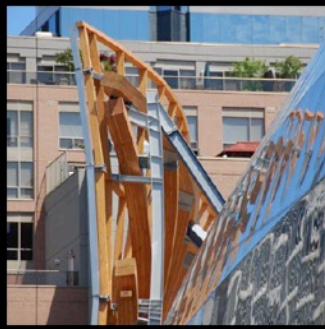




# Modern Steel Construction

Arch 173: Building Construction 2  
Winter 2024

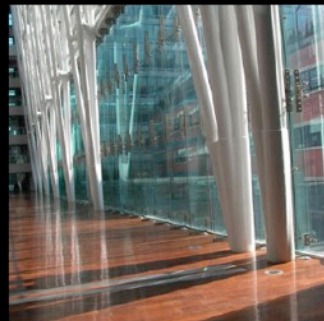
Terri Meyer Boake



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



by Terri Meyer Boake



cisc  icca

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





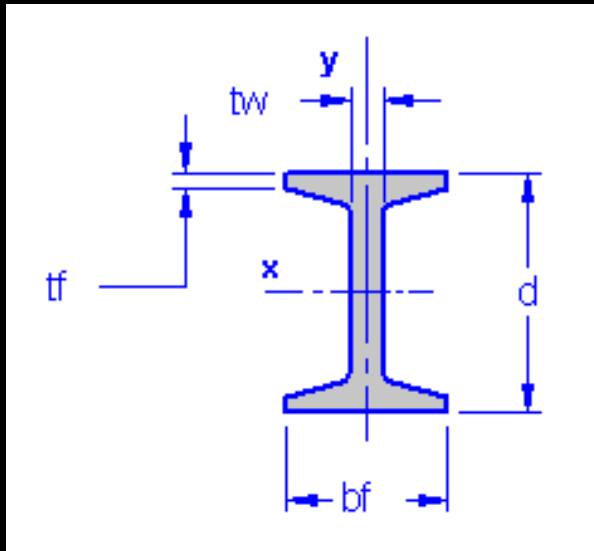
Galvanizing is NOT a type of steel.  
It is a dipping process in hot zinc  
for corrosion protection



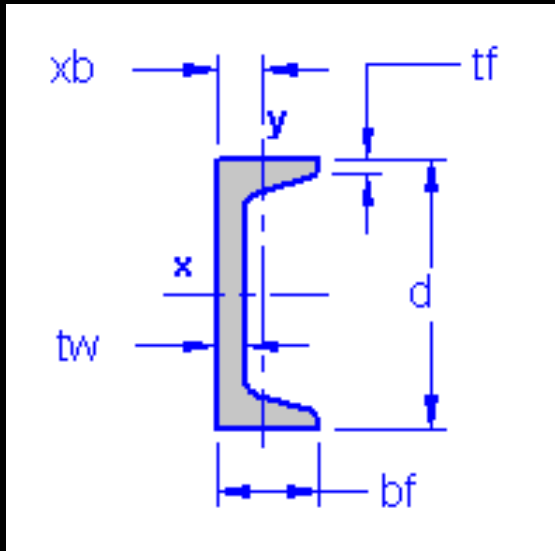
## Structural Steel Shapes

Shapes are either hot rolled  
or

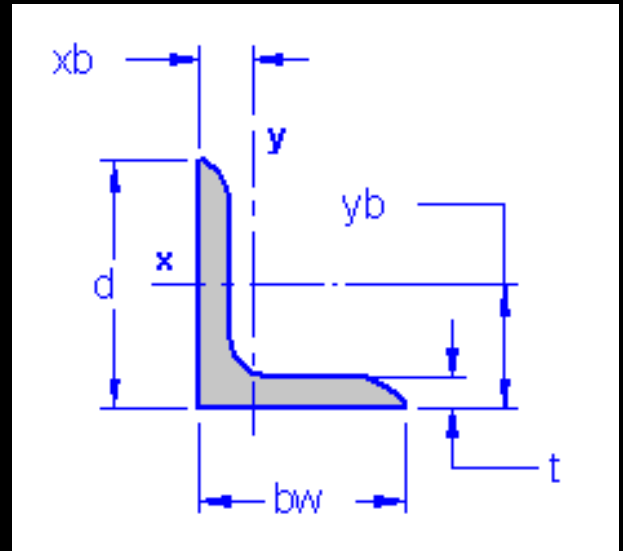
Formed from plate material and  
bent, formed into shapes



Wide Flange

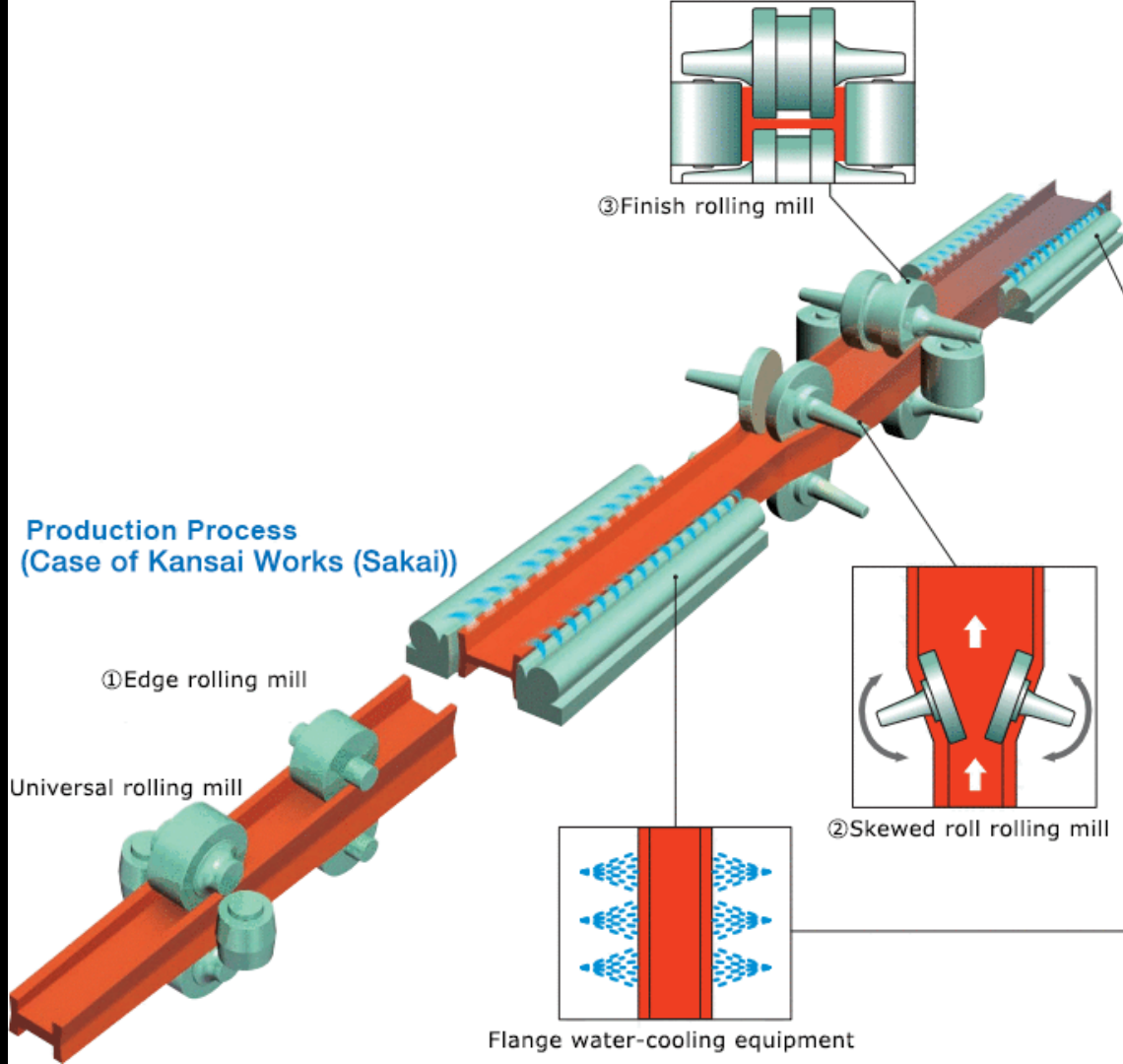


Channel



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

6x6x2 1/2x9  
#125

6x6x3 1/2x9  
#125



HW0216  
33  
10x6  
10x6

10x6x500  
33  
HW0216  
10x6x500  
33

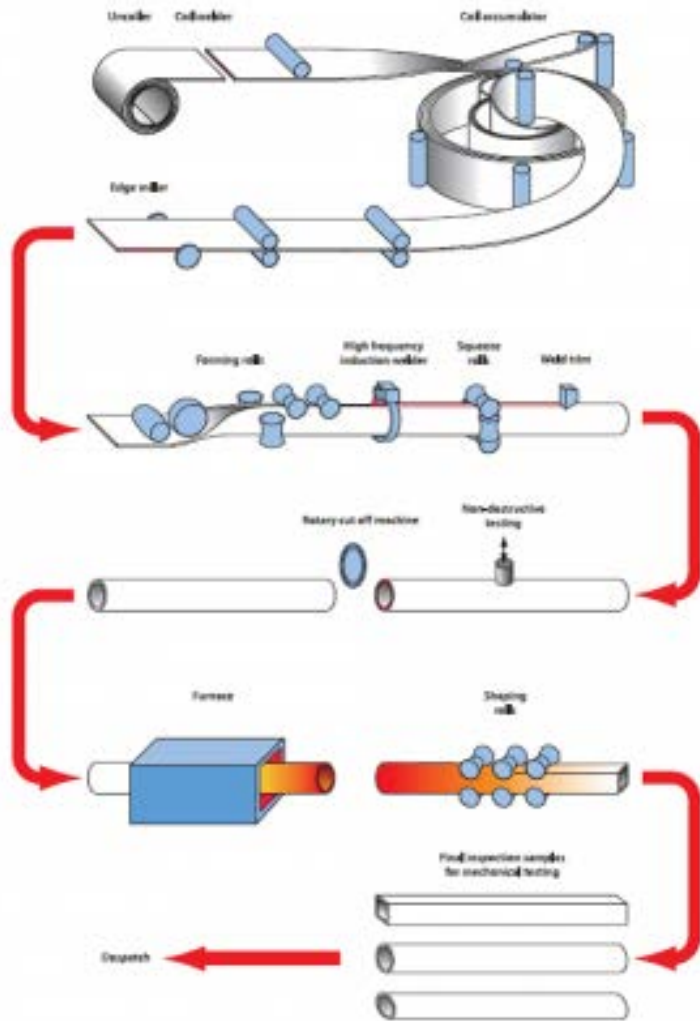
HW0216

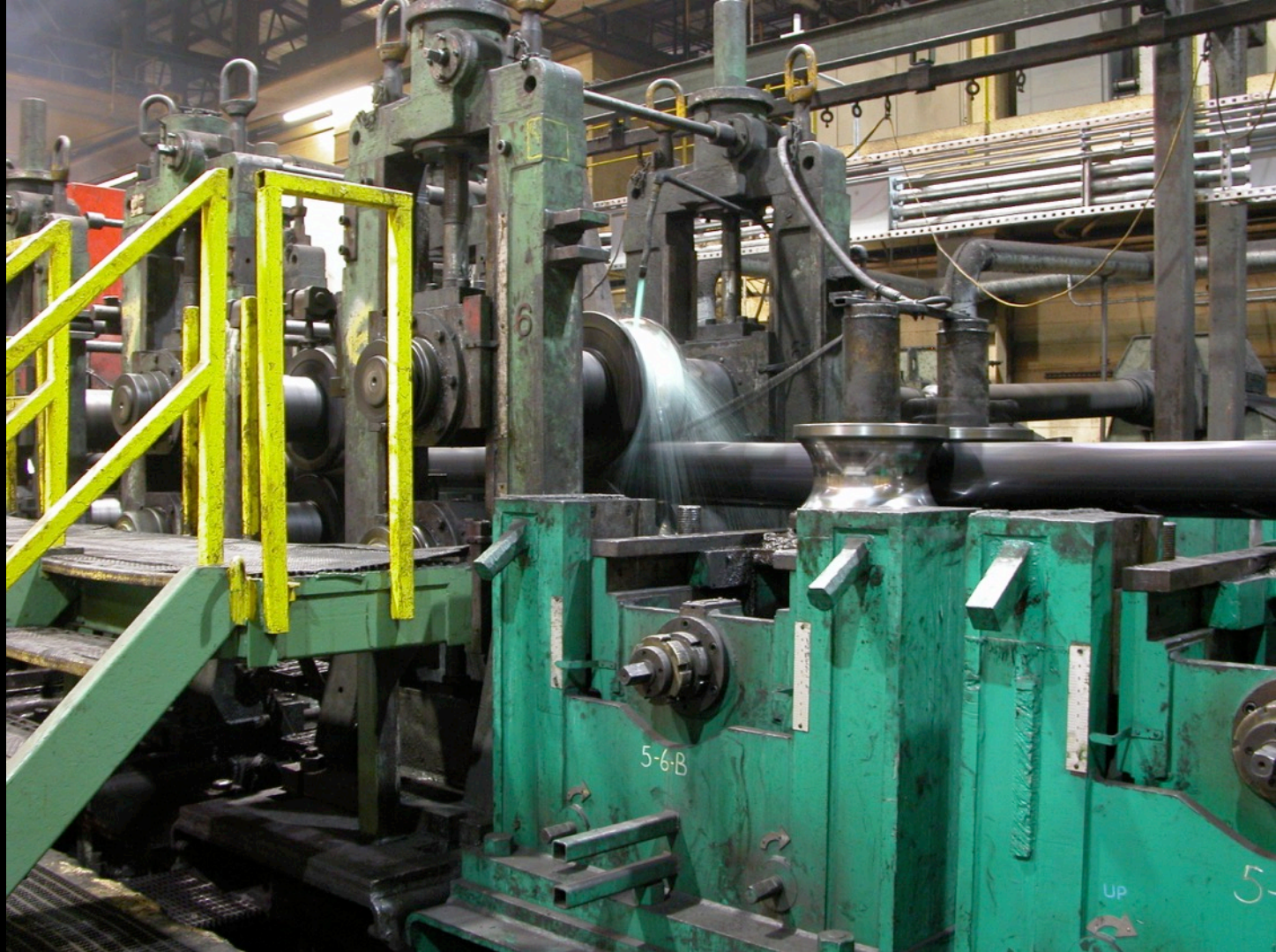
HW0216  
33  
10x6

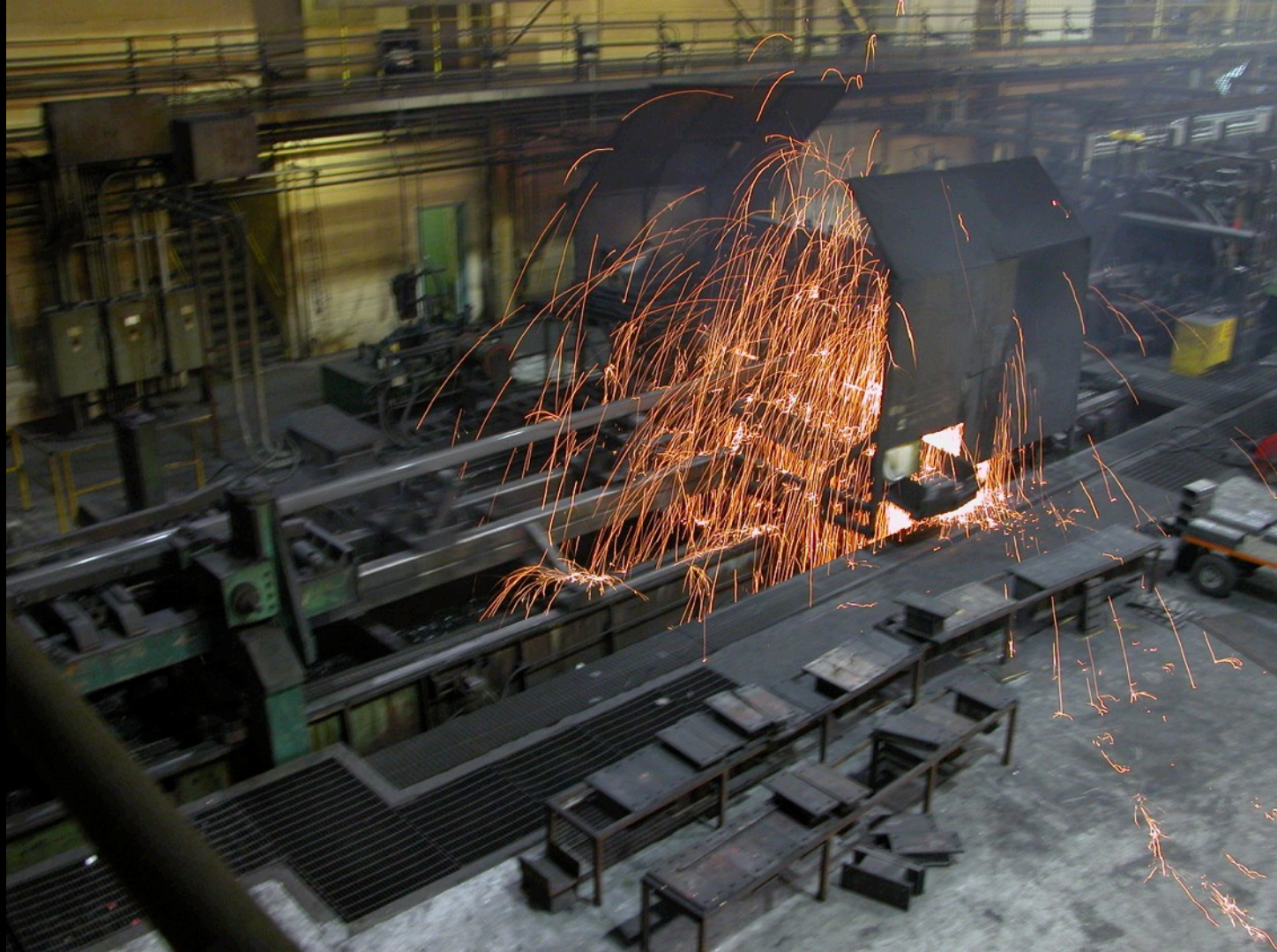
HW0216  
33  
10x6



Hollow Structural Sections  
AKA HSS













STKR600 SIZE: 300x200x1200 11110 HEATNO: 2005076  
STKR600 SIZE: 300x200x1200 11110 HEATNO: 2005076  
STKR600 SIZE: 300x200x1200 11110 HEATNO: 2005076

SHANGHAI METAL CO. LTD  
NO. 1000000000  
SPEC. STKR600  
SIZE: 300x200x1200  
HEAT NO: 2005076

STKR600 SIZE: 300x200x1200 11110 HEATNO: 2005076  
STKR600 SIZE: 300x200x1200 11110 HEATNO: 2005076  
STKR600 SIZE: 300x200x1200 11110 HEATNO: 2005076

STKR600 SIZE: 300x200x1200 11110 HEATNO: 2005076  
STKR600 SIZE: 300x200x1200 11110 HEATNO: 2005076  
STKR600 SIZE: 300x200x1200 11110 HEATNO: 2005076

SHANGHAI METAL CO. LTD  
NO. 1000000000  
SPEC. STKR600  
SIZE: 300x200x1200  
HEAT NO: 2005076

2005 1 12



2005 8 7





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

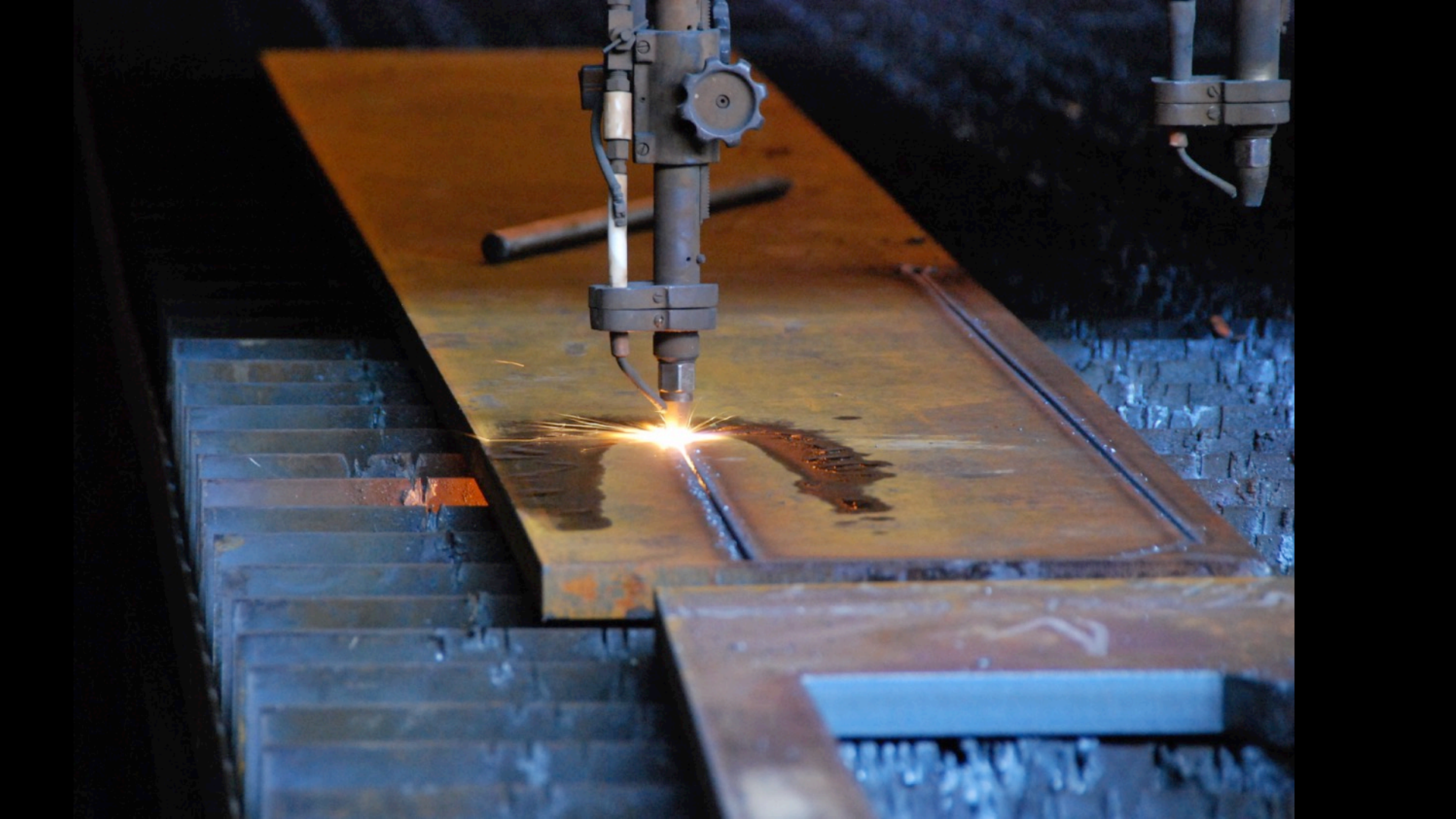
How rounded depends on the thickness of the steel plate.

HSS come:

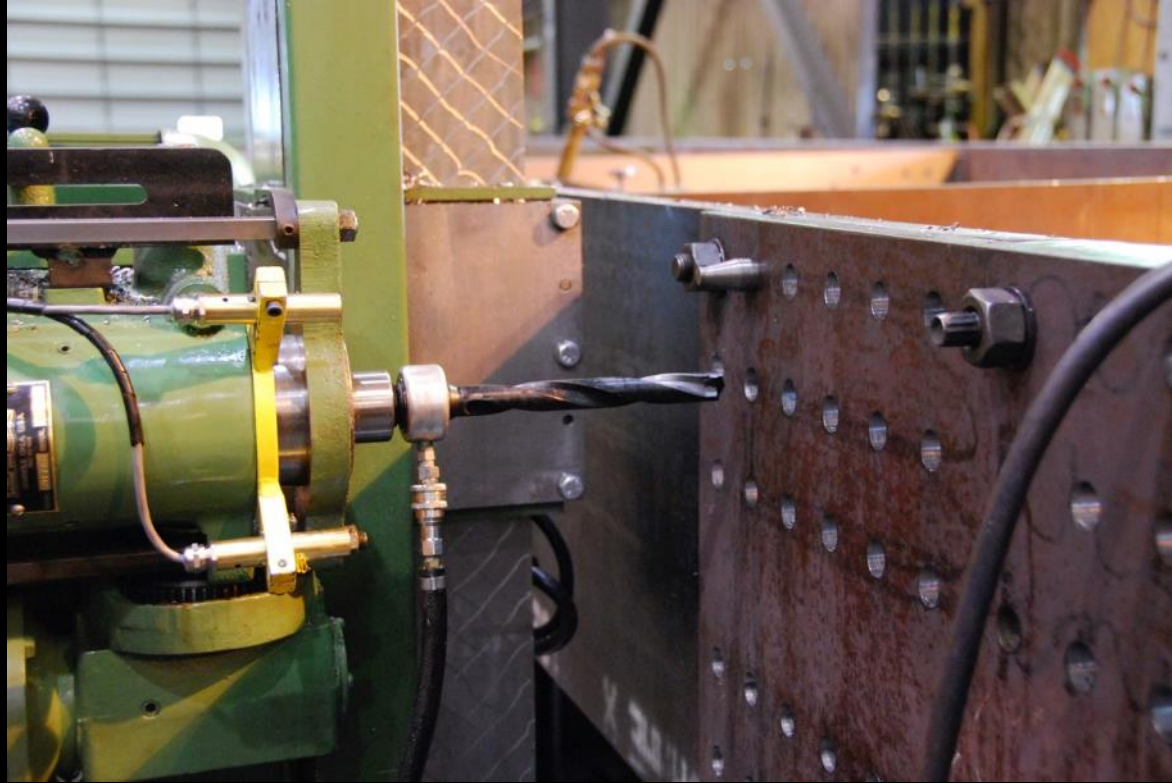
Square, rectangular, circular and in Europe, elliptical



# Fabrication Processes













PG

0527PH

7d

8B

PA

PB











# Principles of Connection

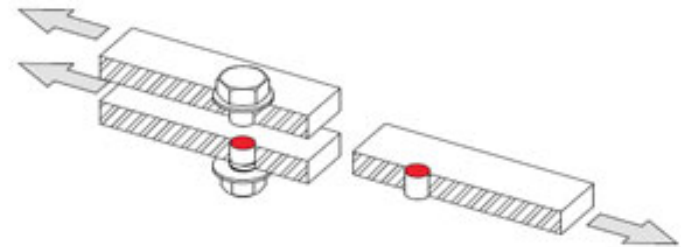
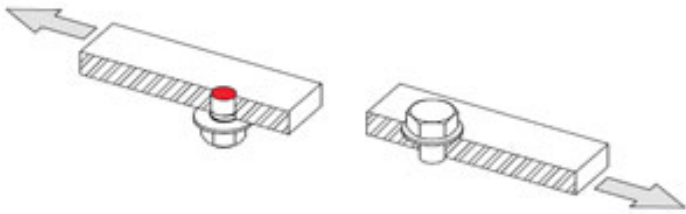
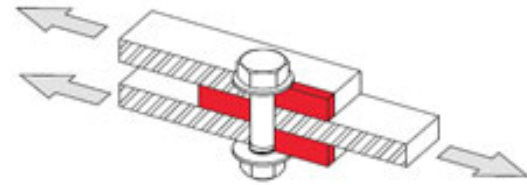
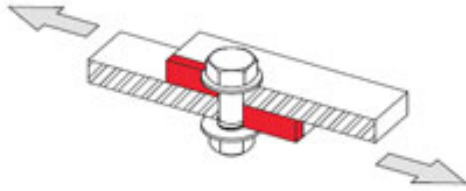
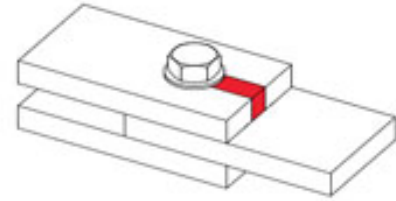
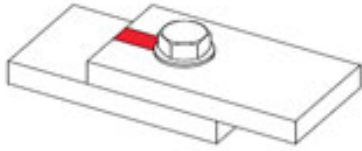


Hex Head Bolt

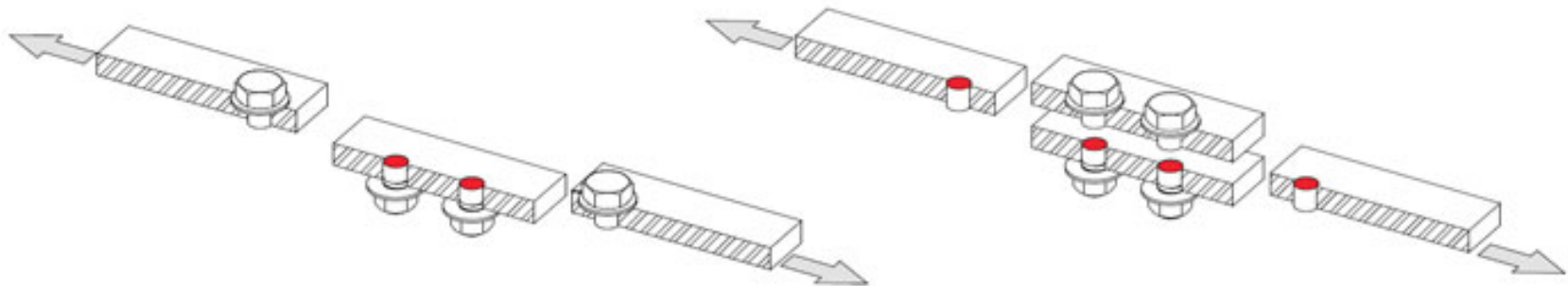
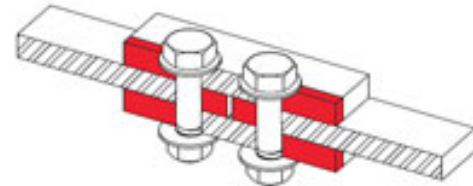
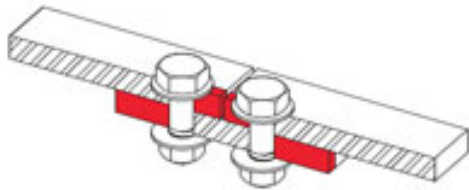
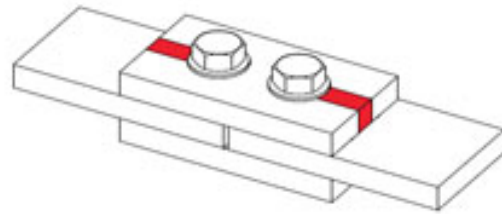
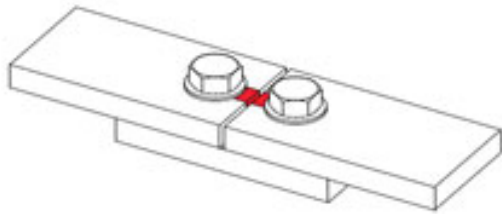


TC (Tension Control) Bolt

# Lap Joints



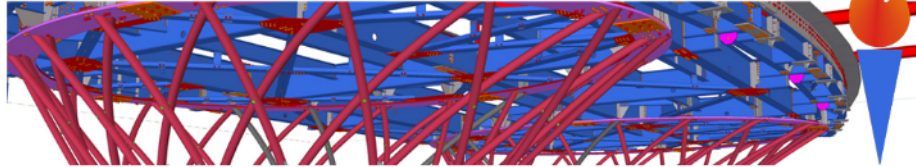
# Butt Joints



# 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

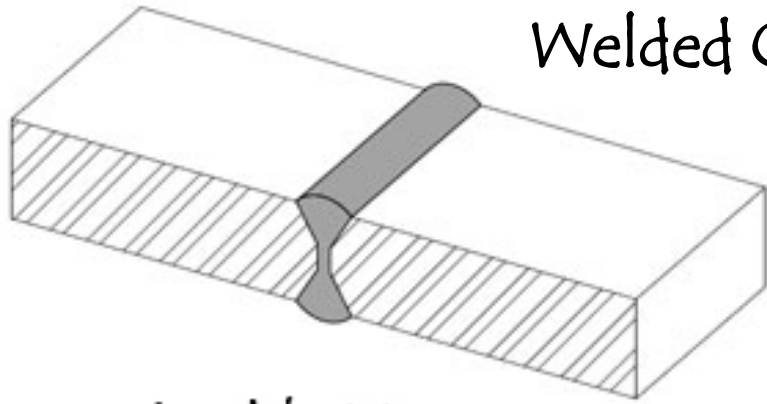
[Project Introduction](#)  
[Using the 3D PDFs](#)  
[About the Authors](#)  
[References and Links](#)  
[Site Index](#)  
[Legal Disclaimer](#)



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".

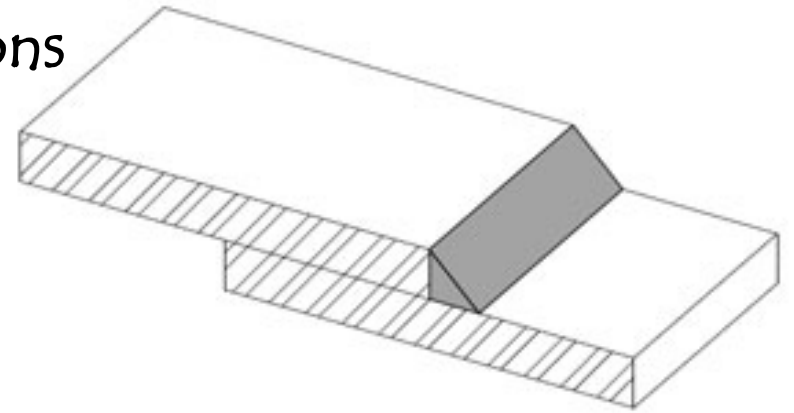
Please check out my [Facebook page for AESS](#) . Many more projects there!

# Welded Connections



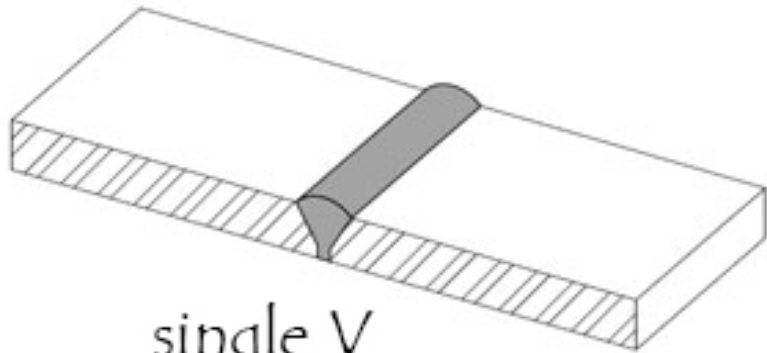
double V

BUTT

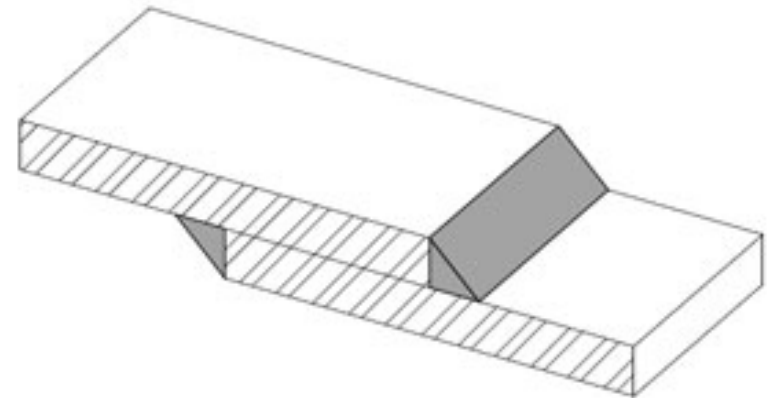


LAPPED

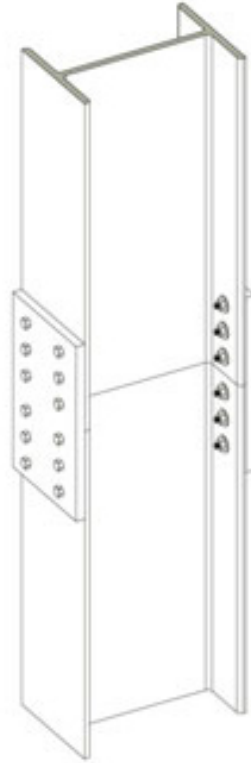
fillet weld



single V



# Column Splices













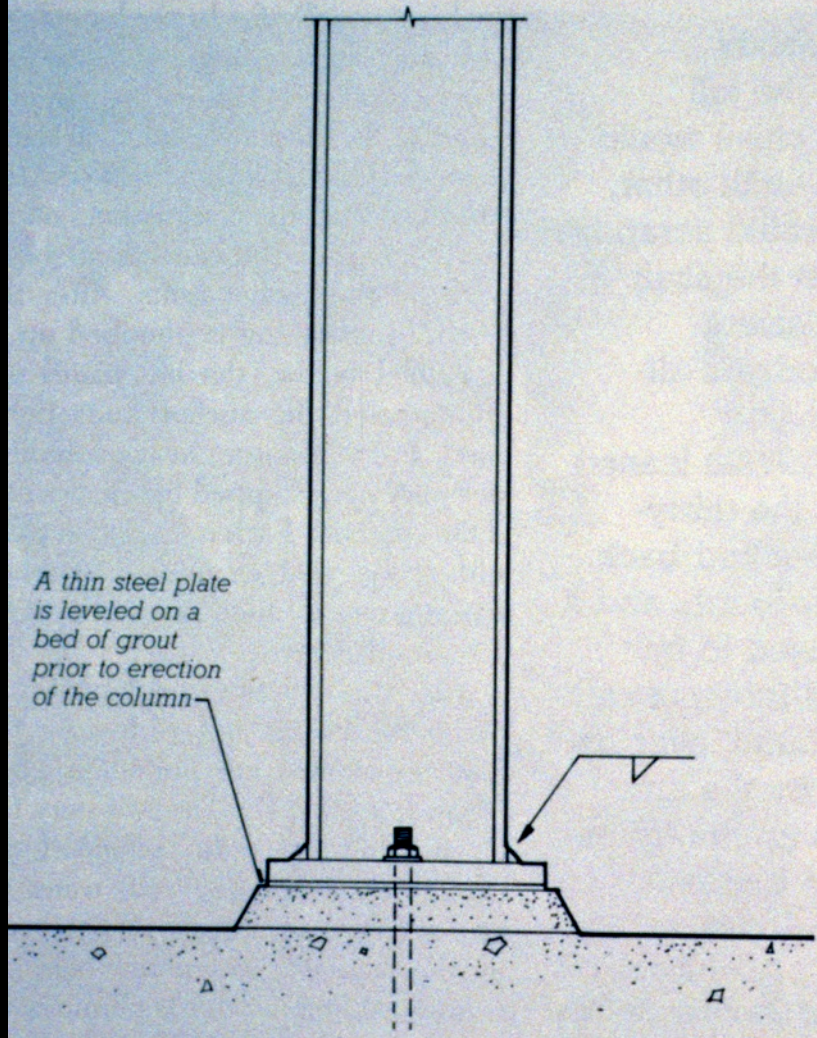
5

✓ PREP 13mm  
28 f

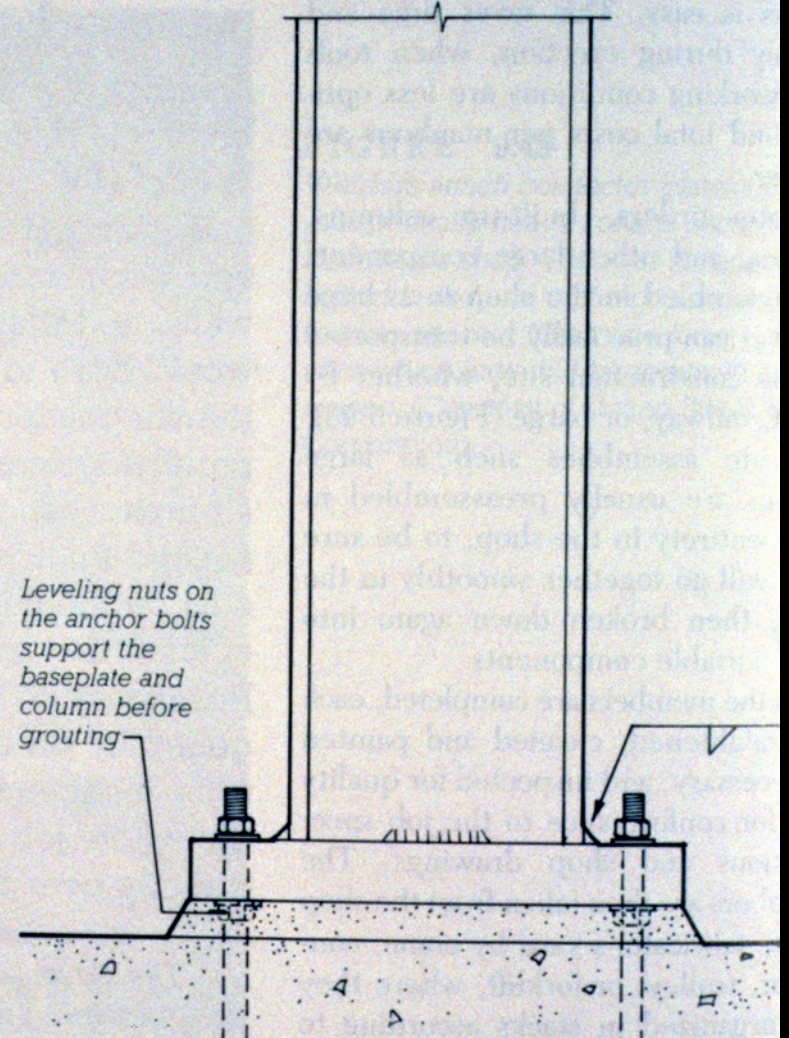
0999 99



*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*

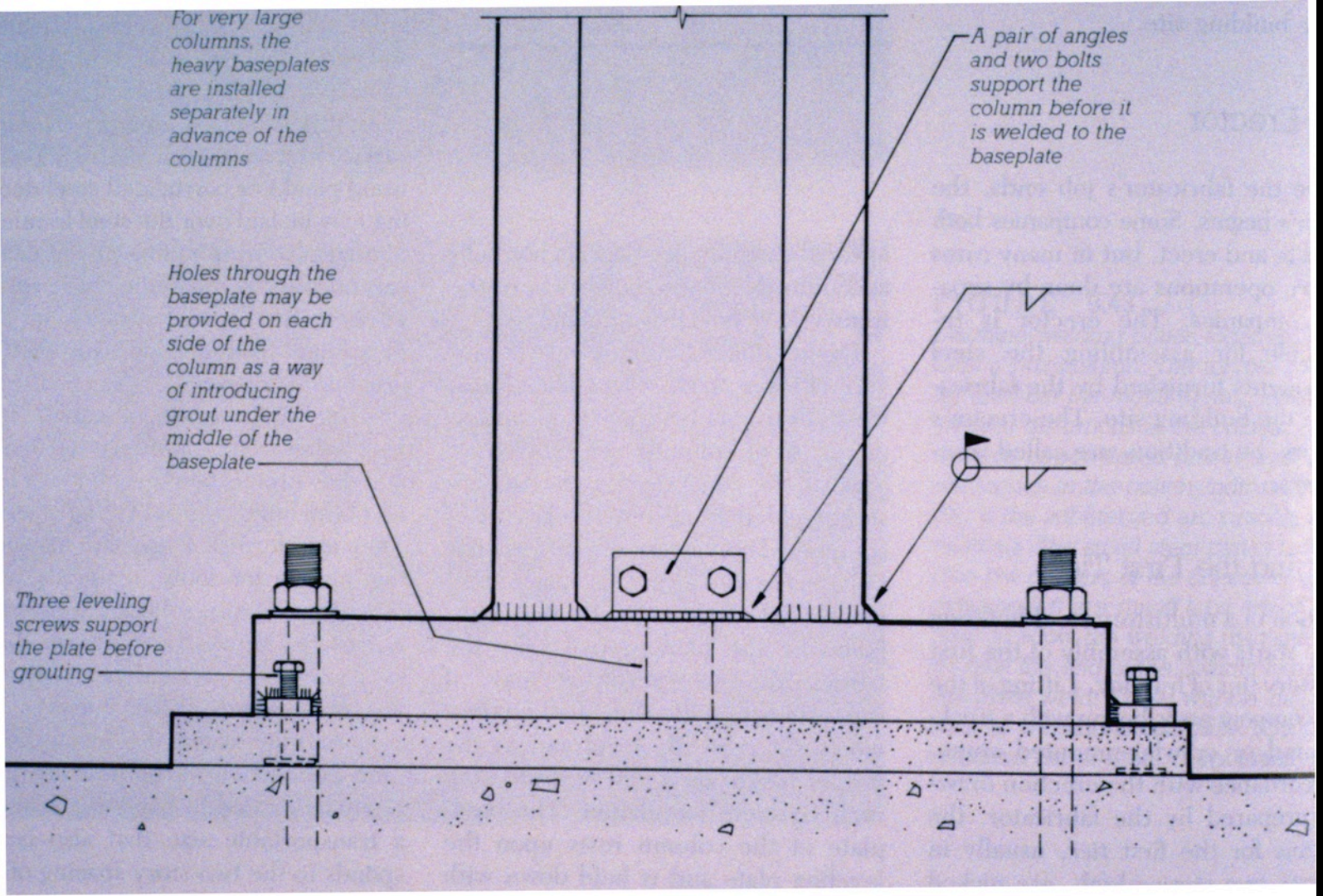


For very large columns, the heavy baseplates are installed separately in advance of the columns

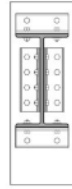
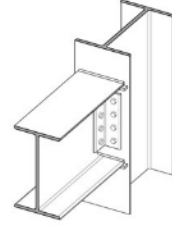
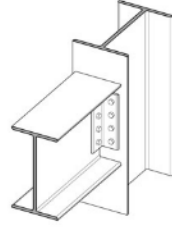
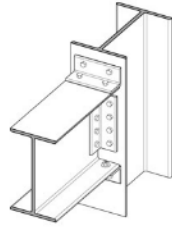
A pair of angles and two bolts support the column before it is welded to the baseplate

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

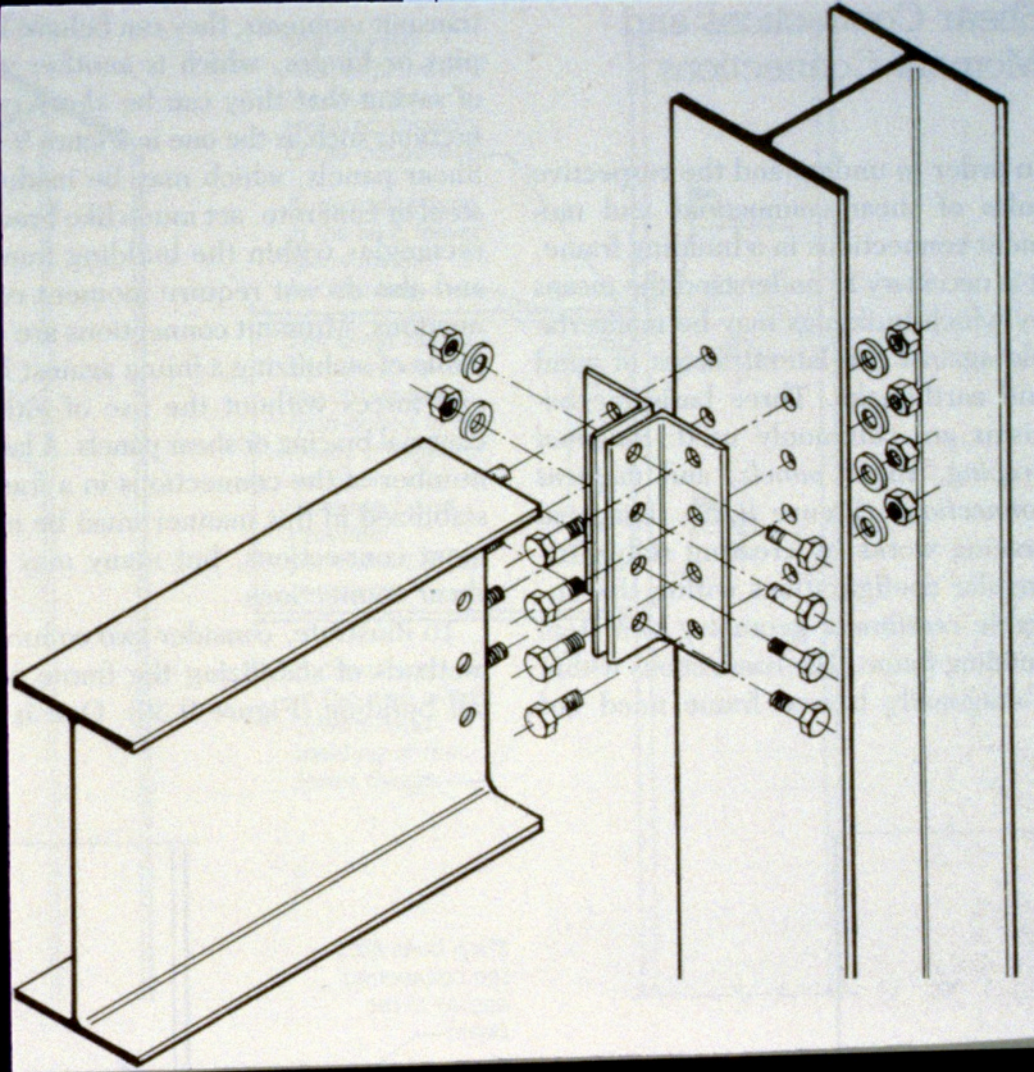
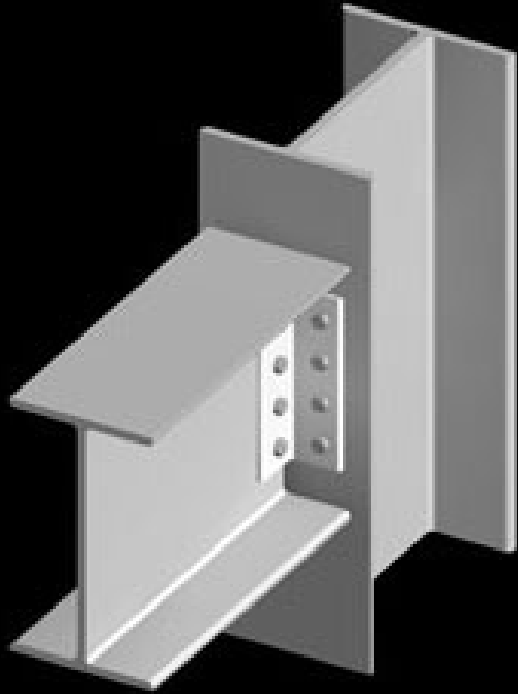
Three leveling screws support the plate before grouting



# Beam to Column Connections

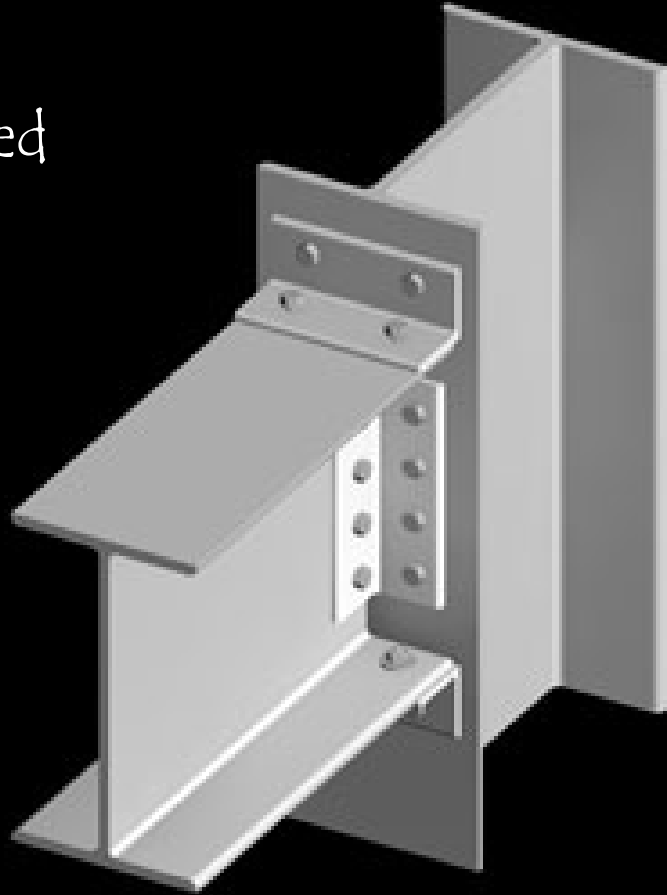


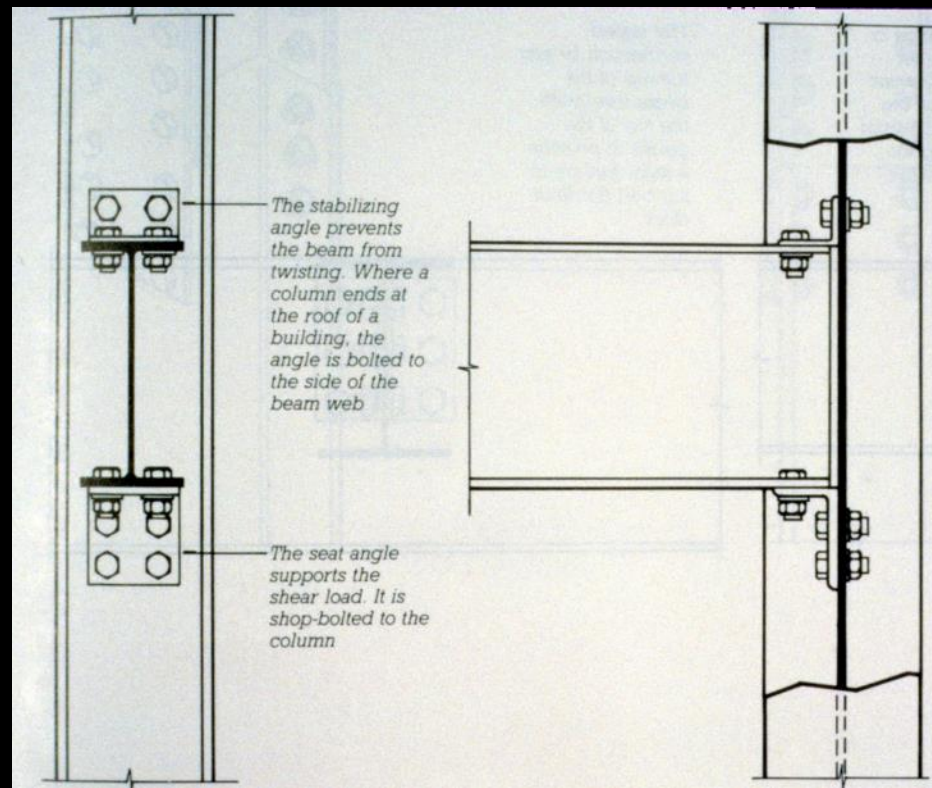
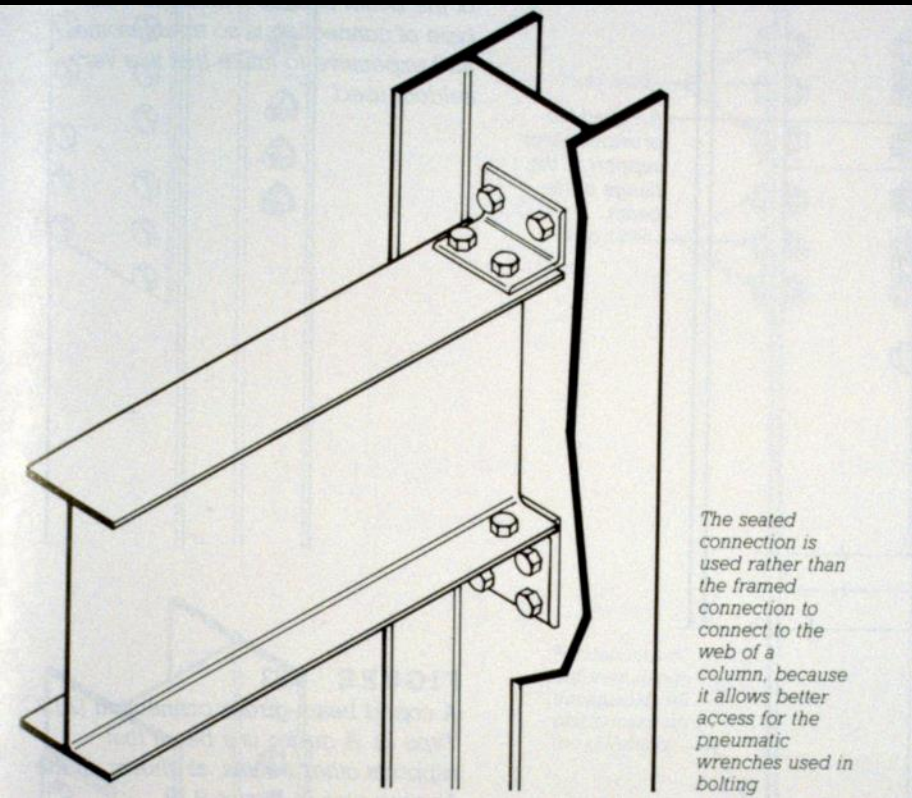
Framed



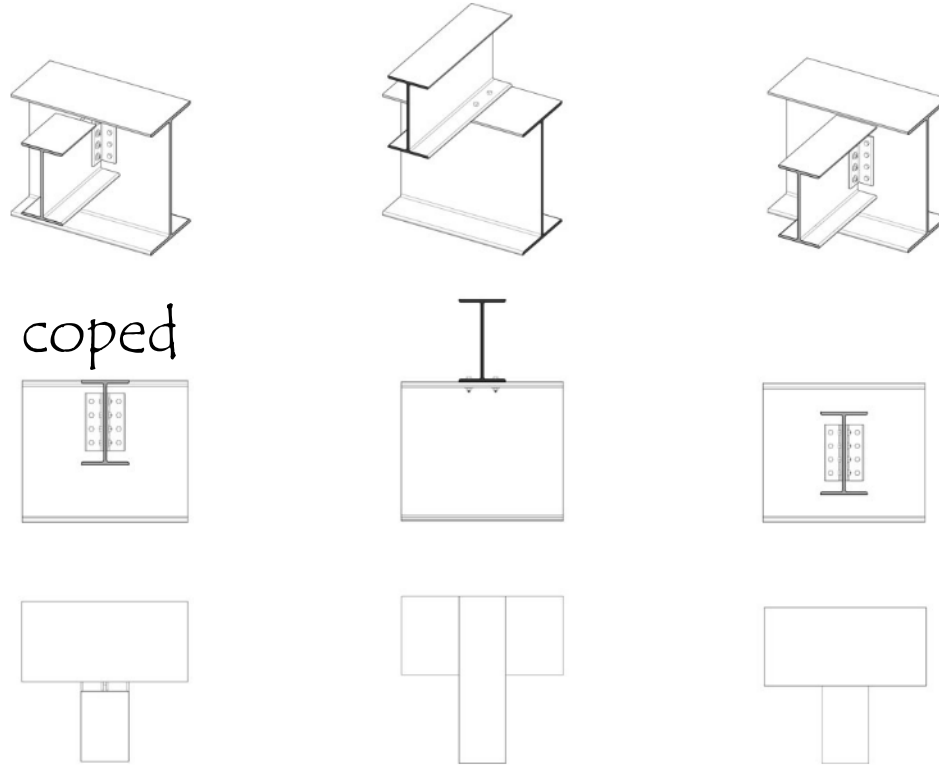


Seated

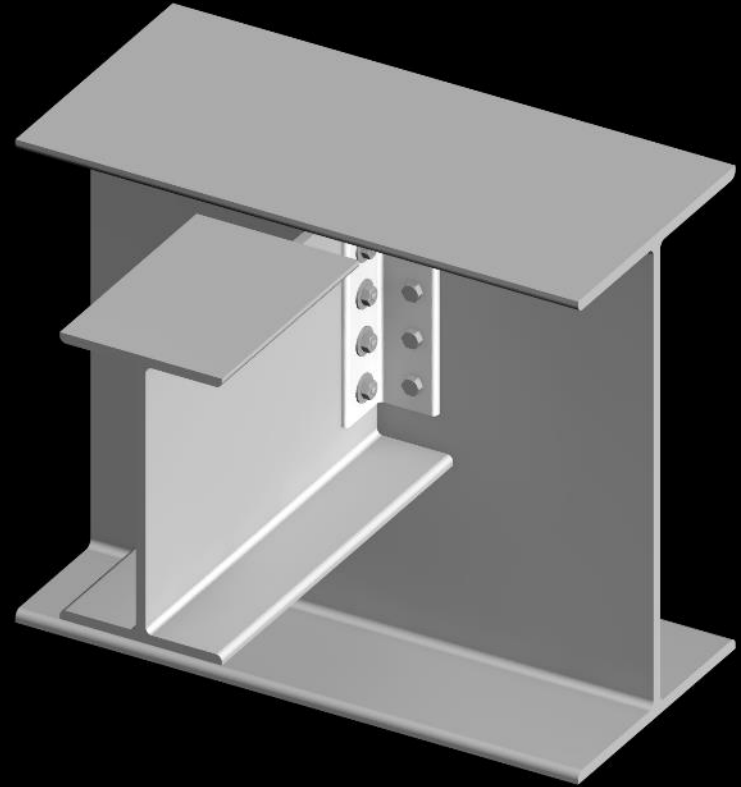




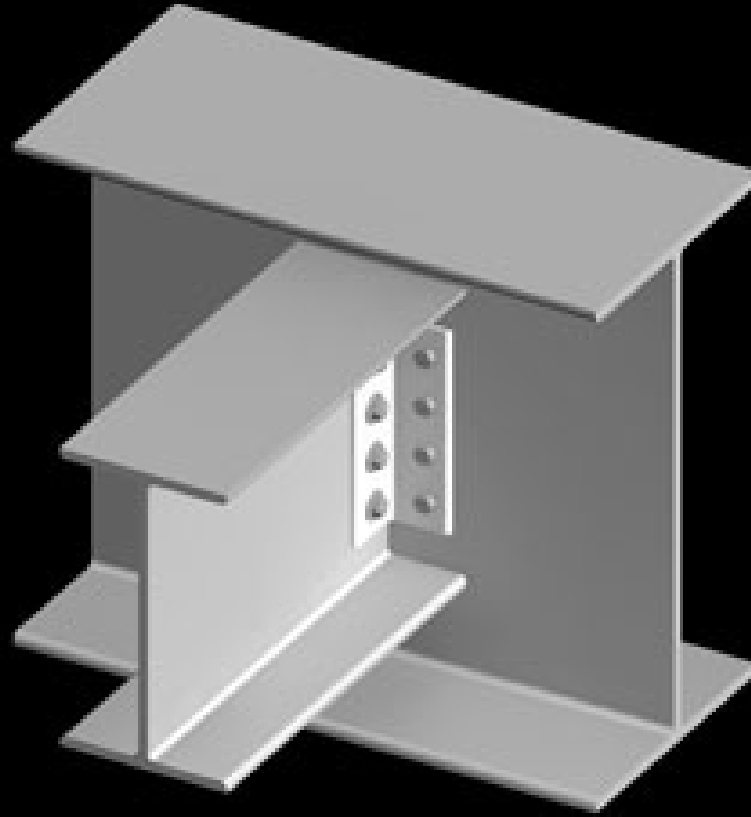
# Beam to Girder Connections



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.

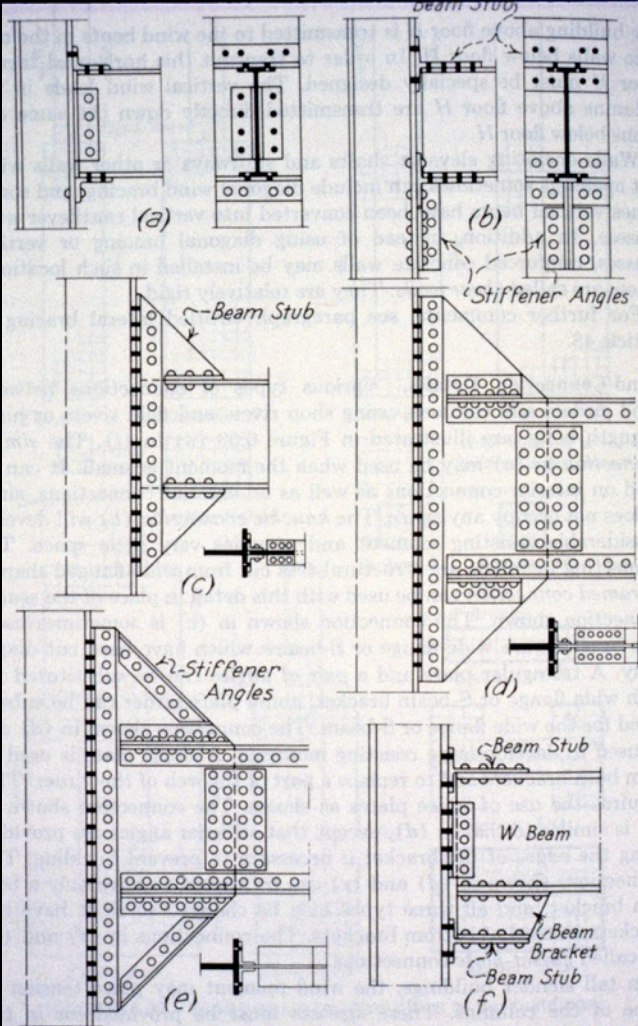


Framed  
connection  
has the beam  
flange below.



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

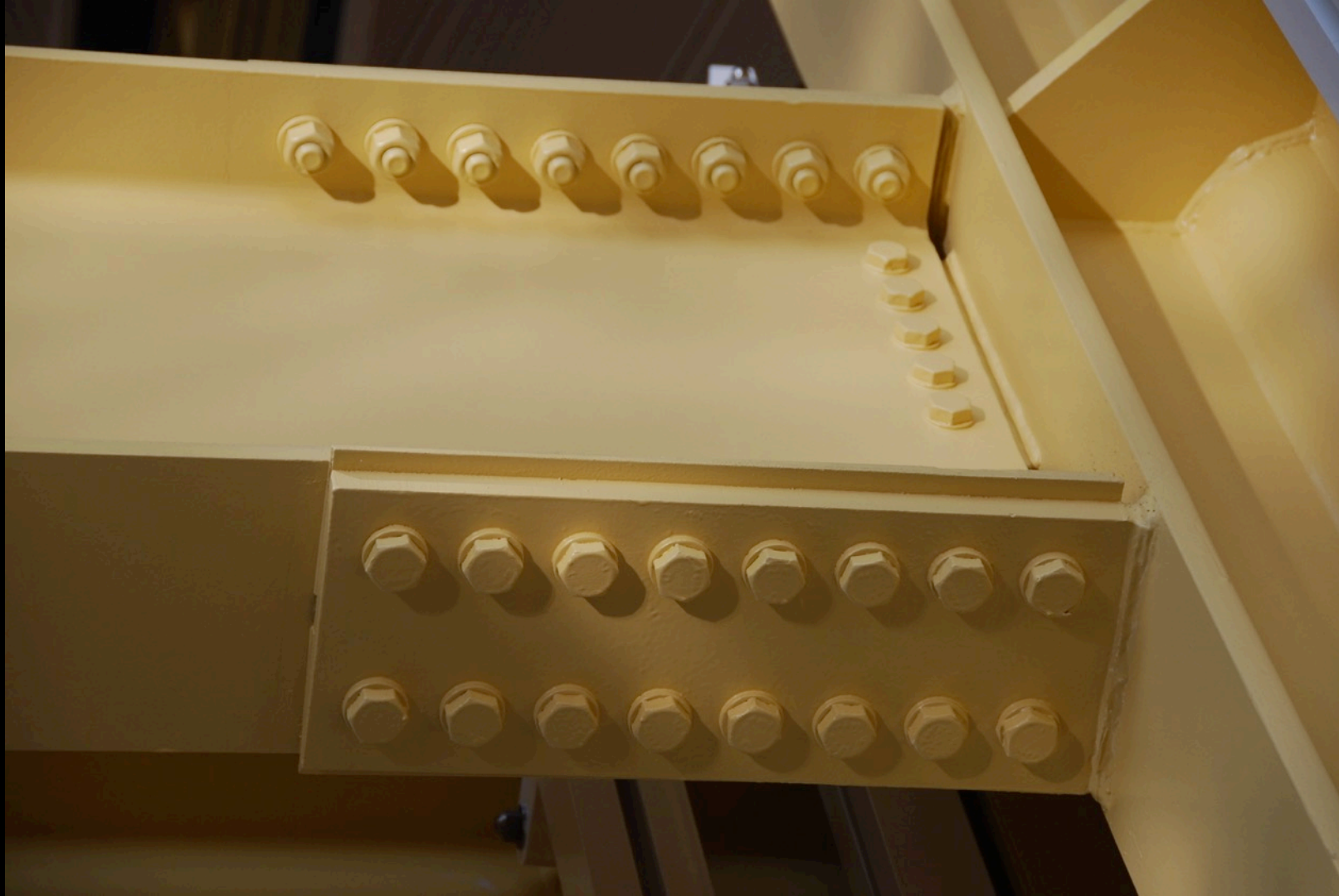
- Resists bending and rotation

















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

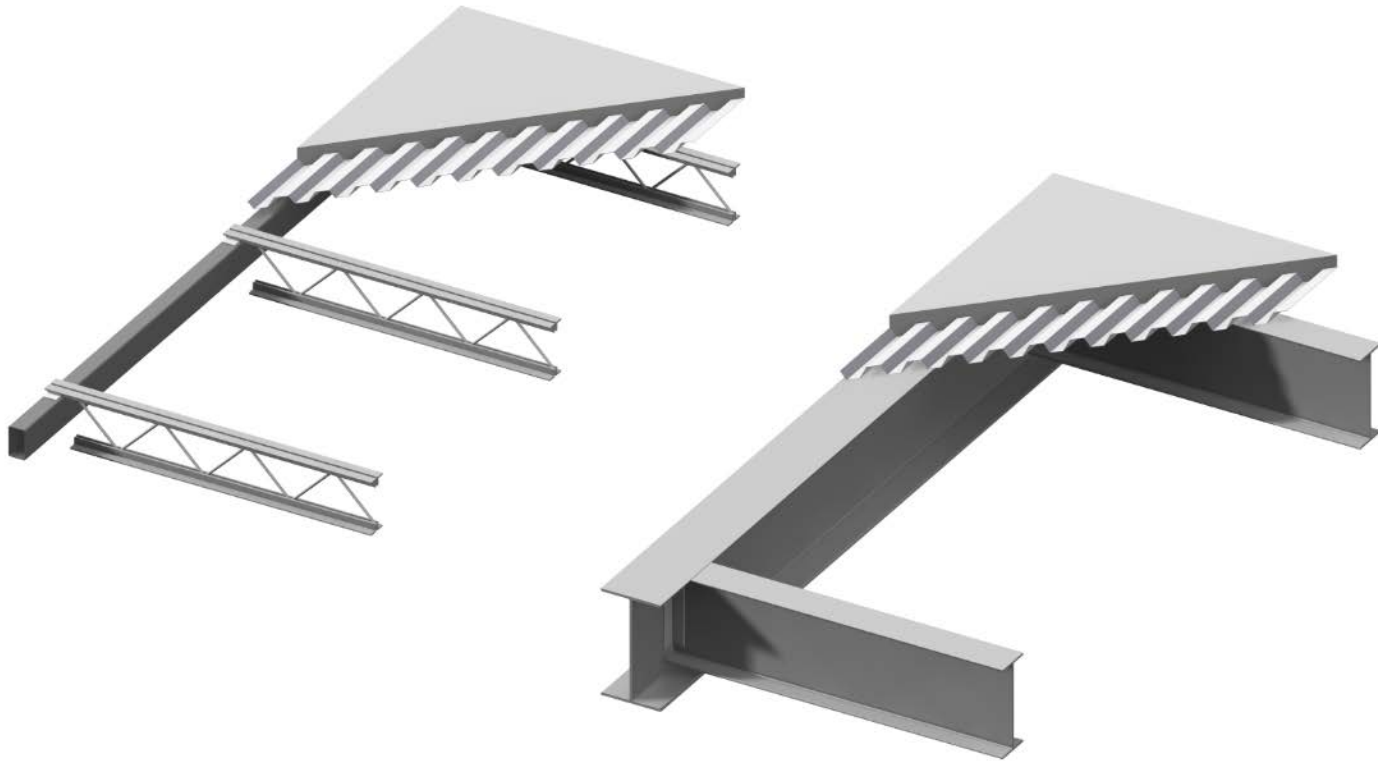
Joists or Beams

Sit on Girders

Girders frame into columns



# Floor Systems



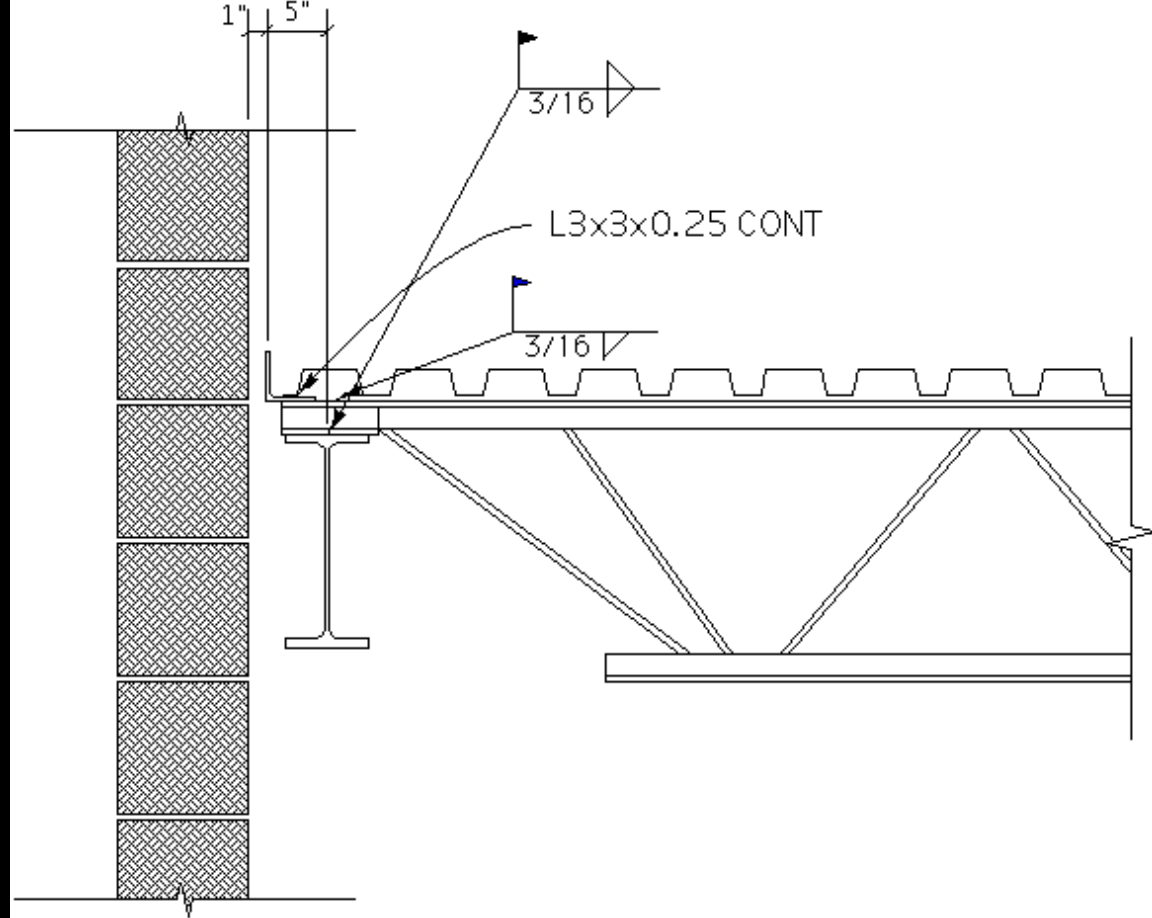




ABSOLUTELY  
UNMATCHED  
IN THIS CLASS  
OF ENGINEERING

Open web steel joists

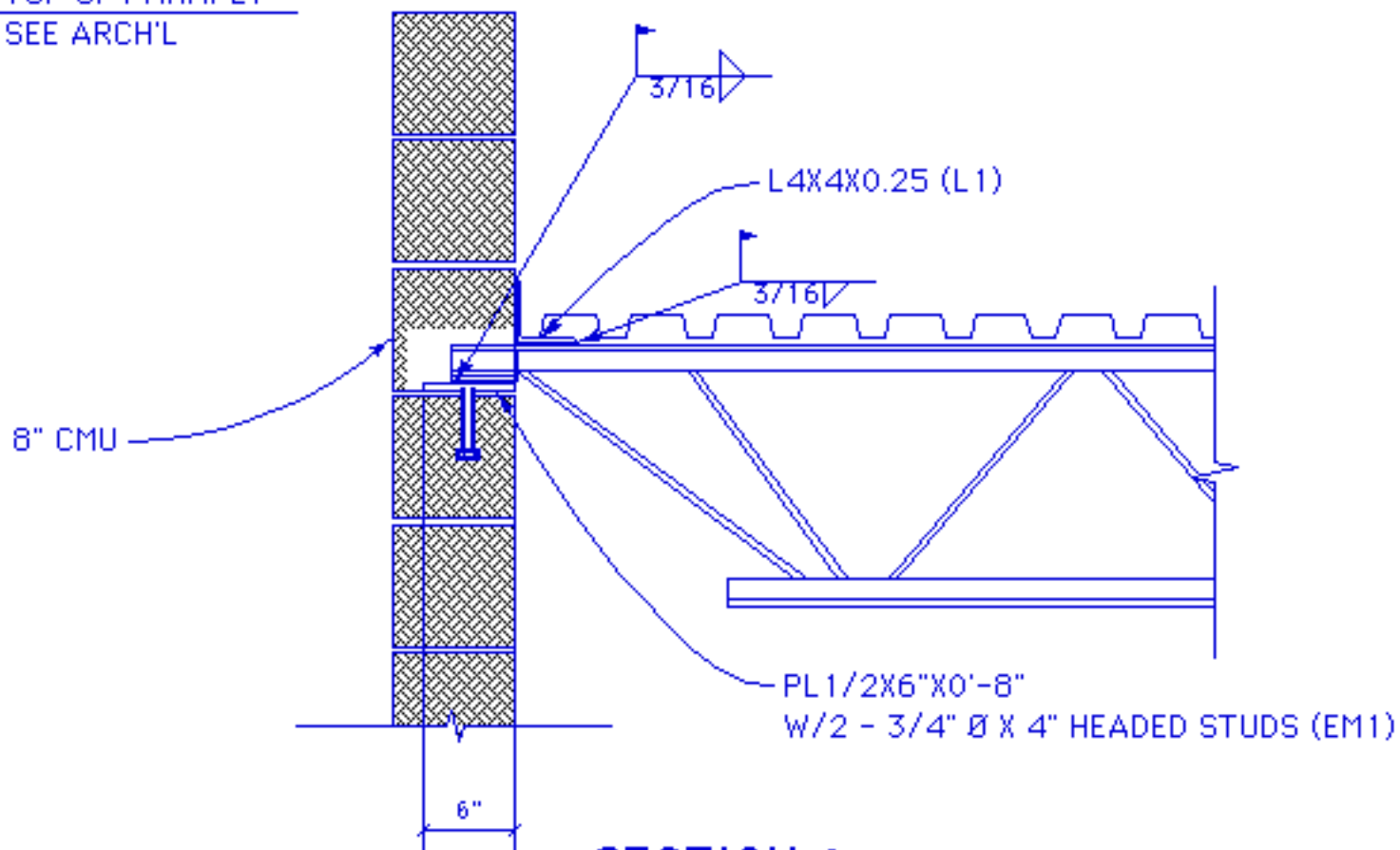




**SECTION 13**



TOP OF PARAPET  
SEE ARCH'L



SECTION 1

















karin pouta

erni patti pappi

madualla jayne morosimo

amelia

shanna

premiere

kevin

barbara

benini

oscar

gabriel

haniel

allie

tonio

oscar

olivia

lesano

marjanna

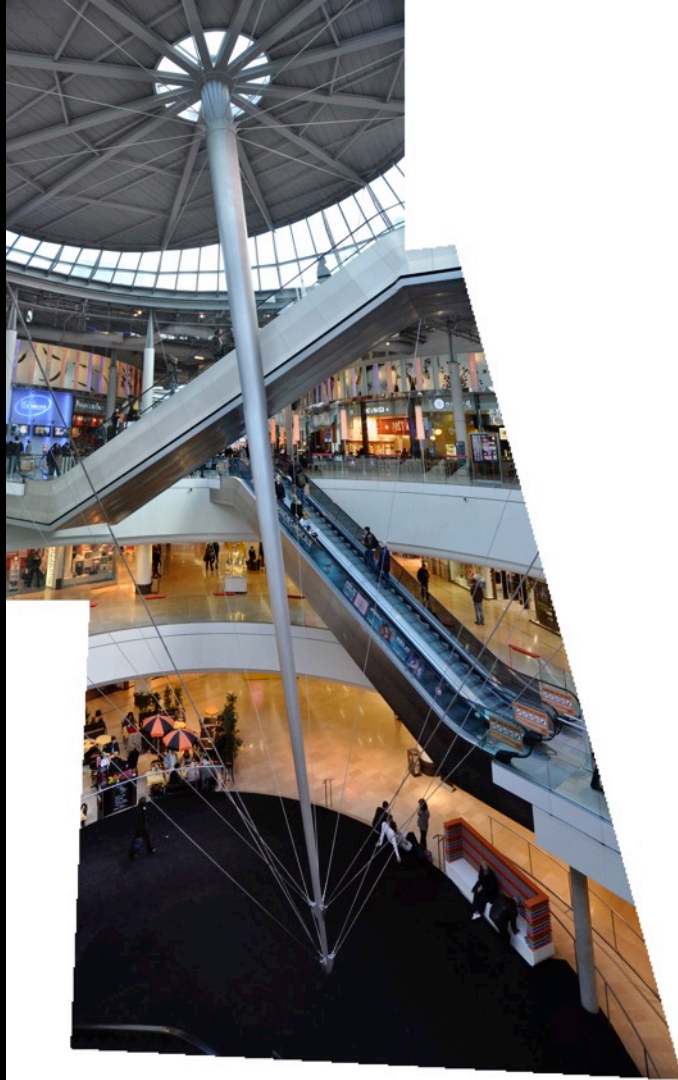
marcos









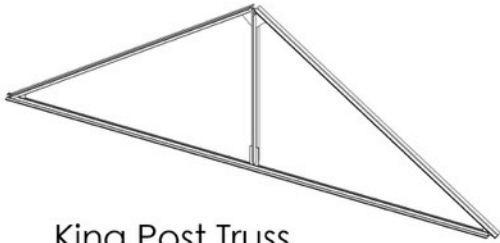




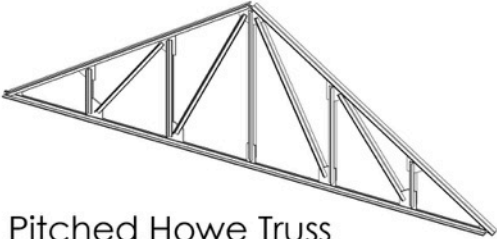




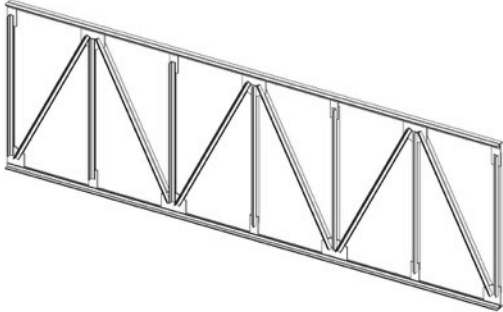
# PLANAR TRUSSES



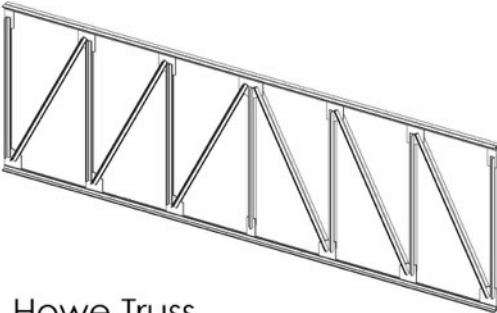
King Post Truss



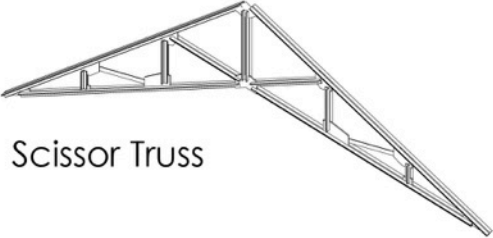
Pitched Howe Truss



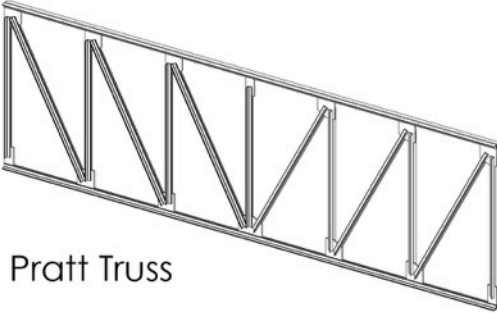
Modified Warren Truss



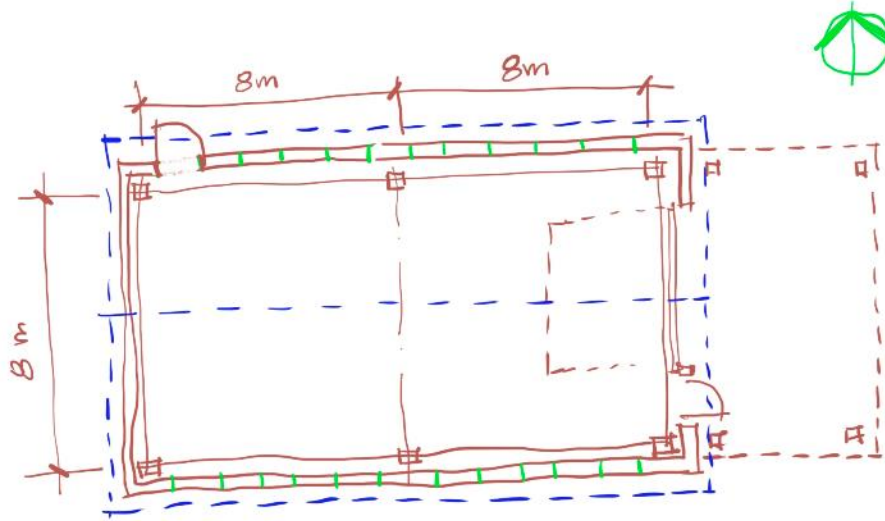
Howe Truss



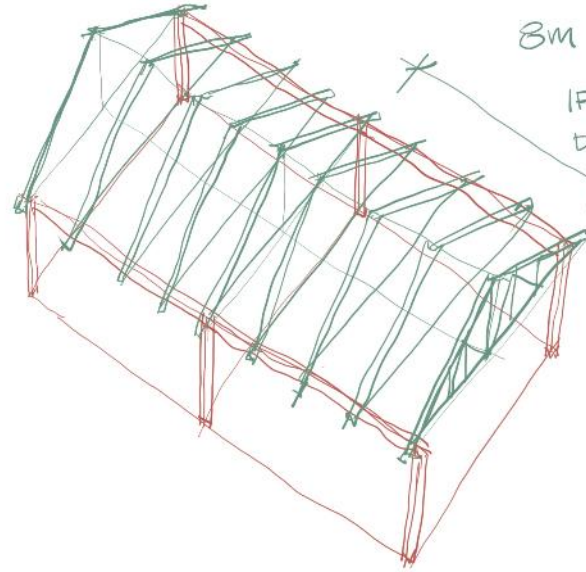
Scissor Truss



Pratt Truss

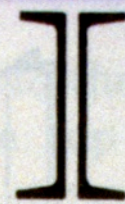
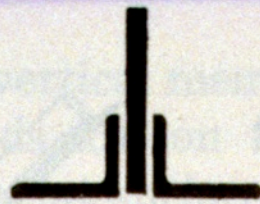


BASIC PLAN

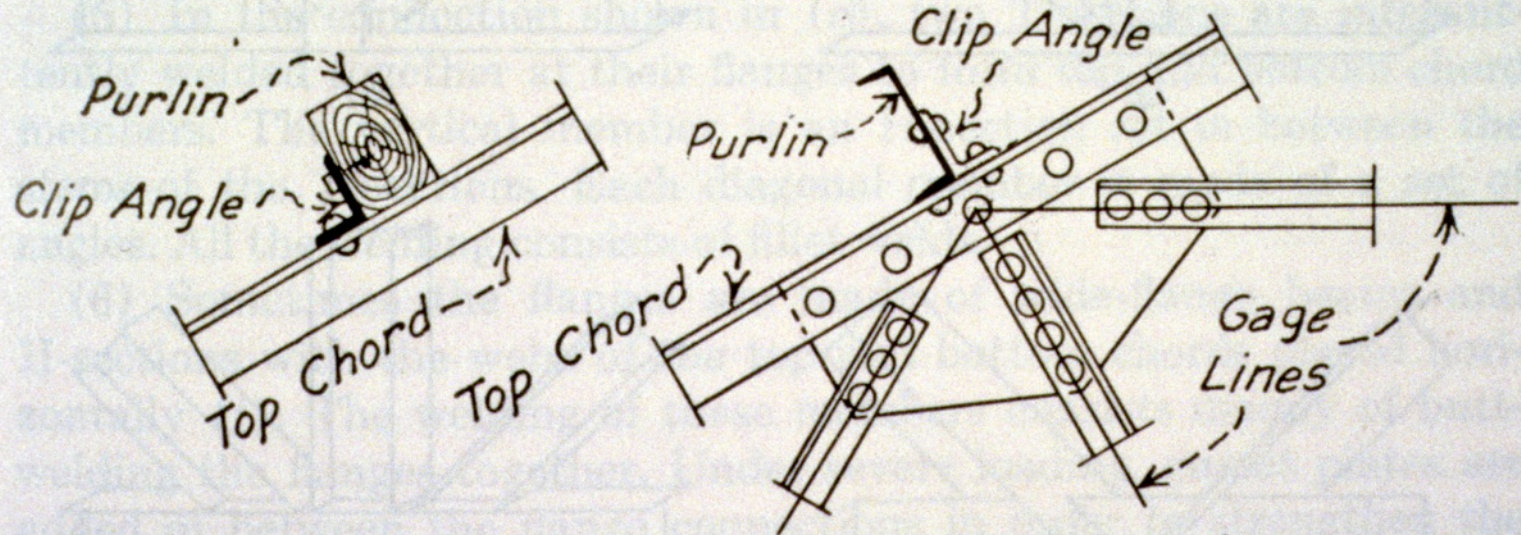


8m ÷ ?

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.

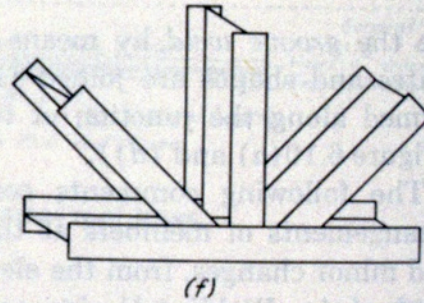
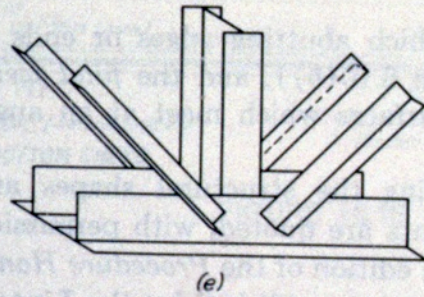
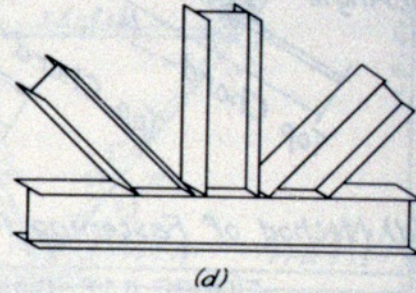
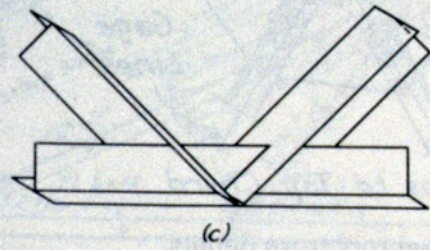
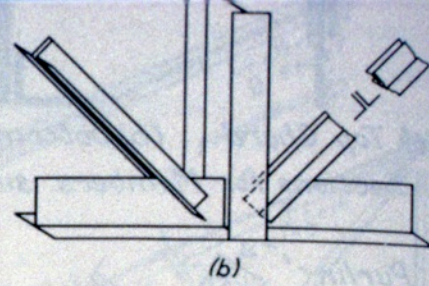
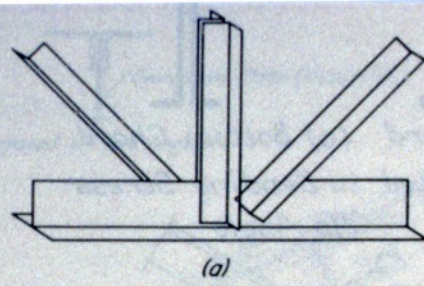
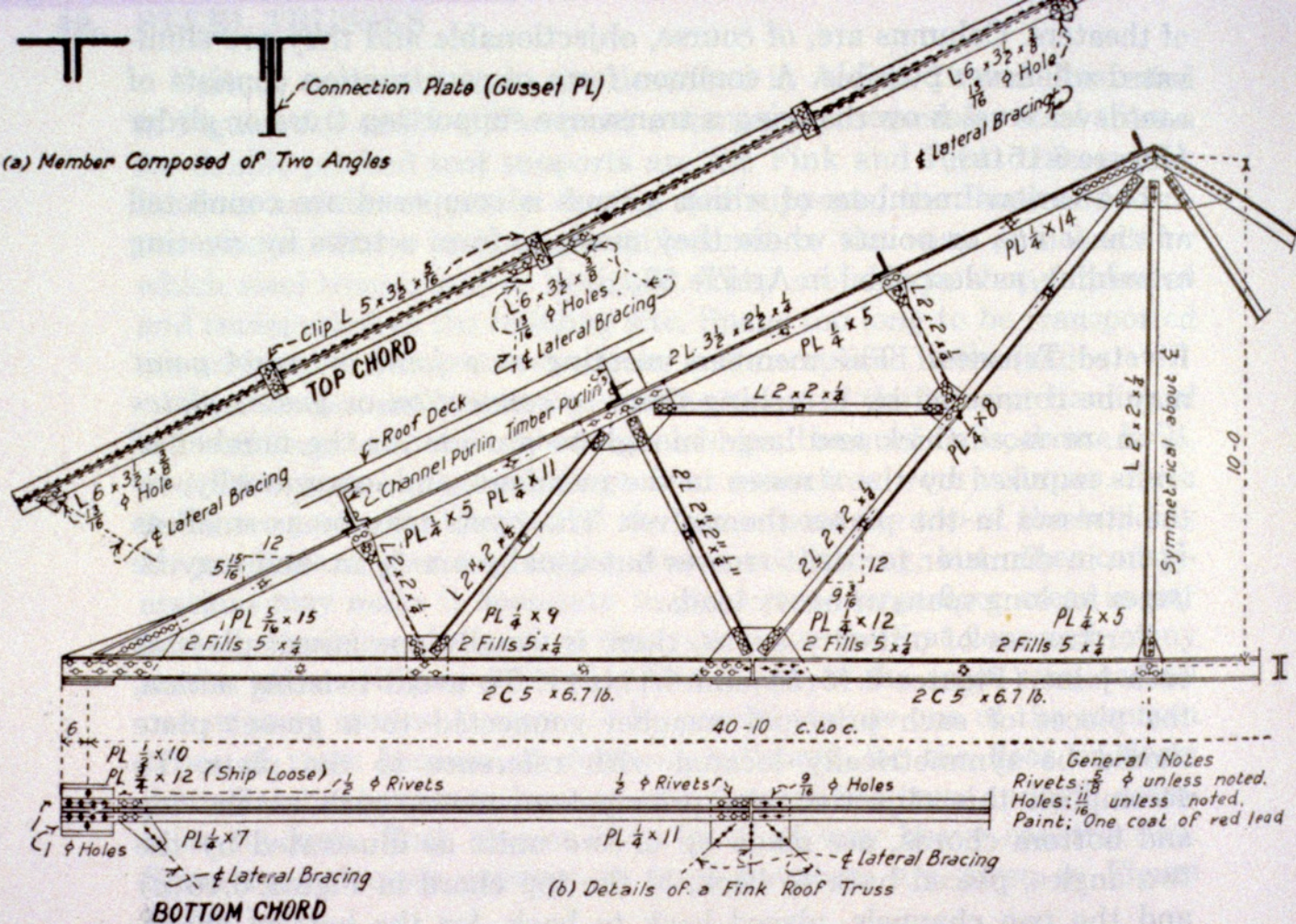


FIGURE 6.18 Connections for simple welded trusses. Lincoln Electric Company.





(a) Member Composed of Two Angles



General Notes  
 Rivets:  $\frac{3}{8}$   $\phi$  unless noted.  
 Holes:  $\frac{11}{16}$  unless noted.  
 Paint; One coat of red lead

(b) Details of a Fink Roof Truss

FIGURE 16.16 Fink steel roof truss.



ELEVATOR

ELEVATOR  
BAGGAGE



















The New School,  
NYC







ONE WAY

114 570 Lbs / 57285 + on  
A Dec 192011

CLOSE

HOUSE

POST NO  
BILLS

























01

794005

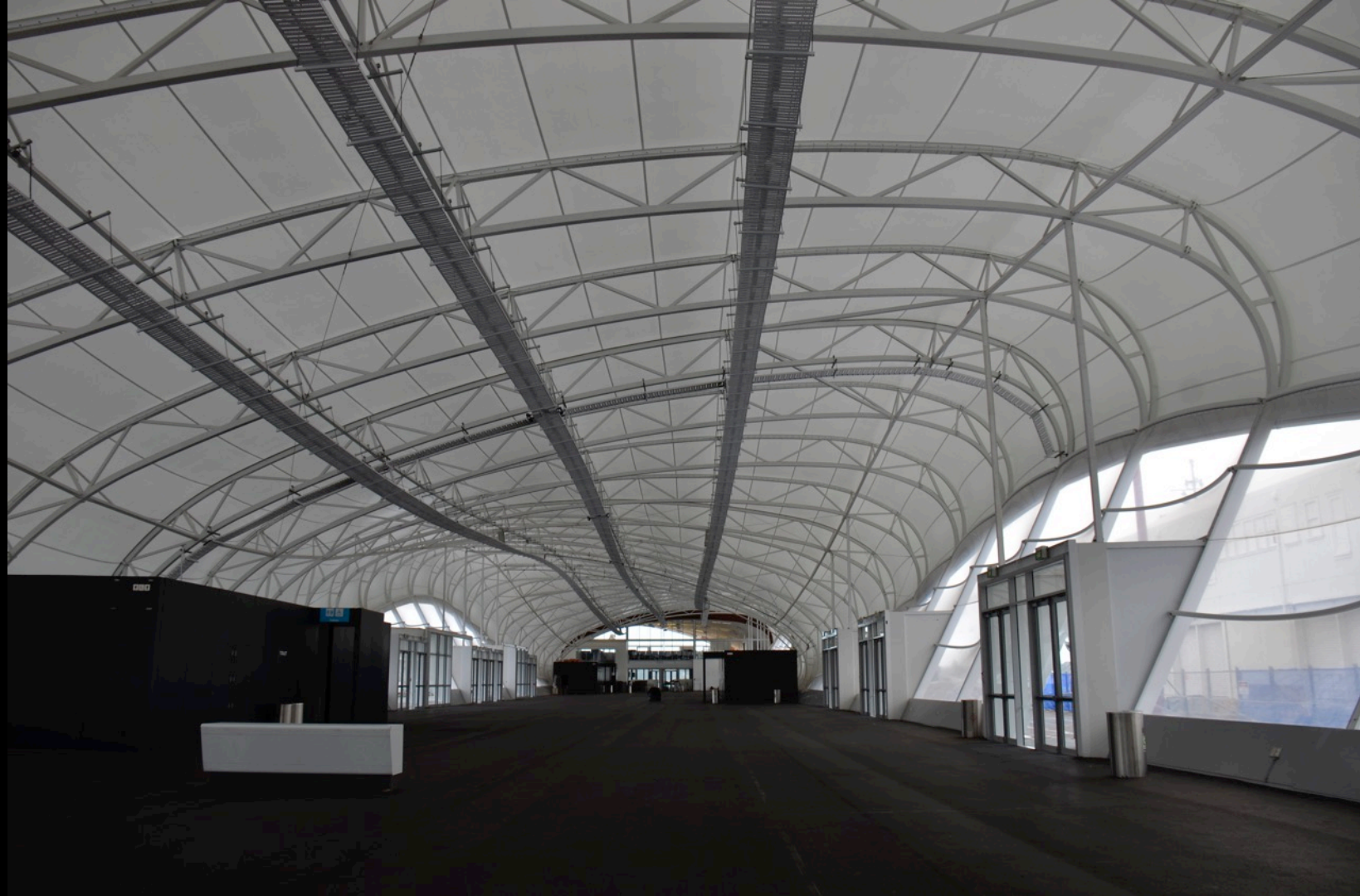






The Cloud  
Auckland, NZ









Les Ailes Shopping Centre  
Montreal, QC




★ War Museum  
Ottawa, ON









The image shows the exterior of the Calgary Water building, a modern architectural structure. The building features a large, curved, arched glass facade that reflects the sky and surrounding environment. A prominent vertical column supports the structure. The building is surrounded by a paved walkway, a parking area with a red motorcycle, and landscaped areas with mulch and young trees. The sky is blue with scattered white clouds.

Calgary Water  
Calgary, AB





# Box Truss





Sainsbury Centre  
England

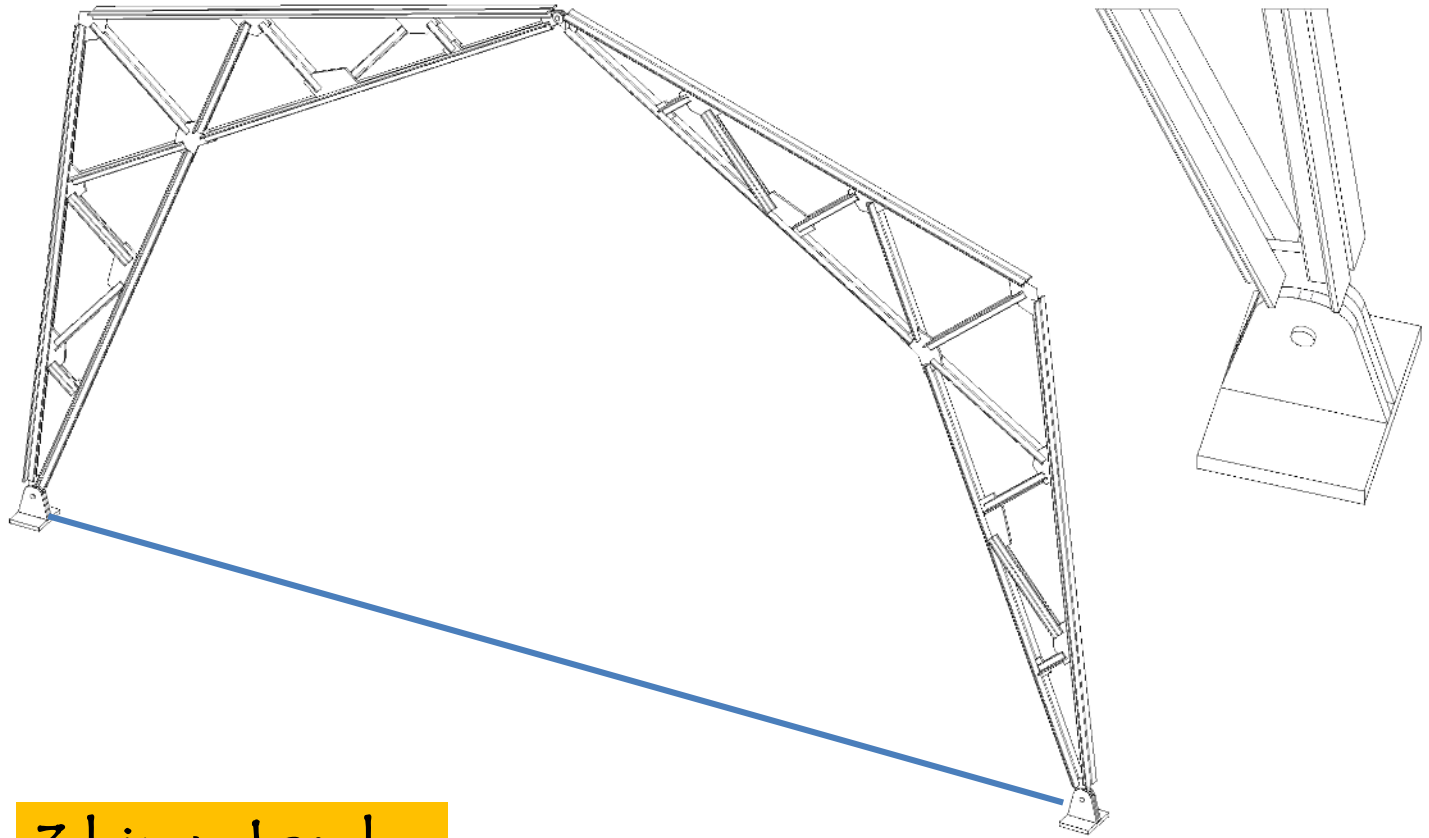


Triangular Truss









3 hinged arch





# Rigid Frames

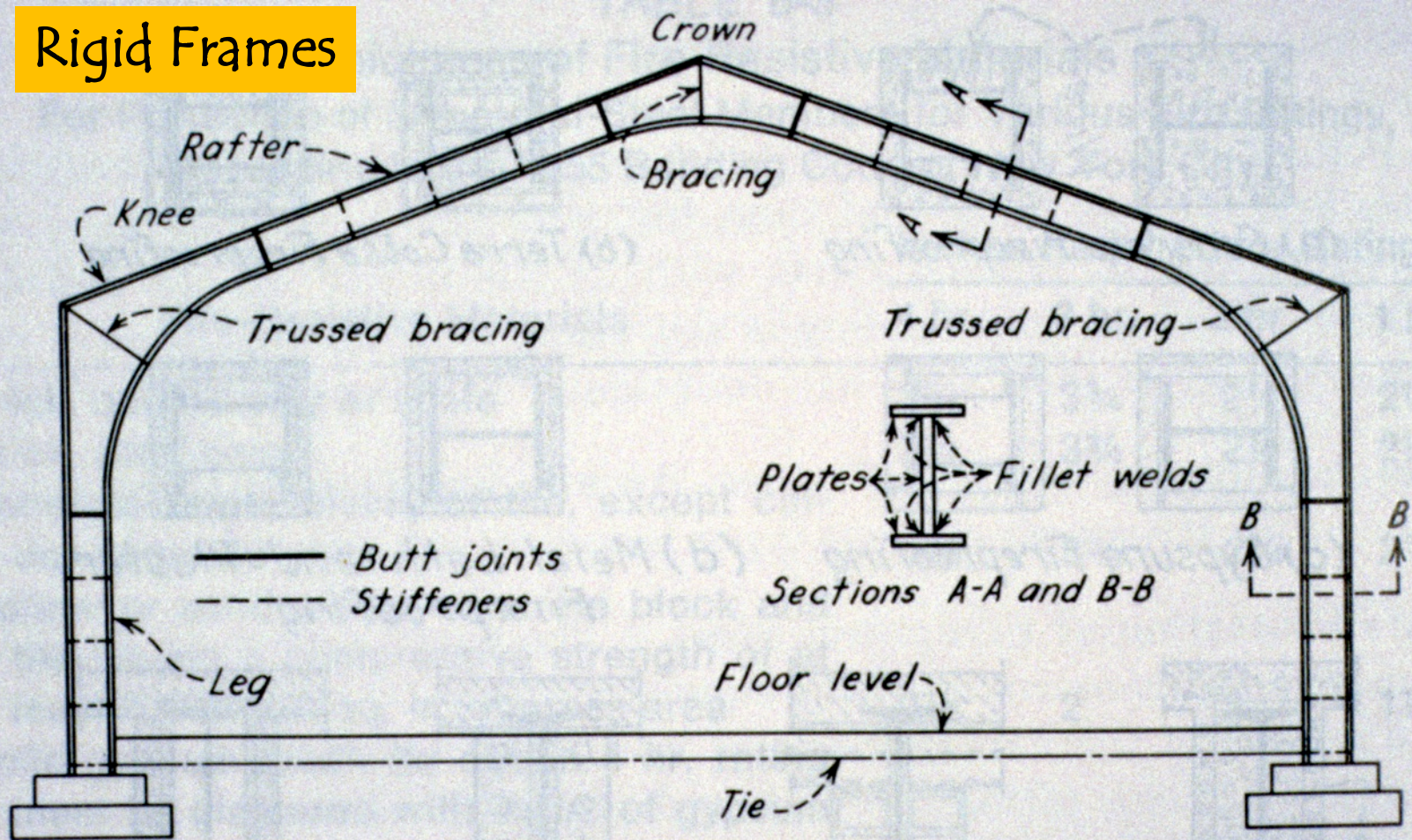


FIGURE 6.32 Steel rigid frame.

Friedrichstrasse Station  
Berlin, Germany



**BIOSPHÄRE  
POTSDAM**

30.08.19 10:00 - 30.08.19 19:00  
VON SAURIERN UND  
SABELZAHNTIGERN

←

Wendehorst	Strussberg Nord
Potsdam Hbf	Ahrenhöhe
Berlin-Spandau	Elster
Berlin-Spandau	Wartenberg

→

U

♿





FRIEDRICHSTADT PALAS  
Europas größter und modernster Show-Palast

Yma ZU SCHÖN,  
UM WAHR ZU SEIN

Previews ab 21. August | Weltpremiere 2. September  
tickets@palast.de | Tickets: 030 - 2326 2326

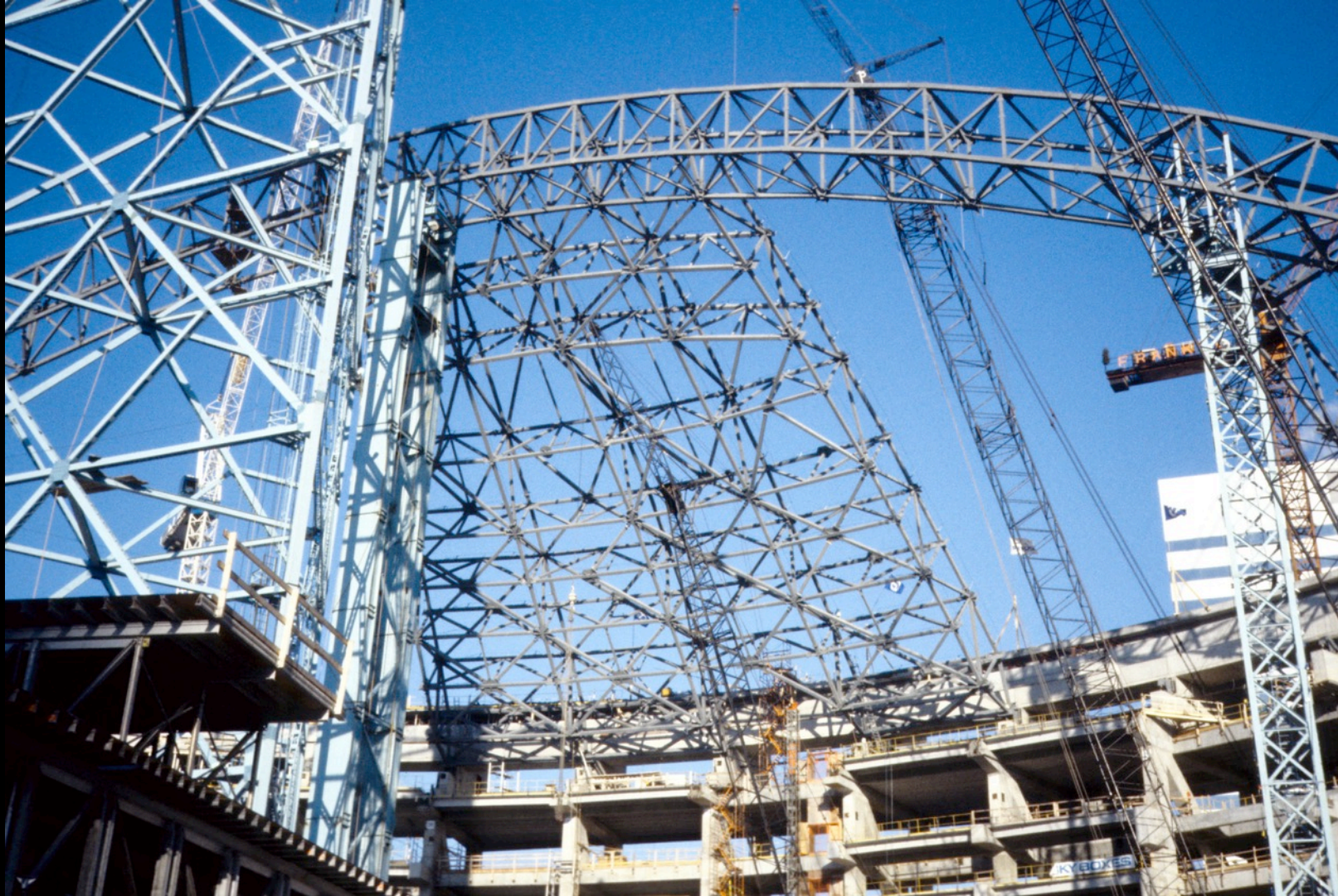






'skydome' AKA Rogers Centre  
Rod Robbie and Michael Allen  
1987



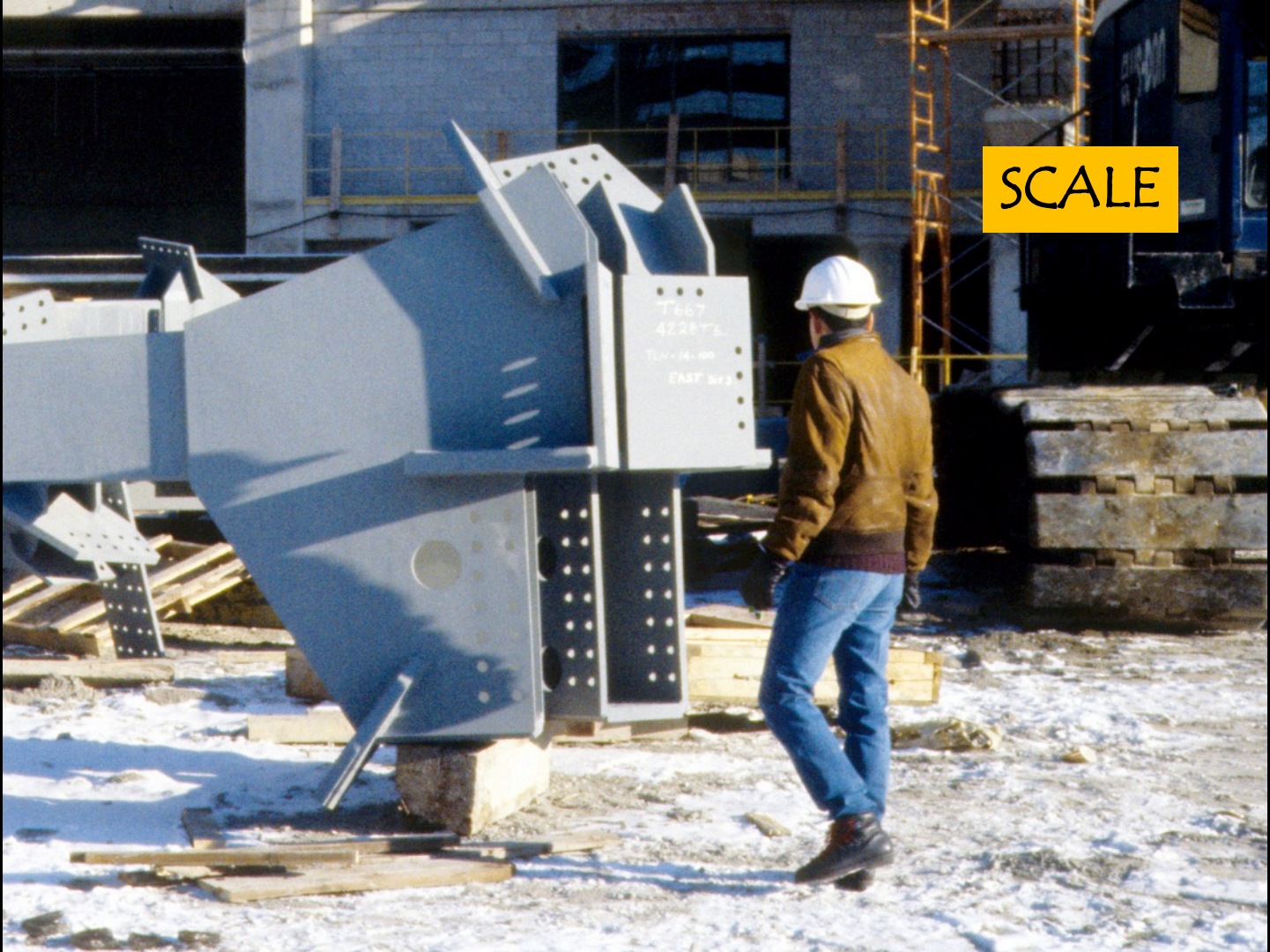








SCALE









4236 T $\leq 13$







Museum of Civilization  
Ottawa/Hull  
Douglas Cardinal Architect  
1987













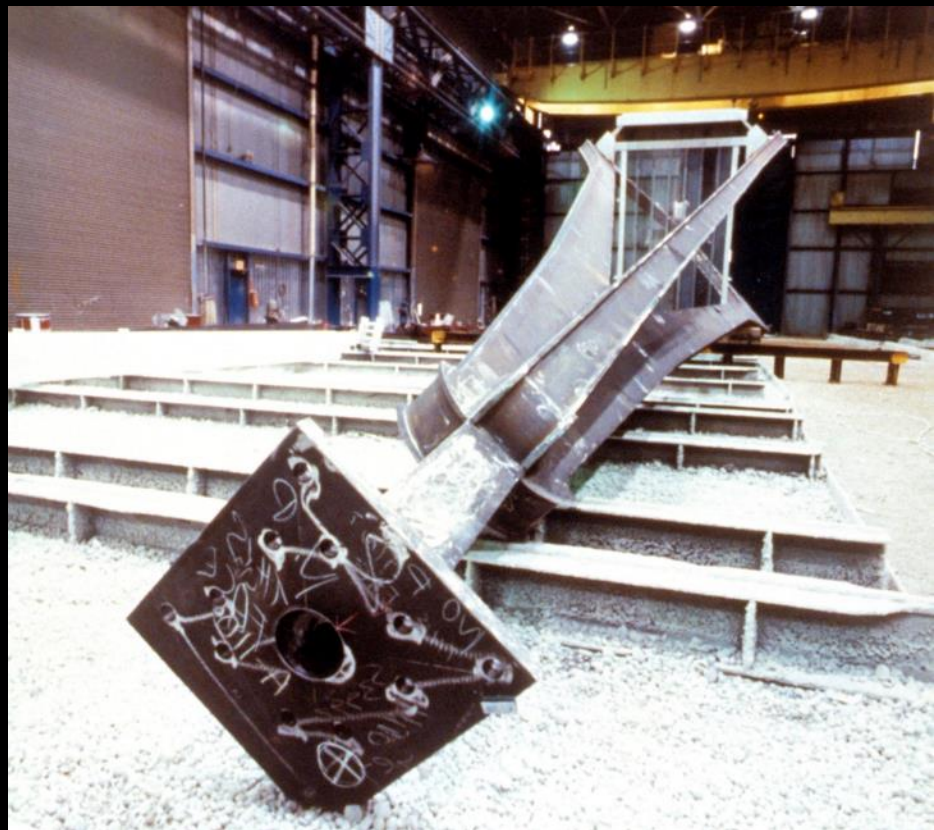
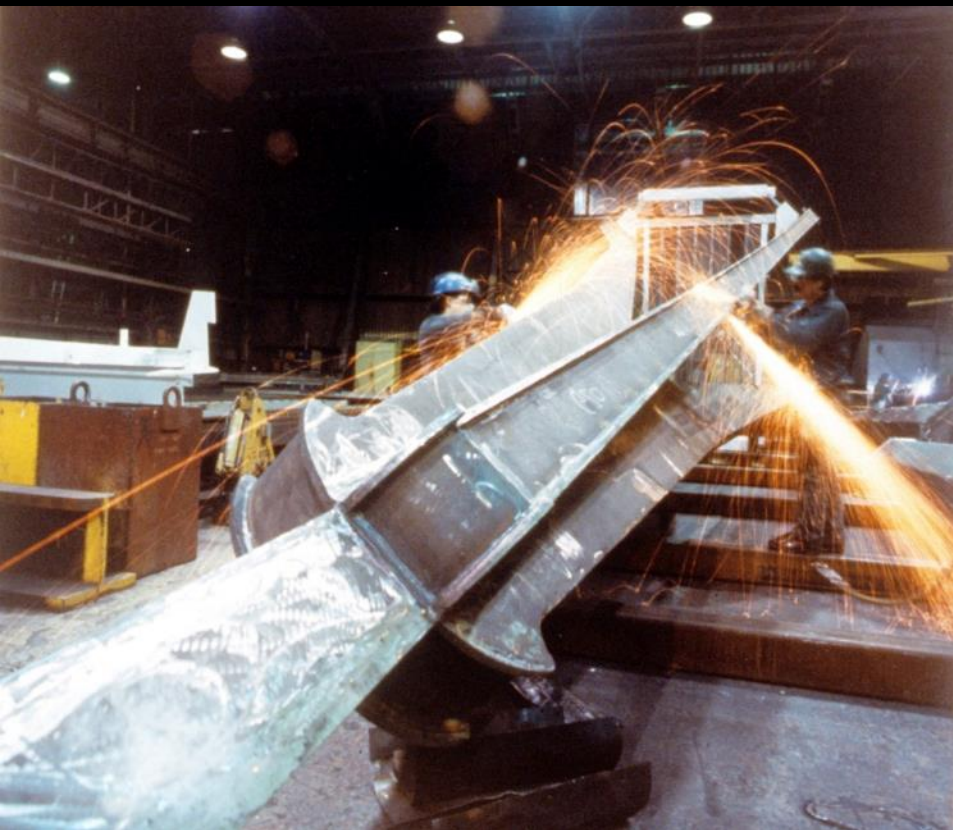




BCE – Brookfield – Place  
Toronto, ON  
Santiago Calatrava  
1992



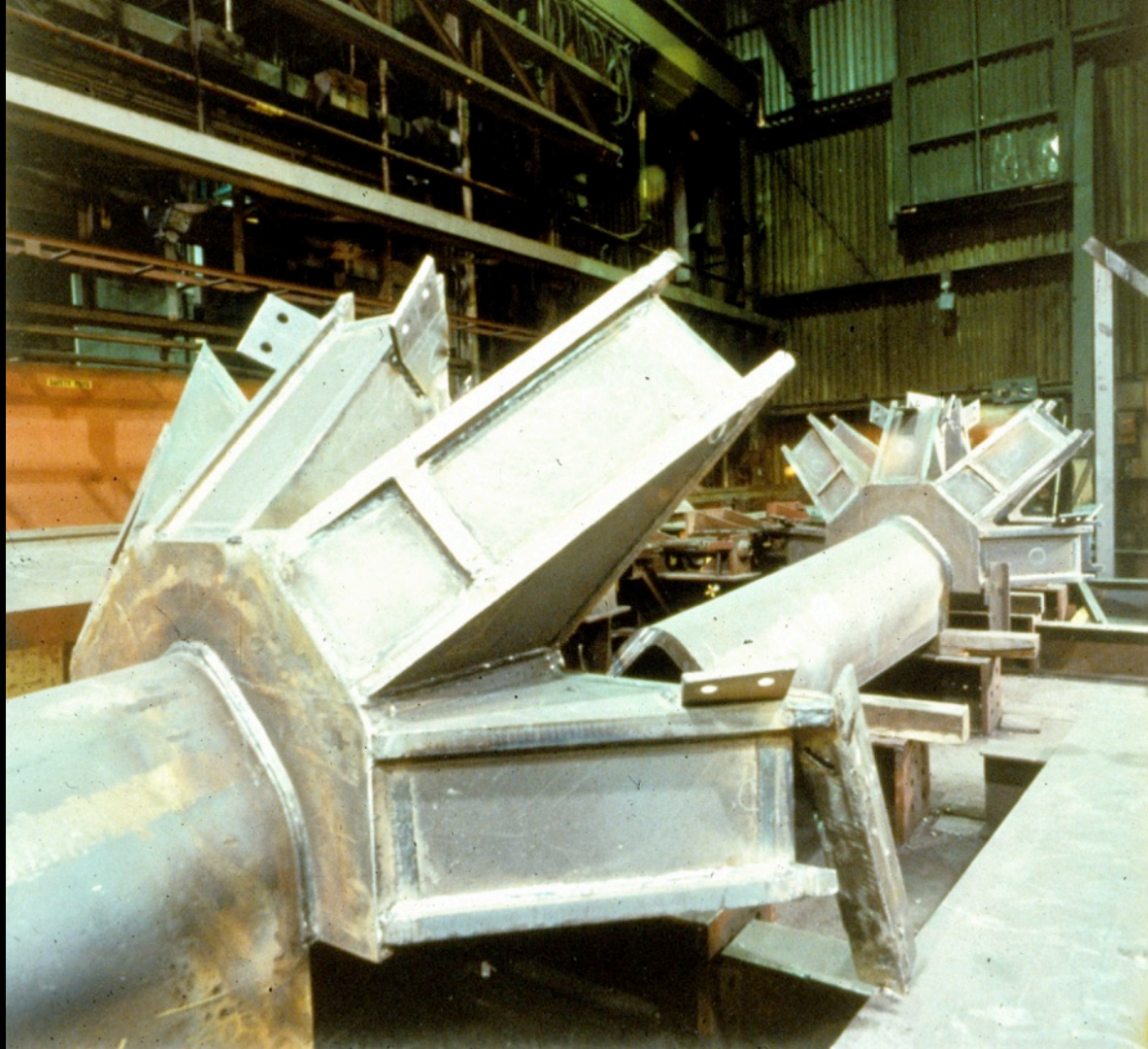




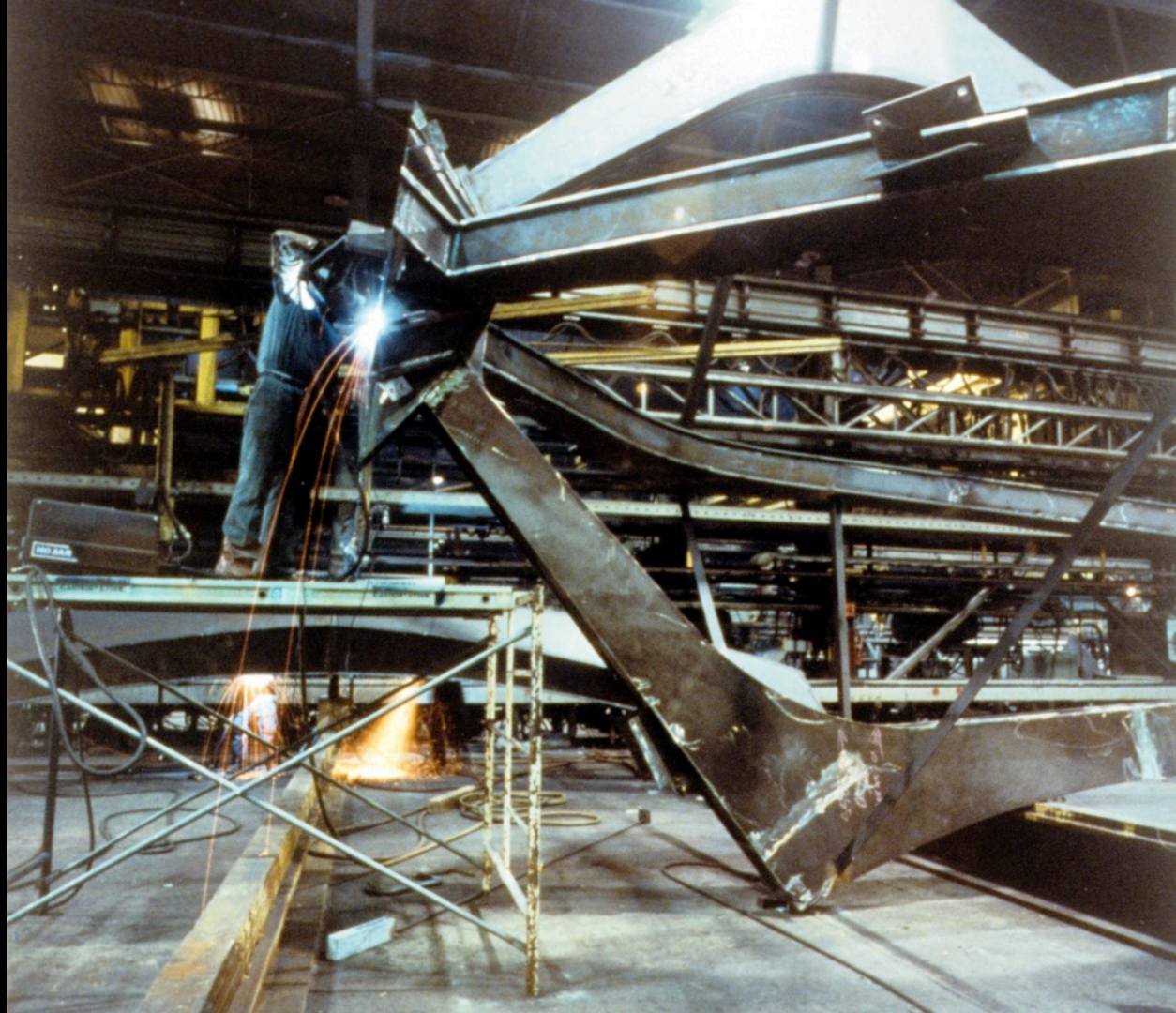


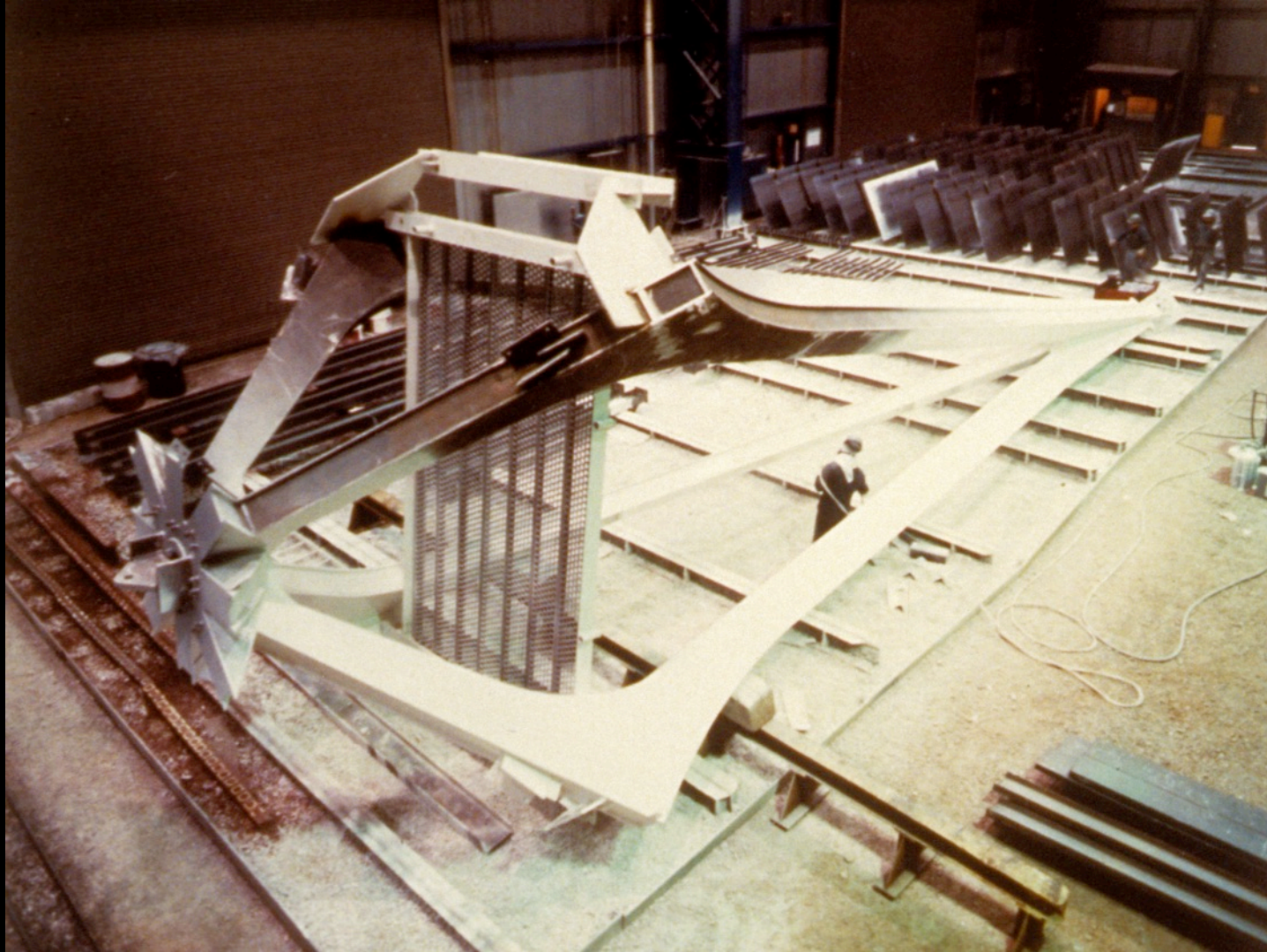


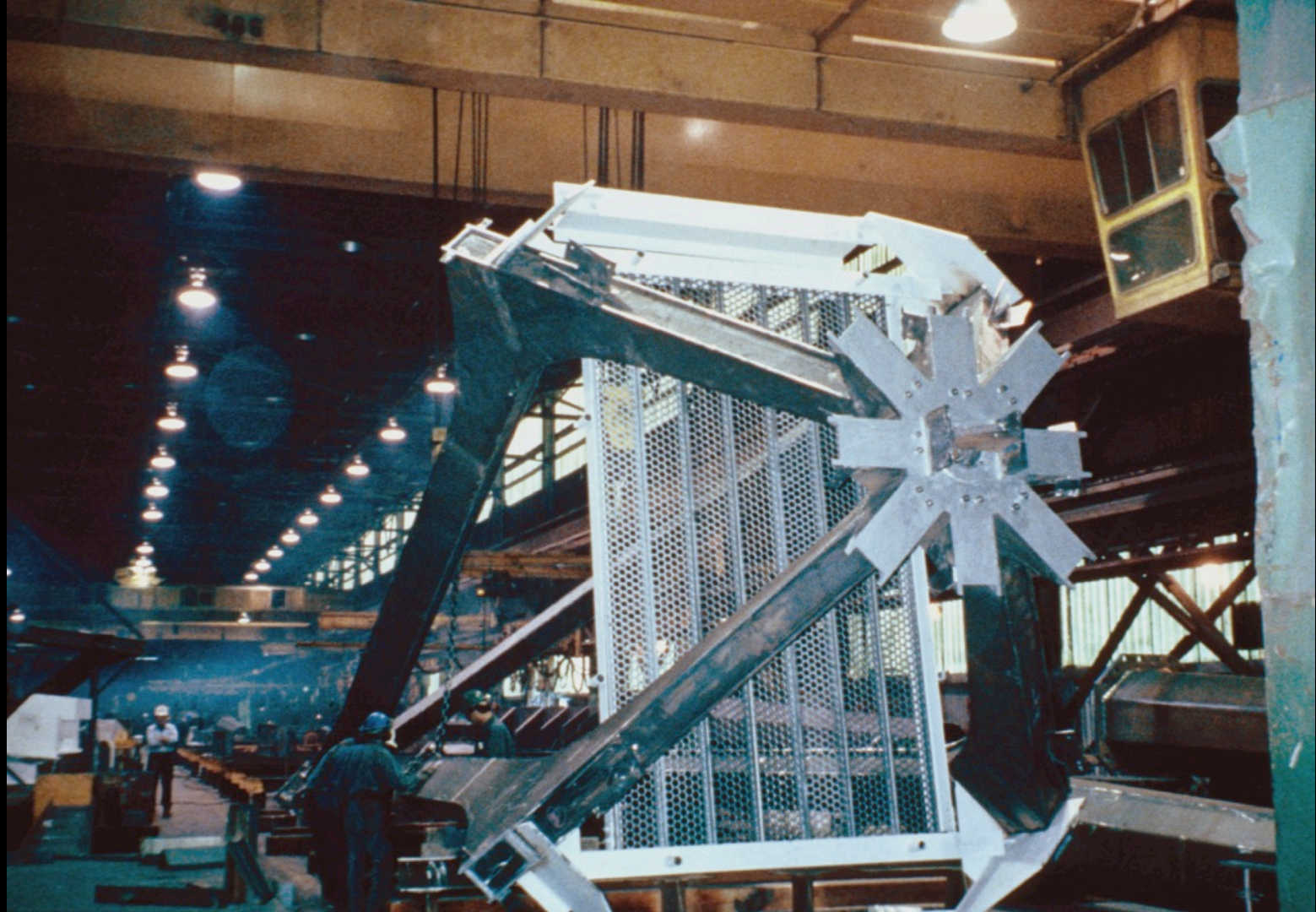




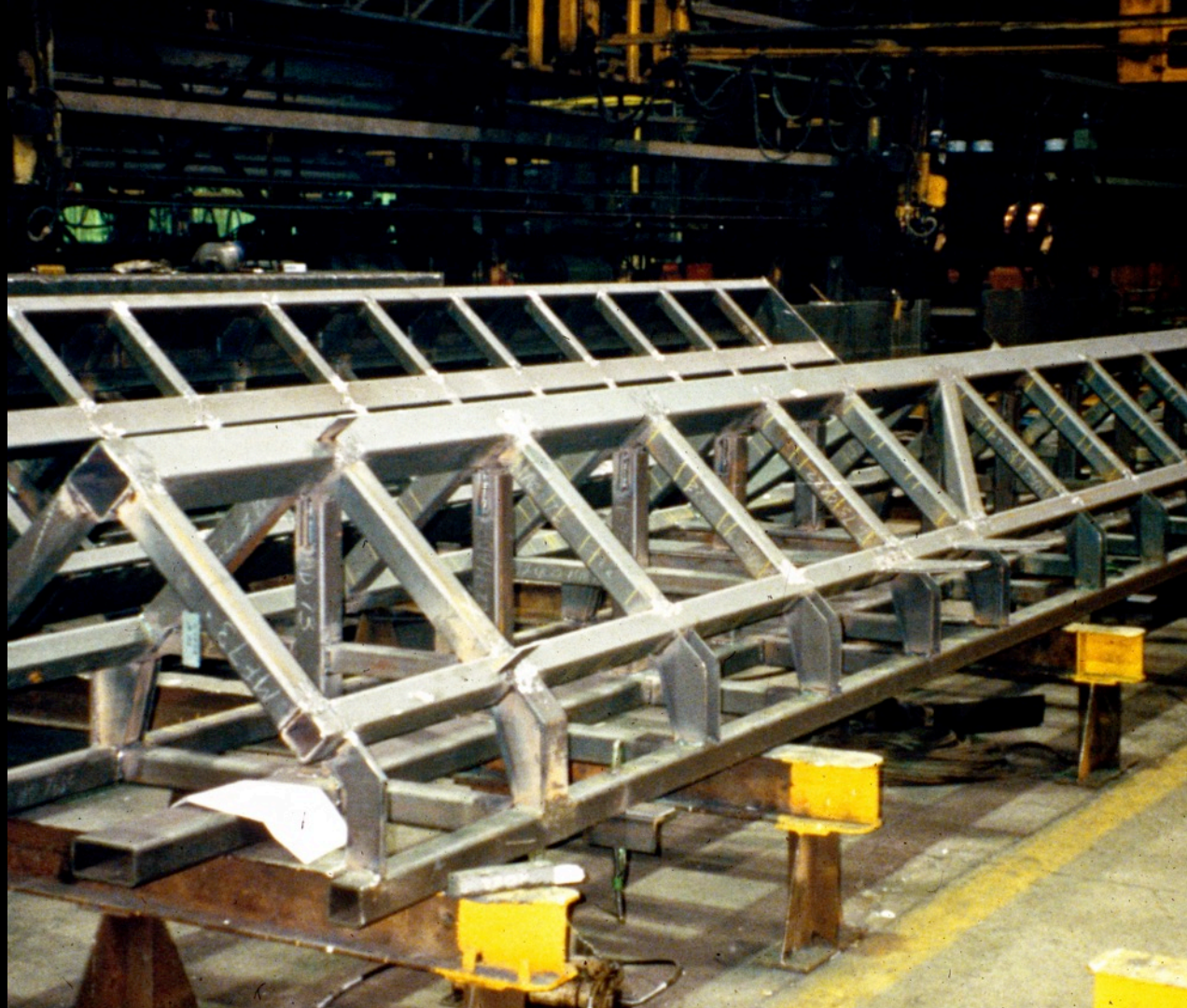


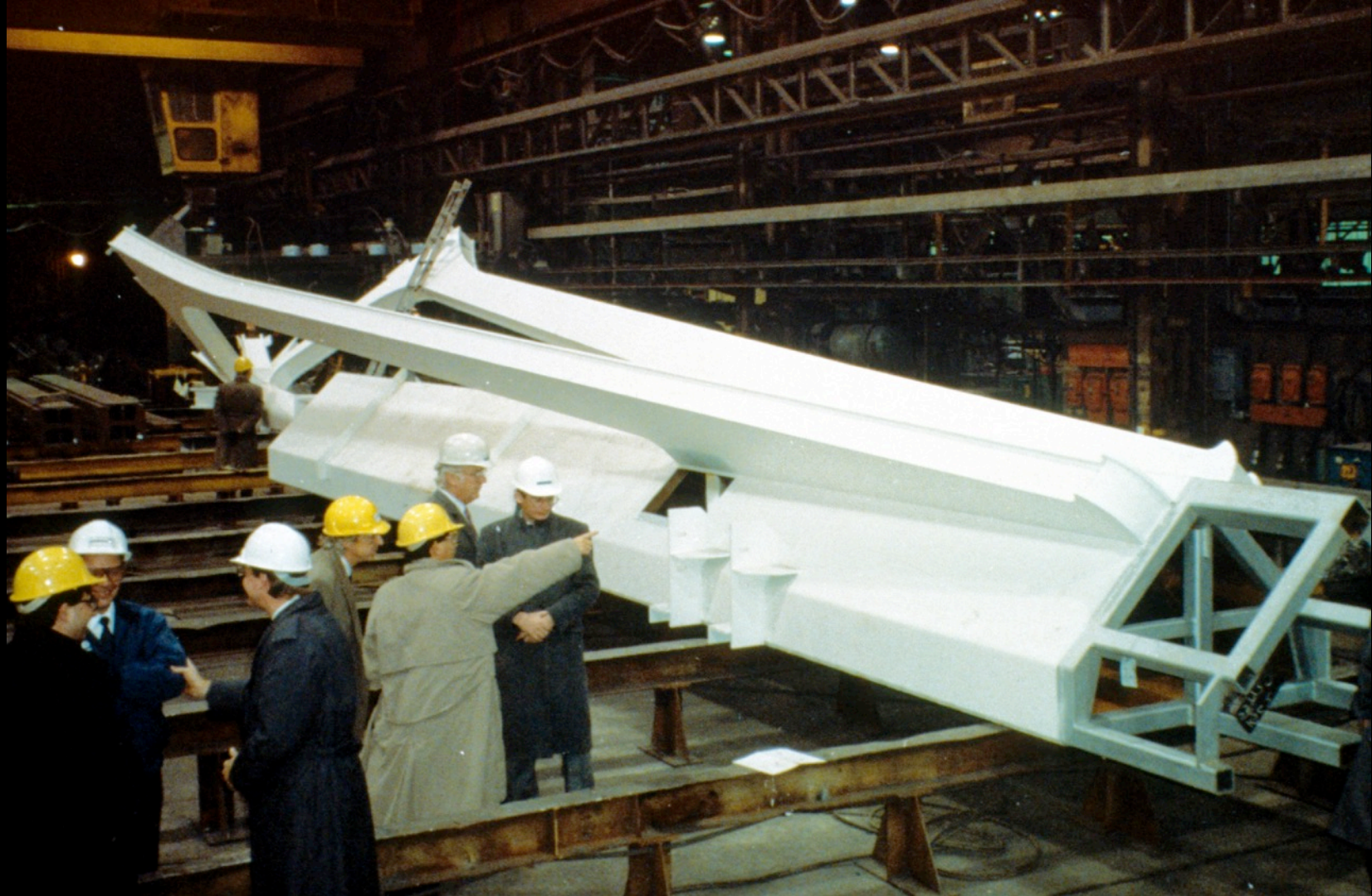








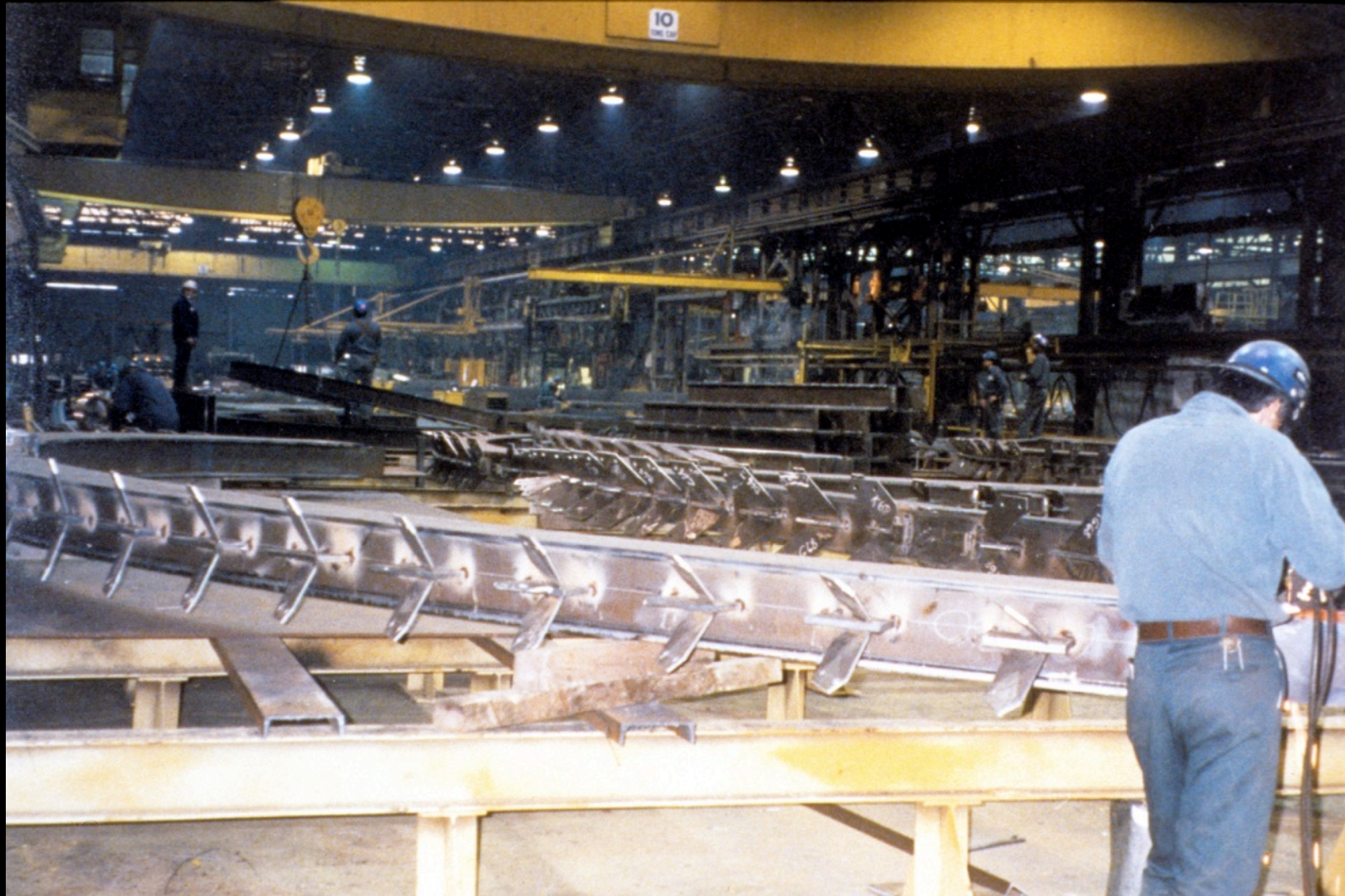










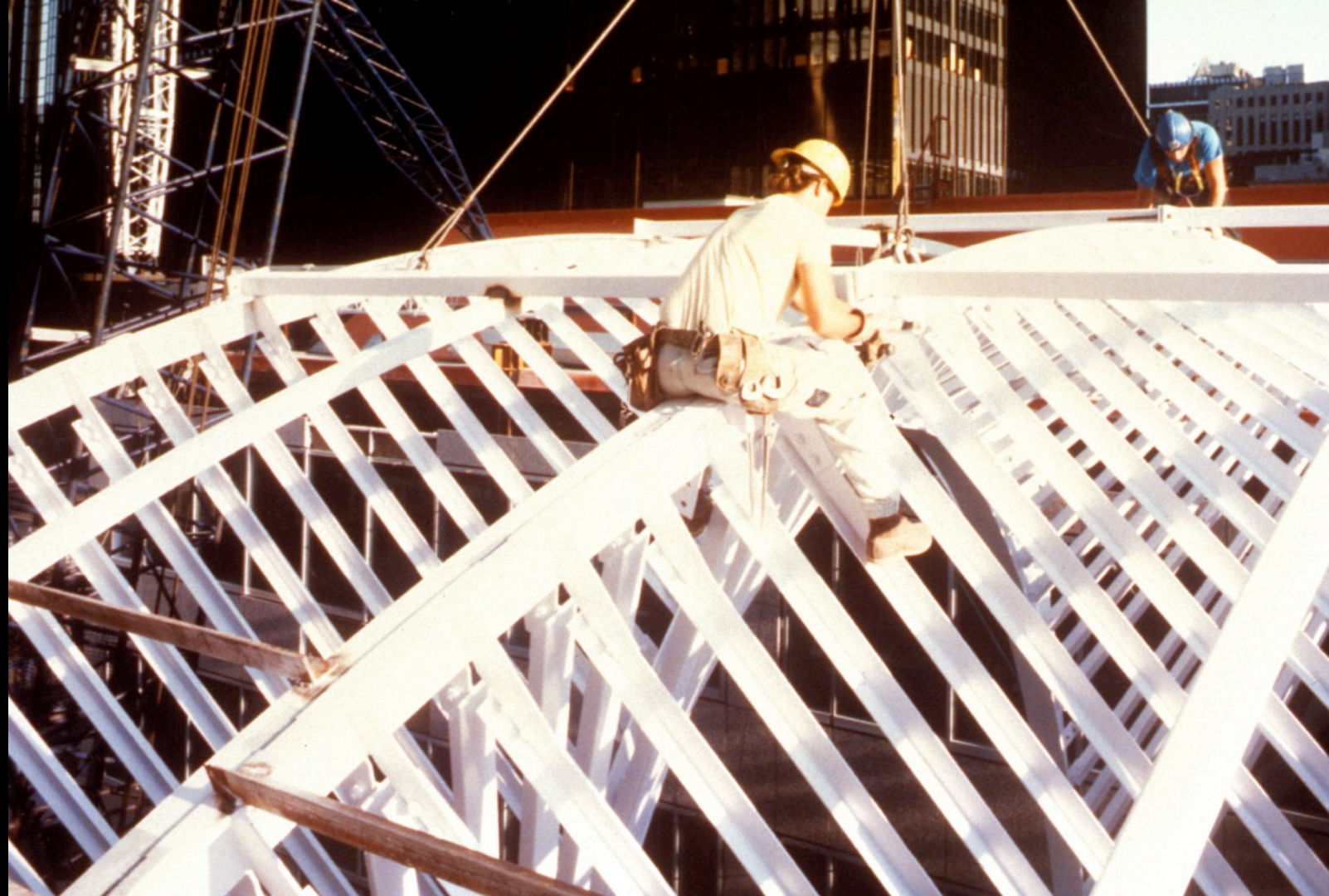




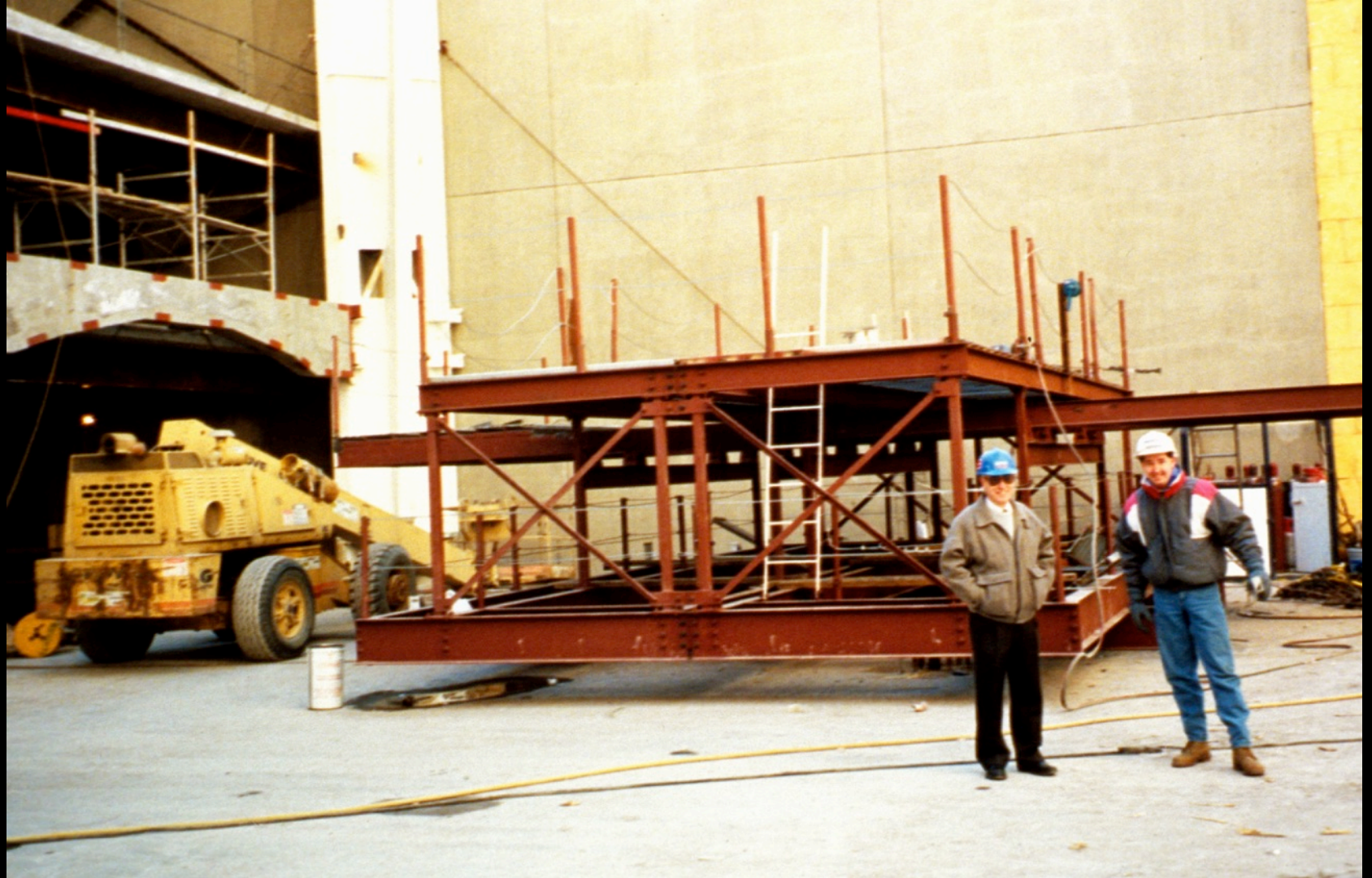




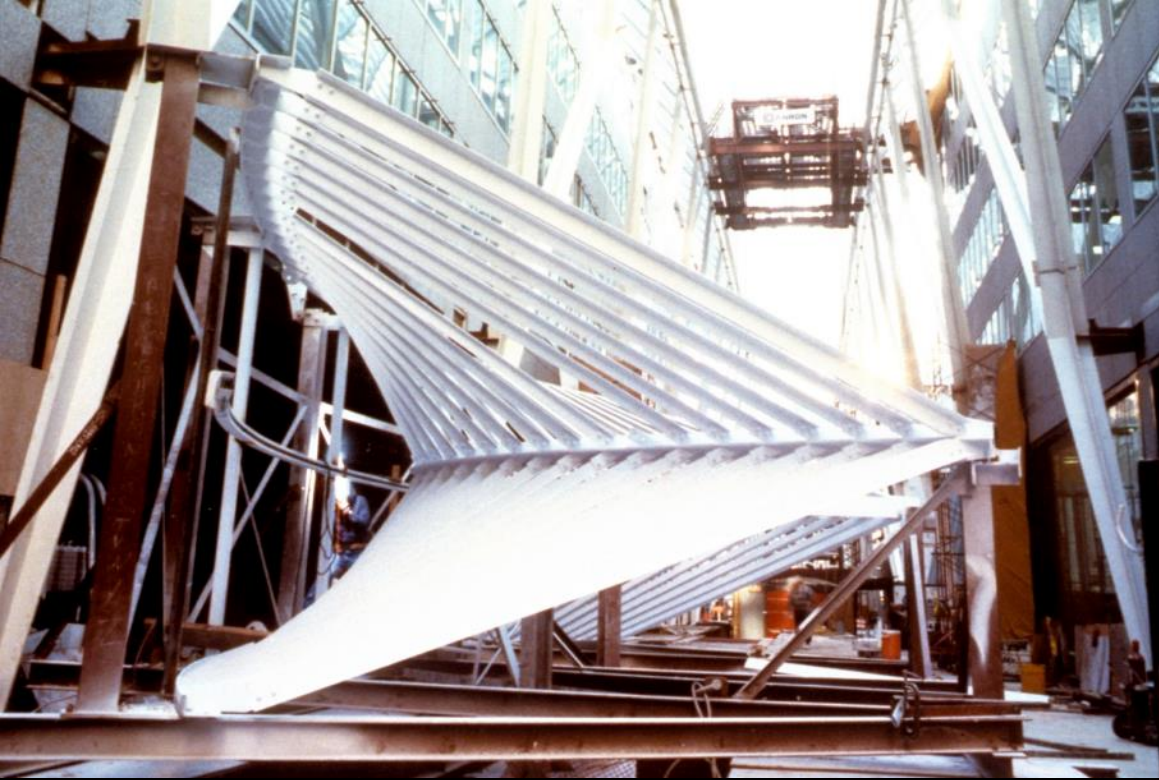


























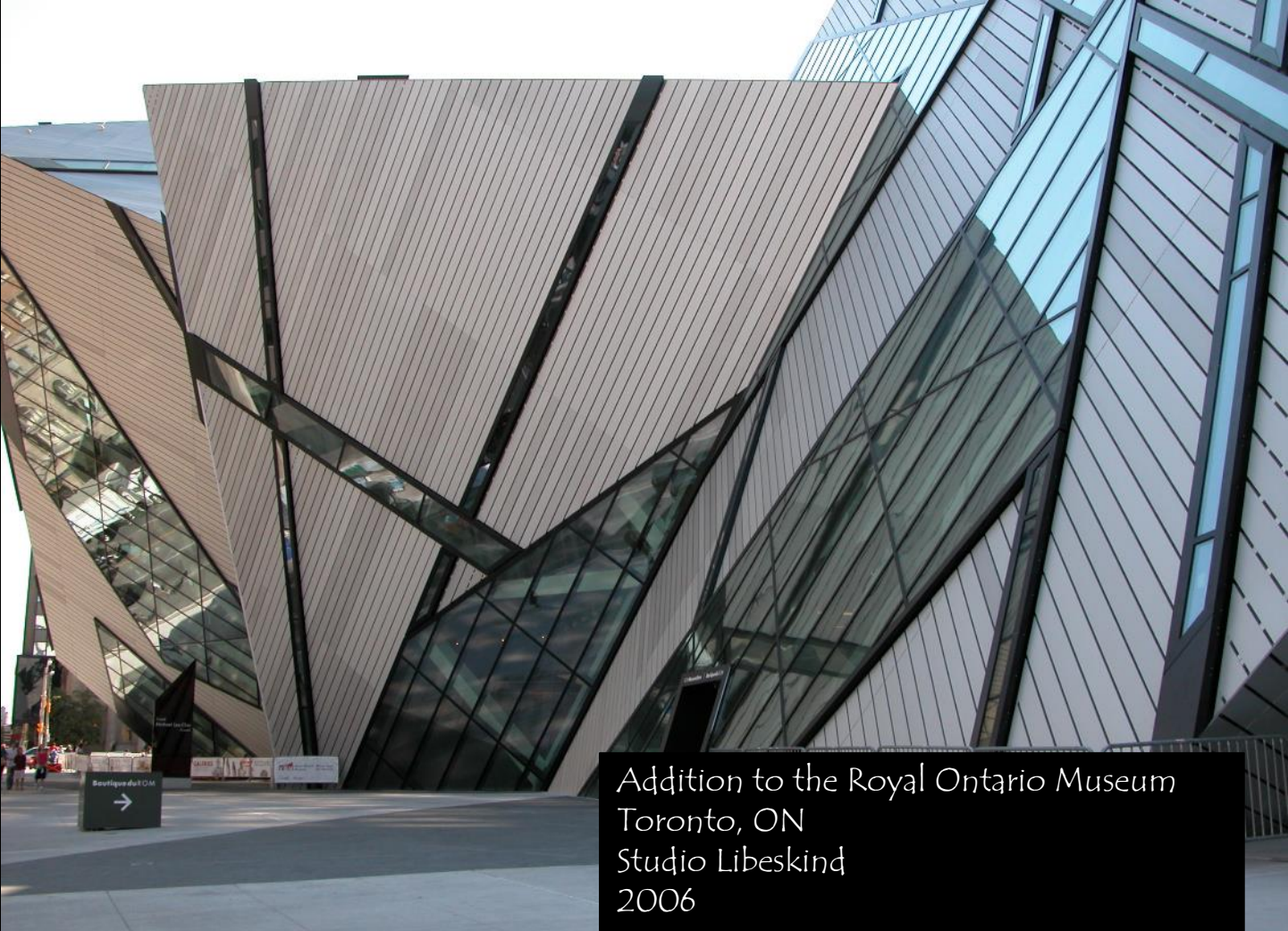










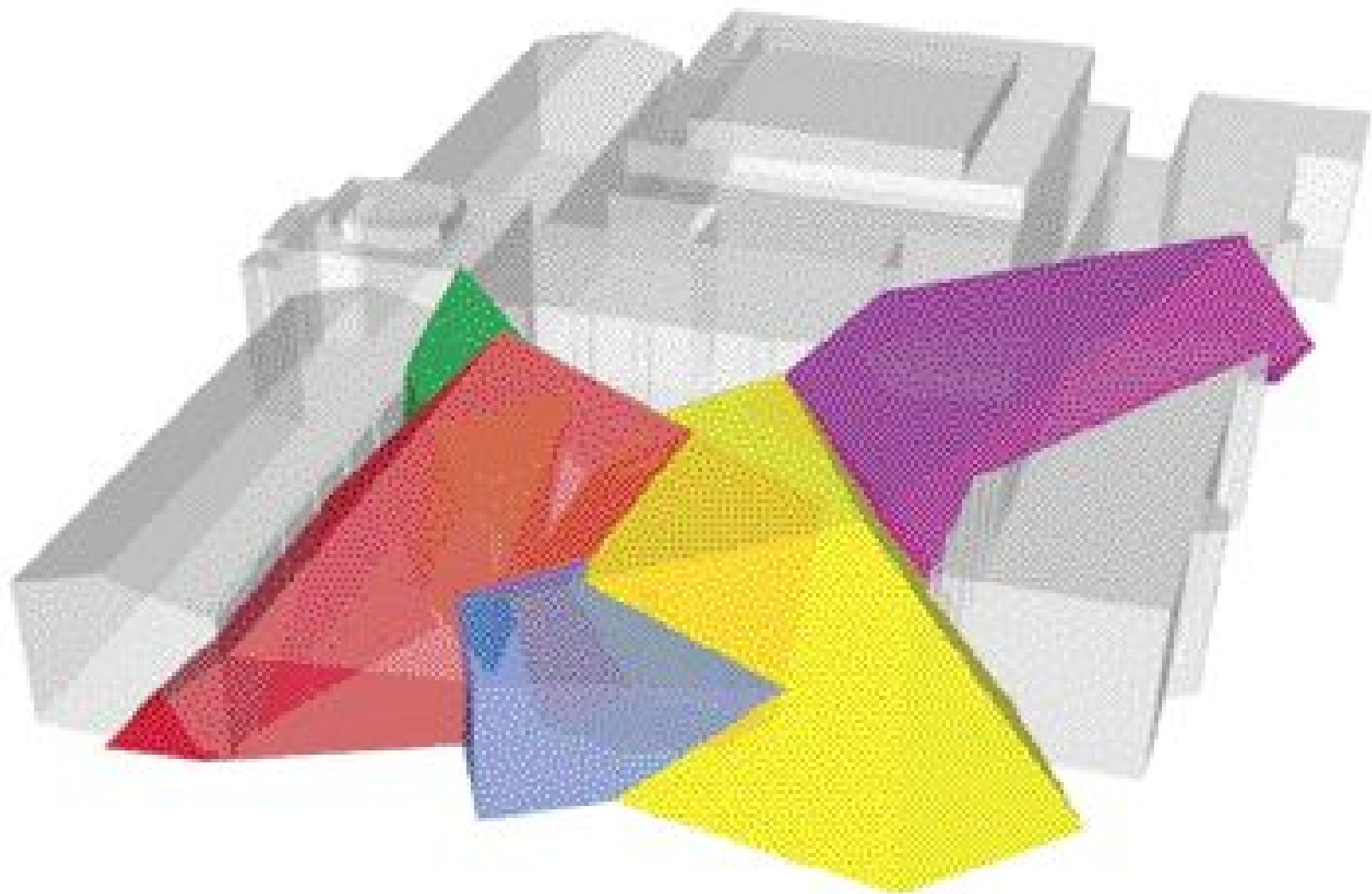


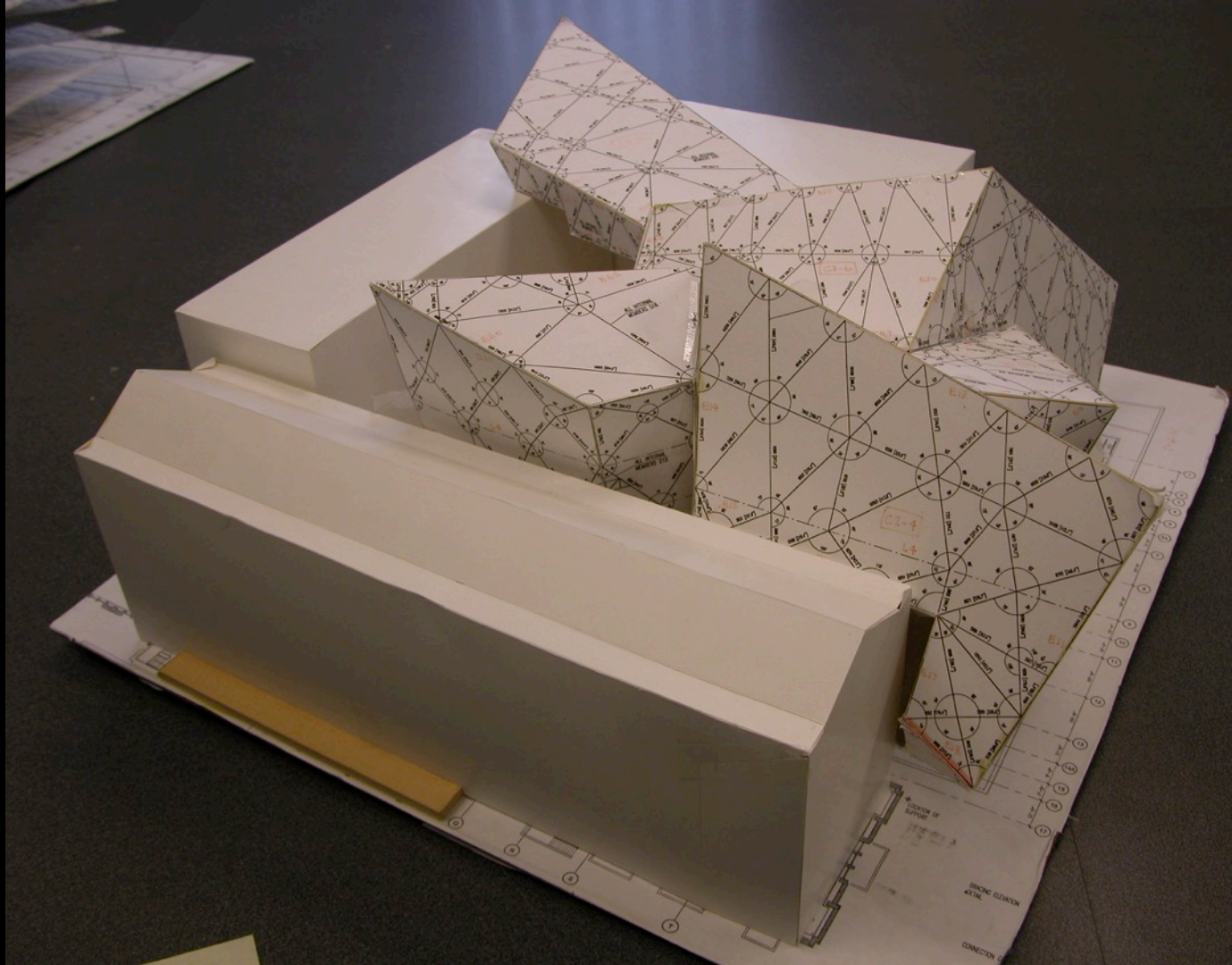
Addition to the Royal Ontario Museum  
Toronto, ON  
Studio Libeskind  
2006

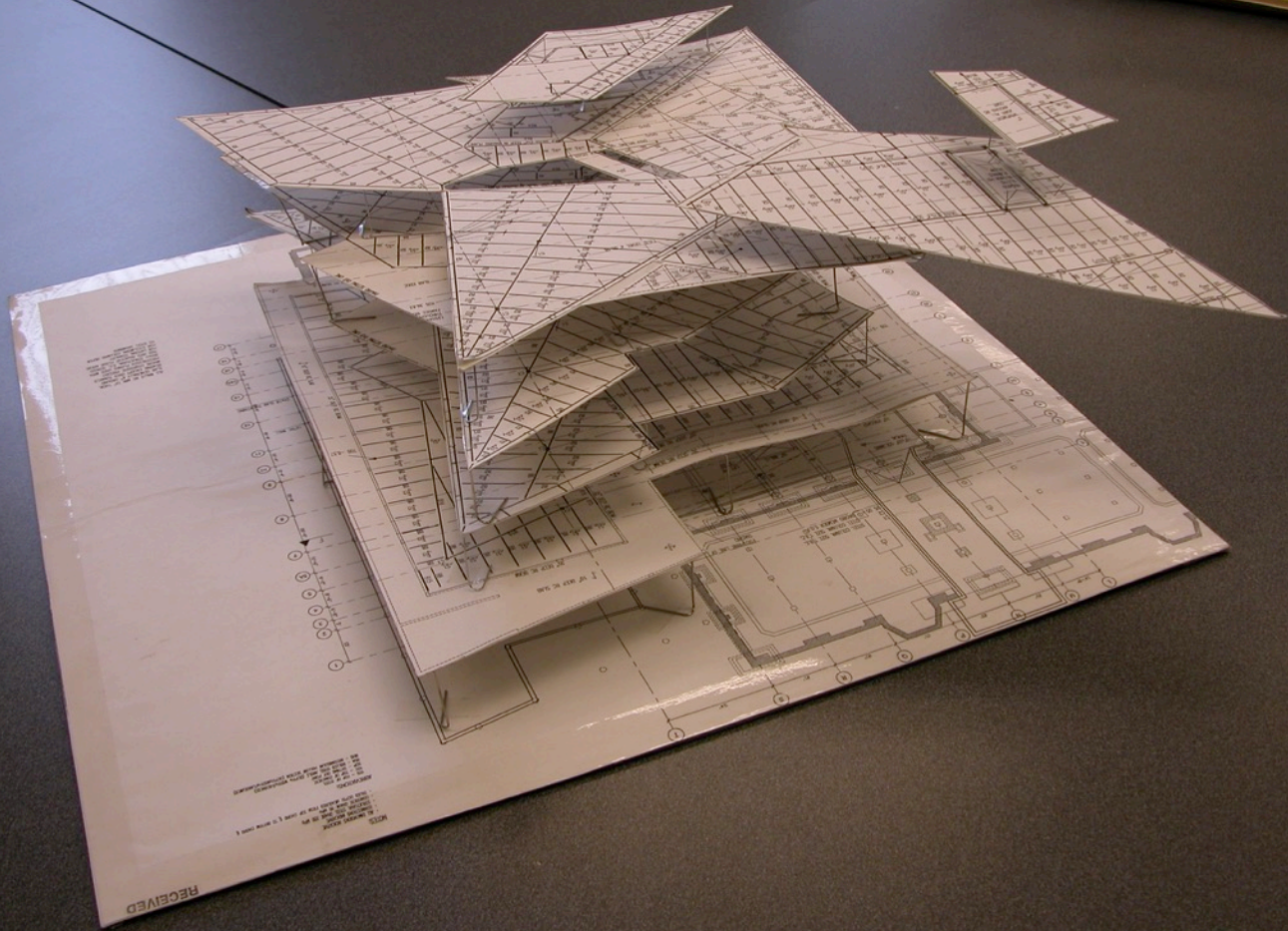


ROM  
TORONTO





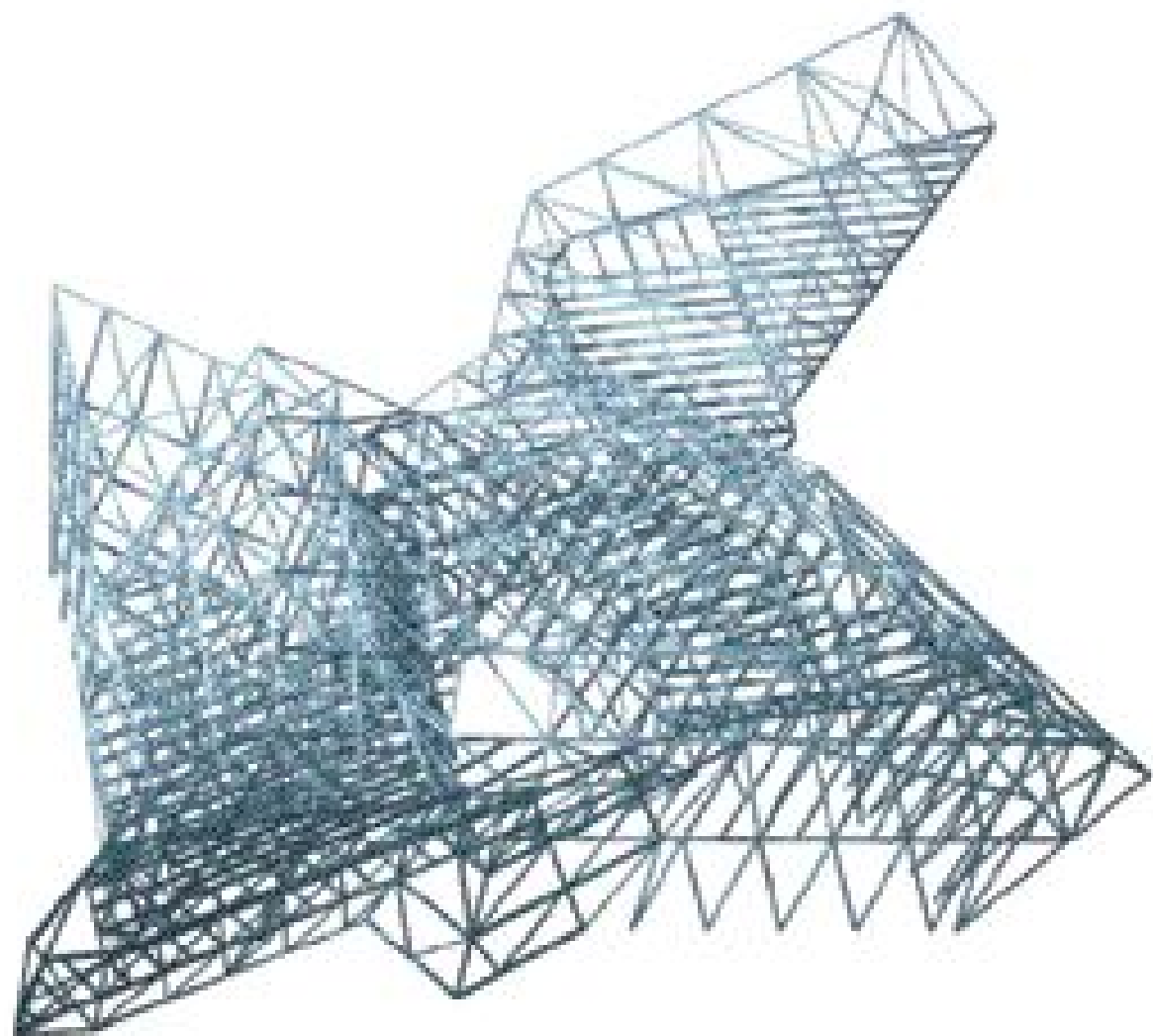


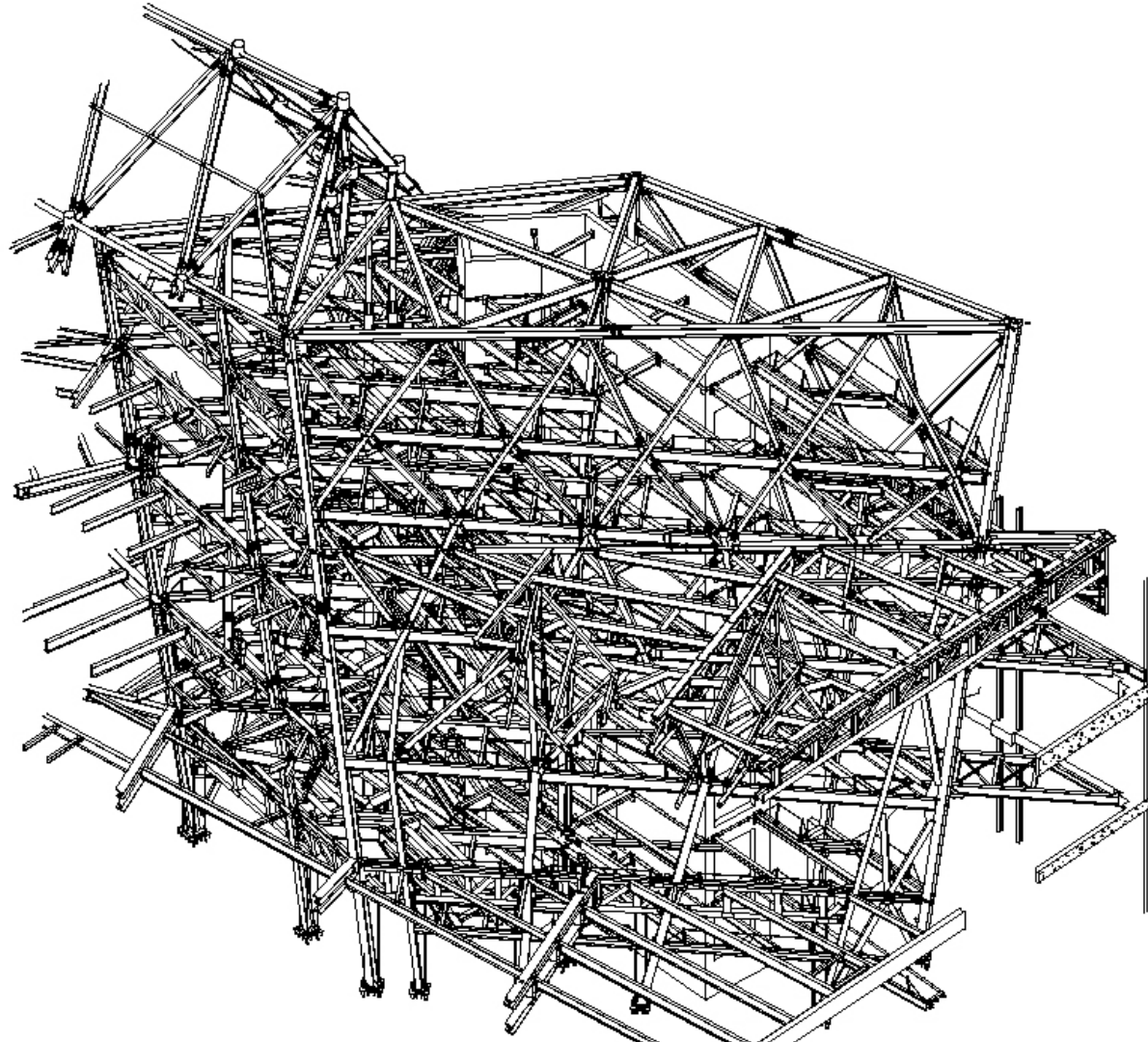


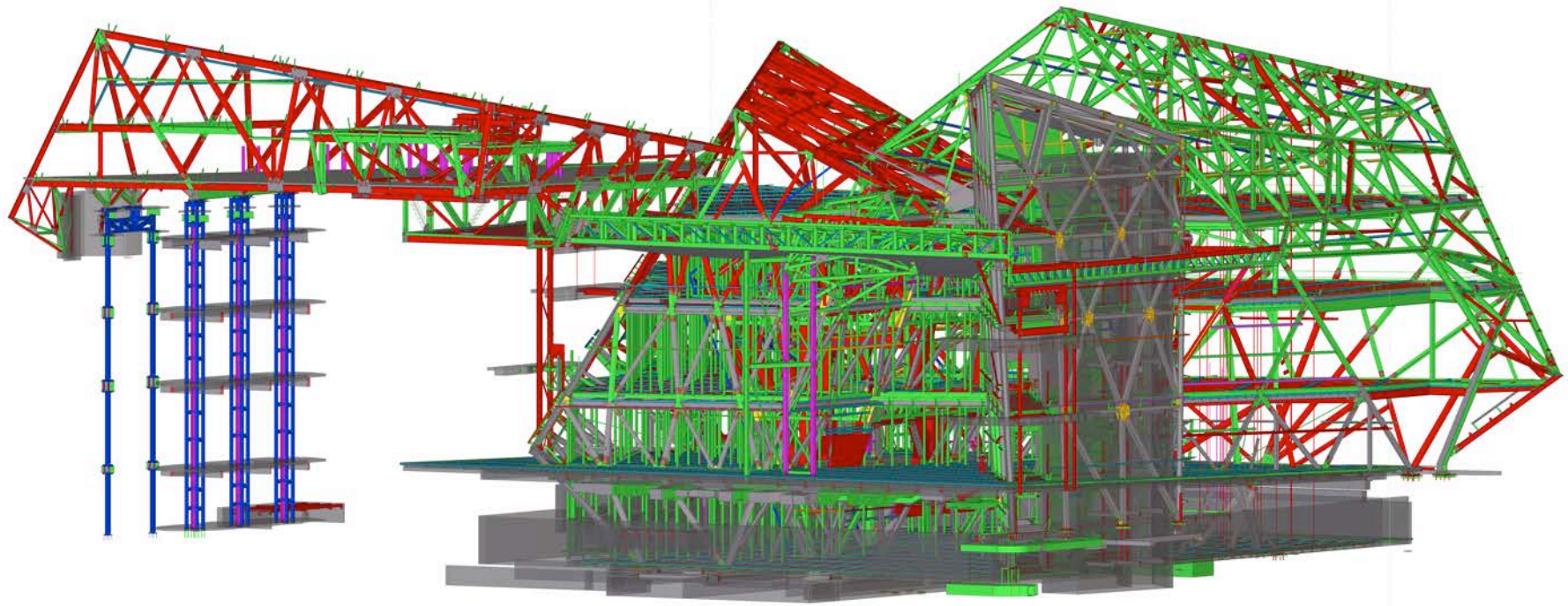
RECEIVED

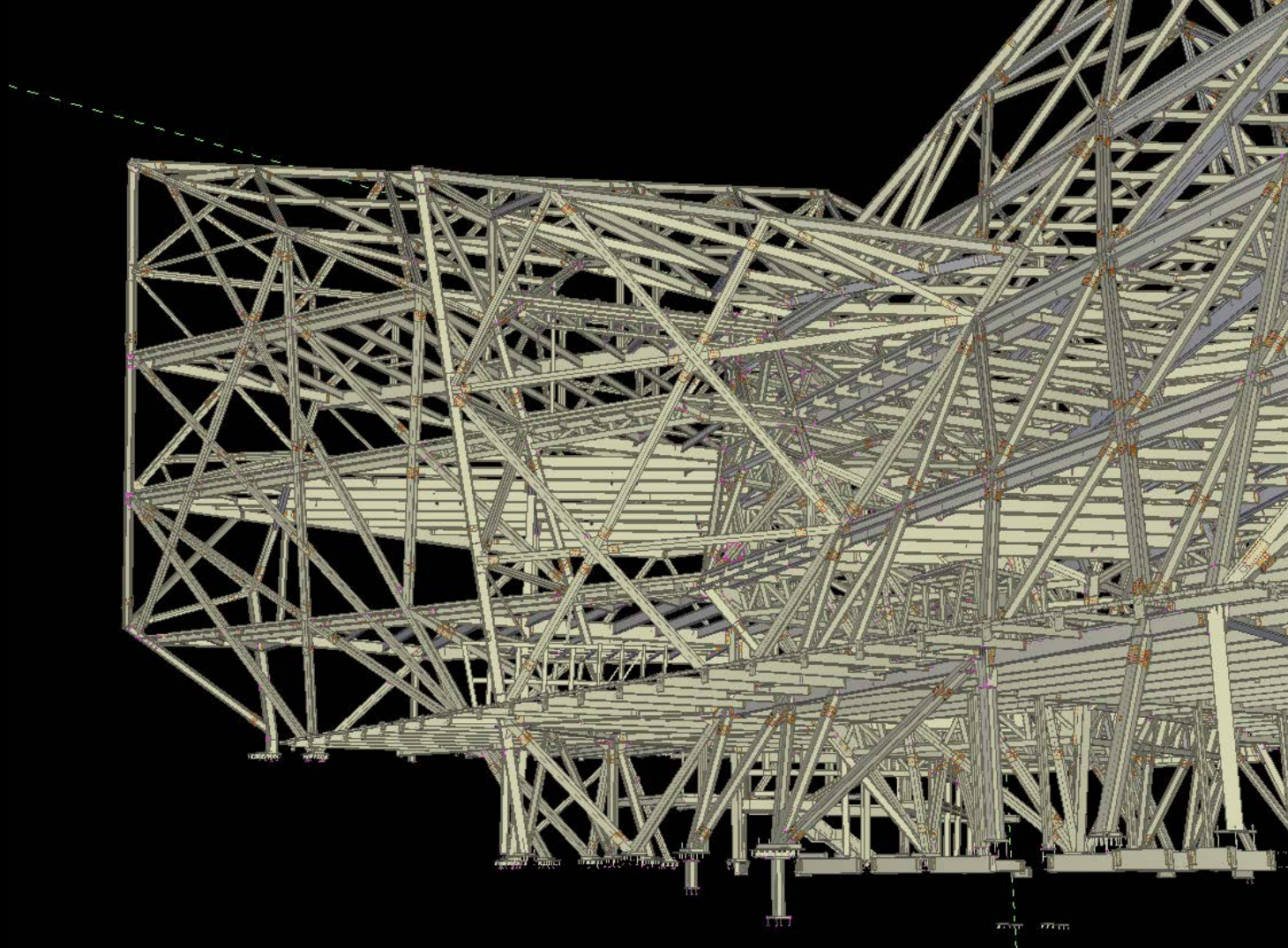
RECEIVED  
ARCHITECTURAL  
DEPARTMENT  
UNIVERSITY OF CALIFORNIA  
BERKELEY  
CALIFORNIA 94720-1700  
TEL: (415) 495-1500  
FAX: (415) 495-1501  
WWW: WWW.ARCH.UMC.BERKELEY.CA.EDU

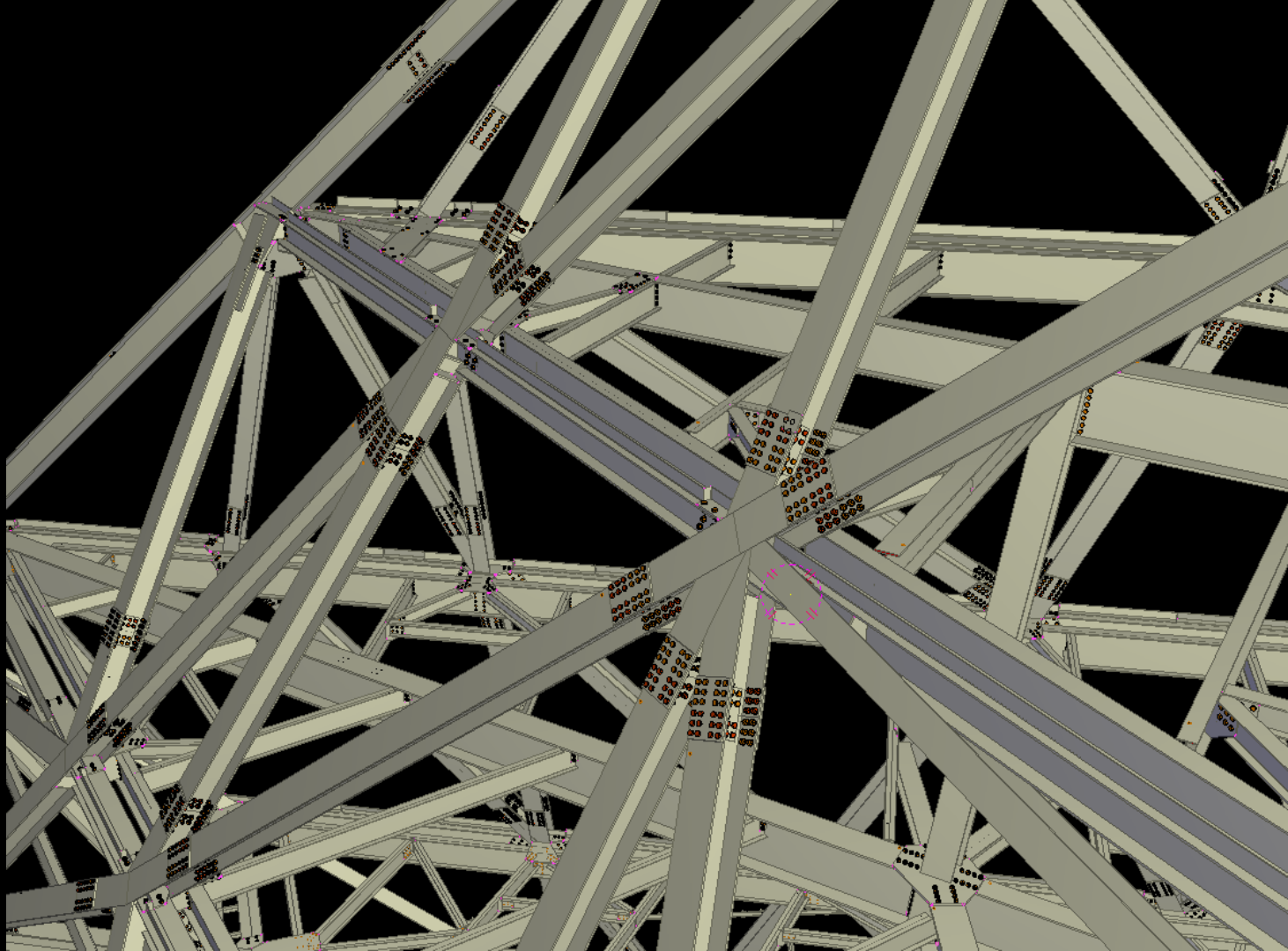
RECEIVED



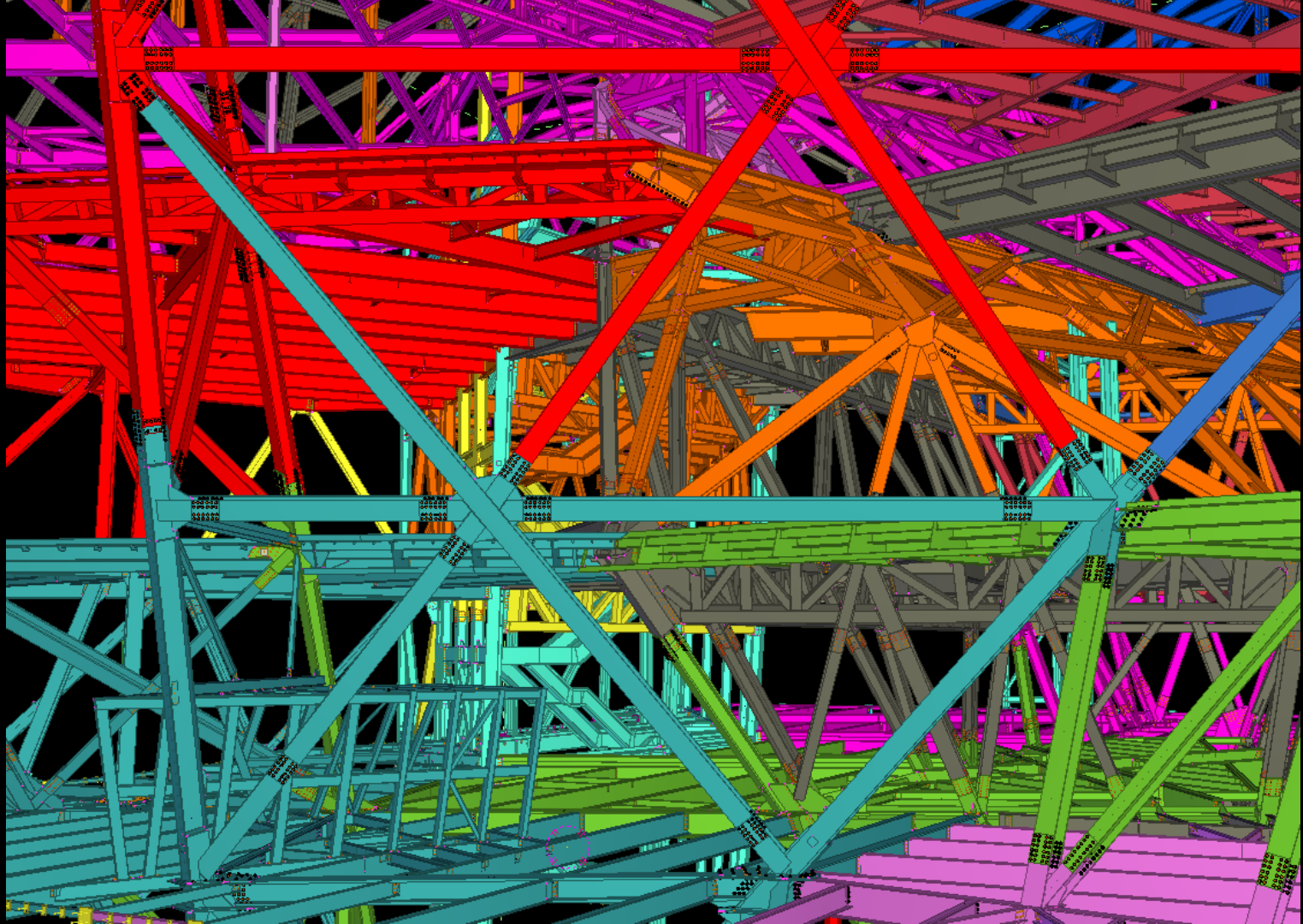


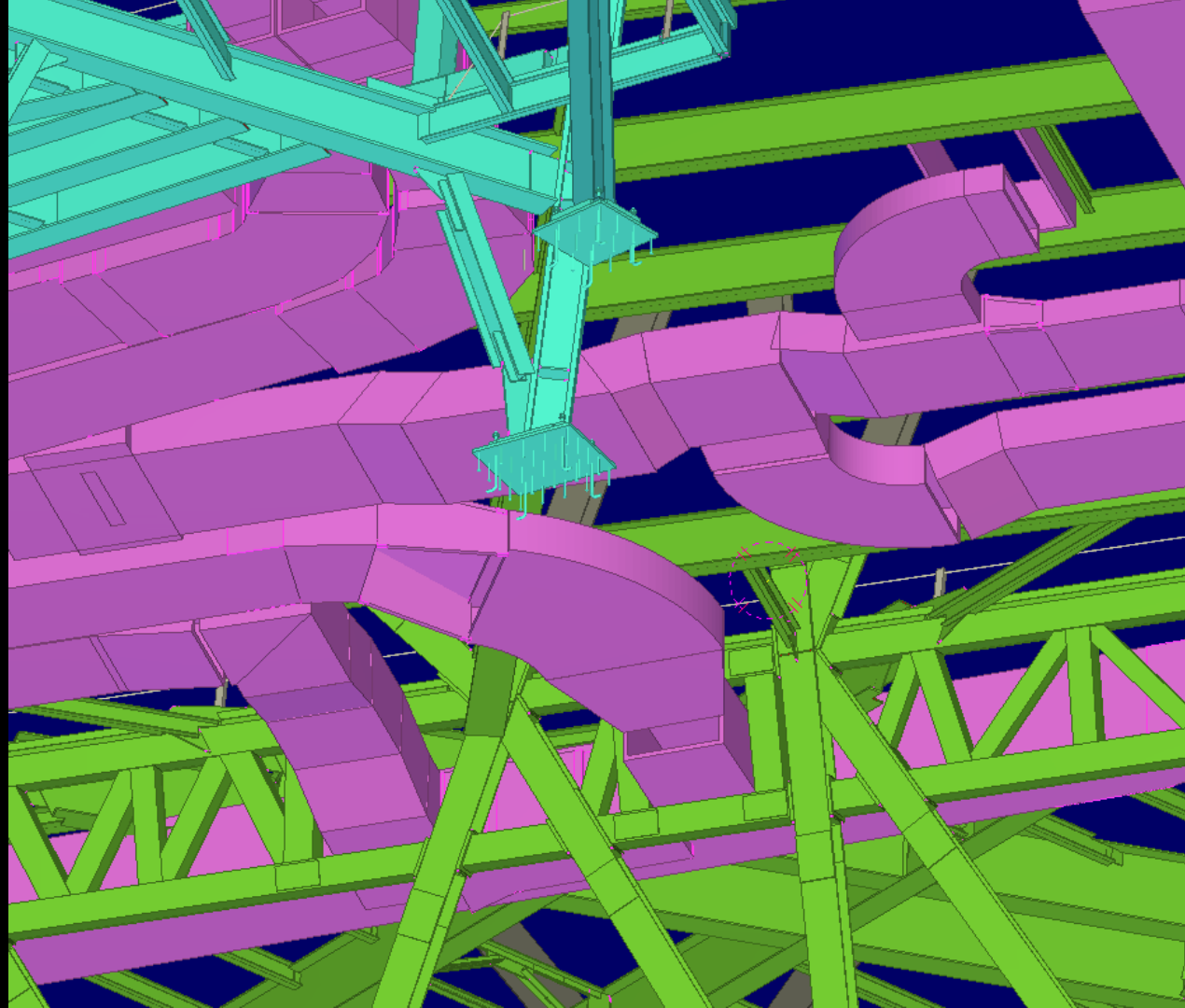


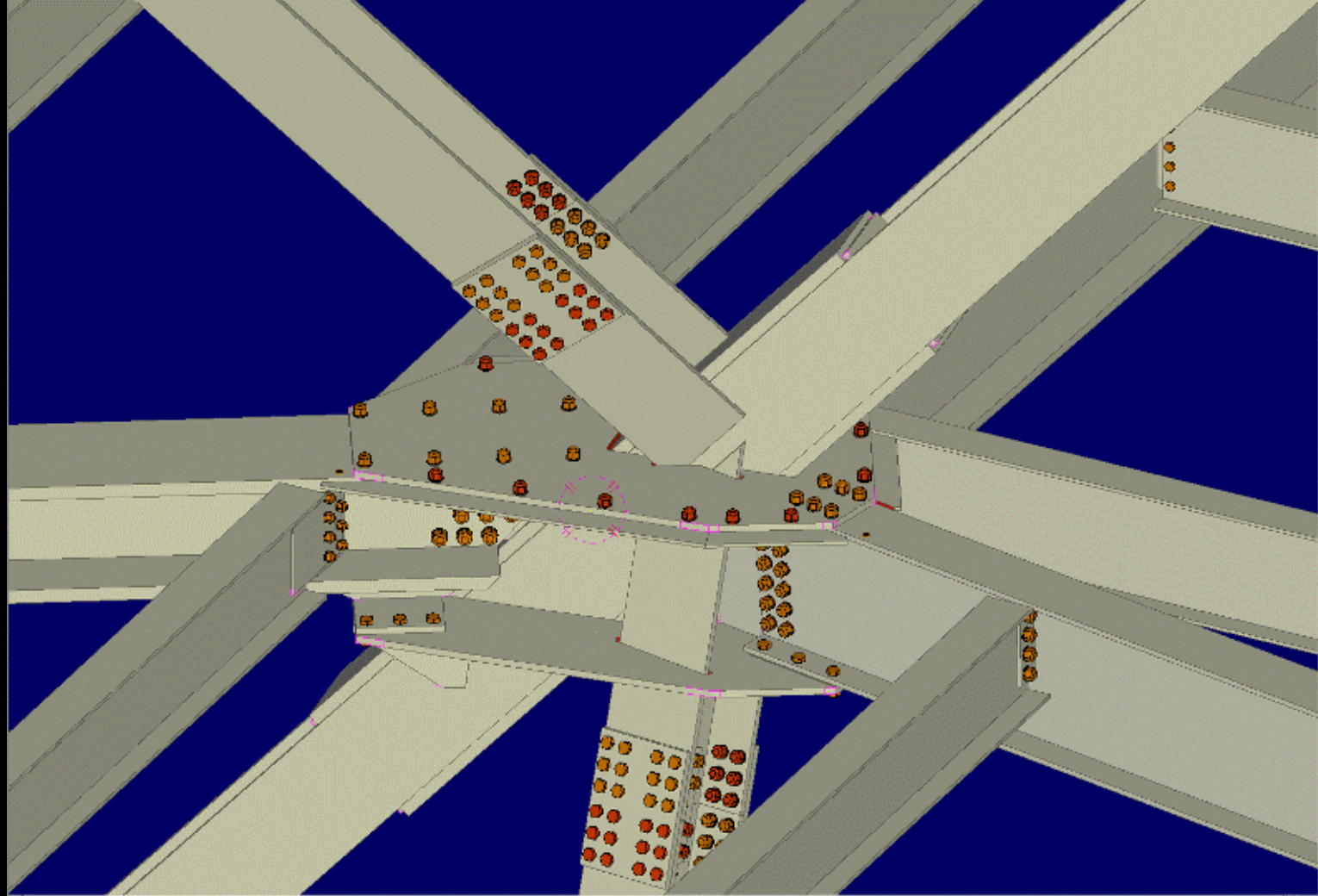






















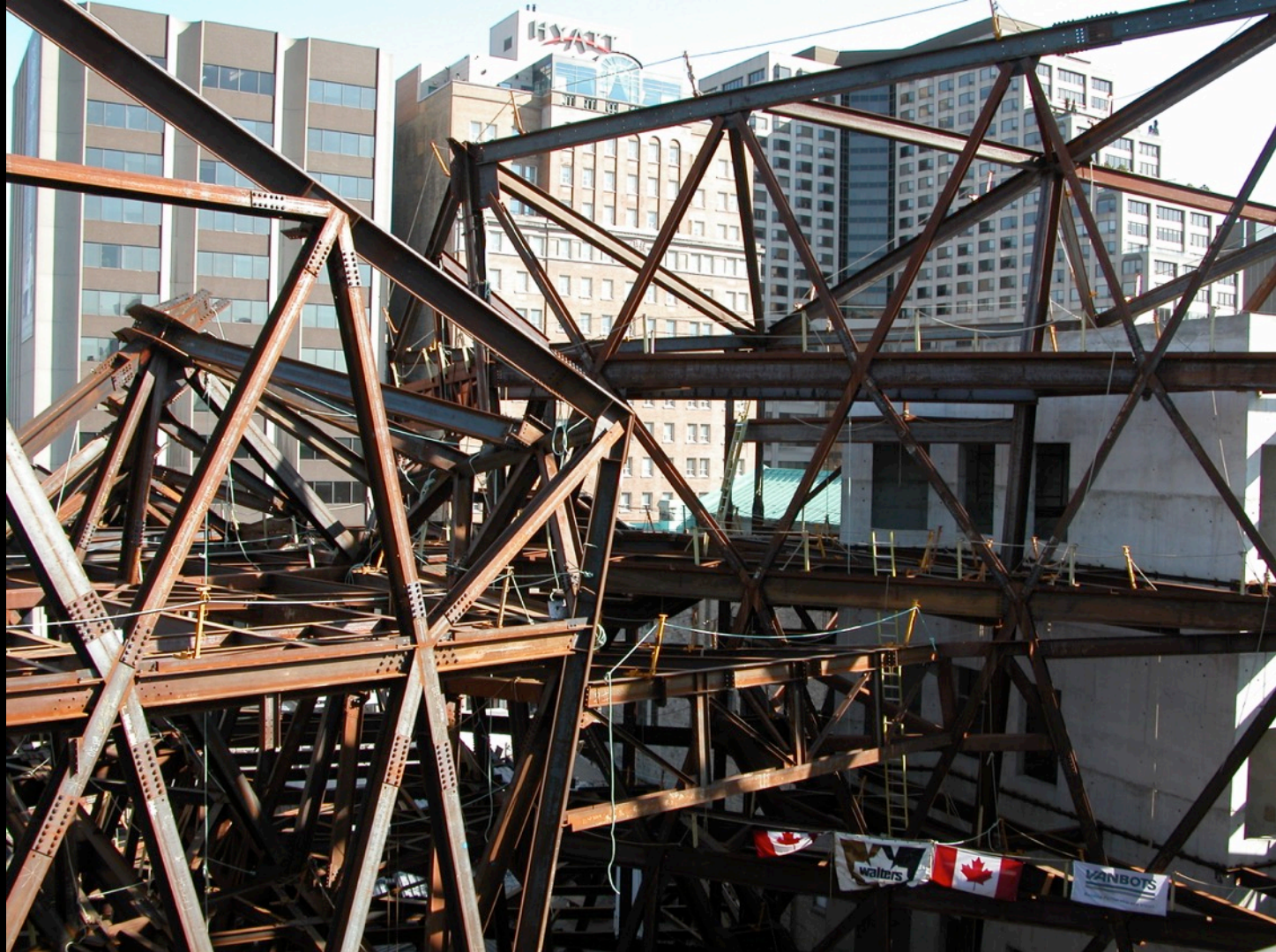














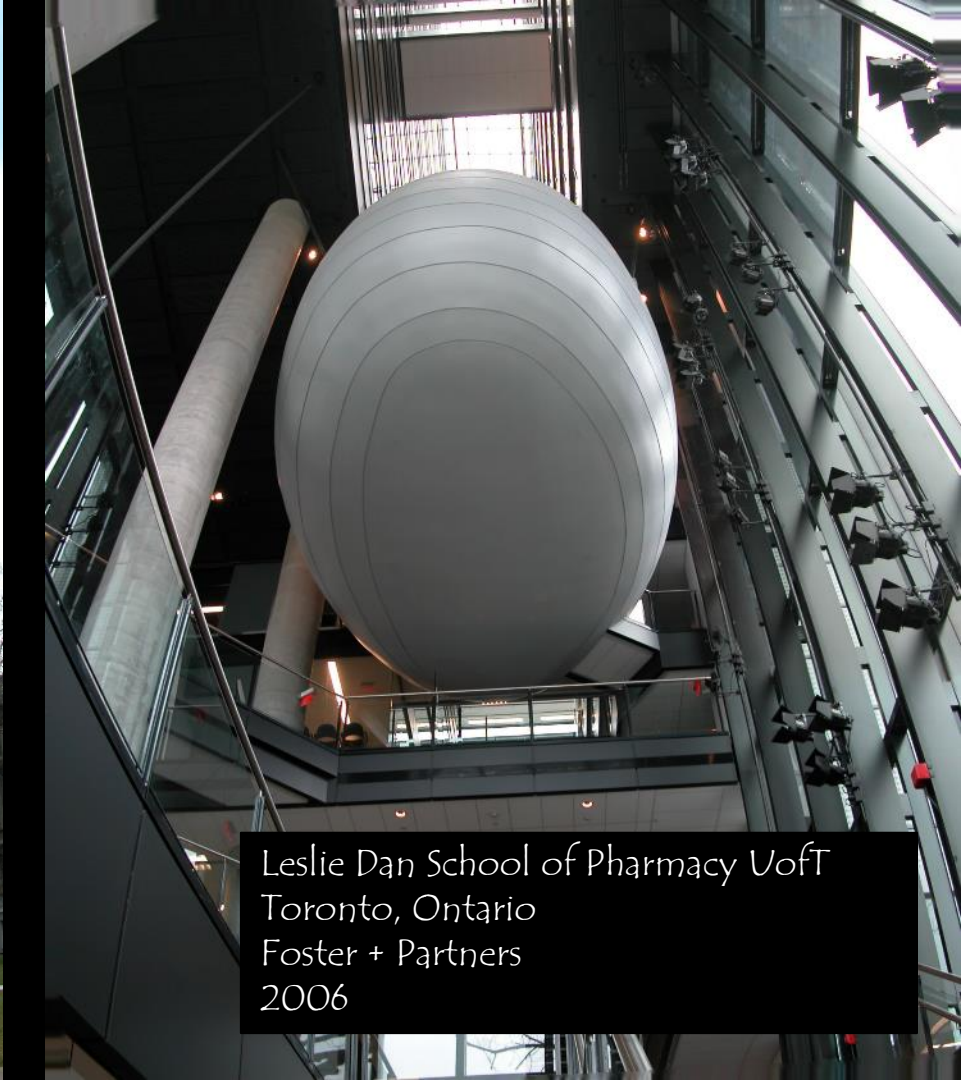




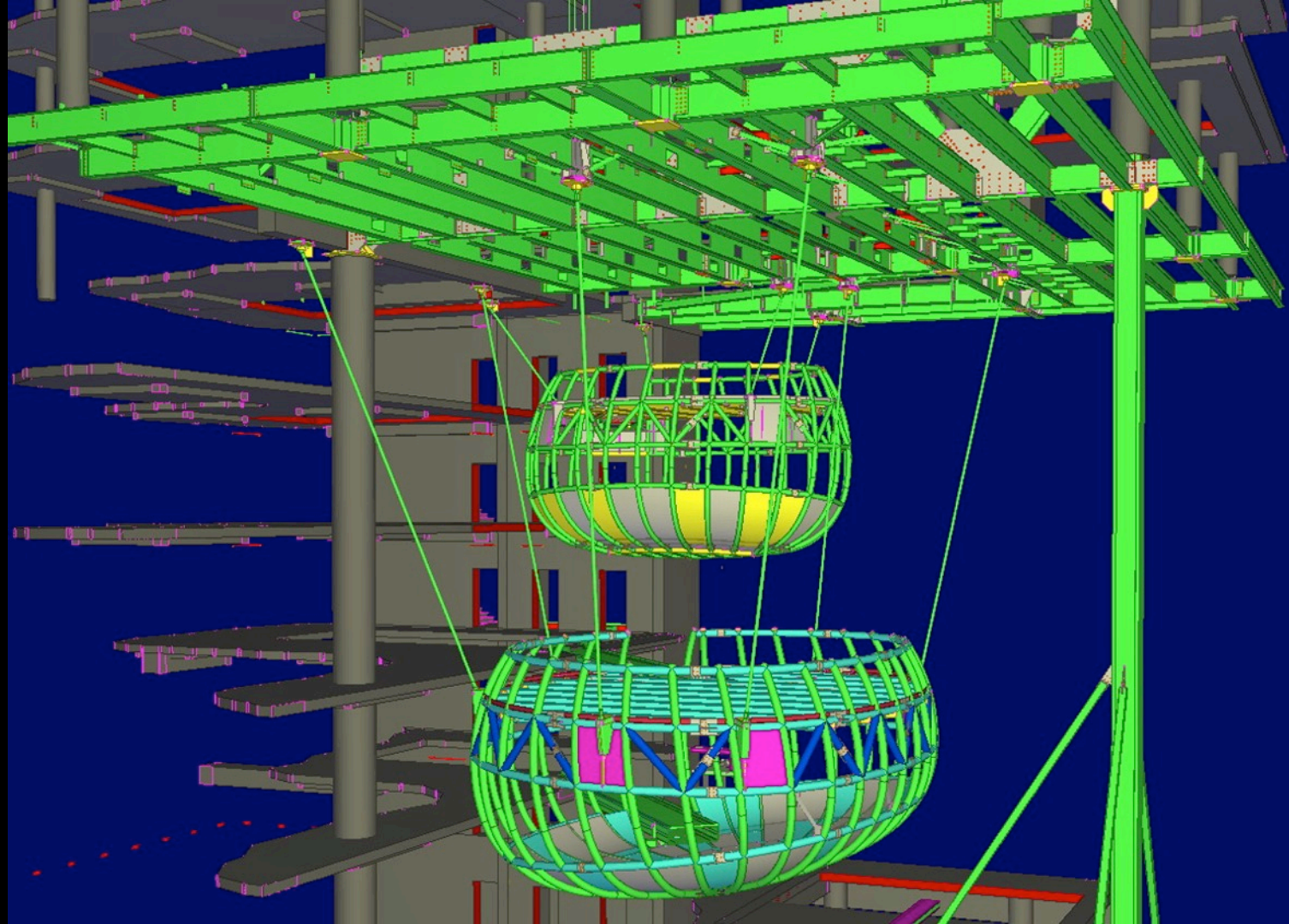


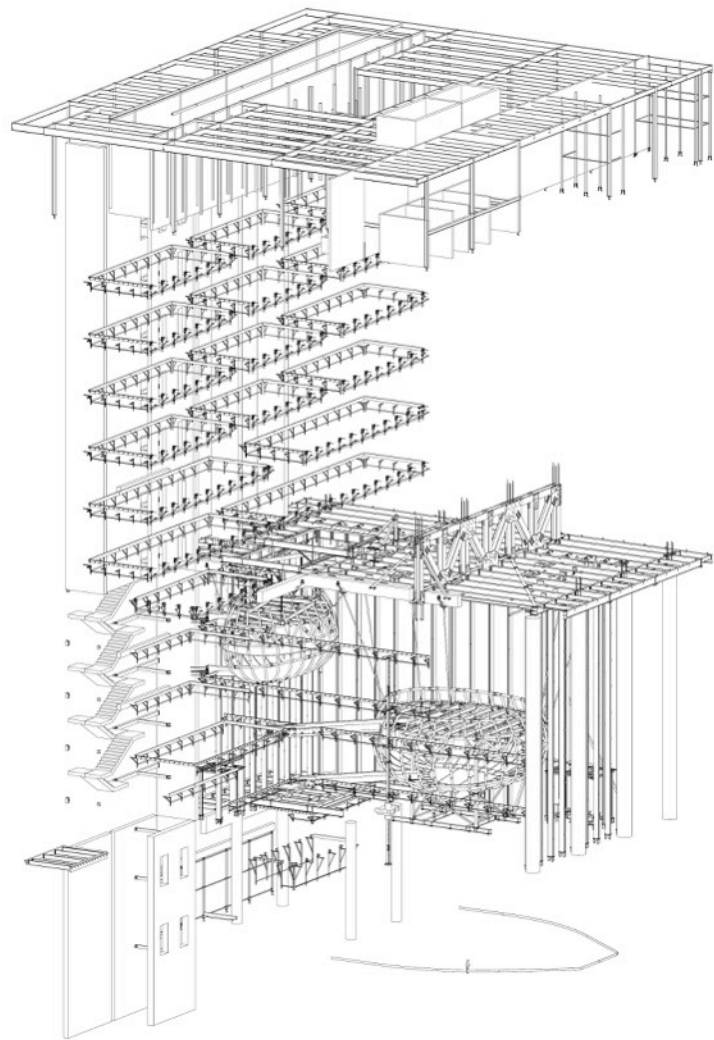


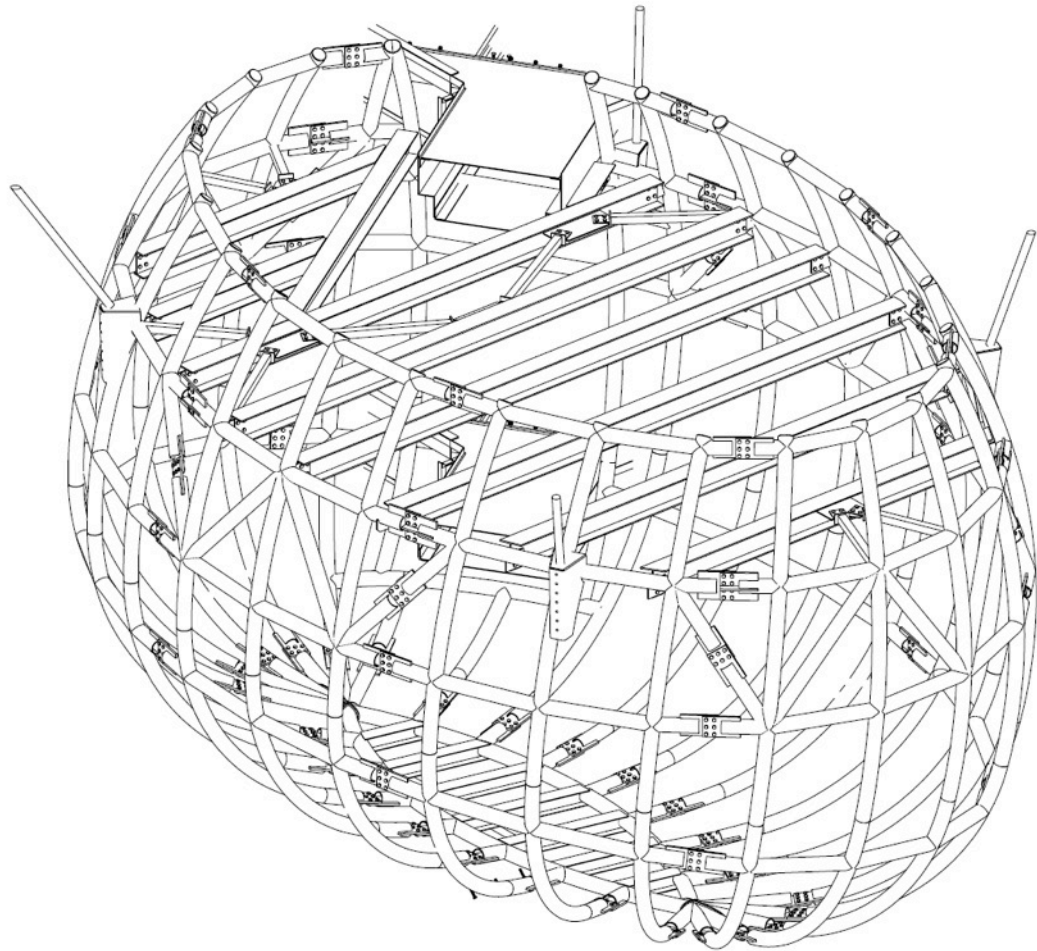


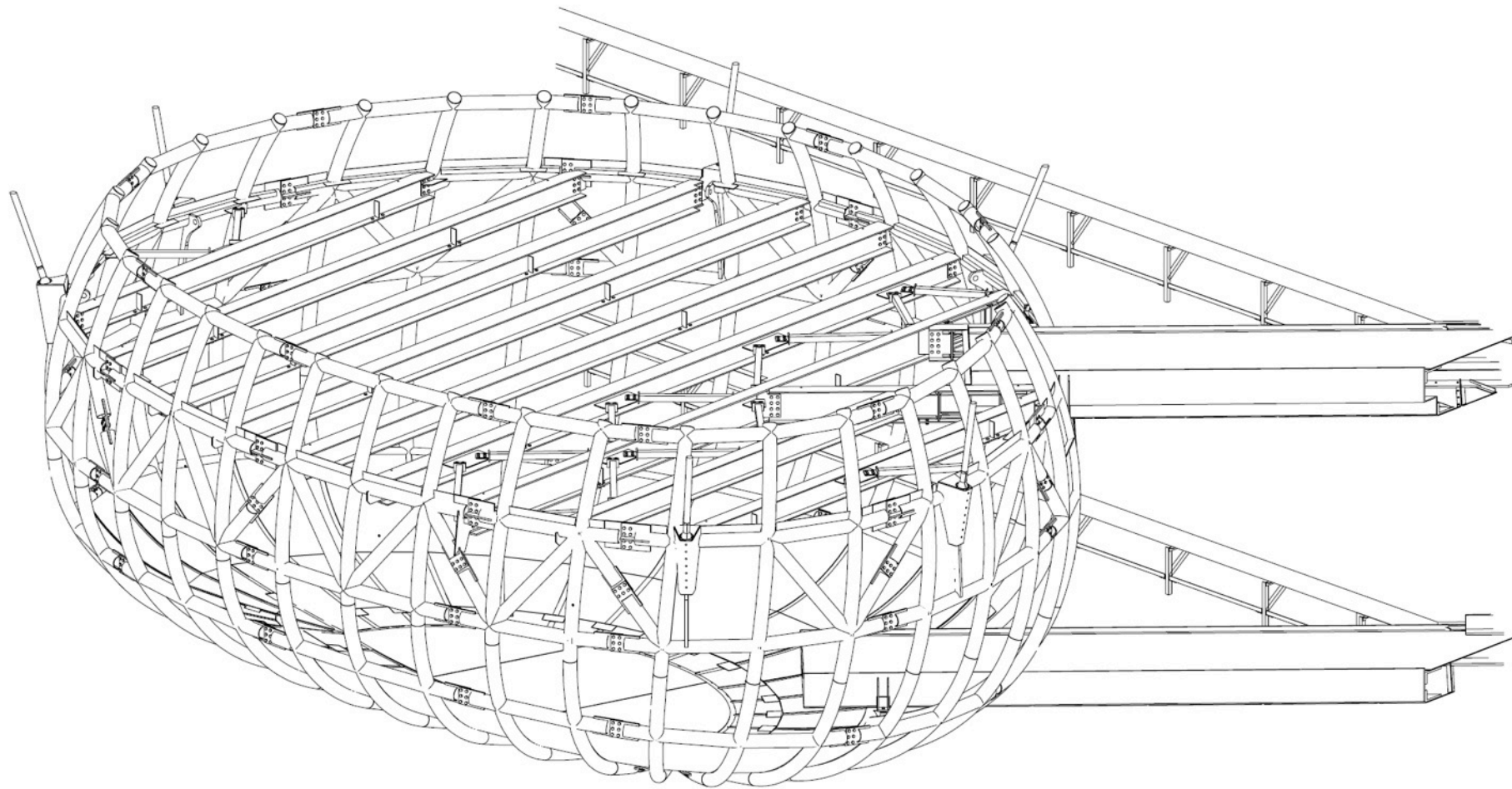


Leslie Dan School of Pharmacy UofT  
Toronto, Ontario  
Foster + Partners  
2006











what it takes to be great

DOUBLING  
EMBRACE





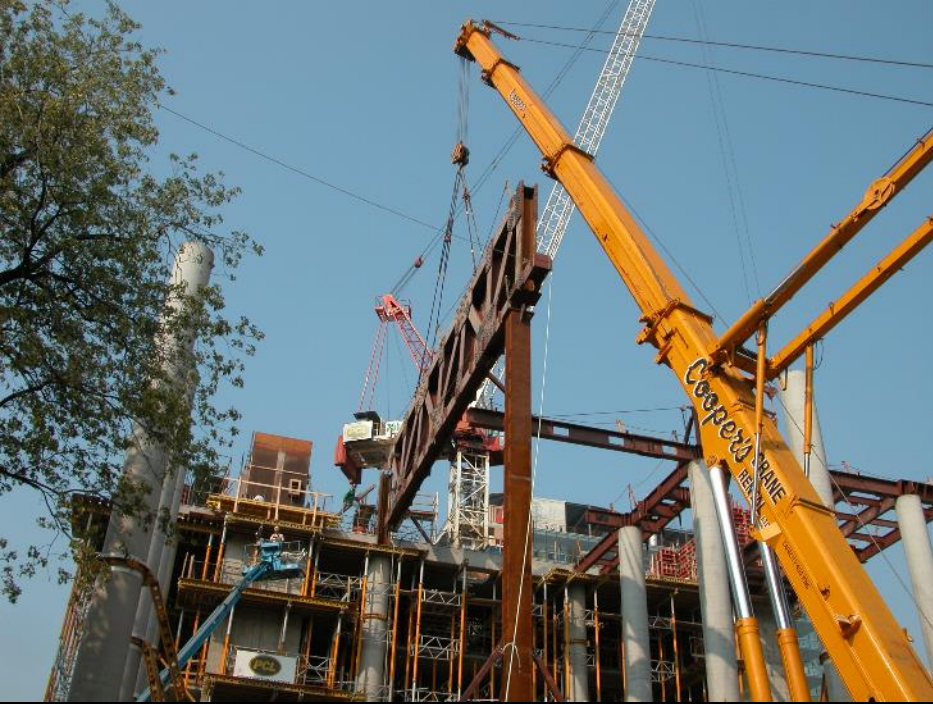






























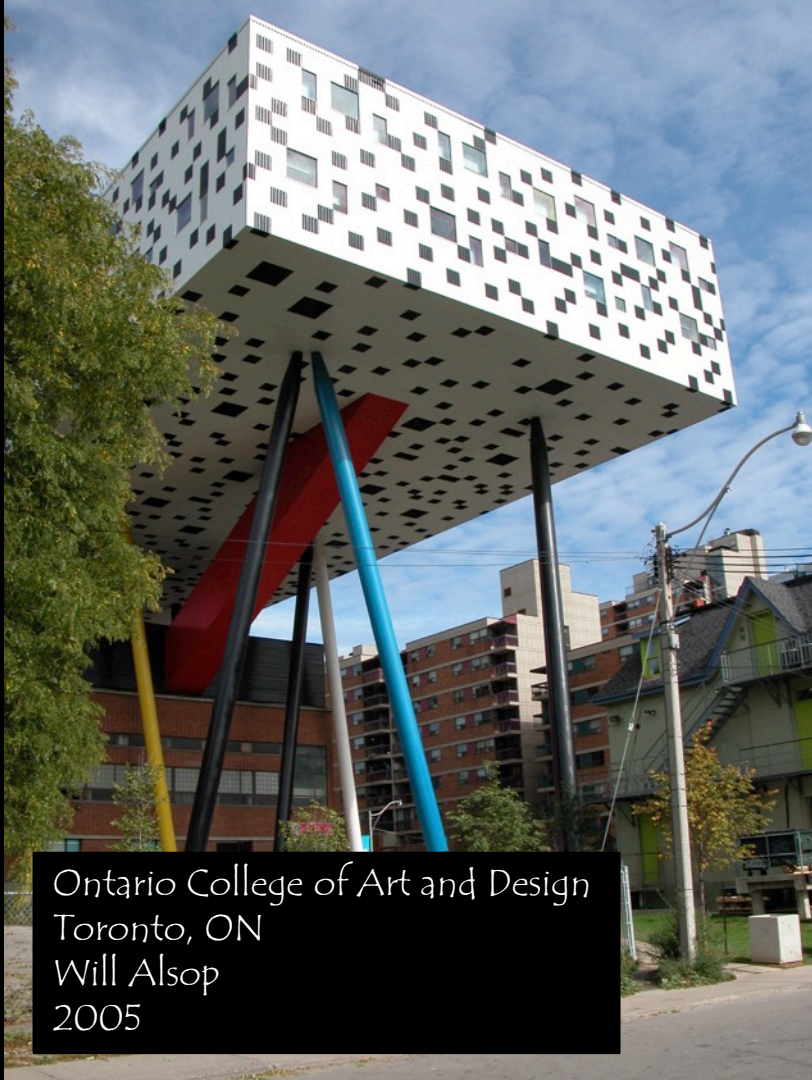


David R. Bloom  
Shoppers Drug Mart  
Lounge

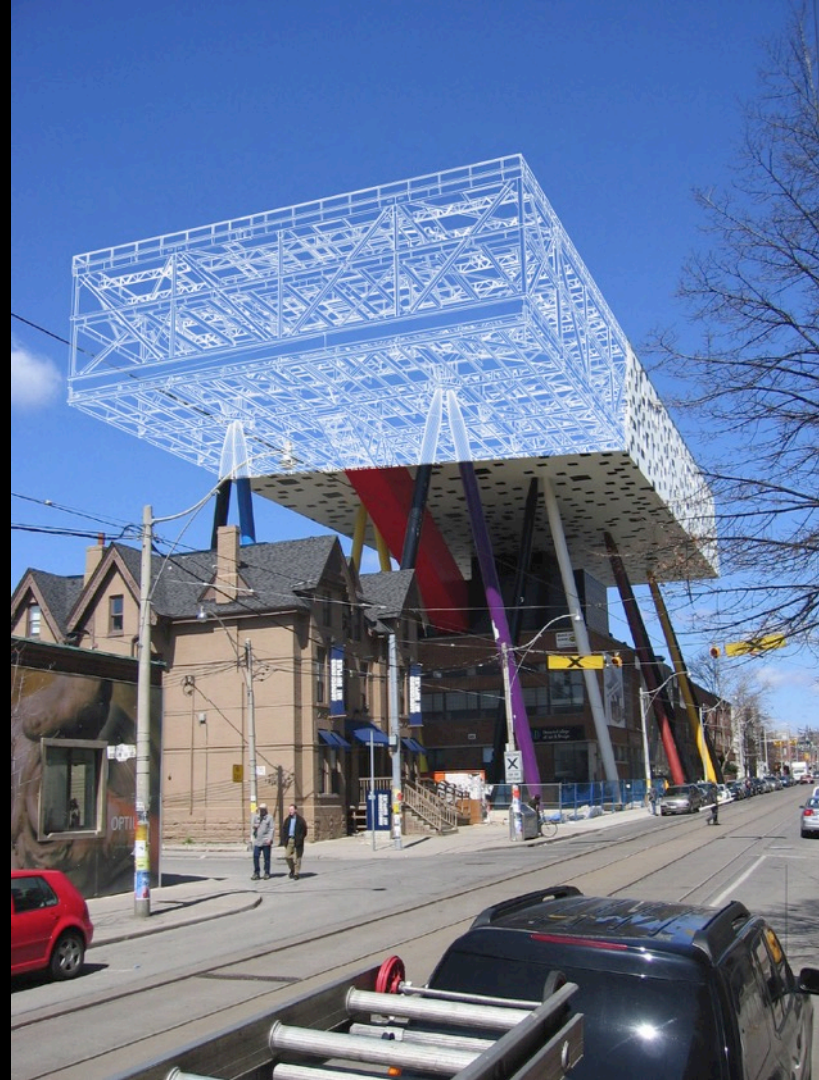
Public Information  
Office  
The Government  
of Ontario  
Linda S. Galt  
Minister  
of  
Public  
Information  
and  
Communications  
Services

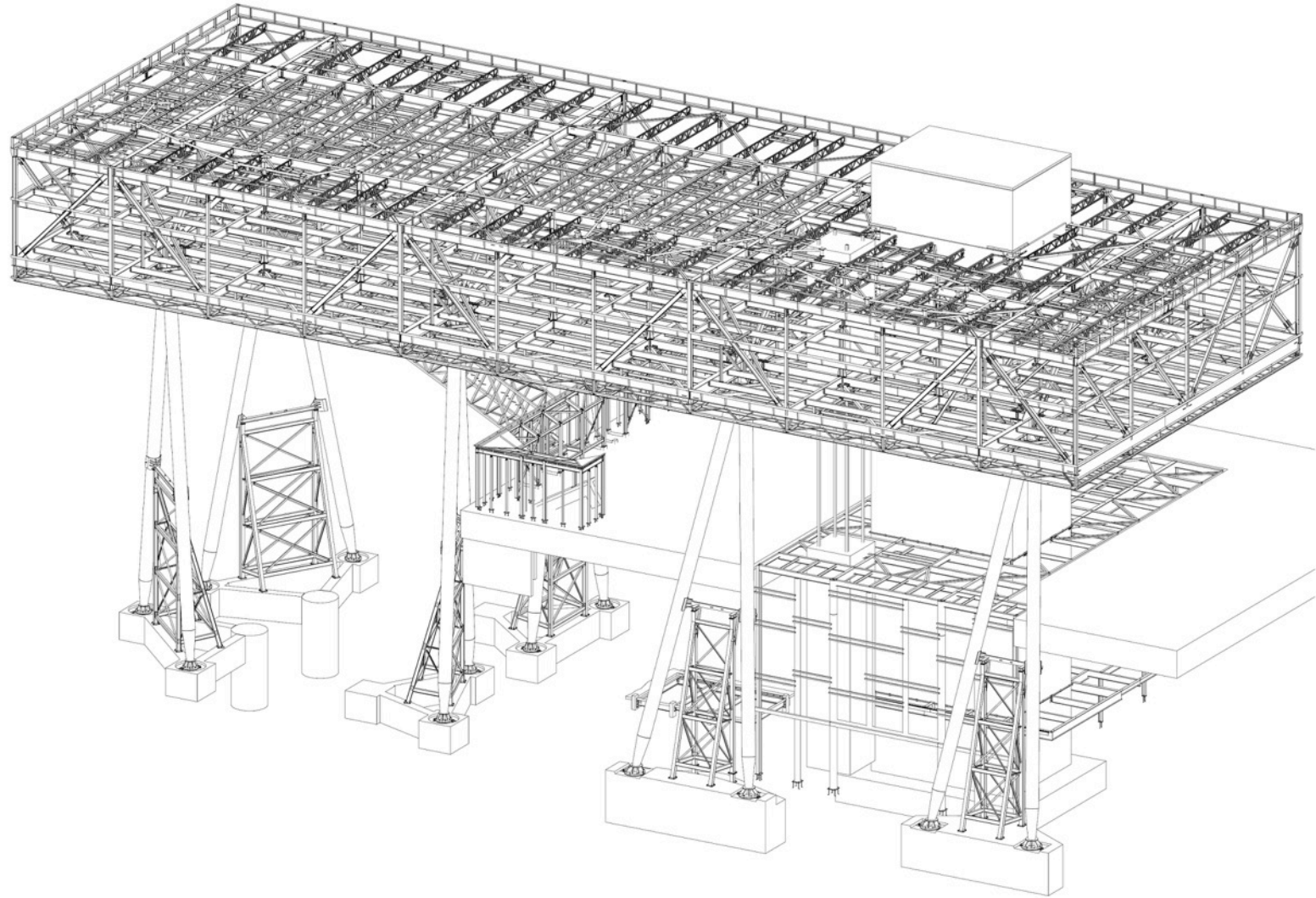


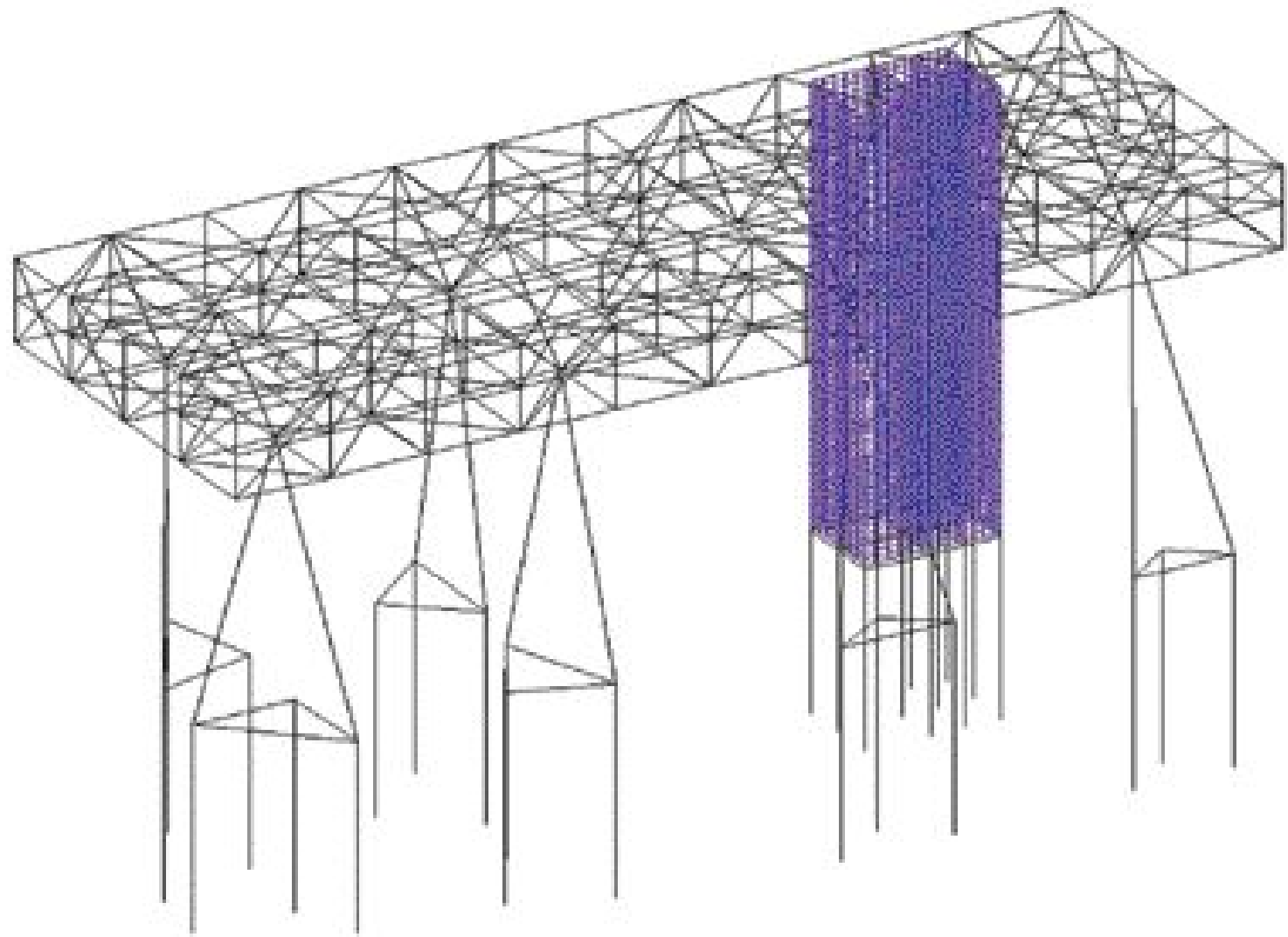


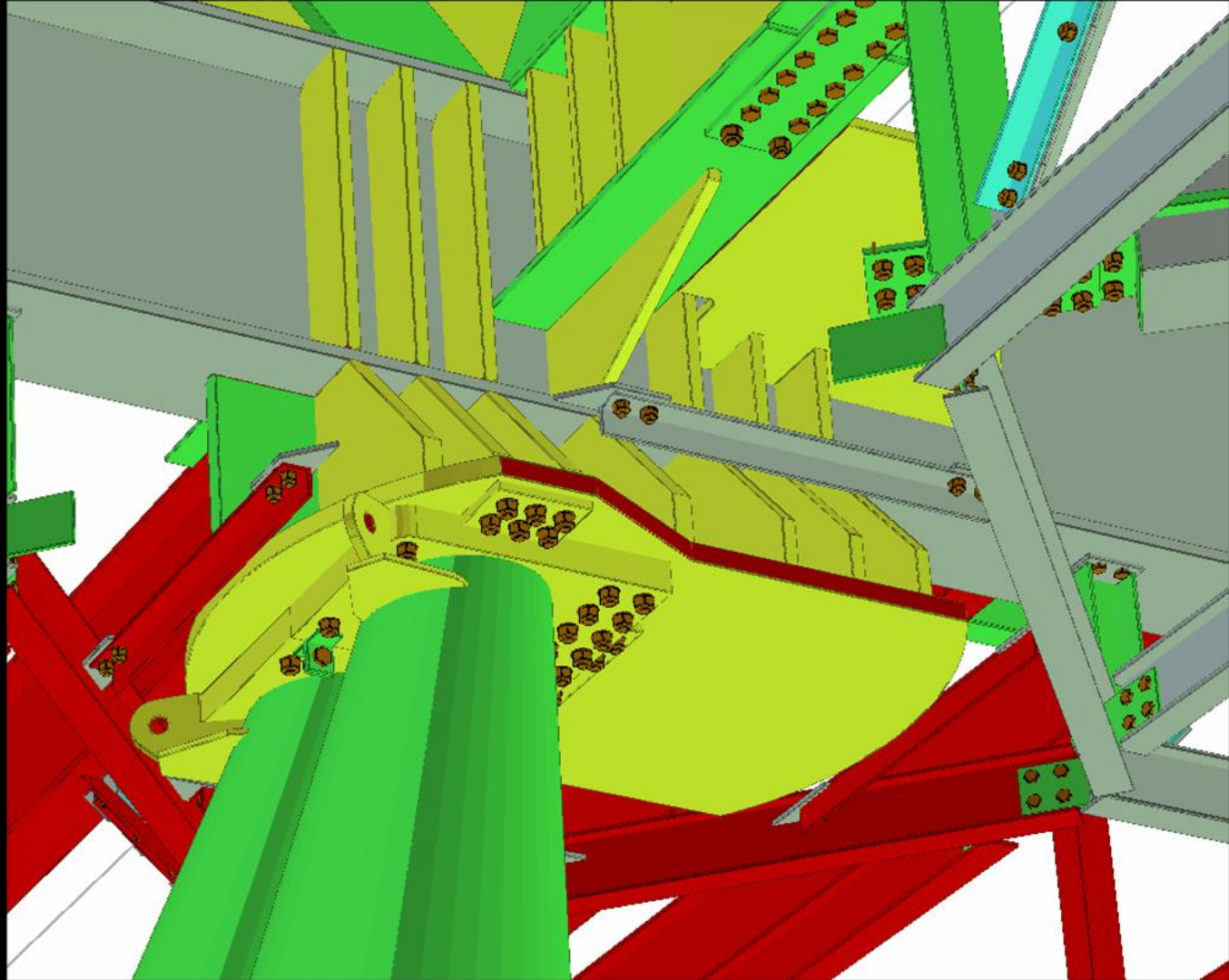


Ontario College of Art and Design  
Toronto, ON  
Will Alsop  
2005











CAB  
2074

INGERSOLL RAND

2003 7 9

ACER  
MILLAGE  
KING OF OLD COUNTRY  
PA 17114  
AGE 1-80-3064



2003 7 9



2003 7 9





2003 7 9





2003 7 9





2003 7 16



2003 7 16



2003 7 28







2003 7 31



2003 8 14

Watch us build a  
stronger future  
for the world.













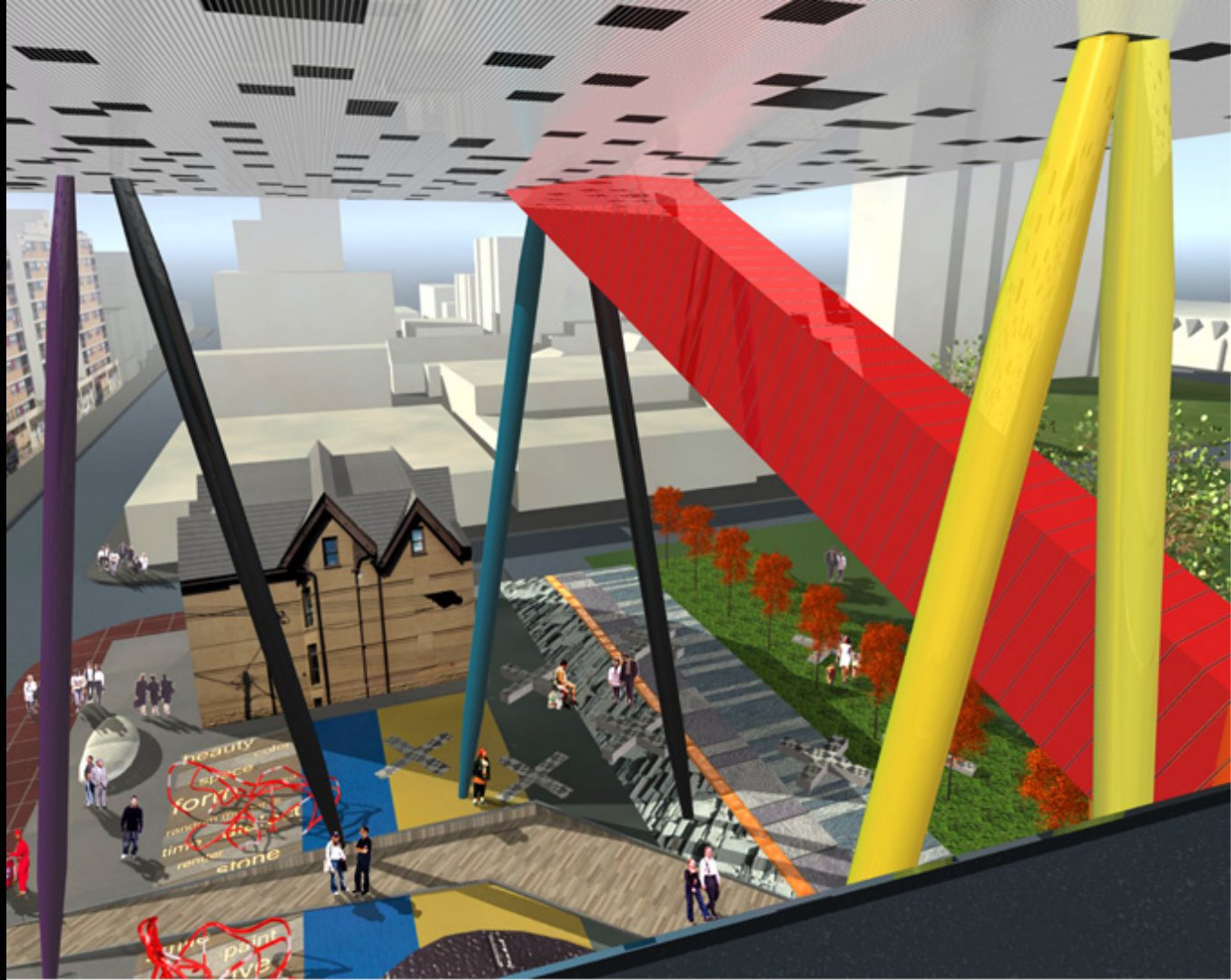




2009-10-8

















Terri Meyer Boake, BES, BArch, MArch, LEED AP  
Professor School of Architecture University of Waterloo  
email: [tbobo@uwaterloo.ca](mailto:tbobo@uwaterloo.ca)



Renaissance Hotel, Barcelona, Spain - Ateliers Jean Nouvel

Arch 570:  
Architecturally  
Exposed Structural  
Steel Design

Fall 2021  
Course Home Page

### course outline

last updated November 27, 2021 2:24 PM

#### Territorial Acknowledgement

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>)

#### Course Description:

THIS COURSE IS ALL ABOUT DESIGN, NOT CALCULATIONS. LEARNING OUTCOMES INCLUDE AN INCREASE IN YOUR ABILITY TO UNDERSTAND HOW STRUCTURES WORK, AND DETAIL THE SAME. PORTFOLIO WORTHY DESIGN PROJECTS.

Using an international database of case studies this course examines in detail the architectural design, specification, fabrication and construction process for Architecturally Exposed Structural Steel (AESS). It references the standards that were developed by the Canadian Institute of Steel Construction. Lectures will address topics including, the AESS Category Approach, fabrication standards and practices, project communication, tensile structures, diagrid structures, curved steel, castings, pedestrian bridges, steel with glazing, steel with timber. The work of the term will use current steel based competitions to explore detailed design application of the material.



Unless you take my Arch  
570 elective in 3B!

