Listen to the truss

Sylvie Boulanger Ph.D. ing.

CONGRESO INTERNACIONAL DE LA CONSTRUCCIÓN CON ACERO

ICCA INSTITUTO COLOMBIANO DE LA CONSTRUCCIÓN CON ACERO

The following presentation was given at the ICCA Conference on June 21, 2019, in Medellin, Colombia.

3

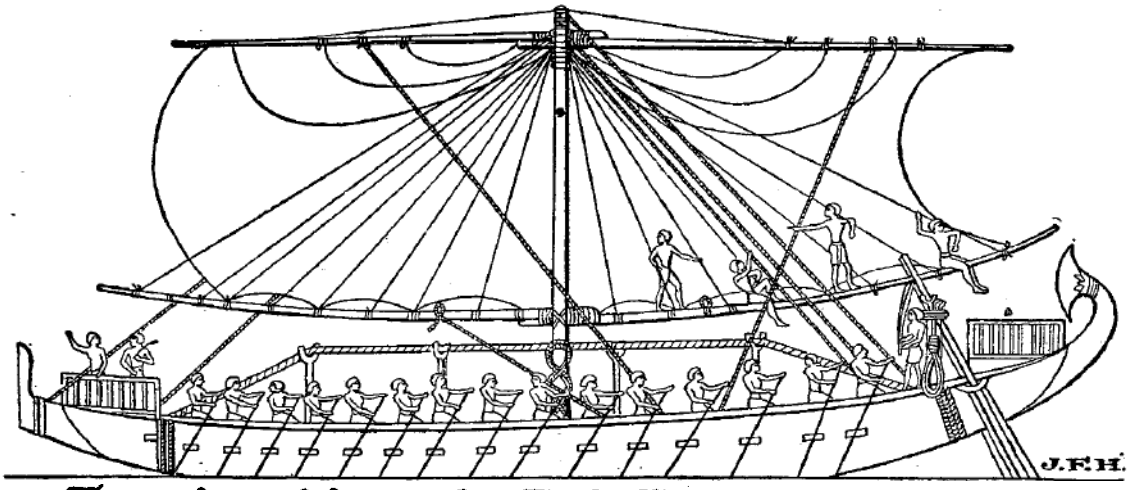
Definition

In engineering, a truss is a structure that "consists of two-force members only, where the members are organized so that the assemblage as a whole behaves as a single object"

*External forces are considered to act only at the **nodes** and result in forces in the members which are either **tensile** or **compressive** forces.*

Wikipedia

4



Egyptian ship on the Red Sea, about 1250 B.C.

Rope Truss

Wikipedia

5

Etymology

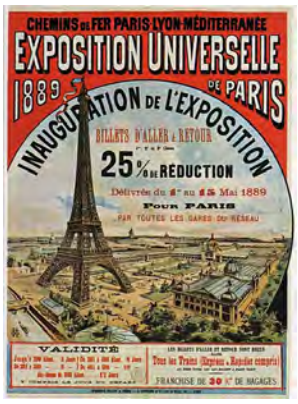
Truss is derived from the old french word trousse, around c.1200, which means "collection of things bound together."

Wikipedia

6

Trusses were initially used for:

Exhibit halls, Train stations,
Sports facilities, Bridges



Universal Exhibit
1889, Paris

7

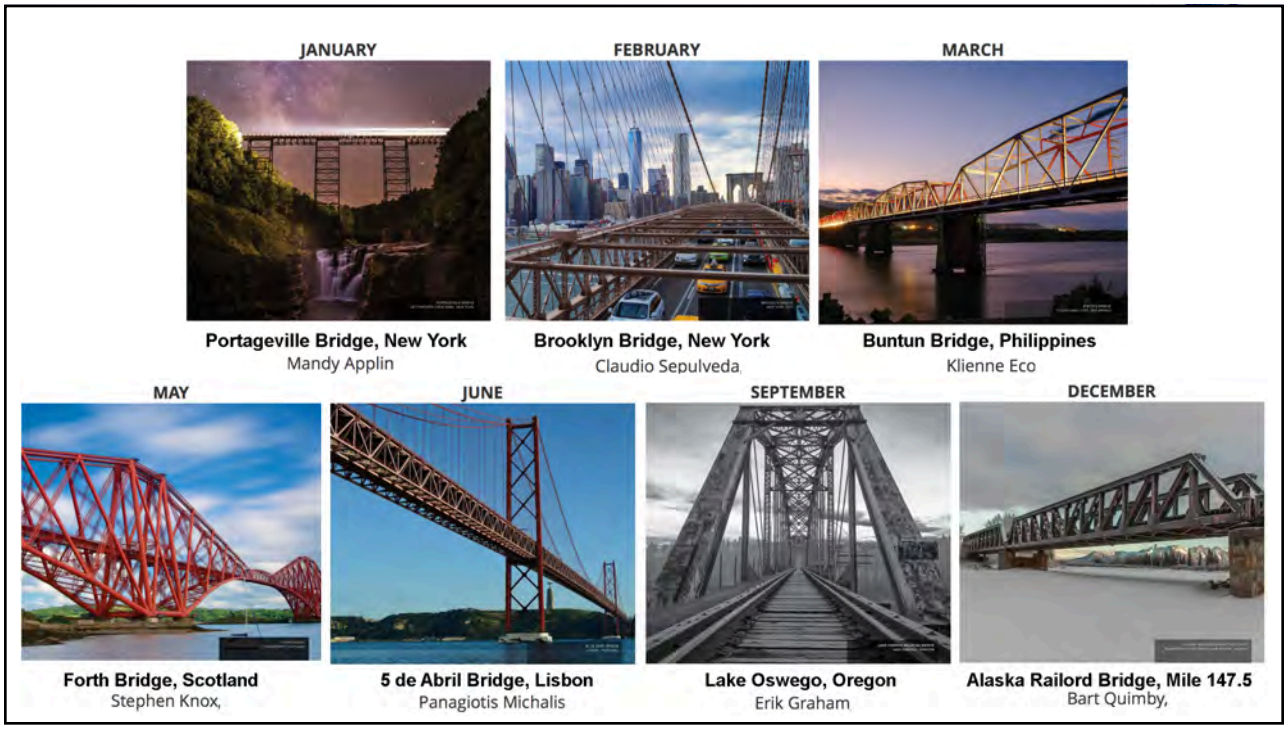
Question

How many months is the steel truss prevalent in the

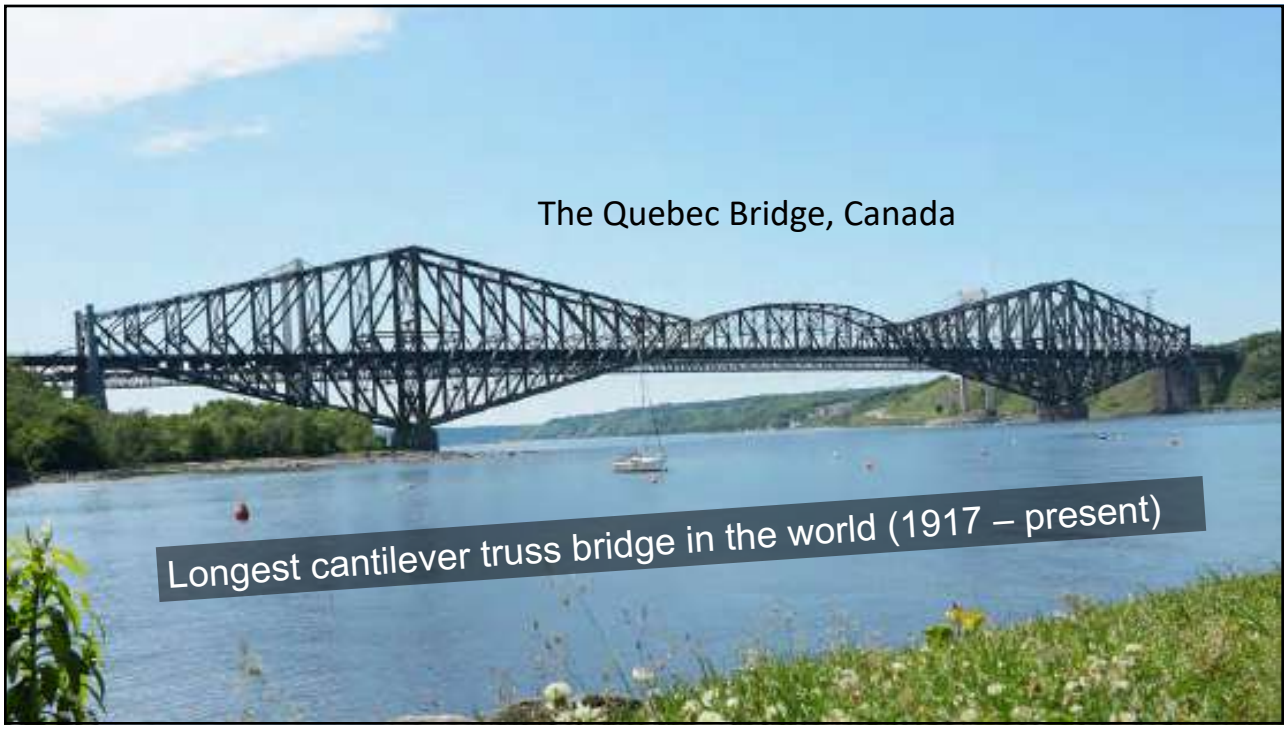
ASCE AMERICAN SOCIETY OF CIVIL ENGINEERS **2019 BRIDGE CALENDAR** ?

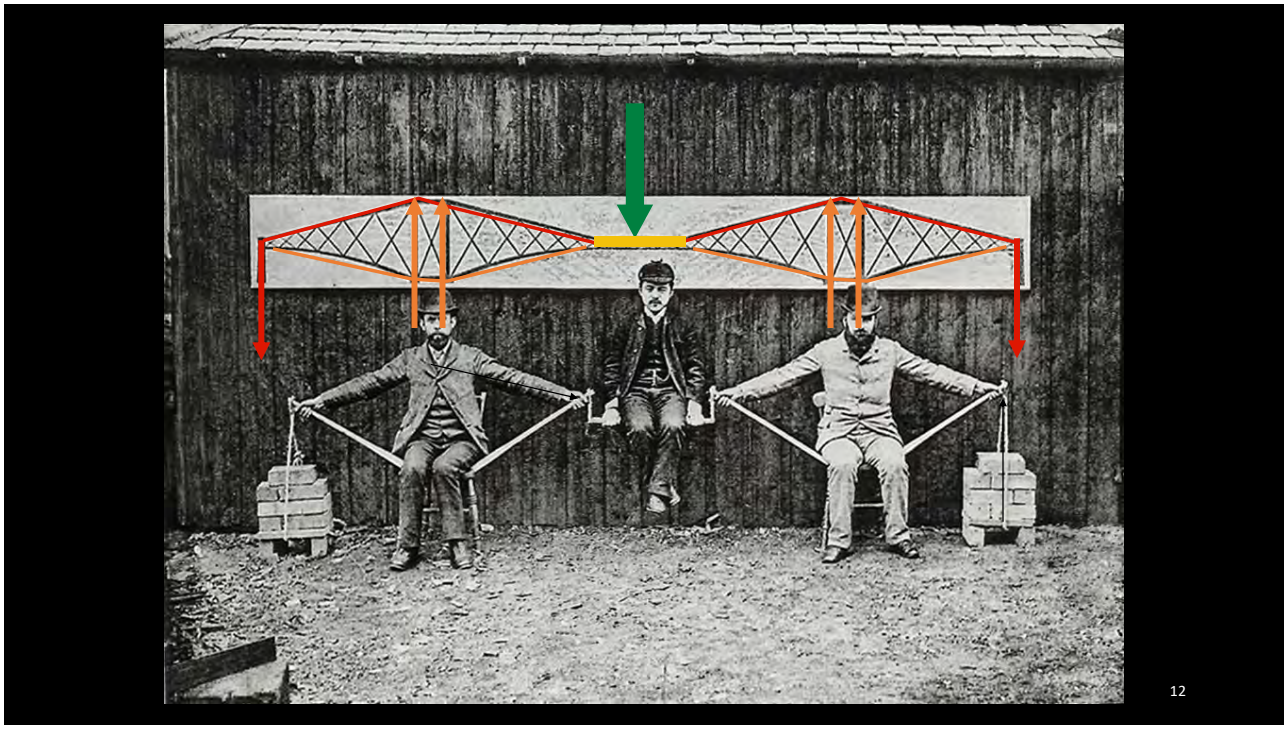
☐ 3 months ☐ 5 months ☑ 7 months

8


JANUARY
Portageville Bridge, New York
Mandy Applin
FEBRUARY
Brooklyn Bridge, New York
Claudio Sepulveda
MARCH
Buntun Bridge, Philippines
Klienne Eco
MAY
Forth Bridge, Scotland
Stephen Knox,
JUNE
5 de Abril Bridge, Lisbon
Panagiotis Michalis
SEPTEMBER
Lake Oswego, Oregon
Erik Graham
DECEMBER
Alaska Railord Bridge, Mile 147.5
Bart Quimby,

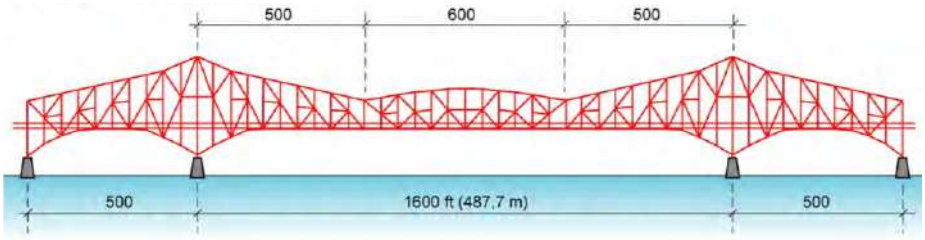

Steel is beautiful.
The steel truss
lasts.


The Quebec Bridge, Canada
Longest cantilever truss bridge in the world (1917 – present)


12

Invitation to tender made by Hoare in 1898

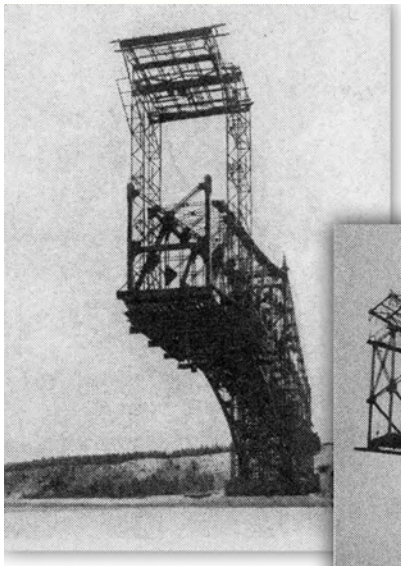
Phoenix Bridge Company



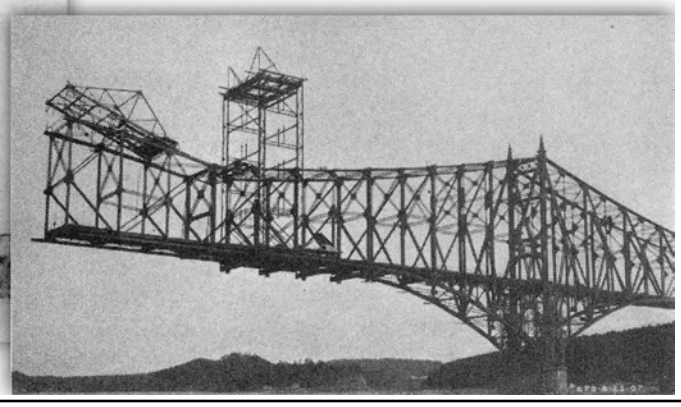
There were many doubtful decisions by T. Cooper, hired as a consulting engineer by the Quebec Bridge Company that directly led to the first failure.

13

CONGRESO INTERNACIONAL DE LA CONSTRUCCIÓN CON ACERO 2019 Medellín, Centro de Eventos El Tesoro Junio 19, 20 y 21



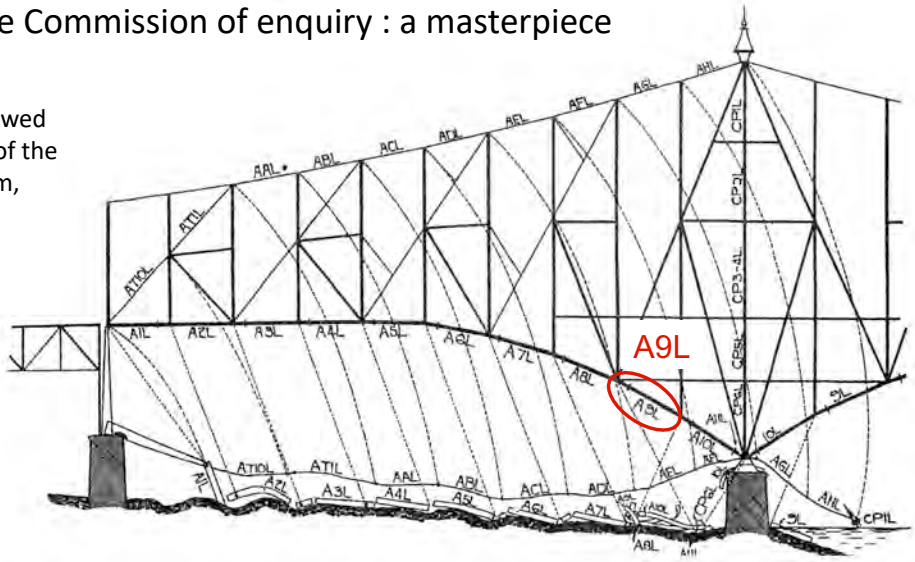
A giant standing on feet of clay



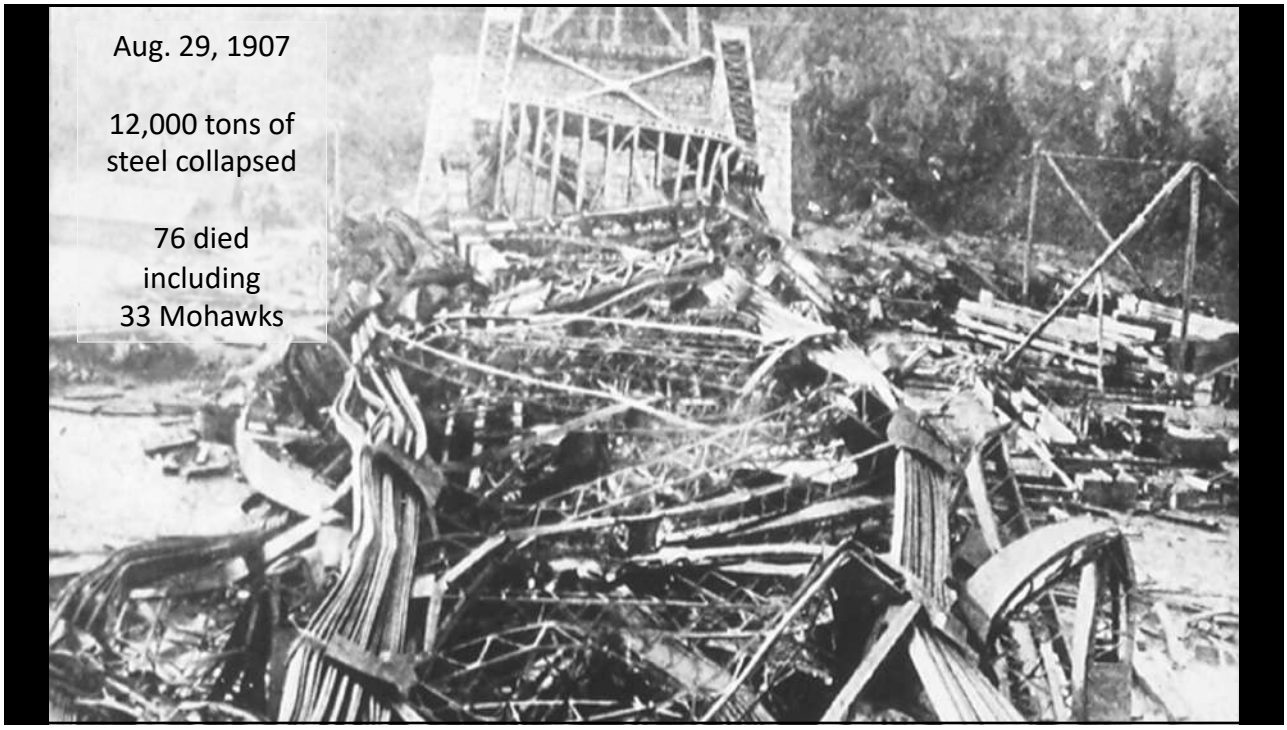
14

Report of the Commission of enquiry : a masterpiece

Trajectories followed by components of the south anchor arm, at failure

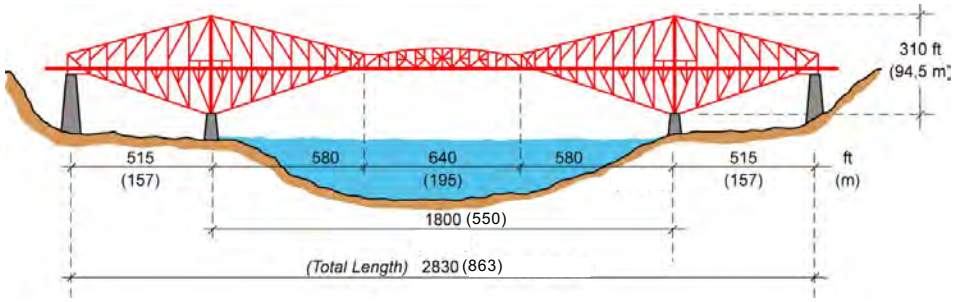


15



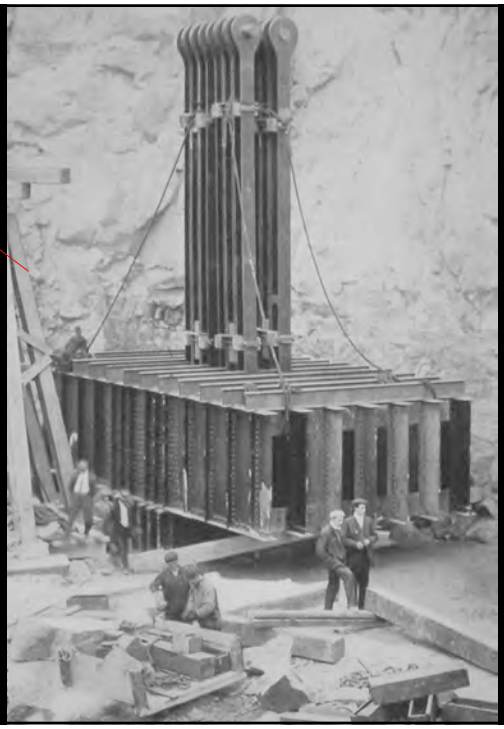
Second tender attracts 32 bids

St. Lawrence Bridge Company

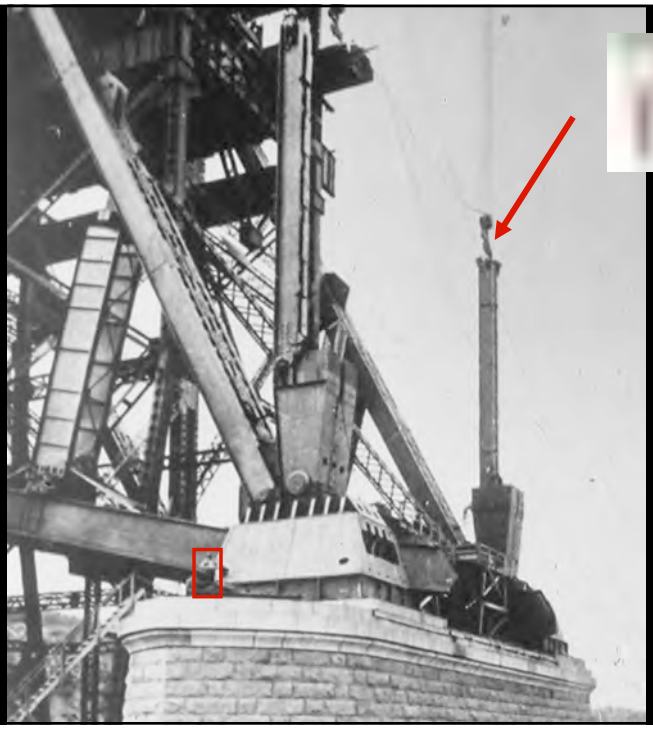


Superstructure was built from 1914-1916
Suspended span collapsed in river in 1916.
Reoconstructed and erected in September 1917.

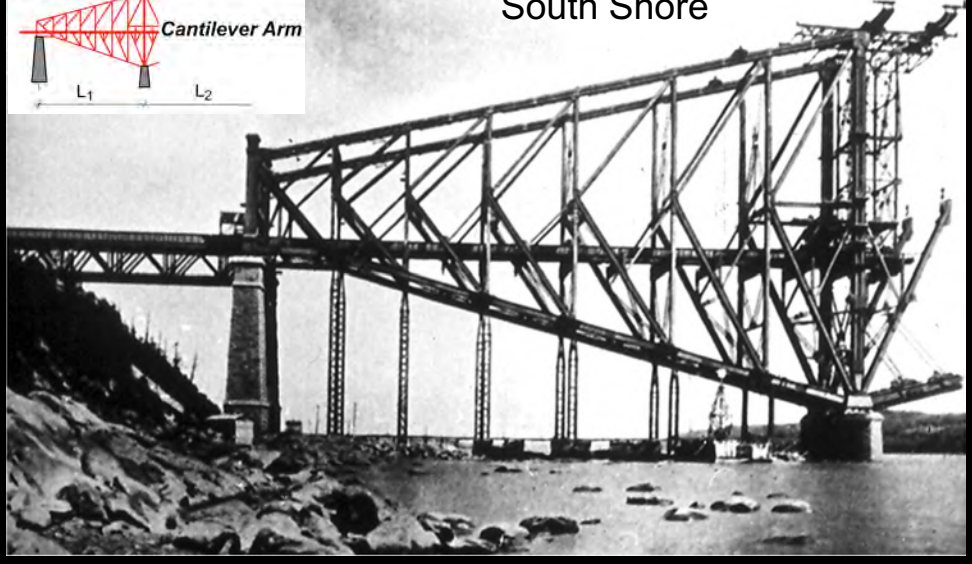
17



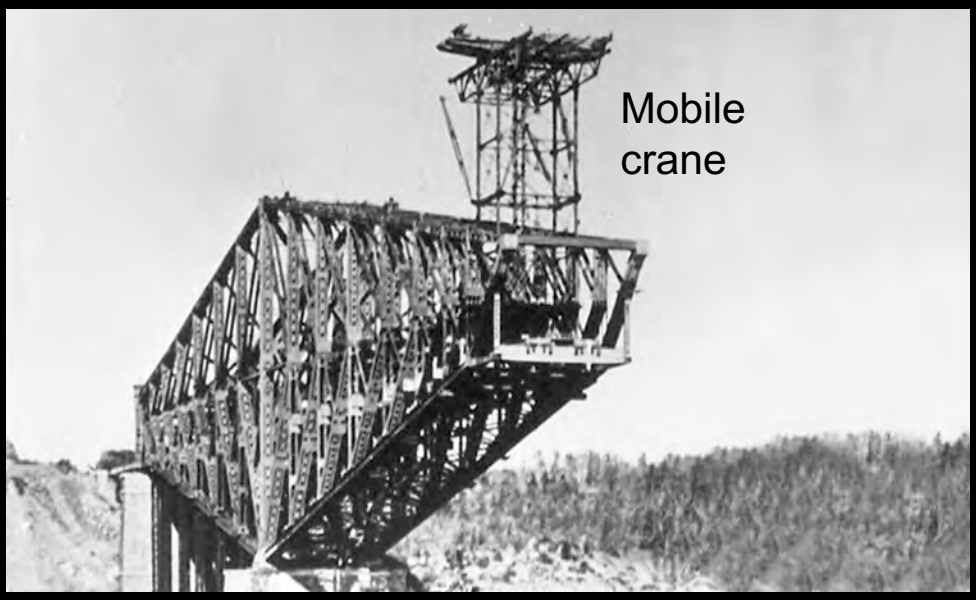
18



19



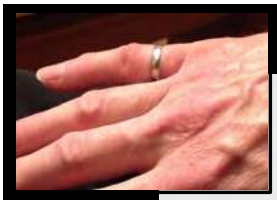
20



21

22

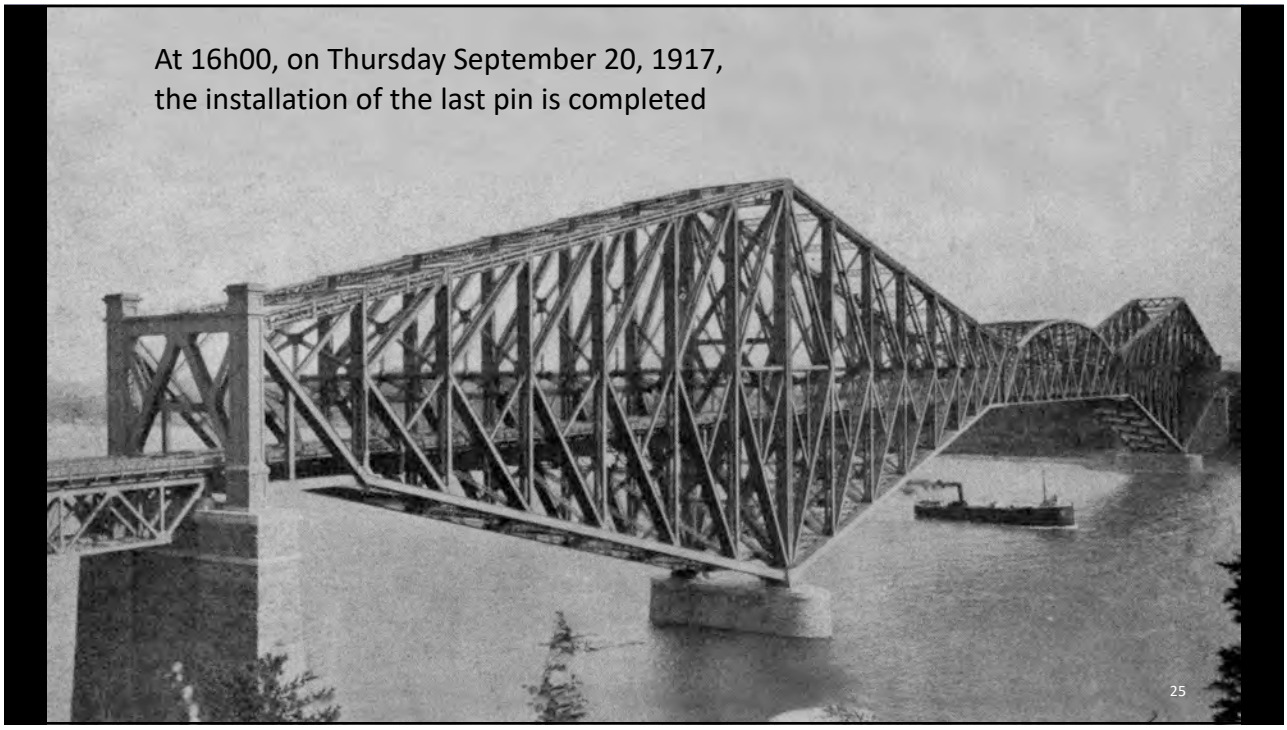
23



September 11, 1916

13 workers were killed

24


At 16h00, on Thursday September 20, 1917,
the installation of the last pin is completed
25

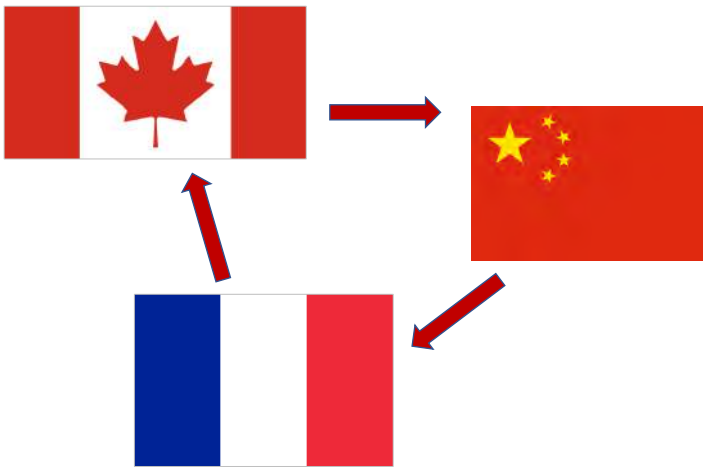

26


27


BRIDGECLIMB
SYDNEY
28

29

Current uses of steel trusses in:



30

Transfer Truss

SUPERMĒTAL
STRENGTH AND FLEXIBILITY

Cantilever Truss

Stacked Truss

Architecturally Exposed
Tubular Truss

32

Factors influencing truss connections

- Overall dimensions
- Geometry
- Loads
- Selected sections
- Erection sequences and planning
- Transportation considerations
- Exposed (AESS) or not exposed

Splices, Connections
Camber, Deflections
Members, Materials
Assembly, Transport
AESS

33

CONGRESO INTERNACIONAL DE LA CONSTRUCCIÓN CON ACERO 2019 Medellín, Centro de Eventos El Tesoro Junio 19, 20 y 21

For bolted truss connections:

Use Snug Tightened high-Strength bolts whenever possible

Use Pretensioned High-Strength Bolts only when absolutely needed

Slip-resistance
- Fatigue
- Load reversals
- Rigorous deflection or stiffness limits

Energy dissipation
- Shear CX in seismic system

Impact, Cyclic or Tensile Loading of bolts

Oversized or Long Slotted holes

34

For welded truss connections:

Favor shop welding, PJP or fillet

Fillet Welds	Partial Penetration Welds (PJP)	Full Penetration Welds (CJP)

Less expensive
No base metal prep

Use smaller, longer fillet welds
Single pass ≤ 5/16”

More costly
More material preparation
Testing requirements
More weld-metal volume
Material distortion

Avoir Full Pen with HSS

35

EIGHTH AVENUE PLACE

East Tower

Calgary, Alberta
Canada

36

EIGHTH Avenue Place

Owner:
Penny Lane II Limited Partnership

Architects:
Gibbs Gage Architects
Pickard Chilton International
Kendall/Heaton Associates Inc.

Structural Engineers:
Dr. P.V. Banavalkar, CBM
Read Jones Christoffersen Ltd.

Construction Manager:
Ellis Don Construction Management Services

Steel fabricator/Detailers/Erector:
Supermétal Structures Inc.

Highlights

- 22.5m (74ft) x 10.9m (36ft)
- Truss weight: 124 tonnes (136 imp. Tons)

Strong enough to support North side of the Tower

37

CONGRESO INTERNACIONAL DE LA CONSTRUCCIÓN CON ACERO 2019 Medellín, Centro de Eventos El Tesoro Junio 19, 20 y 21

Project features

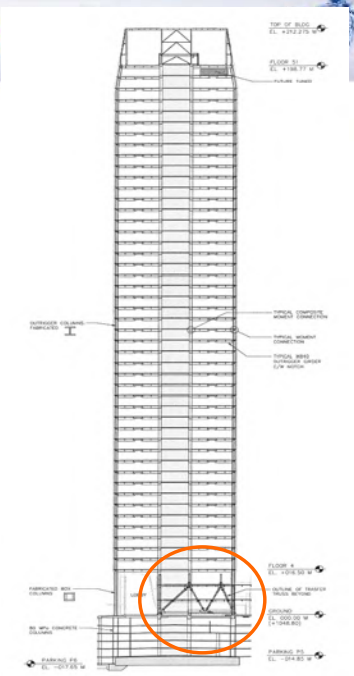
Splices, Connections	Splices transfer large loads Machining of plates and gussets CJP shop welds
Camber, Deflections	Camber analysed to include column shortening and concrete shrinkage
Members, Materials	W shapes ASTM A913 Grade 65 (450 MPa) Bolts: 1 1/8 A490 STD holes
Assembly, Transport	Assemblies governed by weight
AESS	No AESS

38

CONGRESO INTERNACIONAL DE LA CONSTRUCCIÓN CON ACERO

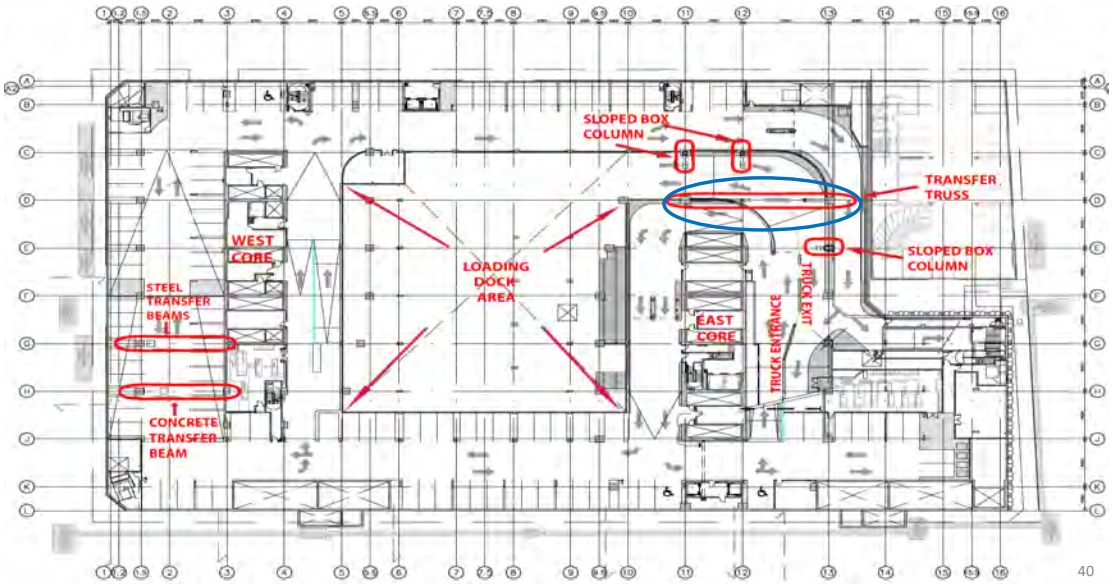
EIGHTH Avenue Place

- Transfers 45 stories
- Max. compressive force: 38 000 kN (8,500 kips)
- Max. tensile force: 15 625 kN (3,500 kips)
- Sections ASTM A913 grade 65 (450 MPa) W360x421 (W14x283), W360x634 (W14x426), W360x1086 (W14x730)

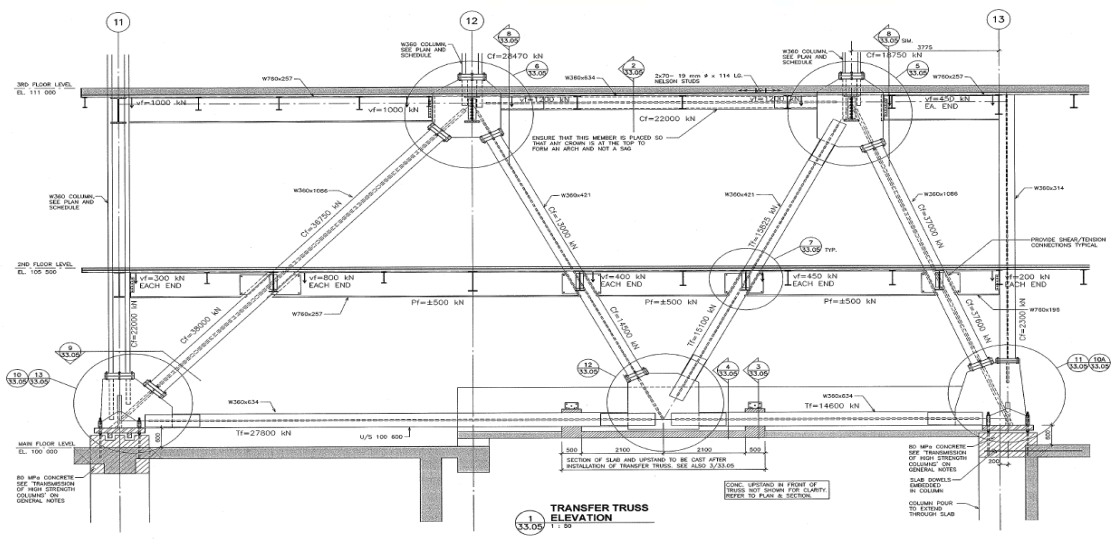


39

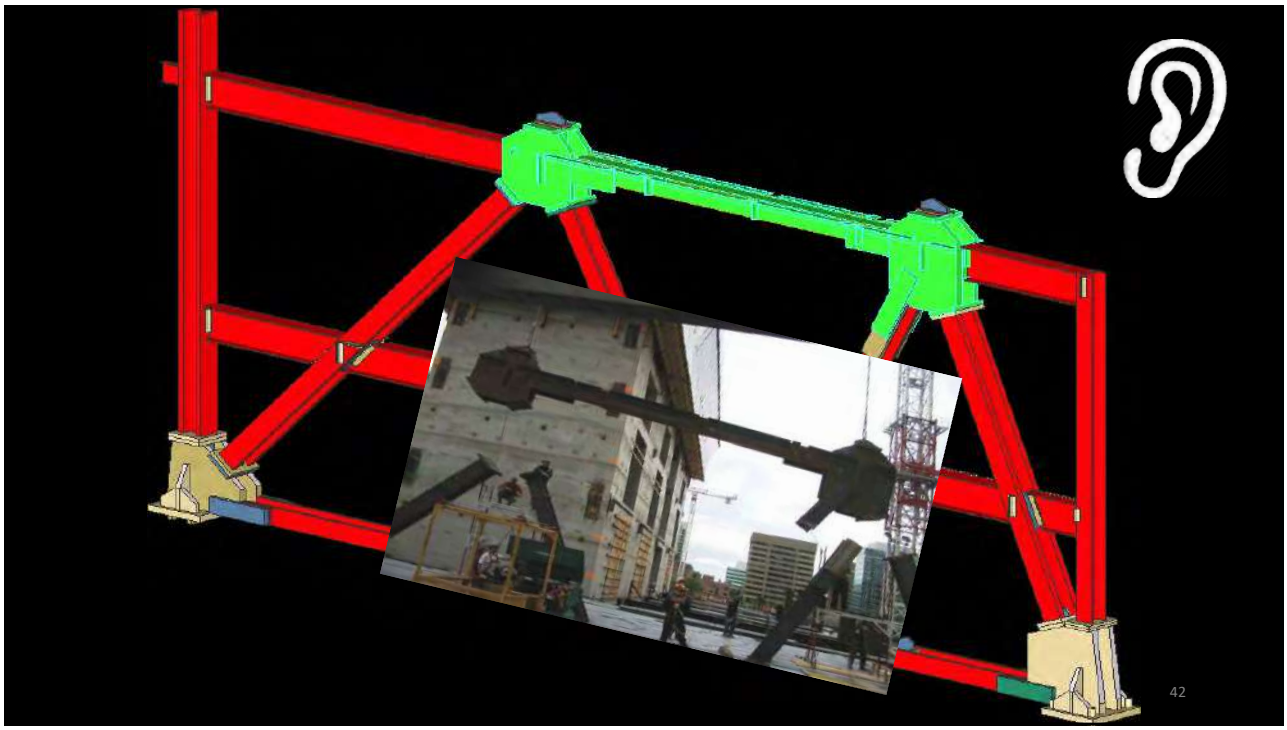
CONGRESO INTERNACIONAL DE LA CONSTRUCCIÓN CON ACERO 2019 Medellín, Centro de Eventos El Tesoro Junio 19, 20 y 21



40

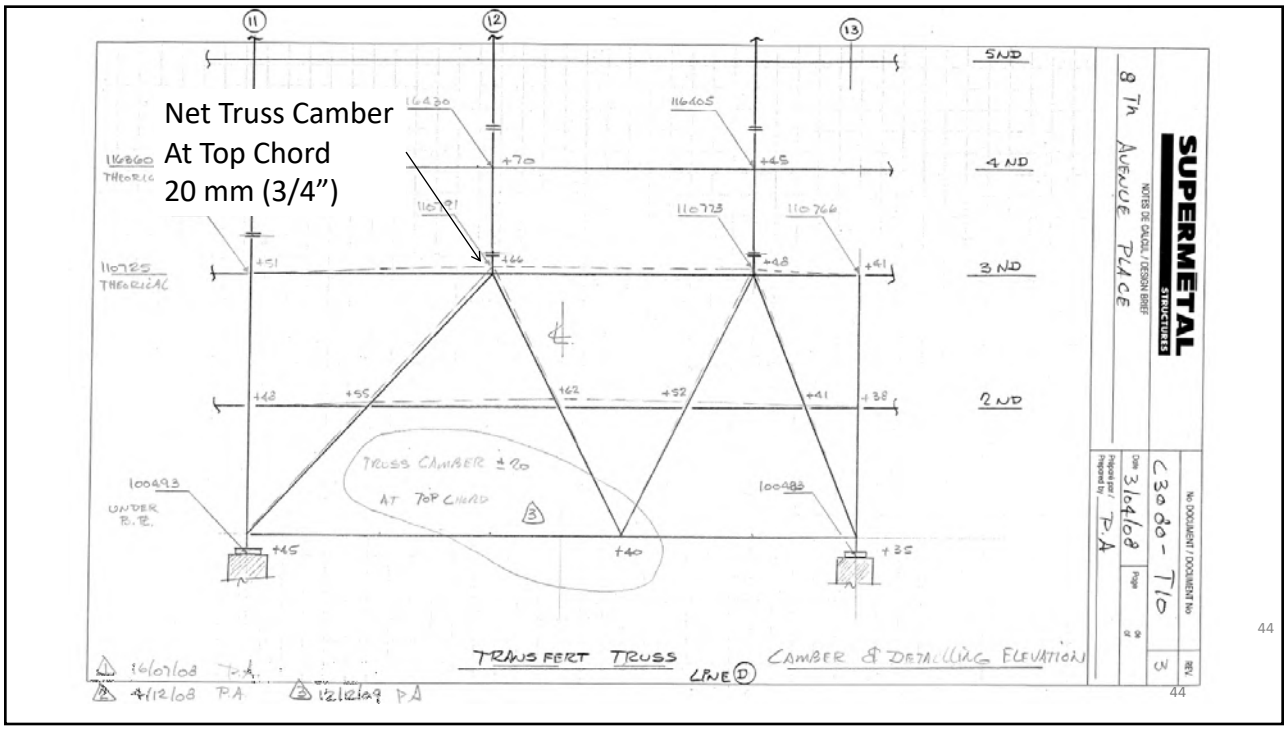

TRANSFER TRUSS
ELEVATION
1 : 50
Cf=28470 kN
Cf=18750 kN
Cf=22000 kN
Tf=27800 kN
Tf=14600 kN
Pf=±500 kN

41

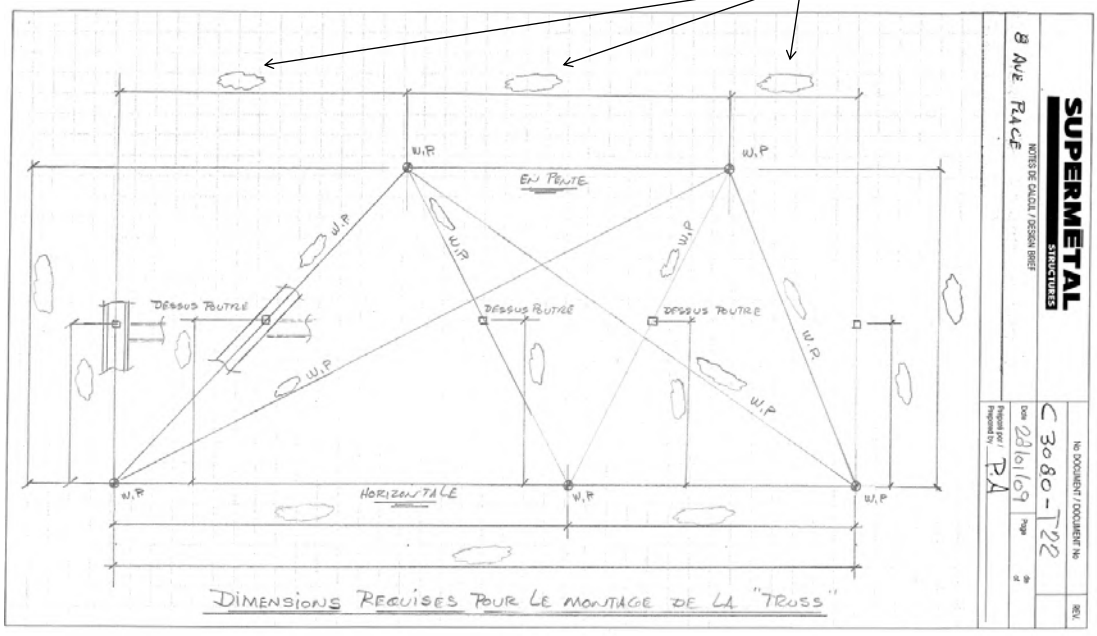


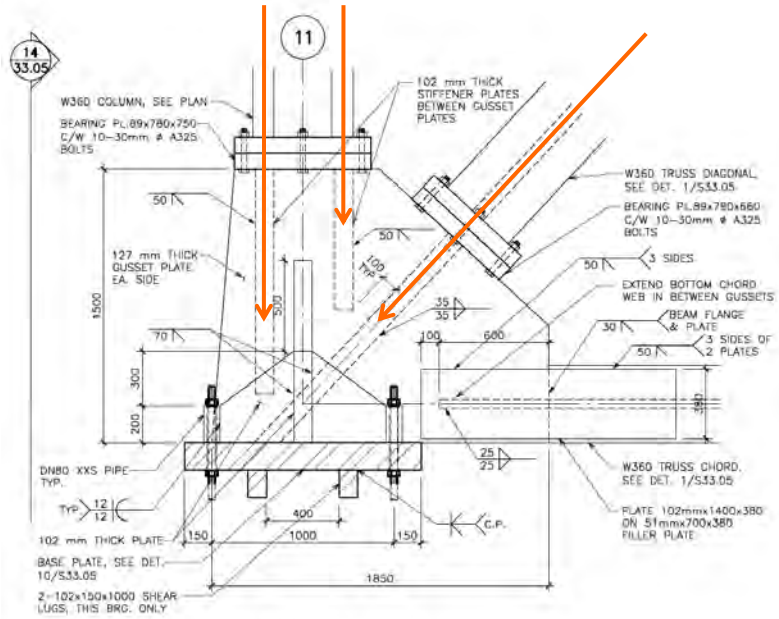
42


43


Net Truss Camber
At Top Chord
20 mm (3/4")
SUPERMETAL
STRUCTURES
8 TH AVENUE PLACE
TRANSFERT TRUSS
CAMBER & DETAILING ELEVATION
C3000 - T10
44

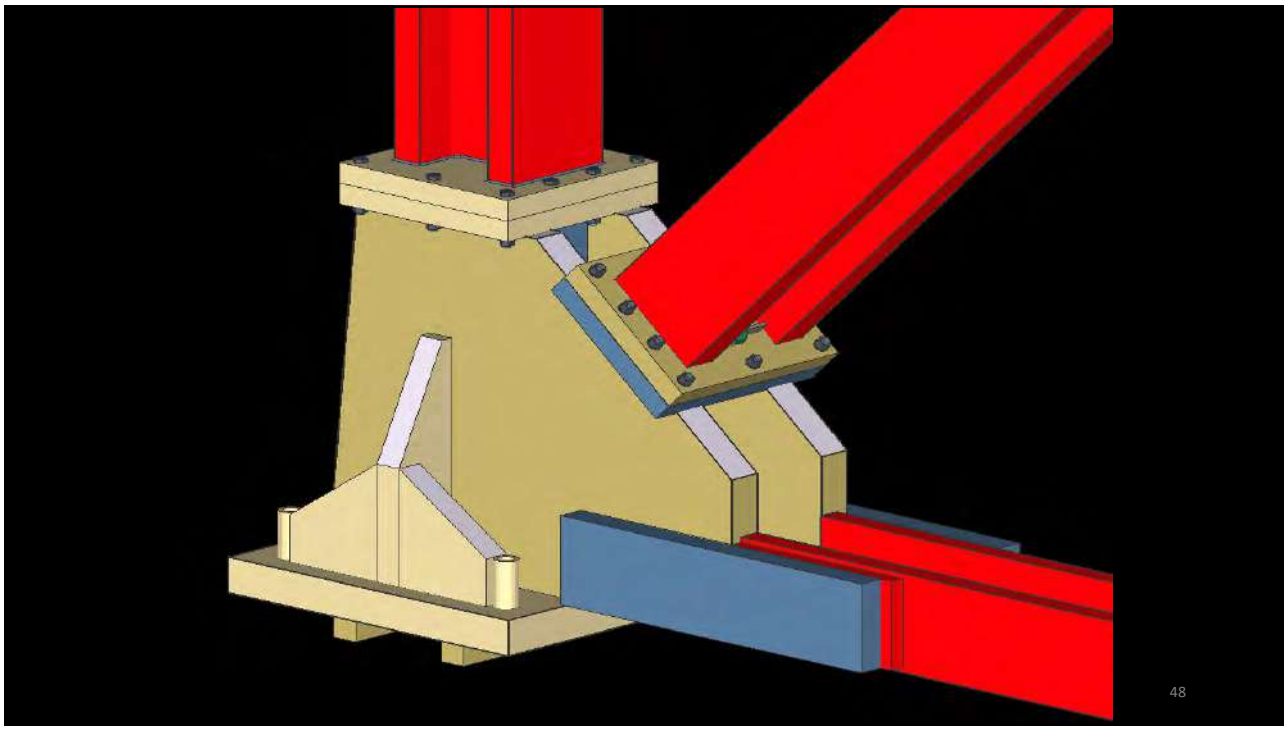
Fabrication staff to fill in the blanks





Loads are transferred as directly as possible

47

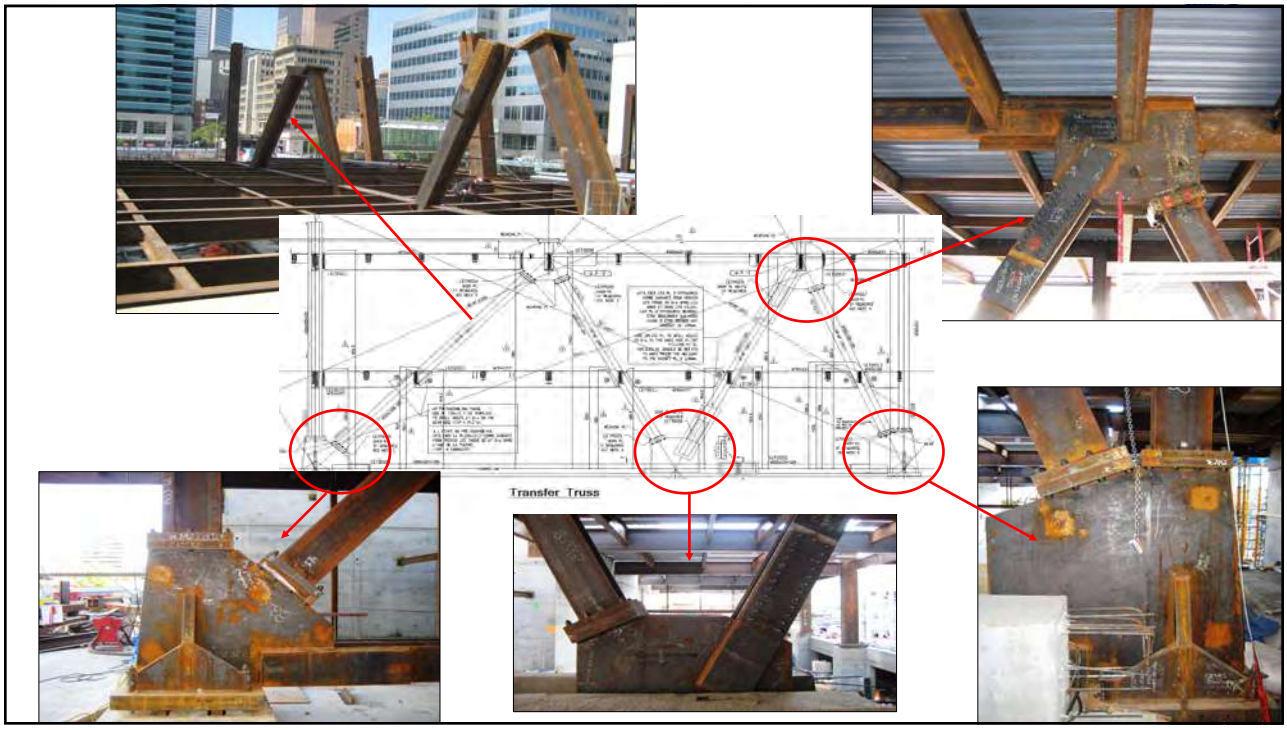


48

Joints in contact bearing were inspected according to Canada's CSA S16 cl. 28.5:

"…such joints shall have at least 75% of the entire contact area in bearing. A separation not exceeding 0.5 mm shall be considered acceptable…, .. Remaining portion shall not exceed 1 mm. "

50


Transfer Truss


IRON ORE COMPANY
(IOC)
of Canada, Labrador
52

IRON ORE COMPANY (IOC)
of Canada, Labrador

Owner:
IOC

Structural Engineer:
Bechtel Inc.

Construction Manager:
Bechtel Inc.

Steel fabricator/Detailers/Erector:
Supermétal Structures inc./MYK Inc.

Highlights

- 26m (86ft) x 23m (77ft)
- Truss weight: 95 tonnes (104 imp. tons)

Good lifting procedure is critical

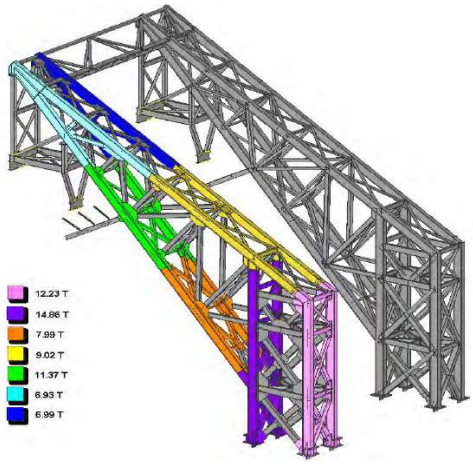
53

CONGRESO INTERNACIONAL DE LA CONSTRUCCIÓN CON ACERO 2019 Medellín, Centro de Eventos El Tesoro Junio 19, 20 y 21

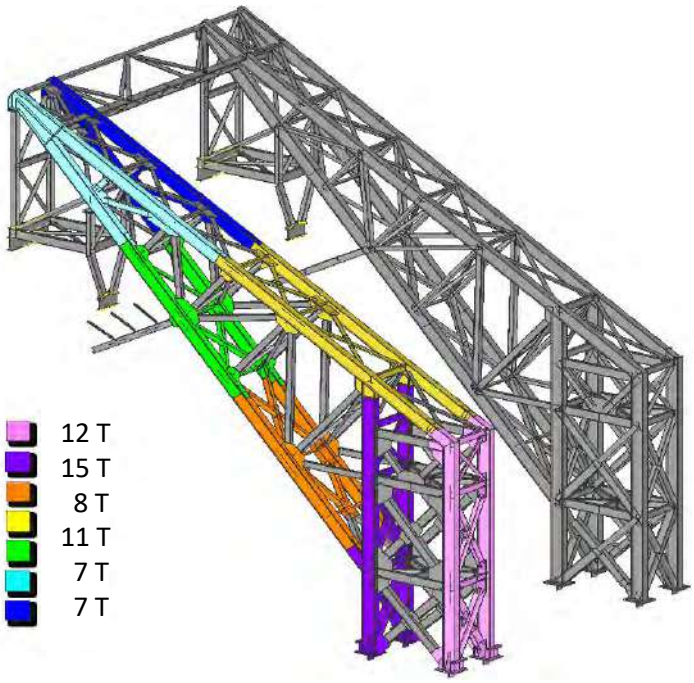
Project features

Splices, Connections	Splices between frames
Camber, Deflections	Camber and deflection analysis
Members, Materials	W shapes ASTM A913 Grade 65 (450 MPa) Bolts: 1 1/8 A490 STD holes
Assembly, Transport	Pre-assembly in shop 7 welded frames (shop), In-between members bolted at site
AESS	No AESS

54

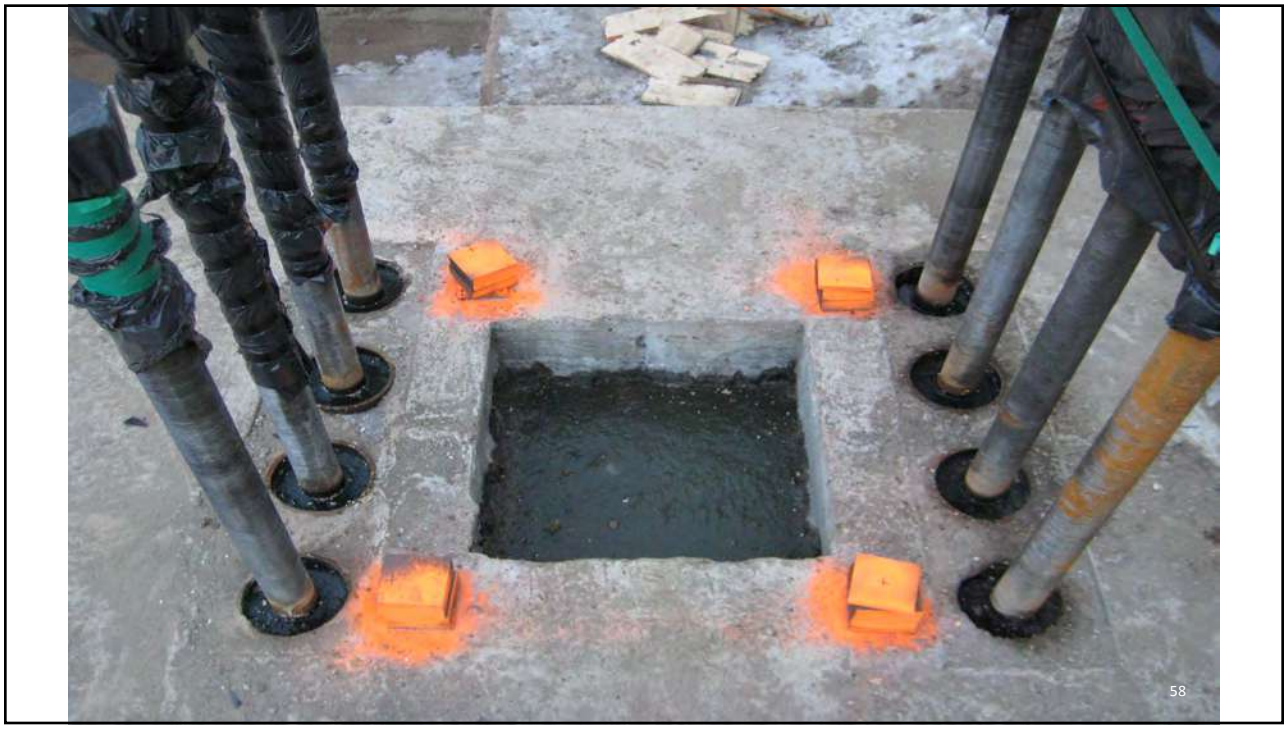


55



56


57


58

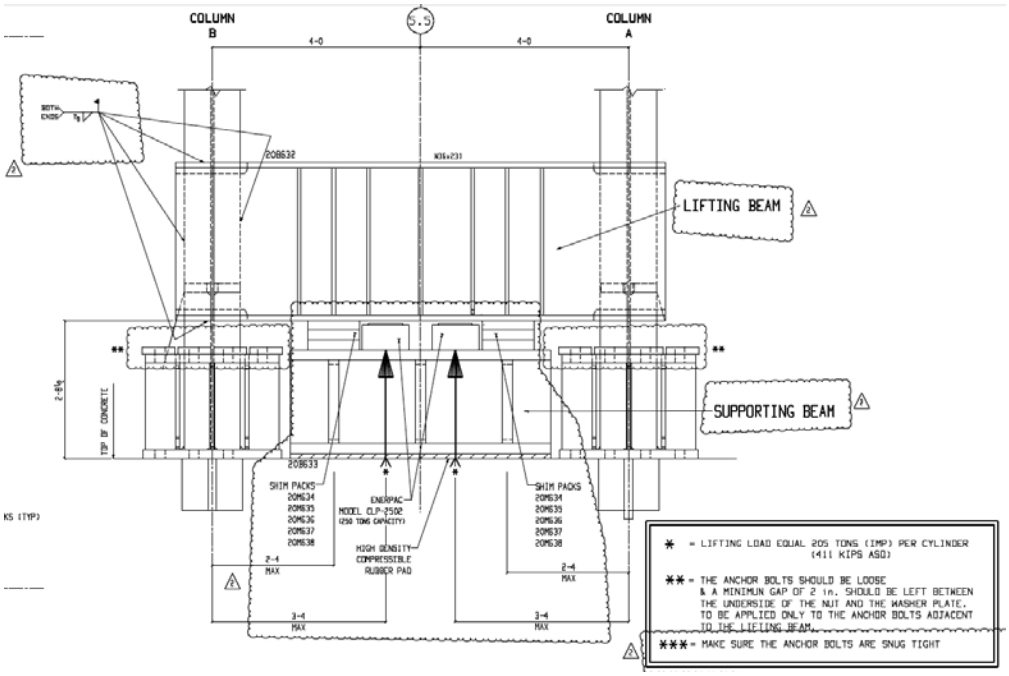
59

60


Conveyor launched inside iron ore warehouse
61


62

63


COLUMN B
COLUMN A
5.5
4-0
4-0
BOTH ENDS
208632
W36x231
LIFTING BEAM
SUPPORTING BEAM
2-8½
TOP OF CONCRETE
208633
SHIM PACKS
20M634
20M635
20M636
20M637
20M638
ENERPAC
MODEL CLP-2502
(250 TONS CAPACITY)
HIGH DENSITY
COMPRESSIBLE
RUBBER PAD
2-4
MAX
3-4
MAX
KS (TYP)
* = LIFTING LOAD EQUAL 205 TONS (IMP) PER CYLINDER (411 KIPS ASD)
** = THE ANCHOR BOLTS SHOULD BE LOOSE & A MINIMUN GAP OF 2 in. SHOULD BE LEFT BETWEEN THE UNDERSIDE OF THE NUT AND THE WASHER PLATE. TO BE APPLIED ONLY TO THE ANCHOR BOLTS ADJACENT TO THE LIFTING BEAM.
*** = MAKE SURE THE ANCHOR BOLTS ARE SNUG TIGHT

64


65


66

© Crosier Kilgour & Partners – G. Kopelow

PEMBINA HALL RESIDENCE

University of Manitoba

67

Pembina Hall Residence
University of Manitoba, Winnipeg MB

Owner:
The University of Manitoba

Architects:
Raymond S.C. Wan architect
Crosier Kilgour & Partners Ltd.

Construction Manager:
Bird Construction Company Ltd.

Steel fabricator/Detailers/Erector:
Supermétal Structures inc.

Highlights

- 14-storey building, constructed over an existing structure
- 4x 49 m (160 ft) trusses per floor

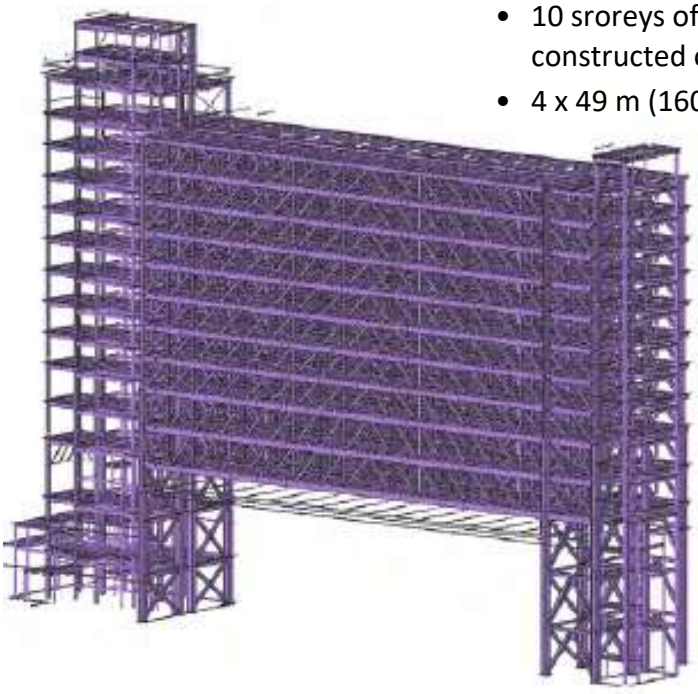
One room = One brace

68

Project features

Splices, Connections	2 Chord Splices per truss, and at Web members
Camber, Deflections	Camber and deflection analysis
Members, Materials	Bolts: ¾" A325N STD for diagonals and vertical, 1" A325N STD for field splices, 1 1/8' A490 OVS for end truss connections Materials: G40.21 350W (ASTM A572-50)
Assembly, Transport	Pre-assembly in shop All diagonal and vertical members were shop welded to the top chord
AESS	AESS with Diagonals in the Windows One Diagonal / Room !!

69

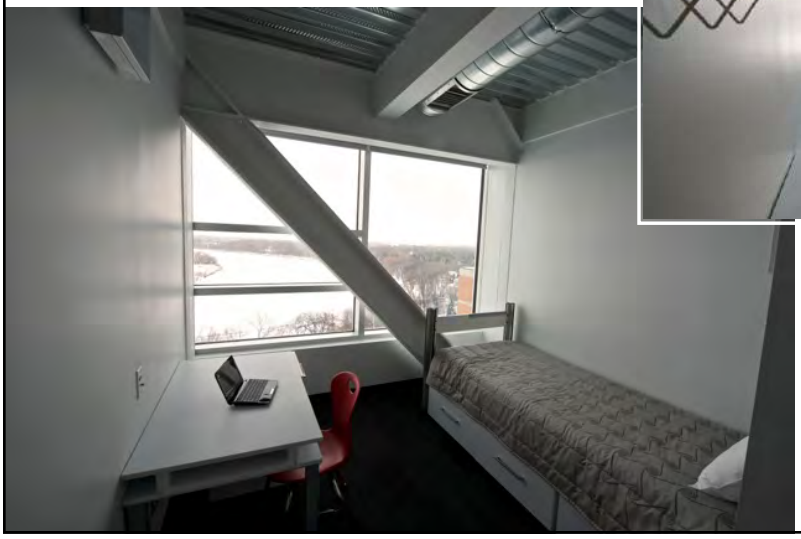


- 10 sroreys of student residence, constructed over an existing structure
- 4 x 49 m (160 ft) trusses per floor

70

EACH ROOM HAS A DIAGONAL

Deck has no fire protection due to use of lightweight concrete



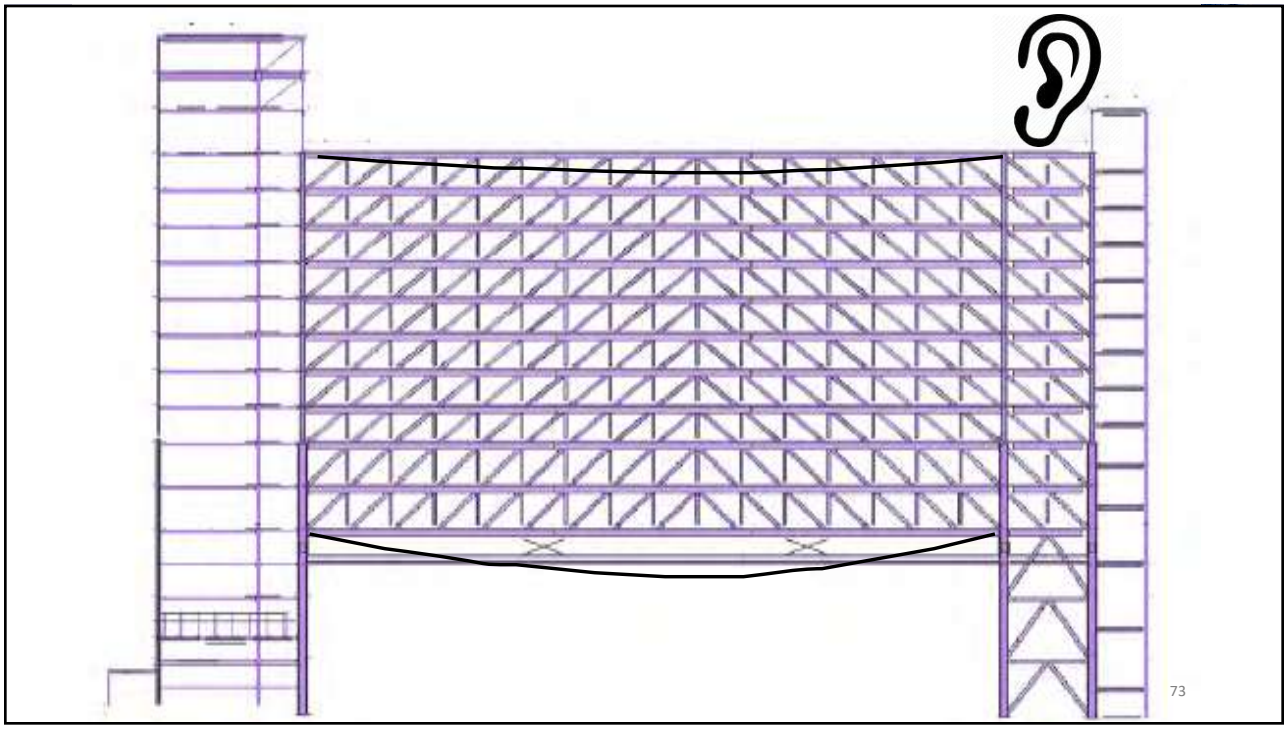
Deck is galvanized to increase light reflection

Diagonal has intumescent coating

“ The biggest challenge was that this design – a multi-truss span over an existing structure – was really unique and had never been done before, ”

says Jean-François Leclerc, Vice President Western Division with Supermétal Structures Inc.

“ We had to think outside the box on how to fabricate and erect [the building]. Deflection was a huge issue. Making sure [the trusses] fit on site. These were the concerns. ”



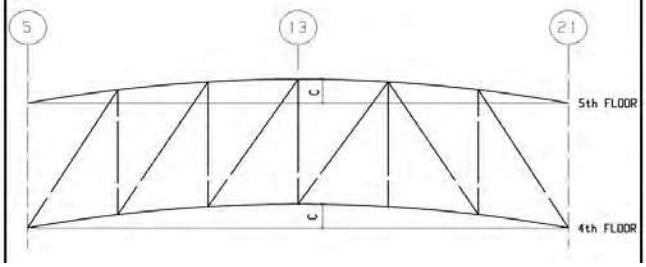
SUPERMETAL
STRENGTH AND FLEXIBILITY

No DOCUMENT / DOCUMENT No: C3117 DIR TRUSS
REV.

NOTES DE CALCUL / DESIGN BRIEF
UNIVERSITY OF MANITOBA
Date: 2010-APR-14 Page: 1 de of 2

REF.: S4.1 & S4.2, INT & EXT TRUSS
Préparé par / Prepared by: ANNIE GAUTHIER

INFORMATIONS MUST BE INCLUDED ON TRUSSES SHOPS DRAWINGS



TRUSS FABRICATION			
From	To	interior truss camber C	exterior truss camber C
4th floor	5th floor	96	70

Up to 2 5/8" camber in corridor trusses on lowest floor !!

TRUSS FABRICATION			
From	To	interior Truss camber C	exterior Truss camber C
5th floor	6th floor	67	42
6th floor	7th floor	61	38
7th floor	8th floor	48	26
8th floor	9th floor	38	19
9th floor	10th floor	30	16
10th floor	11th floor	24	13
11th floor	12th floor	19	10
12th floor	13th floor	14	8
13th floor	roof	10	6

75

76


Sometimes, things don't always go as planned!
77


78


79


80

81

82

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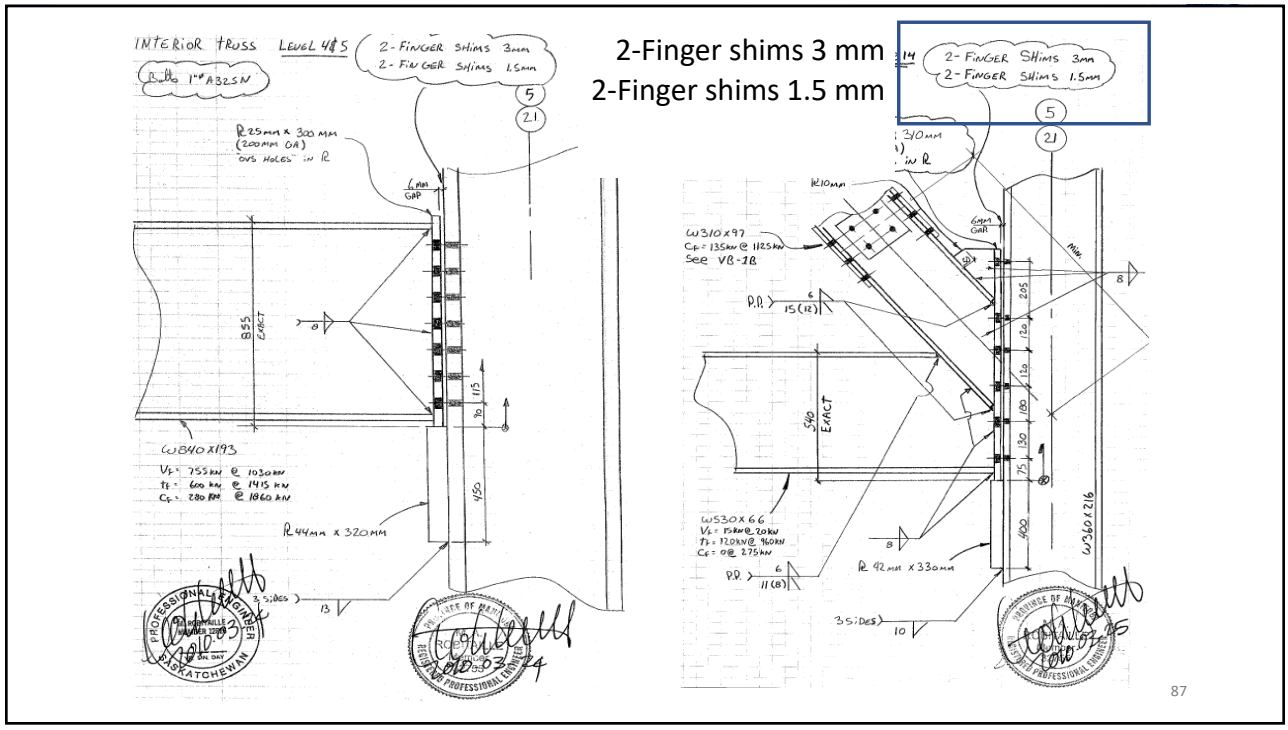
83

84

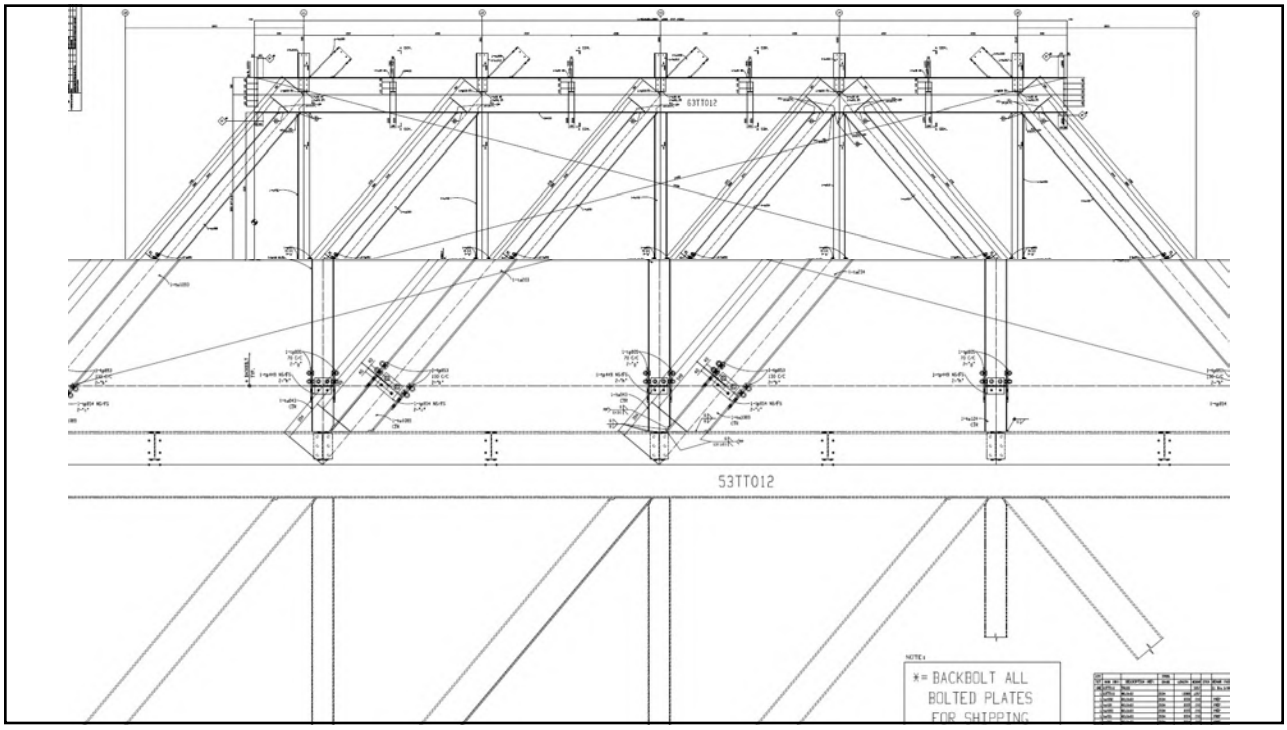

85

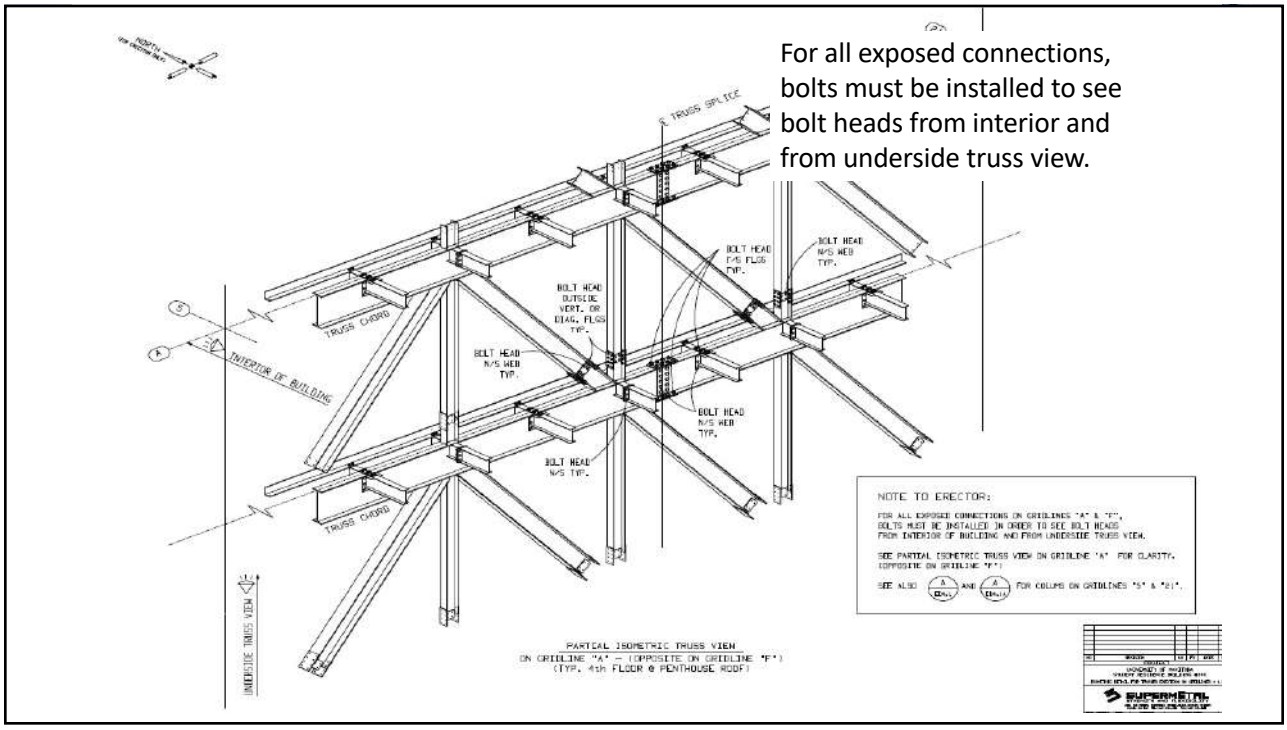

86


INTERIOR TRUSS LEVEL 4 & 5
2- FINGER SHIMS 3mm
2- FINGER SHIMS 1.5mm
2-Finger shims 3 mm
2-Finger shims 1.5 mm
W840x193
W310x97
W530x66
W360x216
R44mm x 320mm
R42mm x 330mm
87

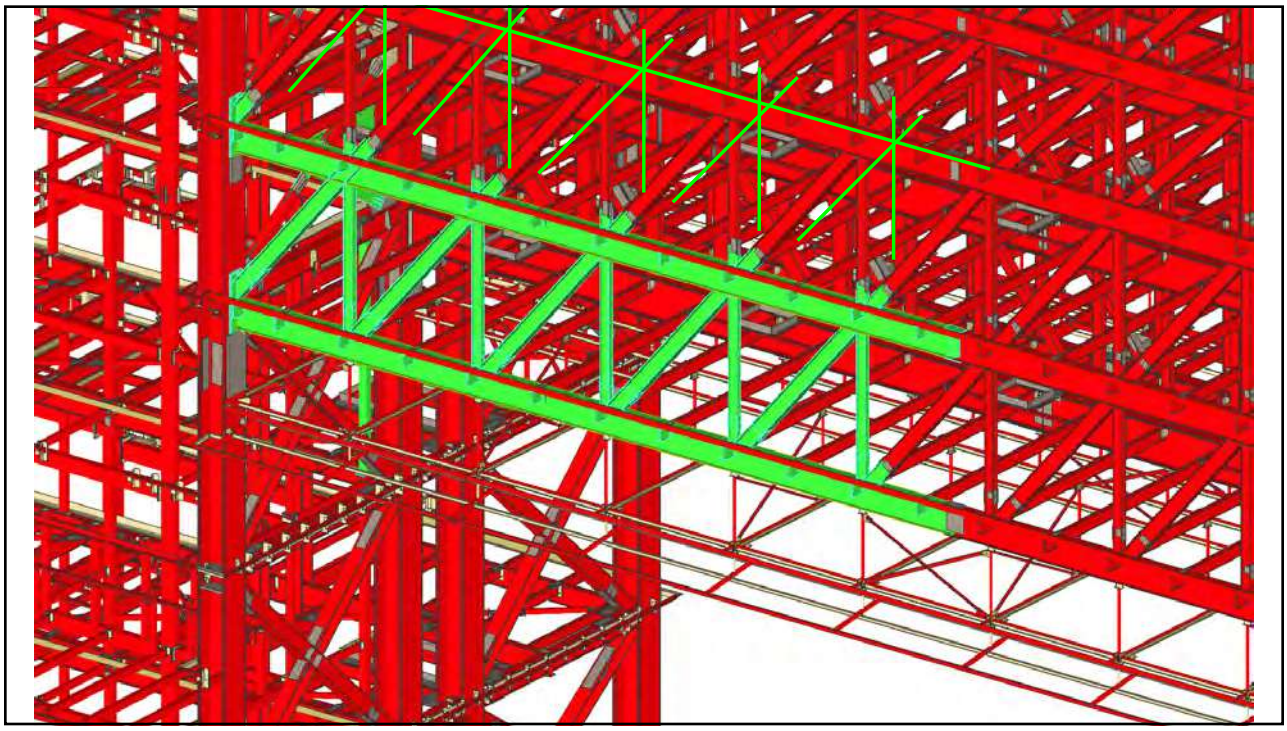

88


© Crosier Kilgour & Partners – G. Kopelow


53TT012
* = BACKBOLT ALL
BOLTED PLATES
FOR SHIPPING



For all exposed connections, bolts must be installed to see bolt heads from interior and from underside truss view.




© Raymond S.C. Chan Architect
94


© Crosier Kilgour & Partners – G. Kopelow
95


CALGARY INTERNATIONAL AIRPORT
INTERNATIONAL USA
INTERNATIONAL USA
AIR CANADA
Photo: Calgary Airport Authority

Calgary International Airport

Owner:
Calgary Airport Authority

Architects:
DIALOG

Structural Engineers:
Read Jones Christoffersen Ltd.

Construction Manager:
Ellis Don Construction Management Services

Steel fabricator/Detailers/Erector:
Supermétal Structures inc.

Highlights

- Longest:123.6m (405ft), weight: 41 metric tons (45 imp. Tons)
- Shortest: 35.6m (117ft), weight: 12 metric tons (14 imp. Tons)

Triangles and curves….

97

CONGRESO INTERNACIONAL DE LA CONSTRUCCIÓN CON ACERO 2019 Medellín, Centro de Eventos El Tesoro Junio 19, 20 y 21

Project features

Splices, Connections	Spice locations between truss sections Hidden “ugly” connections at bottom chords – avoiding CJP welds, Macalloy at top chord
Camber, Deflections	Camber and deflection analysis
Members, Materials	Bolts: ¾” A325N STD for chord splice Materials: G40.21 350W-C (ASTM A500-C)
Assembly, Transport	Pre-assembly in shop Trusses were fabricated in sections, longest = 9 sections, shortest = 1 section Use of jigs, ‘’positionor’’ and ‘’rotator’’ (shop) and temporary erection tower
AESS	All AESS – Two Categories

98

AESS Categories associated to members or assemblies were specified in addendum at bid time

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

100

AESS Matrix

Id	Characteristics	AESS C Custom Elements	AESS 4 Showcase Elements	AESS 3 Feature Elements (Viewed at a Distance ≤ 5 m)	AESS 2 Feature Elements (Viewed at a Distance > 6 m)	AESS 1 Basic Elements	SSS Standard Structural Steel (CSA S16)
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		√				

3D Trusses

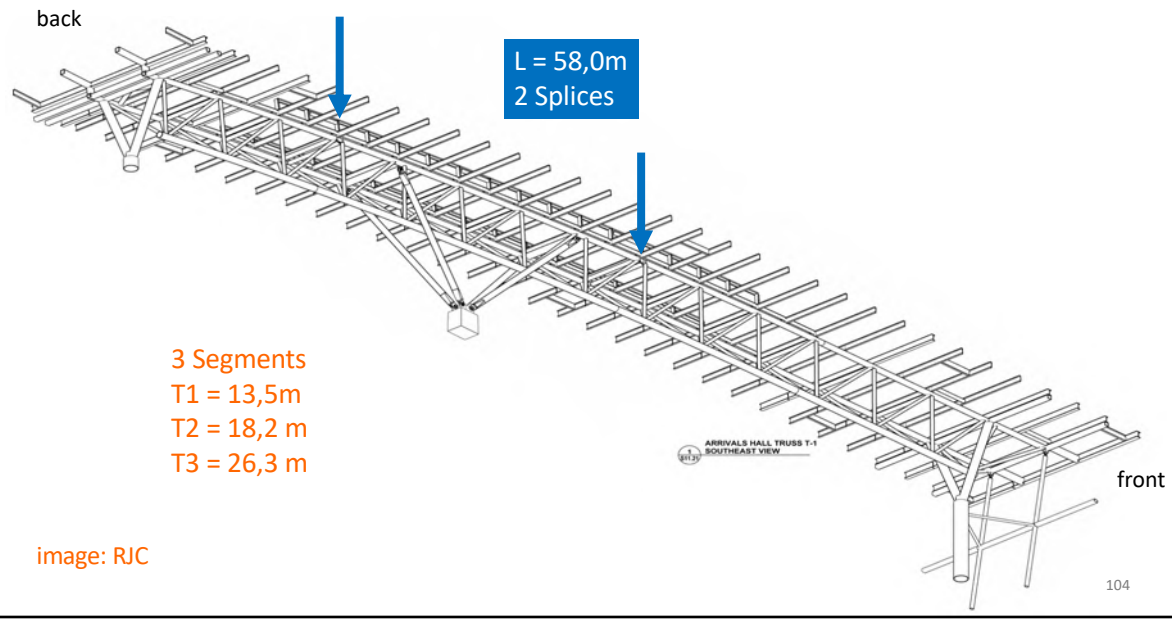
Y-Columns

Struts

102

The AESS Categories help clarify expectations between architect, engineer and fabricator.


Reminder : Distance, light and position are different in a fabrication shop!



105

The “Rotator”!

106

107

108

109

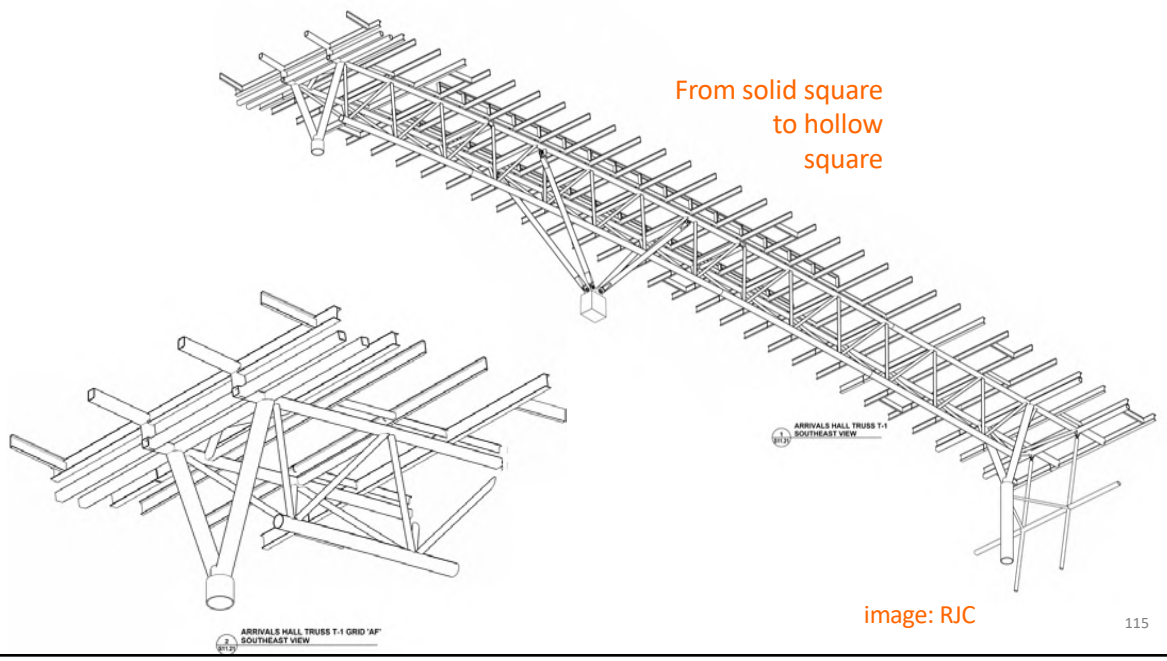
110

111

112


113


LITZ
JLG LIFT
RSC
114

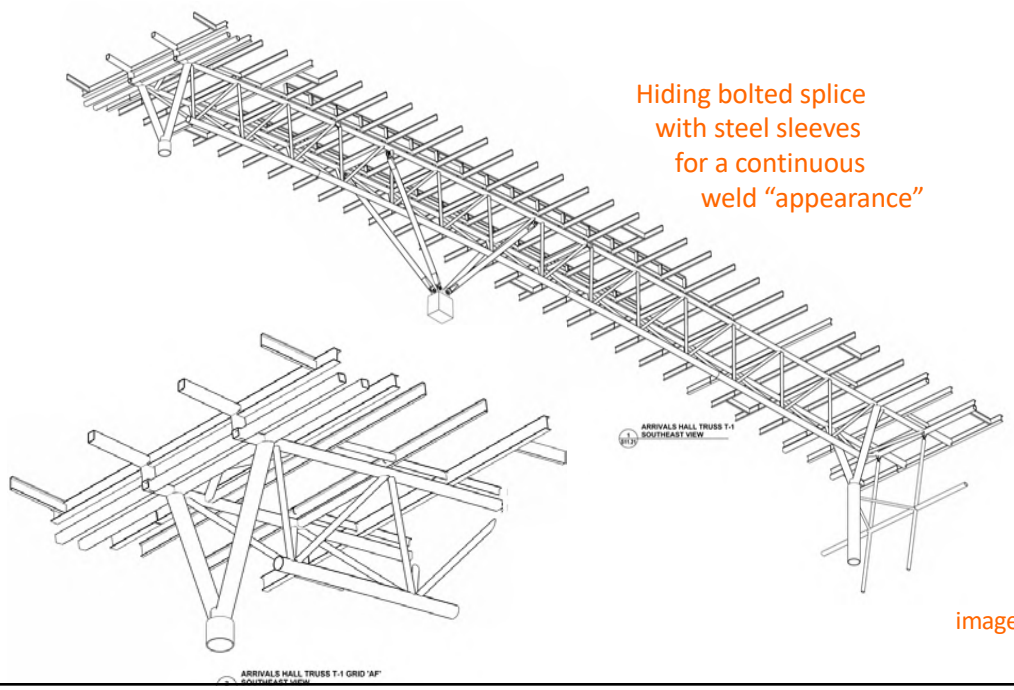


From solid square to hollow square

image: RJC

115

116

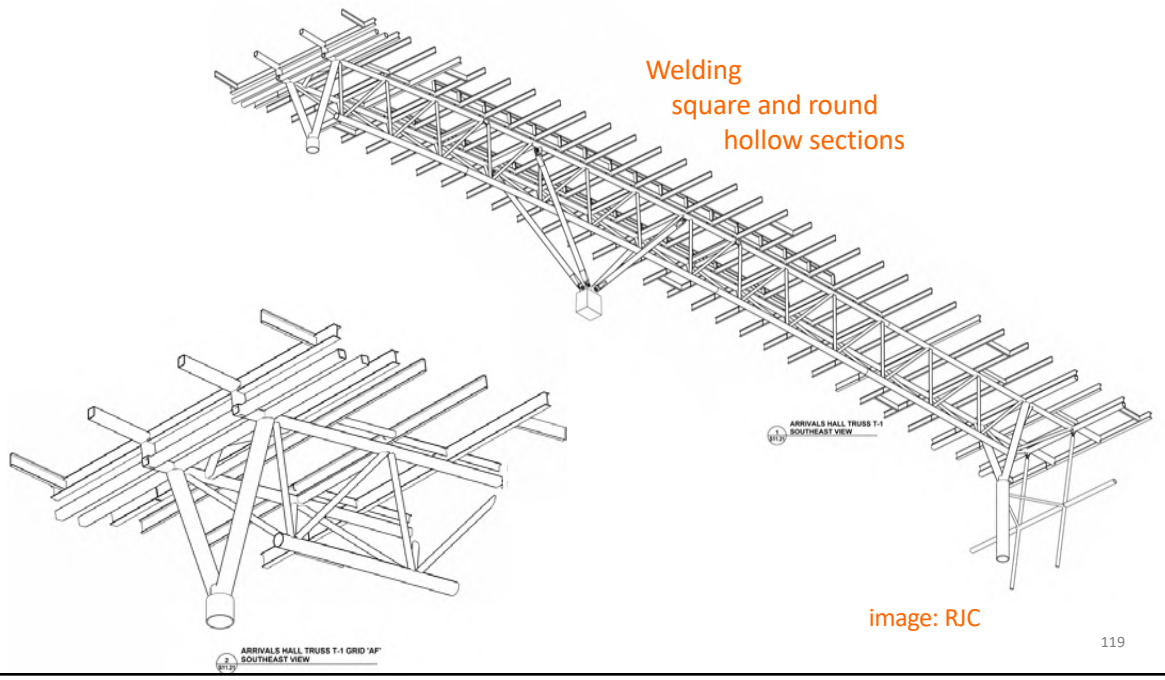


Hiding bolted splice with steel sleeves for a continuous weld "appearance"

image: RJC

117

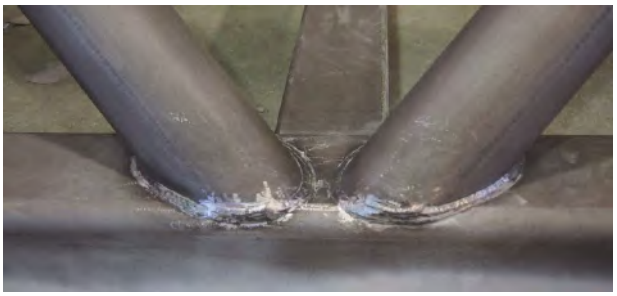
118



Welding
square and round
hollow sections

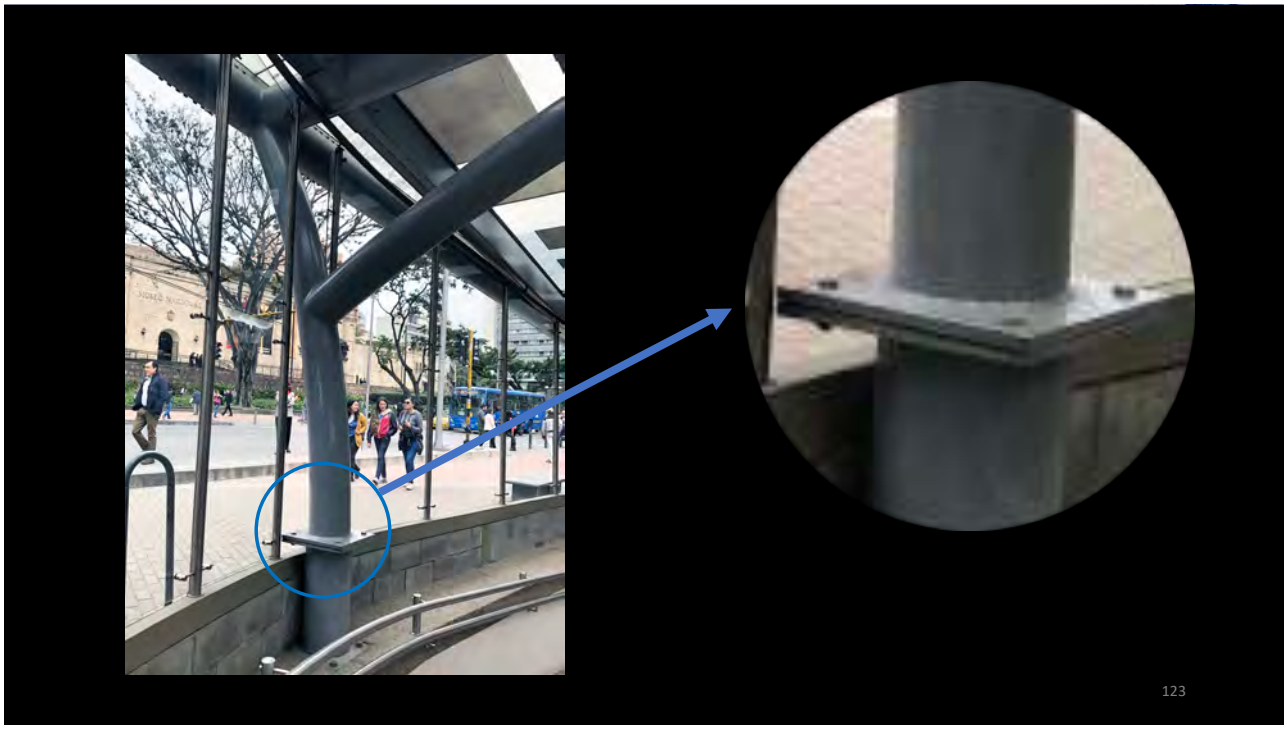
image: RJC

119



120

Photos: Calgary Airport Authority



123

124

125

126

127

Projet PK 1.394
Passerelle Simone-de-Beauvoir

- au-dessus de la Seine

- Henry Bardsley, RFR, Paris
- Dietmar Feichtinger, architectes

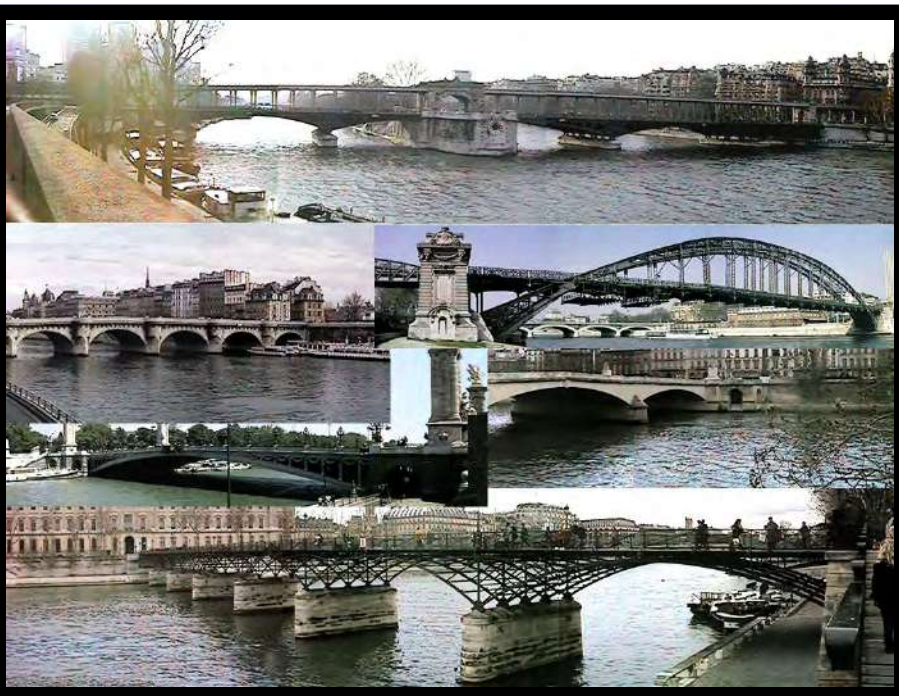
128

Located between Pont de Bercy and Pont de Tolbiac
Links up the 12th and 13th arrondissements of Paris.
Nearest Paris Metro station is Quai de la Gare.

129

The 37th bridge on the Seine River

130



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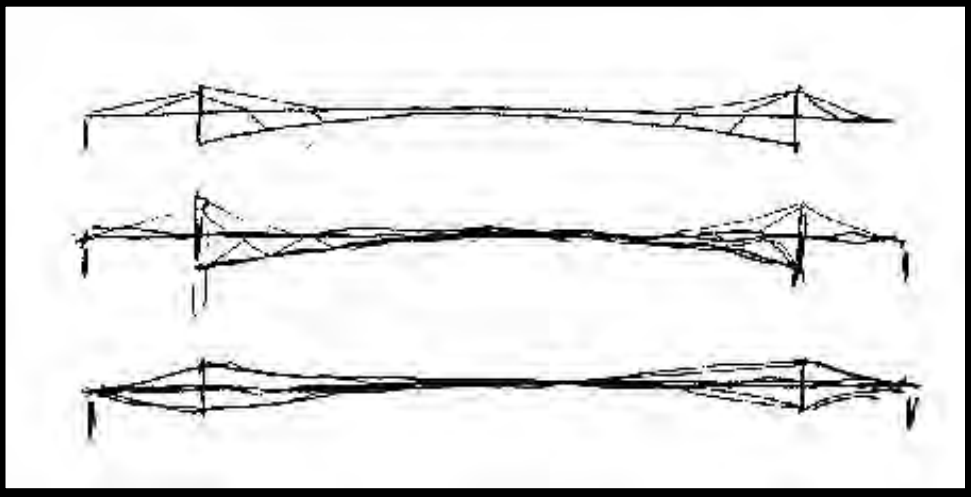

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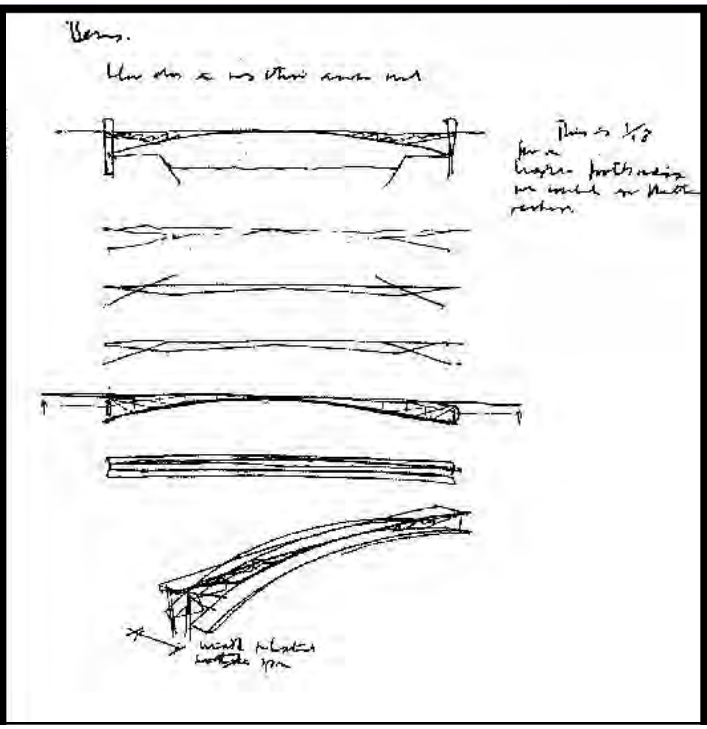

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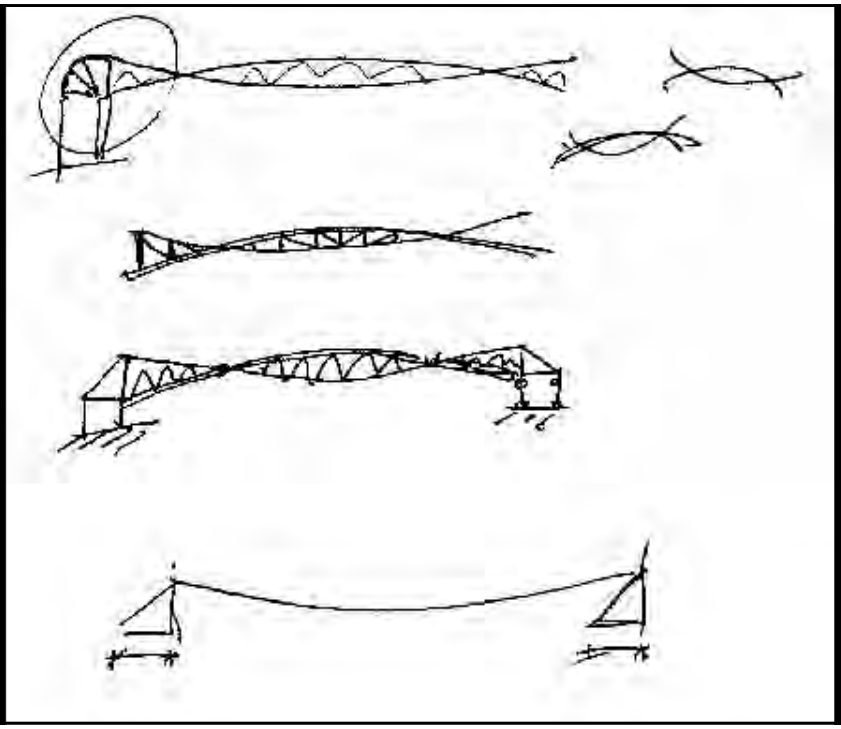

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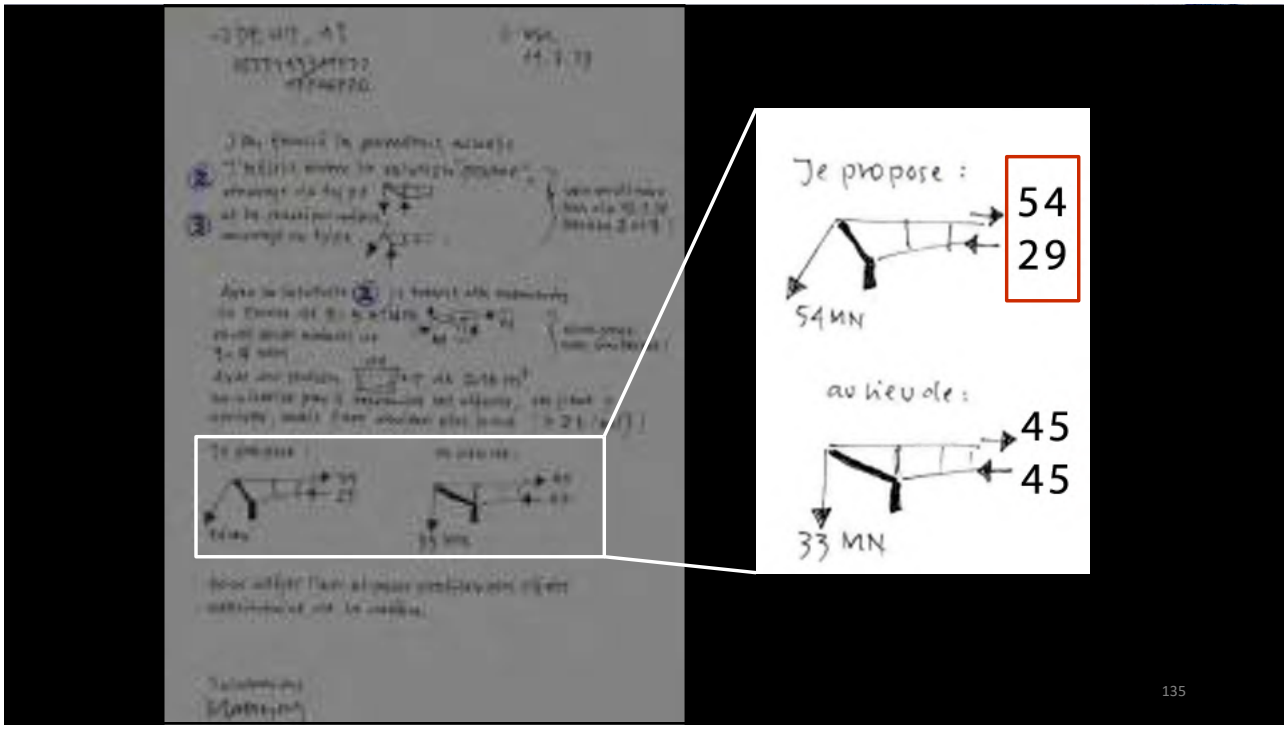
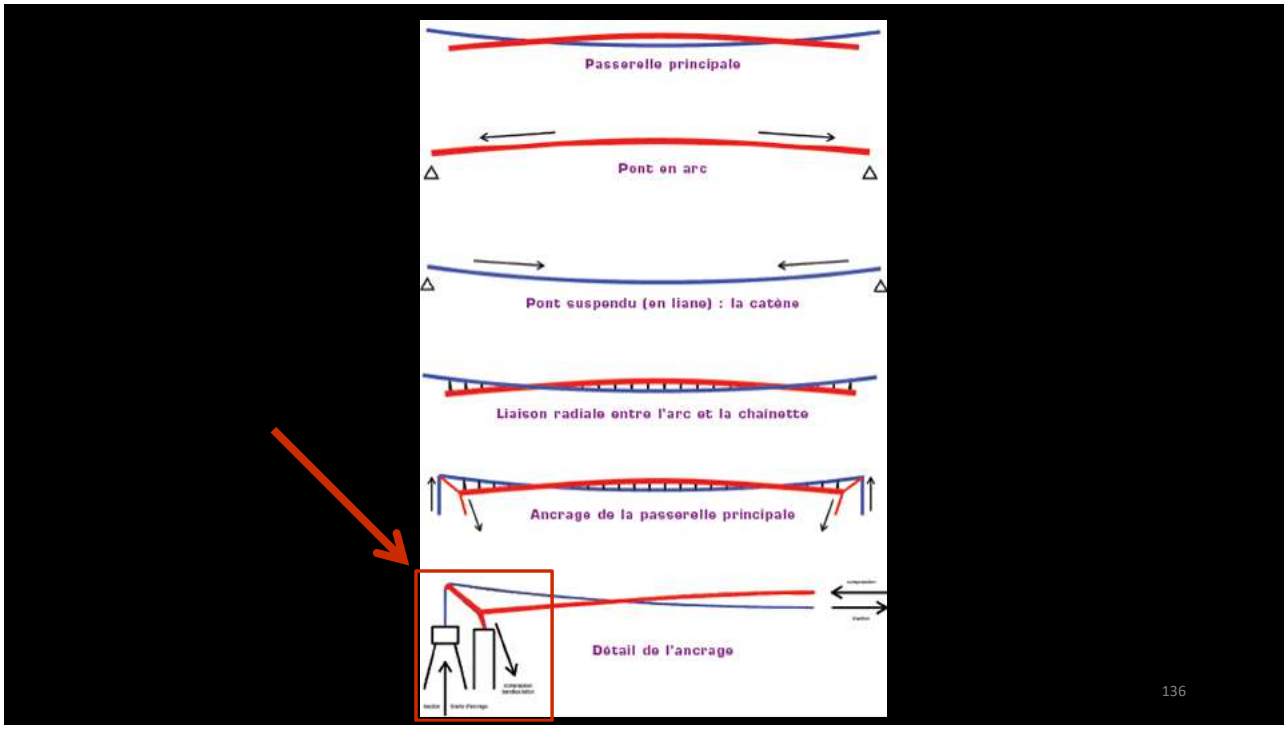
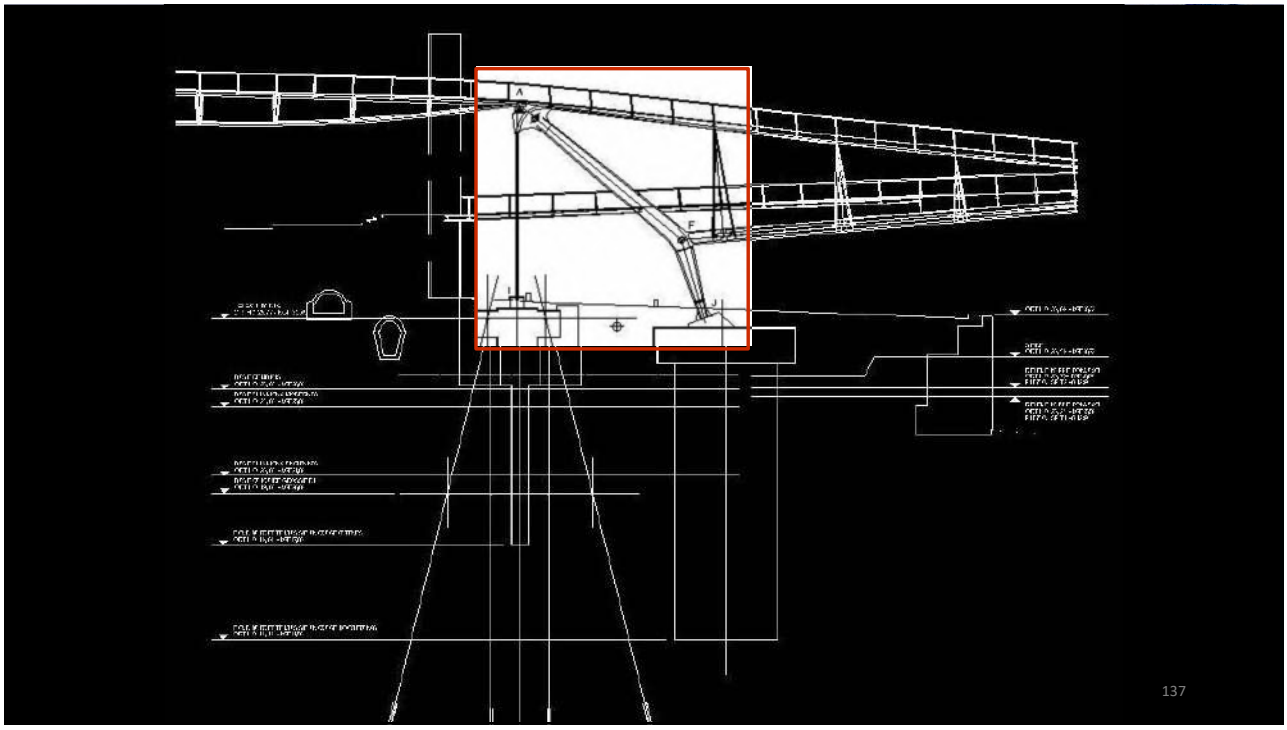

Je propose :
54
29
54 MN
au lieu de :
45
45
33 MN

135


Passerelle principale
Pont en arc
Pont suspendu (en liane) : la caténe
Liaison radiale entre l'arc et la chainette
Ancrage de la passerelle principale
Détail de l'ancrage

136



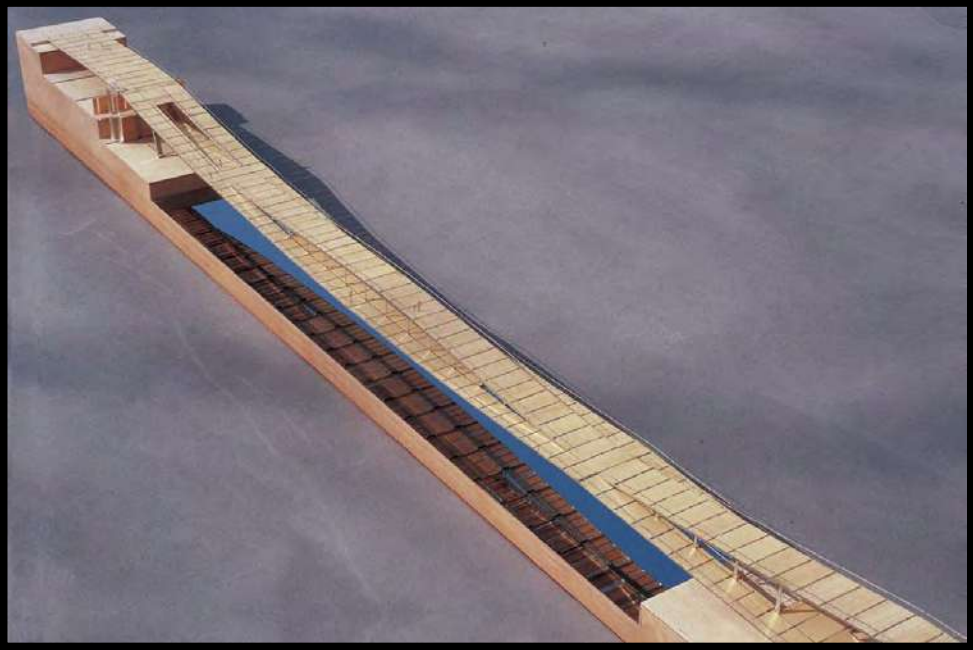
137

138

139

140

141



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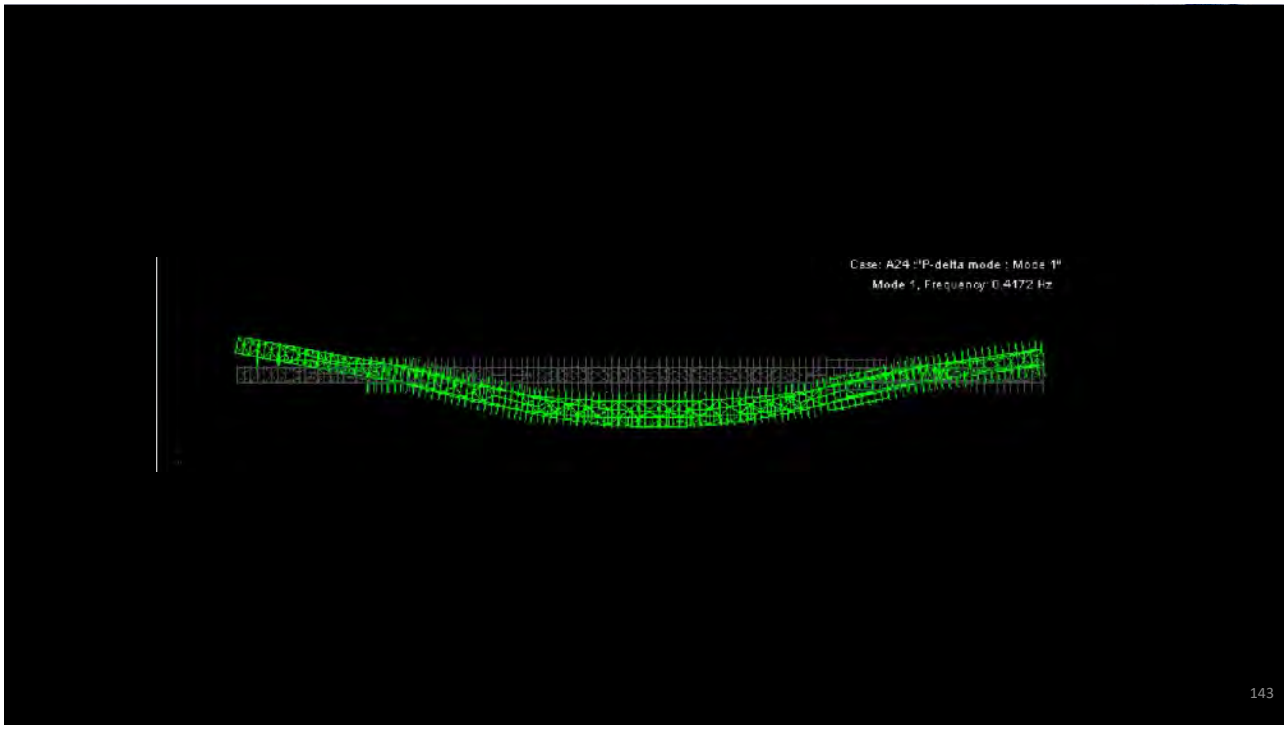
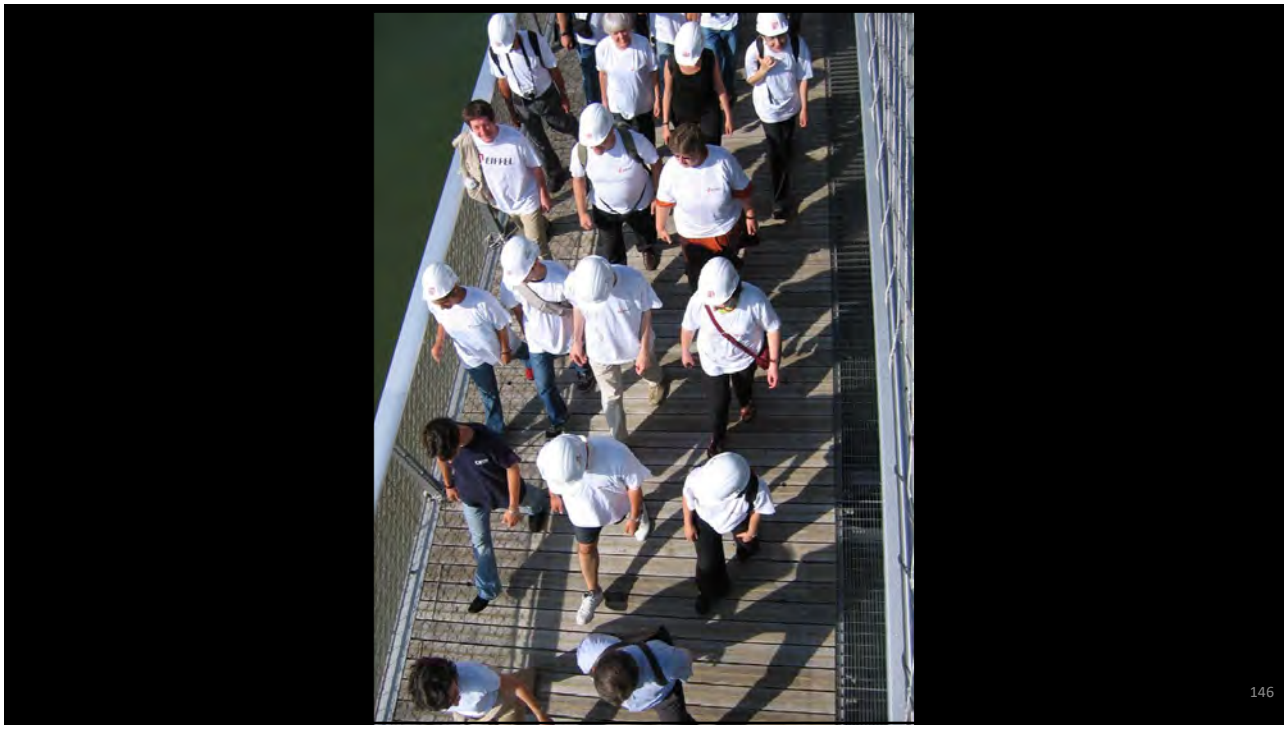


143

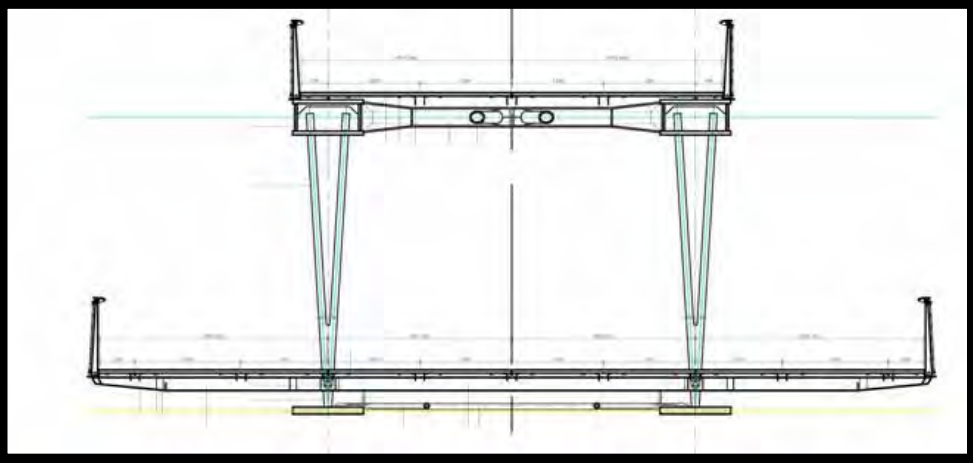
144

145



146

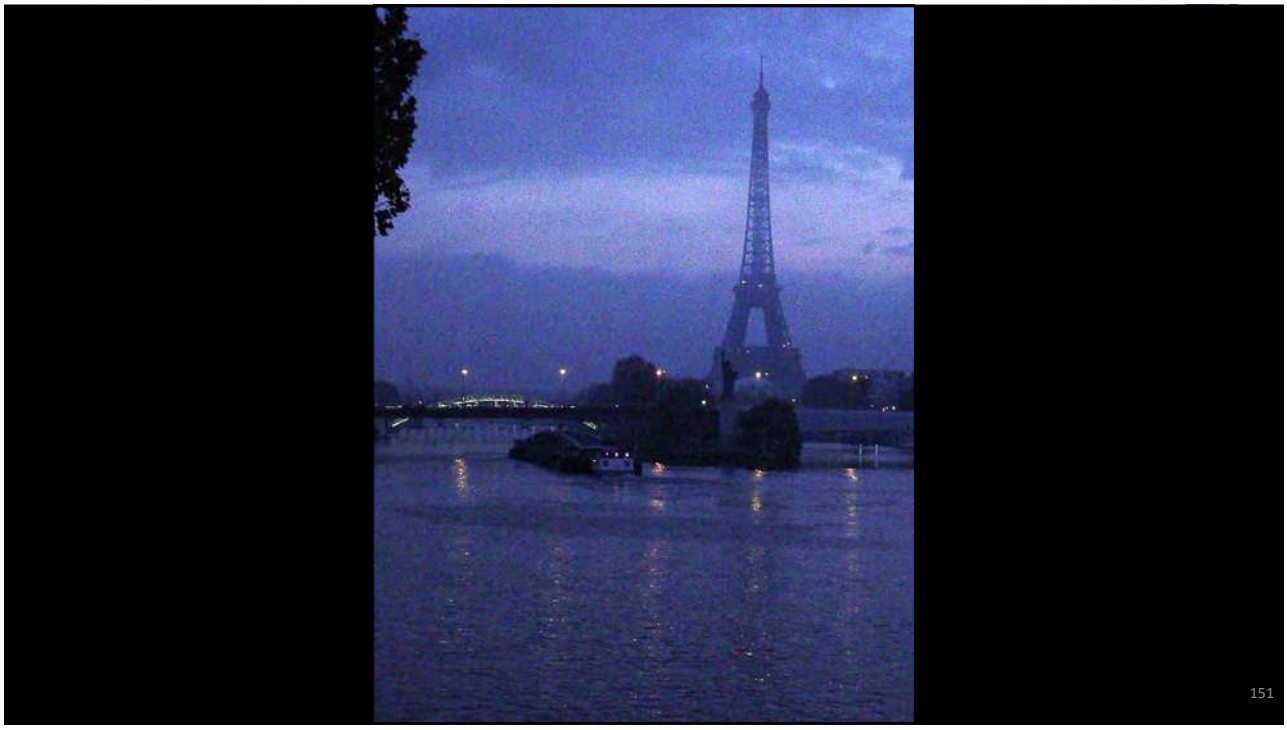
147



148

149

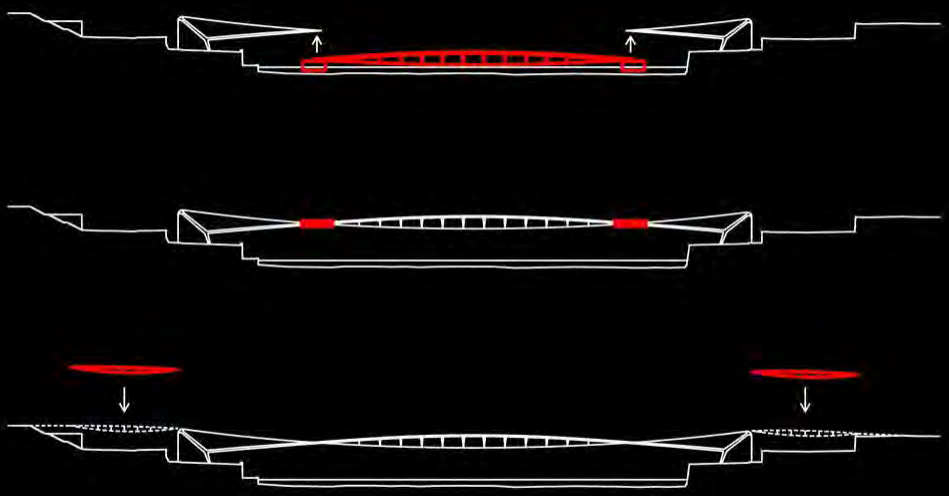
150



151

152

- Parcours de la lentille



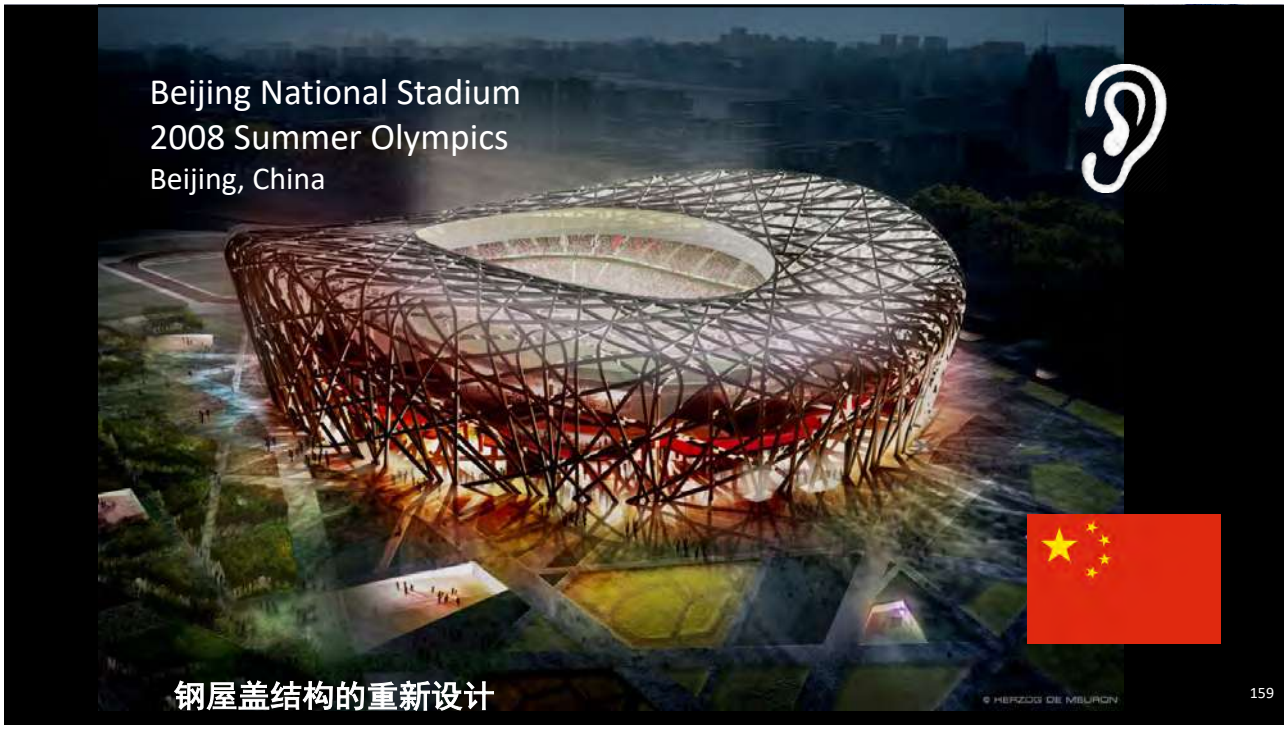
153

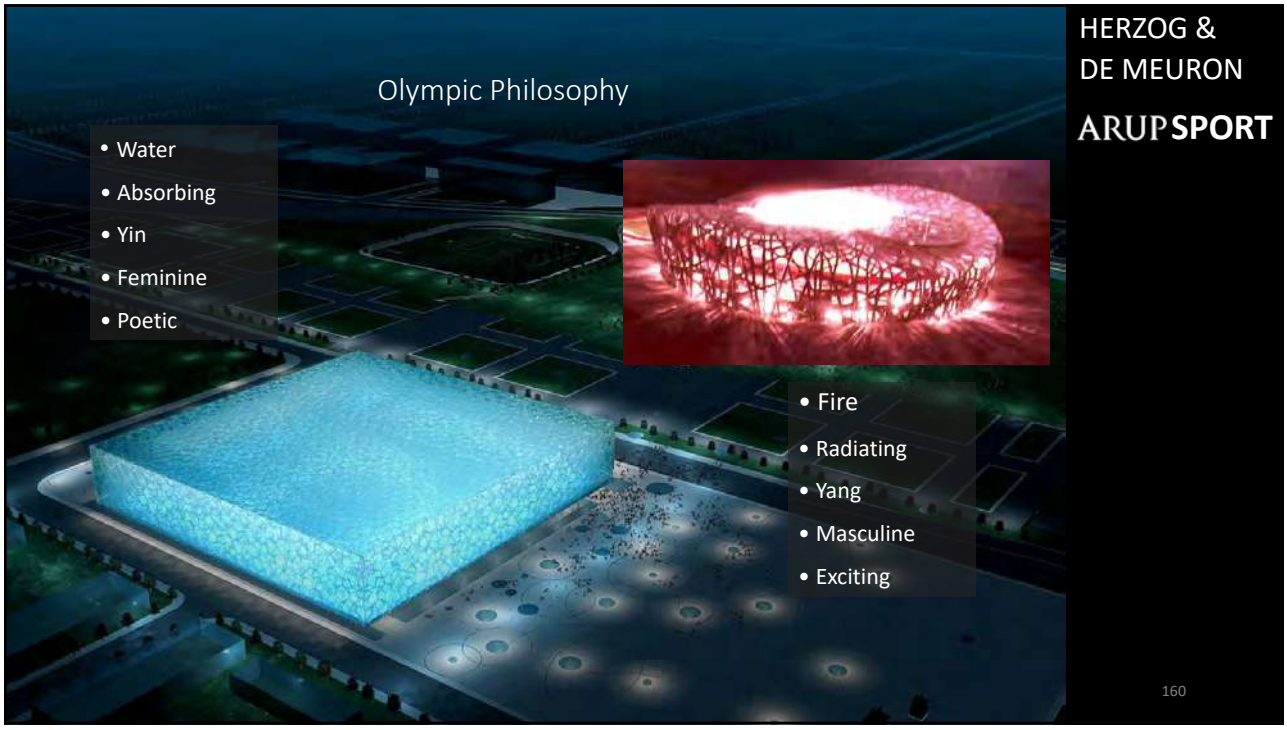
154

156

157

158


Beijing National Stadium
2008 Summer Olympics
Beijing, China
钢屋盖结构的重新设计
159

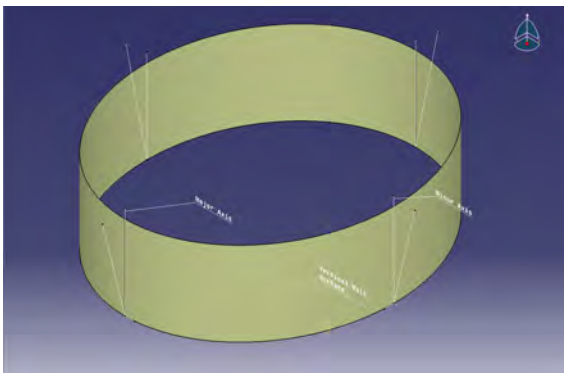

Olympic Philosophy
• Water
• Absorbing
• Yin
• Feminine
• Poetic
• Fire
• Radiating
• Yang
• Masculine
• Exciting
HERZOG &
DE MEURON
ARUP SPORT
160

NOT a Brid's Nest

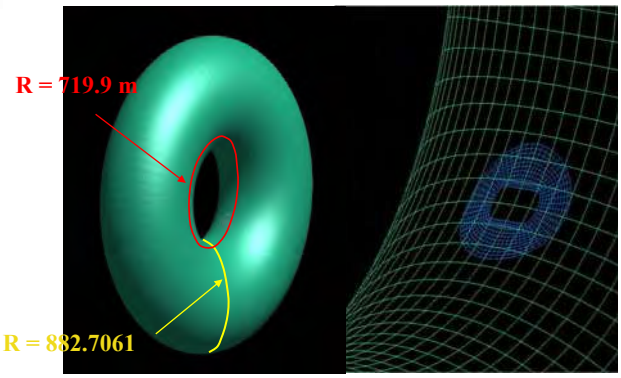
Lingbi stones are found in the soil of the mountain areas of Lingbi county, Anhui province.

They were the most valued stones during the Song dynasty (960-1279 A.D.).

161

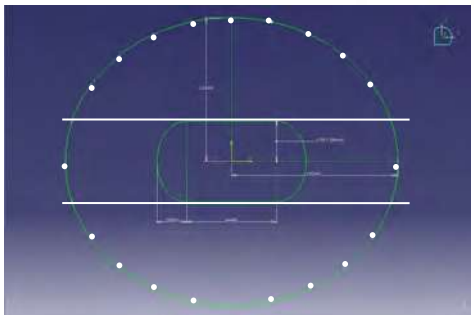


The inner side walls are orientated vertically.

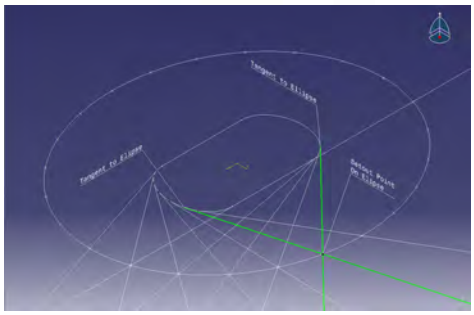


The roof is formed from a toroid patch .

162



The perimeter of the base ellipse is split into 24 equal parts. (The width of the inner ring is also defined by two of these points).

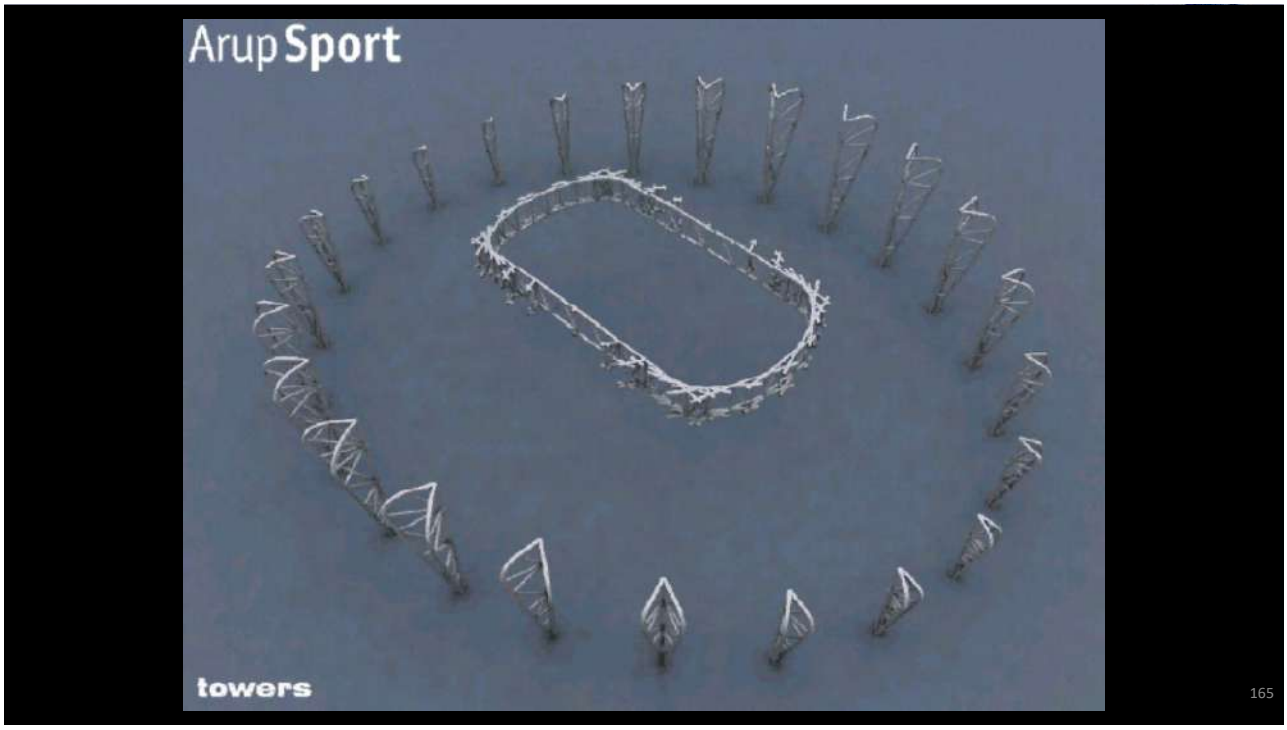


The primary lines are created by taking lines from the points on the outer ellipse to a tangent on the ellipse that forms the inner ring.

163

Foamboard Mockup

164



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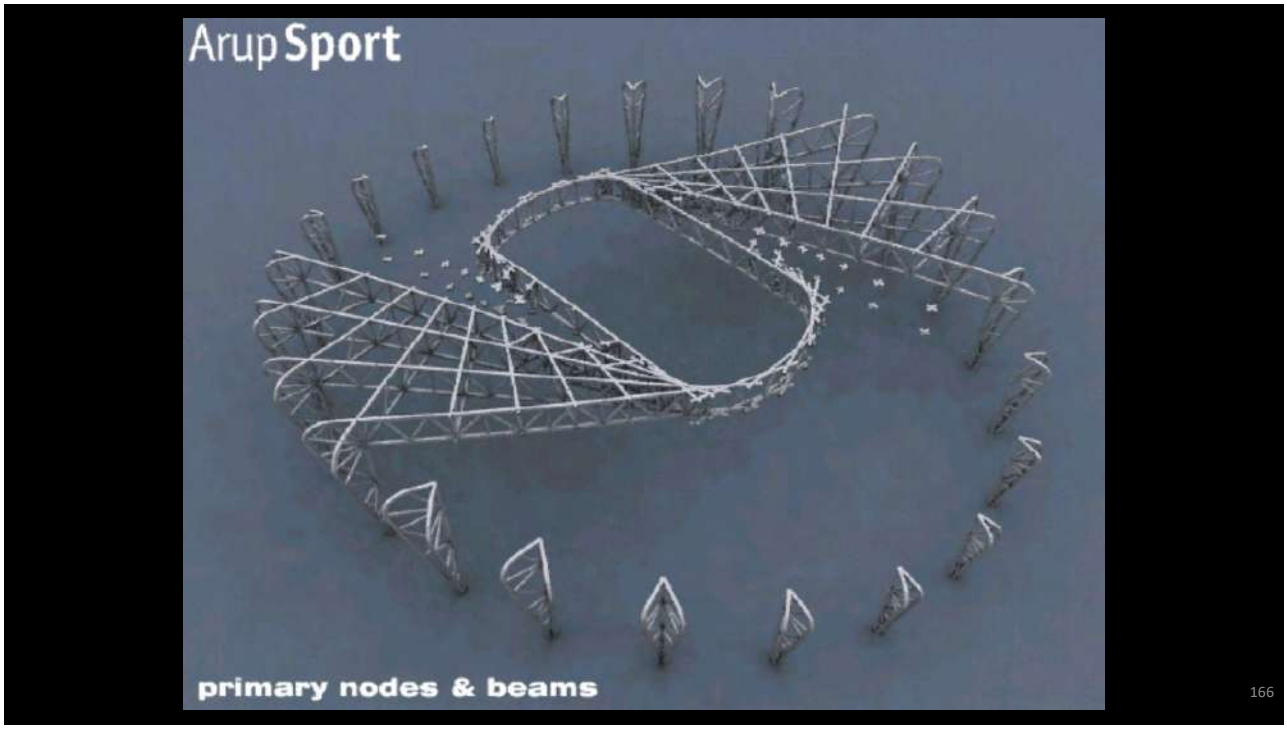

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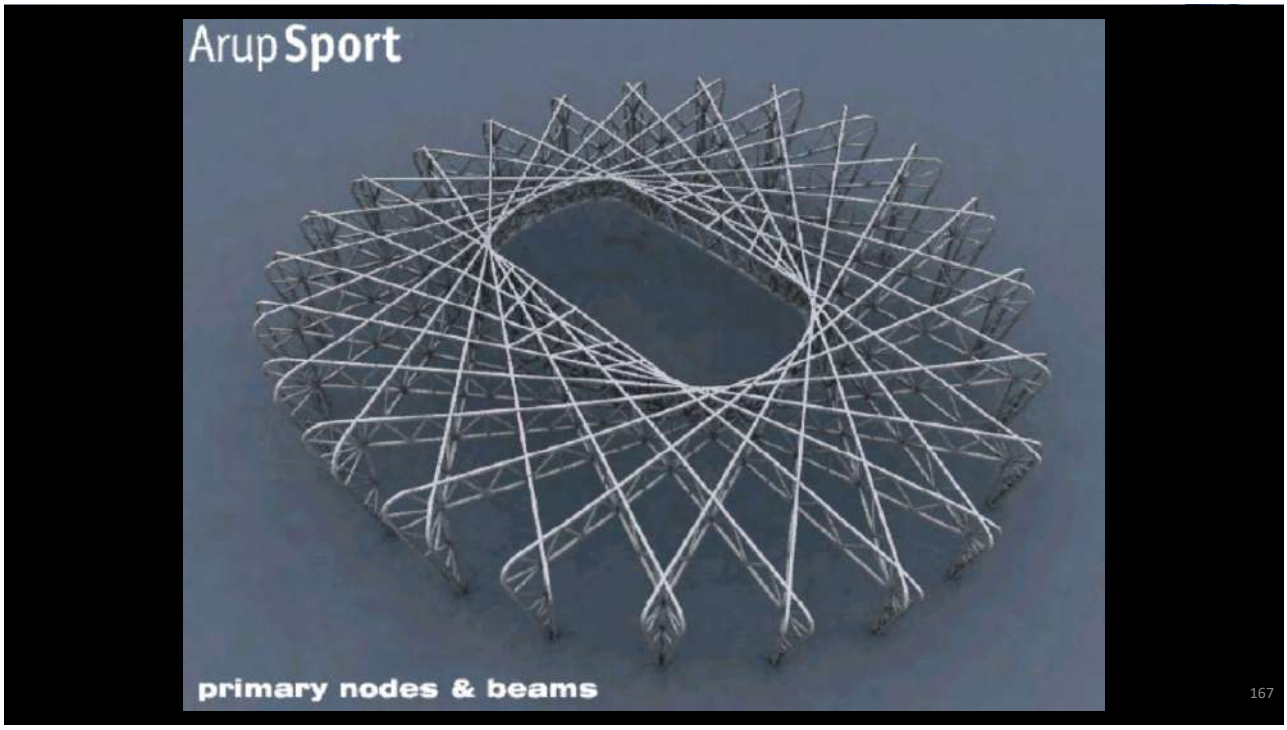
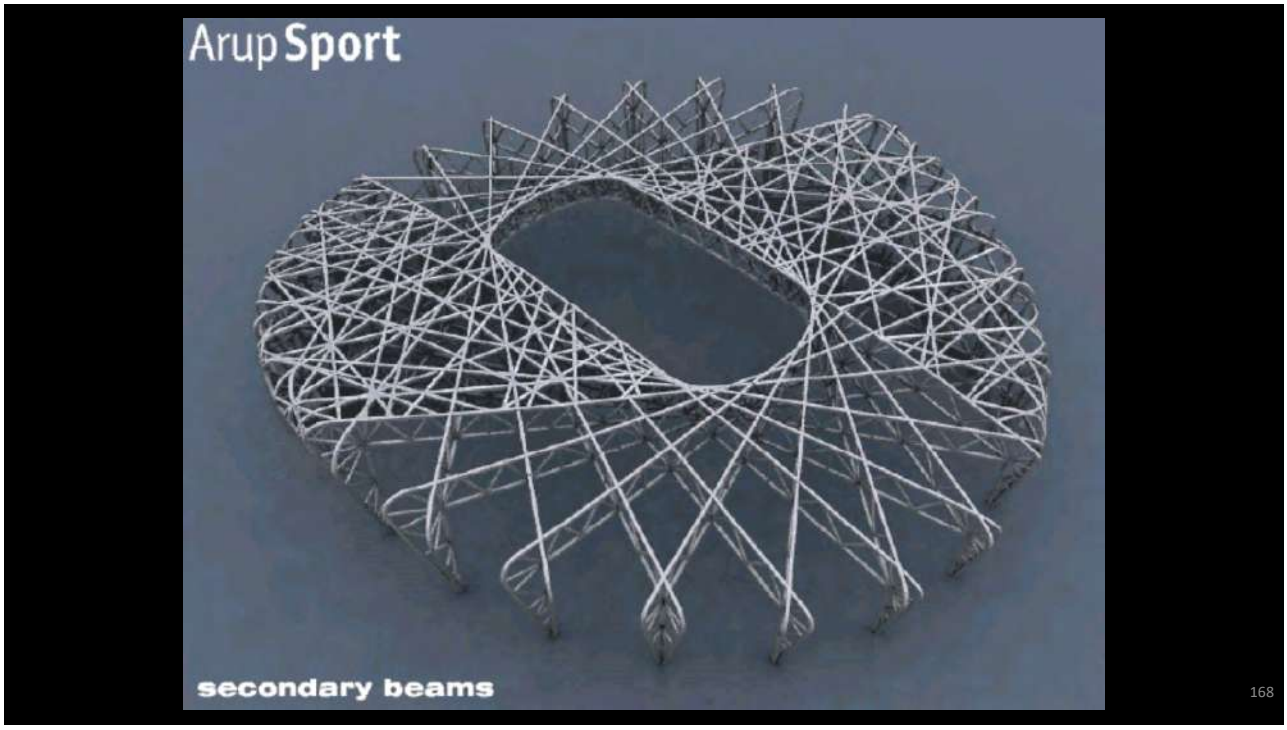
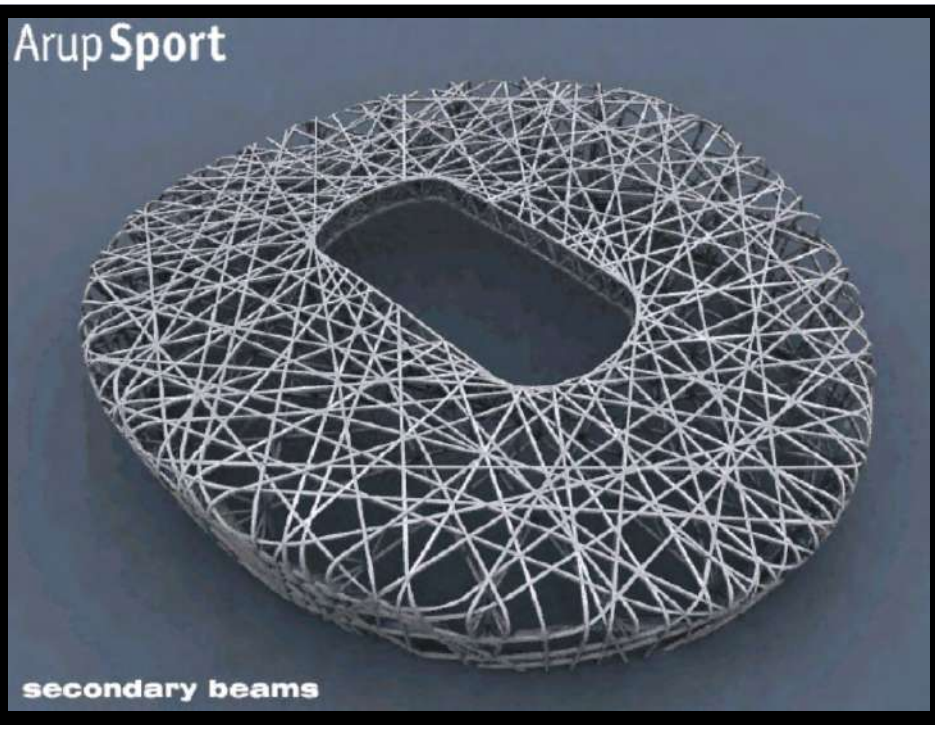

Arup Sport
primary nodes & beams
167


Arup Sport
secondary beams
168



169

170

171

Photo taken in 2011

172

Photos taken in 2011

173

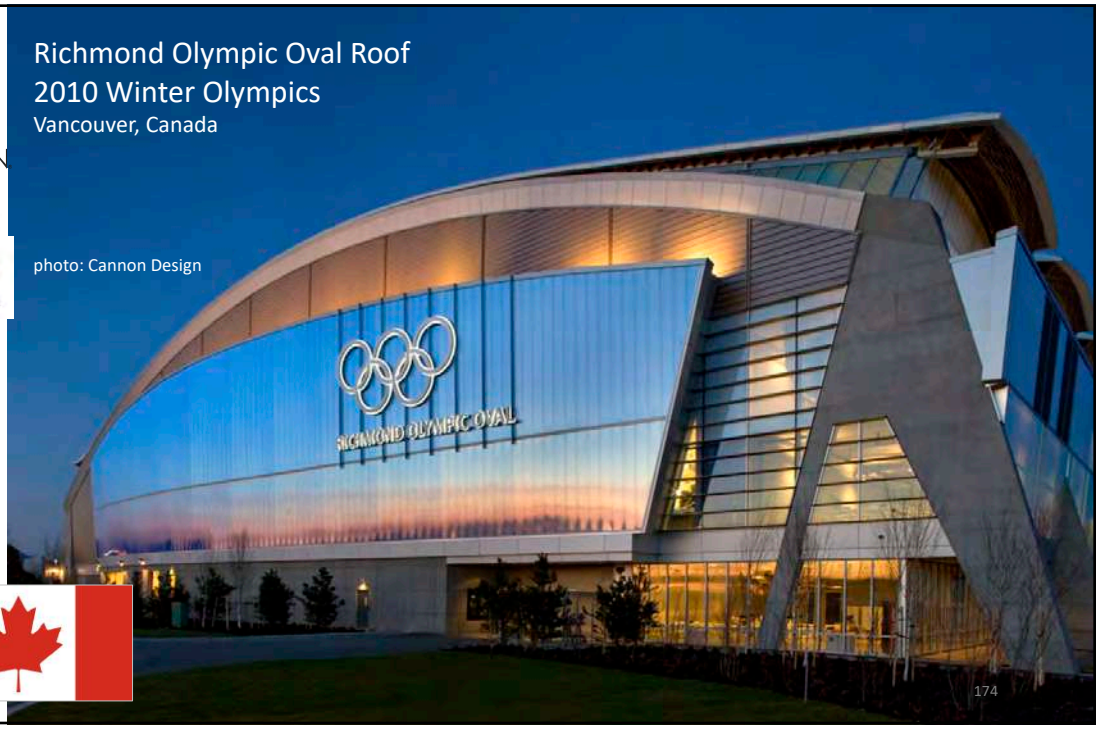
CANNONDESIGN

Fast + Epp
structural engineers

GTS
GEORGE THIRD & SON LTD.

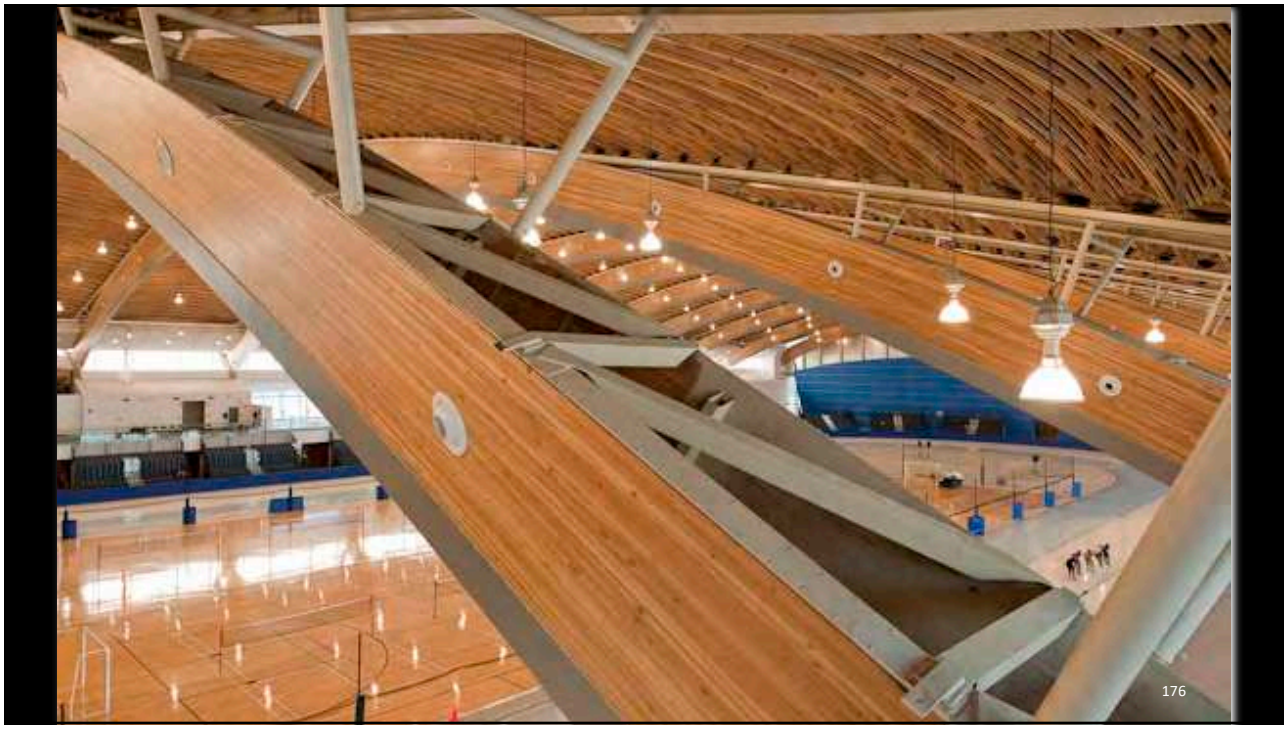
Richmond Olympic Oval Roof
2010 Winter Olympics
Vancouver, Canada

photo: Cannon Design



174


Cannon Design
175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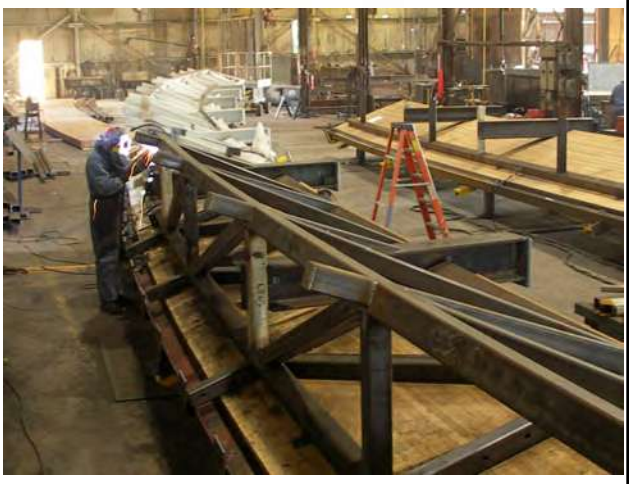


GTS
GEORGE THIRD & SON LTD.

Jacques Cartier Bridge, Montréal, Canada

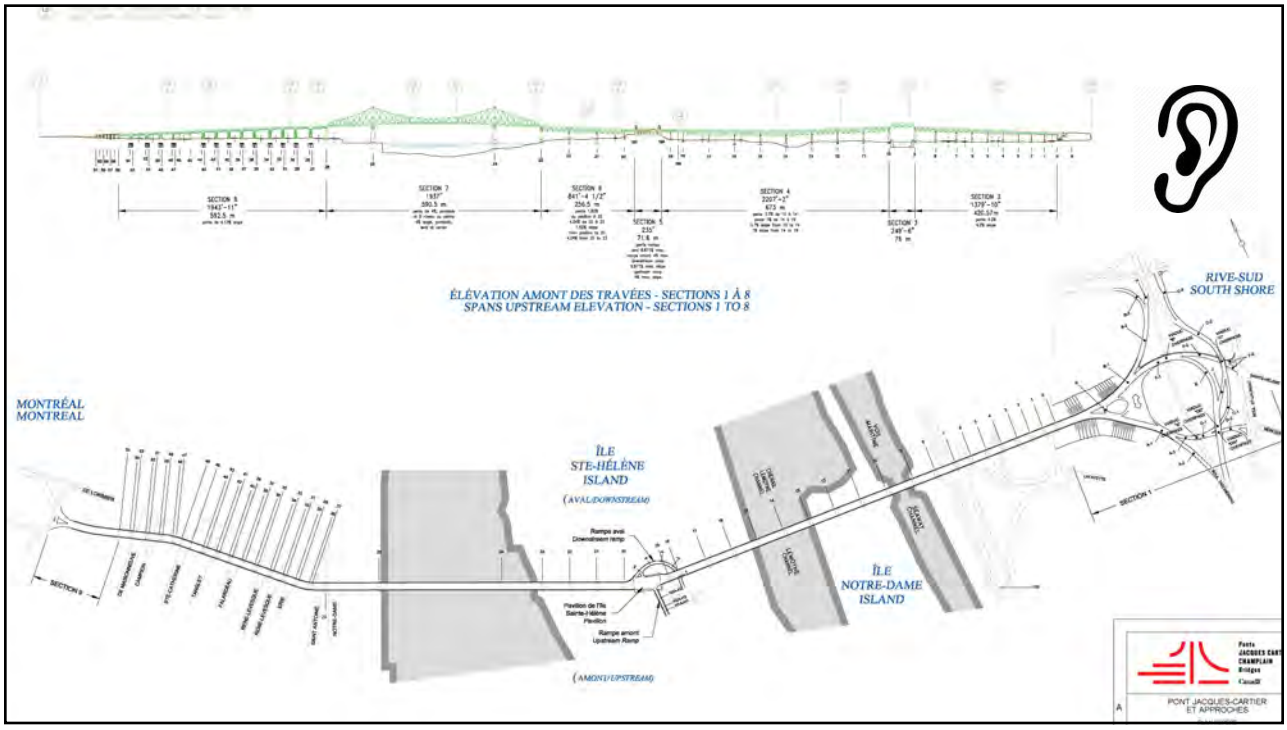
Jacques Cartier Bridge in Numbers

+ Opening Date : **May 14, 1930**
+ Length of Bridge : **2 725 m**

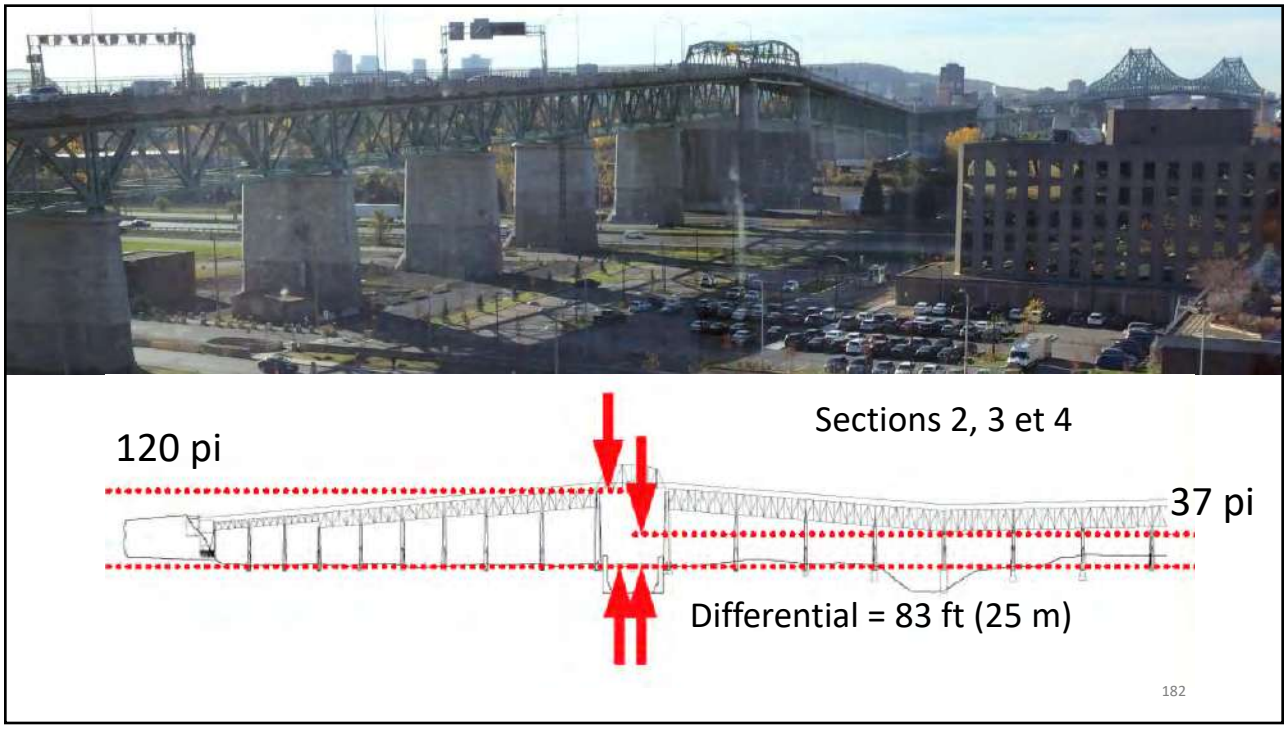
+ Truss Cantilever Section
+ Total Length : 591 m
+ Main Span : 334 m
+ Deck Height : 58,8 m

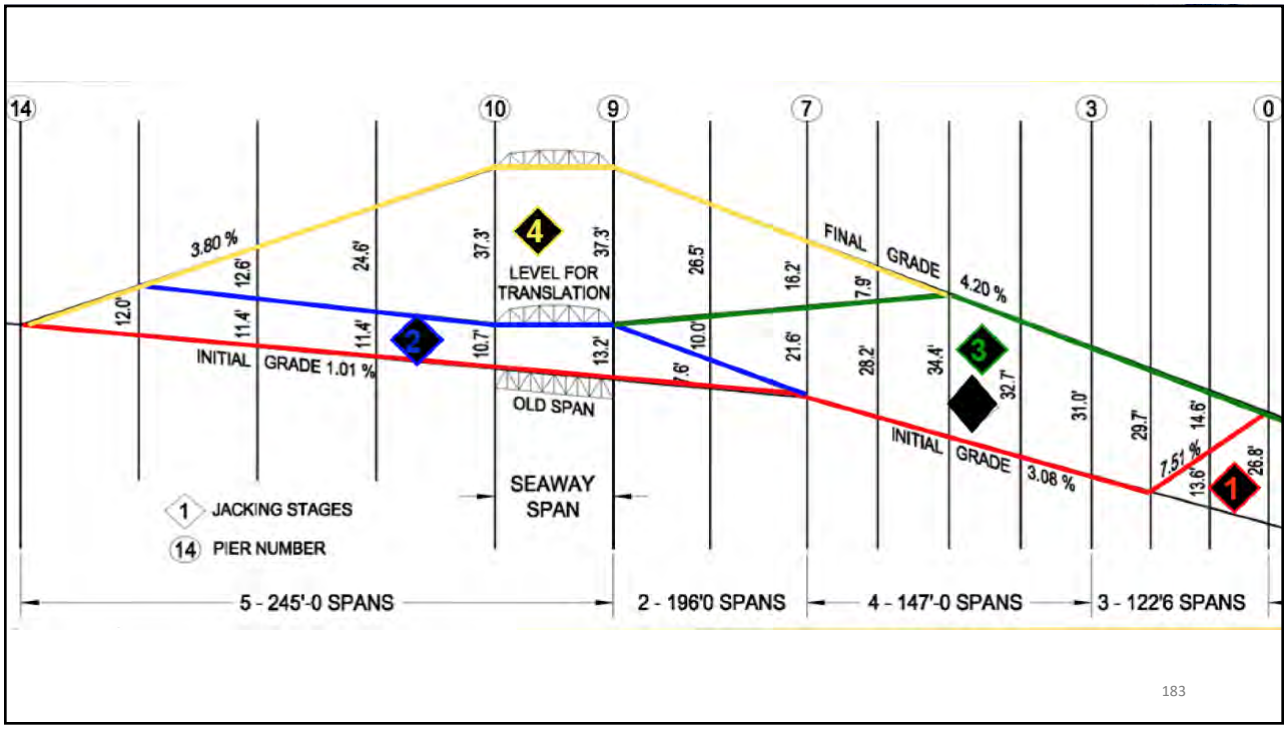
Ponts JACQUES CARTIER + CHAMPLAIN Bridges
Canada
1978 - 2018

179

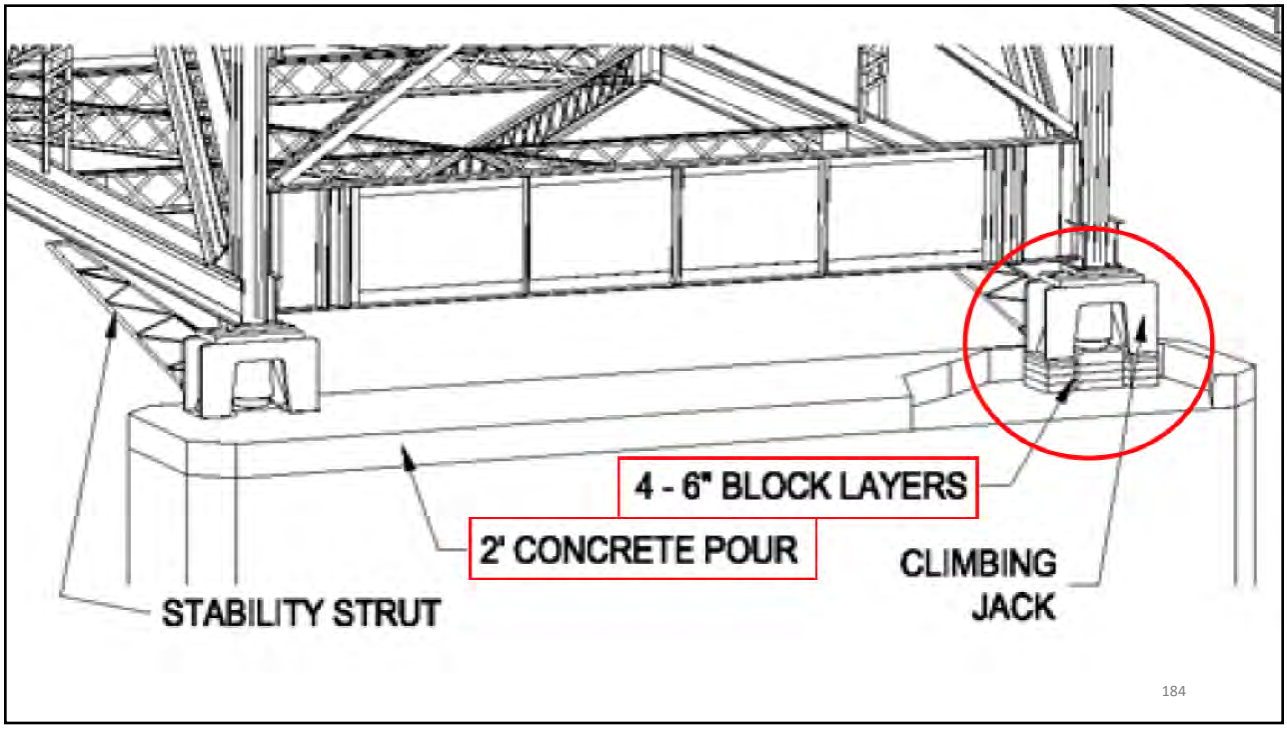



181


120 pi
Sections 2, 3 et 4
37 pi
Differential = 83 ft (25 m)
182


14
10
9
7
3
0
3.80 %
12.0'
12.6'
11.4'
24.6'
11.4'
37.3'
10.7'
4
LEVEL FOR TRANSLATION
37.3'
13.2'
OLD SPAN
26.5'
10.0'
7.6'
16.2'
21.6'
FINAL GRADE
7.9'
28.2'
4.20 %
34.4'
3
32.7'
31.0'
29.7'
14.6'
7.51 %
13.6'
26.8'
1
INITIAL GRADE 1.01 %
INITIAL GRADE
3.08 %
SEAWAY SPAN
1 JACKING STAGES
14 PIER NUMBER
5 - 245'-0 SPANS
2 - 196'0 SPANS
4 - 147'-0 SPANS
3 - 122'6 SPANS

183


4 - 6" BLOCK LAYERS
2' CONCRETE POUR
CLIMBING JACK
STABILITY STRUT

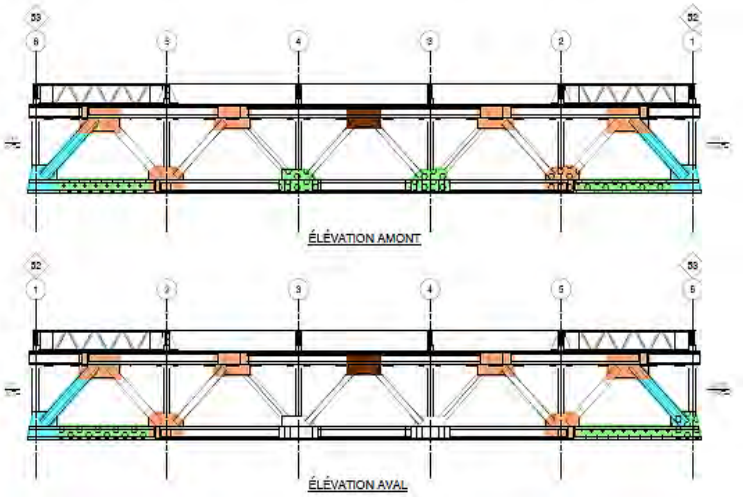
184

Replacement of span over seaway

185

Bottom chord members and gusset plate reinforcement

+ Capacity evaluation + inspection



186

Section 8 construction site – Steel trusses and towers

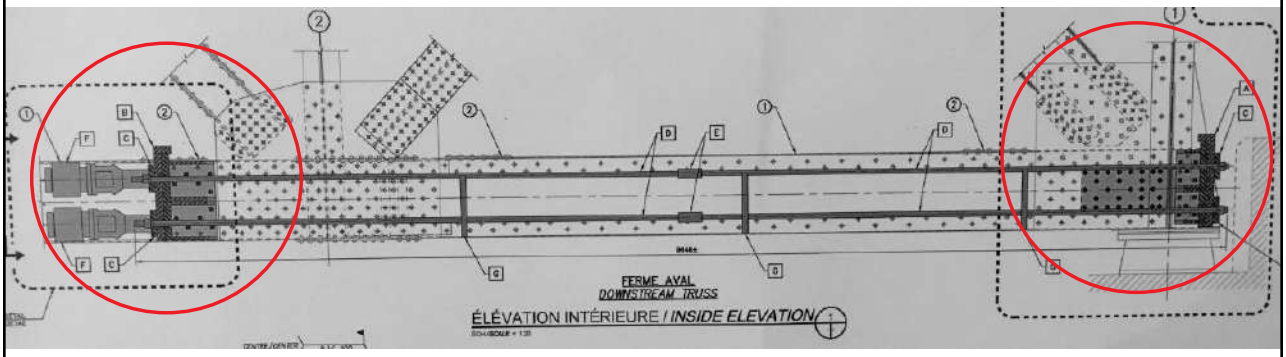
- All field work starts with rivet removal

Noise sources :
- Rivet extraction
- Abrasive cleaning
- Hole rimming

187

Temporary takeover of bottom chord tension force

- Replacement of bottom chord section



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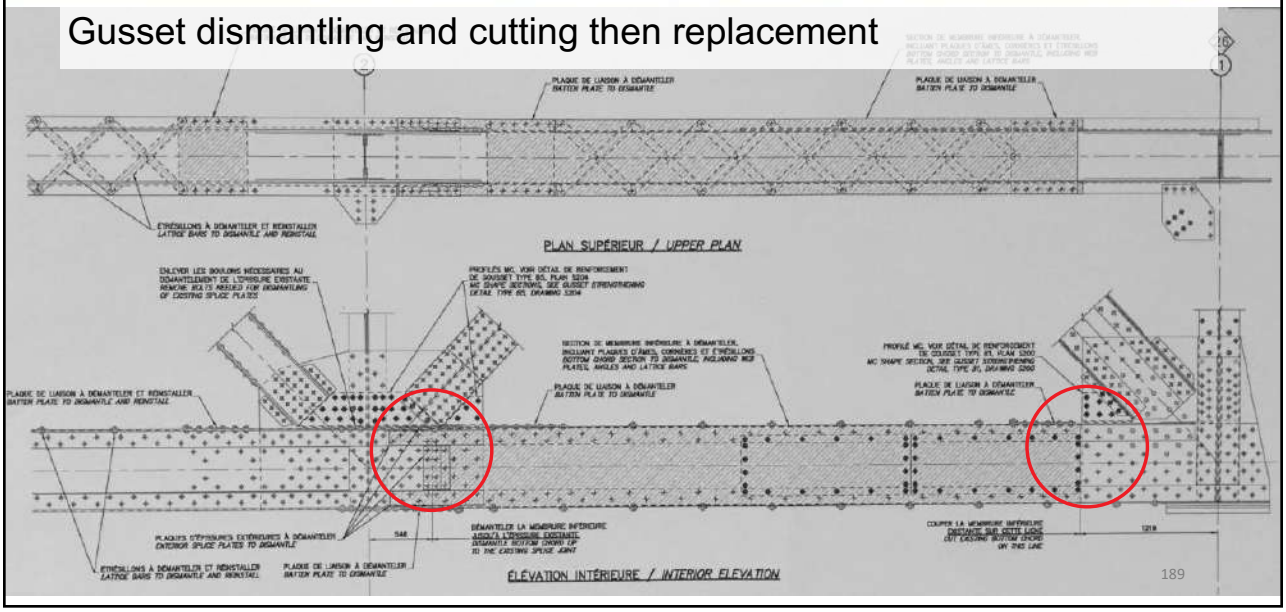
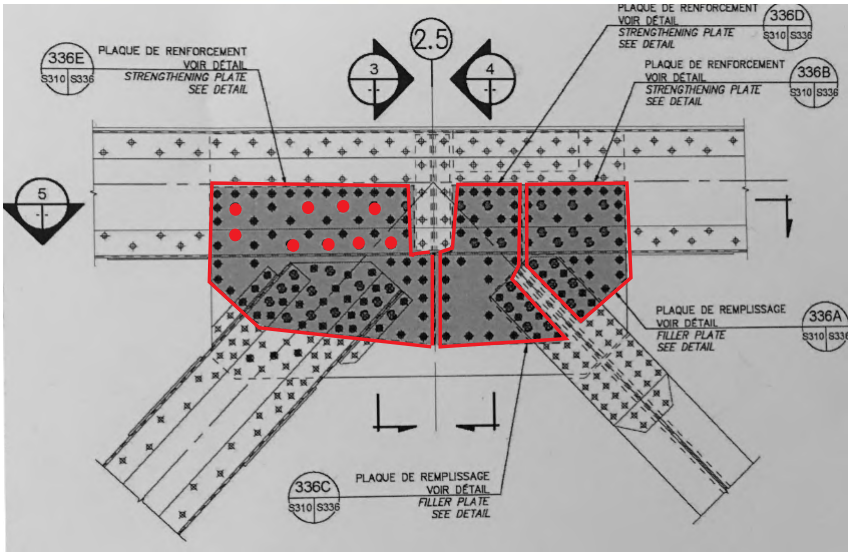
Addition of platework at bottom chord

Gusset dismantling and cutting then replacement



Gusset reinforcement through plate addition



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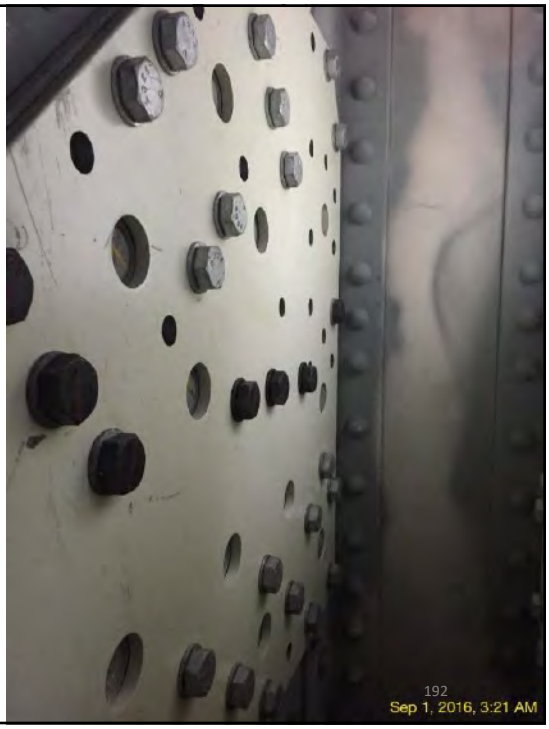

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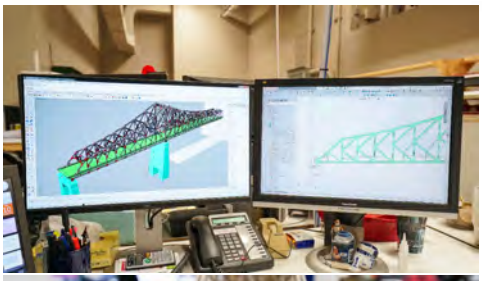
Wind Tunnel Test – Physical Model



3D Solid Works Model

Scale: 1:120

Material: Wood, Plastic, Metal

Hand Building Process

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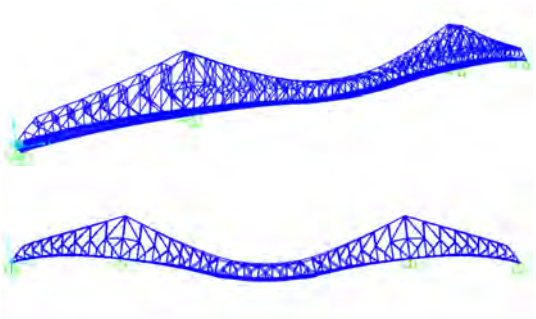
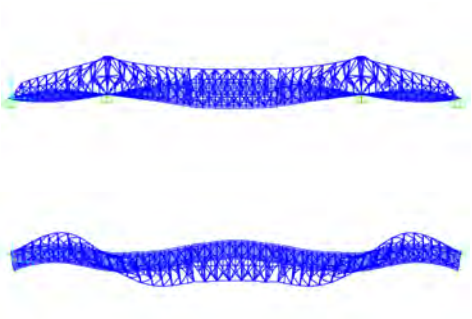
Initial Frequencies obtained from Numerical Model

ALERT: Mode values are close in range

Vertical mode 1- 0.53 Hz



Torsional mode 1- 0.56 Hz



COWI

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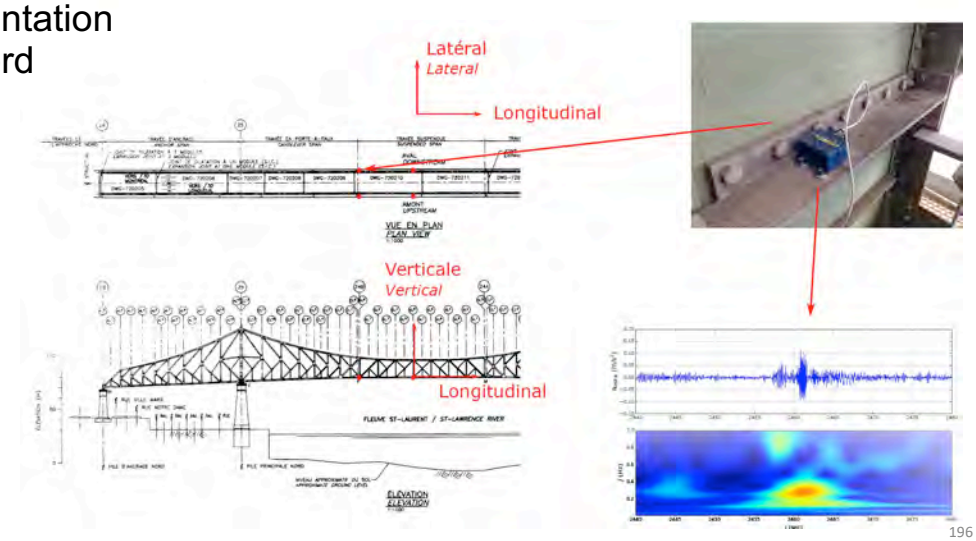
Identification of Bridge Dynamic Properties In Situ

Instrumentation and record sample



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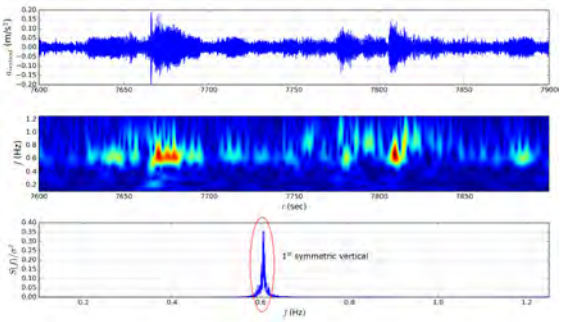
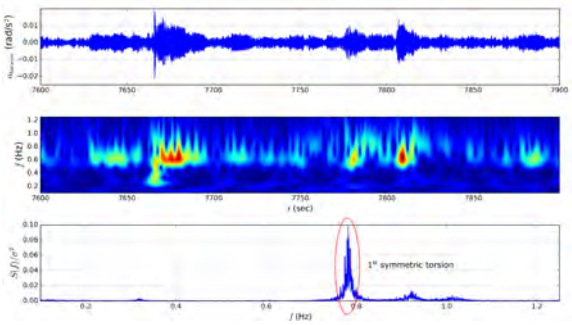
Frequencies obtained through Site Measurements

REALITY CHECK: Frequencies farther apart

Vertical mode 1- ~~0.53 Hz~~ **0.61 Hz**



Torsional mode 1- ~~0.56 Hz~~ **0.79 Hz**



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Wind Tunnel 2D Sectional Model Test

Objectives

- Measure the overall forces on ½ the bridge for both wind directions
- Isolate the drag contribution from the deck
- Redistribute the drag to all truss members for buffeting analysis and wind load derivation

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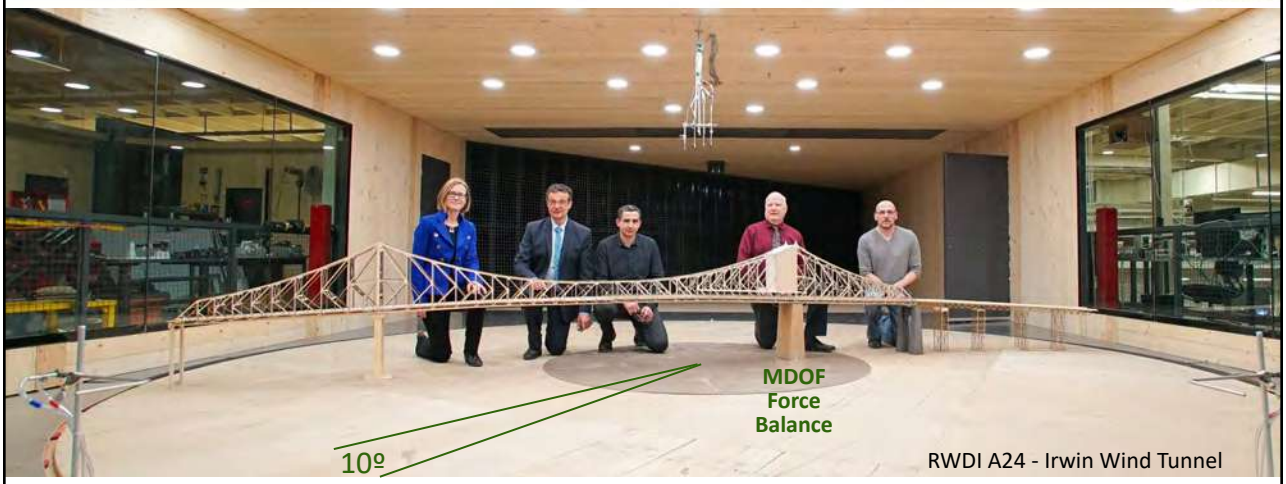
Wind Tunnel 3D Force Model Balance Test



Sectional Model Half Length = 2.47 m representing 293 m at full scale

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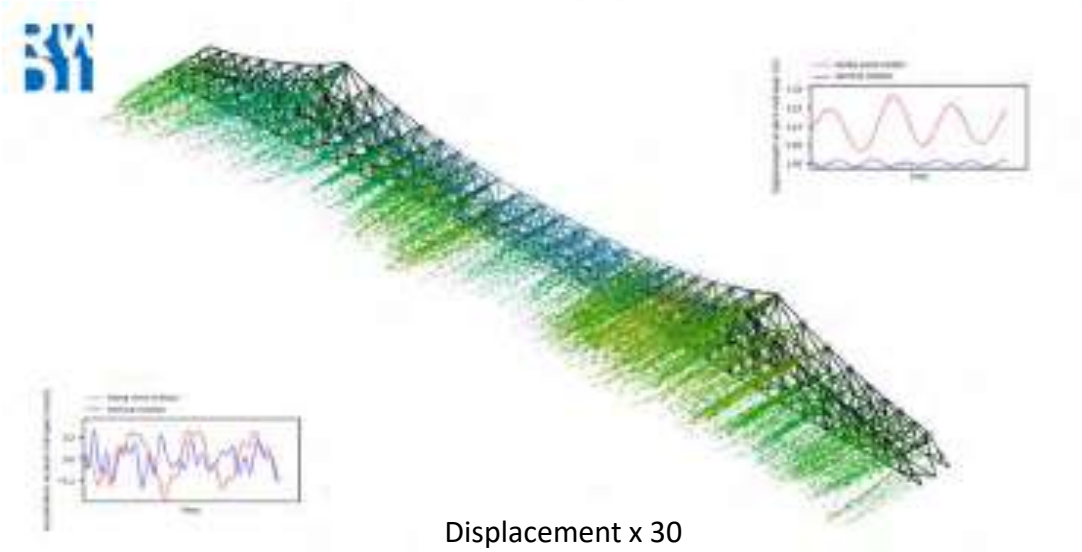
3D Buffeting Response Analysis



Displacement x 30

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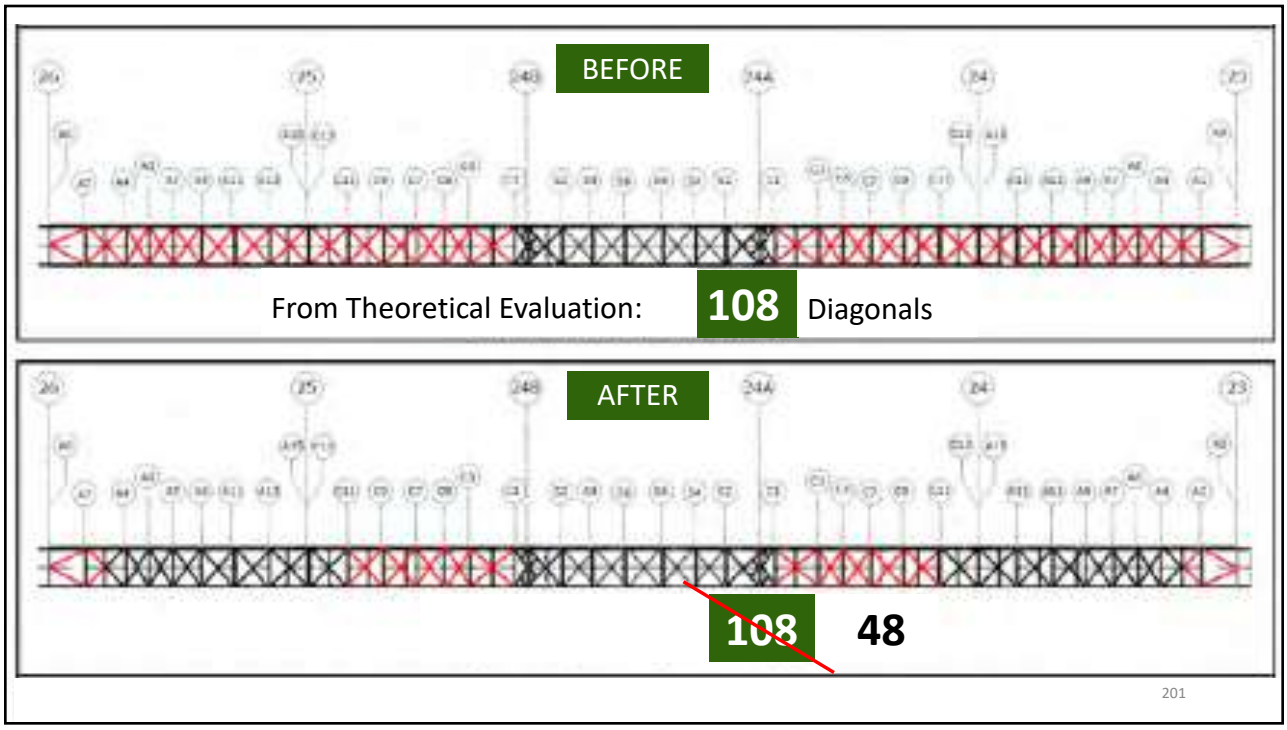
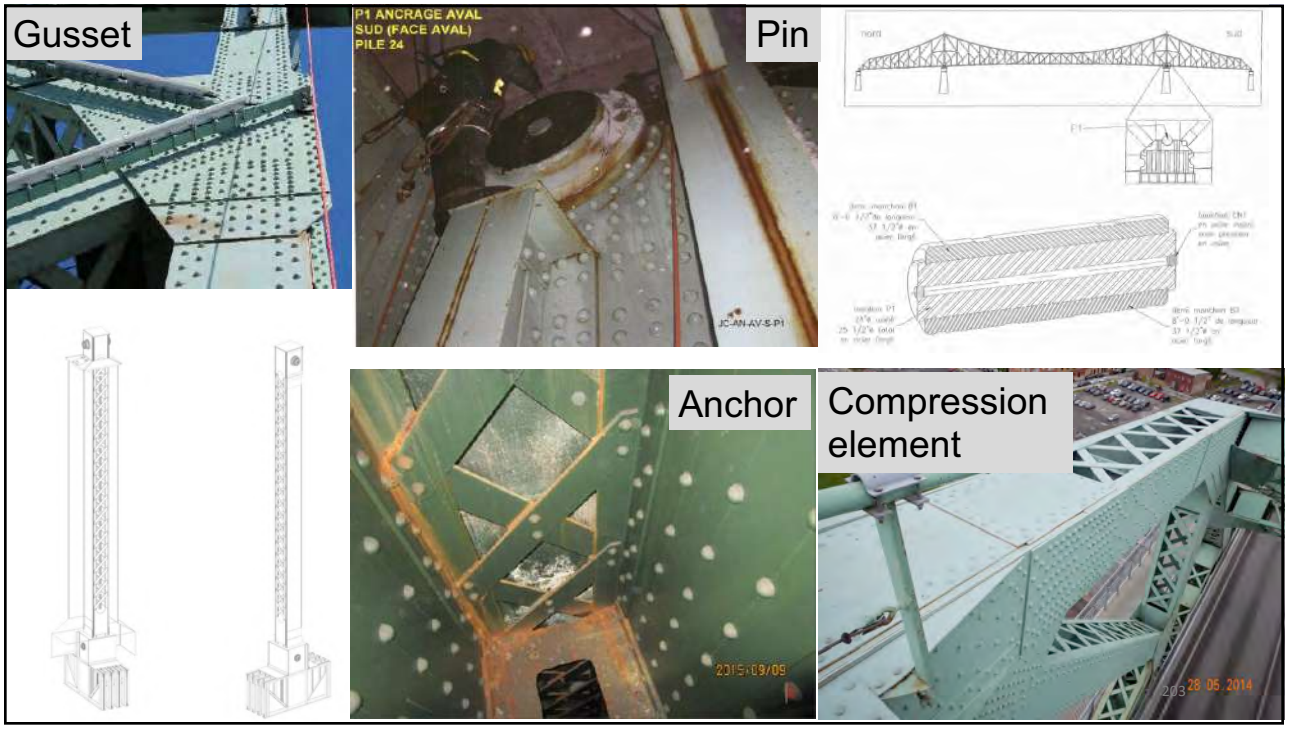
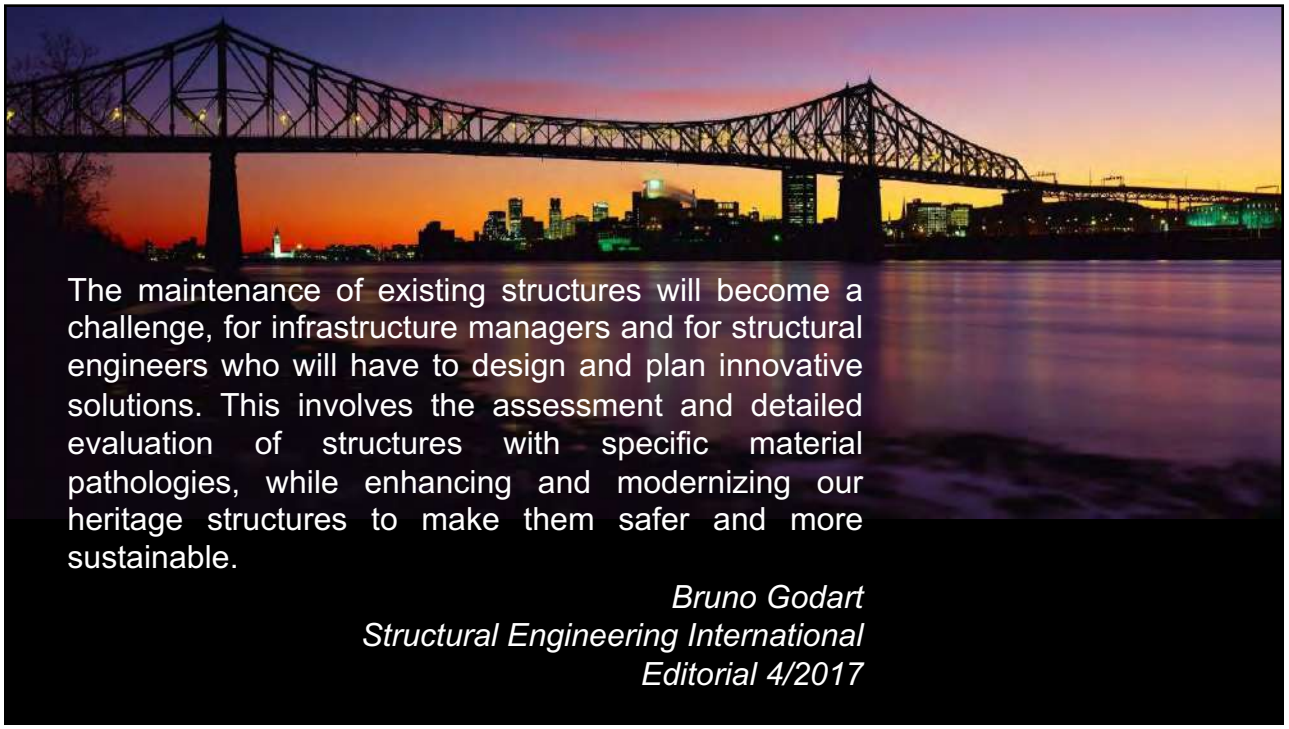


A diagonal under compression

Typical deterioration: close to the ends

Refinement of resistance due to compression





The maintenance of existing structures will become a challenge, for infrastructure managers and for structural engineers who will have to design and plan innovative solutions. This involves the assessment and detailed evaluation of structures with specific material pathologies, while enhancing and modernizing our heritage structures to make them safer and more sustainable.

Bruno Godart
Structural Engineering International
Editorial 4/2017

When working with large trusses, **collaboration** is key.

The Beauties

Use AESS Categories

When hollow sections are used, consider a continuous line, with :

- Compatible member geometries
- Discreet bolted connections
- Hidden bolted connection with welded appearance
- Solid sections or castings,
- Site welding

The Beasts

Take care of :

- Nodes and splice location
- Direct paths
- Pre-assembly

The Special Ones

- All of the above

The Oldies

- Dig deeper, refine the residual capacity, take measurements, do finite analysis.

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CONGRESO INTERNACIONAL DE LA CONSTRUCCIÓN CON ACERO 2019 Medellín, Centro de Eventos El Tesoro Junio 19, 20 y 21

For more info

LinkedIn sboulanger11

Modern Steel Construction

The Splice is Right

Working with large trusses

Book on AESS

By Terri Meyer Boake

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