AESS A

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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

Category

AESS C

AESS 4

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

ld

C.4 C.5

- 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

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- s and fabrication tolorances
- Showcase Custom Feature Feature Basic Standard Structural Elements Elements Elements Elements Elements Steel Viewed at a Viewed at a **CSA S16** Distance $\leq 6 m$ Distance > 6 m Categories go from lowest at the right to highest at the left.

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AESS 1

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AESS 3

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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%

Characteristics

Category

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

2.1 Visual Samples

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

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AESS C Custom Elements	AESS 4 Showcase Elements	AESS 3 Feature Elements	AESS 2 Feature Elements	AESS 1 Basic Elements	SSS Standard Structural Steel
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Viewing distance is noted as the differentiating factor between the high and low end AESS Categories.

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	Category	AESS C Custom Elements	AESS 4 Showcase Elements	AESS 3 Feature Elements	AESS 2 Feature Elements	AESS 1 Basic Elements	SSS Standard Structural
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		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
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		Estimated Cost Premium:	Low to High	High	Moderate	Low to Moderate	Low	None
			(20-250%)	(100-250%)	(60-150%)	(40-100%)	(20-60%)	0%

Standard Structural Steel

The initial point of technical reference is Standard Structural Steel as it is already an established and well-understood as a baseline in construction Specifications.



NOTE: Even if "non rectilinear steel" LOOKS like Standard Structural Steel, the TOLERANCES and FIT required are likely to be more in tune with AESS requirements!

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	Estimated Cost Premiun	n: Low to High (20-250%)	High (100-250%)	Moderate (60-150%)	Low to Moderate	Low (20-60%)	None 0%

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AESS 1 - Basic Elements

- the first step above Standard Structural Steel
- suitable for "basic" elements, which require enhanced workmanship
- should only require a low cost premium in the range of 20% to 60% due to its relatively large viewing distance as well as the lower profile nature of the architectural spaces in which it is used.



A	ESS 2	AESS C Custom Elements	AESS 4 Showcase Elements	AESS 3 Feature Elements	AESS 2 Feature Elements	AESS 1 Basic Elements	SSS Standard Structural Steel
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	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 2 - Feature Elements (> 6 m)

- structure that is intended to be viewed at a distance > 6 m
- The process requires basically good fabrication practices with enhanced treatment of welds, connection and fabrication details, tolerances for gaps, and copes
- might be found in retail and architectural applications where a low to moderate cost premium in the range of 40% to 100% over the cost of **Standard Structural Steel** would be expected.



Although using fairly standard W and C sections, this AESS has incorporated castellated members

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A	ESS 3	ategory	AESS C Custom Elements	AESS 4 Showcase Elements	AESS 3 Feature Elements	AESS 2 Feature Elements	AESS 1 Basic Elements	SSS Standard Structural Steel
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	Estimated Cost P	remium:	Low to High	High	Moderate	Low to Moderate	Low	None
			(20-250%)	(100-250%)	(60-150%)	(40-100%)	(20-60%)	0%

AESS 3 - Feature Elements (≤ 6m)

- structures that will be viewed at a distance ≤ 6m
- suitable for "feature" elements - where the designer is comfortable allowing the viewer to see the art of metalworking
- welds should be generally smooth but visible and some grind marks would be acceptable
- Welds can be ground if desired



 Tolerances must be tighter than normal standards. As this structure is normally viewed closer than six meters it might also frequently be subject to touch by the public, therefore warranting a smoother and more uniform finish and appearance.

 could be expected to incur a moderate cost premium that could range from 60% to 150% over Standard Structural Steel as a function of the complexity and level of final finish desired

A	ESS 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
ld 1.1 1.2	<i>Characteristics</i> Surface preparation to SSPC-SP 6 Sharp edges ground smooth				Viewed at a Distance ≤ 6 m √ √	Viewed at a Distance > 6 m √ √	$\sqrt{1}$	CSA S16
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	S	ample 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 Cos	st 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 Elements

- used where the designer intends that the form is the only feature showing in an element
- All welds are ground and filled edges are ground square and true
- All surfaces are sanded and filled. Tolerances of these fabricated forms are more stringent, generally to half of standard tolerance for standard structural steel



- All of the surfaces would be "glove" smooth
- The cost premium of these elements would be high and could range from 100% to 250% over the cost of Standard Structural Steel completely as a function of the nature of the details, complexity of construction and selected finishes.

Challenge Points for Design

- Decide on the AESS categories
- Understand transportation limitations (how large are the pieces that can fit on a truck, height weight, width)
- How big is the staging area?
- Can you sub assemble larger components on site before lifting?
- Crane position? Reach? How many cranes?
- Limits on access due to roads, traffic, rail lines, etc.
- Determination of splice positions and therefore site welding versus bolting



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

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





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

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NAVIA W



DIALOG

BOOKSTORE

Calgary Airport International Facilities Project



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

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



Typical Truss



Sample AESS Specification

BAMPLE JESS SPECIFICATION FOR CANADA

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- 1.4. RELATED DOCUMENTS Drawbyge are general powleter of the Contral, Industry General are Supplementation Conditions are Divider a "Specific store" Section, apply to this Subsection.
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Subdvision in **Structural Steel** Division of Engineer's **Specification**



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Sample AESS Specification





Sample AESS Specification



Sample AESS2 / AESS3 Table

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

Sample AESS2 / AESS3 Table

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





Calgary Airport Assemblies Mockup at Supermétal Plant



24/02/2012 07:53



Avoiding confusion





When a Mockup is required ...

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

- Distance
- Position
- Lighting




When a Mockup is required ...







When a Mockup is required ...

Photos: Sylvie Boulanger, Supermétal

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



Alignment issues





Hidden splices



How round is round?



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



Struts and columns are AESS3

Overall progress







Panoramic view

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



30 SEPTEMBRE 2012

28 AOÛt 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





Next phase!



Image: DIALOG



Overall structural drawing





Detail

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

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

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



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







Project Profile

Owner University of Toronto, Scarborough Campus

Architects NORR Architects

Construction Manager PCL

Structural Engineer Yolles

Steel Fabricator / Detailer / Erector Walters Inc., Benson Steel, Casey Welding

AQUATIC CENTRE FOR THE 2015 PANAM GAMES Toronto, Ontario



Site access courtesy: Walters Inc.

Working with the fabricator

Taking the steel design from the rendering, through AESS Category consideration and to reality requires the input of the fabricator.

Details of the trusses



Differentiated steel throughout



Primed steel

H St.

Although the overhang will be clad, the concealed steel is primed as not to stain the AESS during construction.

Different categories



The Y columns are AESS3 and the trusses are AESS2 as they are well beyond the 6m viewing distance.

Column to beam connection



Ladder design of web members



Bolted vs welded connections


Splicing the trusses



Splicing the trusses



The 250 foot long trusses arrive to the site in transportable sections. They are assembled on the 'flat' prior to lifting. Site connections are bolted.

Bolted splice



Training pool roof





Project Profile

Owner Brookfield

Architects Pelli Clarke Pelli Architects

Construction Manager Plaza Construction

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

WORLD FINANCIAL CENTRE ENTRY PAVILION New York City, New York



Site access courtesy: Walters Inc.

The Architect's Concept



The 3D Model

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

Complex steel uses digital methods



Top view of plan



Image: Walters Inc.

Detailed view



Planimetric drawings



Setting the jigs



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



Maximizing the fabrication in shop



Curved tubular steel

Issues with matching connecting curved pieces for seamless welded connections.

PAP

FO-4N

Solid connecting steel rods





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

Curves, overlaps and geometry



Shop space and pre-fitting



Aligning future site connections



Why shop weld?



Transportation



Handle with care



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



Lift off of the truck



Lift into place



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



Access to complete connections



Staging and site issues



Sorting pieces



Many pieces for a complex project
Need to ensure adequate labeling to avoid confusion

Upper tiers too large to be shipped assembled

Subdivided into sections to fit shipping limitations



Access to perform work



Complex fit



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



3 months later...



Weld remediation

UTOK

3 months to complete the site welding of the connections between the components.

FH

IG

Installation of roof decking



This takes a long time...

Welding, erecting scaffolding and the sheer number of connections adds up.

The Glass Box



Finished steel





Intumescent coating



Structural columns in glass box




Project Profile

EIGHTH AVENUE PLACE WINTERGARDEN Calgary, Alberta

Owner Penny Lane II Limited Partnership

Development Manager Hines Canada Management Co., ULC

Architects

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

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

Construction Manager Ellis Don Construction Management Services

Steel Fabricator / Detailer / Erector Supermétal



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

Concept

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

Overall structural drawing

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

Haunch detail



Column fabrication



Node connection



Steel erection





Last Arch erection

2nd Arch erection

Completed node



Completed Wintergarden



Details







Owner Cityzen, Fernbrook Homes

Architects architectsAlliance

Construction Manager

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

Project Profile

PIER 27 RESIDENCES Toronto, Ontario



Site access courtesy: Walters Inc.

Bridging with a diagrid 'truss'



Prepping for a lift



Floor support element erected



Team accepting element



What is exposed? What is not?



Bracing in all planes



Intersections



Stiffness through structural choices



Steel to concrete issues



AESS vs structural components



Splice locations



Shipping restrictions



Temporary stabilization systems



Bridges and cantilevers



Diagrid as result



Subtle differentiation



Completed project





Project Profile

PEMBINA HALL University of Manitoba Winnipeg, Manitoba

Owner The University of Manitoba

Architects Raymond S.C. Wan Architect

Structural Engineers Crosier Kilgour & Partners Ltd. SMS Engineering Ltd.

McGowan Russell Group

Stantec Engineering

Dyregrov Robinson Inc.

Construction Manager Bird Construction Company Ltd.

Steel Fabricator / Detailer / Erector Supermétal



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

Structural Isometric



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

Elevation view of steel



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

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

Truss element

The green highlights a single truss element to be fabricated.

Connections and splices



Connections and splices



Site assembly of truss components



Lifting an assembled truss section


First truss in place



Site bolting



Semi finished structural frame





Interior

photos: University of Manitoba

For the interior of the rooms they provided intumescent coating on the diagonals (because they transfer gravity loads), and left the deck exposed (galvanized deck for more luminosity) modifying the concrete mix above and other parameters.





Project Profile

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

Architects Zeidler Partnership

Construction Manager Aecon

Structural Engineer Yolles

Steel Fabricator / Detailer / Erector Walters Inc.

UNION STATION ATRIUM Toronto, Ontario



Site access courtesy: Walters Inc.

Union Station Train Shed



View towards roof



Construction phasing

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



Drawings





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

Images: Walters Inc.

Truss construction



Truss connecton



Column meets heated floor



Exposure levels

- Not all steel is exposed
- Columns are AESS3
- Hanger system is fabricated to AESS standards but is not considered "structural" per se
- Fritted, translucent glazing on soffit obscures the steel trusses

 Stainless steel cables provide some tension support for the glazed wall



Quality fabrication brings projects to life



Image: Zeidler Partnership

Front elevation

Pretty darned close if you have high quality steel fabrication and a great relationship with your Engineer and Fabricator.

Translucency



Support for venting glazing



Hanger connection for side glazing



Custom welded plate for columns



Fine support system for glazing



Obscured by glazing





Construction during a live station





Blending historic with new



Last piece of steel to be lifted





Inside the space truss



Placing the last piece





First Union Station, 1858





Project Profile

John Street Bridge Toronto, Ontario



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

Site access courtesy: Walters Inc.

John Street Bridge




All of the pre painted bridge elements were shipped to the site as would fit transport and assembled on site into one element for a unified lift.

















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

Project Profile

Puente de Luz Toronto, Ontario



Site access courtesy: Walters Inc.

Erection logistics



Closure of GO trains for 5 hours max



Placing the splices



Bolted connections











Project Profile

Owner Allied Properties

Architects &Co Architects

Construction Manager Eastern Construction

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

Castings CastConnex

QUEEN RICHMOND WEST CENTRE Toronto, Ontario



Site access courtesy: Walters Inc. and CastConnex

Special legs



Image: &Co Architects

- The 'legs' that will support the new office tower that sits over the older building at Queen and Richmond Streets in Toronto is set on very large legs created from hollow steel, connected with a large cast connector.
- Referred to as "delta frames" by the team.

Modeling to design

The decisions regarding the shape of the lower 'legs' were based on these models. The tapered ends were chosen.



Image: CastConnex



Overall structural model

Tekla Structures was used to model the overall steel system. The software incorporates full structural requirements as well as detailing of connections.



Connection details



The Tekla model allows for a very detailed development of the connections. Shows temporary tabs for support during erection.

Resin model

A resin casting of the node allowed better visualization of the connection and its curvatures.



Image: CastConnex

Casting process



The casting was done in Kansas as this facility offered the best quality and price.

This sort of node is created using an expendible mould. This means that it is broken in order to remove the casting. These are normally made from sand/resin casting.

Cleaned up

Once the casting is cooled, it is cleaned up and rough edges removed. These were shipped from Kansas to Walters Inc. in Hamilton for further work and preparation for attachment to the legs.



Image: CastConnex

Pre fit the legs to the node



The large tubular legs were fabricated and pre-fit to the node. The system will be filled with concrete to create the required structural strength.





Coordination



Lifting a 31,500 pound cast node requires lot of precision and planning.





AESS 3 and 4 are the only categories that permit grinding. Here some of the temporary tabs are being removed prior to welding the join.



Appreciation of logistics



Erectors will need to work out temporary support systems for geometries that are incapable of stability due to eccentric loading during construction.



The bottom of the leg is a tapered tube. Fabricated via break forming with fully ground welds. AESS4 quality.



Staging of erection



Timing needed to account for the pouring of the concrete to catch up to the steel which is faster to erect.

Support system



The three delta frames support a steel platform that will in turn be used to support the multiple floors of office above.

Weld finishing














Architects Dominique Perrault

Project Profile

ARGANZUELA FOOTBRIDGE Madrid, Spain





Scale: too large to fit on a truck...





Unremediated welded connections



Details









Substantial site welds



Structure of the deck support













Bolted connections for the fins



Port Lands Bridges Toronto





Barge Route



Barge Location

#BridgeWatchTO








































