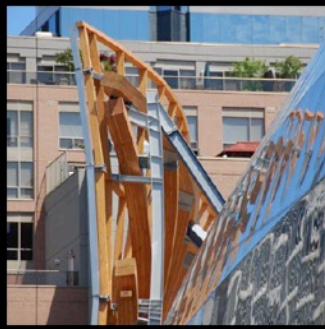




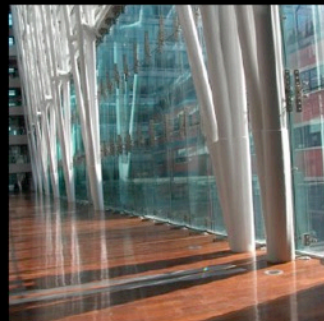
Modern Steel Construction

Arch 173: Building Construction 2
Winter 2022

Terri Meyer Boake



Canadian Institute of Steel Construction Guide for Specifying Architecturally Exposed Structural Steel



BIRKHAUSER

*Understanding
Steel Design*

AN ARCHITECTURAL
DESIGN MANUAL

by Terri Meyer Boake
with Drawings by Vincent Hui

BIRKHAUSER

DIAGRID
STRUCTURES

SYSTEMS
CONNECTIONS
DETAILS

TERRI MEYER BOAKE

BIRKHAUSER

TERRI MEYER BOAKE

ARCHITECTURALLY EXPOSED STRUCTURAL STEEL

SPECIFICATIONS, CONNECTIONS, DETAILS

BIRKHAUSER

TERRI MEYER BOAKE

COMPLEX STEEL STRUCTURES

NON-ORTHOGONAL
GEOMETRIES IN
BUILDING WITH STEEL

Types of steel:

- Regular carbon
- High strength

- Weathering steel (aka Corten)
- Stainless steel











GE Plaza



YOU
COCA-COLA
CANADA

CAFE

Canada Pacific Gateway






BRITISH
COLUMBIA

The Best Place on Earth





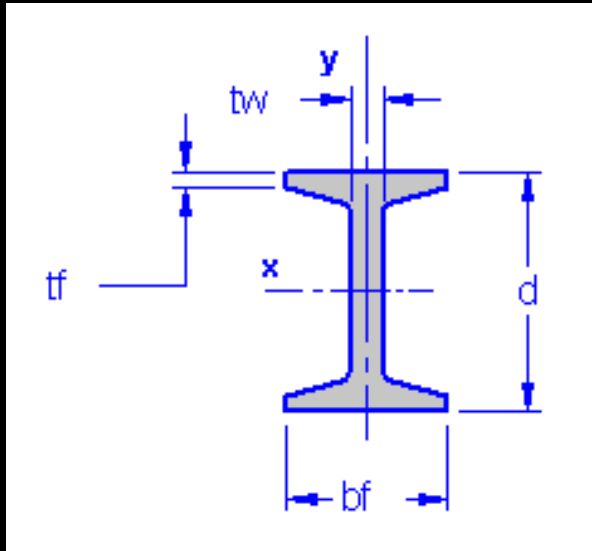
Galvanizing is NOT a type of steel. It is a dipping process in hot zinc for corrosion protection



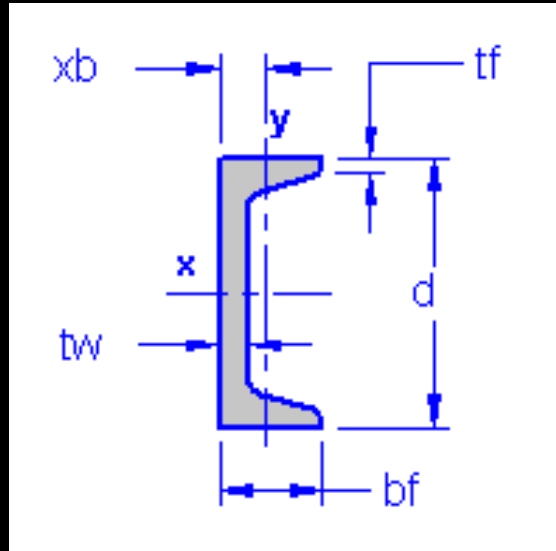
Structural Steel Shapes

Shapes are either hot rolled
or

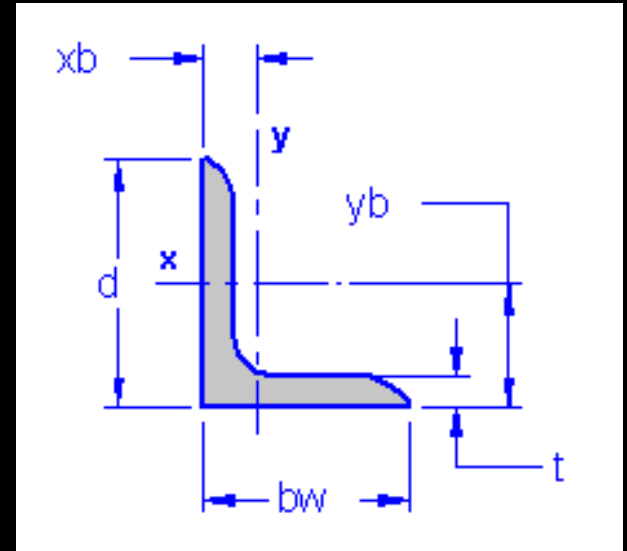
Formed from plate material and
bent, formed into shapes



Wide Flange

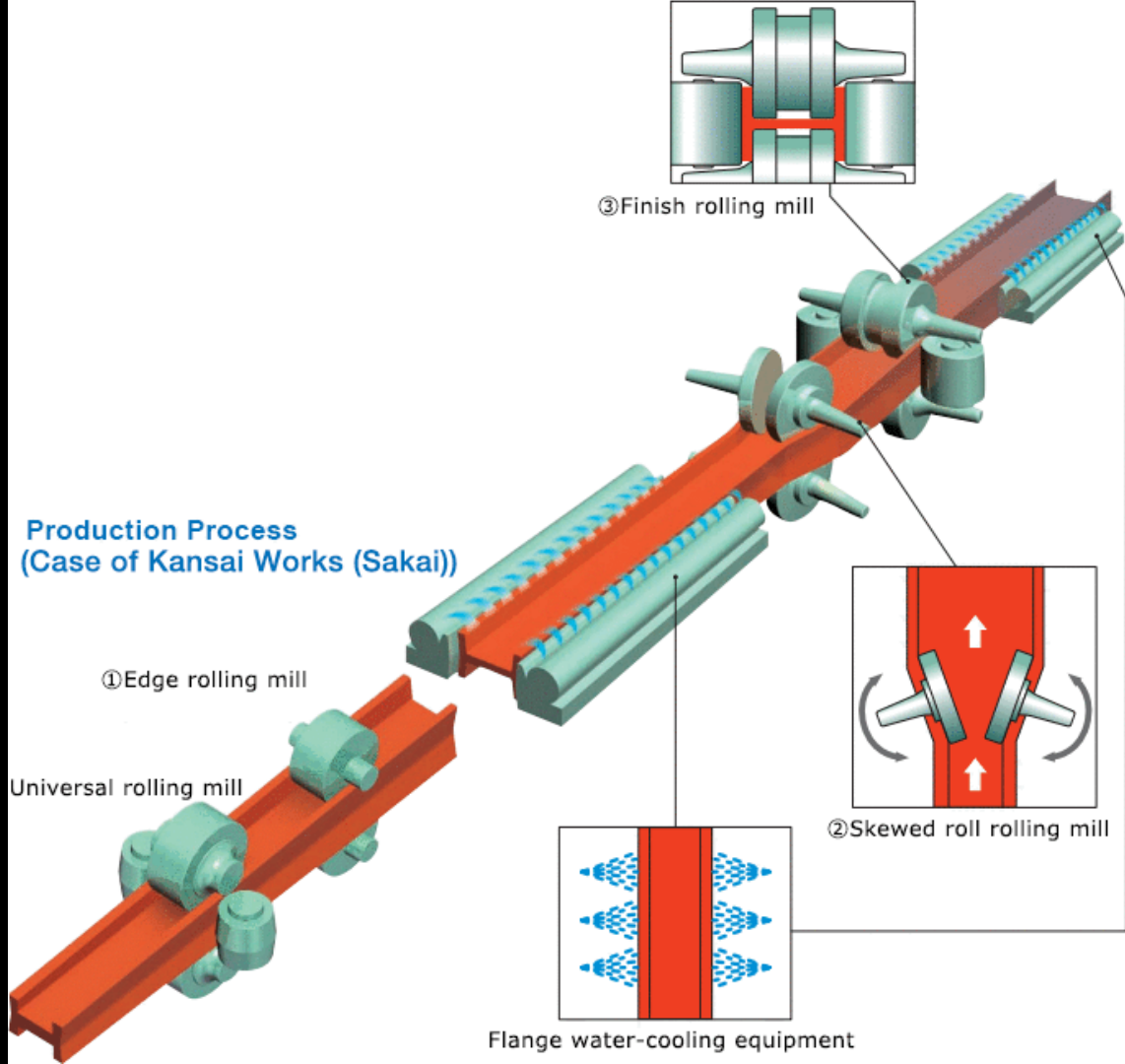


Channel



Angle

**Production Process
(Case of Kansai Works (Sakai))**







Q235 Q235 Q235
1-7977 1-7977 1-7977

Q235
Q235

Q235 Q235
1-7983 1-7983

Q235 Q235
1-7926 1-7926

ZIBO-SINO

2004 9 25



12 pcs
6x6x5/8x45

24 pcs
6x6x2 1/2x10x10

24 pcs
6x6x3/4x9



HW 0216
33
10x6
10x6

HW 0216
33
10x6
10x6

10x6x500
33
HW 0216

HW 0216

10x6x500
33

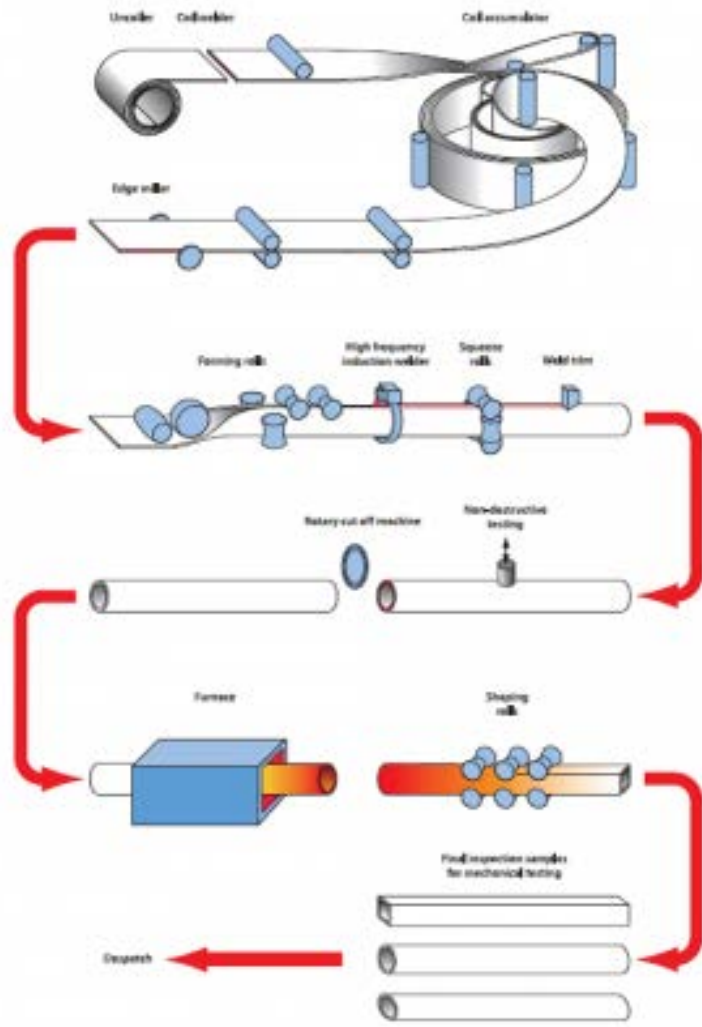
HW 0216
33

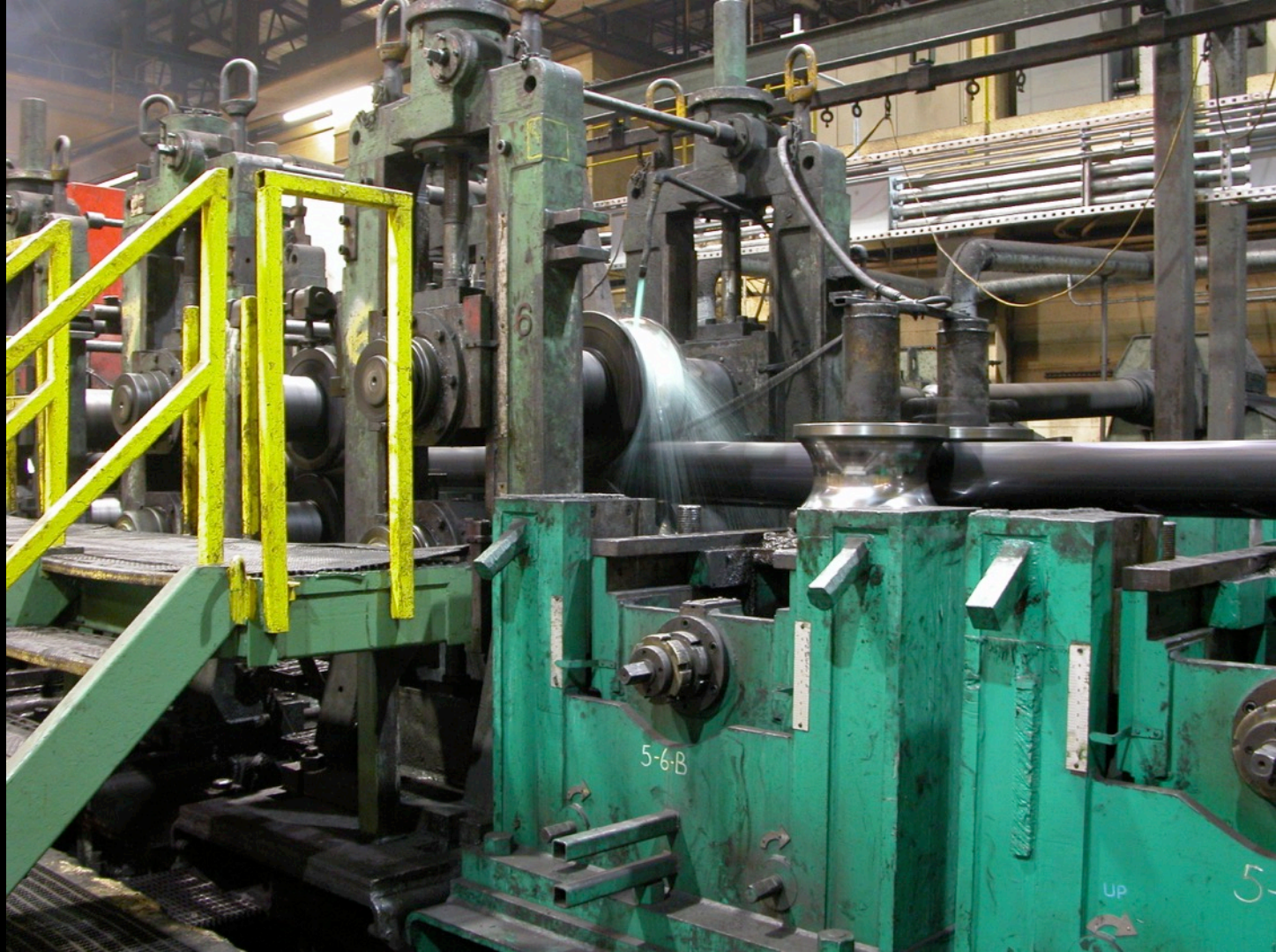
HW 0216
33

HW 0216
33



Hollow Structural Sections
AKA HSS





5-6-B

UP

5







STKR600 SIZE: 300x200x1200 11110 HEATNO: 20050705
STKR600 SIZE: 300x200x1200 11110 HEATNO: 20050705
STKR600 SIZE: 300x200x1200 11110 HEATNO: 20050705

SHANGHAI METAL CO. LTD
NO: 1000000004
SPEC: STKR600
SIZE: 300x200x1200
HEAT NO: 20050705

STKR600 SIZE: 300x200x1200 11110 HEATNO: 20050705
STKR600 SIZE: 300x200x1200 11110 HEATNO: 20050705
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STKR600 SIZE: 300x200x1200 11110 HEATNO: 20050705
STKR600 SIZE: 300x200x1200 11110 HEATNO: 20050705
STKR600 SIZE: 300x200x1200 11110 HEATNO: 20050705

SHANGHAI METAL CO. LTD
NO: 1000000004
SPEC: STKR600
SIZE: 300x200x1200
HEAT NO: 20050705

2005 1 12



2005 8 7





Because the HSS is bent formed into shape the corners are rounded.

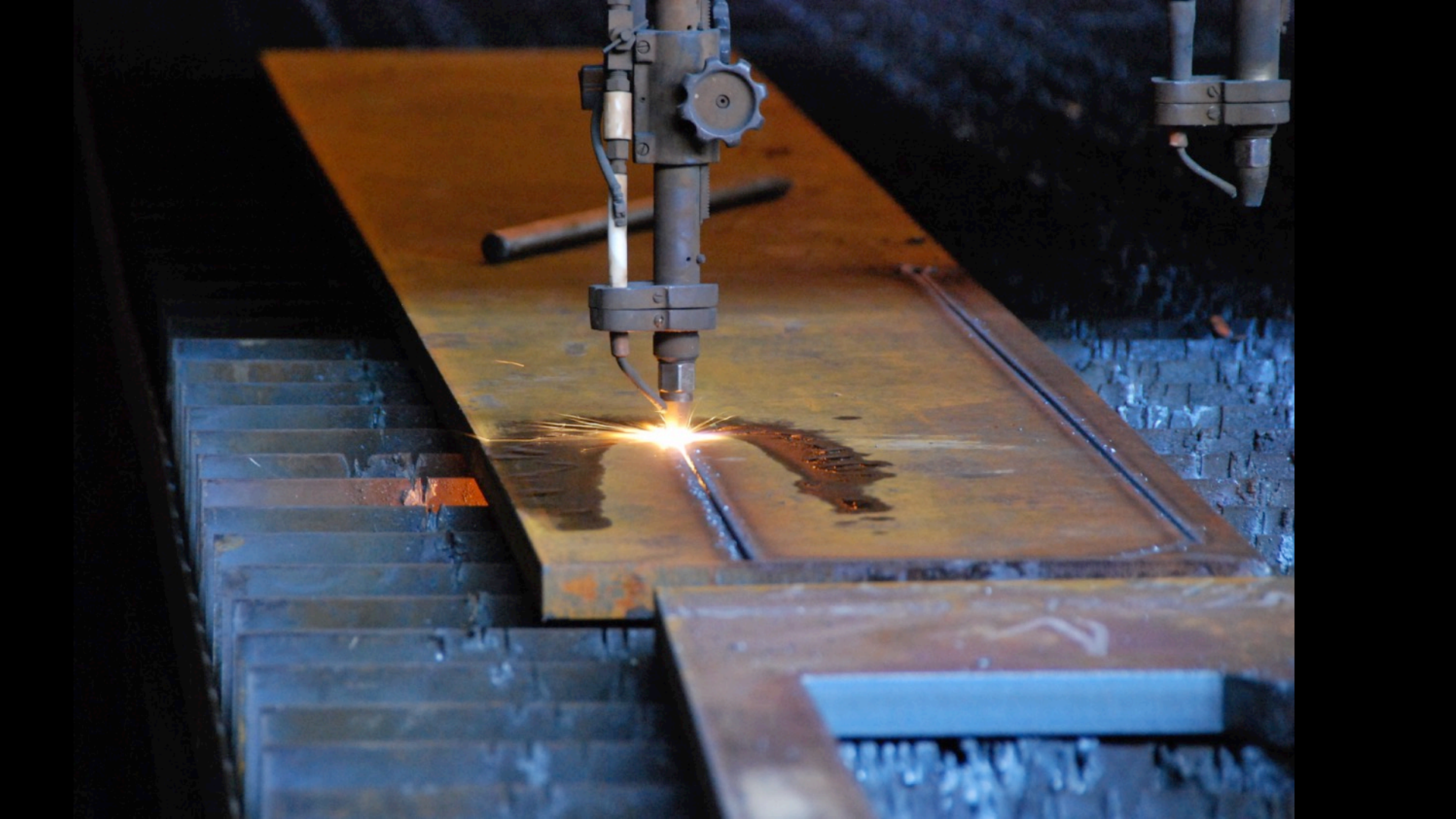
How rounded depends on the thickness of the steel plate.

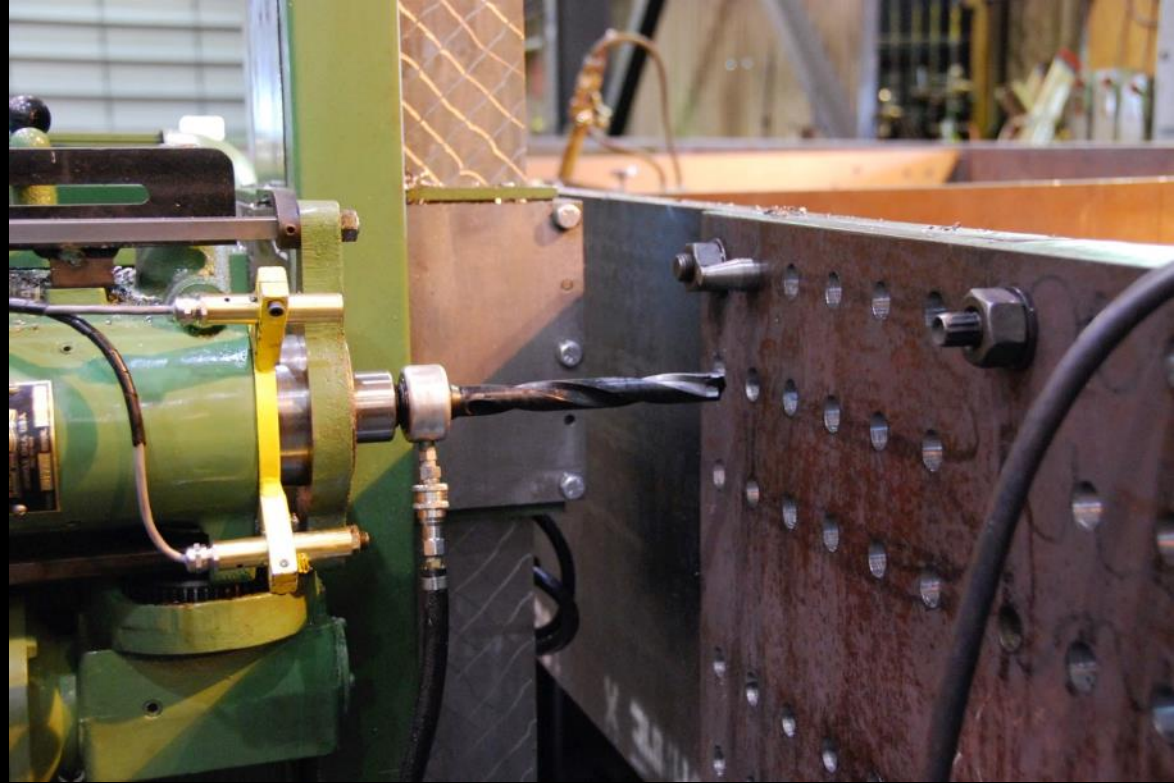
HSS come:

Square, rectangular, circular and in Europe, elliptical



Fabrication Processes



















Principles of Connection

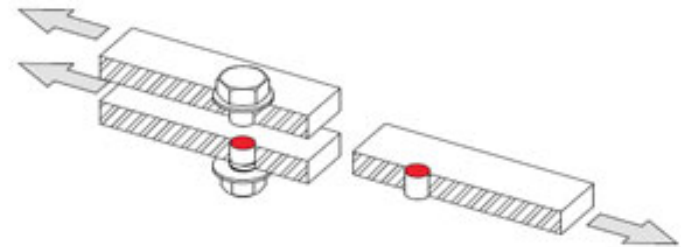
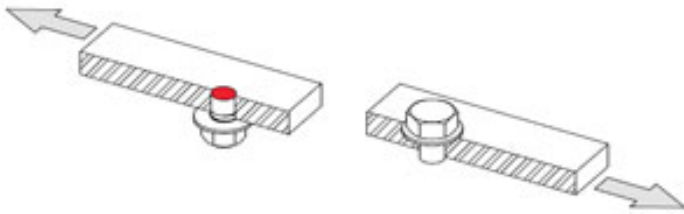
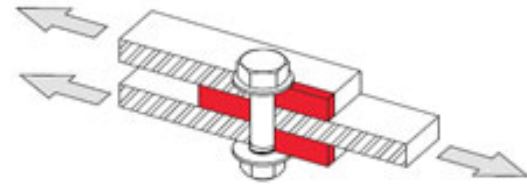
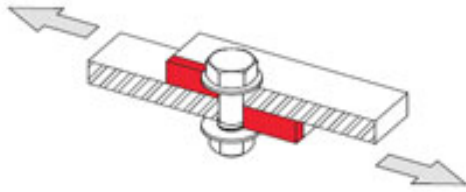
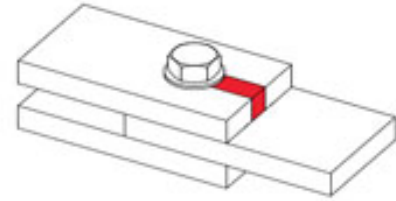
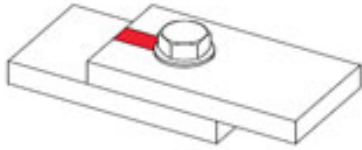


Hex Head Bolt

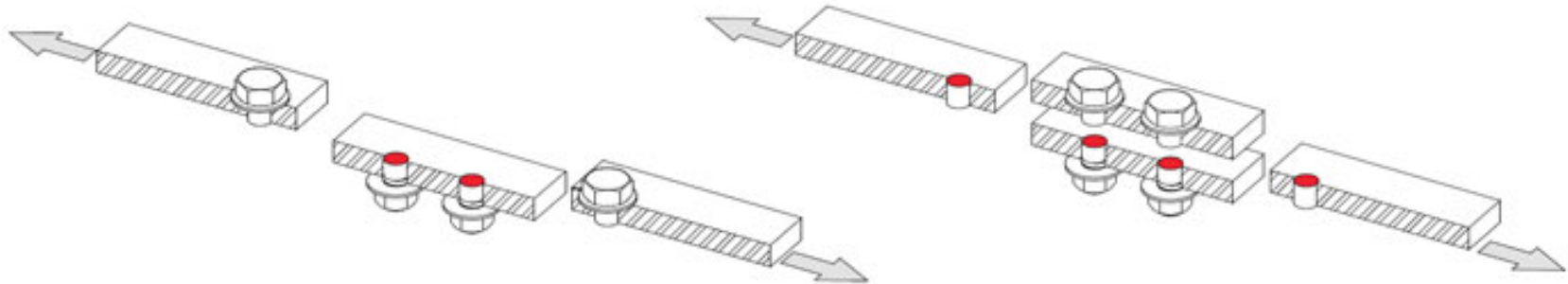
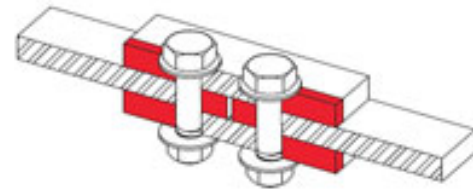
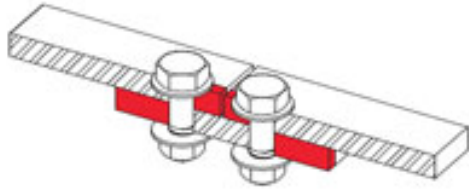
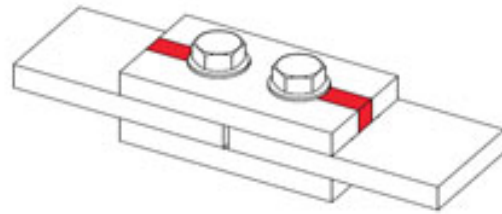
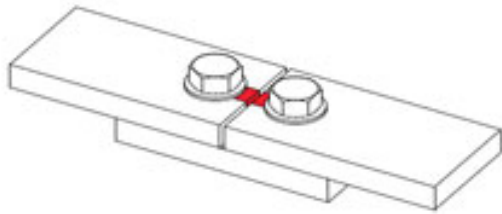


TC (Tension Control) Bolt

Lap Joints



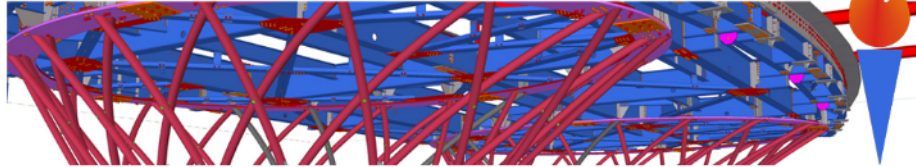
Butt Joints



IMPORTANT RESOURCES!

Fun is in the Details: Innovation in Steel Connections

[CISC](#) [Home](#) [Basic Connections](#) [Steel Framing](#) [AESS](#) [Innovative Connections](#) [Historic Projects](#) [Contemporary Projects](#) [Finishes](#)



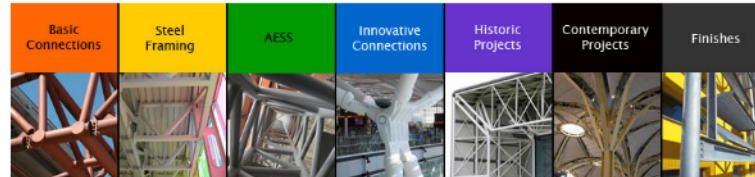
Fun is in the Details: Innovation in Steel Connections A Curriculum Materials Project

Welcome to "Fun is in the Details: Innovation in Steel Connections"! This curriculum materials project has been funded by the **Steel Structures Education Foundation** the former educational arm of the **Canadian Institute of Steel Construction** ([CISC](#)).

The web site is structured into *SEVEN primary sections on CONNECTION DESIGN* that will take you through the understanding and development of steel connections. Navigation is accessible at the top of each page, with subheadings for each section available in the left sidebar or through the pull down menu at the top.

HOME SUB MENU

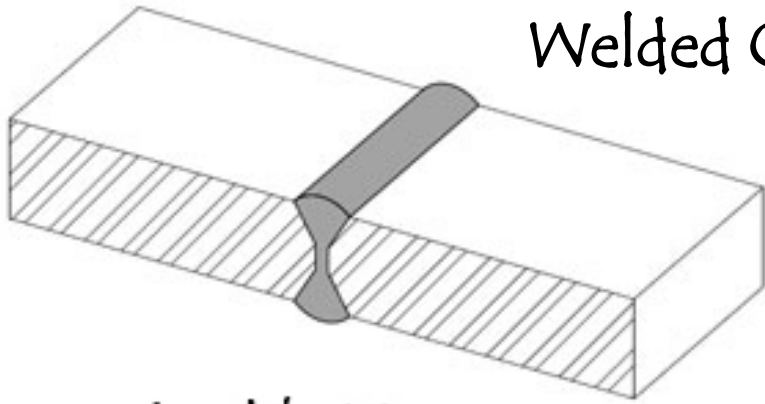
[Project Introduction](#)
[Using the 3D PDFs](#)
[About the Authors](#)
[References and Links](#)
[Site Index](#)
[Legal Disclaimer](#)



This web based project is designed to increasing the understanding of connection design in steel structures to better assist students of architecture and engineering in creating more convincing and compelling structures. The project looks at how to take basic methods of creating connections and transform them into innovative connections, using similar principles. Although Standard Structural Steel connections will be included, the emphasis will be on an exploration of Architecturally Exposed Structural Steel (AESS). The project will reference the new CISC AESS documents, in particular the " [Category Matrix](#) " and " [CISC Guide for Specifying Architecturally Exposed Structural Steel](#) ".

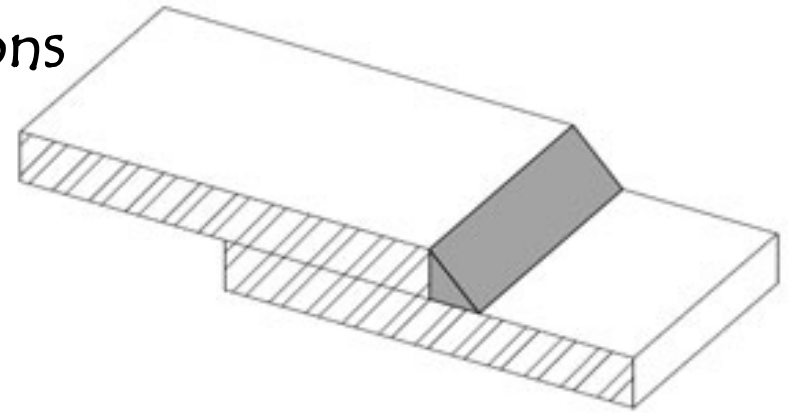
Please check out my [Facebook page for AESS](#) . Many more projects there!

Welded Connections



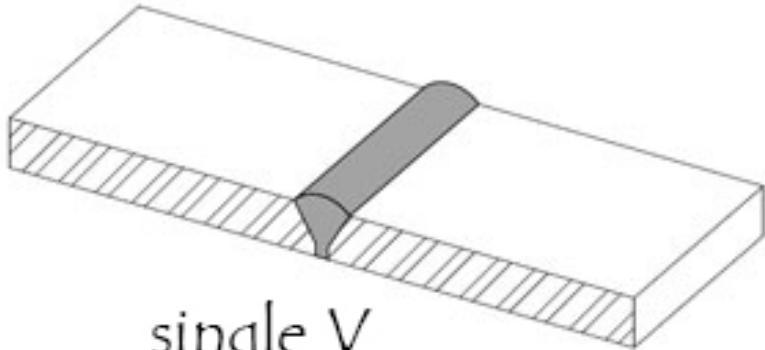
double V

BUTT

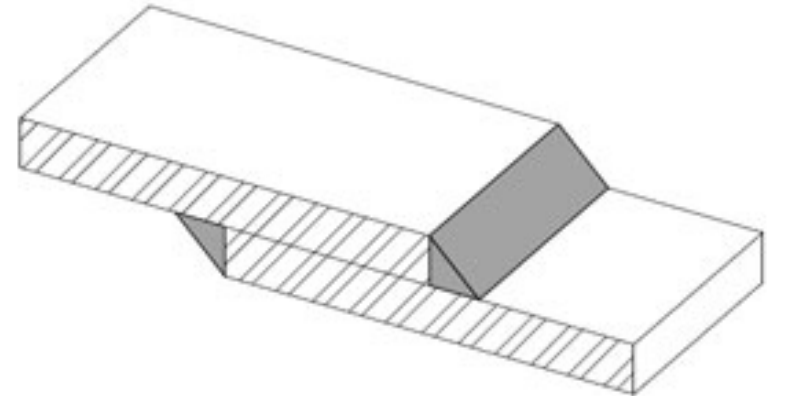


LAPPED

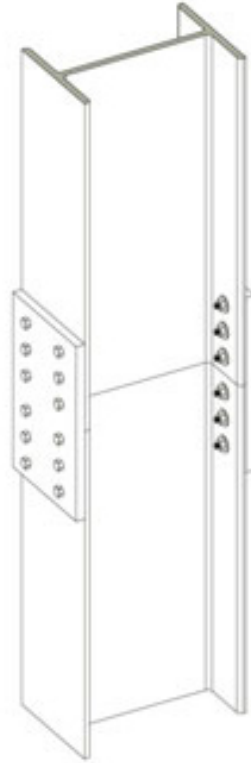
fillet weld



single V



Column Splices











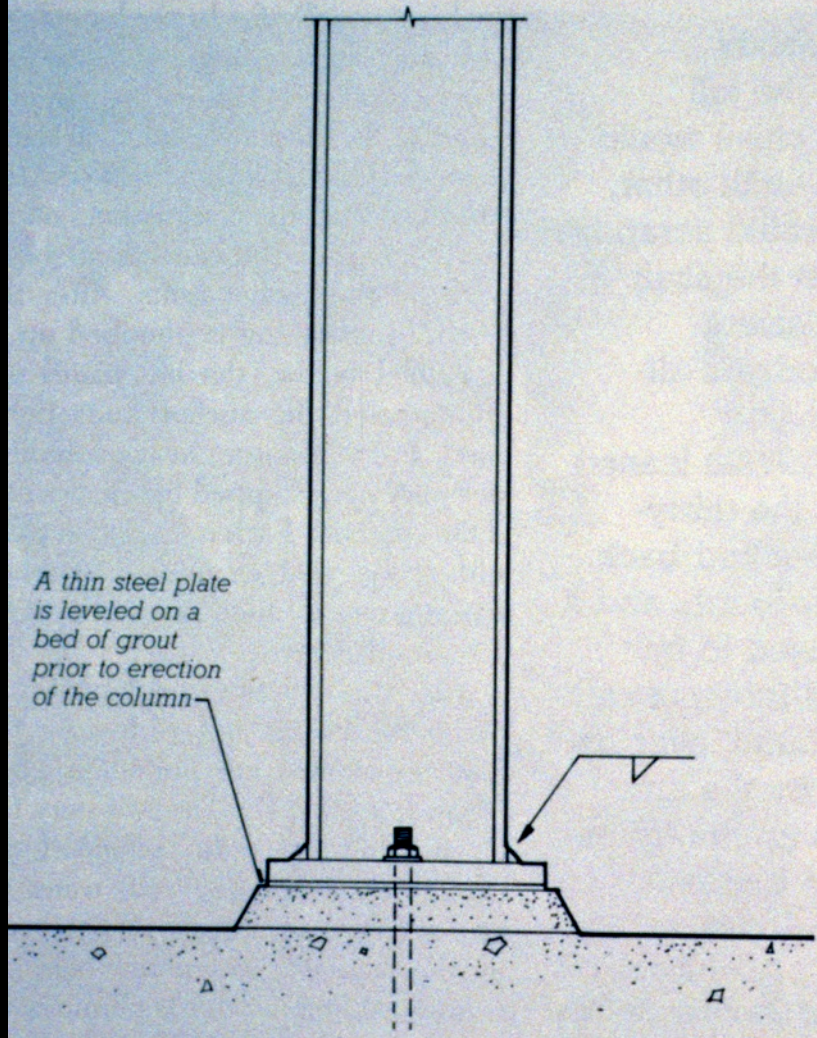
5

✓ PREP 13mm
28 f

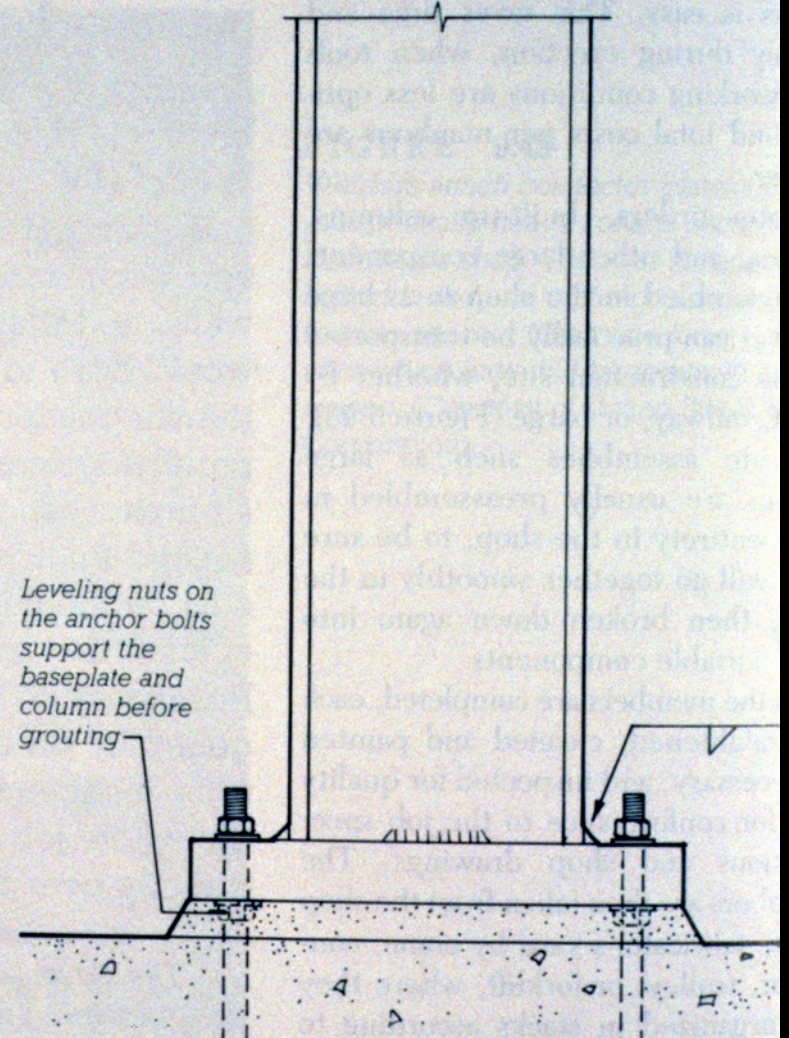
0999 99



A thin steel plate is leveled on a bed of grout prior to erection of the column



Leveling nuts on the anchor bolts support the baseplate and column before grouting

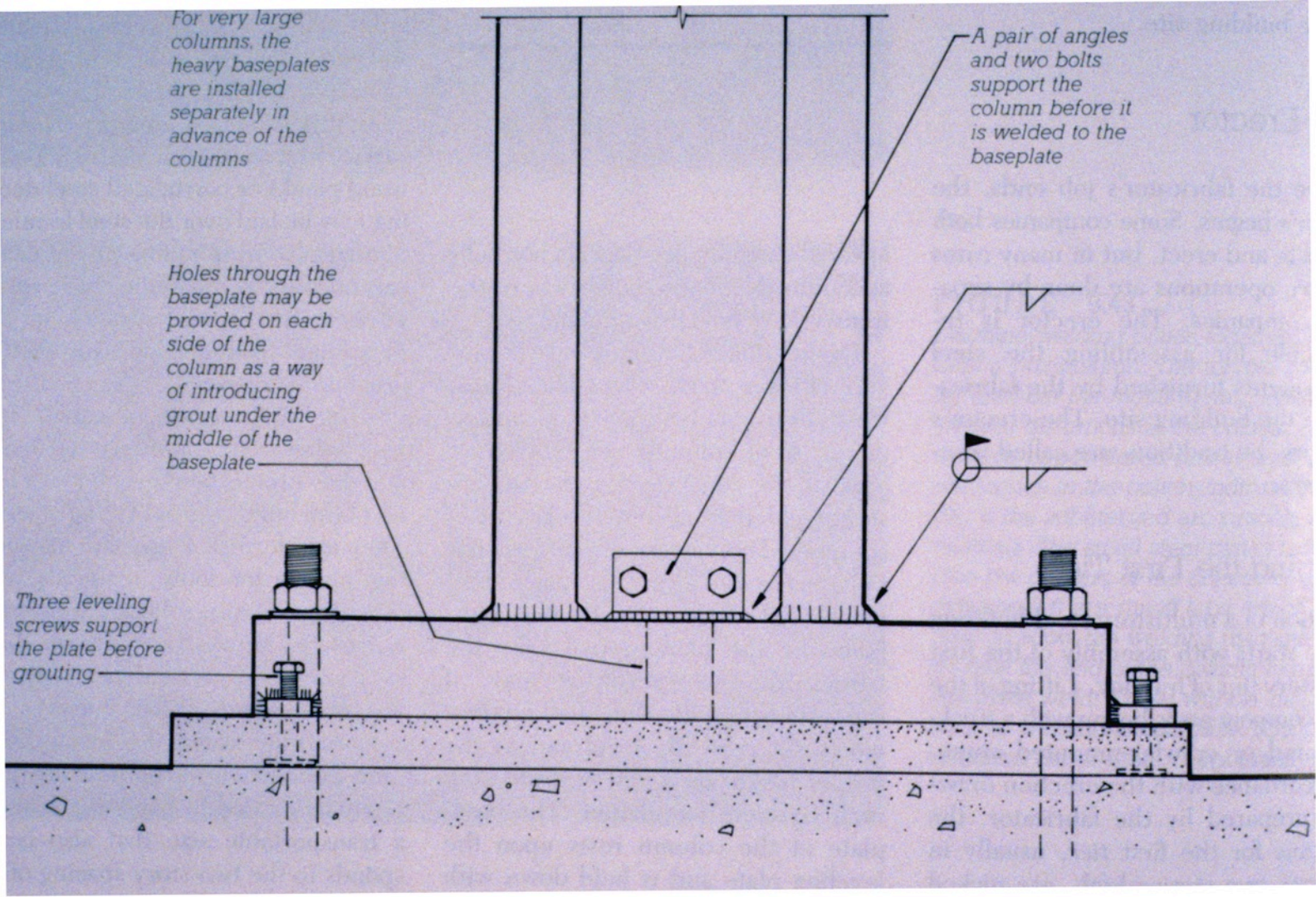


For very large columns, the heavy baseplates are installed separately in advance of the columns

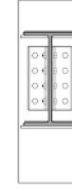
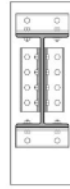
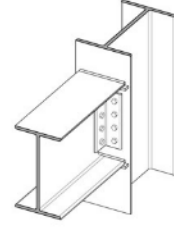
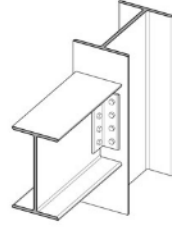
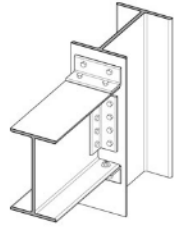
A pair of angles and two bolts support the column before it is welded to the baseplate

Holes through the baseplate may be provided on each side of the column as a way of introducing grout under the middle of the baseplate

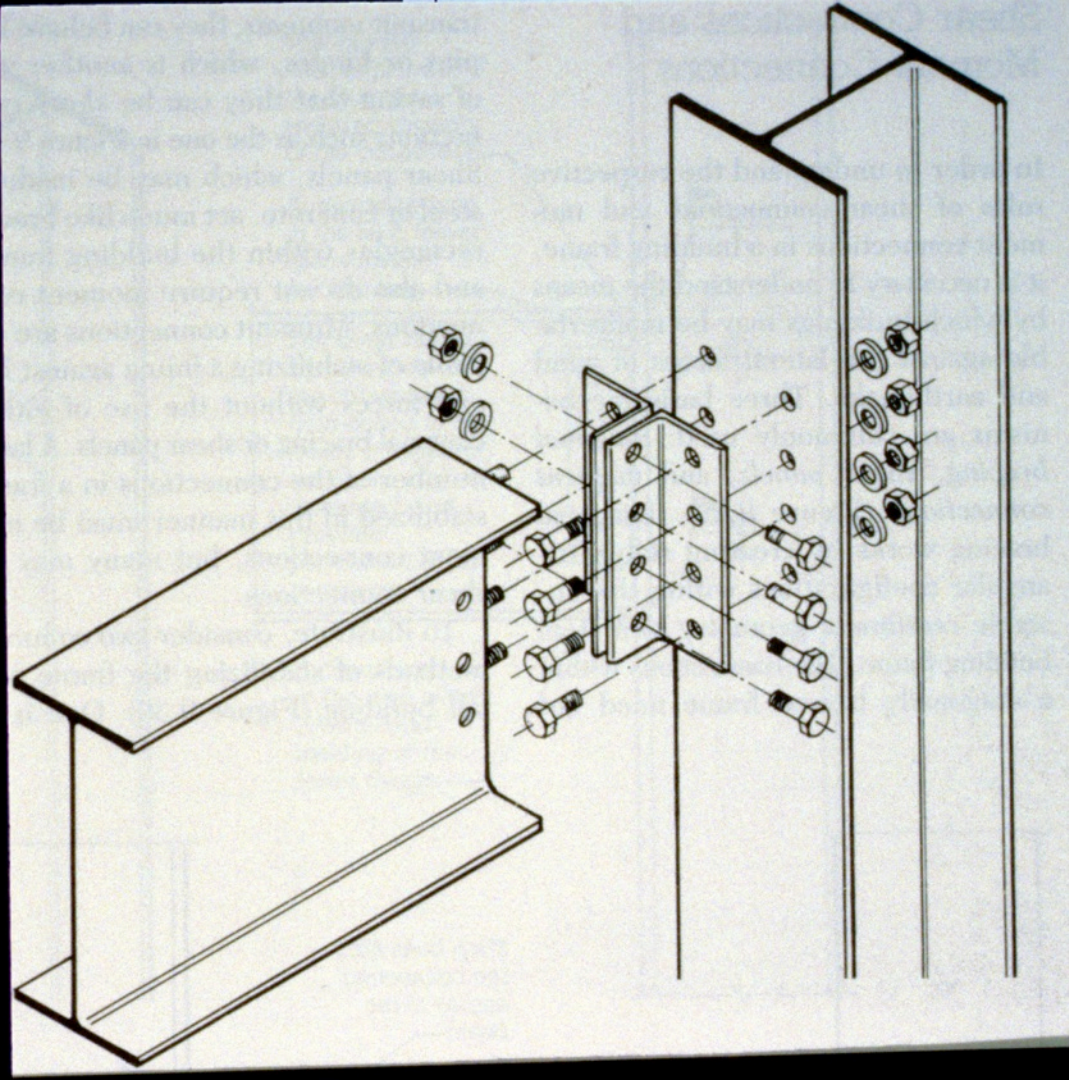
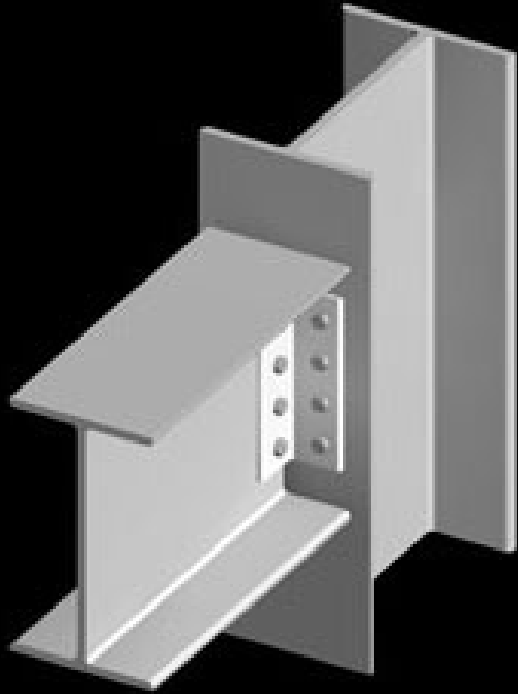
Three leveling screws support the plate before grouting



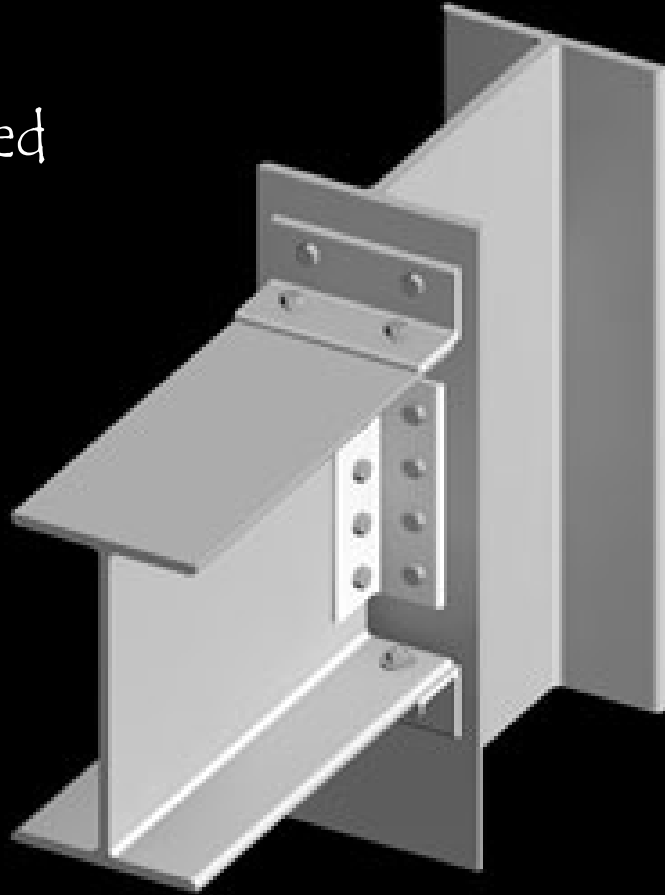
Beam to Column Connections

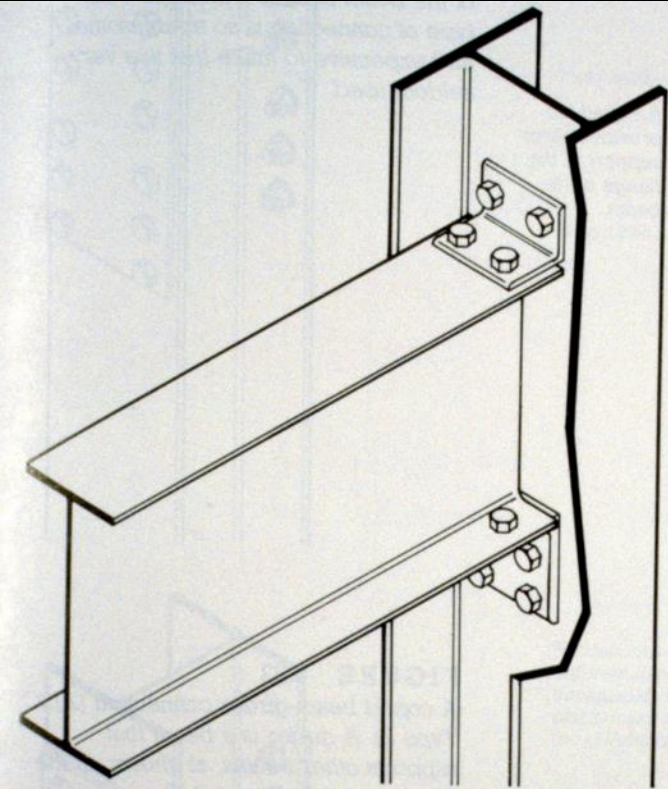


Framed

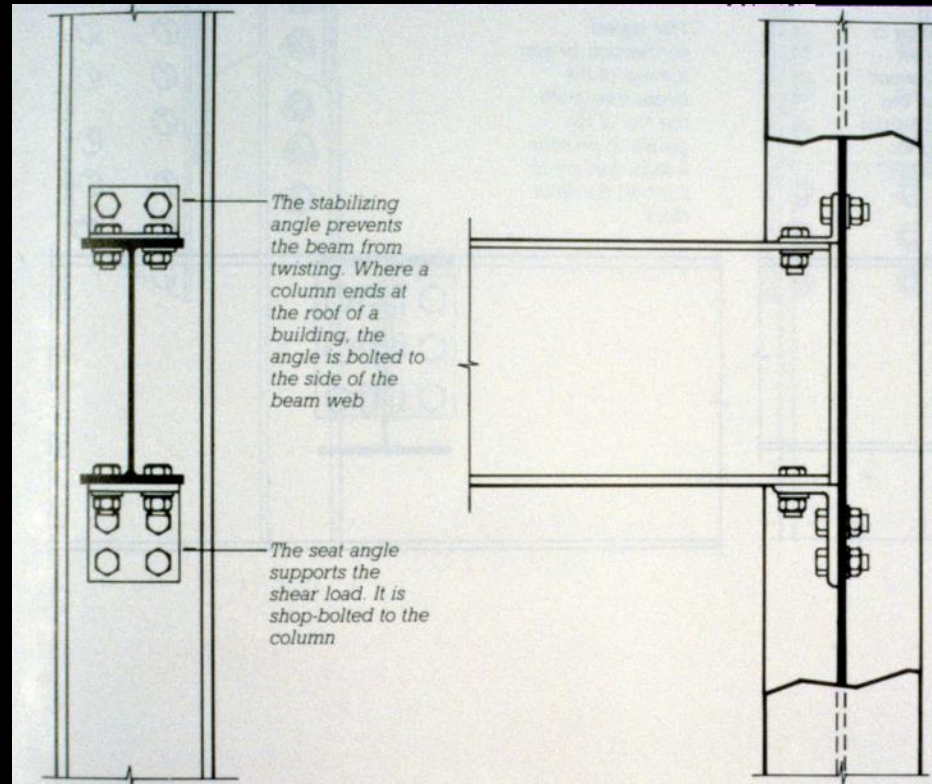


Seated

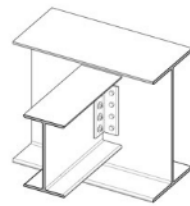
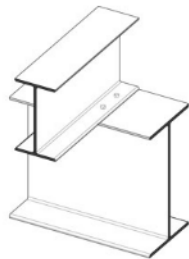
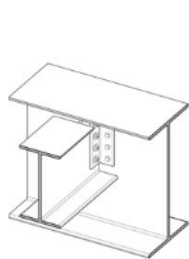




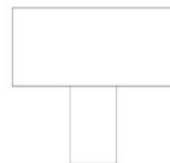
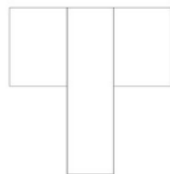
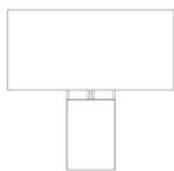
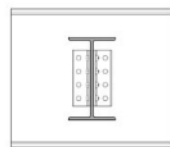
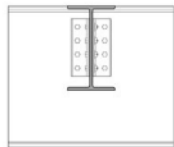
The seated connection is used rather than the framed connection to connect to the web of a column, because it allows better access for the pneumatic wrenches used in bolting



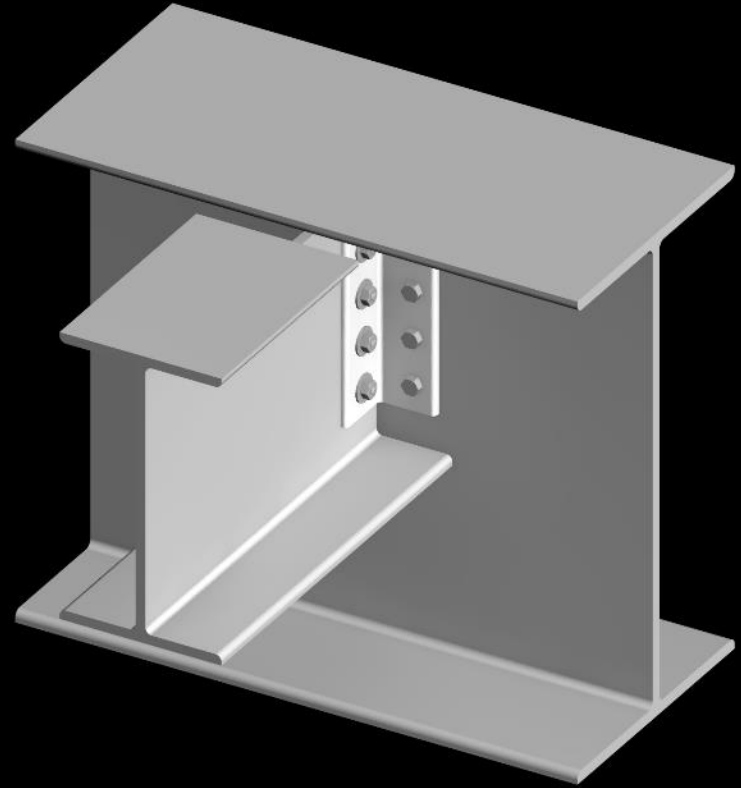
Beam to Girder Connections



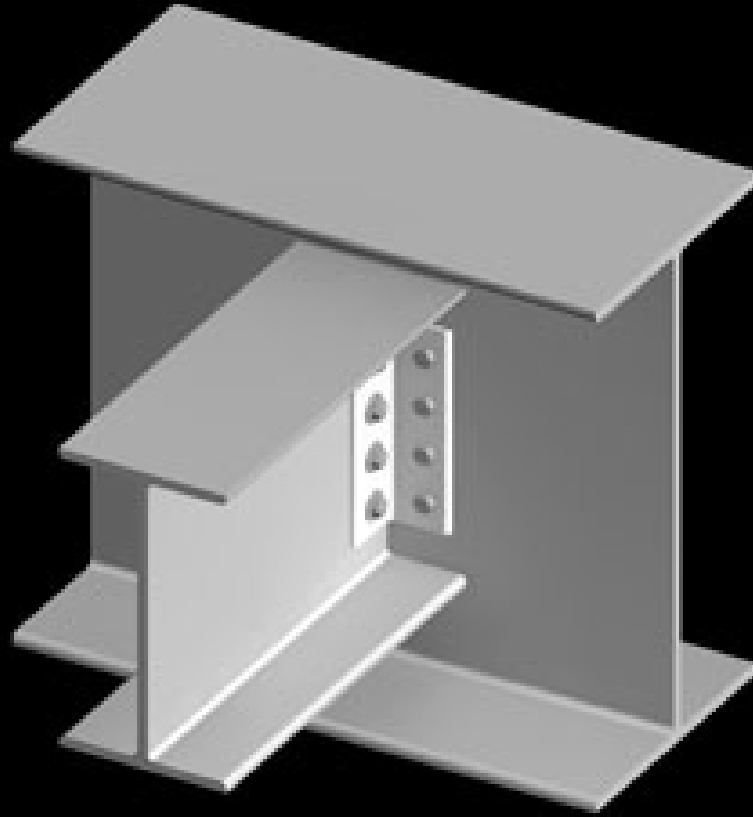
coped



In a coped connection the top flange of the beam is cut away so that the top of the beam and top of the girder will align.

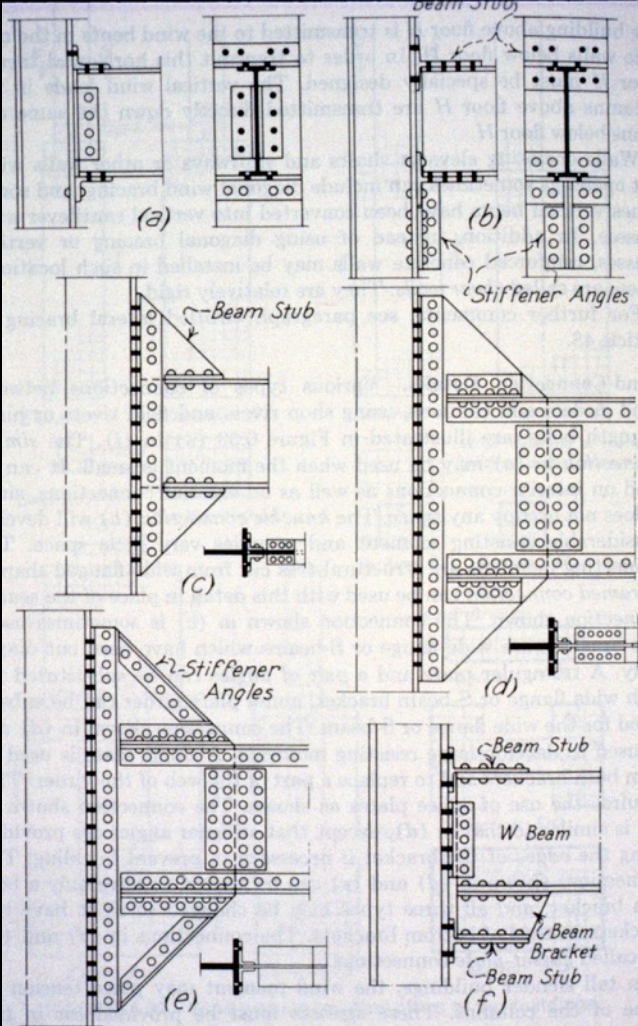


Framed
connection
has the beam
flange below.



Regular
connection
has the beam
sitting on top
of the girder





For taller buildings greater resistance to horizontal wind loads requires moment resisting connections.

FIGURE 6.30 Types of wind connections.

Connection types:

HINGE

- Transfers vertical and horizontal loads
- Not intended to resist some rotation

PIN

- Transfers vertical and horizontal loads
- Free to rotate

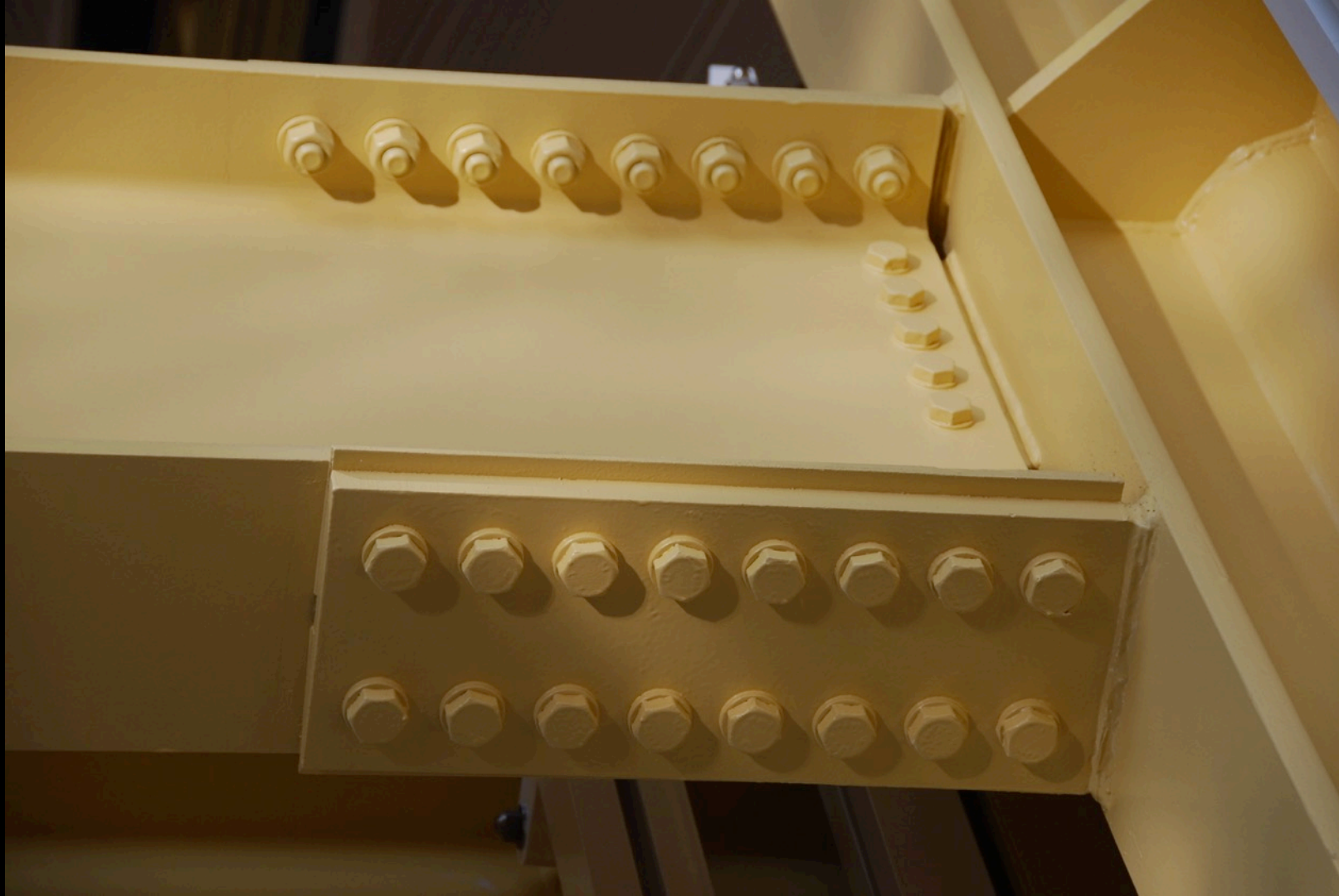
MOMENT

- Resists bending and rotation













A low-angle, upward-looking photograph of the interior of the Canadian War Museum. The image captures a complex, industrial-style steel truss ceiling structure. The walls are clad in vertical corrugated metal panels. Several rows of track lighting are installed, casting a warm, golden glow. The perspective creates a sense of height and architectural scale.

Canadian War Museum
Ottawa, ON















SPAN

How do we span to make floor and roof systems?

- beams, girders
- Joists
- Planar trusses
- Box trusses
- Innovative suspension systems

ESTABLISH HIERARCHY

– LOAD PATH – top down:

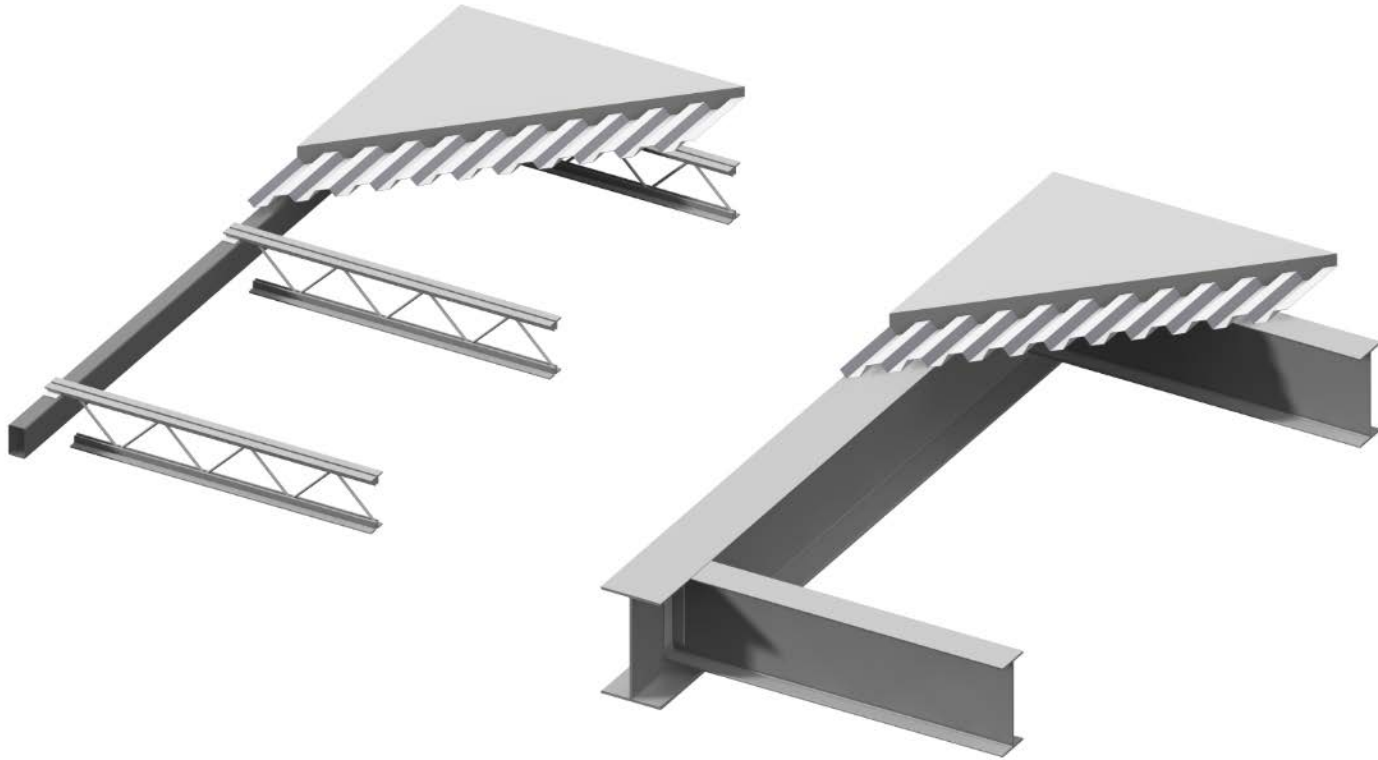
Decking sits on

Joists or Beams

Sit on Girders

Girders frame into columns

Floor Systems



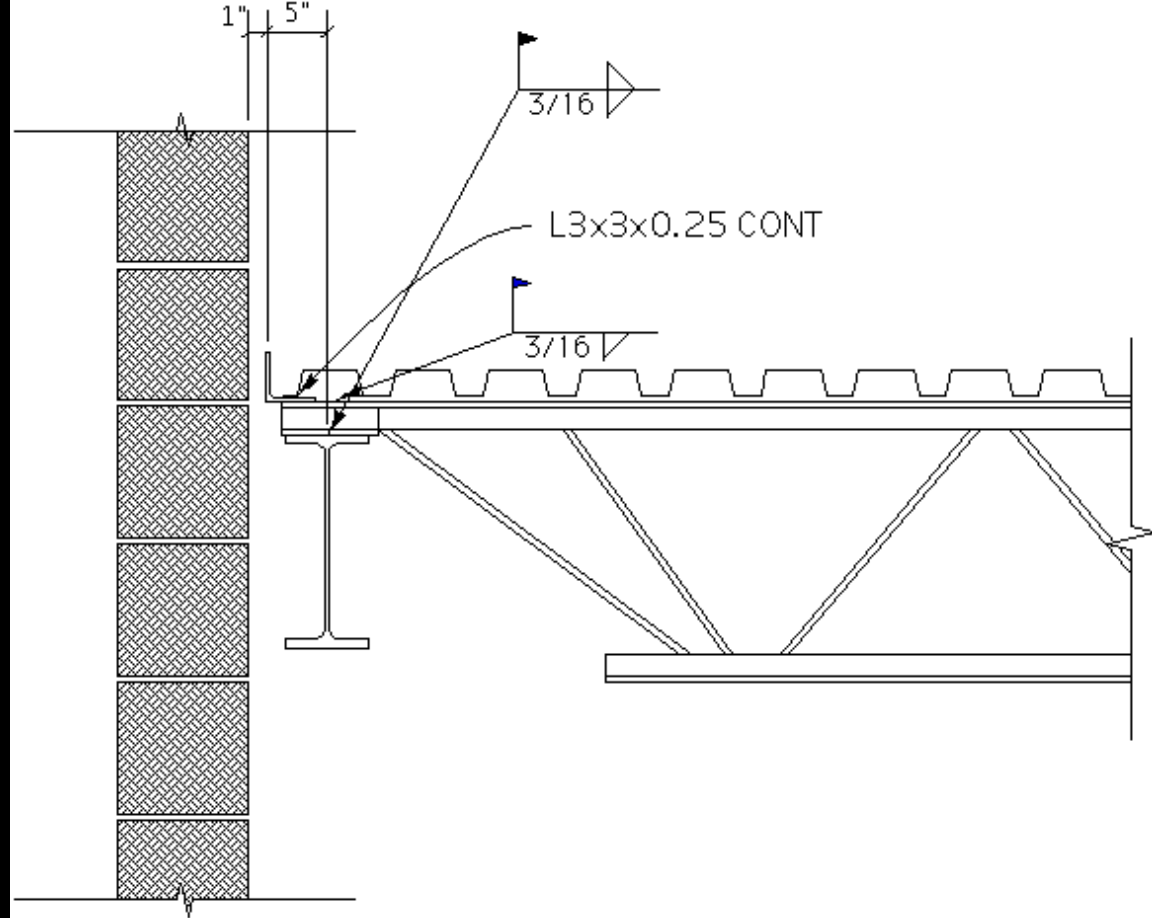




ABSOLUTELY
UNALTERED
IN THIS
COUNTRY
MADE IN
AMERICA

Open web steel joists

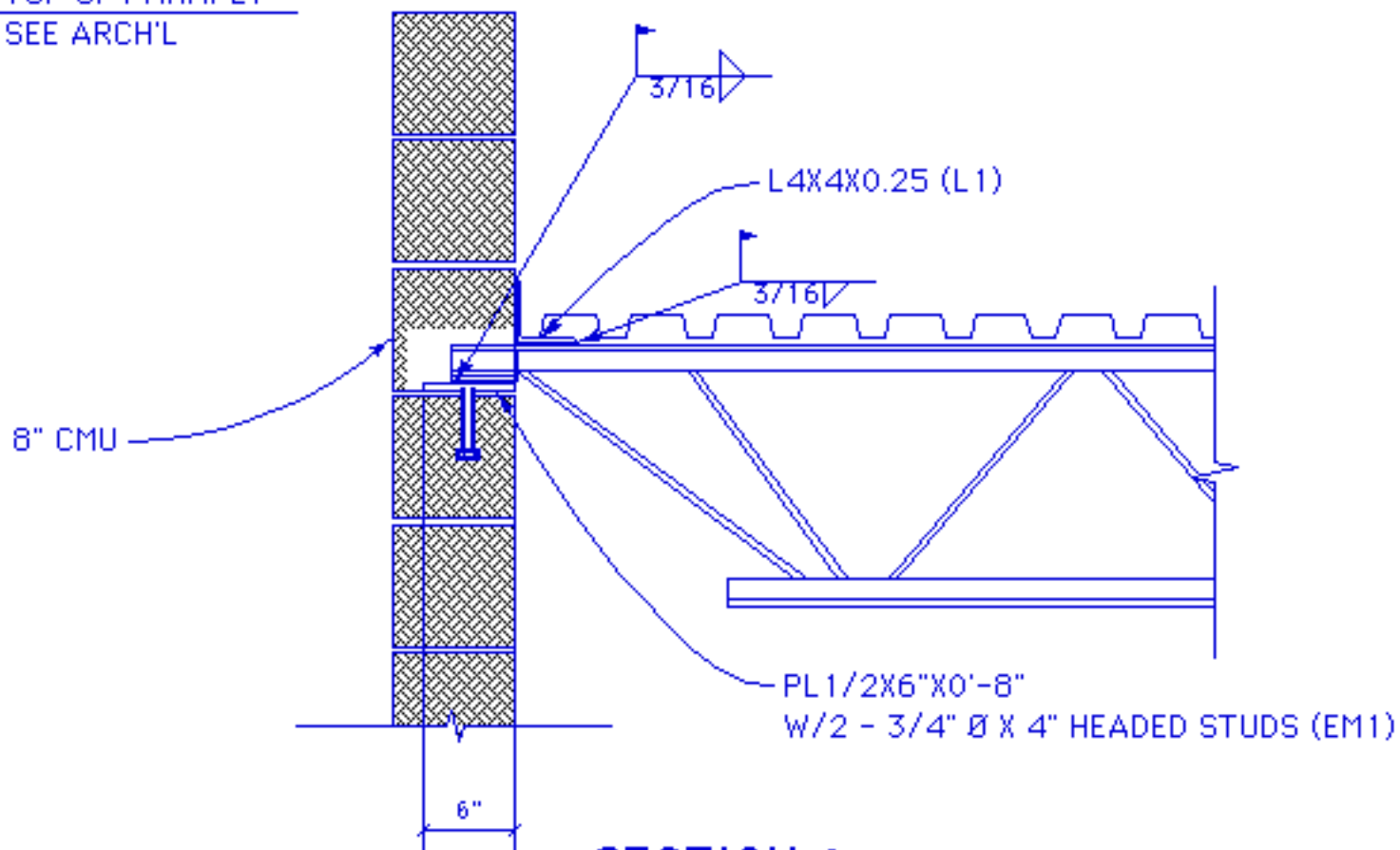




SECTION 13



TOP OF PARAPET
SEE ARCH'L



SECTION 1















karin pironen

erra patti galler

maduilla Payne Morosini

premissa per

amelia

keaja

borbono

peninim tempo

per

estradi pinto

haavel

no

ostri

no

no

no

no

no

no

no

no

no

no

no

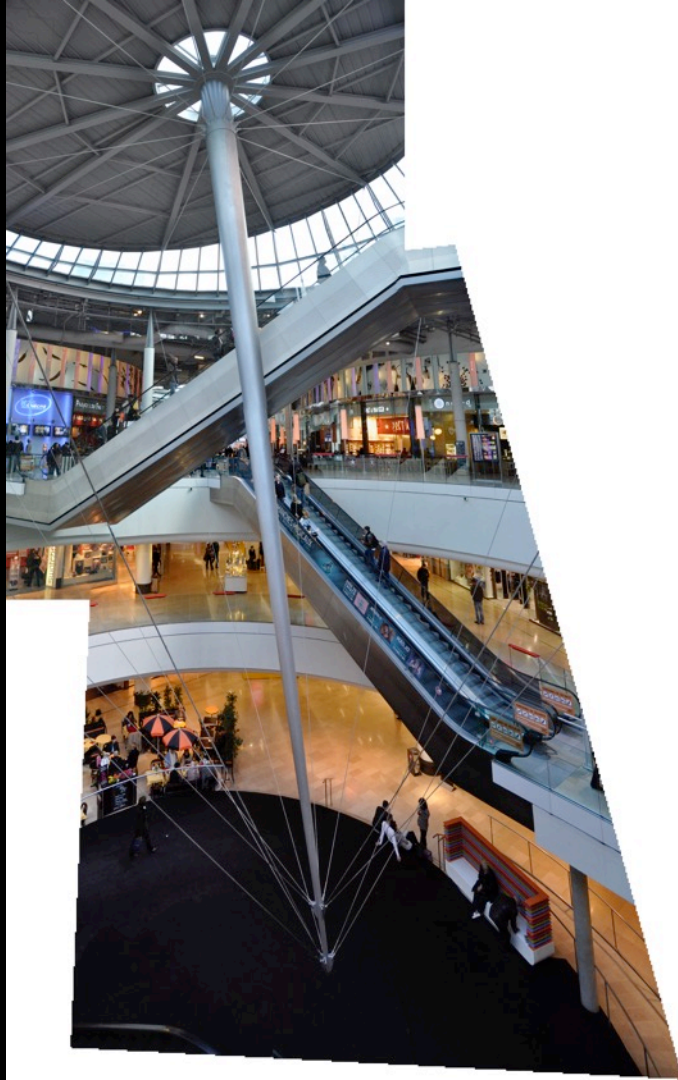
no

no







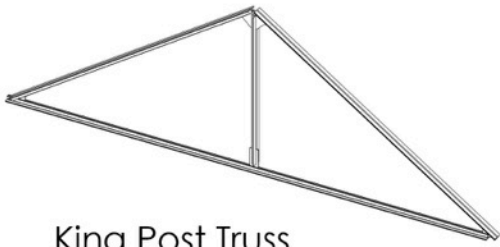




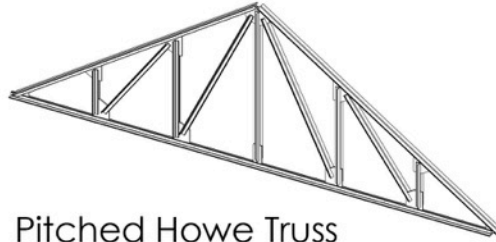




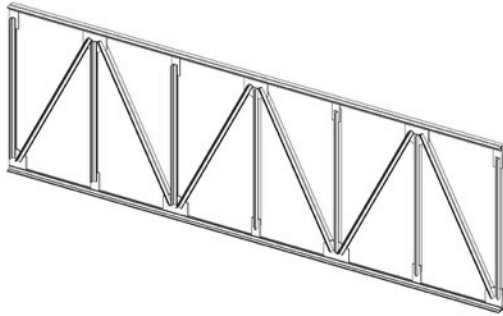
PLANAR TRUSSES



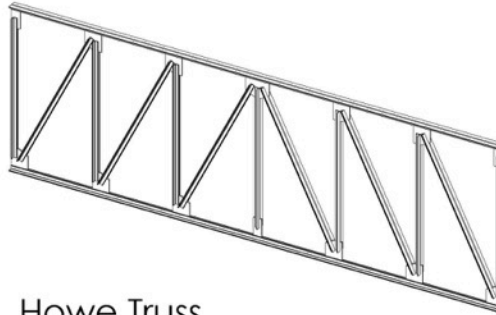
King Post Truss



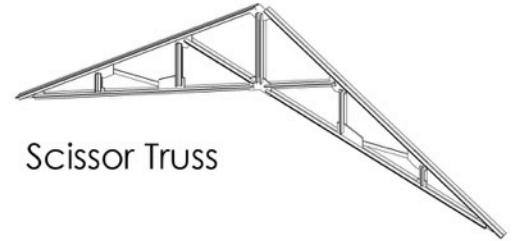
Pitched Howe Truss



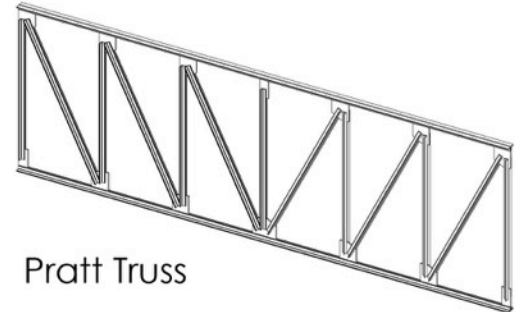
Modified Warren Truss



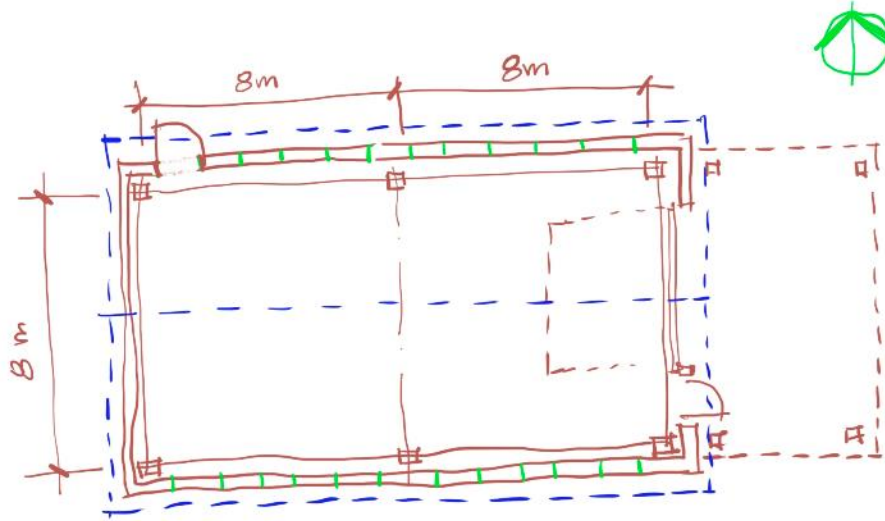
Howe Truss



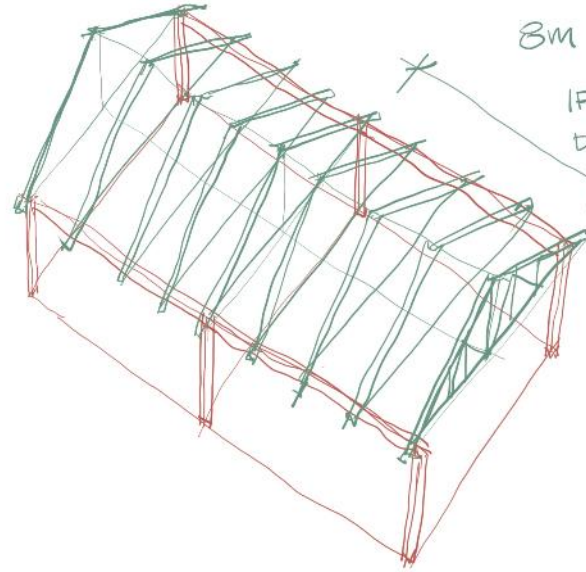
Scissor Truss



Pratt Truss

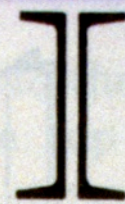
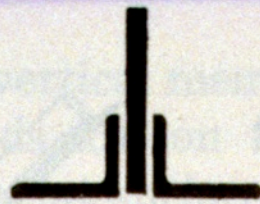


BASIC PLAN

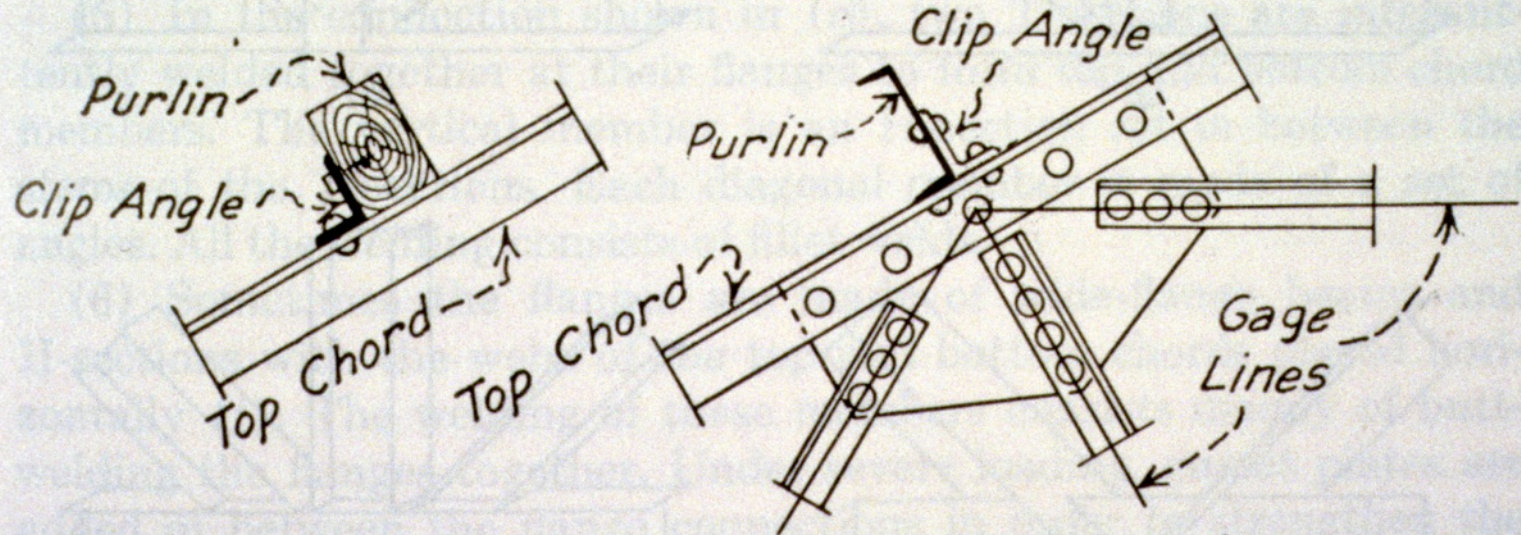


8m ÷ ?

IF 4, THEN ROOF
DECK SPANS 2m



(a) Top Chord (b) Bottom Chord (c) Bottom Chord
Sections for Members subjected to Bending Stress



(d) Method of Fastening Purlins to Top Chord

FIGURE 6.17 Simple steel roof truss details.

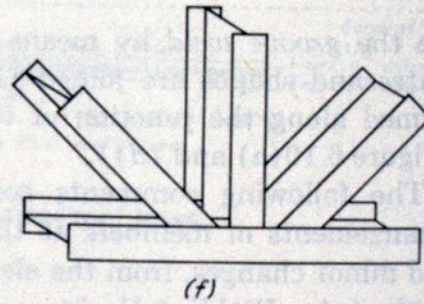
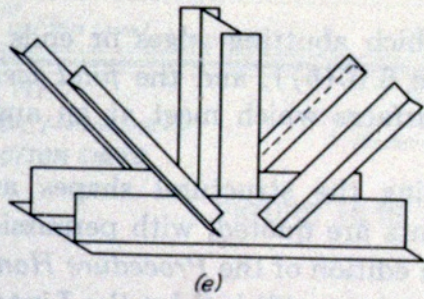
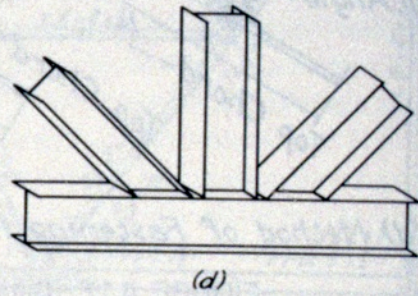
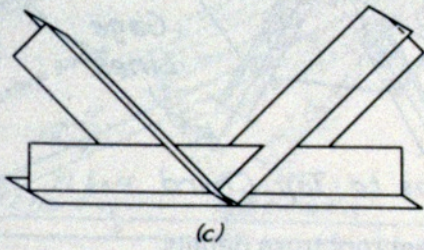
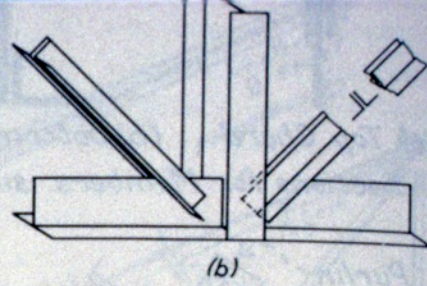
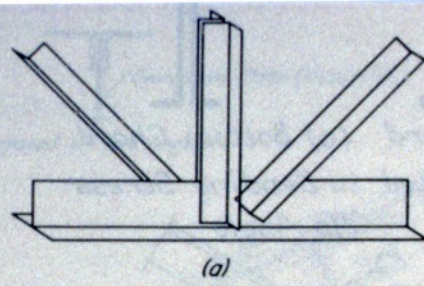


FIGURE 6.18 Connections for simple welded trusses. Lincoln Electric Company.



ELEVATOR

ELEVATOR
BAGGAGE

















The New School,
NYC







ONE WAY

114 570 Lbs / 57285 ton
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POST NO
BILLS



PERIMETAL
retail space
available
7741 590-1142

PERIMETAL
retail space
available
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POST NO BILLS
POST NO BILLS

DEWALK
CLOSED

ACTIVE
TRANSPORT

retail space

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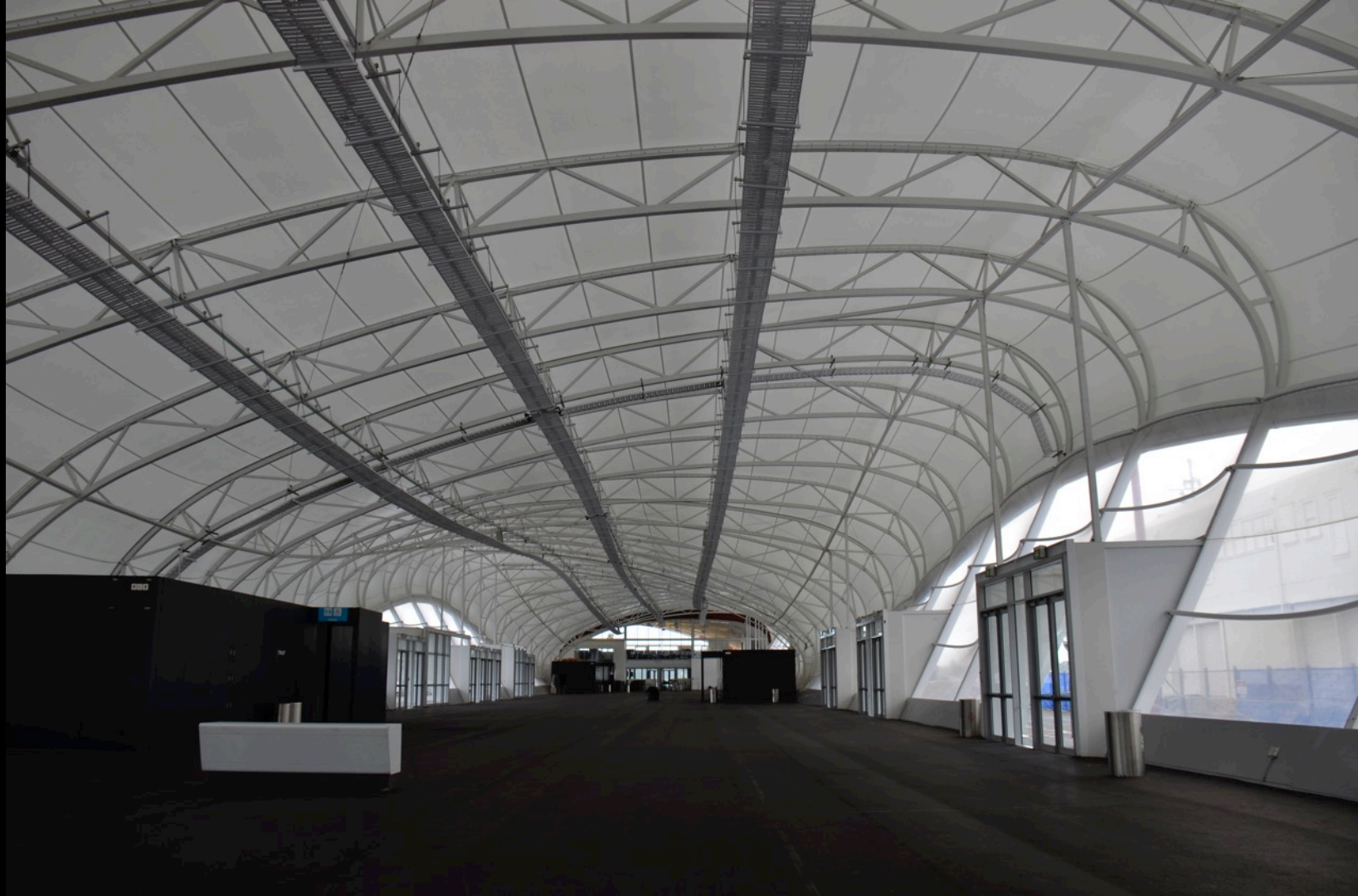






The Cloud
Auckland, NZ










Les Ailes Shopping Centre
Montreal, QC




A wide-angle photograph of a large museum hall. The ceiling is high with a complex steel truss structure and several rows of pendant lights. A silver jet fighter with a red maple leaf on the tail is suspended from the ceiling. Below it, various military vehicles are displayed on the floor, including tanks and armored cars. A large window on the right side of the hall provides natural light. A few people are visible in the background, looking at the exhibits.

★
War Museum
Ottawa, ON





The image shows the exterior of the Calgary Water building, a modern architectural structure. The building features a prominent, large, arched roof structure supported by a network of steel trusses. The facade is composed of light-colored, rectangular panels and large glass windows. A wide, paved walkway leads to the entrance, where several people are walking. To the right, a red motorcycle is parked in a designated area. The sky is blue with scattered white clouds. The foreground consists of a paved walkway and landscaped areas with brown mulch and young trees.

Calgary Water
Calgary, AB





Box Truss





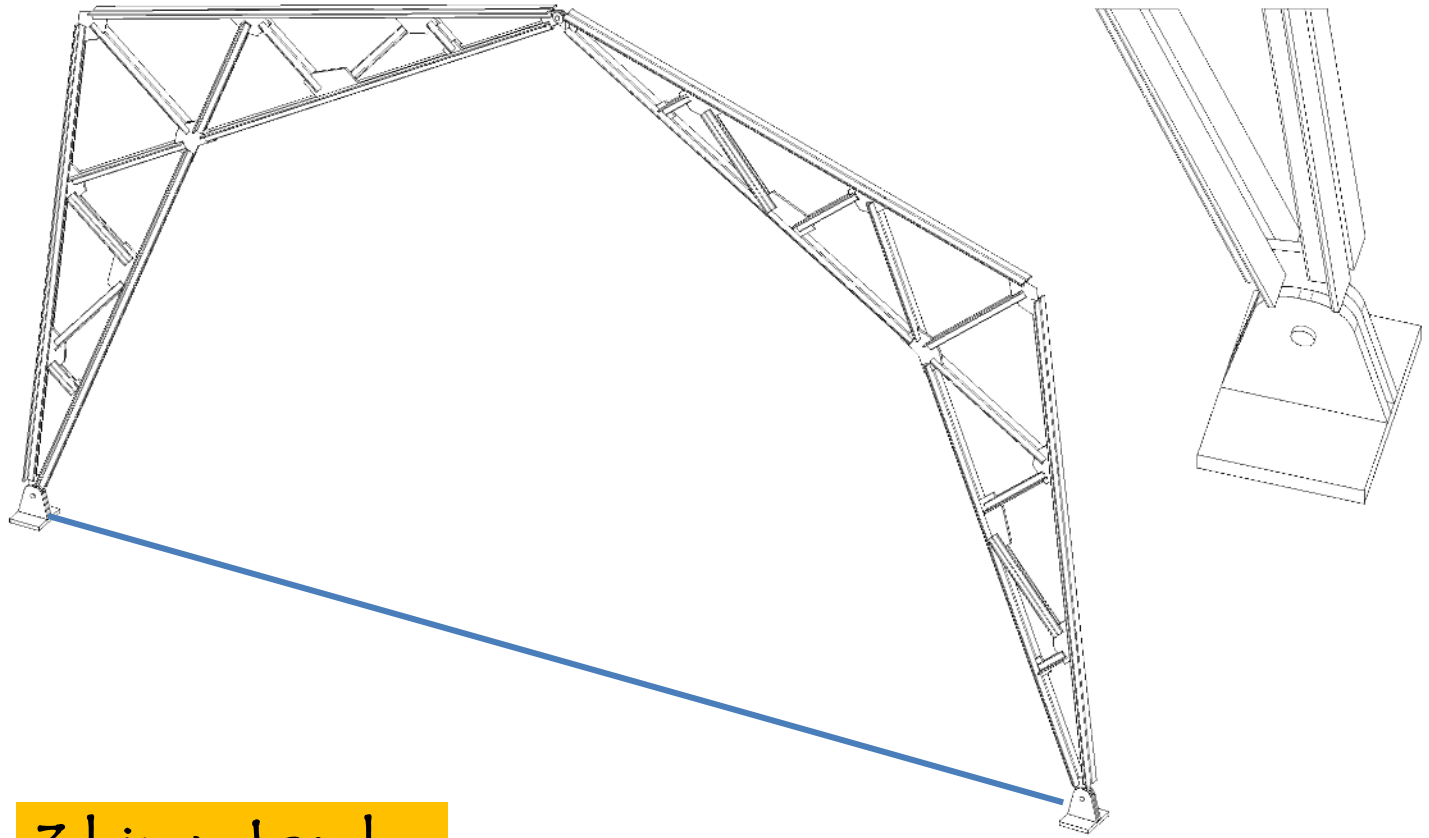
Sainsbury Centre
England



Triangular Truss







3 hinged arch

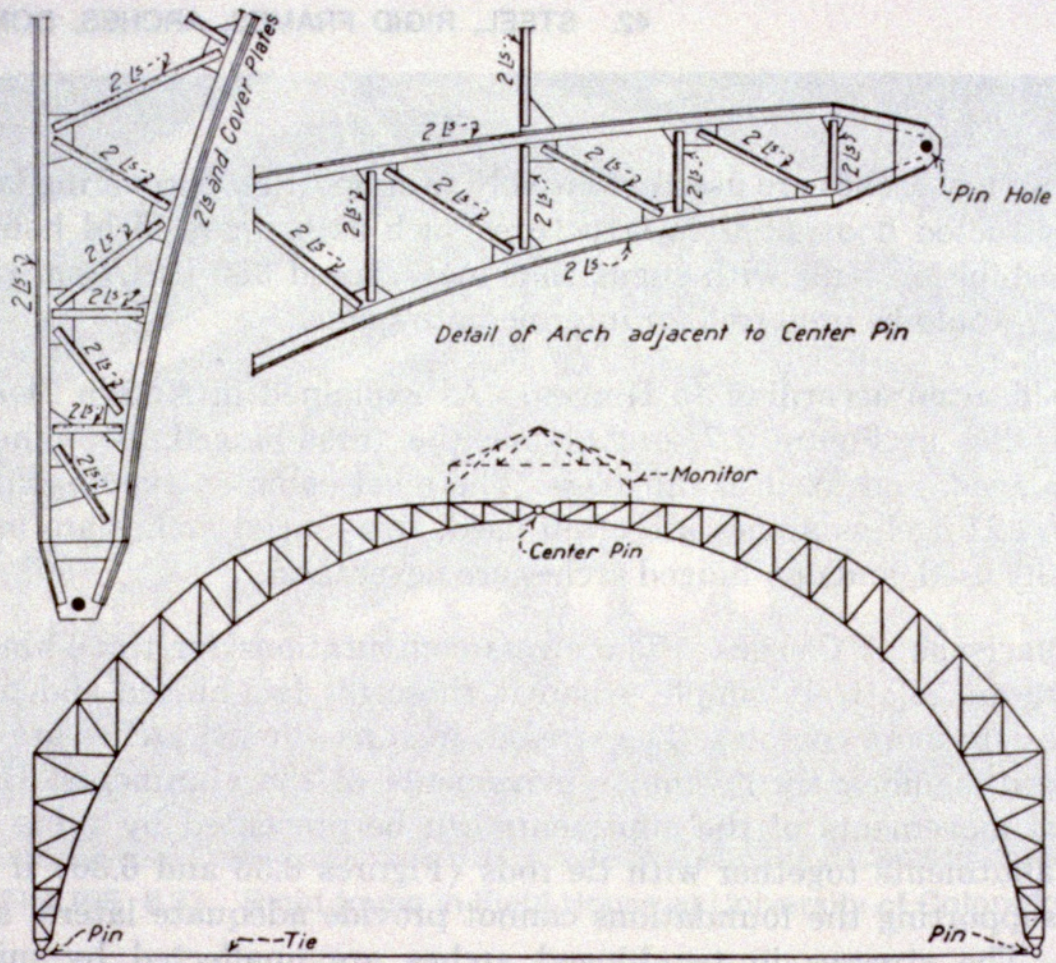


FIGURE 6.35 Riveted three-hinged trussed or framed steel arch with 2 L chords and web members.



Rigid Frames

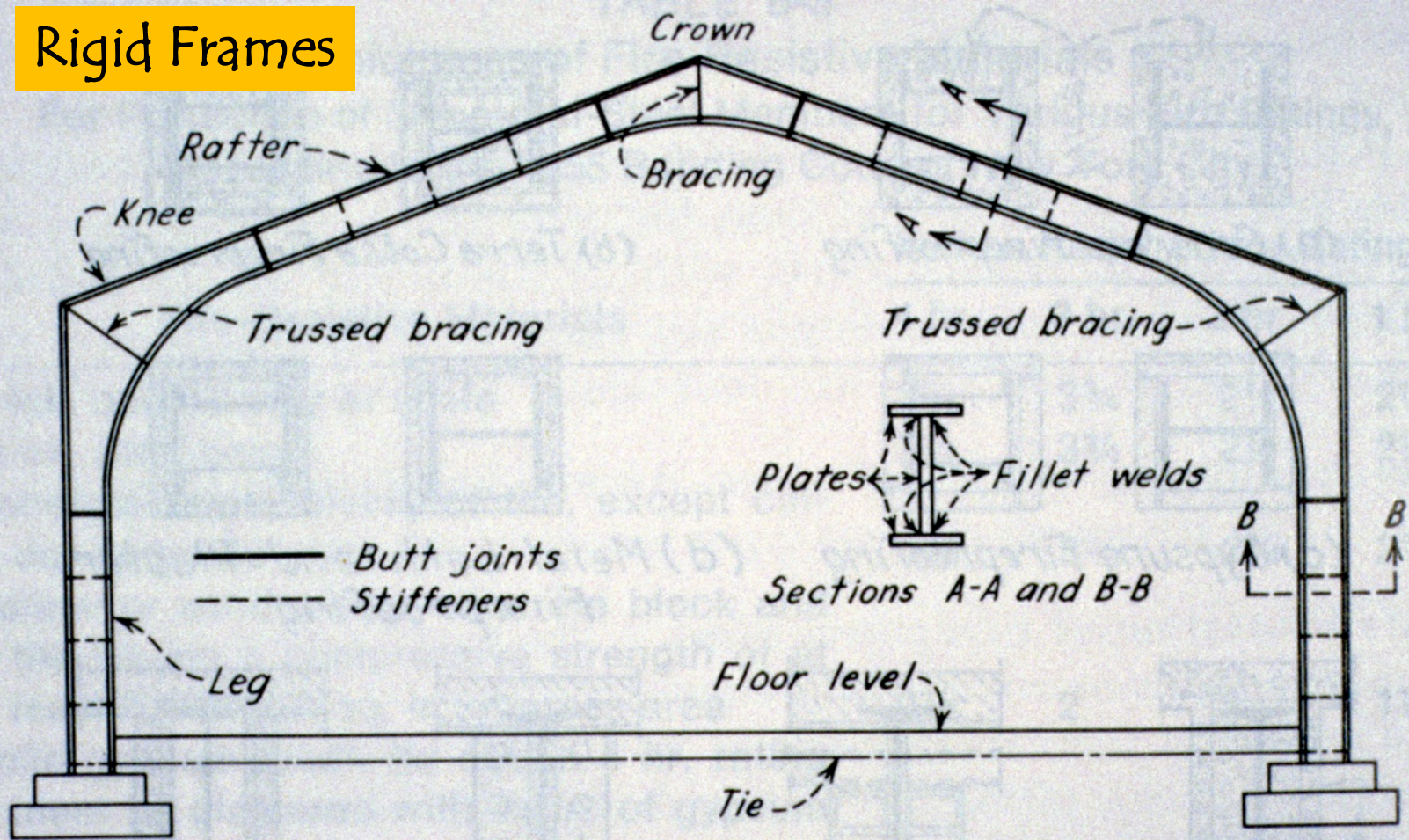



FIGURE 6.32 Steel rigid frame.

Friedrichstraße Station
Berlin, Germany



**BIOSPHÄRE
POTSDAM**

30.08.10.08.30.08.10
VON SAURIERN UND
SABELZÄHNIGERN

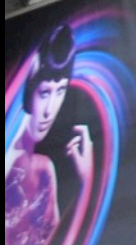


←	Westkreuz Potsdam Hbf Berlin-Spandau Berlin-Spandau	Strausberg Nord Arenshöfde Erfurt Wartenberg	→
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'skydome' AKA Rogers Centre
Rod Robbie and Michael Allen
1987



ELIS-DON

DOMINION BRIDGE

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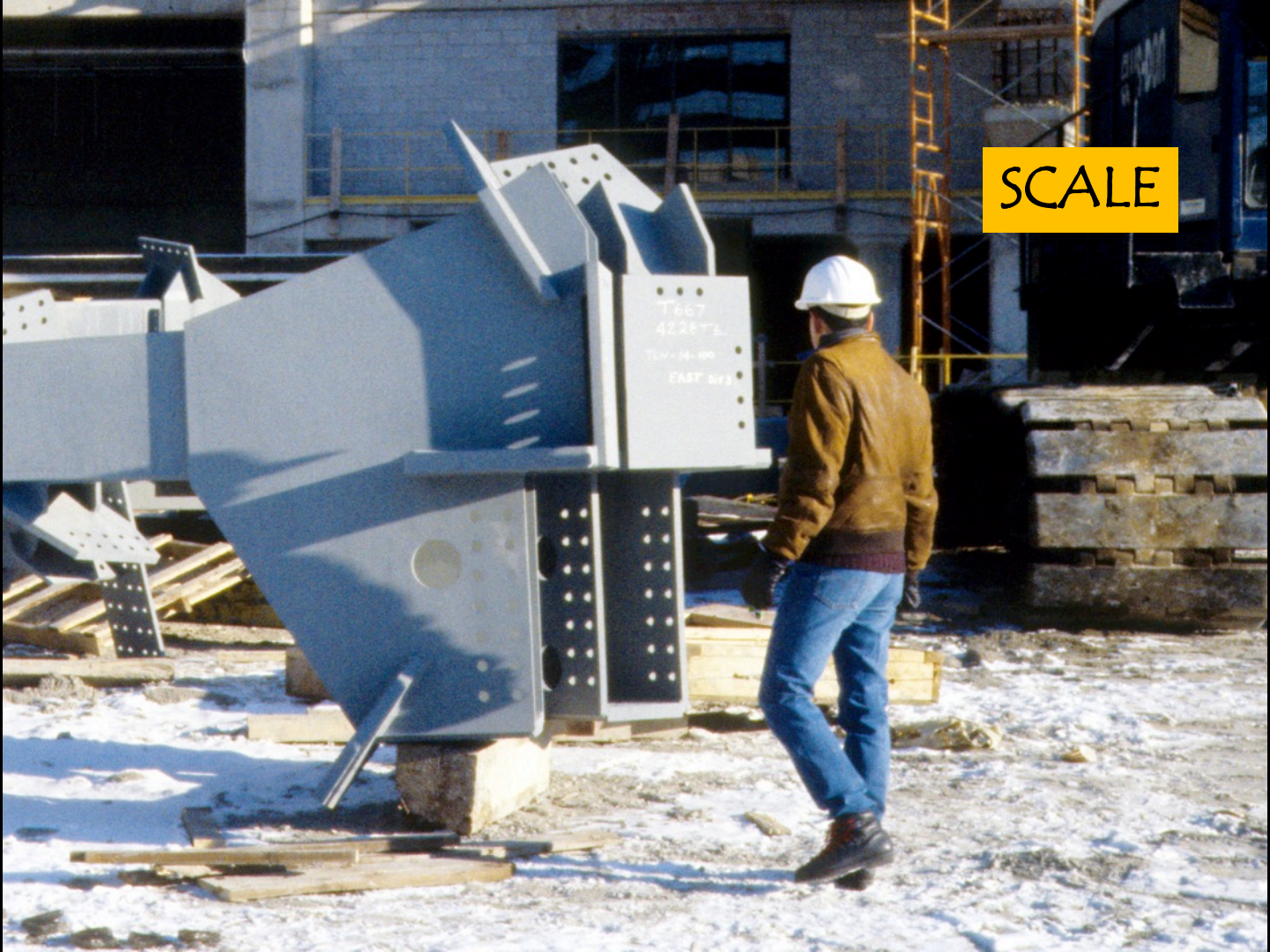








SCALE







4236 T ≤ 13







Museum of Civilization
Ottawa/Hull
Douglas Cardinal Architect
1987











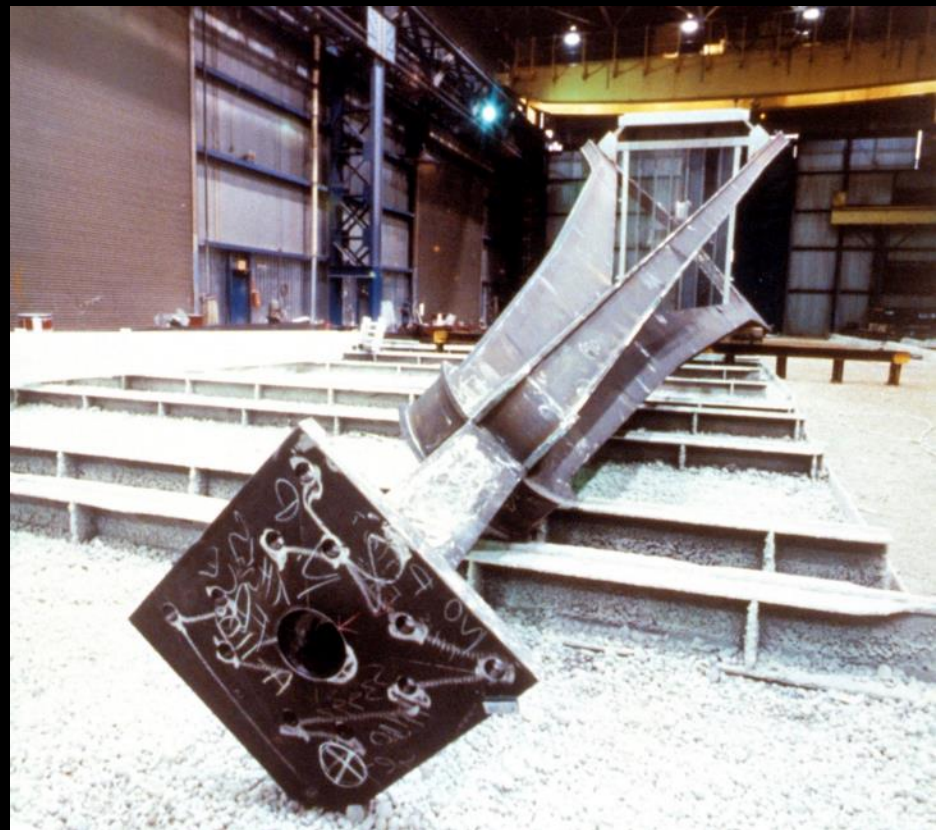
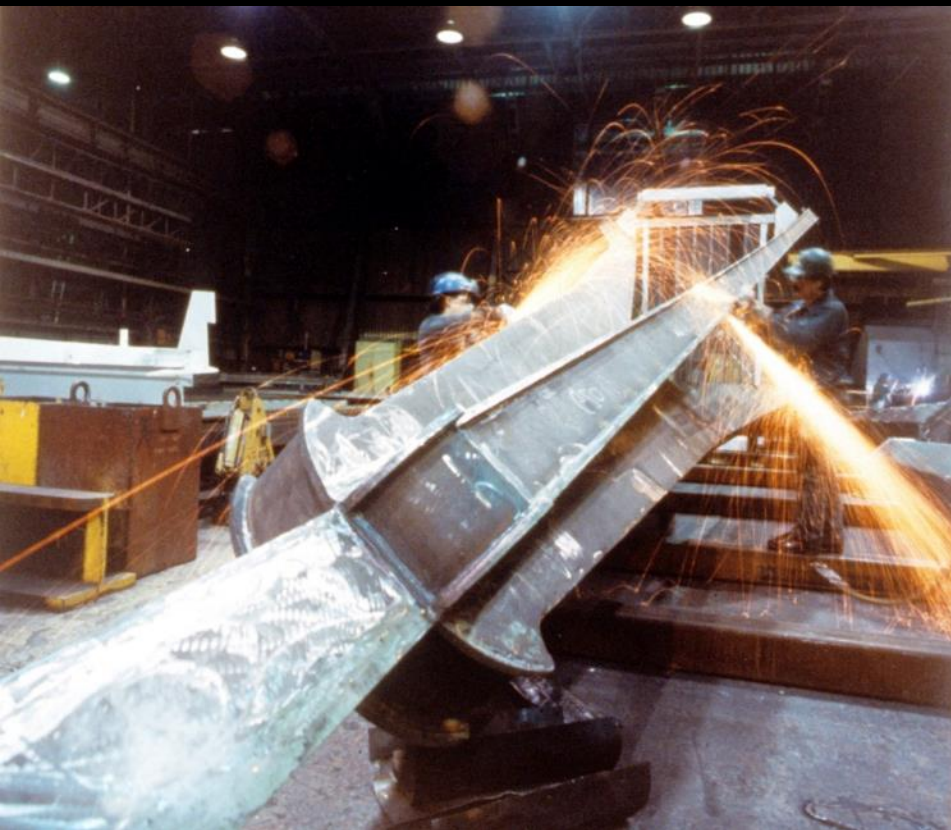




BCE – Brookfield – Place
Toronto, ON
Santiago Calatrava
1992

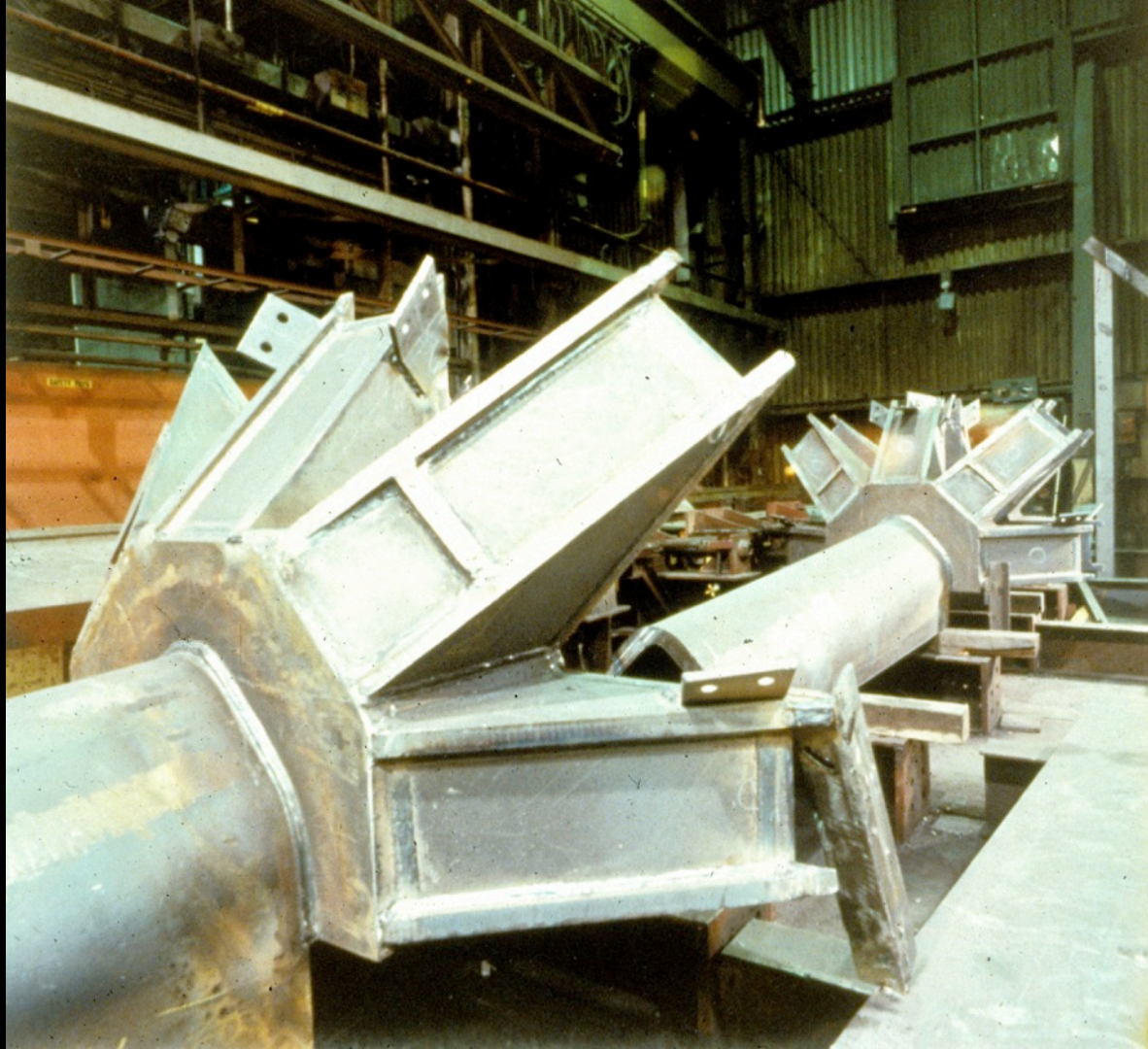




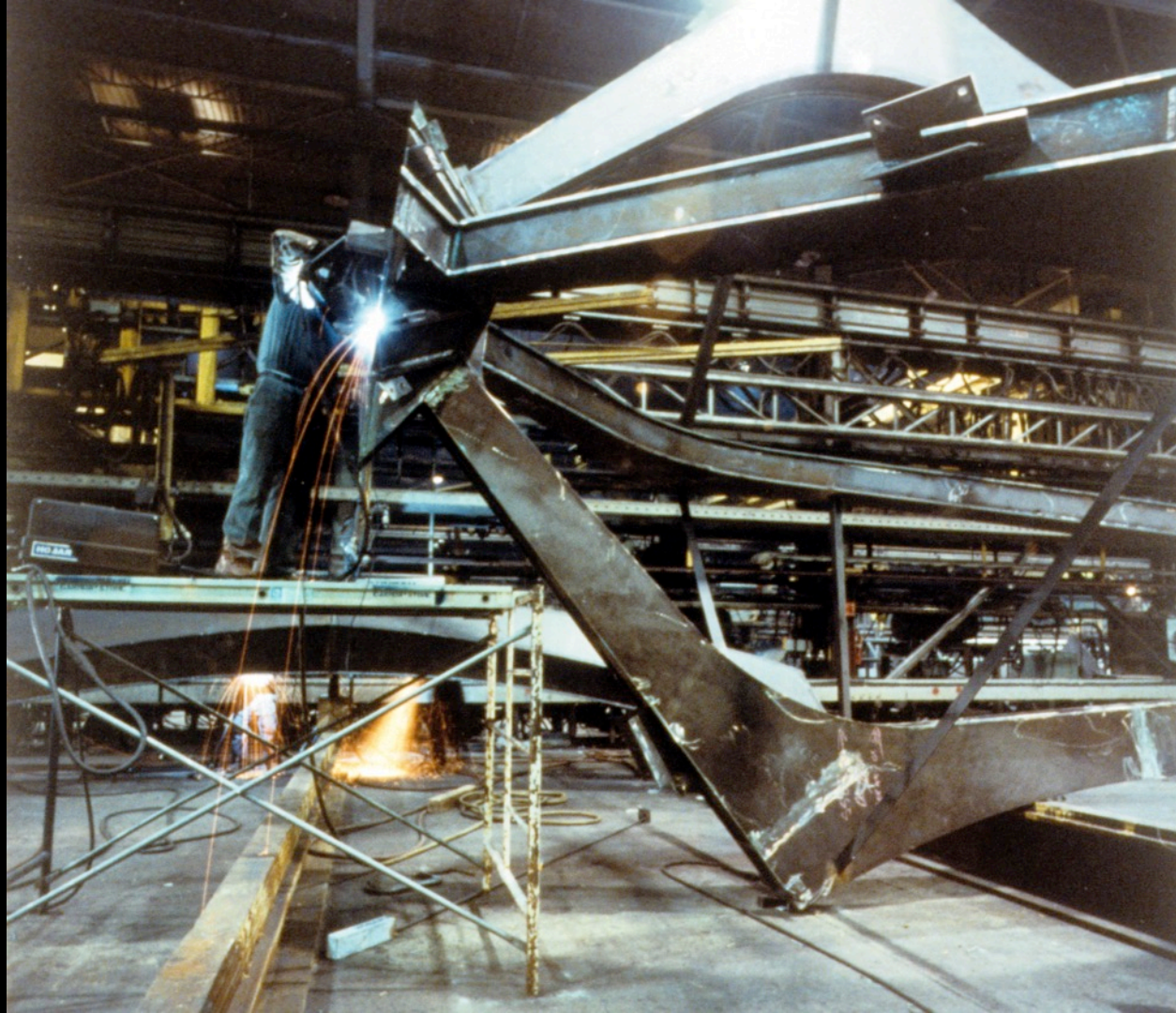


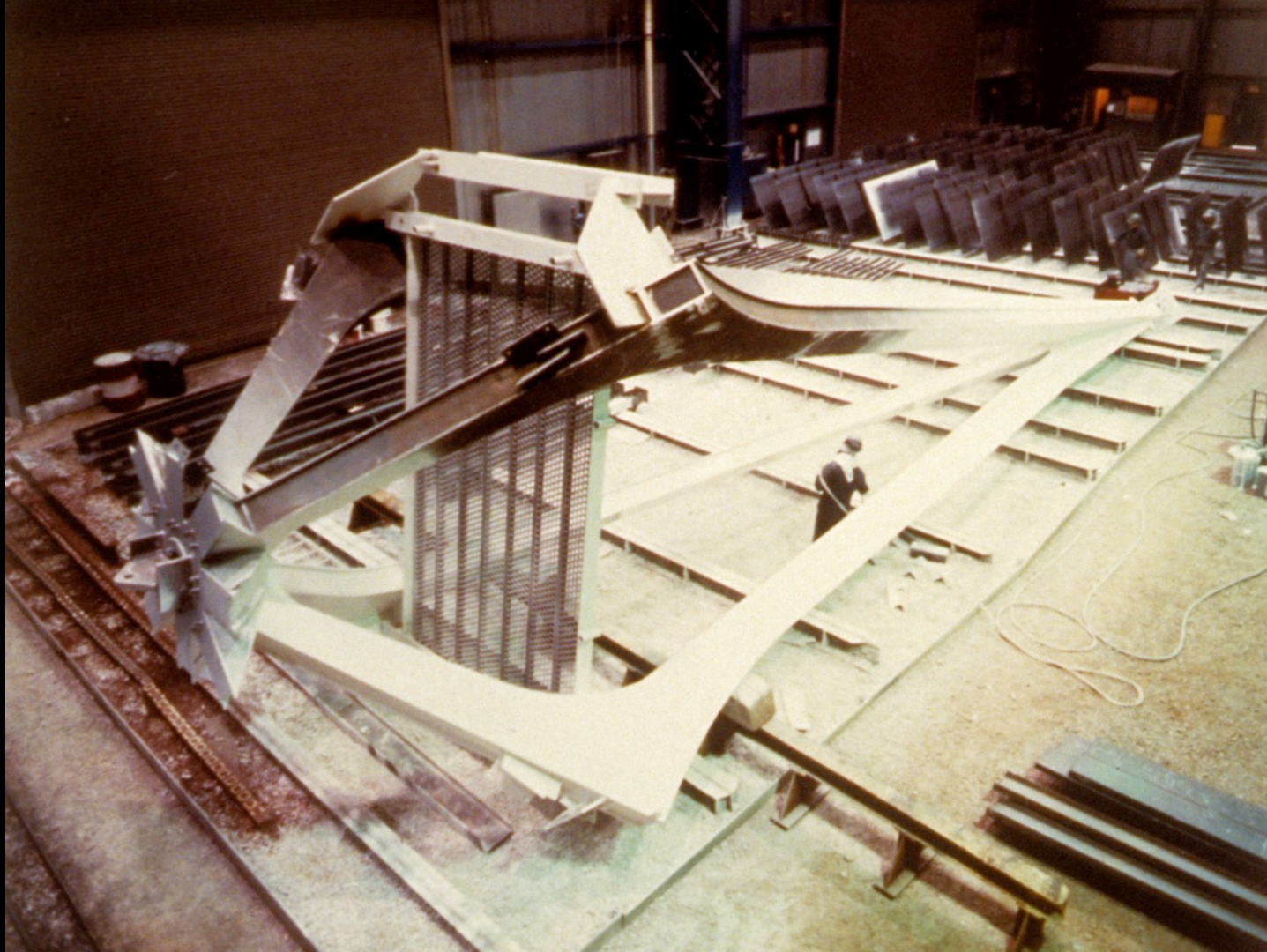


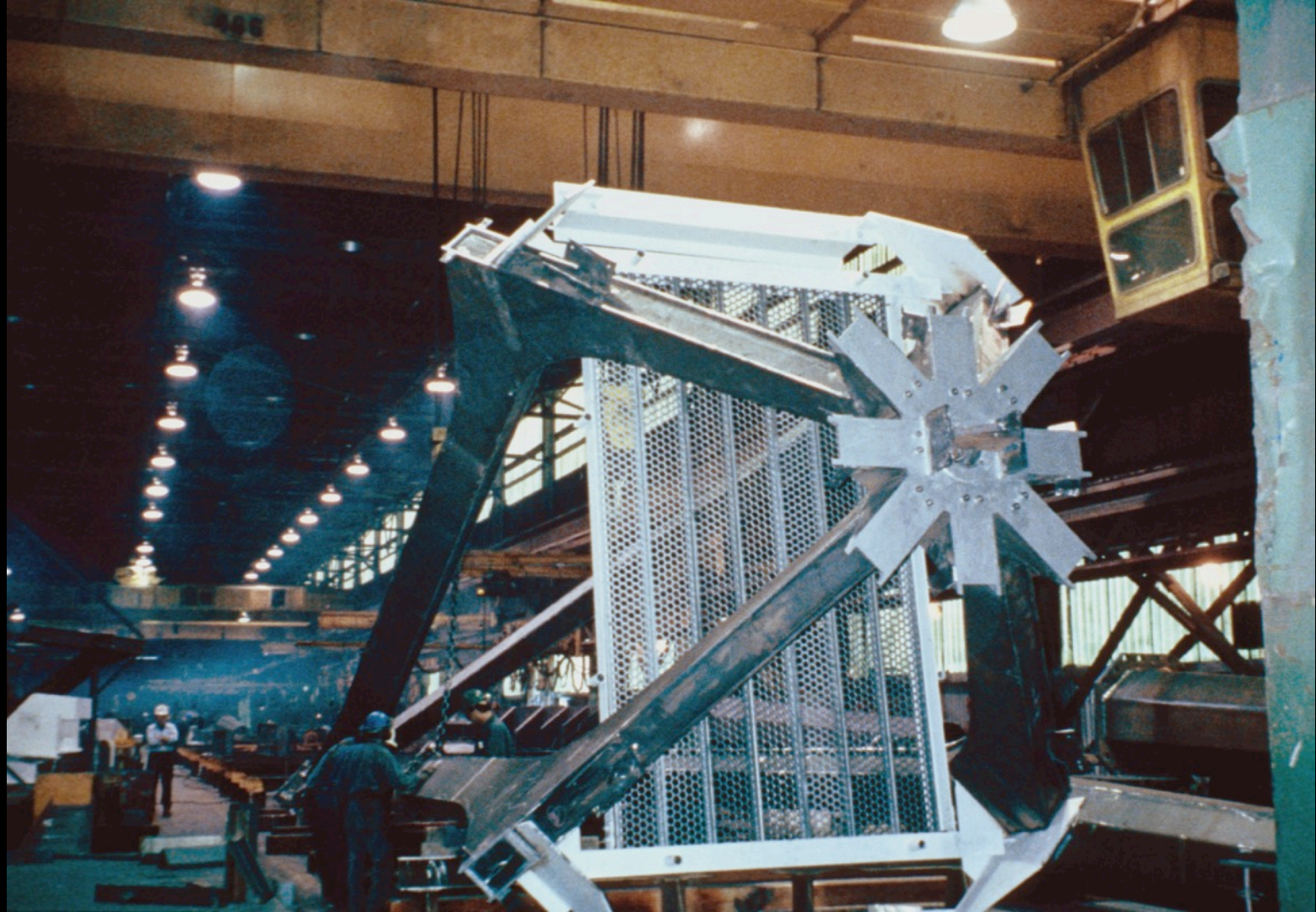




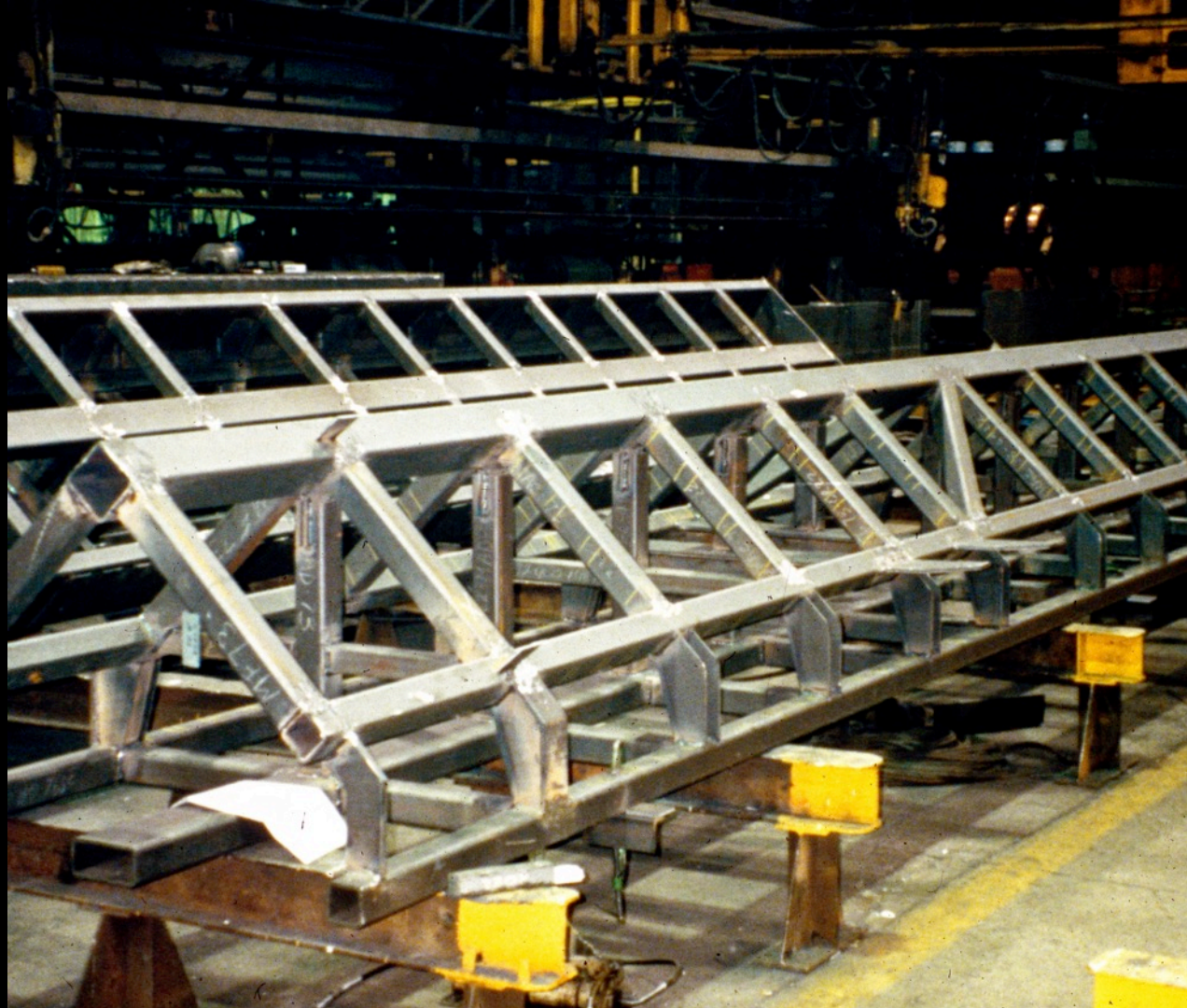


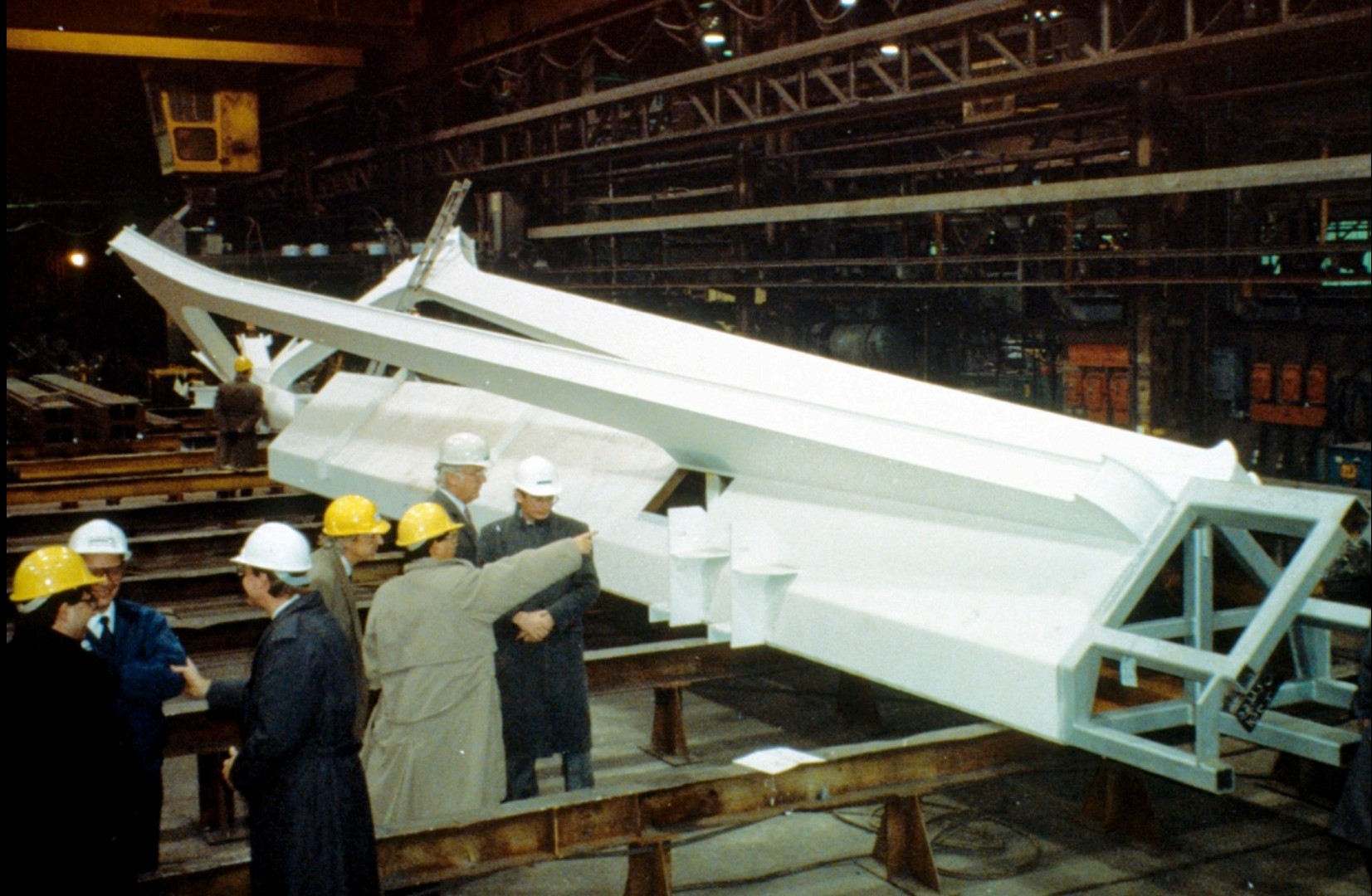






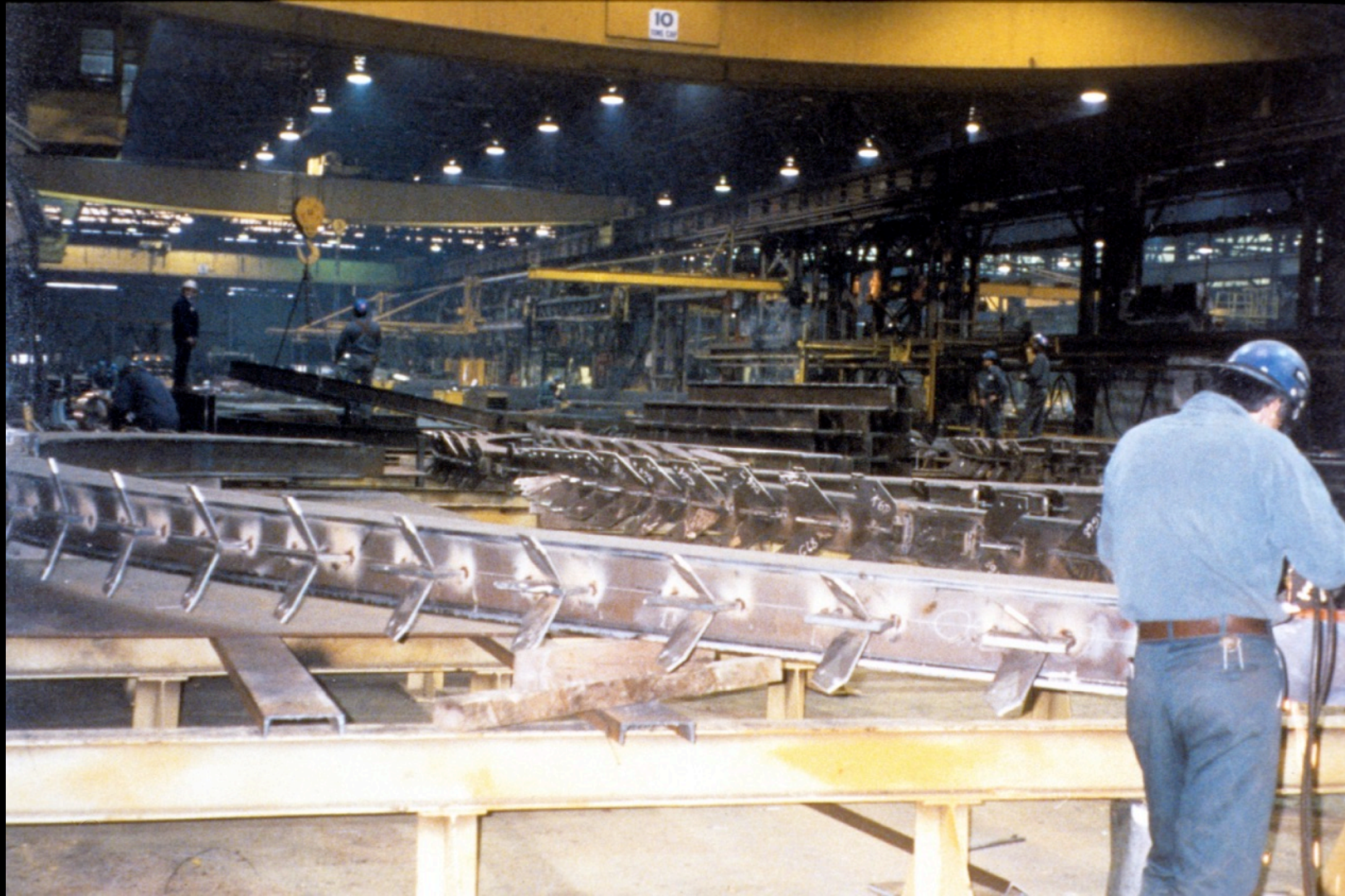








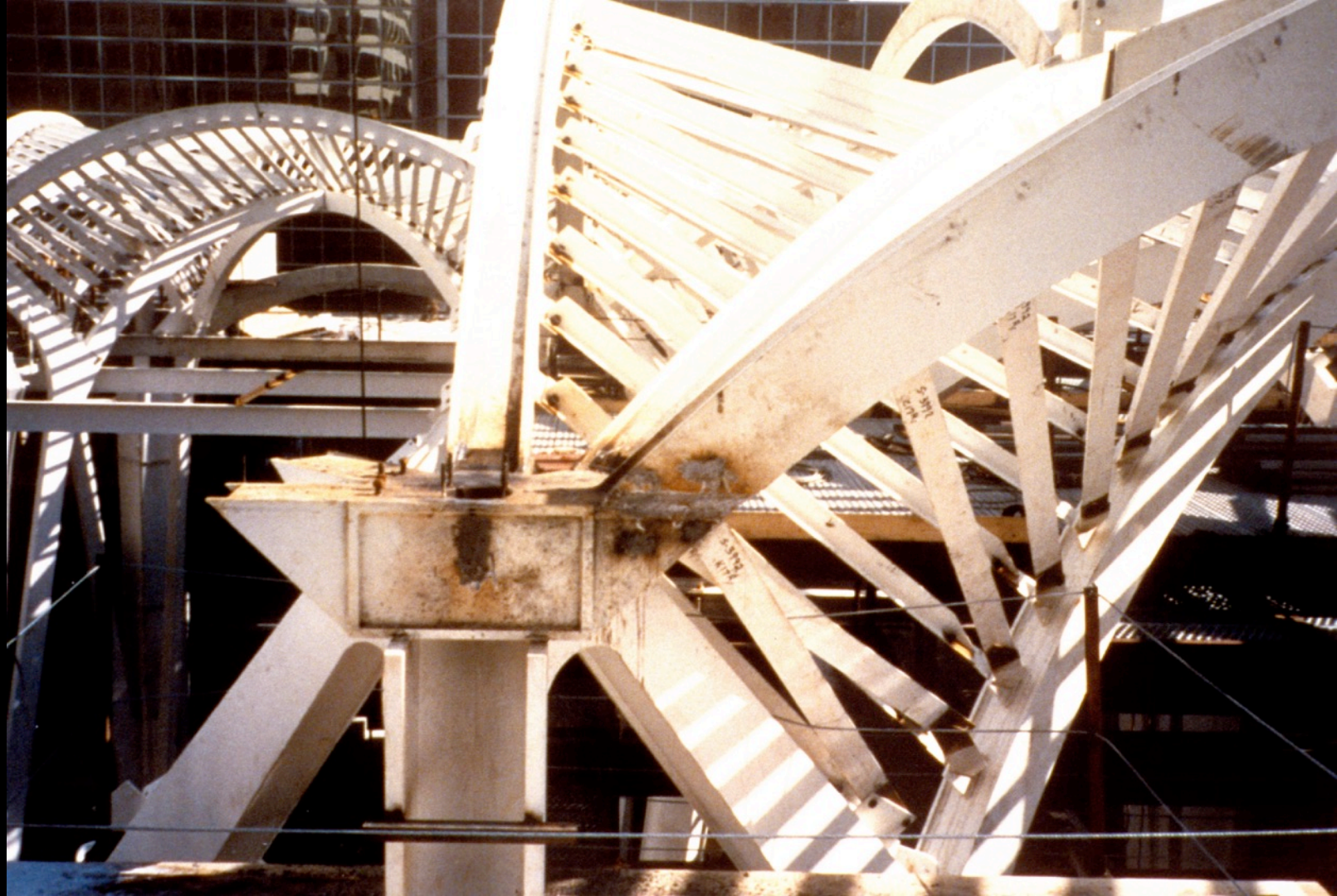


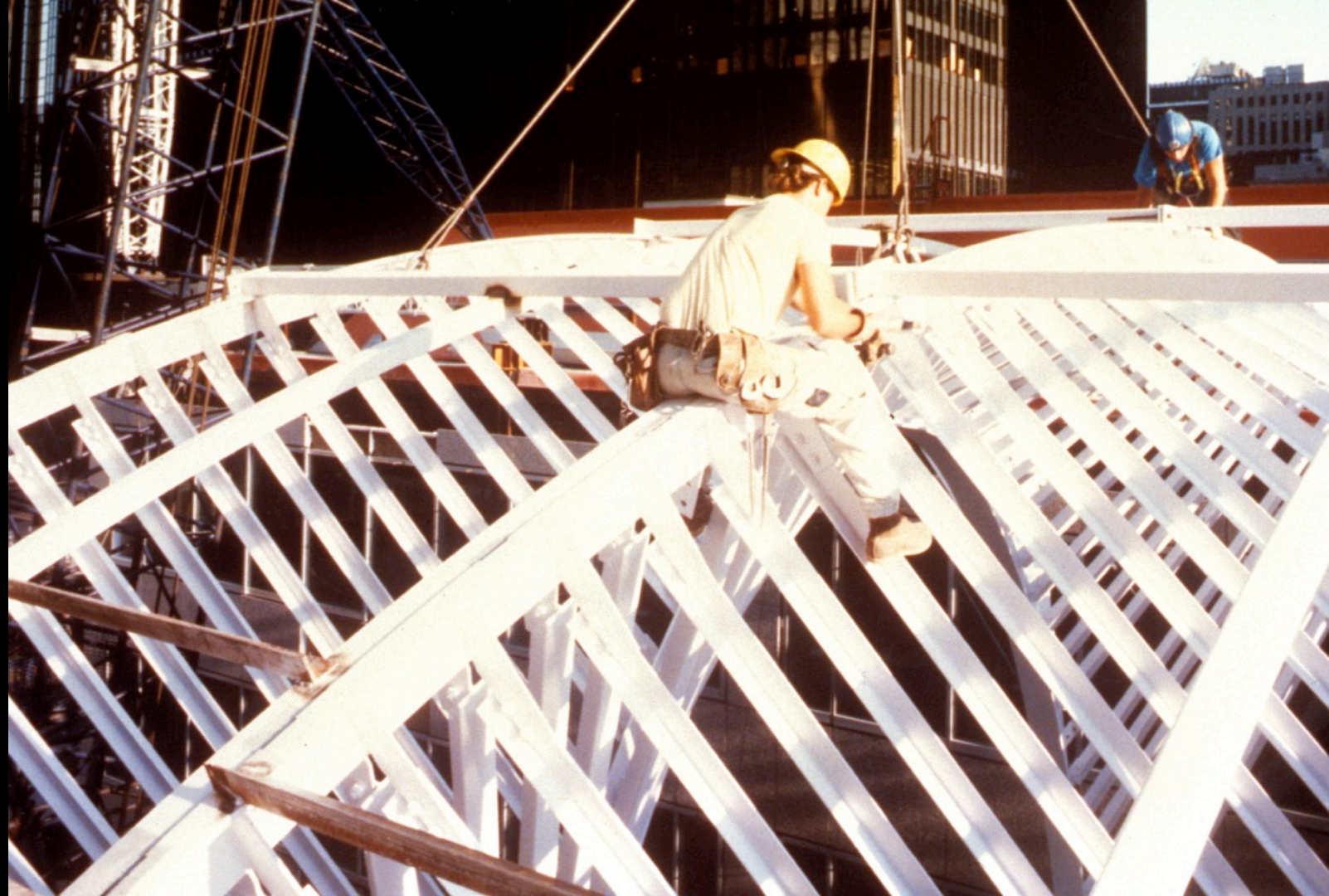


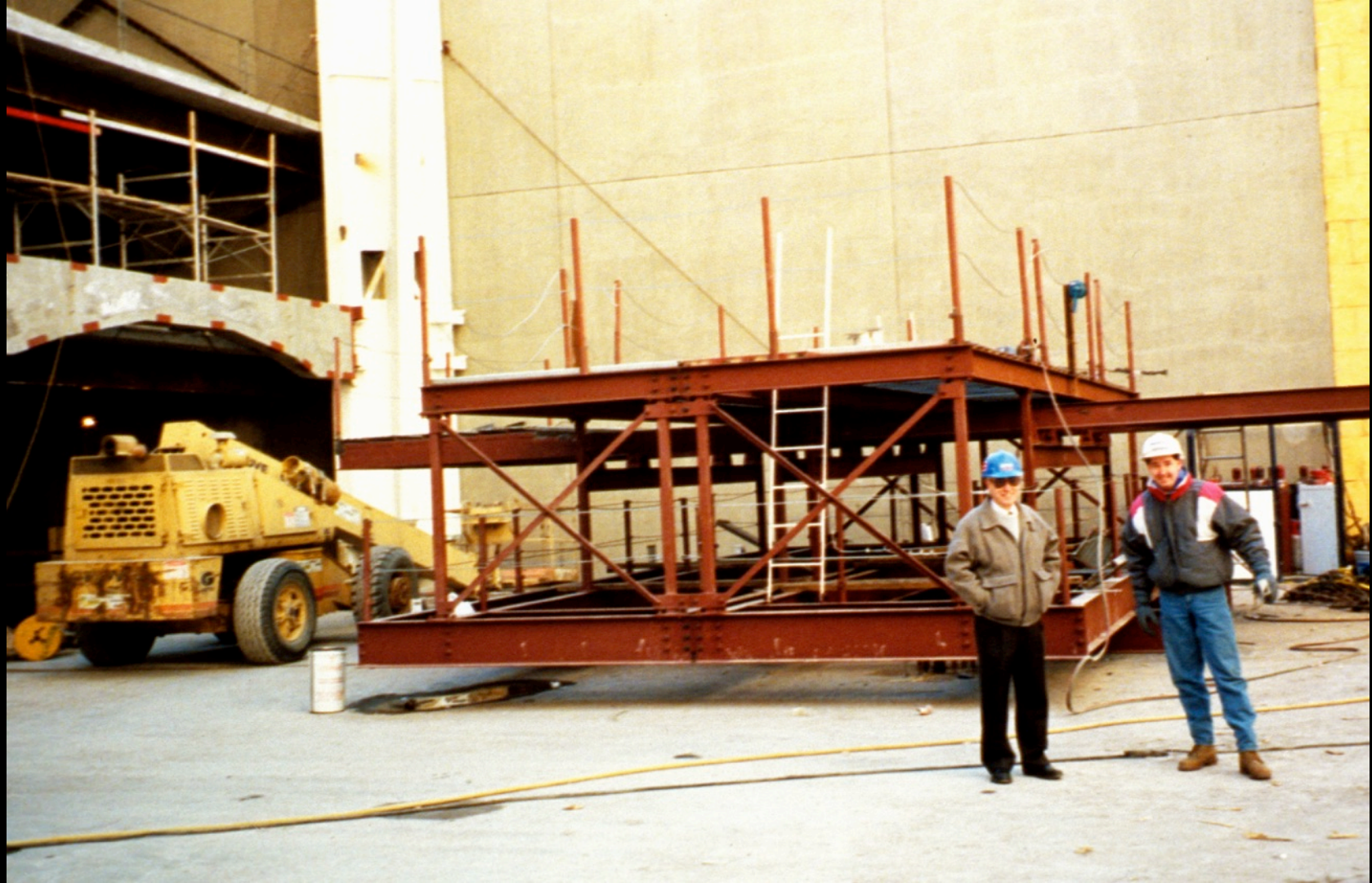




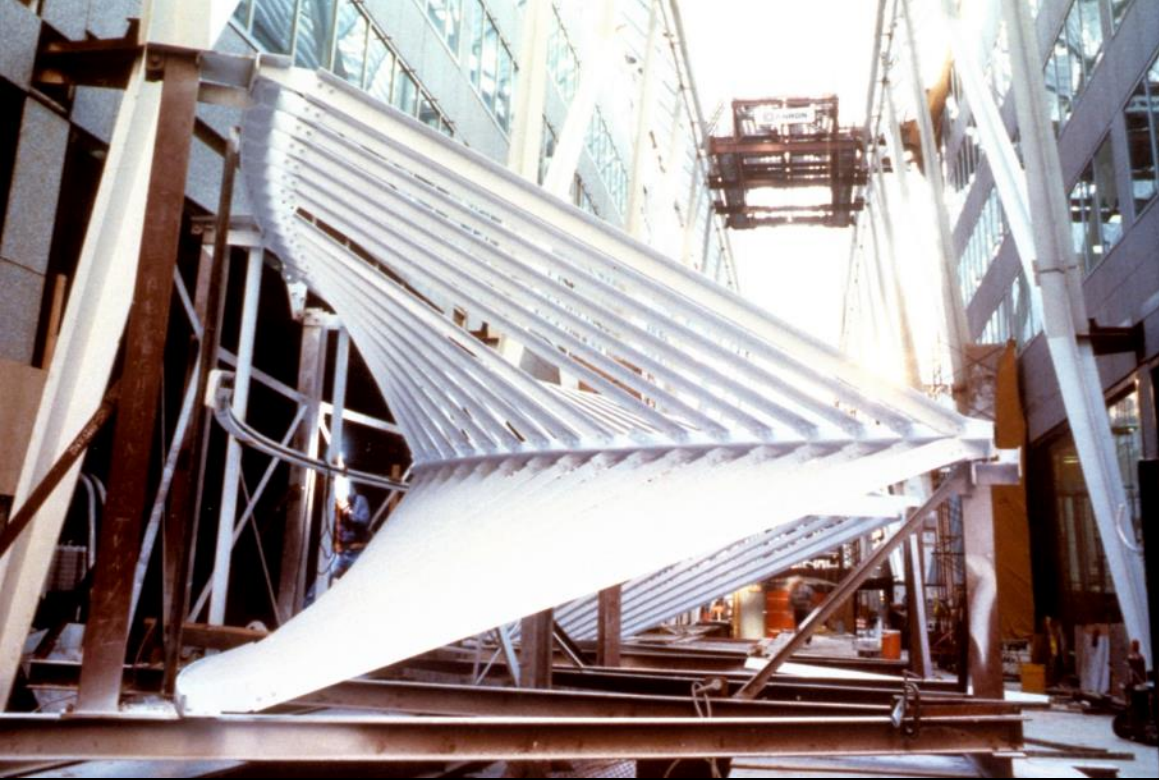
























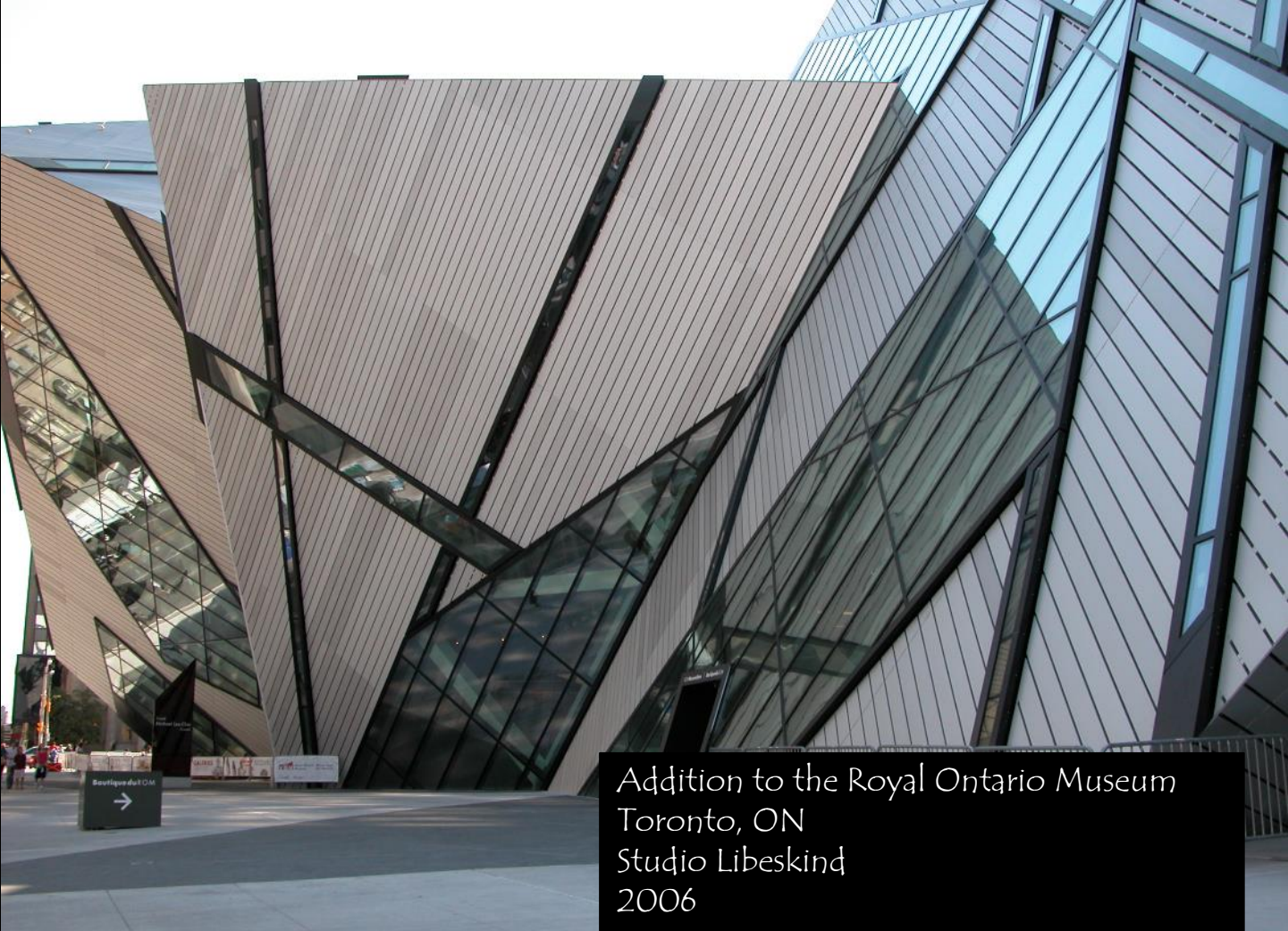










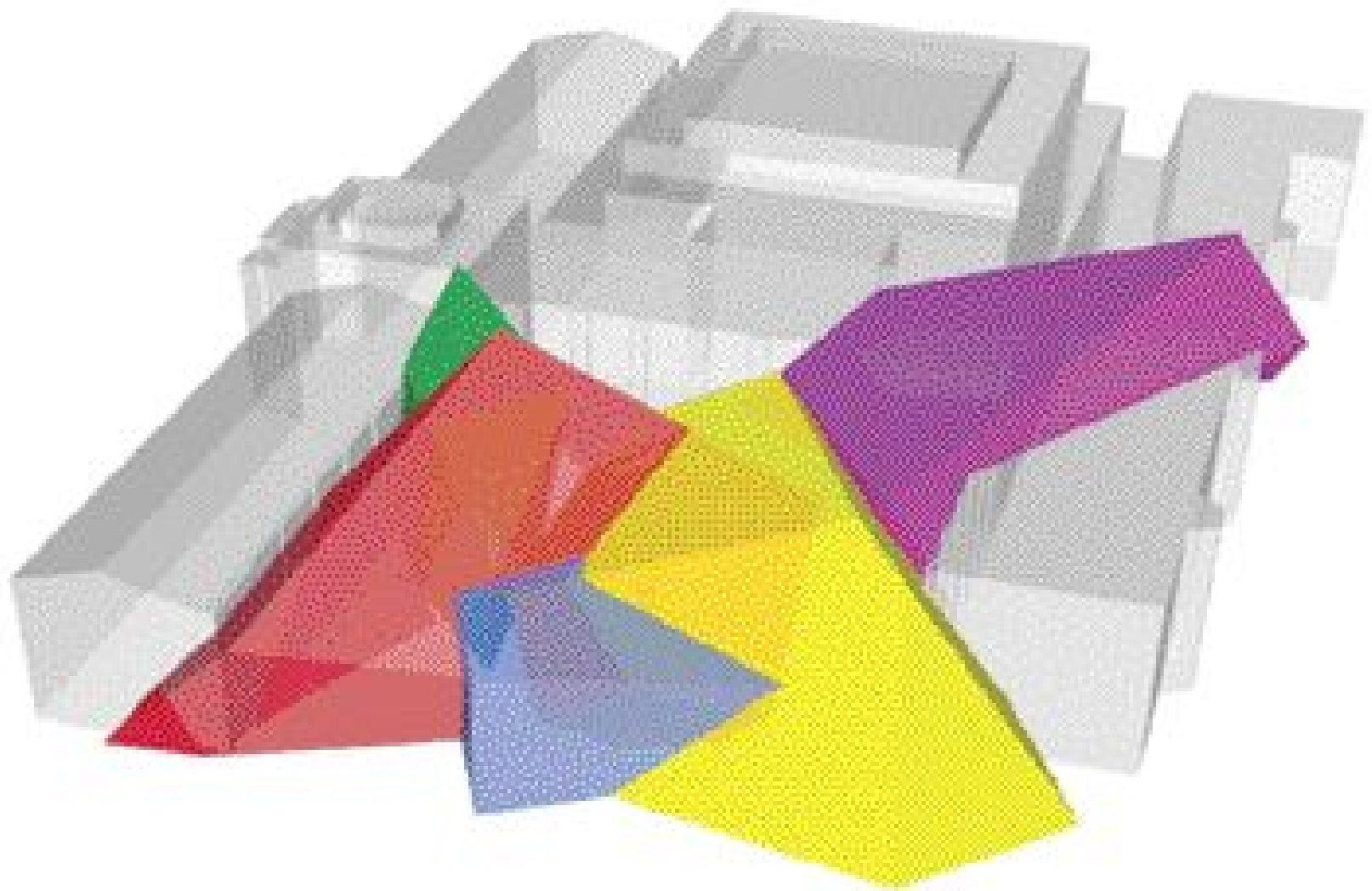


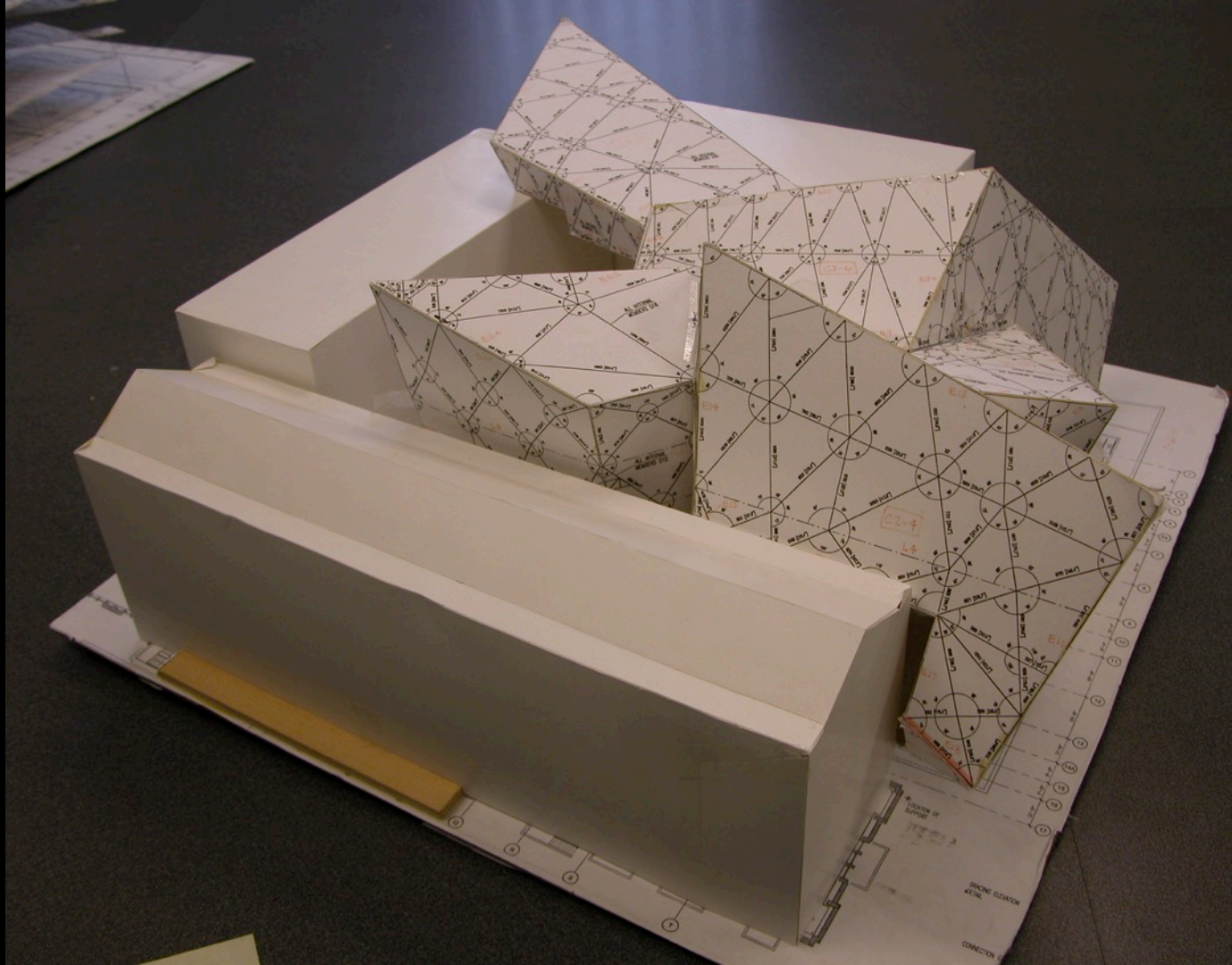
Addition to the Royal Ontario Museum
Toronto, ON
Studio Libeskind
2006

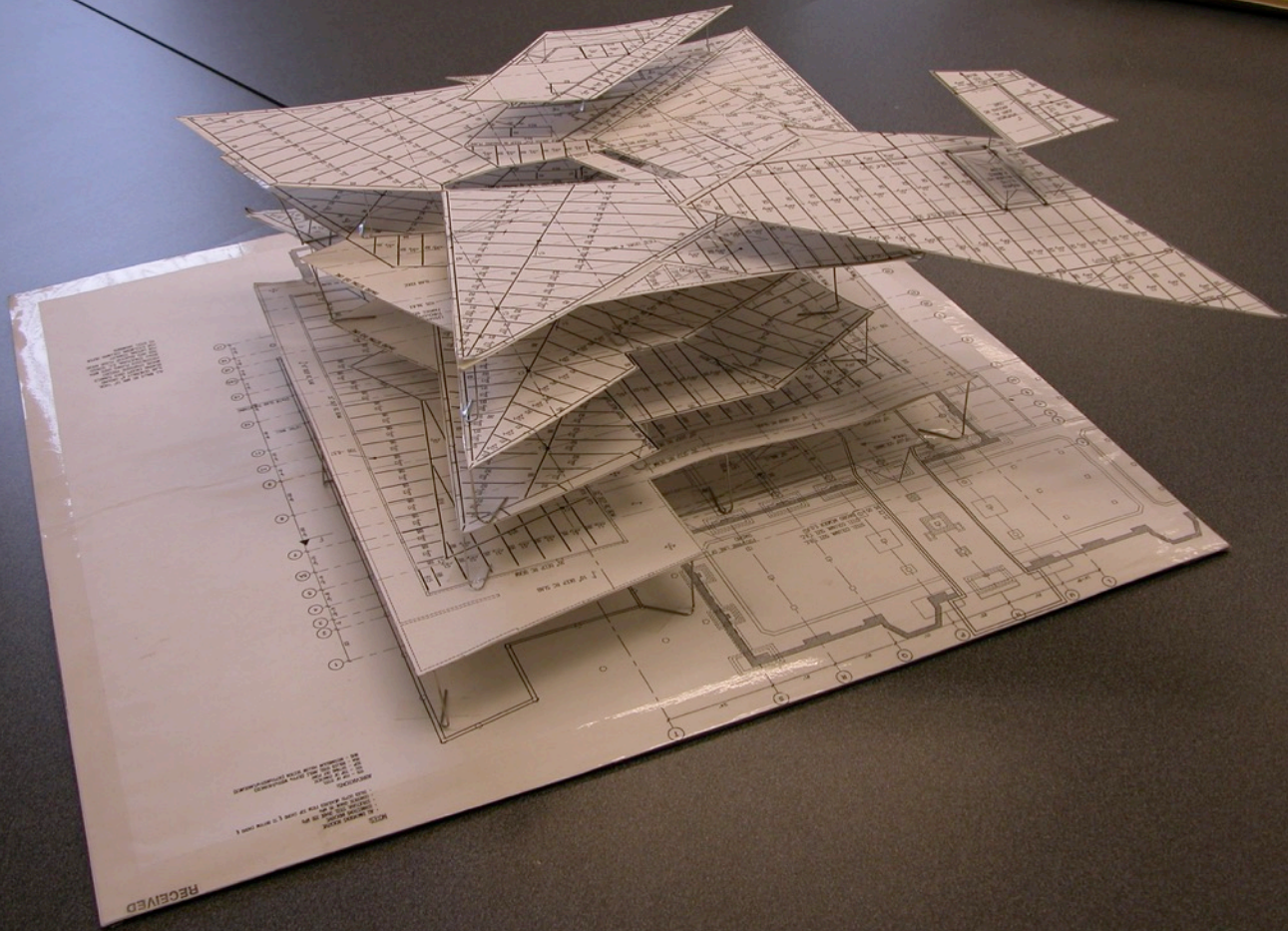


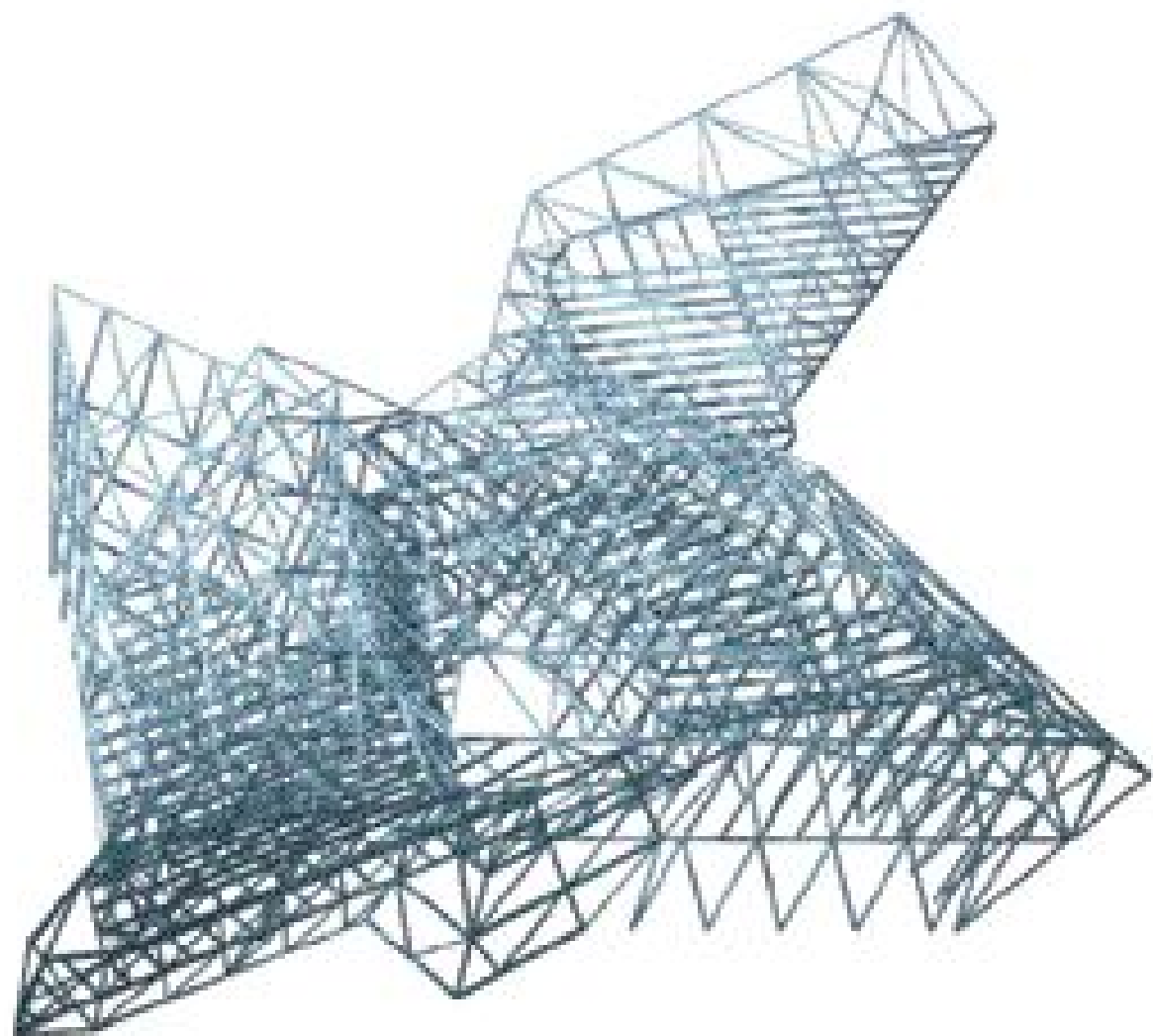
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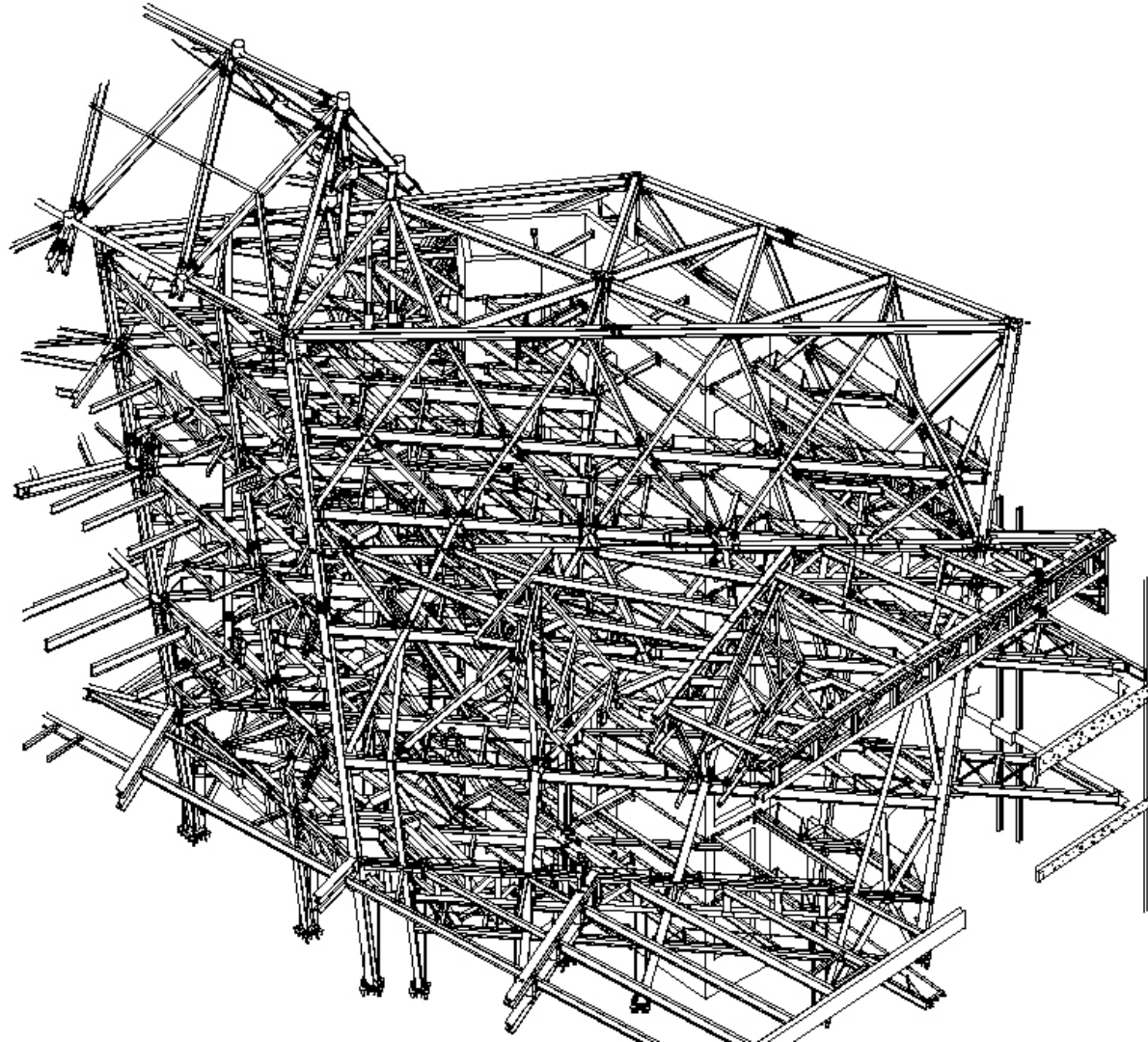


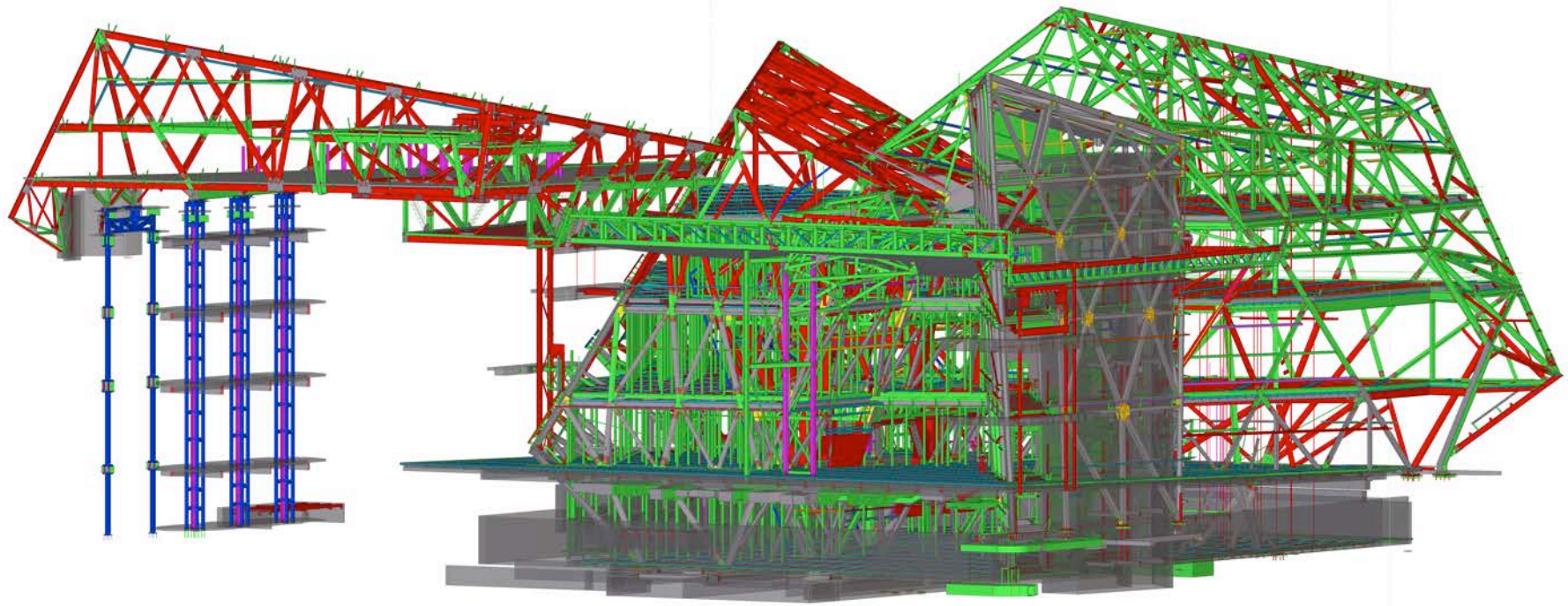


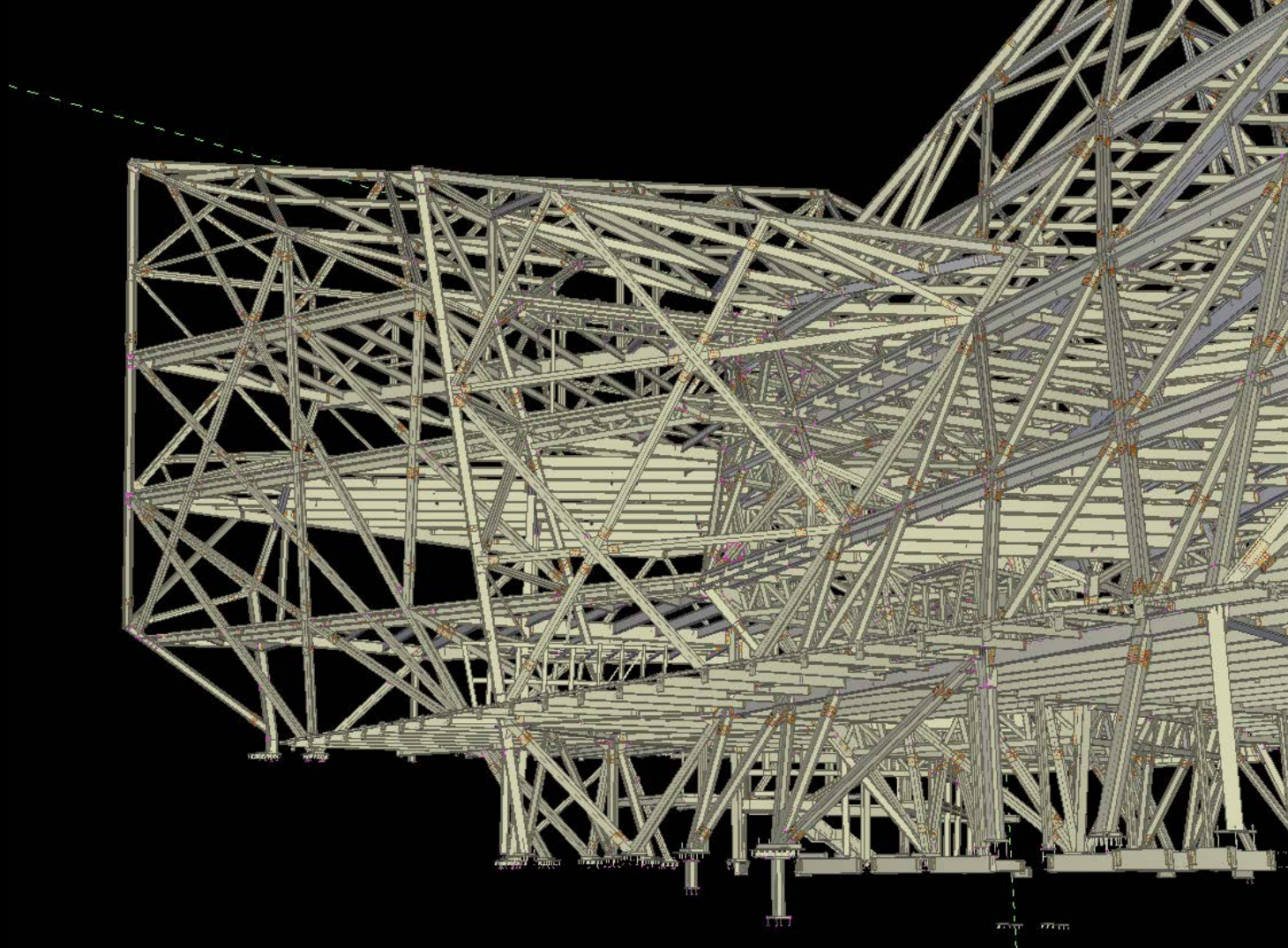


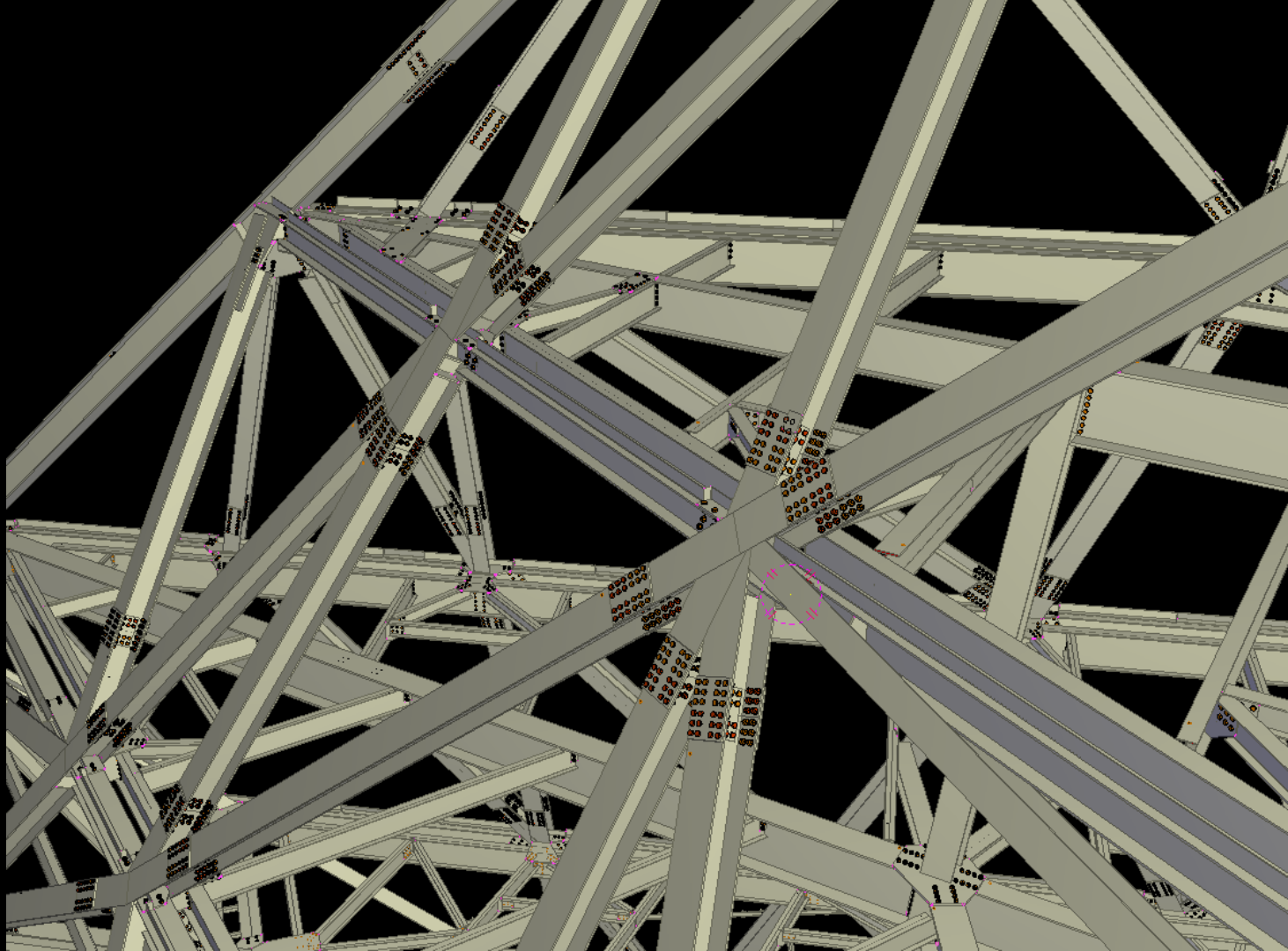


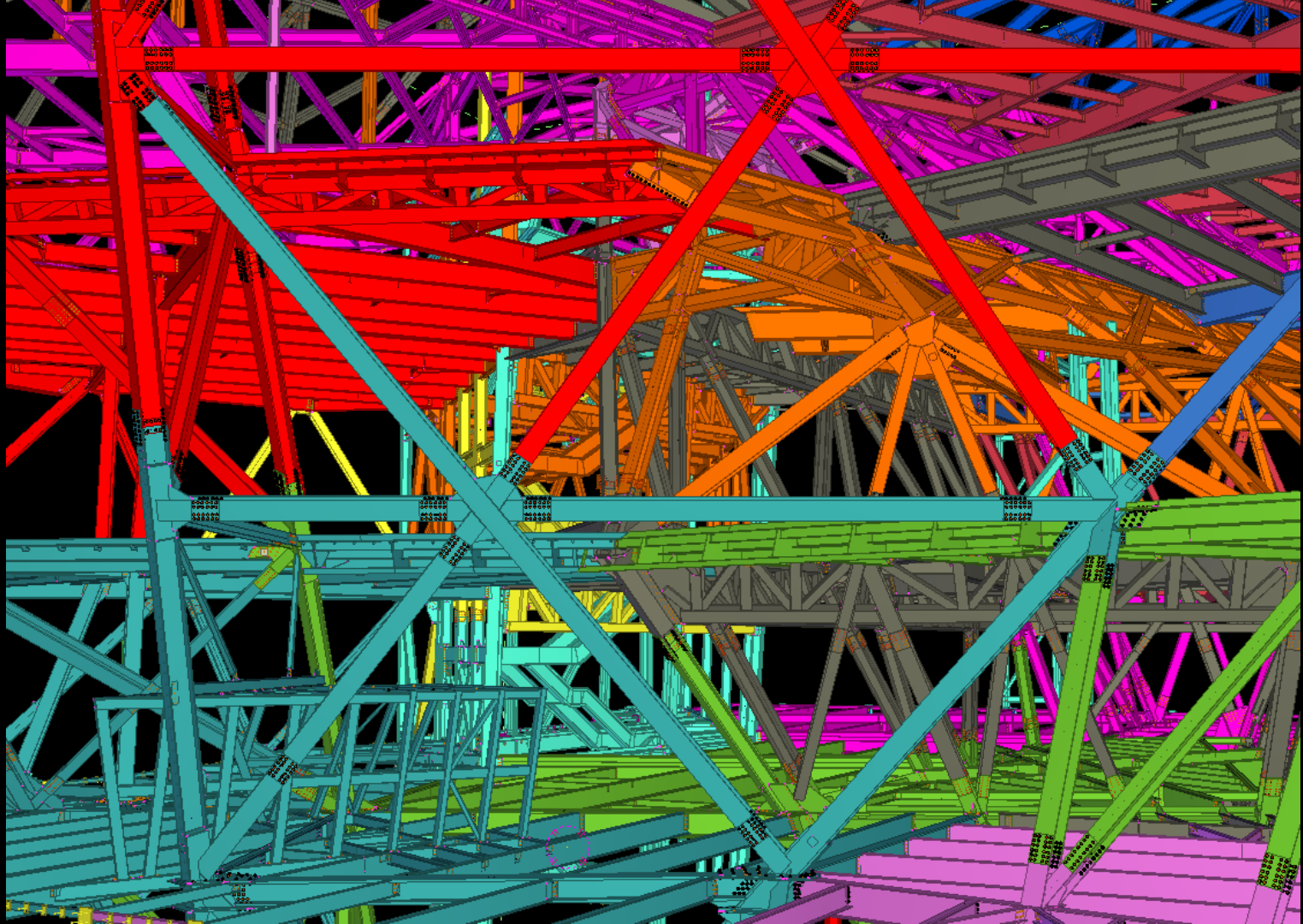


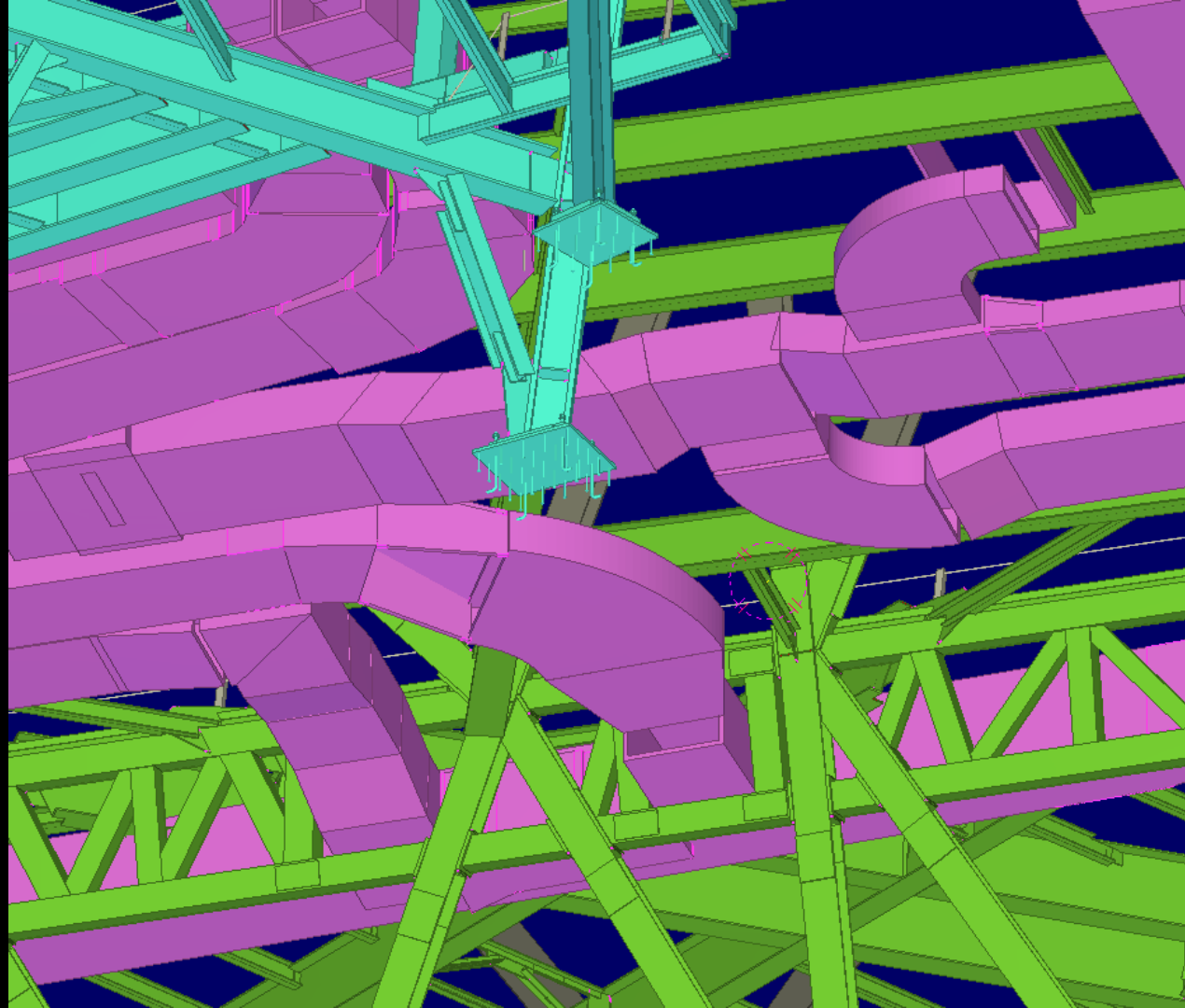


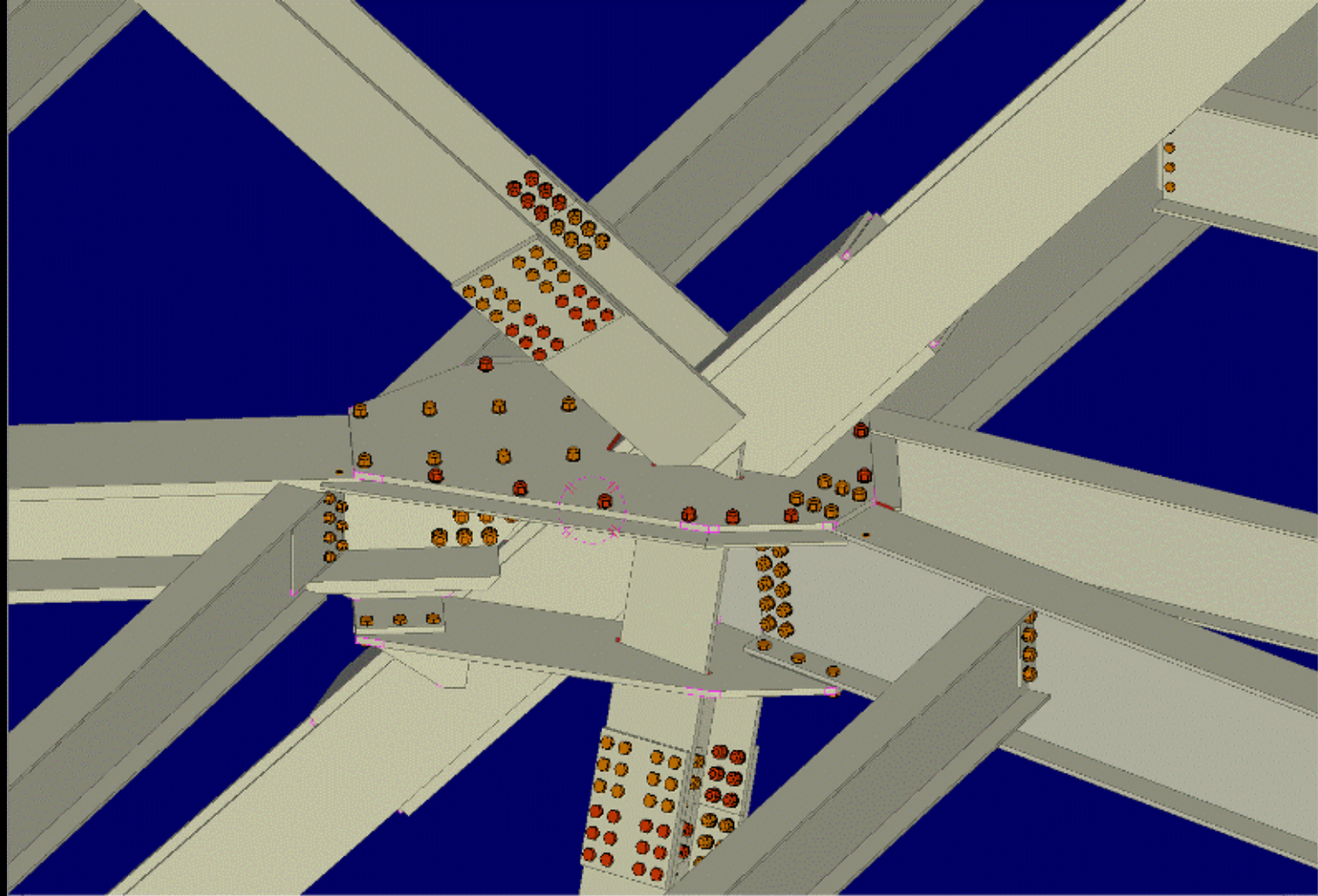




















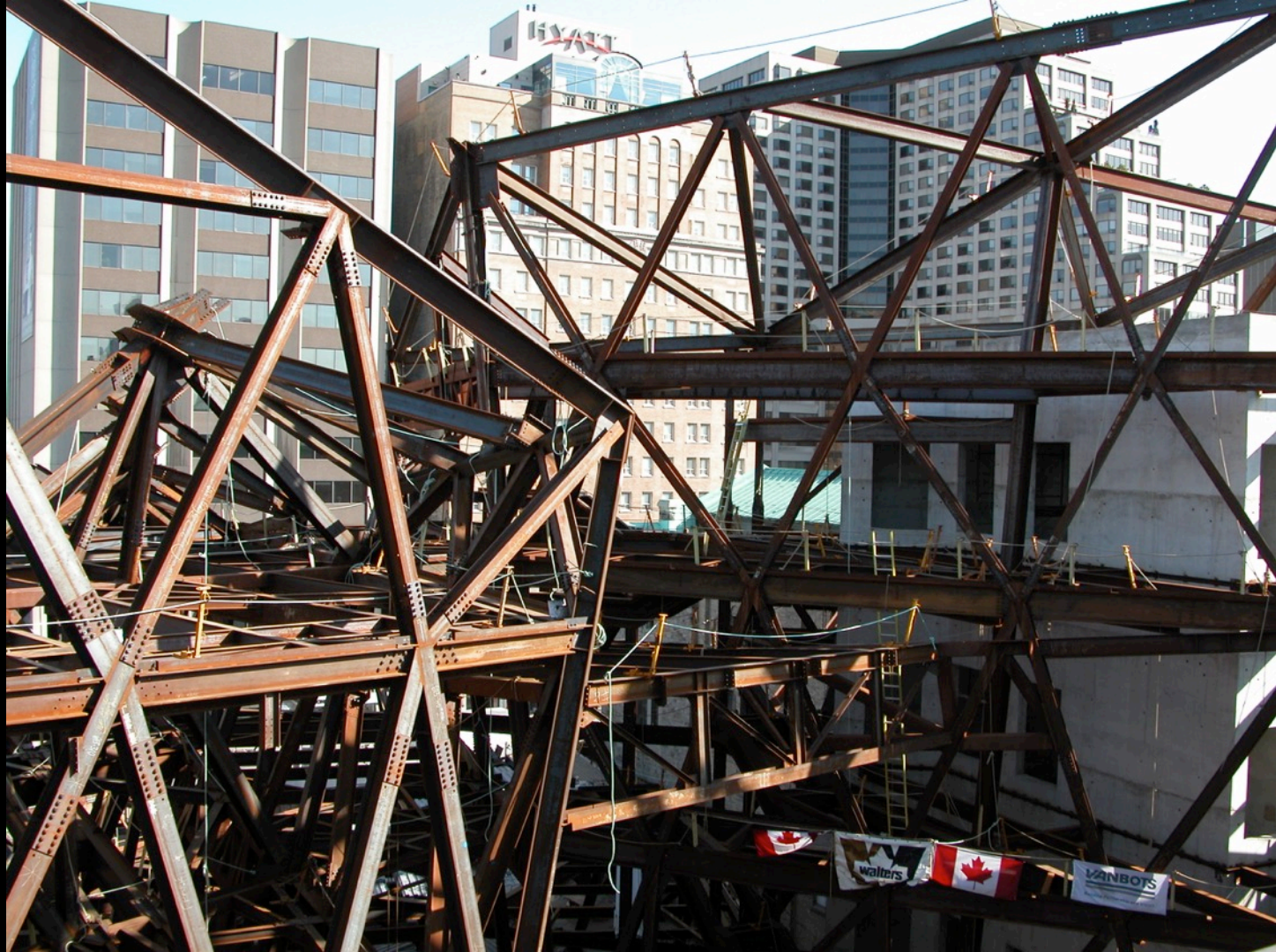


















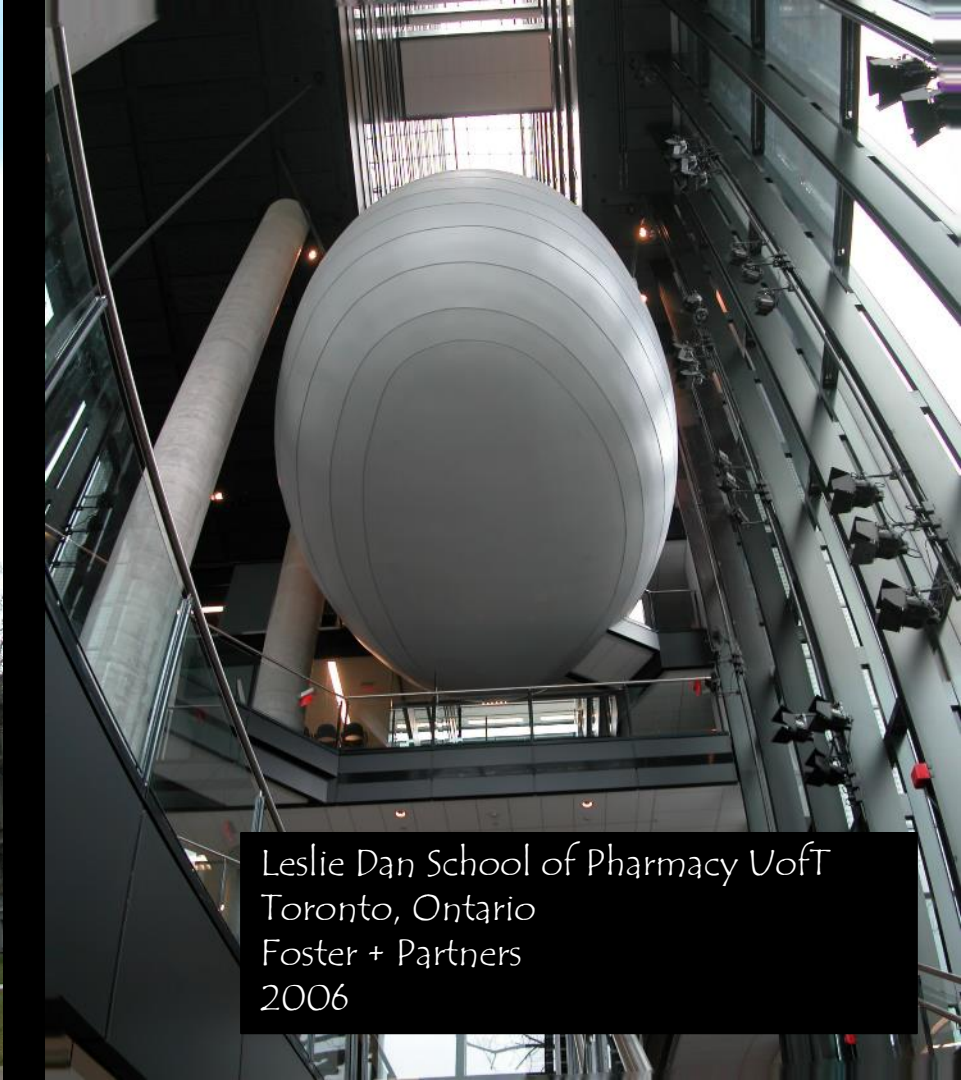
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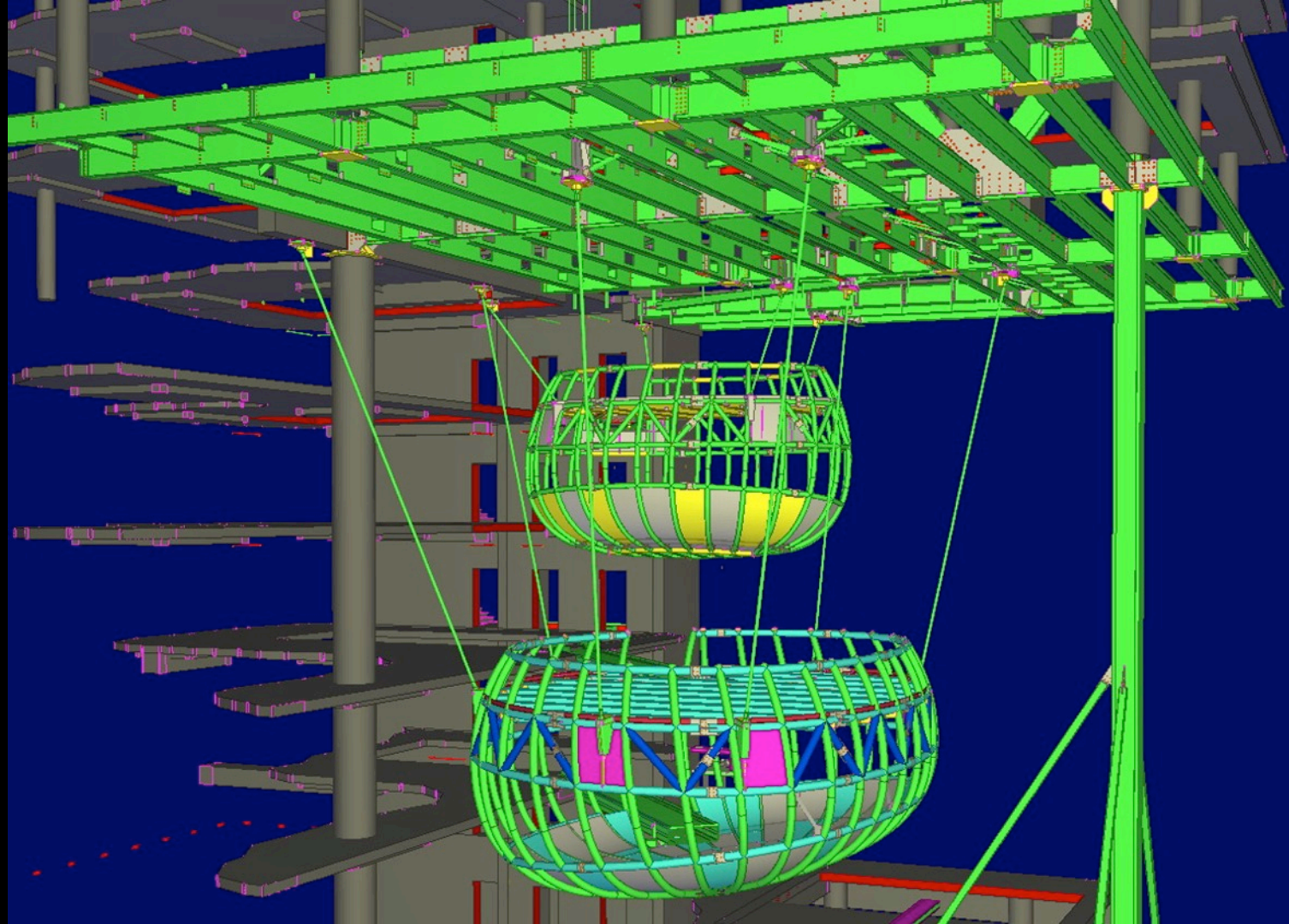
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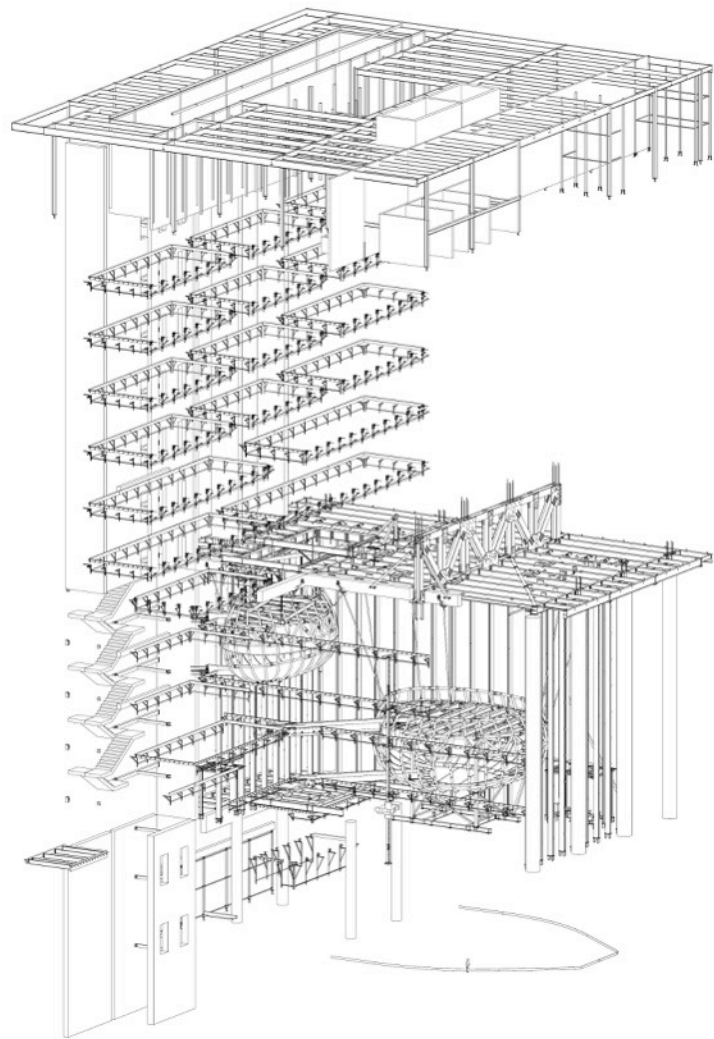


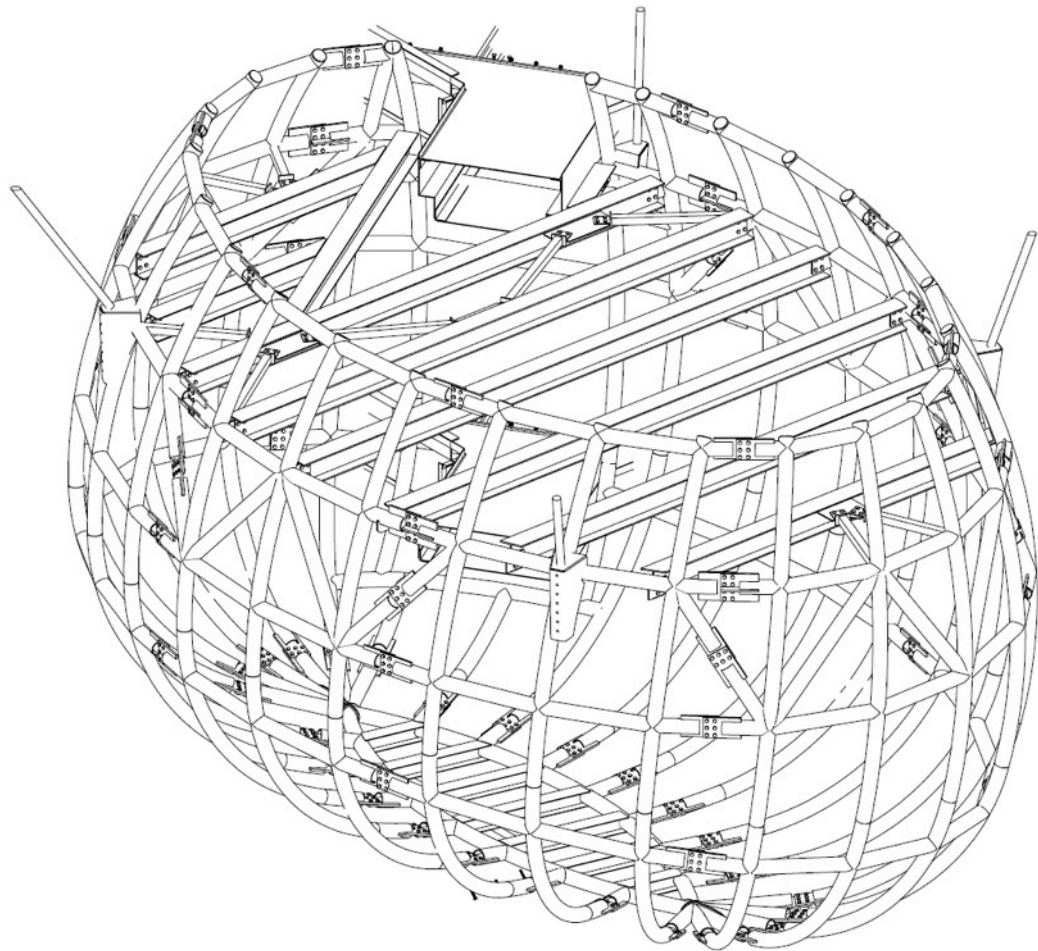


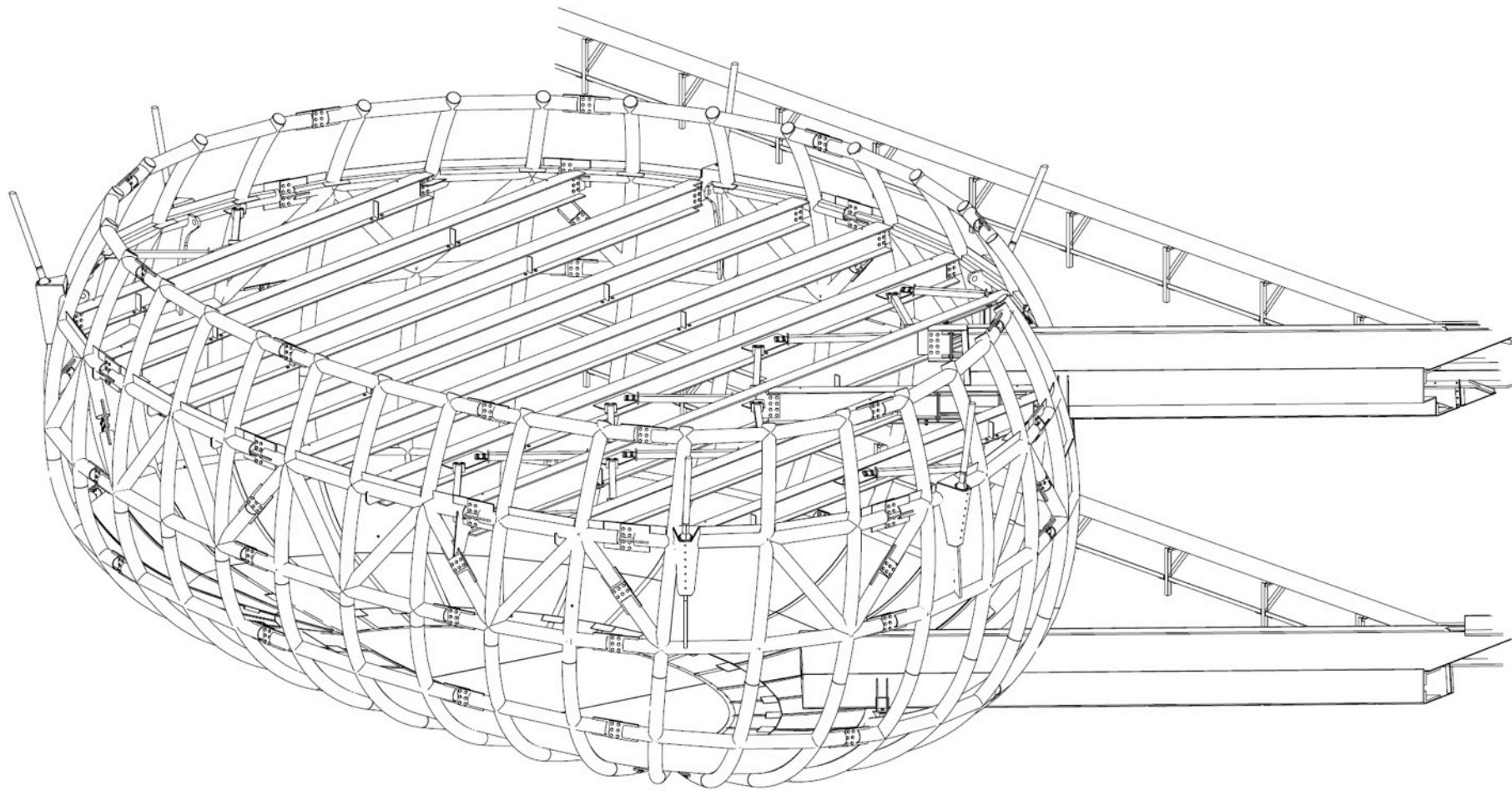


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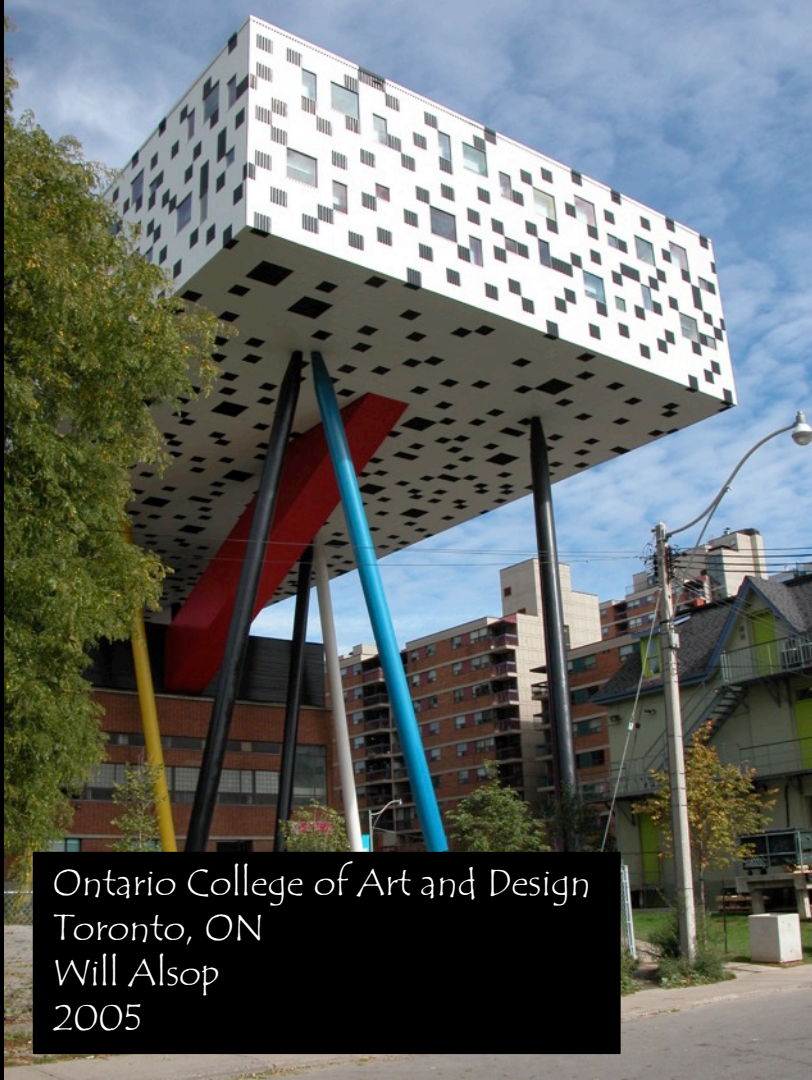




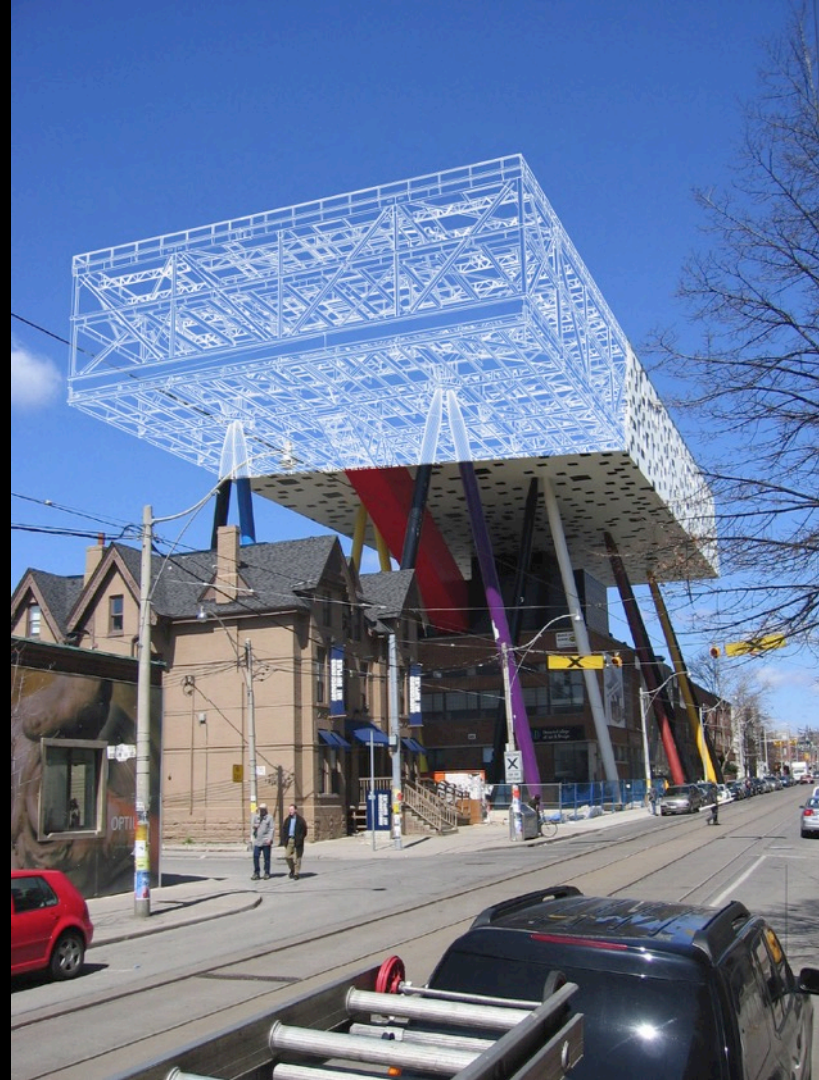
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Lounge

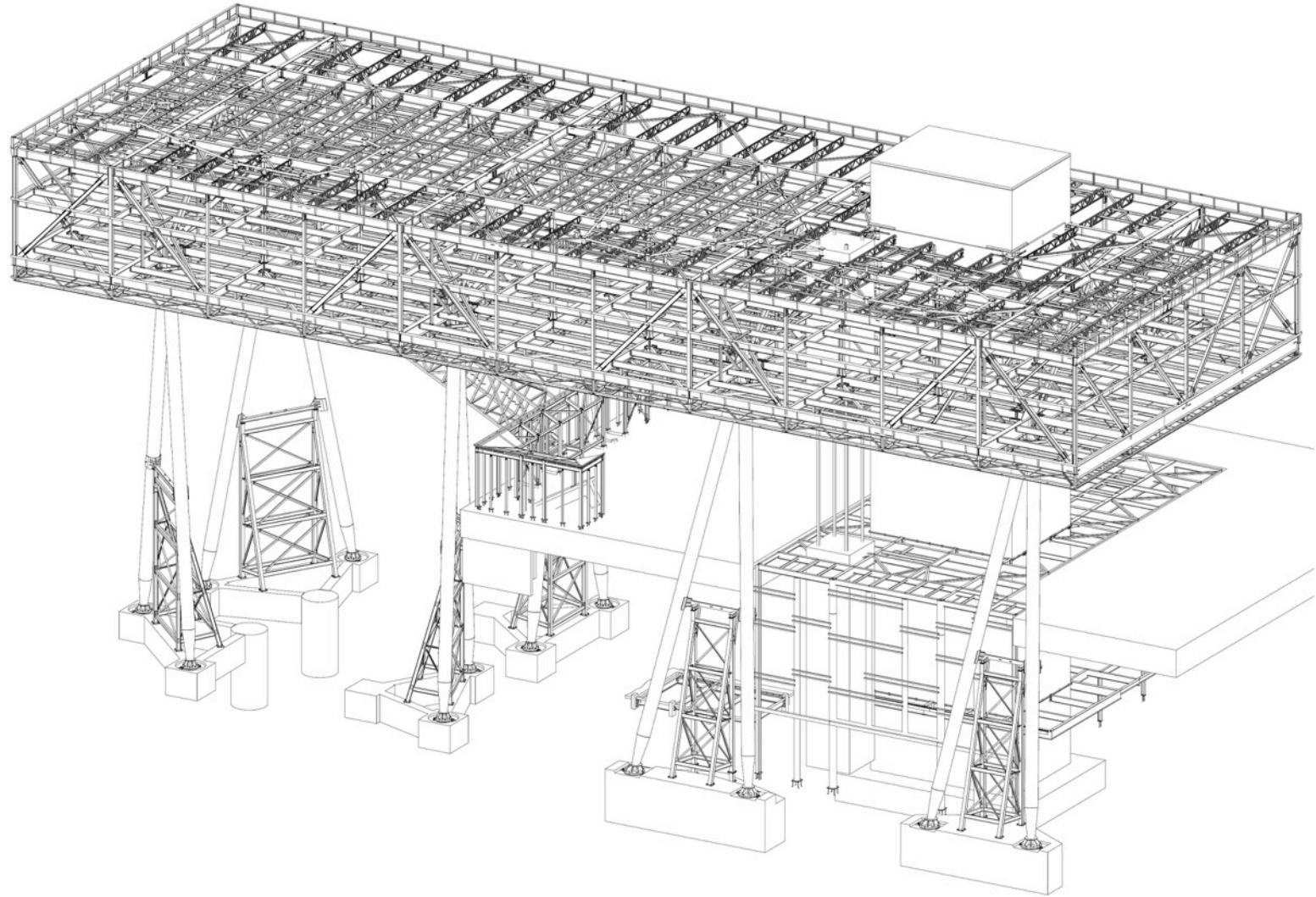
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The State House
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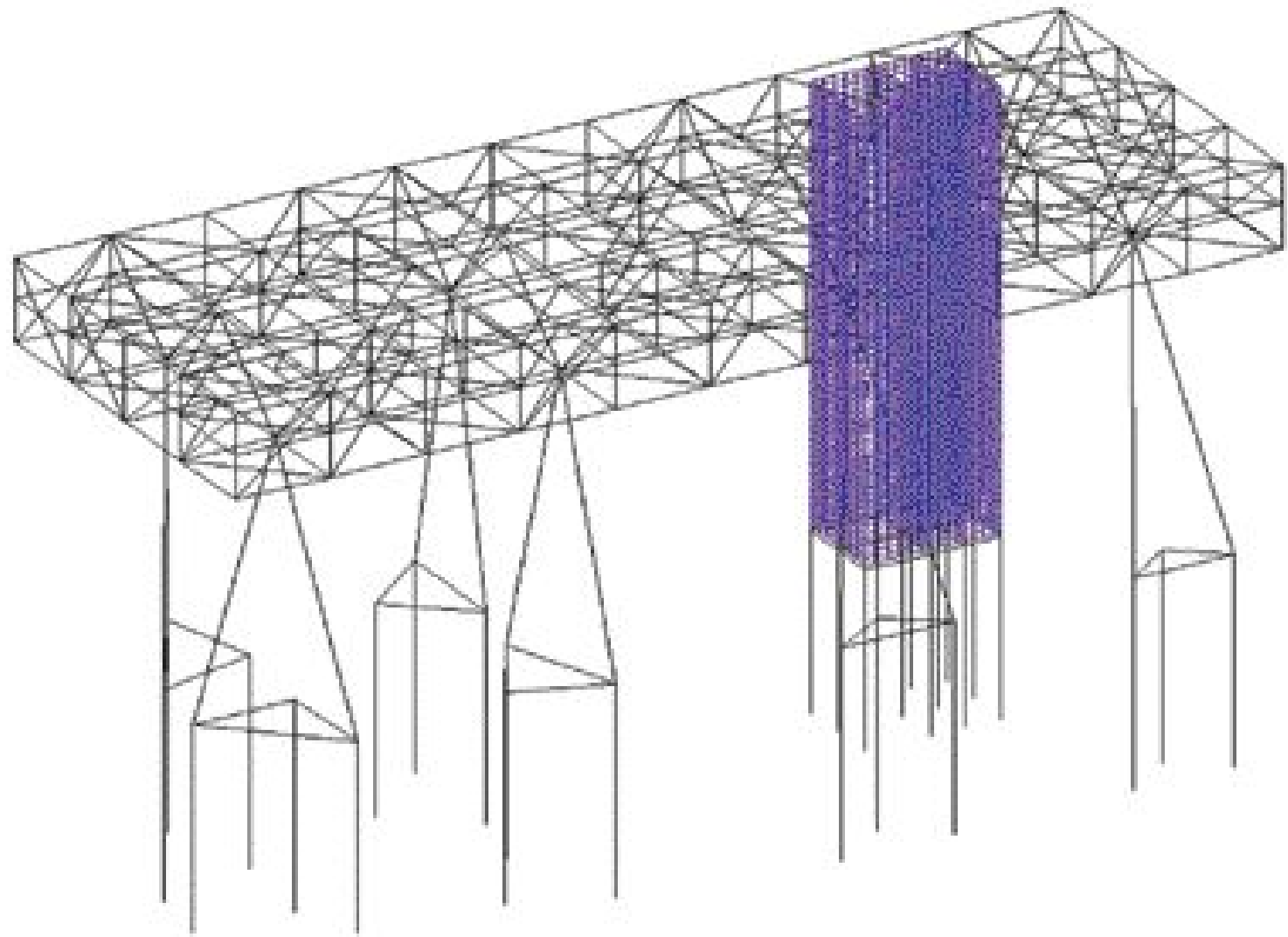


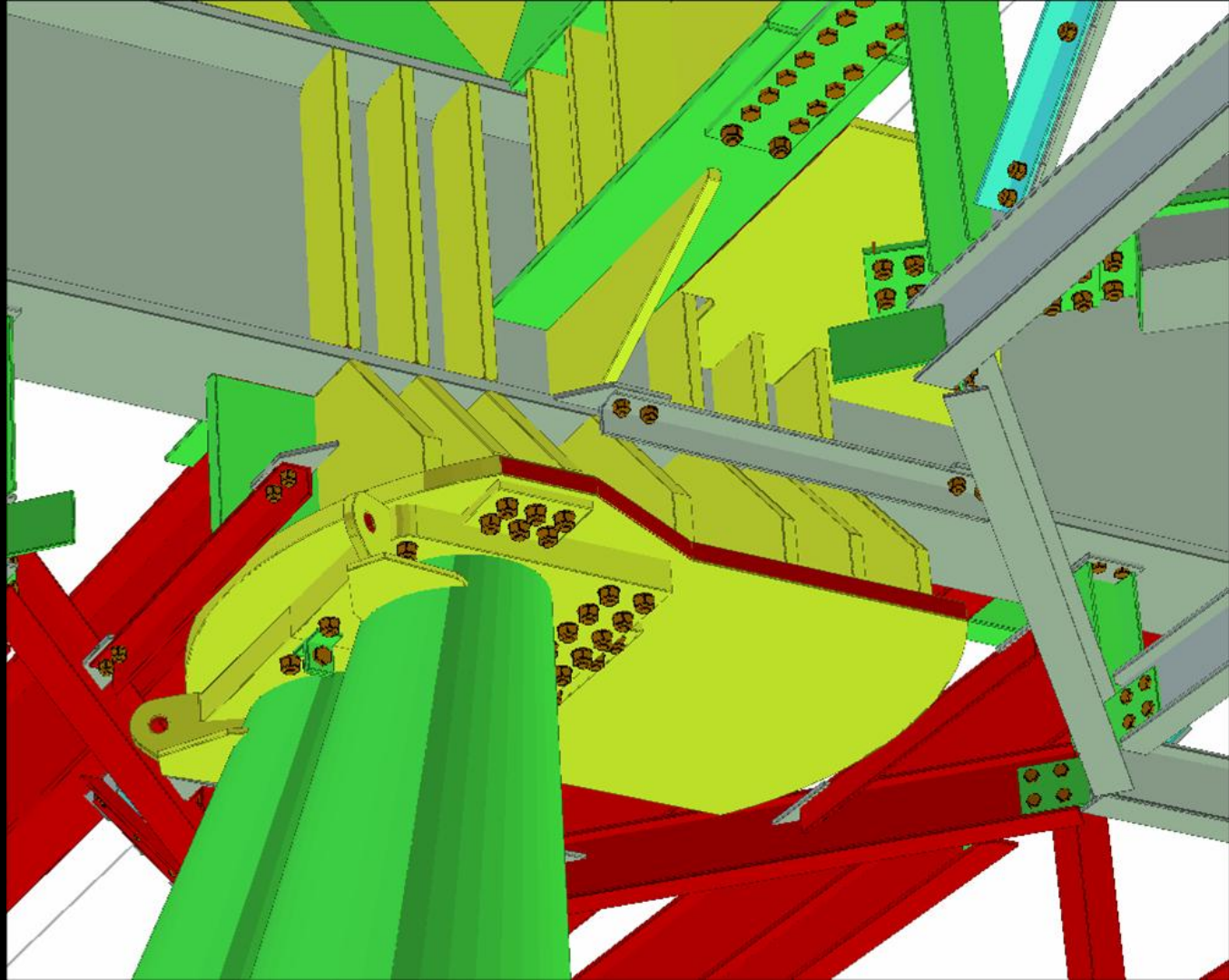


Ontario College of Art and Design
Toronto, ON
Will Alsop
2005











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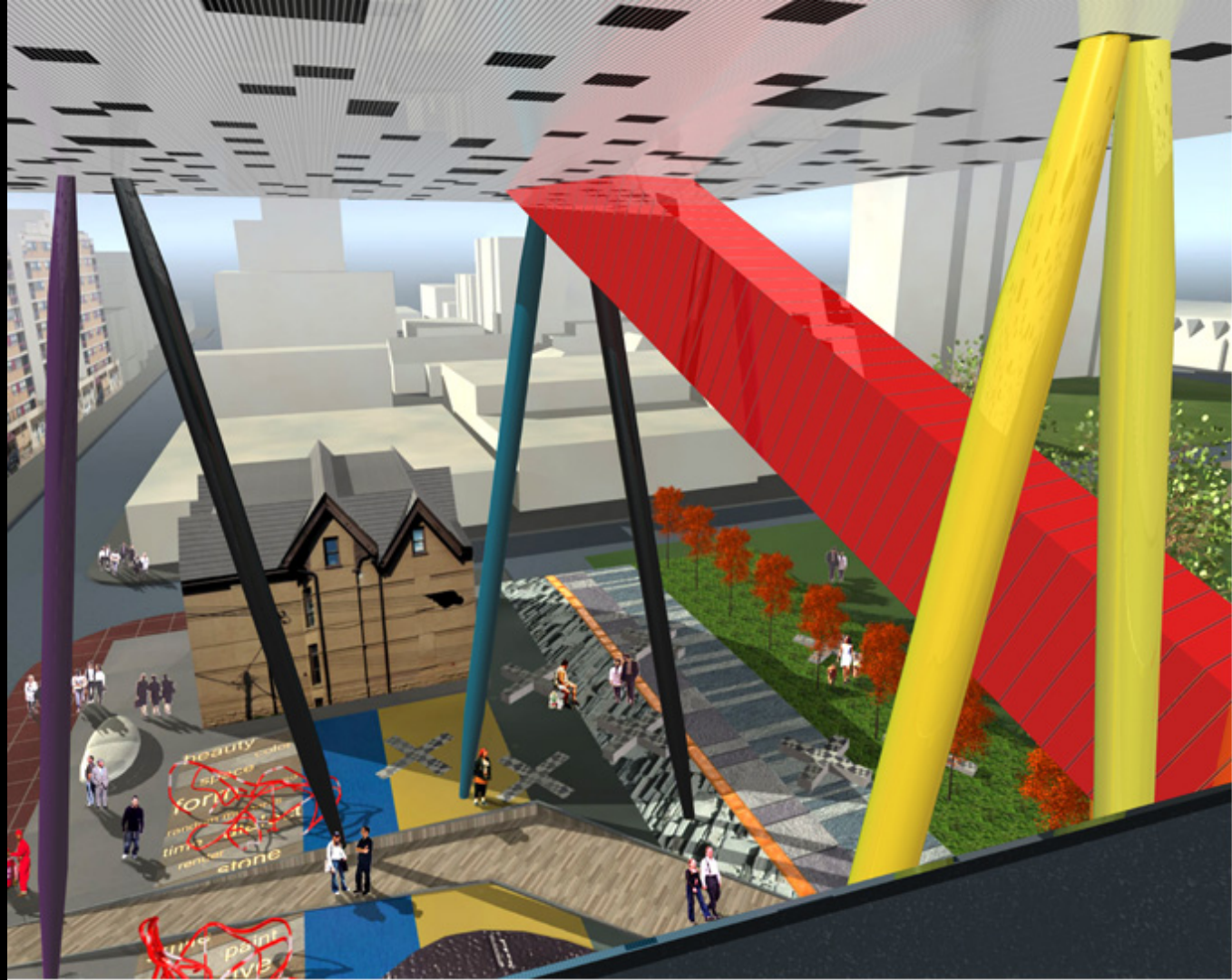




2009-10-8















Terri Meyer Boake, BES, BArch, MArch, LEED AP
Professor School of Architecture University of Waterloo
email: tbmbo@uwaterloo.ca



Renaissance Hotel, Barcelona, Spain - Ateliers Jean Nouvel

Arch 570:
Architecturally
Exposed Structural
Steel Design

Fall 2021
Course Home Page

course outline

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We acknowledge that the School of Architecture is located on the traditional territory of the Neutral, Anishinaabeg and Haudenosaunee peoples. The University is situated on the Haldimand Tract, the land promised to the Six Nations that includes 10 kilometres on each side of the Grand River. (see references here: <https://uwaterloo.ca/engineering/about/territorial-acknowledgement>)

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