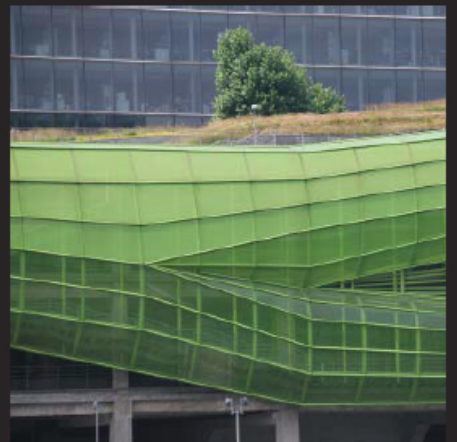
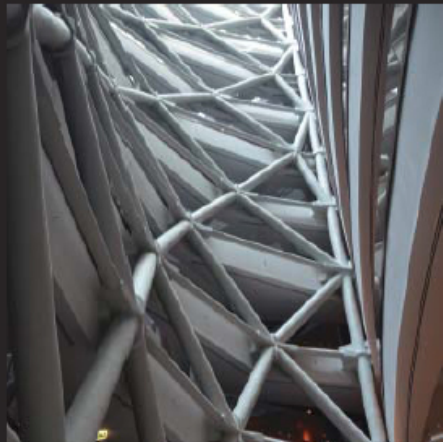




The CISC Architecturally Exposed Structural Steel Documents



What is AESS?

- Architecturally Exposed Structural Steel is steel that has been purposefully left exposed
- It must fulfill structural functions
- It is normally part of the Architectural aesthetic of the space
- It usually requires detailing, finish and handling that requires more attention and care than regular structural steel
- It adds to the cost of the contract

High Tech Architecture



Hollow sections were only “invented” in the 1970s and their adoption truly changed steel design and detailing. ▶

Foster, Sainsbury Centre, 1977

Contemporary AESS



Chicago
O'Hare United
Airlines
Terminal by
Murphy/Jahn
was the first
AESS Airport –
finished in
1987

How good is “Good Enough”?



- AESS was being used on very high profile projects
- AESS was also being specified for mid to lower end projects
- Not all projects had/have the budget to pay for the sort of detailing of “A Calatrava”
- There was no agreed language or specification that could assist in the communication of expectations between the Architect, Engineer and Fabricator

Brookfield Place, Toronto, Santiago Calatrava

Problems Specifying AESS

- Miscellaneous Metals spec does not address the **structural** requirements of AESS
- AESS can be priced out of sight on projects if excessive requirements are added “out of ignorance”

The Bottom Line is that:

- *All AESS does NOT need to be equally crafted...*
- Not to say that it should not be properly crafted, but not all situations or projects either need or can afford the same level of detailing



“God is in the details”
What are they doing?

They are grinding the surfaces ...



... for a structure that will be visible close-up, but for passengers that are just standing by, waiting for an airport taxi.





The welded connections on this tubular truss are basic welded connections, not particularly refined.





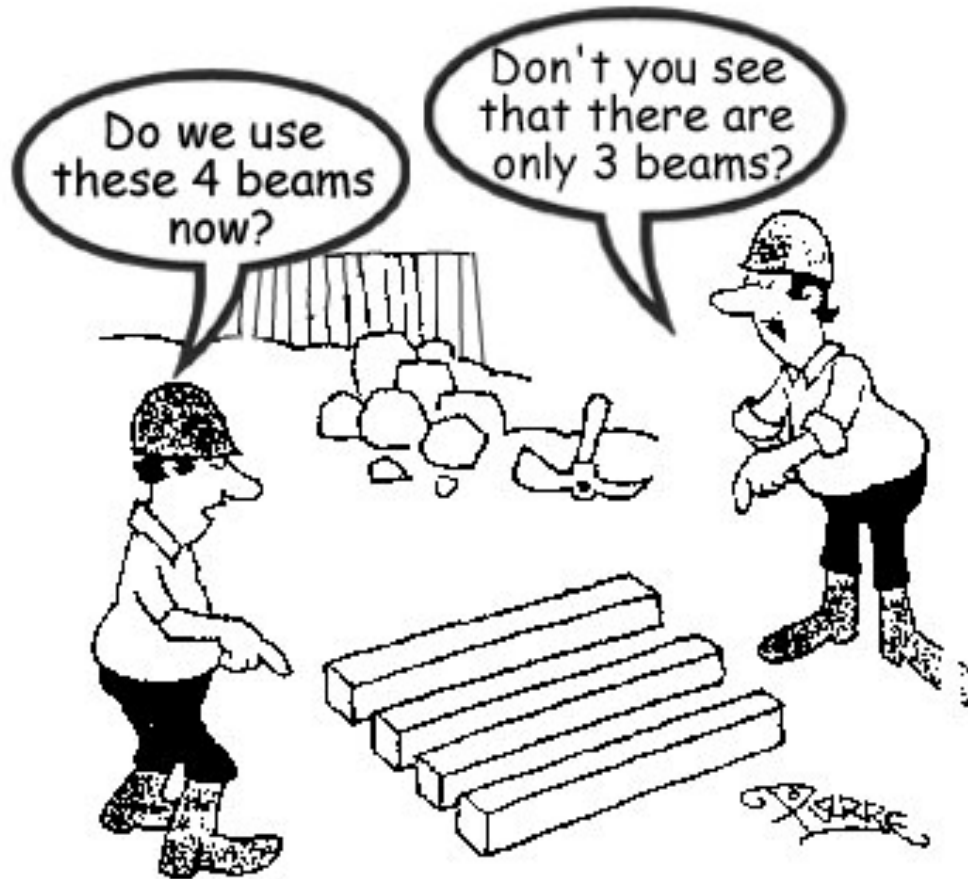
Why?

Because it doesn't matter,
given the thickness of the
coating ...



... and the distance.

Purpose of the new AESS Documents



*To find
common
ground*

*And clarify
communication*



architect

engineer

fabricator



I want nice connections!



architect



engineer



fabricator



I want nice connections!

Not all AESS *need* be created equal.



Exquisite/expensive detailing

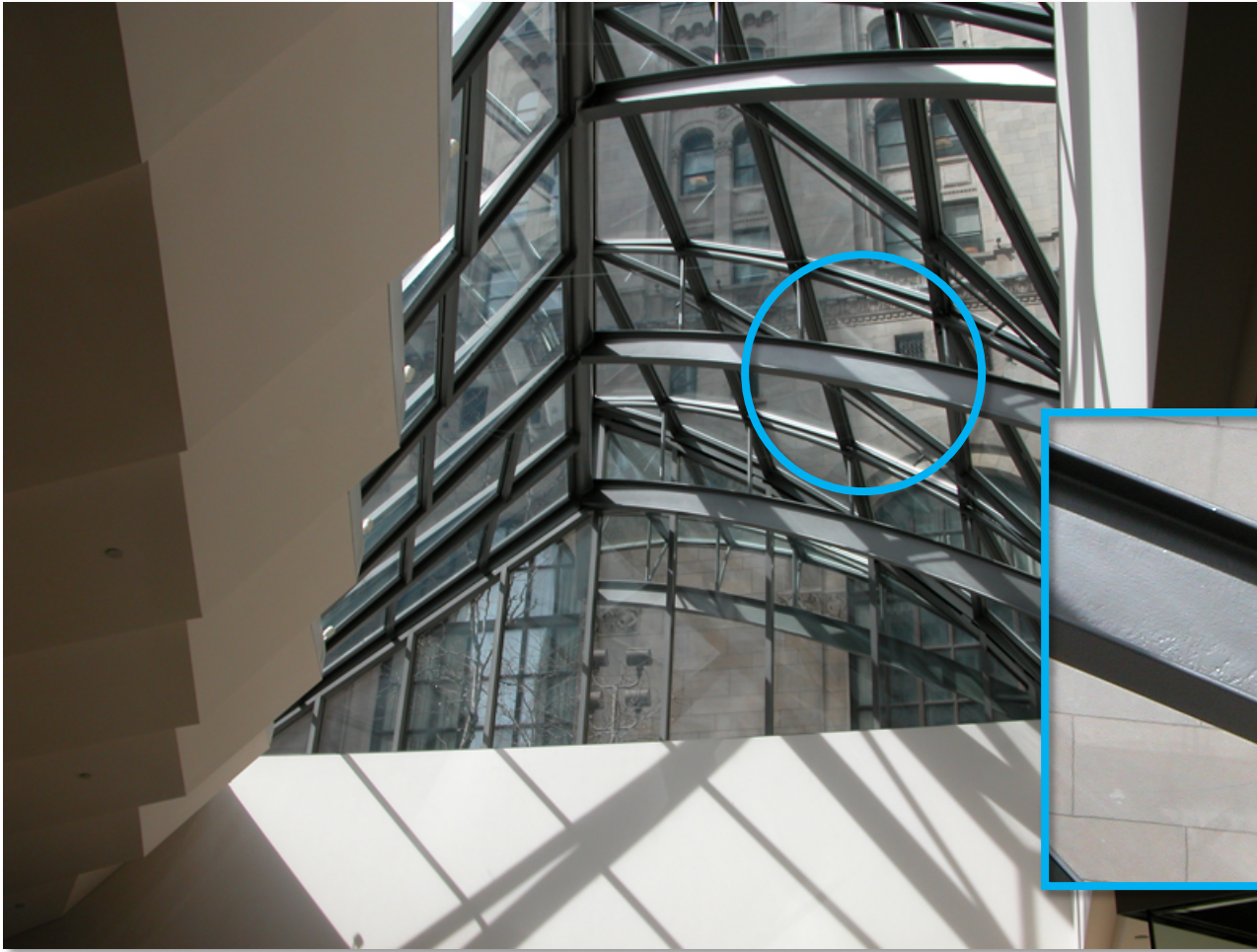


Needs to be close enough to be seen, and even touched, to be warranted





Distance should play a factor



Can
anyone
really see
this?



Distance should play a factor



City Hall Atrium



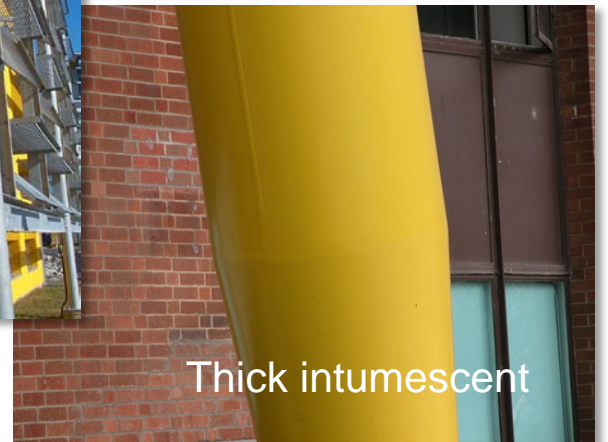
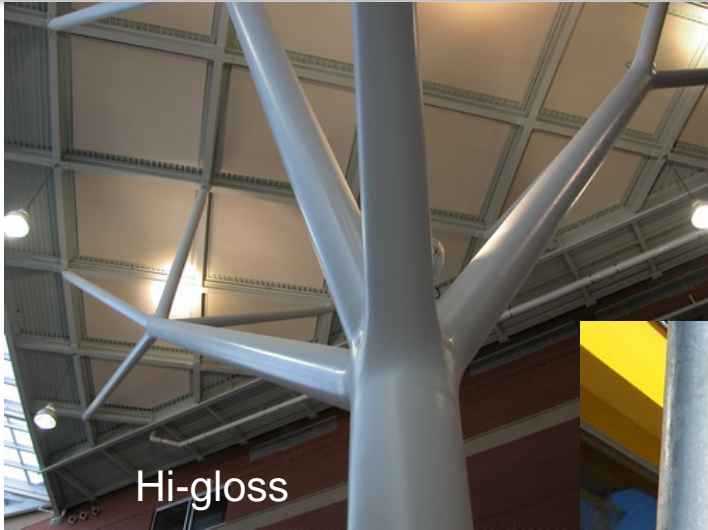
Distance should play a factor (360°)



9 Storey Atrium



Coating, protection systems should be a factor



Connection types are important differentiators





Bolts vs Welds

The choice is there....



And the AESS is very different...

AESS: Primary Factors of influence

- Distance. Visibility.
- Connections mostly bolted or welded
- Tolerances required at fabrication and erection
- Access to detail to perform required finish

- Interior or exterior setting
- Paint finish, corrosion resistance, fire protection

- Degree of expression
- Size and shape of structural elements

AESS: Primary Factors of influence

FIT

FORM

FINISH



New AESS Documents



- ✓ Subdivision of **Specification** for Structural Steel
- ✓ Fabricator's document
- ✓ Visual **Guide** for specifying AESS
- ✓ Category **Matrix**

AESS: Factors of influence

SPEC
+
CODE

GUIDE

GUIDE

MATRIX

Approximating Cost Premiums

- Discussions/roundtables made it apparent that Architects and Engineers wanted cost premiums provided
- Cost premiums could begin to differentiate the AESS Categories
- A “range” of extra cost has been included
- *The range is very wide and should only be used as a starting point for contractual discussions between the Architect, Engineer, Fabricator and Client*

Table 1 - AESS Category Matrix

Category		AESS C <i>Custom Elements</i>	AESS 4 <i>Showcase Elements</i>	AESS 3 <i>Feature Elements</i>	AESS 2 <i>Feature Elements</i>	AESS 1 <i>Basic Elements</i>	SSS <i>Standard Structural Steel</i>
Characteristics				<i>Viewed at a Distance ≤ 6 m</i>	<i>Viewed at a Distance > 6 m</i>		<i>CSA S16</i>
1.1	Surface preparation to SSPC-SP 6		√	√	√	√	
1.2	Sharp edges ground smooth		√	√	√	√	
1.3	Continuous weld appearance		√	√	√	√	
1.4	Standard structural bolts		√	√	√	√	
1.5	Weld spatters removed		√	√	√	√	
2.1	Visual Samples		optional	optional	optional		
2.2	One-half standard fabrication tolerances		√	√	√		
2.3	Fabrication marks not apparent		√	√	√		
2.4	Welds uniform and smooth		√	√	√		
3.1	Mill marks removed		√	√			
3.2	Butt and plug welds ground smooth and filled		√	√			
3.3	HSS weld seam oriented for reduced visibility		√	√			
3.4	Cross sectional abutting surface aligned		√	√			
3.5	Joint gap tolerances minimized		√	√			
3.6	All welded connections		optional	optional			
4.1	HSS seam not apparent		√				
4.2	Welds contoured and blended		√				
4.3	Surfaces filled and sanded		√				
4.4	Weld show-through minimized		√				
C.1							
C.2							
C.3							
C.4							
C.5							
	<i>Sample Use:</i>	Elements with special requirements	Showcase or dominant elements	Airports, shopping centres, hospitals, lobbies	Retail and architectural buildings viewed at a distance	Roof trusses for arenas, retail warehouses, canopies	
	<i>Estimated Cost Premium:</i>	Low to High (20-250%)	High (100-250%)	Moderate (60-150%)	Low to Moderate (40-100%)	Low (20-60%)	None 0%

Categories go from lowest at the right to highest at the left.

Table 1 - AESS Category Matrix

Category		AESS C Custom Elements	AESS 4 Showcase Elements	AESS 3 Feature Elements	AESS 2 Feature Elements	AESS 1 Basic Elements	SSS Standard Structural Steel CSA S16
Id	Characteristics			Viewed at a Distance ≤ 6 m	Viewed at a Distance > 6 m		
1.1	Surface preparation to SSPC-SP 6		✓	✓	✓	✓	
1.2	Sharp edges ground smooth		✓	✓	✓	✓	
1.3	Continuous weld appearance		✓	✓	✓	✓	
1.4	Standard structural bolts						
1.5	Weld spatters removed						
2.1	Visual Samples						
2.2	One-half standard fabrication tolerances						
2.3	Fabrication marks not apparent						
2.4	Welds uniform and smooth						
3.1	Mill marks removed		✓	✓			
3.2	Butt and plug welds ground smooth and filled		✓	✓			
3.3	HSS weld seam oriented for reduced visibility		✓	✓			
3.4	Cross sectional abutting surface aligned		✓	✓			
3.5	Joint gap tolerances minimized		✓	✓			
3.6	All welded connections		optional	optional			
4.1	HSS seam not apparent		✓				
4.2	Welds contoured and blended		✓				
4.3	Surfaces filled and sanded		✓				
4.4	Weld show-through minimized		✓				
C.1							
C.2							
C.3							
C.4							
C.5							
	Sample Use:	Elements with special requirements	Showcase or dominant elements	Airports, shopping centres, hospitals, lobbies	Retail and architectural buildings viewed at a distance	Roof trusses for arenas, retail warehouses, canopies	
	Estimated Cost Premium:	Low to High (20-250%)	High (100-250%)	Moderate (60-150%)	Low to Moderate (40-100%)	Low (20-60%)	None 0%

Viewing distance is noted as the differentiating factor between the high and low end AESS Categories.



Grinding permitted \$\$

No Grinding!!

Table 1 - AESS Category Matrix

Category		AESS C <i>Custom Elements</i>	AESS 4 <i>Showcase Elements</i>	AESS 3 <i>Feature Elements</i> <i>Viewed at a Distance ≤ 6 m</i>	AESS 2 <i>Feature Elements</i> <i>Viewed at a Distance > 6 m</i>	AESS 1 <i>Basic Elements</i>	SSS <i>Standard Structural Steel</i> CSA S16
Id	Characteristics						
1.1	Surface preparation to SSPC-SP 6		√	√	√	√	
1.2	Sharp edges ground smooth						
1.3	Continuous weld appearance						
1.4	Standard structural bolts						
1.5	Weld spatters removed						
2.1	Visual Samples						
2.2	One-half standard fabrication tolerances						
2.3	Fabrication marks not apparent		√	√	√		
2.4	Welds uniform and smooth		√	√	√		
3.1	Mill marks removed		√	√			
3.2	Butt and plug welds ground smooth and filled		√	√			
3.3	HSS weld seam oriented for reduced visibility		√	√			
3.4	Cross sectional abutting surface aligned		√	√			
3.5	Joint gap tolerances minimized		√	√			
3.6	All welded connections		optional	optional			
4.1	HSS seam not apparent		√				
4.2	Welds contoured and blended		√				
4.3	Surfaces filled and sanded		√				
4.4	Weld show-through minimized		√				
C.1							
C.2							
C.3							
C.4							
C.5							
	<i>Sample Use:</i>	Elements with special requirements	Showcase or dominant elements	Airports, shopping centres, hospitals, lobbies	Retail and architectural buildings viewed at a distance	Roof trusses for arenas, retail warehouses, canopies	
	<i>Estimated Cost Premium:</i>	Low to High (20-250%)	High (100-250%)	Moderate (60-150%)	Low to Moderate (40-100%)	Low (20-60%)	None 0%

Characteristics are listed from the most common/least expensive at the top to the more specialized at the bottom.

Table 1 - AESS Category Matrix

Category		AESS C <i>Custom Elements</i>	AESS 4 <i>Showcase Elements</i>	AESS 3 <i>Feature Elements</i>	AESS 2 <i>Feature Elements</i>	AESS 1 <i>Basic Elements</i>	SSS <i>Standard Structural Steel</i>
Characteristics				<i>Viewed at a Distance ≤ 6 m</i>	<i>Viewed at a Distance > 6 m</i>		<i>CSA S16</i>
1.1	Surface preparation to SSPC-SP 6		√	√	√	√	
1.2	Sharp edges ground smooth		√	√	√	√	
1.3	Continuous weld appearance		√	√	√	√	
1.4	Standard structural bolts		√	√	√	√	
1.5	Weld spatters removed		√	√	√	√	
2.1	Visual Samples		optional	optional	optional		
2.2	One-half standard fabrication tolerances		√	√	√		
2.3	Fabrication marks not apparent		√	√	√		
2.4	Welds uniform and smooth		√	√	√		
3.1	Mill marks removed		√	√			
3.2	Butt and plug welds ground smooth and filled		√	√			
3.3	HSS weld seam oriented for reduced visibility		√	√			
3.4	Cross sectional abutting surface aligned		√	√			
3.5	Joint gap tolerances minimized		√	√			
3.6	All welded connections		optional	optional			
4.1	HSS seam not apparent		√				
4.2	Welds contoured and blended		√				
4.3	Surfaces filled and sanded		√				
4.4	Weld show-through minimized						
C.1							
C.2							
C.3							
C.4							
C.5							

Estimated cost premiums over Standard Structural Steel are noted at the bottom.

<i>Sample Use:</i>	Elements with special requirements	Showcase or dominant elements	Airports, shopping centres, hospitals, lobbies	Retail and architectural buildings viewed at a distance	Roof trusses for arenas, retail warehouses, canopies	
<i>Estimated Cost Premium:</i>	Low to High (20-250%)	High (100-250%)	Moderate (60-150%)	Low to Moderate (40-100%)	Low (20-60%)	None 0%

Table 1 - AESS Category Matrix

AESS 1

Category

AESS C
Custom
Elements

AESS 4
Showcase
Elements

AESS 3
Feature
Elements

AESS 2
Feature
Elements

AESS 1
Basic
Elements

SSS
Standard
Structural
Steel

CSA S16

Id Characteristics

- 1.1 Surface preparation to SSPC-SP 6
- 1.2 Sharp edges ground smooth
- 1.3 Continuous weld appearance
- 1.4 Standard structural bolts
- 1.5 Weld spatters removed

- 2.1 Visual Samples
- 2.2 One-half standard fabrication tolerances
- 2.3 Fabrication marks not apparent
- 2.4 Welds uniform and smooth

- 3.1 Mill marks removed
- 3.2 Butt and plug welds ground smooth and filled
- 3.3 HSS weld seam oriented for reduced visibility
- 3.4 Cross sectional abutting surface aligned
- 3.5 Joint gap tolerances minimized
- 3.6 All welded connections

- 4.1 HSS seam not apparent
- 4.2 Welds contoured and blended
- 4.3 Surfaces filled and sanded
- 4.4 Weld show-through minimized

- C.1
- C.2
- C.3
- C.4
- C.5

Viewed at a
Distance ≤ 6 m

Viewed at a
Distance > 6 m

optional

optional

optional

optional

optional

Roof trusses
for arenas, retail
warehouses,
canopies
Cost premium: Low
(20-60%)

Sample Use:

Elements with
special
requirements

Showcase or
dominant elements

Airports,
shopping
centres,
hospitals, lobbies

Retail and
architectural
buildings viewed
at a distance

Roof trusses for
arenas, retail
warehouses,
canopies

Estimated Cost Premium:

Low to High
(20-250%)

High
(100-250%)

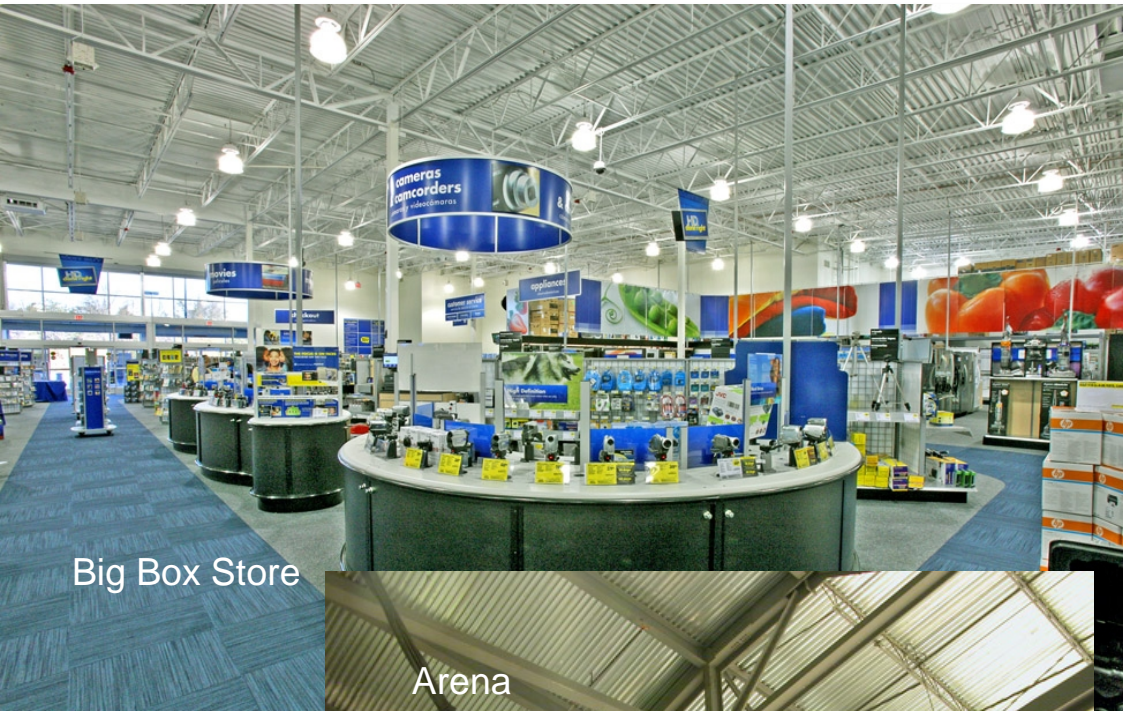
Moderate
(60-150%)

Low to Moderate
(40-100%)

Low
(20-60%)

None
0%

AESS 1 – Basic Elements



Big Box Store



Library



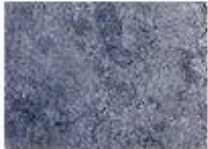
Arena

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 15



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

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

1.1 Surface preparation to SSPC-SP 6



Shot blast cleaning with
the use of abrasives

1.2 Sharp edges ground smooth



1.3 Continuous weld *appearance*



1.3 Continuous *weld appearance*



Consider carefully your reasons for welding.



1.4 Standard structural bolts

Hex bolts by default

The side on which the bolt heads should appear can be specified not the rotation!



1.4 Standard structural bolts

or TC (tension control) bolts



It is a VERY simple request,
but makes a HUGE aesthetic
difference!



1.4 Standard structural bolts





1.5 Remove weld spatter

Weld spatter prevents a quality/smooth finish as the imperfections will translate through the coatings.

Table 1 - AESS Category Matrix

AESS 2

Category

AESS C
Custom Elements

AESS 4
Showcase Elements

AESS 3
Feature Elements

AESS 2
Feature Elements

AESS 1
Basic Elements

SSS
Standard Structural Steel

CSA S16

Viewed at a Distance $\leq 6 m$

Viewed at a Distance $> 6 m$

Id	Characteristics
1.1	Surface preparation to SSPC-SP 6
1.2	Sharp edges ground smooth
1.3	Continuous weld appearance
1.4	Standard structural bolts
1.5	Weld spatters removed
2.1	Visual Samples
2.2	One-half standard fabrication tolerances
2.3	Fabrication marks not apparent
2.4	Welds uniform and smooth
3.1	Mill marks removed
3.2	Butt and plug welds ground smooth and filled
3.3	HSS weld seam oriented for reduced visibility
3.4	Cross sectional abutting surface aligned
3.5	Joint gap tolerances minimized
3.6	All welded connections
4.1	HSS seam not apparent
4.2	Welds contoured and blended
4.3	Surfaces filled and sanded
4.4	Weld show-through minimized
C.1	
C.2	
C.3	
C.4	
C.5	

		√	√	√	√
		√	√	√	√
		√	√	√	√
		√	√	√	√
		√	√	√	√
		optional	optional	optional	
		√	√	√	
		√	√	√	
		√	√	√	
		√	√	√	
		√	√	√	
		√	√	√	
		optional	optional		
		√			
		√			
		√			
		√			

Retail and architectural bldgs viewed at a distance
 Cost premium: Low to Moderate (40-100%)

Retail and architectural buildings viewed at a distance

Sample Use:

Elements with special requirements	Showcase or dominant elements	Airports, shopping centres, hospitals, lobbies	Retail and architectural buildings viewed at a distance	Roof trusses for arenas, retail warehouses, canopies	
------------------------------------	-------------------------------	------------------------------------------------	---------------------------------------------------------	------------------------------------------------------	--

Estimated Cost Premium:

Low to High (20-250%)	High (100-250%)	Moderate (60-150%)	Low to Moderate (40-100%)	Low (20-60%)	None (0%)
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AESS 2 – Feature Elements (>6m)

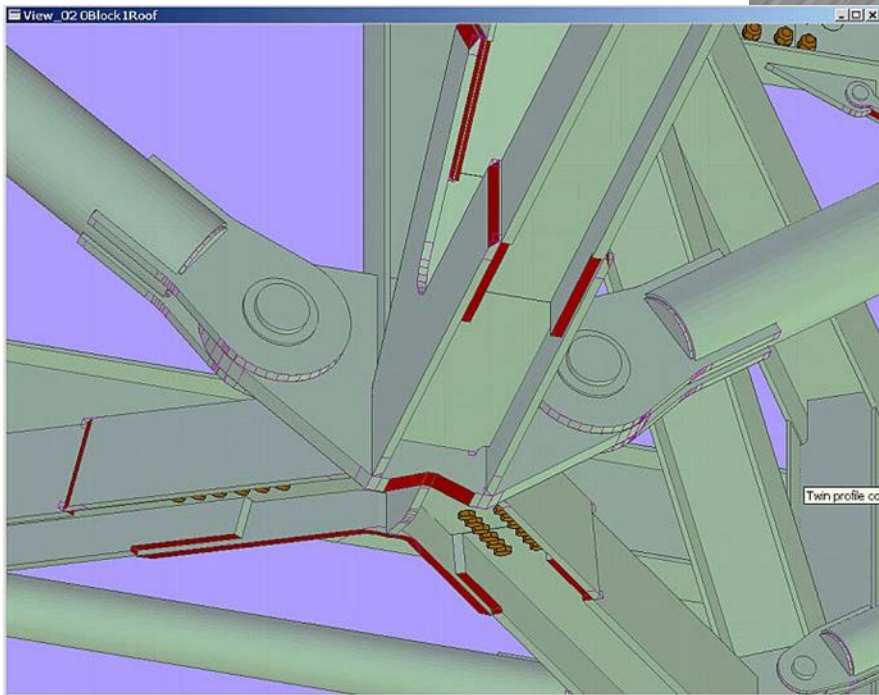


2.1 Visual Samples (optional)

1. 3-D rendering;
2. Physical sample of surface preparation and welds;
3. First off inspection; First element fabricated for use in finished structure
4. Mockups; Scaled or full-scale. Mockups are to demonstrate aesthetic effects as well as qualities of materials and execution:
 - a. May have finished surface
 - b. Architect's approval of mockups required;
 - c. Retained until project is completed;
 - d. Approved full-scale mockups may be part of work.

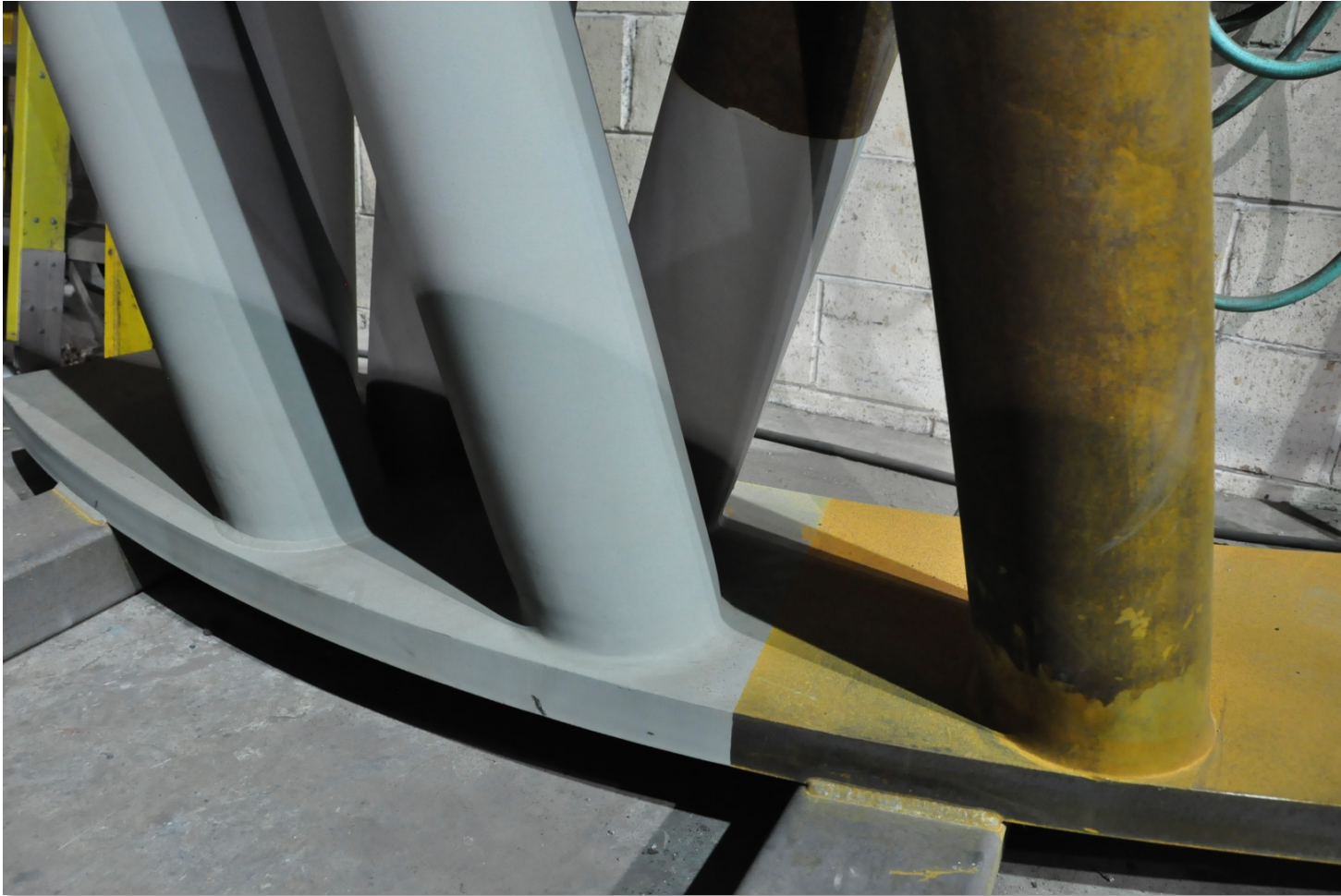
Option 1: 3-D rendering

This standard 3D image, taken from the Fabricators' detailing software, combined with built examples of previous work was enough to agree on the requirements.





Option 2: Physical Samples



Sample of base connections for World Financial Centre baskets showing the appearance of the welds with and without remediation. ▶

Option 2: Physical Samples



The client needs to understand that THIS is what the welds look like in order to make the structural connection FIRST.

Is there room to do the WORK?

Option 3: First off inspection



Element is included in the final structure. Subsequent elements may have minor modifications. ▶

Option 3: Approved first off inspection assembly

One of the “wishbones” is the full scale first off inspected assembly. Can you tell which one?



Option 4: Mock-up



When a mock-up is required....

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

- Distance
- Position
- Lighting





2.2 One-half standard fabrication tolerances

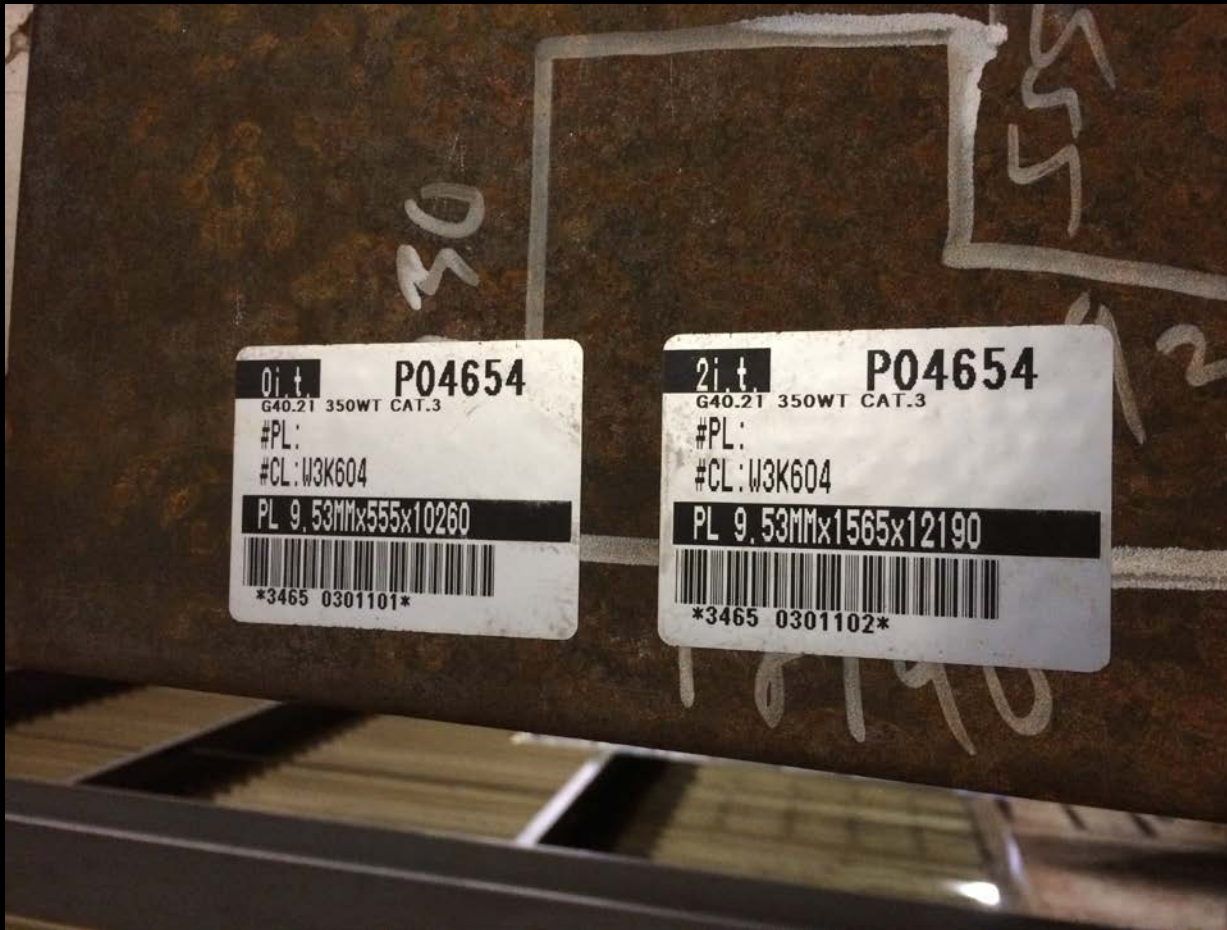


2.3 Fabrication marks *not* apparent



photo: AISC AESS Guide

2.3 Fabrication marks *not* apparent



2.4 Welds uniform and smooth



2.4 Welds uniform and smooth



3 very different welded conditions,
yet all are appropriate to the project

Table 1 - AESS Category Matrix

AESS 3

Id	Characteristics
1.1	Surface preparation to SSPC-SP 6
1.2	Sharp edges ground smooth
1.3	Continuous weld appearance
1.4	Standard structural bolts
1.5	Weld spatters removed
2.1	Visual Samples
2.2	One-half standard fabrication tolerances
2.3	Fabrication marks not apparent
2.4	Welds uniform and smooth
3.1	Mill marks removed
3.2	Butt and plug welds ground smooth and filled
3.3	HSS weld seam oriented for reduced visibility
3.4	Cross sectional abutting surface aligned
3.5	Joint gap tolerances minimized
3.6	All welded connections
4.1	HSS seam not apparent
4.2	Welds contoured and blended
4.3	Surfaces filled and sanded
4.4	Weld show-through minimized
C.1	
C.2	
C.3	
C.4	
C.5	

Category

AESS C <i>Custom Elements</i>	AESS 4 <i>Showcase Elements</i>	AESS 3 <i>Feature Elements</i> <i>Viewed at a Distance ≤ 6 m</i>	AESS 2 <i>Feature Elements</i> <i>Viewed at a Distance > 6 m</i>	AESS 1 <i>Basic Elements</i>	SSS <i>Standard Structural Steel</i> CSA S16
		✓	✓	✓	
		✓	✓	✓	
		✓	✓	✓	
		✓	✓	✓	
		✓	✓	✓	
	optional	optional	optional		
	✓	✓	✓		
	✓	✓	✓		
	✓	✓	✓		
	✓	✓	✓		
	✓	✓	✓		
	optional	optional			
	✓				
	✓				
	✓				
	✓				

Airports, shopping centres, hospitals, lobbies
 Cost premium: Moderate (60-150%)

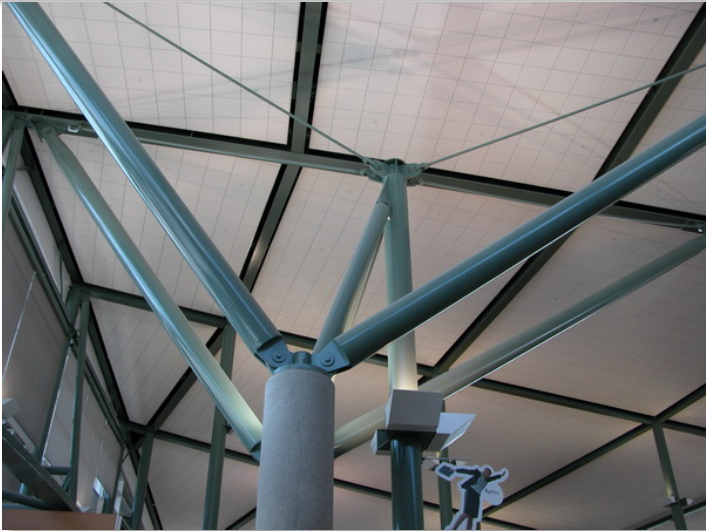
Sample Use:

Elements with special requirements	Showcase or dominant element	Airports, shopping centres, hospitals, lobbies	Retail and architectural buildings viewed at a distance	Roof trusses for arenas, retail warehouses, canopies	
------------------------------------	------------------------------	------------------------------------------------	---------------------------------------------------------	------------------------------------------------------	--

Estimated Cost Premium:

Low to High (20-250%)	High (100-250%)	Moderate (60-150%)	Low to Moderate (40-100%)	Low (20-60%)	None 0%
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AESS 3 – Feature Elements ($\leq 6m$)

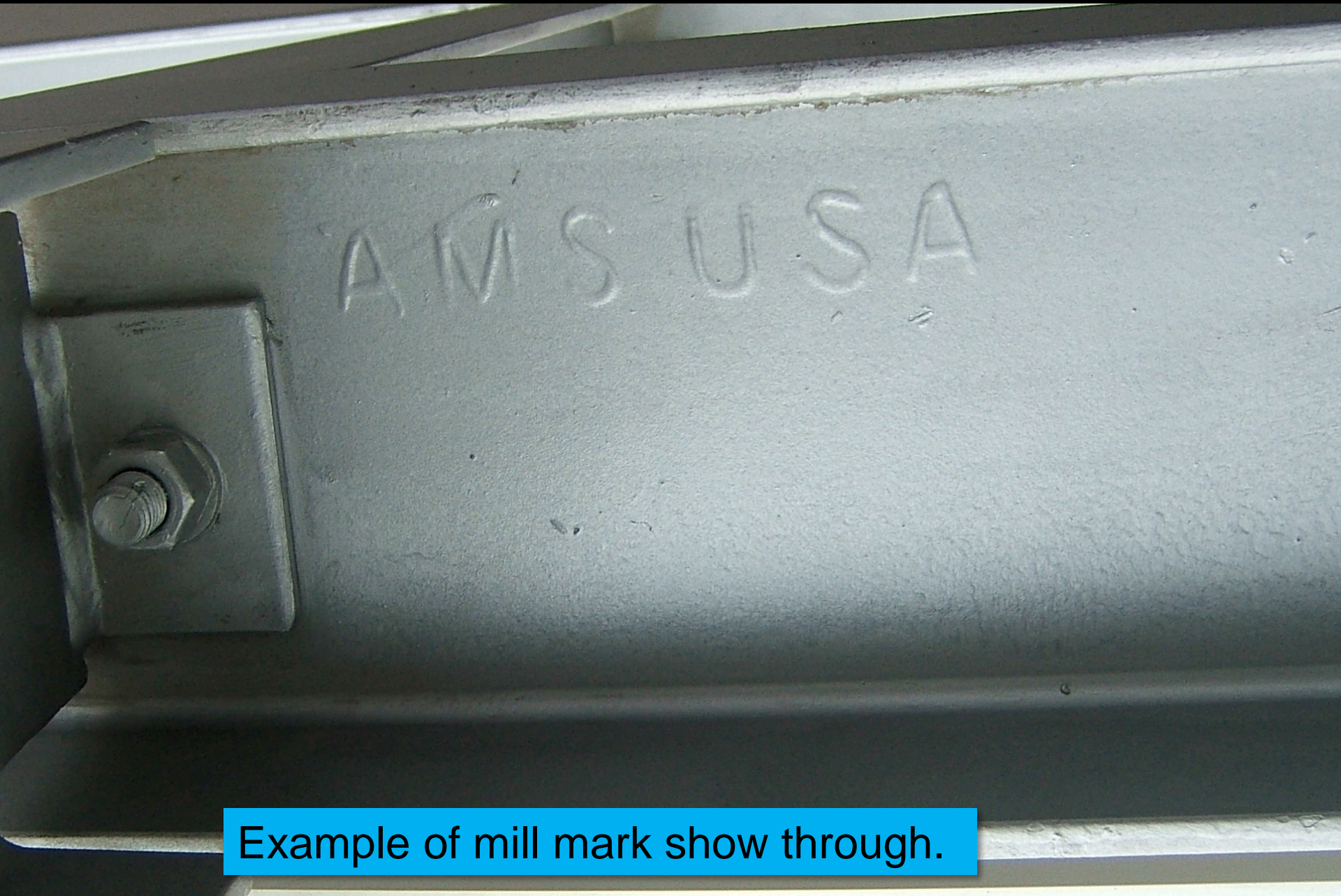


3.1 Mill marks removed



photo: AISC AESS Guide

Grinding first appears in AESS 3!

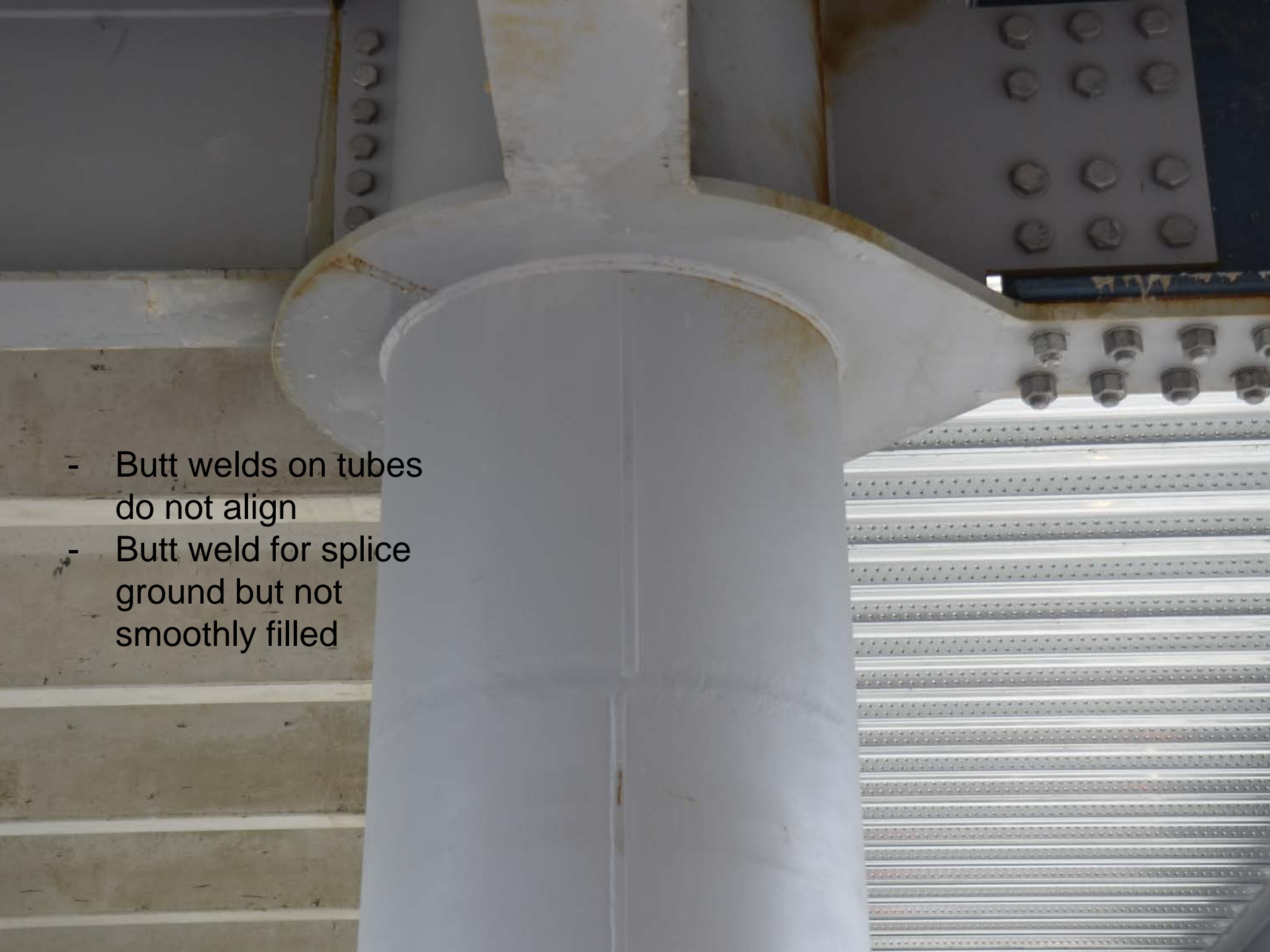



Example of mill mark show through.

3.2 Butt and plug welds ground smooth and filled



Right side shows groove weld ground smooth.

- 
- Butt welds on tubes do not align
 - Butt weld for splice ground but not smoothly filled


A close-up photograph of a white metal joint. The image shows a vertical column on the right and a horizontal channel on the left. The joint is made of round plug welds, which are barely visible as faint, circular indentations. There is some rust and discoloration at the top of the joint. The background is dark, suggesting an indoor or shaded outdoor setting.

- Very faint traces of
the round plug
welds visible that
join the column with
the channel

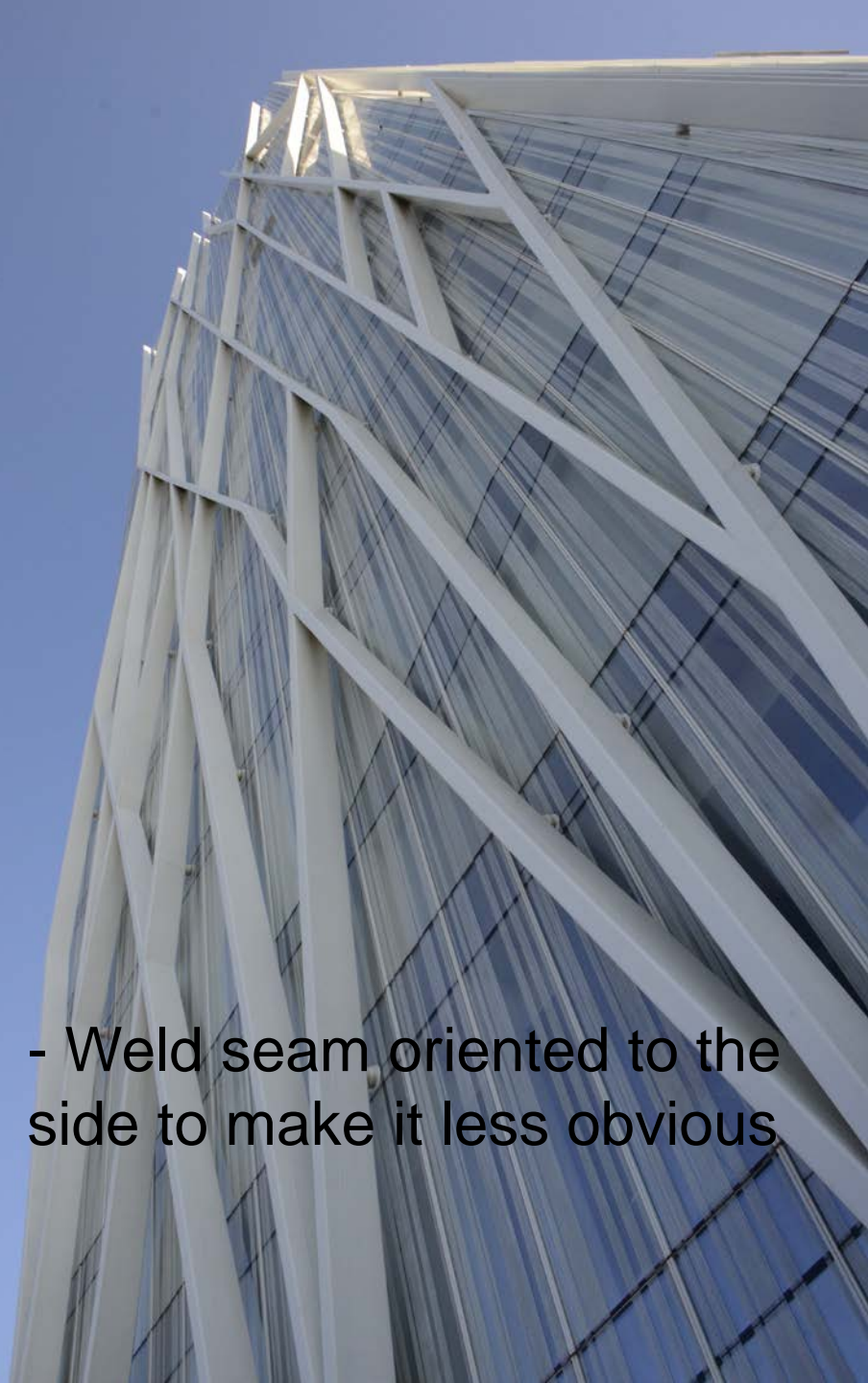


3.3 HSS weld seam oriented for reduced visibility





- Weld seam could
have been turned to
face the window



- Weld seam oriented to the side to make it less obvious



3.4 Cross sectional abutting surface aligned

3.5 Joint gap tolerances minimized



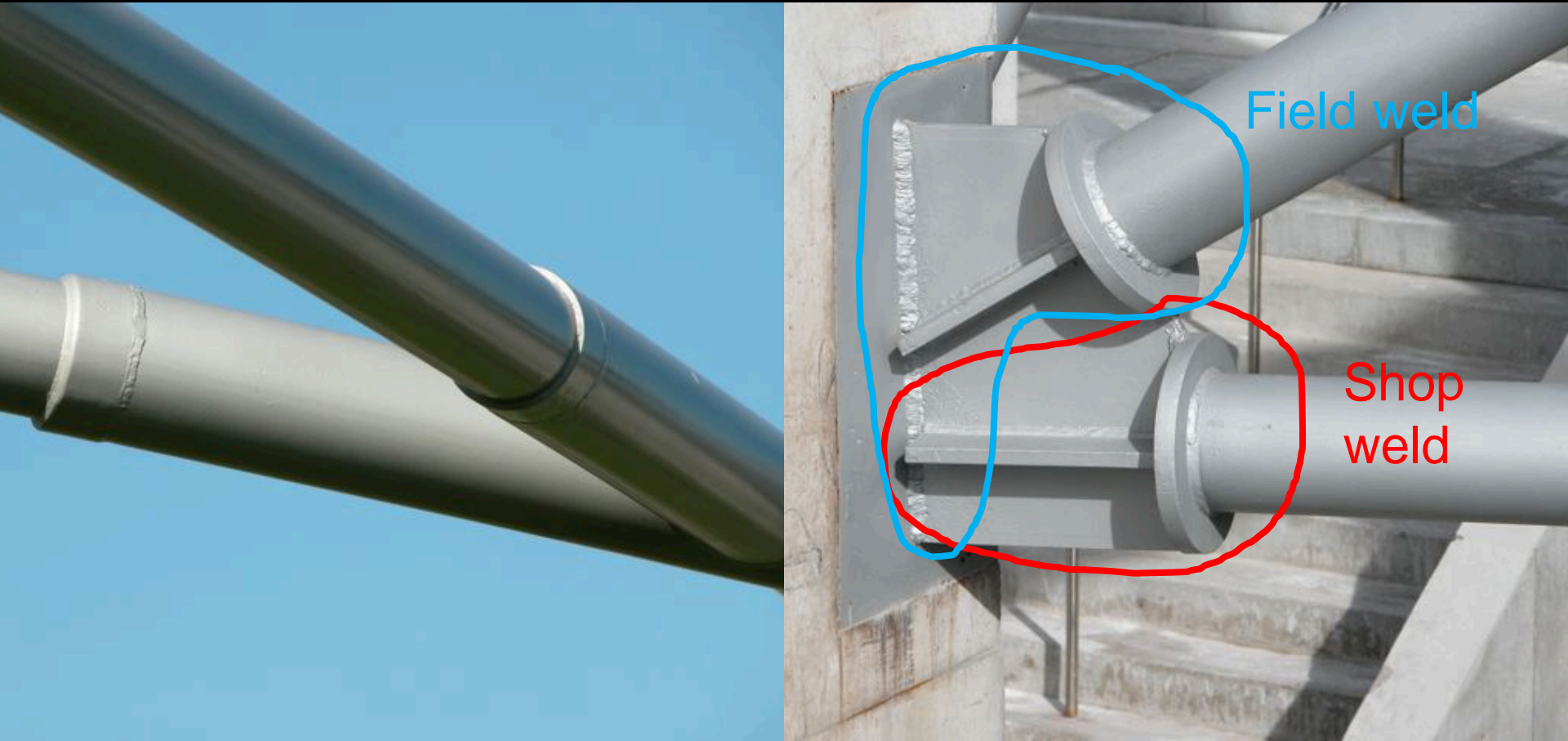
3.5 Joint gap tolerances minimized



Required to accommodate complexity and alignment



3.6 All welded connections (optional)



Requires skilled field welder.

Welded connections

The Abilities Centre in Whitby, Ontario, uses curved steel to create the top and bottom chords of these large, long span trusses over the rink area of the sports facility.



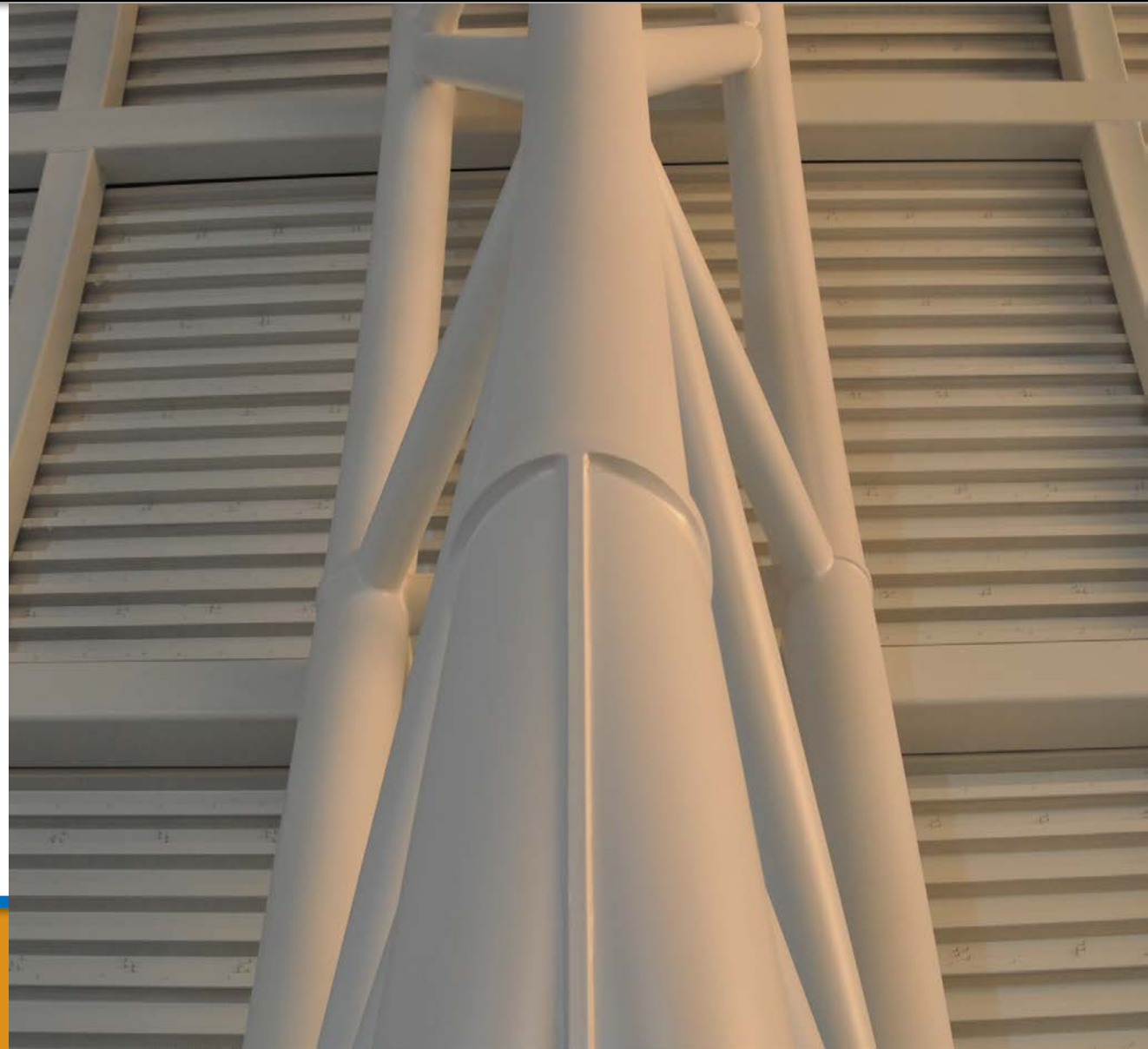
Welded connections

The connection between the curved “vertical” truss and the long horizontal members have been done as to be invisible. The AESS4 level of this project requires impeccable workmanship.



Welding choices

It is not always necessary to hide connections. Here plates are used between the joining elements of the truss to accentuate the detail. This is easier to accomplish than a fully blended weld, and truly adds elegance to the detail.



3.6 All welded connections (optional)



Requires access and remediation to remove the markings from the temporary bolted connections.

3.6 All welded connections (optional)



Discreet bolts can be proposed as unobtrusive.

Unobtrusive connections



Even where design governs, there are alternates to field welding

Hidden connections or splices

Where site welding might be problematic, make parties aware that bolted connections may be effectively “hidden”



Hidden connections or splices

This hidden connection must also be weatherproof





A bolted connection can be used for a splice. A simple sleeve is fitted over the connection to provide continuity of appearance.

Table 1 - AESS Category Matrix

AESS 4

Category

AESS C
Custom Elements

AESS 4
Showcase Elements

AESS 3
Feature Elements

AESS 2
Feature Elements

AESS 1
Basic Elements

SSS
Standard Structural Steel

CSA S16

Viewed at a Distance ≤ 6 m

Viewed at a Distance > 6 m

Id	Characteristics
1.1	Surface preparation to SSPC-SP 6
1.2	Sharp edges ground smooth
1.3	Continuous weld appearance
1.4	Standard structural bolts
1.5	Weld spatters removed
2.1	Visual Samples
2.2	One-half standard fabrication tolerances
2.3	Fabrication marks not apparent
2.4	Welds uniform and smooth
3.1	Mill marks removed
3.2	Butt and plug welds ground smooth and filled
3.3	HSS weld seam oriented for reduced visibility
3.4	Cross sectional abutting surface aligned
3.5	Joint gap tolerances minimized
3.6	All welded connections
4.1	HSS seam not apparent
4.2	Welds contoured and blended
4.3	Surfaces filled and sanded
4.4	Weld show-through minimized
C.1	
C.2	
C.3	
C.4	
C.5	

✓	✓	✓	✓
✓	✓	✓	✓
✓	✓	✓	✓
✓	✓	✓	✓
✓	✓	✓	✓
optional	optional	optional	
✓	✓	✓	
✓	✓	✓	
✓	✓	✓	
✓	✓	✓	
✓	✓	✓	
✓	✓	✓	
optional	optional		
✓	✓		
✓	✓		
✓	✓		
✓	✓		

Showcase or dominant elements, sculptures
Cost premium: High (150-250%)

Sample Use:

Elements with special requirements	Showcase or dominant elements	Airports, shopping centres, hospitals, lobbies	Retail and architectural buildings viewed at a distance	Roof trusses for arenas, retail warehouses, canopies
------------------------------------	-------------------------------	------------------------------------------------	---------------------------------------------------------	------------------------------------------------------

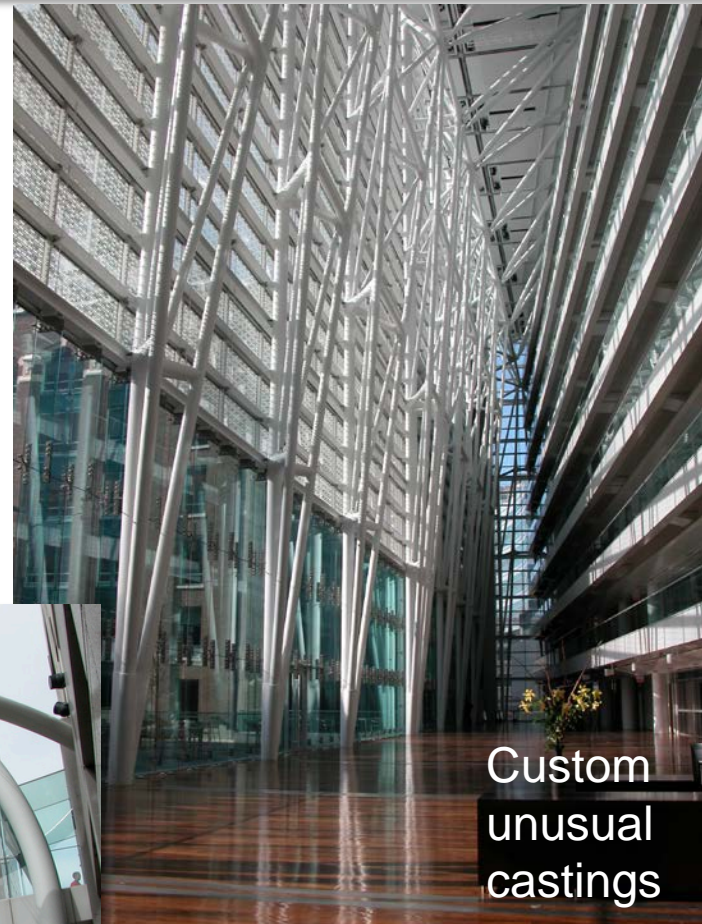
Estimated Cost Premium:

Low to High (20-250%)	High (100-250%)	Moderate (60-150%)	Low to Moderate (40-100%)	Low (20-60%)	None 0%
-----------------------	-----------------	--------------------	---------------------------	--------------	---------

AESS 4 - Showcase or dominant elements



Custom
platework +
sharp
edges

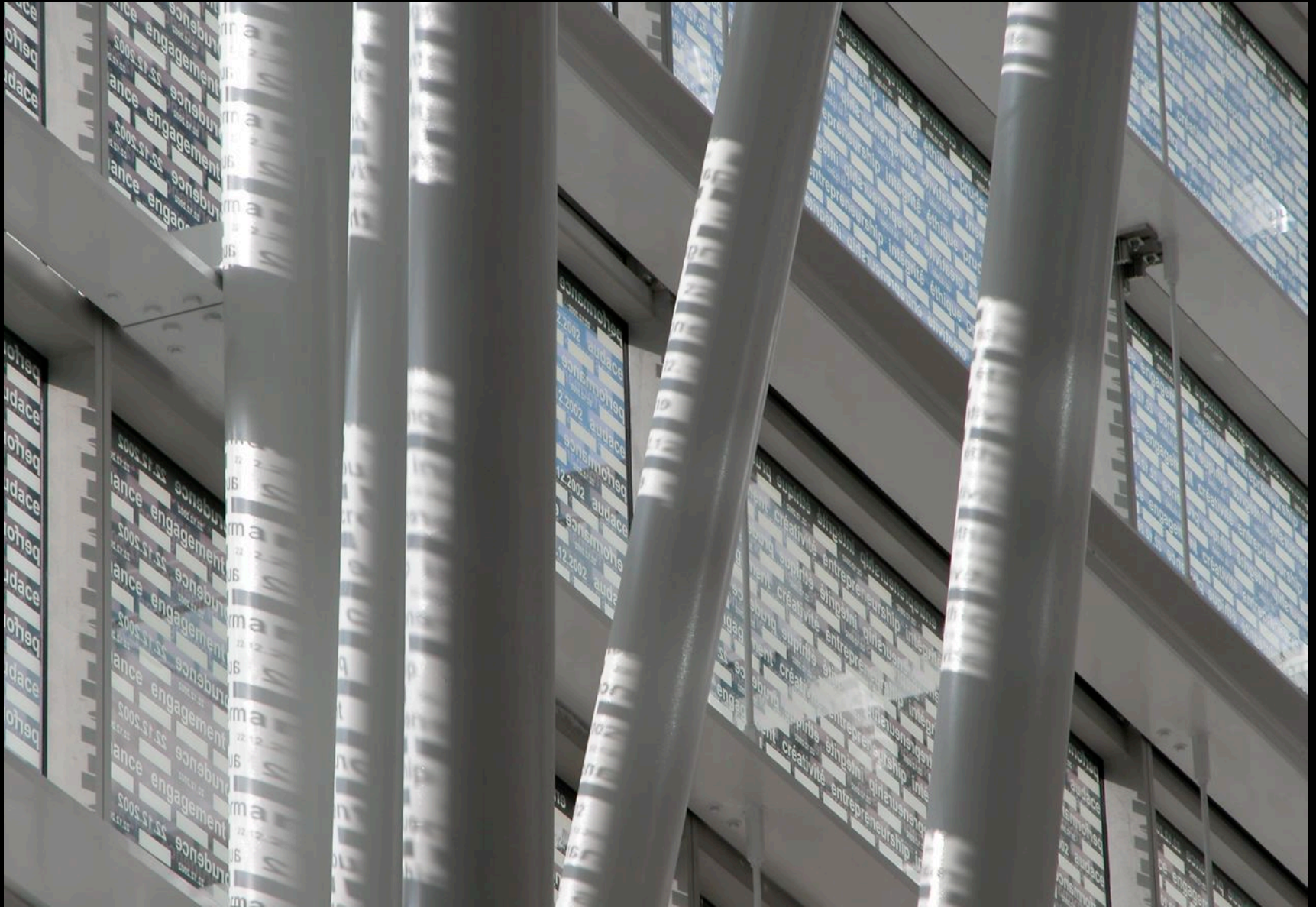


Custom
unusual
castings

Large
curved
members



4.1 HSS seam not apparent



4.1 HSS seam not apparent



Exposed columns should make orientation of seams consistent and ensure splices such as the one at right are better done.

4.2 Welds contoured and blended



TYPICAL STRUCTURAL
STEEL WELDS

WELDS CONTOURED
& BLENDED

4.2 Welds contoured and blended



4.3 Surfaces filled and sanded



4.4 Weld show-through minimized

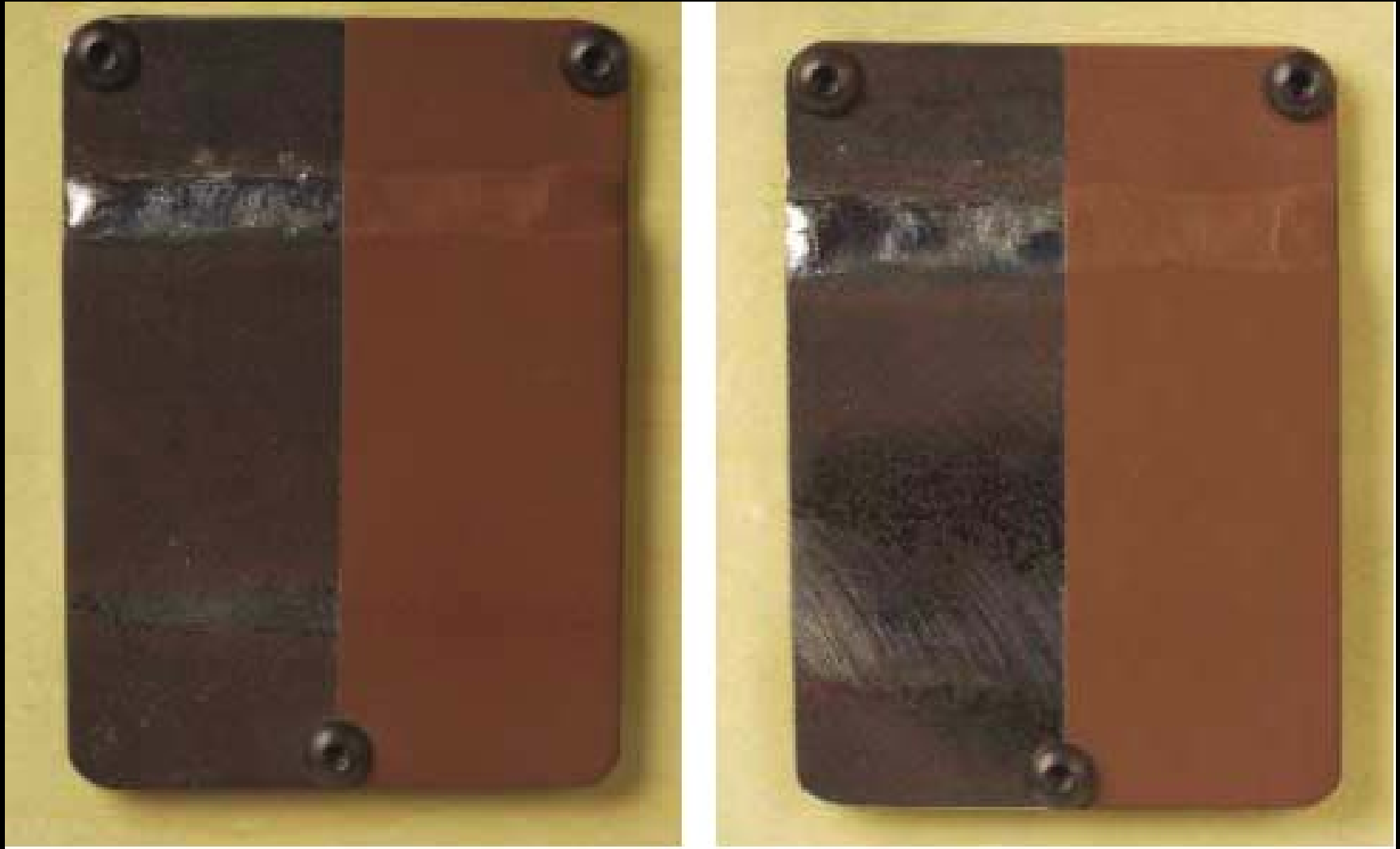


Table 1 - AESS Category Matrix

AESS C		<i>Category</i>	AESS C <i>Custom Elements</i>	AESS 4 <i>Showcase Elements</i>	AESS 3 <i>Feature Elements</i>	AESS 2 <i>Feature Elements</i>	AESS 1 <i>Basic Elements</i>	SSS <i>Standard Structural Steel</i> CSA S16
<i>Id</i>	<i>Characteristics</i>				<i>Viewed at a Distance ≤ 6 m</i>	<i>Viewed at a Distance > 6 m</i>		
1.1	Surface preparation to SSPC-SP 6		√	√	√	√		
1.2	Sharp edges ground smooth		√	√	√	√		
1.3	Continuous weld appearance		√	√	√	√		
1.4	Standard structural bolts		√	√	√	√		
1.5	Weld spatters removed		√	√	√	√		
2.1	Visual Samples		optional	optional	optional			AESS1-4 are NEVER modified!
2.2	One-half standard fabrication tolerances		√	√	√			
2.3	Fabrication marks not apparent		√	√	√			
2.4	Welds uniform and smooth		√	√	√			
3.1	Mill marks removed		√	√				This section is for those who have unusual requirements or are confident enough to create their own set of requirements
3.2	Butt and plug welds ground smooth and filled		√	√				
3.3	HSS weld seam oriented for reduced visibility		√	√				
3.4	Cross sectional abutting surface aligned		√	√				
3.5	Joint gap tolerances minimized		√	√				
3.6	All welded connections		optional	optional				
4.1	HSS seam not apparent		√					
4.2	Welds contoured and blended		√					
4.3	Surfaces filled and sanded		√					
4.4	Weld show-through minimized		√					
C.1								
C.2								
C.3								
C.4								
C.5								
	<i>Sample Use:</i>	Elements with special requirements	Showcase or dominant elements	Airports, shopping centres, hospitals, lobbies	Retail and architectural buildings viewed at a distance	Roof trusses for arenas, retail warehouses, canopies		
	<i>Estimated Cost Premium:</i>	Low to High (20-250%)	High (100-250%)	Moderate (60-150%)	Low to Moderate (40-100%)	Low (20-60%)	None 0%	

Re-used / Sustainable Steel

- An increasing number of projects are making use of re-used steel to be sustainable
- Some of these projects choose to leave the steel exposed to “celebrate” its re-use
- A Custom spec will be required for such projects as the demounting, transportation, re-erection of the steel will be unique and vary by project

Adaptive Re-use



- Project used an old steam locomotive shed
- Repurposed for offices and a grocery store
- Most of the steel was left in its original condition to show off the reuse

- Other was “cleaned up and repainted, leaving the original rivets exposed.



Highlight Re-used Elements



Steel beams saved from demolition were reused to support the roof.





Rivets





CISC
Guide for Specifying
Architecturally Exposed
Structural Steel

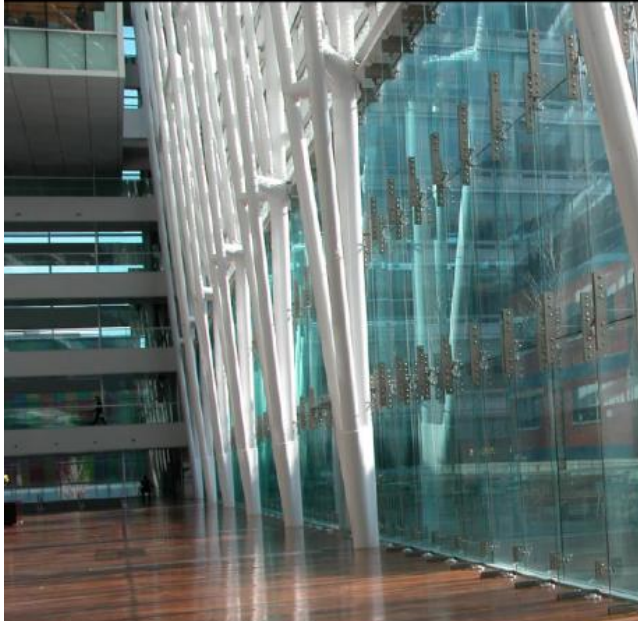


cisc  **icca**

by Terri Meyer Boake

Added Topics in the AESS Guide

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Acknowledgements:

This publication would not have been possible without the input of a great many dedicated people in the steel industry. I would particularly like to thank Walter Koppelaar for letting me learn the trade through my experience of the fabrication and erection of several key projects. Also to Sylvie Boulanger for working through all the details of AESS with unparalleled enthusiasm. Also to everyone at CISC who made me feel very much part of the family.

It is sincerely hoped that this guide will assist in leveraging the position, ease and use of Architecturally Exposed Structural Steel in the Canadian building industry.

CISC Guide for Specifying Architecturally Exposed Structural Steel

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The AESS Guide for the Architects includes all of the technical issues addressed in the Spec and Code

Additional Topics

5 Connections

General Issues
Connection Mock-Ups
Which Type of Connection Should I Choose?
Bolted Connections
Welded Connections
Cast Connections

6 Curves & Cuts

Designing for Complex Curves and Cuts
Bending
Elliptical Tubes
Hole Punching and Drilling
Shearing, Plasma Cutting and Torch

7 Erection & Challenges

Best Practices
Transportation Issues
Care in Handling
Erection Issues
Staging and Site Area Requirements
Steel and Timber
Steel and Glass

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Disclaimer:

It is not the intention of the CISC AESS Committee that the projects and details included in this Guide should be replicated or necessarily represent "best practices". They are included only to hopefully allow for a better understanding of the visual intentions of the practices and procedures outlined in the Guide and related specification documents - understanding that "a picture might be worth a thousand words".

Image credits:

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p

1 The Challenge

What is AESS?

Architecturally Exposed Structural Steel, AESS, is steel that must be designed to be both structurally sufficient to support the primary needs of the structure of the building, canopies or ancillary structures, while at the same time be exposed to view, and therefore is a significant part of the architectural language of the building. The design, detailing and finish requirements of AESS will typically exceed that of regular structural steel that is normally concealed by other finishes.

The Evolution of Architecturally Exposed Structural Steel:

The basic understanding of steel construction lies in its roots as an "assembled", largely pre-fabricated methodology. Steel construction is "elemental" in nature, and its artistry reliant on not only the appropriate choice of members (shapes versus tubes), but also heavily on the method of attachment. AESS steel design requires detailing that can approach "industrial design standards" when creating joints between members. The structural requirements of shear and moment resistance must be accommodated, along with tighter dimensional tolerances, along with "other" considerations such as balance, form, symmetry and economy. If the creation of connections requires an excessive degree of unique fabrication details, the designer can price the project out of existence. The method of preparation and finishing of the connections can also radically increase costs. Specialized welds and unnecessary ground and filed finishes increase fabrication and erection expenses.

Much of the architectural "enjoyment" as well as "challenge" in designing with AESS is in the creation of the key details and connections that give the structure its distinctive character. After the primary choice of member type and "system" (shape vs. tube), the challenge lies in determining the method of connection - welding vs. bolting, and ultimately the "Design" of the joint itself. Whereas designers tend not to be involved in connection issues for concealed structural systems, exposed systems become the architectural trademark of the building, hence requiring much involvement. Compositional issues usually necessitate the addition of "extra" steel at the joints to create a "beautiful" connection. Unfortunately not all designers are adequately informed either to choosing appropriate methods of attachment or to the cost implications of their choices.

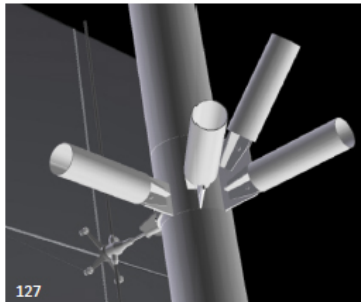
The surge in the use of AESS has created a paradigm shift in the sequential communication that usually takes place in a more conventional building where the steel structure is hidden. The ar-



...with more information and image references on:

- Maintenance & design
- Coatings & finishes
- Connections
- Member types
- Curves & Cuts
- Erection issues
- Steel with glass
- Steel with timber

Connection Design



127

3-D modelled detail as can be used to verify connection details through a digital mock-up.



128

Tubular members can be connected using very inventive means. This combination of plates allows for constructability, minimal on site welding and enhanced interest in appearance.



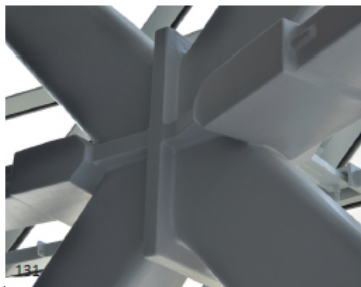
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This connection has taken care to align the required intermittent welds with the bolts. This avoided unnecessary welding or filling.



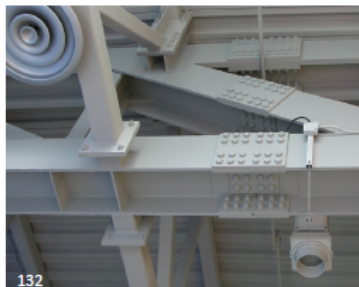
130

This building uses extensive diagrids formed with I sections. These are very simply attached using bolted splice plates on both sides of the flange.



131

This heavy connection in a diagrid uses welding in combination with plates and RHS members to aesthetically handle the large load paths in this node.



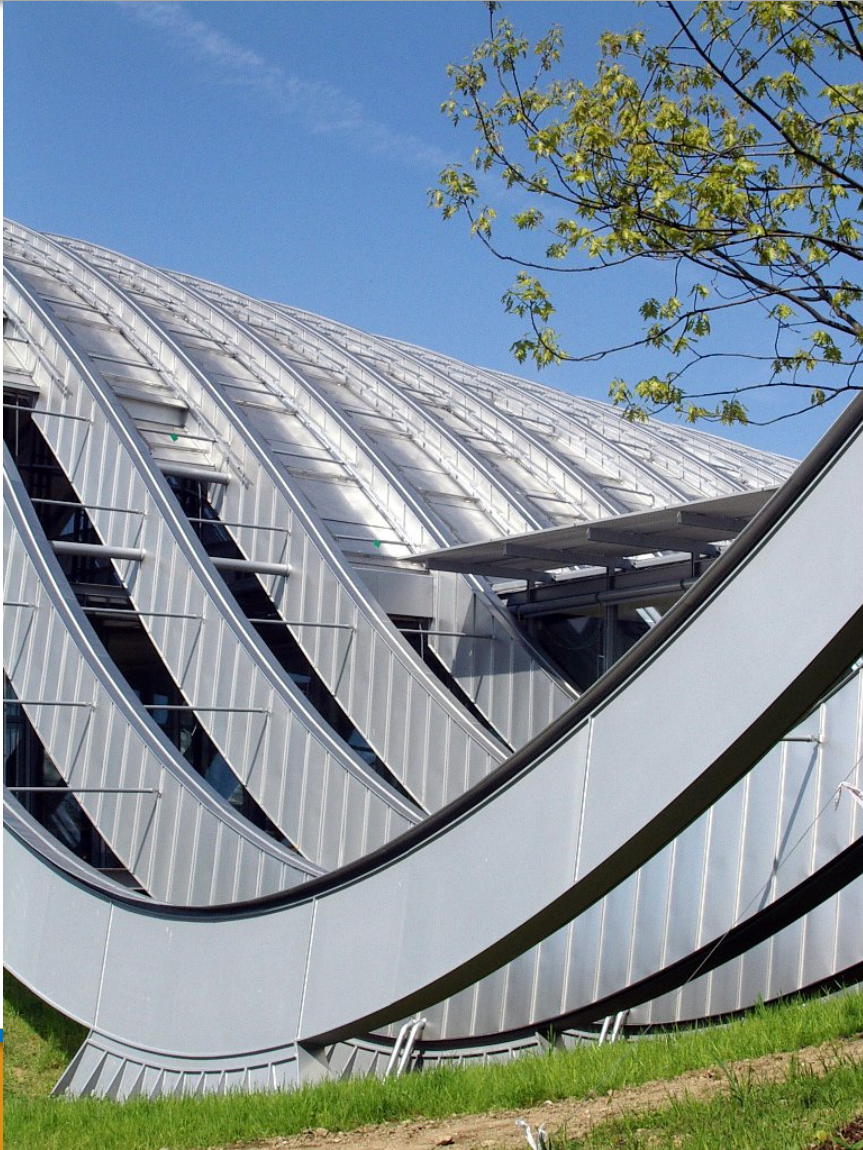
132

Varying approaches to bolting are used to achieve the splicing of the I sections and the joining of the SHS members to the truss.

SELECTING A CONNECTION TYPE

- A huge impact on detailing!
- Impacts fabrication costs
- Impacts erection and constructability
- Impacts timing of the project
- Impacts transportation
- How big are the pieces
- How much can be assembled in the shop?
- BOLTS VS. WELDS
- SHAPES VS. TUBES

Coatings & Finishes



- The protection type and finish **MUST** be known at the beginning of design.
- The level of gloss will either mask or reveal minute imperfections.

Coatings and finishes are covered in their respective specs, not in the AESS spec.



EXTERIOR VS INTERIOR FINISHES

- Water, snow and weathering are obvious issues here. Steel must be detailed so that moisture does not get trapped inside, causing the structure to rust out.
- Some details create ledges that will trap snow and meltwater.
- Some arrangements will also collect dirt and provide roosts for pigeons.

Primers & Painting

SHOP VS SITE PAINTING

- Quality is better with shop painting
- Shop painting is less costly
- Shop painted steel requires better care and handling during transportation, site staging and erection
- Anticipate that some touch up work will be required

PRIMERS

- A BIG caution note here!
- Each type of final finish requires a DIFFERENT primer
- Incompatible primers must be removed
- Especially important with intumescent fire protection.
- Some steel does not need a primer – cost and environmental savings!

Intumescent coatings

- Acrylic

Commercial/architectural applications, mostly interior, field applied

- water based

- longer to dry, more fragile, but “greener”, for interior

- solvent based

- faster, most common use, robust, mostly interior setting but also exterior

- Epoxy

Industrial applications, ext. or int., shop applied

- very fast to dry, very resistant (also anti-corrosion)



Intumescent coatings have become a widely used way of expanding the application of exposed steel, but have major ramifications when specifying the level of fit and form on a project!

Solvent based intumescent being site applied.

Intumescent Issues



- The finish is not the same as paint – it has an orange peel like texture
- Intumescent coatings will NOT provide a precise colour match to adjacent paint
- Must be top coated against damage
- Should be detailed to allow for routine repair and refinishing

When you need corrosion protection ...



- Galvanizing
- Hot Metal Spray (metalizing)
- Paint systems
- Intumescent coatings (epoxy) ▶
- Weathering steel
- Stainless steel

Corrosion + Fire Protection



Support legs covered with a shop applied epoxy intumescent coating.

Requires additional care during erection to protect (and repair) the surfaces.



THE ENGINEER AND FABRICATOR SAY ABOUT
GALVANIZED STEEL:

It was NEVER meant to be a “FINISH”!
It is a corrosion protection system!

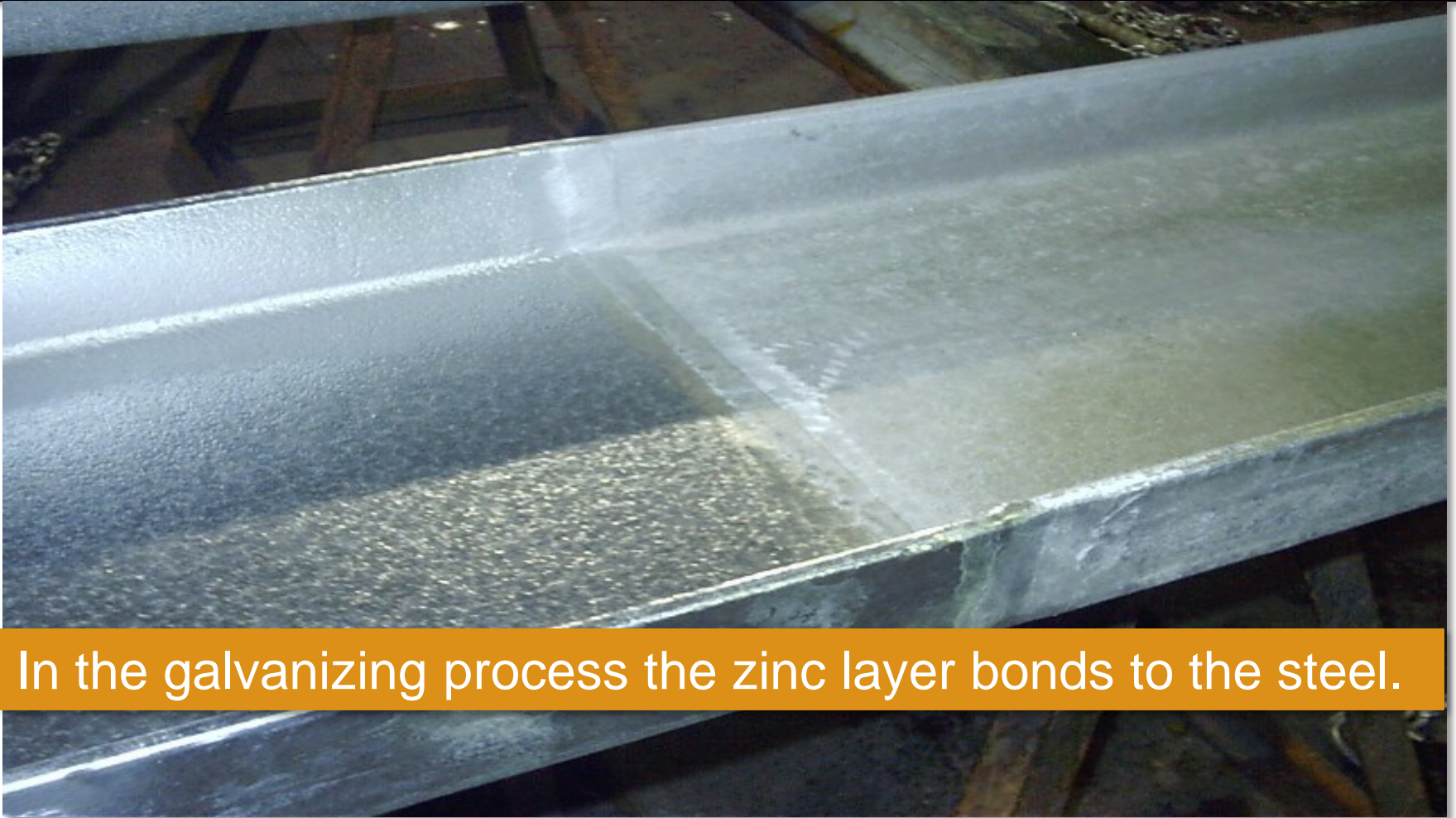
THE ARCHITECT SAYS:

But it looks so cool! I want it as a FINISH – can you make it
look consistent please??

What impacts the final look of galvanized steel?

- Impurities, presence of certain chemicals, especially silicon
- Steel origin from several different heats
- Thickness of material: too thin, too different
- Access to all surfaces being dipped
- Size of pieces of steel

Differences between heats of steel!



In the galvanizing process the zinc layer bonds to the steel.

Galvanizing Applications



Access for cleaning (and re-painting)



Also included! Sections on:



Erection & Challenges

- Best Practices
- Transportation Issues
- Care in Handling
- Erection Issues
- Staging and Site Area Requirements
- Steel and Wood
- Steel and Glass
- Curved Steel



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

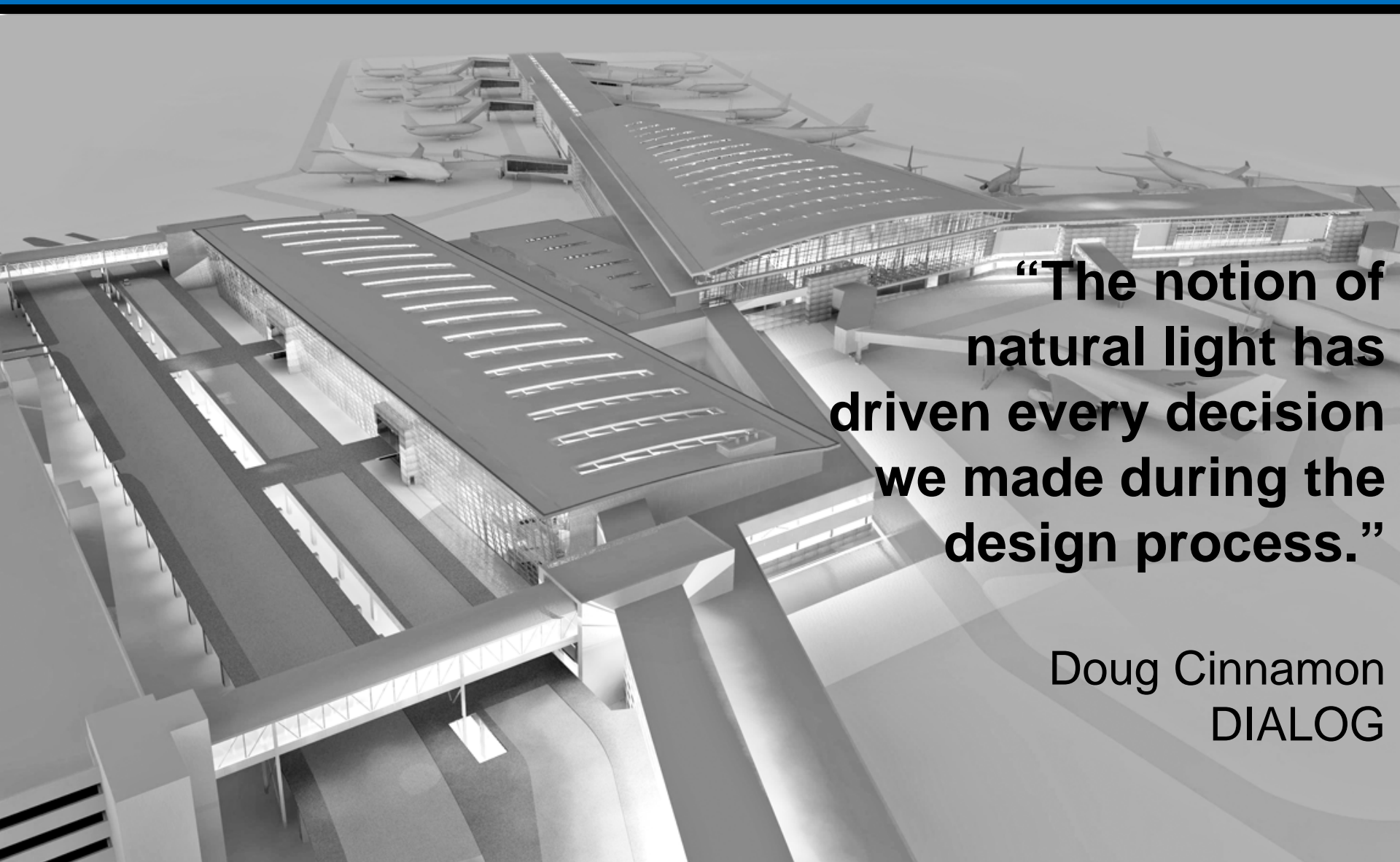


Photo credits this section: Supermétal

Content: Sylvie Boulanger, Vice President, Technical Marketing

Calgary Airport International Facilities Project

image: DIALOG

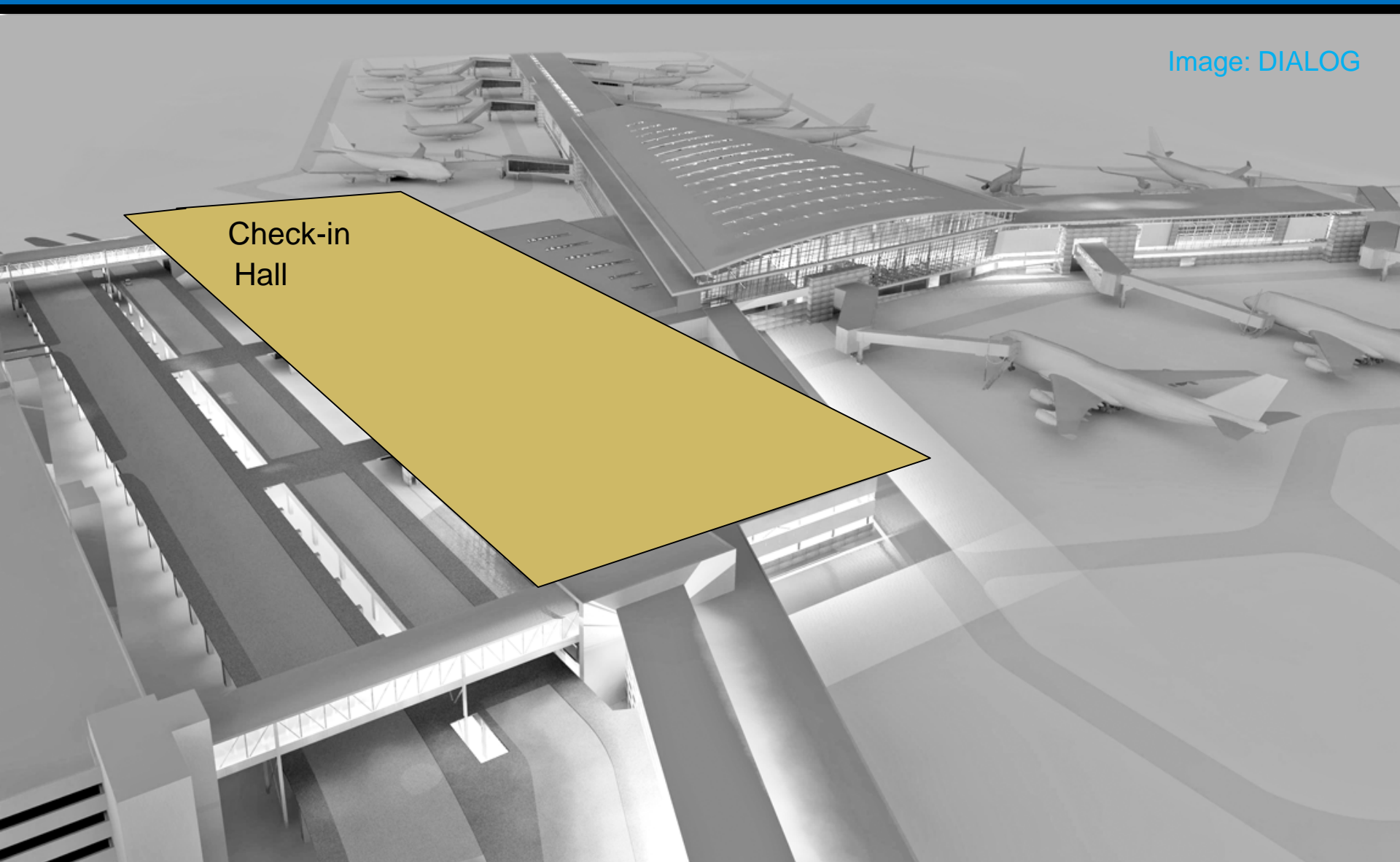


“The notion of natural light has driven every decision we made during the design process.”

**Doug Cinnamon
DIALOG**

Calgary Airport International Facilities Project

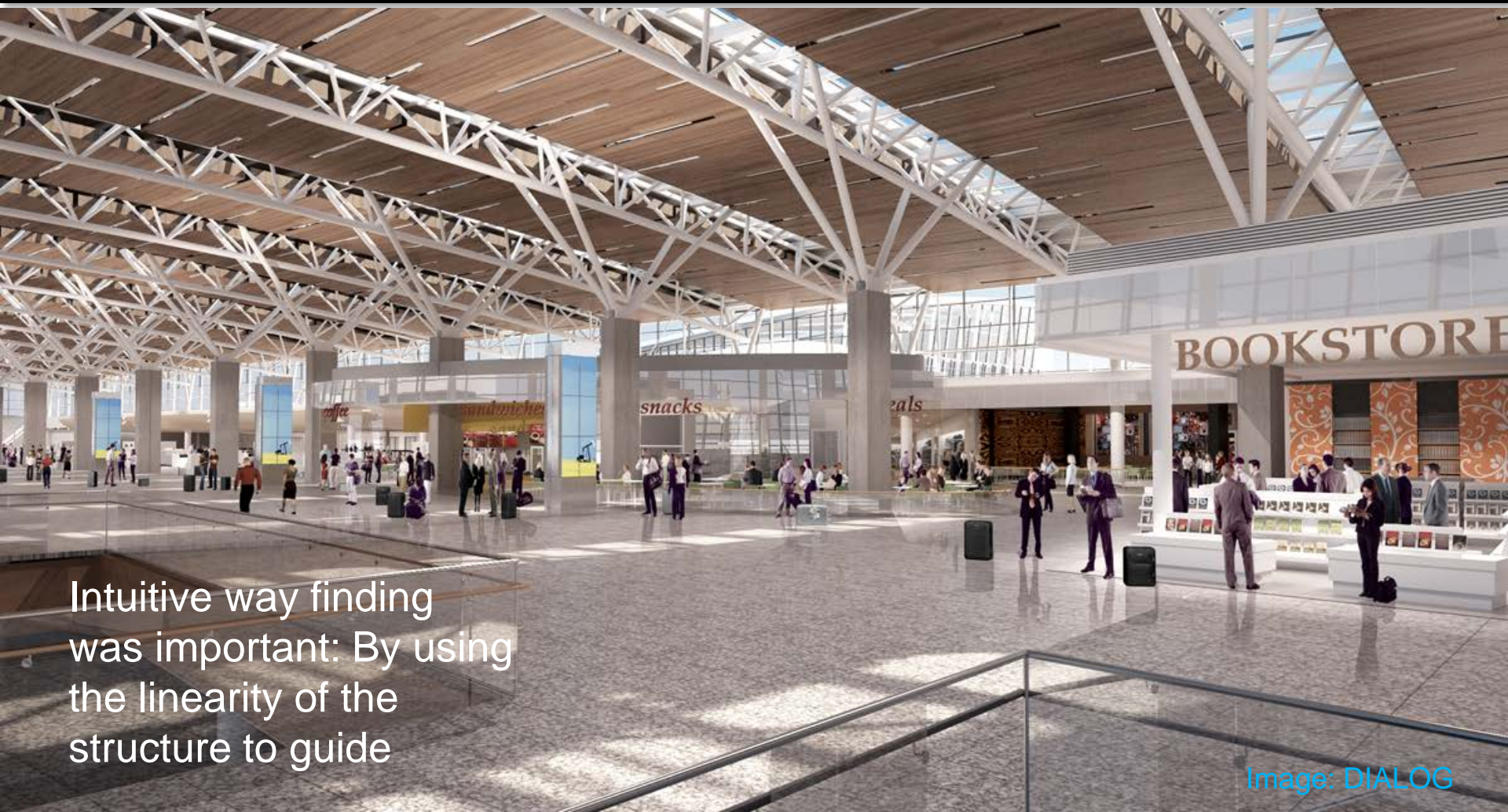
Image: DIALOG



Check-in
Hall

A 3D architectural rendering of the Calgary Airport International Facilities Project. The image shows a large, modern airport terminal building with a curved roof and a series of jet bridges extending from the terminal to the tarmac. Several commercial aircraft are parked at the gates. A yellow callout box highlights a specific area of the terminal, labeled 'Check-in Hall'. The rendering is in a light gray color scheme, emphasizing the structural and architectural details of the building.

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 m²
22 new aircraft gates
Green building features

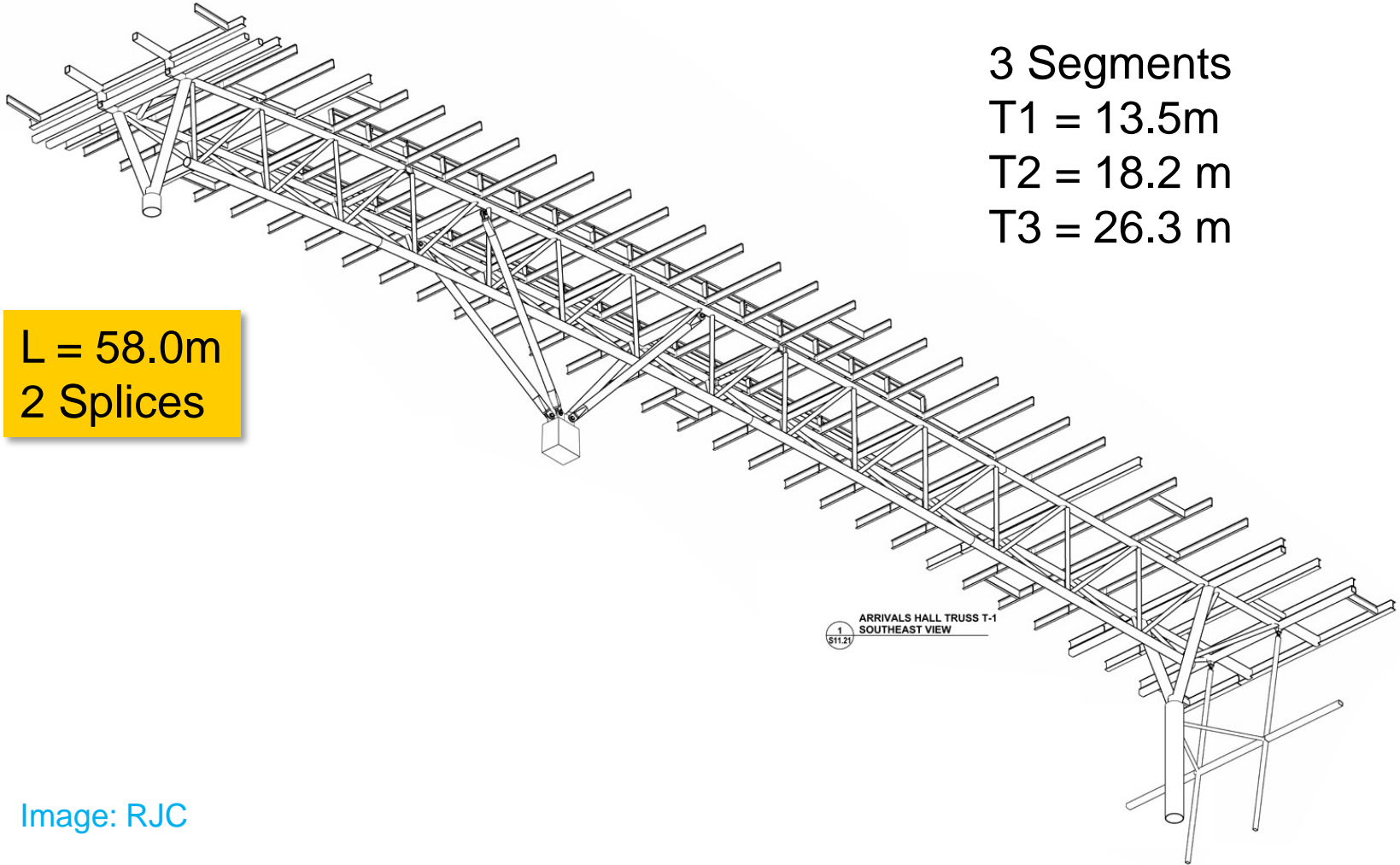
Structural Steel

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



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

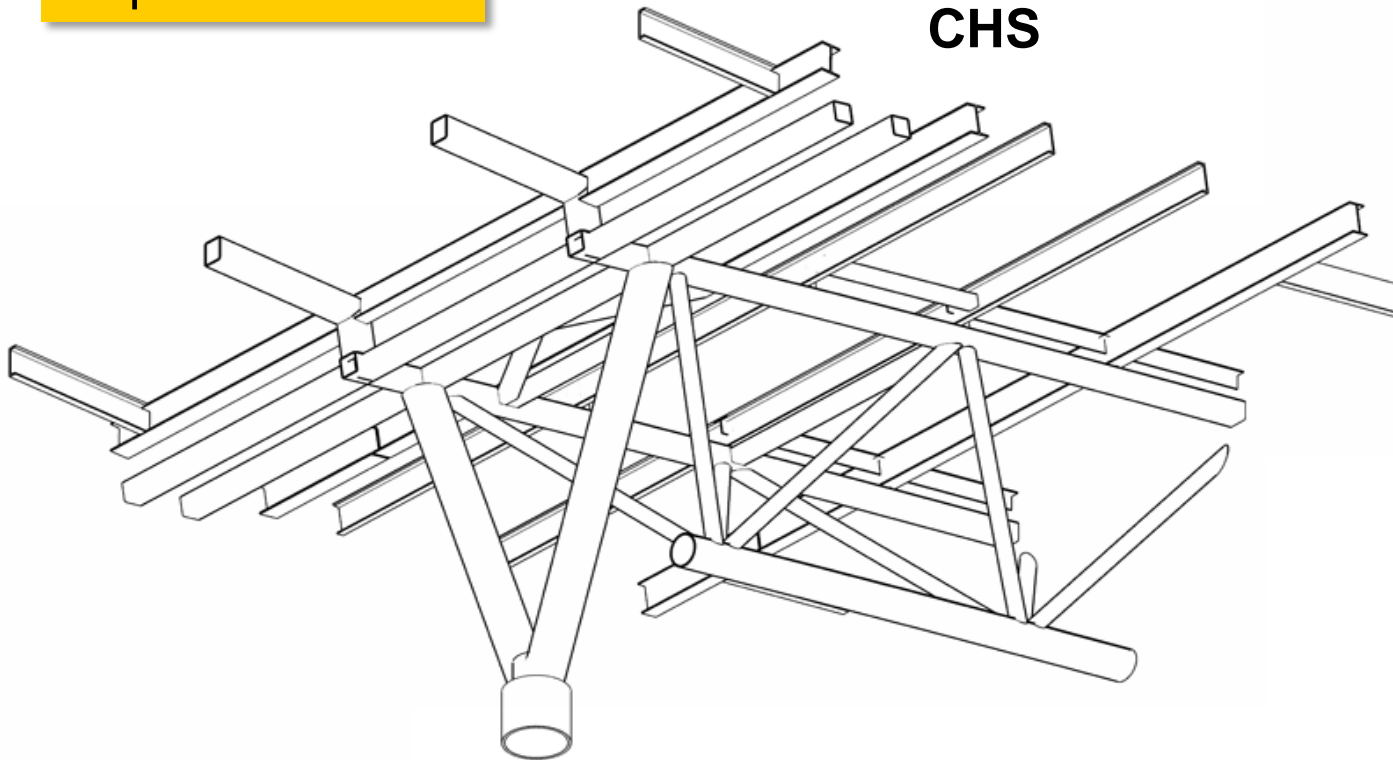


Image: RJC

2
\$11.21

ARRIVALS HALL TRUSS T-1 GRID 'AF'
SOUTHEAST VIEW

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

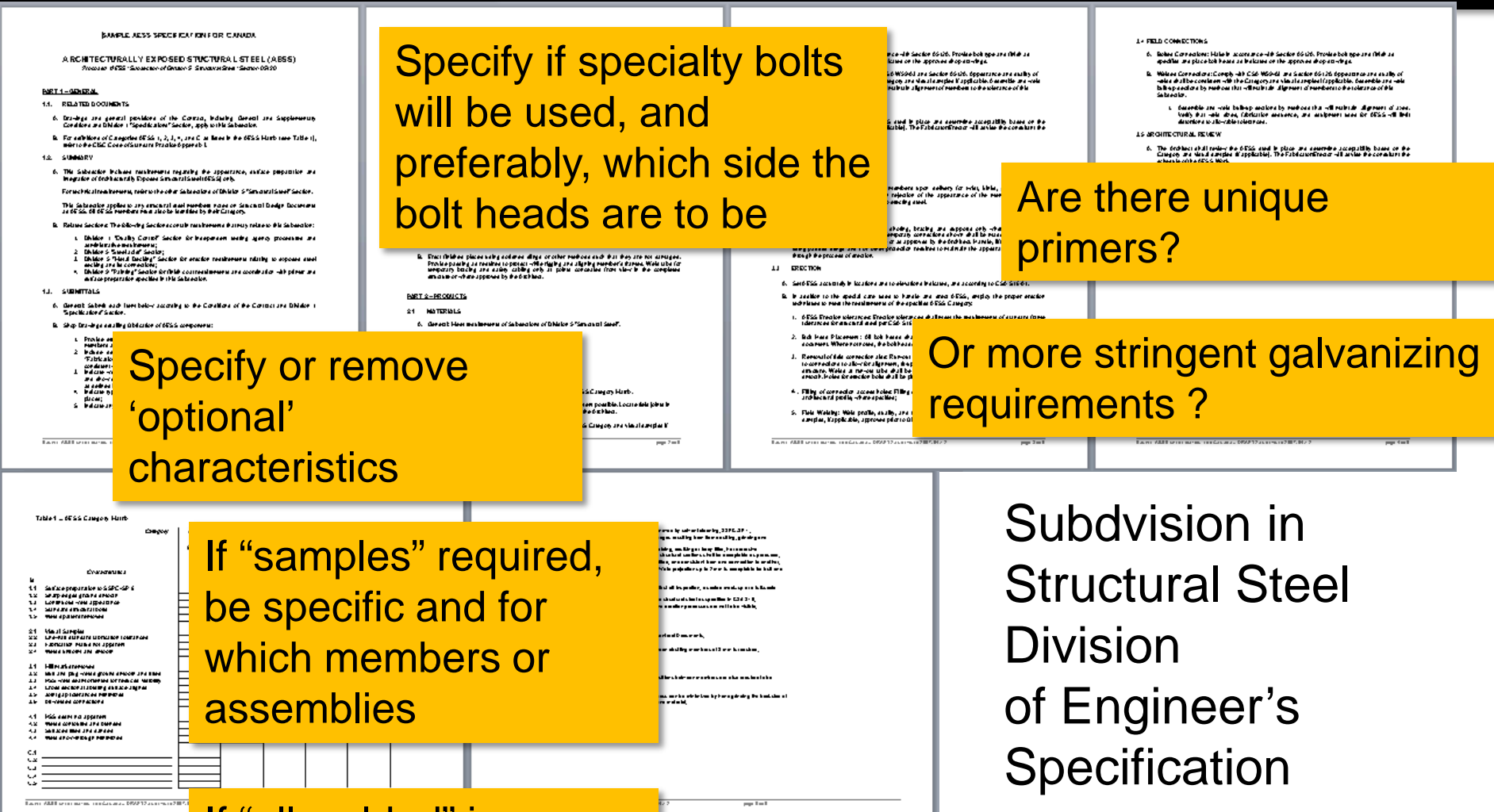
Are there unique primers?

Or more stringent galvanizing requirements ?

Specify or remove 'optional' characteristics

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

If "all welded" is chosen ... negotiate!



Select AESS Categories associated to members or assemblies

Sample AESS2 / AESS3 Table

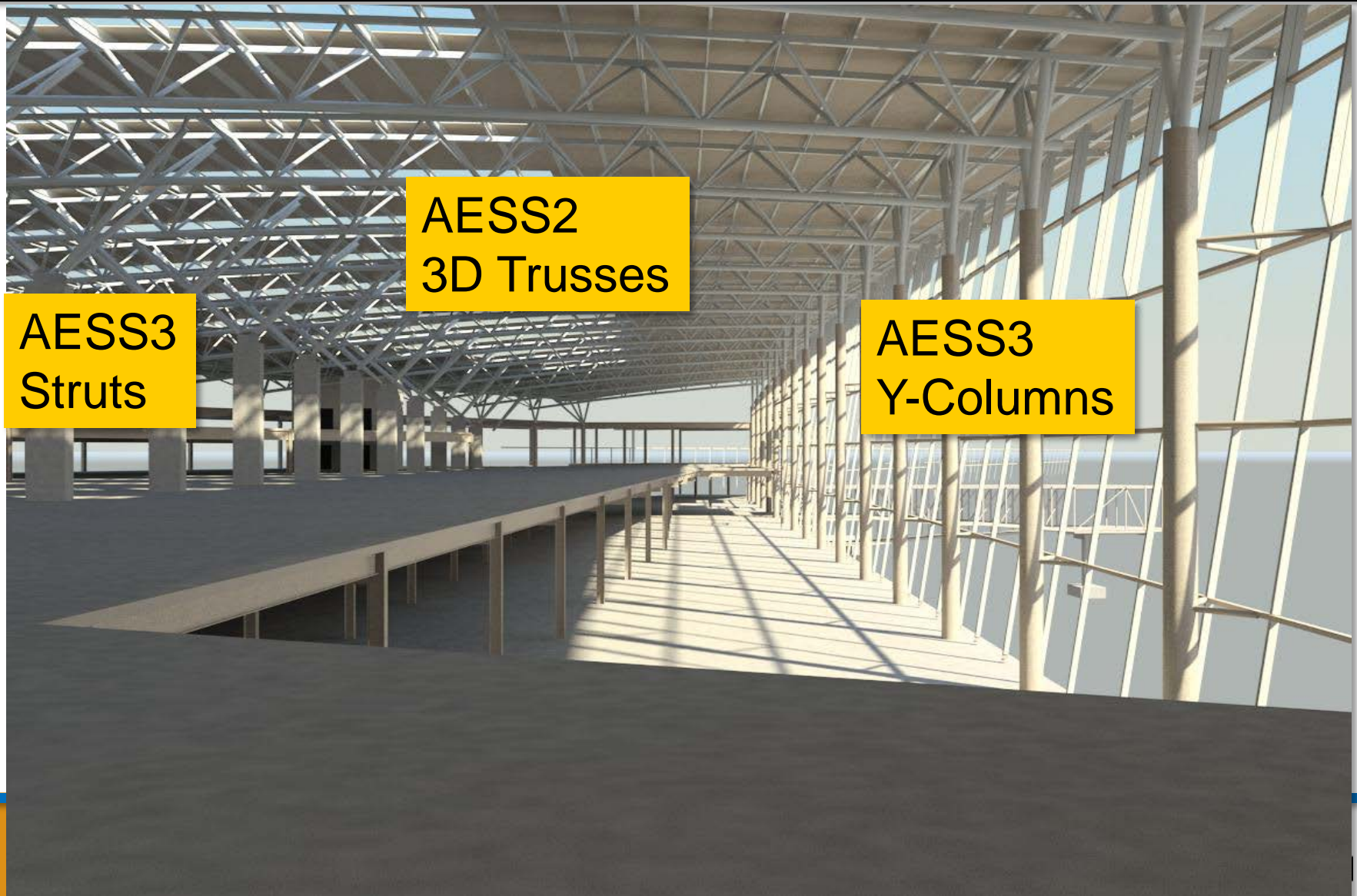
Contract Area(s)	Element (Members and Associated Connections)	AESS Category (Refer to TABLE 1)
Hotel Terminal	Canopies	-
Hotel Terminal Piers	Glazing Supports (Interior)	AESS 3
Terminal Piers	Glazing Supports (Exterior)	AESS 3
Hotel Terminal Piers	Glazing Support Pin Connections at Floor Level	AESS 3
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	-
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

Location of the AESS elements



AESS2
3D Trusses

AESS3
Struts

AESS3
Y-Columns

Mockups at Supermétal Plant



Mockups at Supermétal Plant



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

The “Rotator”!

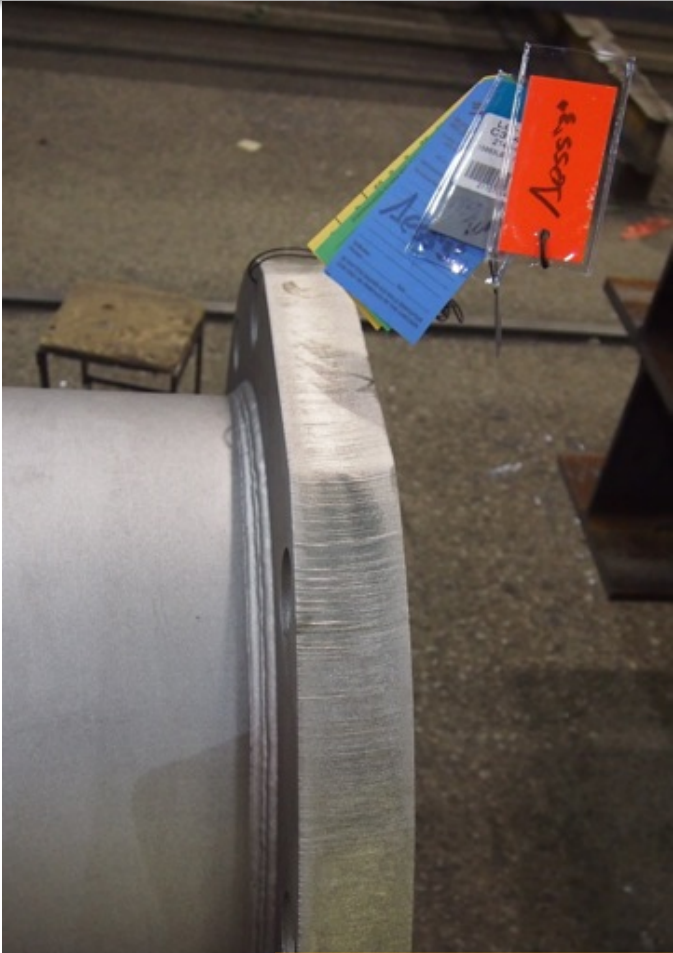


The main truss elements were placed in a jig that rotated to permit access for operations.

Calgary Airport Assemblies Mockup at Supermétal Plant



Avoiding confusion



Labels help during
fabrication and
erection

When a Mockup is required ...

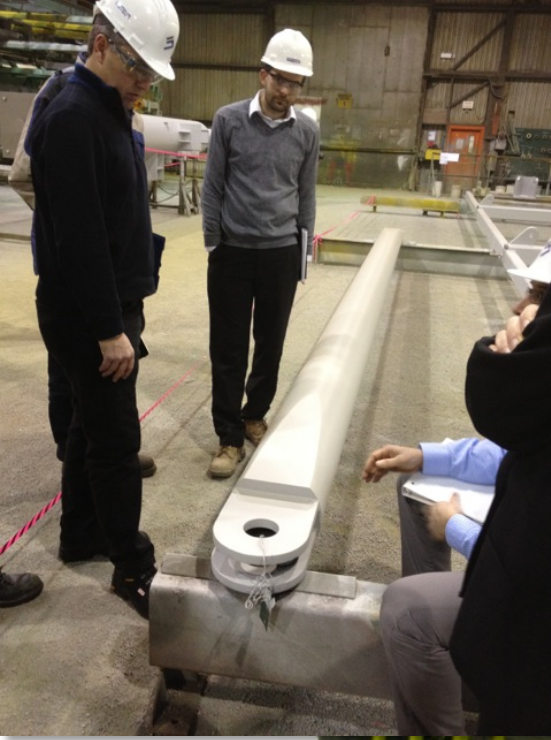


Remember that the shop conditions are different than the final conditions, with respect to:

- Distance
- Position
- Lighting



When a Mockup is required ...



When a Mockup is required ...



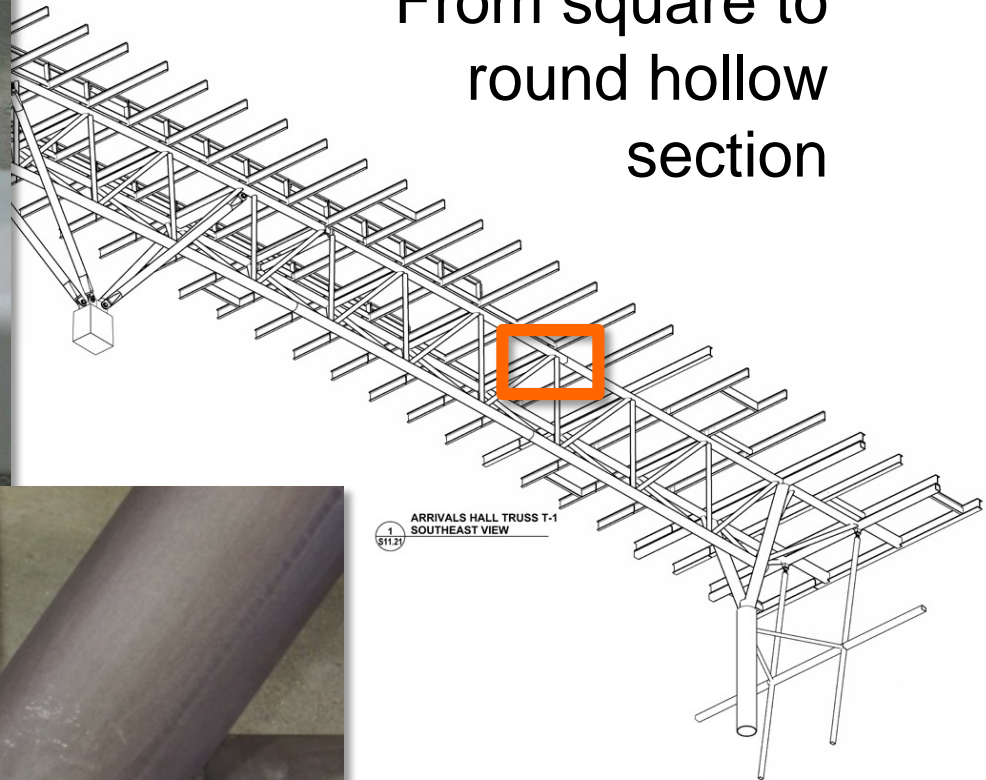
Photos: Sylvie Boulanger, Superm tal

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.

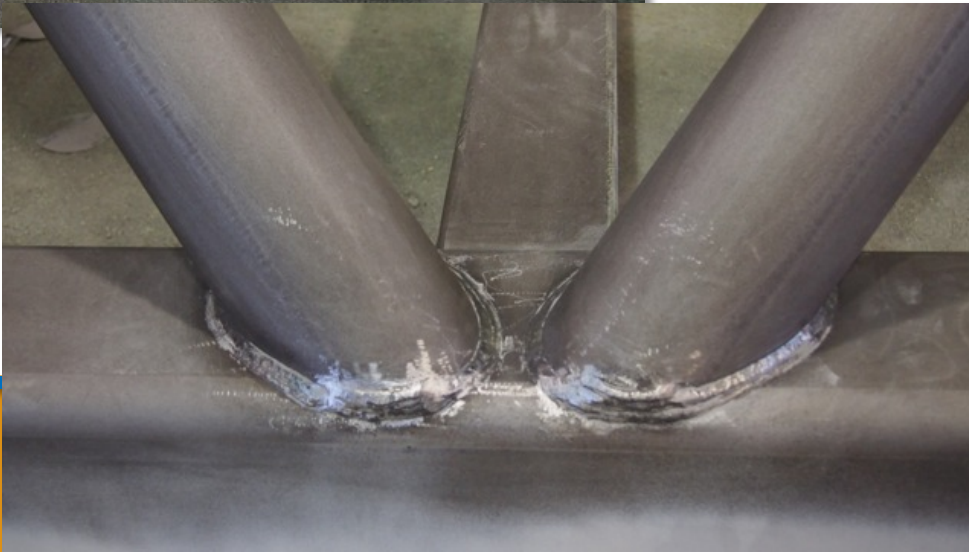
Alignment issues



From square to
round hollow
section

ARRIVALS HALL TRUSS T-1
SOUTHEAST VIEW

Image: RJC



Alignment issues

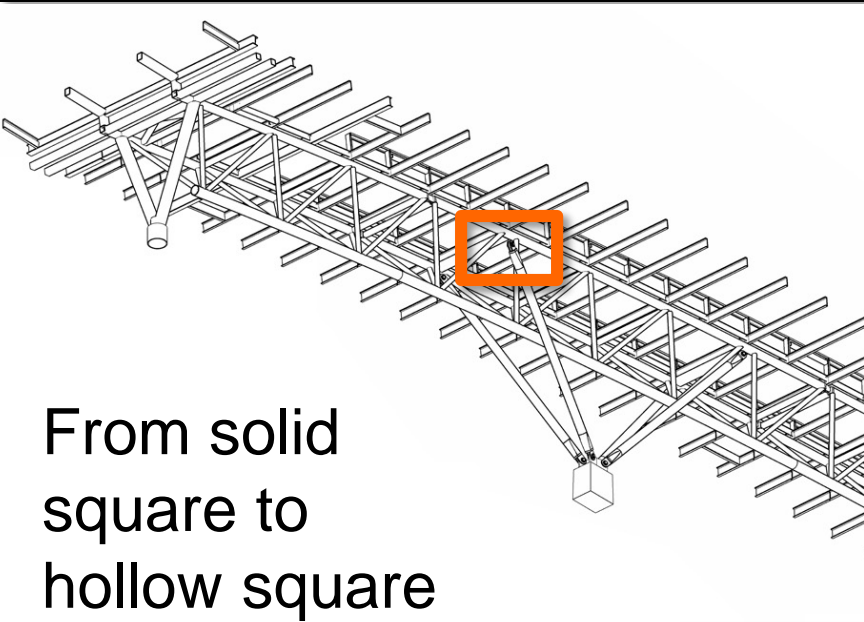


Image: RJC





Hidden splices



Hiding bolted splice
with steel sleeves

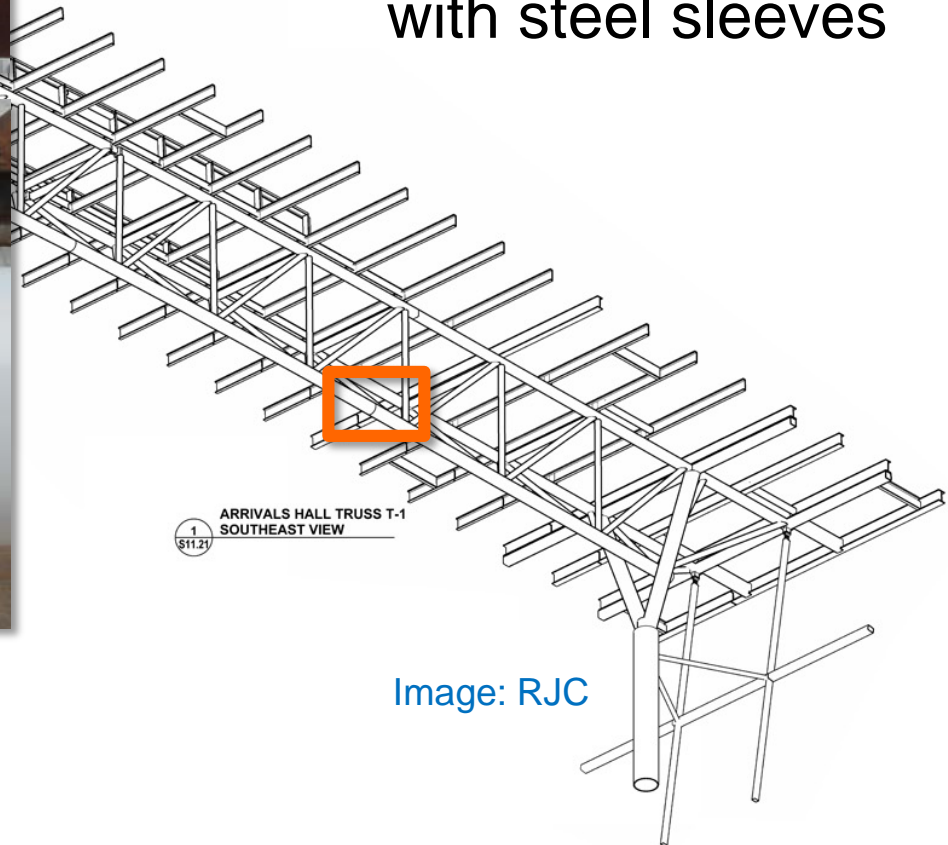
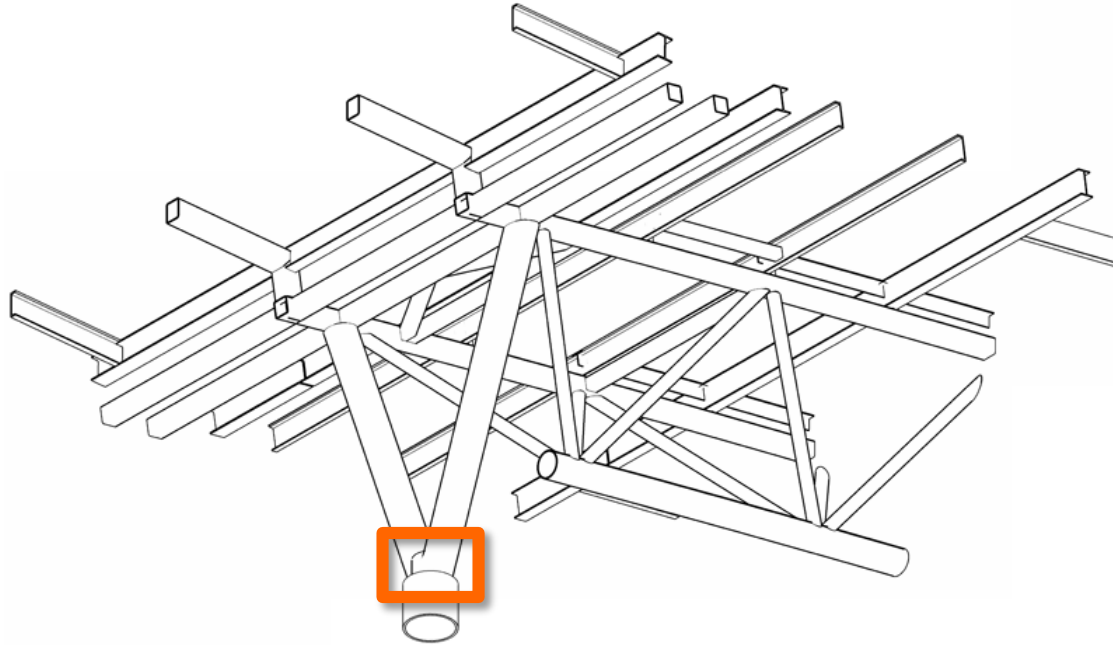


Image: RJC

How round is round?



From round column to
round plate

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

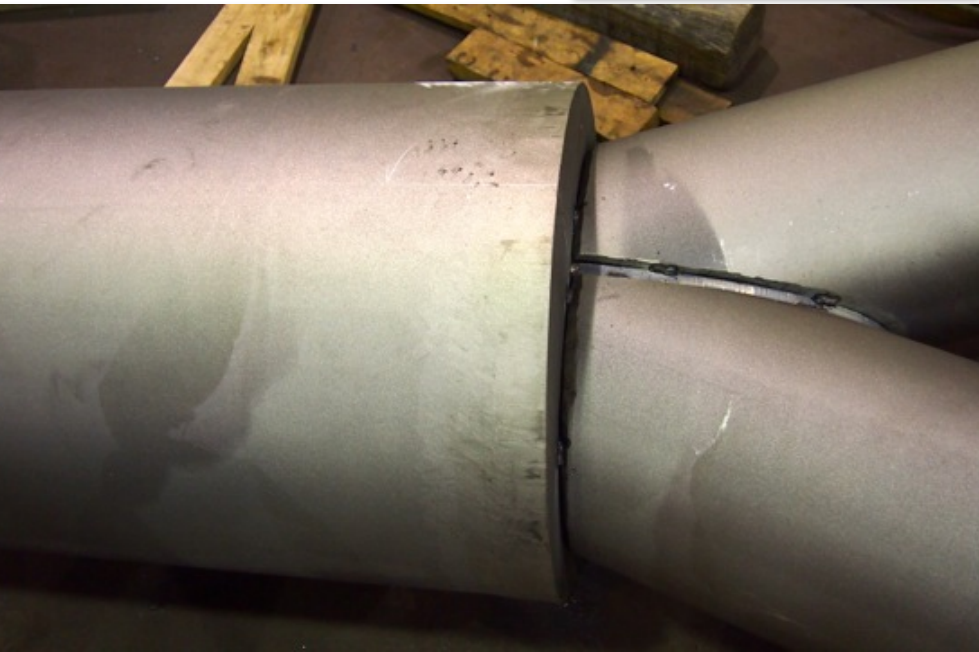
Image: RJC

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



Lifting a truss element



Threading the struts



Bolting the strut



Location of AESS Categories



Truss is AESS2

Struts and columns are AESS3



Overall progress



Panoramic view

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

28 AOÙt 2012



30 SEPTEMBRE 2012

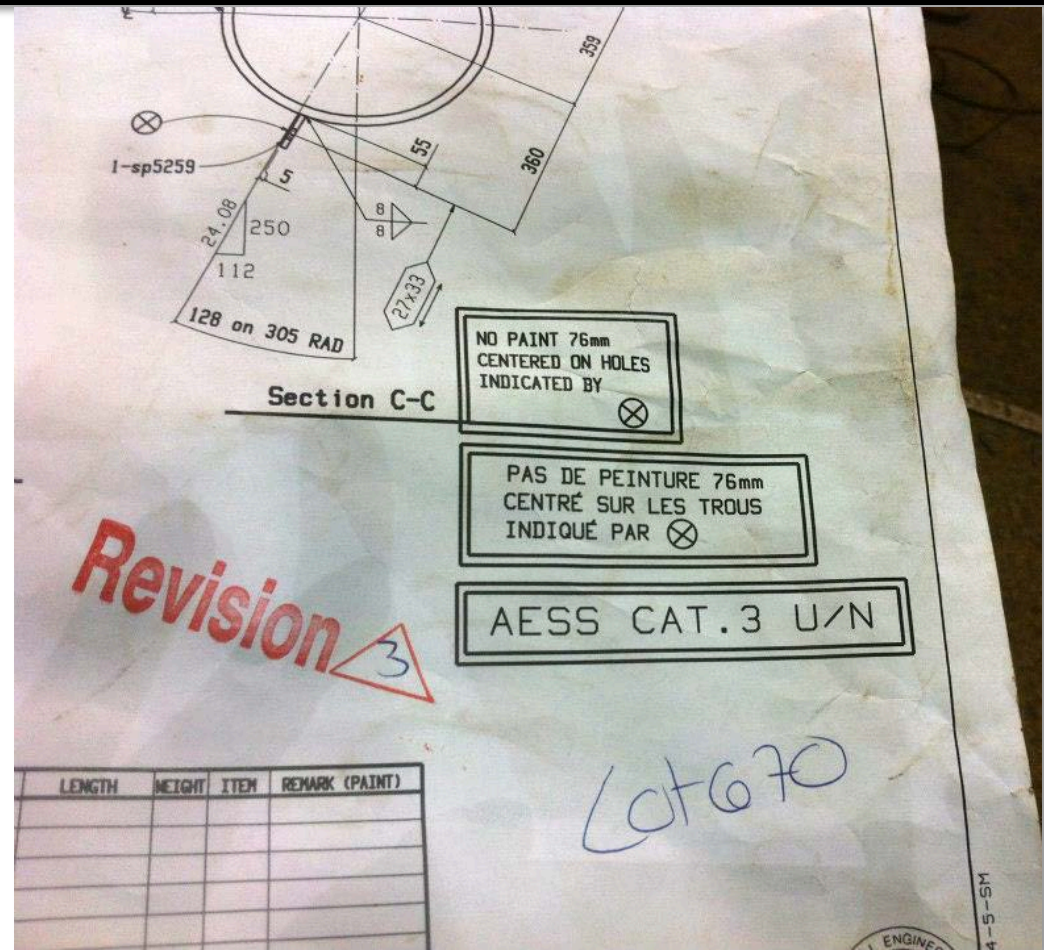


26 OCTOBRE 2012



Lessons Learned

- Better bids
- More productive plant visits
- Expectations more aligned
-
- Smooth weld still subject to interpretation
- Identical vs equivalent reproduction
- Inspection consistency



The core idea! FORM, FIT & FINISH

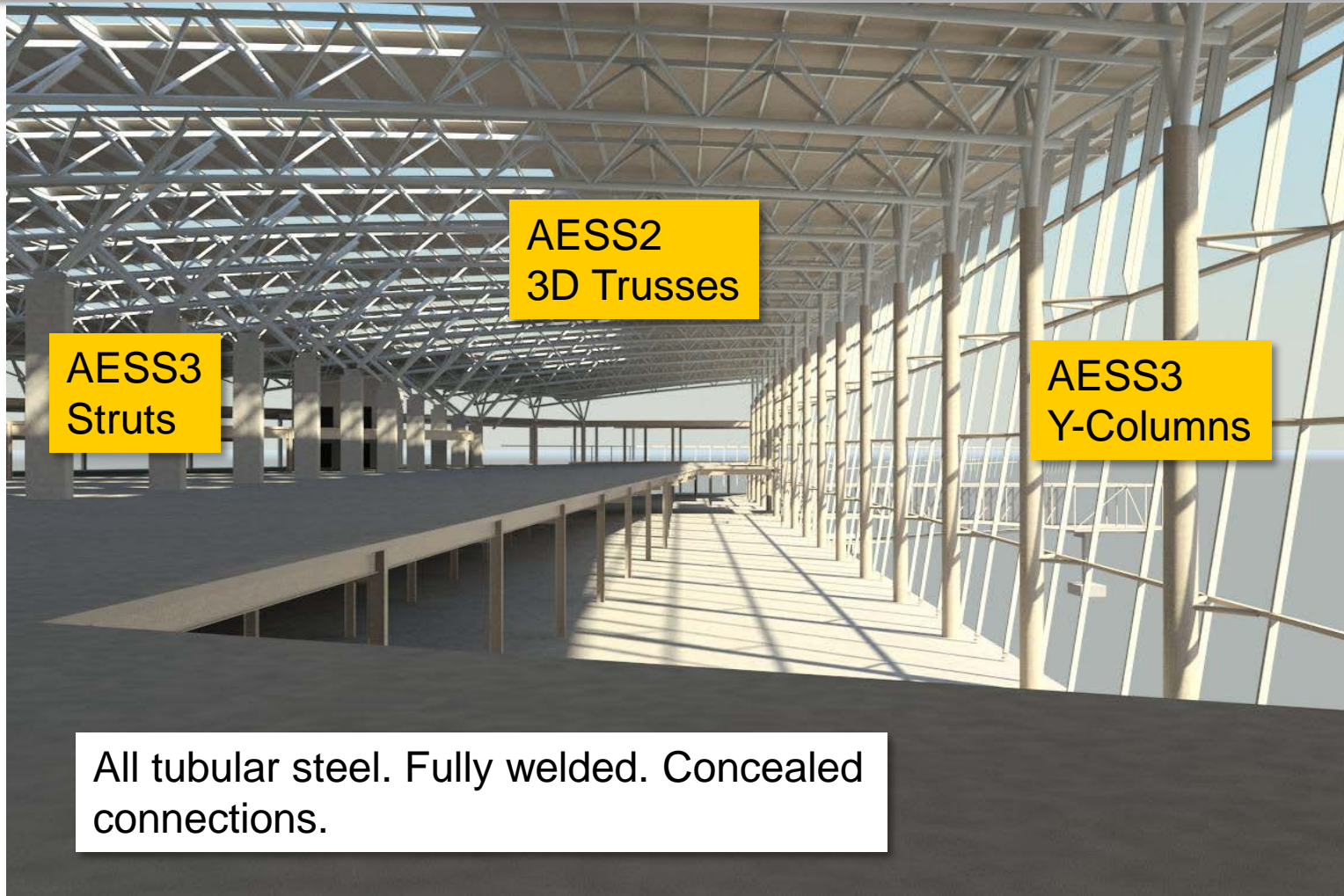


Two “TREES” – both AESS – each quite different from the other – so why would the AESS Specification be even remotely the same???

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

AESS 2 and 3 Combination 1



AESS3
Struts

AESS2
3D Trusses

AESS3
Y-Columns

All tubular steel. Fully welded. Concealed connections.

Construction shot



Closer view



AESS 2 and 3 Combination 2



AESS2 Trusses

AESS3 V-columns

Truss span over the primary pool is 250 feet.

More technical looking aesthetic



Tubular only on V-columns. Tubes are straight with plates top and bottom. Use of regular sections to fabricate trusses.

Splicing the trusses




Site connections all bolted with fairly simple detailing. View is far overhead.

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; 1 and 2; 2 and 3; 3 and 4...
- Fabricators to **bid on Engineering documents** and the Categories specified.

Fabrication and Erection Implications

- Architects need to fully appreciate and include AESS considerations in their designs and *negotiate with the Fabricator for more appropriate details*
- 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

New AESS Documents

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

*SAMPLE AESS SPEC FOR
STRUCTURAL STEEL*

Engineer



Architect

*GUIDE FOR
SPECIFYING
AESS*

Fabricator

*CODE OF
PRACTICE*

