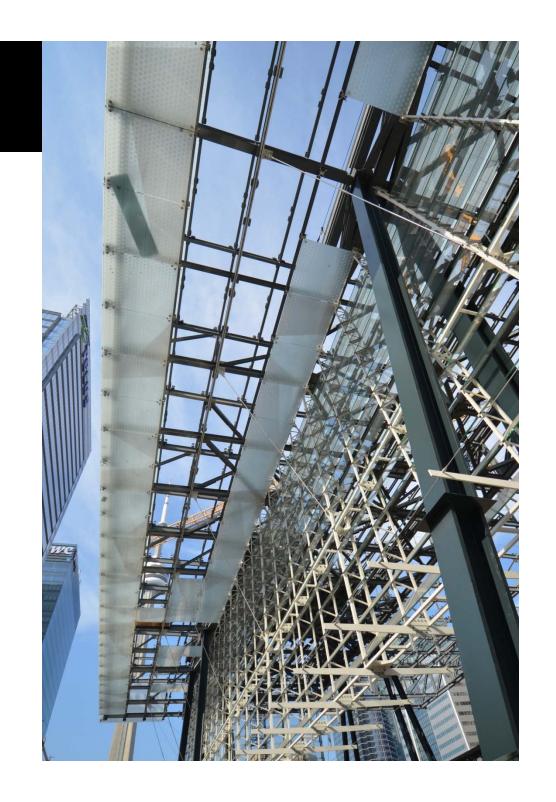


Column meets heated floor

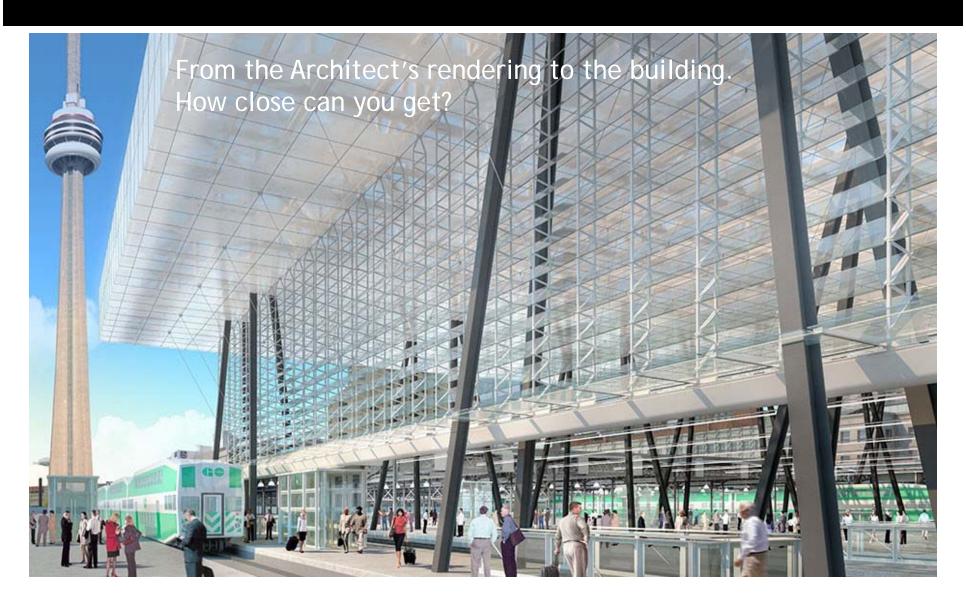


Exposure levels

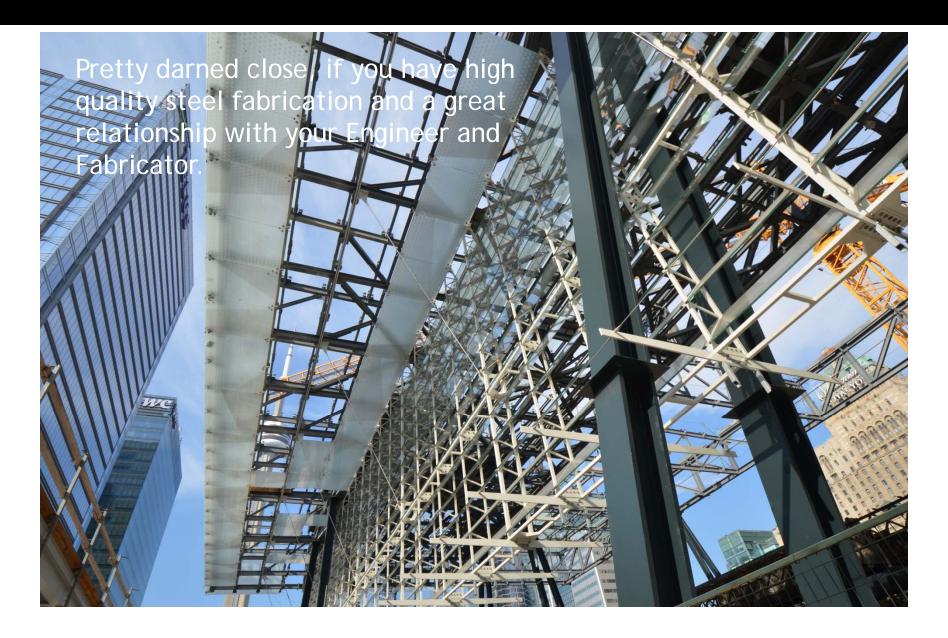
- Not all steel is exposed
- Columns are AESS3
- Hanger system is fabricated to AESS standards but is not considered "structural" per se
- Fritted, translucent glazing on soffit obscures the steel trusses
- Stainless steel cables provide some tension support for the glazed wall



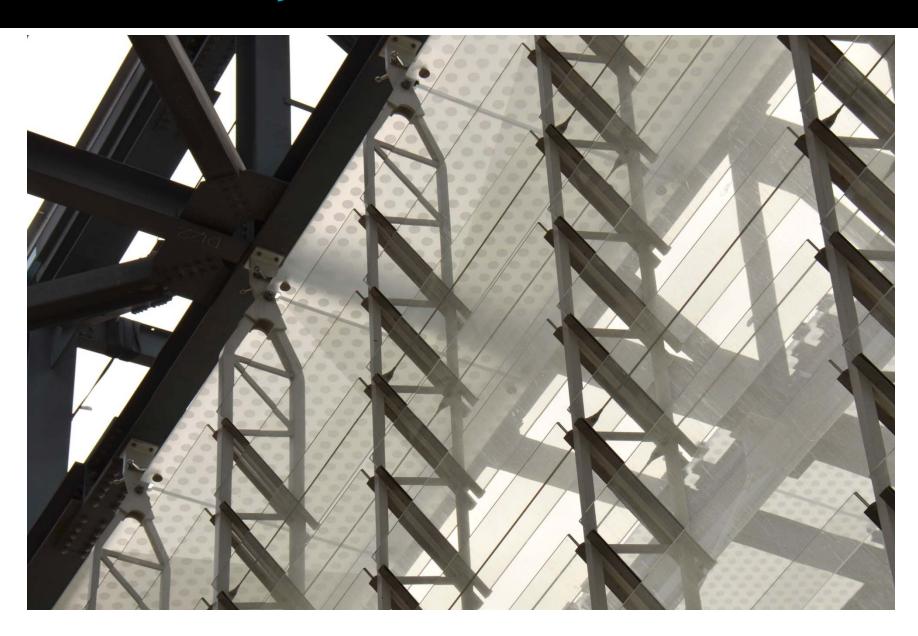
Quality fabrication brings projects to life



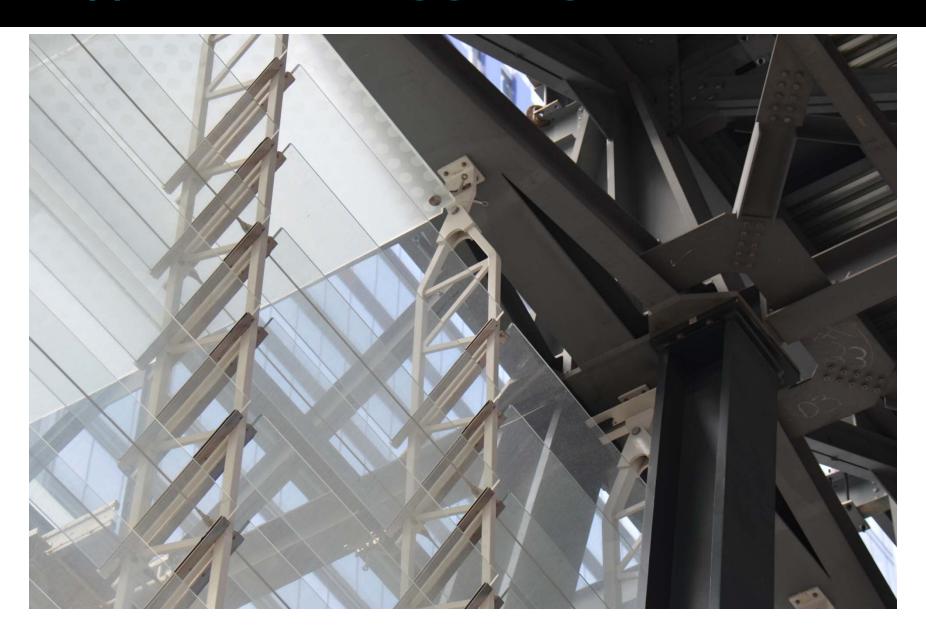
Front elevation



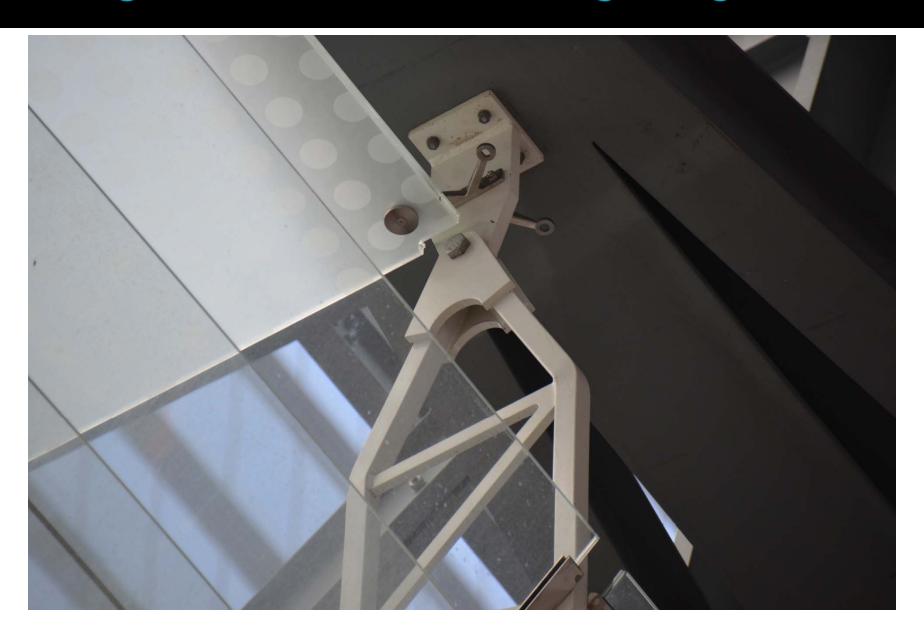
Translucency



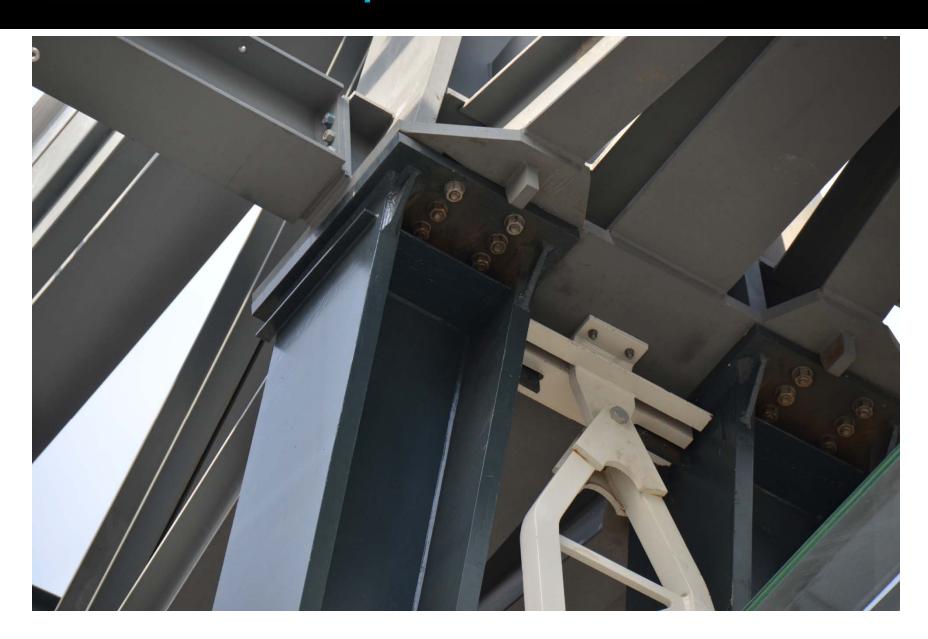
Support for venting glazing



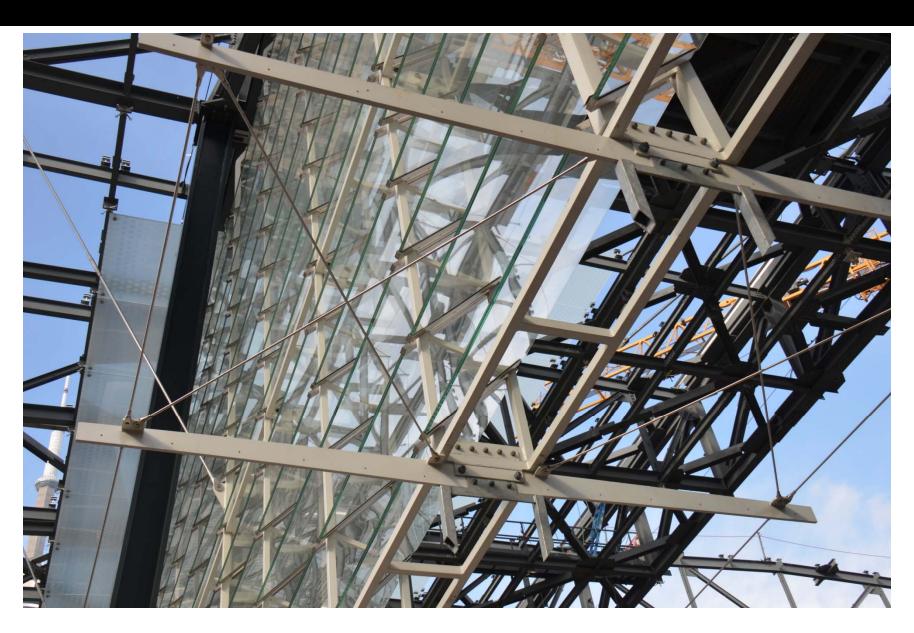
Hanger connection for side glazing



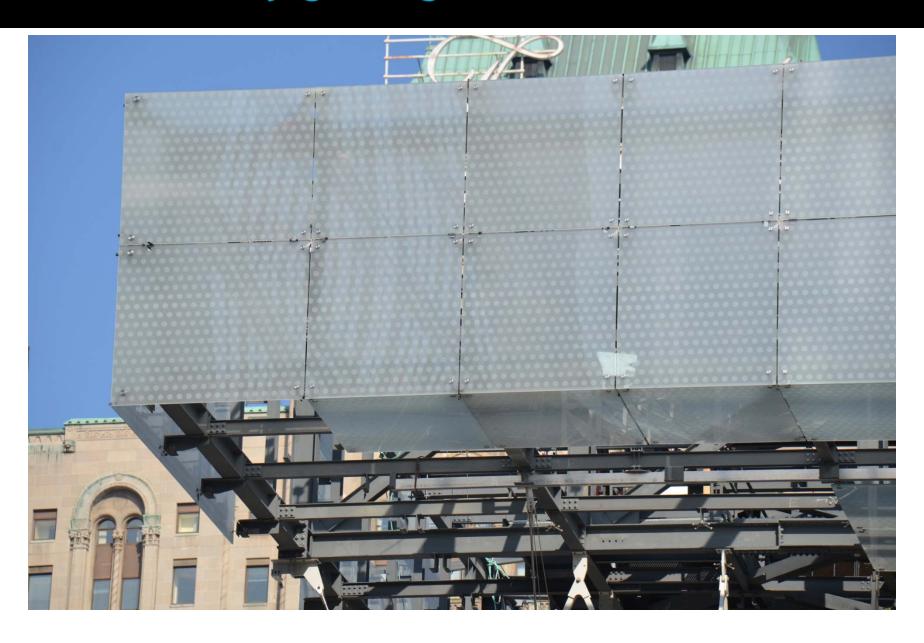
Custom welded plate for columns

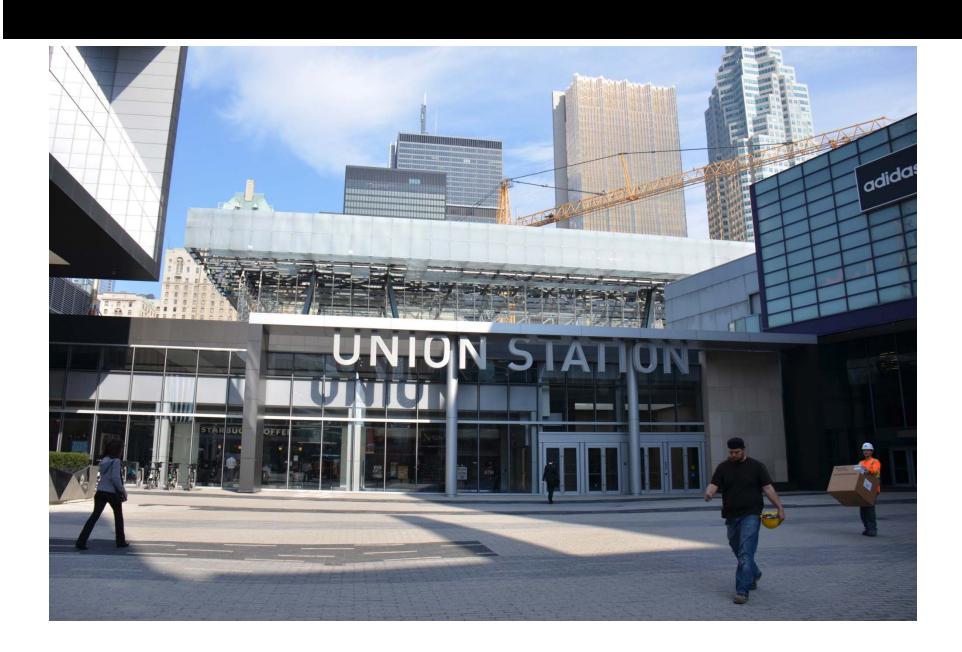


Fine support system for glazing



Obscured by glazing





AESS LE

Design process implications

- Architects and engineers have to talk to decide on AESS Categories.
- AESS Categories need to appear on all contract documents as per Spec.
- We typically expect that there will be 2 Categories specified per structure
 - ex. AESS 2 upper portion of atrium, AESS 3 for the lower portion
- Fabricators to bid on Engineering documents and the Categories specified.

Fabrication and Erection Implications

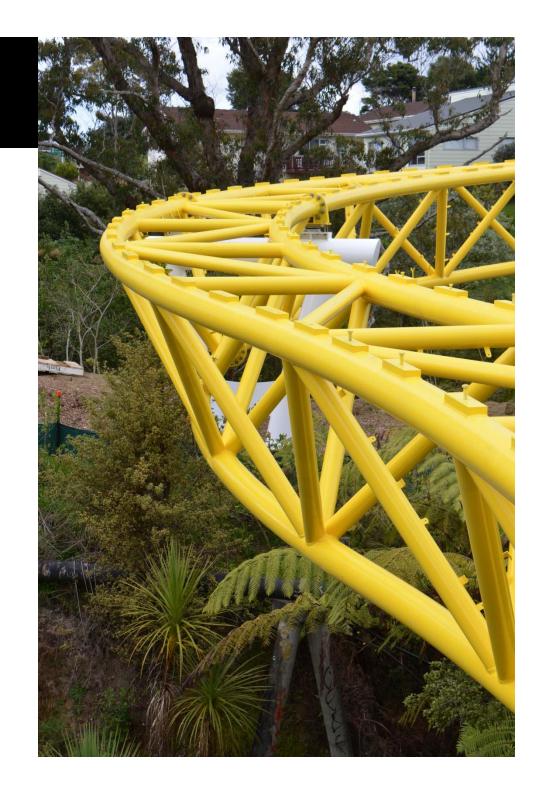
- Categories specified infer sequencing, cost and constructability issues.
- Higher level of care as provided for in the Code for Fabricators.
- AESS Categories to appear on all Shop and Erection drawings.

Positive outcomes

- AESS system standardizes basic design and fabrication issues
- Eliminates many 'routine' issues through the Category System
- Very important NOT to change AESS Categories
- If you want something different, pick CUSTOM
- Allows team to concentrate efforts on more particular issues for the project

Credits

- Sylvie Boulanger, Supermétal, Vice President, Technical Marketing (for images, project content and the original work on the development of the CISC AESS Documents and System)
- Walters Inc.
 (for providing site access and documentation for their projects)
- ARUP, London
 (for technical information on a number of projects)

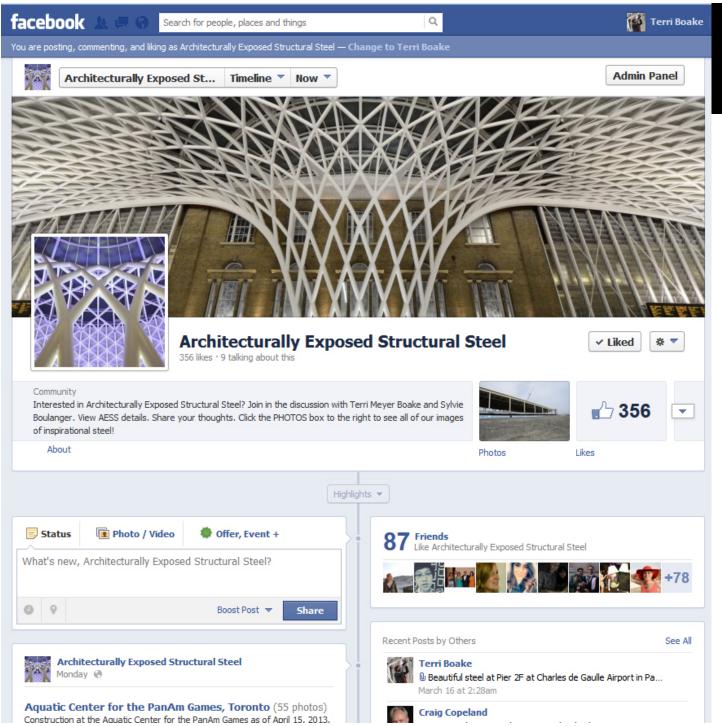


New AESS Documents

- Available for purchase and download:
 - CISC Guide for Specifying Architecturally Exposed Structural Steel
- Available for download at

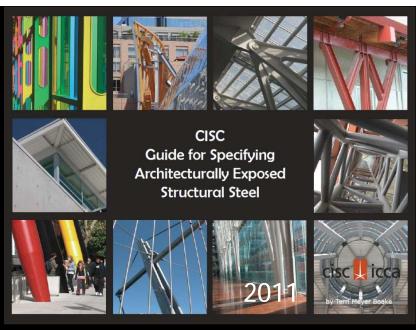
http://cisc-icca.ca/aess

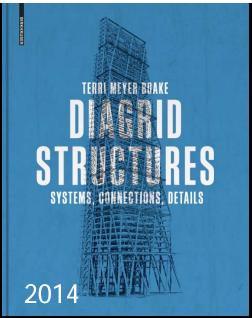
- Sample Specification
- Code of Practice for Fabricators
- Matrix

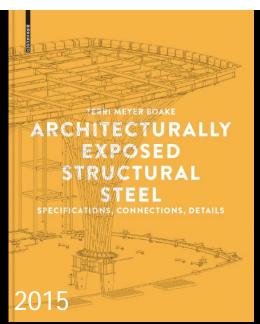


Check out our AESS Facebook Page!

facebook.com/aess4u









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tboake@uwaterloo.ca www.tboake.com

Content development credit: Sylvie Boulanger, Supermétal