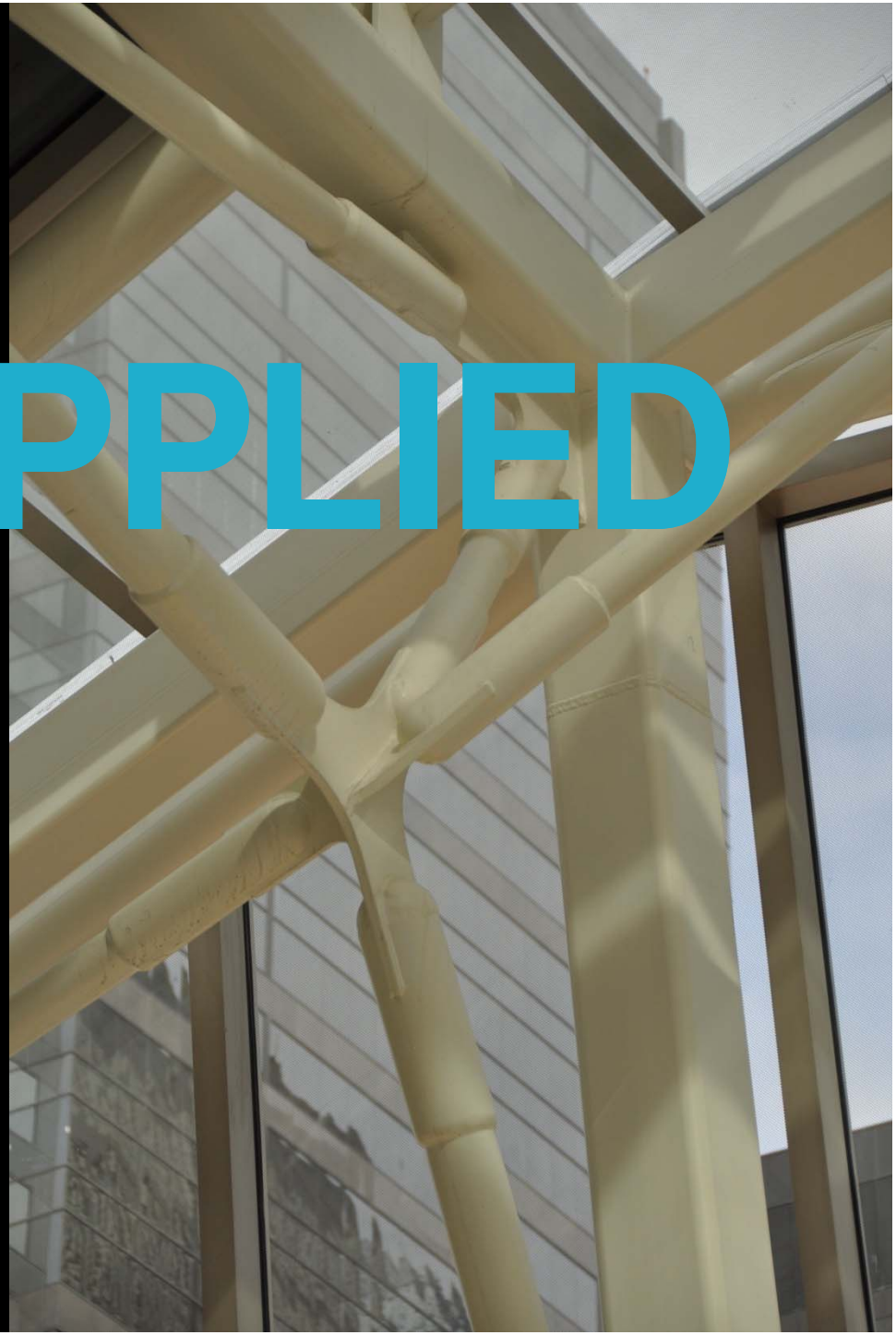
AESS APPLIED

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

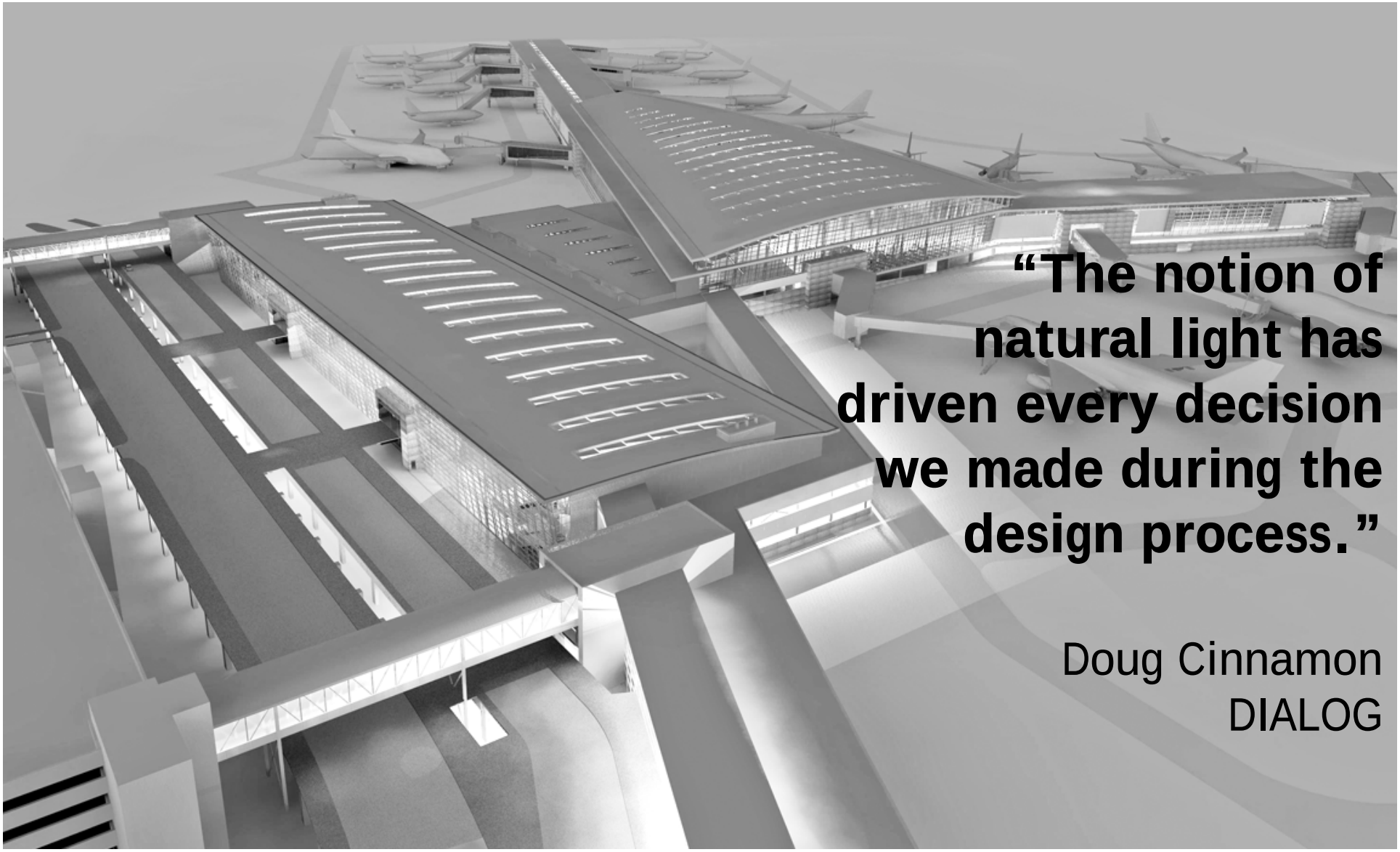
Steel Fabricator / Detailer / Erector
Supermétal

Project Profile

CALGARY INTERNATIONAL AIRPORT
International Facilities Project

Photo credits this section: Supermétal
Content: Sylvie Boulanger, Vice President, Technical Marketing

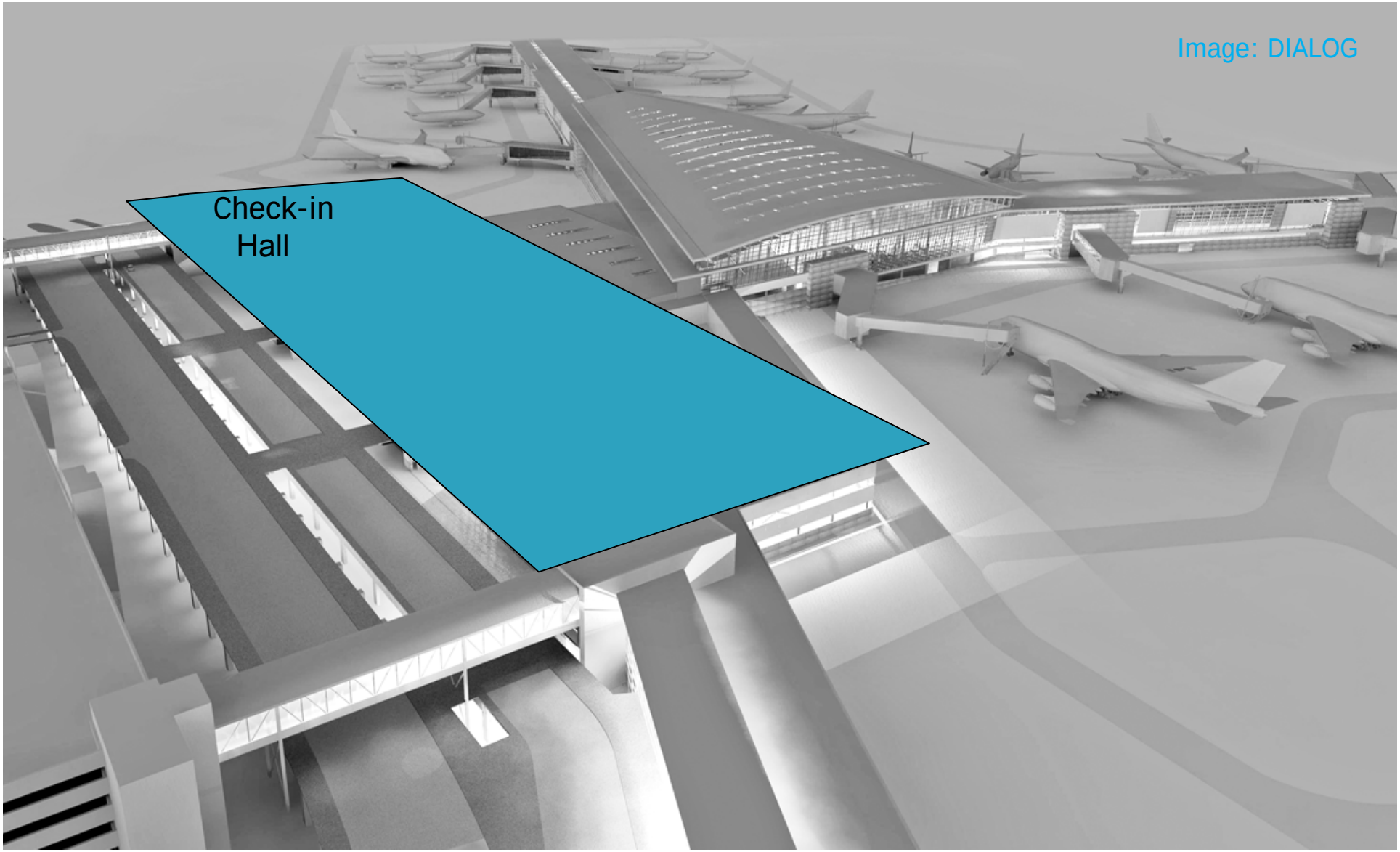
Calgary Airport International Facilities Project



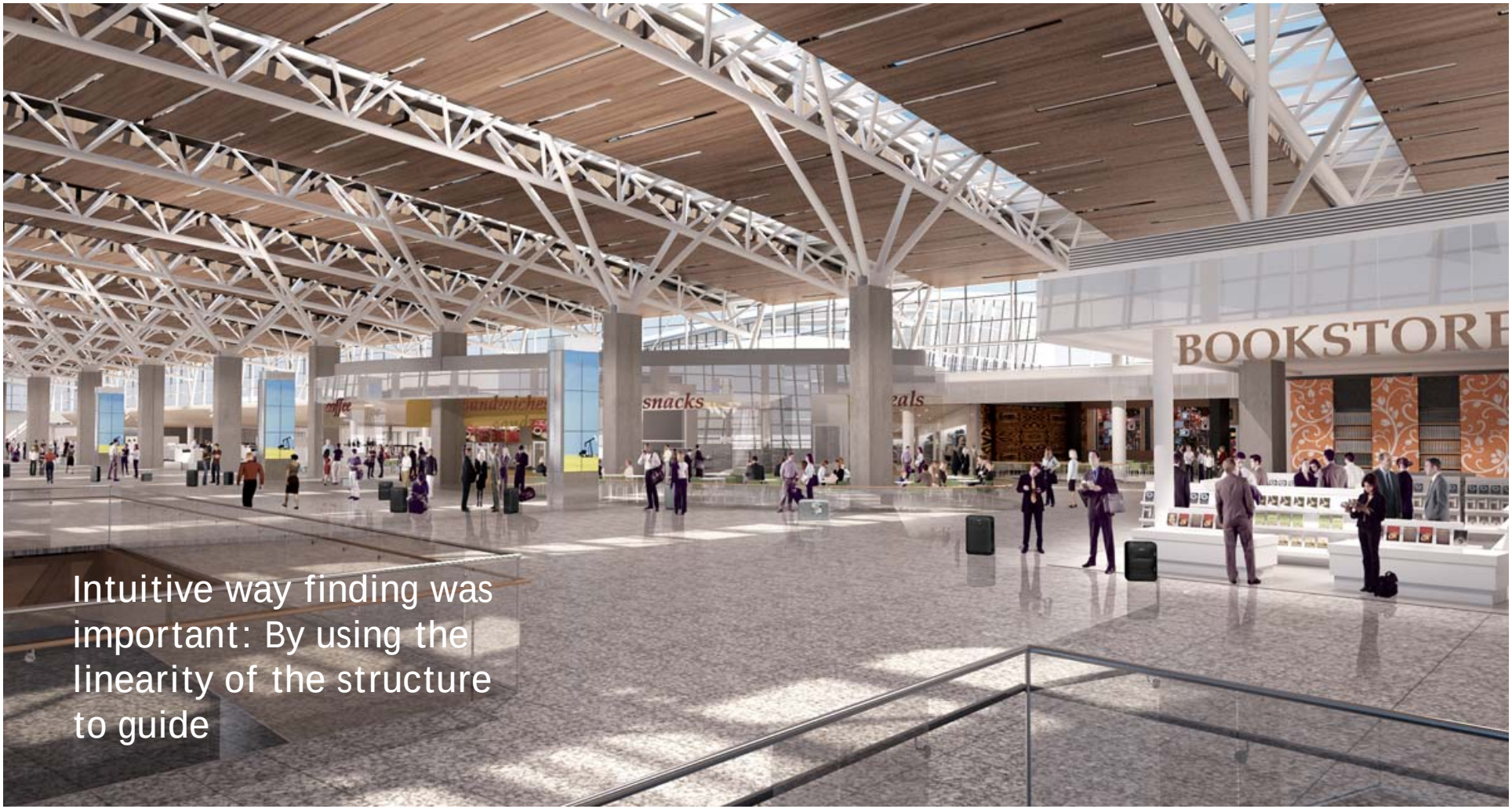
“The notion of natural light has driven every decision we made during the design process.”

Doug Cinnamon
DIALOG

Calgary Airport International Facilities Project



Check-in Hall



Intuitive way finding was important: By using the linearity of the structure to guide

Image: DIALOG

Calgary Airport International Facilities Project

Clear open space was another driver:
Fewest columns for maximum flexibility and comfort

Image: RJC

Quick Facts

International Facilities Project

$1.4 billion investment
In-service October 2015
Five levels and 183,500 m^2
22 new aircraft gates
Green building features

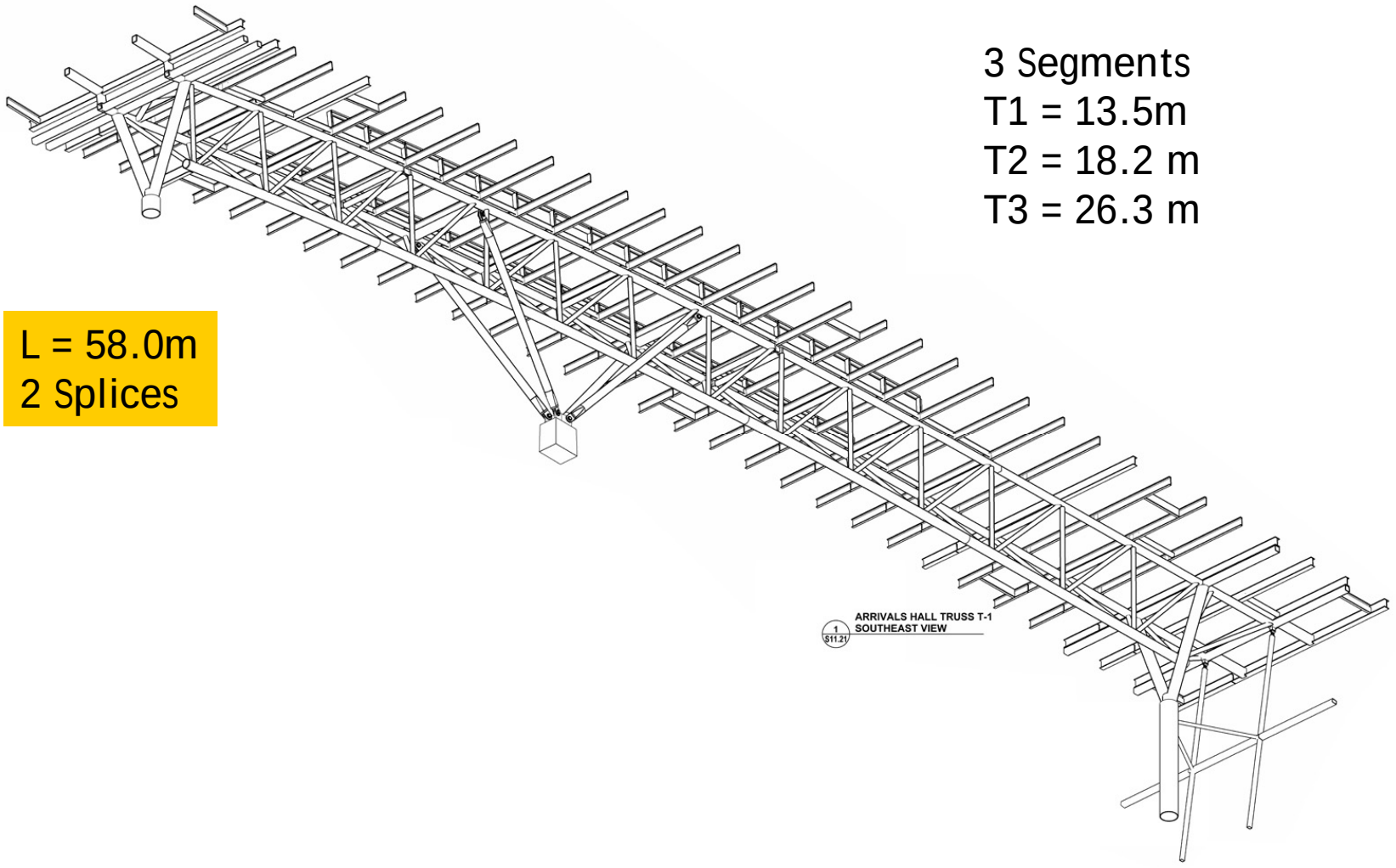
Structural Steel

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

Check-in Hall

Area of 48,100 m^2
17 x 58m triangulated trusses
Weight per truss: 22.5 tons
Heaviest segment: 9 tons

Typical truss



3 Segments
T1 = 13.5m
T2 = 18.2 m
T3 = 26.3 m

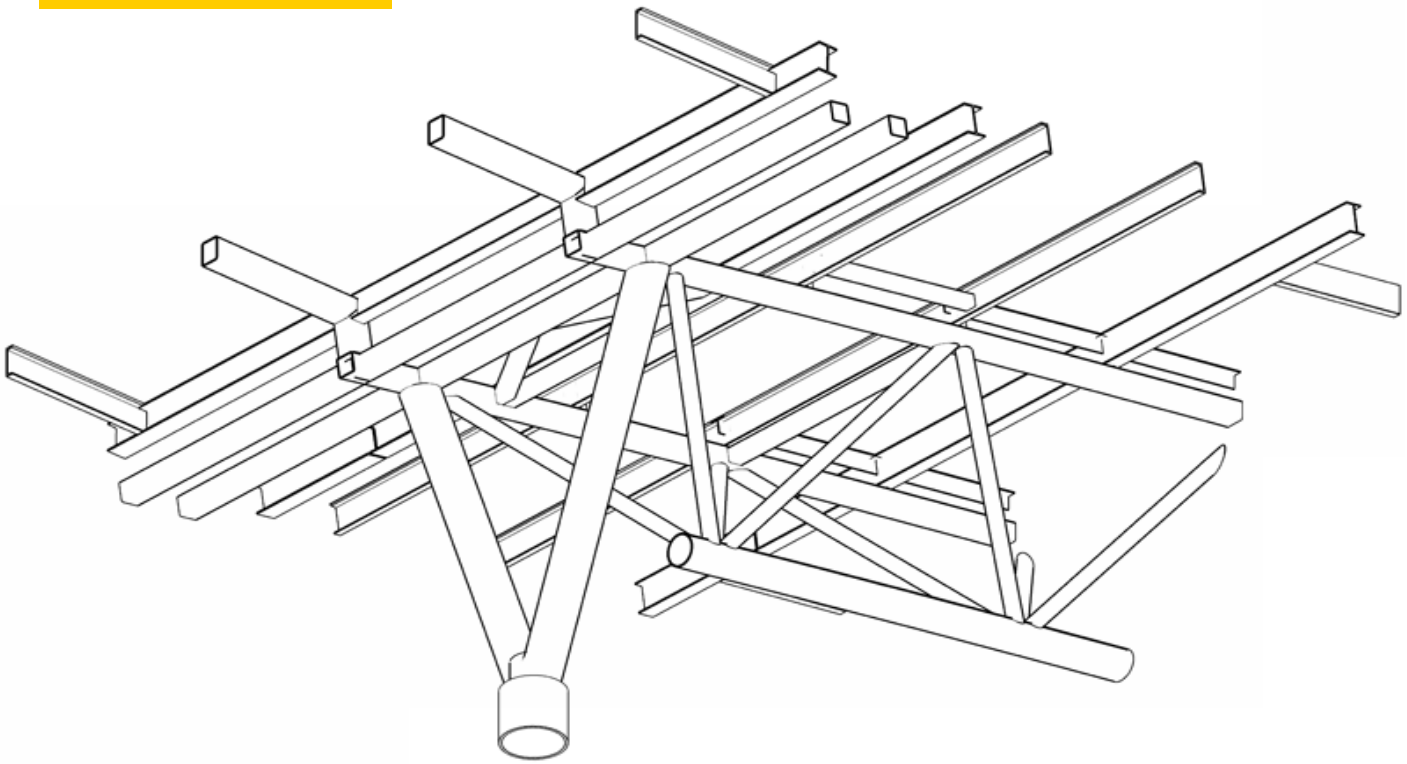
L = 58.0m
2 Splices

Image: RJC

Typical Truss

Width = 3.2m
Depth = 2.3 m

Top Chords – **RHS**
Bottom Chord and Web – **CHS**

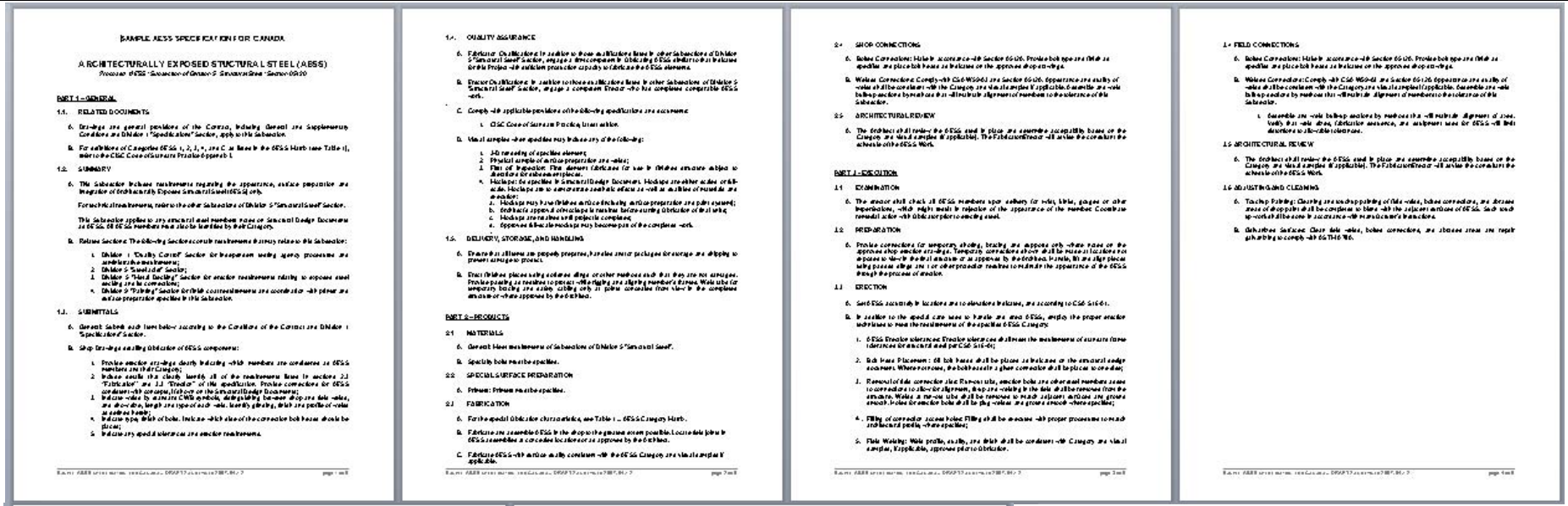


2
S11.21
ARRIVALS HALL TRUSS T-1 GRID 'AF'
SOUTHEAST VIEW

Image: RJC

Select AESS Categories associated to members or assemblies

Sample AESS Specification



SAMPLE AESS SPECIFICATION FOR CANADA

A RCHITECTURALLY EXPOSED STUCTURA L STEEL (AESS)

PART 1 – GENERAL

1.1. RELATED DOCUMENTS

1.2. SUMMARY

1.3. SUBMITTALS

1.4. QUALITY ASSURANCE

1.5. DELIVERY, STORAGE, AND HANDLING

2.1 MATERIALS

2.2 SPECIAL SURFACE PREPARATION

2.3 FABRICATION

2.4 SHOP CONNECTIONS

2.5 ARCHITECTURAL REVIEW

PART 3 – EXECUTION

3.1 EXAMINATION

3.2 PREPARATION

3.3 ERECTION

3.4 FIELD CONNECTIONS

3.5 ARCHITECTURAL REVIEW

3.6 ADJUSTING AND CLEANING

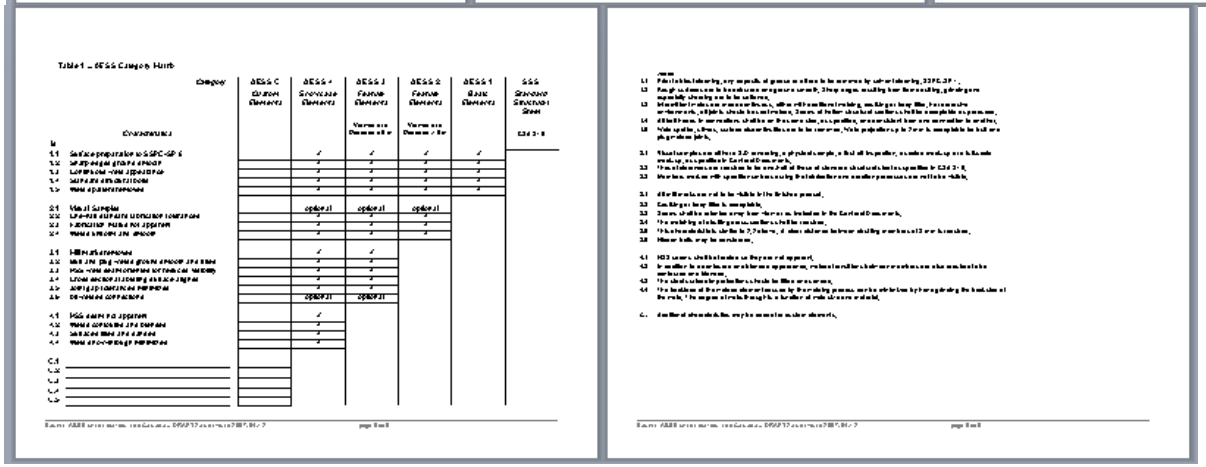


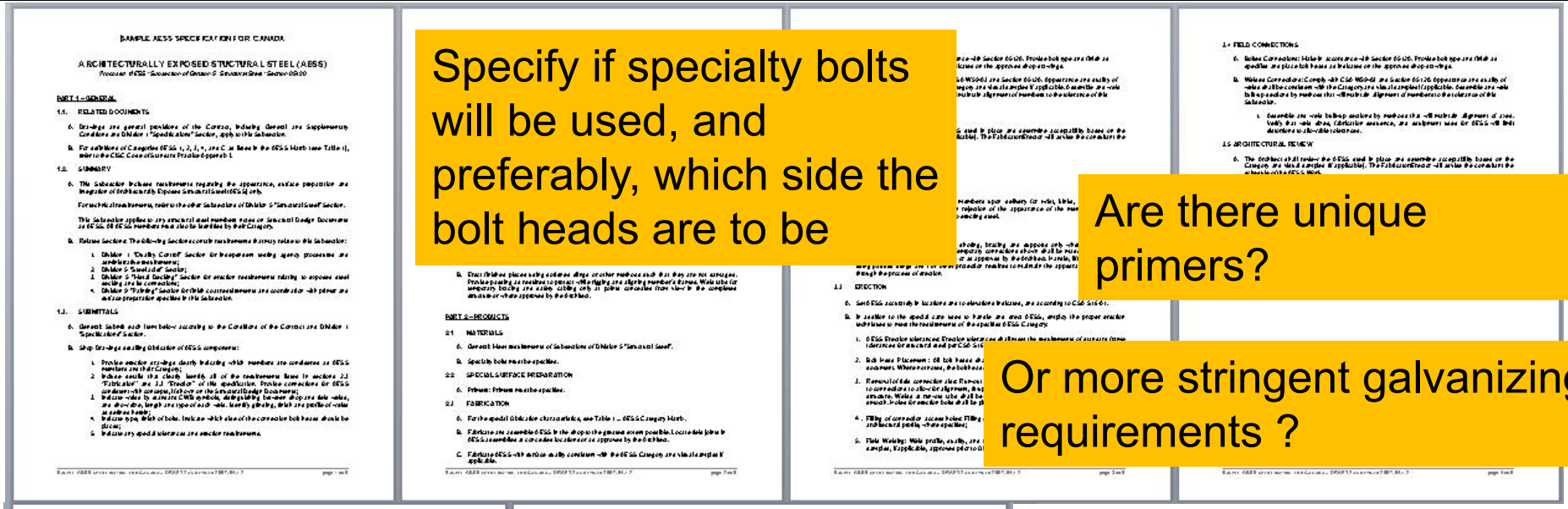
Table 1 – AESS Category Matrix

Characteristics	AESS C Custom Elements	AESS 4 Showcase Elements	AESS 3 Feature Elements	AESS 2 Feature Elements	AESS 1 Basic Elements	SSS Standard Structural Steel
1.1 Surface preparation to SSPC-SP 6		✓	✓	✓	✓	
1.2 Shop-applied prime coat		✓	✓	✓	✓	
1.3 Complete coat system		✓	✓	✓	✓	
1.4 Surface embedments		✓	✓	✓	✓	
1.5 Weld spatter removal		✓	✓	✓	✓	
2.1 Visual Samples		optional	optional	optional		
2.2 Low-rise curtain wall erection tolerances		✓	✓	✓		
2.3 Horizontal holes not allowed		✓	✓	✓		
2.4 Welds smooth and ground		✓	✓	✓		
3.1 Weld Soundness		✓	✓			
3.2 Weld ends ground smooth and flush		✓	✓			
3.3 Welds discontinuous for mechanical reasons		✓	✓			
3.4 Weld access holes ground smooth		✓	✓			
3.5 Weld splices in flanges		✓	✓			
3.6 Bolted connections		optional	optional			
4.1 Weld seam for appearance		✓				
4.2 Welds concave and ground		✓				
4.3 Splices filled and ground		✓				
4.4 Weld stop-design members		✓				
C.1 _____						
C.2 _____						
C.3 _____						
C.4 _____						
C.5 _____						

Subdvision in Structural Steel Division of Engineer's Specification

Select AESS Categories associated to members or assemblies

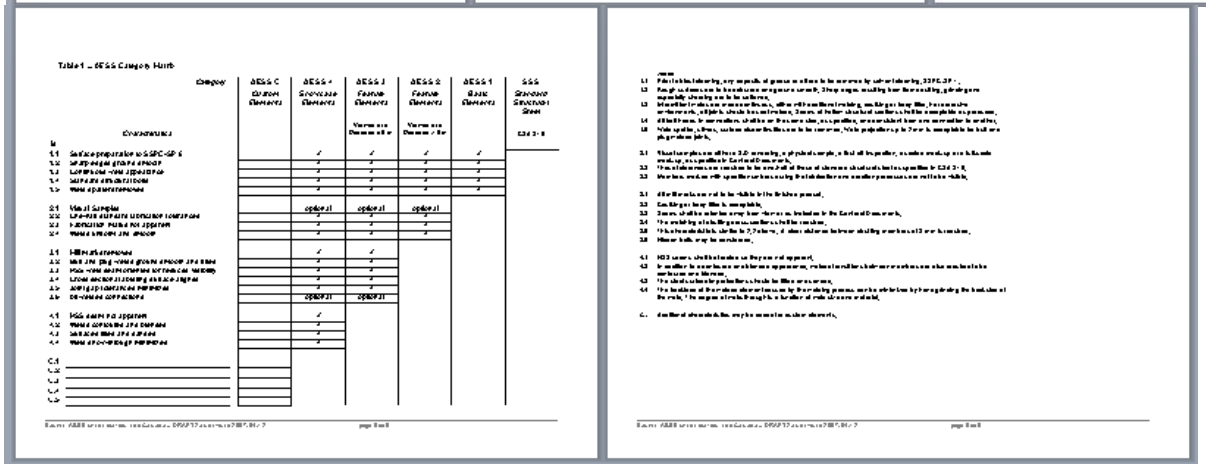
Sample AESS Specification



Specify if specialty bolts will be used, and preferably, which side the bolt heads are to be

Are there unique primers?

Or more stringent galvanizing requirements ?



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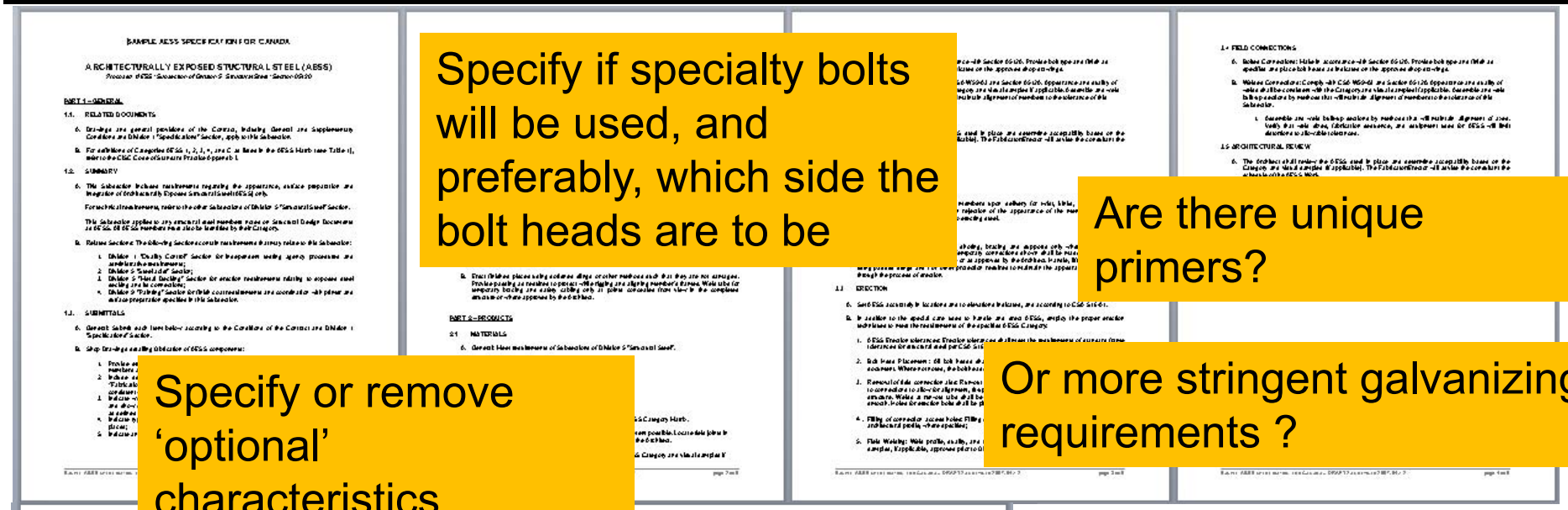
Sample AESS Specification

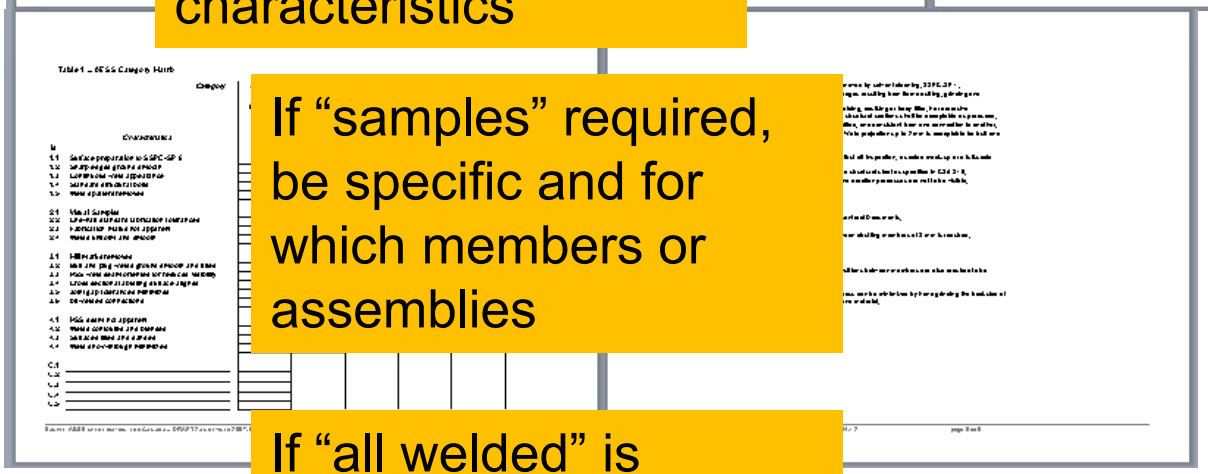


Specify if specialty bolts will be used, and preferably, which side the bolt heads are to be

Are there unique primers?

Specify or remove ‘optional’ characteristics

Or more stringent galvanizing requirements ?



If “samples” required, be specific and for which members or assemblies

If “all welded” is chosen …. negotiate!

Subdvision in Structural Steel Division of Engineer’s Specification

Select AESS Categories associated to members or assemblies

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 Terminal Piers	Columns	AESS 3
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

Select AESS Categories associated to members or assemblies

Sample AESS2 / AESS3 Table

Contract Area(s)	Element (Members and Associated Connections)	AESS Category (Refer to TABLE 1)
Hotel Terminal	Canopies	-
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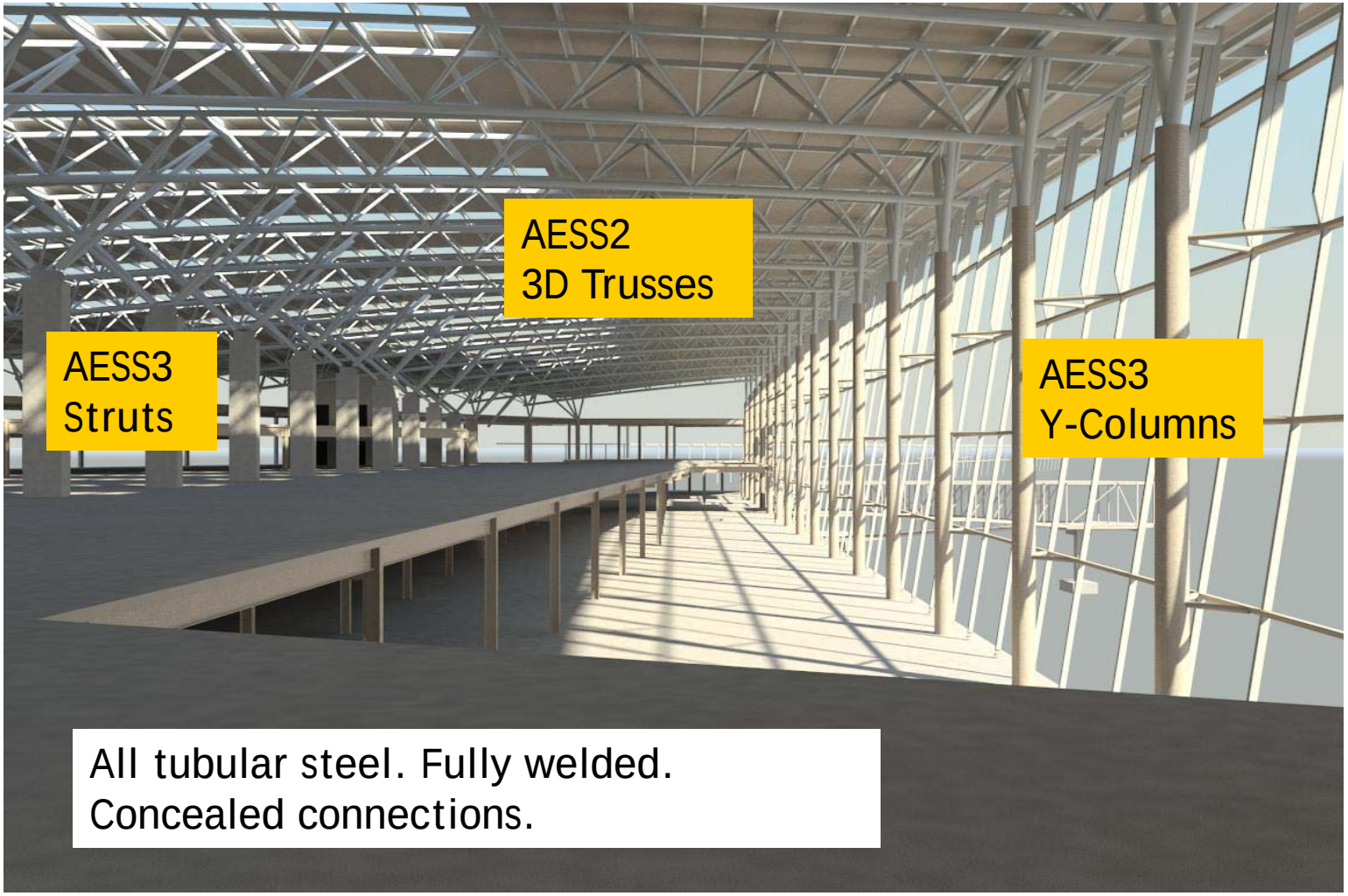
Hotel Terminal Piers	Columns	AESS 3
Hotel Terminal Piers	Column Struts to Glazing	AESS 3
Terminal	Column Struts to Trusses	AESS 3
Terminal	Roof Trusses	AESS 2
Hotel Terminal	Braces	AESS 3
Hotel Terminal Piers	Moment Frames	AESS 2

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.

Calgary Airport Assemblies
Mockup at Supermétal Plant

Avoiding confusion

Labels help during fabrication and erection

When a Mockup is required ...

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

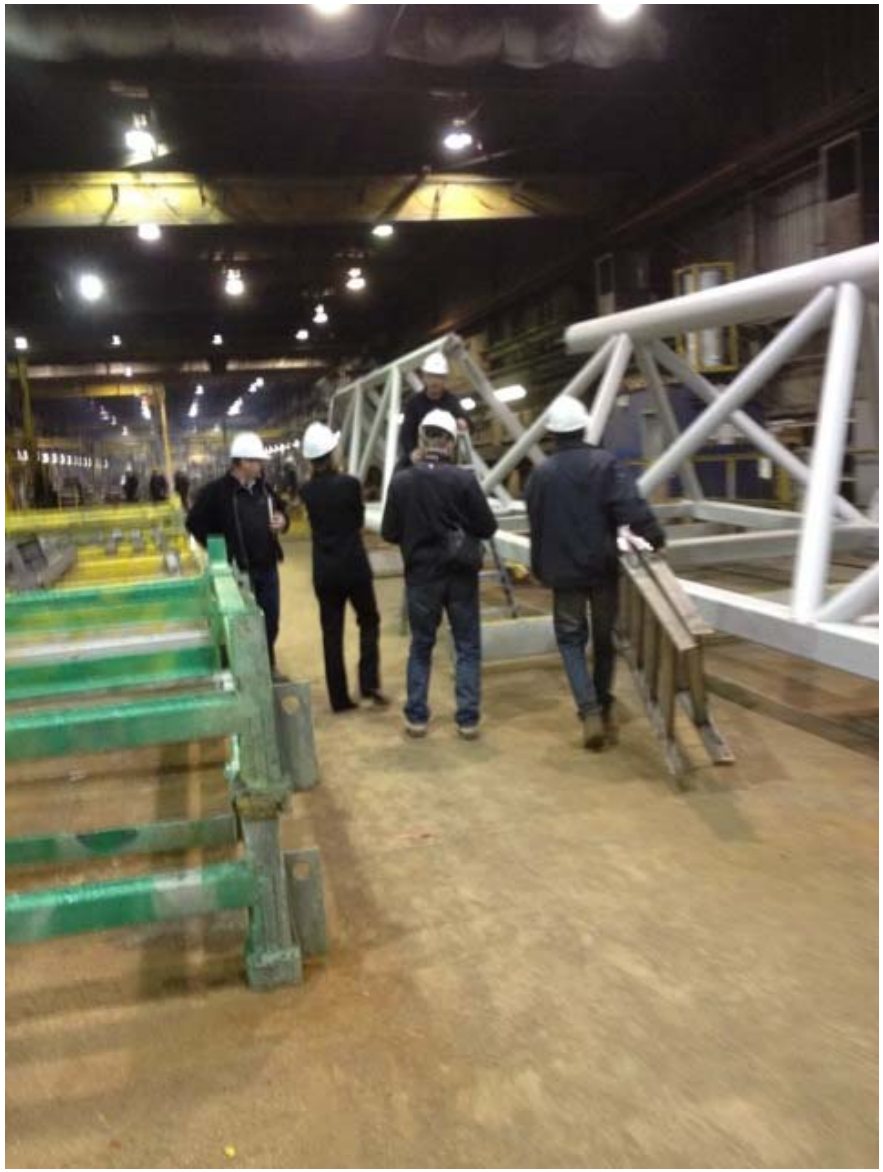
- Distance
- Position
- Lighting

When a Mockup is required …

When a Mockup is required …

Photos: Sylvie Boulanger, Supermétal

Replicating the view angle



Member sizes and alignment issues

- It is critical to understand the physical ‘size’ of the weld when choosing member sizes.
- Must allow for the weld.

Alignment issues

From square to round hollow section

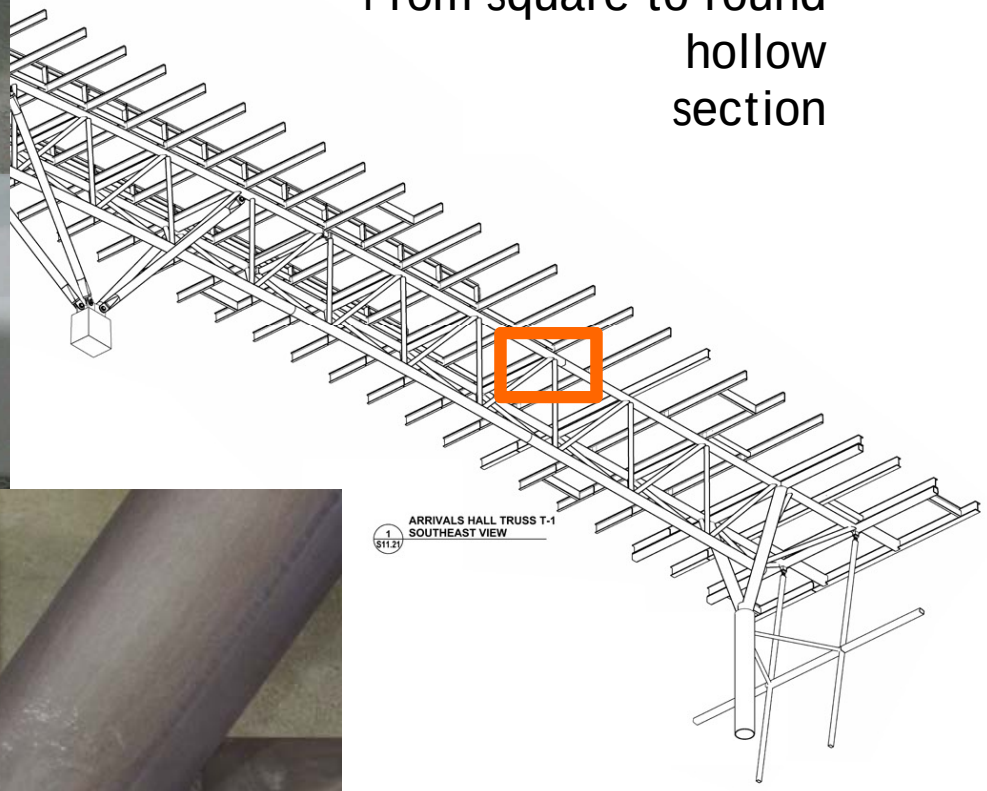
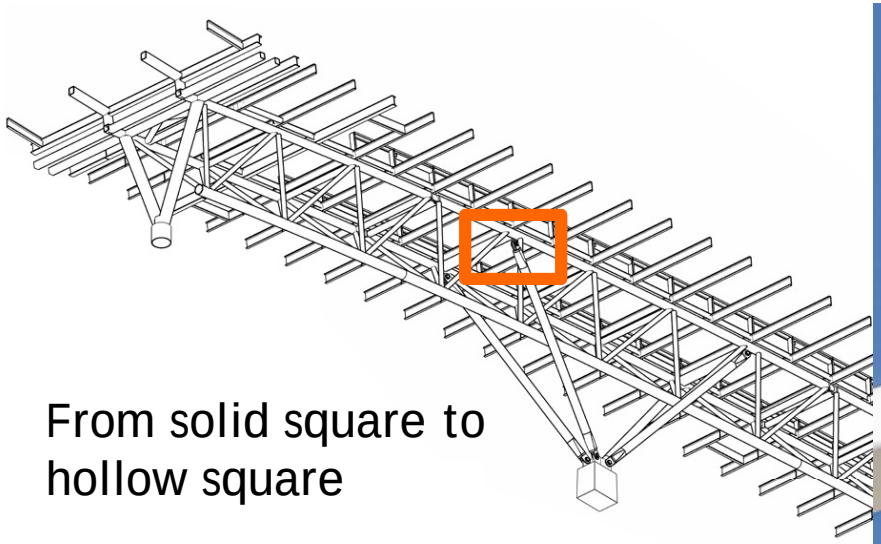


Image: RJC

Alignment issues



From solid square to hollow square

Image: RJC

Hidden splices

Hiding bolted splice with steel sleeves

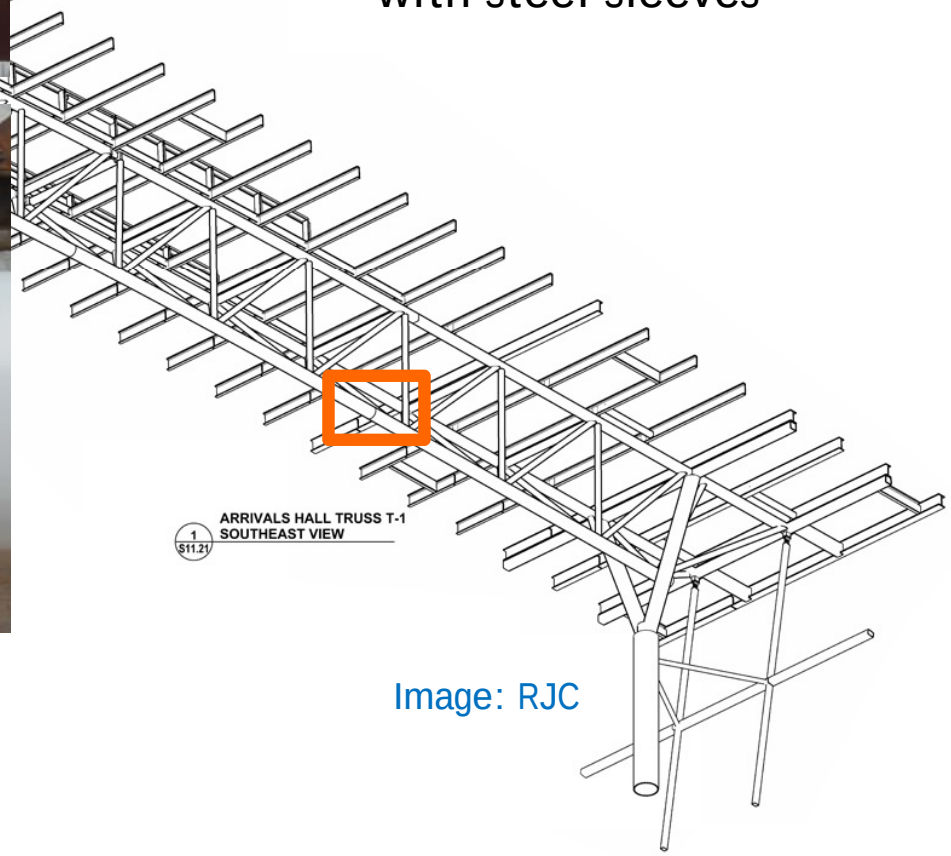
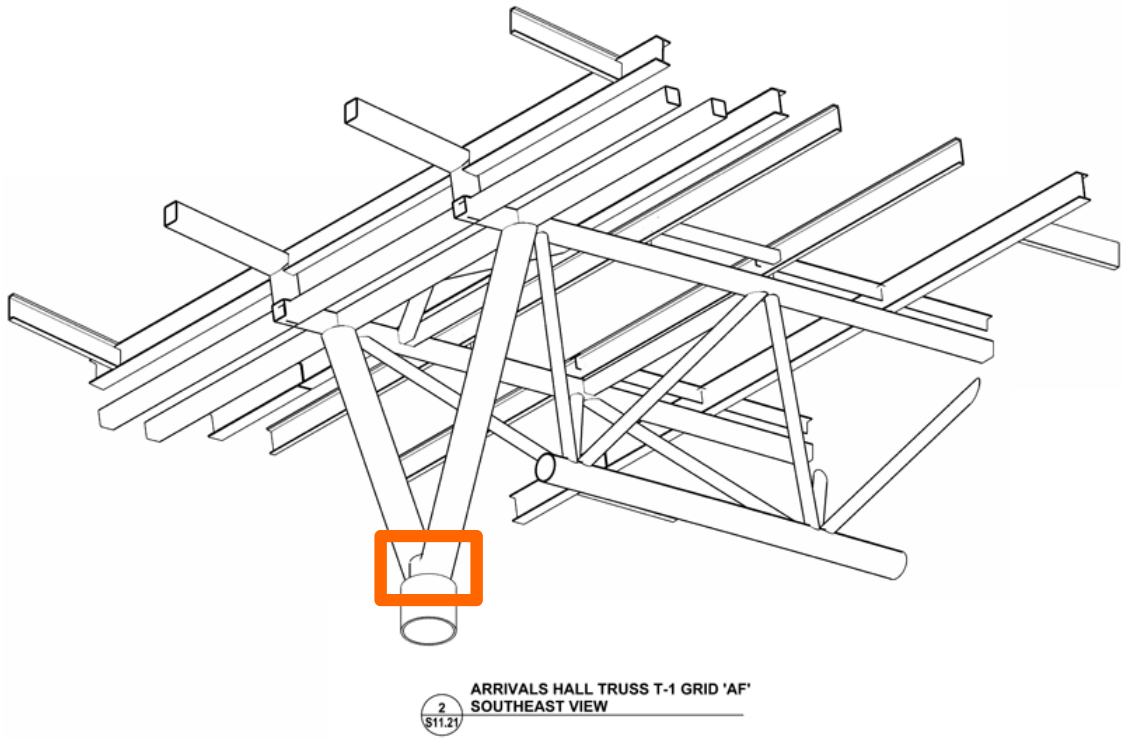


Image: RJC

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 tube or inside tube…

Care in transportation and handling

- AESS is normally shop painted
- Must be well protected during transport
- Use padded slings and supports

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

Truss is AESS2

Struts and columns are AESS3

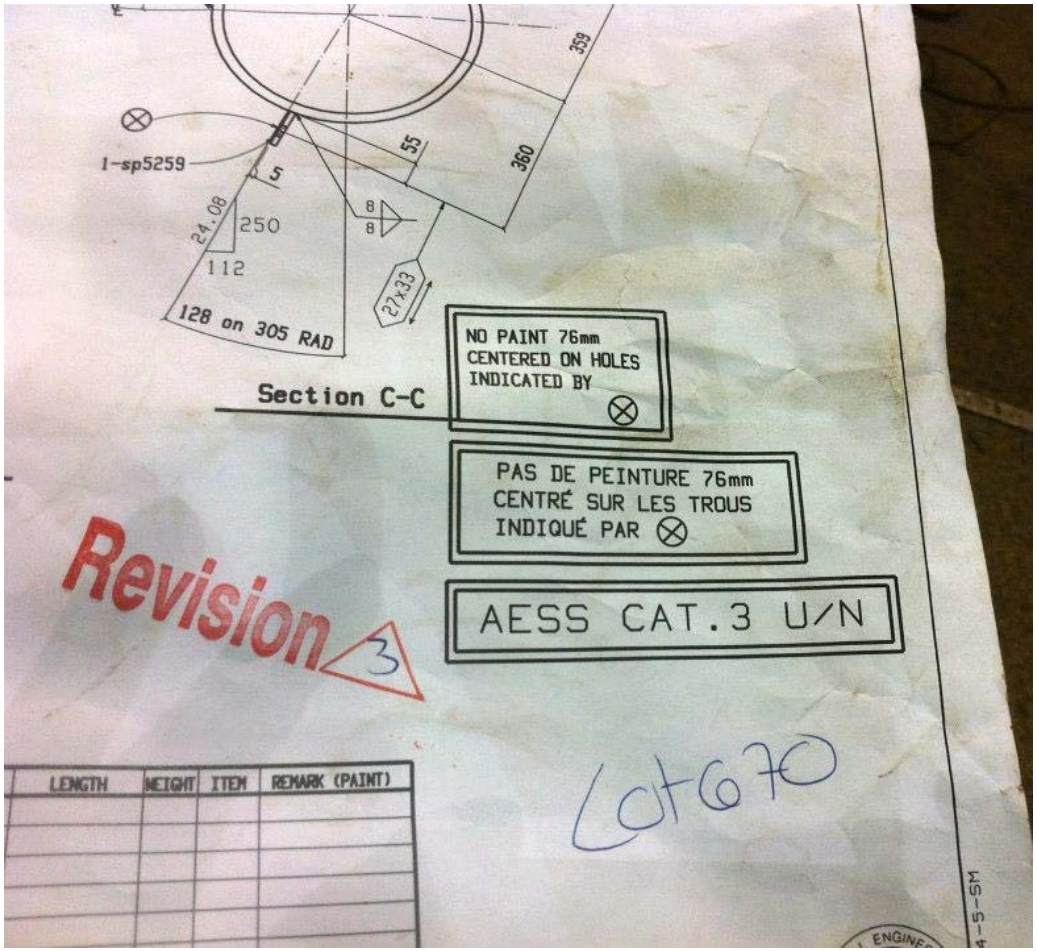
Overall progress

Construction proceeds

Lessons Learned

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

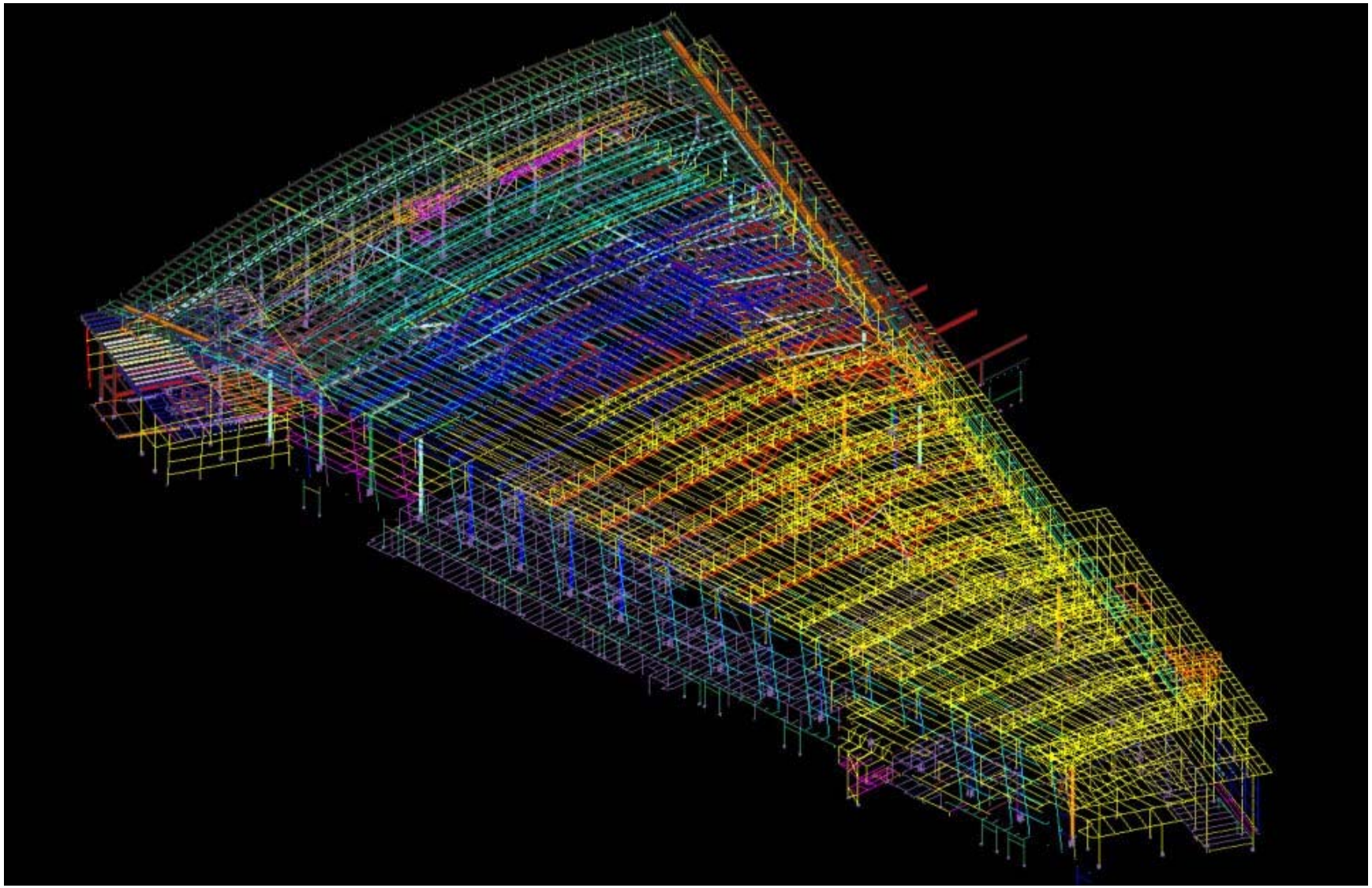
- Smooth weld still subject to interpretation
- Identical vs equivalent reproduction
- Inspection consistency



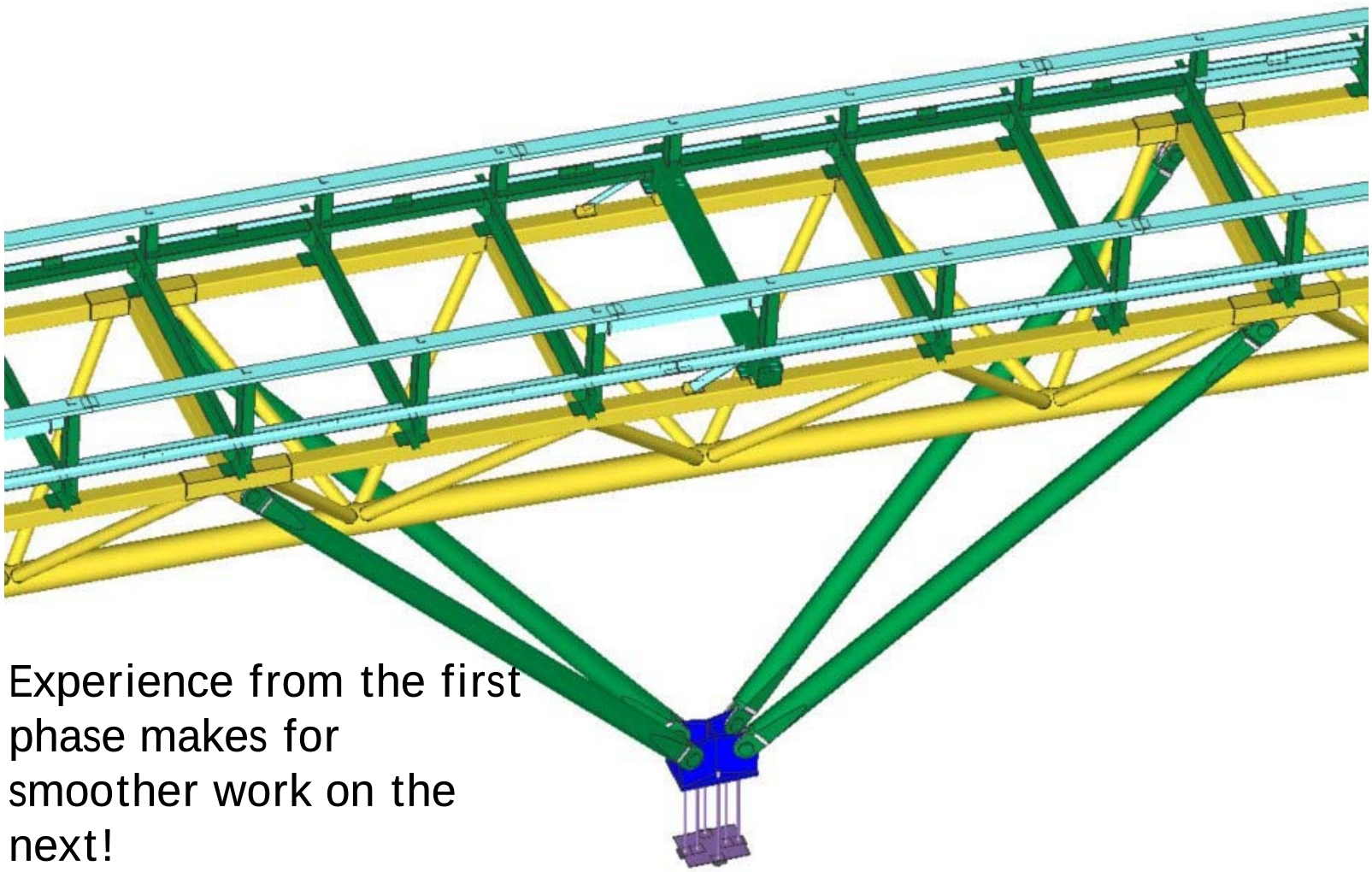
Next phase!

Image: DIALOG

Overall structural drawing



Detail



Experience from the first phase makes for smoother work on the next!

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

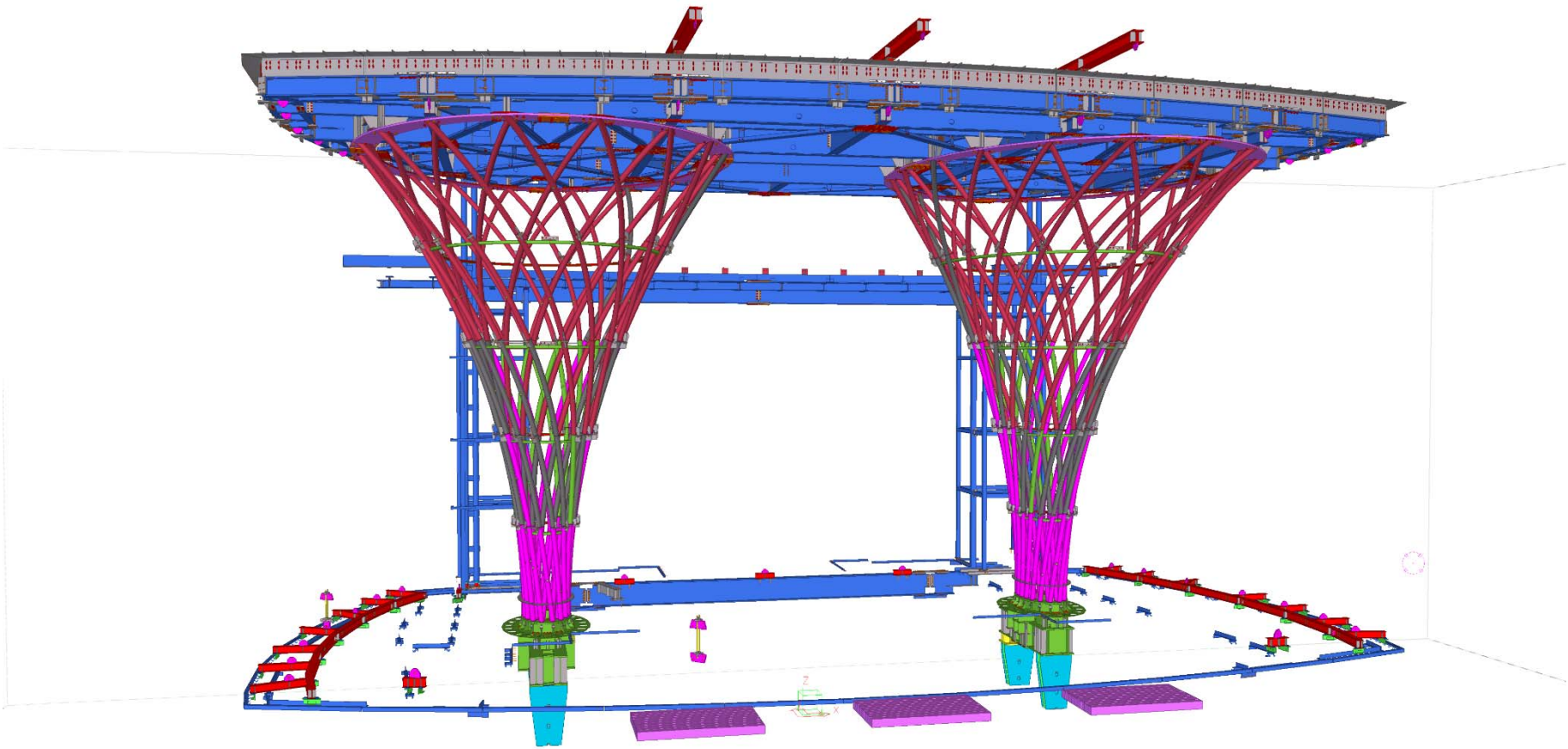
Project Profile

WORLD FINANCIAL CENTRE ENTRY PAVILION
New York City, New York

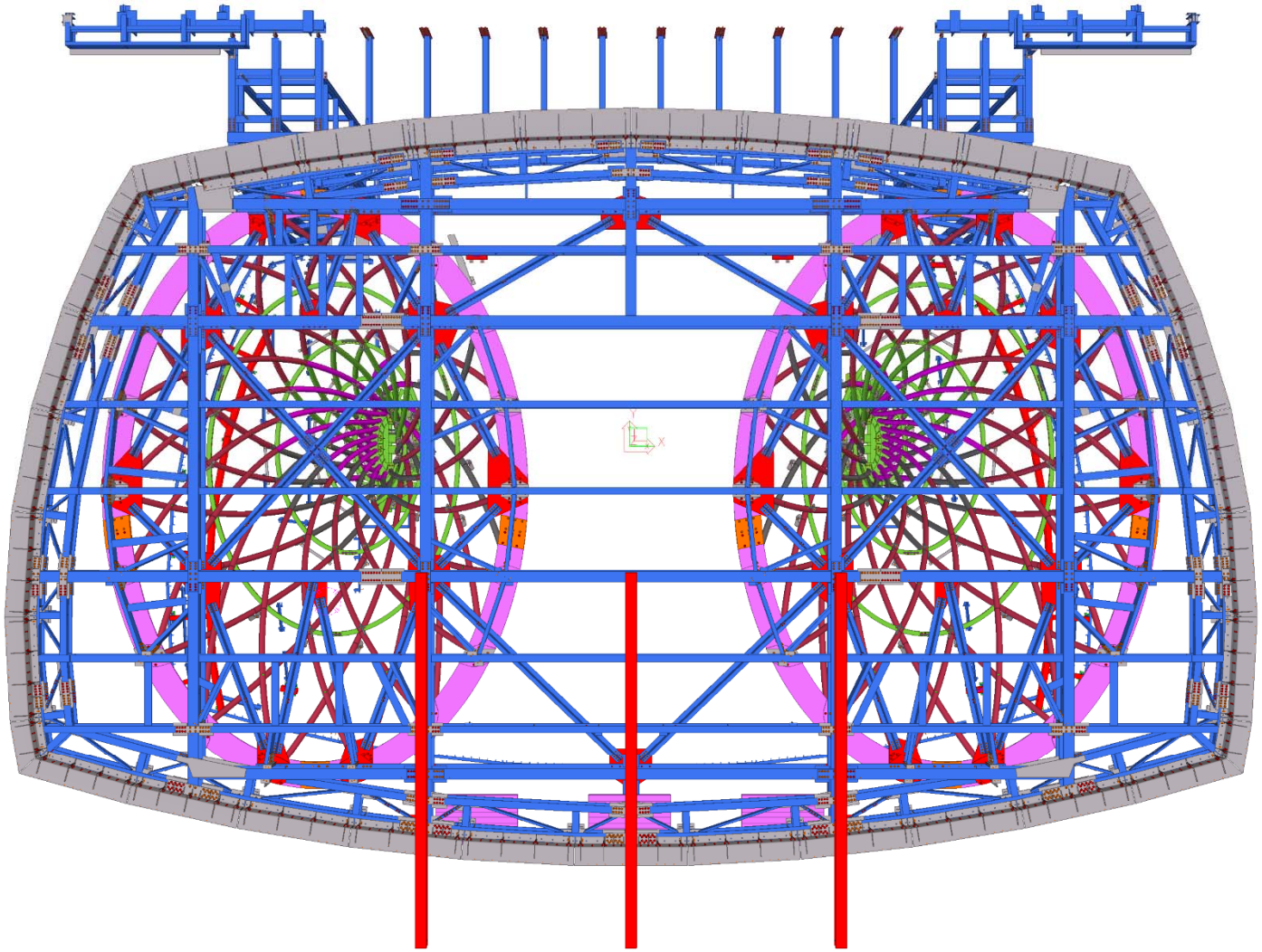
Site access courtesy: Walters Inc.

The Architect's Concept

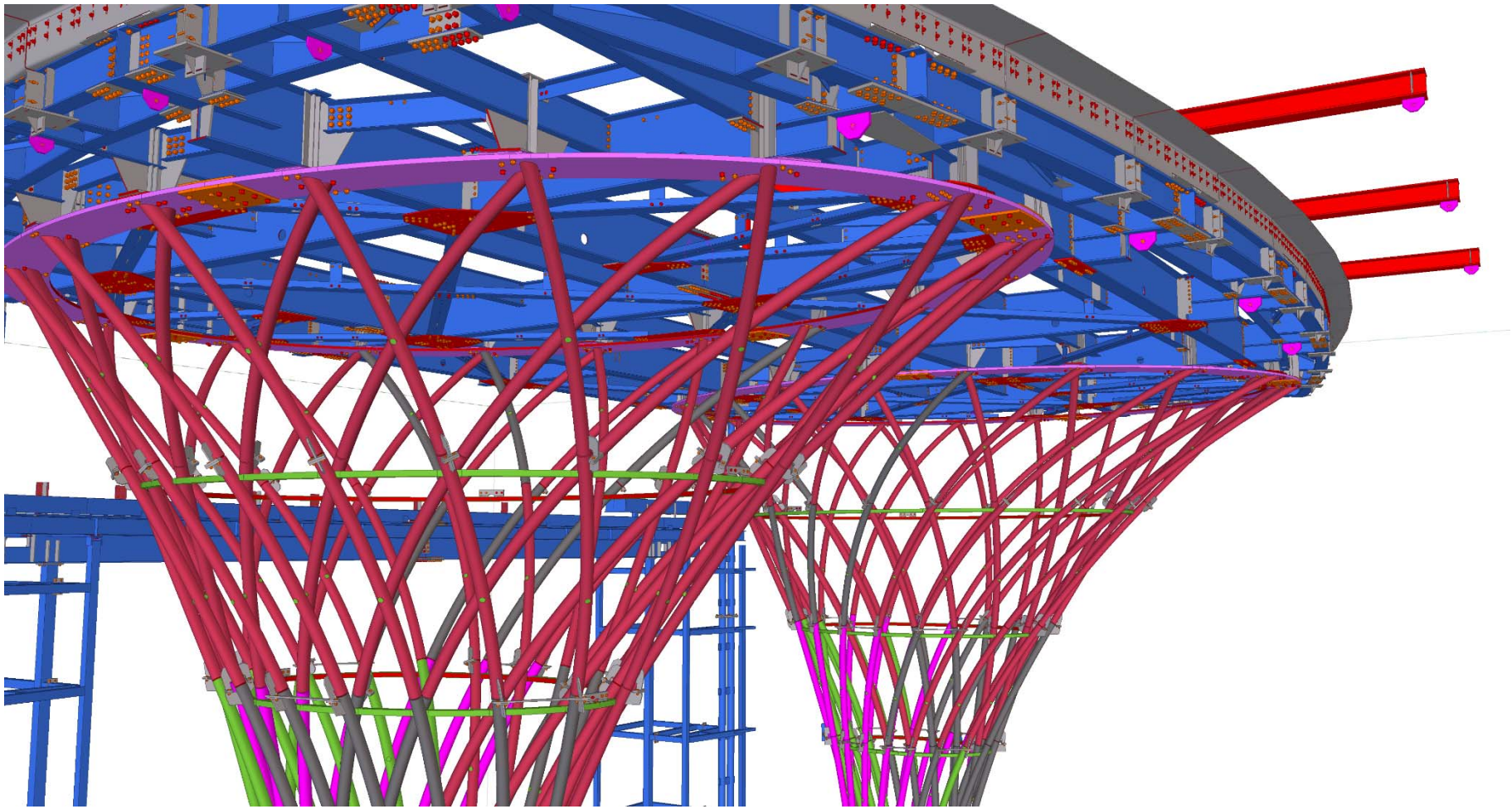
Complex steel uses digital methods



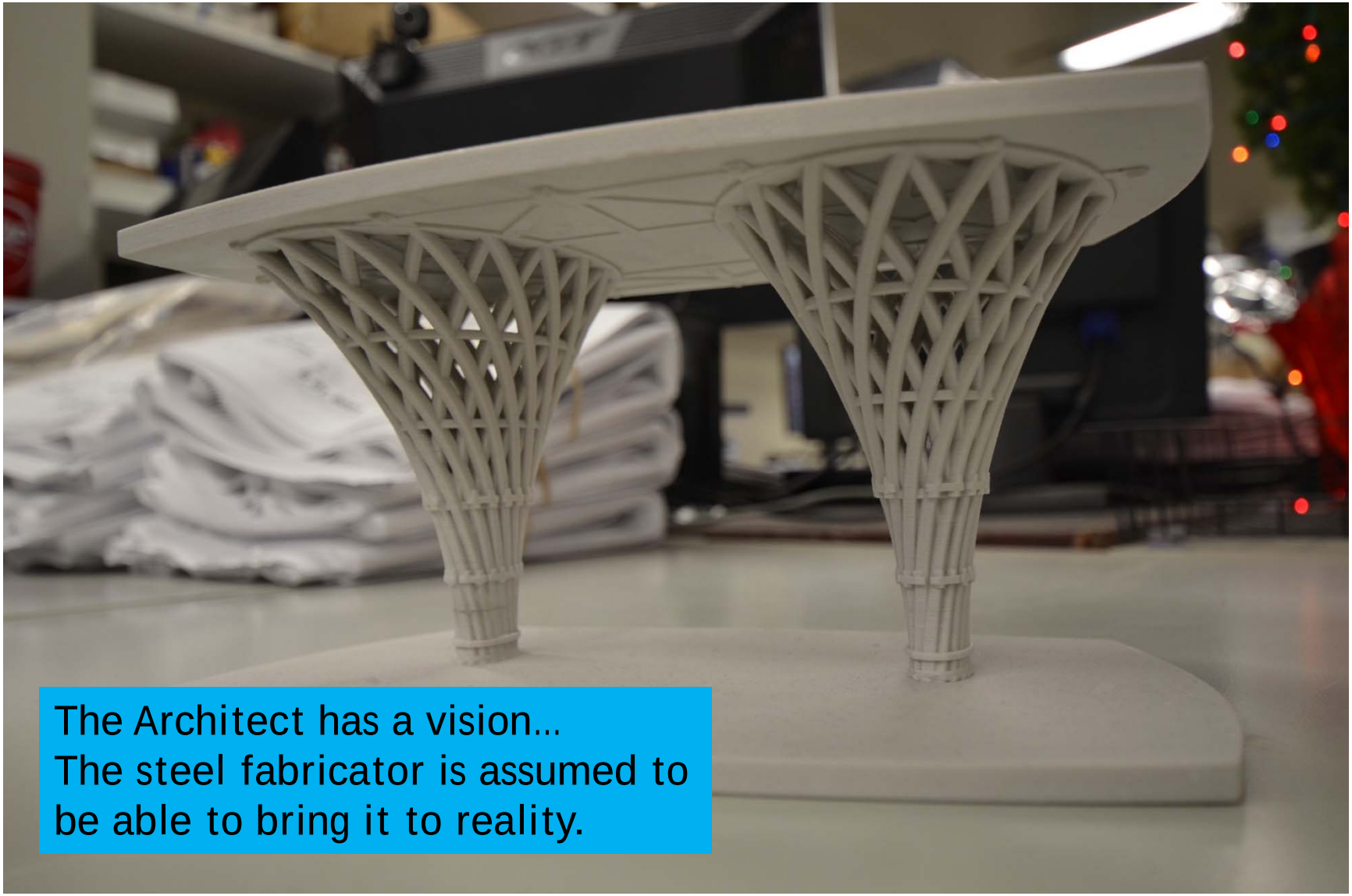
Top view of plan



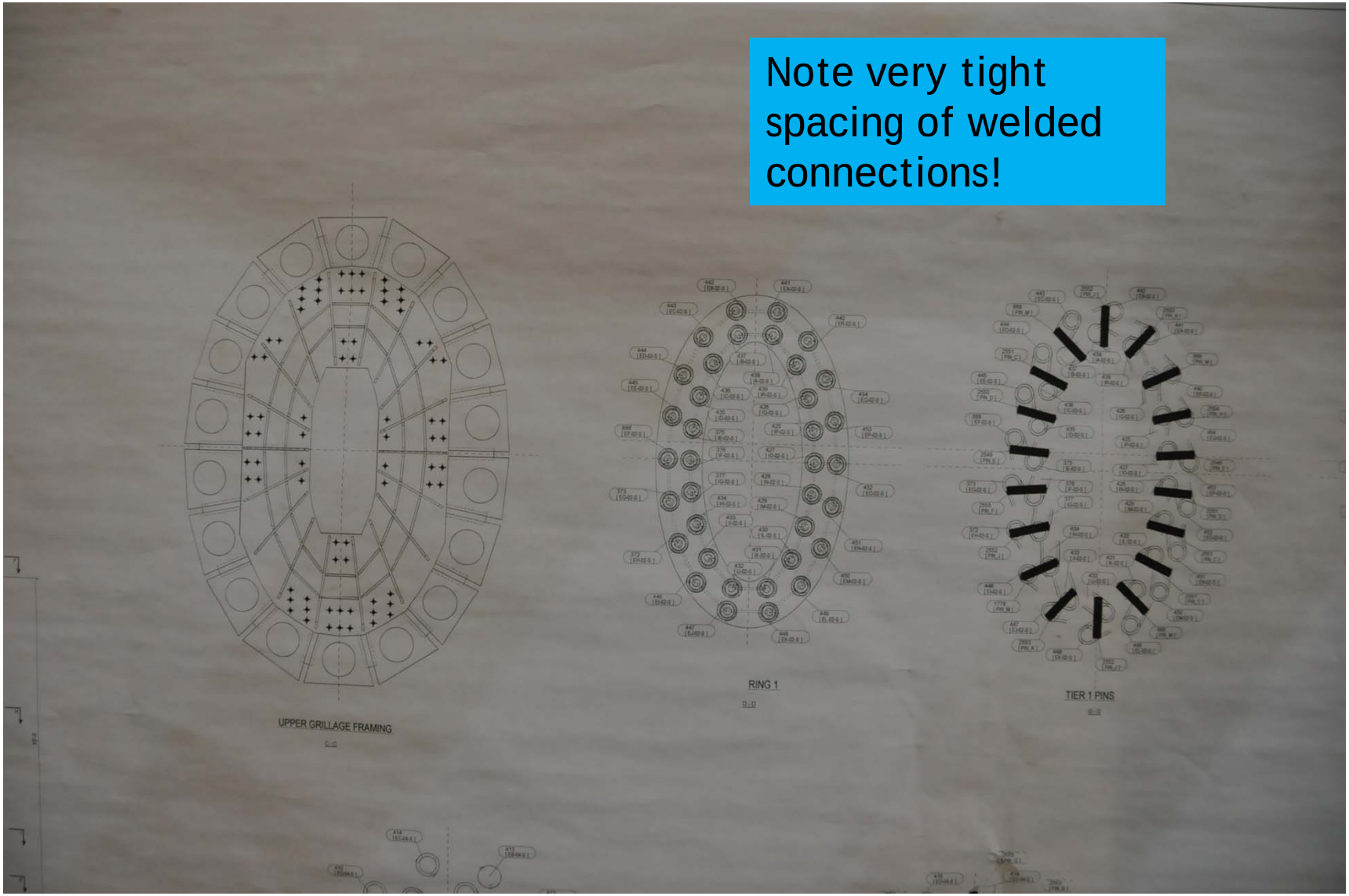
Detailed view



The 3D Model


The Architect has a vision…
The steel fabricator is assumed to be able to bring it to reality.

Planimetric drawings



Setting the jigs

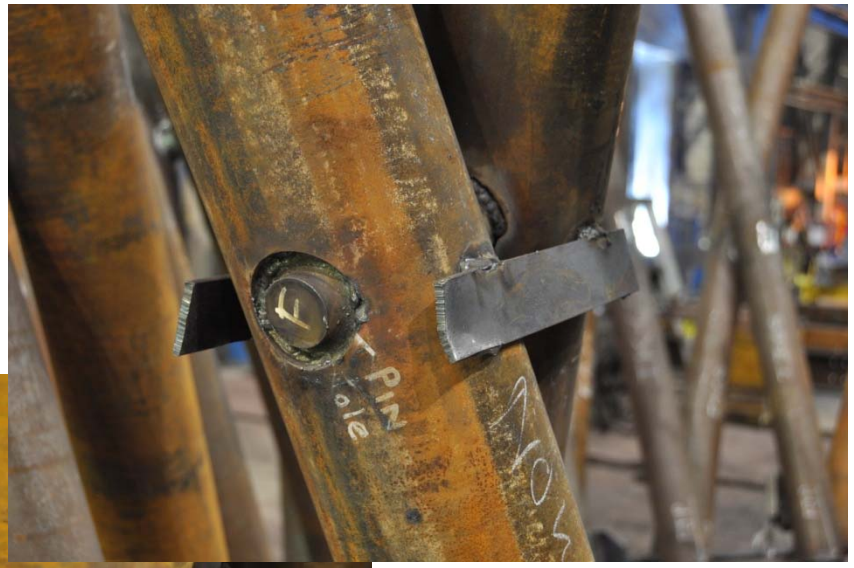
- Two “baskets”
- 5 tiers each
- Fully welded AESS4
- Understand truck limitations
- Minimize site connections
- Transport to NYC from Hamilton

Maximizing the fabrication in shop

Curved tubular steel

Issues with matching connecting curved pieces for seamless welded connections.

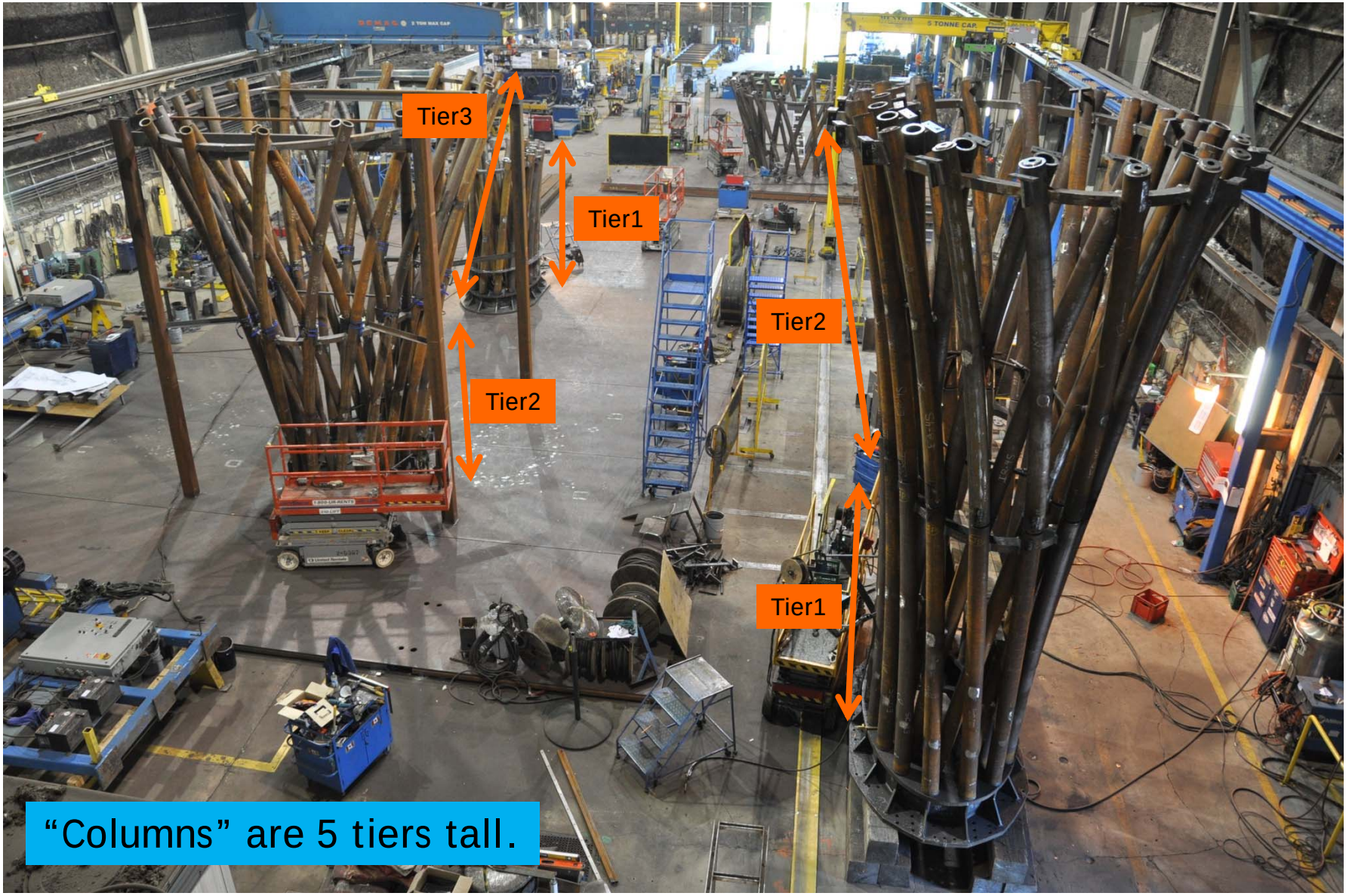
Solid connecting steel rods



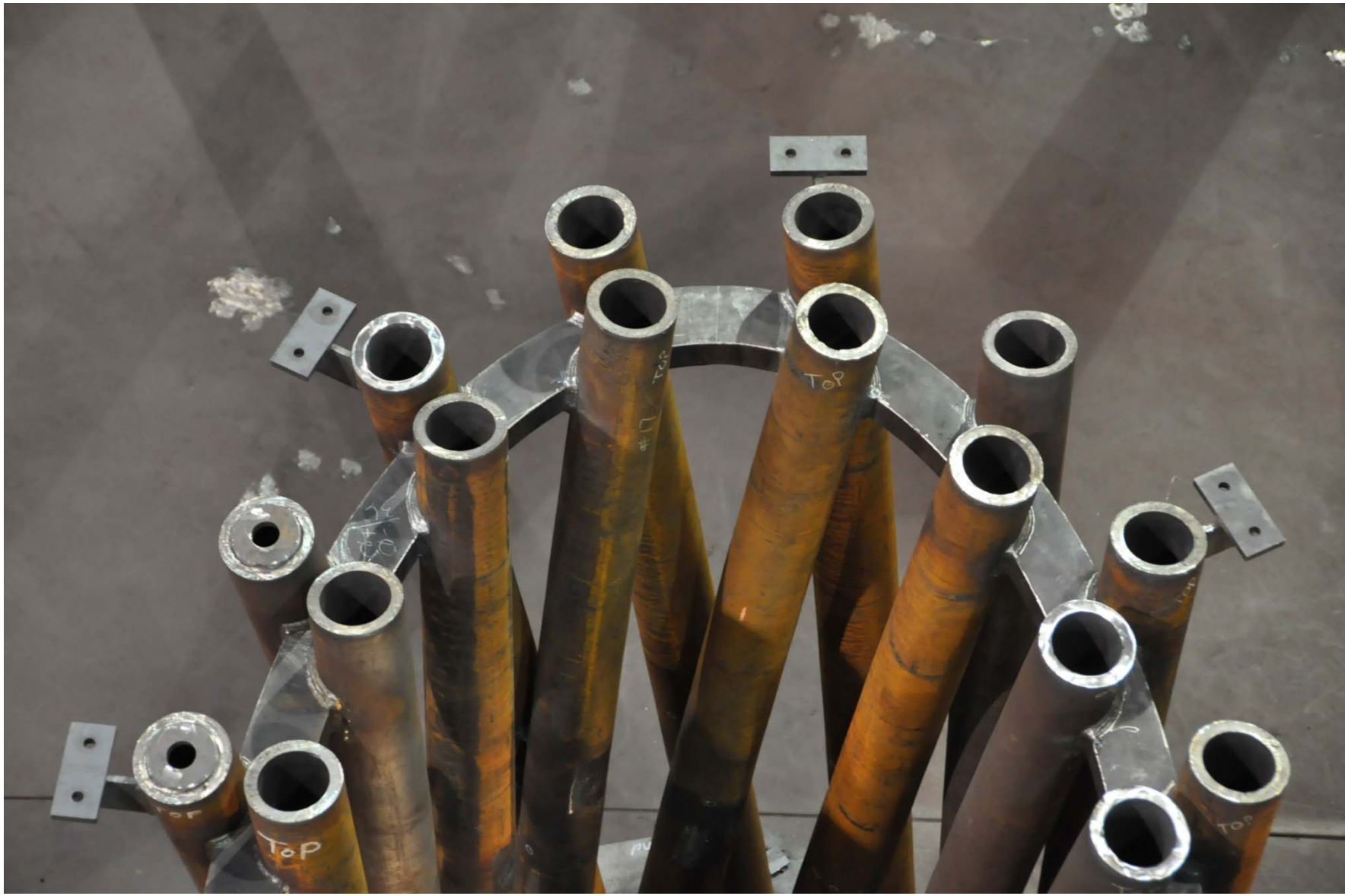
For AESS4 these connections must be ground and filled and
'made to disappear'

Curves, overlaps and geometry

Shop space and pre-fitting



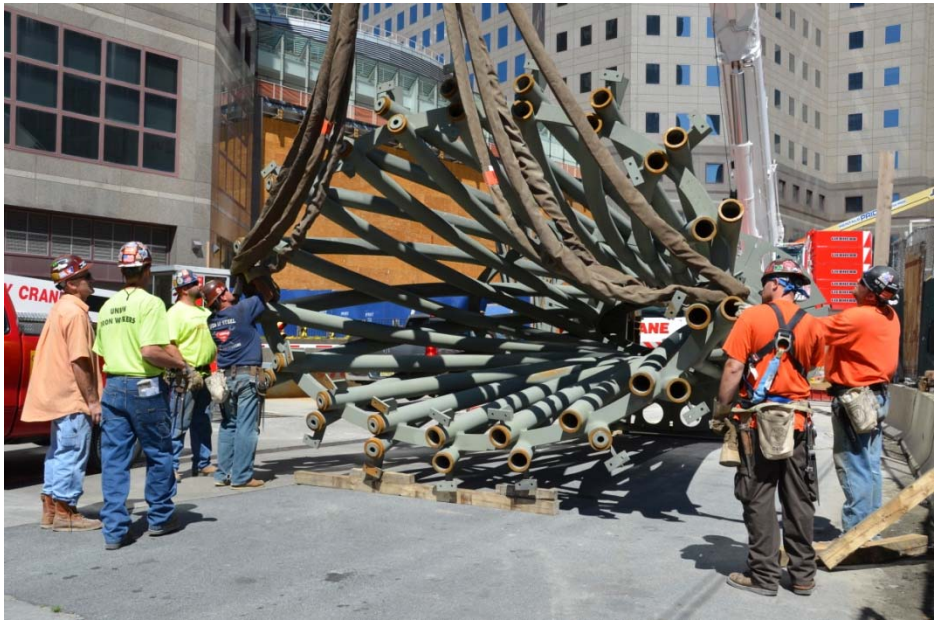
Aligning future site connections



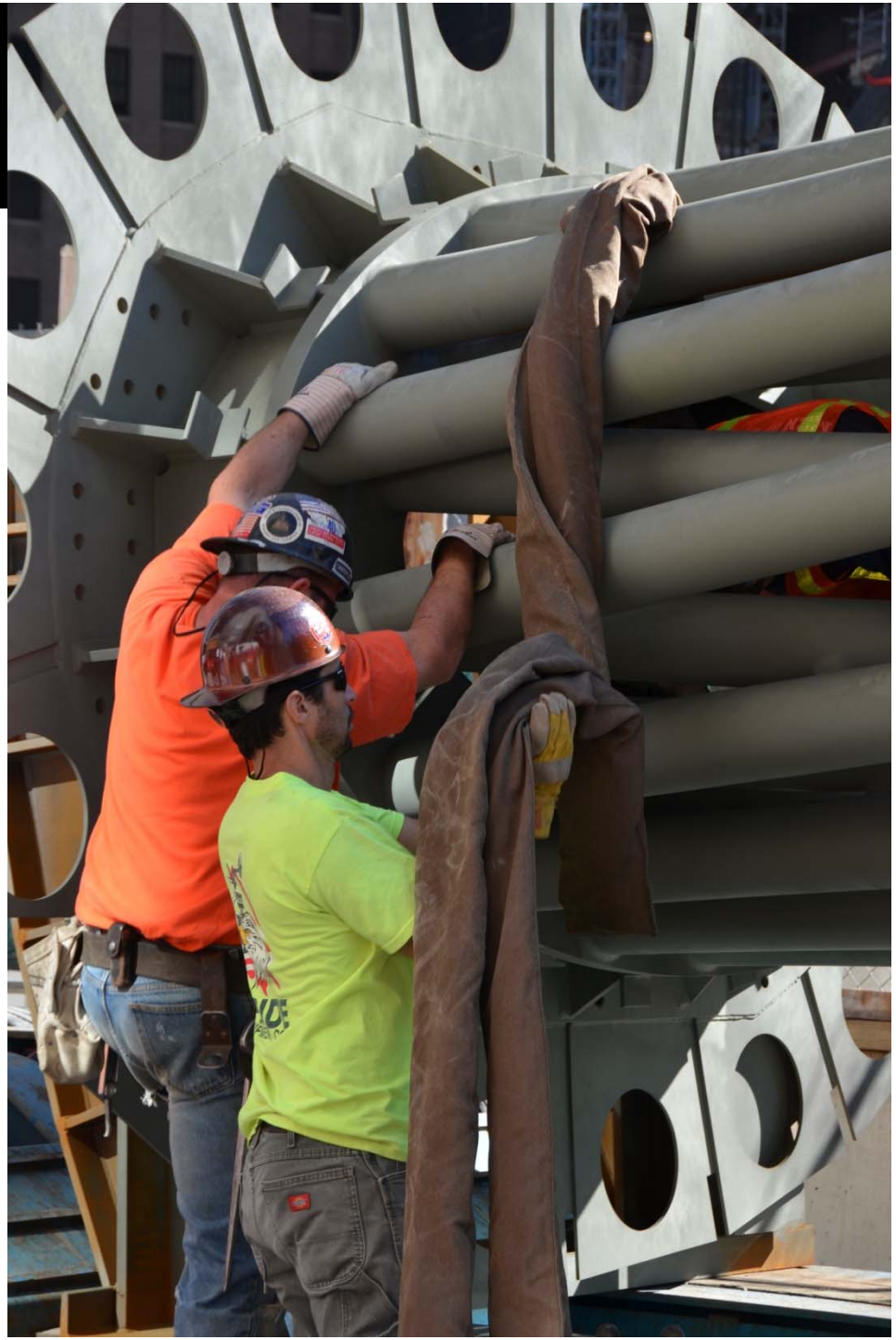
Why shop weld?

Transportation

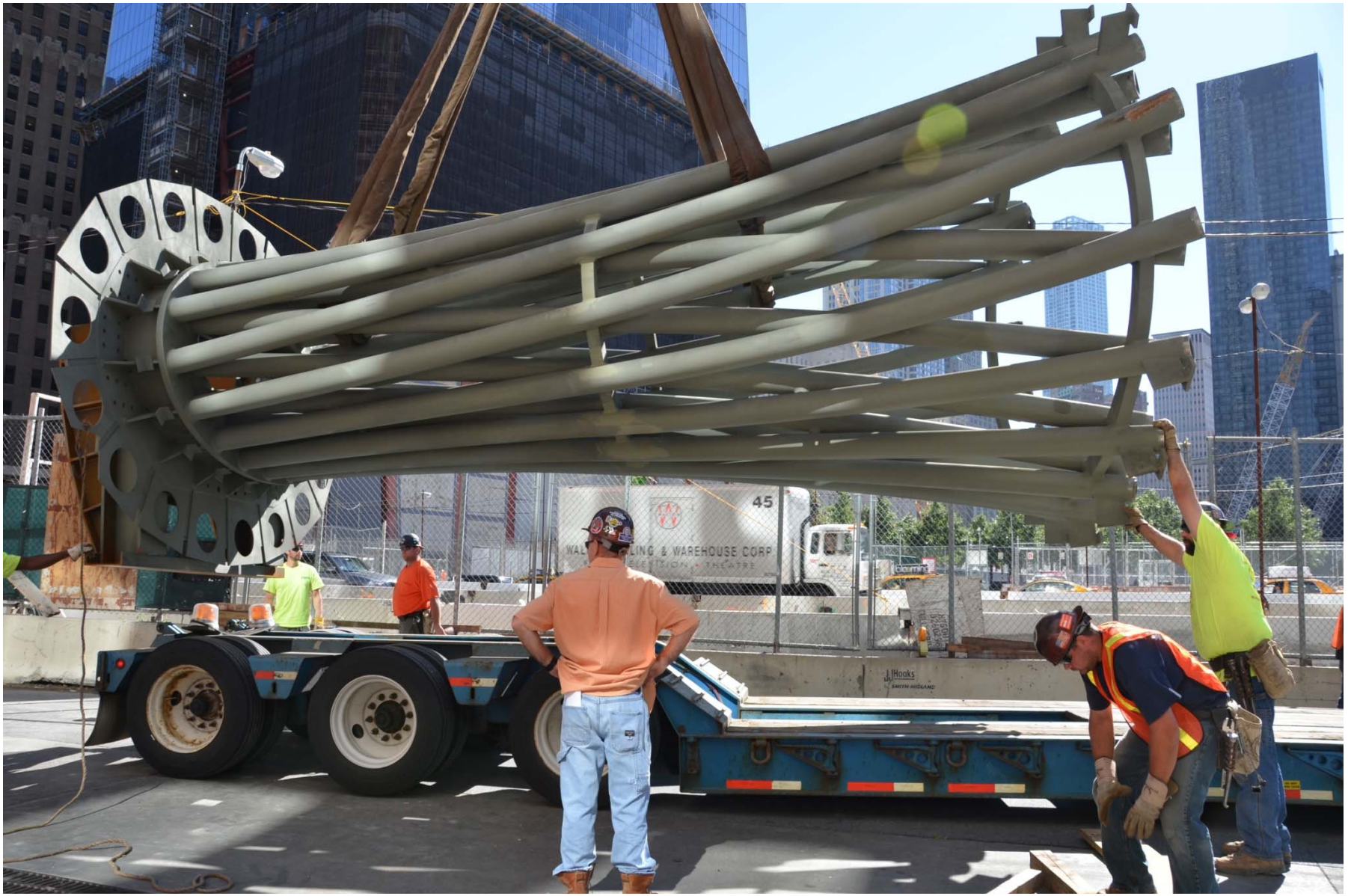
Handle with care



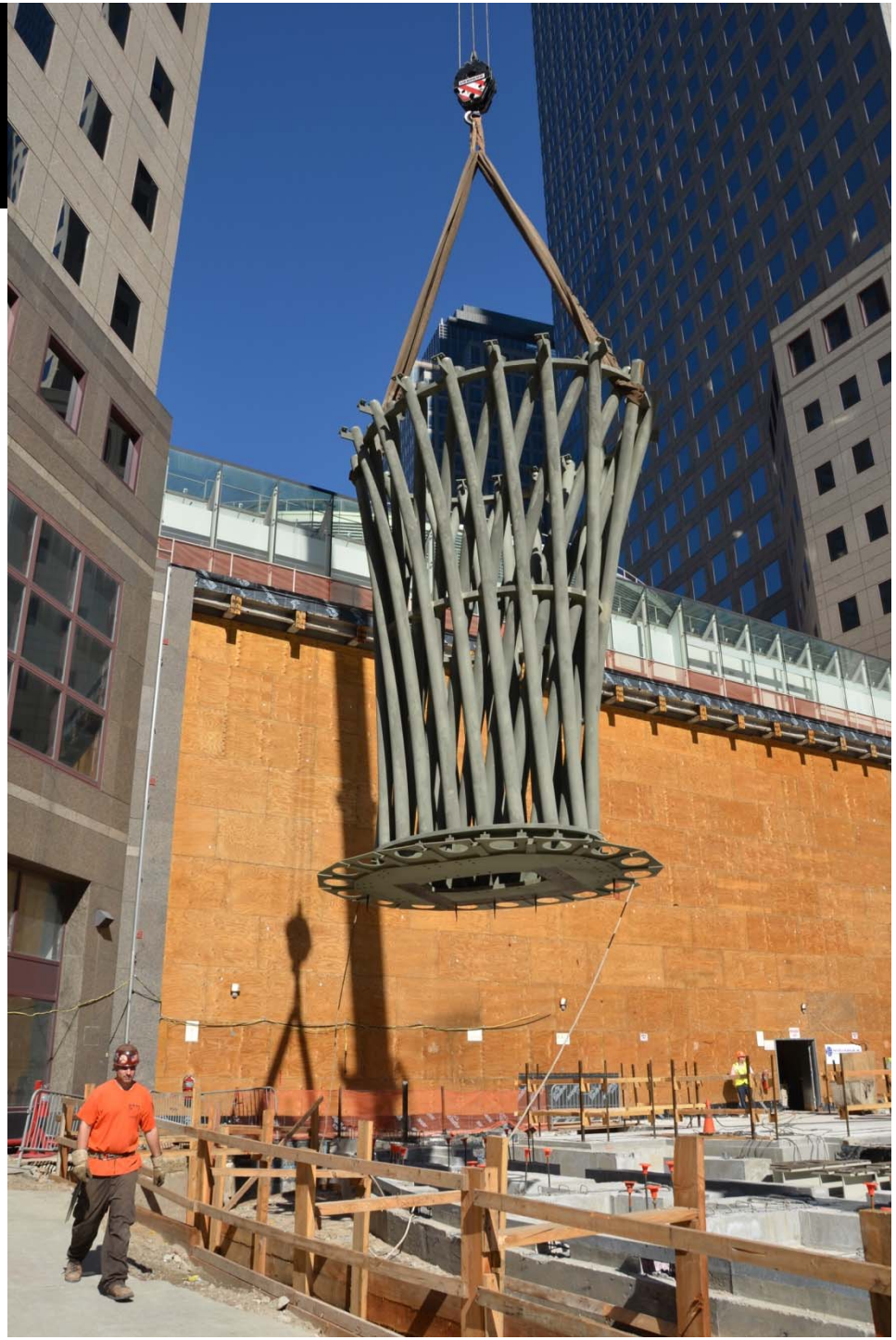
- Erection crew different from fabrication crew
- Lifting odd shapes difficult
- Steel is primed
- Surfaces must not be damaged



Lift off of the truck



Lift into place

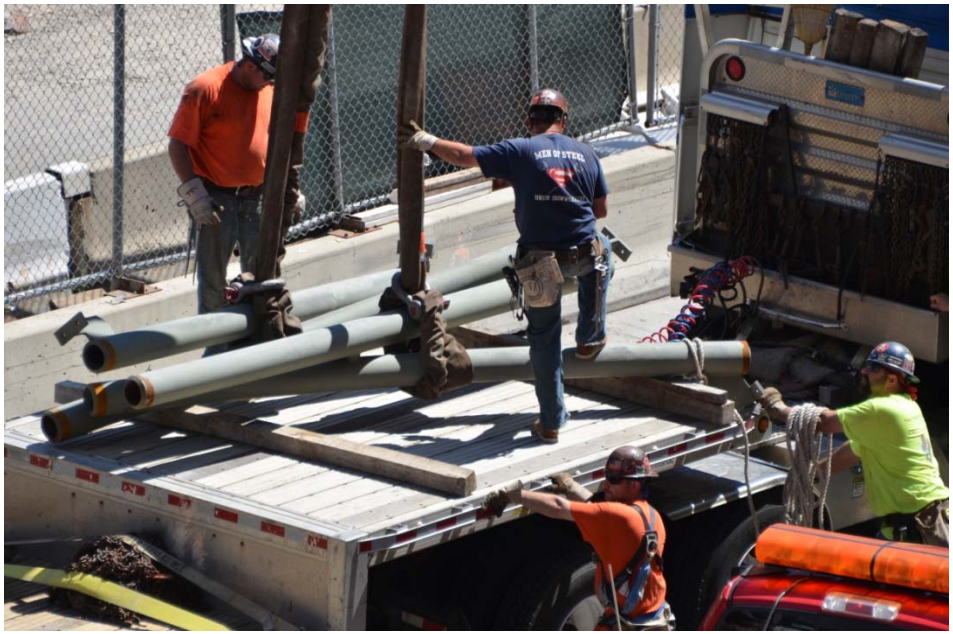


- Site preparations must be accurate
- AESS requires precision
- Plumb element
- Remember this is structural steel

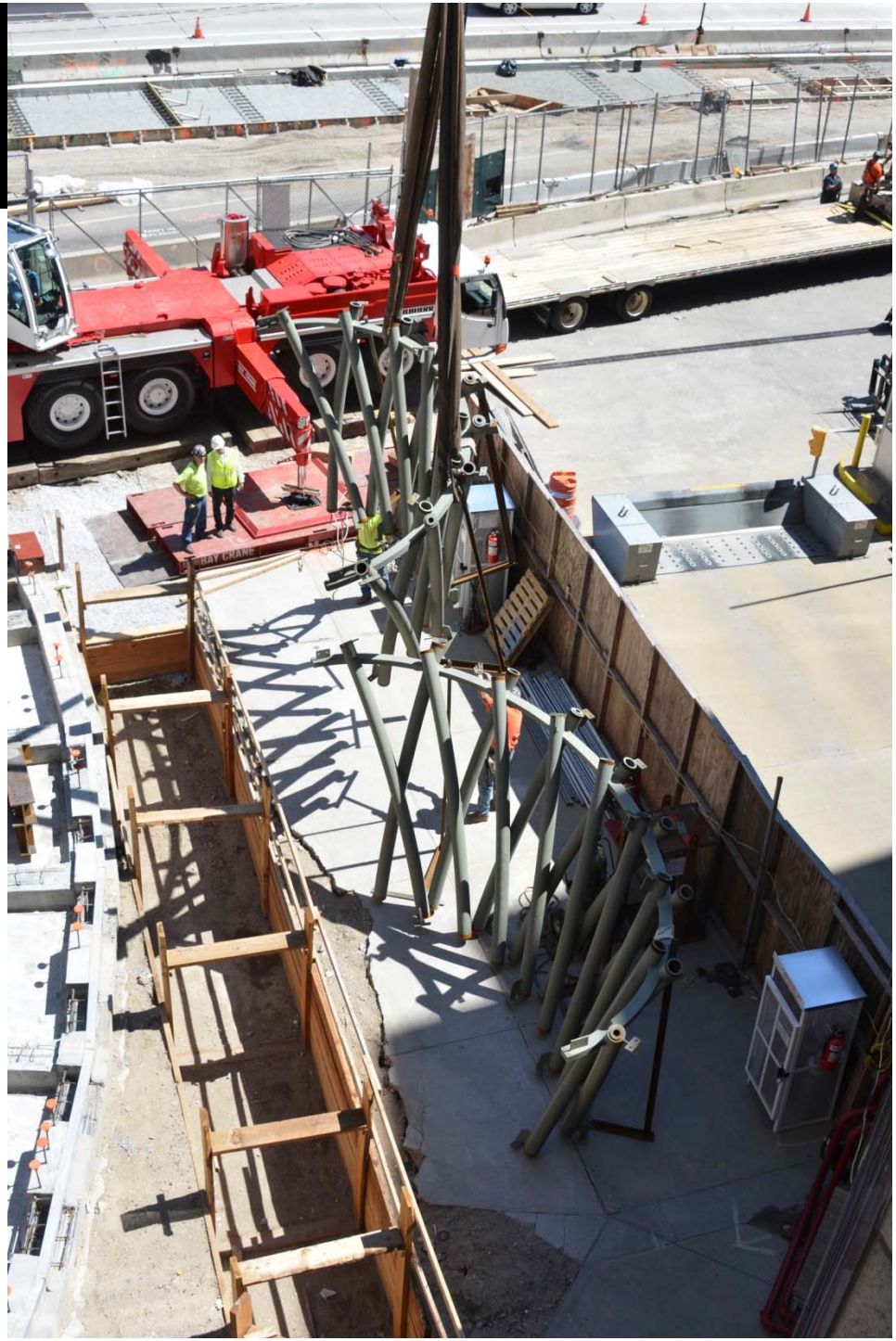
Access to complete connections

Staging and site issues

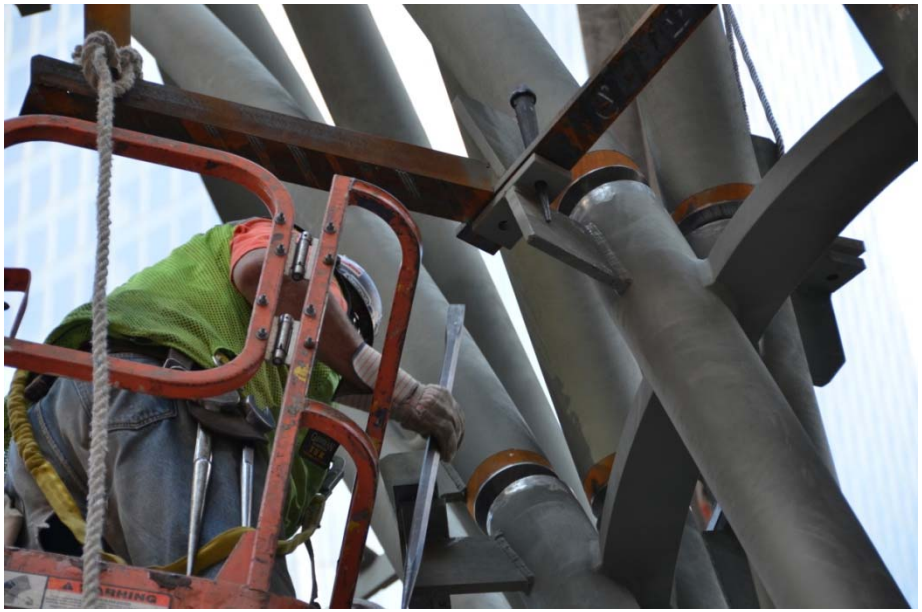
Sorting pieces



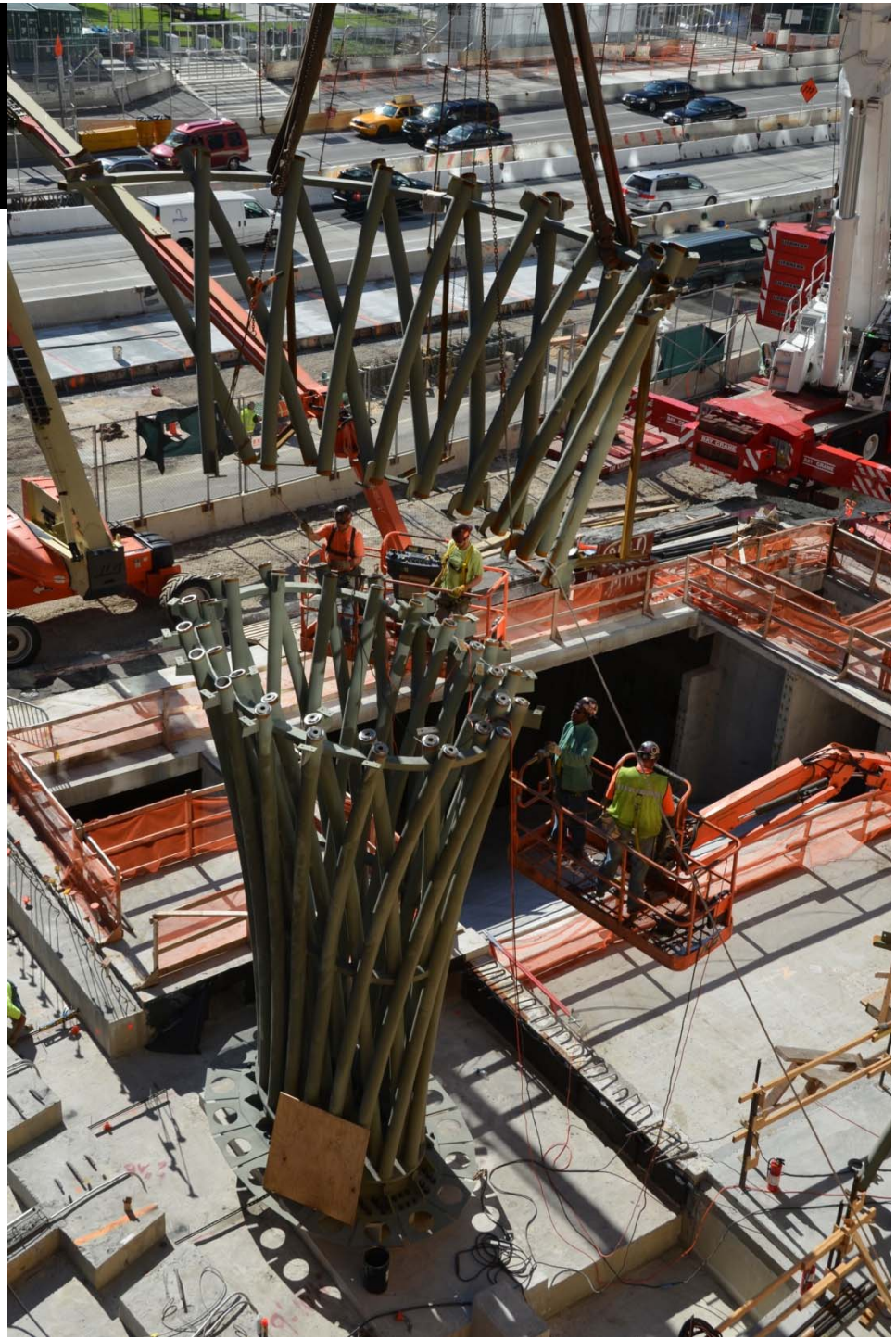
- Many pieces for a complex project
- Need to ensure adequate labeling to avoid confusion
- Upper tiers too large to be shipped assembled
- Subdivided into sections to fit shipping limitations



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...

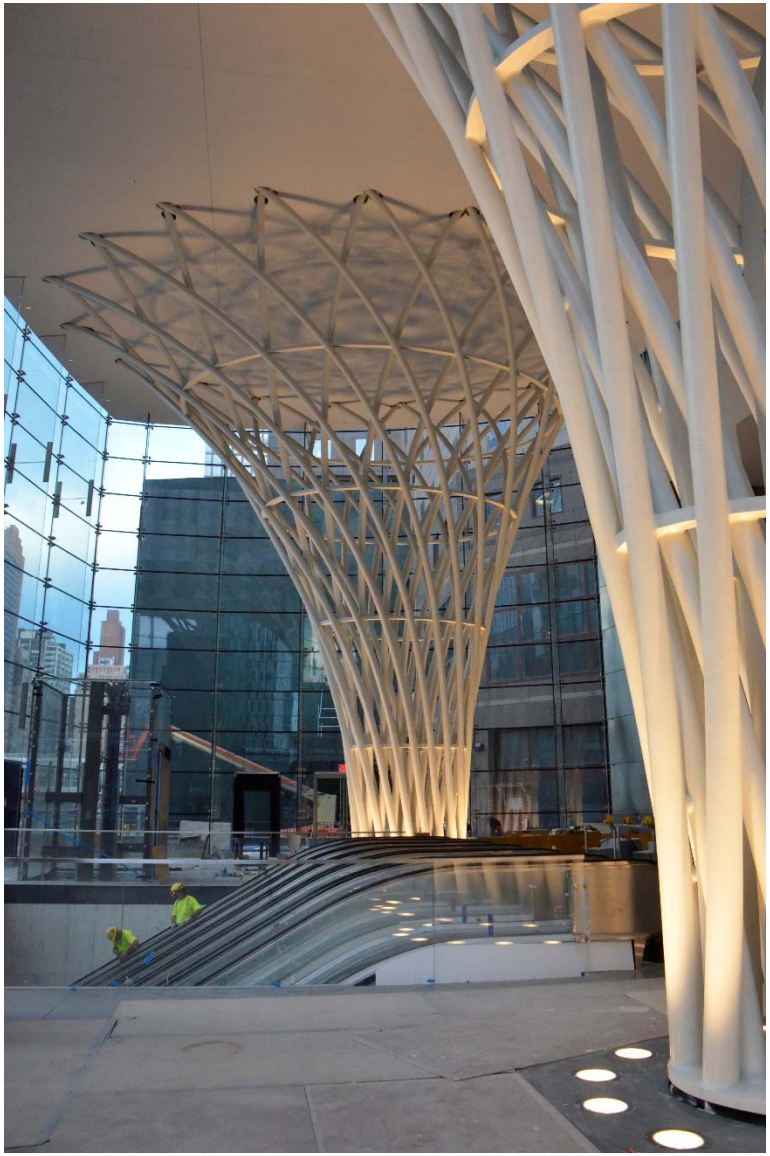
Weld remediation

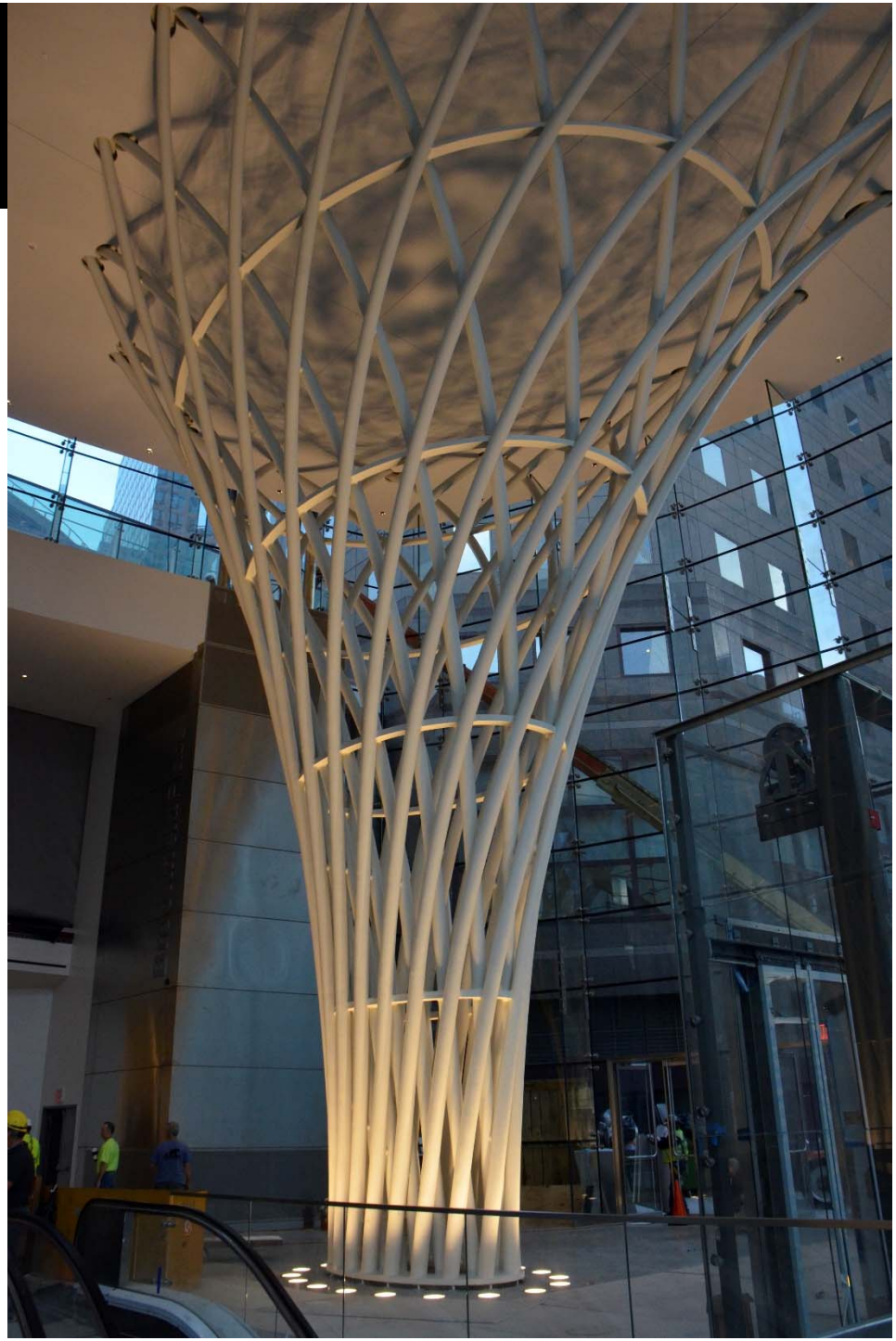
Installation of roof decking

This takes a long time...

The Glass Box

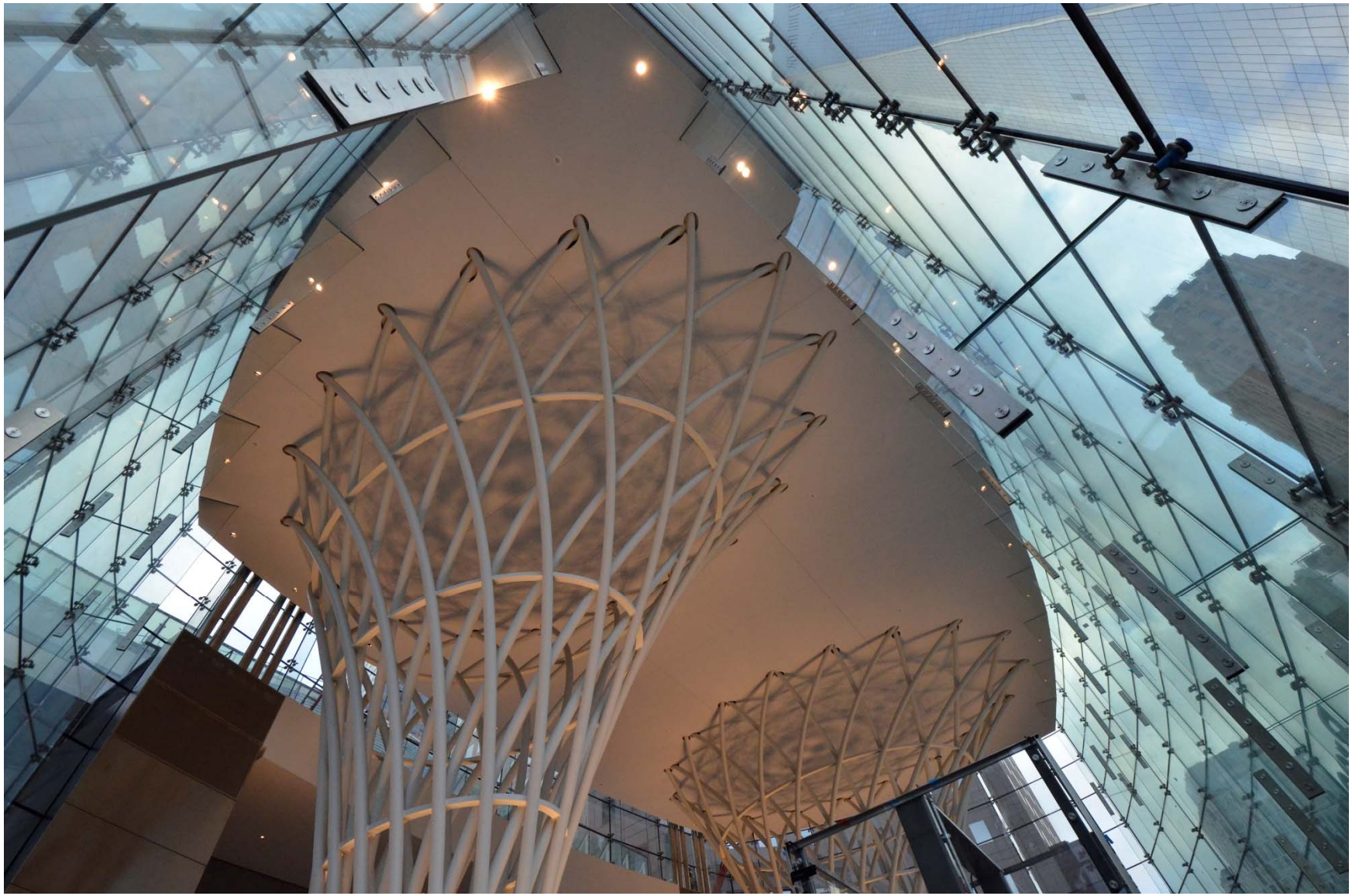
Finished steel

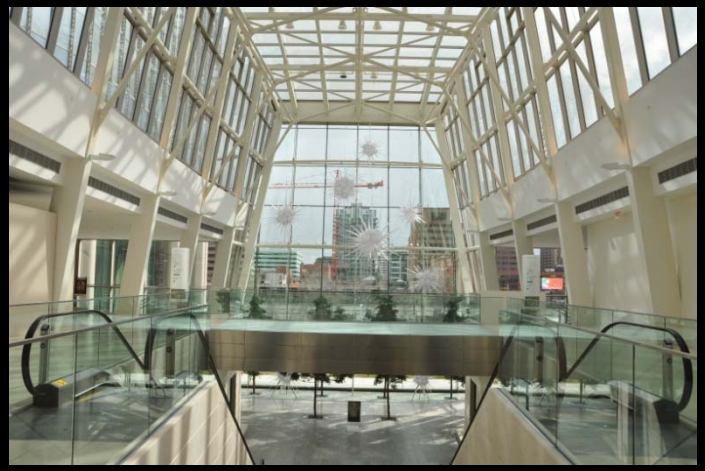




Intumescent coating

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

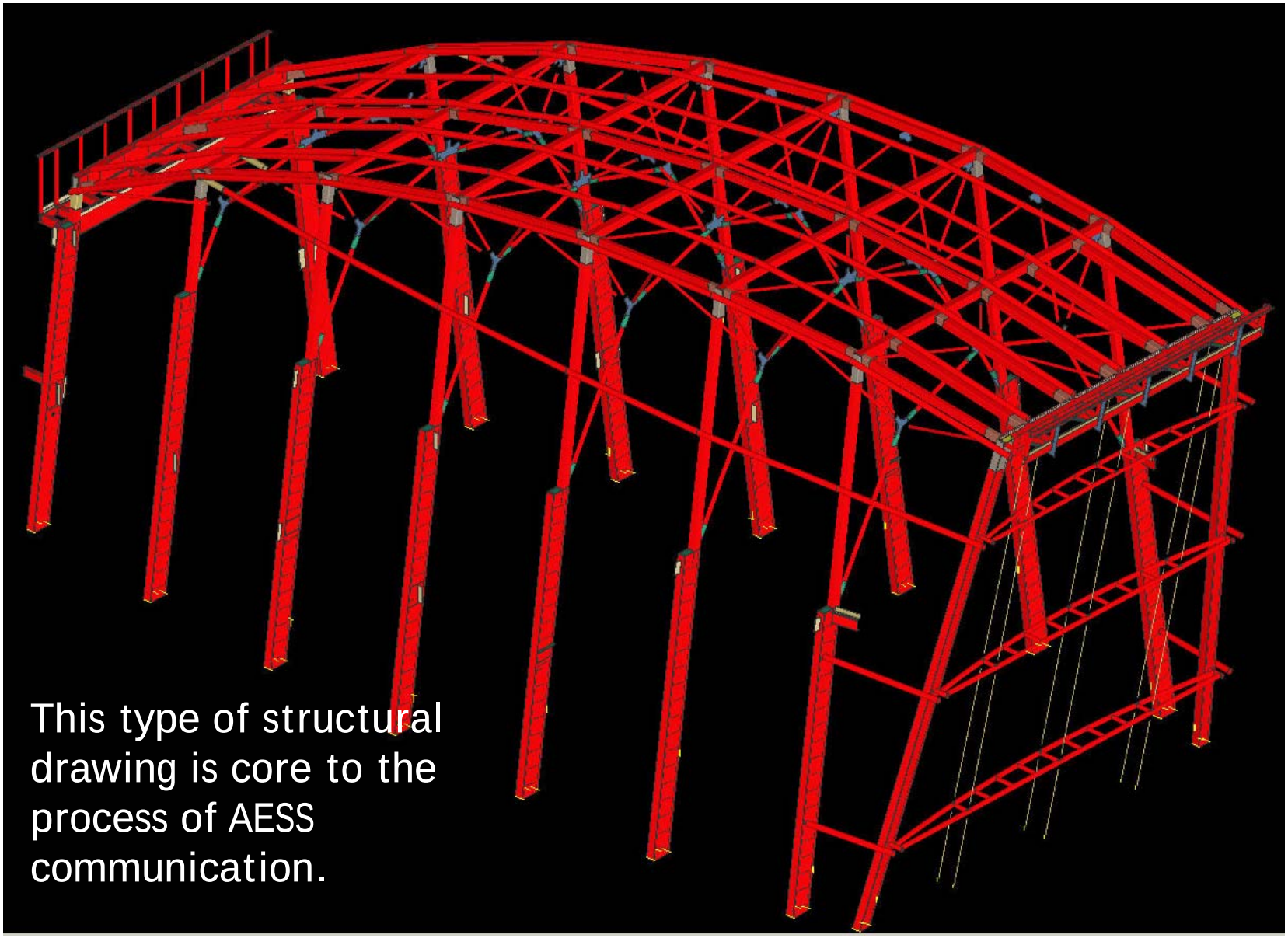
Concept

- The main structure comprises **eight large trapezoidal arches** connected by a web of smaller steel tubes, which form an interconnected three dimensional truss-frame.

- All of the **complex structural connections** between the steel arches and tubes were architecturally designed and engineered

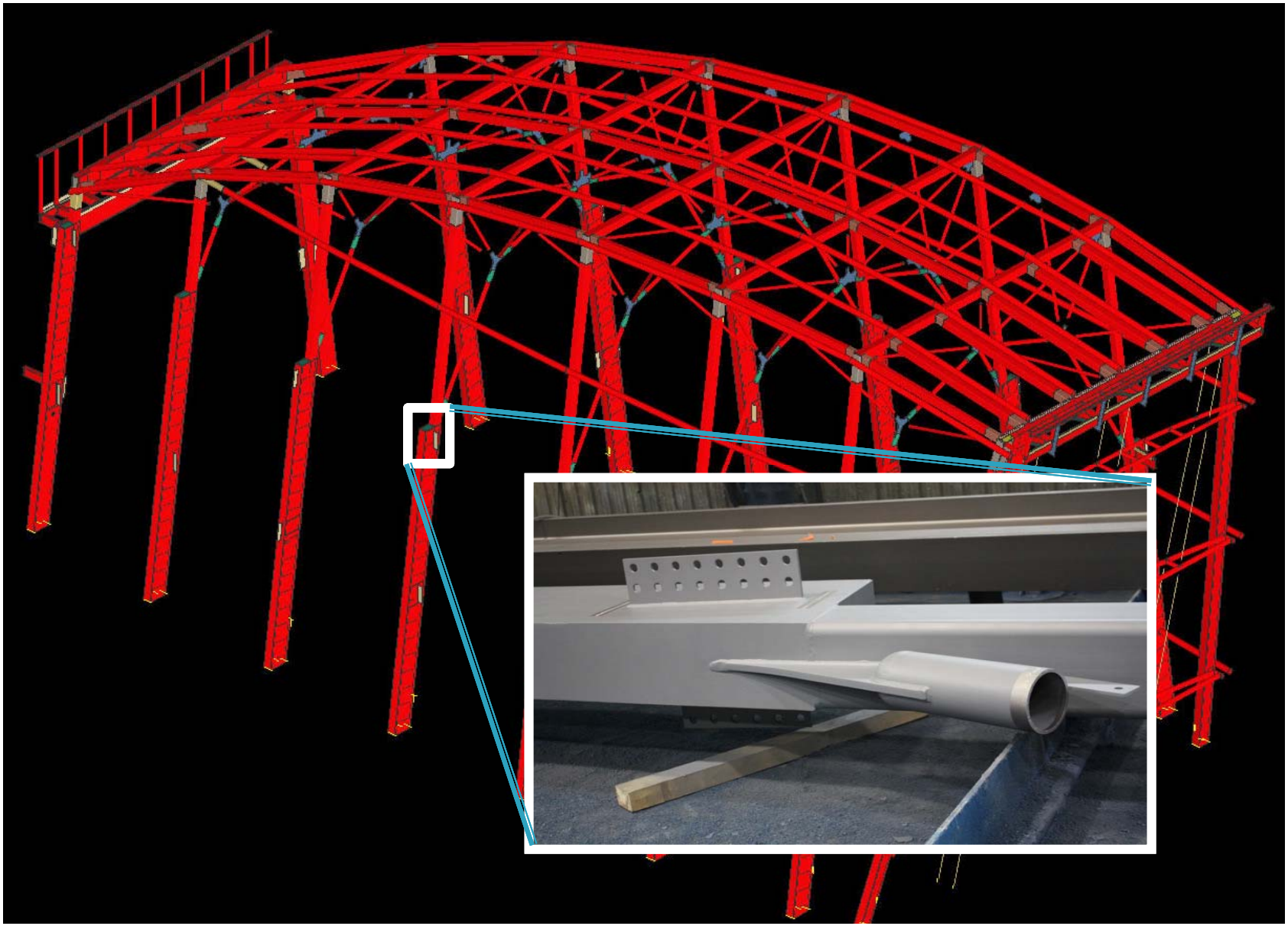
- Specification approaches **CISC's AESS2 and AESS3** Categories, for 'far from view' and 'close to view' steel

Overall structural drawing



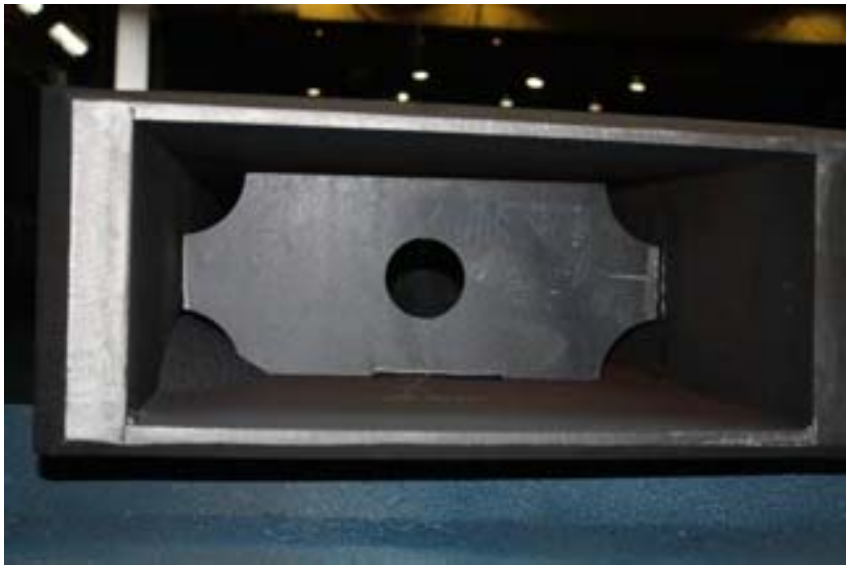
This type of structural drawing is core to the process of AESS communication.

Haunch detail

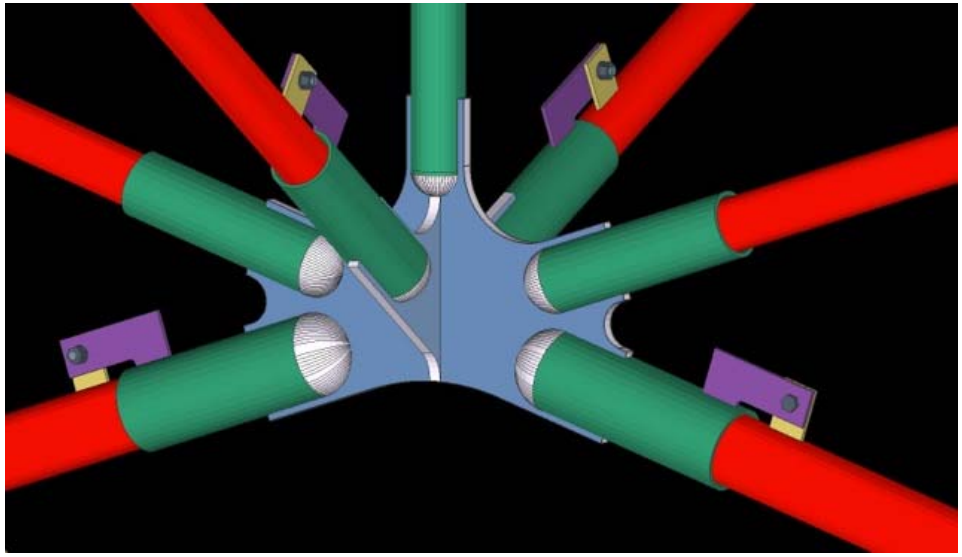


Column fabrication

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



Node connection



Steel erection

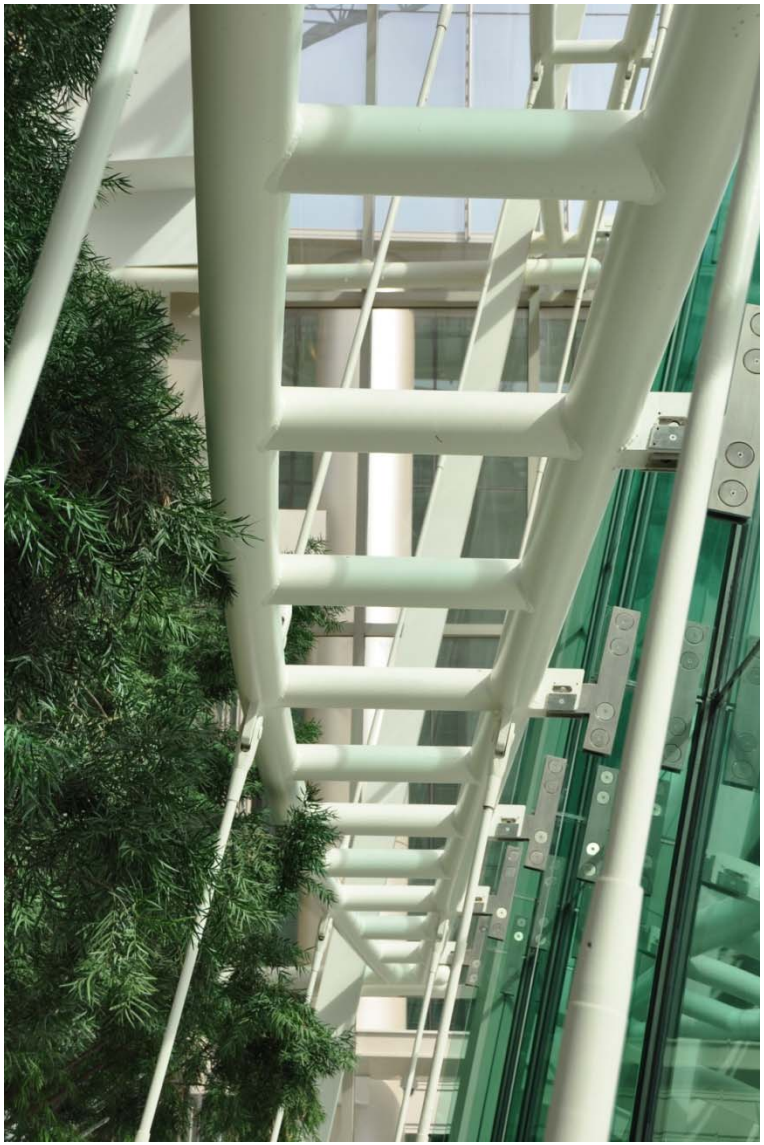
Last Arch erection

2nd Arch erection

Completed node

Completed Wintergarden

Details



Owner
Cityzen, Fernbrook Homes

Architects
architectsAlliance

Construction Manager

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

Project Profile

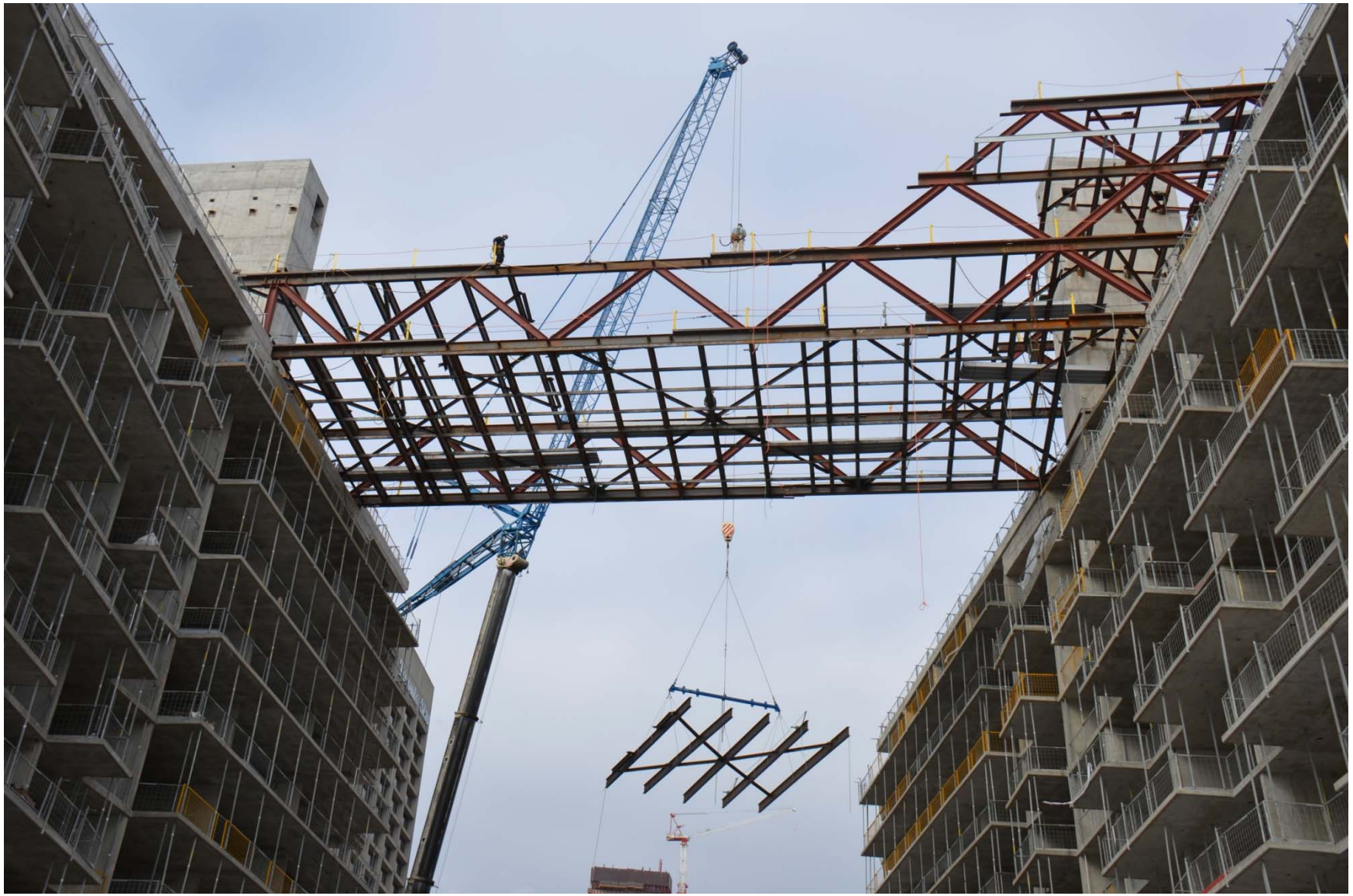
PIER 27 RESIDENCES
Toronto, Ontario

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

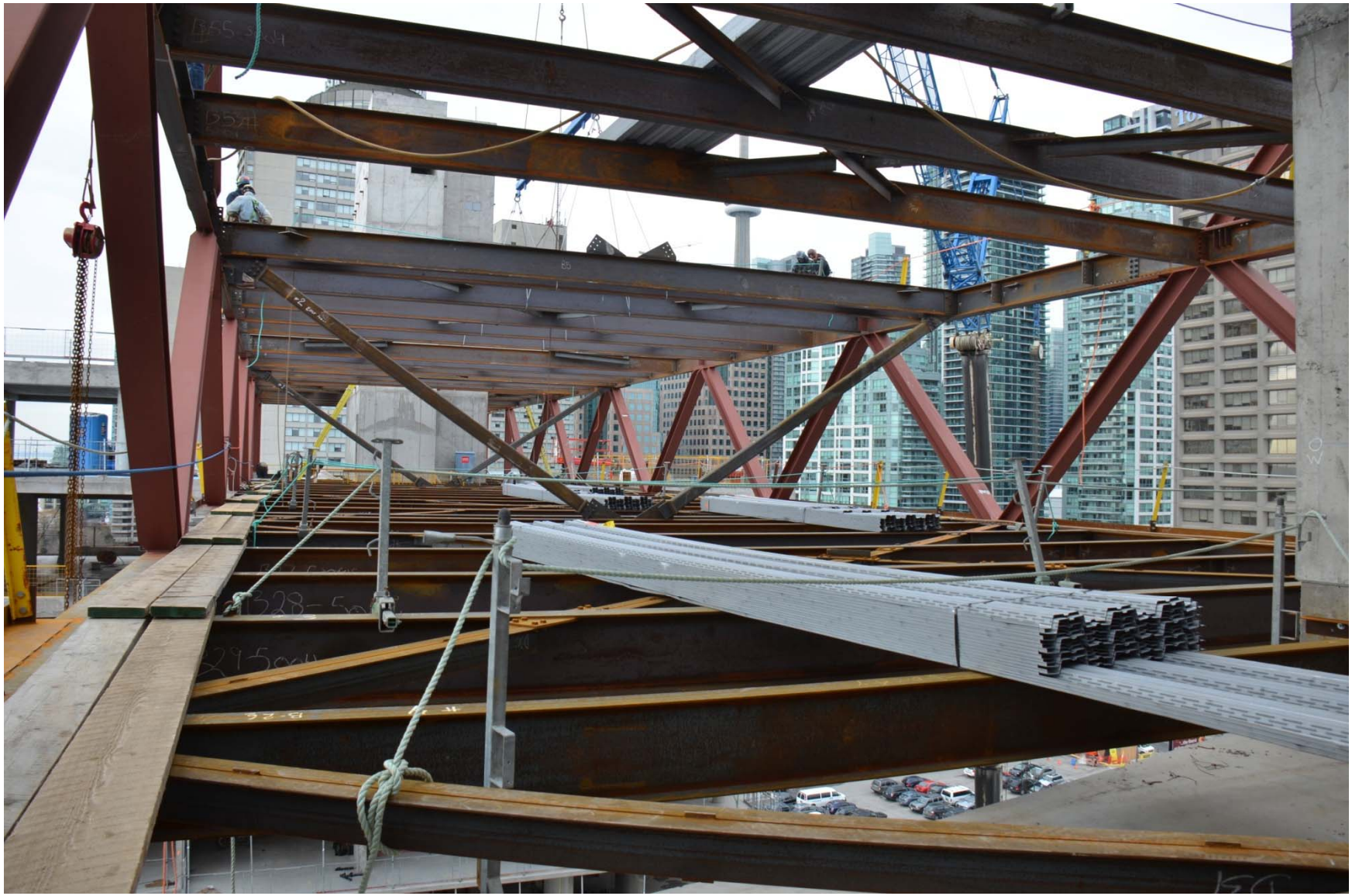
Steel to concrete issues

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

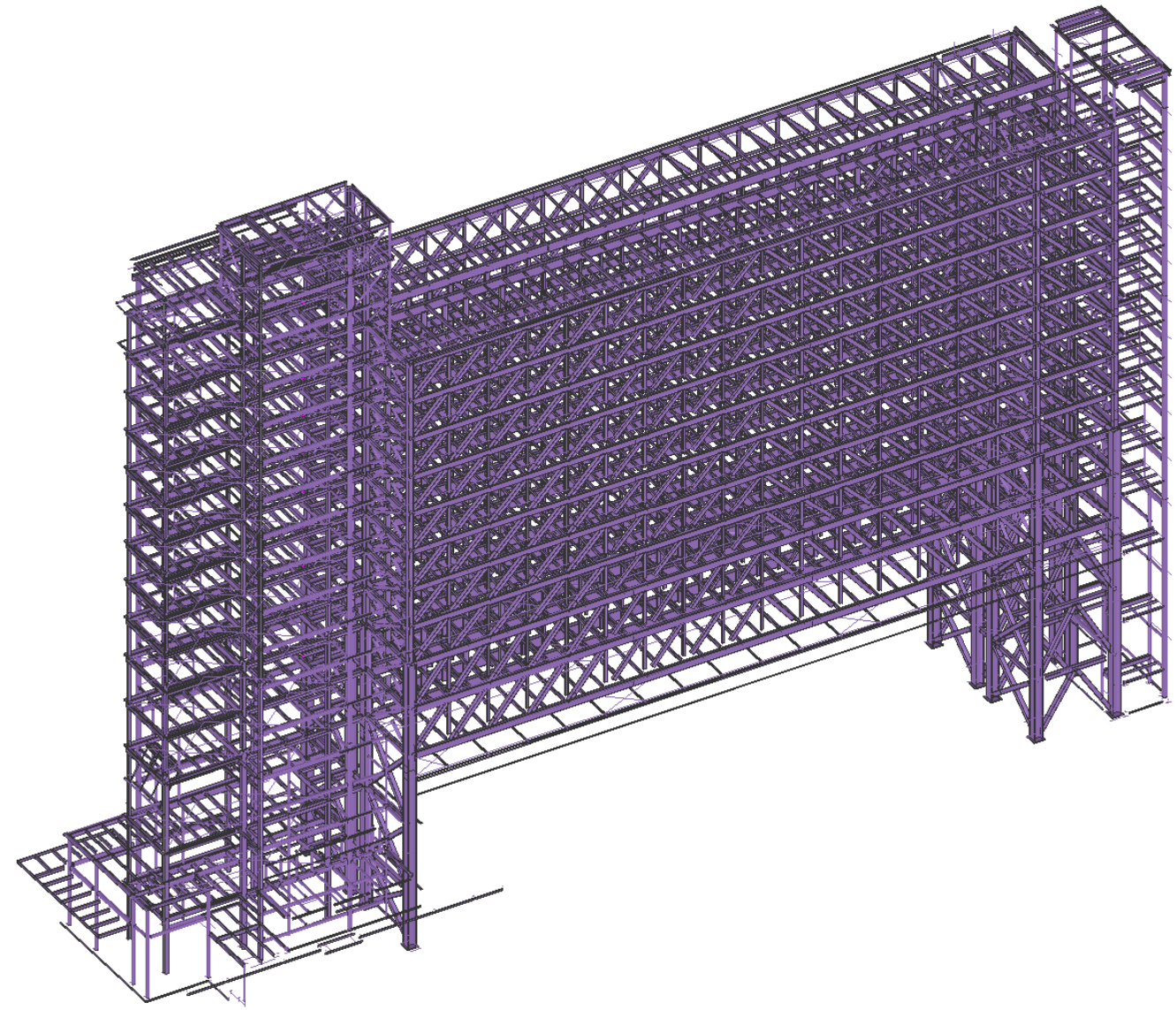
Dyregrov Robinson Inc.

Construction Manager
Bird Construction Company Ltd.

Steel Fabricator / Detailer / Erector
Supermétal

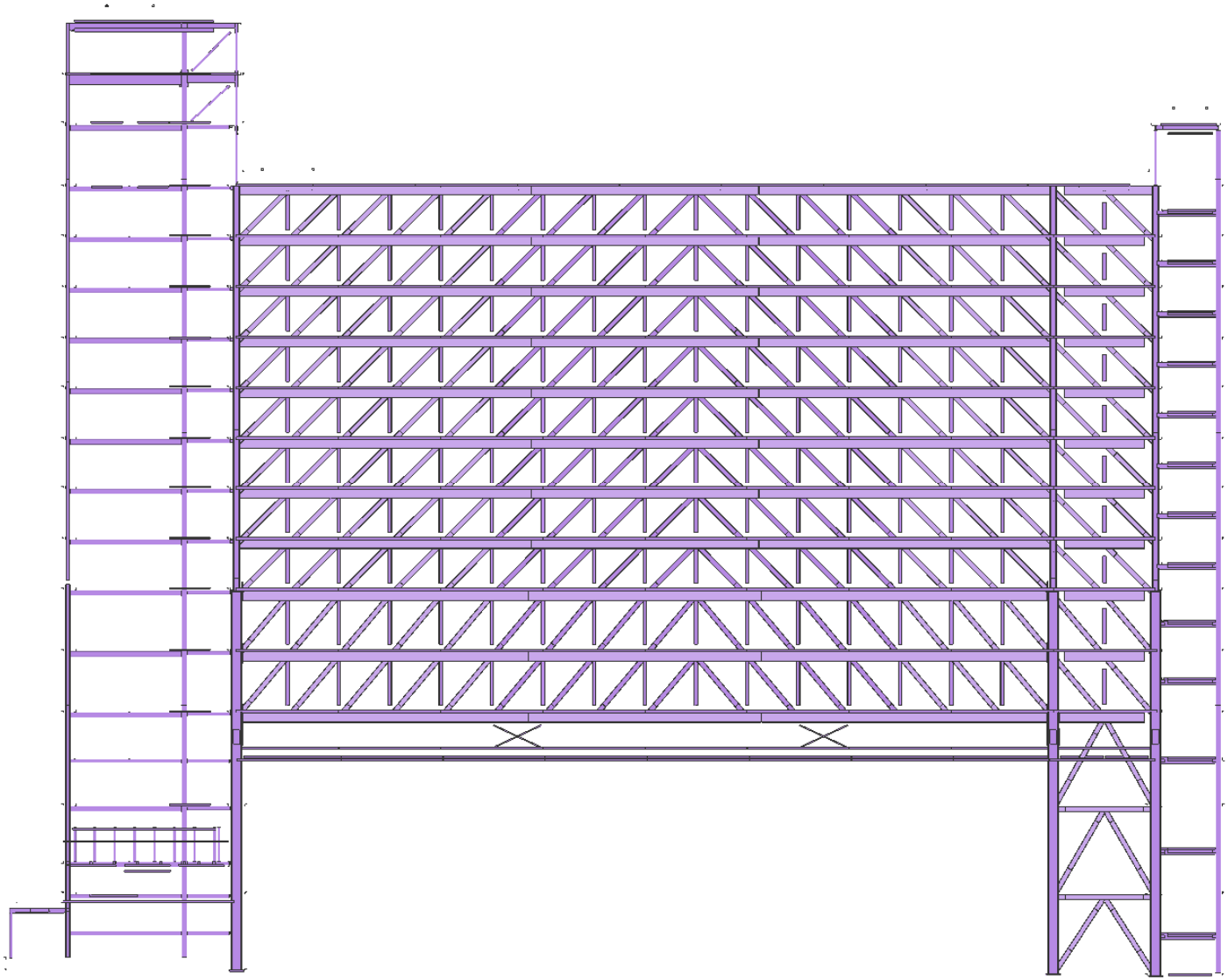
Photo credits this section: Supermétal
Content: Sylvie Boulanger, Vice President, Technical Marketing

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.

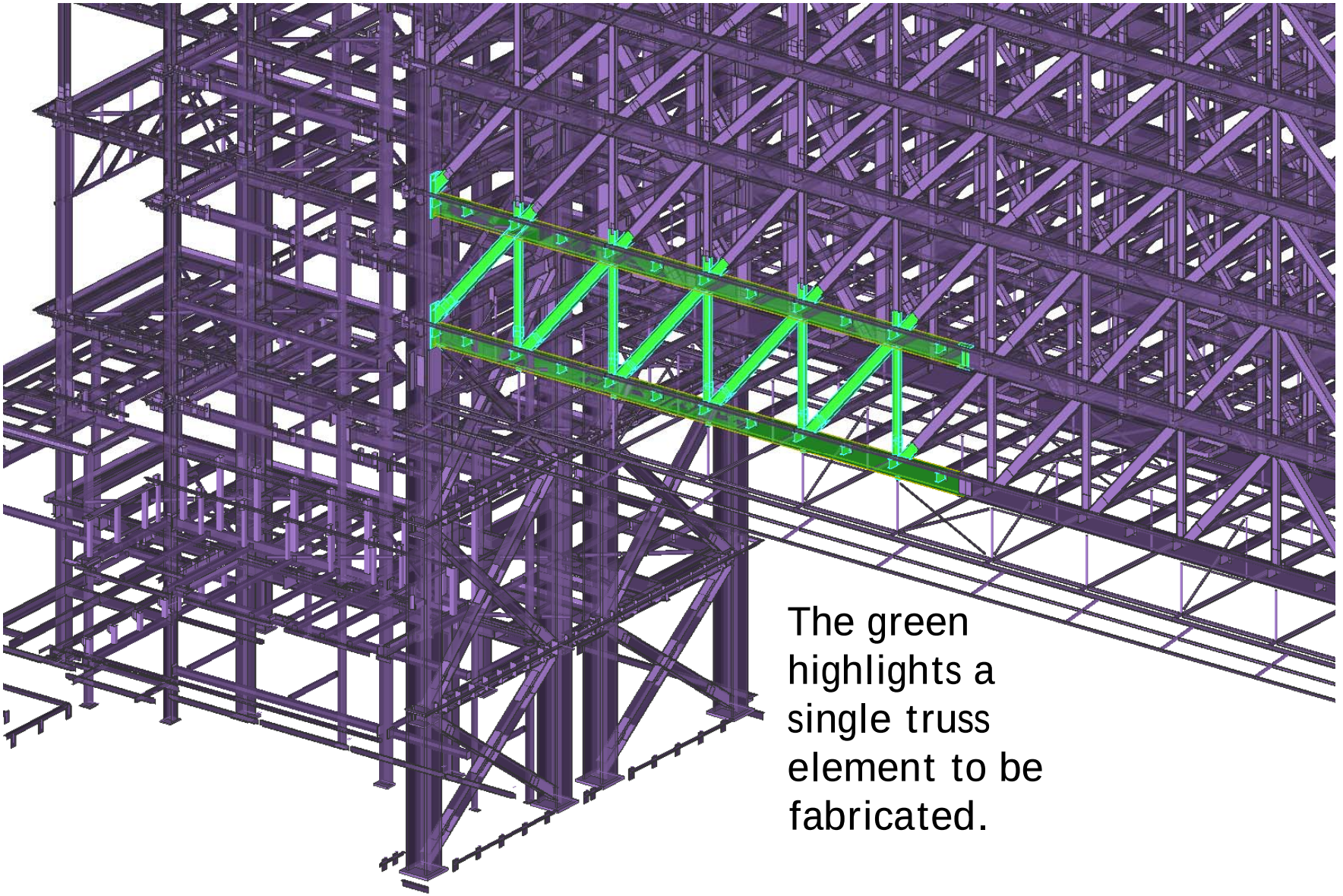
Elevation view of steel



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

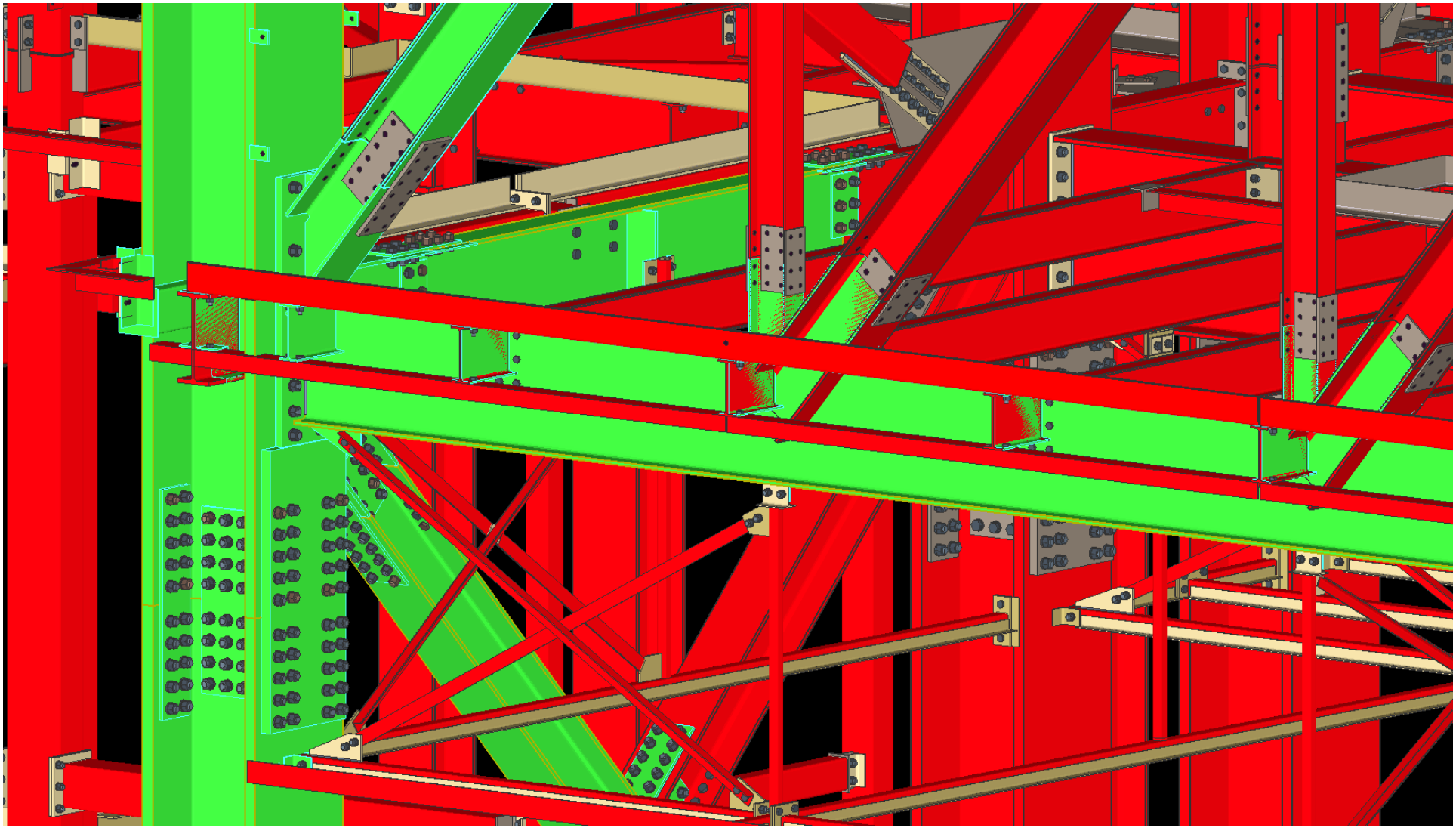
The direction of the diagonal chords was an aesthetic choice as it puts them in compression which is not optimal loading.

Truss element

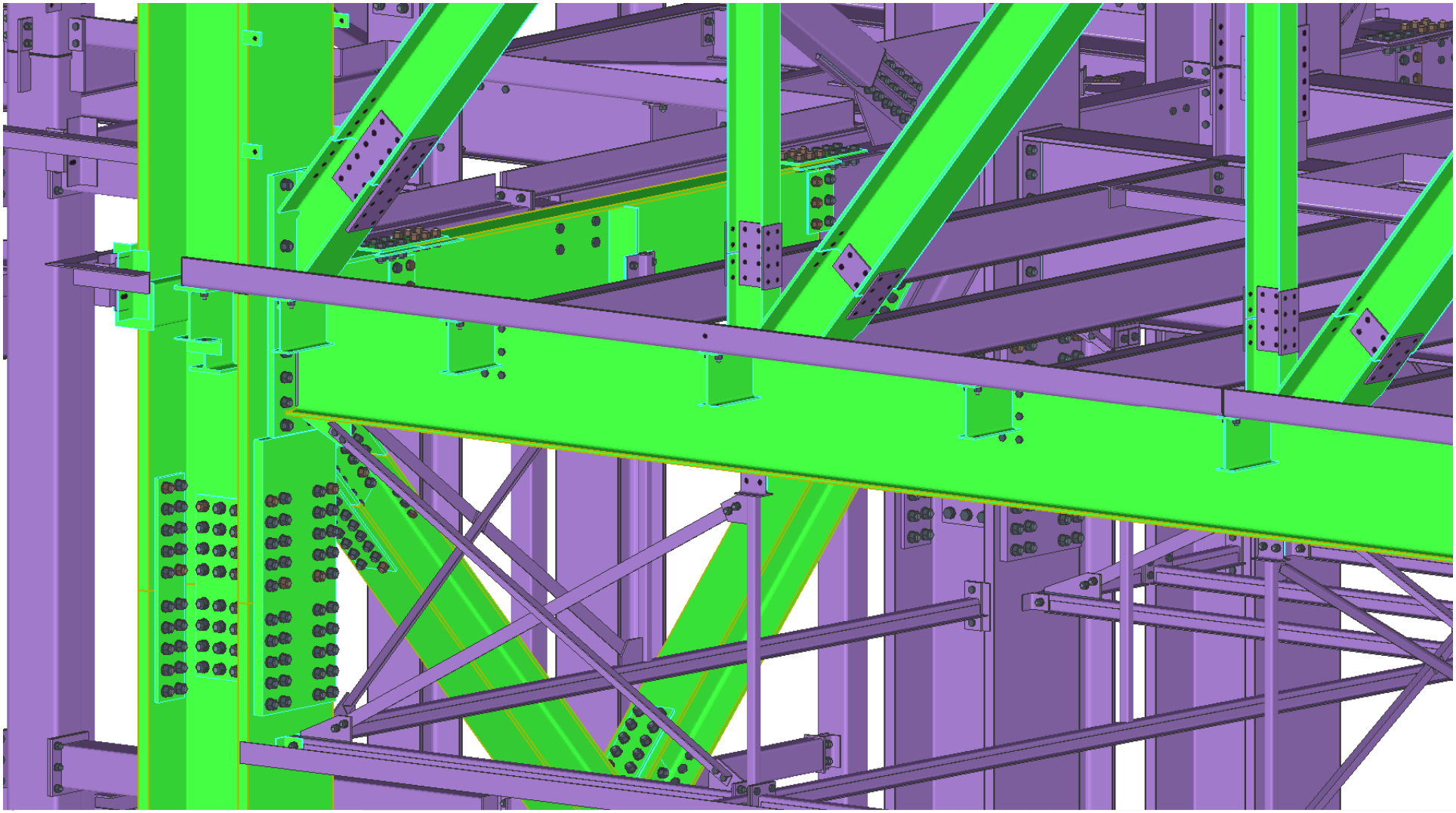


The green highlights a single truss element to be fabricated.

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

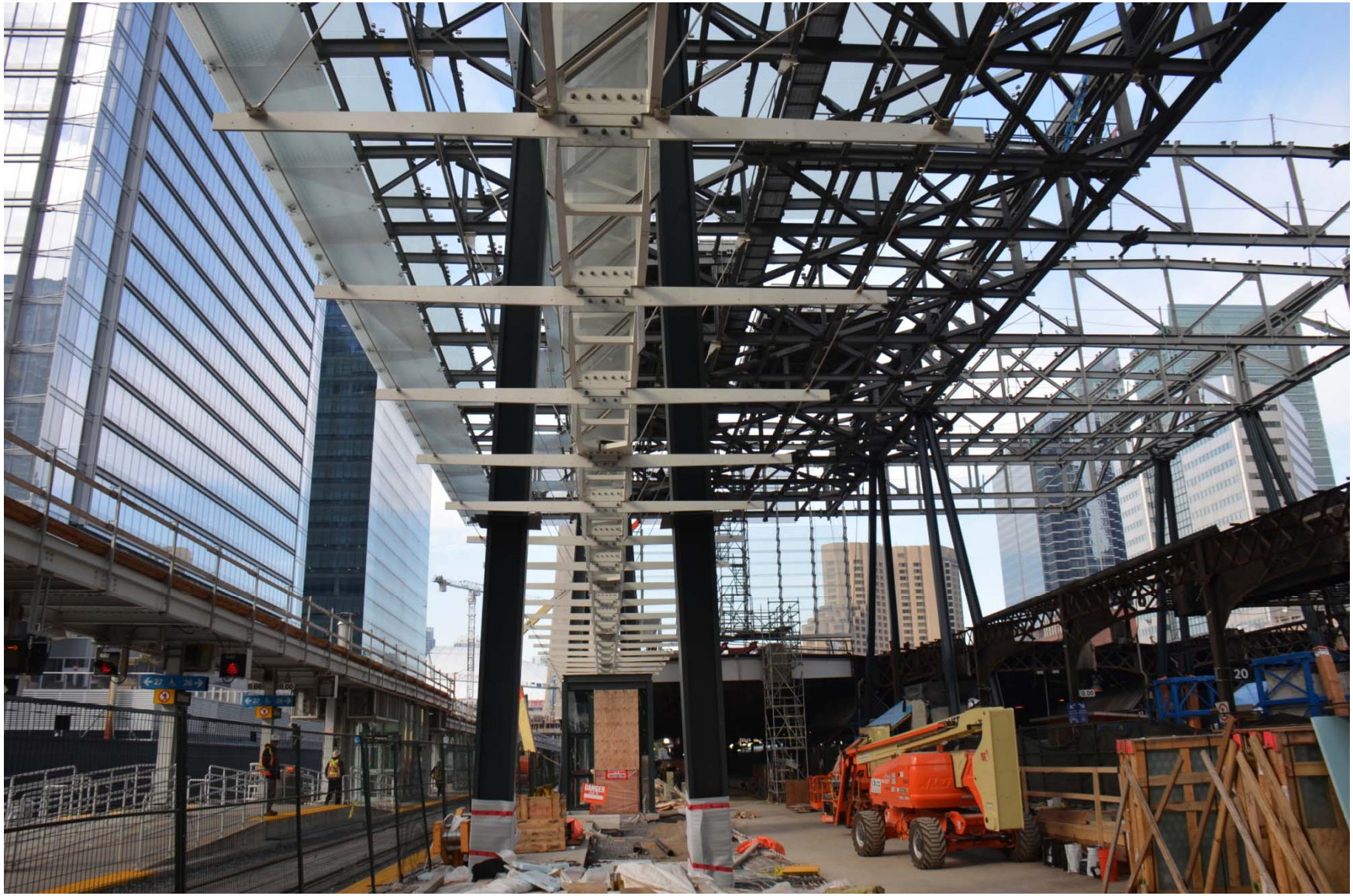
Construction Manager
Aecon

Structural Engineer
Yolles

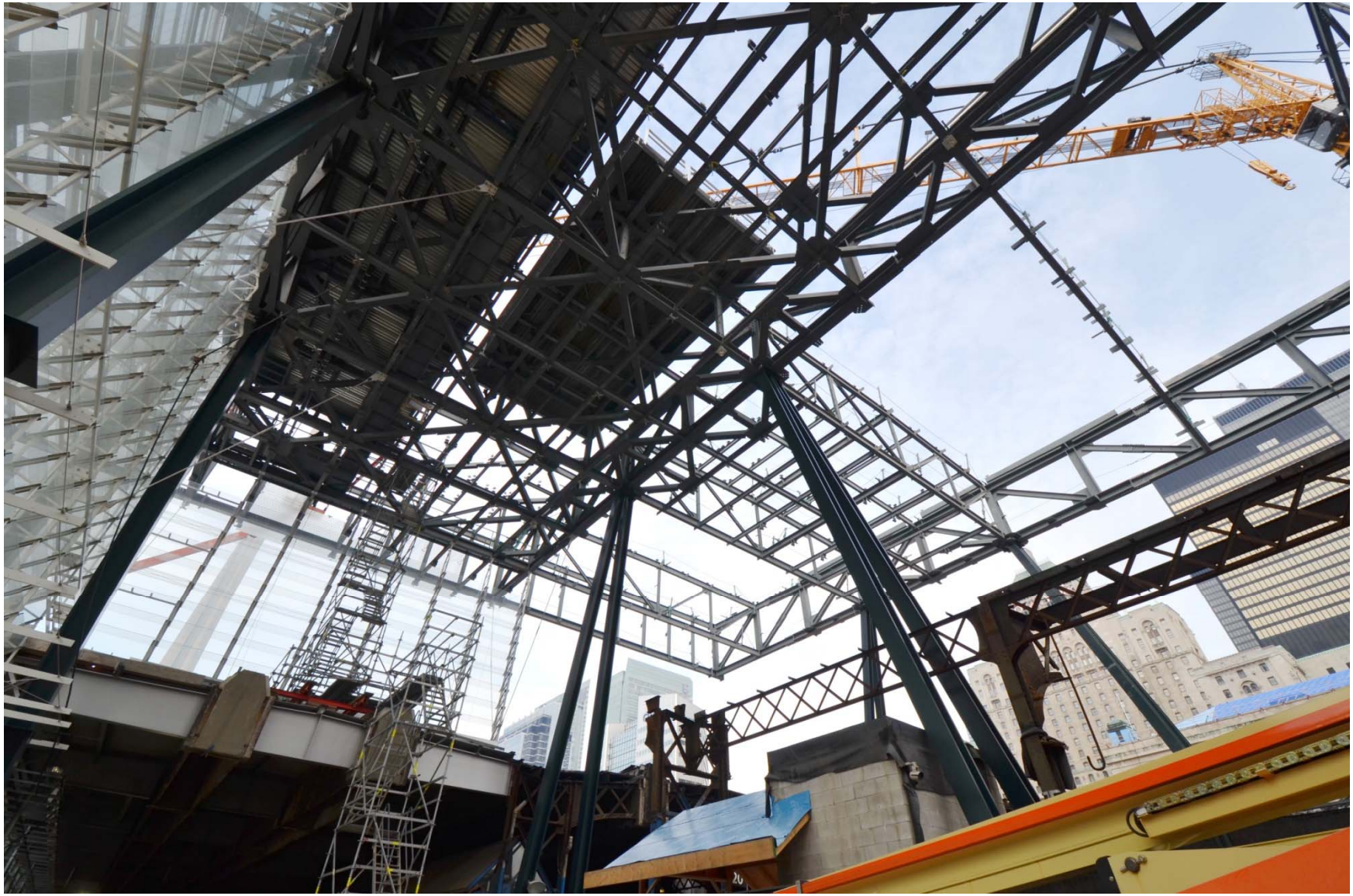
Steel Fabricator / Detailer / Erector
Walters Inc.

Site access courtesy: Walters Inc.

Union Station Train Shed

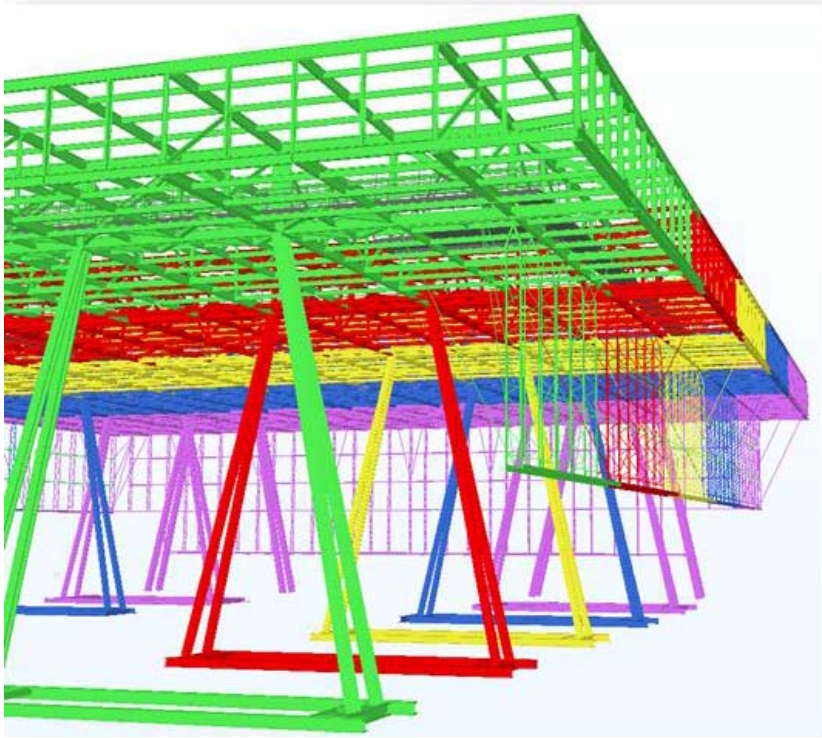


View towards roof

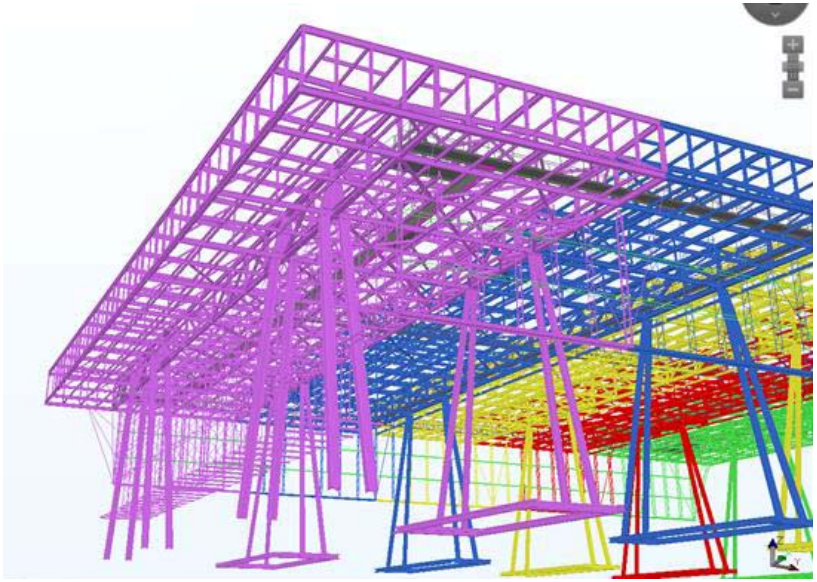


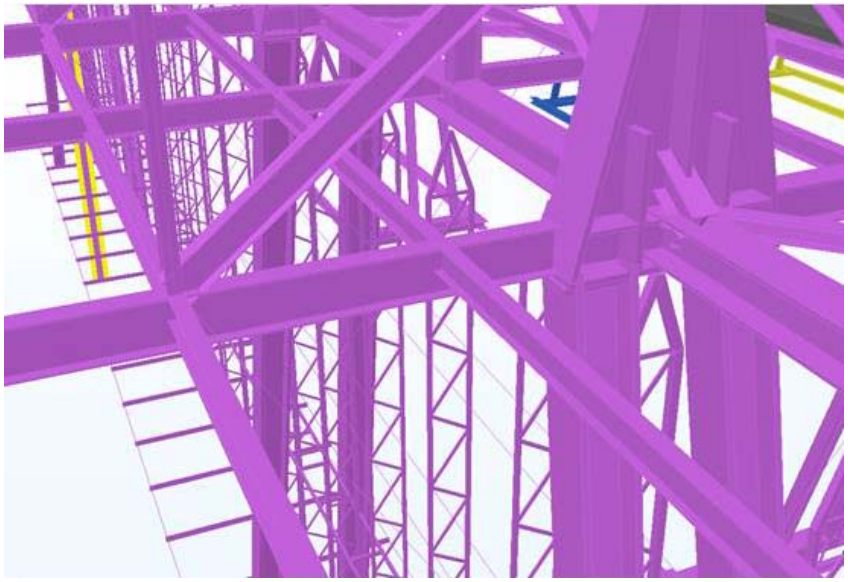
Construction phasing

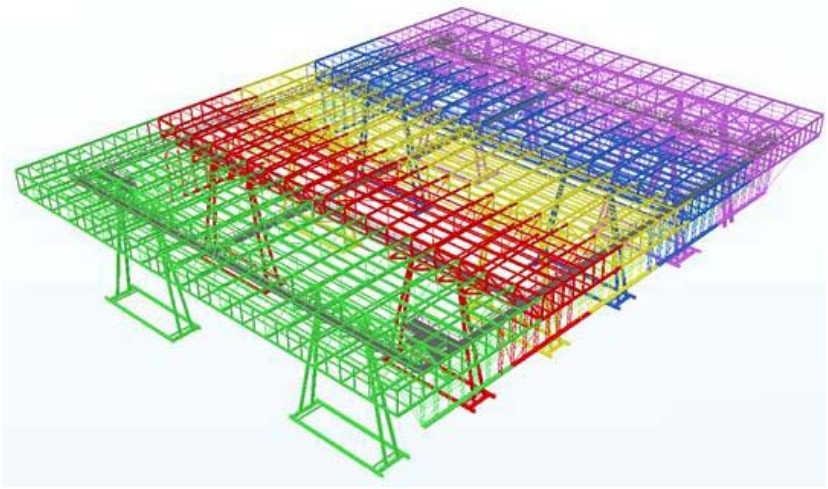
- The location provides many ‘issues’
- The tracks have to be kept open and operational
- The work has to be sequenced
- Major lifting that does require track closure can only occur at night
- This costs ‘extra’ given the time of day issues



Drawings





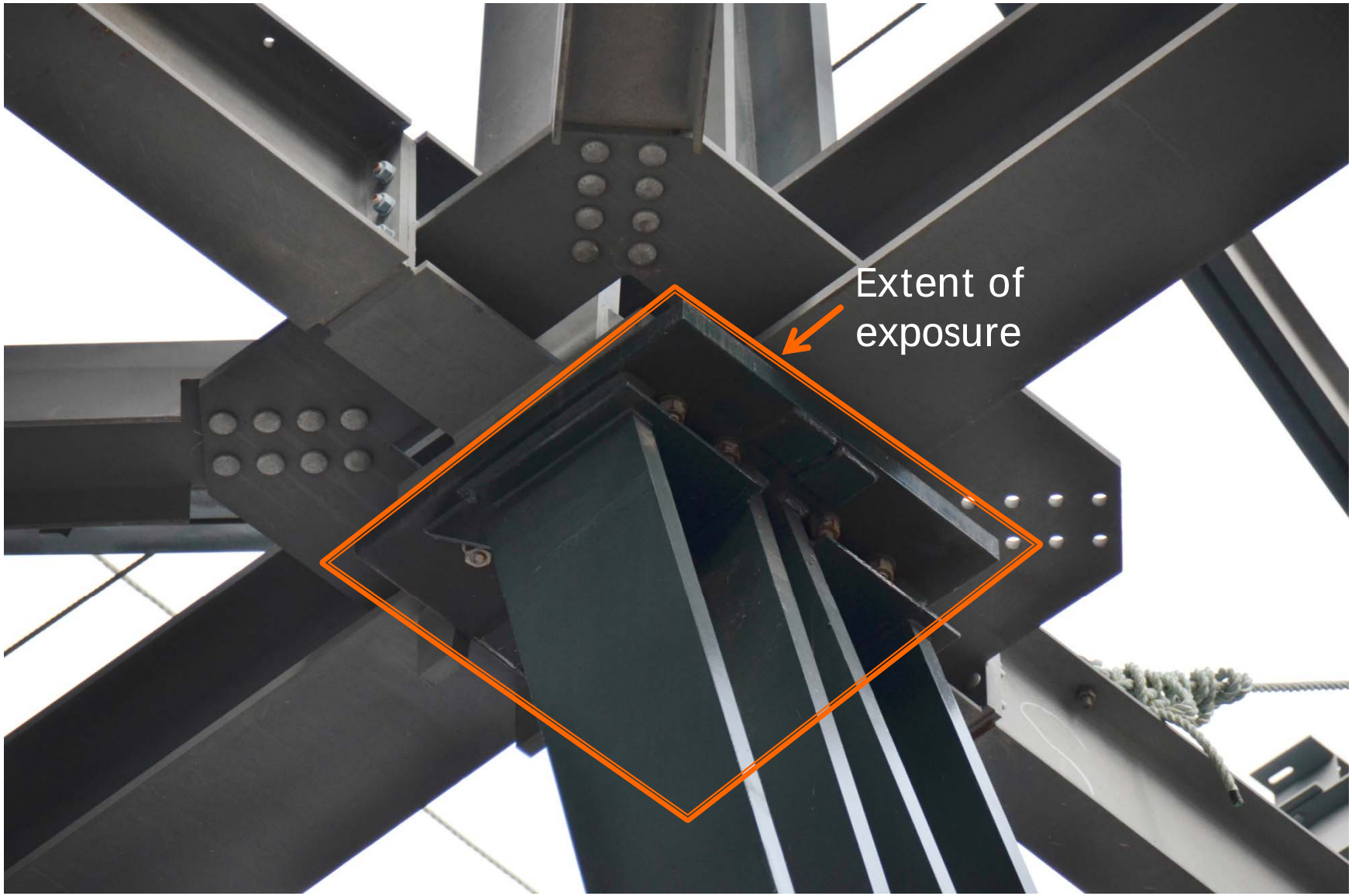


Detailing software allows the fabricator to design all of the connections as well as produce drawings for each element and for erection sequencing.

Images: Walters Inc.

Truss construction

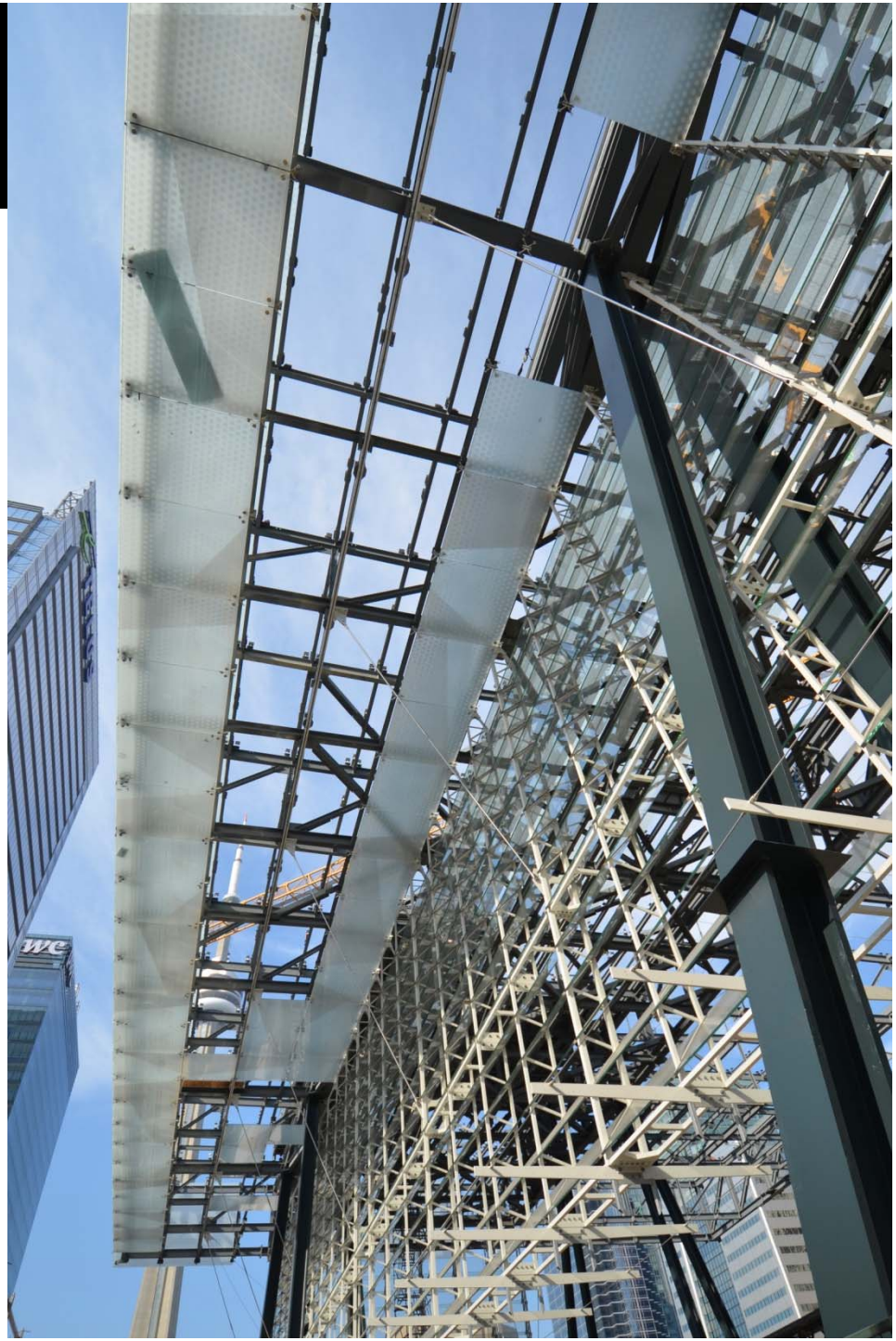
Truss connecton



Column meets heated floor

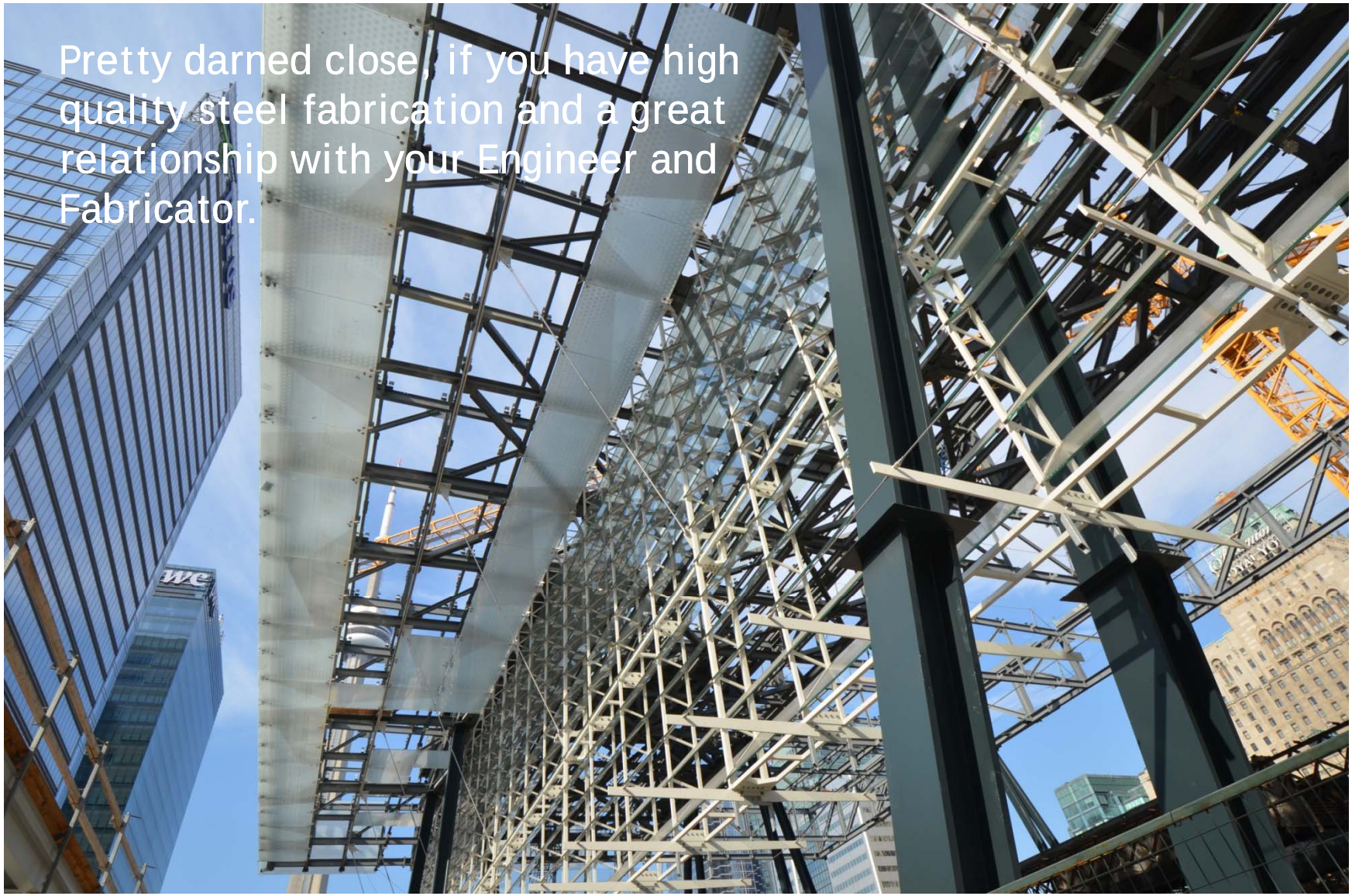
Exposure levels

- 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

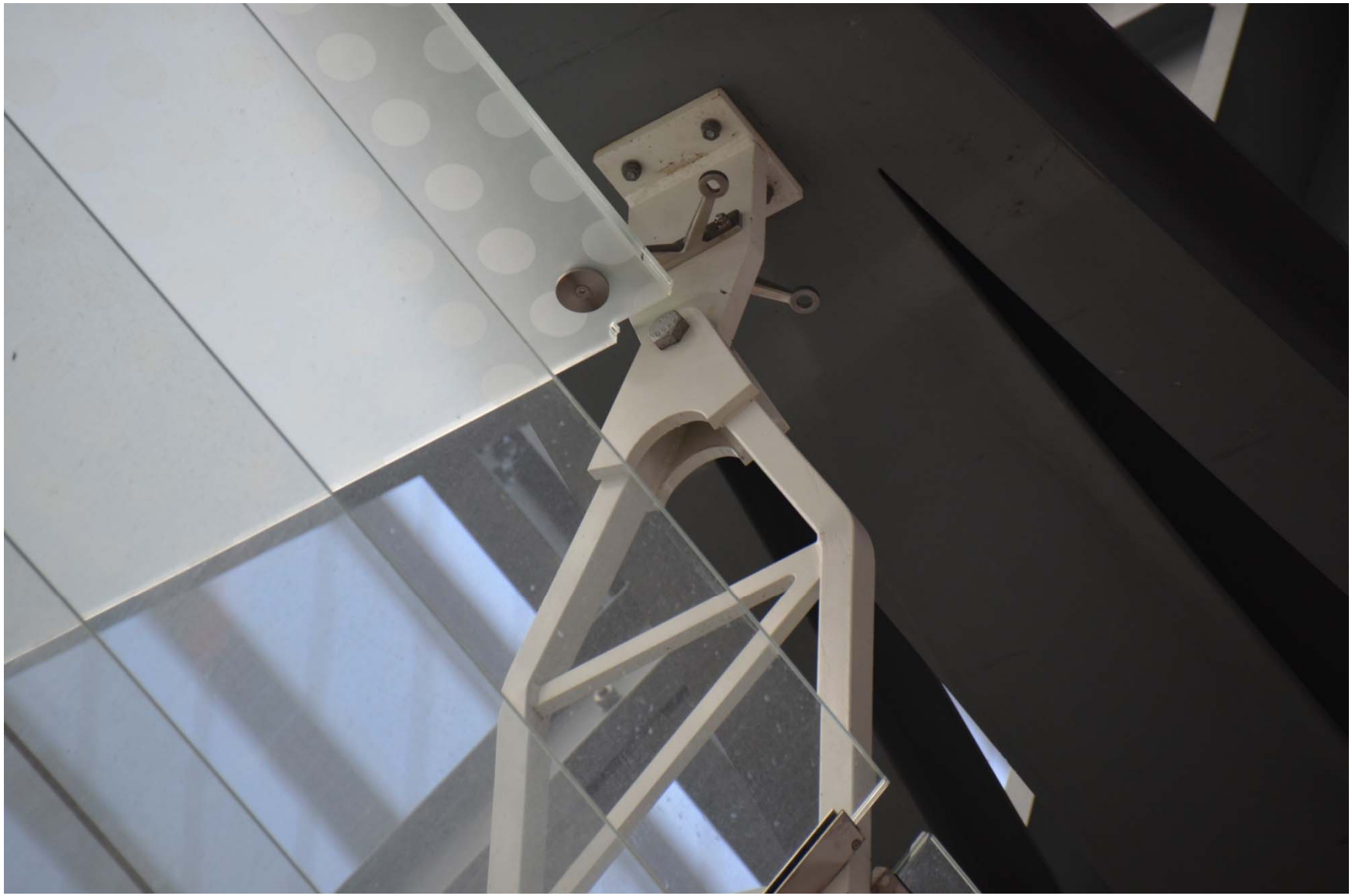
Front elevation



Translucency

Support for venting glazing

Hanger connection for side glazing



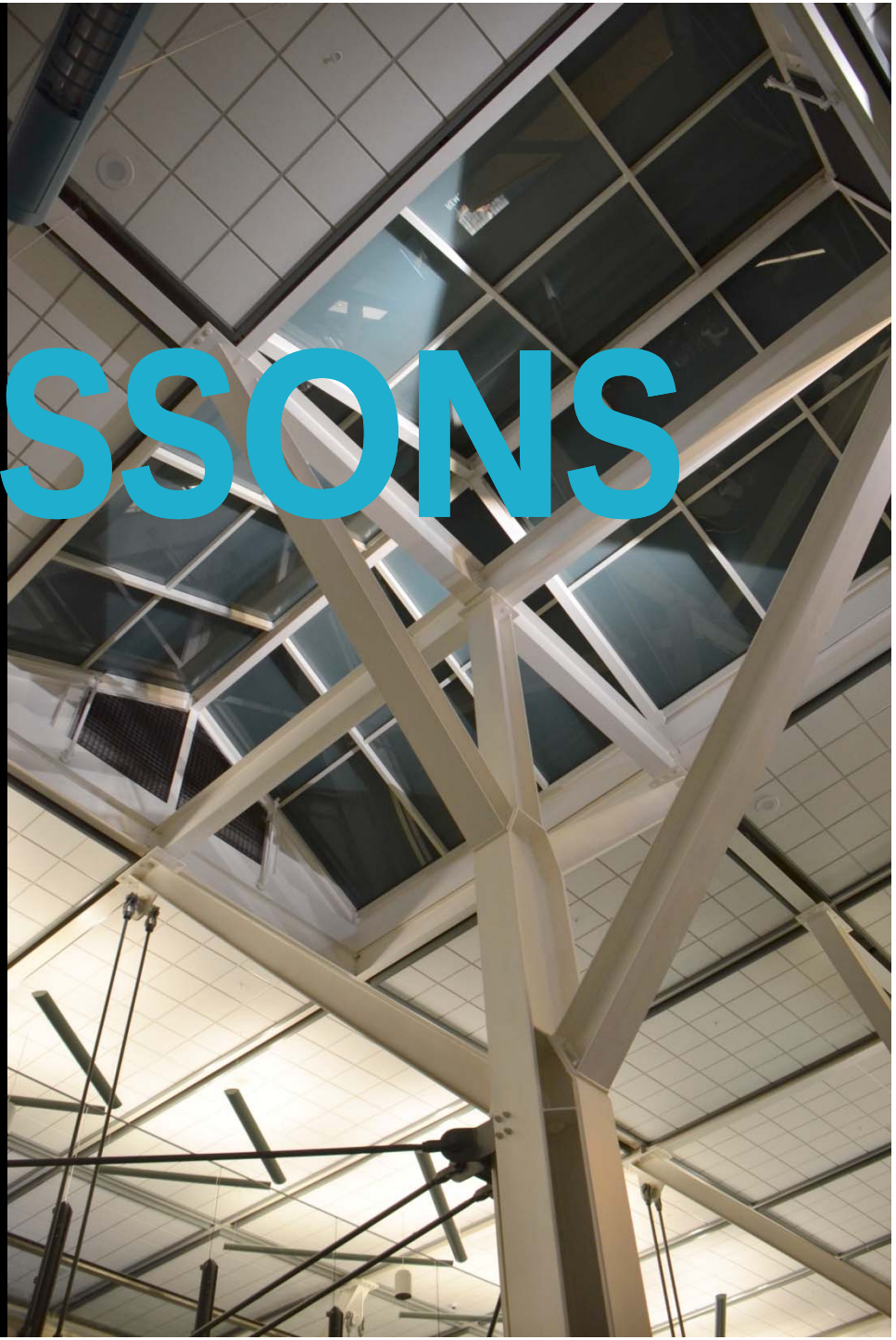
Custom welded plate for columns

Fine support system for glazing

Obscured by glazing


UNION STATION
adidas

AESS LESSONS



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

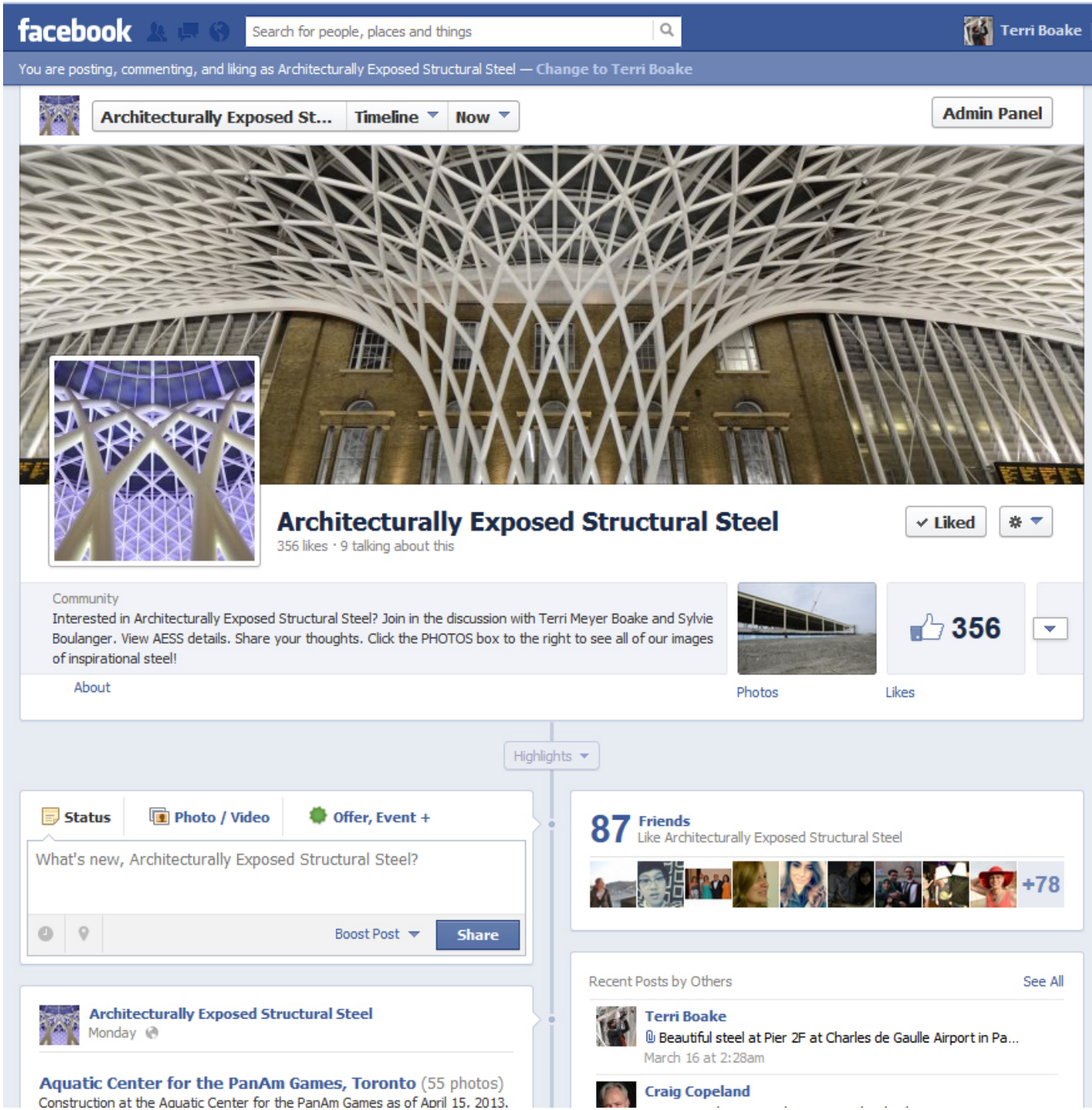
- Sylvie Boulanger, Supermétal, Vice President, Technical Marketing
  (for images, project content and the original work on the development of the CISC AESS Documents and System)

- Walters Inc.
  (for providing site access and documentation for their projects)

- ARUP, London
  (for technical information on a number of projects)

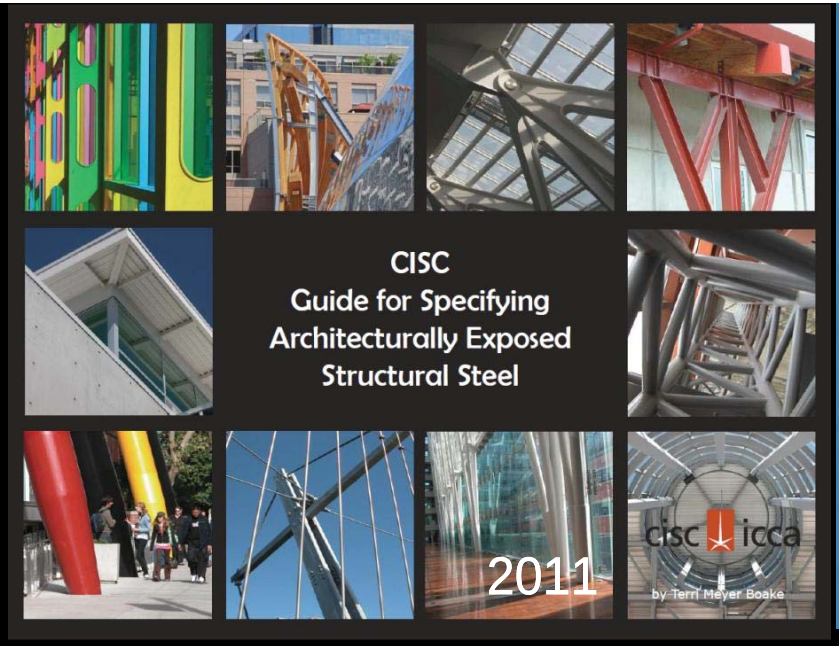
New AESS Documents

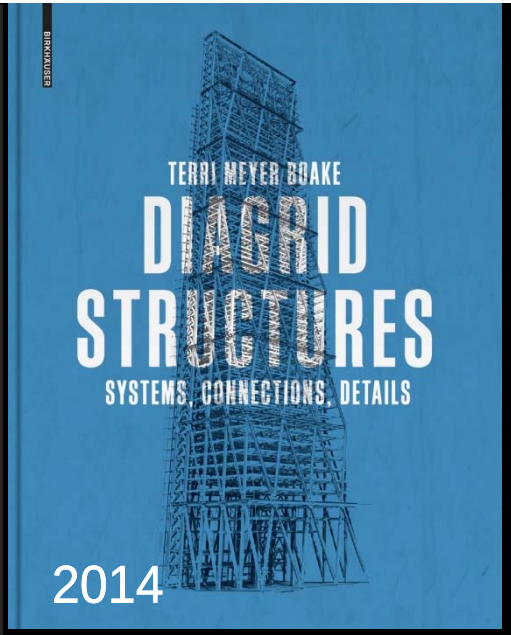
- Available for purchase and download:
  - CISC Guide for Specifying Architecturally Exposed Structural Steel
- Available for download at http://cisc-icca.ca/aess
  - Sample Specification
  - Code of Practice for Fabricators
  - Matrix

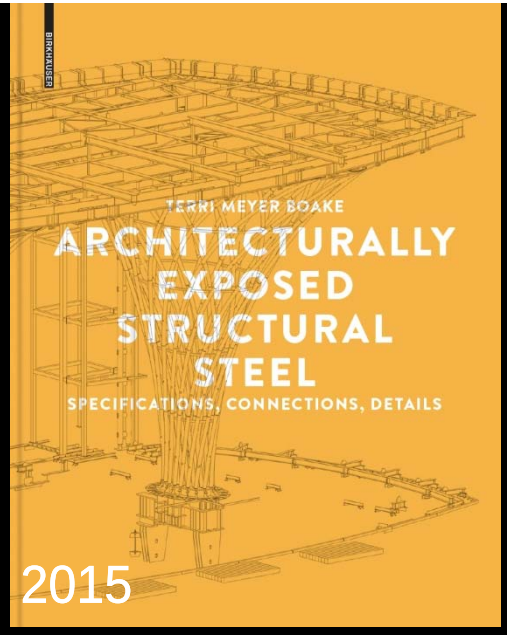


Check out our AESS Facebook Page!

facebook.com/aess4u







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