

# 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

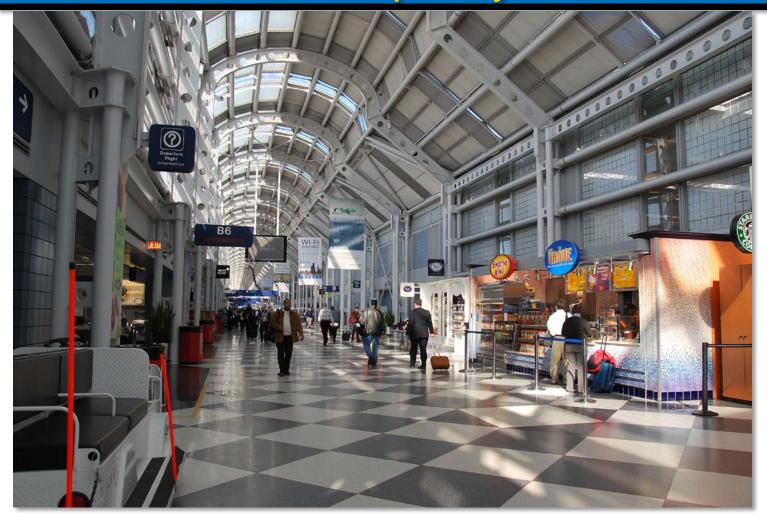


Hollow sections were only "invented" in the 1970s and their adoption truly changed steel design and detailing.

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









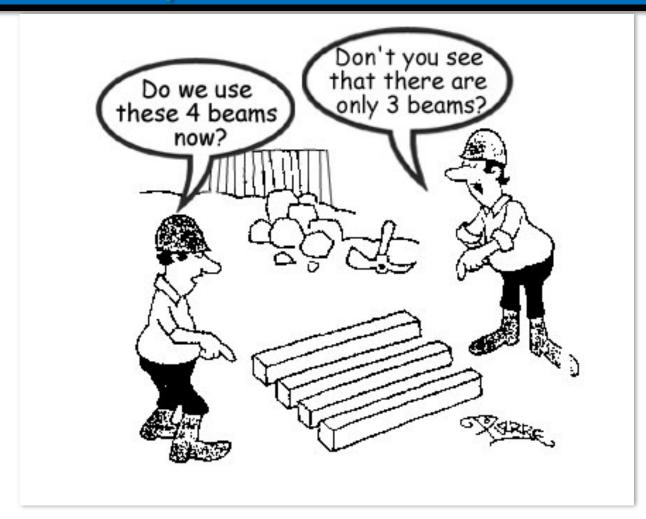








# Purpose of the new AESS Documents



To find common ground

And clarify communication





architect

engineer

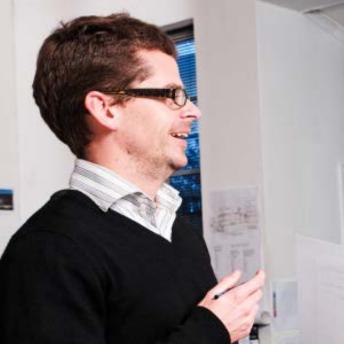
fabricator







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





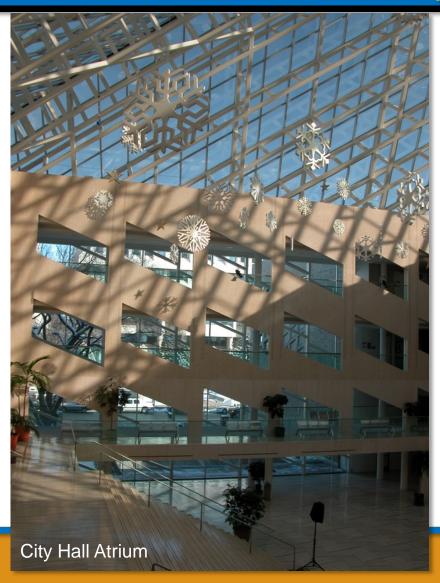


## Distance should play a factor





## Distance should play a factor

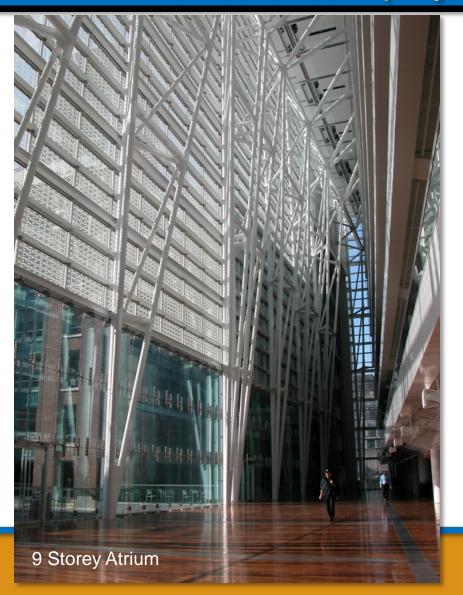


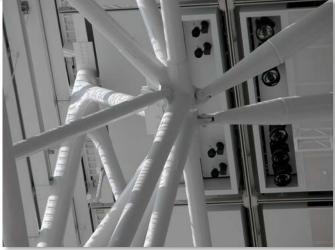






## Distance should play a factor (360°)

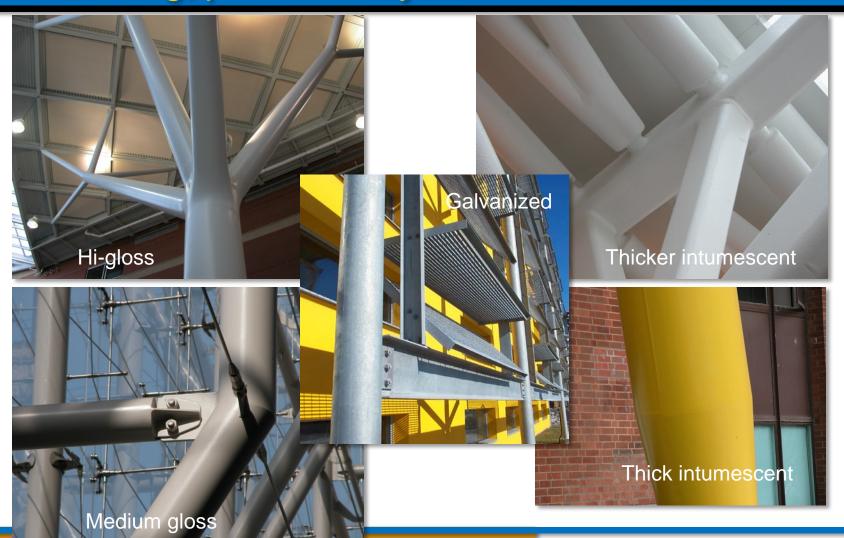








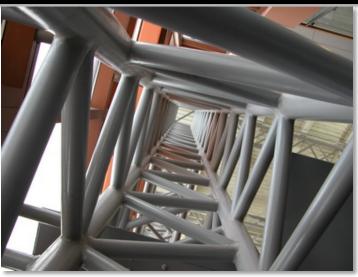
## Coating, protection systems should be a factor





# 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
- Degree of expression
- Size and shape of structural elements

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



# **AESS: Primary Factors of influence**

**FINISH** FIT **FORM** 



#### **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								
	Characteristics	AESS C Custom Elements	AESS 4 Showcase Elements	AESS 3 Feature Elements Viewed at a	AESS 2 Feature Elements Viewed at a	AESS 1 Basic Elements	SSS Standard Structural Steel CSA S16		
ld	Characteristics			Distance ≤ 6 m	Distance > 6 m		CSA 516		
	Surface preparation to SSPC-SP 6 Sharp edges ground smooth		V	V	N N	V			
	Continuous weld appearance	Cotogorico de franciones la telescripia la la							
	Standard structural bolts	Categories go from lowest at the right to							
	Weld spatters removed	highest at the left.							
	Visual Samples		υριισπαι	ориона	υριισπαι				
	One-half standard fabrication tolerances Fabrication marks not apparent		V	V	V				
	Welds uniform and smooth		V	V	V				
3.2 3.3 3.4 3.5 3.6	Mill marks removed Butt and plug welds ground smooth and filled HSS weld seam oriented for reduced visibility Cross sectional abutting surface aligned Joint gap tolerances minimized All welded connections  HSS seam not apparent Welds contoured and blended		√ √ √ √ optional	√ √ √ √ optional					
	Surfaces filled and sanded Weld show-through minimized		\ \ \						
C.1	-								
C.2		<u> </u>	-						
C.3			1						
C.4			]						
C.5			J						
	Sample Use:	Elements with special requirements	Showcase or dominant elements	hospitals, lobbies	Retail and architectural buildings viewed at a distance	Roof trusses for arenas, retail warehouses, canopies			
	Estimated Cost Premium:	Low to High	High	Moderate	Low to Moderate	Low	None		
		(20-250%)	(100-250%)	(60-150%)	(40-100%)	(20-60%)	0%		

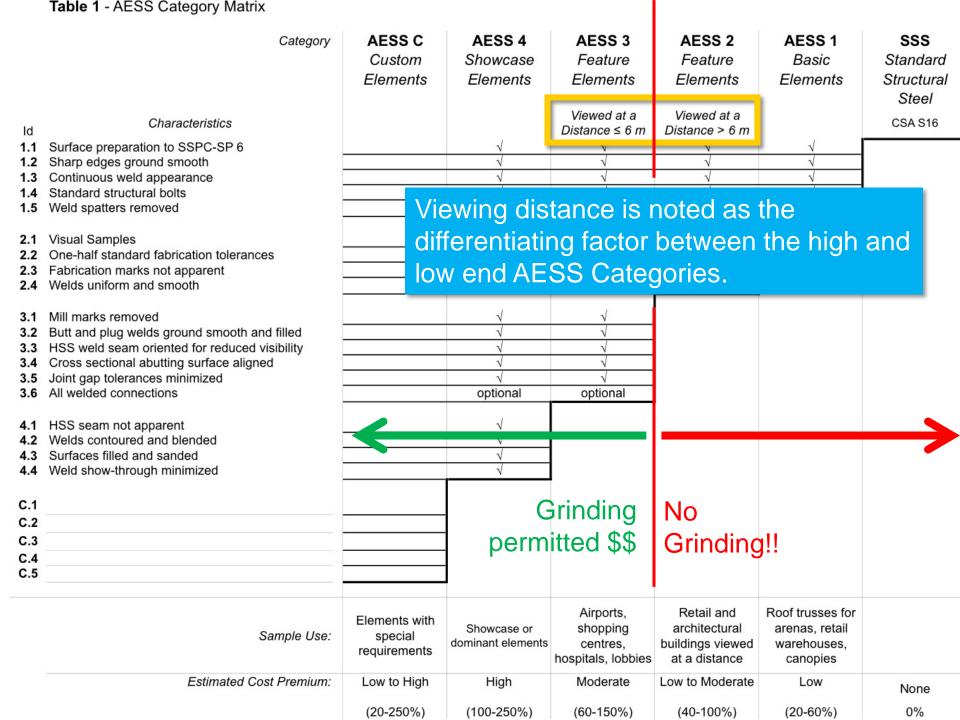


Table 1 - AESS Category Matrix

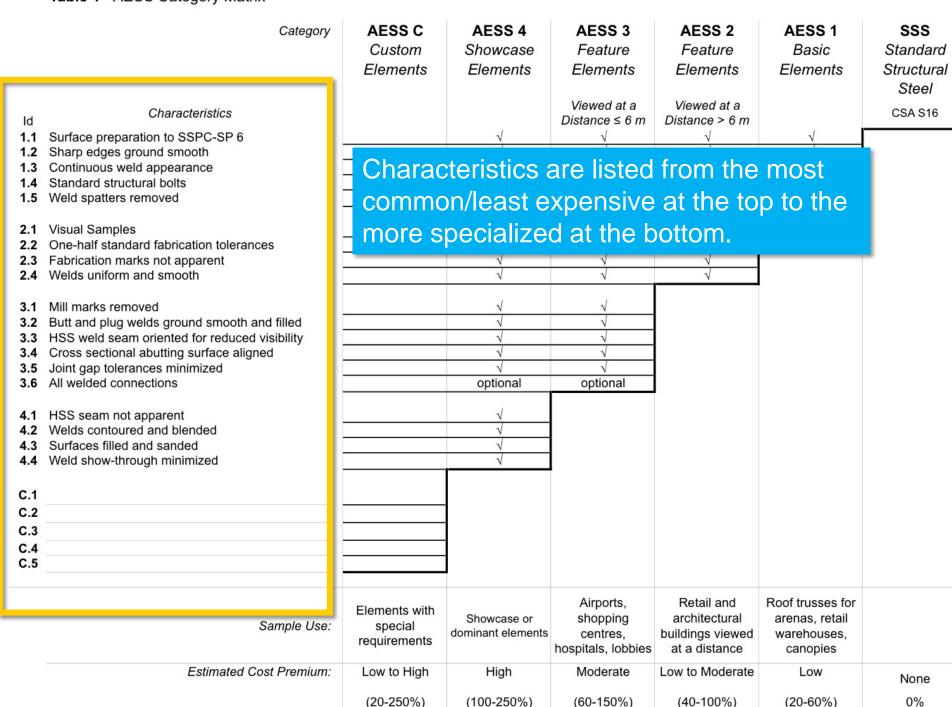
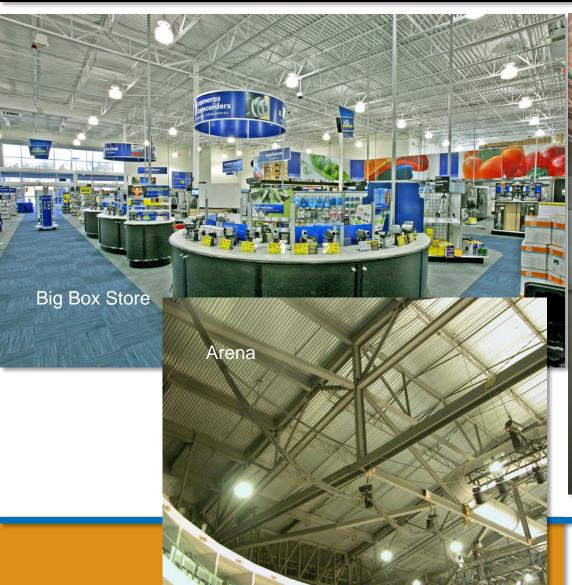


 Table 1 - AESS Category Matrix

		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
ld	Characteristic	cs			Viewed at a Distance ≤ 6 m	Viewed at a Distance > 6 m		CSA S16
1.1 1.2	Continuous weld appearance Standard structural bolts			√ √	√ √	V	√ √	
1.3				V	V	V	V	
1.4 1.5				V	√ √	V	√ √	
1.5				V	V	V	V	
2.1	<ul><li>.2 One-half standard fabrication tolerances</li><li>.3 Fabrication marks not apparent</li></ul>			optional	optional	optional		
2.2				V	N V	N N		
2.4				V	V	V		
3.1	Mill marks removed			al.	1			
3.2	Butt and plug welds ground smooth and filled HSS weld seam oriented for reduced visibility Cross sectional abutting surface aligned Joint gap tolerances minimized			V V	V V			
3.3				V	√.			
3.4				V	V			
3.5 3.6				v optional	optional			
-	All Worded Confections			ор шолиш.	ориона:			
4.1	<ul> <li>Welds contoured and blended</li> <li>Surfaces filled and sanded</li> <li>Weld show-through minimized</li> </ul>			V				
4.2 4.3				√				
4.4			E C C			01	100	
			Estimate					
C.1 C.2		Structura						
C.3				10 110100				
C.4								
C.5		<u> </u>						
					Airports,	Retail and	Roof trusses for	
		0	Elements with	Showcase or	shopping	architectural	arenas, retail	
		Sample Use:	special requirements	dominant elements	centres,	buildings viewed	warehouses,	
			·		hospitals, lobbies	at a distance	canopies	
	Estima	ated Cost Premium:	Low to High	High	Moderate	Low to Moderate	Low	None
			(20-250%)	(100-250%)	(60-150%)	(40-100%)	(20-60%)	0%

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

# AESS 1 – Basic Elements



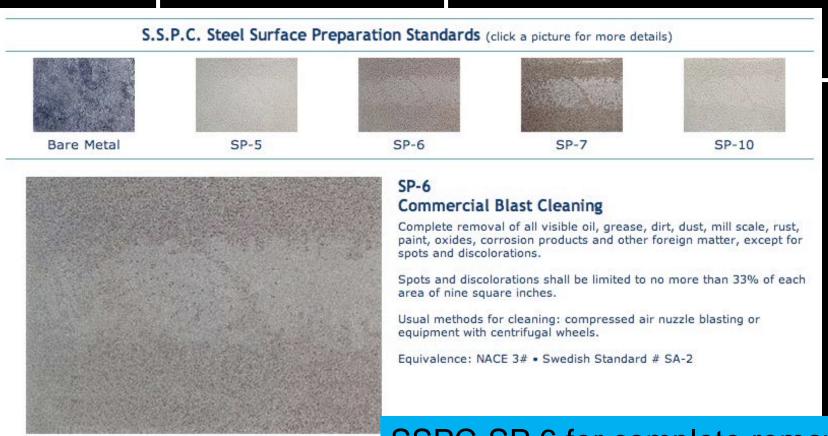




#### 1.1 Surface preparation to SSPC-SP 6

SP 3: Power Tool Cleaning

SP 6: Commercial Blast Cleaning



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



photo: AISC AESS Guide

# 1.3 Continuous weld appearance

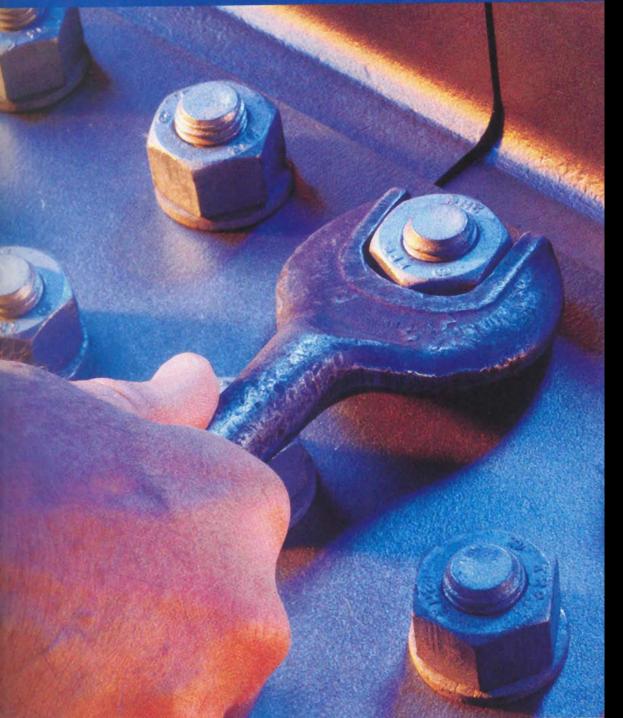




# 1.3 Continuous weld *appearance*



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





# 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

A	ESS 2	AESS C Custom Elements	AESS 4 Showcase Elements	AESS 3 Feature Elements	<b>AESS 2</b> Feature Elements	<b>AESS 1</b> Basic Elements	SSS Standard Structural Steel
ld	Characteristics			Viewed at a Distance ≤ 6 m	Viewed at a Distance > 6 m		CSA S16
1.1	Surface preparation to SSPC-SP 6	i e	<b>V</b>	√	√	√,	
1.2 1.3	Sharp edges ground smooth Continuous weld appearance		V	N N	N N	√ √	
1.4	Standard structural bolts		V	V	Ž	V	
1.5	Weld spatters removed		<b>√</b>	√	√	√	
2.1	Visual Samples		optional	optional	optional		
2.2	One-half standard fabrication tolerances		√ 1	V	√ 1		
2.3 2.4	Fabrication marks not apparent Welds uniform and smooth		V V	V	7		
_			,	,			
3.1 3.2	Mill marks removed Butt and plug welds ground smooth and filled		V	N V			
3.3	HSS weld seam oriented for reduced visibility		V	V	Retail	and ard	nitectural
3.4	Cross sectional abutting surface aligned		V	V			
3.5 3.6	Joint gap tolerances minimized All welded connections		√ optional	√ optional	bldgs	viewed a	at
			optional	ориона	a dista		
4.1 4.2	HSS seam not apparent Welds contoured and blended		V		Coct	romium	LOW
4.3	Surfaces filled and sanded		V		Cost	premium	LOW
4.4	Weld show-through minimized		V		to Mo	derate	
C.1					(40-10	00%)	
C.2					(101)		
C.3 C.4		10 2					
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	High	Moderate	Low to Moderate	Low	None
		(20-250%)	(100-250%)	(60-150%)	(40-100%)	(20-60%)	0%

## AESS 2 – Feature Elements (>6m)











#### 2.1 Visual Samples (optional)

- 1. 3-D rendering;
- 2. Physical sample of surface preparation and welds;
- 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?



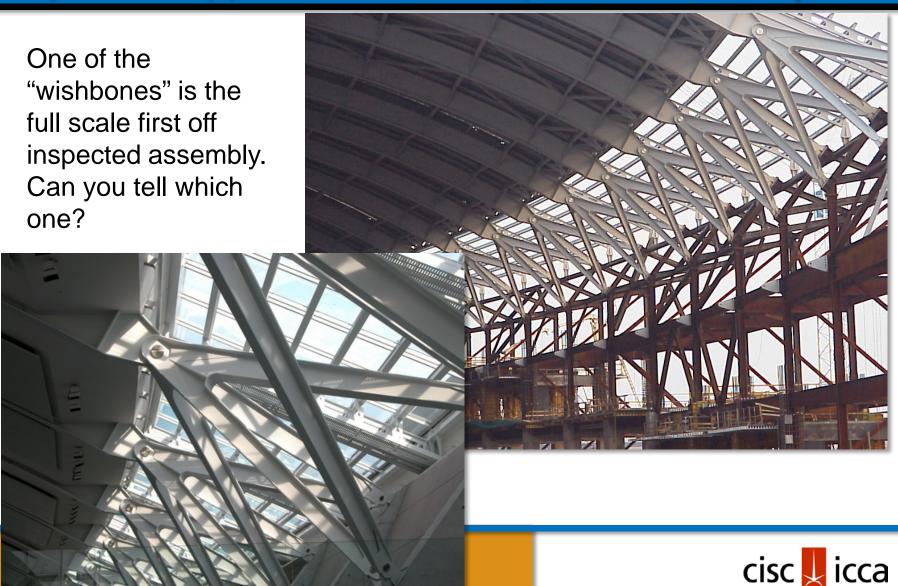
# Option 3: First off inspection



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



#### Option 3: Approved first off inspection assembly



#### 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

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

# AESS 3 – Feature Elements (≤6m)











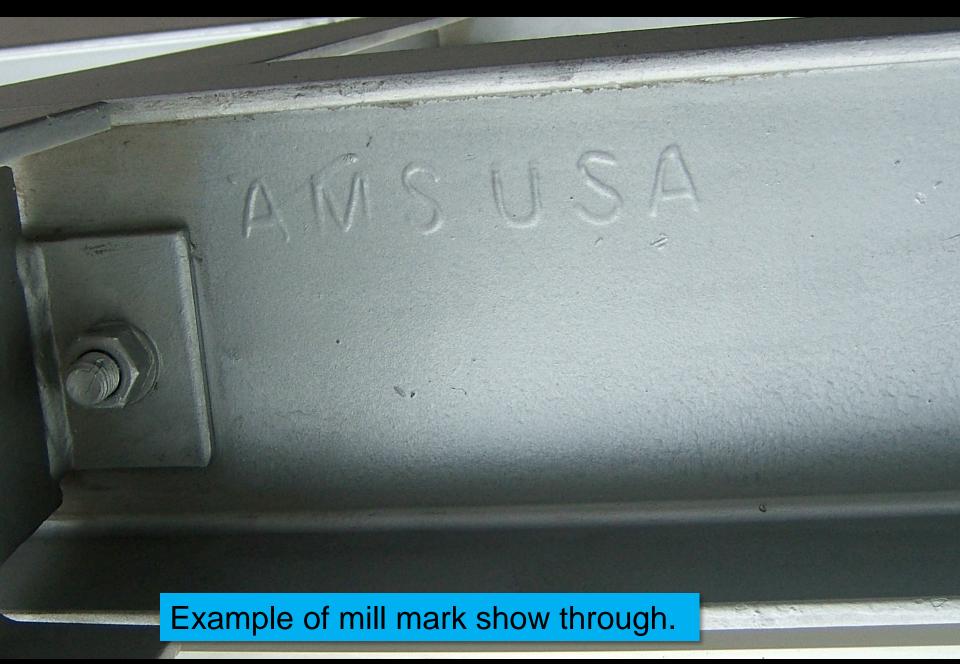
# 3.1 Mill marks removed



photo: AISC AESS Guide

Grinding first appears in AESS 3!

#### AESS 3

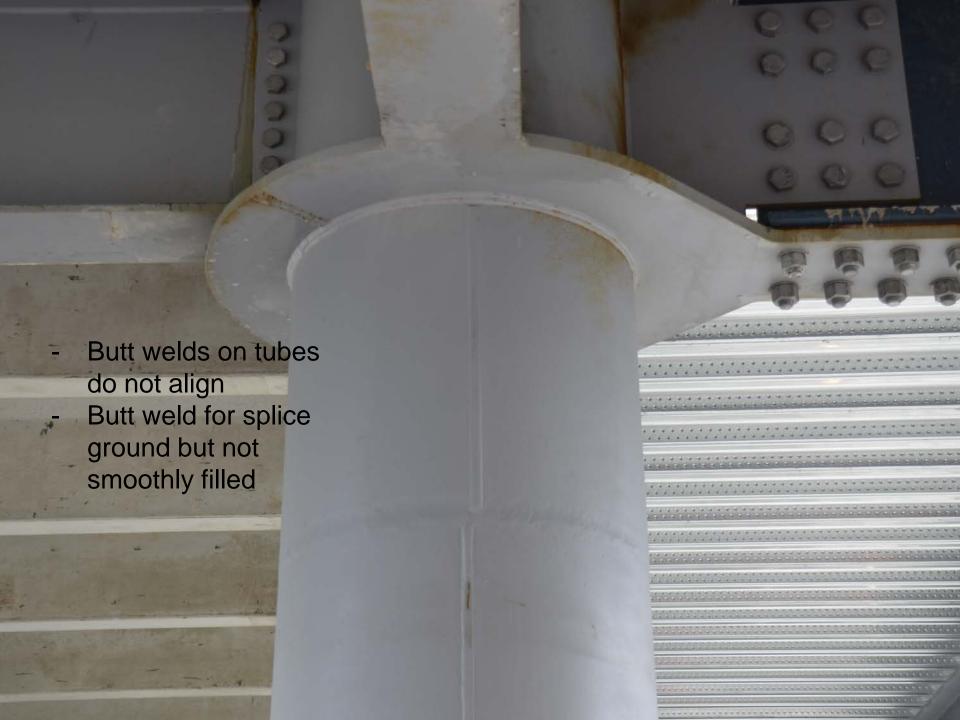


#### 3.2 Butt and plug welds ground smooth and filled



Right side shows groove weld ground smooth.

photo: AISC AESS Guide



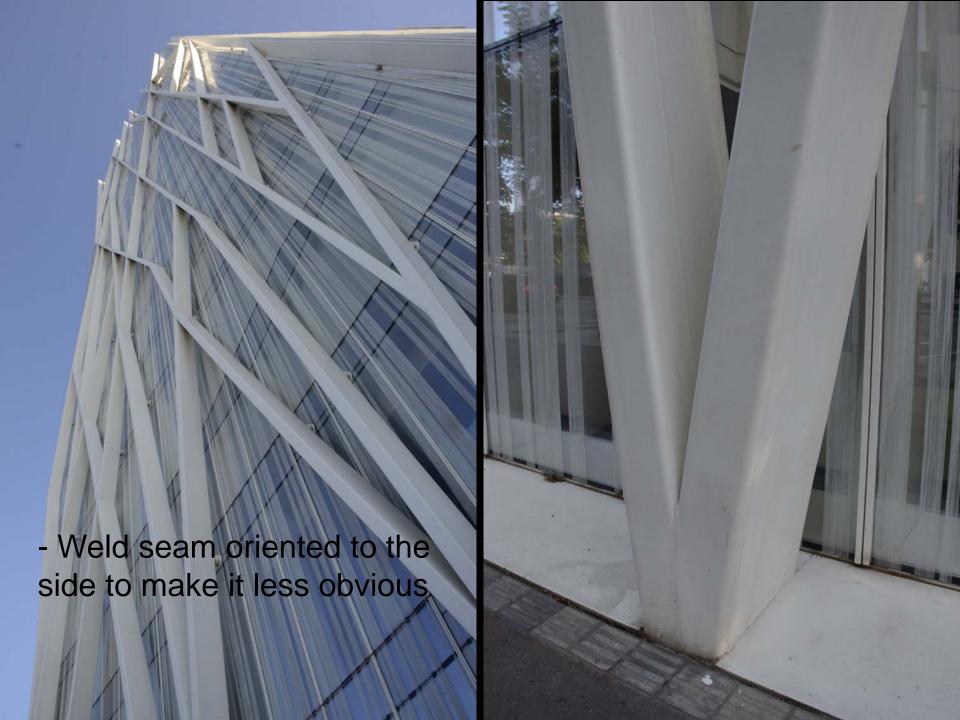




# 3.3 HSS weld seam oriented for reduced visibility







# 3.4 Cross sectional abutting surface aligned3.5 Joint gap tolerances minimized

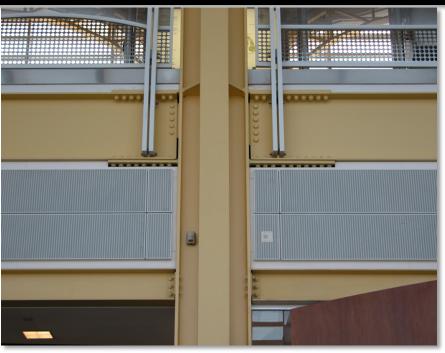


photo: AISC AESS Guide

# 3.5 Joint gap tolerances minimized





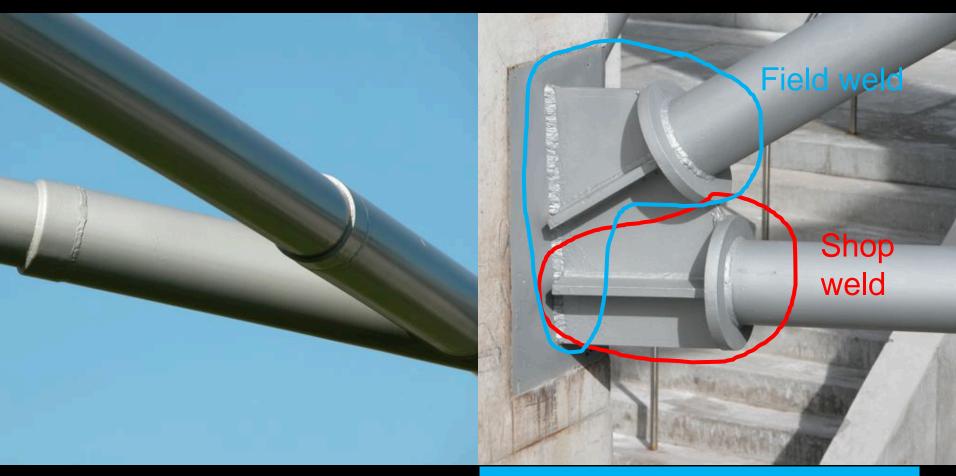


Required to accommodate complexity and alignment





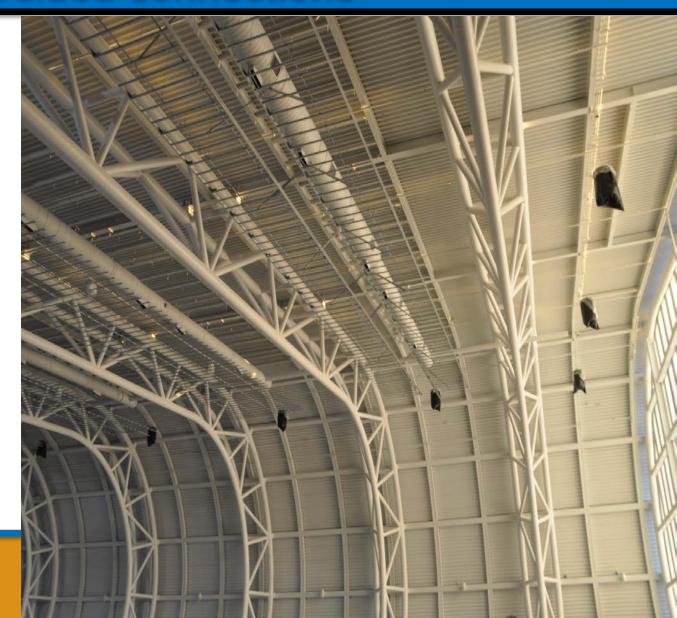
# 3.6 All welded connections (optional)



Requires skilled field welder.

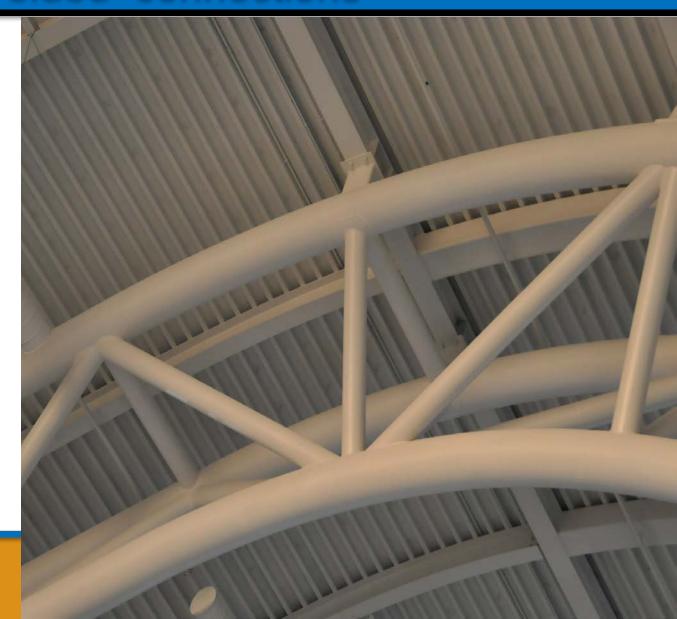
### Welded connections

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.



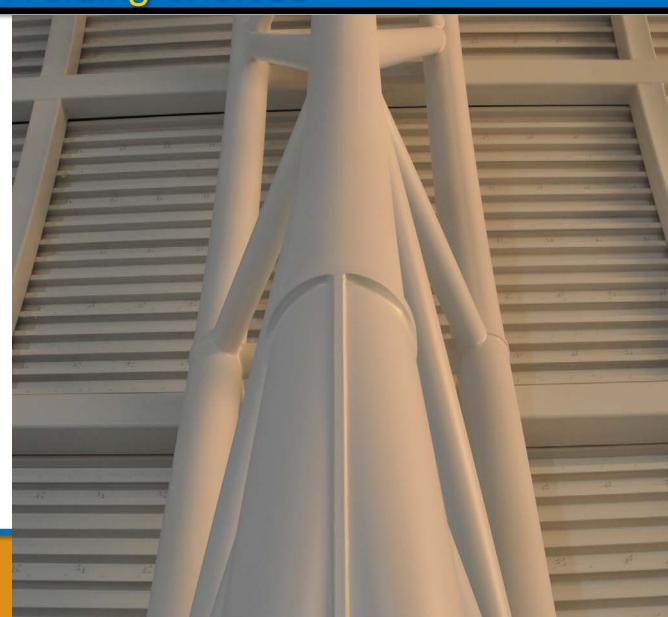
### Welded connections

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)

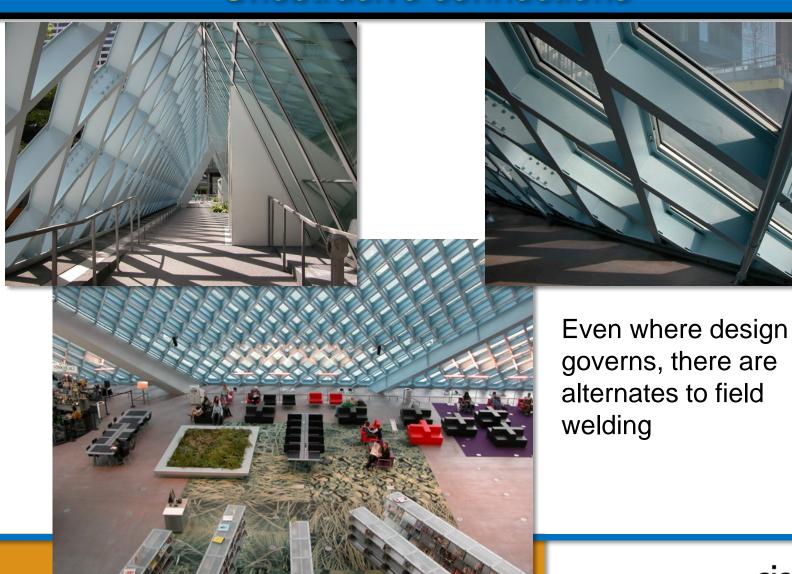


Requires access and remediation to remove the markings from the temporary bolted connections.

# 3.6 All welded connections (optional)



### Unobtrusive connections





### 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







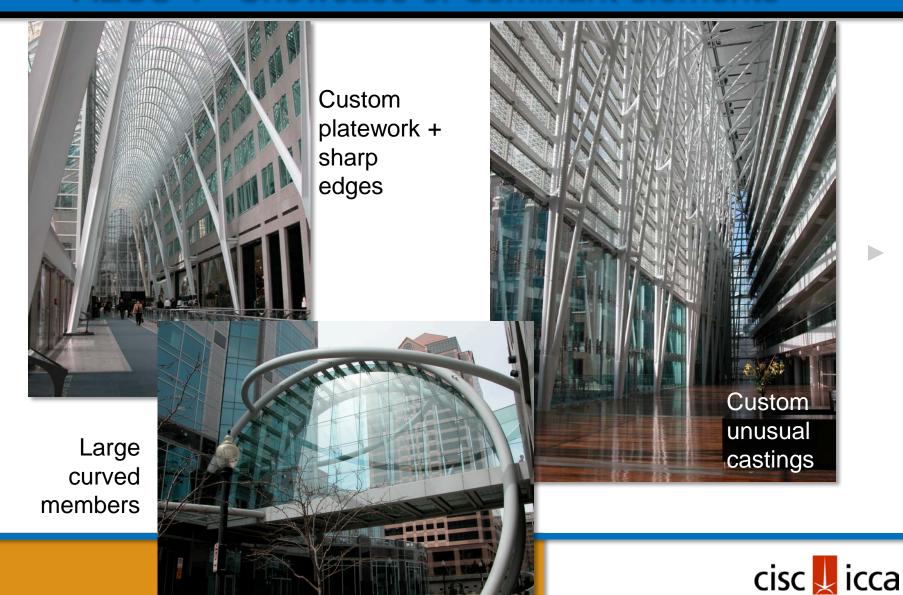
A bolted connection can be used for a splice. A simple sleeve is fitted over the connection to provide continuity of appearance.



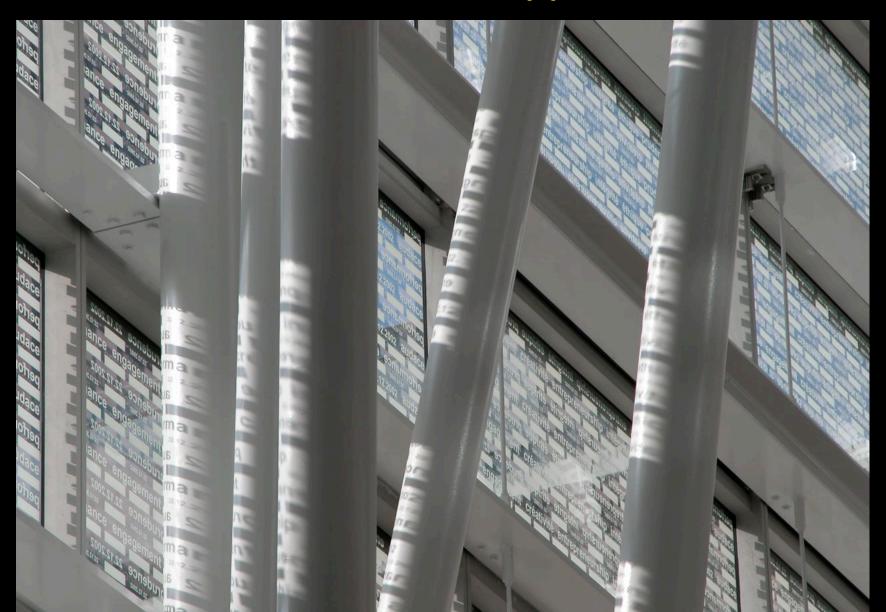
 Table 1 - AESS Category Matrix

Category AESS C AESS 4 AESS 3 AESS 2 AESS 1 SSS							
Λ	Category	AESS C Custom	Showcase	AESS 3 Feature	AESS 2 Feature	AESS 1 Basic	<b>SSS</b> Standard
A	ESS 4	Elements	Elements	Elements	Elements	Elements	Standard
		Elements	Elements	Elements	Elements	Elements	Steel
ld	Characteristics			Viewed at a Distance ≤ 6 m	Viewed at a Distance > 6 m		CSA S16
1.1	Surface preparation to SSPC-SP 6		<b>√</b>	Distance ≤ 0 III	Distance ≥ 0 III	√ [	
1.2	Sharp edges ground smooth		,	Į.	V	V	
1.3	Continuous weld appearance		√	√	√	V	
1.4	Standard structural bolts		<u> </u>	<u>√</u>	<b>√</b>	<b>√</b>	
1.5	Weld spatters removed		√	V	<b>√</b>	V	
2.1	Visual Samples		optional	optional	optional		
	One-half standard fabrication tolerances		<b>√</b>	√	V		
	Fabrication marks not apparent		1		V		
2.4	Welds uniform and smooth		<b>√</b>	· · · · · ·	V		
3.1	Mill marks removed		√	√			
	Butt and plug welds ground smooth and filled		√	√			
	HSS weld seam oriented for reduced visibility		<u> </u>	<u>√</u>			
	Cross sectional abutting surface aligned	10	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	N al			
3.5	Joint gap tolerances minimized All welded connections	<u> </u>	optional	optional			
			optional .	opaona.			
4.1	HSS seam not apparent		√				
4.2	Welds contoured and blended		<b>√</b>	Show	ase or do	minant	
4.3	Surfaces filled and sanded Weld show-through minimized		<b>√</b>				
	Weld Show-through minimized		,		nts, sculpt		
C.1				Cost p	remium: F	High	
C.2				(150-2			
C.3				(130-2	30 70)		
C.4							
C.5			_				
					D	5	
		Elements with	Showcase or	Airports,	Retail and architectural	Roof trusses for	
	Sample Use:	special	dominant elements	shopping centres,	buildings viewed	arenas, retail warehouses,	
		requirements		hospitals, lobbies	at a distance	canopies	
	Estimated Cost Premium:	Low to High	High	Moderate	Low to Moderate	Low	None
		(20-250%)	(100-250%)	(60-150%)	(40-100%)	(20-60%)	0%

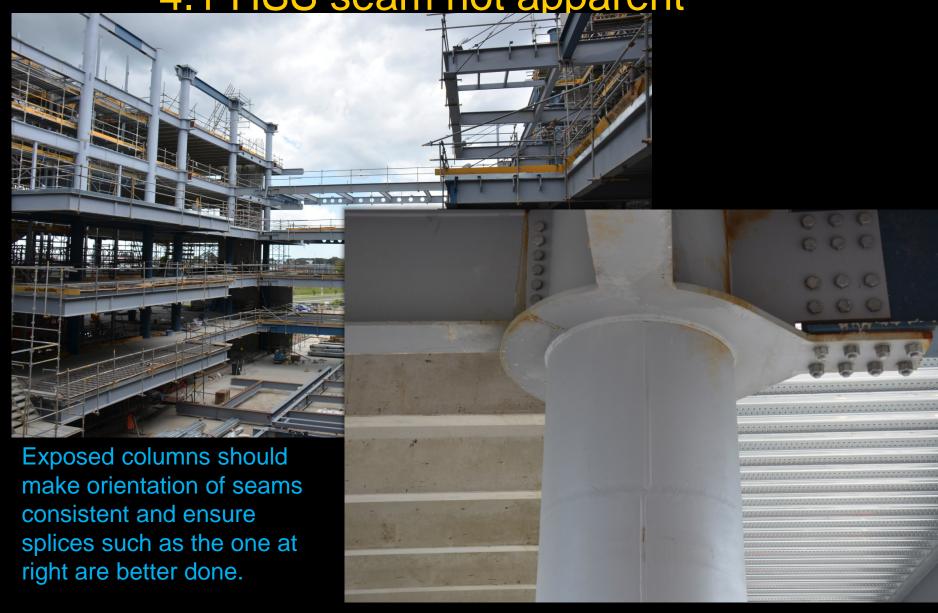
### AESS 4 - Showcase or dominant elements



# 4.1 HSS seam not apparent



4.1 HSS seam not apparent

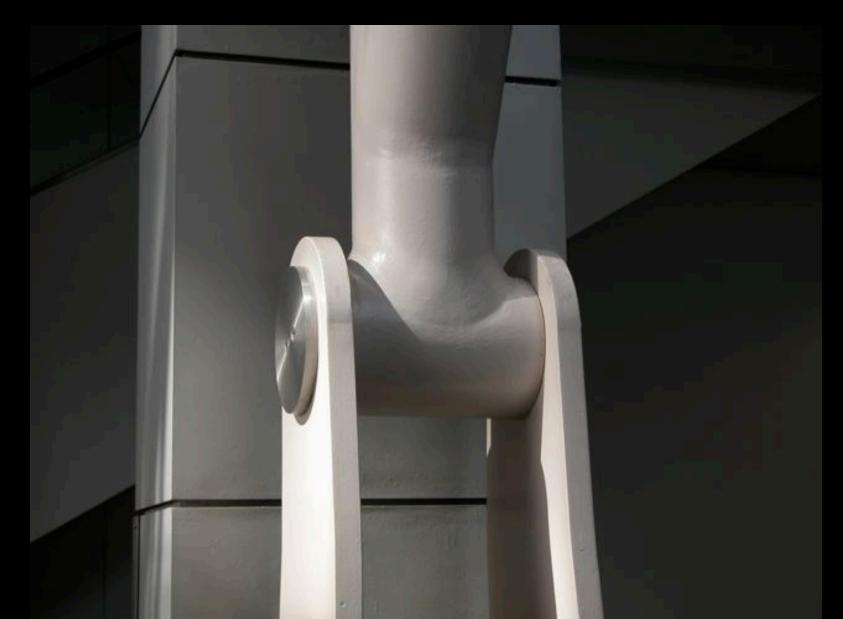


### 4.2 Welds contoured and blended



Very expensive

# 4.2 Welds contoured and blended



# 4.3 Surfaces filled and sanded





# 4.4 Weld show-through minimized



photo: AISC AESS Guide

Table 1 - AESS Category Matrix

	Table 1 - ALGG Gategory Watth		_				
Λ_	Category	AESS C	AESS 4	AESS 3	AESS 2	AESS 1	SSS
Α	ESS C	Custom	Showcase	Feature	Feature	Basic	Standard
		Elements	Elements	Elements	Elements	Elements	Structural
							Steel
	Characteristics			Viewed at a	Viewed at a		CSA S16
ld			-1	Distance ≤ 6 m	Distance > 6 m		
1.1 1.2	Surface preparation to SSPC-SP 6 Sharp edges ground smooth		V V	V	V	√ √	
1.3	Continuous weld appearance		- V	V	Ž	V	
1.4	Standard structural bolts		V	V	V	V	
1.5	Weld spatters removed		<b>√</b>	√	√	√	
							·
2.1	Visual Samples		optional	optional	optional	AFSS	1-4 are
2.2	One-half standard fabrication tolerances Fabrication marks not apparent	2	- V	V	N N	ALSS	174 alt
	Welds uniform and smooth		<u> </u>	V	V	NEVE	R
			·	,	. 1		
3.1	Mill marks removed		√	√		modifi	ed!
3.2	Butt and plug welds ground smooth and filled		√.	√			<u> </u>
	HSS weld seam oriented for reduced visibility	-	<u>√</u>	√,			
3.4	Cross sectional abutting surface aligned	P	V	V			
3.5 3.6	Joint gap tolerances minimized All welded connections		optional	optional	I This se	ction is fo	or those
0.0	7 III Wolded Confidencial		ориони	ориона			
4.1	HSS seam not apparent		√		who ha	ve unusu	al
4.2	Welds contoured and blended	4	√.		wa anniwa.		
4.3	Surfaces filled and sanded		<b>√</b>		requirer	ments or	are
4.4	Weld show-through minimized		√		confide	nt enougl	h to
					Cormue	nt enough	
C.1					create t	heir own	set of
C.2 C.3							
C.3					requirer	ments	
C.5							
0.0							
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	0	Elements with	Showcase or	shopping	architectural	arenas, retail	
	Sample Use:	special requirements	dominant elements		buildings viewed	warehouses,	
		requirements		hospitals, lobbies	at a distance	canopies	
	Estimated Cost Premium:	Low to High	High	Moderate	Low to Moderate	Low	None
		(20-250%)	(100-250%)	(60-150%)	(40-100%)	(20-60%)	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

















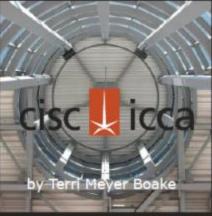
CISC
Guide for Specifying
Architecturally Exposed
Structural Steel











# Added Topics in the AESS Guide

1 The Challenge

What is AESS?

# **Table of Contents** 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 AESS Guide - Table of Contents - 1

#### 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

Draft version 1.1 - November 2009

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### **Additional Topics**

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General Issues
Connection Mock-Ups
Which Type of Connection Should I Choose?
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6 Curves & Cuts p 24

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Bending

Elliptical Tubes

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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 specificiation documents - understanding that "a picture
might be worth a thousand words".

#### Image credits:

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#### 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 prefabricated 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-



CISC AESS Guide - Table of Contents - 2

...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



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



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



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.



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.



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



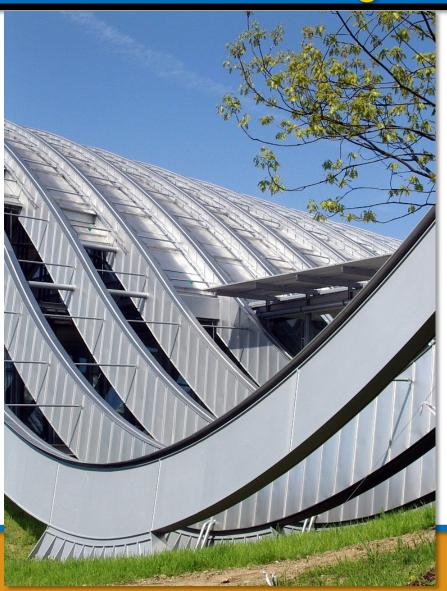
the splicing of the I sections and the joining of the SHS members to the truss.

#### **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.





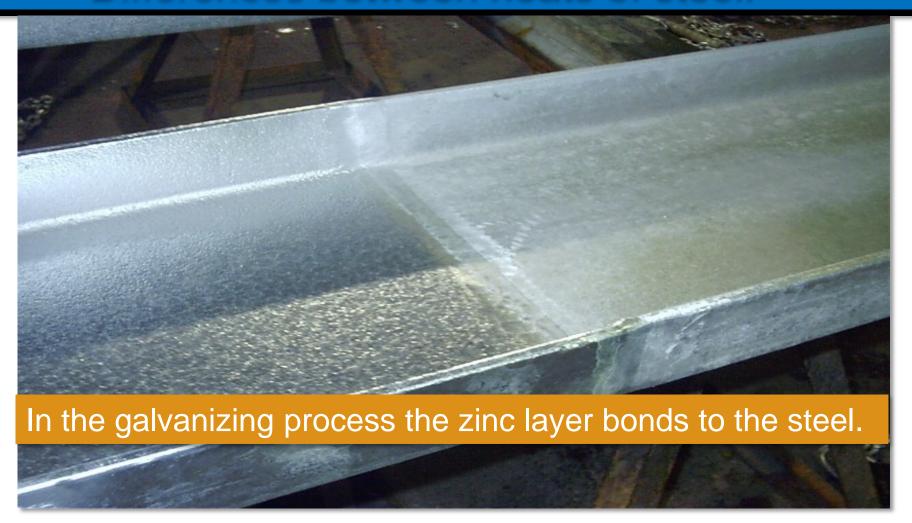
### What impacts the final look of galvanized steel?

- 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

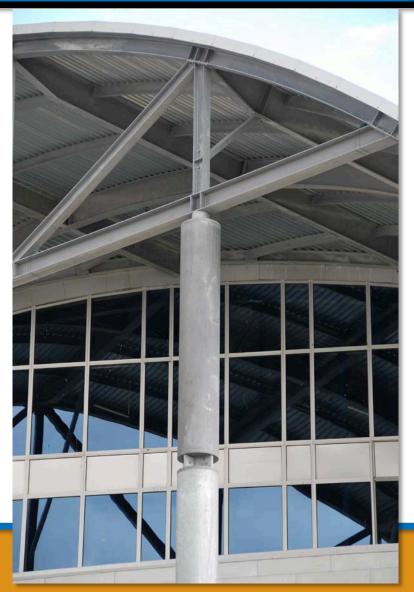


### Differences between heats of steel!





# **Galvanizing Applications**







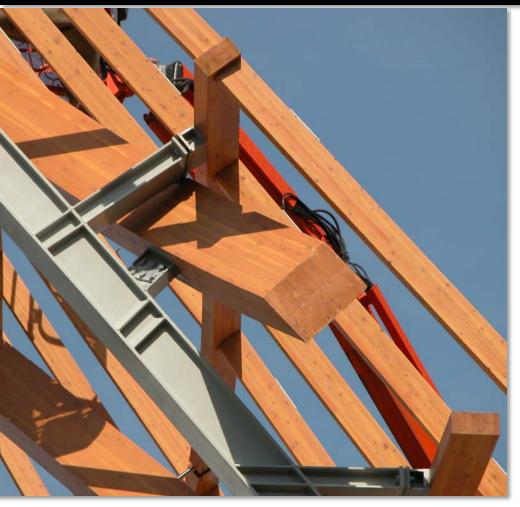


# Access for cleaning (and re-painting)





### 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





# **Project Profile**

### **Owner**

Calgary International Airport

**Architect** DIALOG

**Structural Engineers** 

Read Jones Christoffersen Ltd.

**Construction Manager** 

Ellis Don Construction Management Services

Steel Fabricator / Detailer / Erector Supermétal

# CALGARY INTERNATIONAL AIRPORT International Facilities Project



Photo credits this section: Supermétal

Content: Sylvie Boulanger, Vice President, Technical Marketing

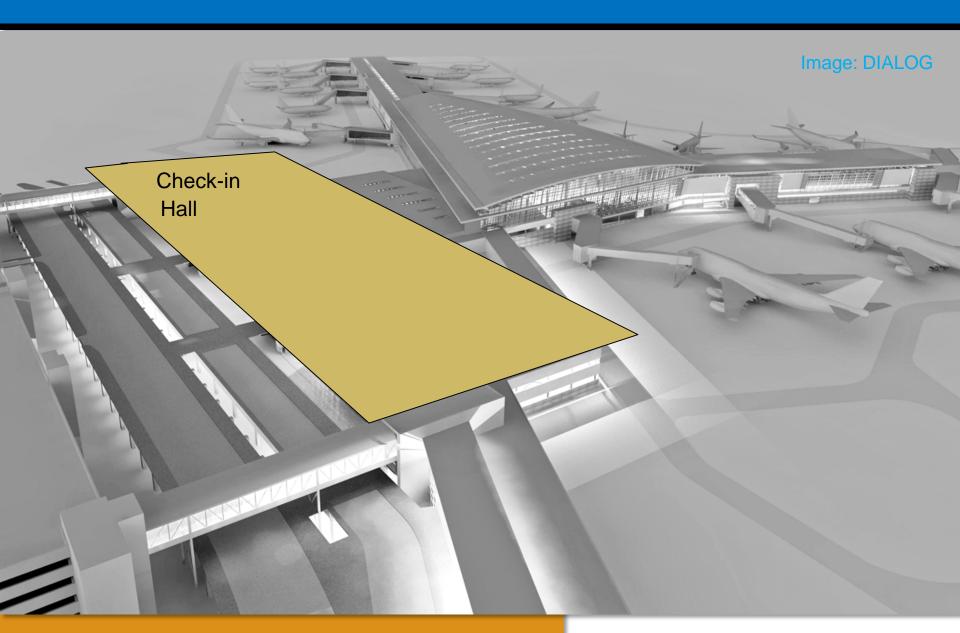


### Calgary Airport International Facilities Project

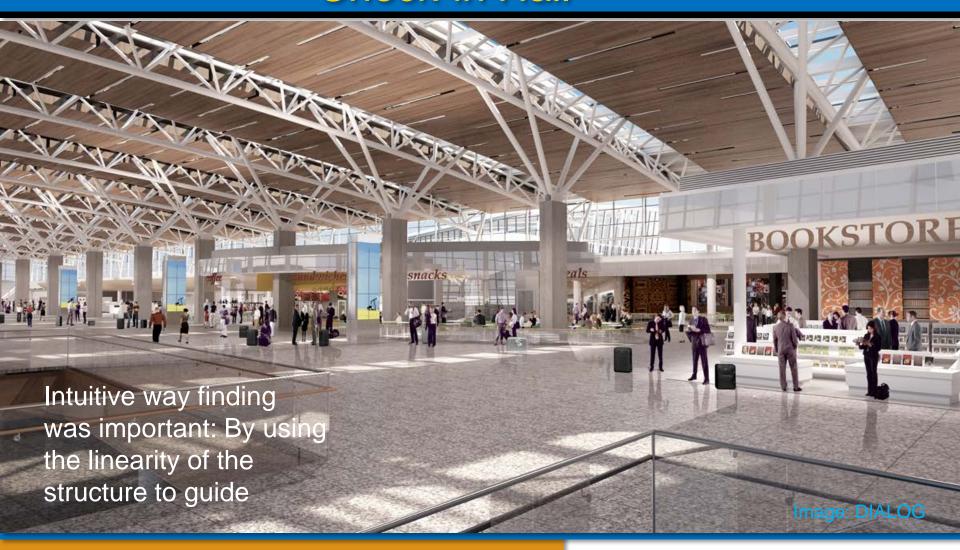
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### Calgary Airport International Facilities Project



# Check-in Hall





### Calgary Airport International Facilities Project



### **Quick Facts**

# International Facilities Project

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

### Structural Steel

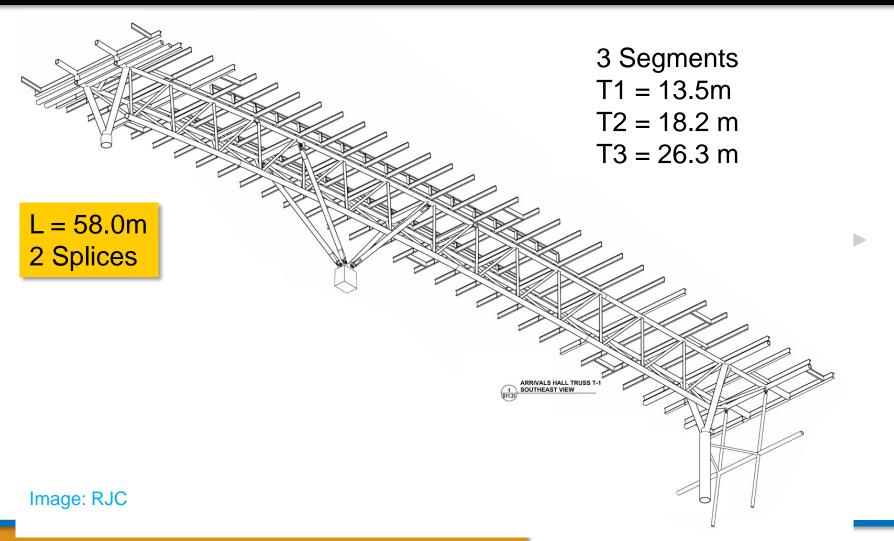
8000 tons, including 2000 tons of AESS in Check-in and Departures Halls

### **Check-in Hall**

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

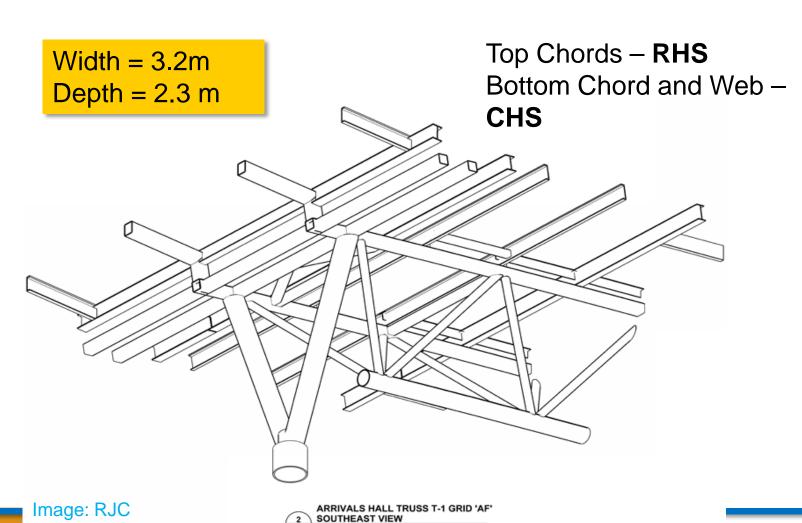


# Typical truss





# Typical Truss





### **Select AESS Categories** associated to members or assemblies

### Sample AESS Specification

### BAMPLE ALSS SPECIFICATION FOR CANADA

A ROHITECTURALLY EXPOSED STUCTURAL STEEL (ABSS)

### 1.1. RELATED DOCUMENTS

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- 25 ARCHITECTURAL REVIEW
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### **Select AESS Categories** associated to members or assemblies

### Sample AESS Specification

A ROHITECTURALLY EXPOSED STUCTURAL STEEL (ABSS)

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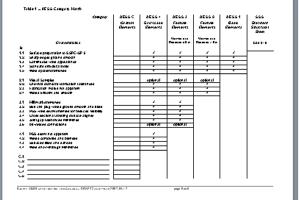
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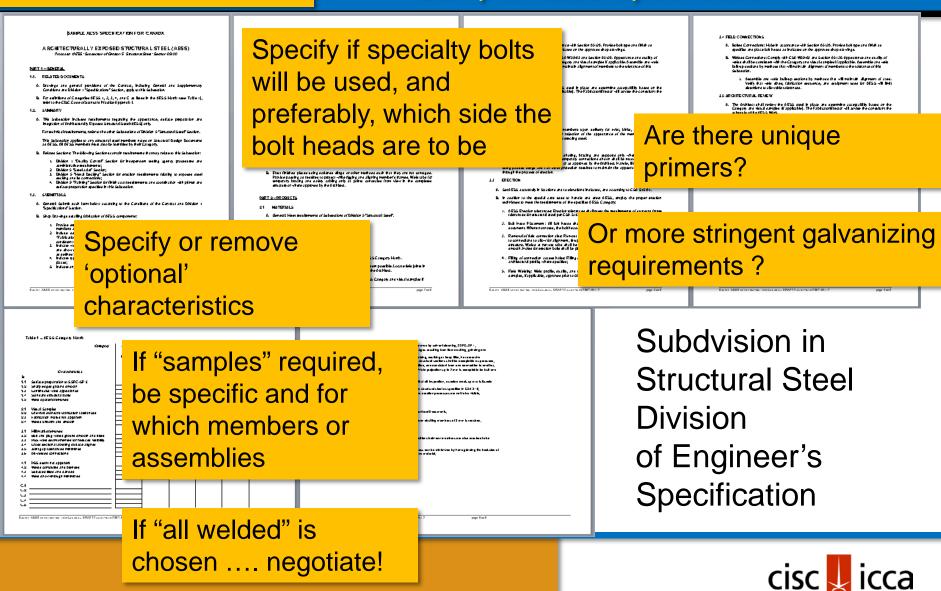
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Subdvision in Structural Steel Division of Engineer's **Specification** 



# Select AESS Categories associated to members or assemblies

### Sample AESS 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	Canopies	-
Terminal		
Hote	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
Termina		
Piers		
Hotel	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		

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	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
note Termina	braces	AESS 3
Hotel Terminal Piers	Moment Frames	AESS 2

### Location of the AESS elements

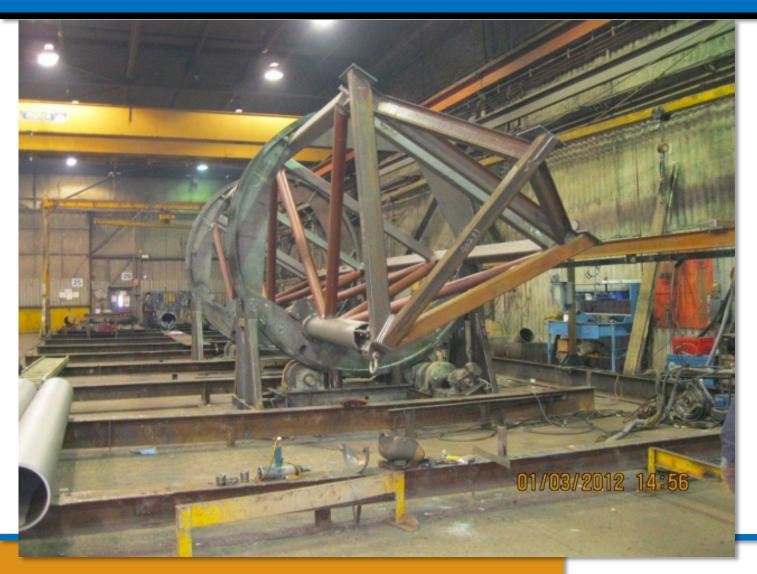


# Mockups at Supermétal Plant





### 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.





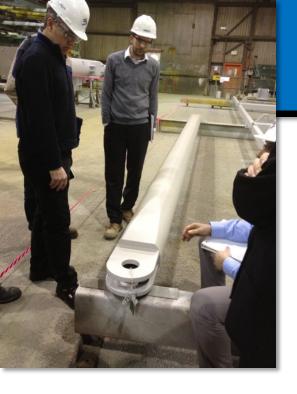
# Avoiding confusion







Labels help during fabrication and erection



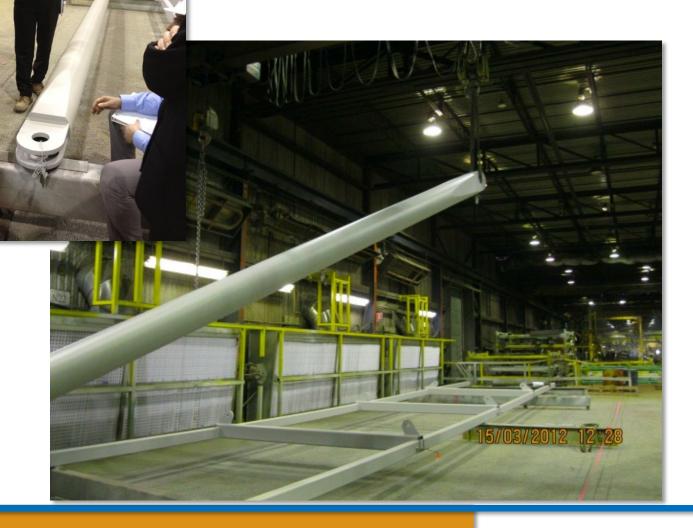
### When a Mockup is required ....

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

- Distance
- Position
- Lighting



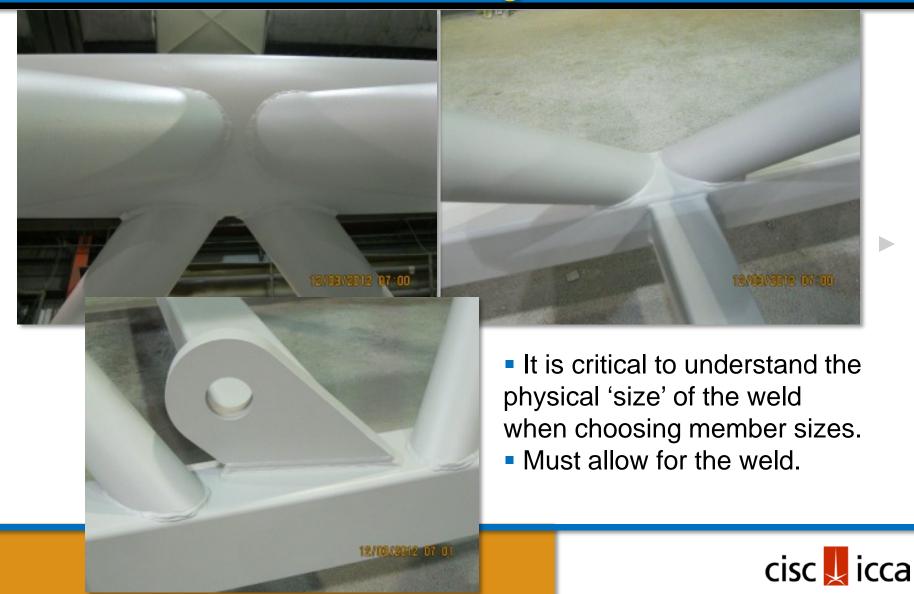
# When a Mockup is required ...



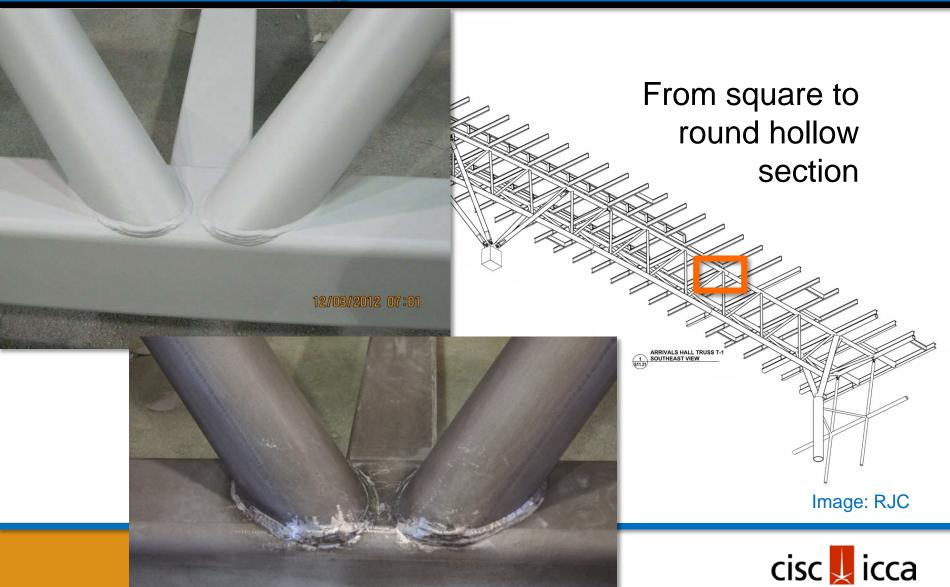




# Member sizes and alignment issues



# Alignment issues

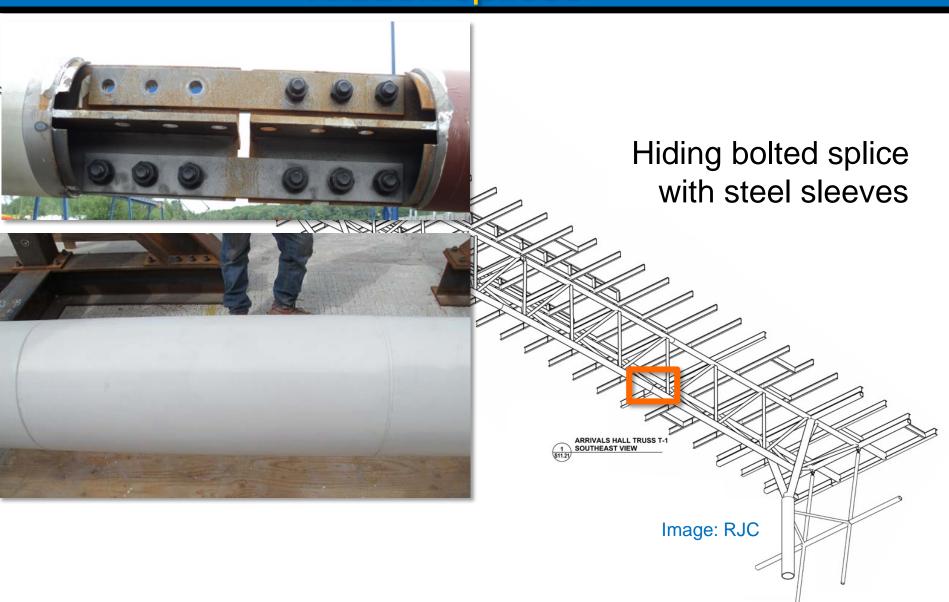


# Alignment issues

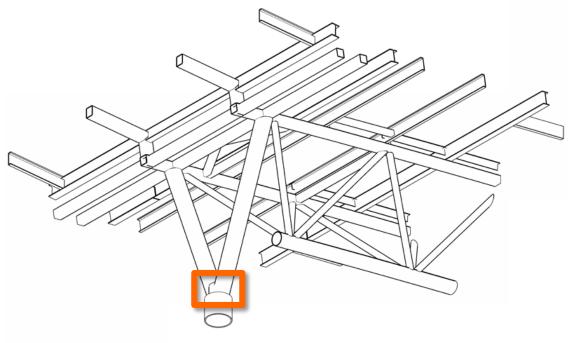




### Hidden splices



### How round is round?



From round column to round plate

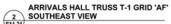


Image: RJC



## How round is round?

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



Plate either goes on top of tube or inside tube...



### Care in transportation and handling



# Lifting a truss element



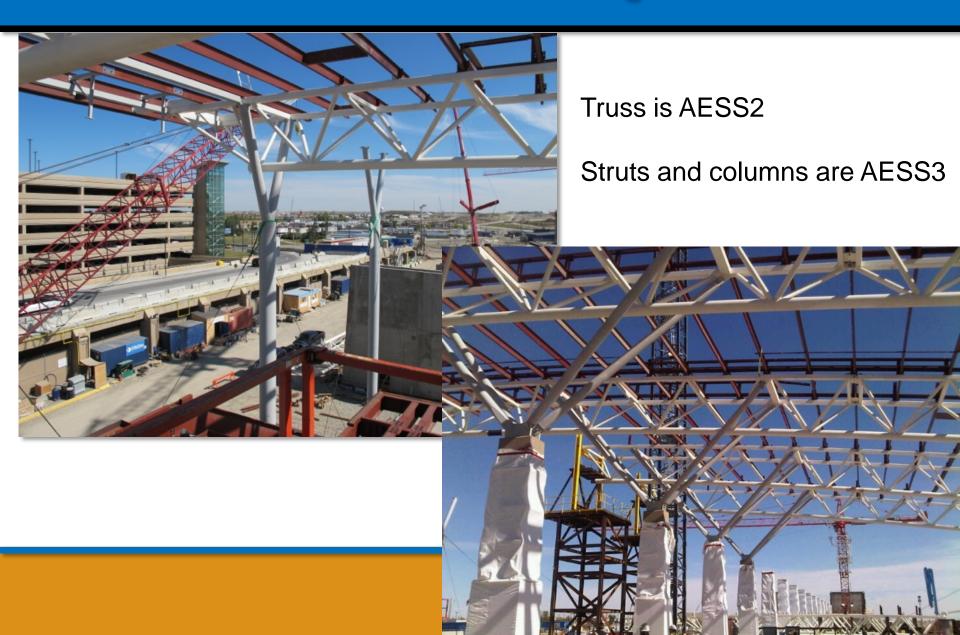
# Threading the struts



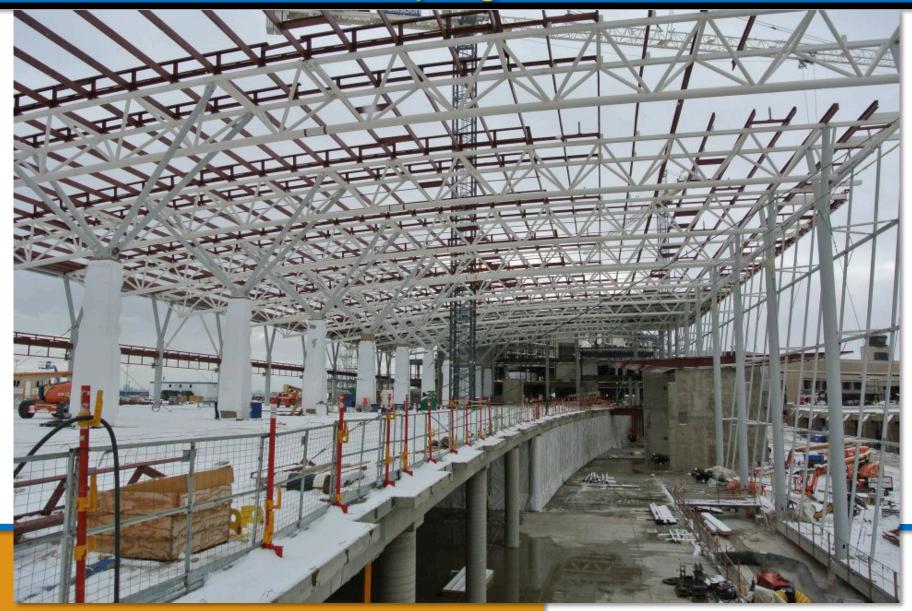
# Bolting the strut



## **Location of AESS Categories**



## Overall progress



### Panoramic view

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

28 AOÛt 2012



30 SEPTEMBRE 2012



**26 OCTOBRE 2012** 

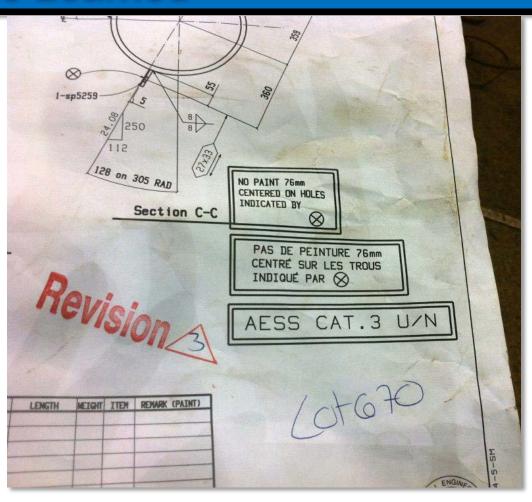


#### **Lessons Learned**

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

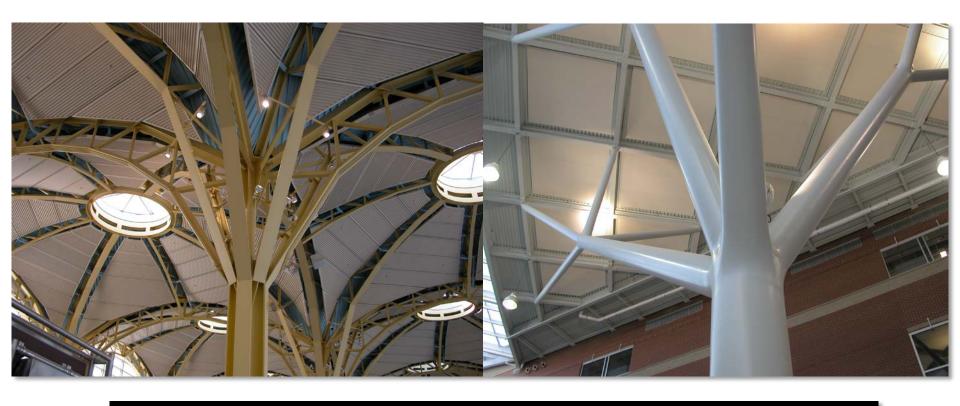
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- Smooth weld still subject to interpretation
- Identical vs equivalent reproduction
- Inspection consistency





### 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????

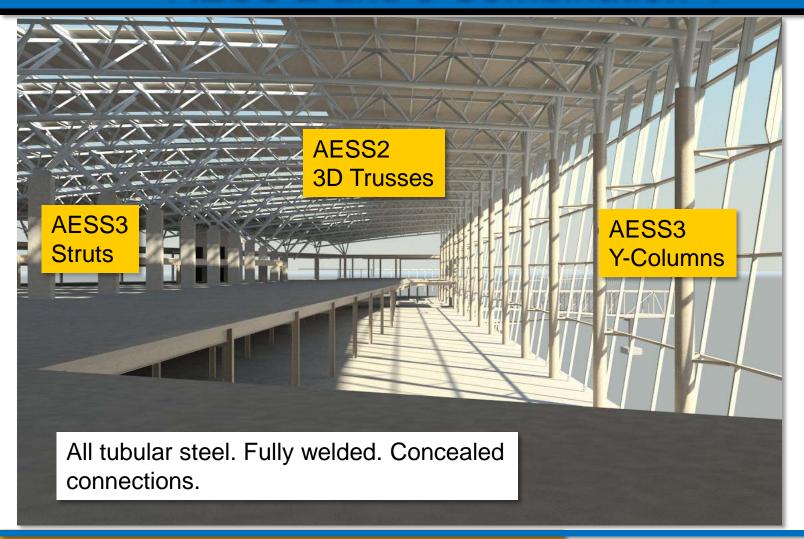


### Cost impact items

- 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

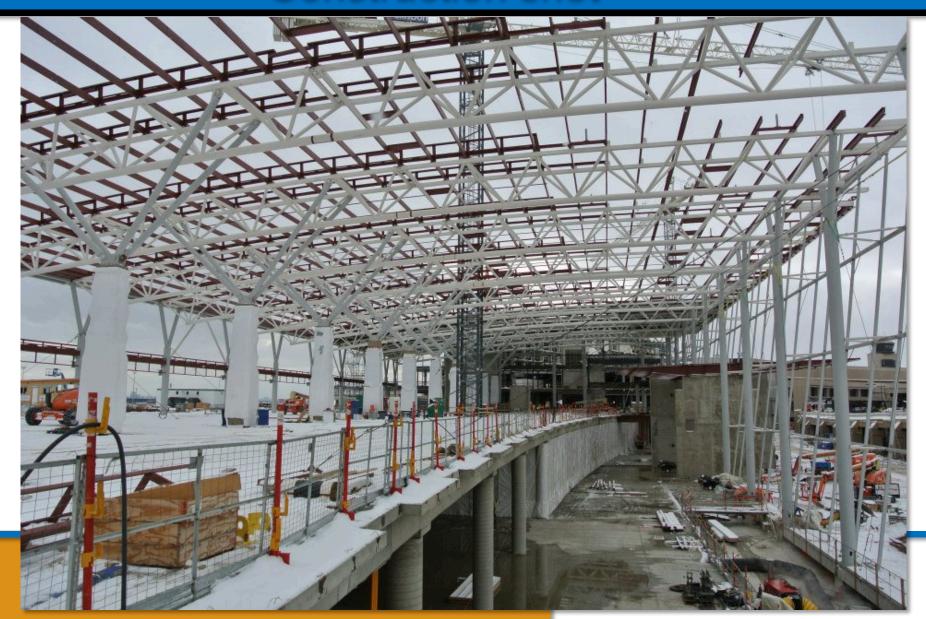


#### **AESS 2 and 3 Combination 1**





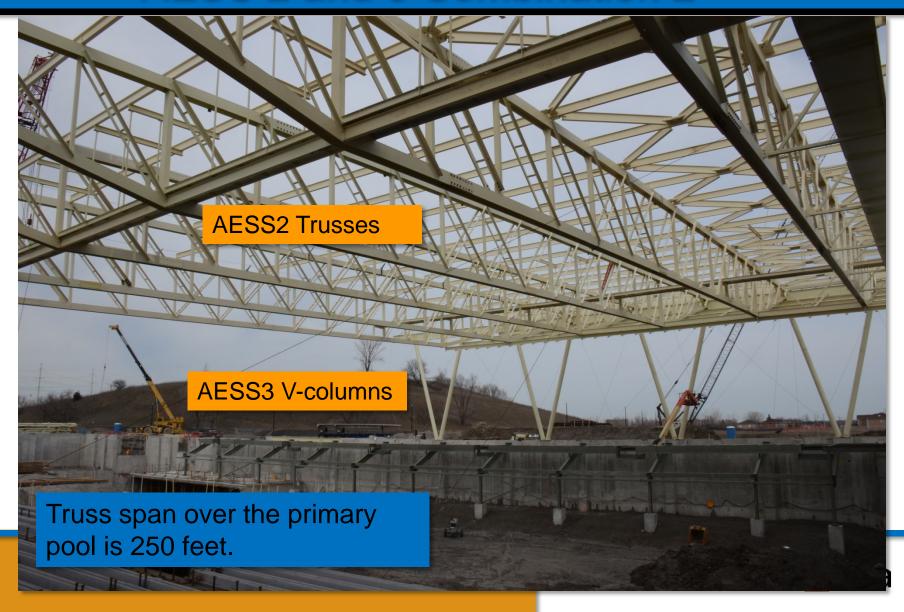
## Construction shot



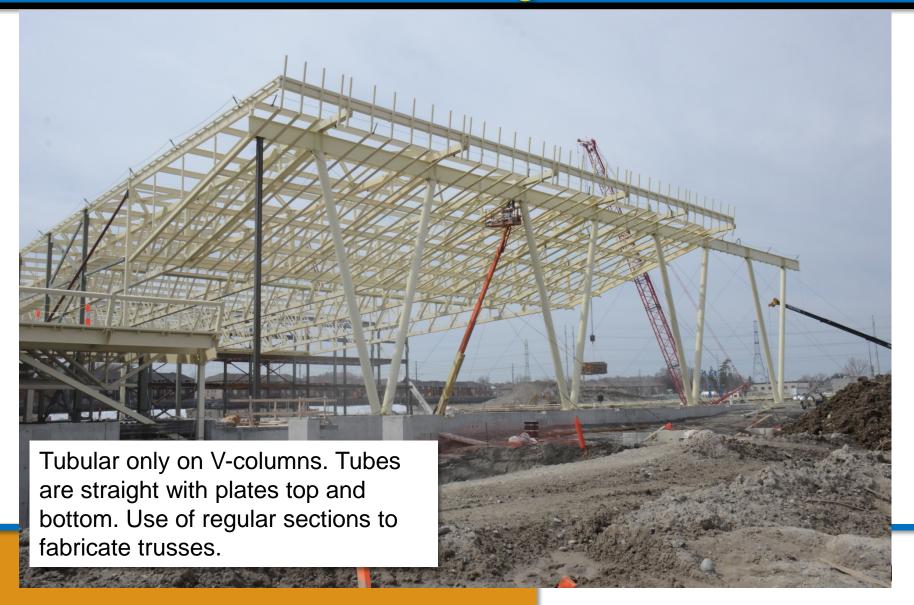
## Closer view



### AESS 2 and 3 Combination 2



### More technical looking aesthetic



### Splicing the trusses



### 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



