Leveraging Cast Steel Connections for Steel-Timber Hybrid Constructions

7th November, 2024

SBI Steel Construction Day

Jennifer Anna Pazdon, MSE, PE

Vice President, USA | Director, UK Division

j.pazdon@castconnex.com | +44 0798 556 1101

CASTCONNEX
innovative components for inspired designs

SBI Stålbyggnadsinstitutet
The Swedish Institute of Steel Construction

WHO WE ARE

Leader in the **Design and Delivery** of Steel Castings for use in Buildings, Bridges and Specialty Structures

Responsible for **tens-of-thousands of castings** in hundreds of structures in North America and globally

Portfolio includes **projects of all sizes across every building sector**

Thought Leader in the AEC industry on the benefits of steel castings

CASTCONNEX®

PRESENTATION OUTLINE

- What are Structural Steel Castings?
- Performance Benefits and a *Fast* History of Applications in Contemporary Structures
- How are Steel Castings Made: Sphere Case Study
- Steel-Timber Hybrid Case Studies
- Questions

WHAT ARE STRUCTURAL STEEL CASTINGS?

MANUFACTURING: ROLLED STEEL

A continuous casting process is used to manufacture conventional rolled steel shapes.

MANUFACTURING: STEEL CASTINGS

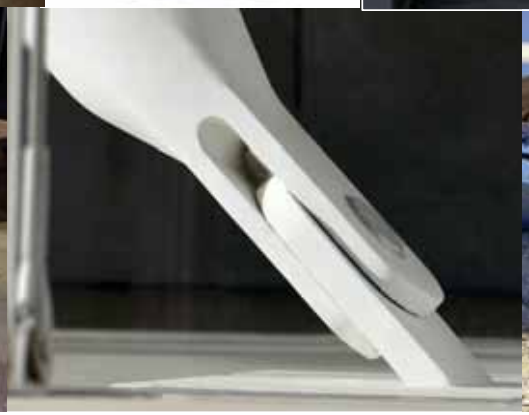
Steel castings are manufactured by pouring molten steel directly into a 3-dimensional mould.









STANDARDIZED CASTINGS

- Available off the shelf in a range of sizes to fit small to large members.
- Economy of scale achieved through standardization.

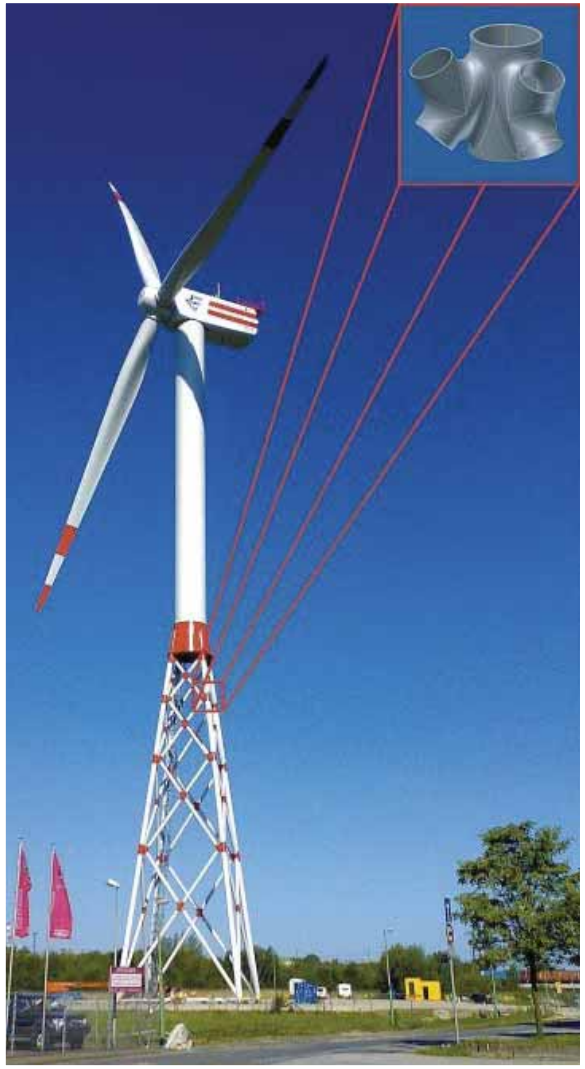


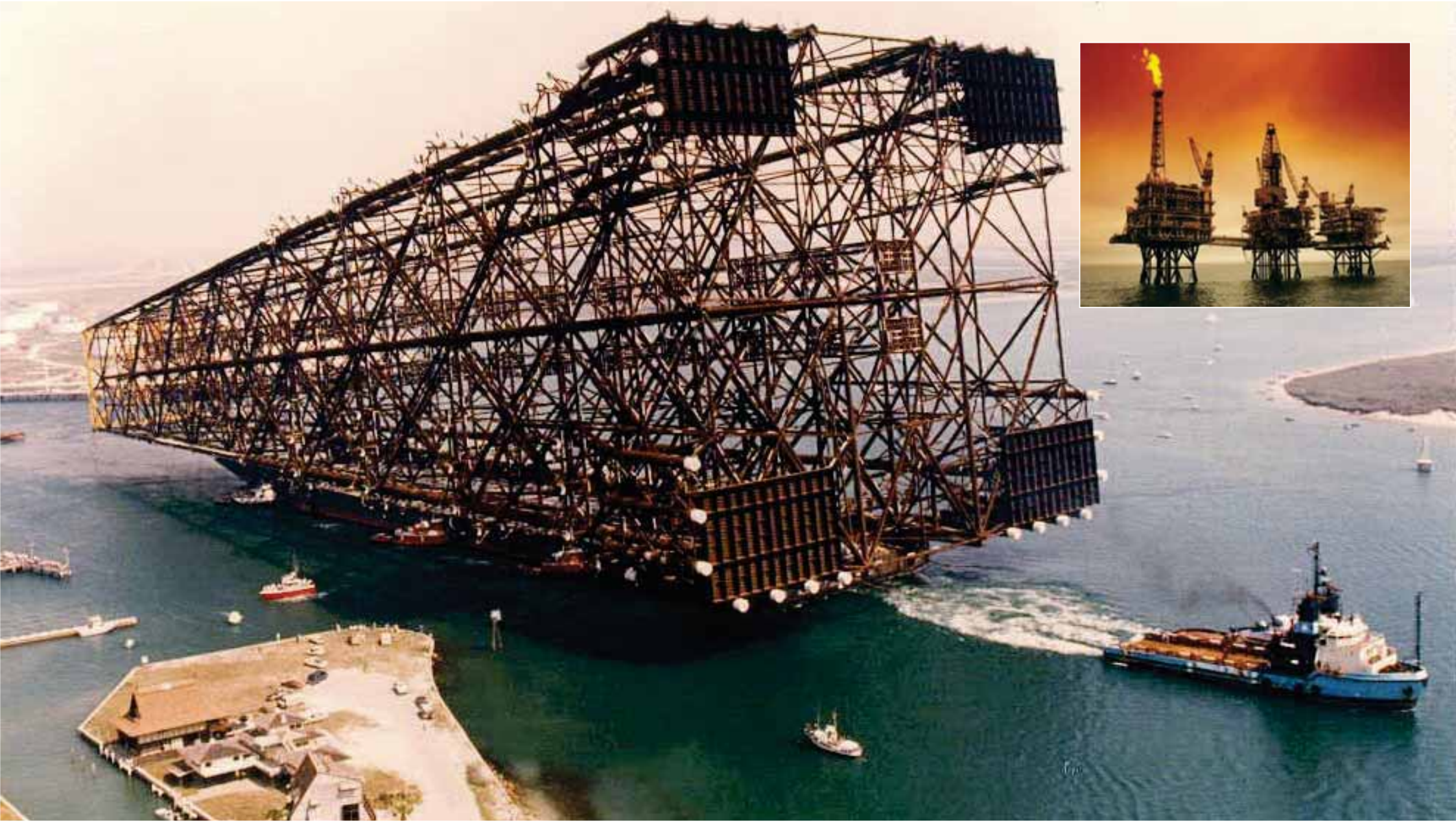


CUSTOM/BESPOKE CASTINGS

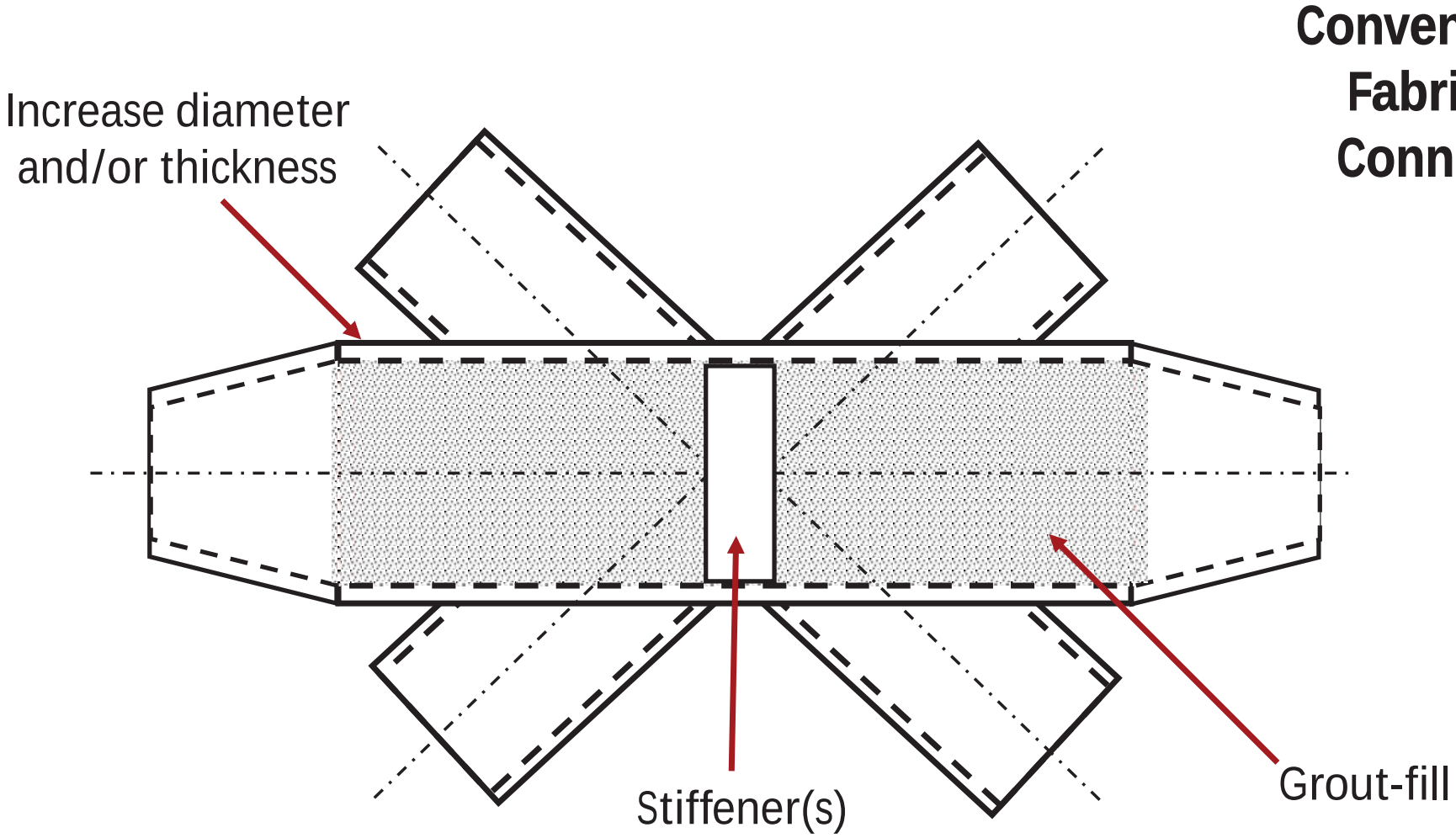
- Designed for unique project performance requirements.
  - complex geometries
  - multi-member nodes
  - arduous loading
  - repetitive geometries (economy of scale)
  - and/or aesthetic requirements

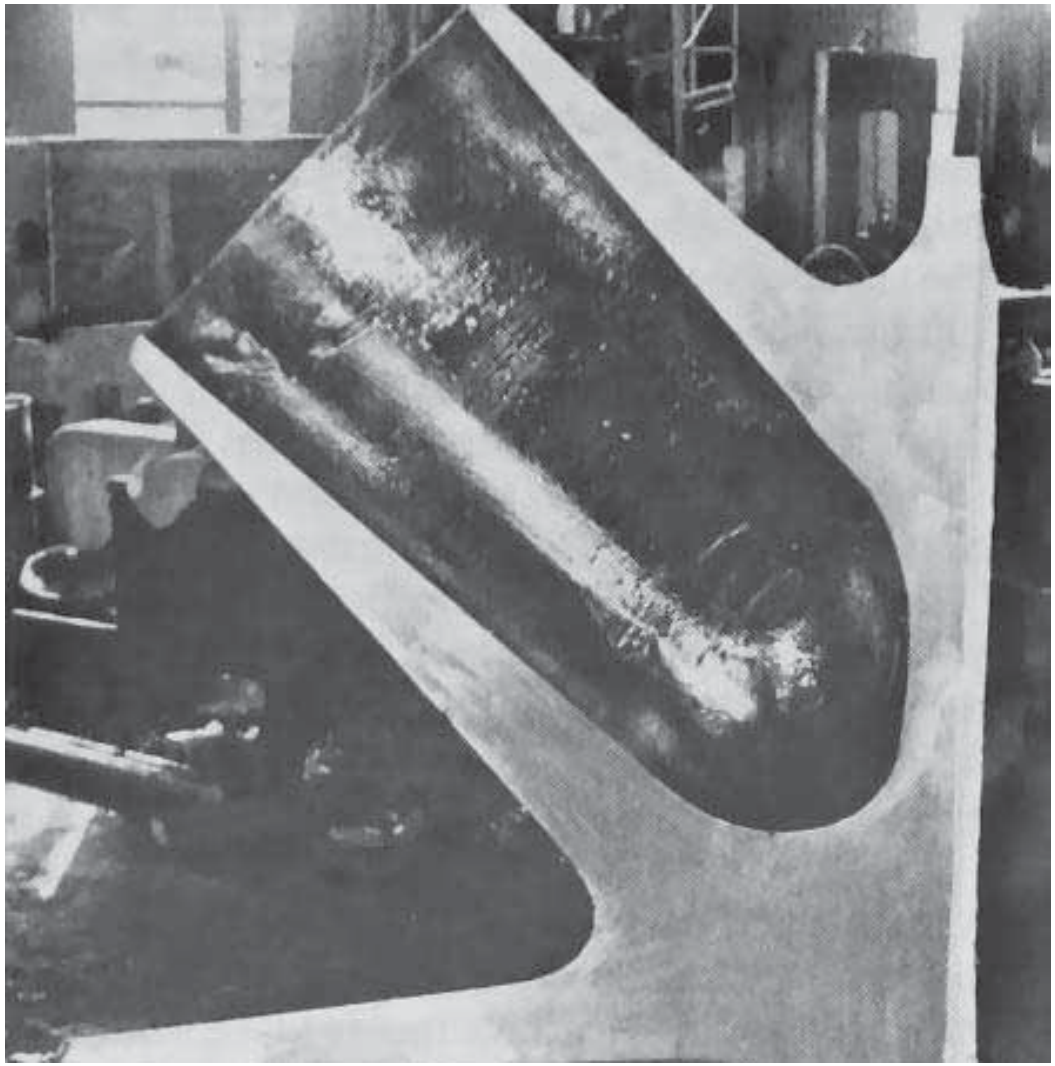
PERFORMANCE BENEFITS & *FAST* REVIEW OF APPLICATIONS



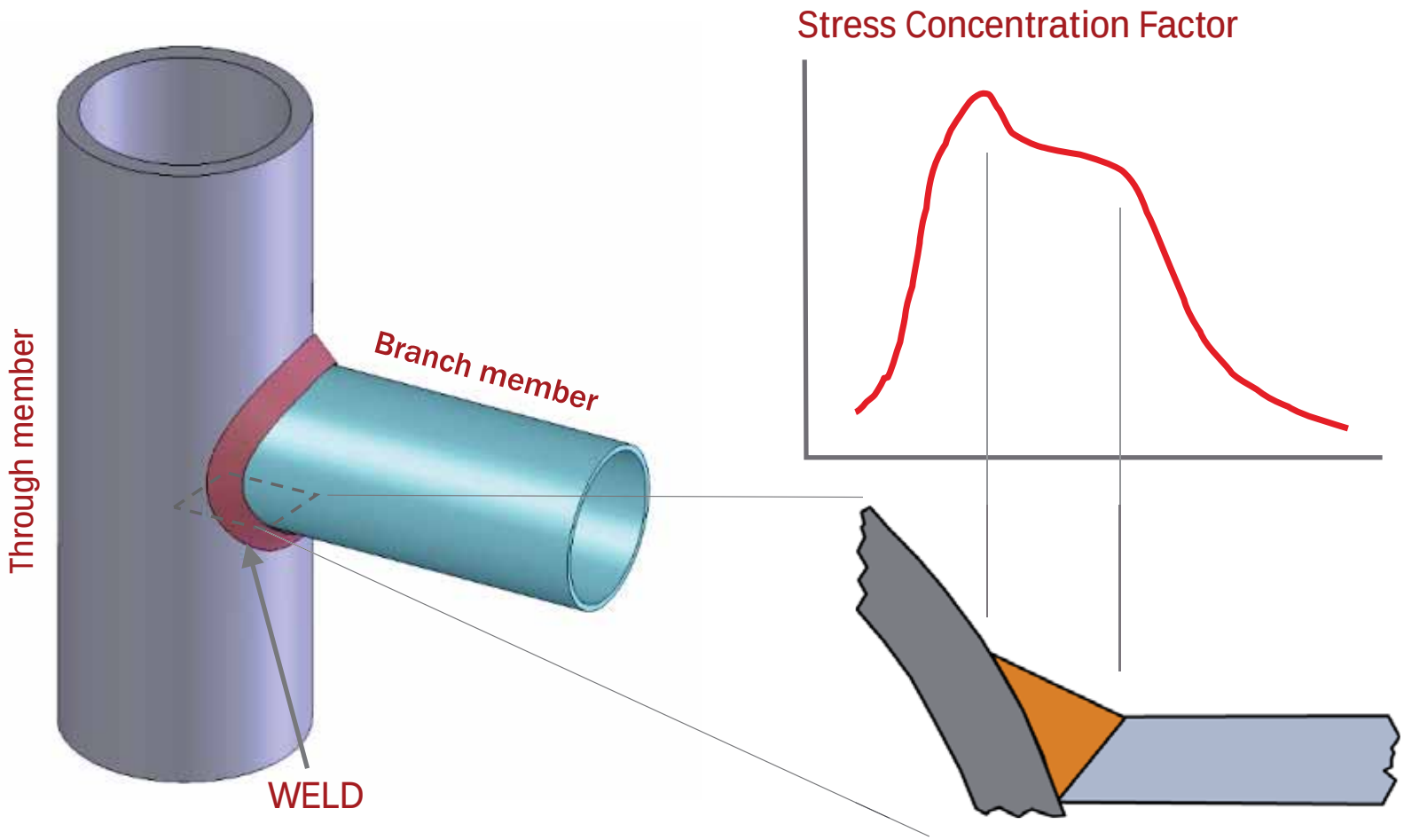


Conventionally Fabricated Connection

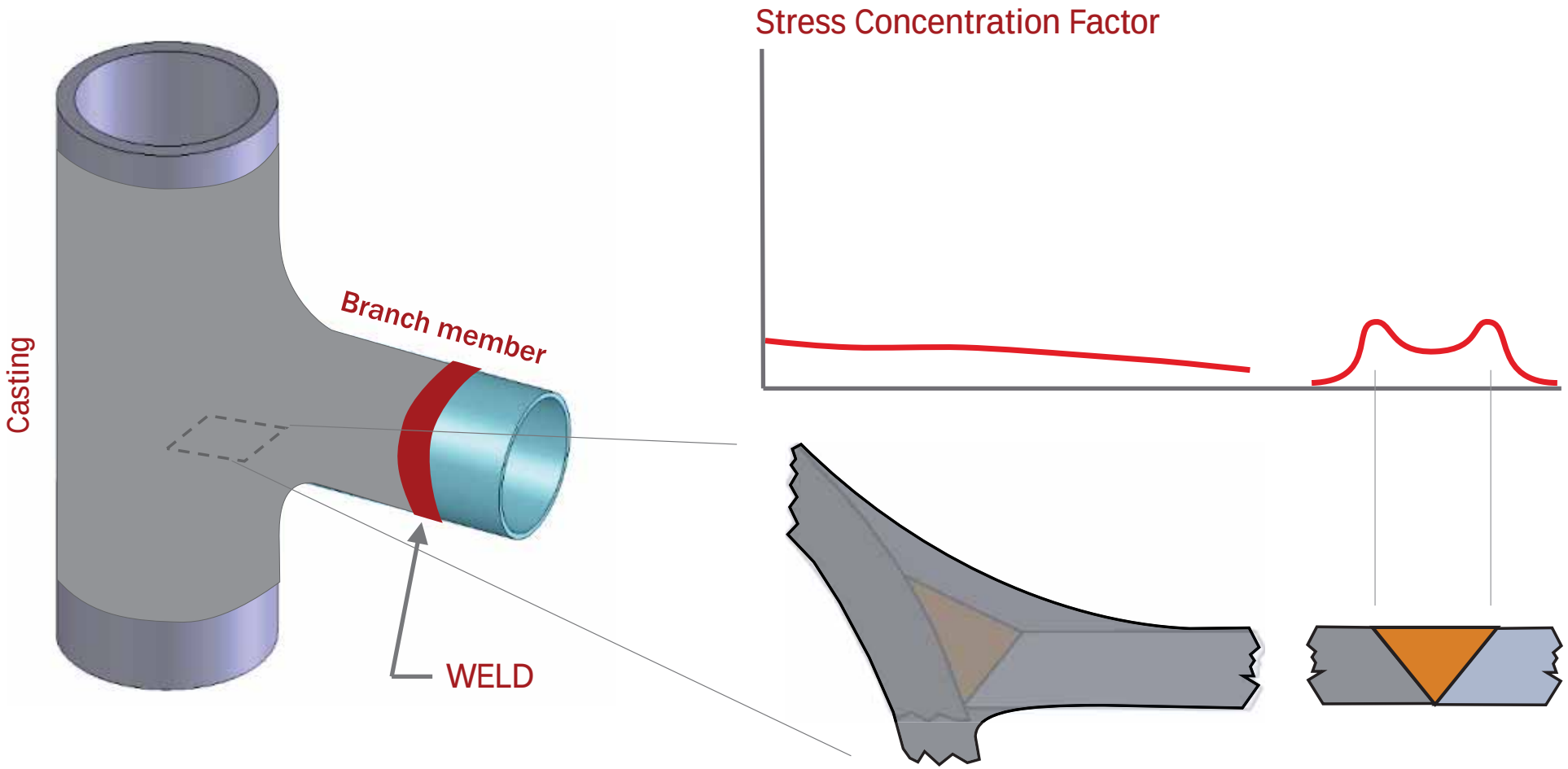




CONVENTIONALLY FABRICATED HSS-TO-HSS CONNECTION



CONNECTION WITH CAST STEEL NODE



PERFORMANCE BENEFITS OF CAST STEEL NODES

Enhanced overall structural performance and efficiency via:

- Elimination of local connection limit states
- Reduction in member design forces
- Increased connection stiffness
- Improved fatigue performance

Simplified fabrication – improved weld access, elimination of complex fabrication

Simplified field activities – tightened tolerances -> improved fit-up -> reduced risk

Improved coating system performance and longevity

Installed project cost savings

Reduced total life cycle cost

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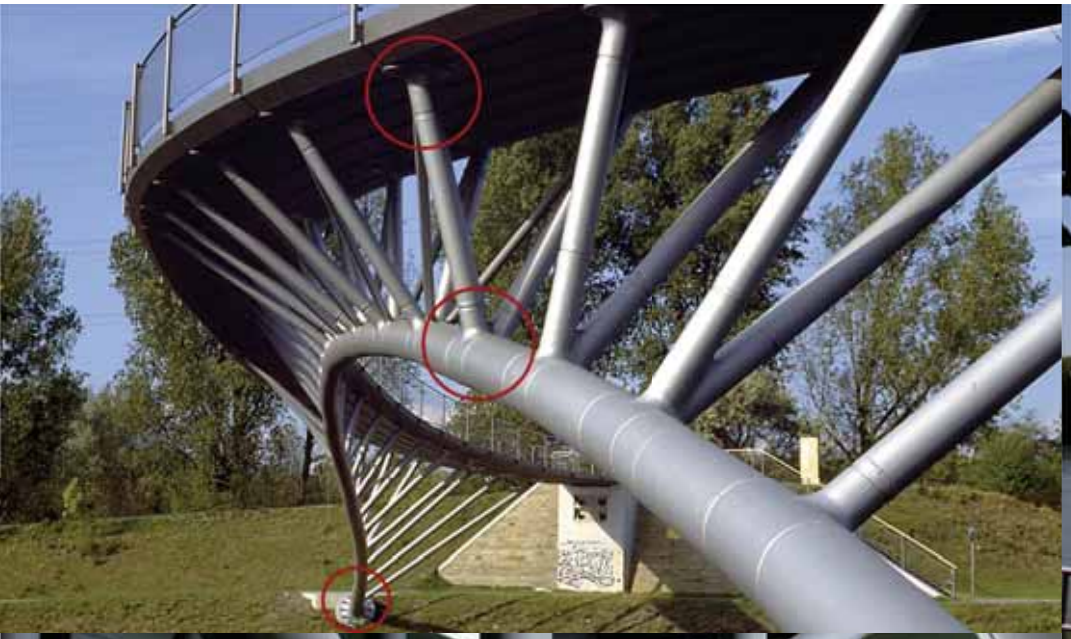
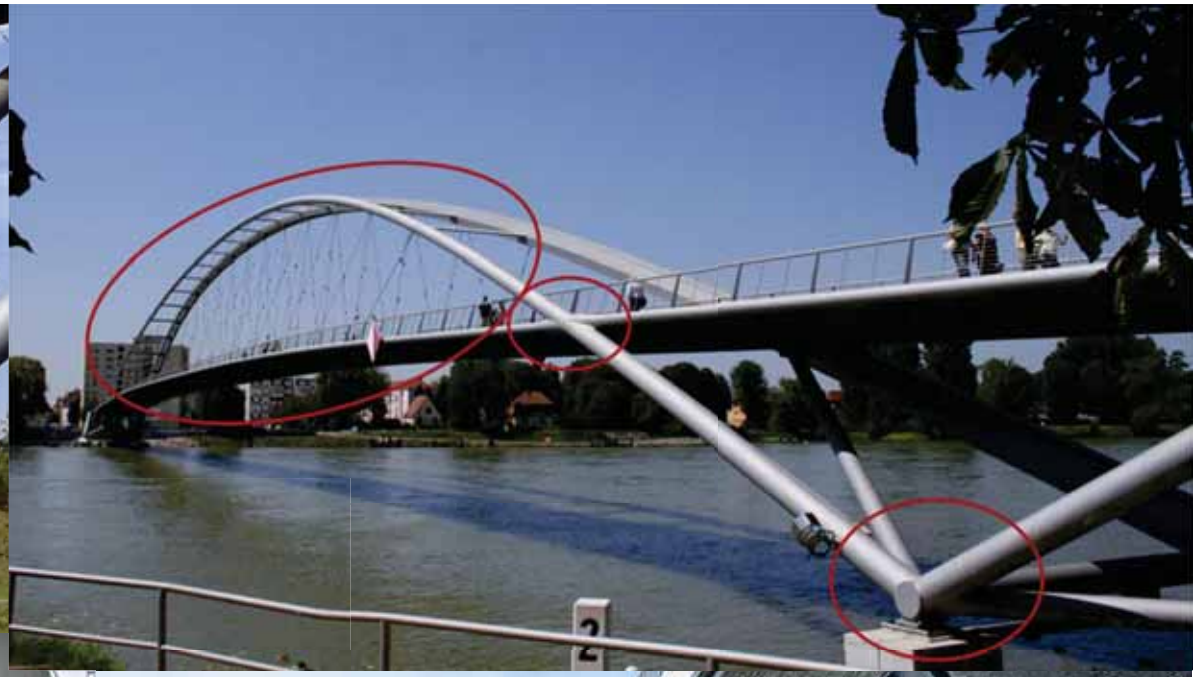
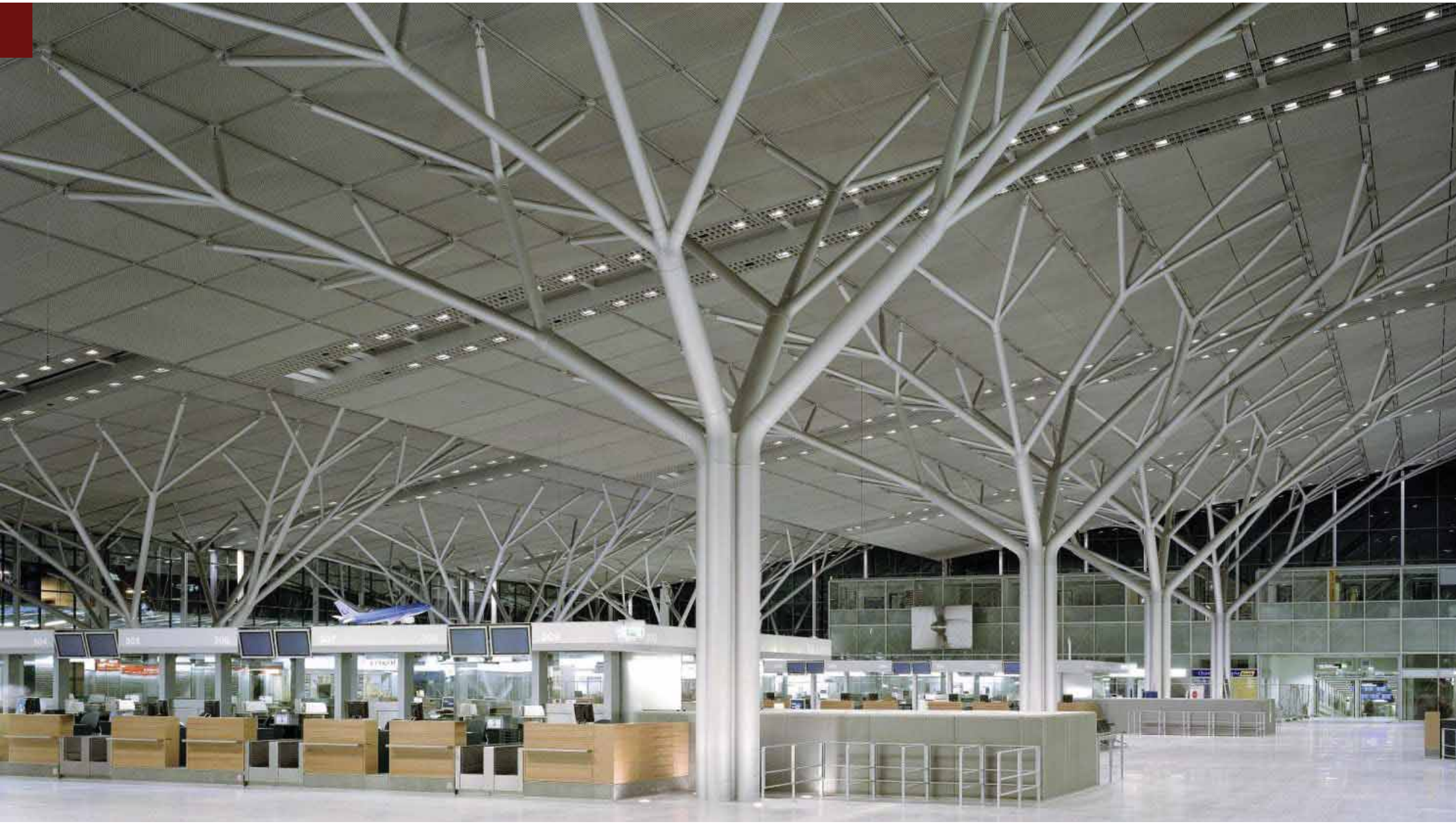
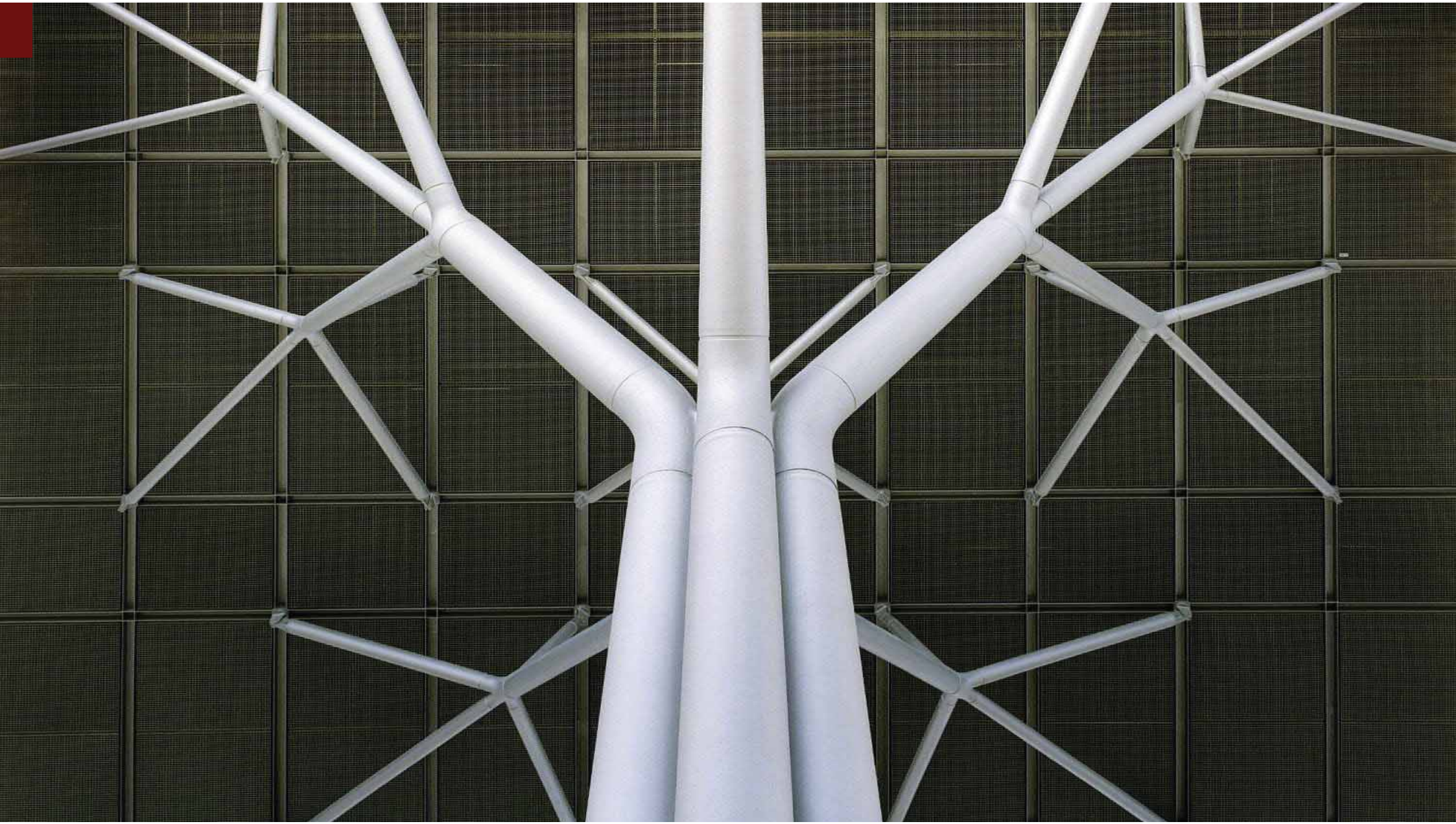
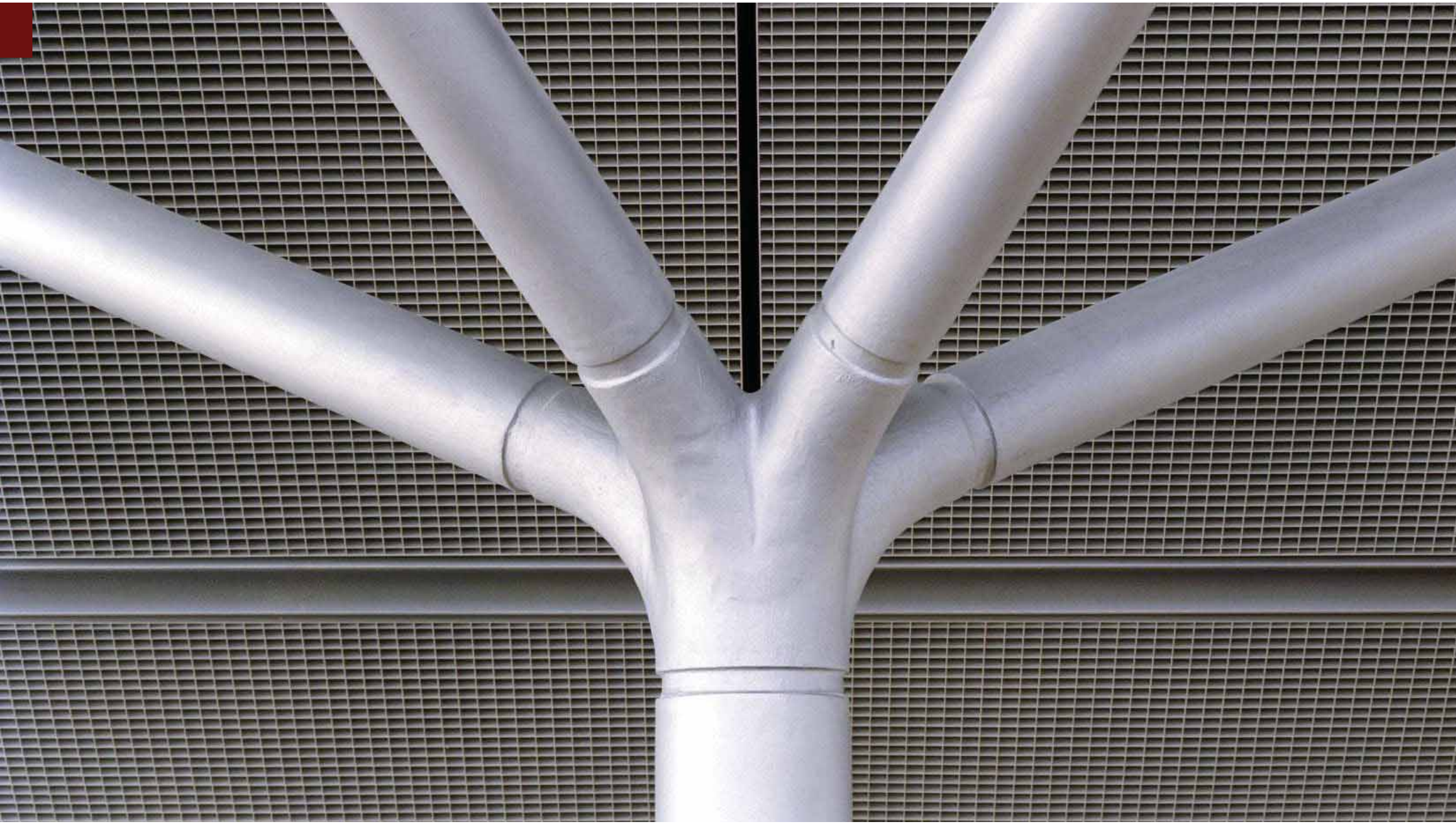
Unmatched Aesthetics









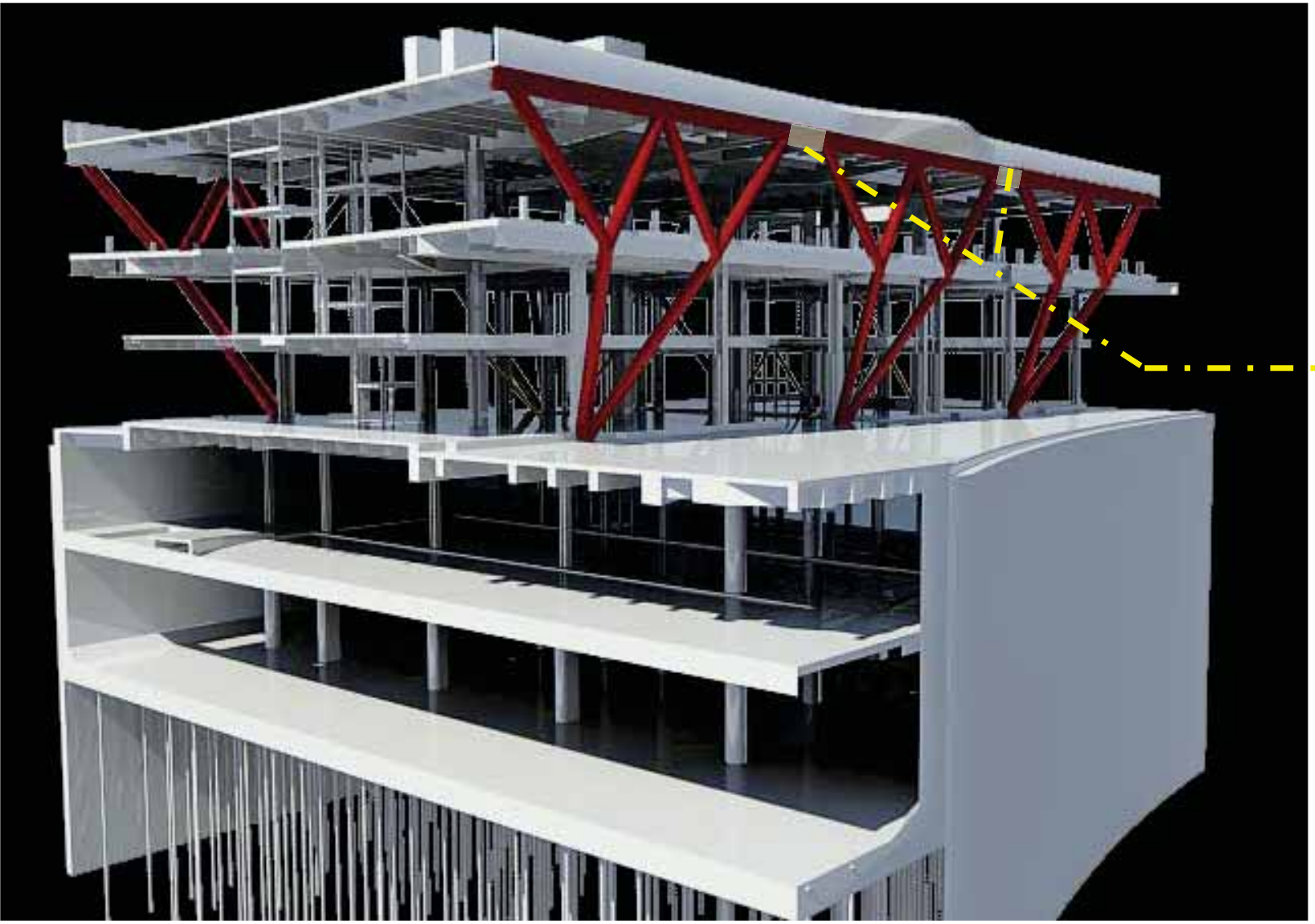



Assisted Travel
Lounge

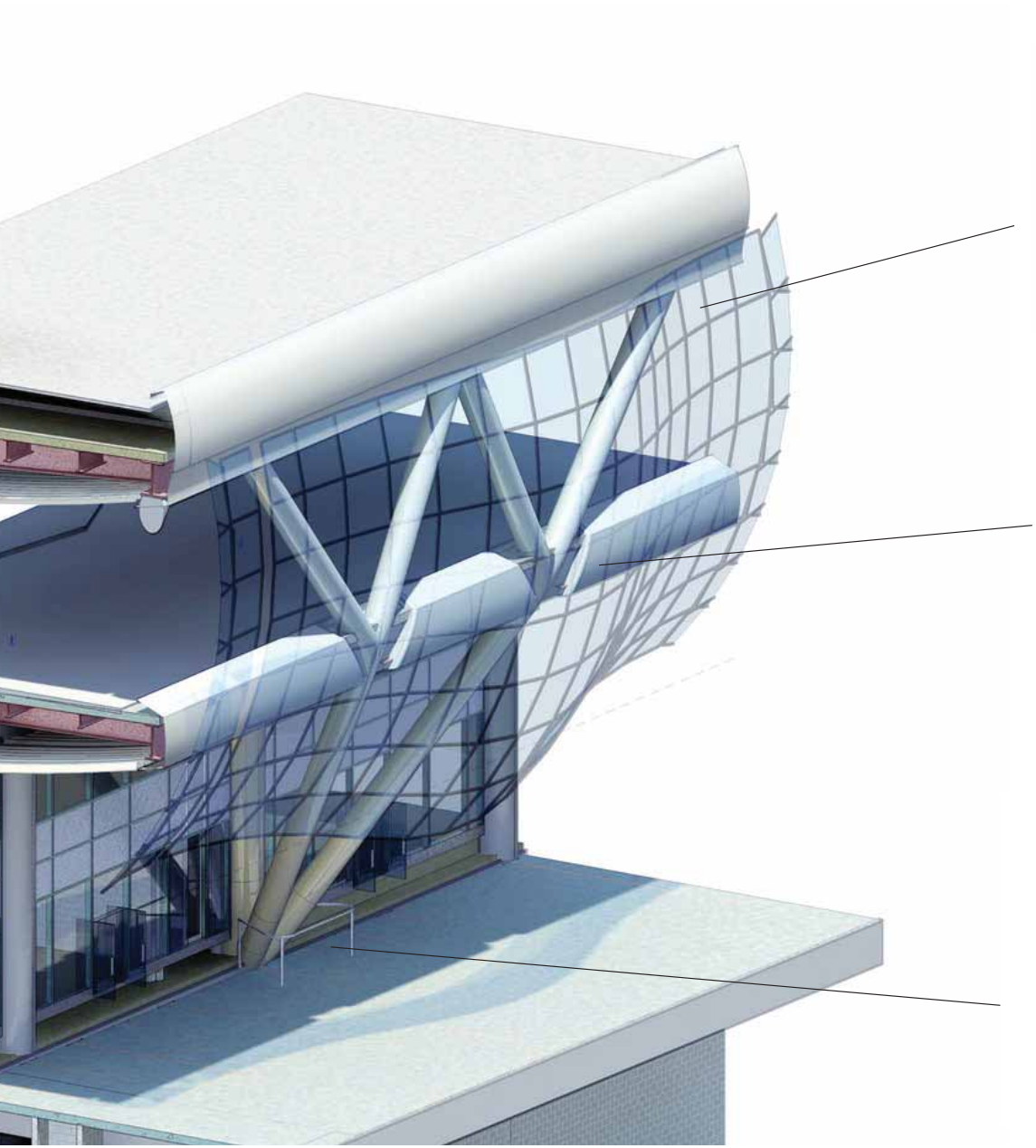
SALESFORCE TRANSIT CENTER

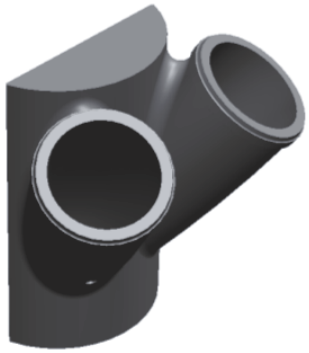
Pelli Clarke & Partners
Thornton Tomasetti
schlaich bergermann partner

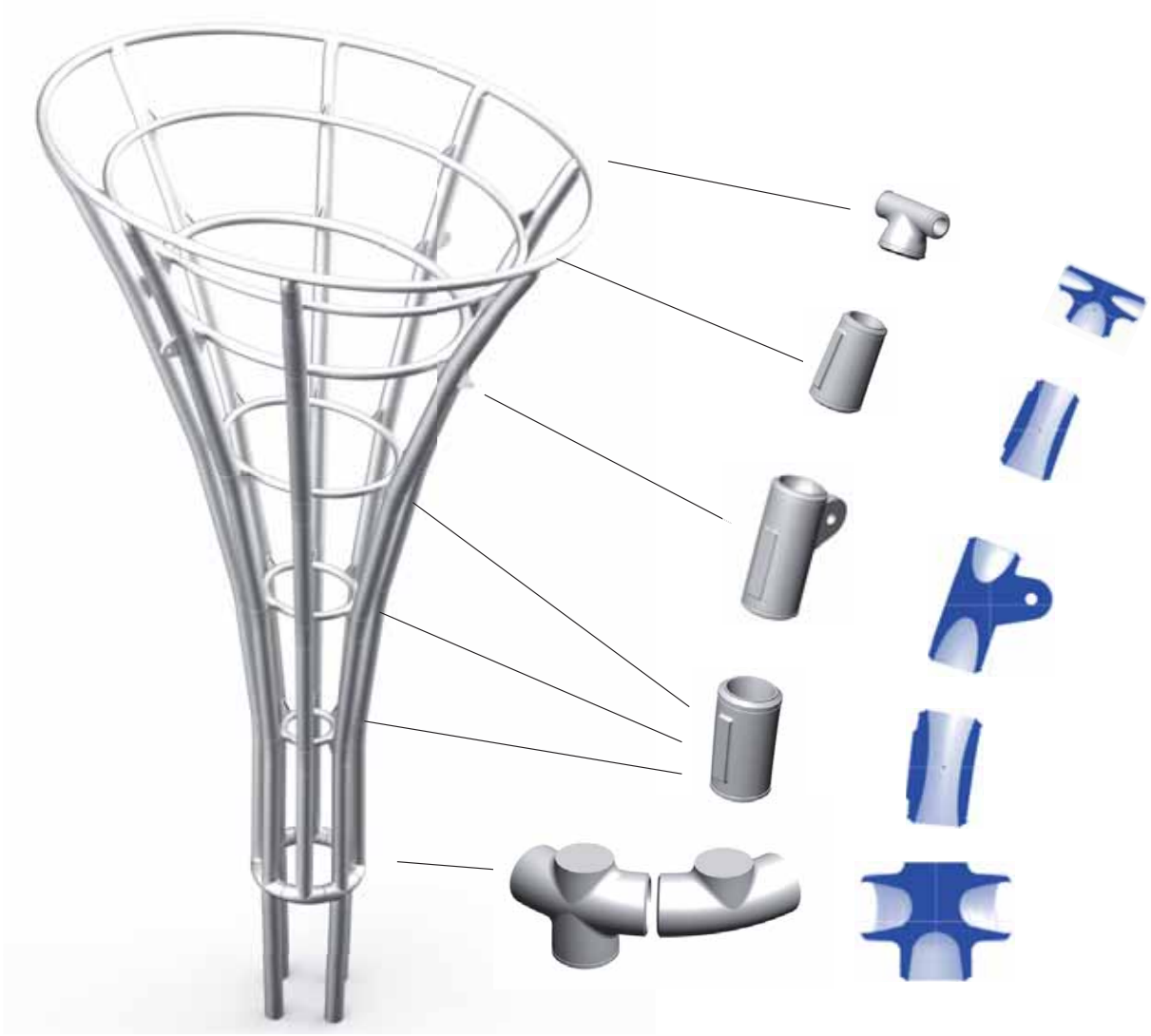
San Francisco, CA



Sesimic Force Resisting System: Eccentric Braced Frame with conventionally fabricated Shear Links and cast steel tubular nodes



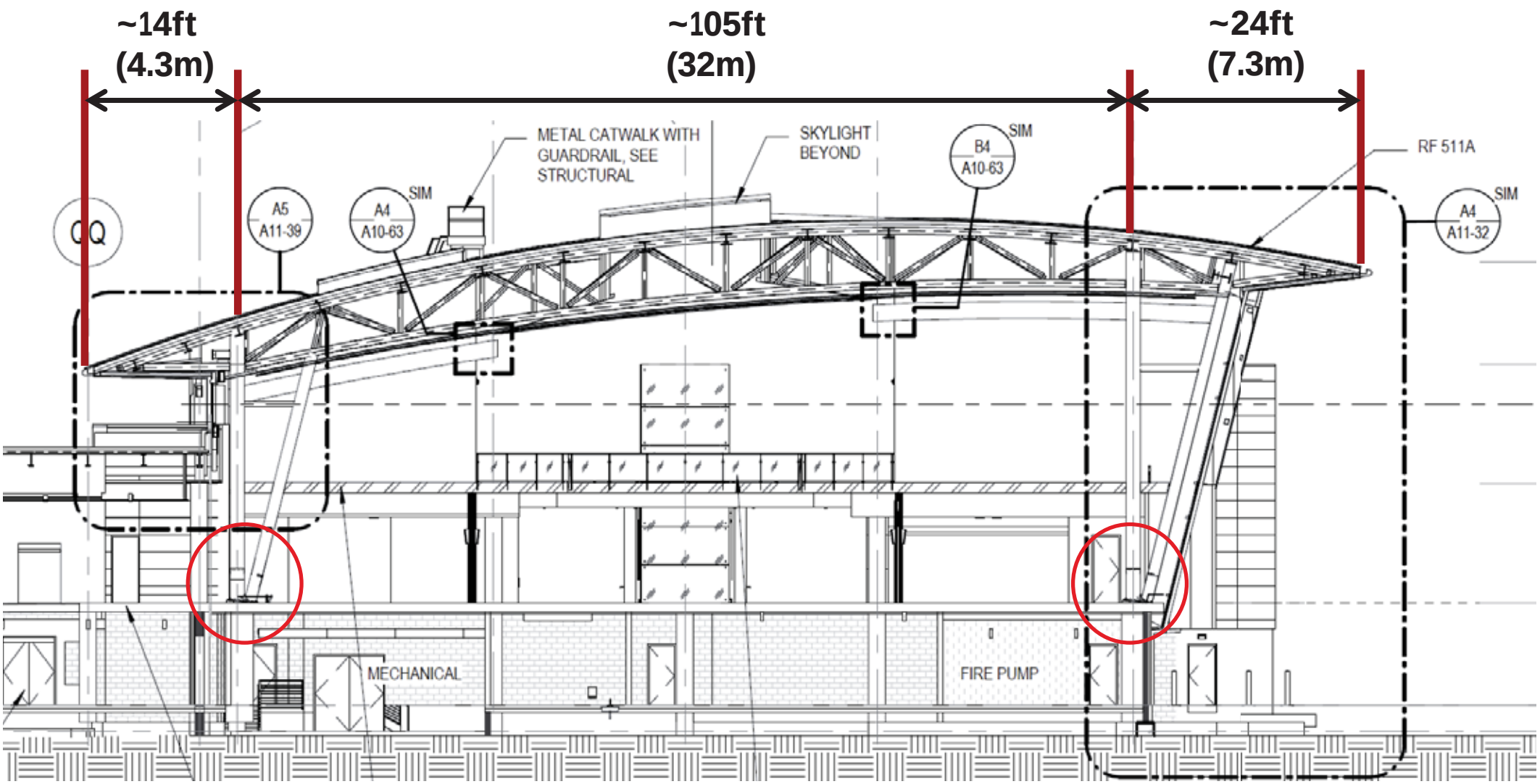


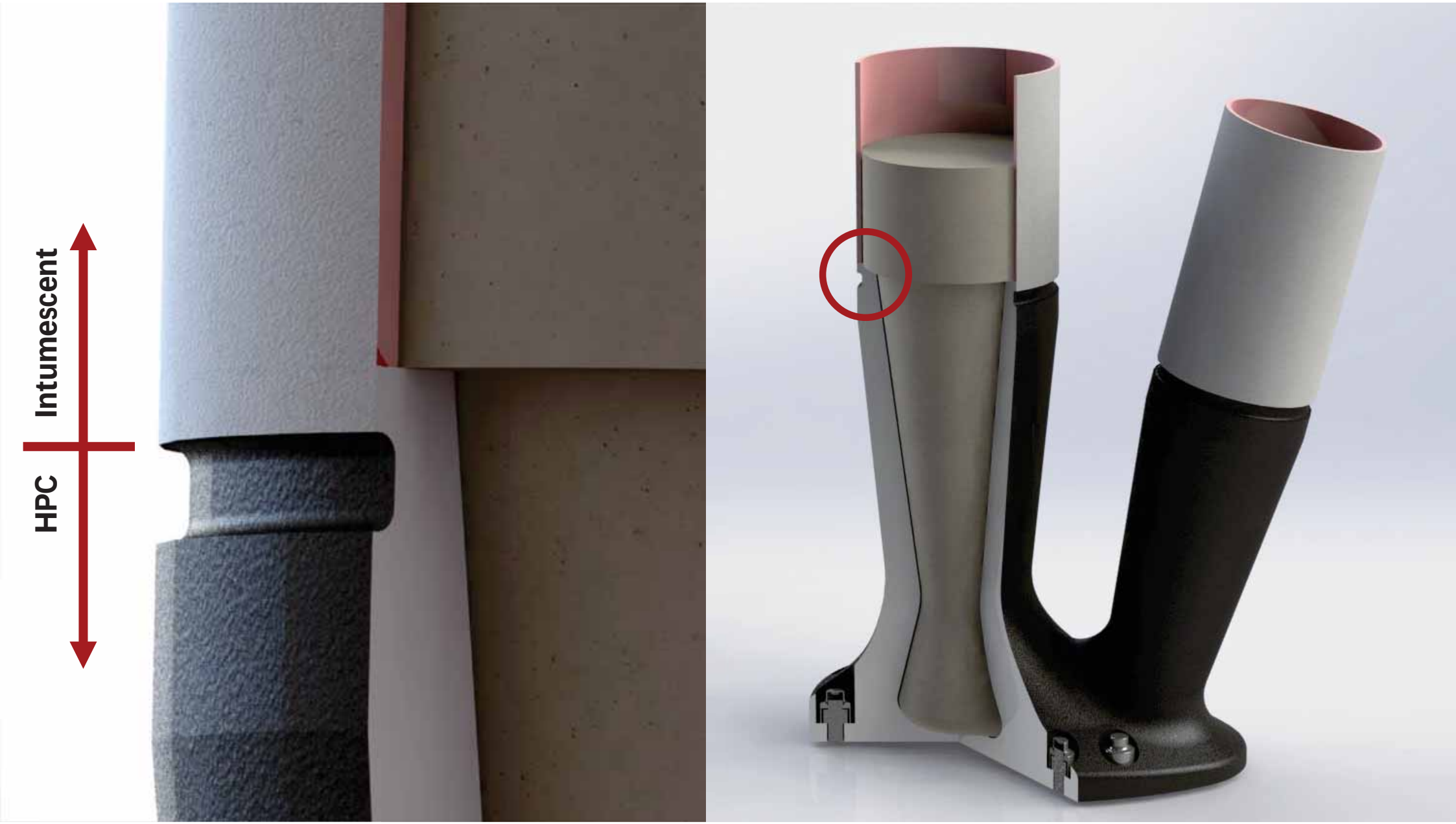


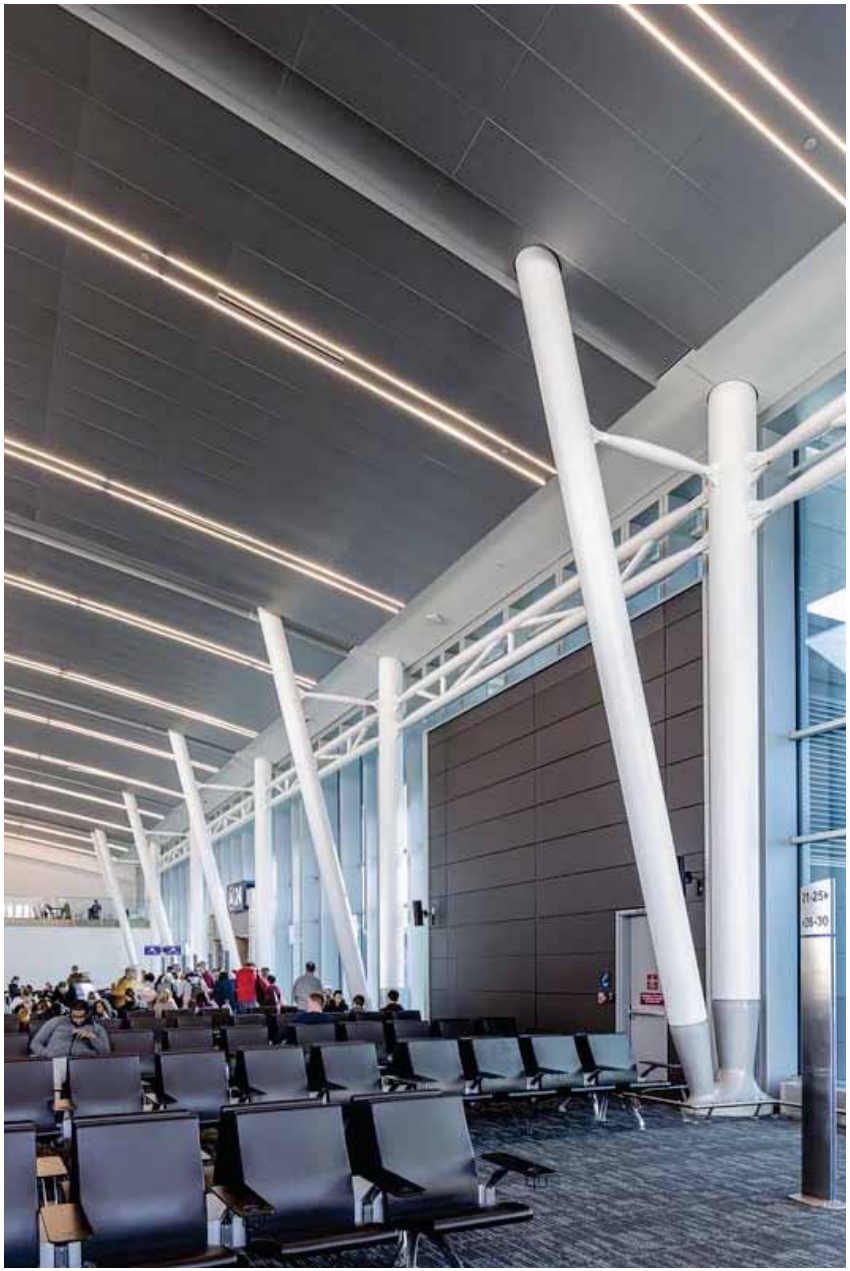
CHARLOTTE DOUGLASS INTERNATIONAL AIRPORT EXPANSION

Charlotte, NC

PERKINS & WILL


~14ft
(4.3m)
~105ft
(32m)
~24ft
(7.3m)
METAL CATWALK WITH GUARDRAIL, SEE STRUCTURAL
SKYLIGHT BEYOND
SIM
B4
A10-63
RF 511A
SIM
A4
A11-32
QQ
A5
A11-39
SIM
A4
A10-63
MECHANICAL
FIRE PUMP


Intumescent
HPC



THE LEAF AT CANADA'S DIVERSITY GARDENS

Winnipeg, MB, Canada

KPMB Architects

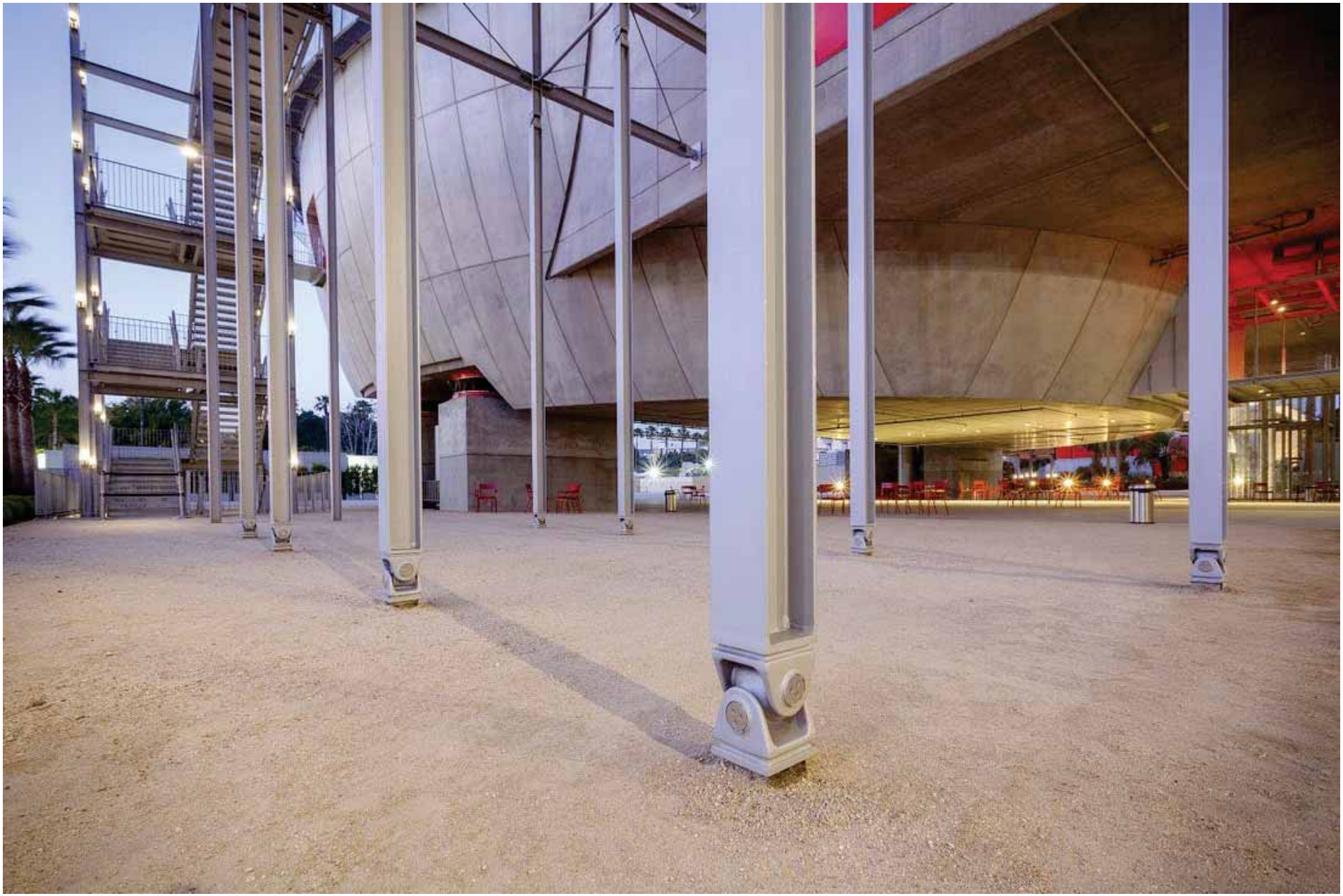
Blackwell Structural Engineers

ACADEMY MUSEUM OF MOTION PICTURES

Los Angeles, CA

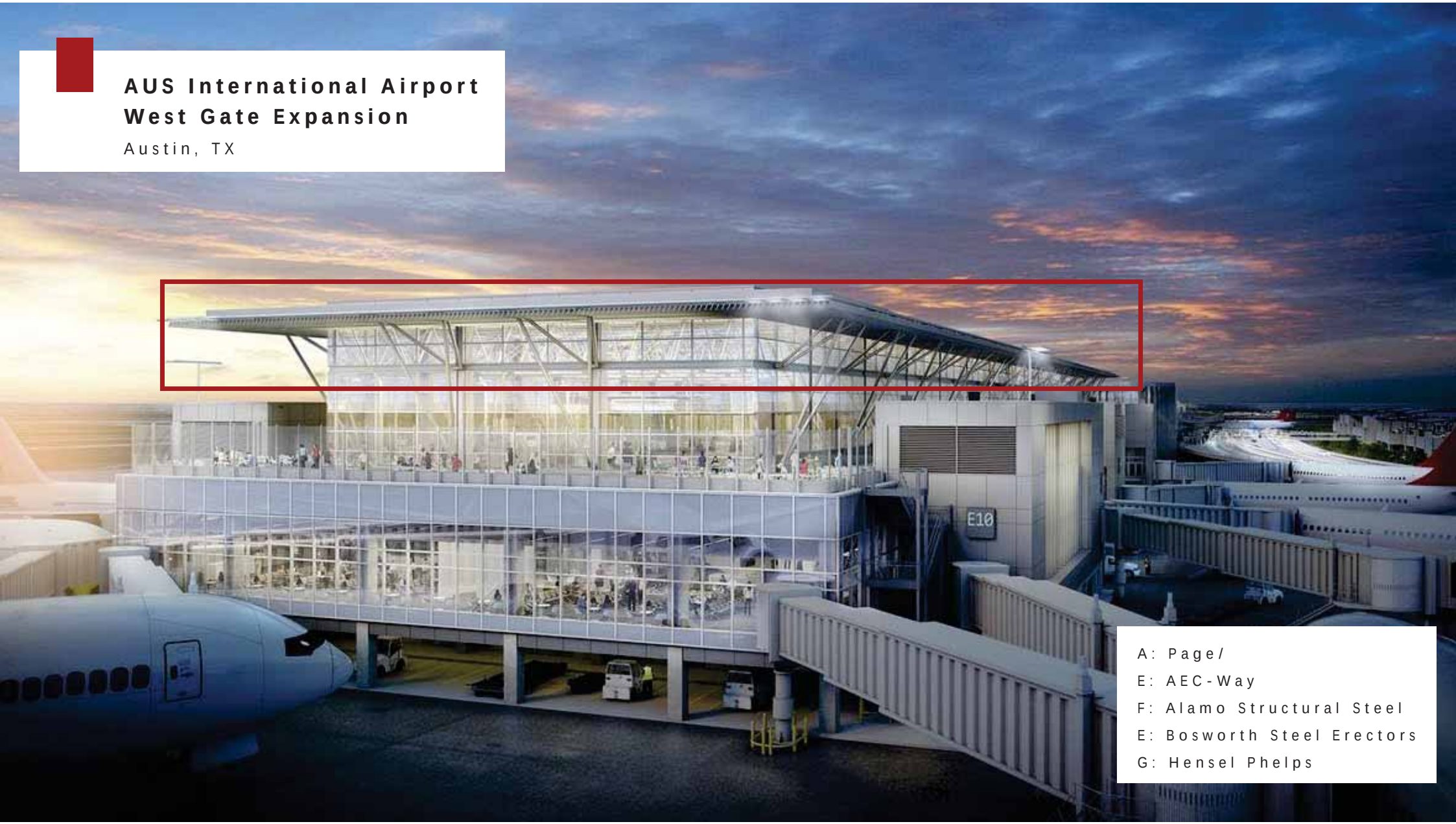
ARCHITECT: RPBW

STRUCTURAL ENGINEER: BURO HAPPOLD



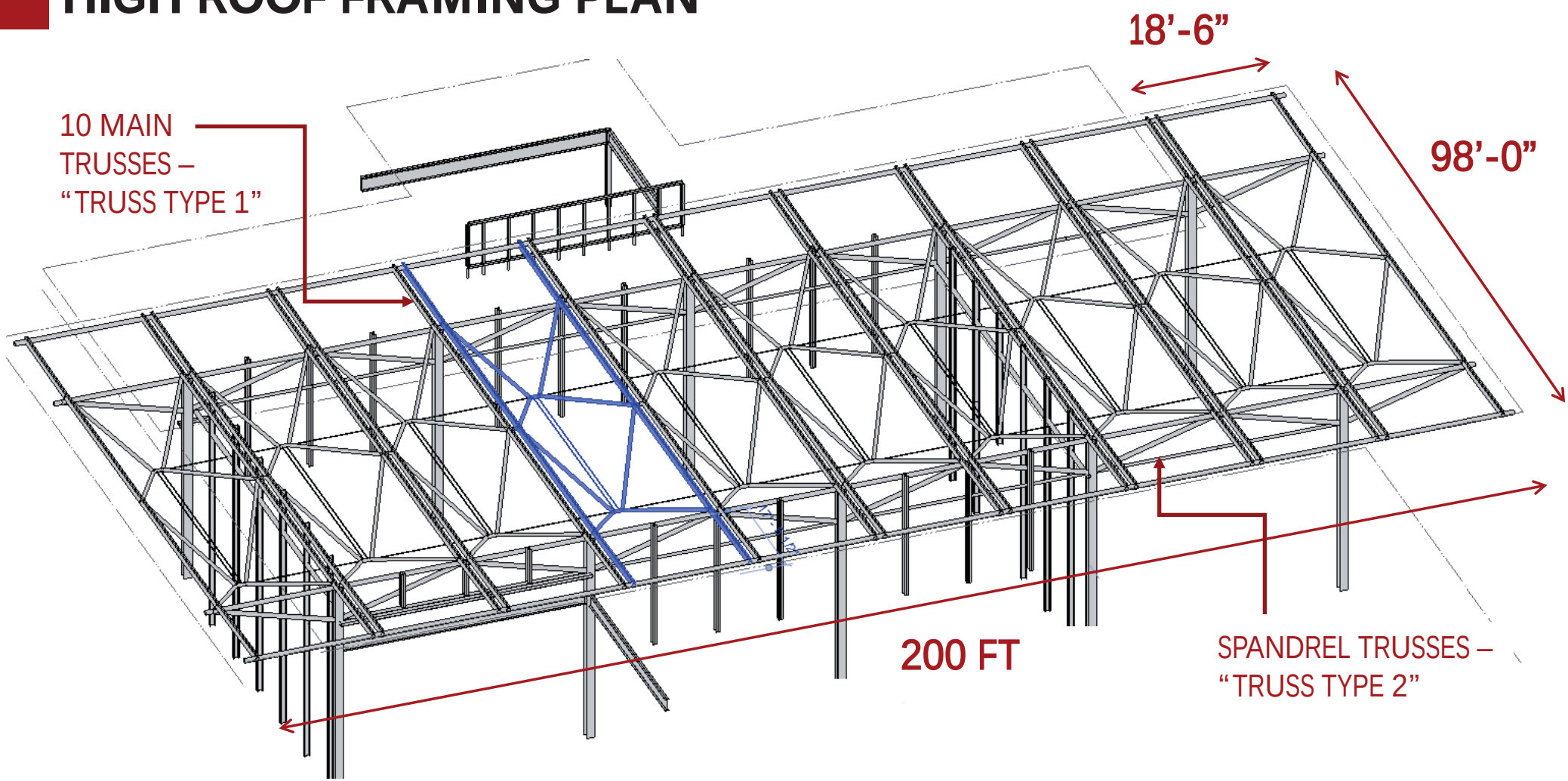
AUS International Airport West Gate Expansion

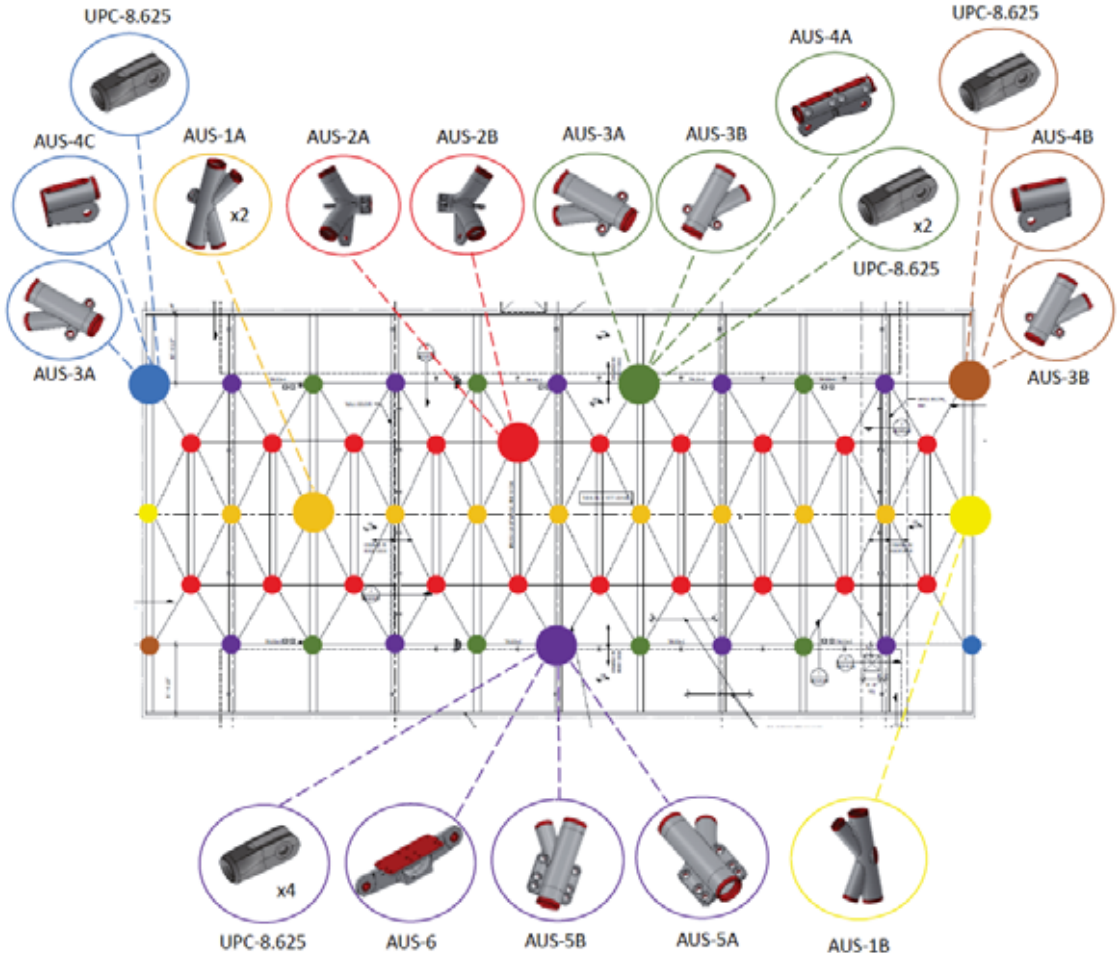
Austin, TX



A: Page/
E: AEC-Way
F: Alamo Structural Steel
E: Bosworth Steel Erectors
G: Hensel Phelps

HIGH ROOF FRAMING PLAN




UPC-8.625
AUS-4C
AUS-1A
AUS-2A
AUS-2B
AUS-3A
AUS-3B
AUS-4A
UPC-8.625
AUS-4B
x2
x2
UPC-8.625
AUS-3A
AUS-3B
x4
UPC-8.625
AUS-6
AUS-5B
AUS-5A
AUS-1B

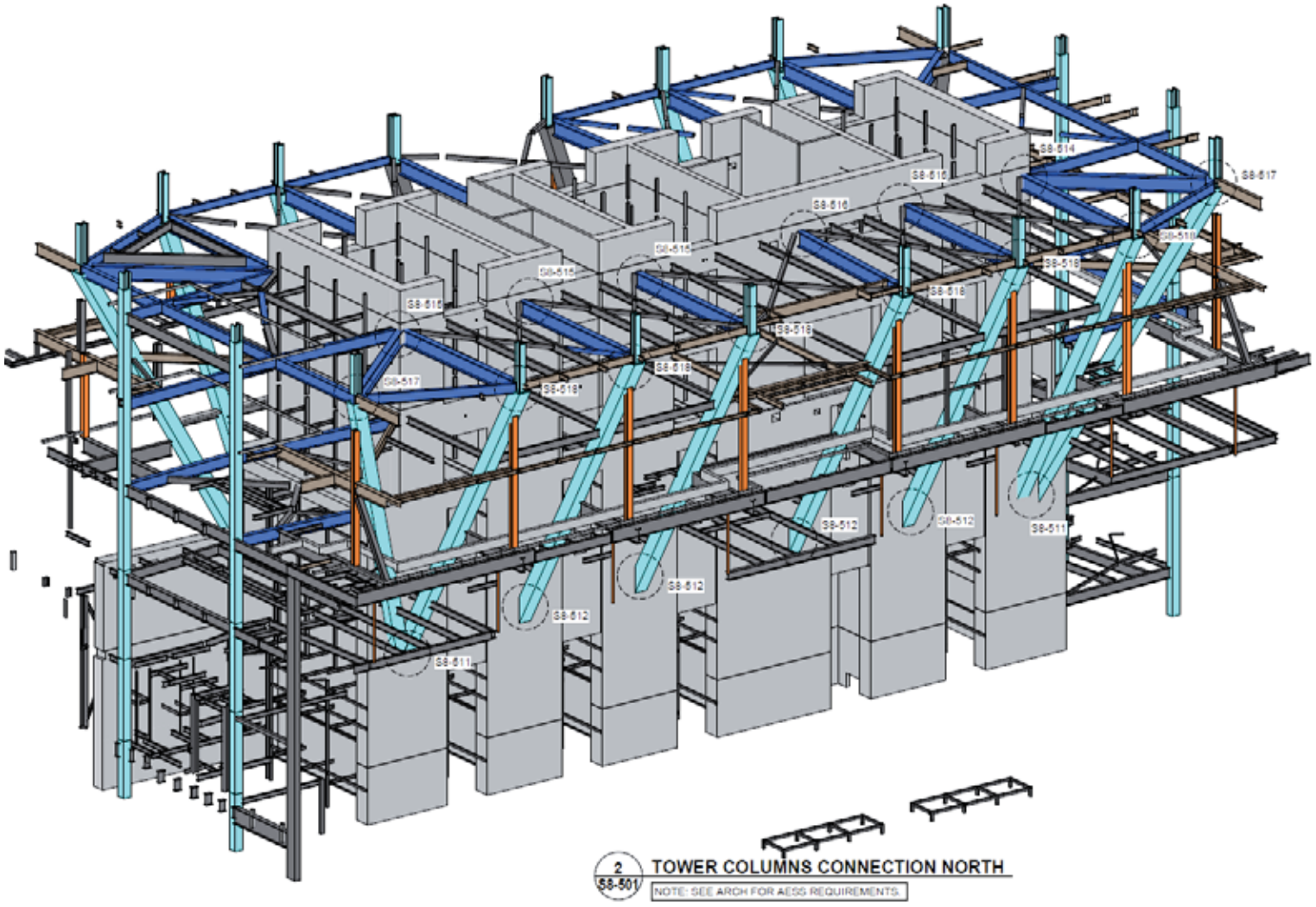

SOBRA

CIBC SQUARE (141 Bay St)

Toronto, ON

Wilkinson Eyre and Adamson Associates

RJC Engineers



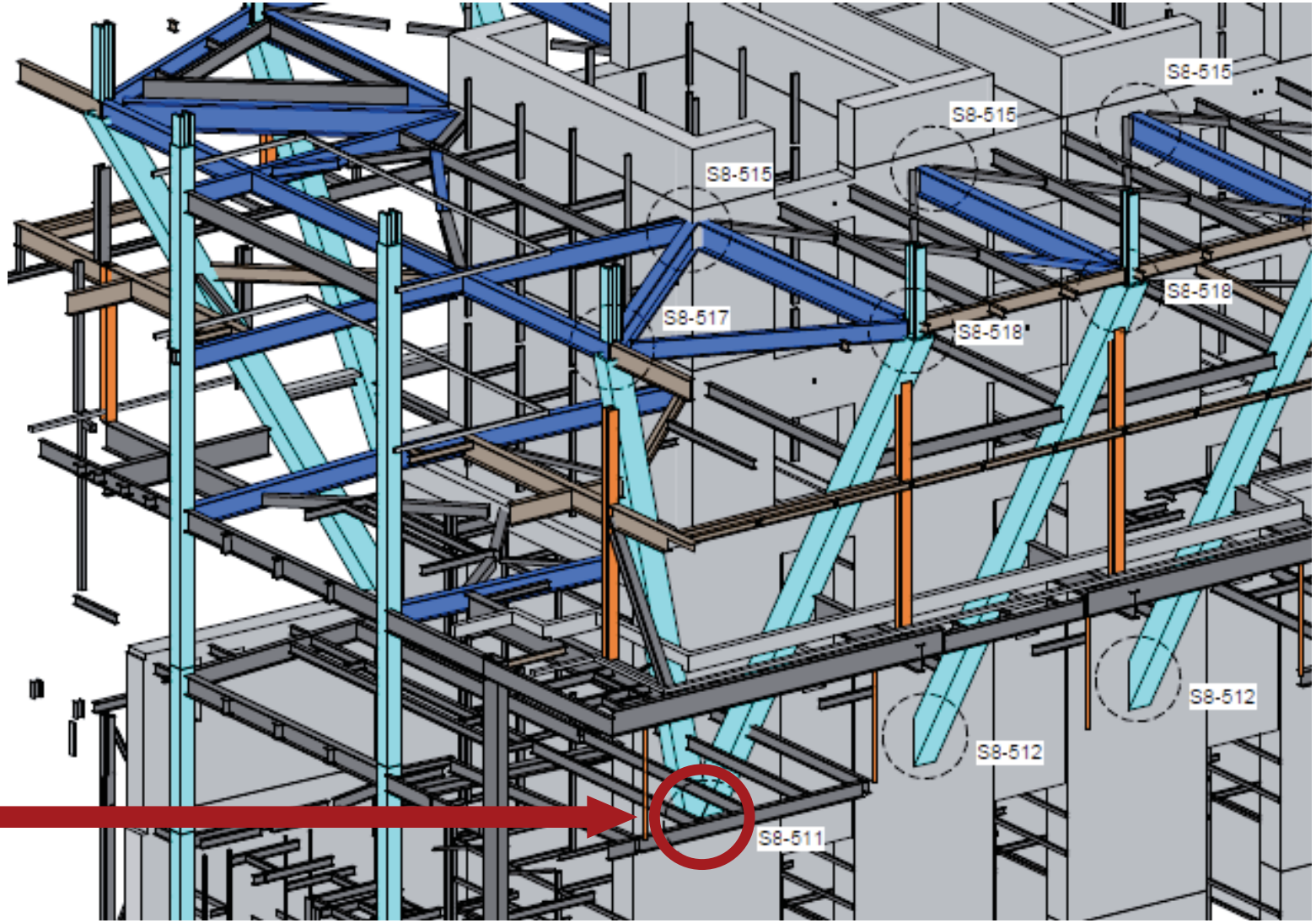
Composite construction: steel with concrete core.

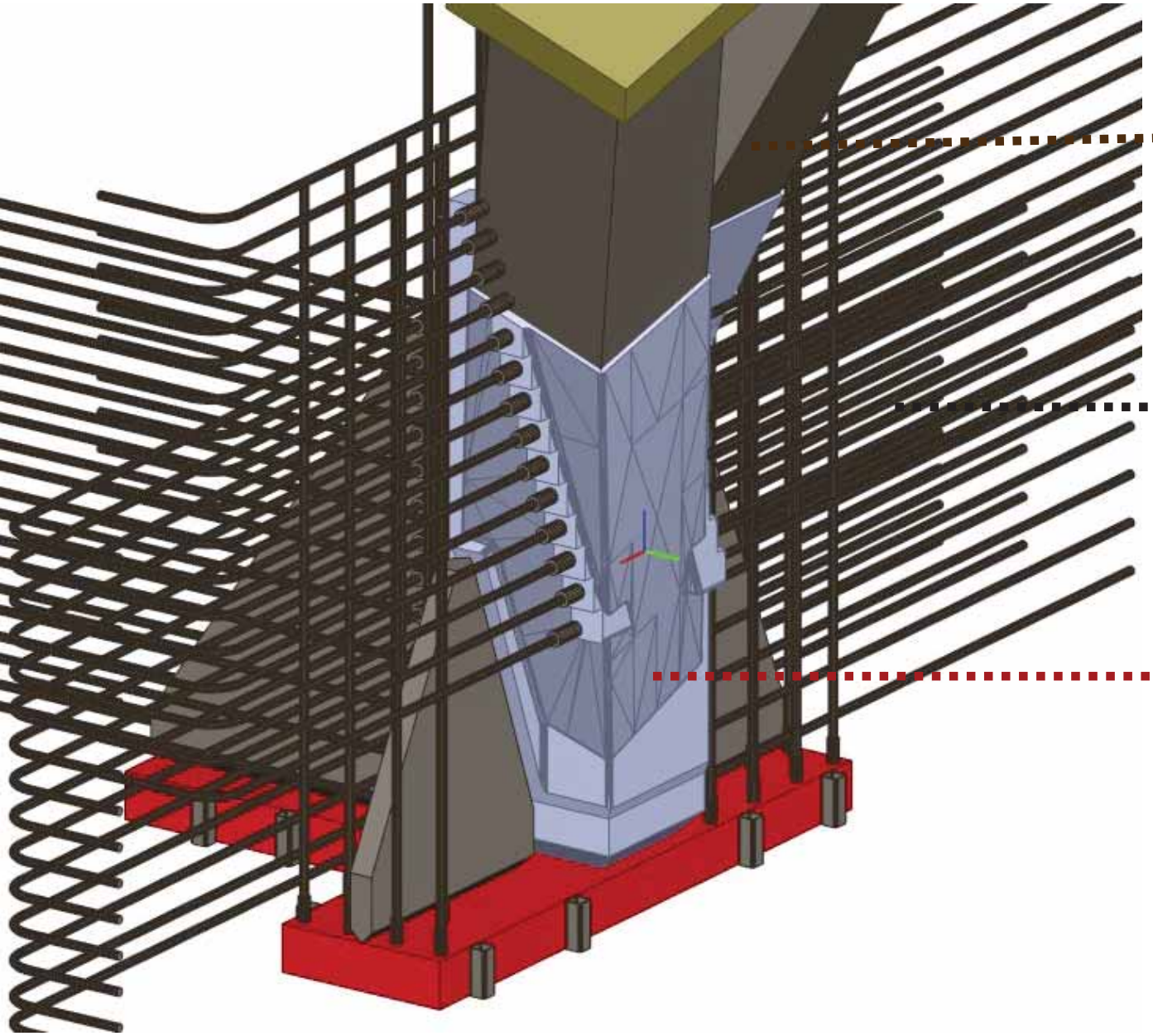
Building perimeter columns transfer back to core to avoid elevated rail and offer open lobby.

Transfer forces and complex geometries of connection points could not be adequately addressed with conventionally fabricated welded or bolted connections.

CAST CONNEX engineered and supplied custom castings and High Integrity Block (engineered cast forgings), choosing the best option for each location to optimize performance requirements and economy.

CAST STEEL NODE
EMBEDDED IN CORE



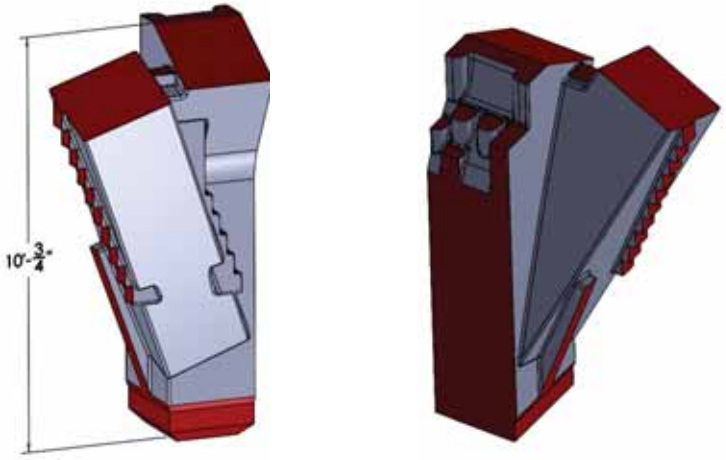


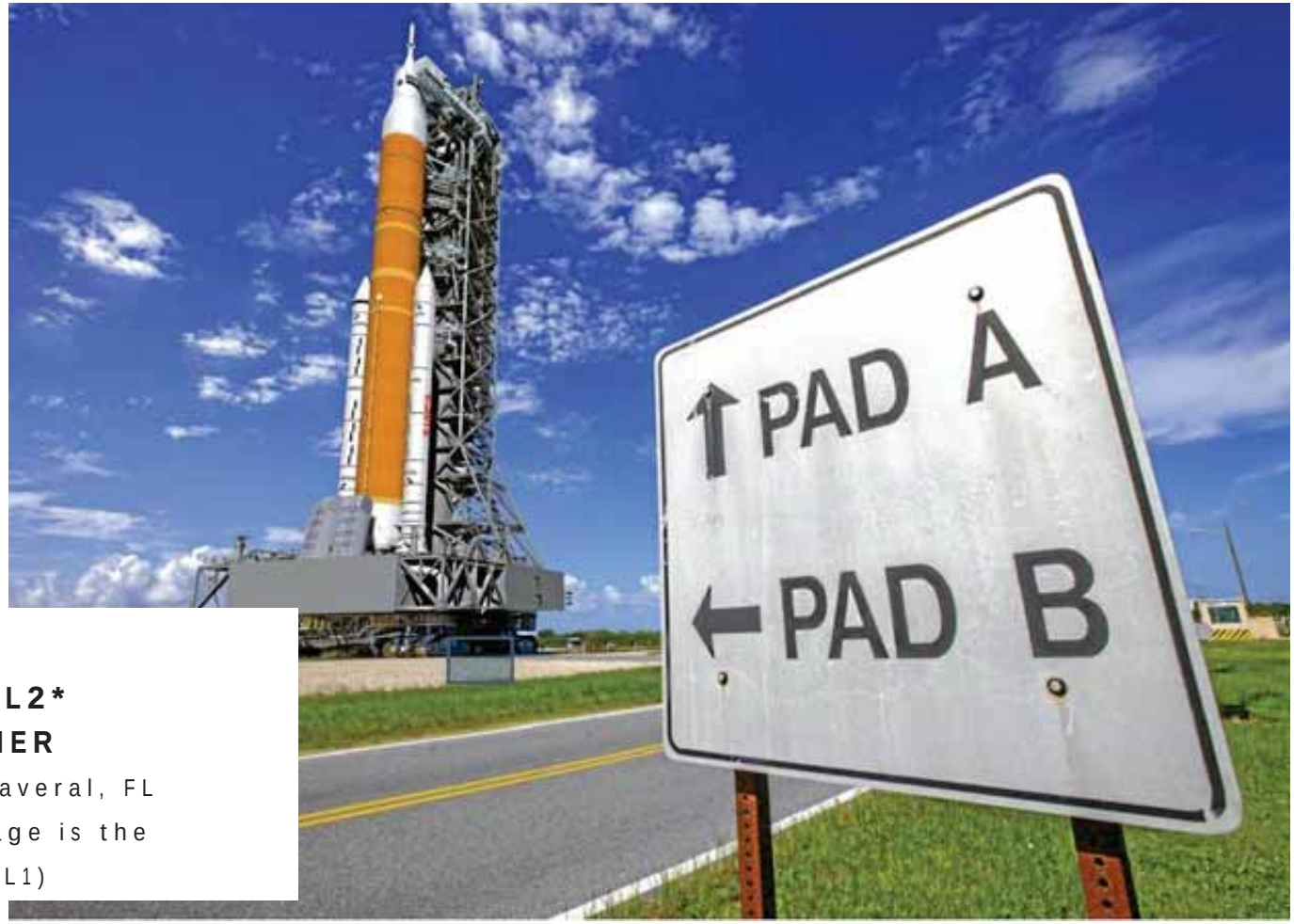
Rolled Steel Plate Fabrications

Structural Concrete Walls with Large Diameter Reinforcement

Custom Steel Casting:

Embedded in concrete, simplifies complex rebar detailing and resolves transfer forces.


10'-3/4"



NASA ML2* LAUNCHER

Cape Canaveral, FL

(*this image is the smaller ML1)

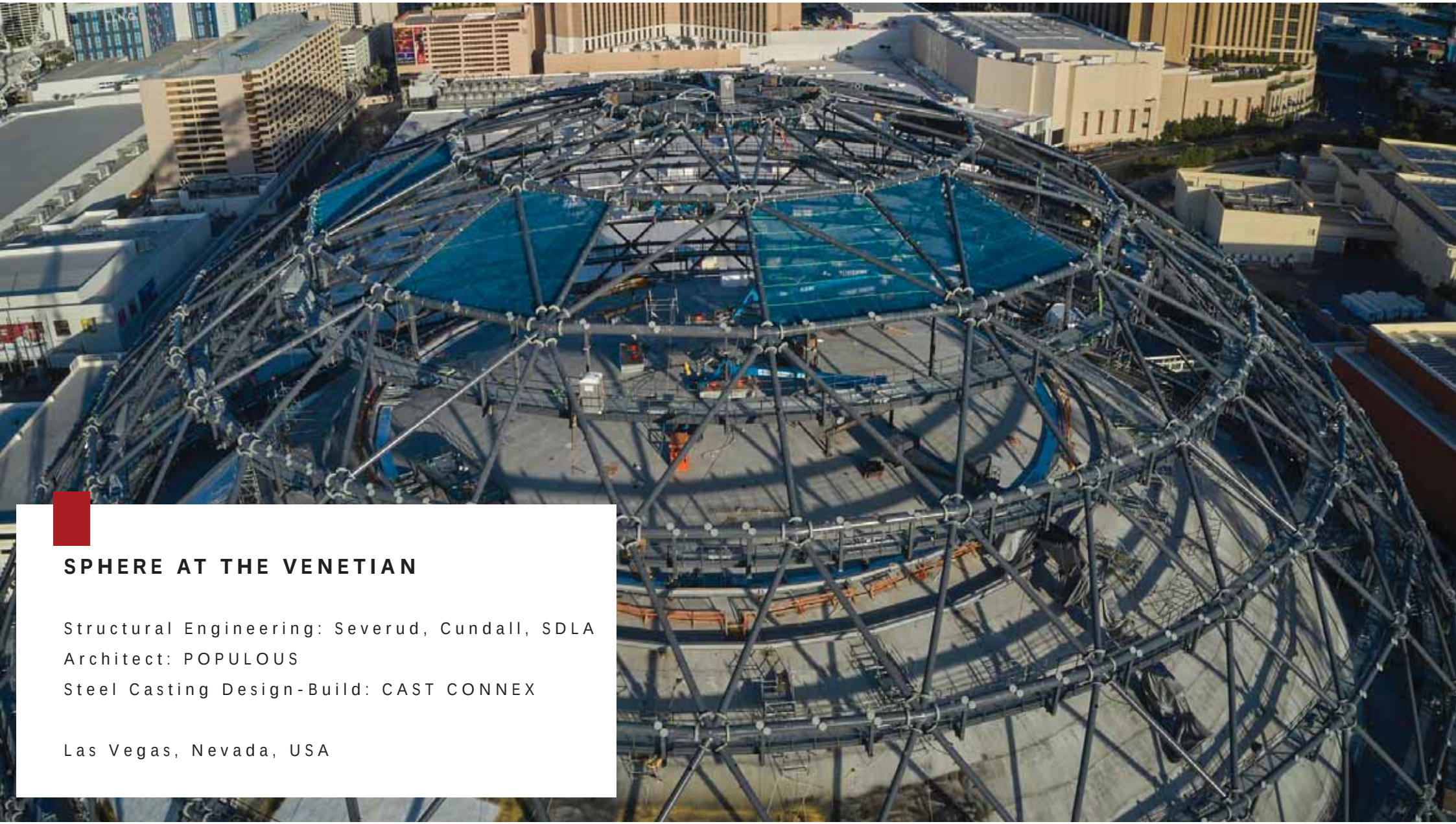
40-ft. modules will be a vital part of constructing the impressive 377-ft. structure.

VANCOUVER INTERNATIONAL AIRPORT

Vancouver, BC

KPMB

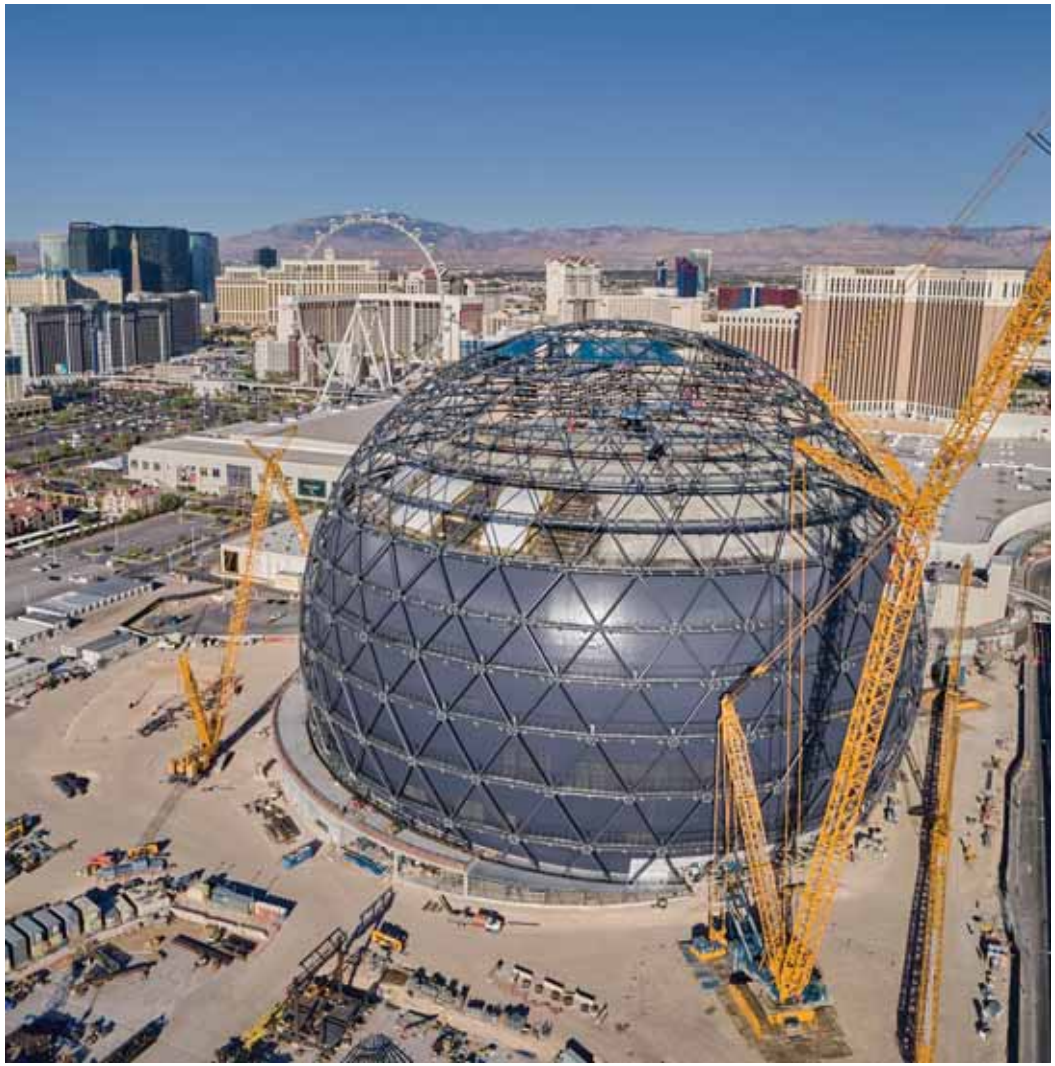
HOW STEEL CASTINGS ARE MADE: SPHERE AT THE VENETIAN

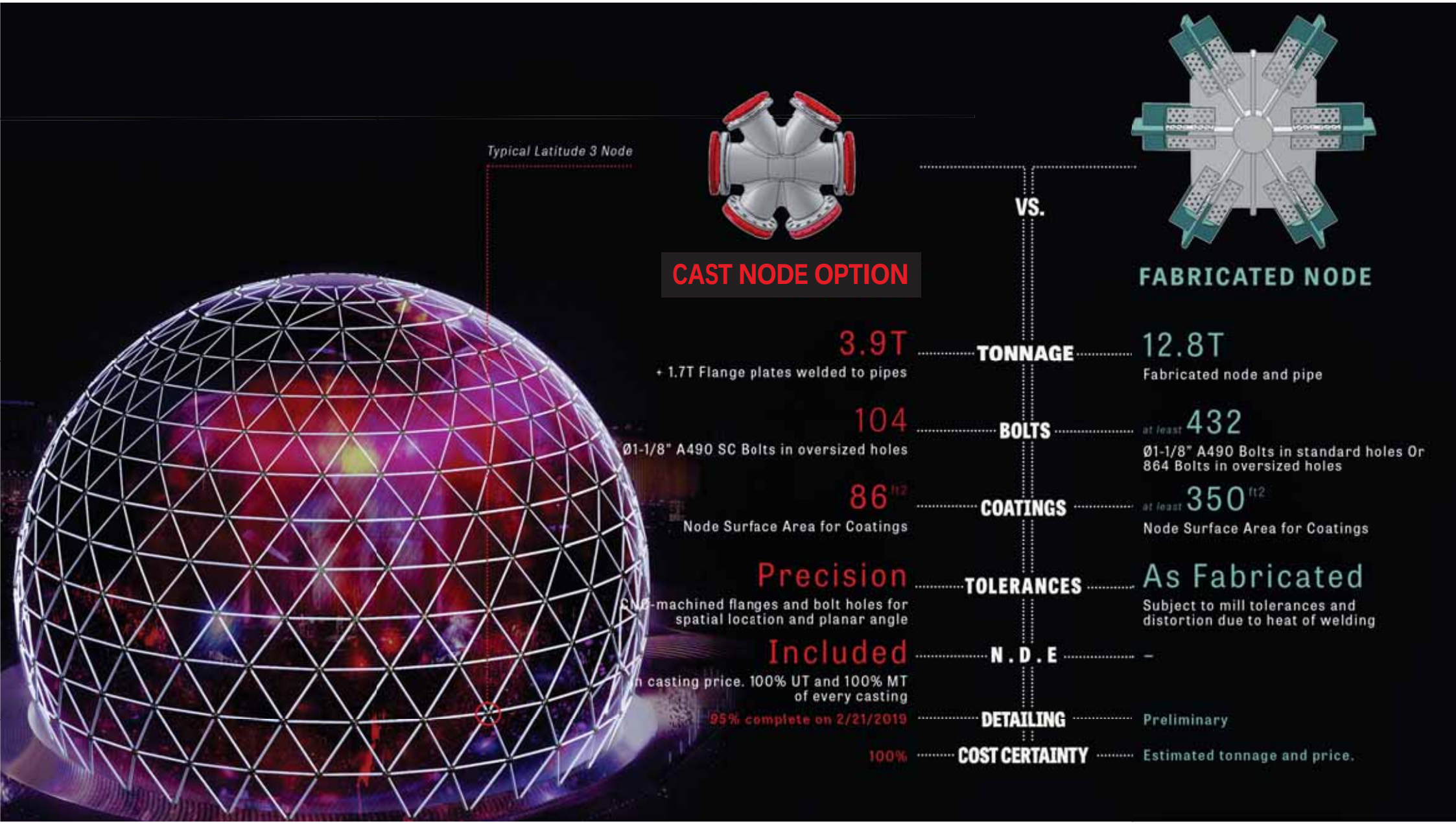


SPHERE AT THE VENETIAN

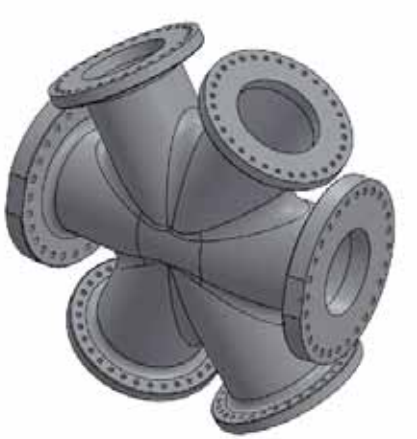
Structural Engineering: Severud, Cundall, SDLA
Architect: POPULOUS
Steel Casting Design-Build: CAST CONNEX

Las Vegas, Nevada, USA

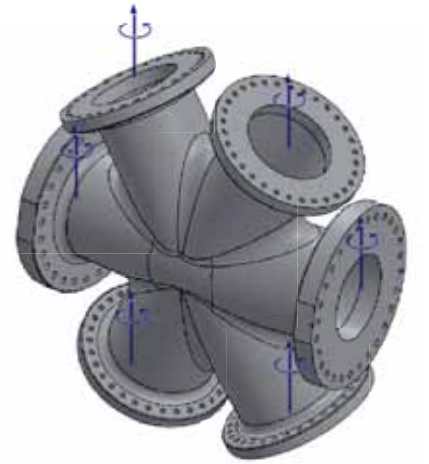



Typical Latitude 3 Node
CAST NODE OPTION
VS.
FABRICATED NODE
3.9T
+ 1.7T Flange plates welded to pipes
TONNAGE
12.8T
Fabricated node and pipe
104
Ø1-1/8" A490 SC Bolts in oversized holes
BOLTS
at least 432
Ø1-1/8" A490 Bolts in standard holes Or 864 Bolts in oversized holes
86 ft2
Node Surface Area for Coatings
COATINGS
at least 350 ft2
Node Surface Area for Coatings
Precision
-machined flanges and bolt holes for spatial location and planar angle
TOLERANCES
As Fabricated
Subject to mill tolerances and distortion due to heat of welding
Included
n casting price. 100% UT and 100% MT of every casting
N . D . E
–
95% complete on 2/21/2019
DETAILING
Preliminary
100%
COST CERTAINTY
Estimated tonnage and price.

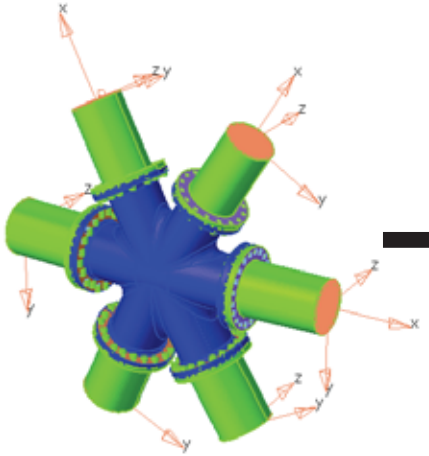
1. Geometry



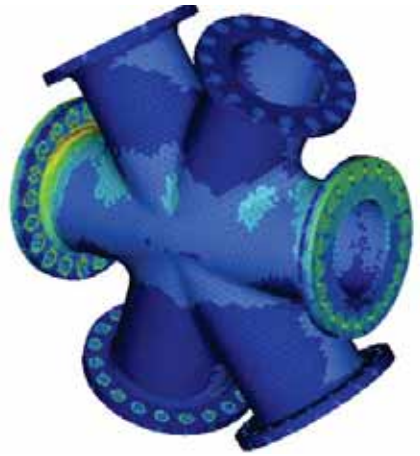
2. Loading

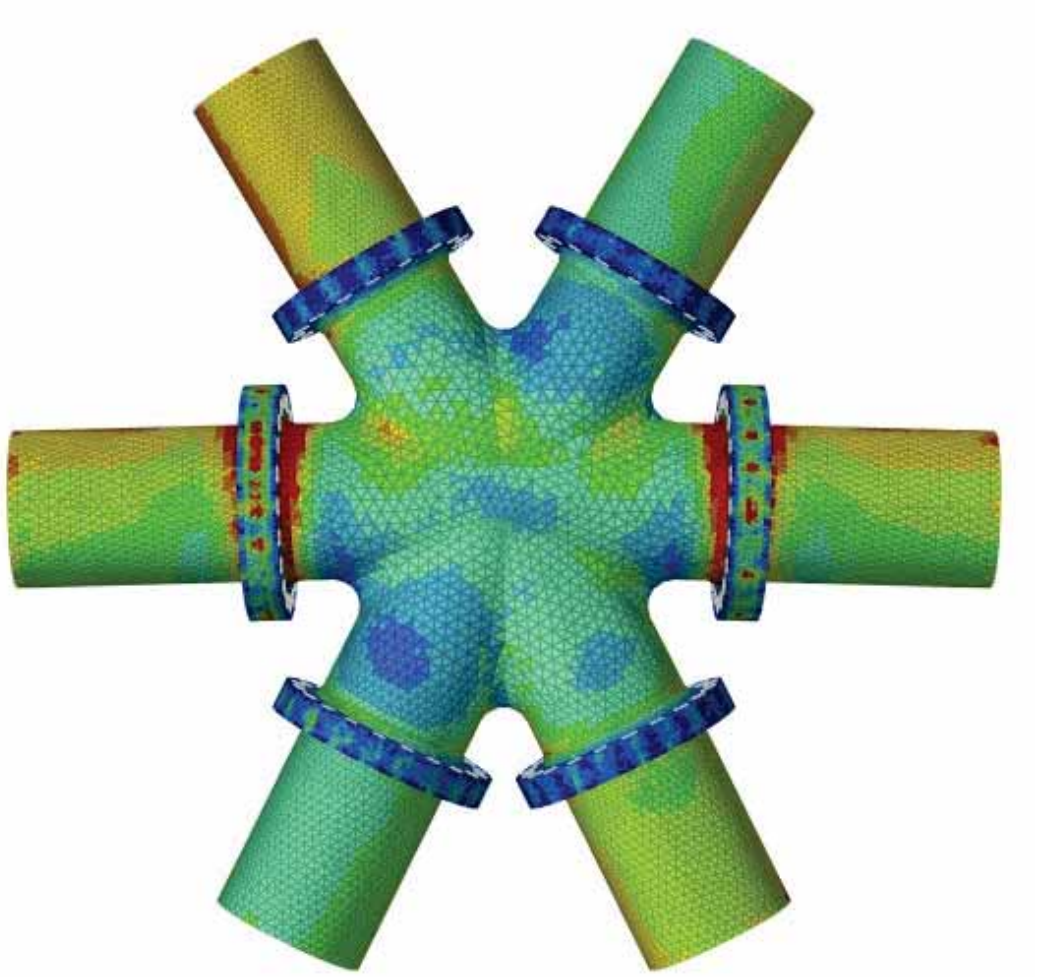


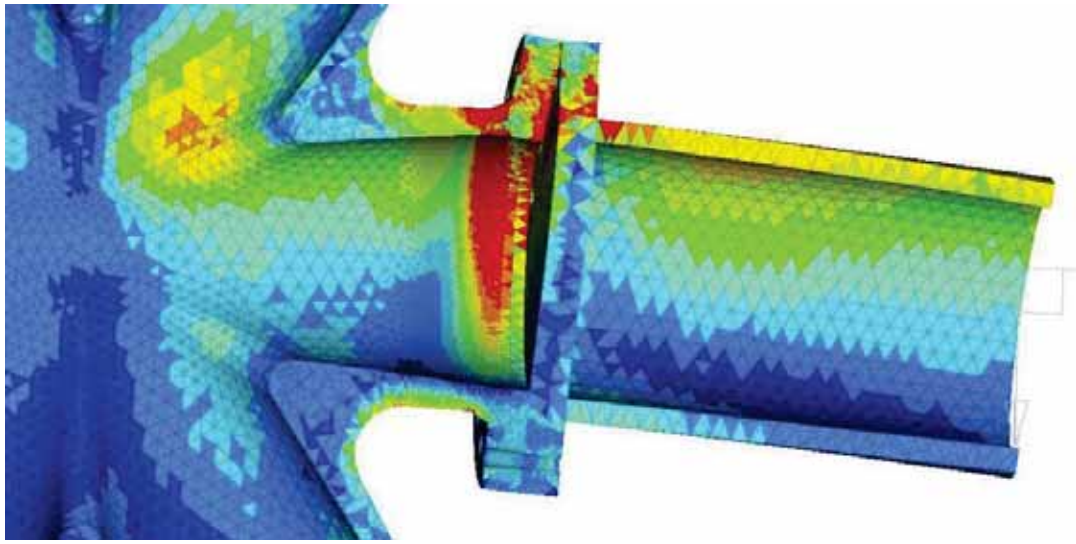
3. FEA Modelling

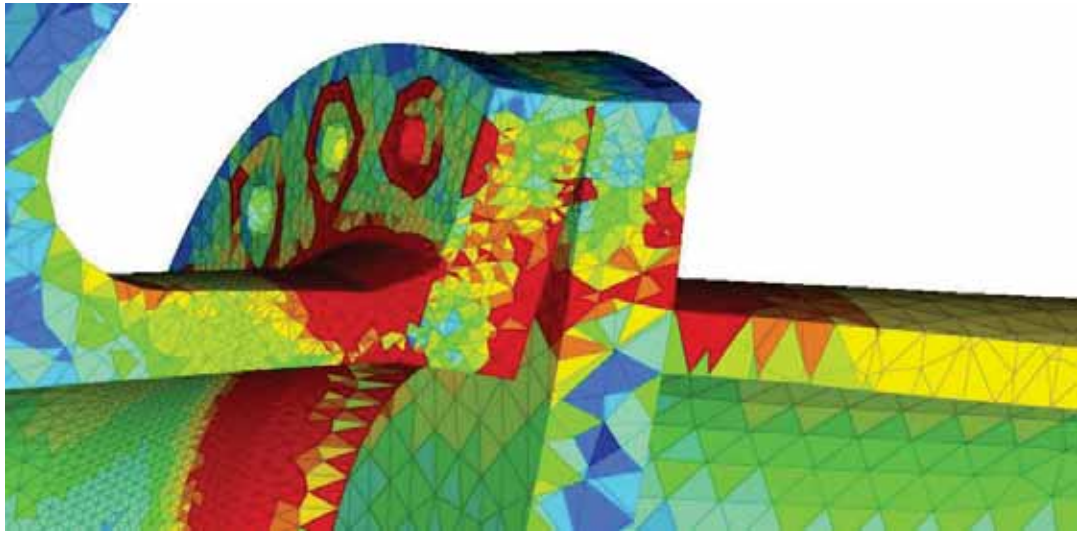


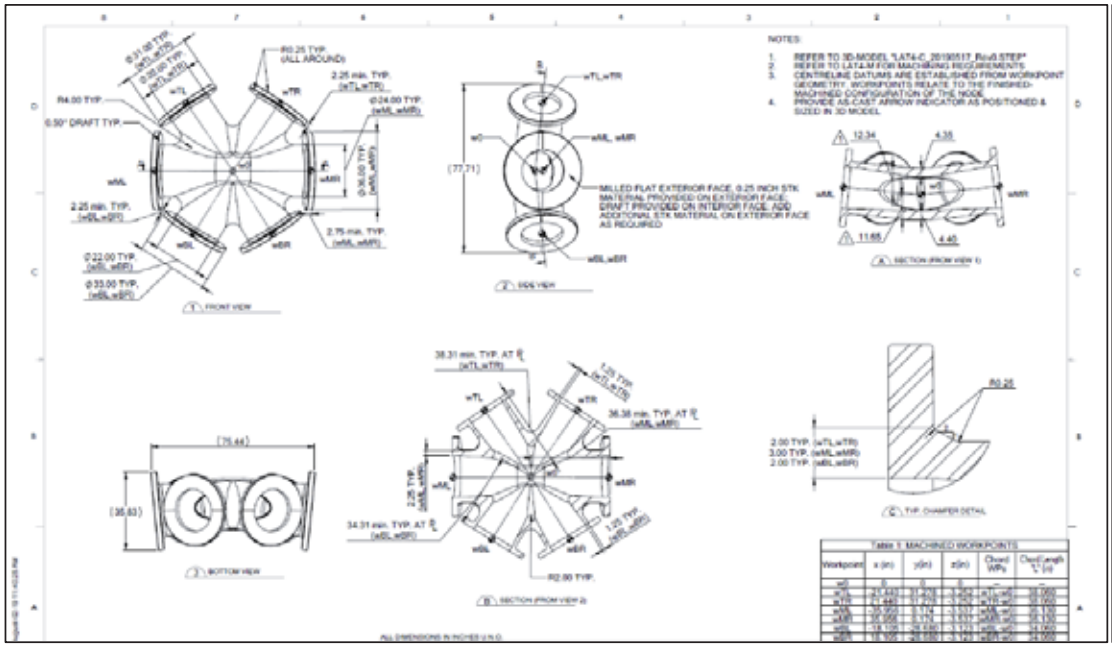
4. Post-Processing



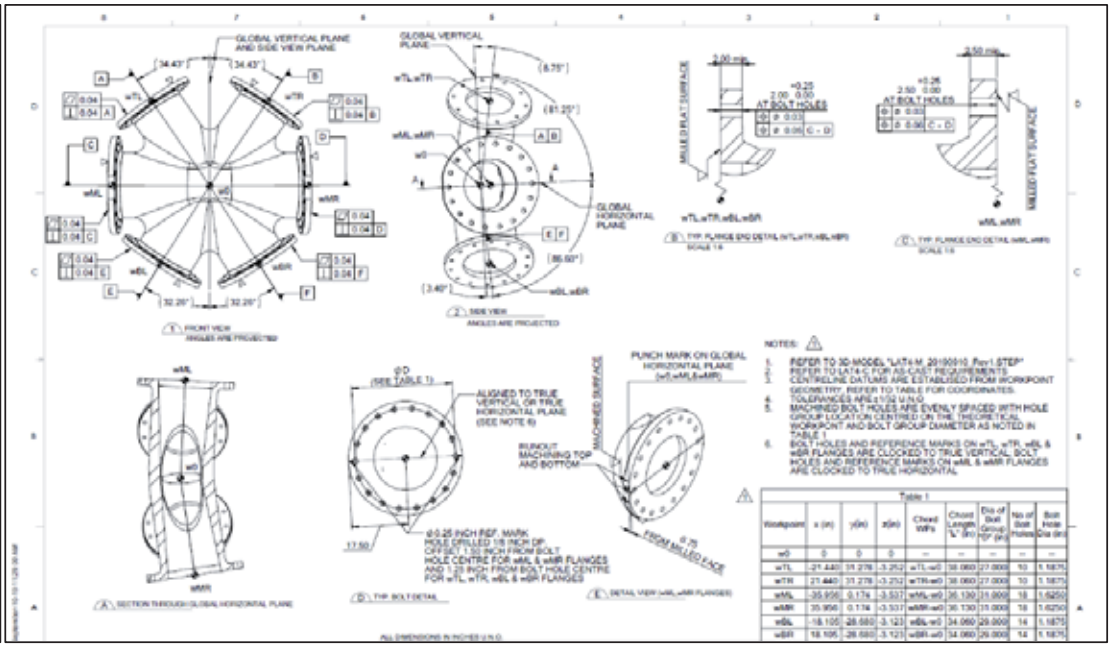






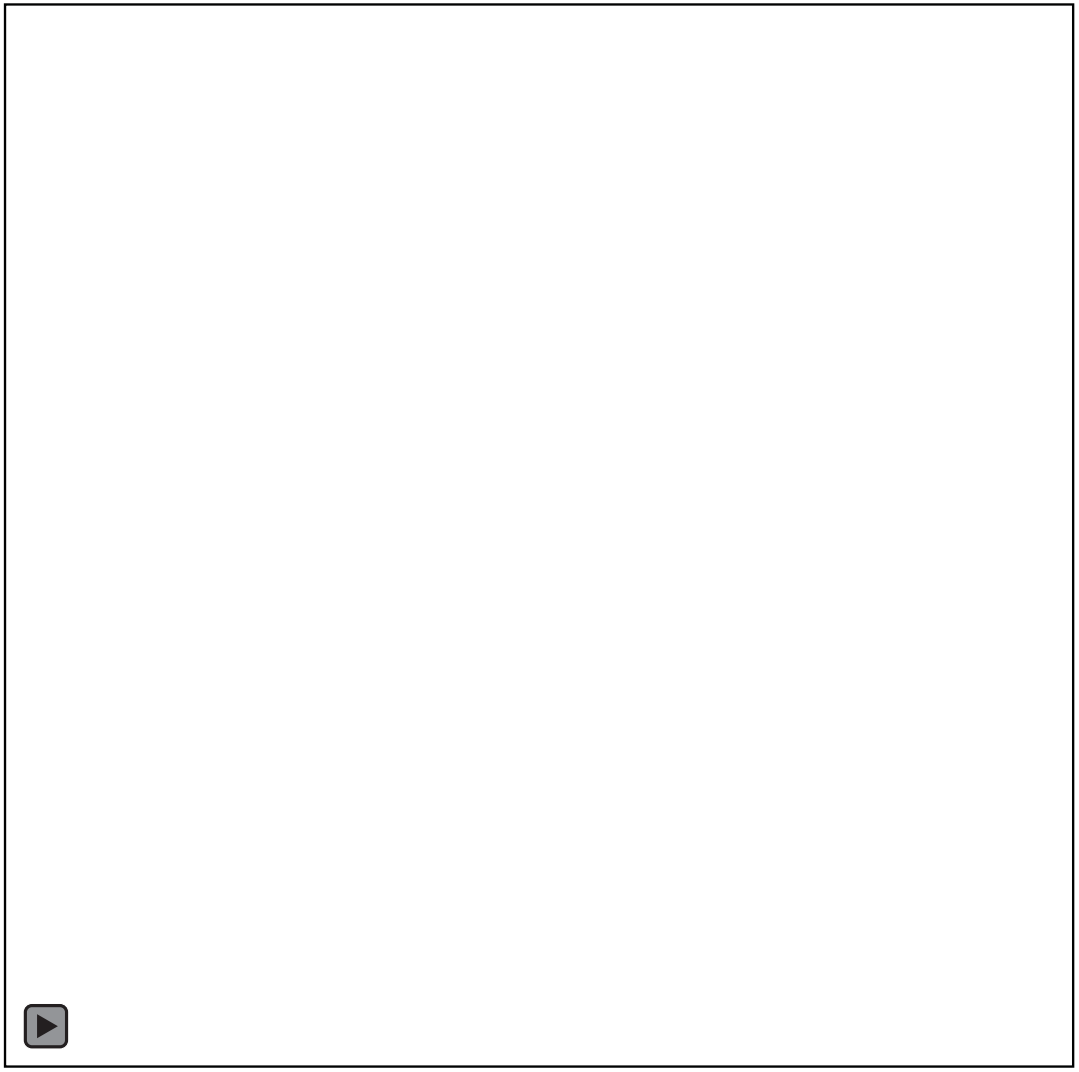


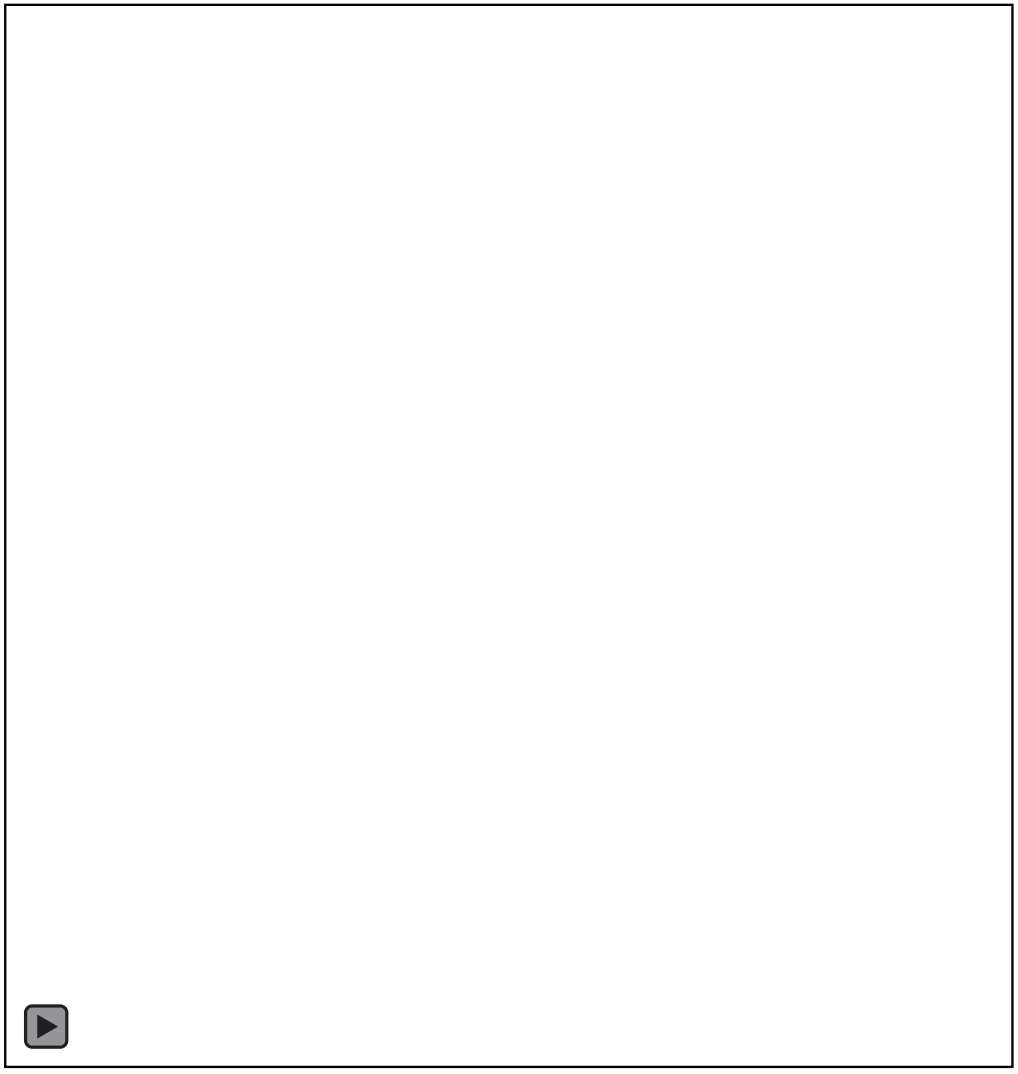
As-Cast shop drawing



Machining shop drawing


LAT3





NON-DESTRUCTIVE EXAMINATION

- Radiographic Testing (RT)
- Ultrasonic Testing (UT)
- Magnetic Particle Inspection (MT)
- Visual Examination

- Acceptance Criteria are based on predefined “levels”, each of which correlates to allowable indication size and distribution, which in turn correlates to the structural efficacy of the casting

- Areas of castings which have indications that exceed Acceptance Criteria undergo production welding and are re-examined to confirm conformance to specification

STEEL-TIMBER HYBRID CASE STUDIES

PERFORMANCE BENEFITS OF CAST STEEL NODES: *STEEL-TIMBER HYBRID CONSTRUCTIONS*

Freeform Geometry

- Flexible solutions for new construction typology/material, material optimization
- Aesthetic quality for exposed structure unmatched by conventional steel fabrication

Improved Structural Performance

- Ductile and efficient LFRS for multi-story buildings

Simplification of Construction

- Minimized coordination between trades in shop and field activities

Overall Saving in Material, Time and Carbon

- Turn-key solutions, pre-engineered, modularized and available off the shelf.
- Minimized site time with simple assemblies

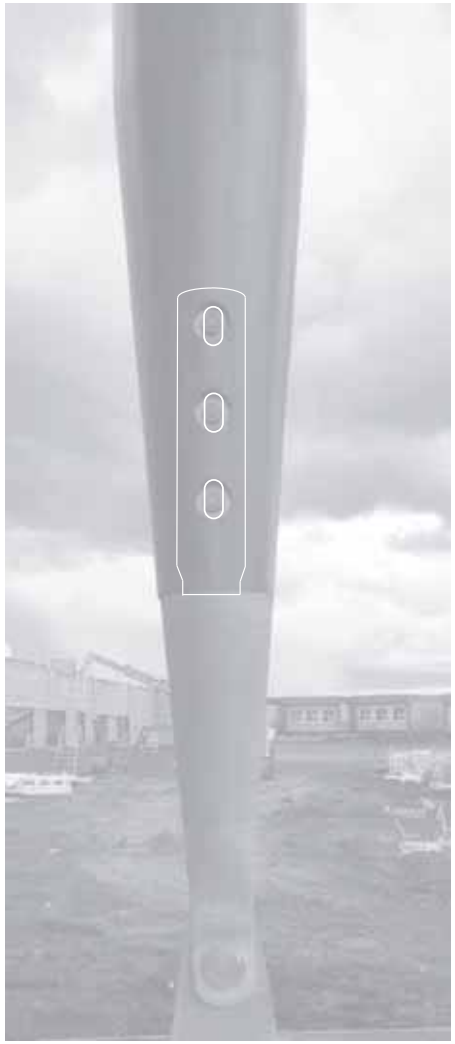
ROY BICKELL PUBLIC SCHOOL

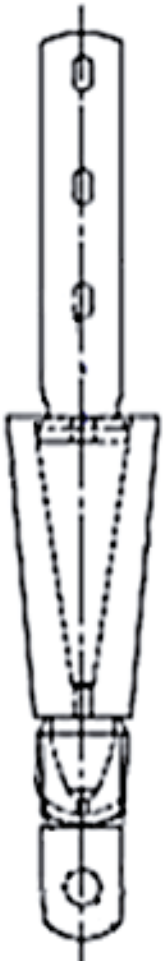
Stantec

Western Archrib

Grand Prairie, Alberta, Canada


ROY BICKELL PUBLIC SCHOOL
GRANDE PRAIRIE PUBLIC SCHOOL DISTRICT





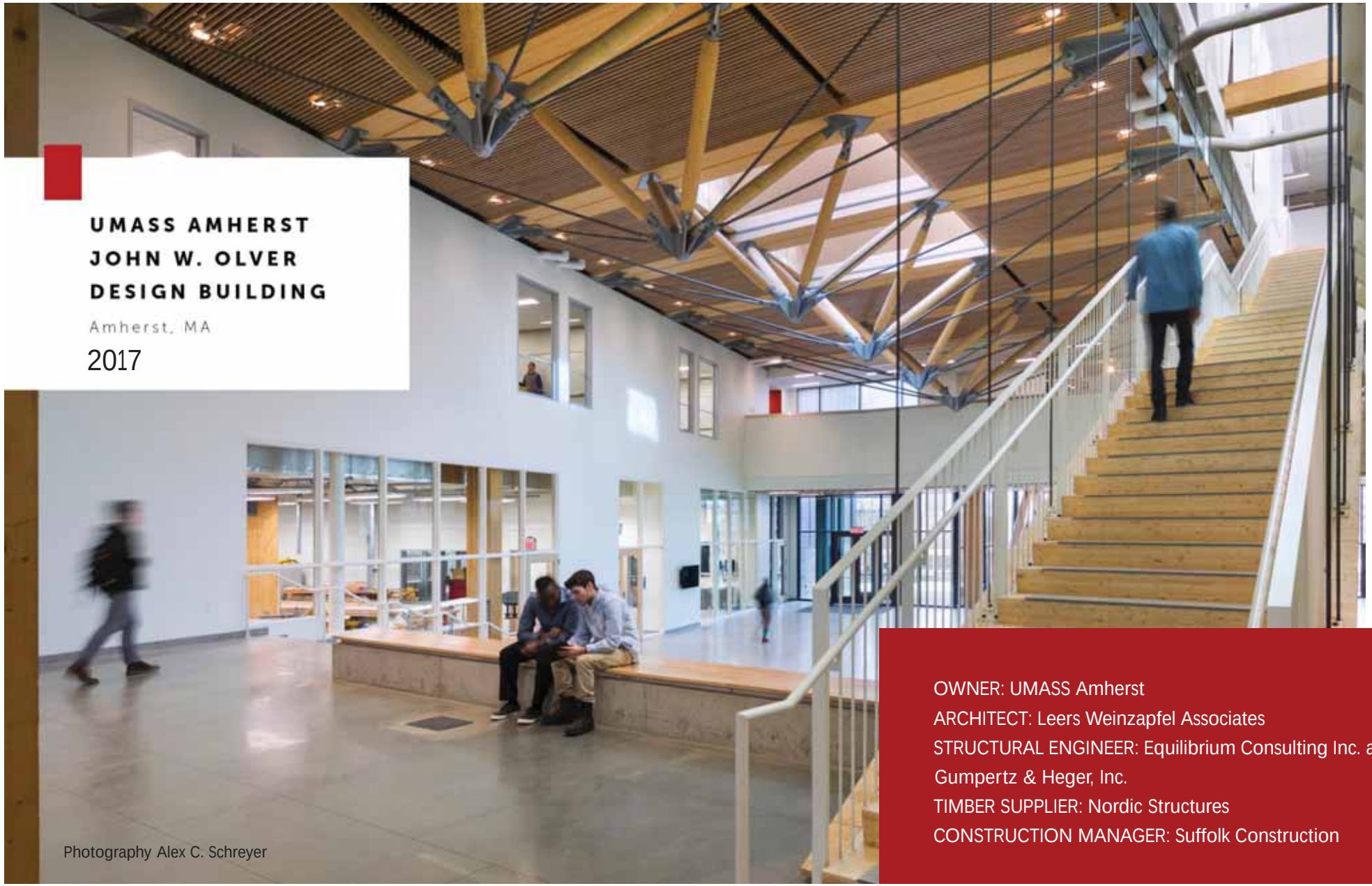
KNIFE PLATE C/W SLOTTED HOLES (WELDED TO CAP PLATE)

CAP PLATE C/W DRAIN HOLES (WELDED TO ART)

CAST CONNEX ARCHITECTURAL TAPER (ART-168-MOD C/W DRILLED VENT HOLE & RECESSED END TO ACCEPT CAP PLATE)

PJP WELD (AESS)

CAST CONNEX UNIVERSAL PIN CONNECTOR (UPC-102L-MOD C/W WITH DRILLED VENT HOLE)



UMASS AMHERST
JOHN W. OLVER
DESIGN BUILDING

Amherst, MA

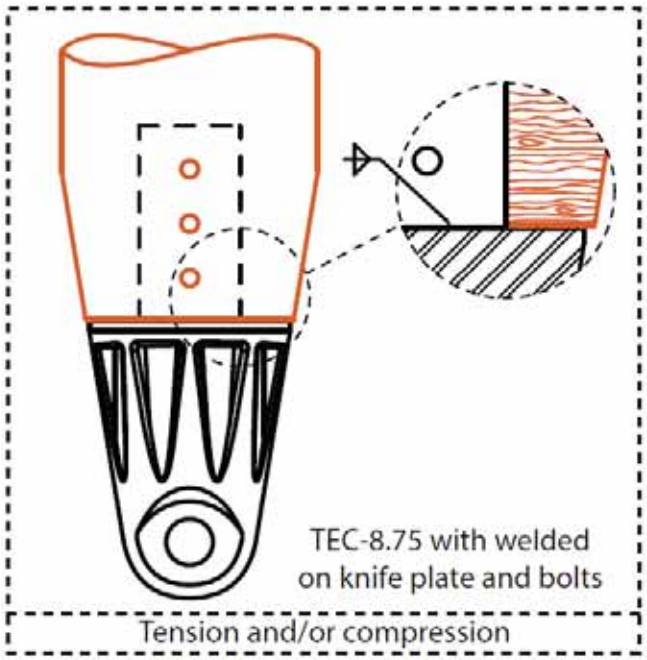
2017

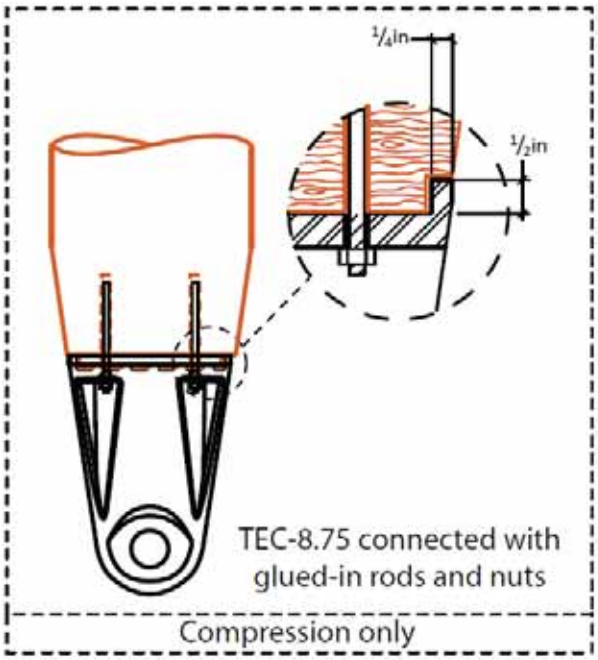
Photography Alex C. Schreyer

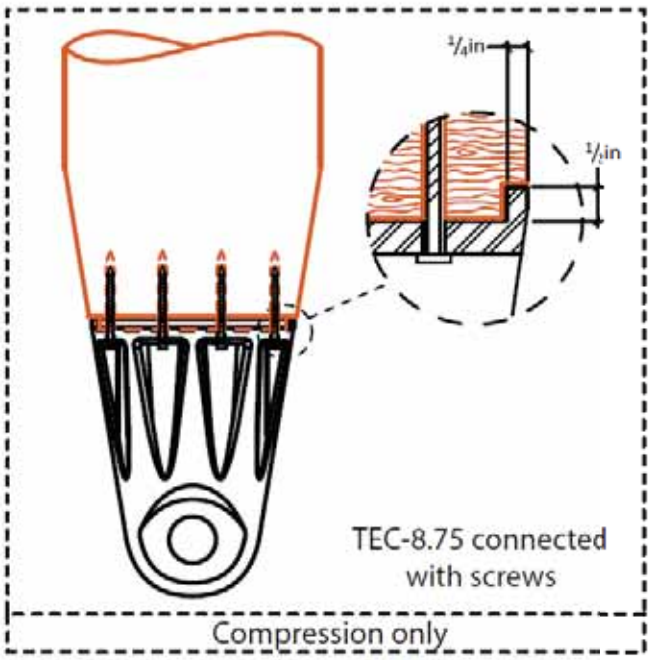
OWNER: UMASS Amherst
ARCHITECT: Leers Weinzapfel Associates
STRUCTURAL ENGINEER: Equilibrium Consulting Inc. and Simpson Gumpertz & Heger, Inc.
TIMBER SUPPLIER: Nordic Structures
CONSTRUCTION MANAGER: Suffolk Construction

Photography Alex C. Schreyer

TIMBER END
CONNECTOR™







DETAIL 2: TEC TO TIMBER

VANCOUVER INTERNATIONAL AIRPORT (YVR) PIER D EXPANSION

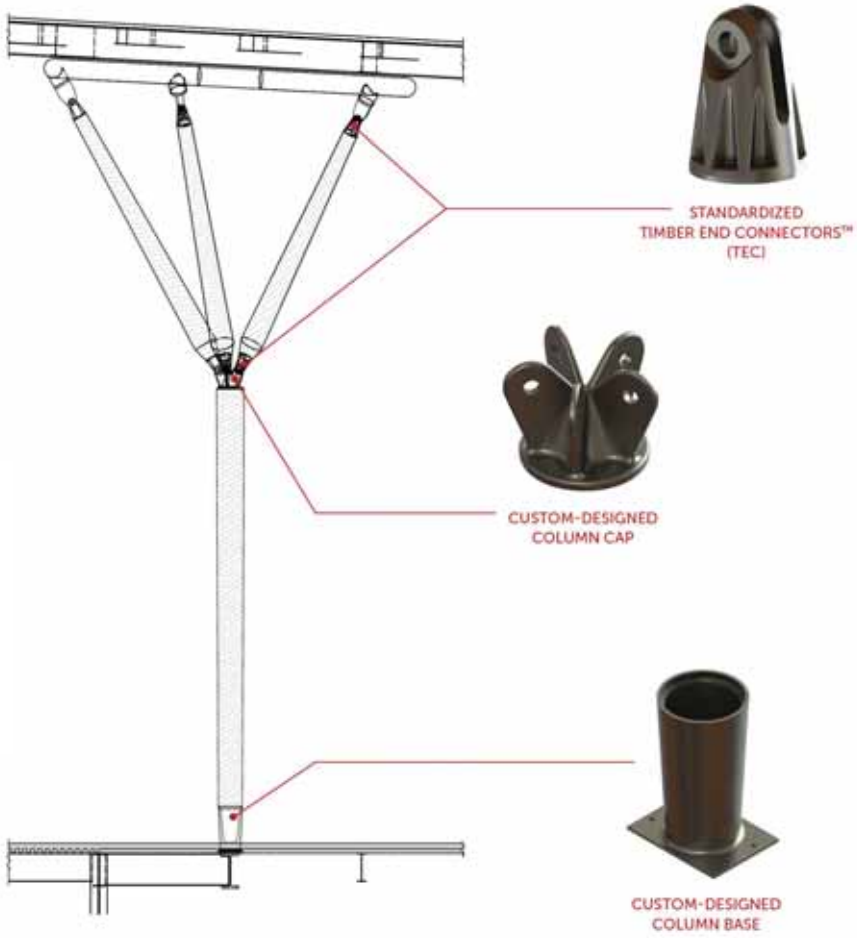
Richmond, BC

2020

Photography Courtesy of Vancouver International Airport and Andy Metten

OWNER: YVR Airport Authority
ARCHITECT: Kasian Architecture
STRUCTURAL ENGINEER: Bush, Bolman & Partners, LLP
STEEL FABRICATOR: Whitemud Ironworks Group
TIMBER SUPPLIER: FraserWood Industries
GENERAL CONTRACTOR: PCL Construction

TREE COLUMN

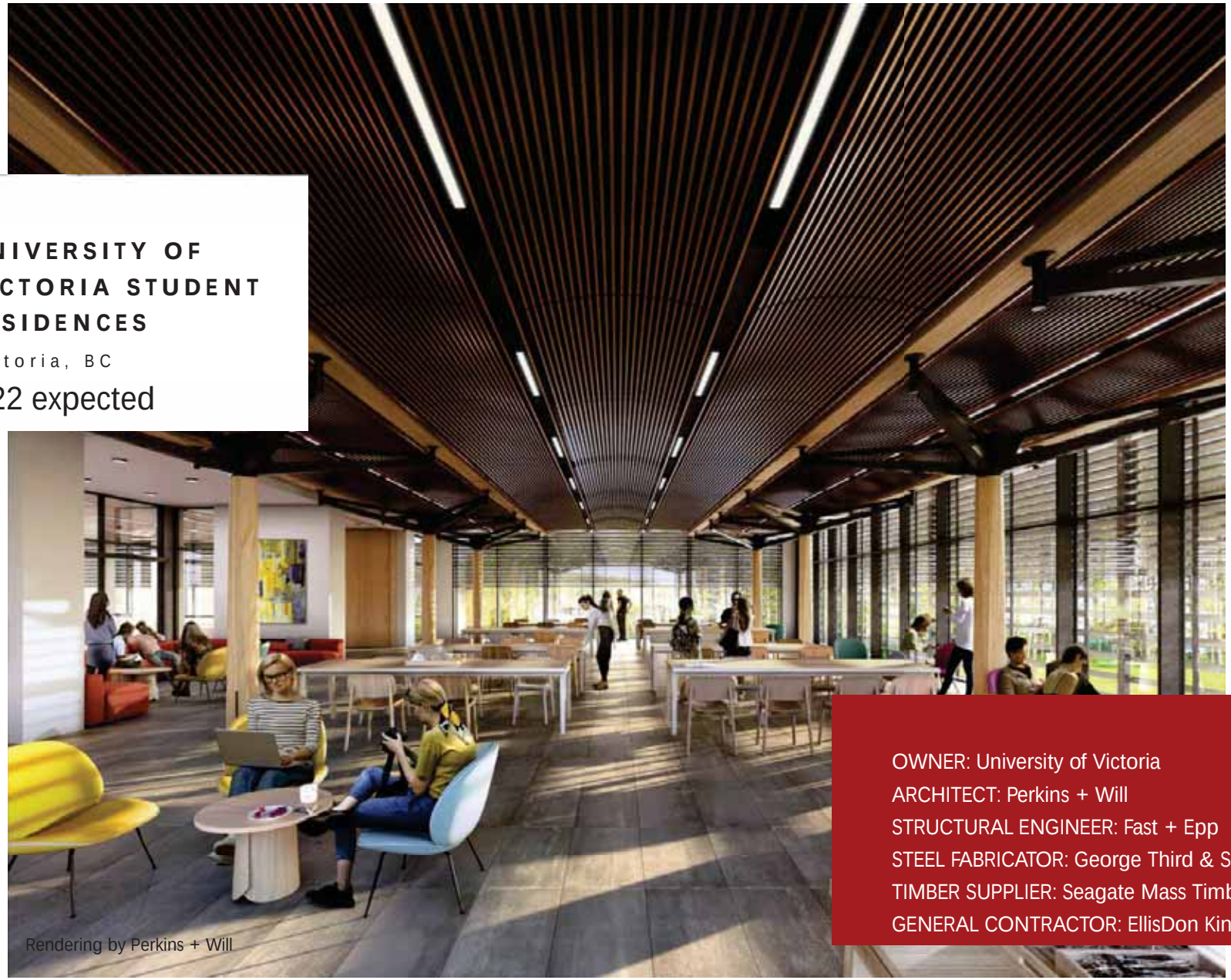


Typical structural tree elevation

UNIVERSITY OF VICTORIA STUDENT RESIDENCES

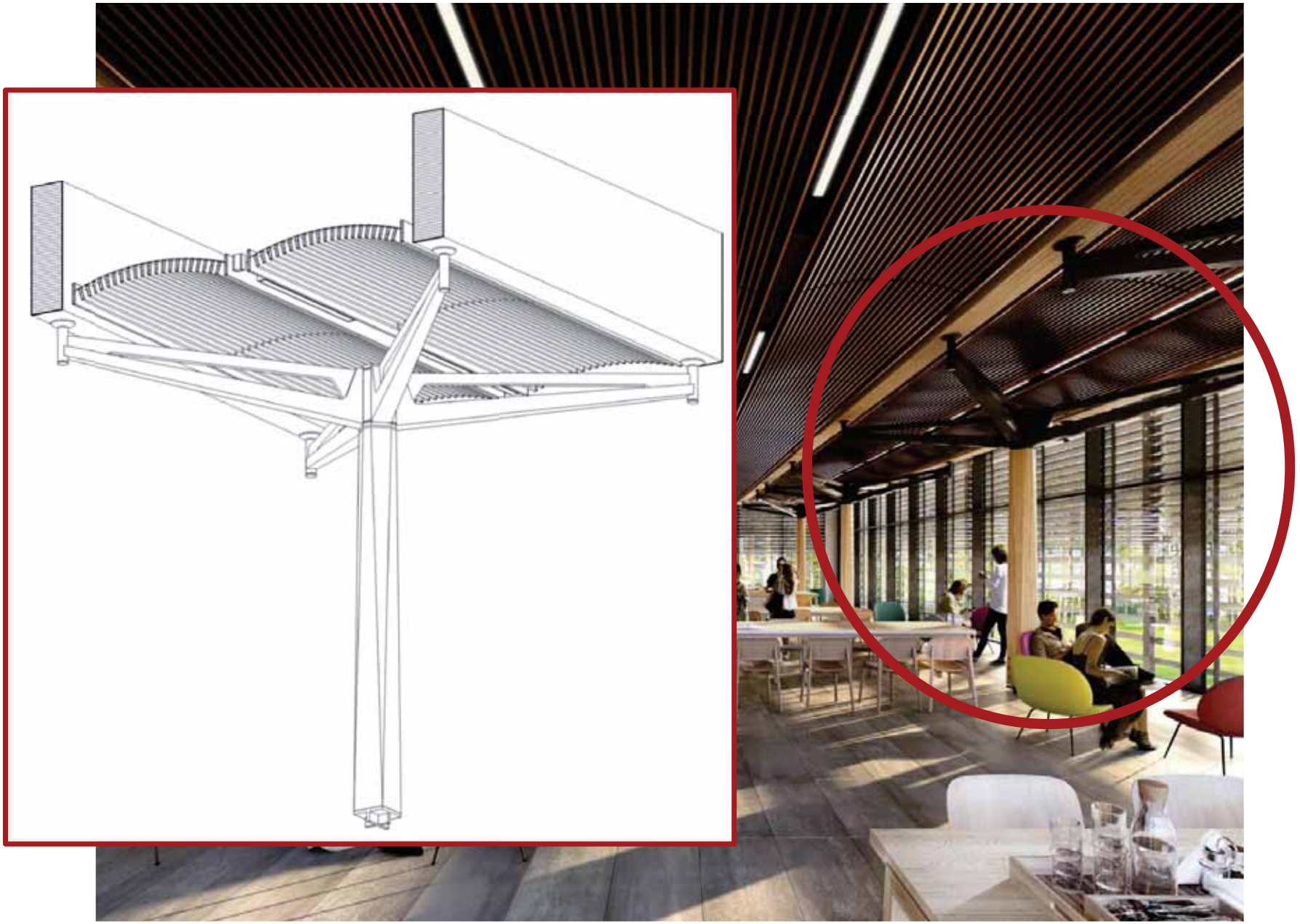
Victoria, BC

2022 expected

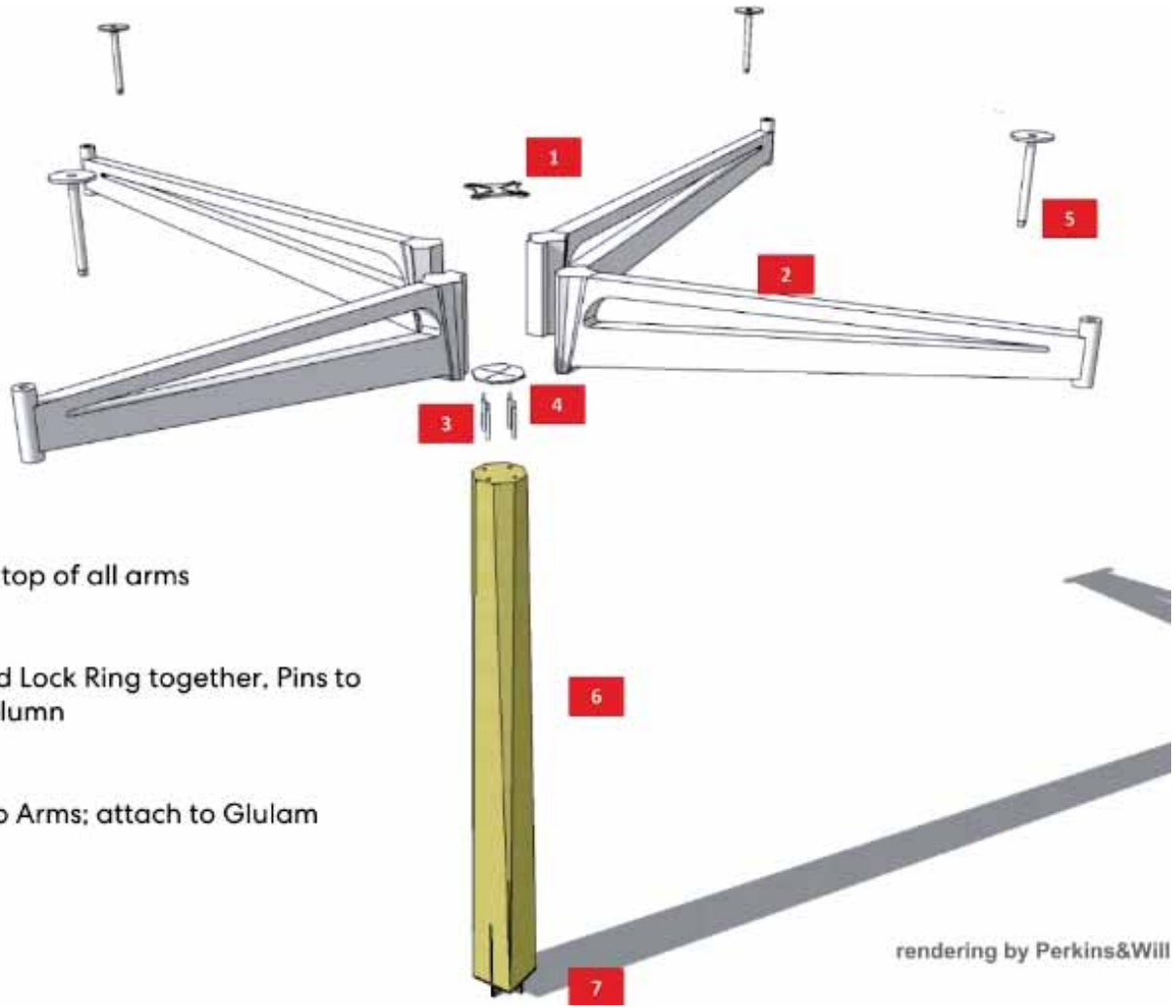


Rendering by Perkins + Will

OWNER: University of Victoria
ARCHITECT: Perkins + Will
STRUCTURAL ENGINEER: Fast + Epp
STEEL FABRICATOR: George Third & Son Ltd.
TIMBER SUPPLIER: Seagate Mass Timber and Kalesnikoff
GENERAL CONTRACTOR: EllisDon Kinetic JV

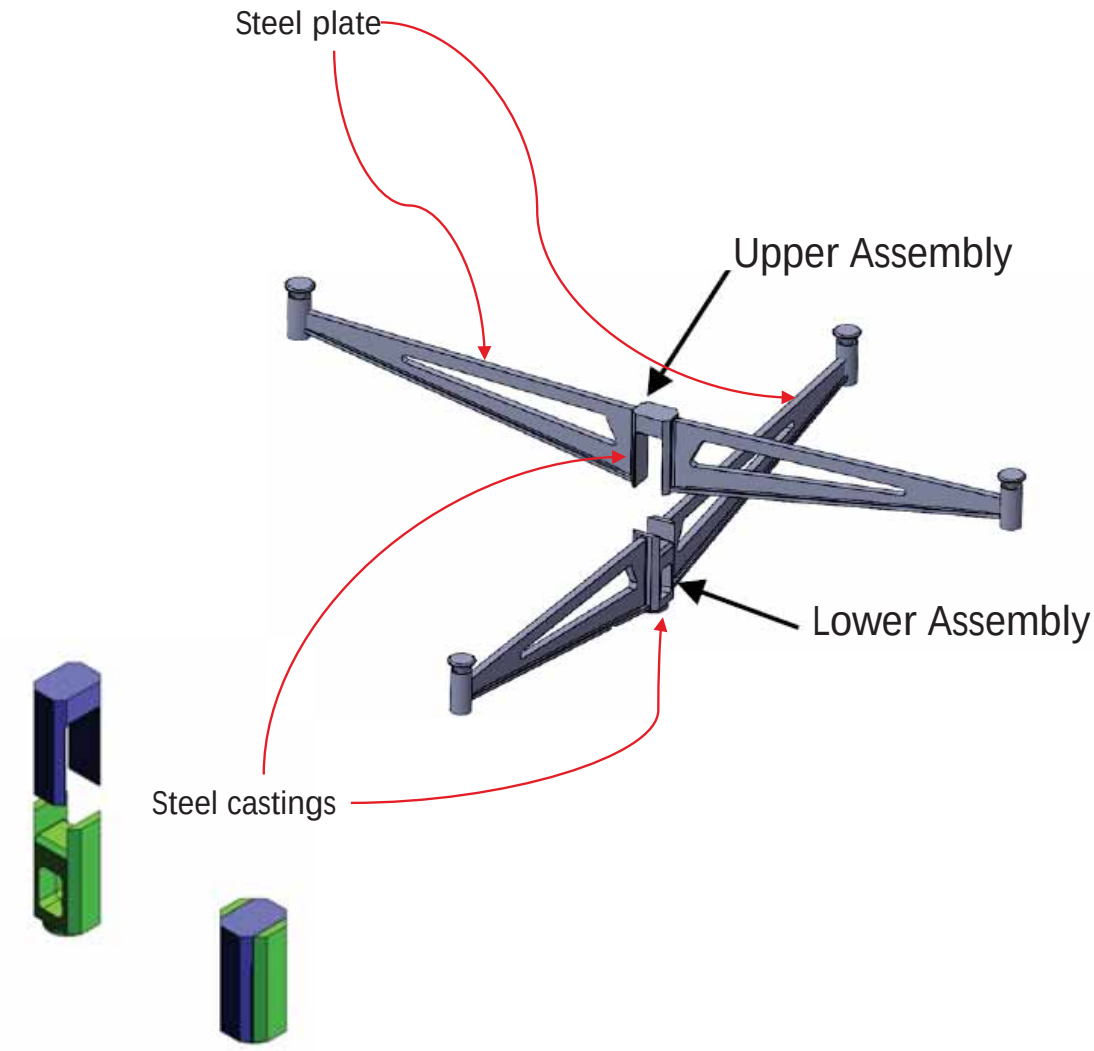


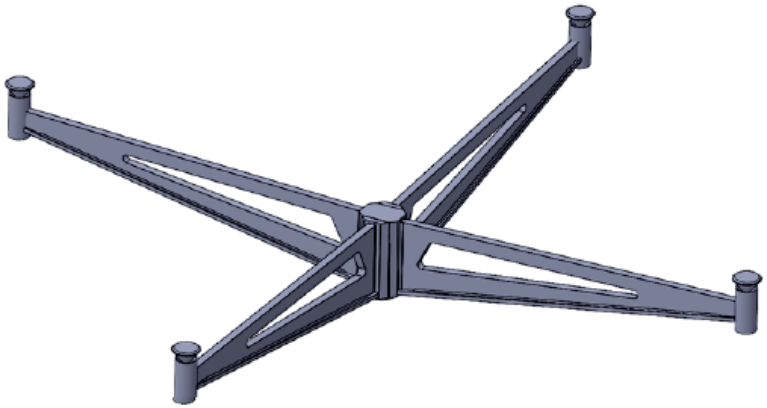
Tree Columns



Exploded view

1 Crown Top Plate
   To be welded to top of all arms
2 Arms
3 Crown pins
   To hold arms and Lock Ring together. Pins to be glued into Column
4 Arm Lock Ring
5 Node
   Threaded (?) into Arms; attach to Glulam Beams?
6 Column
7 Column Base





After shop welding castings to steel plate arms, Upper and Lower Assemblies are flat packed for transport to site. On site, Lower Assembly is bolted to glulam column before Upper Assembly is fit over top.

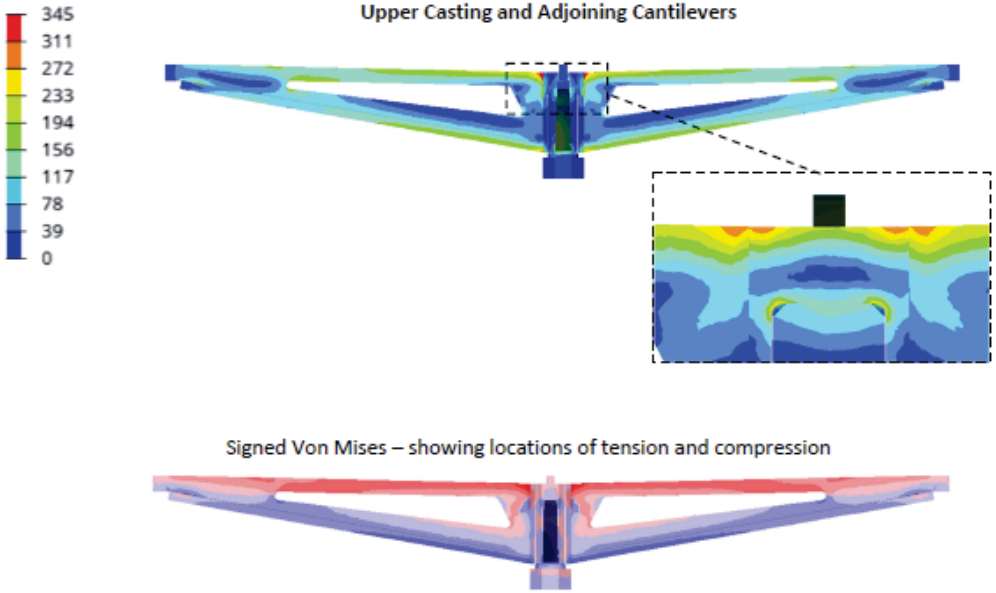
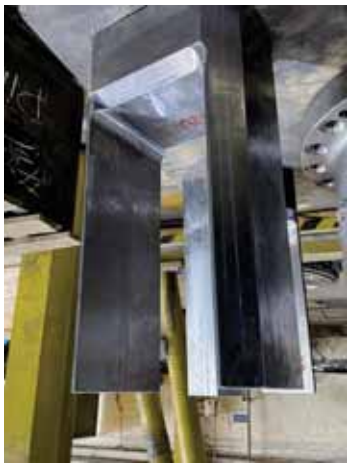
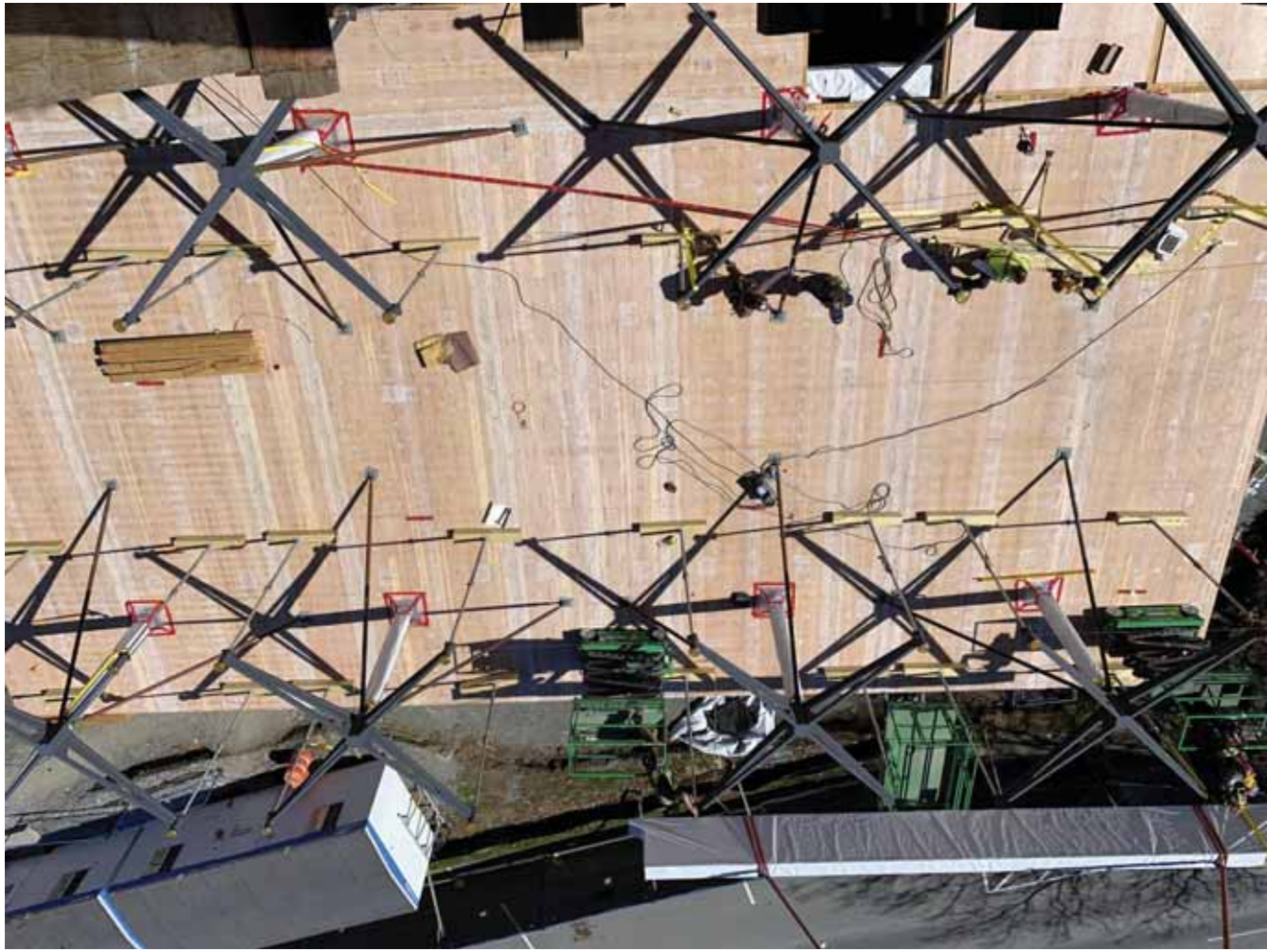
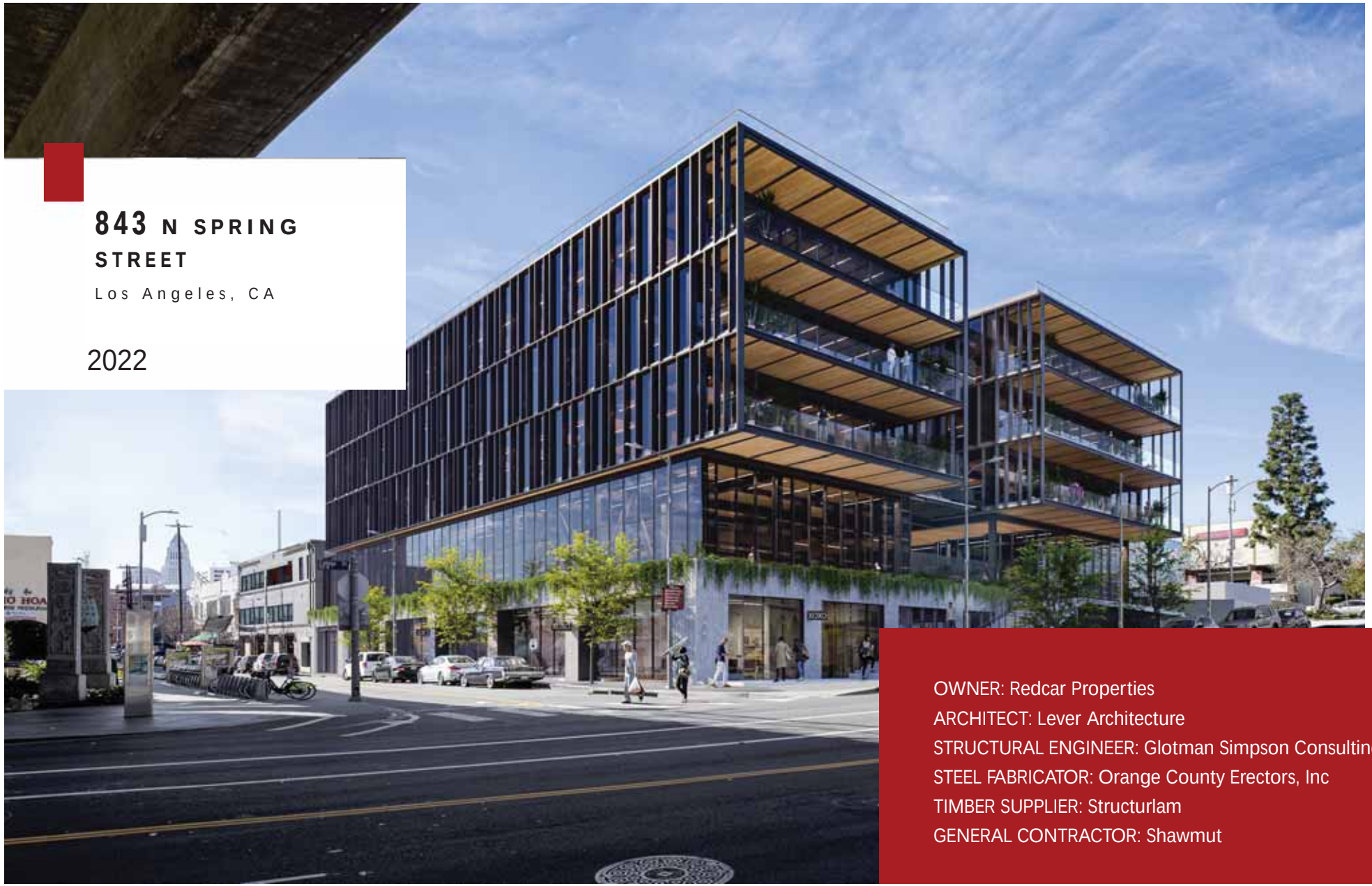


Figure 15: Cantilever Von Mises Stress Results




armour





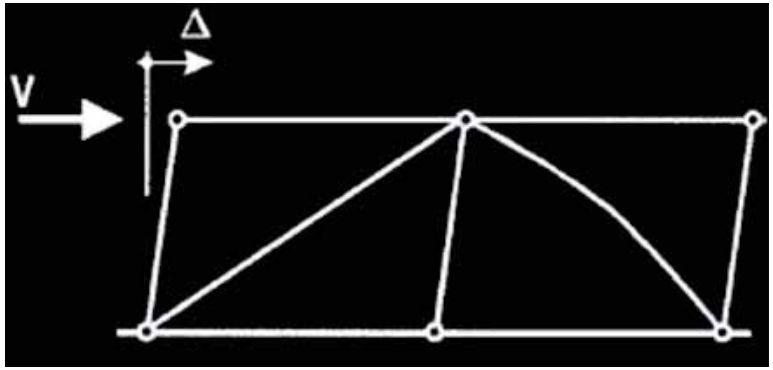
843 N SPRING STREET

Los Angeles, CA

2022

OWNER: Redcar Properties
ARCHITECT: Lever Architecture
STRUCTURAL ENGINEER: Glotman Simpson Consulting Engineers
STEEL FABRICATOR: Orange County Erectors, Inc
TIMBER SUPPLIER: Structurlam
GENERAL CONTRACTOR: Shawmut

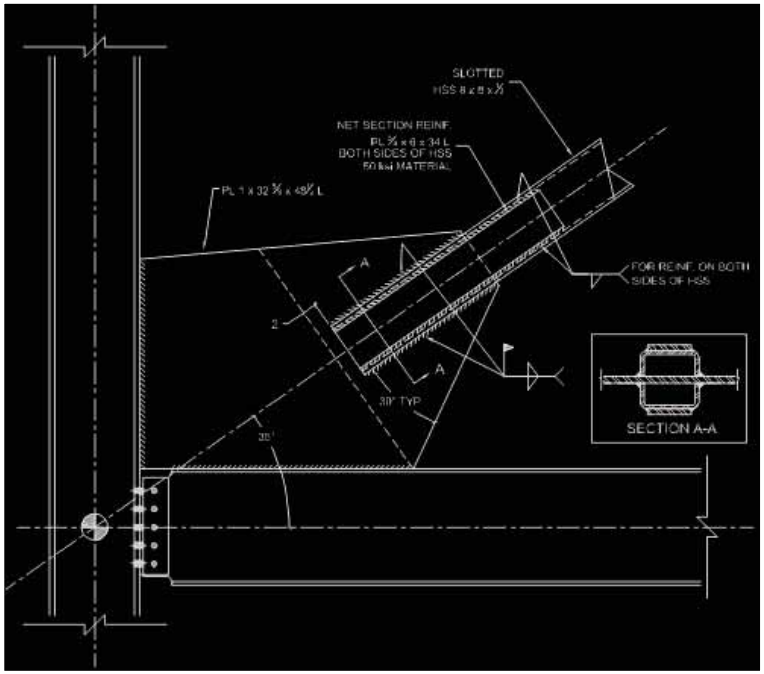

Chinatown



Special Concentric Braced Frame (SCBF) Basics

As a frame deforms beyond its elastic range, its brace members are intended to **yield in tension** and **buckle in compression**

Special detailing requirements of SCBF connections can be **time consuming to design**, and are **complex to fabricate and erect**, requiring **local reinforcement, extensive field welding** and consequent **special inspections**

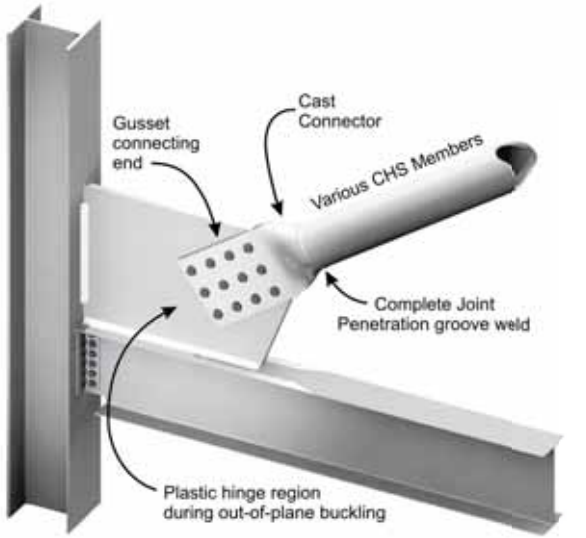


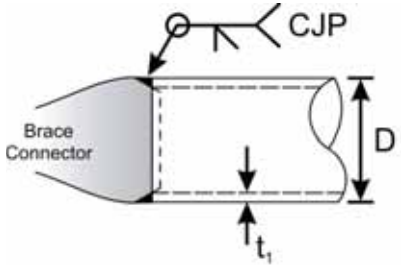
Field welded option

Field bolted option

HIGH STRENGTH CONNECTORS™

CAST CONNEX High Strength Connectors™ simplify and improve connections to round hollow structural section (HSS) brace members in seismic-resistant concentrically braced frames (SCBF, OCBF, MD-CBF or LD-CBF).





QUESTIONS?

CASTCONNEX®
innovative components for inspired designs

Jennifer Anna Pazdon, MSE, PE
Vice President, USA | Director, UK Division
j.pazdon@castconnex.com
www.castconnex.com

HIB

UPC
Universal Pin Connector

CC
Custom Casting

TEC
Timber End Connector

Architectural Taper

ART

ART + UPC

HSC
High Strength Connector

DBS