CAST CONNEX

NOVEMBER 7, 13, & 20, 2024

Evolution of Structures

Steel Castings in the Eye of the Design Team

Featuring Speakers from:

ELEMA MdeAS

Severud Associates
CONSULTING ENGINEERS P.C.

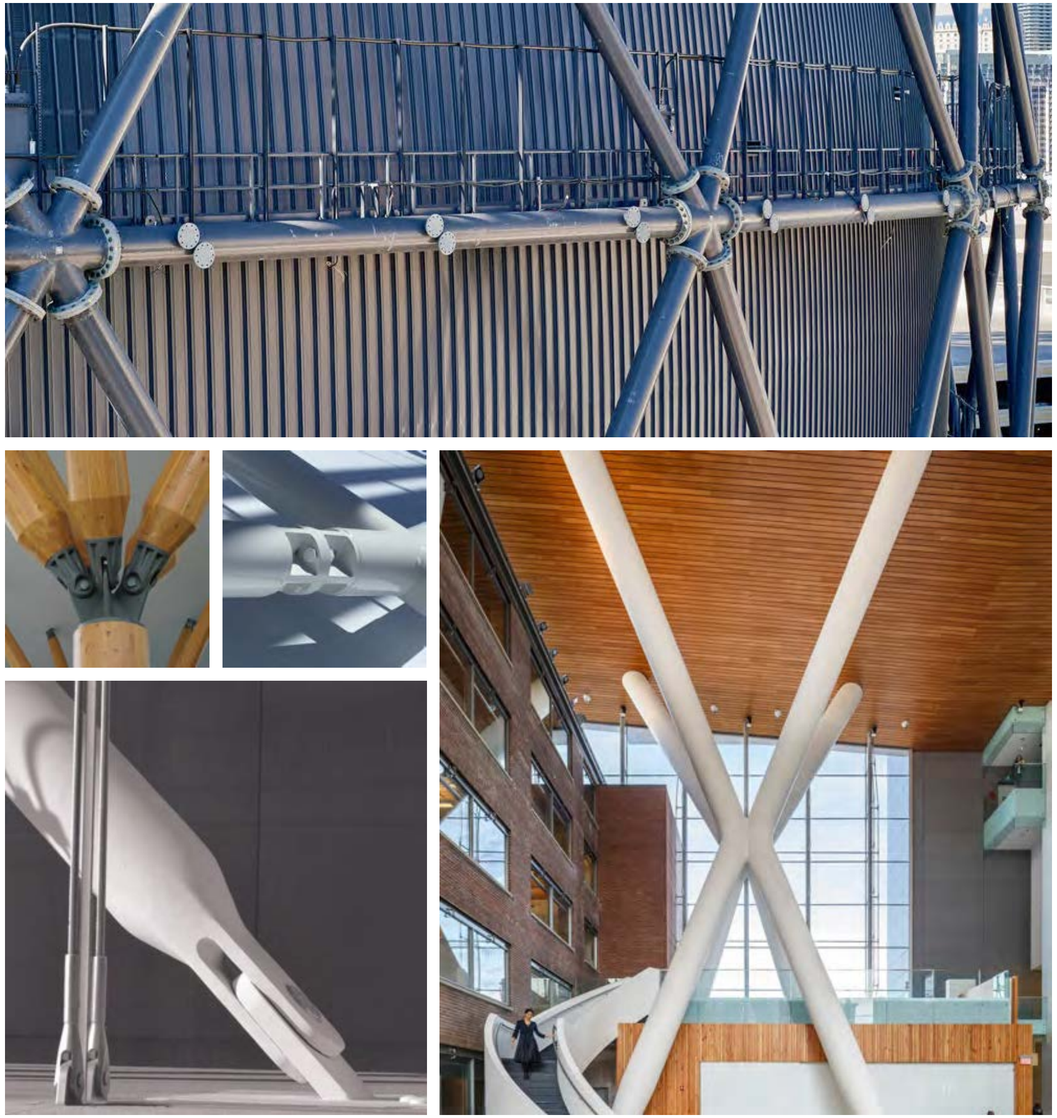
Industry leaders use steel castings to turn bold visions into reality.

»

CASTCONNEX®
innovative components for inspired designs

We simplify the design and enhance the performance of structures by enabling Architects and Engineers to use cast steel connections.

We take pride in collaborating in the creation of safer, innovative, and more beautiful built environments.



Evolution of Structures
Steel Castings in the Eye of the Design Team

Longueuil Downtown TOD

An Innovative Urban Center

CASTINGS301-24 | 1LU/HSW | Live Webinar | Introductory | Prerequisites: None
AIA CES PROVIDER NUMBER:404108320

Speaker: **Félix Bédard, M.Eng., P.Eng.**
Vice President & Co-Founder | Elema

ELEMA

Moderator: **Tarana Haque, M.A.Sc, P.Eng.**
Technical Sales Manager, North America | CAST CONNEX

CAST CONNEX®

COURSE DESCRIPTION

This presentation will explore the design and engineering of the Longueuil Downtown Lot 2 project, which is part of a multi-million-dollar real estate development for the city's transit-oriented development (TOD) initiative – an upcoming urban centre in the Greater Montreal region. This project is made up of two 33-storey residential towers, each located on either side of the Longueuil–Université-de-Sherbrooke metro terminal tunnel. Its podium feature allows the towers above to overhang the infrastructures of the tunnels and platforms of the metro station while providing access for STM (Société de transport de Montréal) transit users to the station below. To provide commercial space and a food court in the podium feature, the design includes impressive "tree-shaped" steel structures which span the tunnels and platforms of the metro station below.

In this presentation, learn about the design and engineering of this project, along with the challenges of building over an existing transit line. Learn how the design team incorporated flexible design practices to account for existing yet imprecise infrastructure. Explore the architectural programming and how the architecturally exposed structural steel (AESS) trees complete with custom-designed cast steel nodes enabled large free-spans and architecture for commercial space and access for transit users to the metro tunnels and platform.

LEARNING OBJECTIVES

1. Understand how the design and construction of the towers and podiums met the architectural and structural goals set by the project stakeholders: the city, the metro, and the developer.

2. Explore the flexible design methods the engineer of record used to adapt for the on-site imprecise or unknown geometry of existing infrastructure.

3. Quantify the effects of laying new foundations from existing metro installations from complex geotechnical and geomechanical studies.

4. Investigate how the architecturally exposed structural steel (AESS) trees with cast steel nodes support free-space architecture in the podium, enabling long spans for the food court and commercial area.

SUMMARY

- **Location:** Longueuil, Canada
- **Years:** 2018 – On going
- **Development value:** $500 million
- **Scale:** total area of 1.2 million square feet
- 1,200 housing units
- Nearly 60 000 square feet of commercial/public space
- Development sits on top of a STM subway station
- Neighbours ARTM public transit terminal
- Direct access to Sherbrooke Univertity's Longueuil campus

DEVIMCO IMMOBILIER

EDYFIC CONSTRUCTION

fabg Architectes

stgm

dupras ledoux ingénieurs

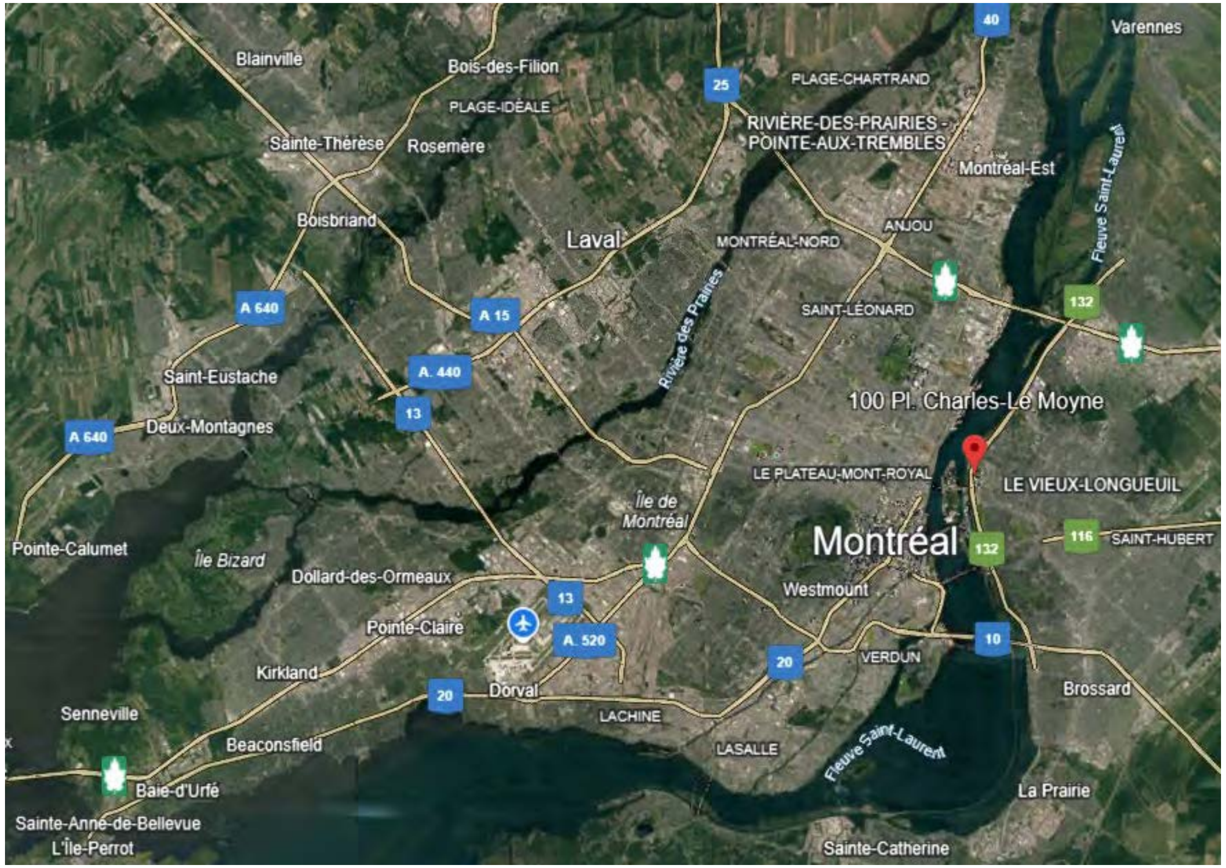
BA BEAUCE ATLAS

SDB STRUCTURAL STEEL ERECTOR ERECTEUR DE STRUCTURES D'ACIER MEMBER OF CAMNOR GROUP | MEMBRE DU GROUPE CAMNOR

Render credits: Devimco – Myral Condominiums

PROJECT CONTEXT, SITE AND HISTORY

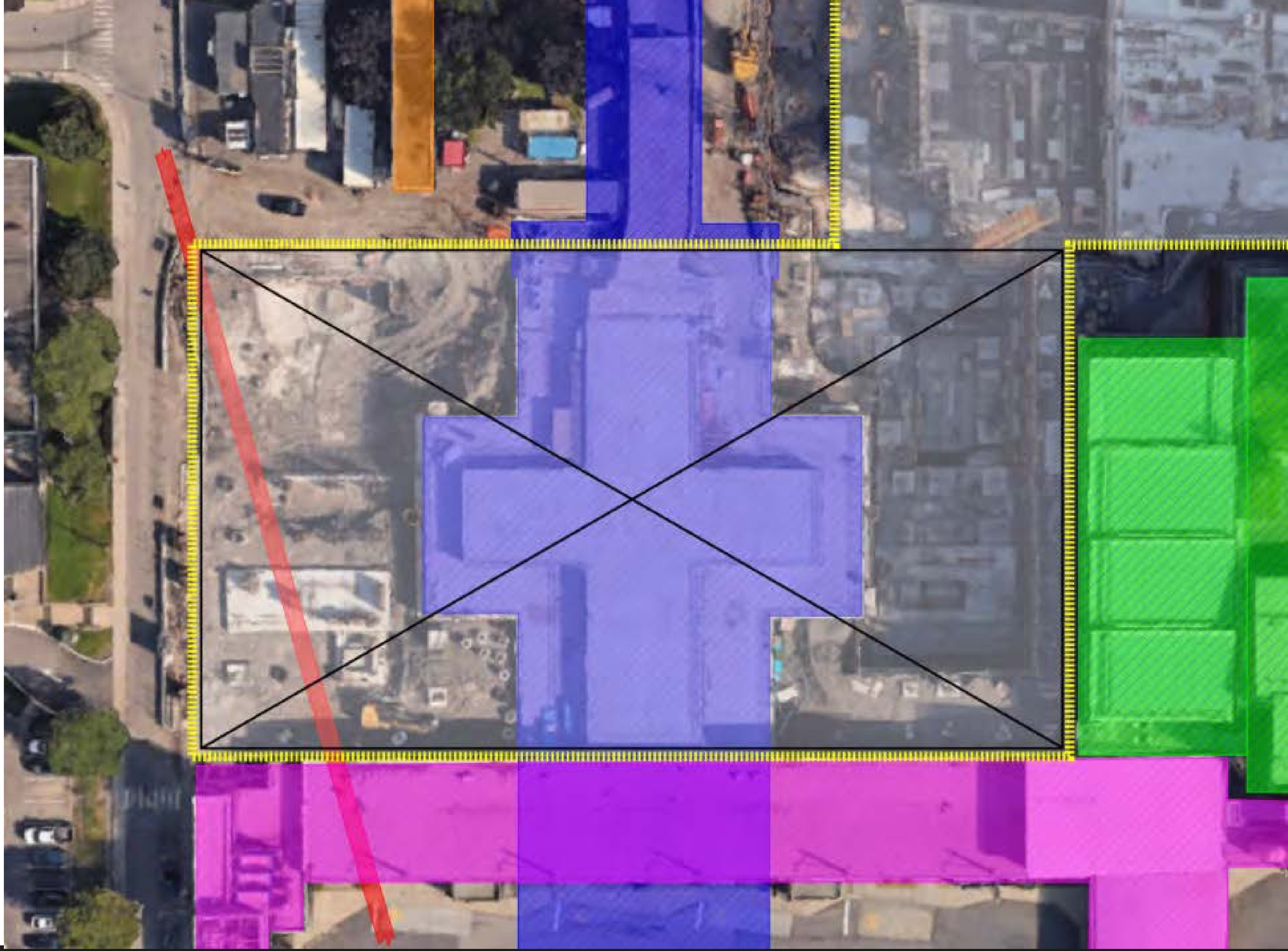
CONTEXT


Blainville
Bois-des-Filion
PLAGE-CHARTRAND
Varennes
PLAGE-IDÉALE
RIVIÈRE-DES-PRAIRIES - POINTE-AUX-TREMBLES
Sainte-Thérèse
Rosemère
Montréal-Est
Boisbriand
Laval
MONTRÉAL-NORD
ANJOU
SAINT-LÉONARD
Saint-Eustache
Deux-Montagnes
100 Pl. Charles-Le Moyne
LE PLATEAU-MONT-ROYAL
LE VIEUX-LONGUEUIL
Île de Montréal
Montréal
SAINT-HUBERT
Pointe-Calumet
Île Bizard
Dollard-des-Ormeaux
Westmount
Pointe-Claire
VERDUN
Kirkland
Dorval
Brossard
Senneville
LACHINE
Beaconsfield
LASALLE
Baie-d'Urfé
La Prairie
Sainte-Anne-de-Bellevue
L'Île-Perrot
Sainte-Catherine

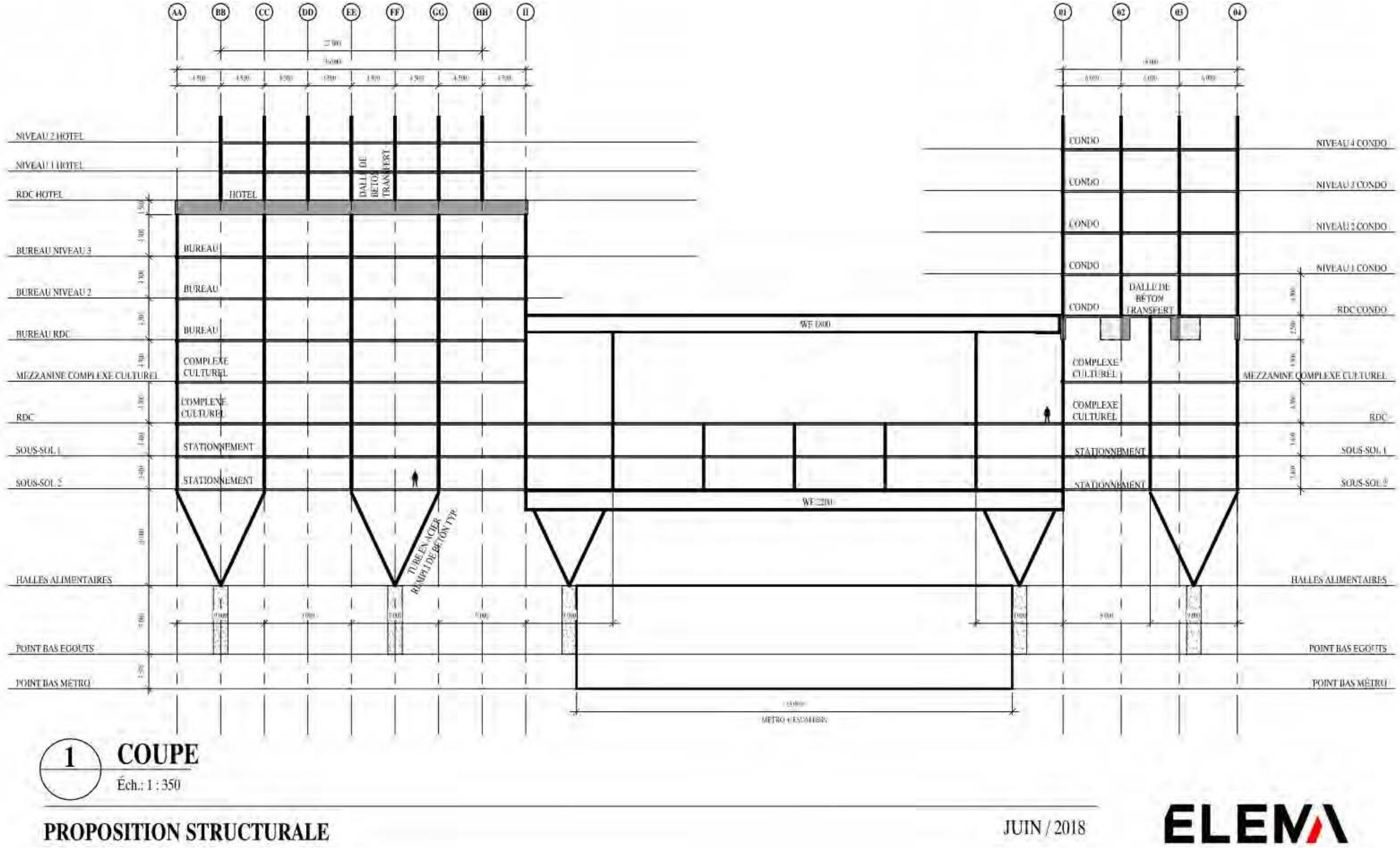

UQAM - Campus de Longueuil
Électroforme Longueuil
Université de Sherbrooke - Campus de Longueuil
100 Pl. Charles-Le Moyne
Collège Ellis - Campus de Longueuil
Garderie Biamel V

CONTEXT

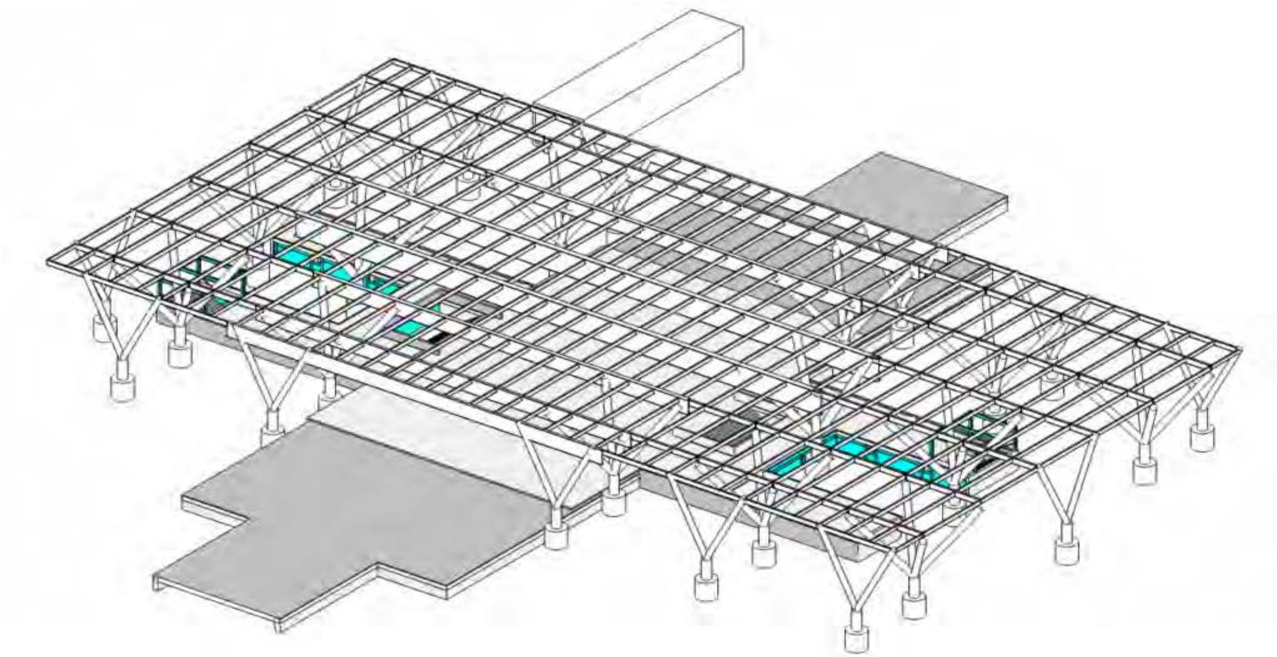
- PROJECT SITE
  STM SUBWAY
- ARTM BUS TERMINAL
- SHERBROOKE UNIVERSITY
- UNDERGROUND DRAINAGE LINE

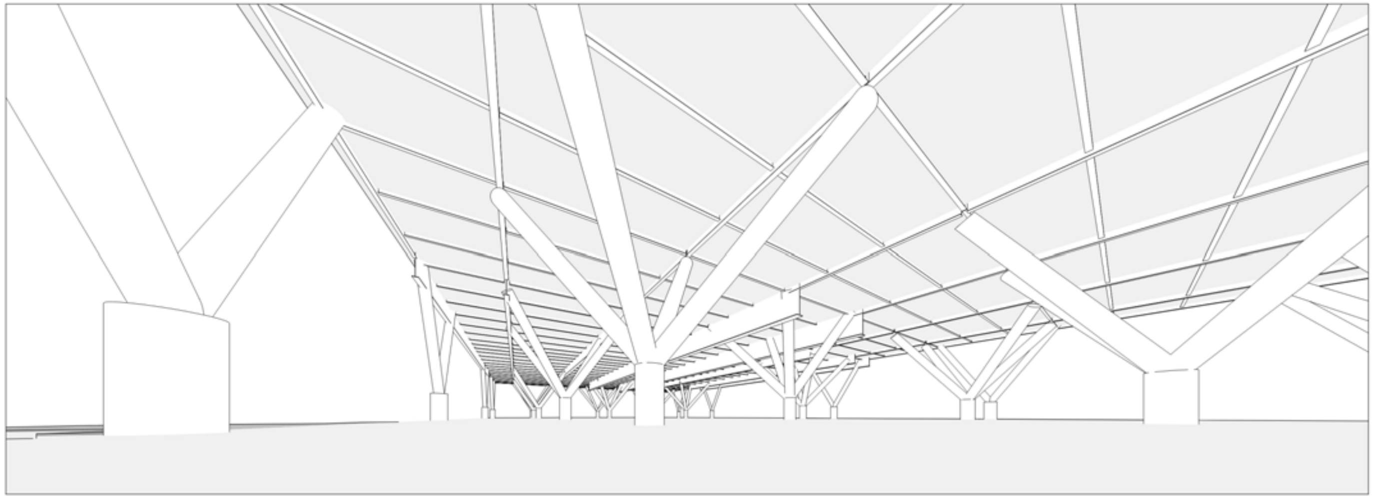


EVOLUTION OF THE PROJECT

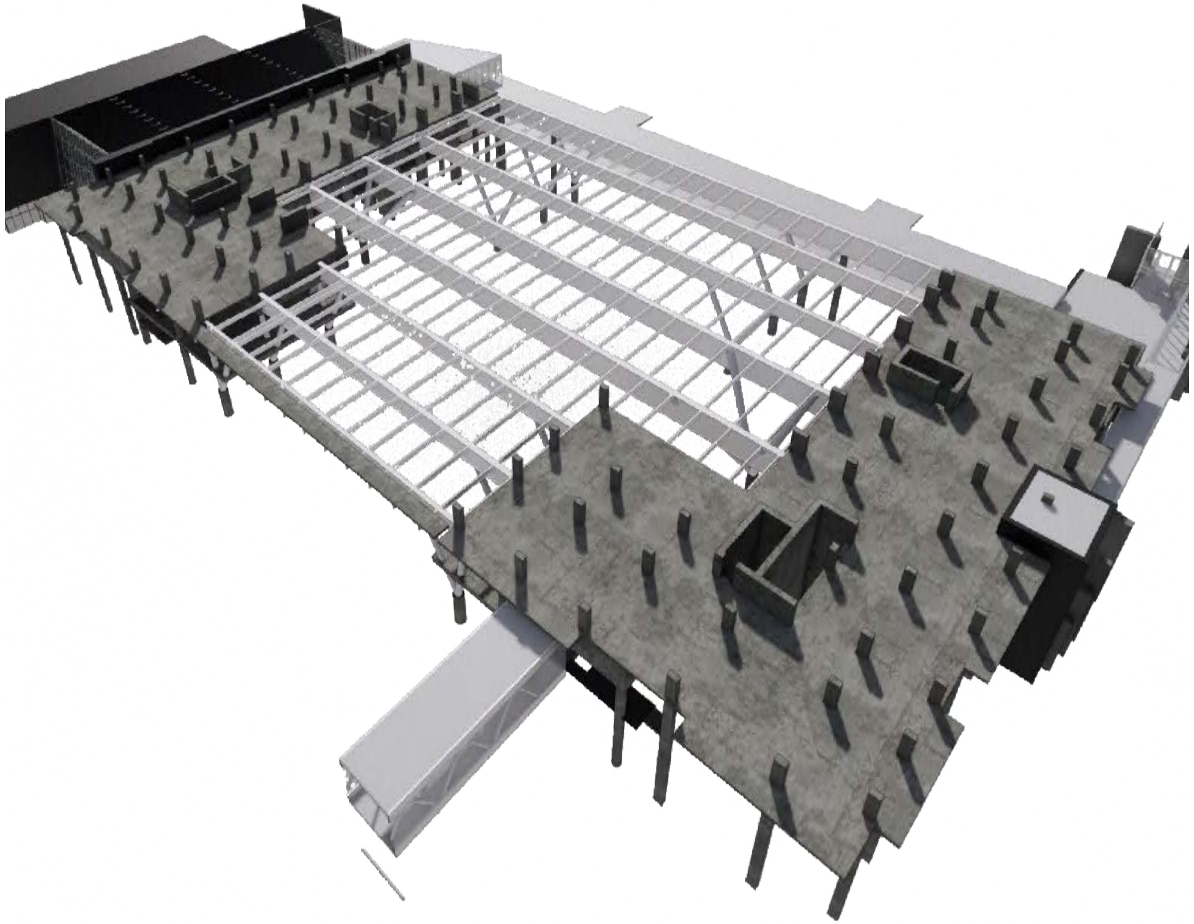


EVOLUTION OF THE PROJECT



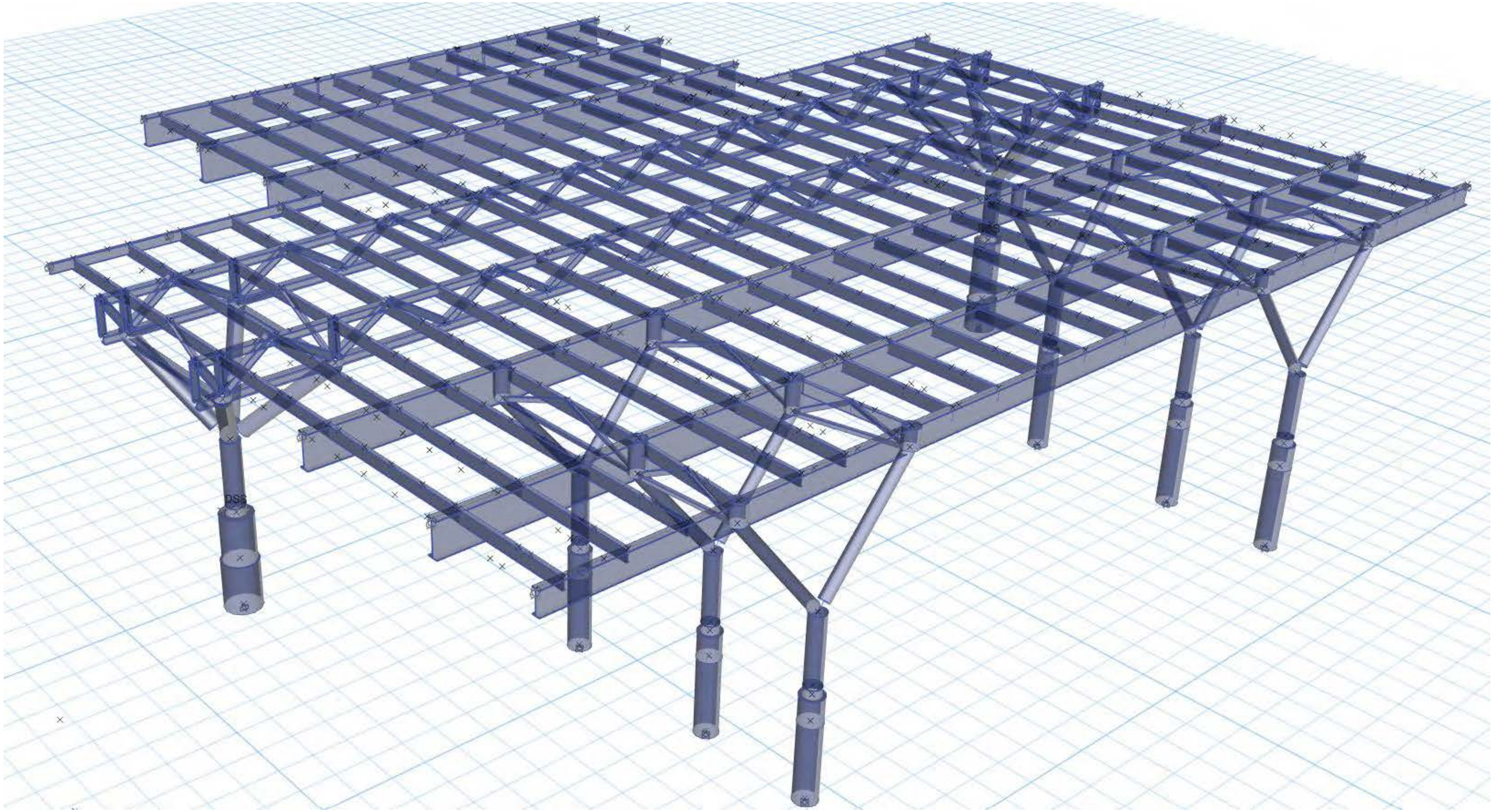


EVOLUTION OF THE PROJECT

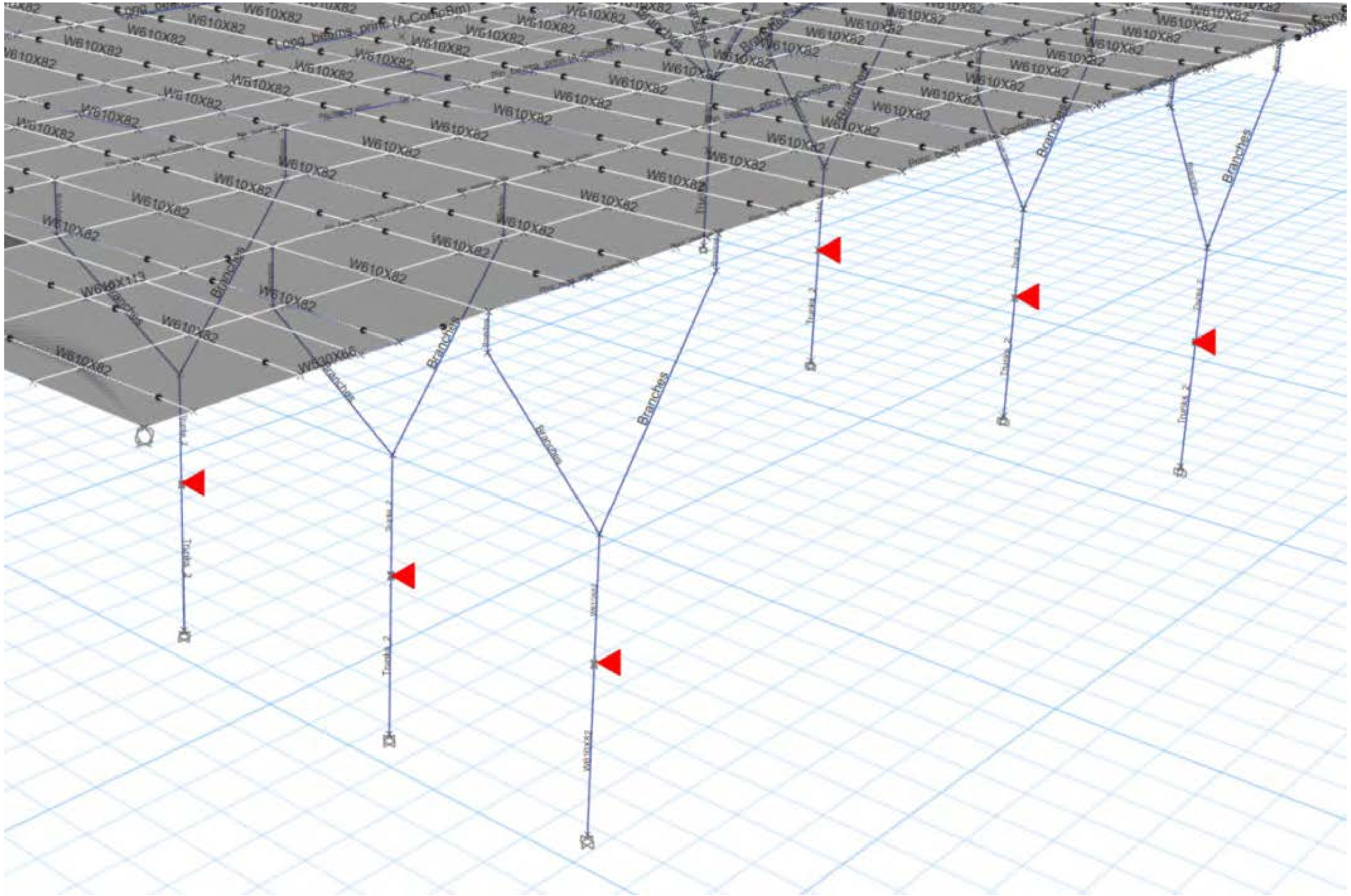


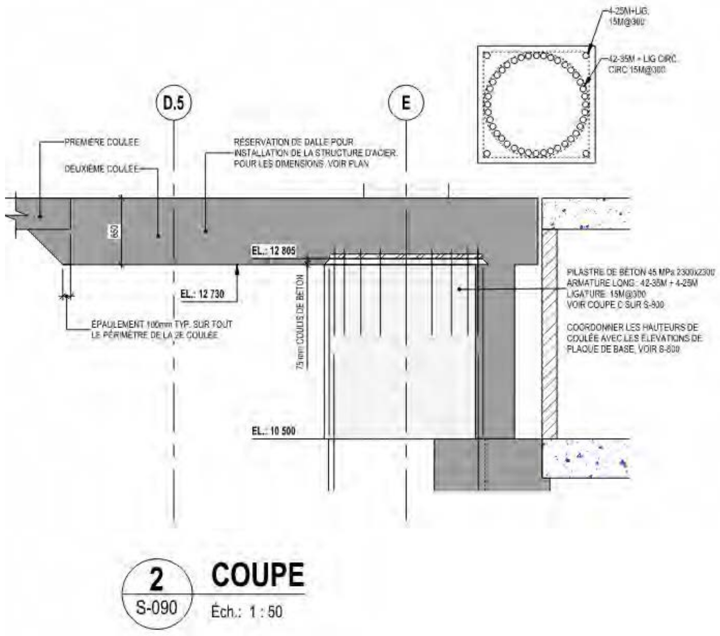
STRUCTURAL DESIGN

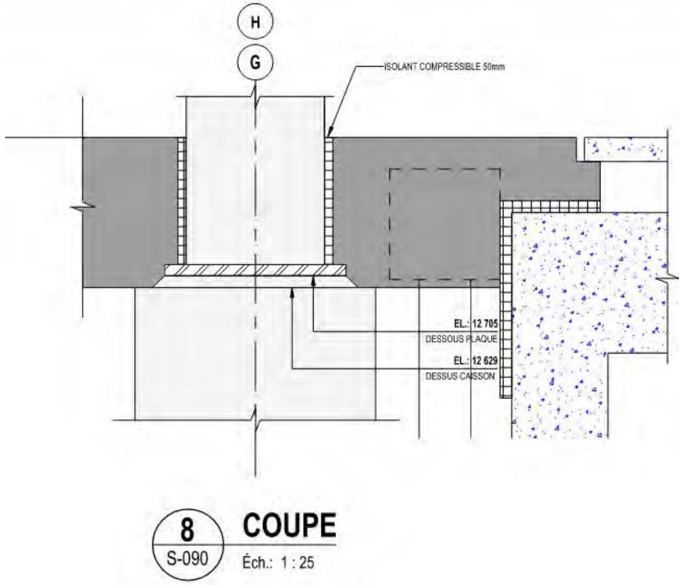
STRUCTURAL MODELING



STRUCTURAL MODELING

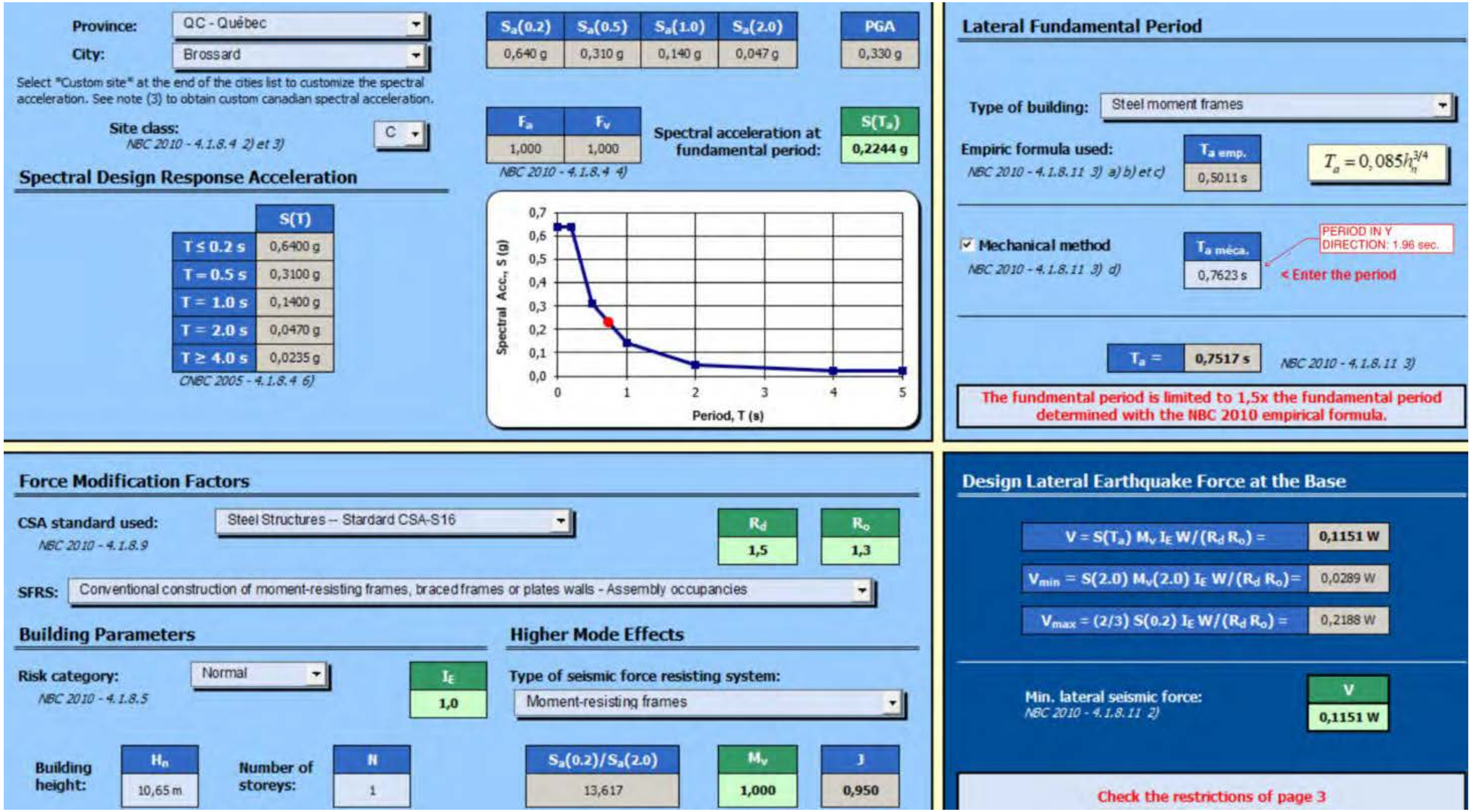




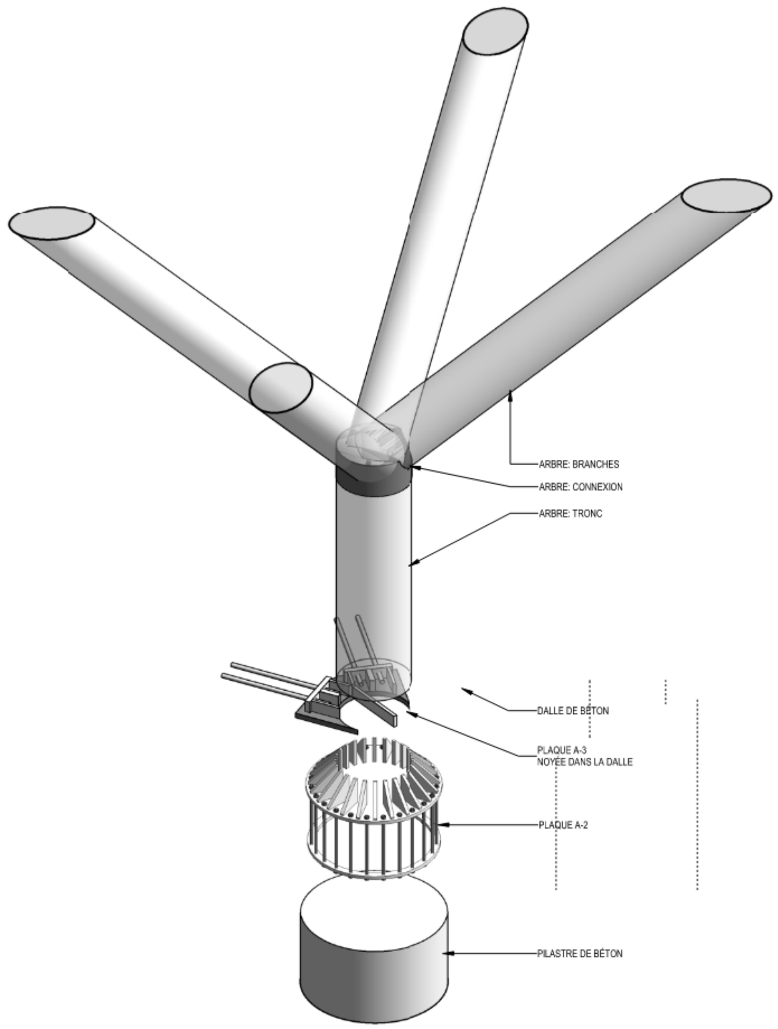


STRUCTURAL MODELING

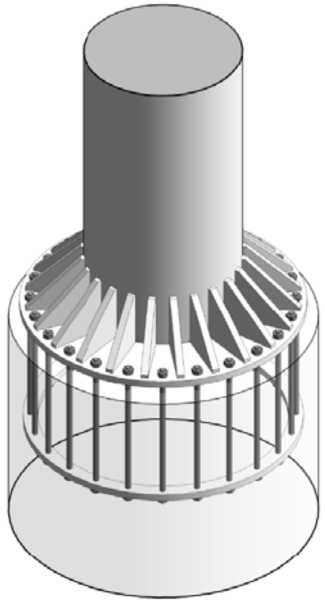
DESIGN ACCORDING TO CNBC/CCQ 2010 & 2015 – DIVISION B PART 4

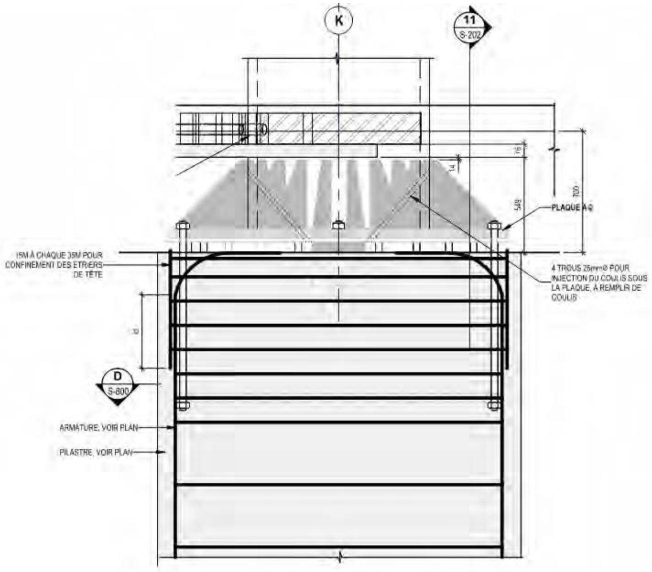


DETAILED DESIGN

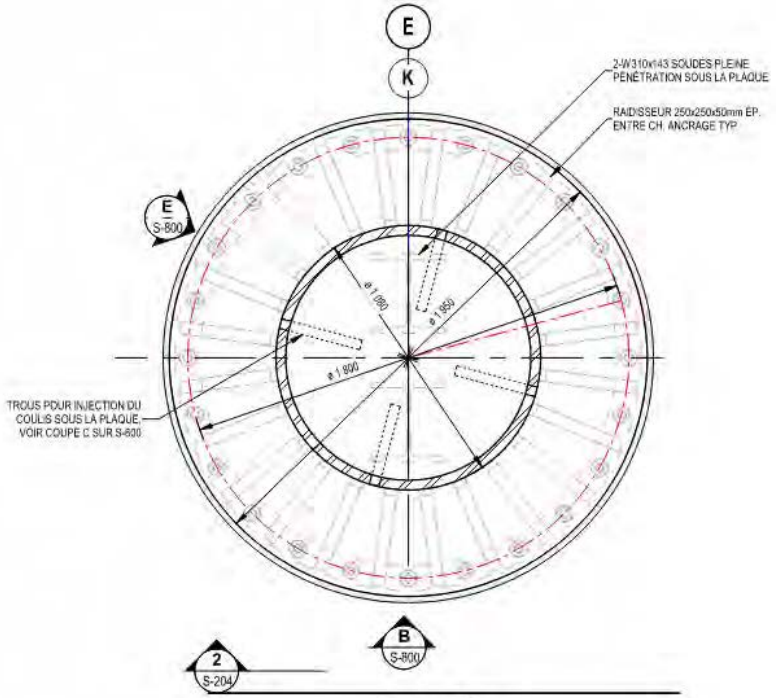


VUE 3D DES ARBRES ET CONNEXIONS DEPLOYÉES





C S-800 COUPE
Éch.: 1 : 20



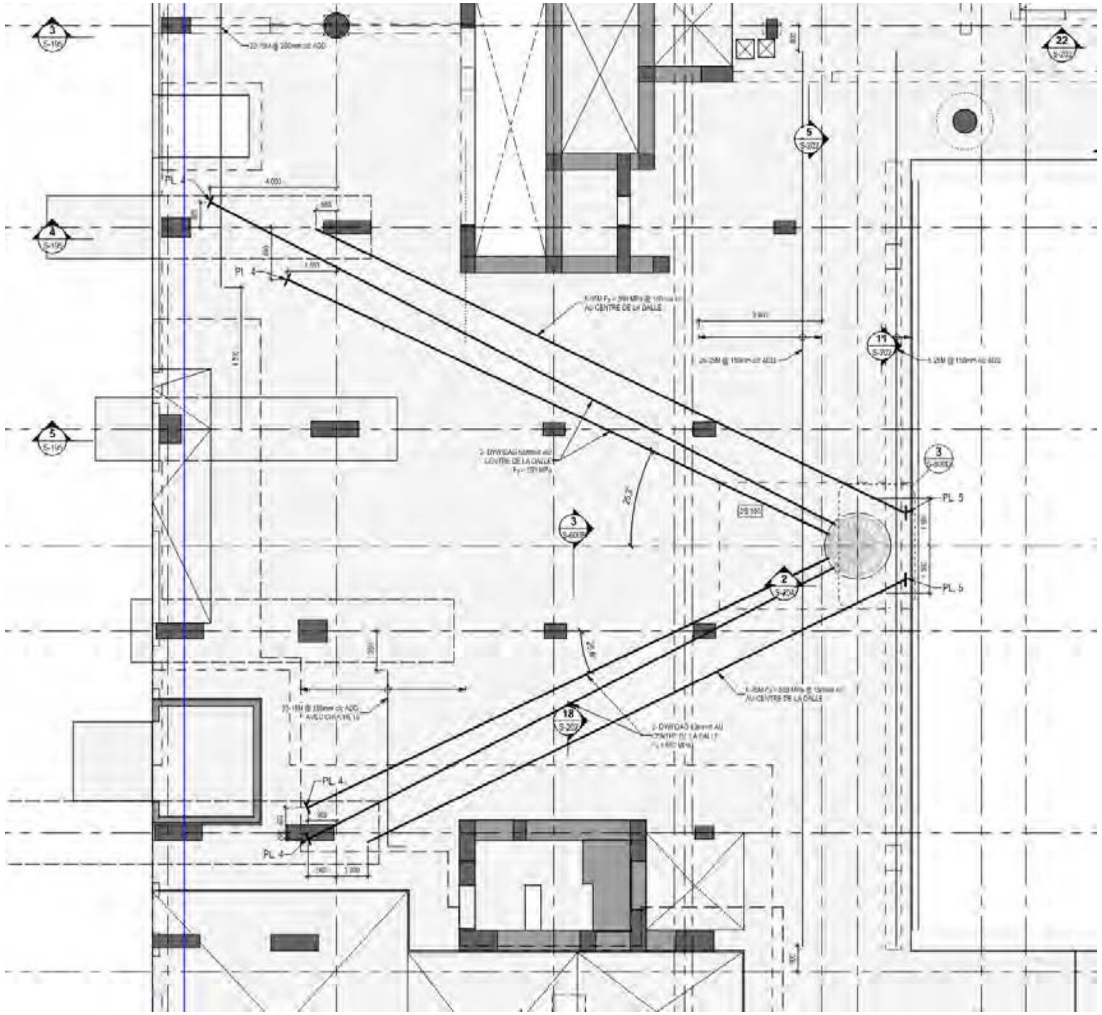
PL - A2

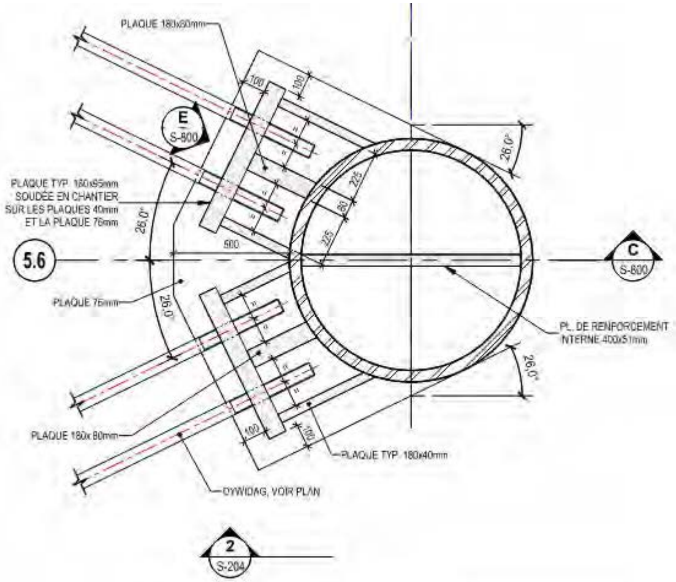
PLAQUE	1950mm DIA. x 50mm ÉP. 345 MPa
ANCRAGES	24 x 44mm DIA. ENF. 1150mm + 2-W310x143 250mm LG.
ELEVATION DESSOUS PLAQUE DE BASE	12 805

TOUTES PLAQUES 345 MPa S.I.C.
ANCRAGES TYPE F3125-150 AVEC F_{ub} = 1040 MPa

Anchor patterns:
24 x 44mm dia (1,75in)

DETAILED DESIGN





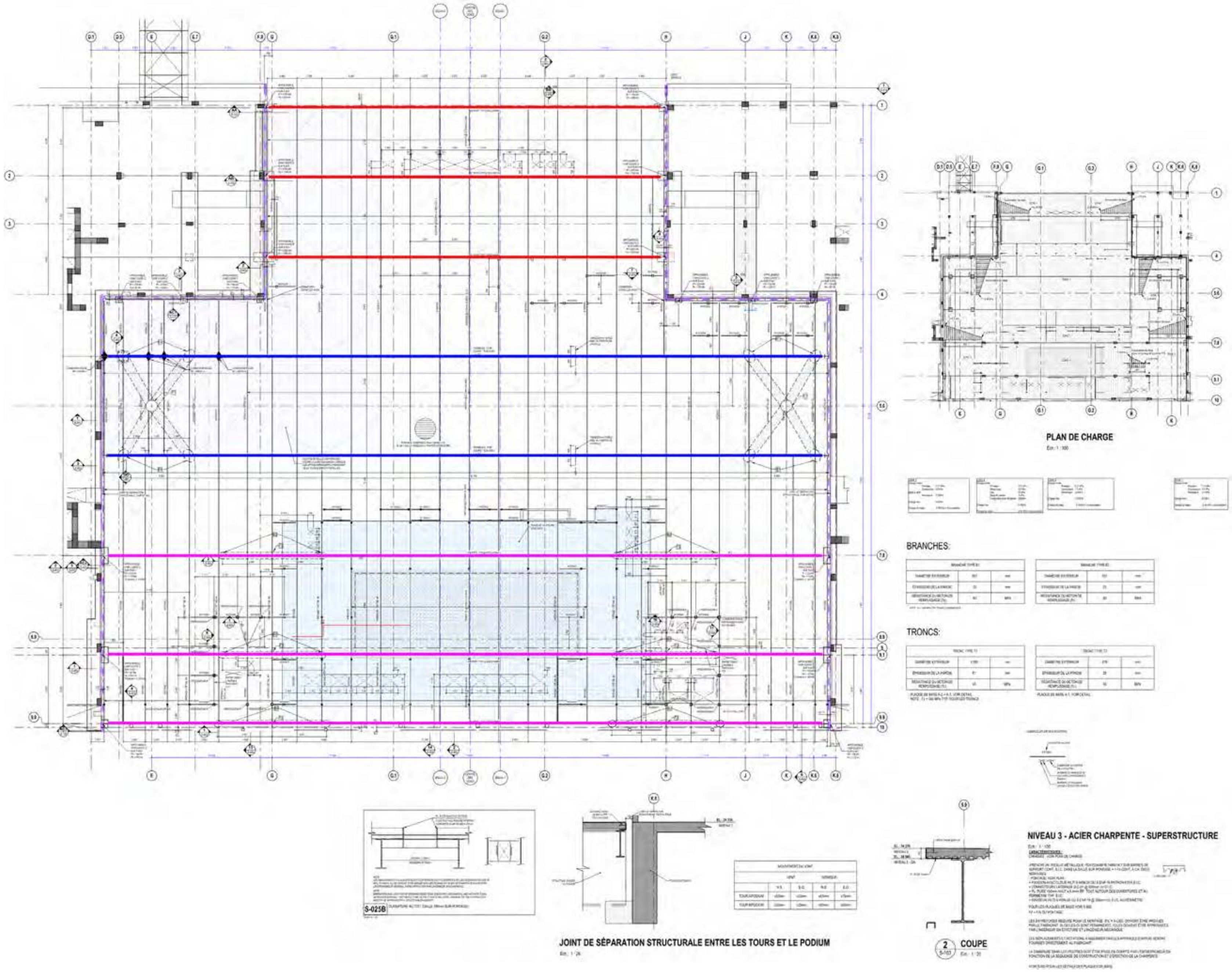
PL - A3	
PLAQUE	76 mm
ANCRAGES	VOIR PLAQUE A2

TOUTES PLAQUES 345 MPa S.I.C.

DETAILED DESIGN

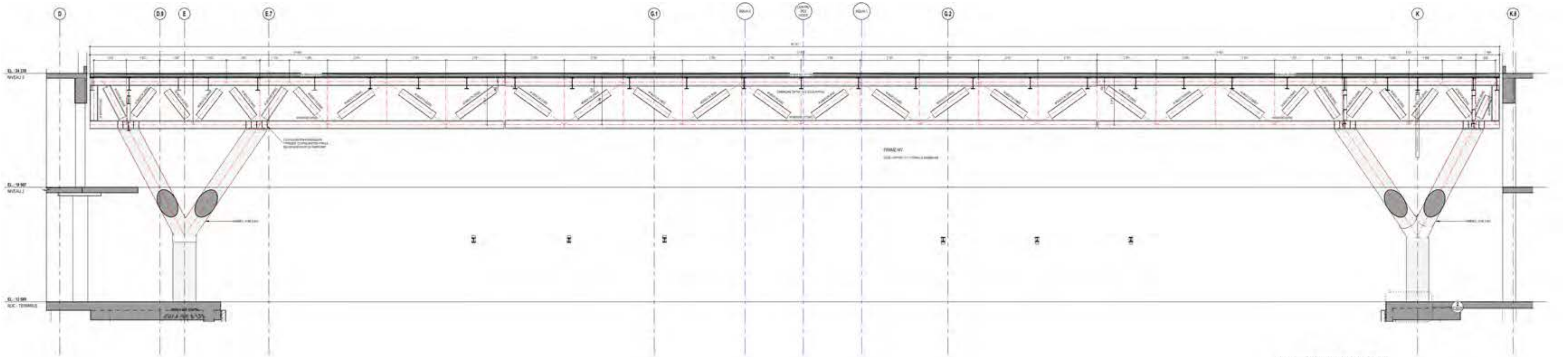
DETAILED DESIGN

- 8 main members
- 140-210mm composite slab on deck

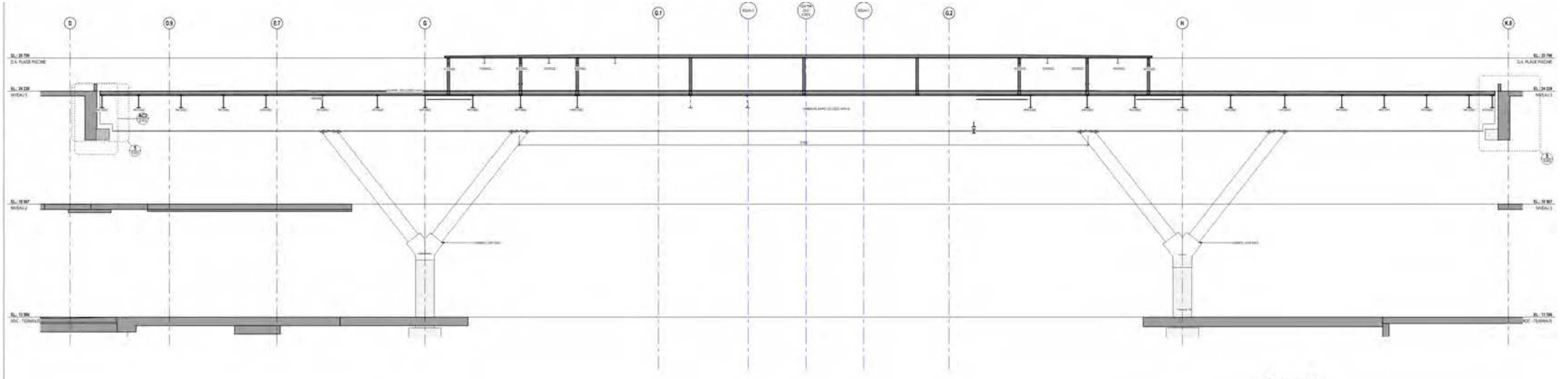


DETAILED DESIGN

Warren Truss : 2400mm deep (8ft), max span 57,5m (189ft)

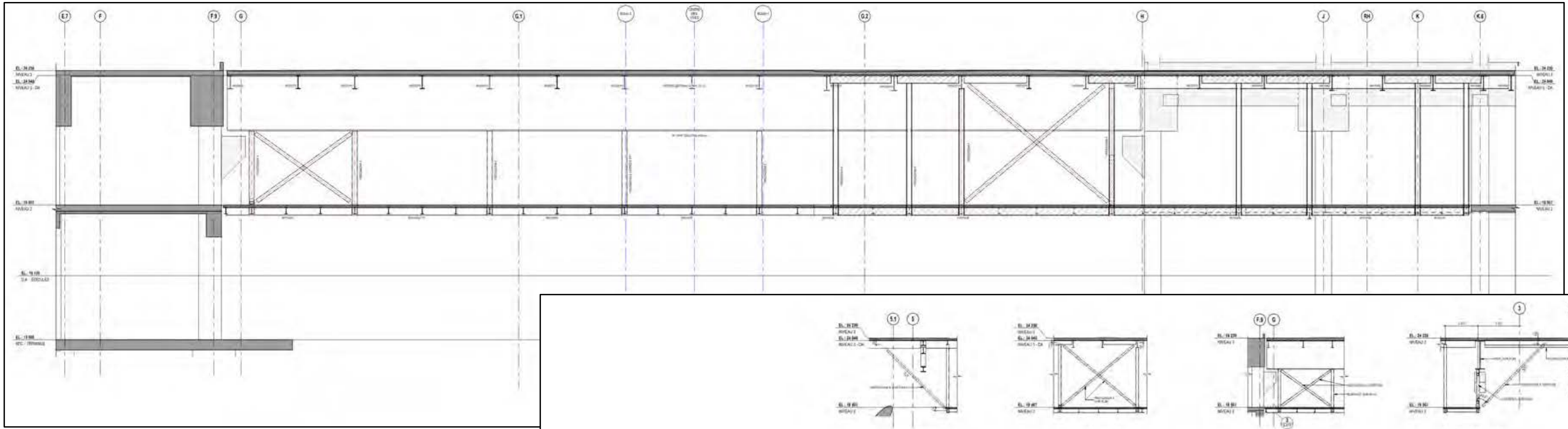


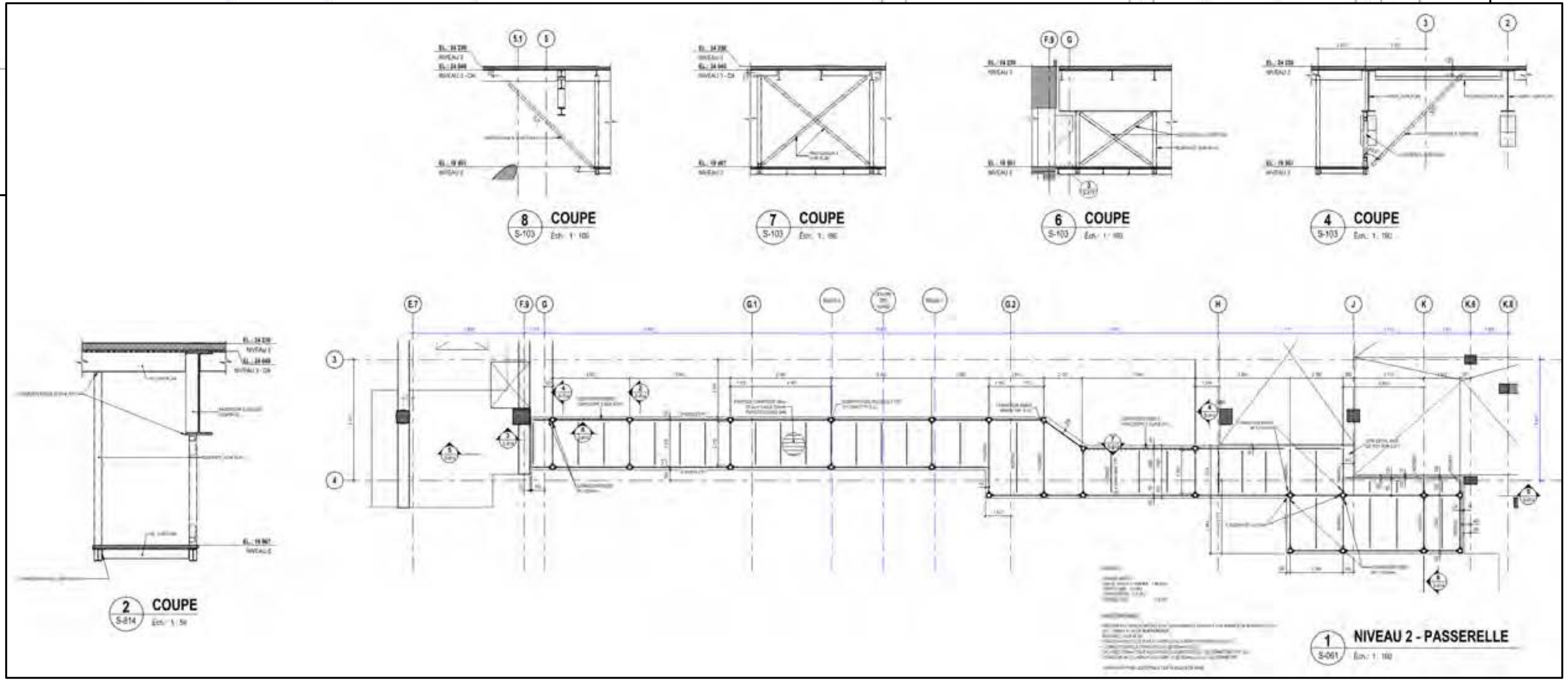
1 S-801 COUPE (FERME W2)



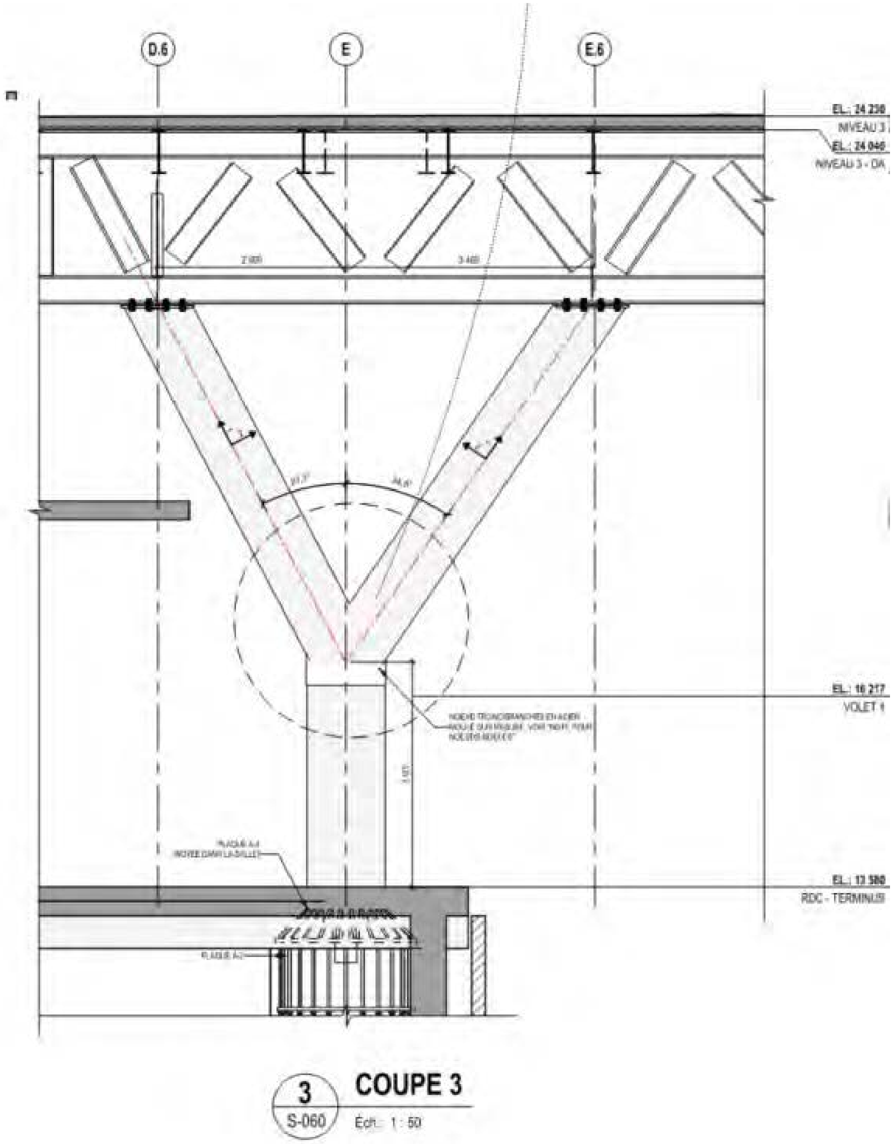
2 S-801 COUPE

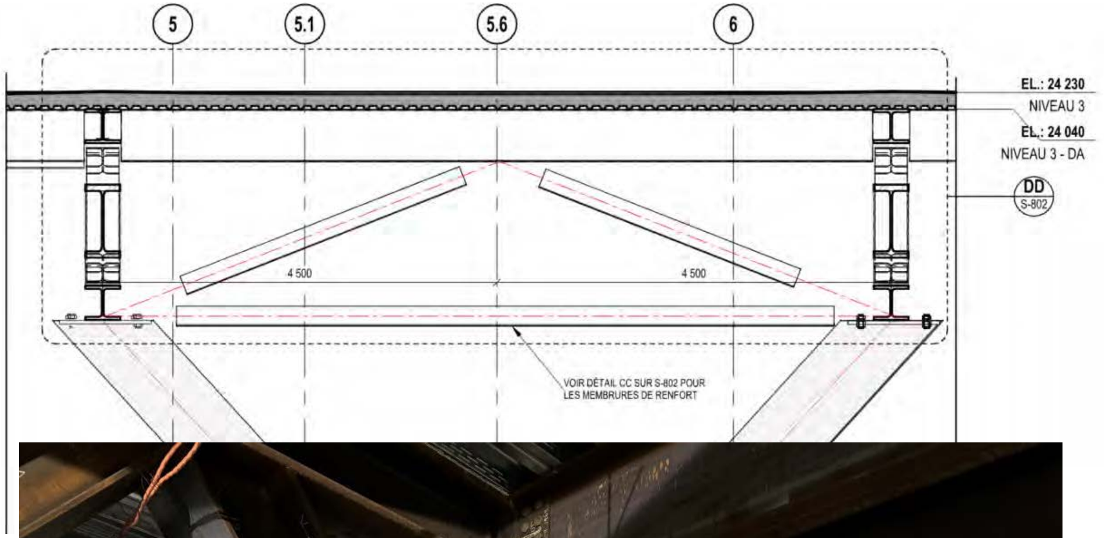
DETAILED DESIGN





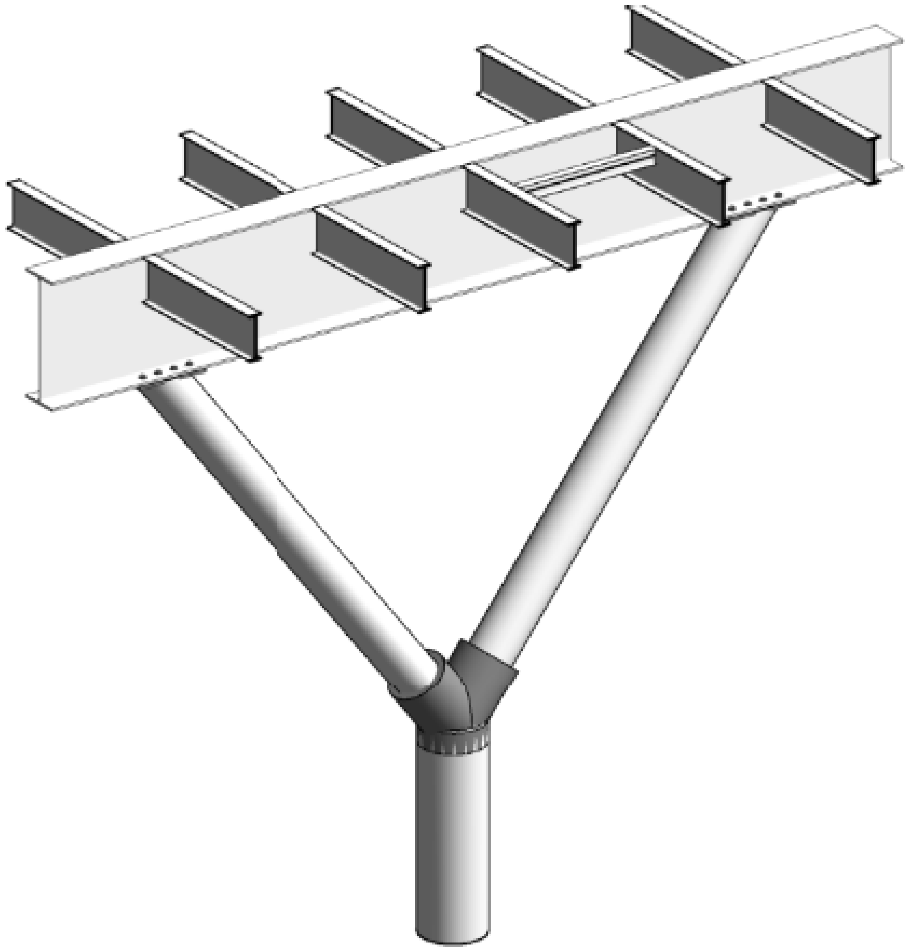
DETAILED DESIGN



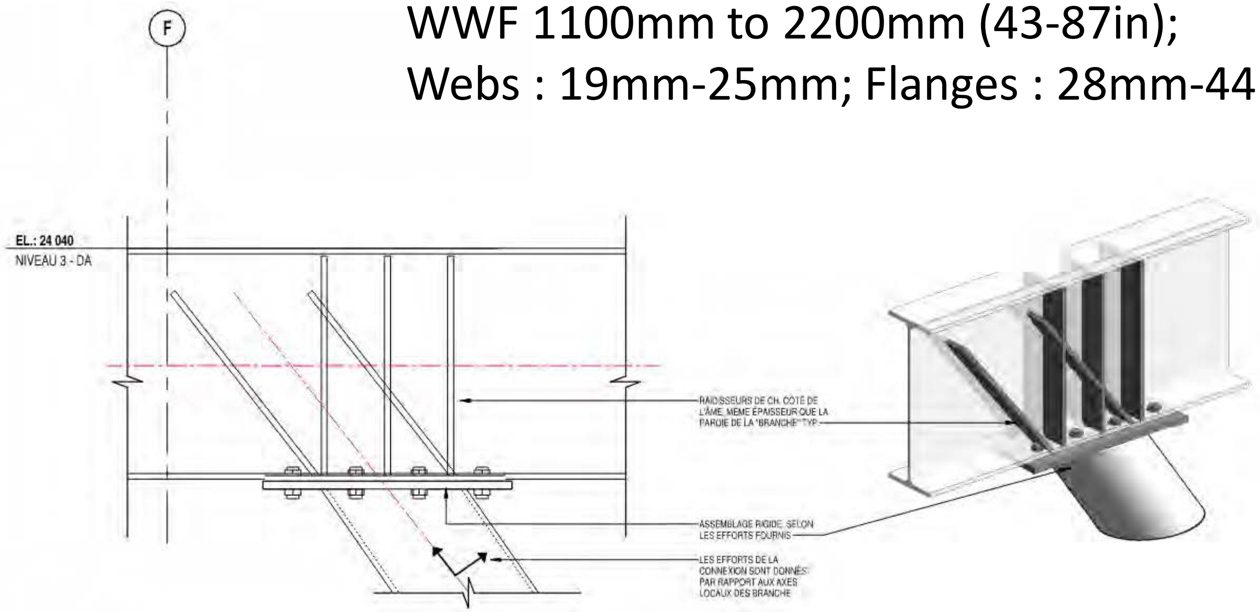


DETAILED DESIGN

WWF 1100mm to 2200mm (43-87in);
Webs : 19mm-25mm; Flanges : 28mm-44mm



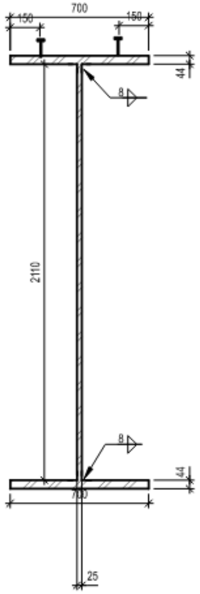
VUE 3D DES ARBRES DES AXES 7.8 ET 9.1



NOTES :
- TOUS LES ASSEMBLAGES DOIVENT ÊTRE ENTIÈREMENT CONÇUES PAR LE FABRICANT (NOMBRE DE BOULONS À TITRE INDICATIF SEULEMENT)
- LES ARBRES (TRONC ET BRANCHES) DOIVENT AVOIR UN DEGRÉ DE FINITION ARCHITECTURAL AESS 2, INCLUANT LES ASSEMBLAGES
- AVANT LA SOUMISSION DES DESSINS D'ATELIER, LE FABRICANT D'ACIER DEVRA FOURNIR UNE SÉRIE DE CROQUIS MONTRANT LES DÉTAILS D'ASSEMBLAGE DES ARBRES (TRONC ET BRANCHES) AVEC NOTES DE CALCULS COMPLETS. CES CROQUIS FERONT L'OBJET D'UN EXAMEN DE L'INGÉNIEUR EN STRUCTURE AINSI QUE DE L'ARCHITECTE QUI SE RÉSERVE LE DROIT D'EXIGER DES AJUSTEMENTS, NOTAMMENT POUR LES CONNEXIONS ARCHITECTURALE, DANS LE
BUT DE RESPECTER L'INTENTION VISUELLE.

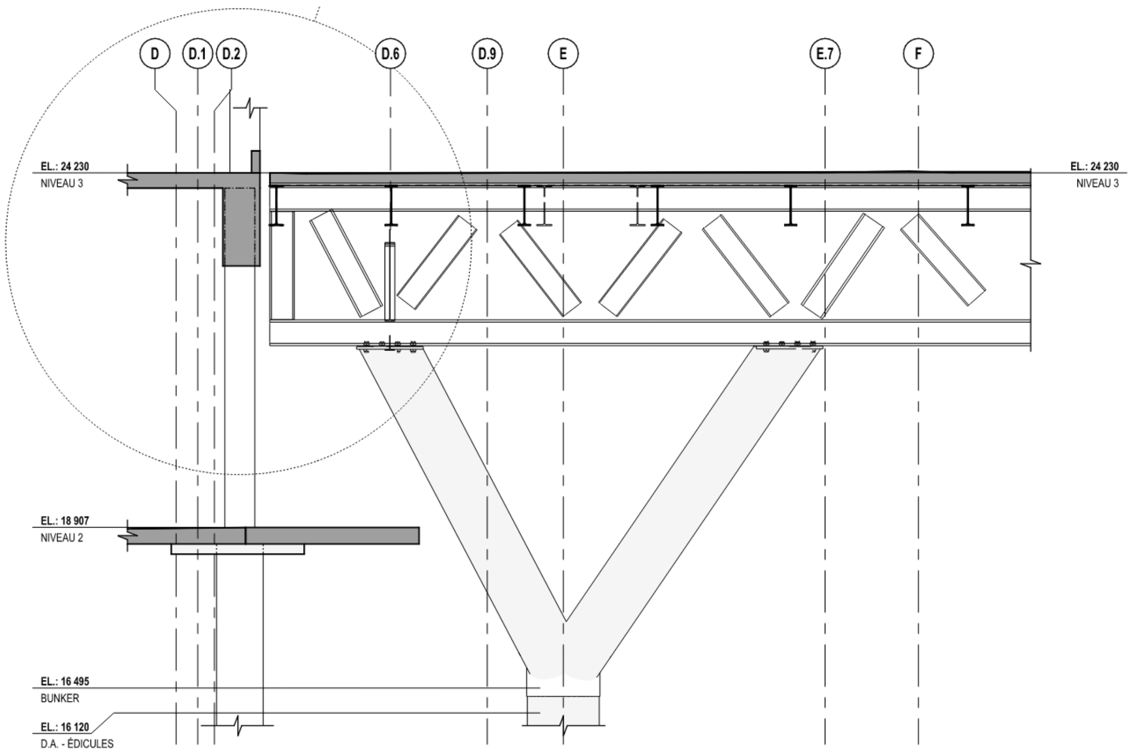
5 S-802 **CONNEXION TYPIQUE BRANCHE/POUTRE**

Éch.: 1 : 20

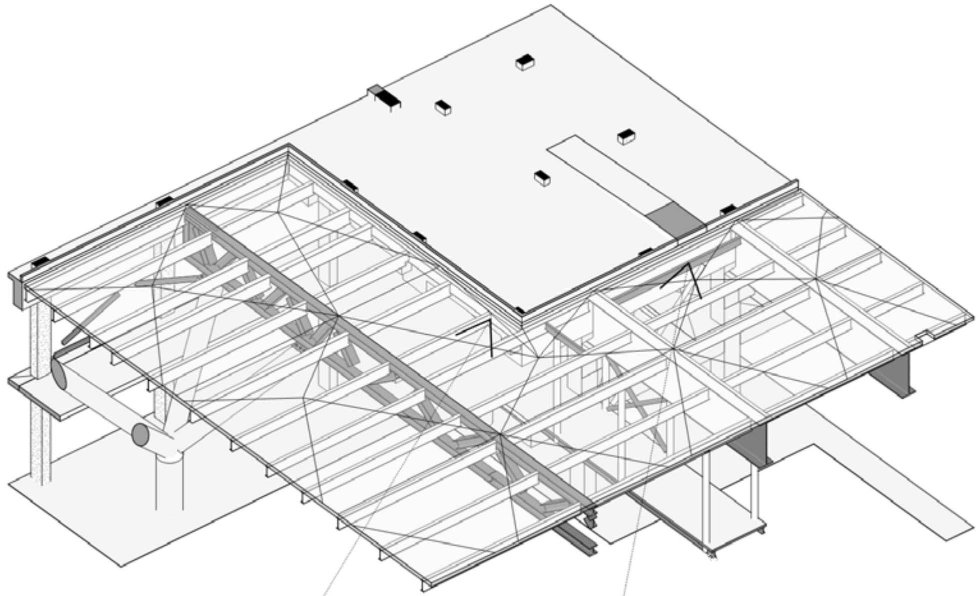


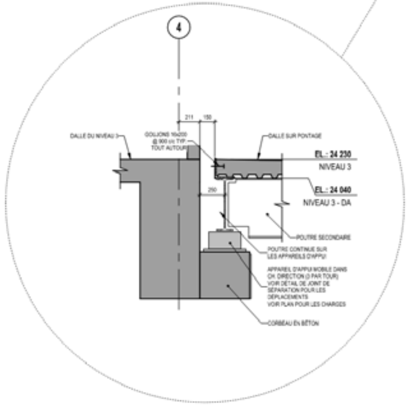
W1

DETAILED DESIGN

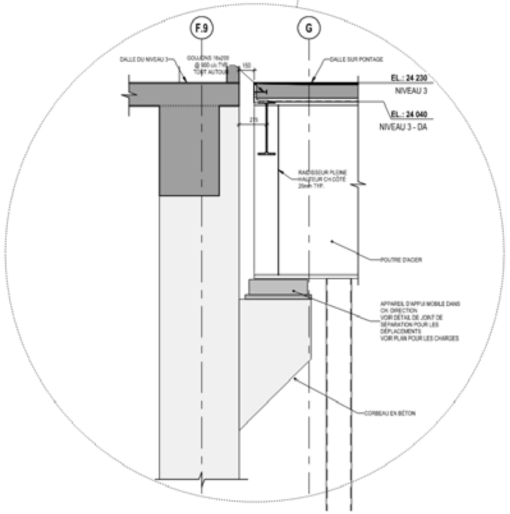


1 COUPE
Éch.: 1 : 50

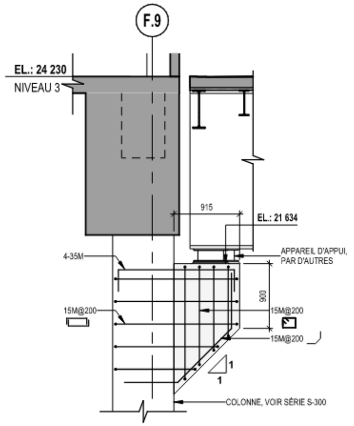




3 S-801 COUPE C
Éch.: 1 : 25



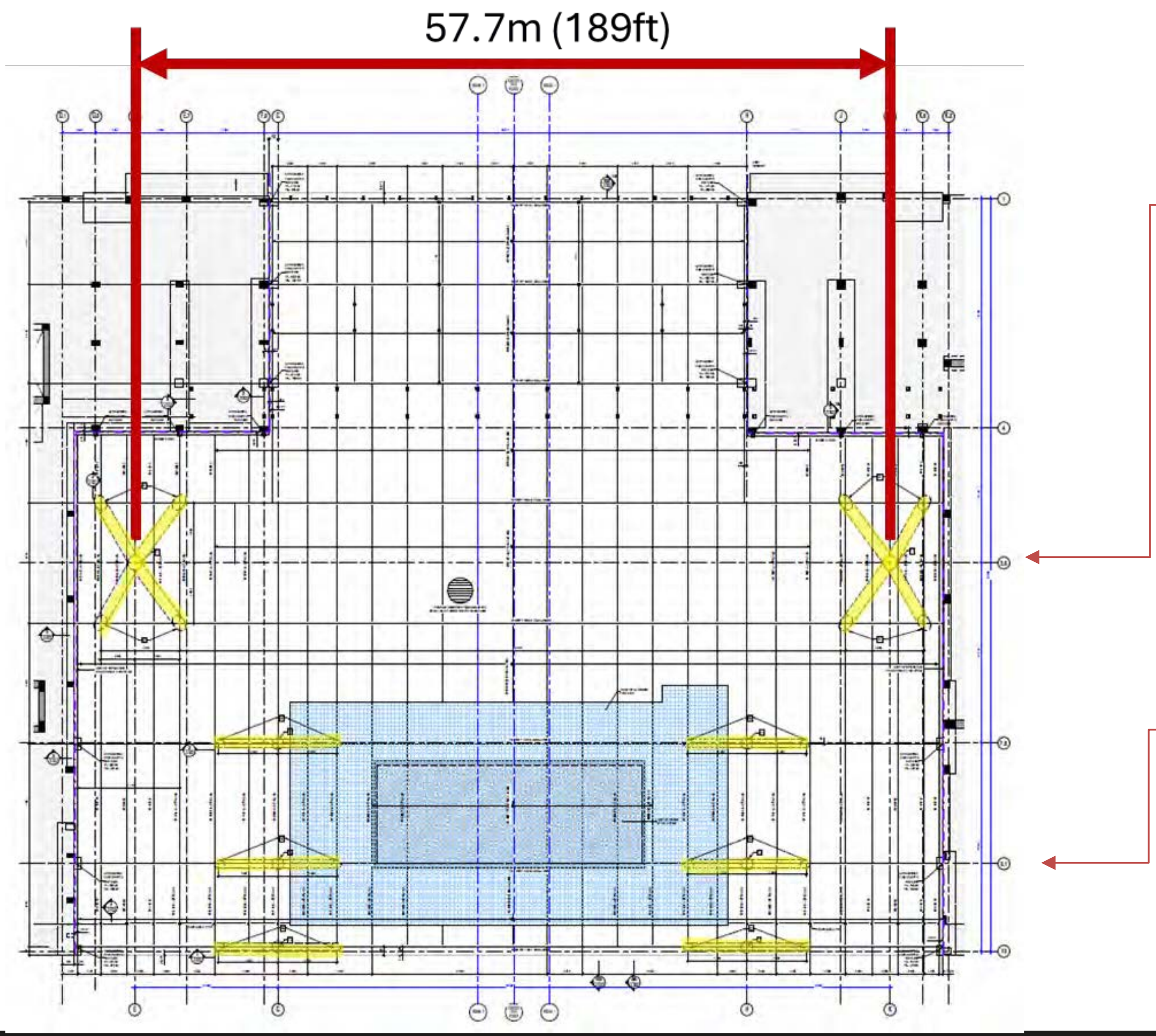
2 S-801 COUPE B
Éch.: 1 : 25



AB S-103 COUPE
Éch.: 1 : 50

ELEMA & CAST CONNEX COLLABORATION

CONTRACT DOCUMENTS

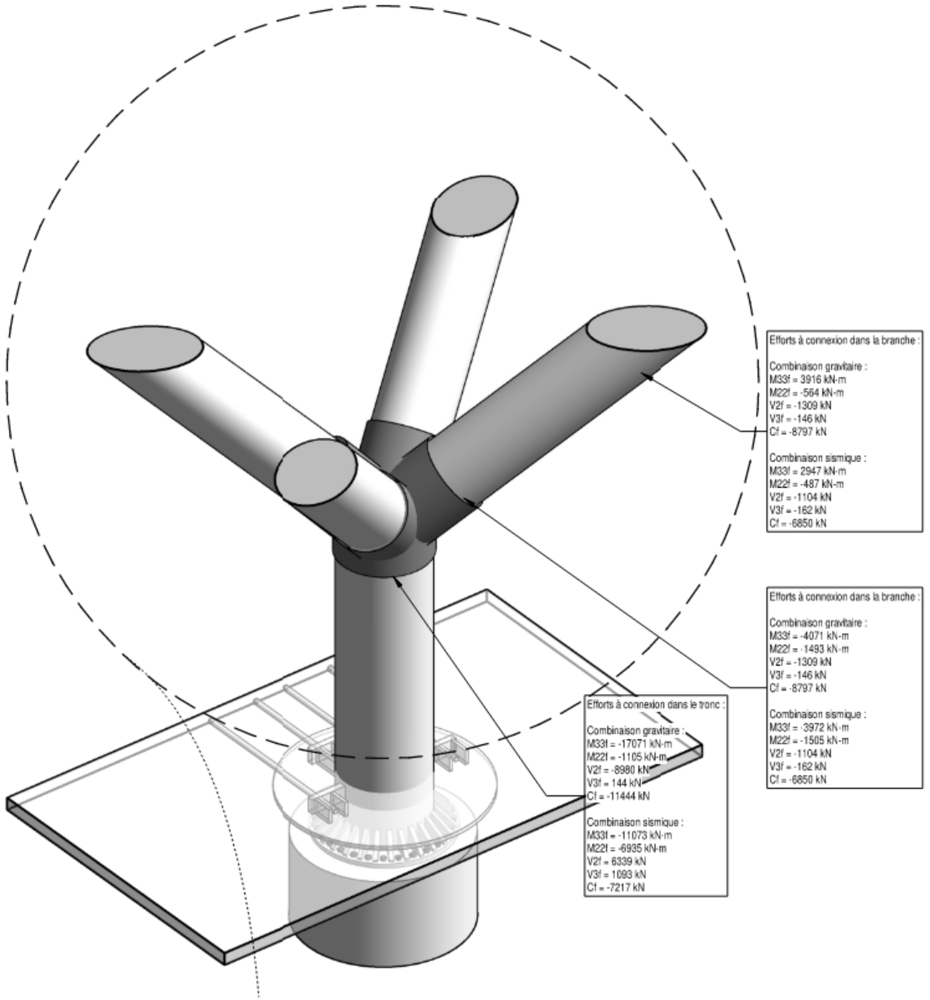


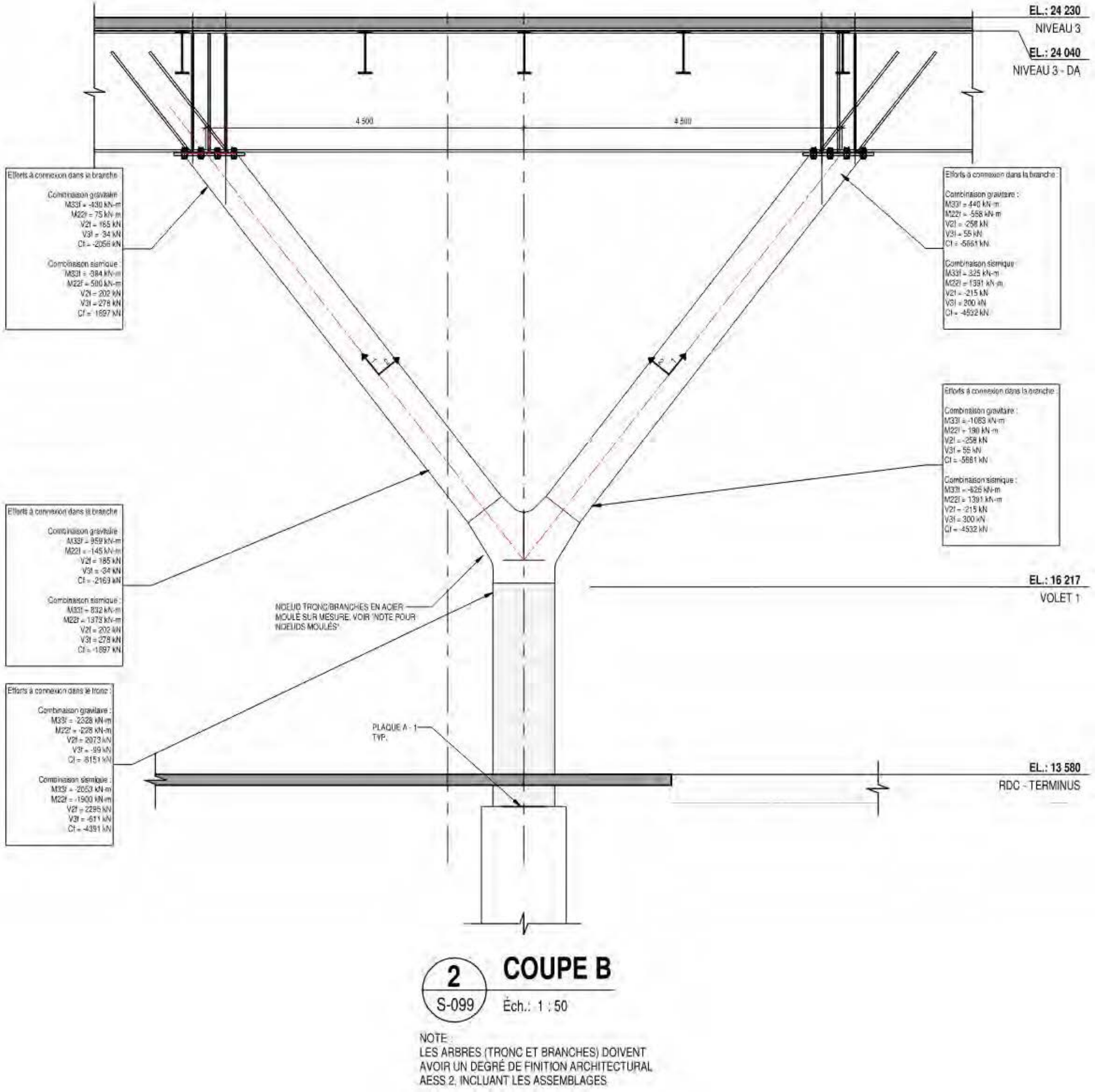
2 x Tree Nodes*	OD x t (mm)
Trunk	1050 x 48
Branch (4)	850 x 32

6 x Y-Nodes*	OD x t (mm)
Trunk	875x 28
Branch (2)	600 x 25

* Concrete-filled, f'c = 40 MPa

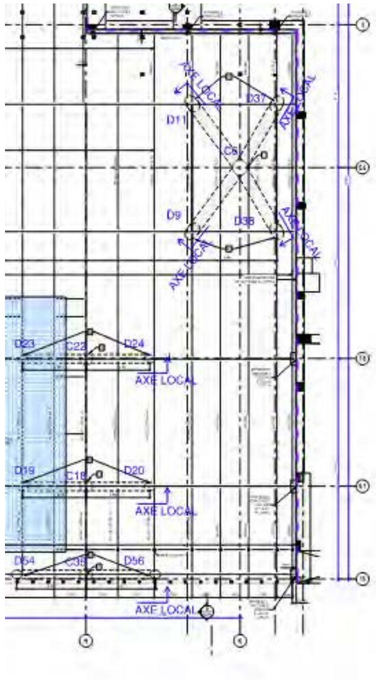
CONTRACT DOCUMENTS

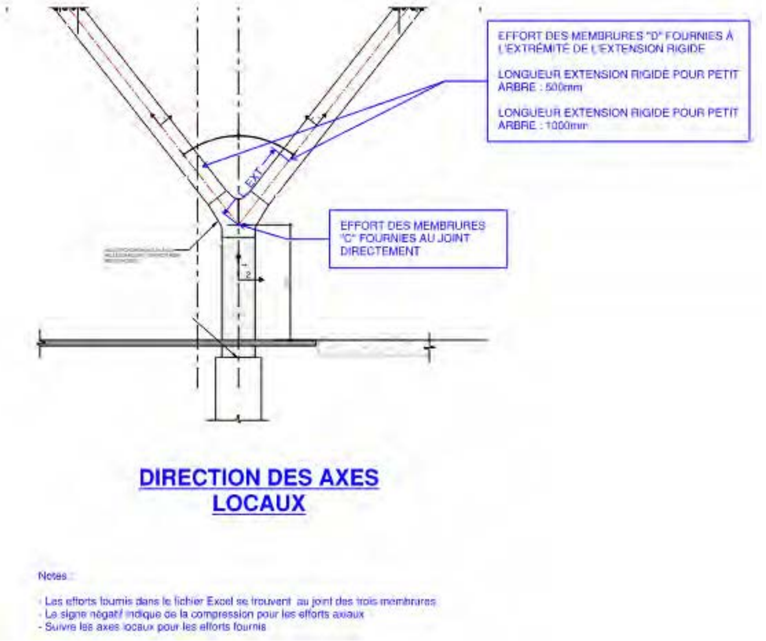




EQUILIBRATED FORCES

Colonne	Cas de chargement	Modèle	Step Typ	P kN	V2 kN	V3 kN	T kN-m	M2 kN-m	M3 kN-m
C13	1.25D+1.25SD+1.5L	1		-6178	-724	-63	-91	-10	2718
C18	1.25D+1.25SD+1.5L	1		-6181	703	-55	99	2	-2747
C21	1.25D+1.25SD+1.5L	1		-6549	-803	-19	7	-123	3017
C22	1.25D+1.25SD+1.5L	1		-6572	770	-14	5	-111	-3025
C35	1.25D+1.25SD+1.5L	1		-2207	358	-50	92	-2	-1325
C5	1.25D+1.25SD+1.5L	1		-10094	-7511	115	-29	-1361	15168
C6	1.25D+1.25SD+1.5L	1		-10144	7557	125	69	-1180	-15246
C7	1.25D+1.25SD+1.5L	1		-2208	-349	-57	-85	-17	1267
C13	1.25D+1.25SD+1.5L	2		-6109	-910	-70	-91	-42	2750
C18	1.25D+1.25SD+1.5L	2		-6113	881	-59	102	-23	-2807
C21	1.25D+1.25SD+1.5L	2		-6466	-1010	-20	11	-136	3051
C22	1.25D+1.25SD+1.5L	2		-6492	961	-13	4	-118	-3084
C35	1.25D+1.25SD+1.5L	2		-2183	422	-53	96	-25	-1255
C5	1.25D+1.25SD+1.5L	2		-10093	-7507	124	-25	-1296	15169
C6	1.25D+1.25SD+1.5L	2		-10146	7569	136	72	-1102	-15216
C7	1.25D+1.25SD+1.5L	2		-2187	-405	-61	-86	-46	1178
C13	1.25D+1.25SD+1.5L	3		-6178	-724	-63	-90	-10	2717
C18	1.25D+1.25SD+1.5L	3		-6181	704	-55	99	2	-2748
C21	1.25D+1.25SD+1.5L	3		-6548	-803	-19	7	-123	3016
C22	1.25D+1.25SD+1.5L	3		-6572	770	-14	5	-111	-3026
C35	1.25D+1.25SD+1.5L	3		-2207	359	-51	92	-2	-1325
C5	1.25D+1.25SD+1.5L	3		-10095	-7331	116	-29	-1353	15606
C6	1.25D+1.25SD+1.5L	3		-10143	7375	124	69	-1181	-15651
C7	1.25D+1.25SD+1.5L	3		-2209	-349	-57	-85	-17	1266
C13	1.25D+1.25SD+1.5L	4		-6109	-909	-70	-91	-42	2747
C18	1.25D+1.25SD+1.5L	4		-6112	882	-60	102	-24	-2810
C21	1.25D+1.25SD+1.5L	4		-6466	-1008	-20	11	-135	3046
C22	1.25D+1.25SD+1.5L	4		-6491	964	-14	3	-119	-3089
C35	1.25D+1.25SD+1.5L	4		-2184	423	-54	95	-26	-1255
C5	1.25D+1.25SD+1.5L	4		-10094	-7331	126	-28	-1279	15631
C6	1.25D+1.25SD+1.5L	4		-10145	7385	134	69	-1111	-15677





20-0332 - PCL2

2022-05-24
Olivier B.
Félix B.

Exemple de l'équilibre des nœuds

Exemple 1 :

Data 1.25D+1.25SD+1.5L Modèle 2

		P1	V2	V3	T1	M2	M3
D54	B1	-1891	-64	-36	150	-81	-465
D56	B2	-980	138	17	-37	77	685
C35	C	2183	-422	53	-96	25	1255

SFX

P1	V2	V3	T1	M2	M3
1201,6	-49,4	0,0	0,0	0,0	0,0
-622,7	-106,6	0,0	0,0	0,0	0,0
0,0	-422,0	0,0	0,0	0,0	0,0

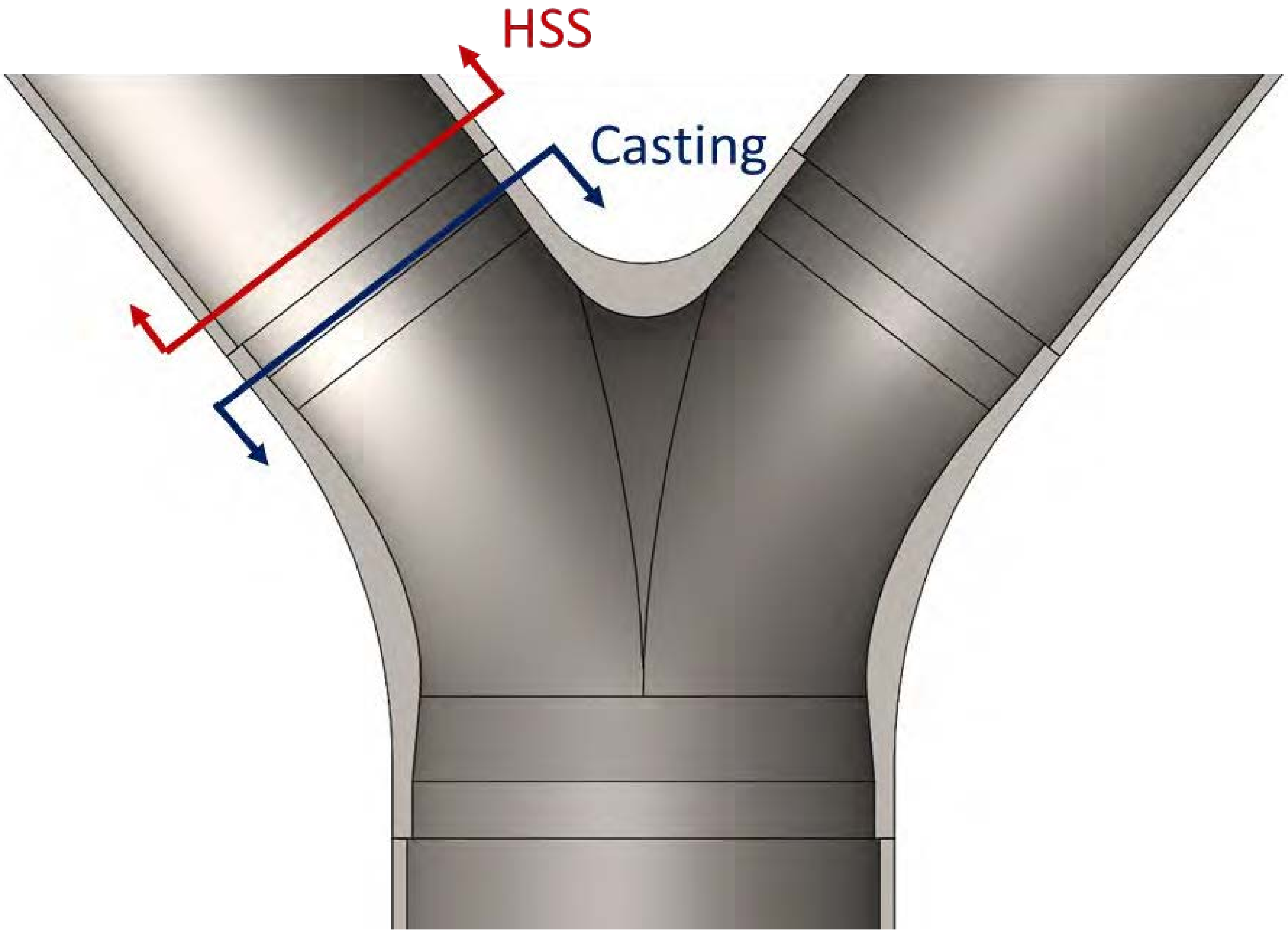
	Résidu	Pourcentage
SFX	0,9	0%
SFY	13,1	1%
SFZ	0,0	0%
SMX	1,4	6%
SMY	0,2	0%
SMZ	-4,0	0%

Résidu	0,9
Pourcentage	0%

DESIGN OF CAST STEEL NODES

Preliminary sectional analysis:

- Does the incoming HSS member rely on the concrete inside to resist the load? **YES**
- Can the custom casting be designed to carry the loads alone without considering concrete? **YES**
- How can we develop an analysis model to find a possible load path that allows loads carried by the concrete filled HSS to be transferred into the casting?



DESIGN OF CAST STEEL NODES

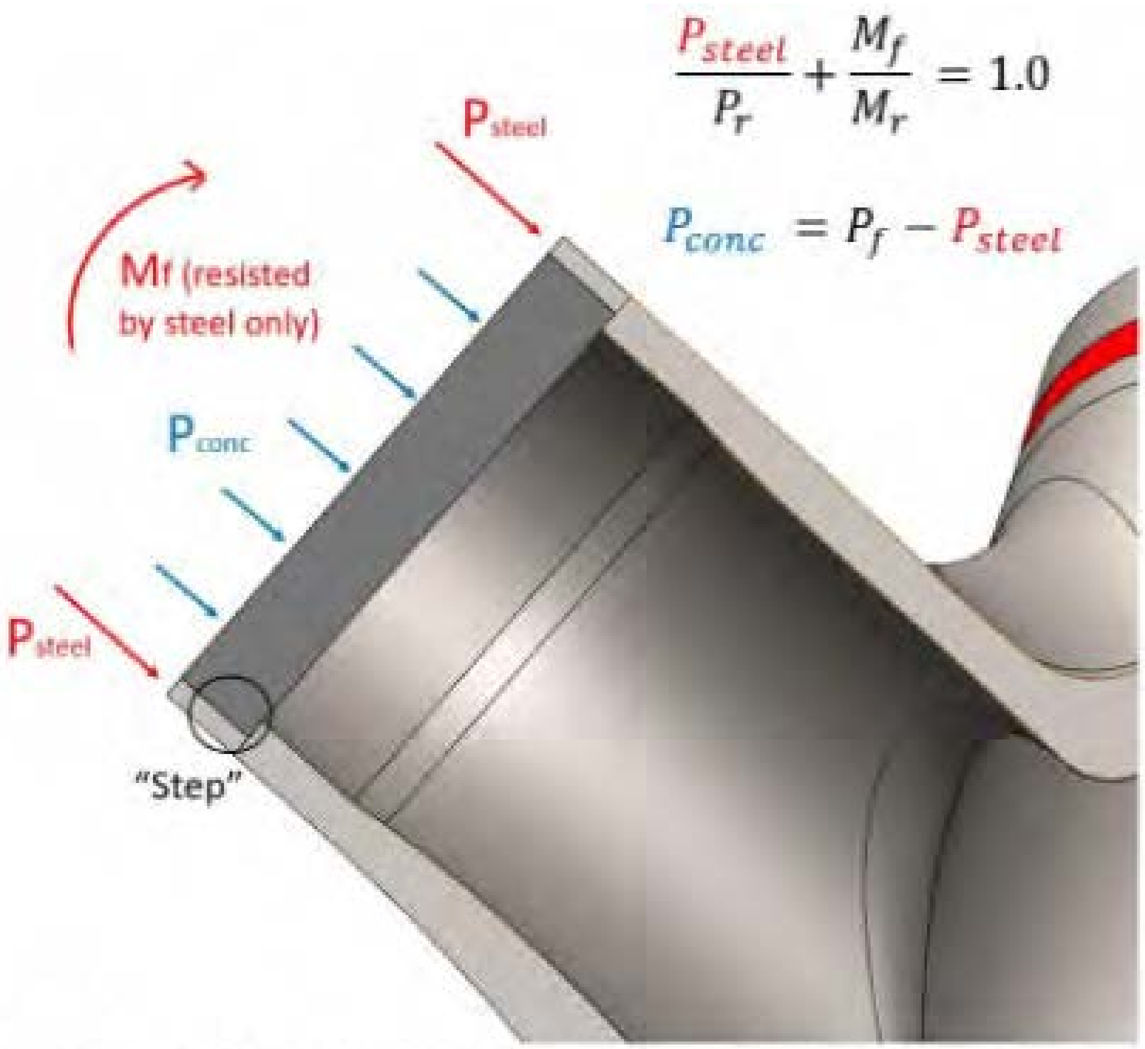


Figure 9. Established load path from concrete filled HSS to casting body

Assume:

- The HSS member takes the full applied bending with additional axial loads until its utilization factor reaches 1.0.
- The remaining axial load will be carried by the concrete and transfer to the casting through the internal "step" without crushing the concrete.

DESIGN OF CAST STEEL NODES

CASTCONNEX					
Project: Edyfic Place Charles-Lemoyne				Project No. P21-111	No. 11 of 19
Design: FW	Drawn: FW	Checked: MGG	Date: July 06, 2022	W.P. No.	Scale N.T.S.
Subject: Cast Steel Nodes for Edyfic Place Charles-Lemoyne – Engineering Report				Reference:	

Table 2: Geometry properties and factored resistance of attached HSS members

Node Type	Member	Diameter (mm)	Design Thickness (mm)	**Pr** = ϕAFy (kN)	**Mr** = ϕMp (kN*m)
EPCL-01 (Tree-Node)	B1 (branch)	850.9	31.75	25369	6618
	T1 (column)	1079.5	50.8	50975	16705
EPCL-02 (Y-Node)	B2 (branch)	596.9	25.4	14159	2577
	T2 (column)	876.3	25.4	21082	5711

4.2.1 Example Calculation of Utilization Factor

To demonstrate the calculation of utilization factors, Table 3 lists one set of loading information at the interface between column member C5 and node EPCL-01. Evaluating this set of loads against the factored resistance of member "T1" included in Table 2, it is demonstrated that member "T1" will not be over-utilized in this particular case.

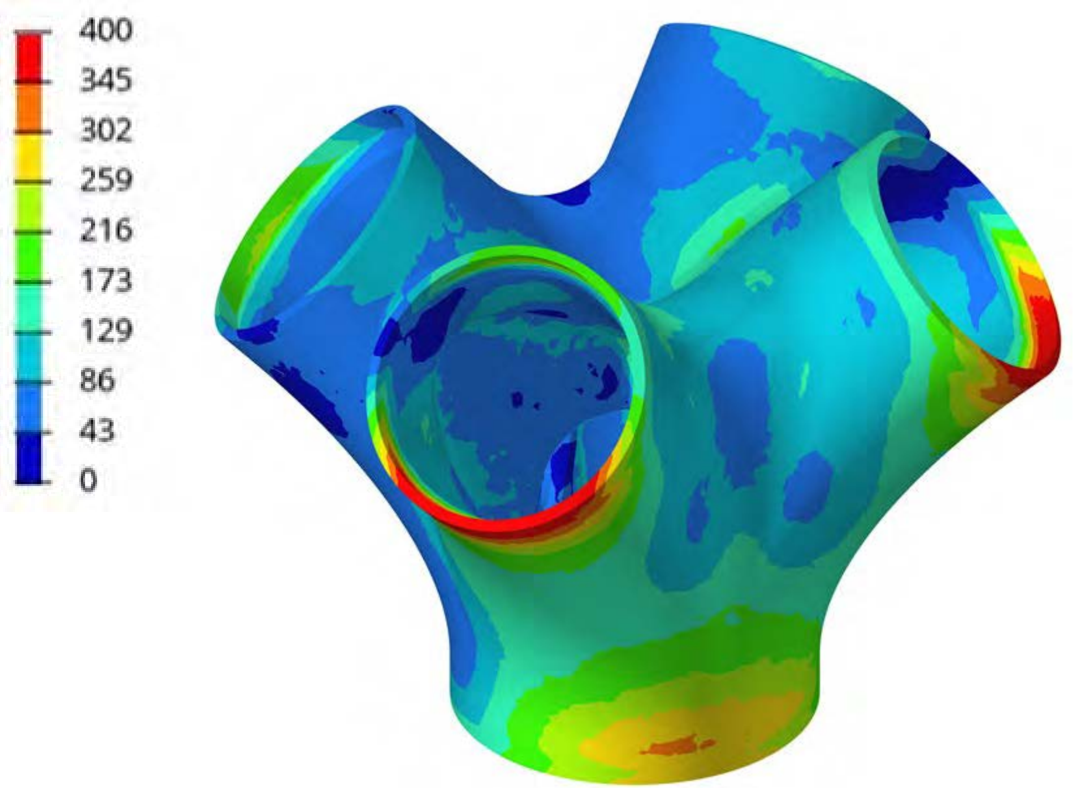
Table 3: Processed loading information at the interface between member C5 and EPCL-01

Member	Load Combination	Mode	**P (kN)**	F2 (kN)	F3 (kN)	T (kN*m)	**M2 (kN*m)**	**M3 (kN*m)**
C5	1.25D+1.25SD+1.5S	1	**9919**	6937	-38	-40	**-449.4**	**-9151.1**

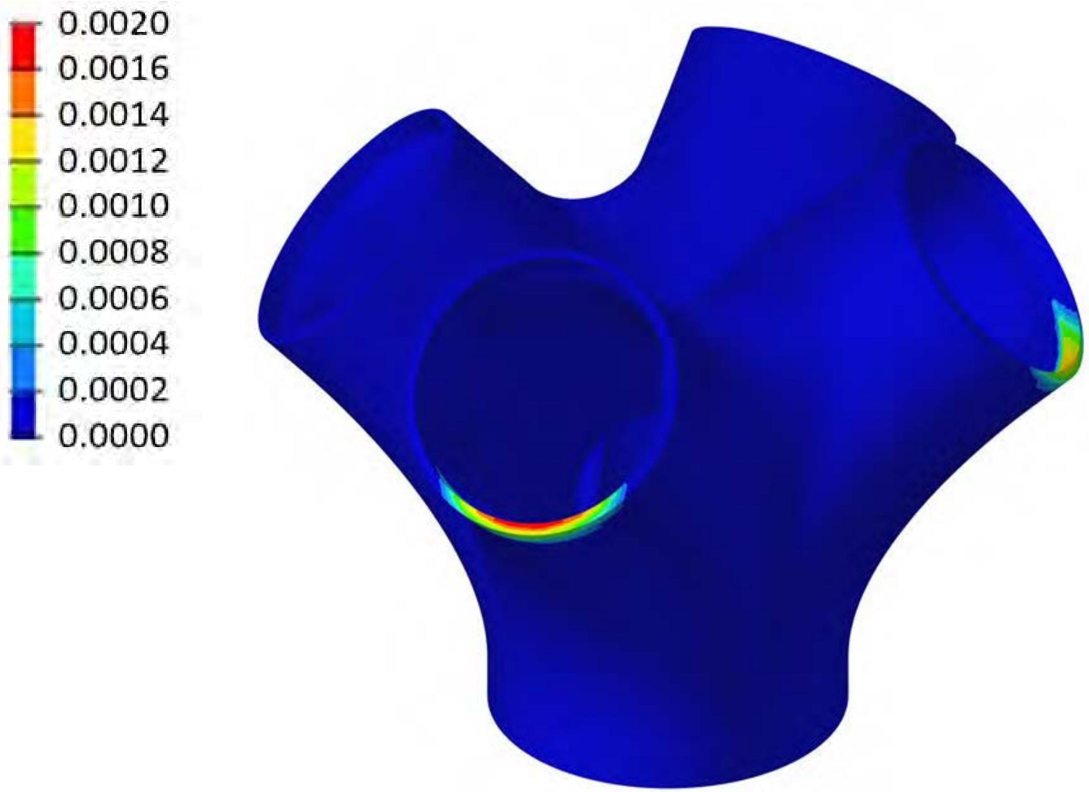
$$Utilization\ Factor = \frac{P_f}{P_r} + \frac{M_f}{M_r} = \frac{9919}{50975} + \frac{\sqrt{449.4^2 + 9151.1^2}}{16705} = 0.743 \leq \mathbf{1.0}$$

DESIGN OF CAST STEEL NODES : TREE NODES

Von Mises stress contours (MPa)
Max value = 350MPa



Plastic strain contours (mm/mm)
Max value = 0.0024



DESIGN OF CAST STEEL NODES : Y-NODES

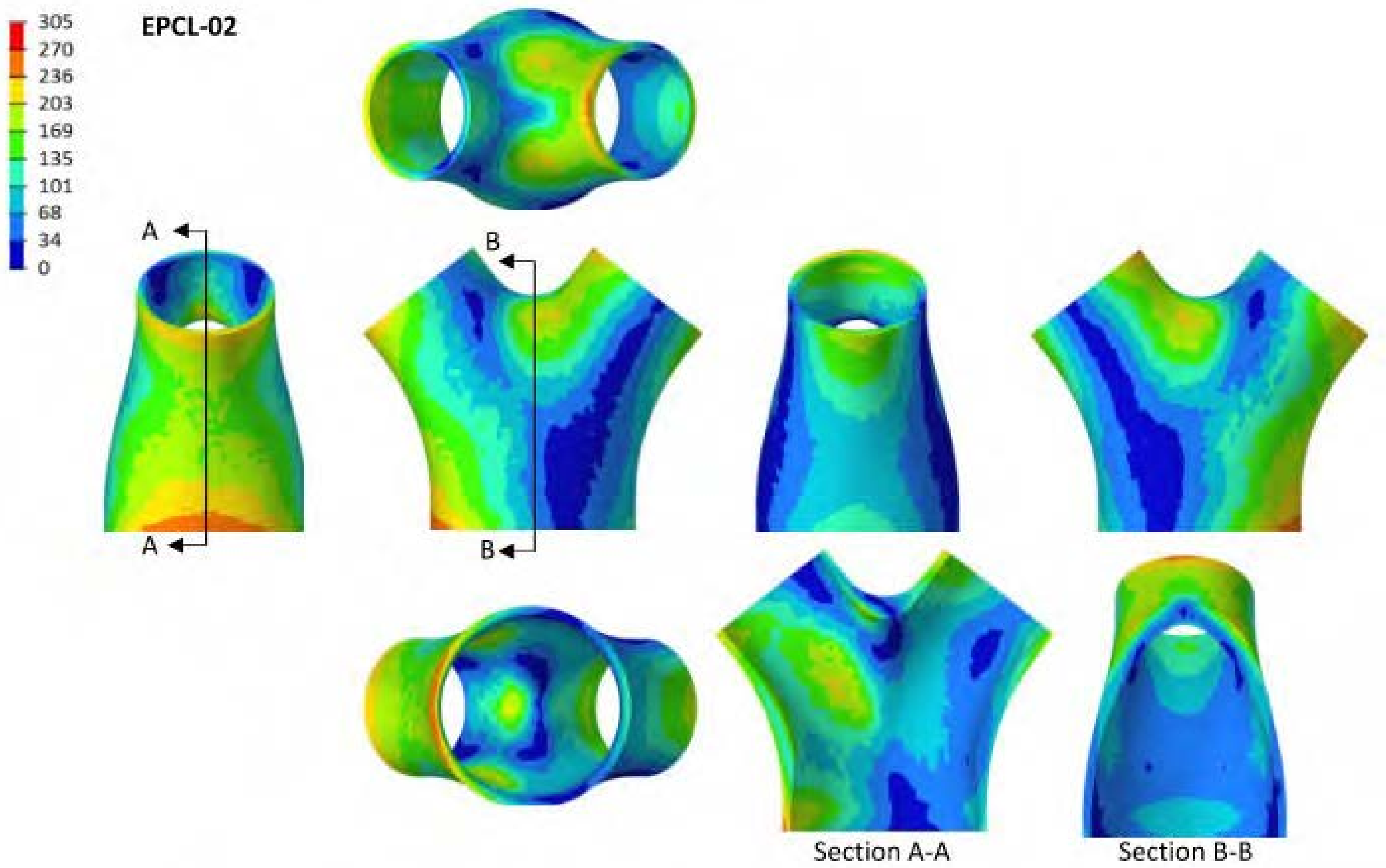
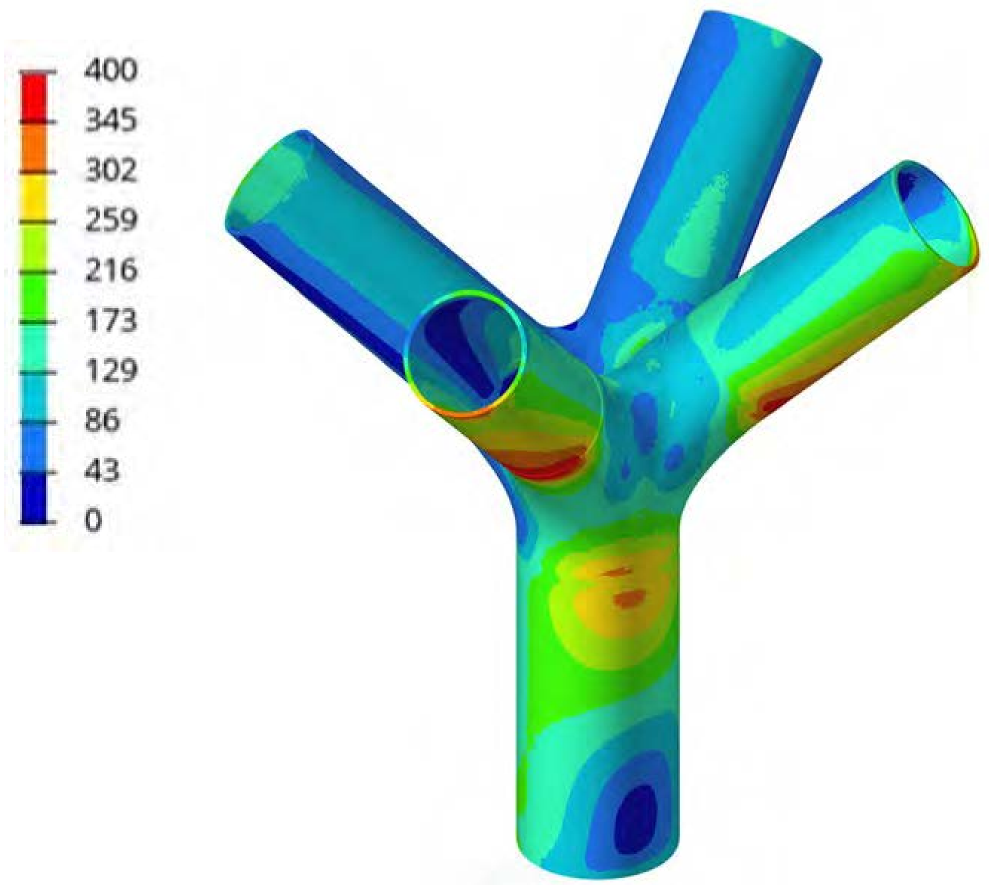


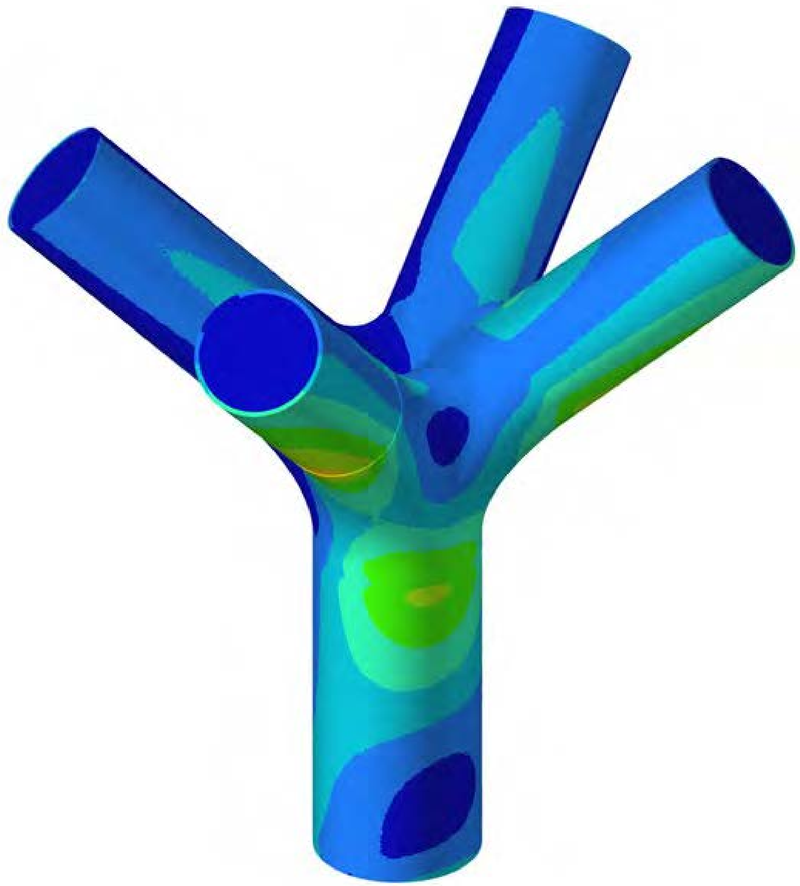
Figure 14. von Mises stress distribution of the EPCL-02 node (1.25D+1.25SD+1.5L) [MPa]

UPPER & LOWER BOUND REVIEW

Simplified Concrete Bearing
Von Mises stress contours (MPa)



Elastic "Concrete" Filling
Von Mises stress contours (MPa)



CASTING SHOP DRAWINGS

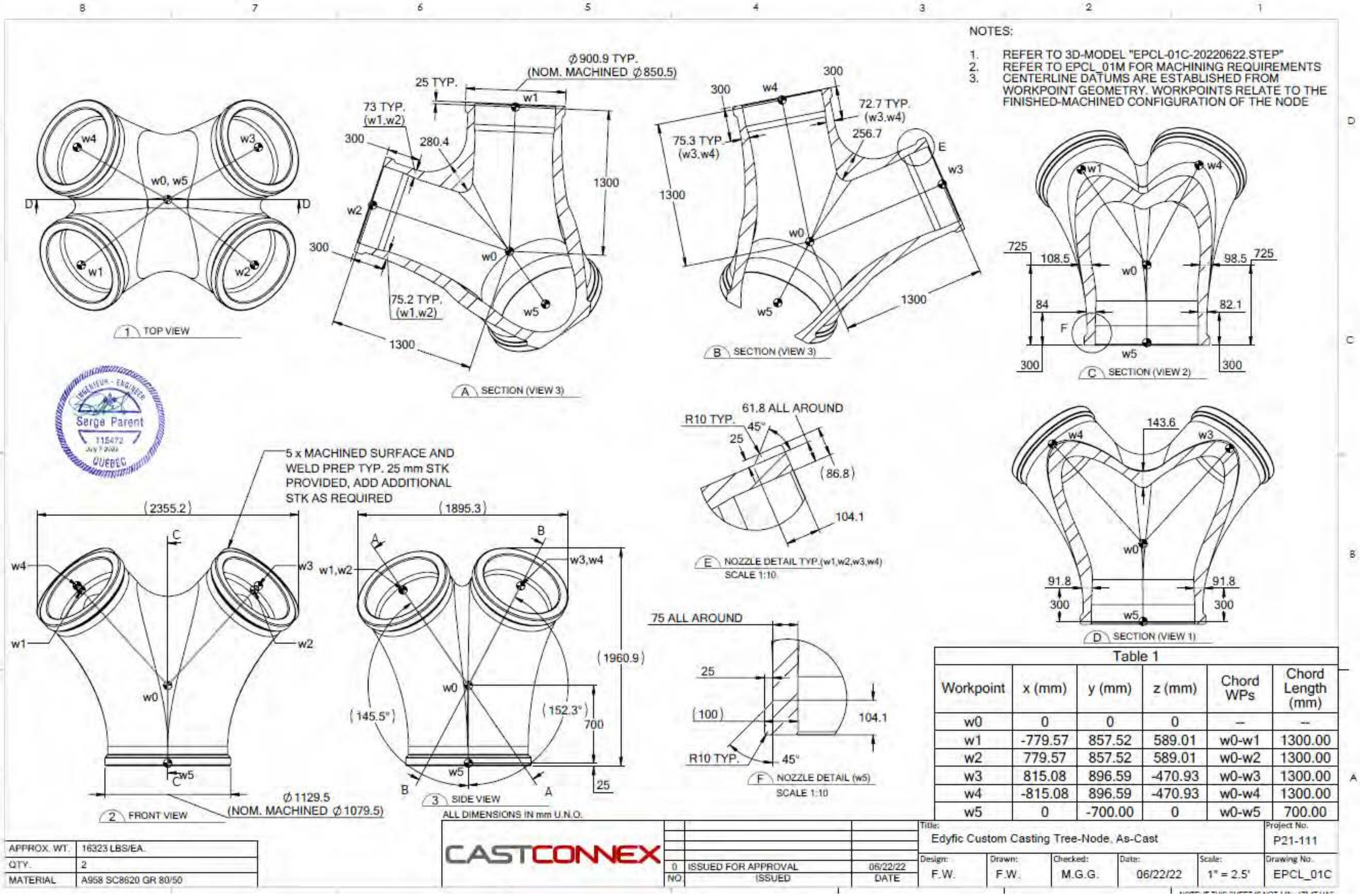
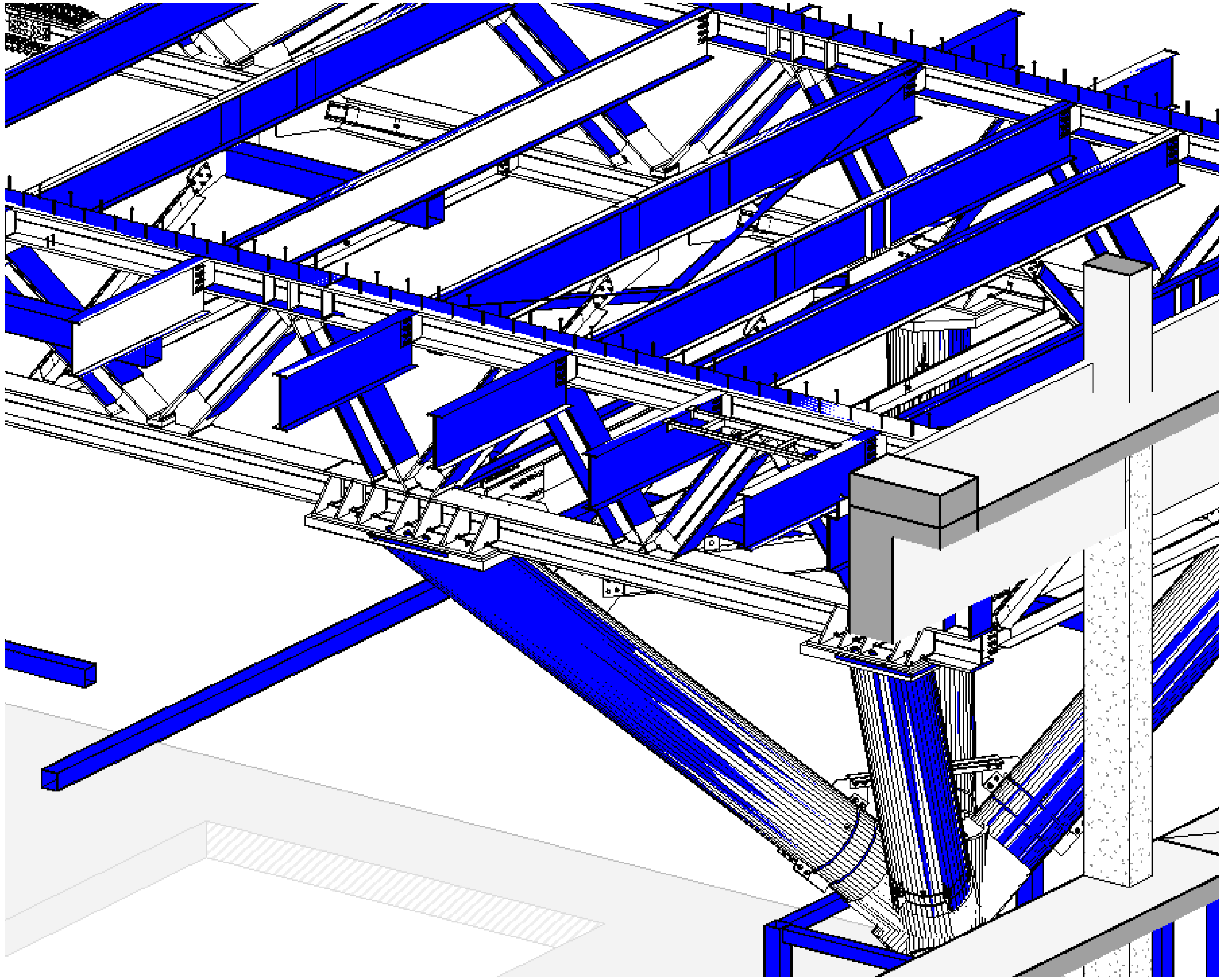
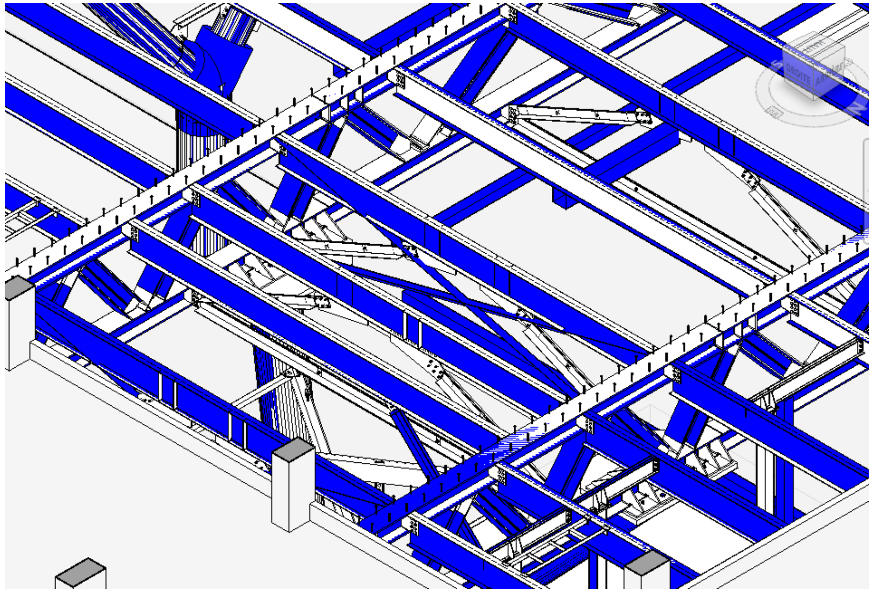


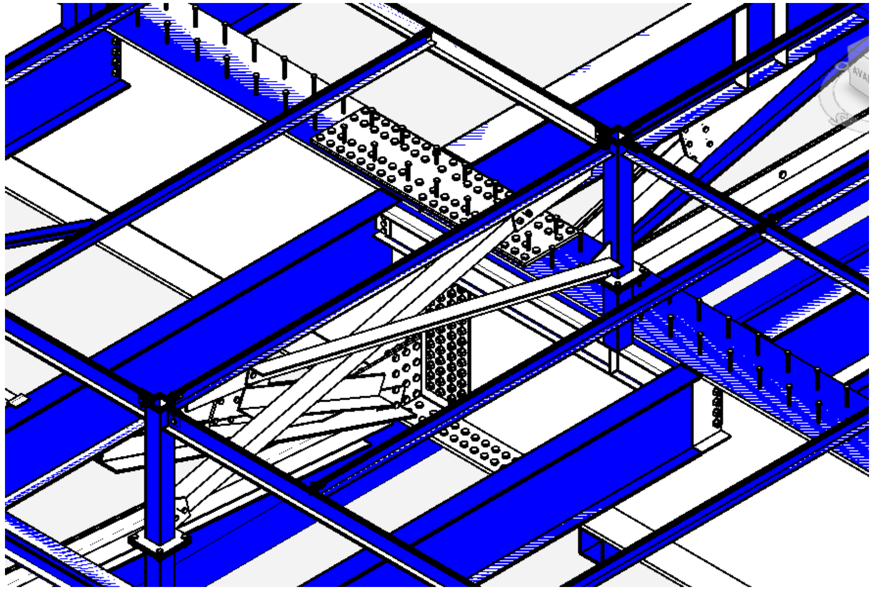
Table 1

Workpoint	x (mm)	y (mm)	z (mm)	Chord WPs	Chord Length (mm)
w0	0	0	0	–	–
w1	-779.57	857.52	589.01	w0-w1	1300.00
w2	779.57	857.52	589.01	w0-w2	1300.00
w3	815.08	896.59	-470.93	w0-w3	1300.00
w4	-815.08	896.59	-470.93	w0-w4	1300.00
w5	0	-700.00	0	w0-w5	700.00

3D MODEL COORDINATION







MANUFACTURING & FABRICATION

CASTING PRODUCTION SPECIFICATION DEVELOPMENT

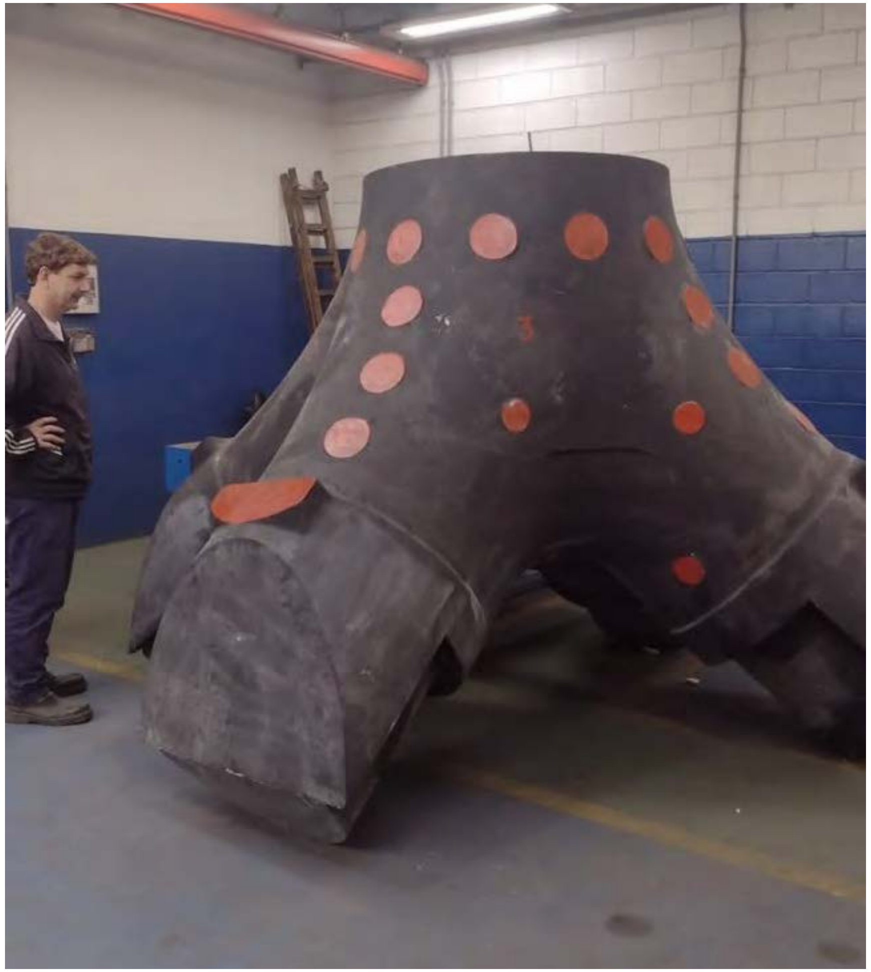
1) Stipulate production means and methods to the foundry
   Ex. Feeding, gating, riser locations, etc.

2) Select material grade for strength, toughness, weldability and ductility
   Ex. ASTM A958 Gr80/50

3) Set non-destructive examination methods and acceptance criteria
   Including Ultrasonic (UT), Magnetic Particle (MT), Radiograhic (RT) & Visual

4) Establish as-cast and machining dimensional requirements and tolerances
   Shop drawings: as-cast drawing & machining print

CASTING MANUFACTURING : PATTERN PRODUCTION



Photos credits: Cast Connex

CASTING MANUFACTURING : POUR, SHAKEOUT & FETTLING

Photos credits: Cast Connex

CASTING MANUFACTURING : MACHINING

NON-DESTRUCTIVE EXAMINATION

Procedures include:

- Radiography Testing (RT)
- Ultrasonic Testing (UT)
- Magnetic Particle Inspection (MPI)
- Visual Examination

Predefined Acceptance Criteria (ASTM Standards)

- Based on predefined "levels"
  - Correlates to allowable indication size and distribution
    - Correlates to the structural efficacy of the casting

Areas that exceed acceptance criteria:

- Weld repaired
- Re-examined to confirm conformance to specification prior to final heat treat

Photos credits: Cast Connex

COMPLETED CASTINGS

6 x Y-Nodes	OD x t (mm)
Trunk	875x 28
Branch (2)	600 x 25

2 x Tree Nodes	OD x t (mm)
Trunk	1050 x 48
Branch (4)	850 x 32

Photos credits: Cast Connex

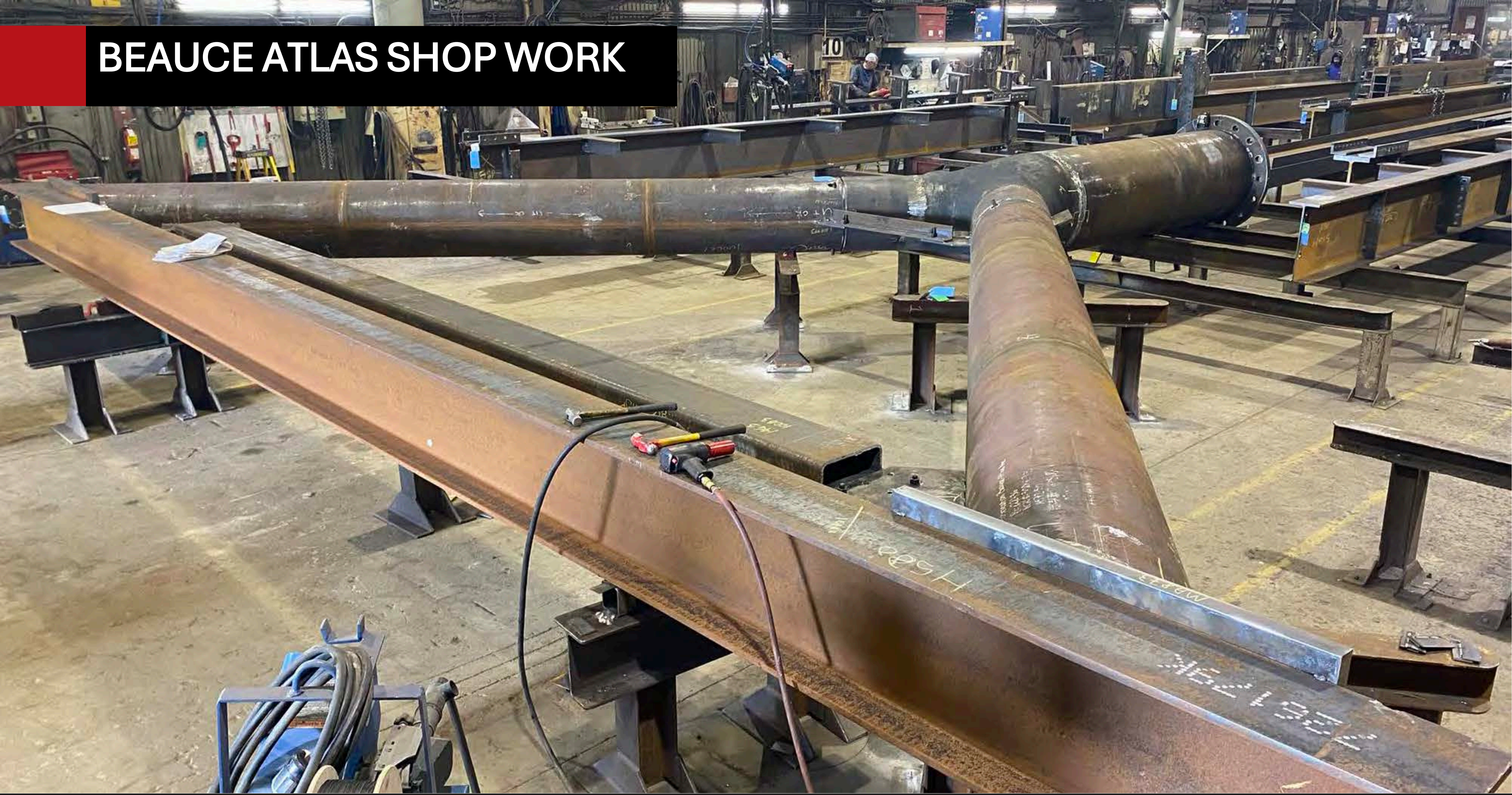
DELIVERING CASTINGS TO BEAUCE ATLAS

Photos credits: Beauce Atlas

BEAUCE ATLAST SHOP WORK

Photos credits: Beauce Atlas

BEAUCE ATLAS SHOP WORK



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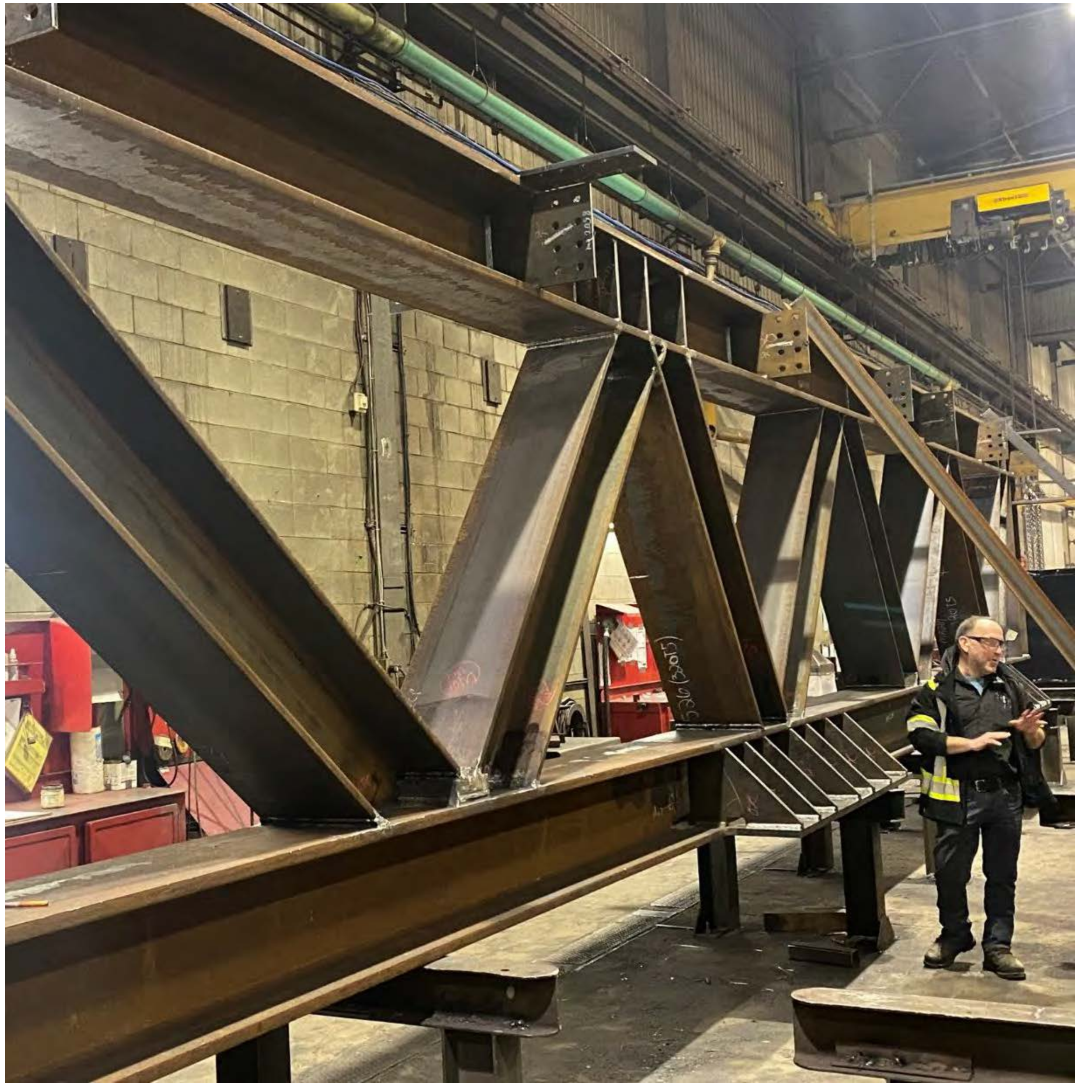
BEAUCE ATLAS SHOP WORK

Photo credits: Beauce Atlas

BEAUCE ATLAS SHOP WORK



FABRICATION YARD

DELIVERY & SITE ERECTION

TO SITE

Photo credits: Beauce Atlas

TO SITE

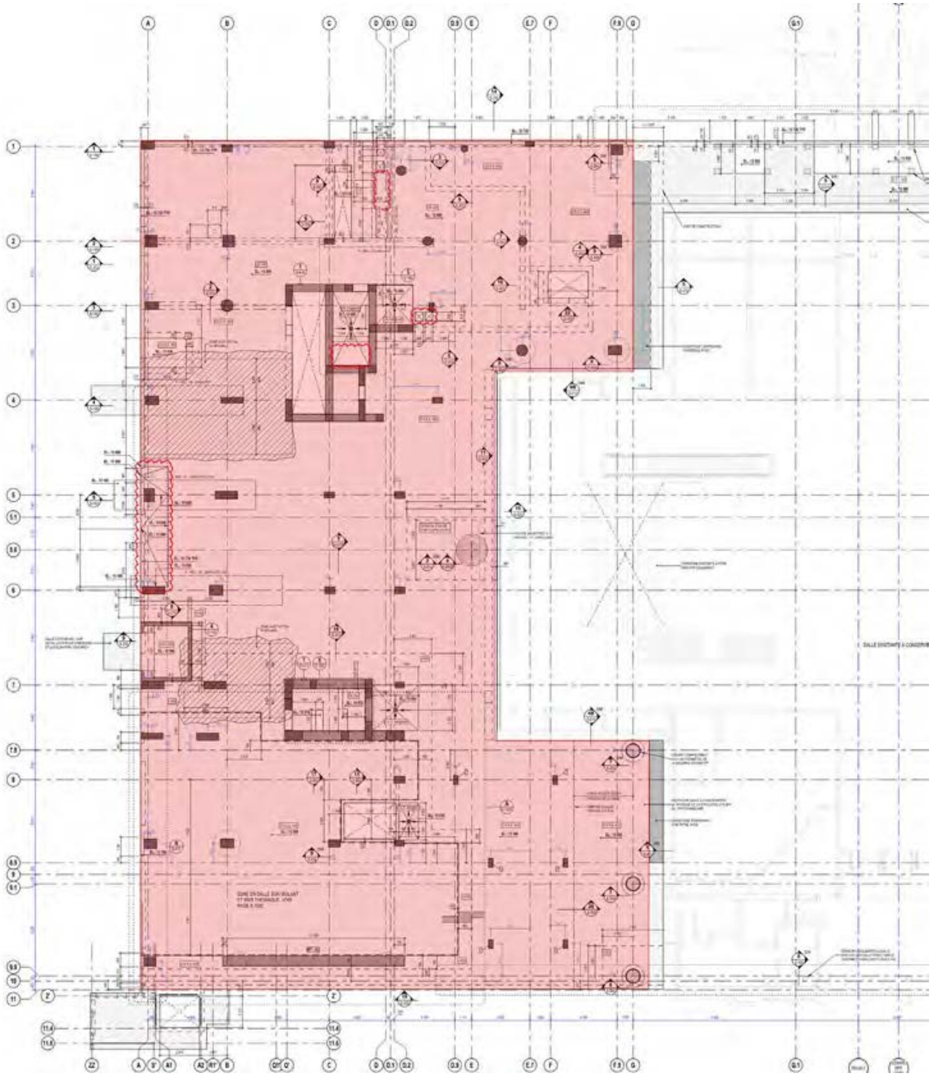

D'Assigny
LE CENTRE DE LONGUEUIL
SE CONSTRUIT
BELLEMARE
BELLEMARE
L858883

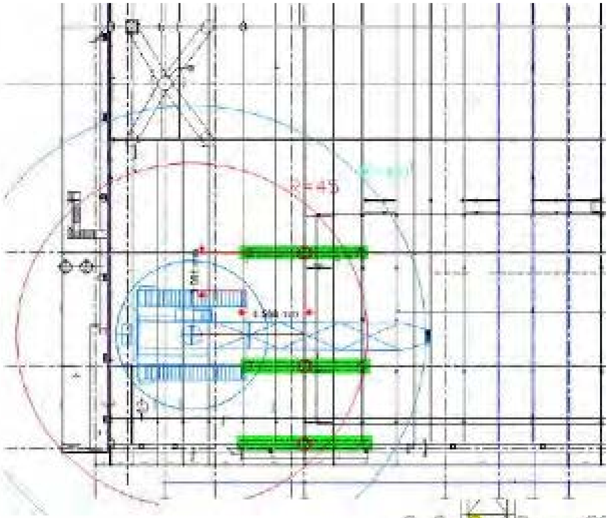

Rue
D'Assigny
Charles-Le Moyne

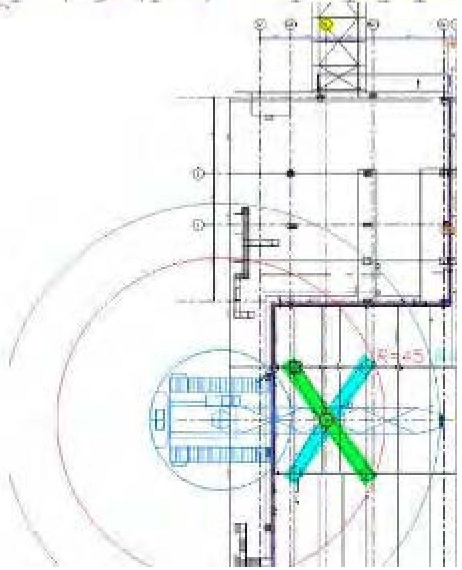
ON SITE

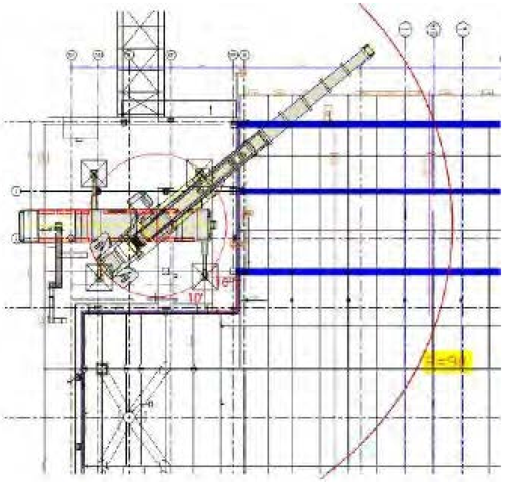
CRANE WORK

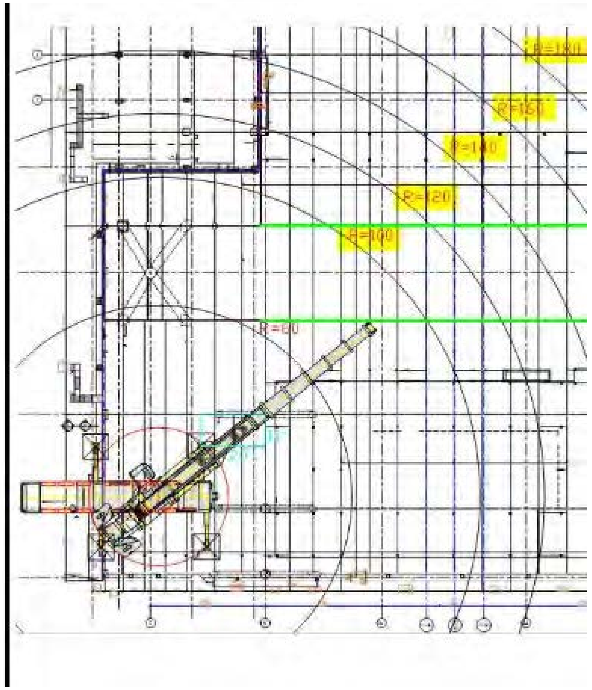
650T mobile crane + 250T Crawler



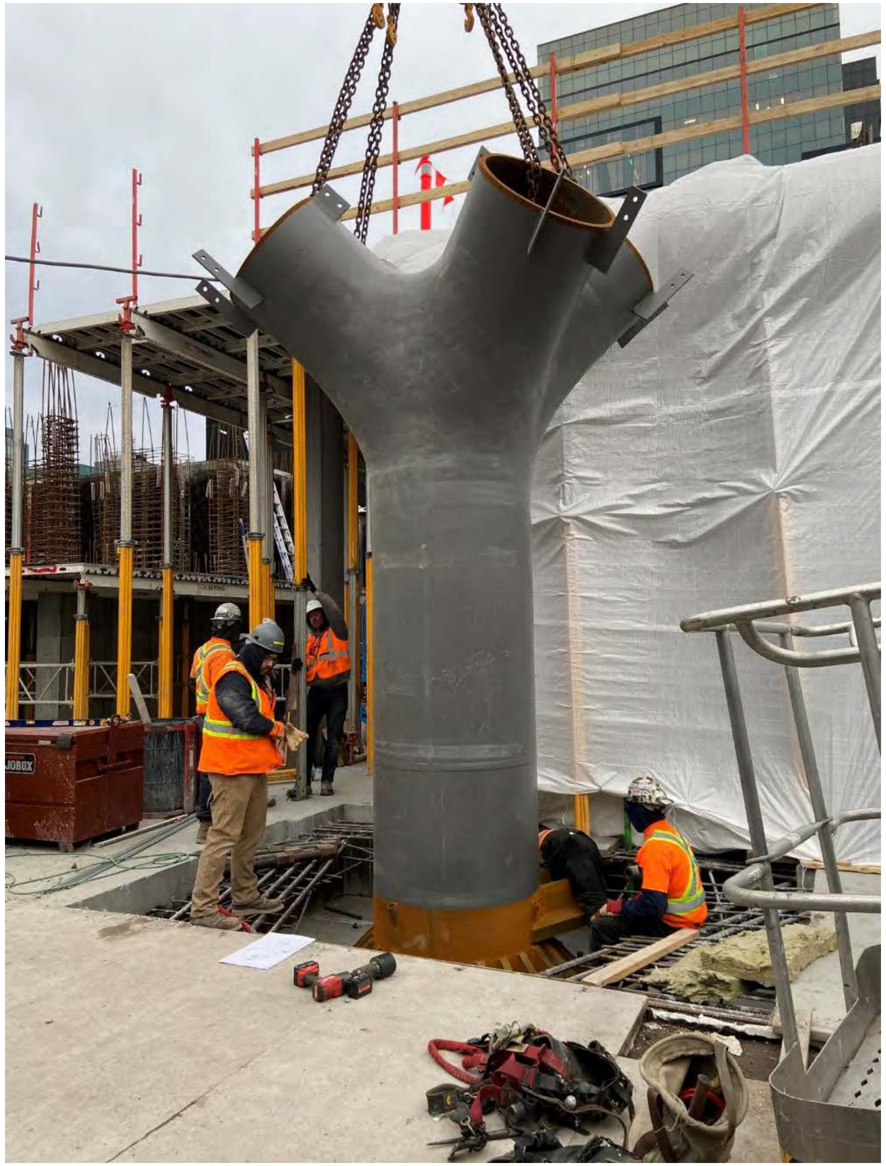








SITE WORK



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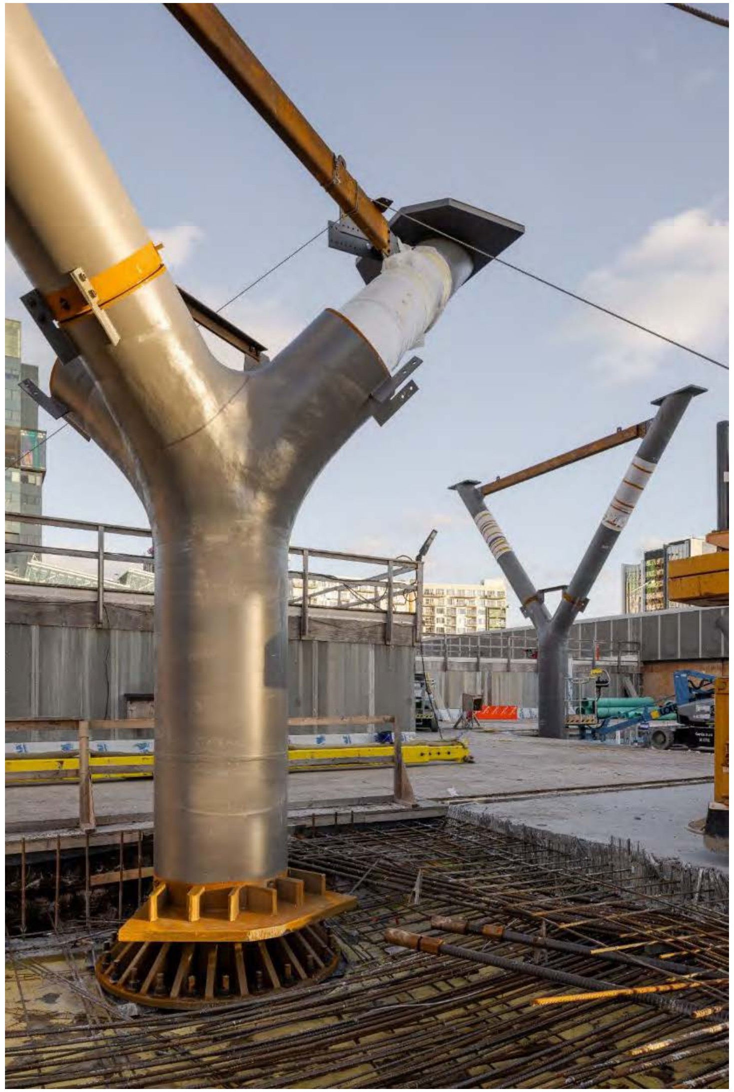
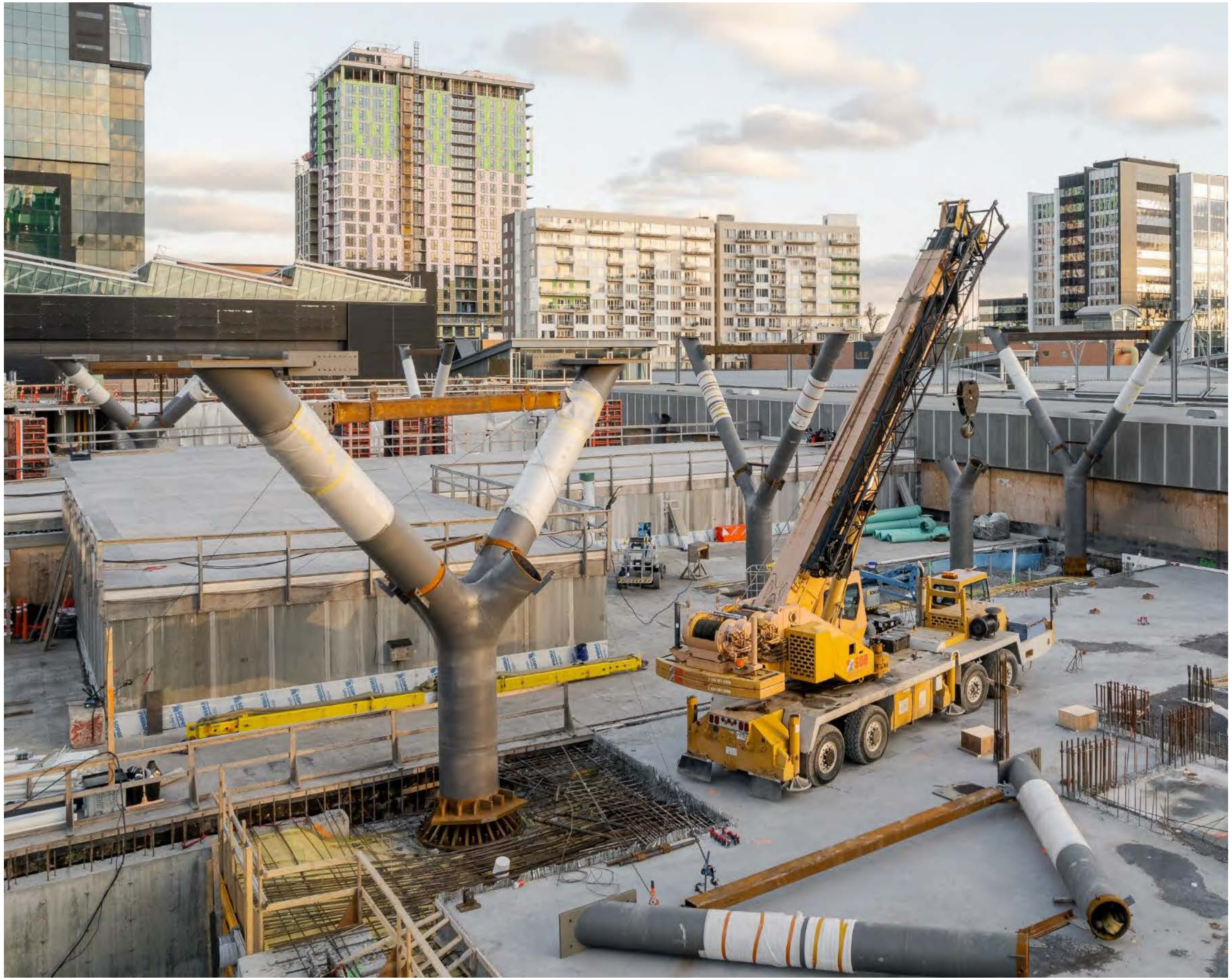
SITE WORK





ELEMA CASTCONNEX

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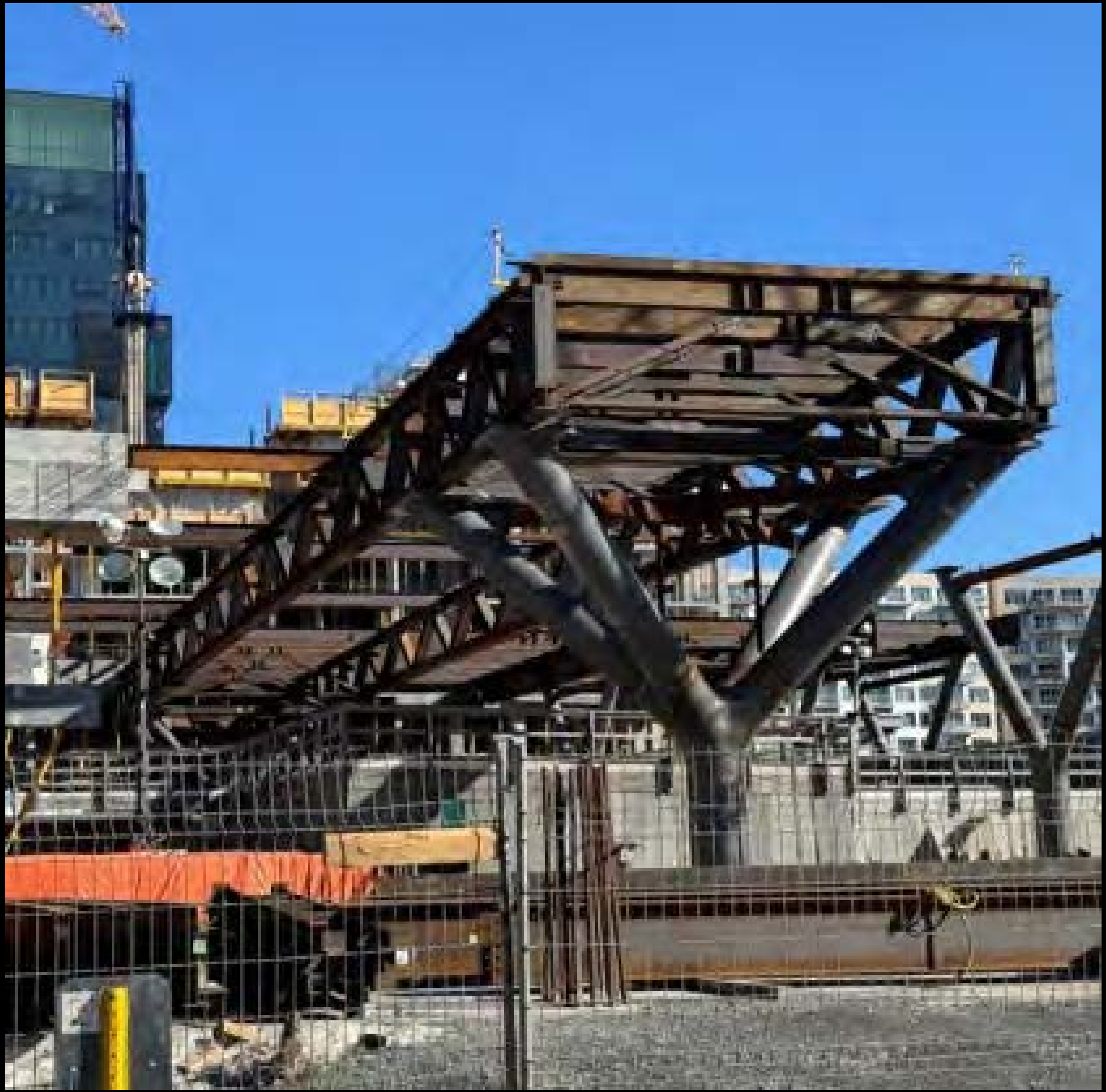

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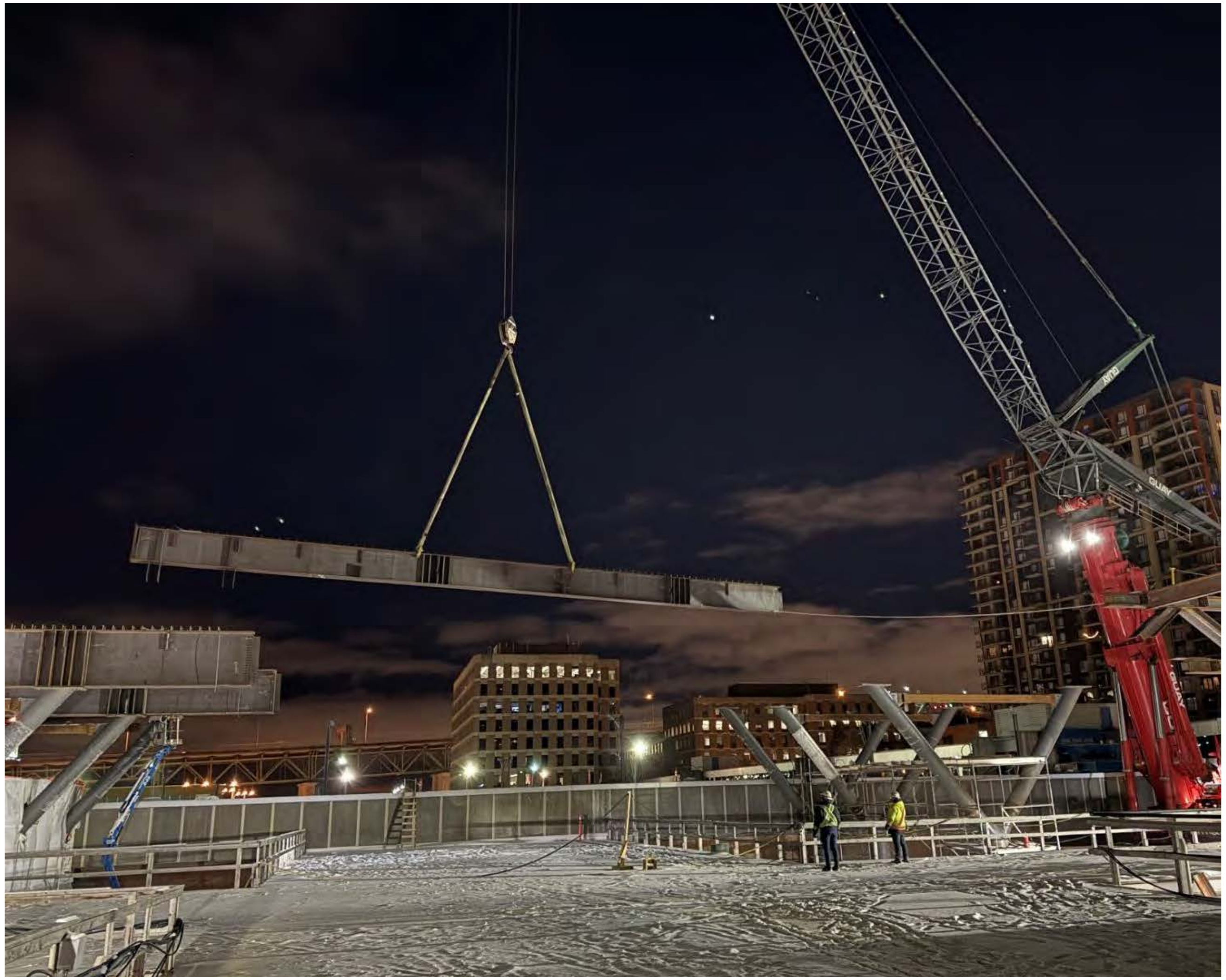

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ELEMA CASTCONNEX

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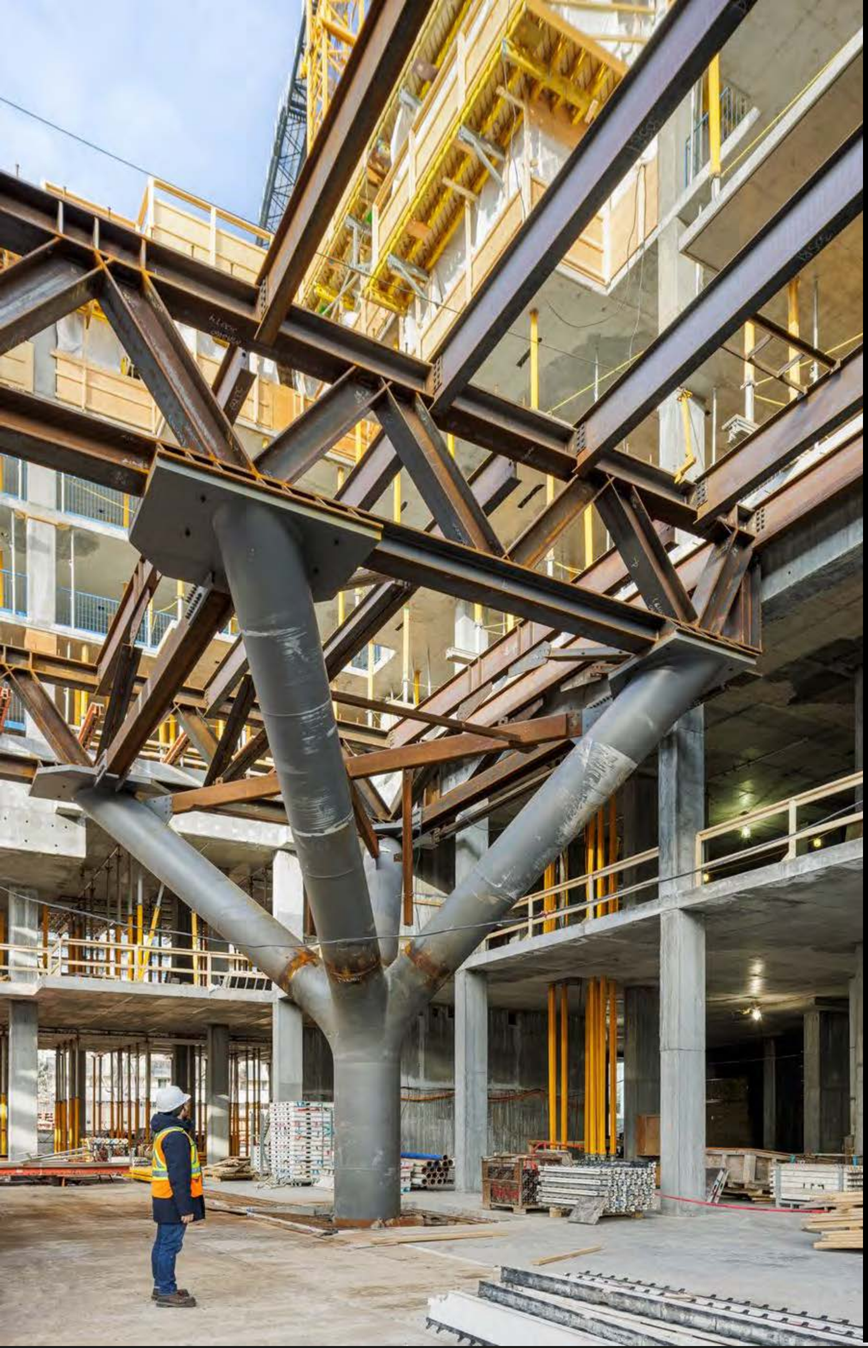

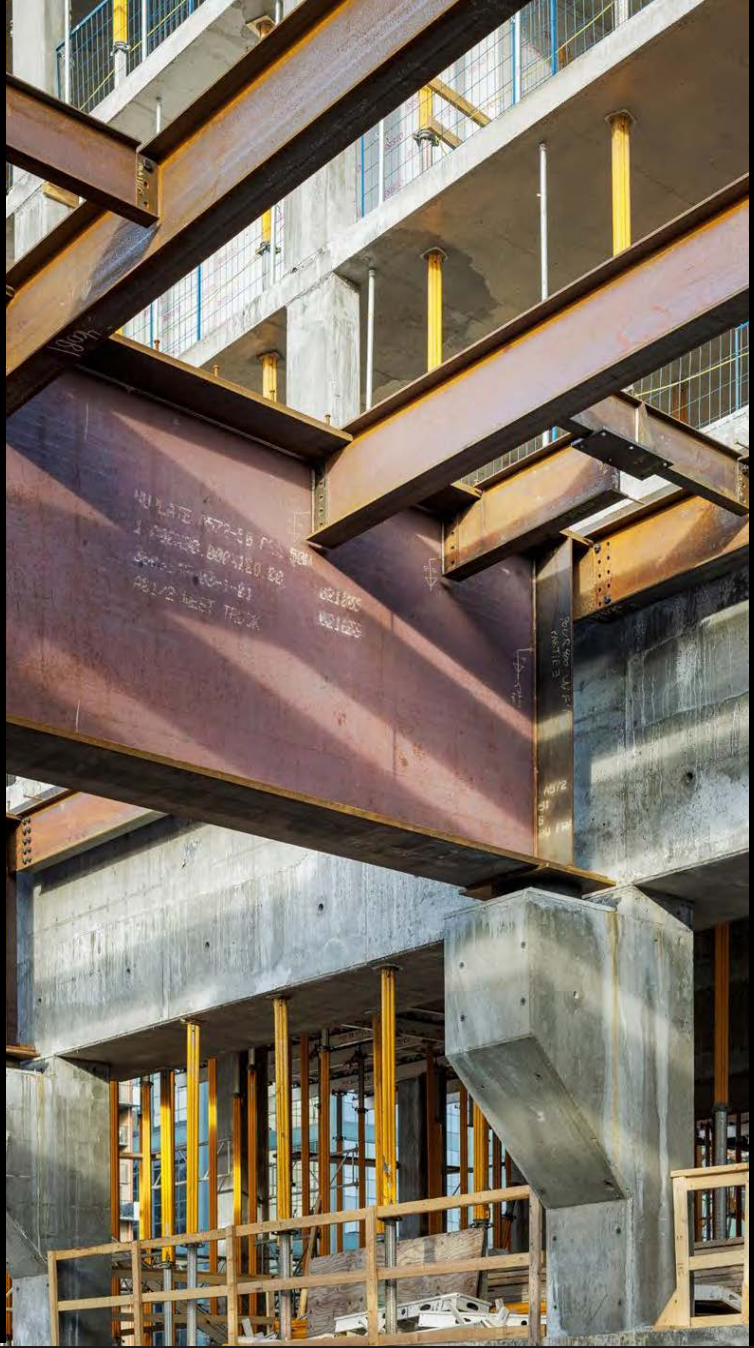


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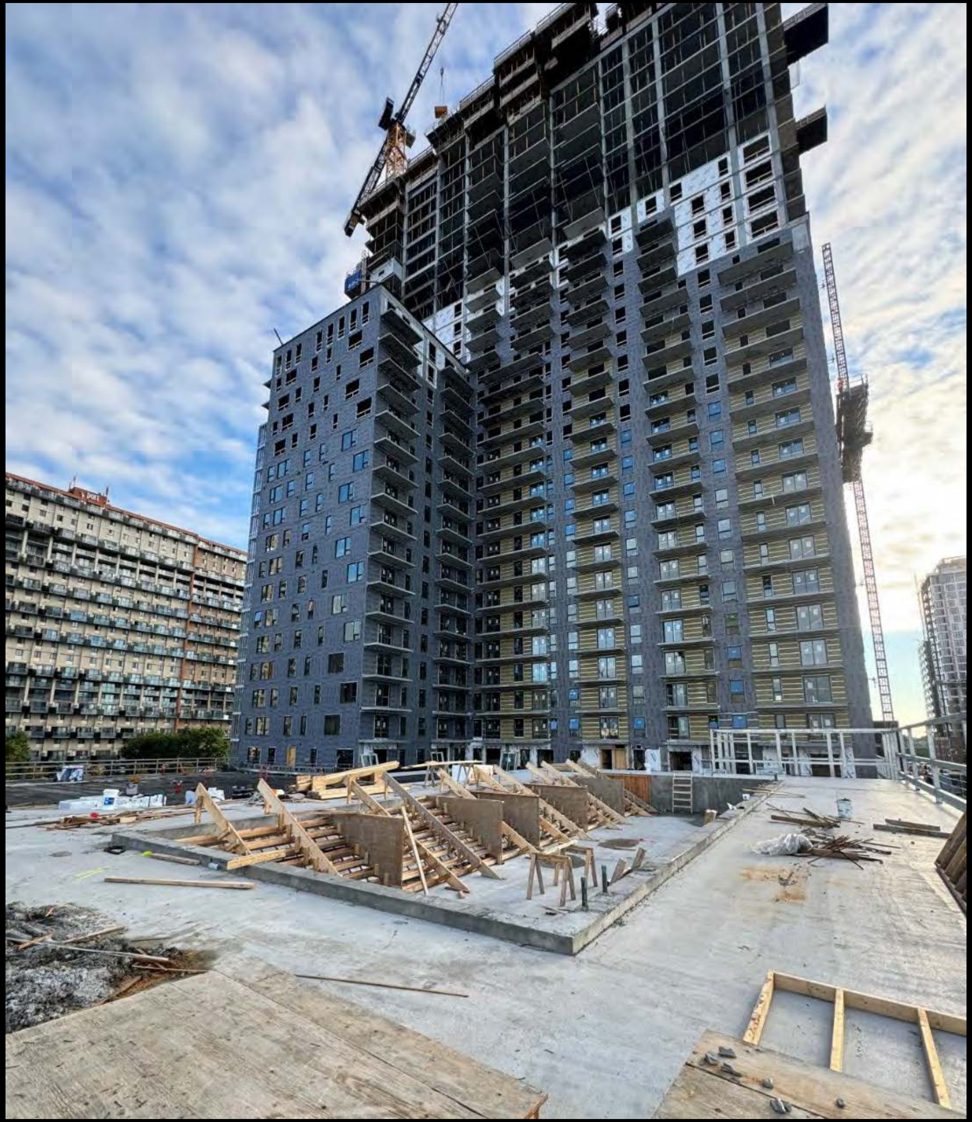

FROM CONCEPT TO REALITY

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