MaP3
Engineering
Structural
Design

CONSTRUIRACIER
LES VISITES DE CHANTIER

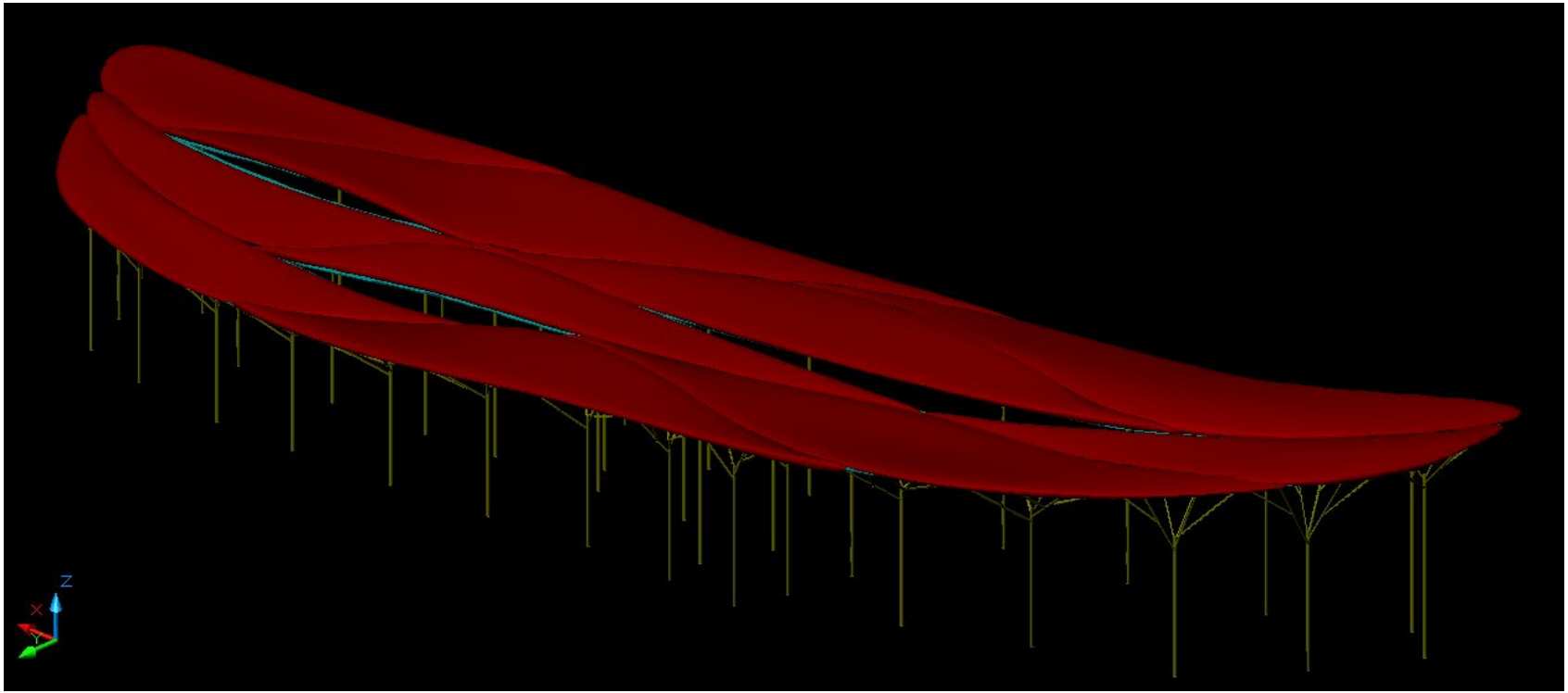
AREP

Gare de Rennes

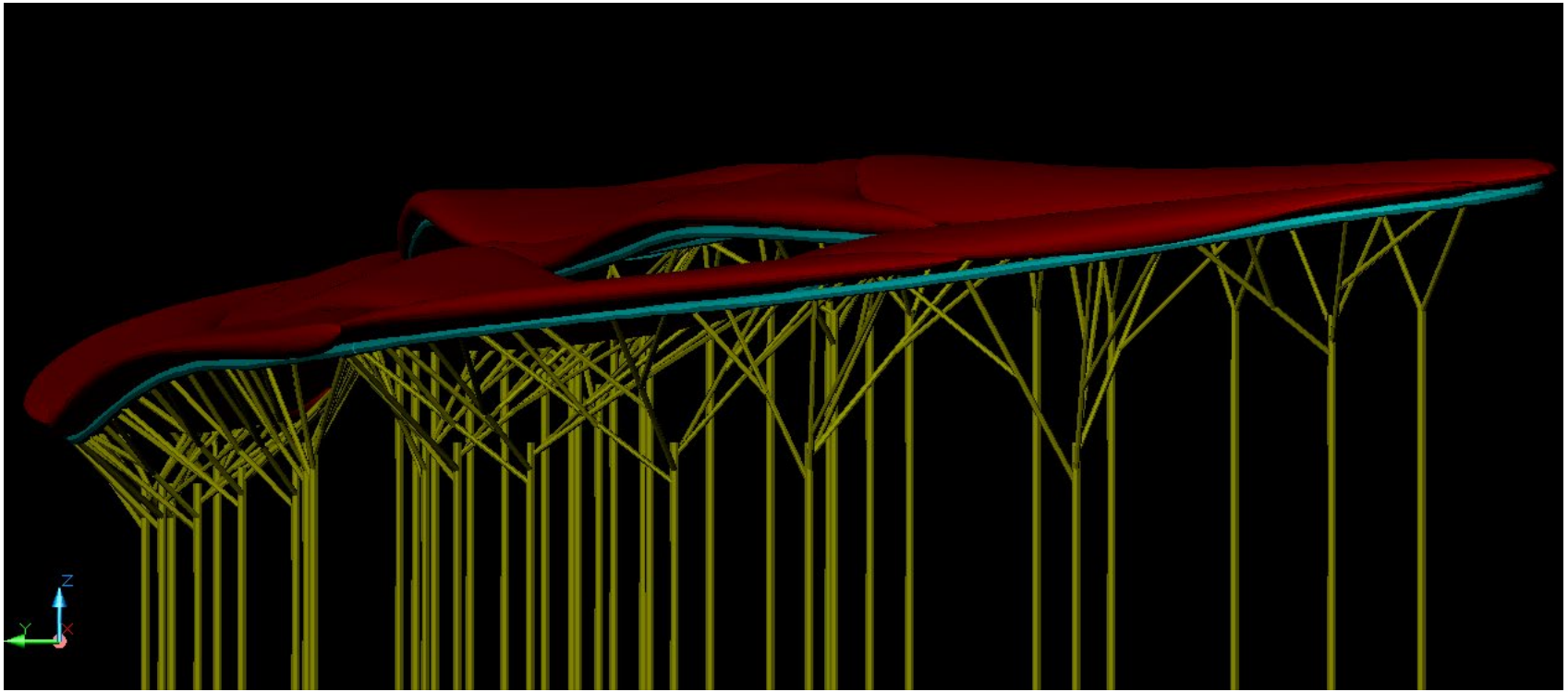
Structure

23/01/2019

Etudes – Base projet architecte



Etudes – Base projet architecte

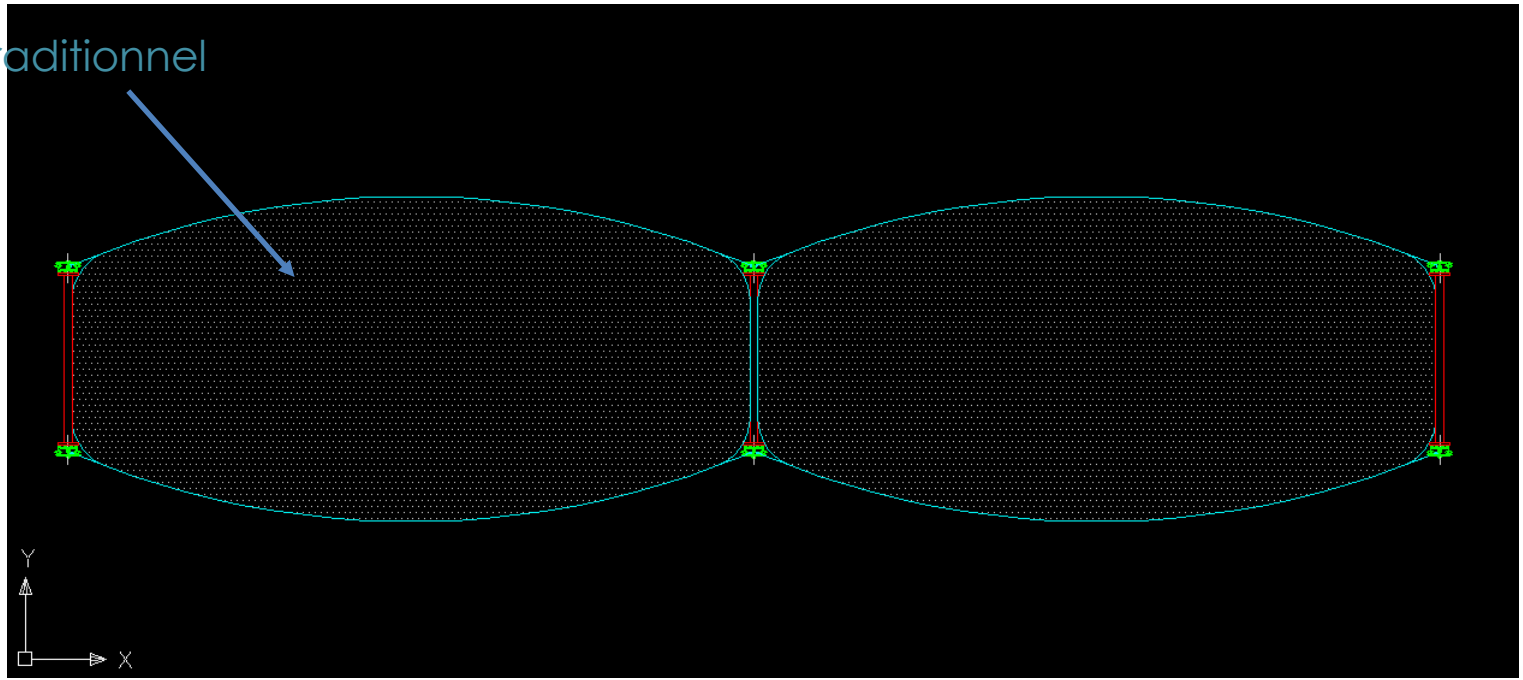


Etudes – Base projet architecte

- Nappes oblongues posées sur des poteaux arborescents
- Pas de bord métallique
- Intégration de baies vitrées

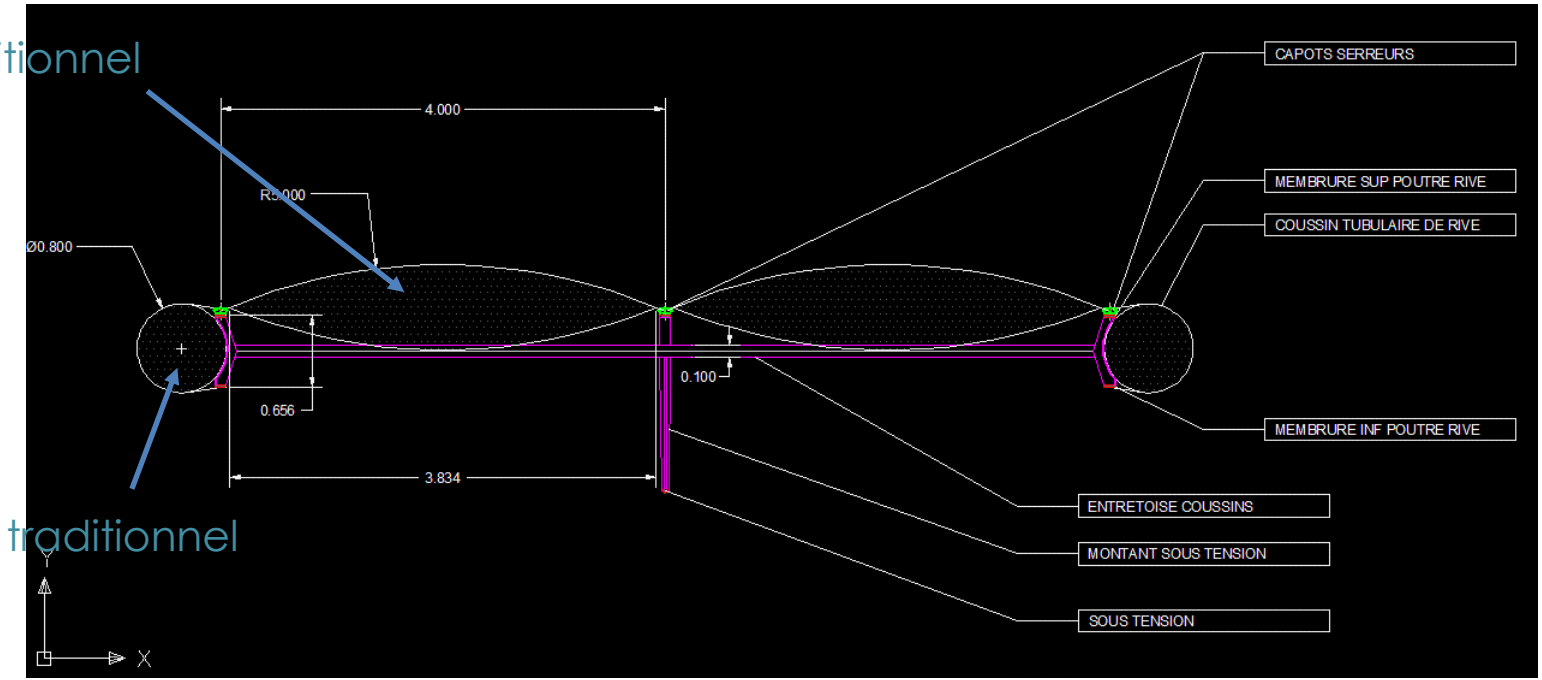
Conception toiture ETFE – option 1

Non traditionnel



Conception toiture ETFE – option 2

traditionnel

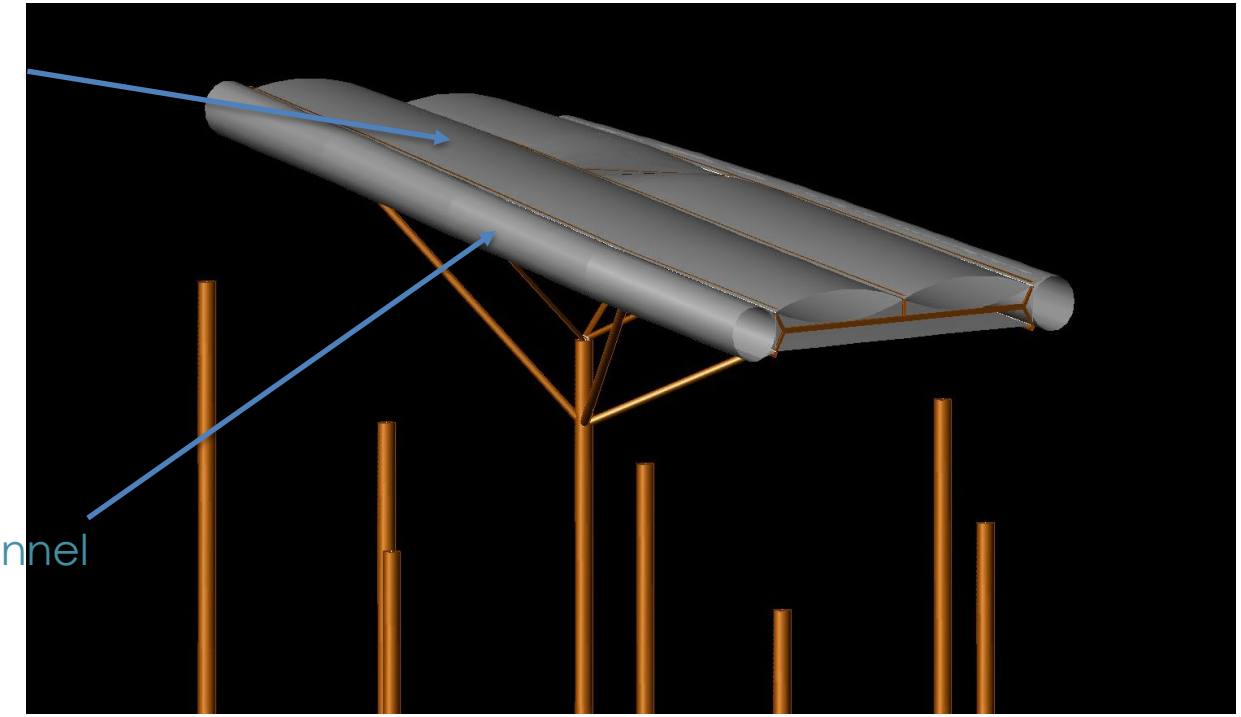


Non traditionnel

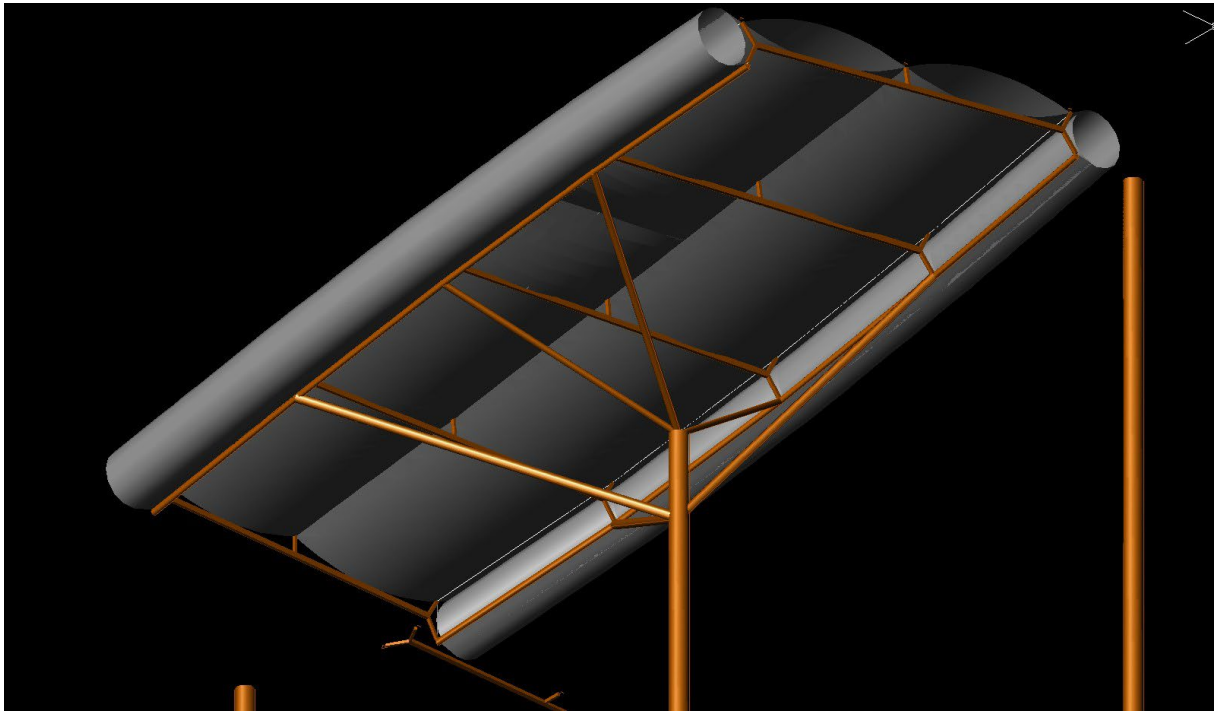
Conception toiture ETFE

traditionnel

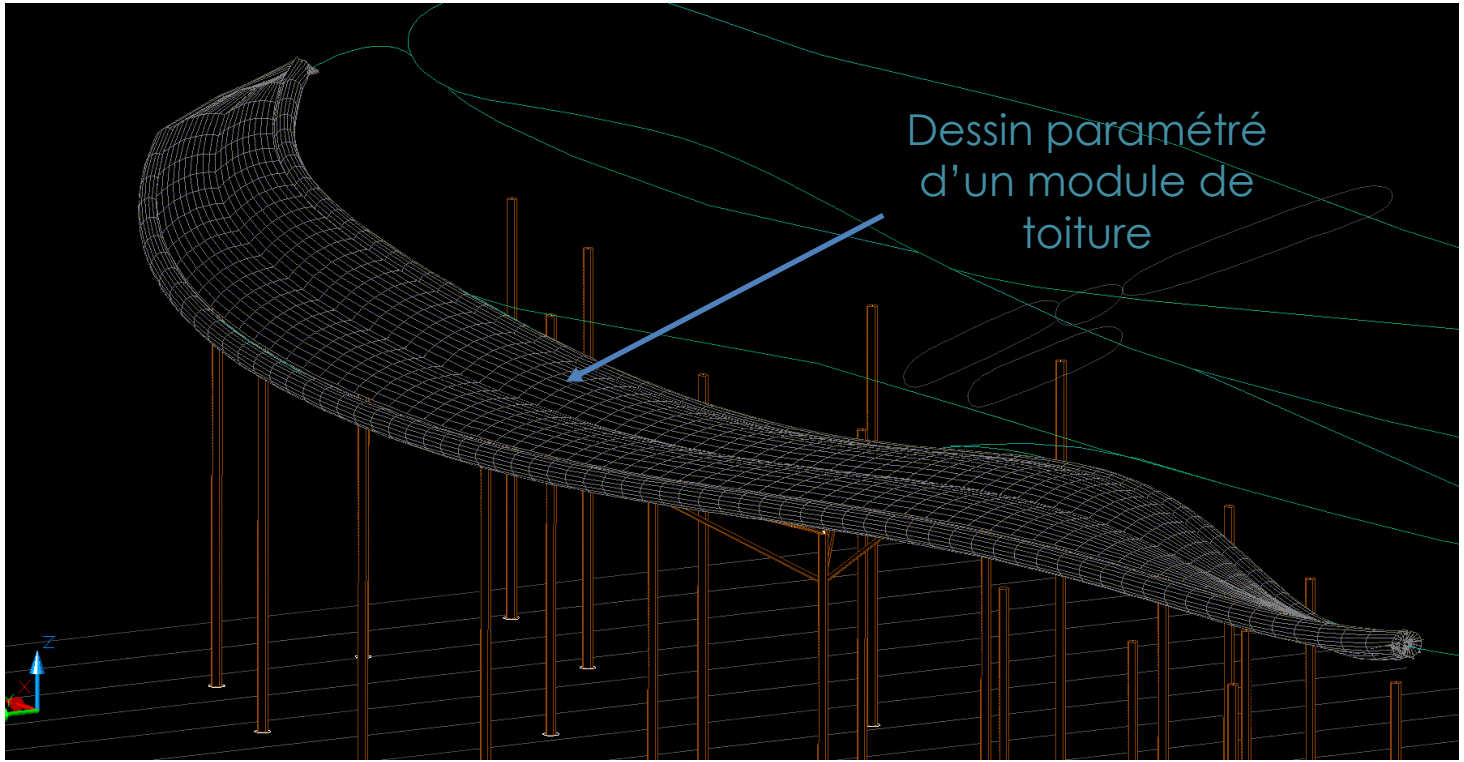
Non traditionnel



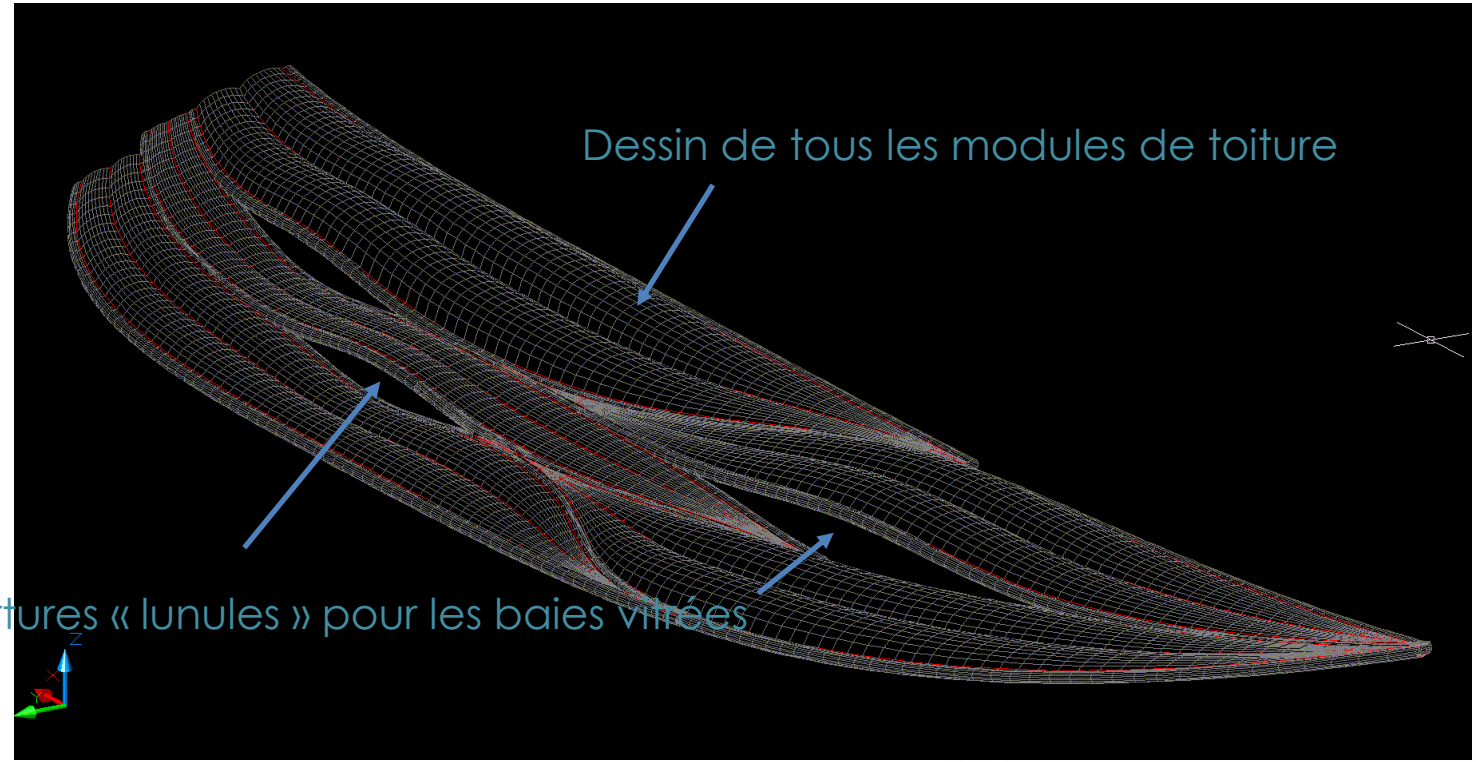
Conception toiture ETFE



Conception toiture ETFE



Conception toiture ETFE



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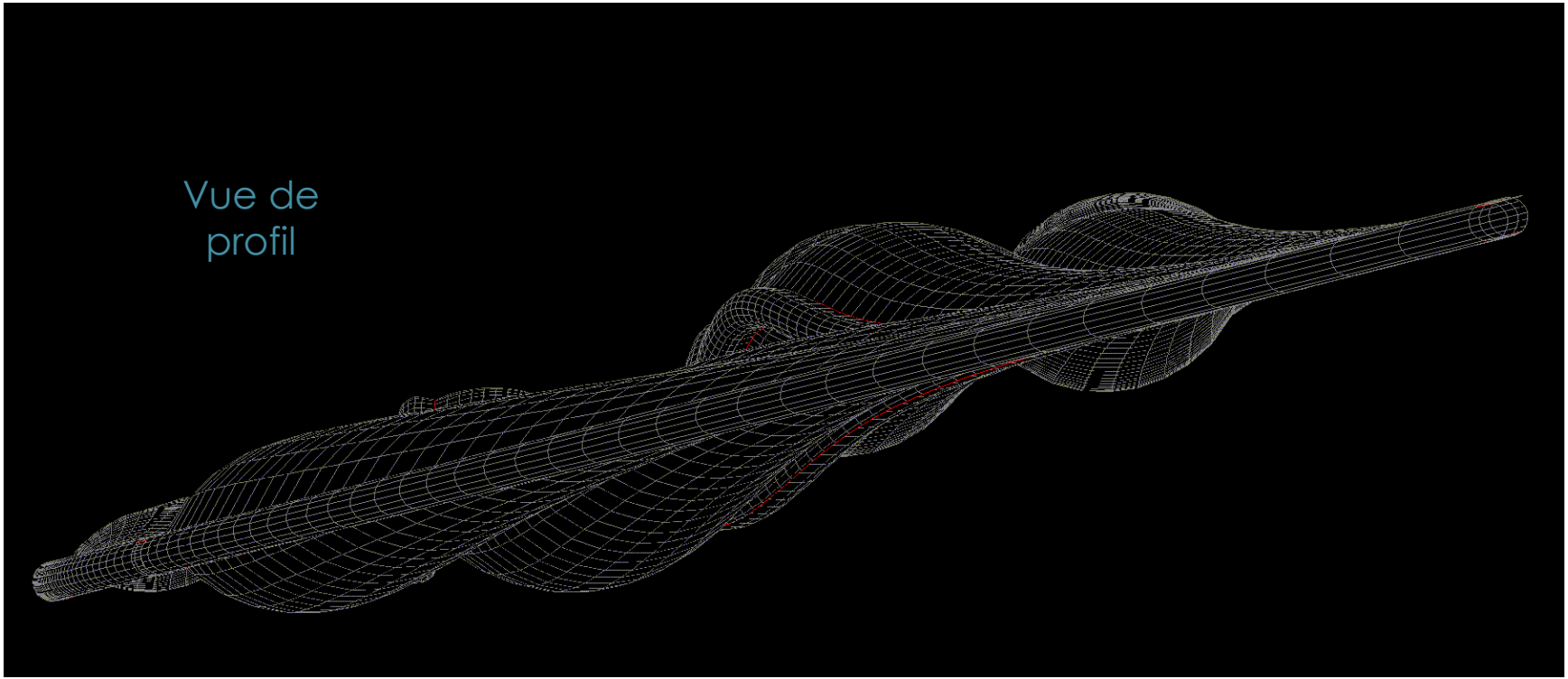

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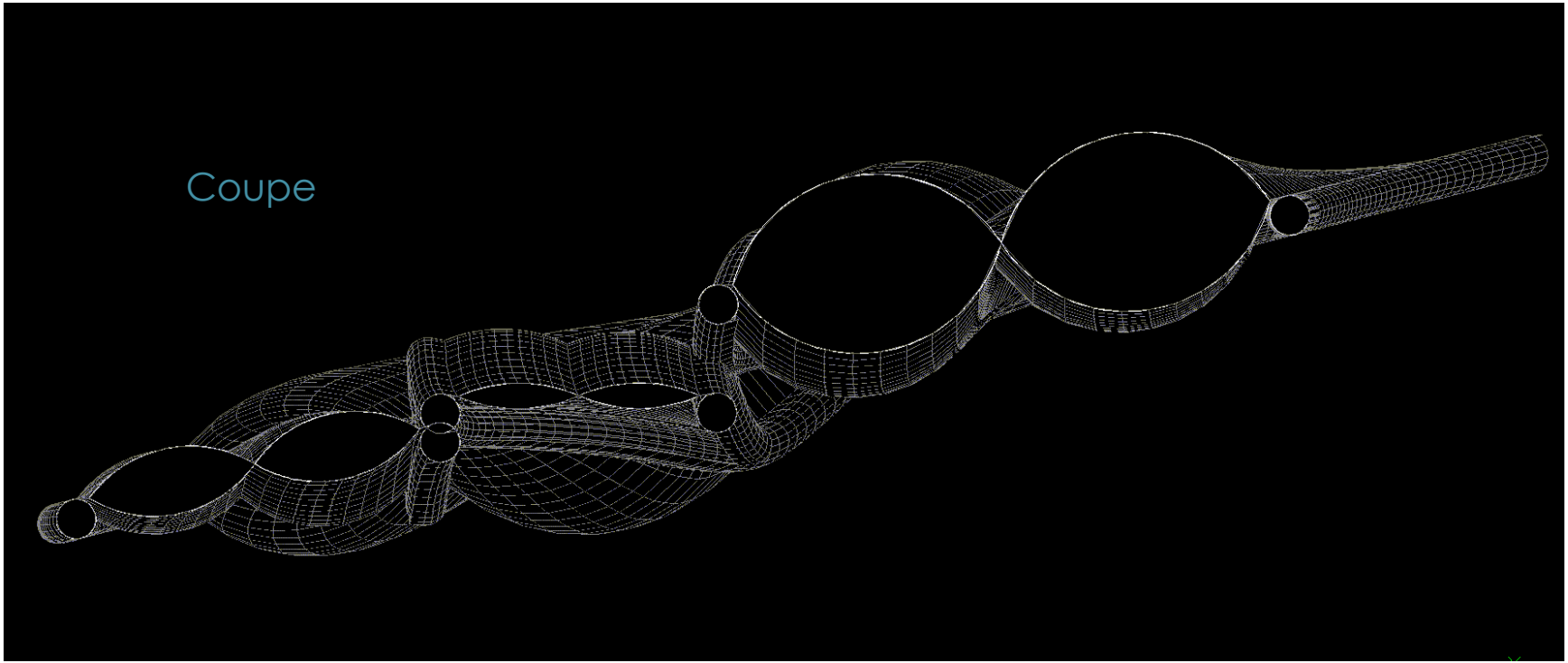
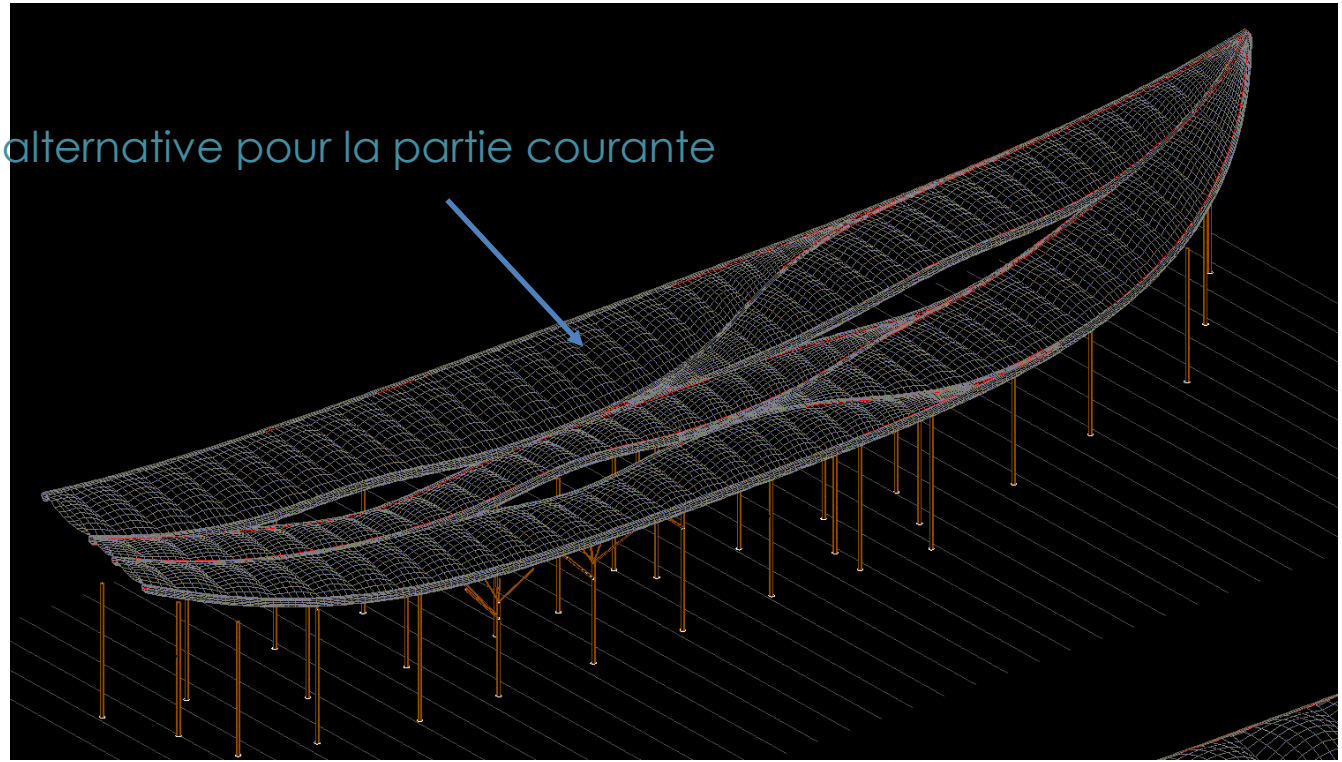
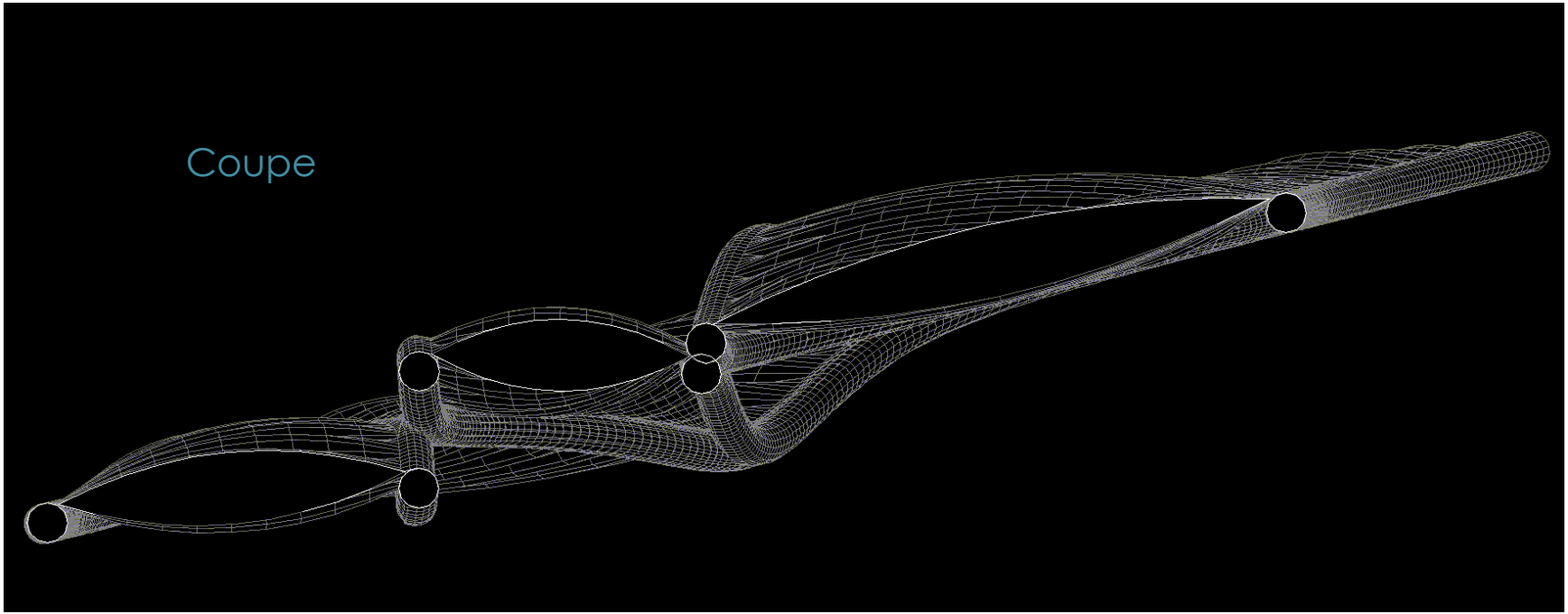


Conception toiture ETFE

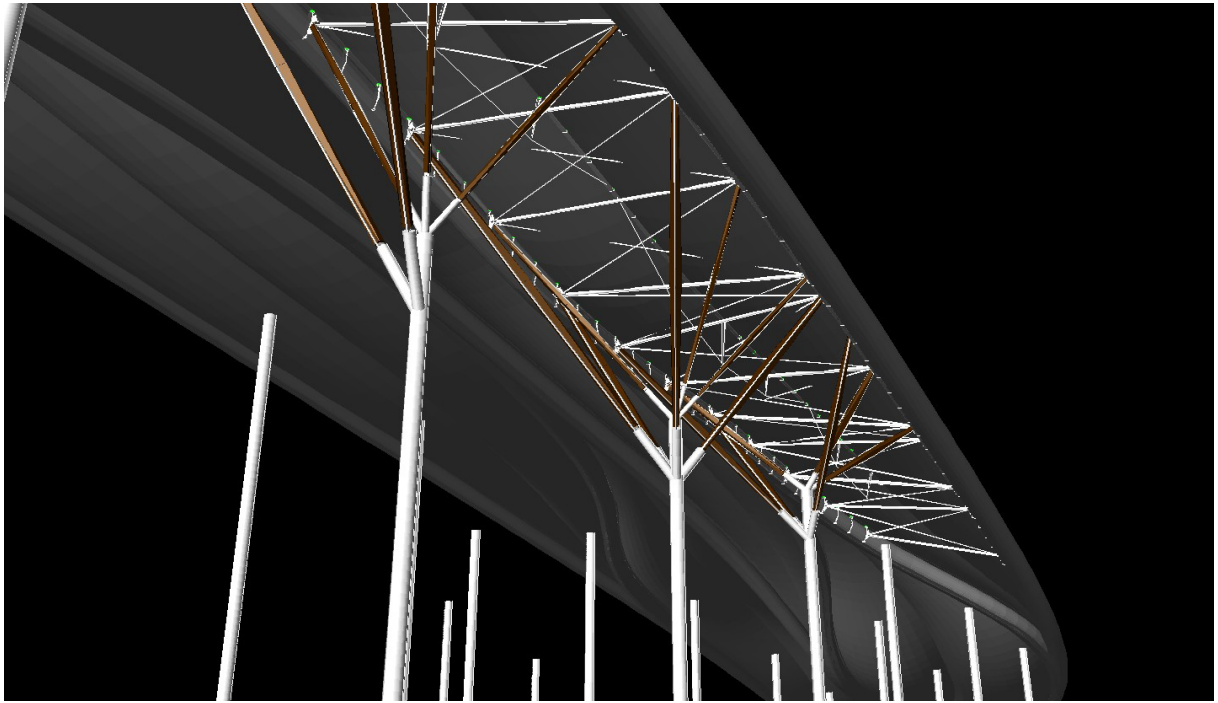
Solution alternative pour la partie courante



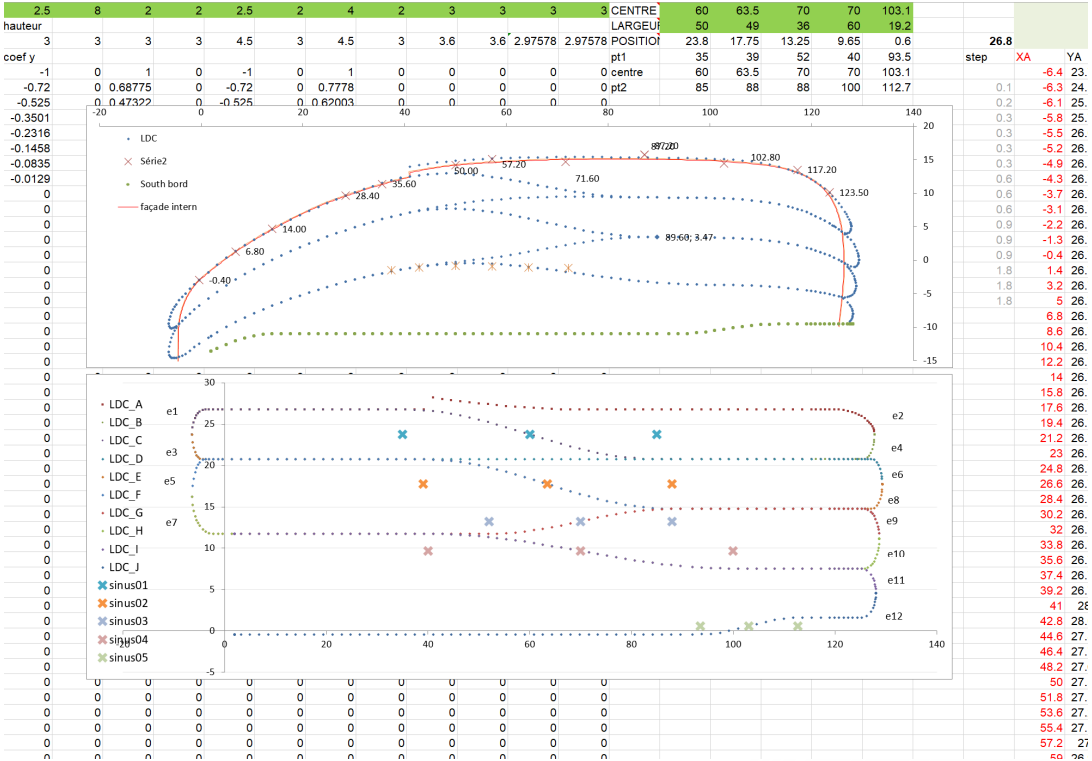
Conception toiture ETFE



Conception toiture ETFE

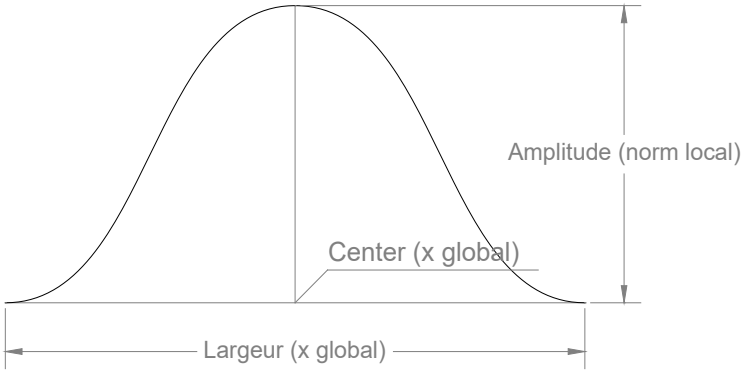


Paramétrage de la géométrie



Paramétrage de la géométrie

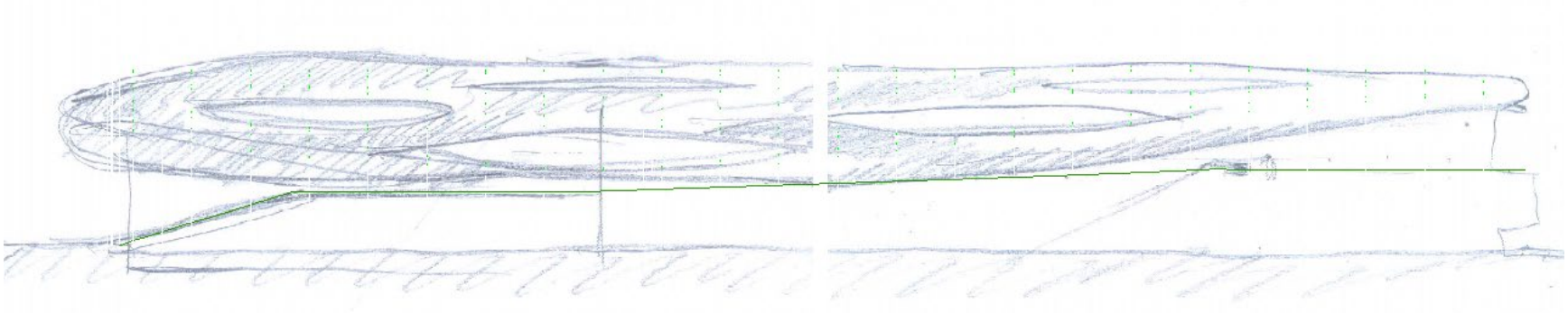
Modèle mathématique



$$y = H\cos\left[\pi\left(\min\left(\max\left(\frac{x-x_0}{2L_0};-1\right);1\right)\right)\right]$$

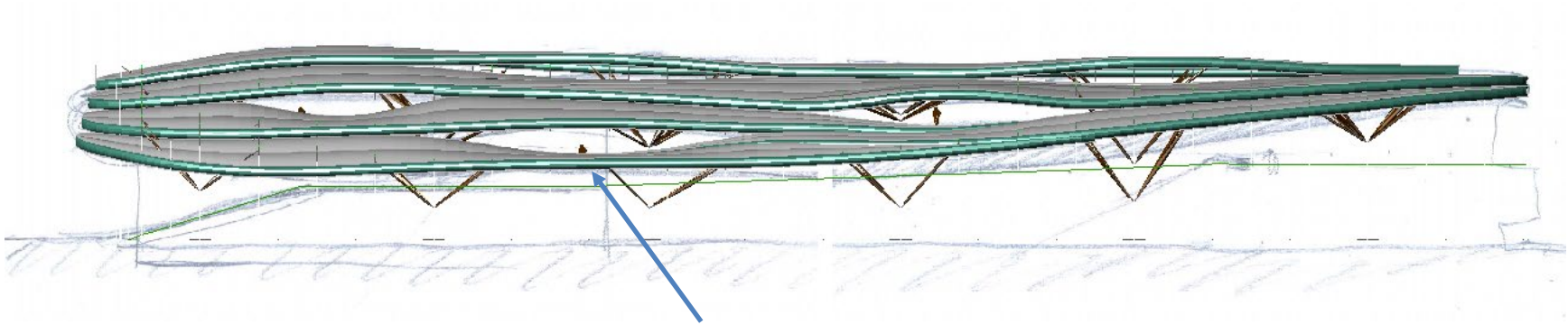
Paramétrage de la géométrie

Croquis architecte



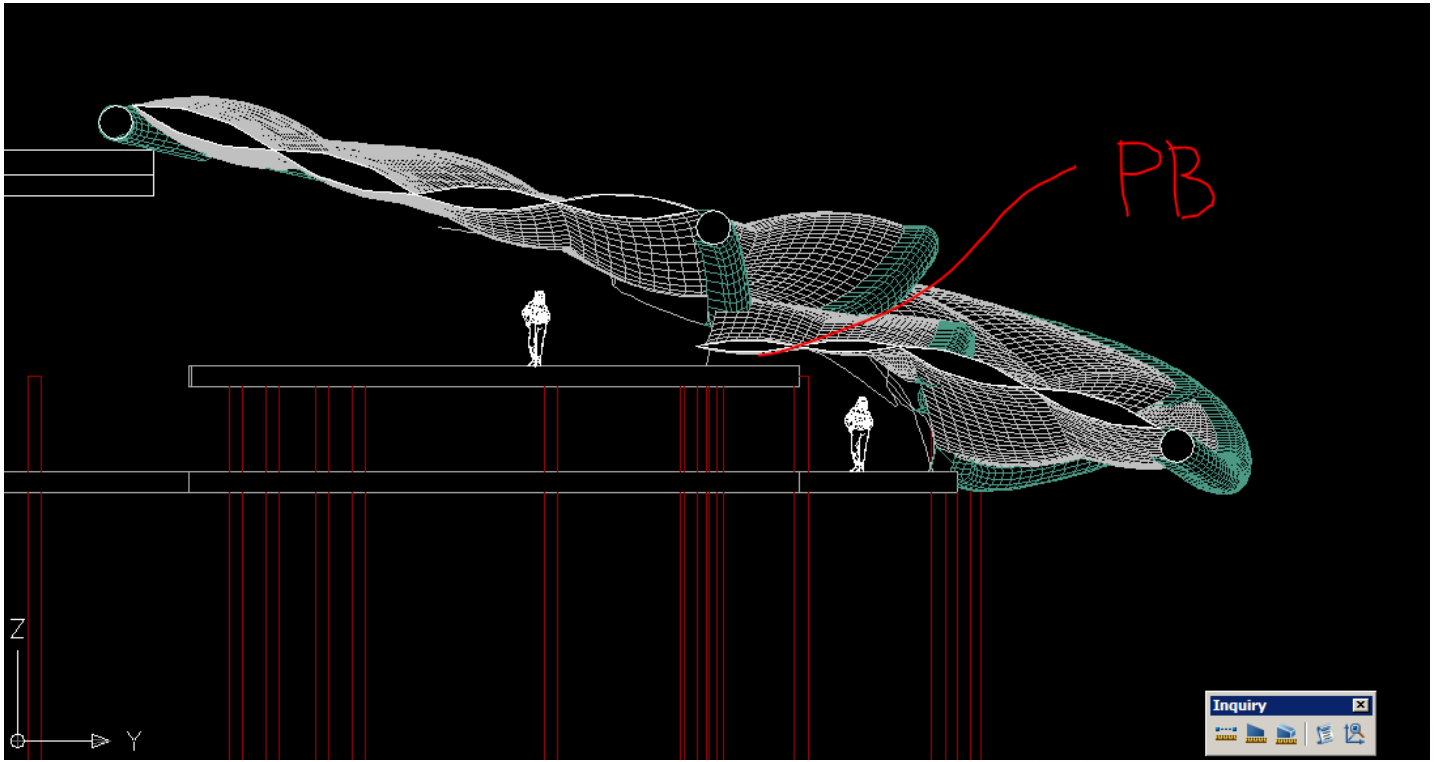
Paramétrage de la géométrie

Croquis architecte

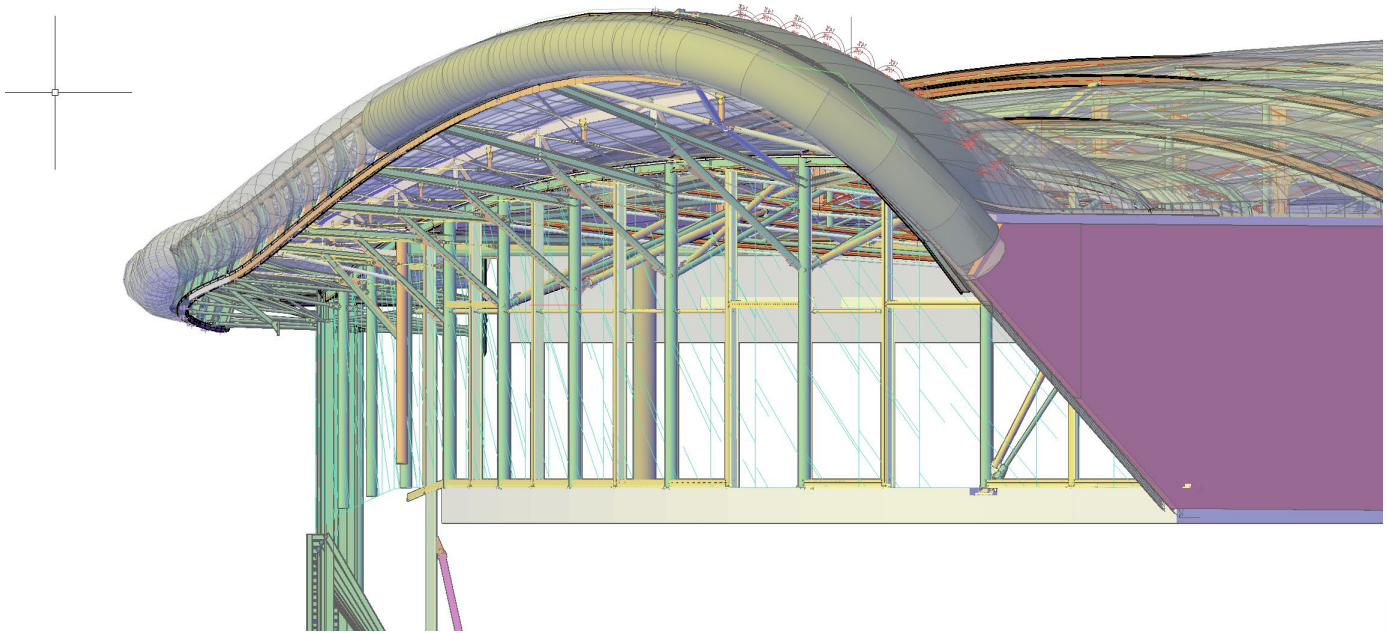


Modélisation mathématique superposée

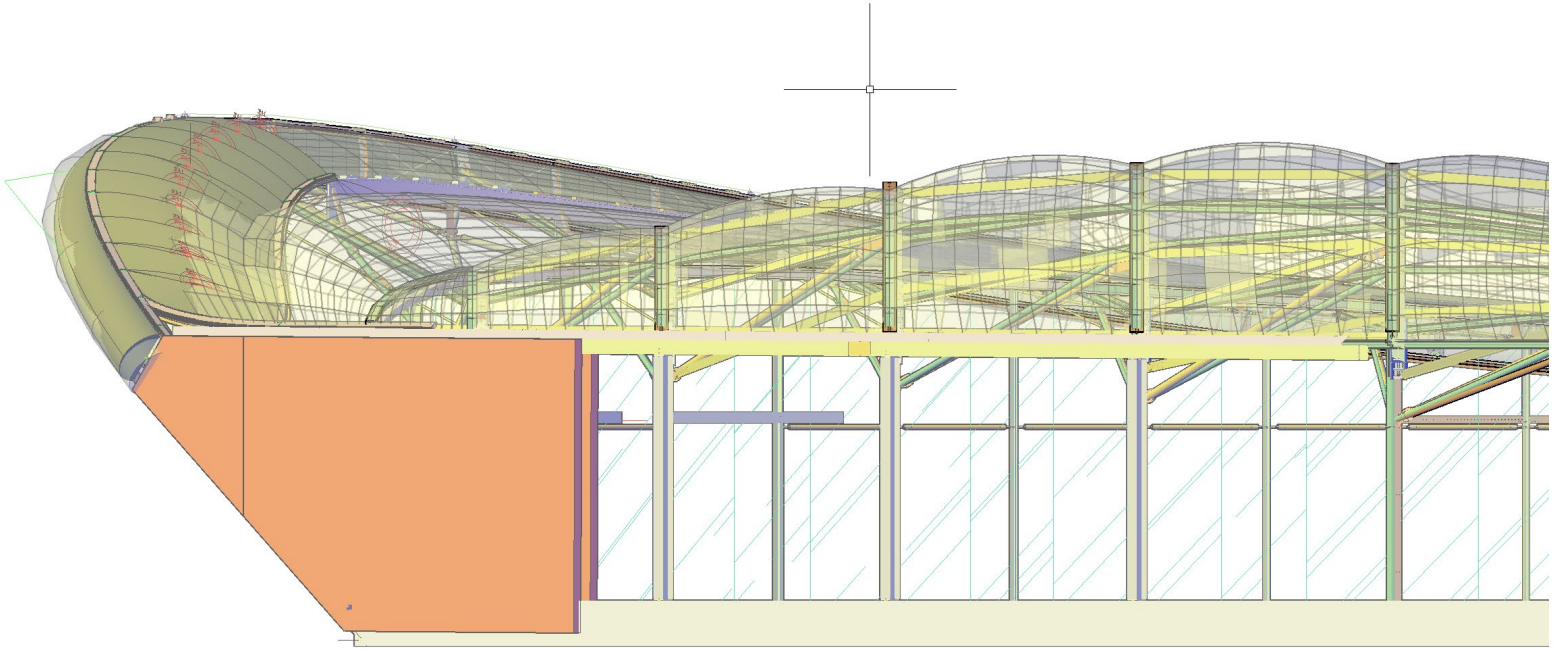
Paramétrage de la géométrie



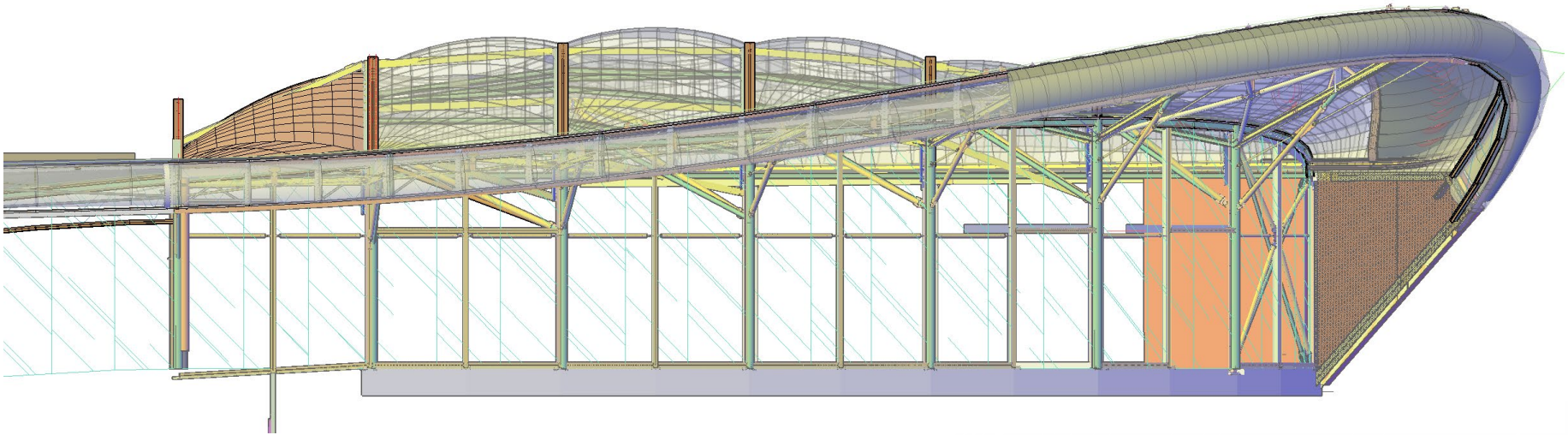
Paramétrage de la géométrie



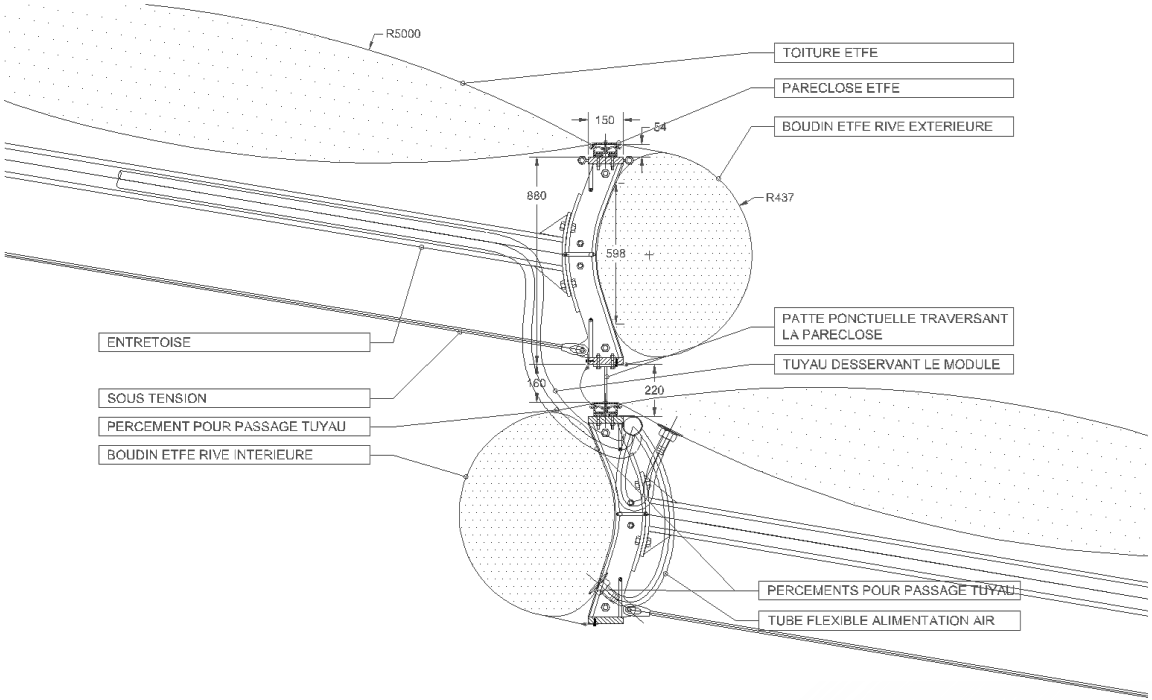
Paramétrage de la géométrie



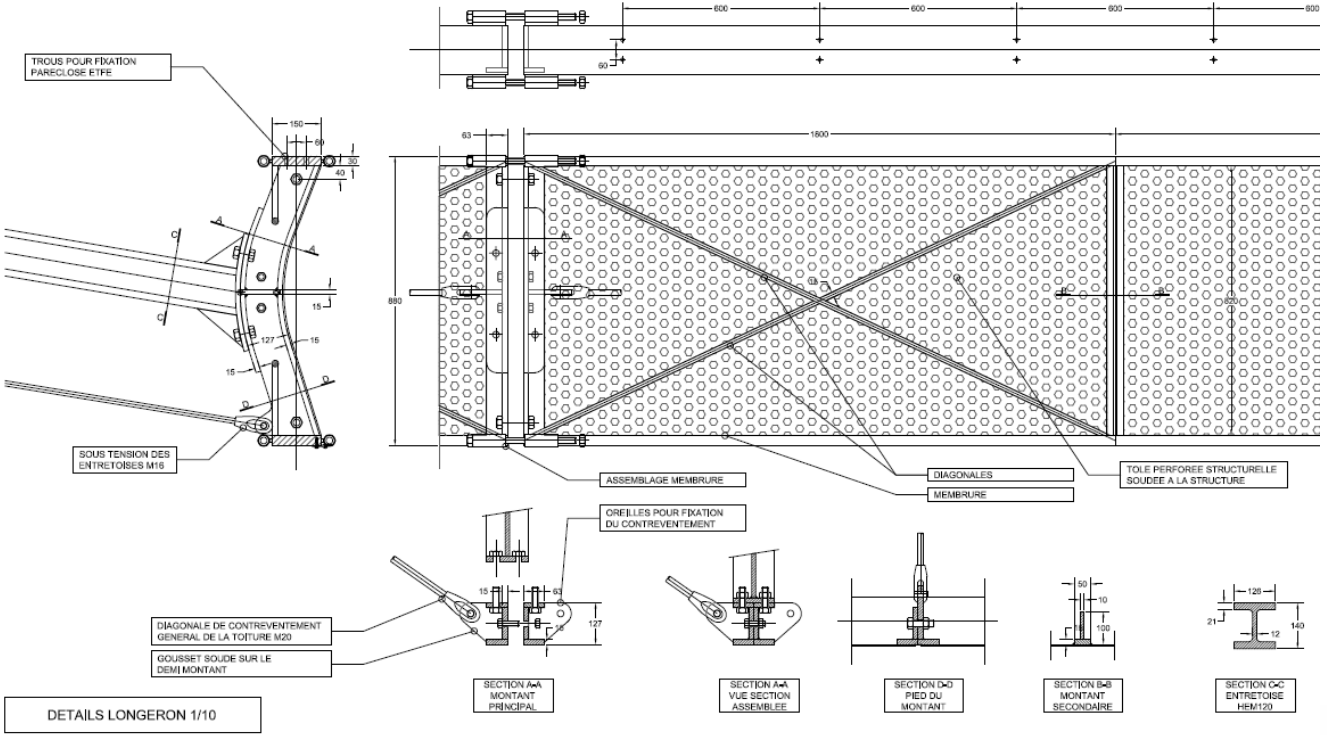
Paramétrage de la géométrie



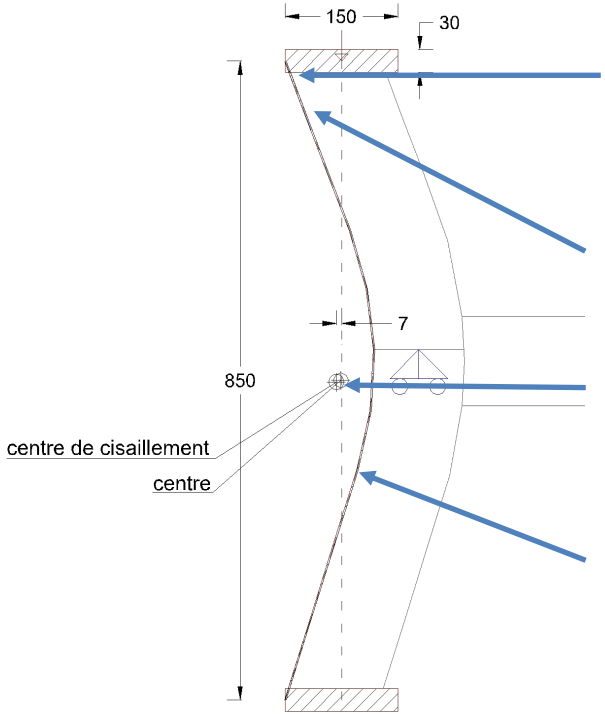
Détails structure – toiture



Détails structure – toiture



Détails structure – toiture



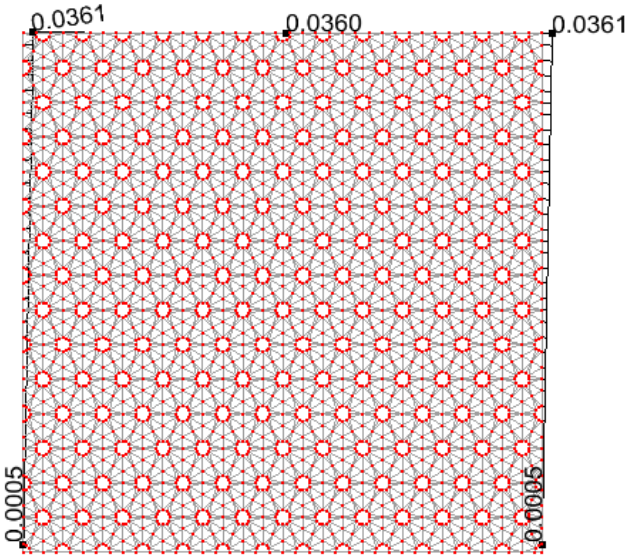
Ame soudée côté extérieur des membrures => contribue à leur inertie autour de l'axe vertical.

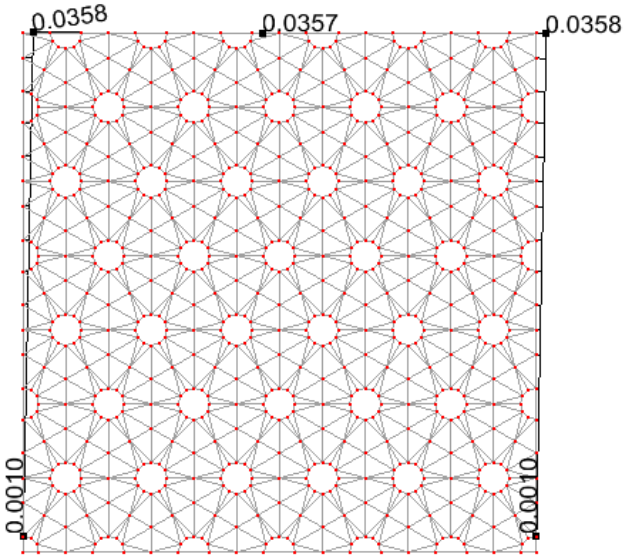
Angle au démarrage de la tôle absorbe une partie de la composante horizontale de l'effort du coussin.

Centre de cisaillement proche du plan moyen de la section. Cela minimise les torsions parasites dues à l'excentrement.

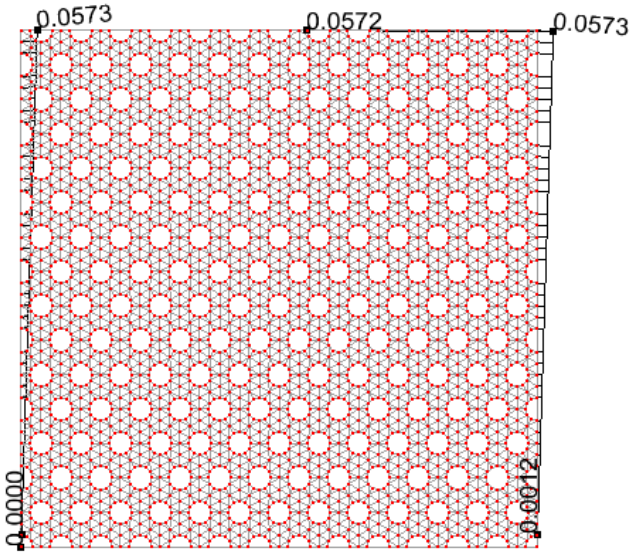
La courbure de l'âme augmente sa résistance au voilement

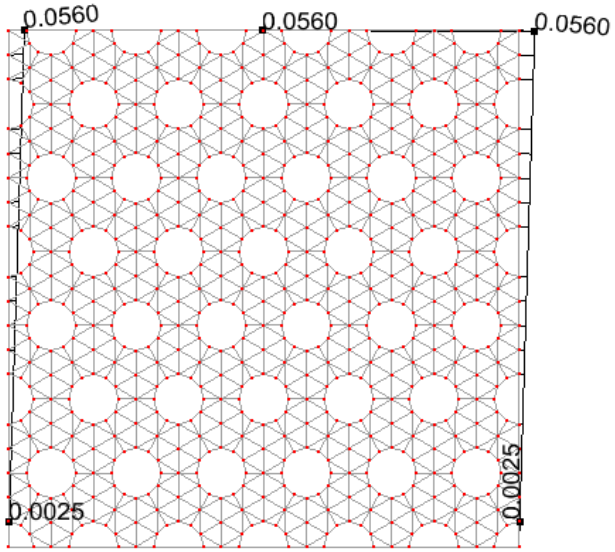
Détails structure – âme tôle perforée



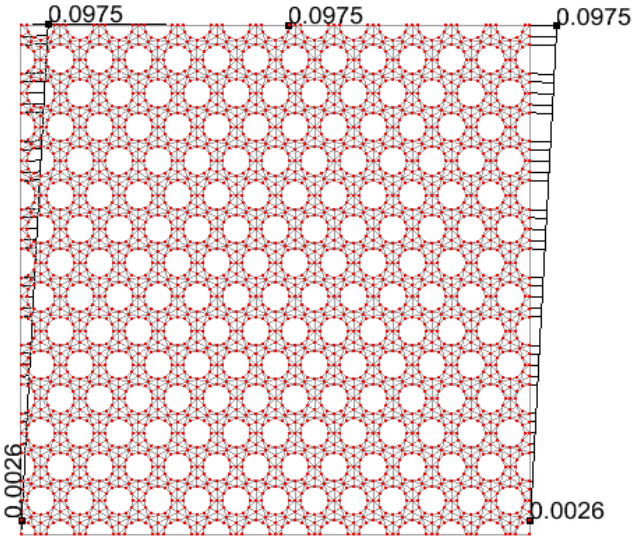


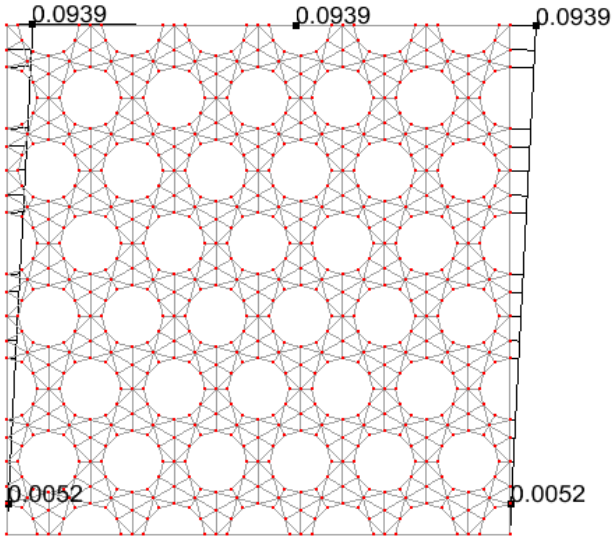
Détails structure – âme tôle perforée



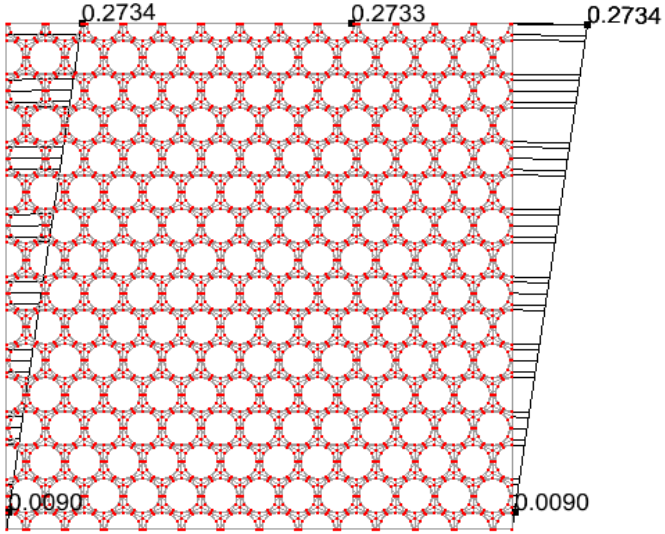


Détails structure – âme tôle perforée

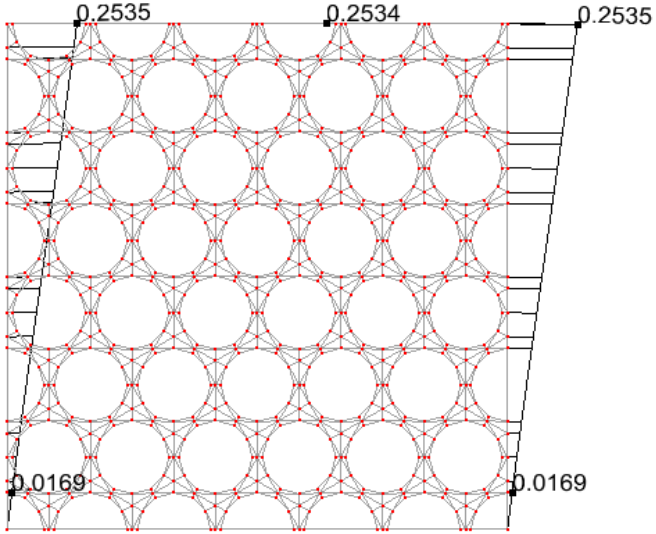




Détails structure – âme tôle perforée



$$\rho = \frac{\delta_{tole\ perforee}}{\delta_{tole\ pleine}}$$

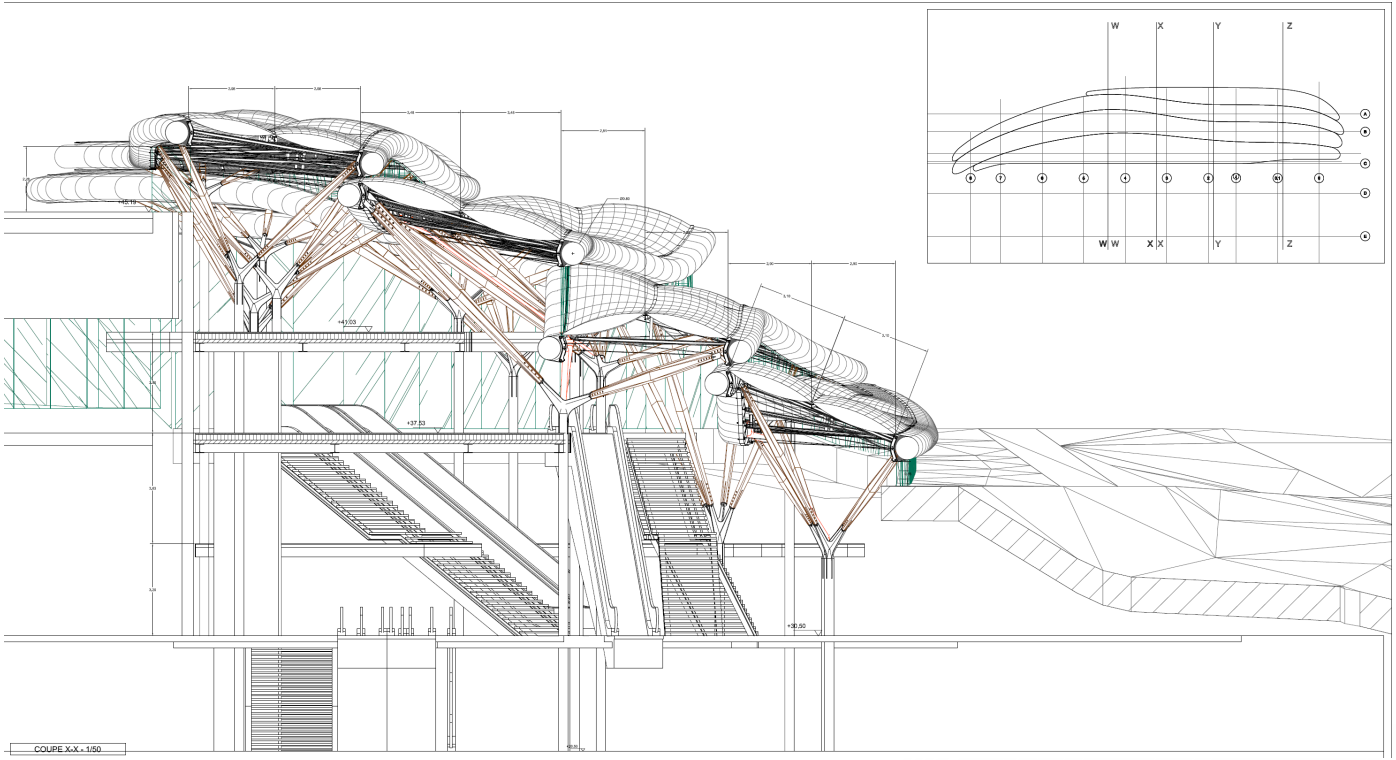


Détail structure – prototype

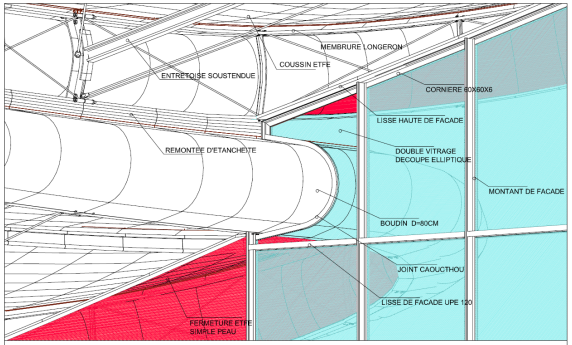
Détail structure – prototype

Détail structure – prototype

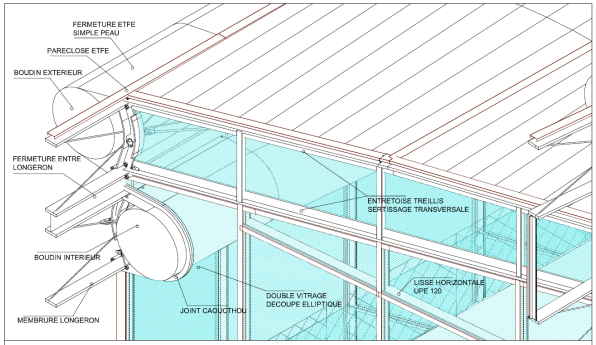
Détails structure



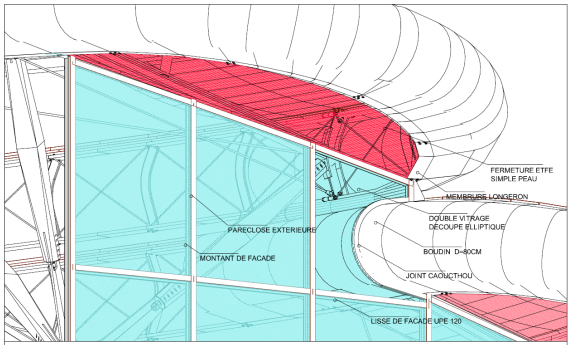
Détails structure



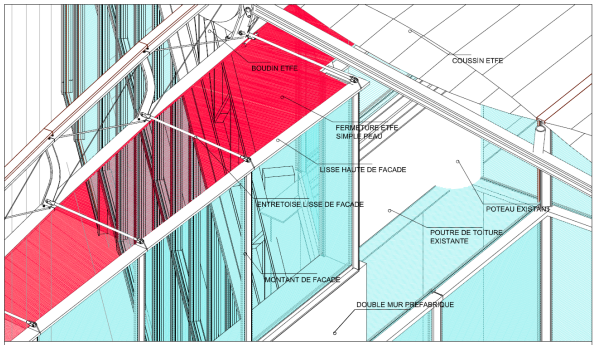
DET 14 :TRAVERSEMENT BOUDIN FACADE EXTERNE - VUE 1



DET 13 :TRAVERSEMENT BOUDIN FACADE INTERNE

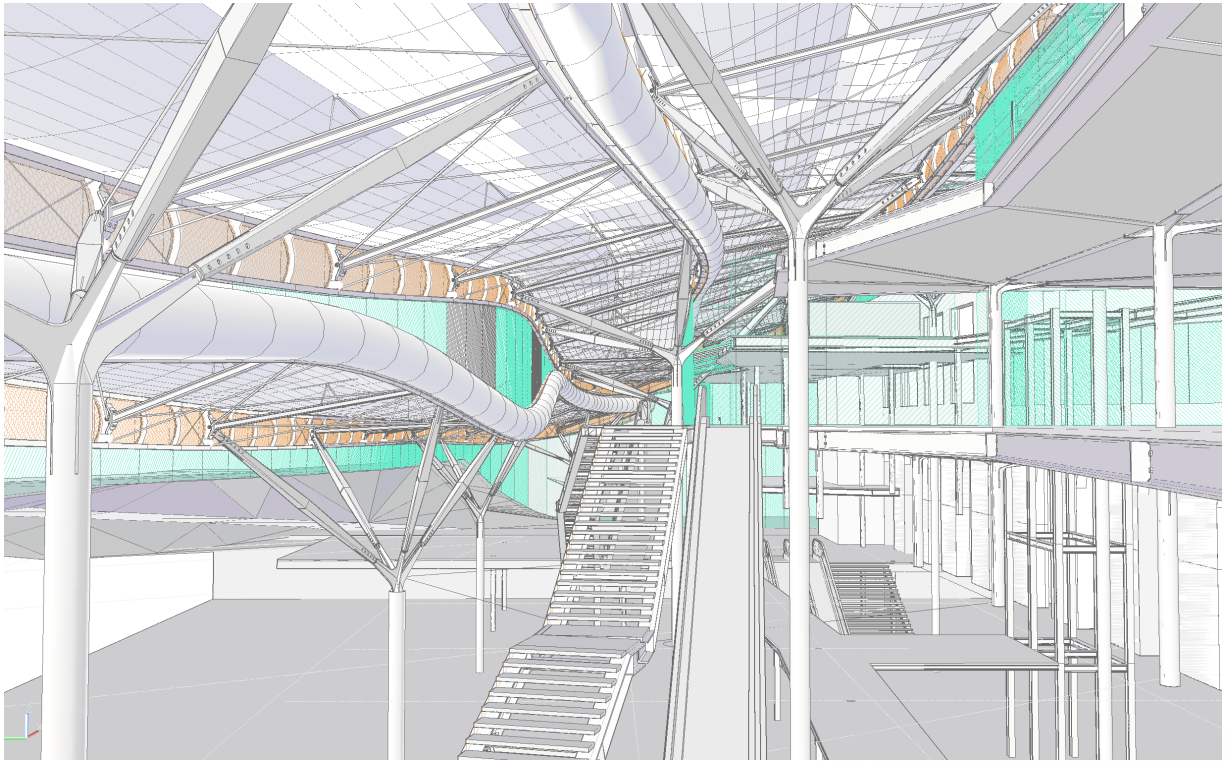


DET 14 :TRAVERSEMENT BOUDIN FACADE EXTERNE - VUE 2



DET 09b : FERMETURE HORIZONTALE ETFE SIMPLE PEAU

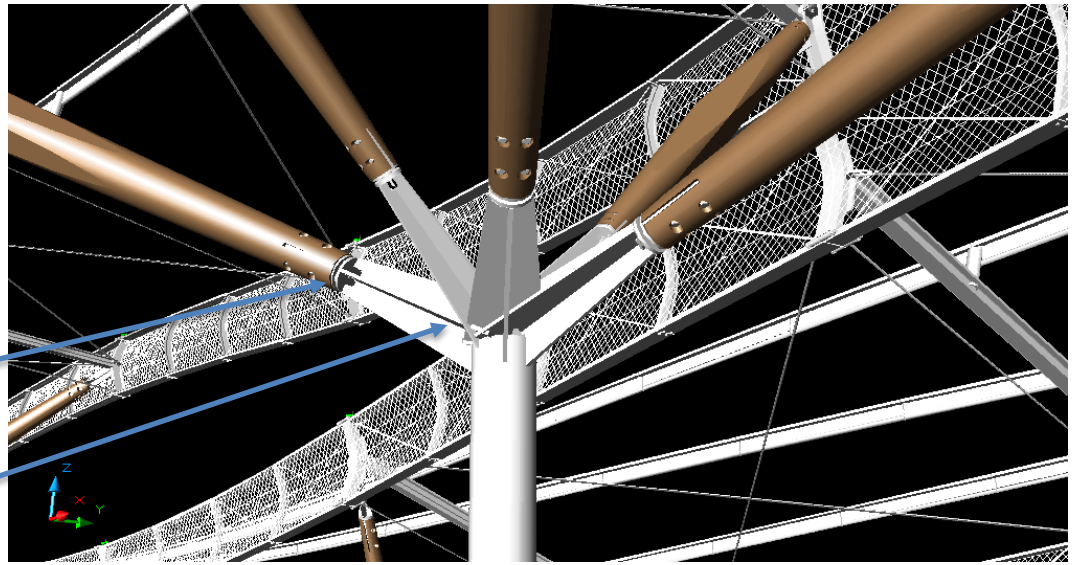
Détails structure



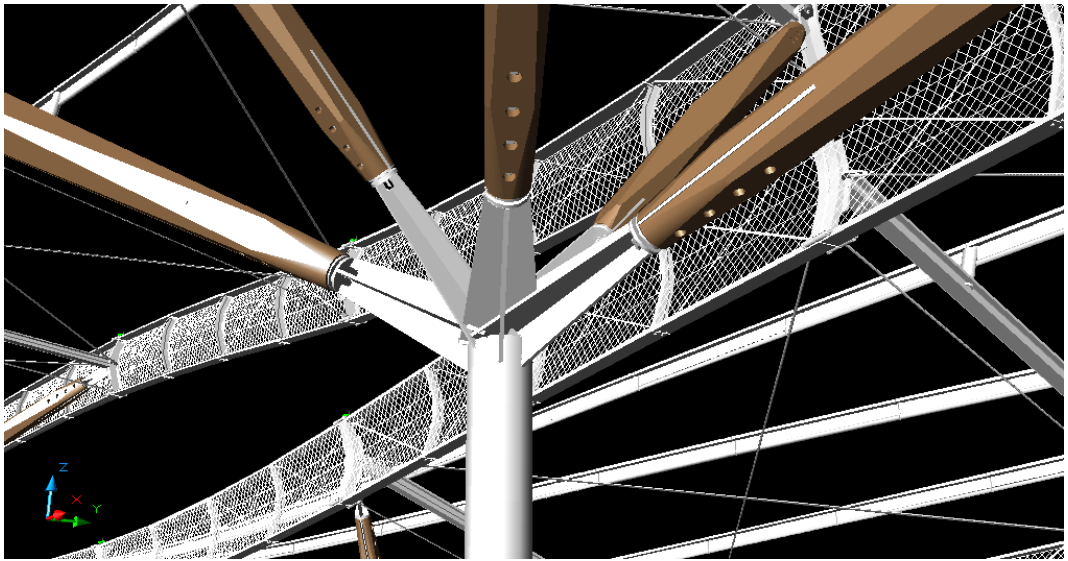
Détails structure – poteaux

Articulation

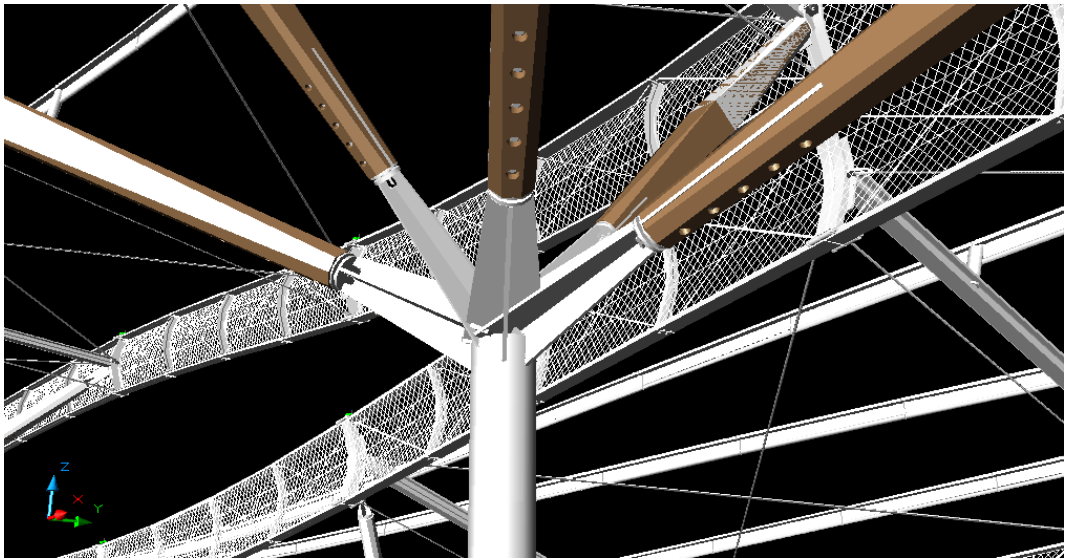
Attentes



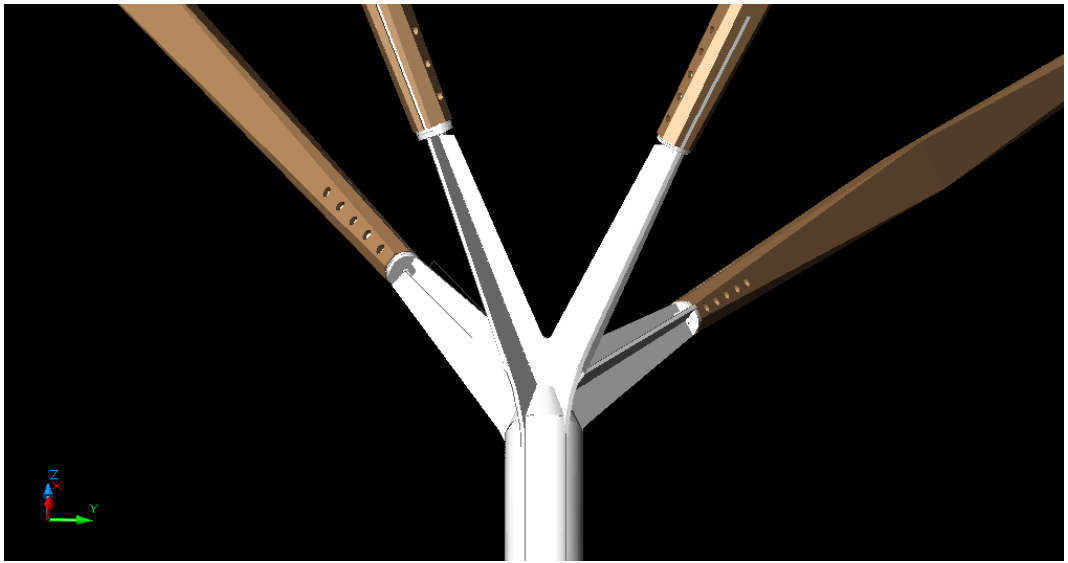
Détails structure – poteaux



Détails structure – poteaux



Détails structure – poteaux



Détails structure – poteaux

Prototype usine

Détails structure – poteaux

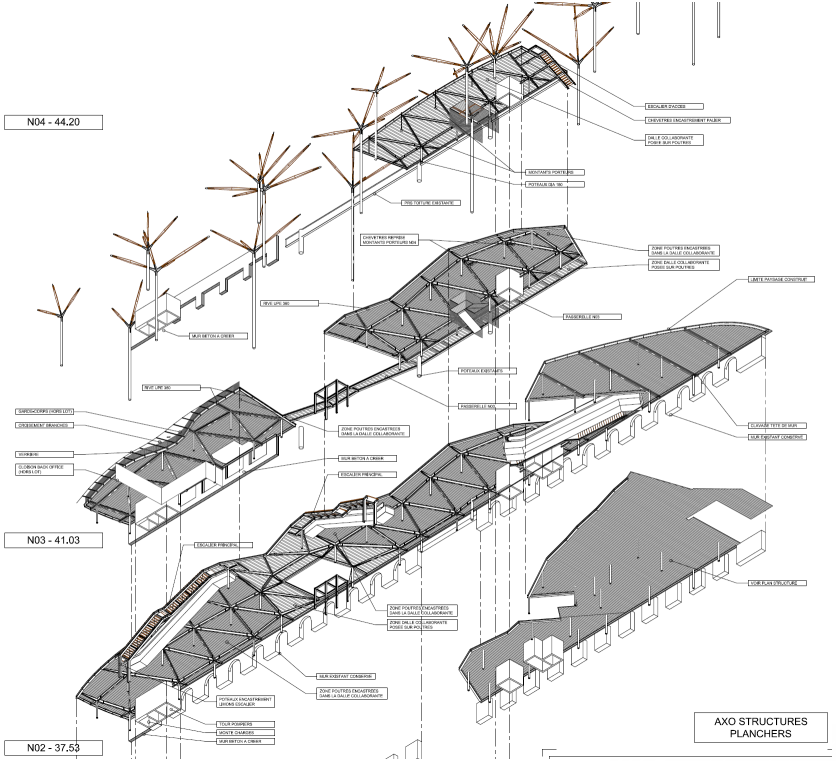
prototype

Détails structure – poteaux

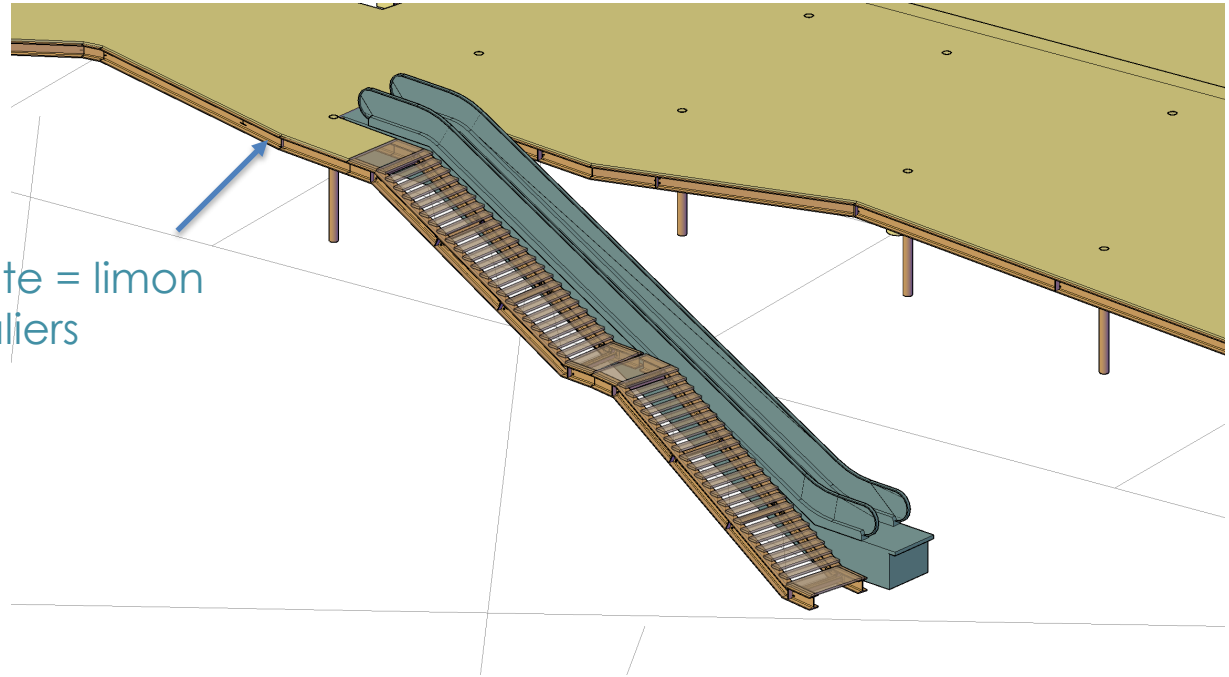
Détails structure – poteaux

Lamellé collé chêne

Détails structure – planchers



Détails structure – planchers

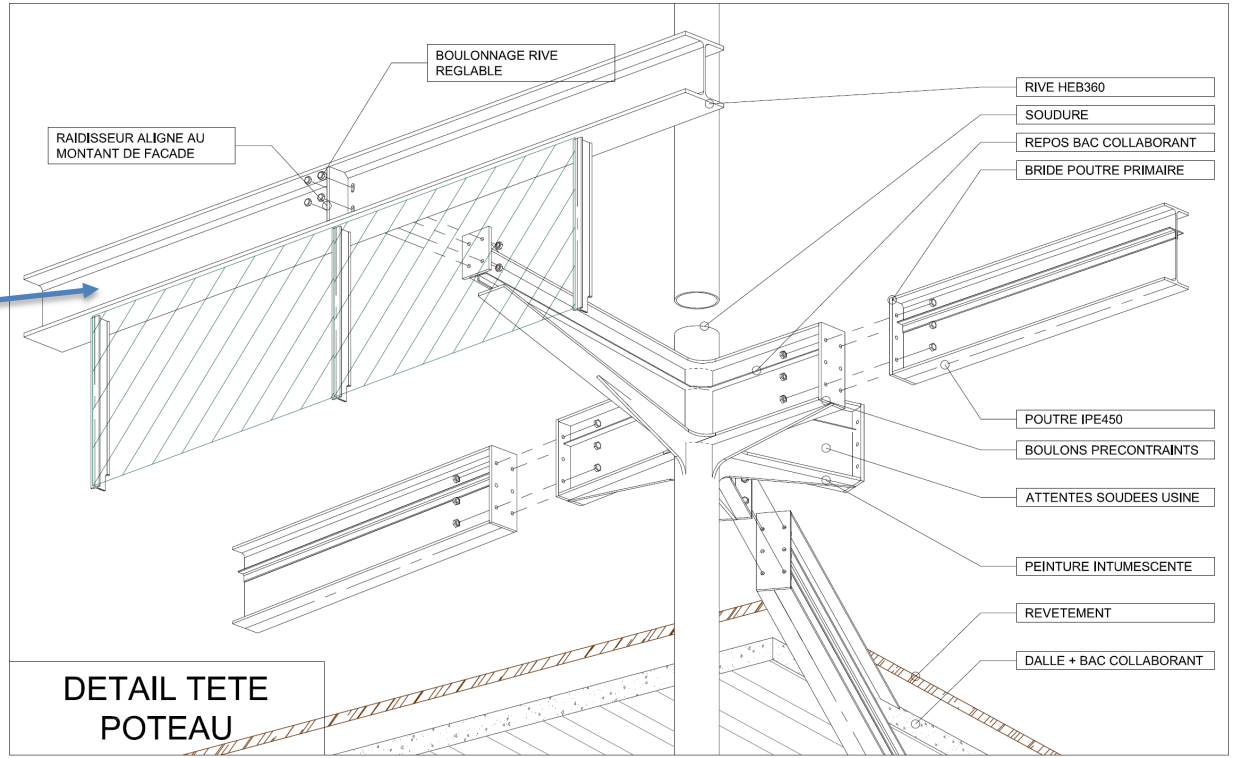


Rive filante = limon des escaliers

Détails structure – planchers

Rive filante = limon des escaliers

HEB360



Détails structure – planchers

Plafond bois

Semelle inférieure apparente

Goussets de renfort

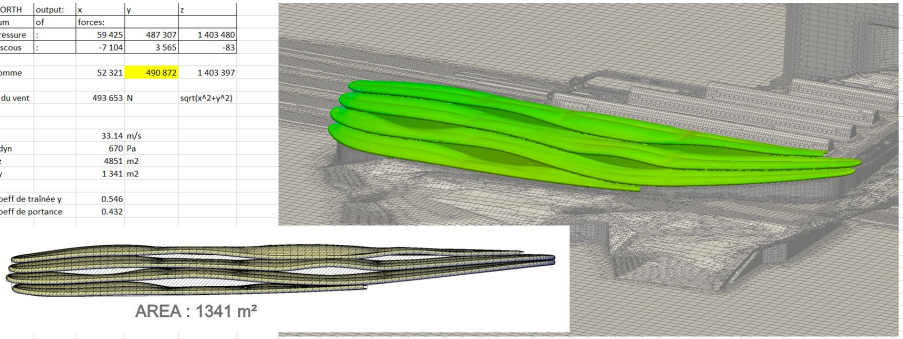
Calcul de la toiture ETFE

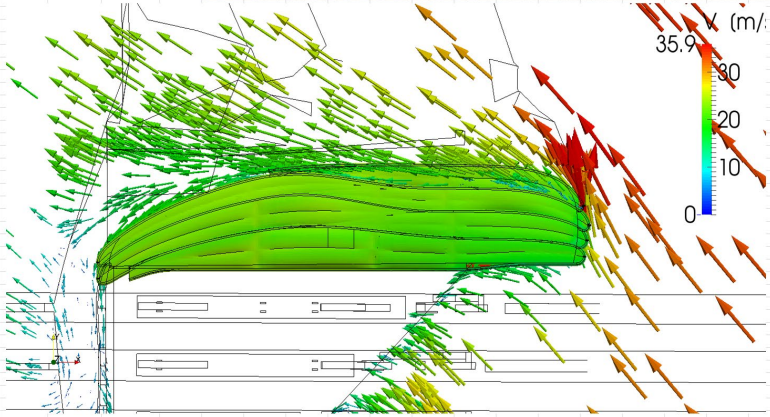
- Charges de vent
- Charges de neige
- Poches d'eau

Calcul de la toiture ETFE

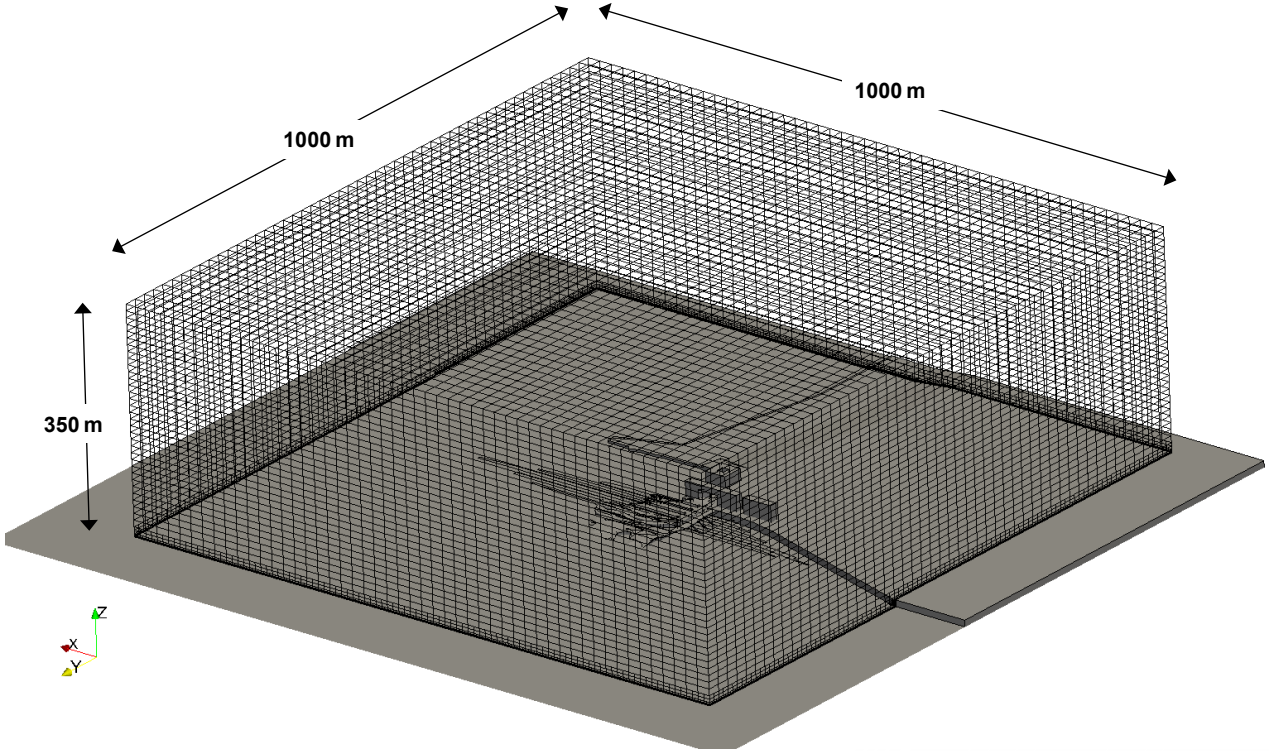
Charges de vent

forces	NORTH	output:	x	y	z
	sum	of	forces:		
	pressure	:	59 425	487 307	1 403 480
	viscous	:	-7 104	3 565	-83
	somme		52 321	490 872	1 403 397
suivant l'axe du vent			493 653	N	sqrt(x^2+y^2)
Vérification					
	V		33.14	m/s	
	Pdyn		670	Pa	
	Sz		4851	m2	
	Sy		1 341	m2	
	coeff de traînée y		0.546		
	coeff de portance		0.432		

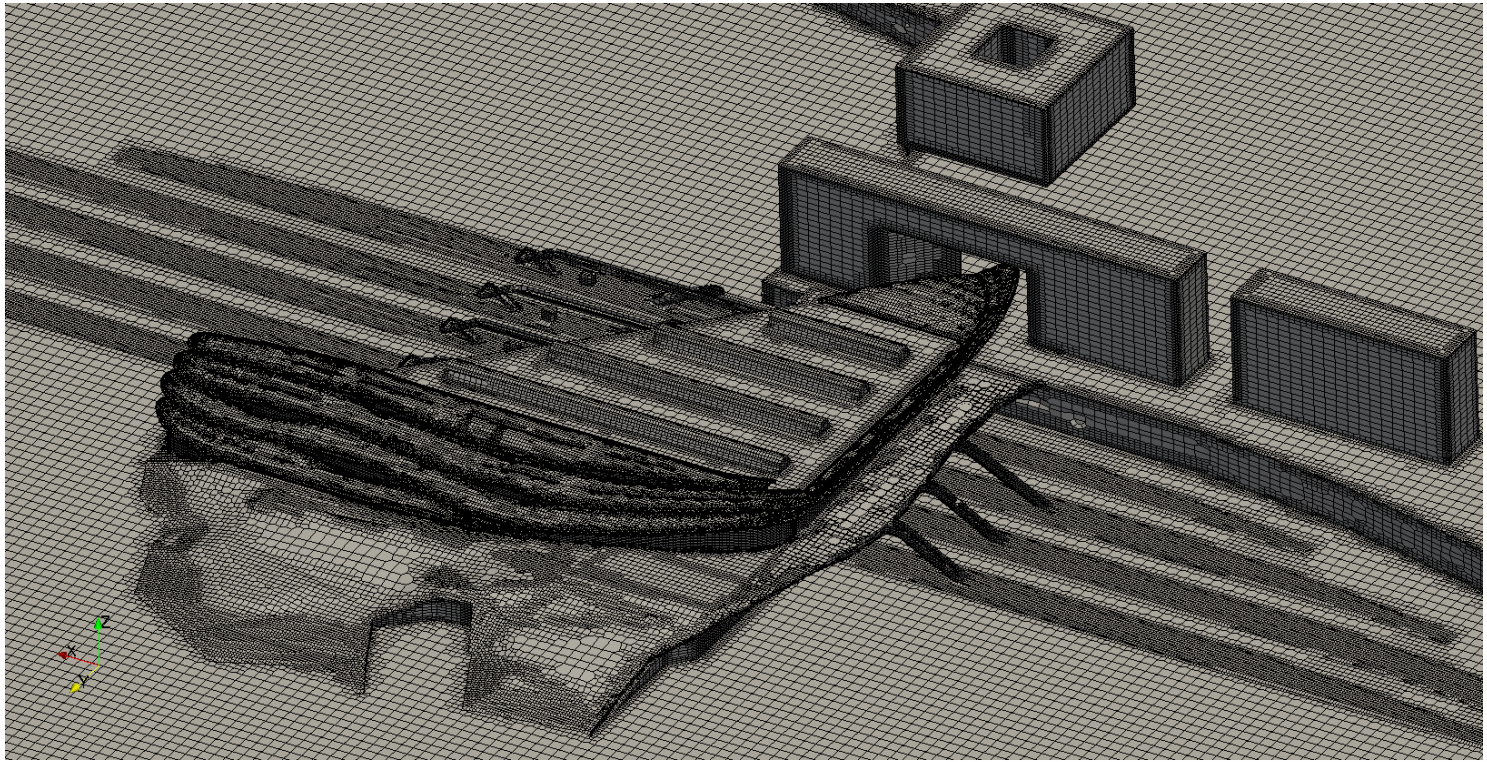




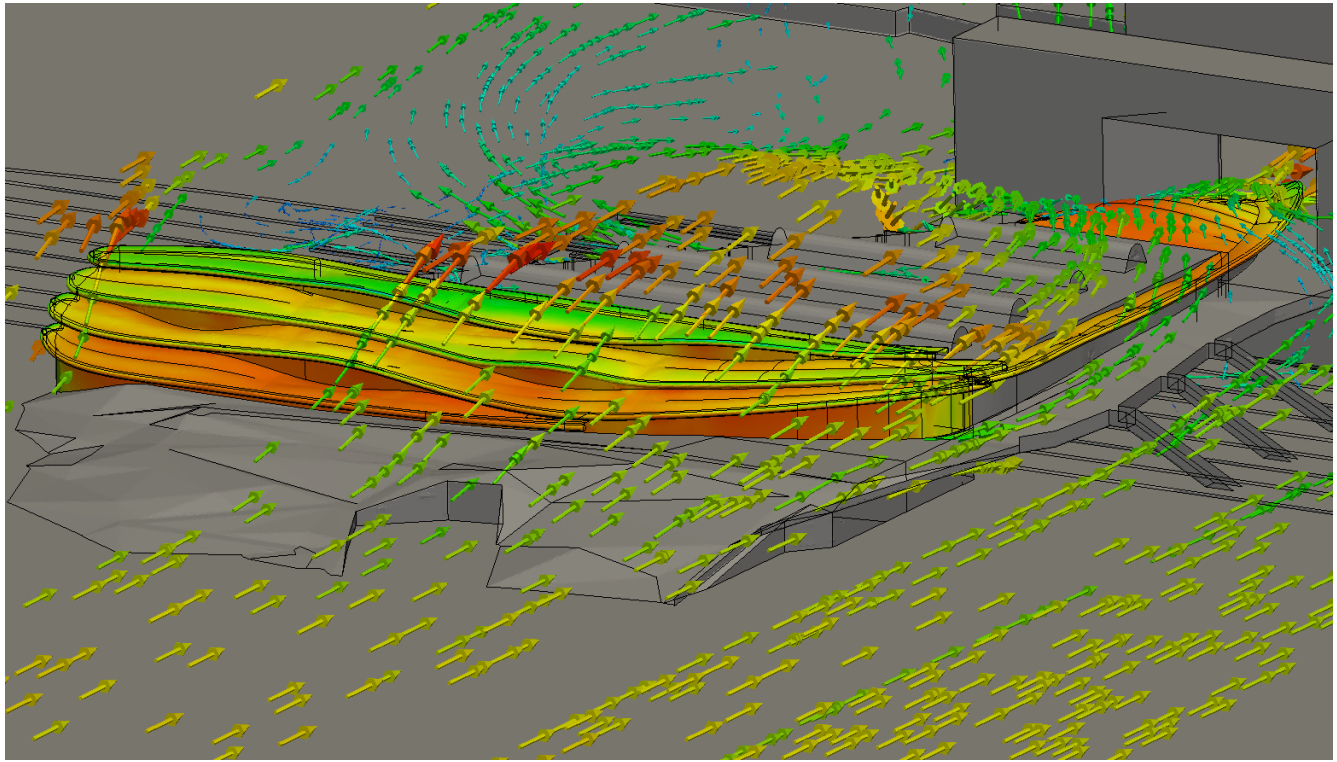
Calcul de la toiture ETFE



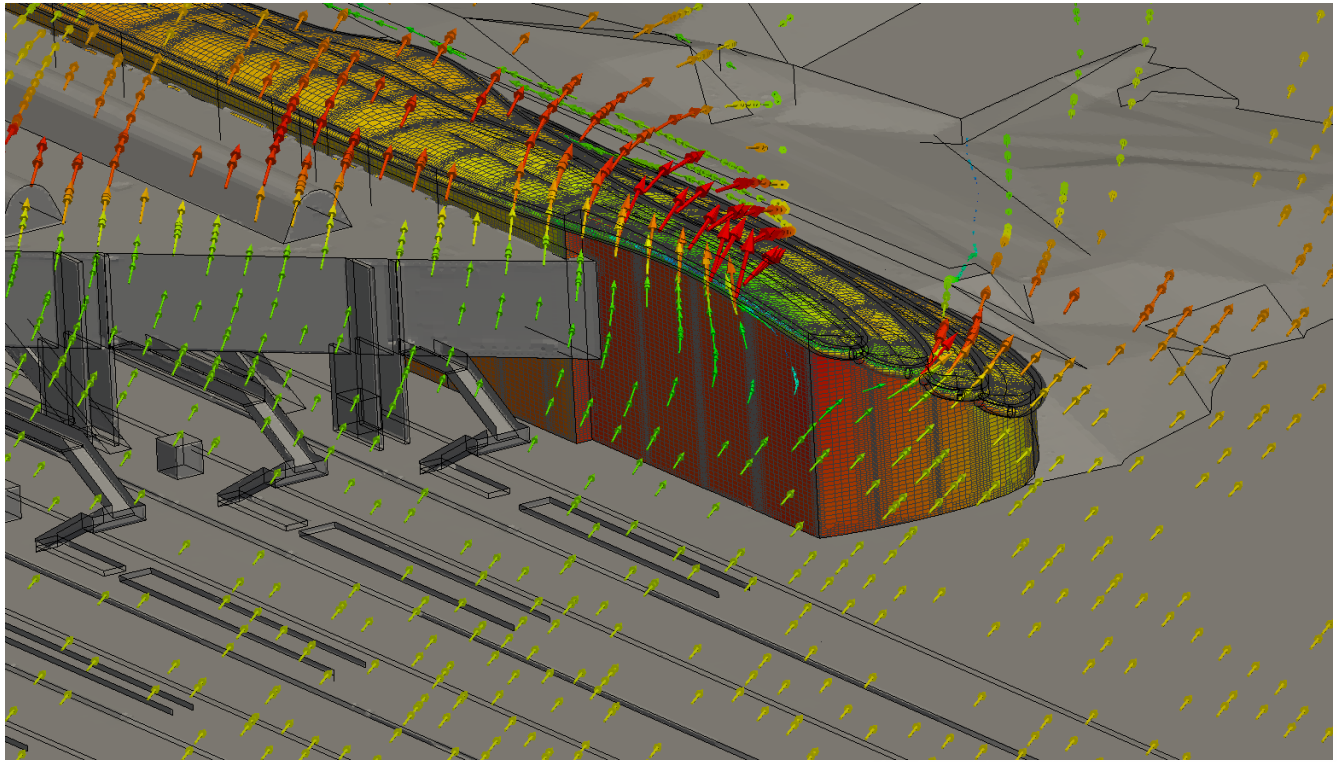
Calcul de la toiture ETFE



Calcul de la toiture ETFE

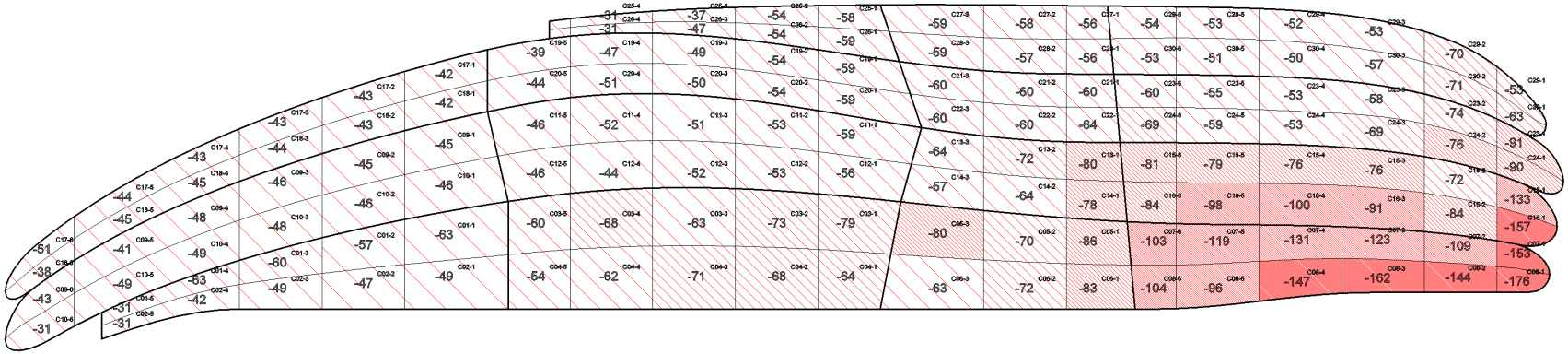


Calcul de la toiture ETFE



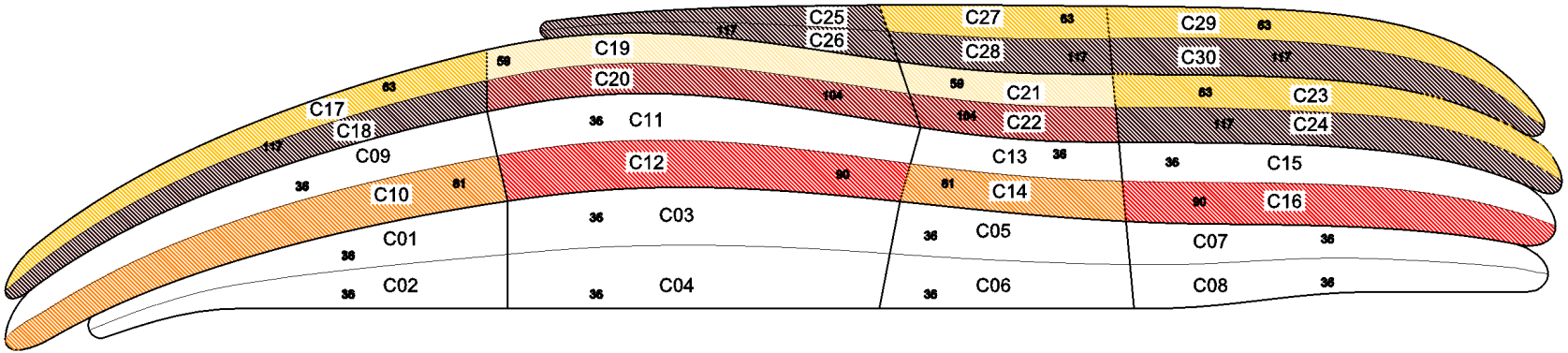
Calcul de la toiture ETFE

Charges de vent



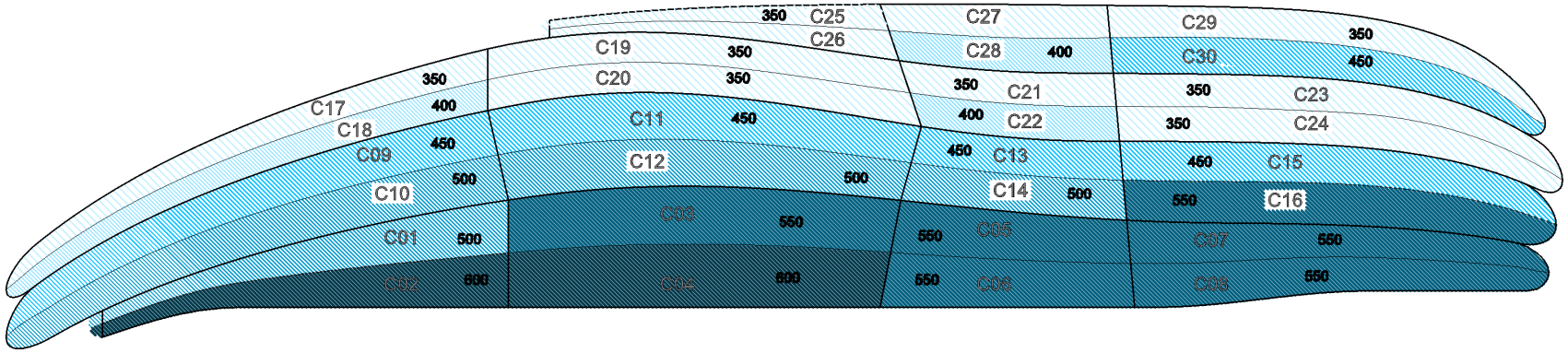
Calcul de la toiture ETFE

Charges de neige



0.8	1.3	1.4	1.8	2.0	2.3	2.6
36	59	63	81	90	104	117

Calcul de la toiture ETFE



Calcul de la toiture ETFE

- 18 Octobre 2016 : accident à la gare Victoria de Manchester dû à la crevaison d'une poche d'eau

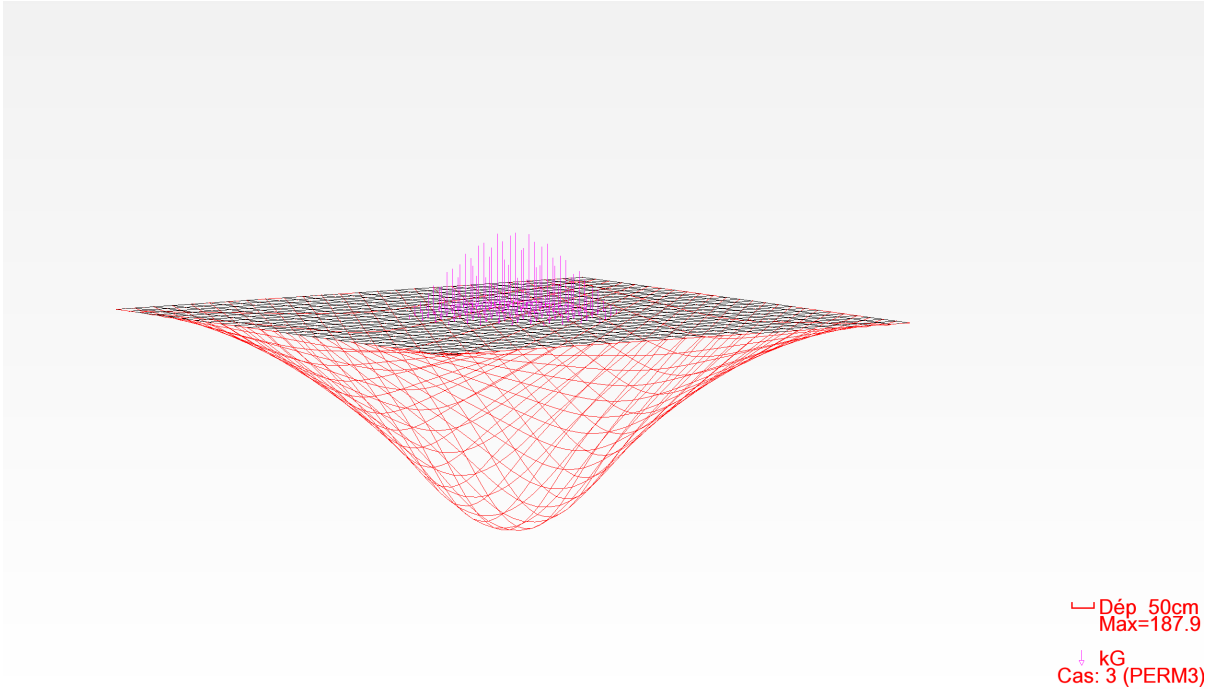
Calcul de la toiture ETFE

- Les poches d'eau sont désormais interdites en France

- Le projet a été conçu avant cet événement, on ne peut pas éliminer la formation de poches d'eau,

- Le projet fait l'objet d'un ATEx, il est crucial de contrôler les poches d'eau

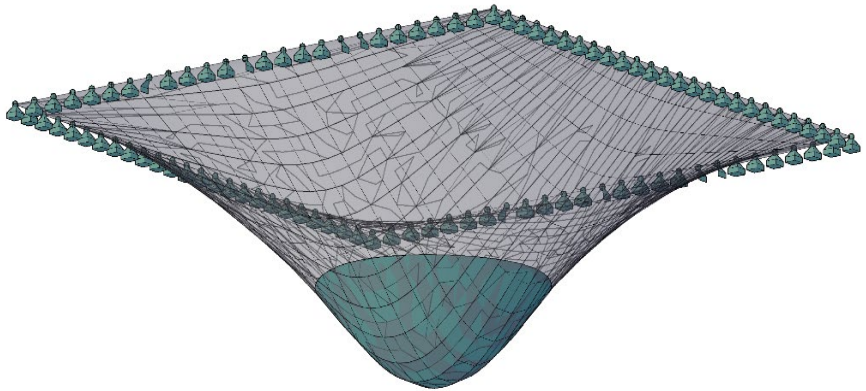
Calcul de la toiture ETFE



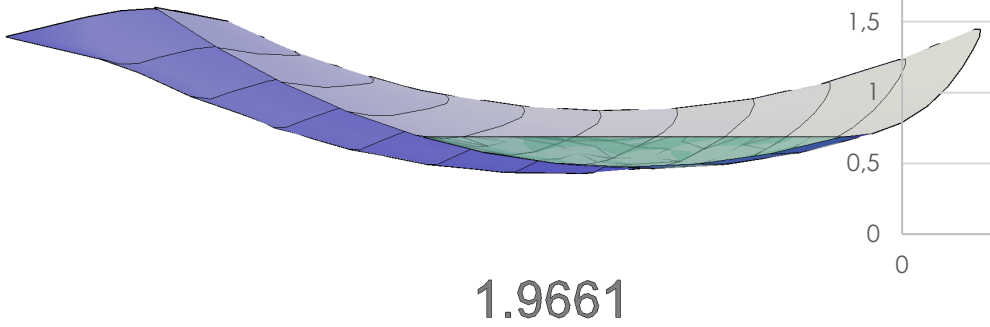
$$p(x,y) = \rho g \cdot \left[u_z(x,y) - h_w\right]$$

Calcul de la toiture ETFE

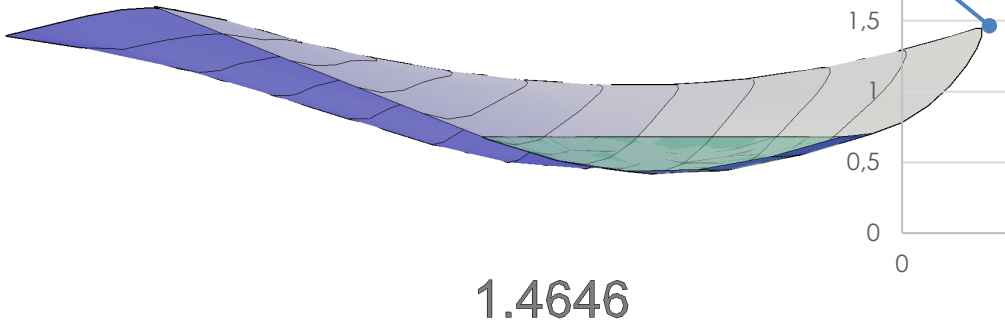
Après n itérations, on obtient un volume d'eau

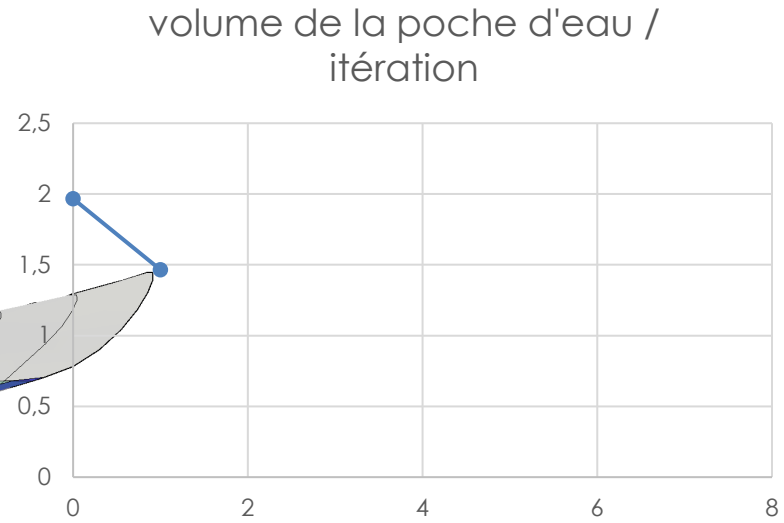


Calcul itératif des poches d'eau



Calcul itératif des poches d'eau





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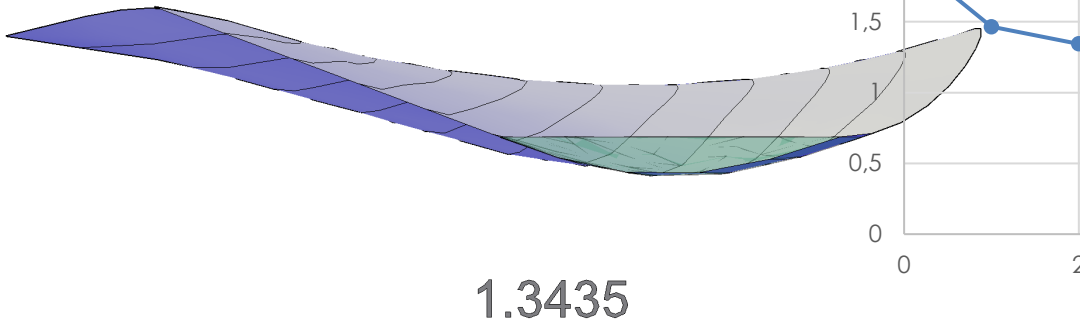

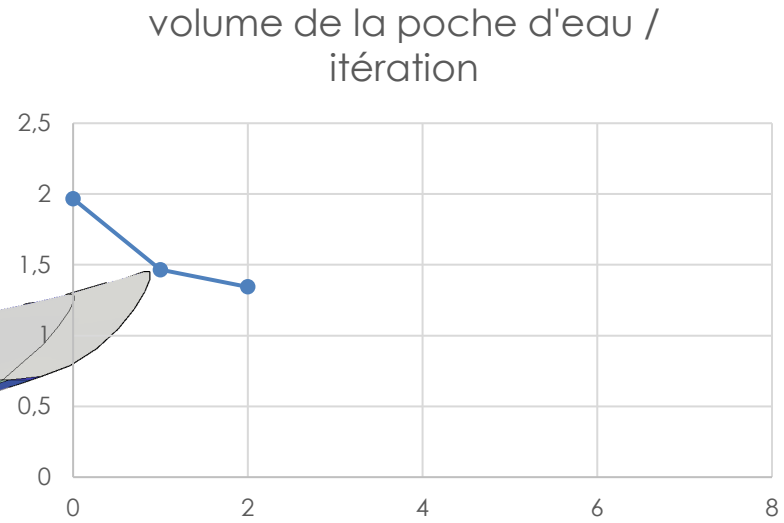

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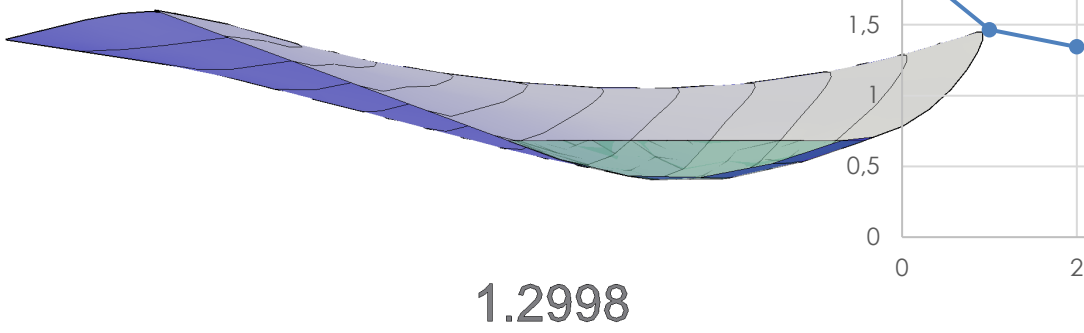

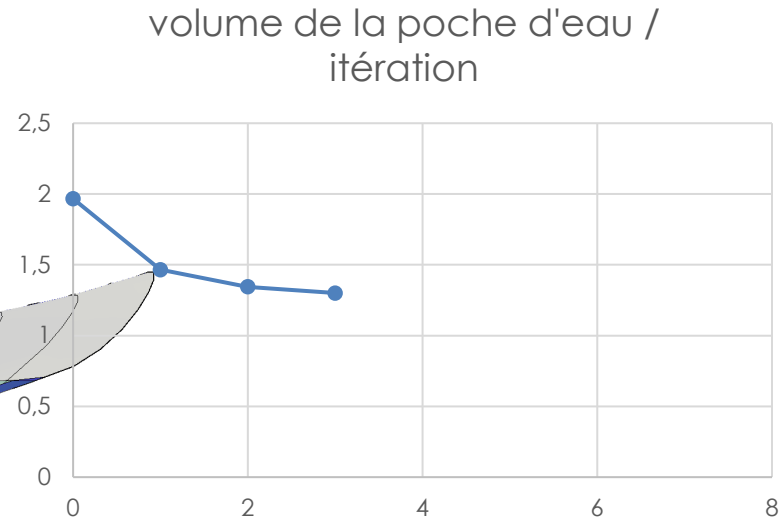

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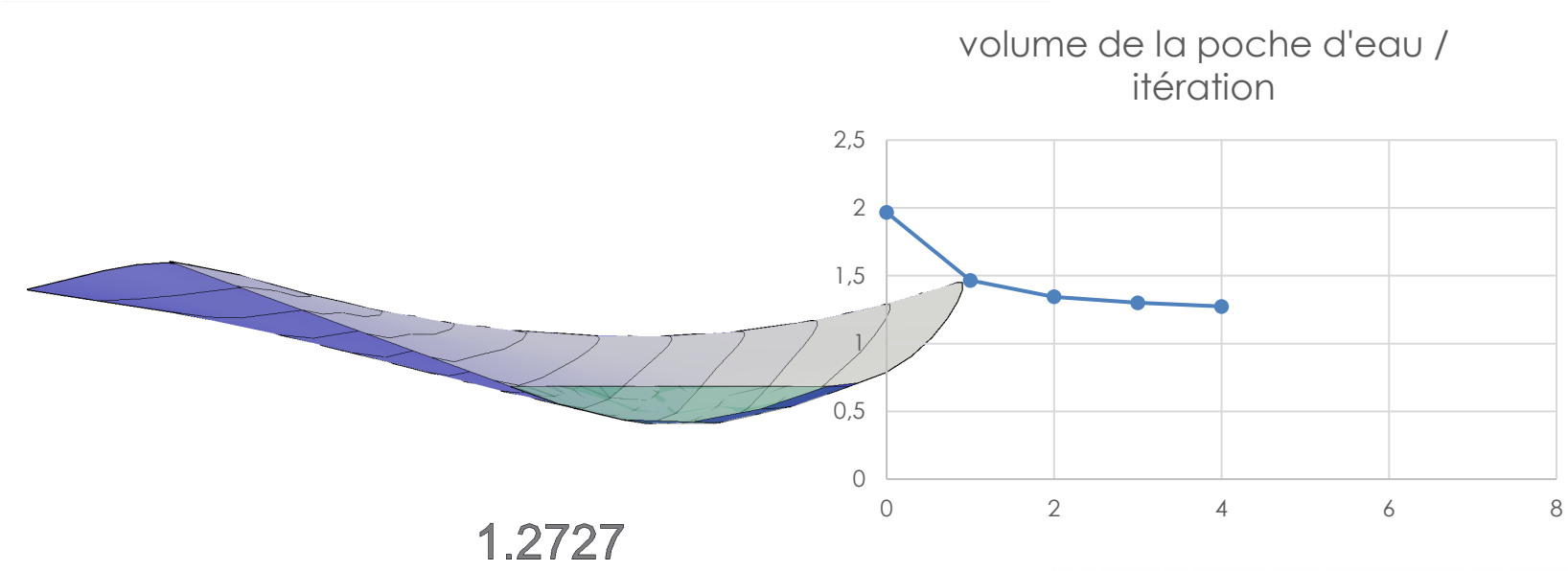
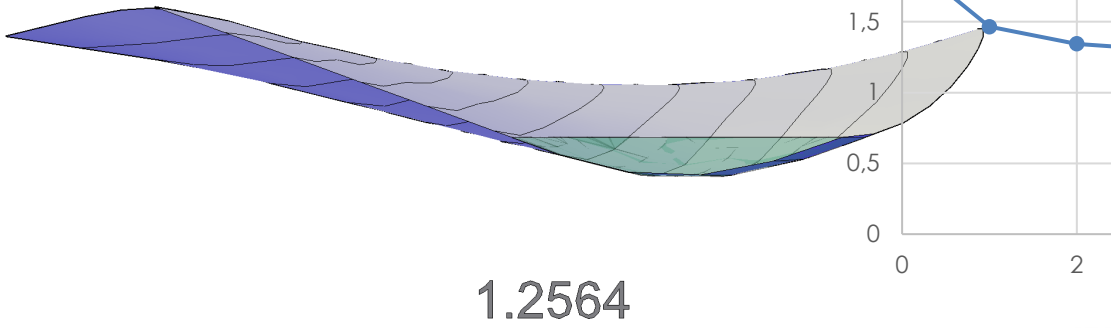
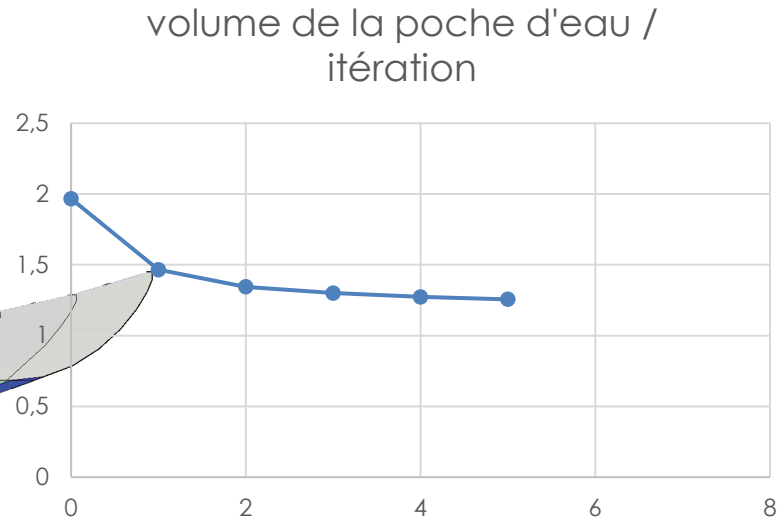


Calcul itératif des poches d'eau





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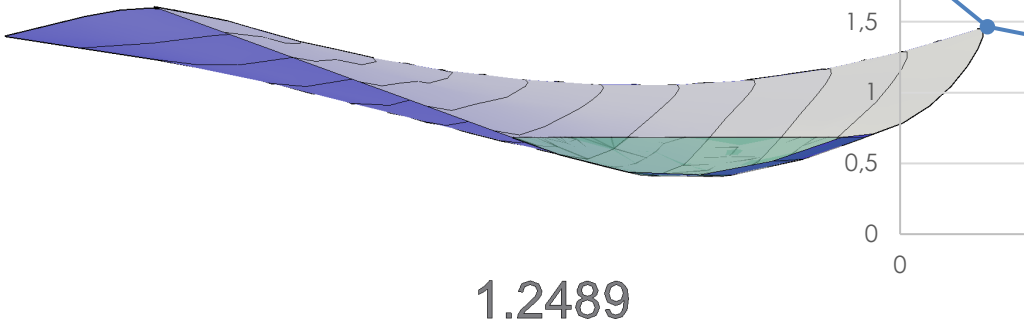

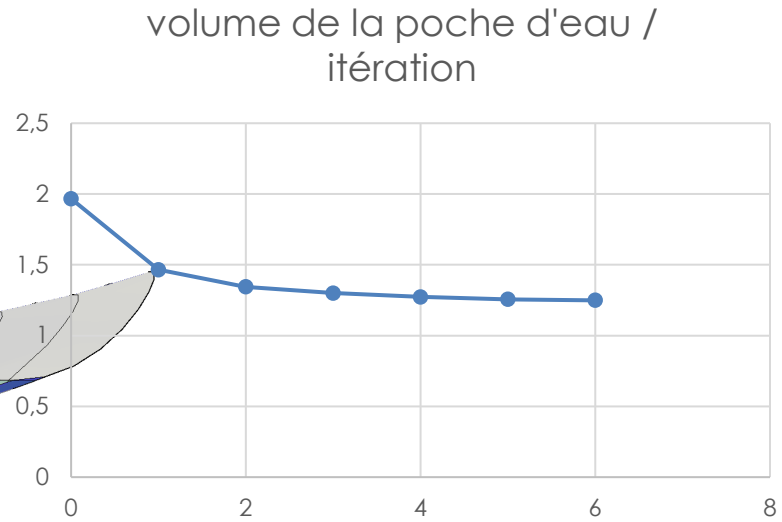

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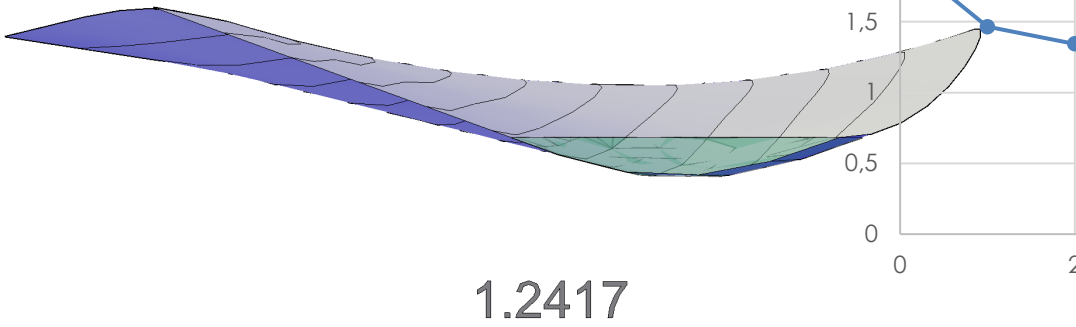

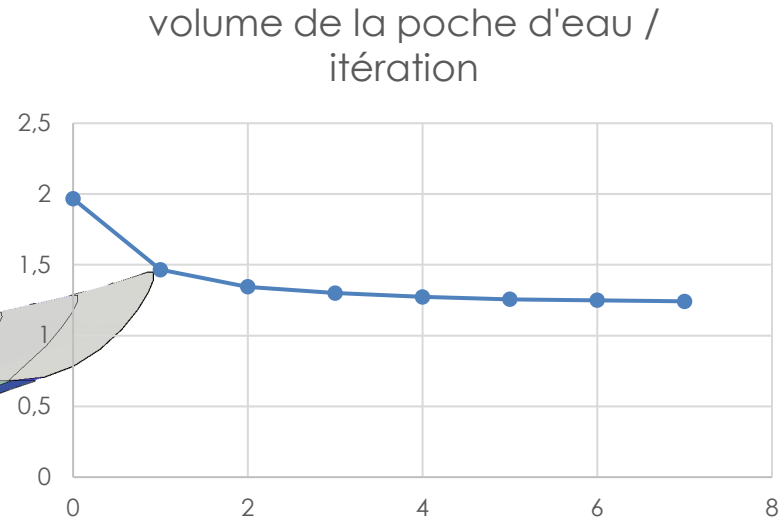

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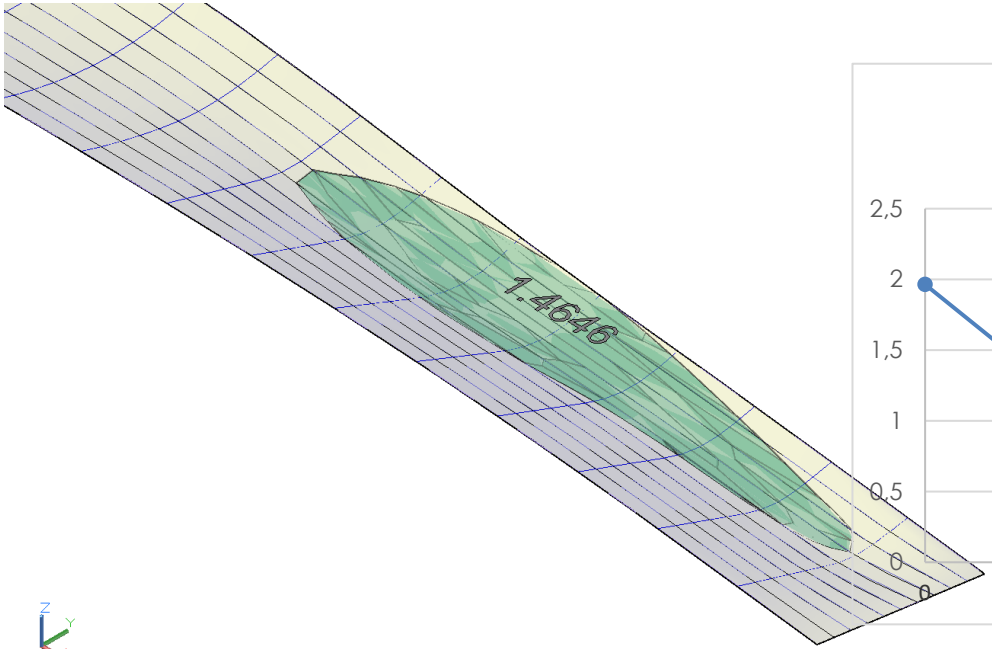

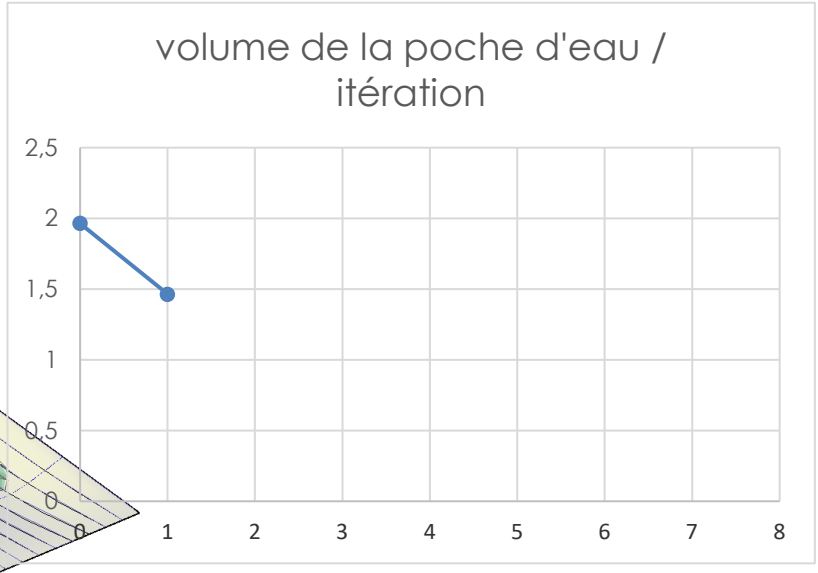

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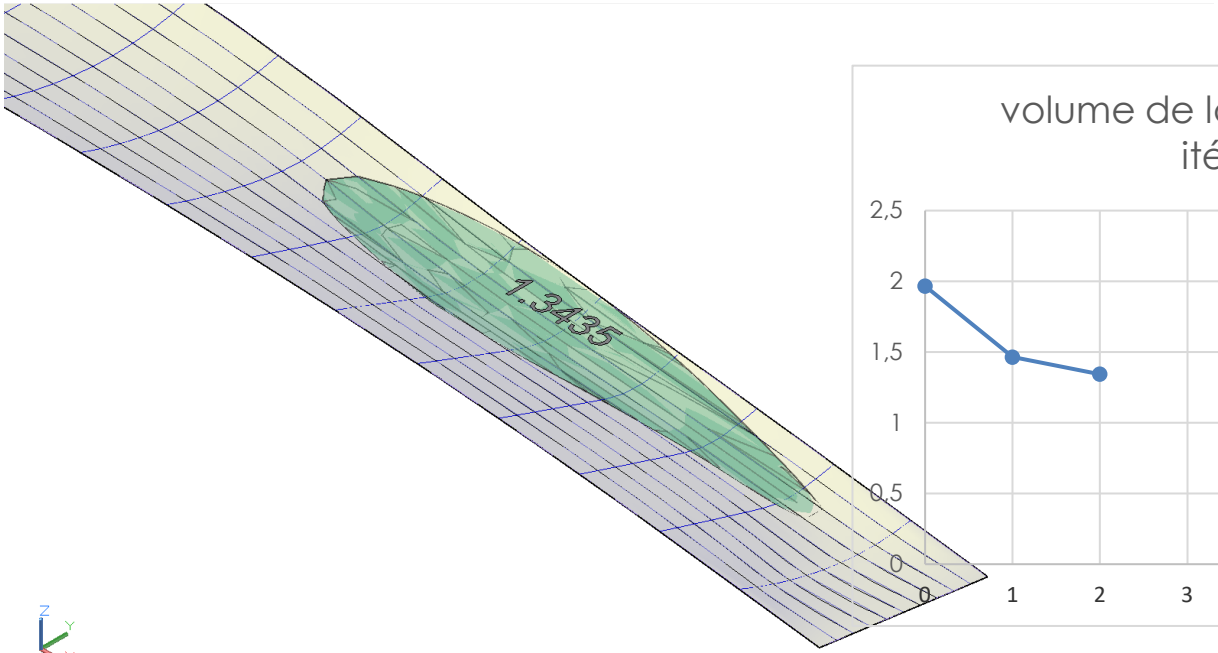

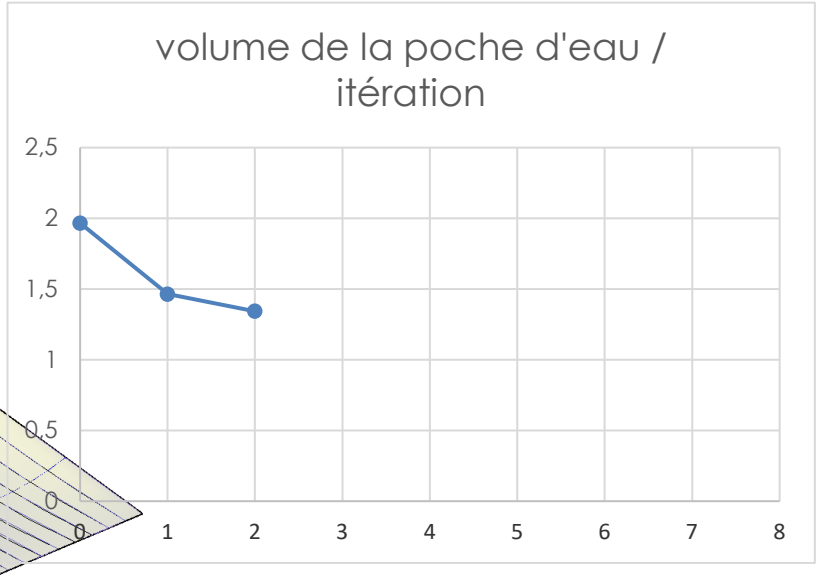

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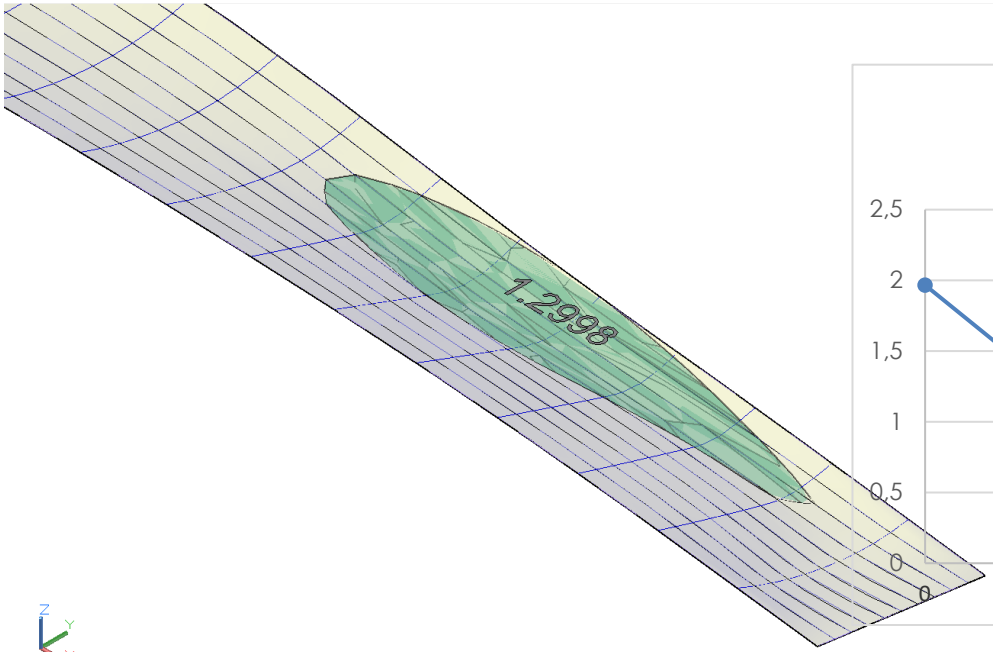

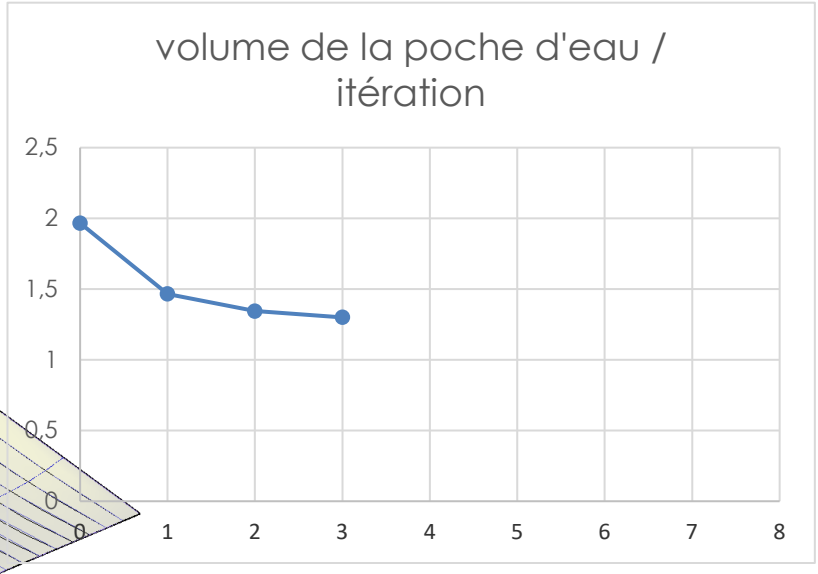

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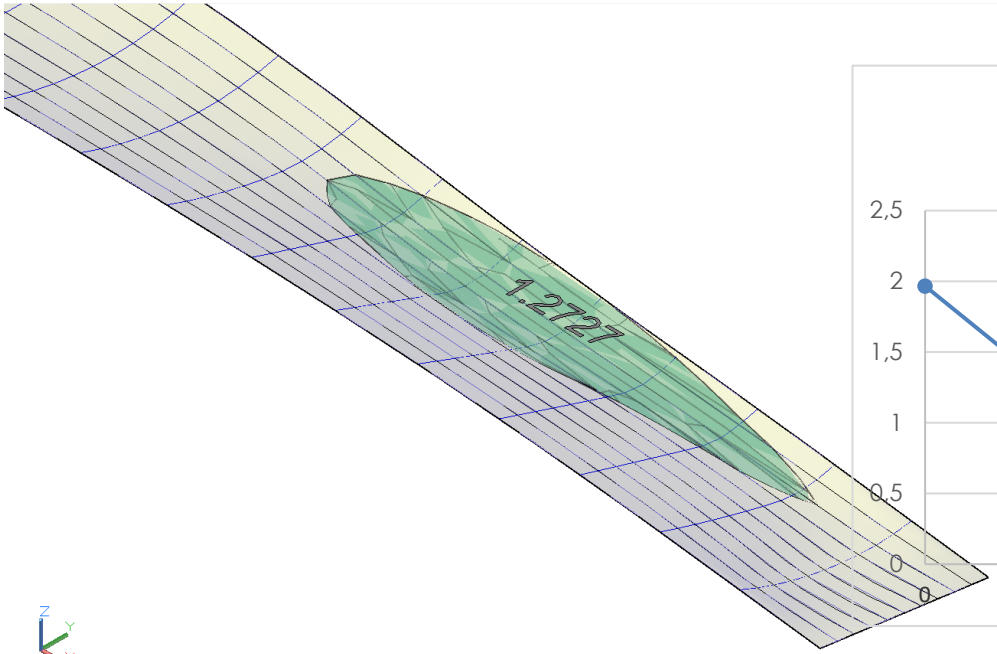

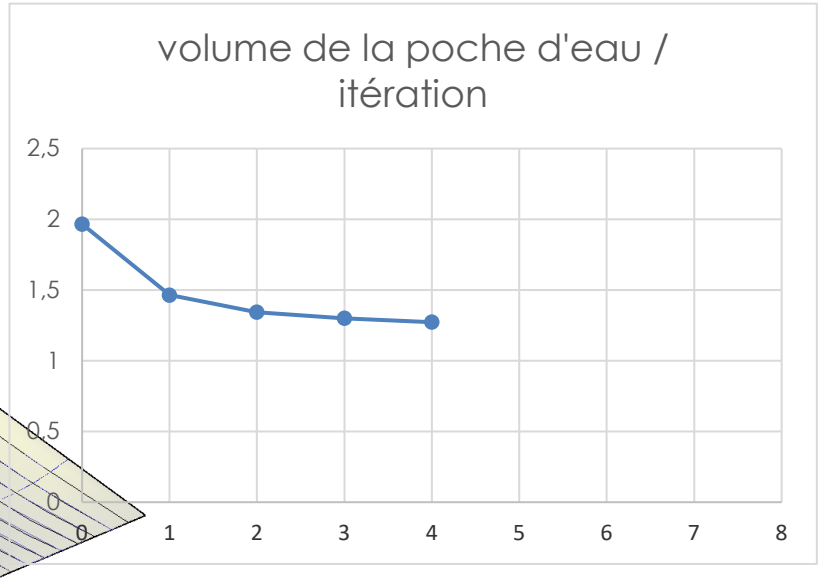

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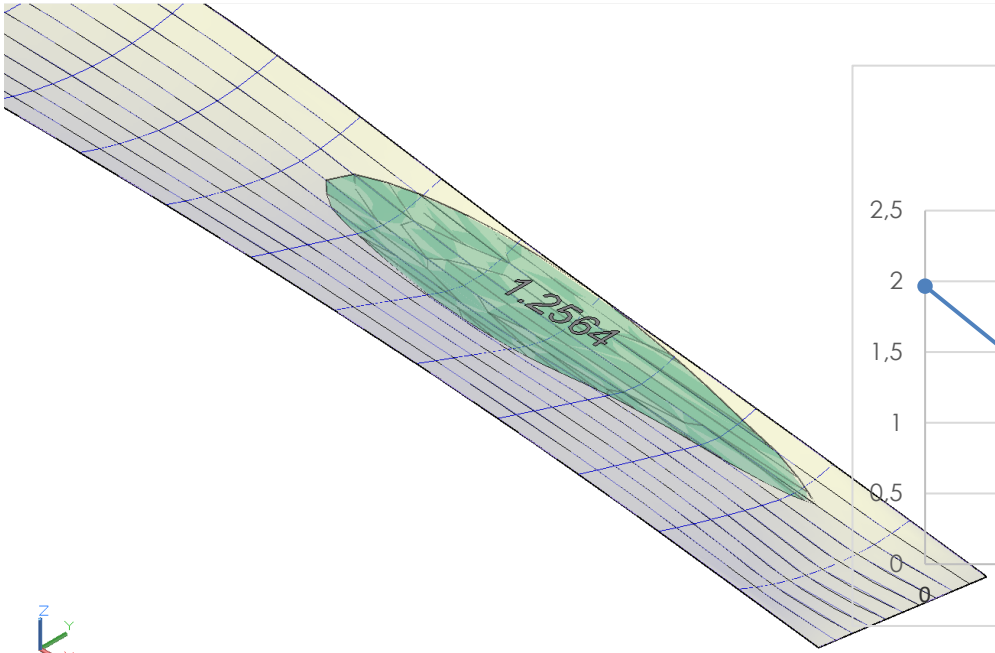

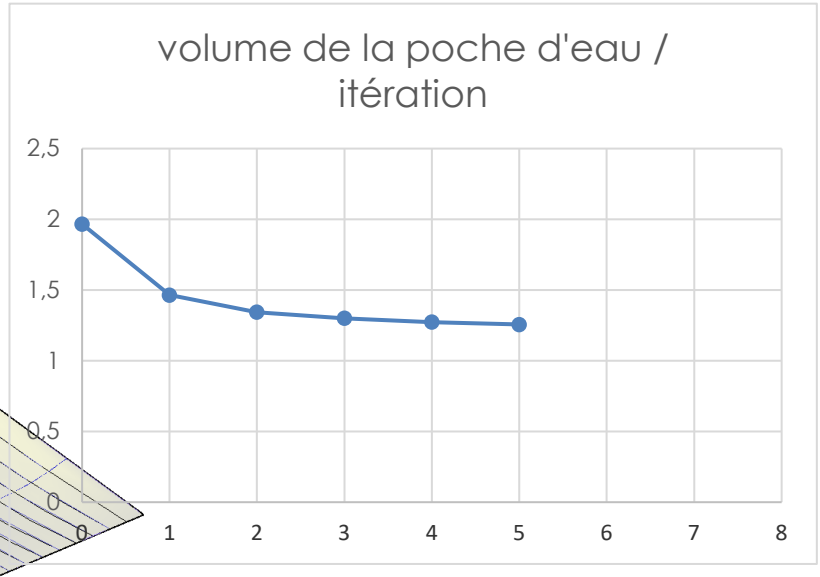

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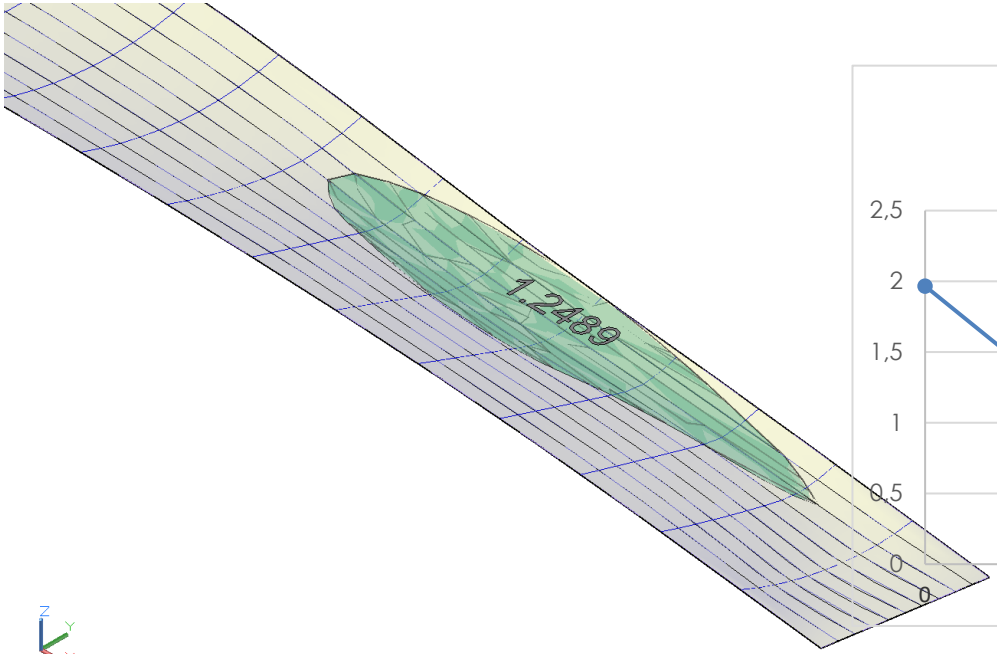

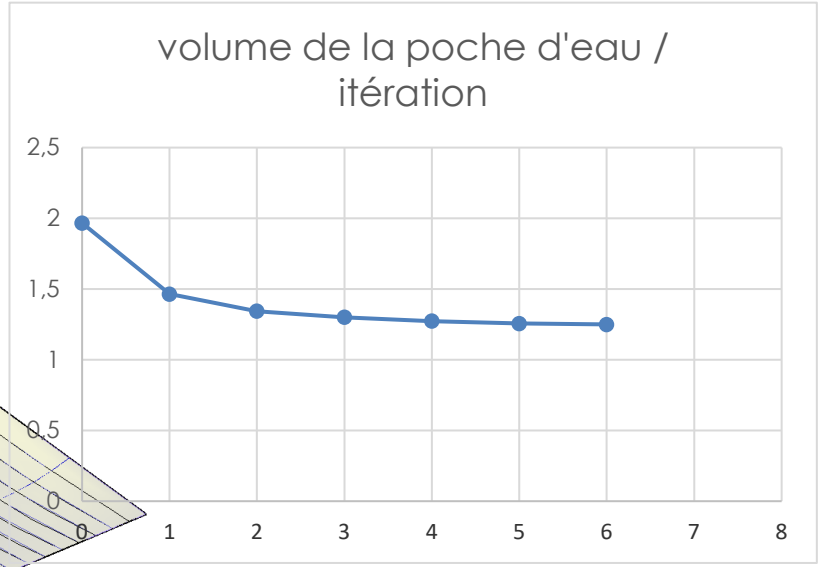

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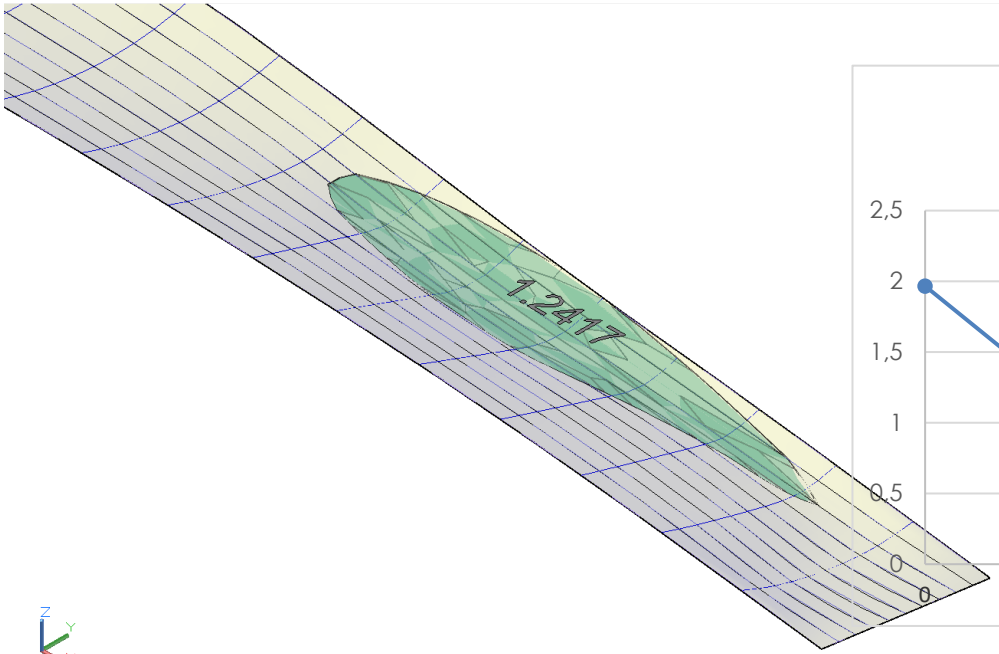
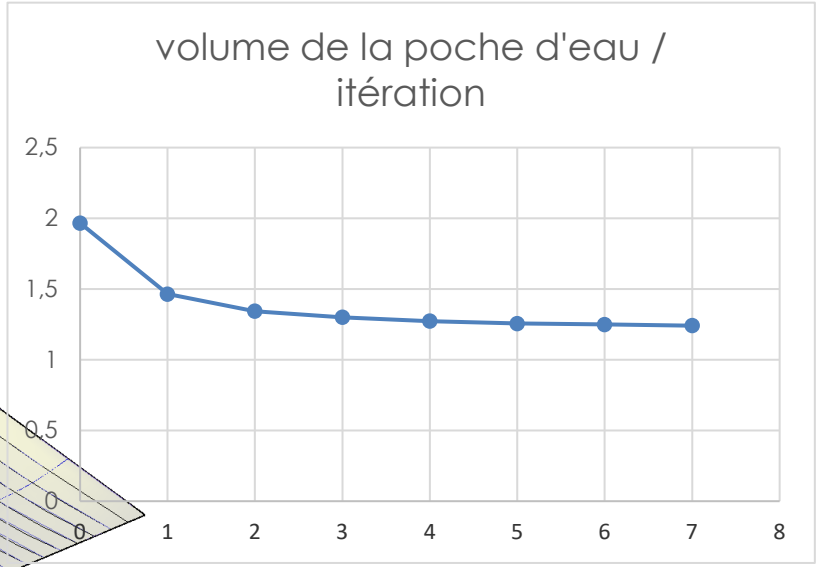
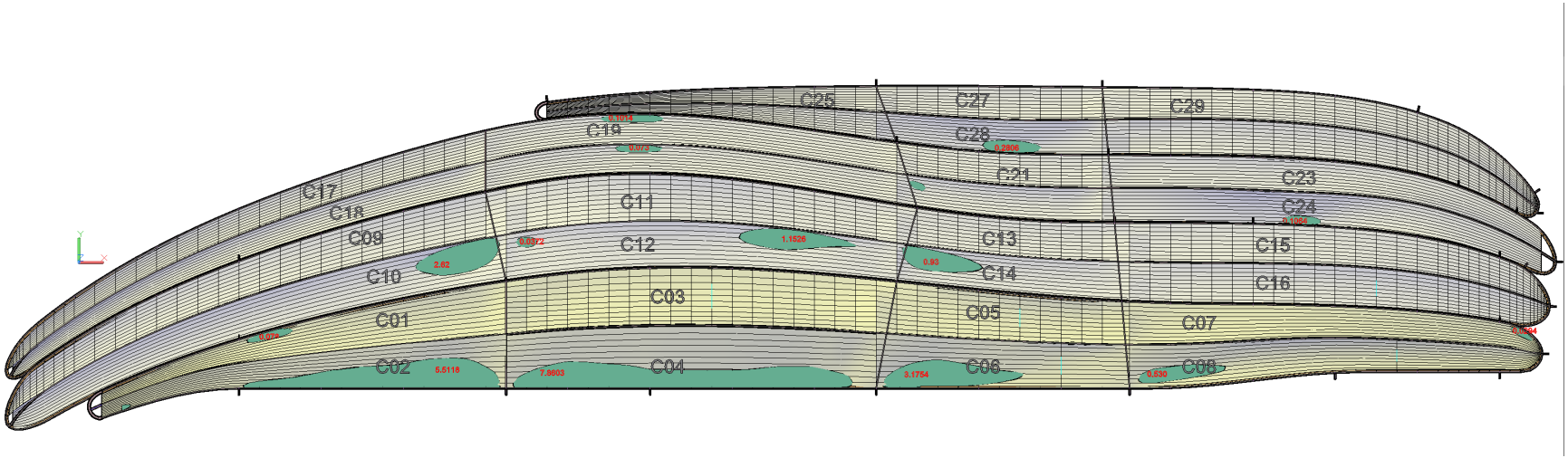
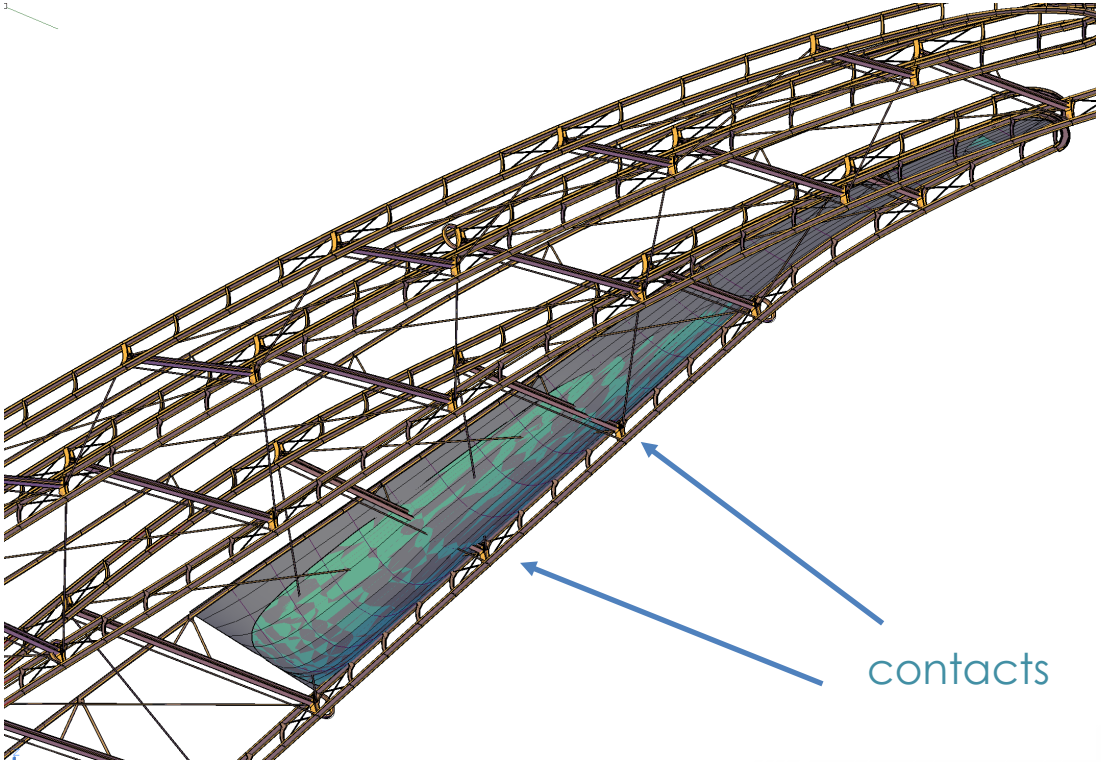




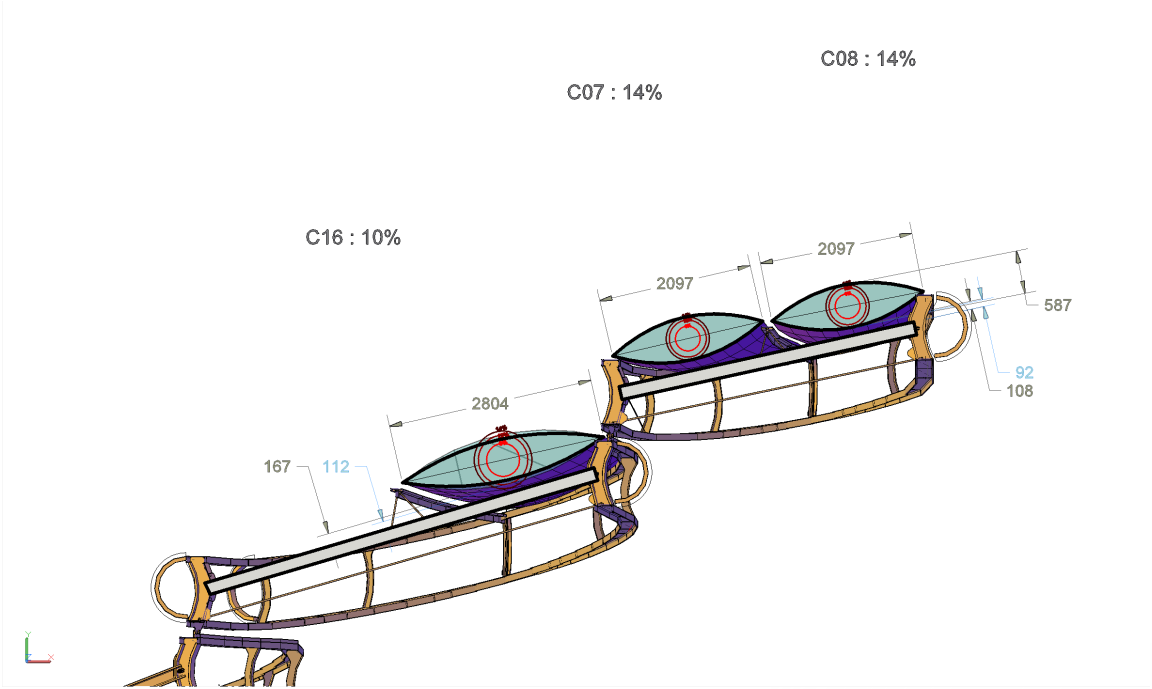
Calcul des poches d'eau



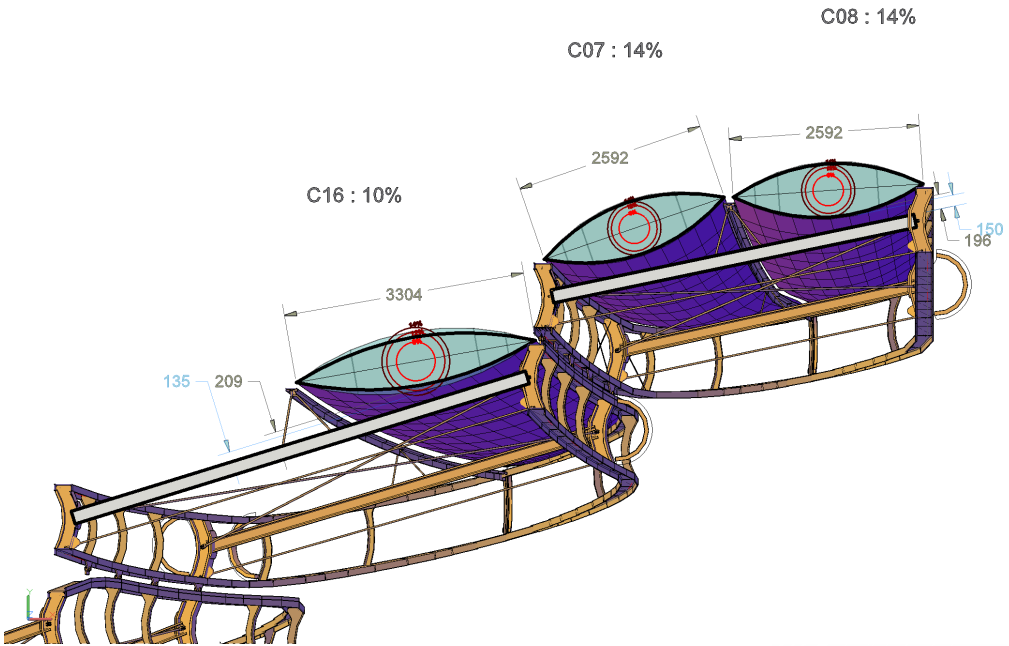
Poches d'eau : non contact avec charpente



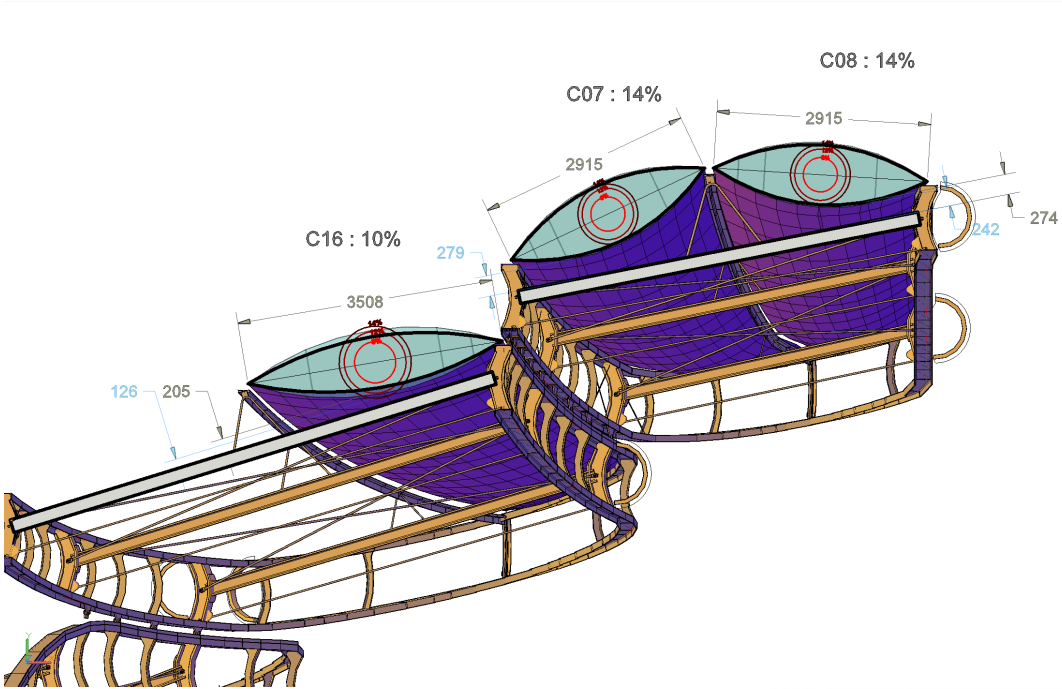
Non contact avec la charpente – gonflage



Non contact avec la charpente – gonflage 540



Non contact avec la charpente – gonflage 540



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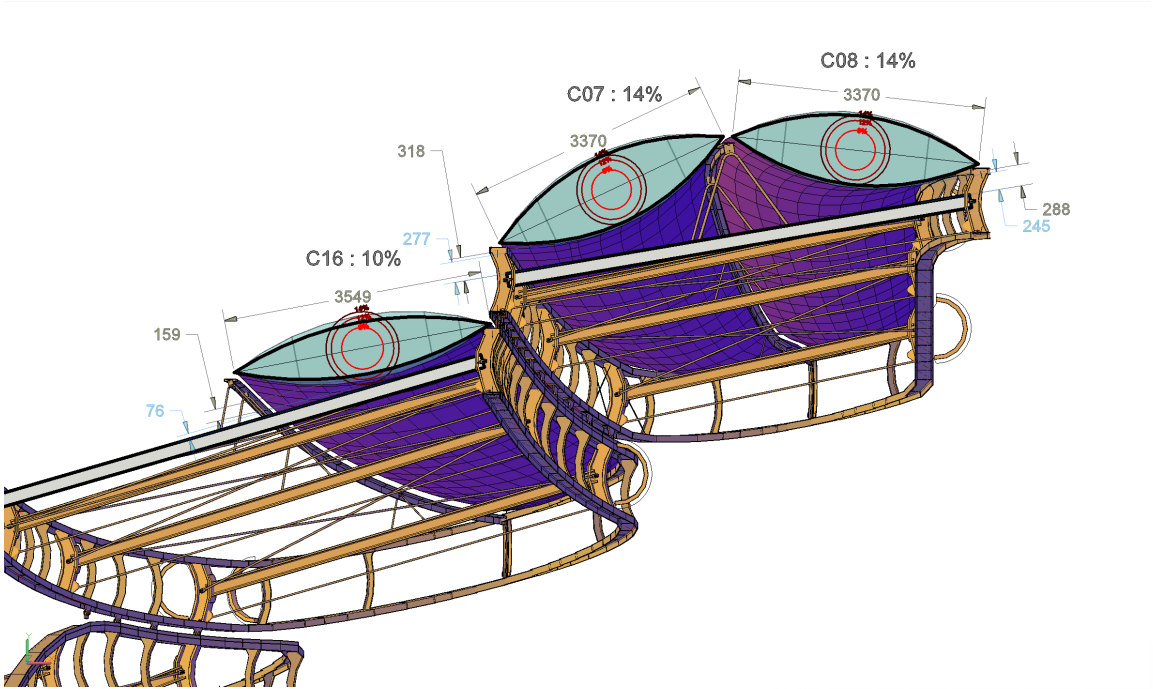

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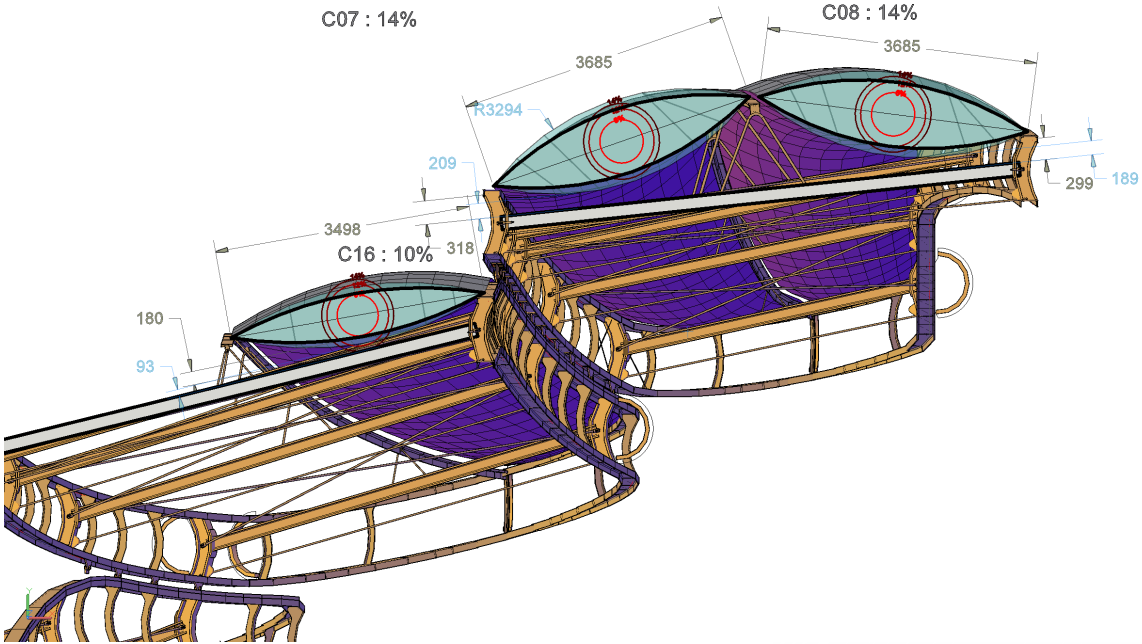

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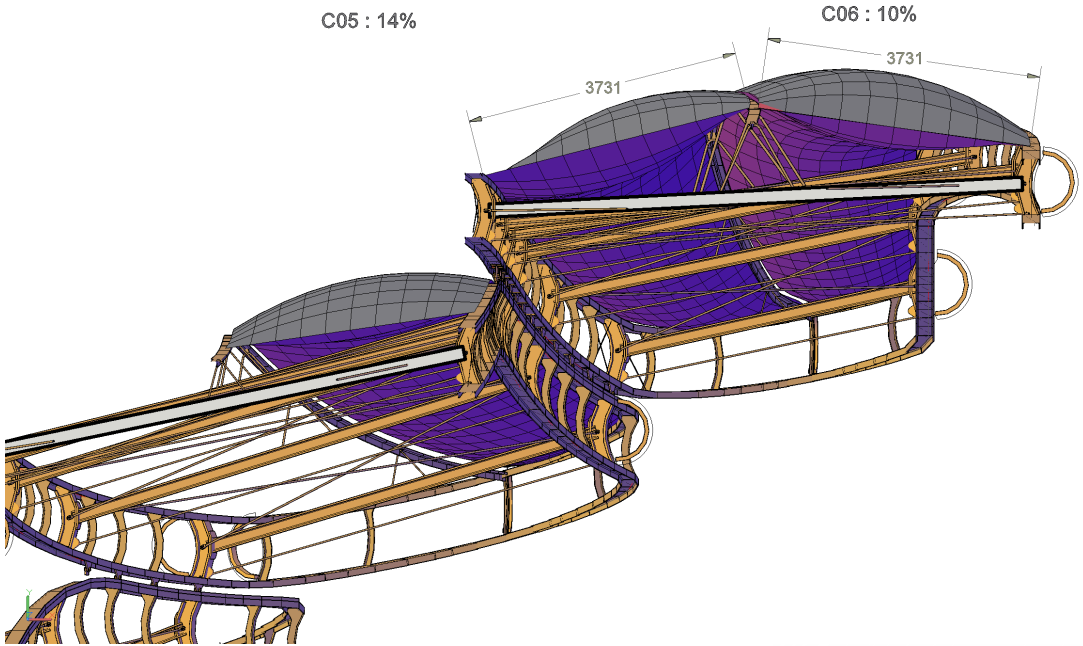
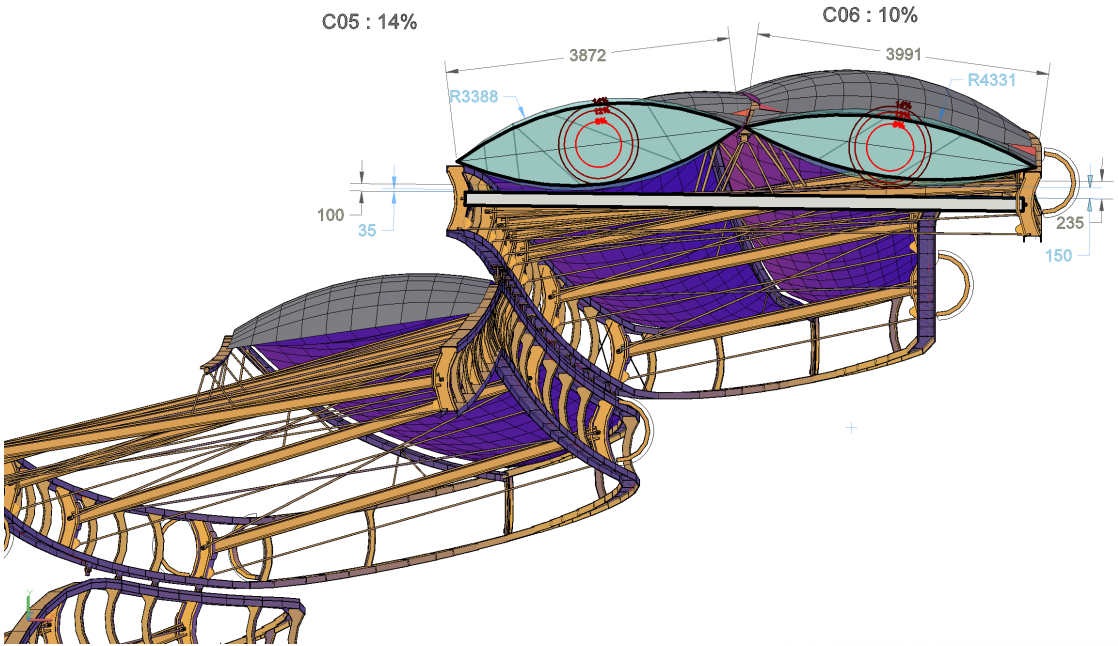
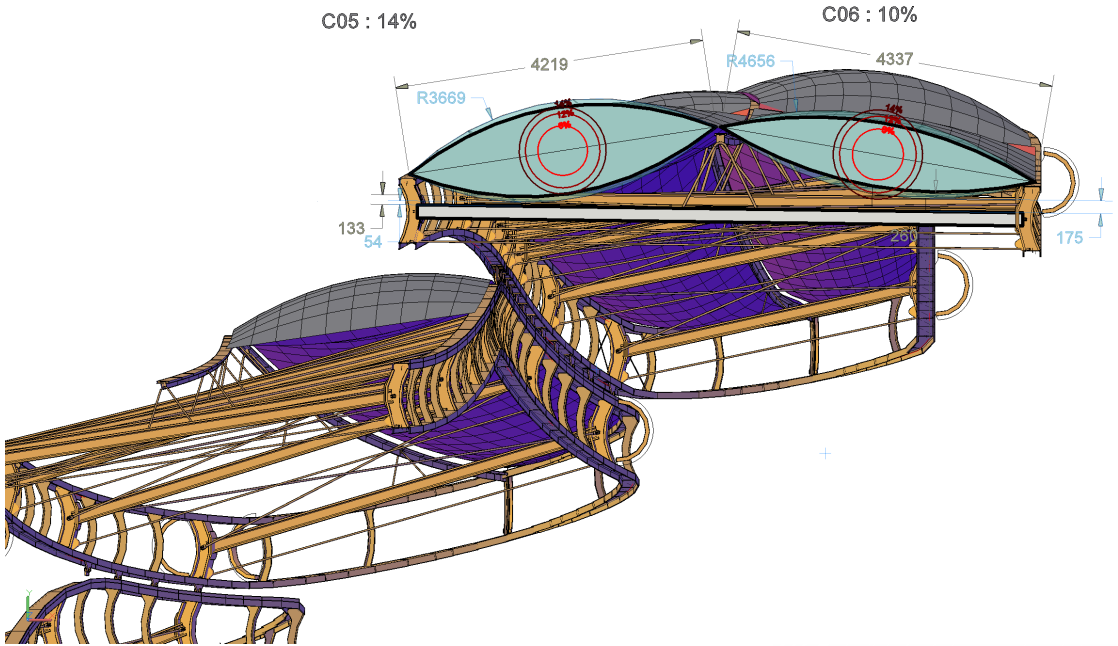


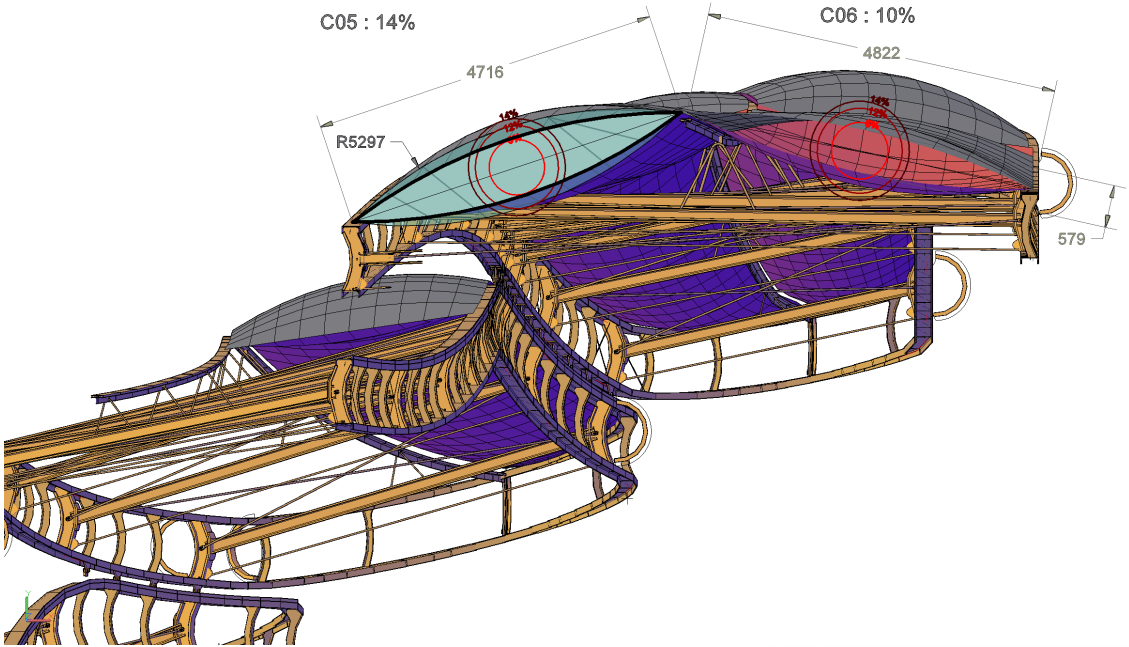
Non contact avec la charpente – gonflage 540



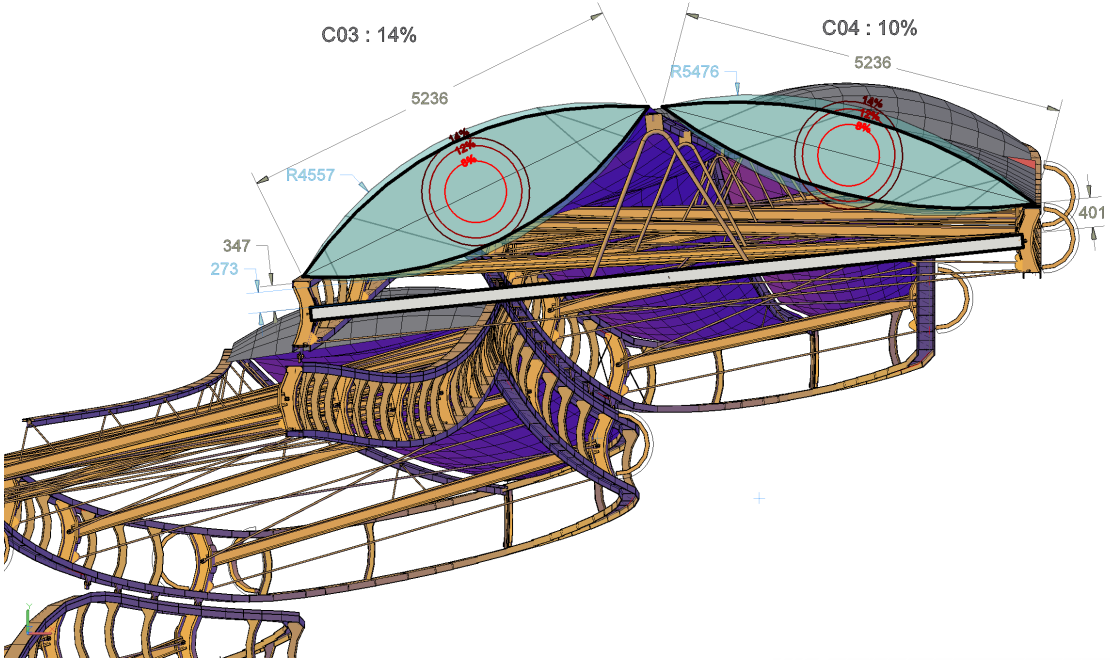
Non contact avec la charpente – gonflage 540



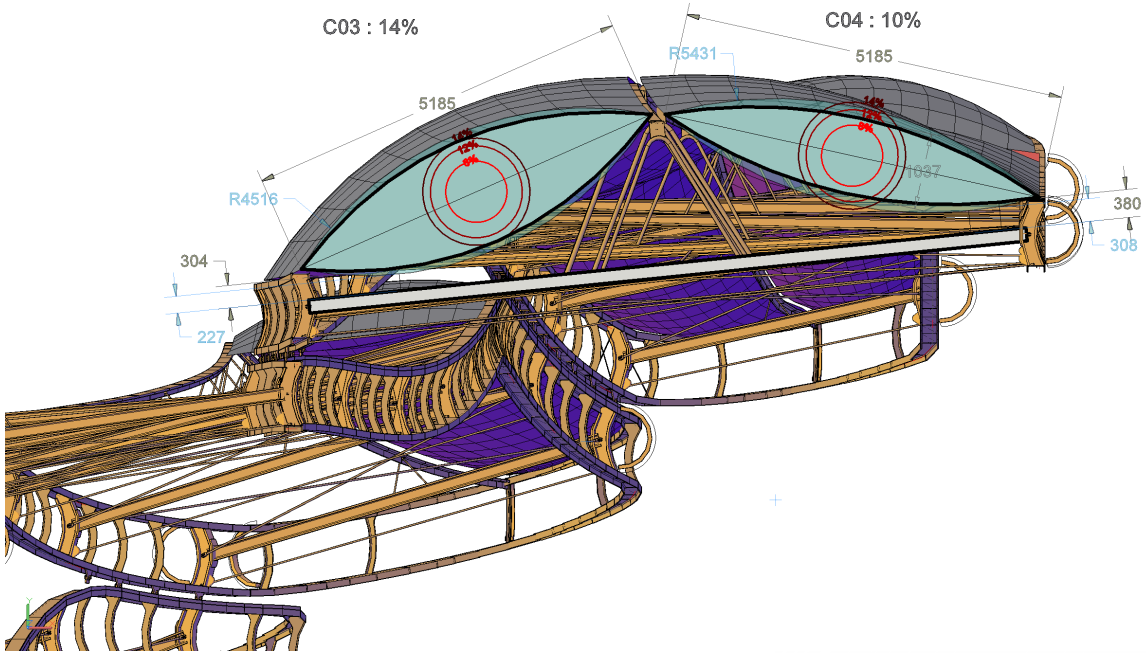
Non contact avec la charpente – gonflage 540



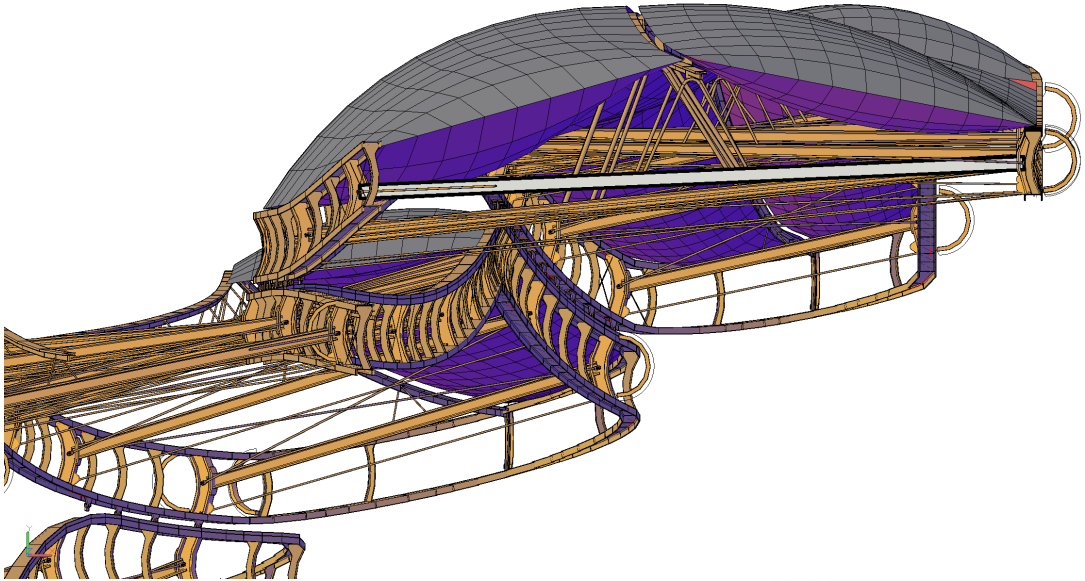
Non contact avec la charpente – gonflage 540



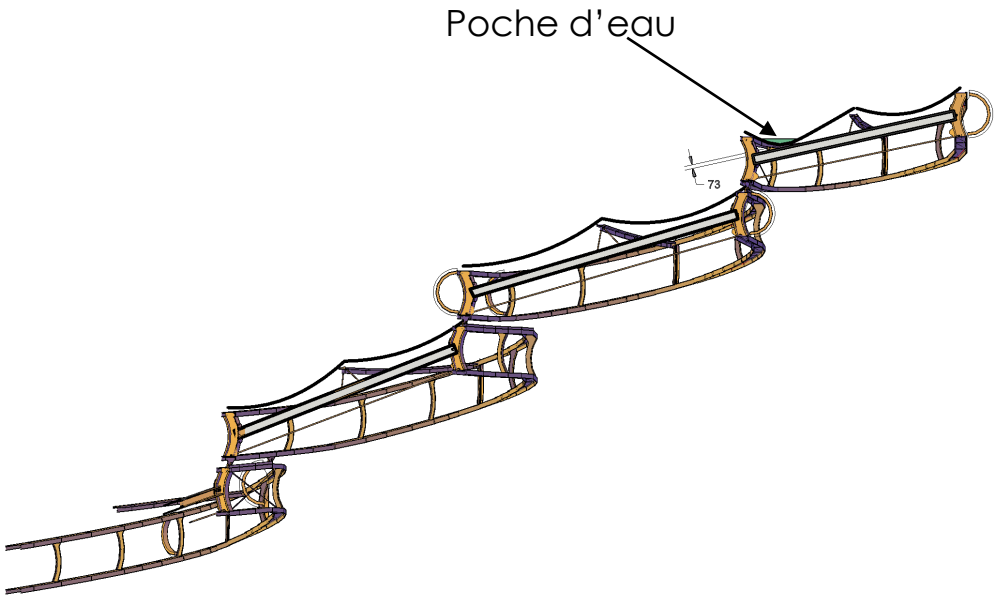
Non contact avec la charpente – gonflage 540



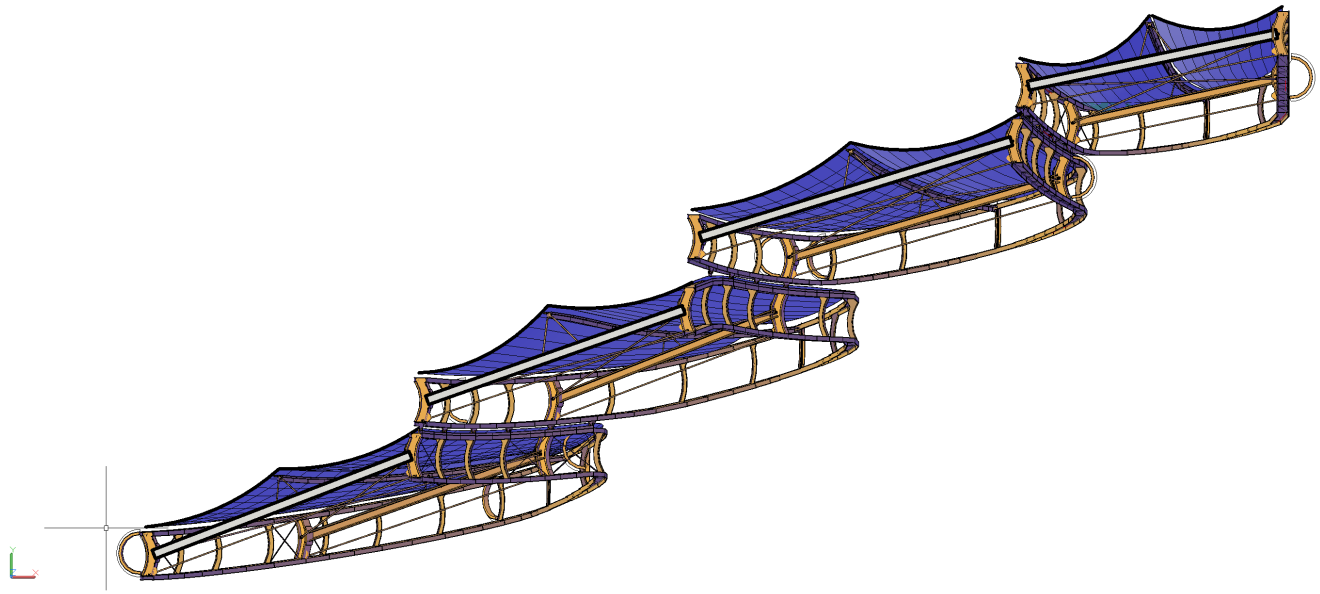
Non contact avec la charpente – gonflage 540



Non contact avec la charpente – poches d'eau



Non contact avec la charpente – poches d'eau



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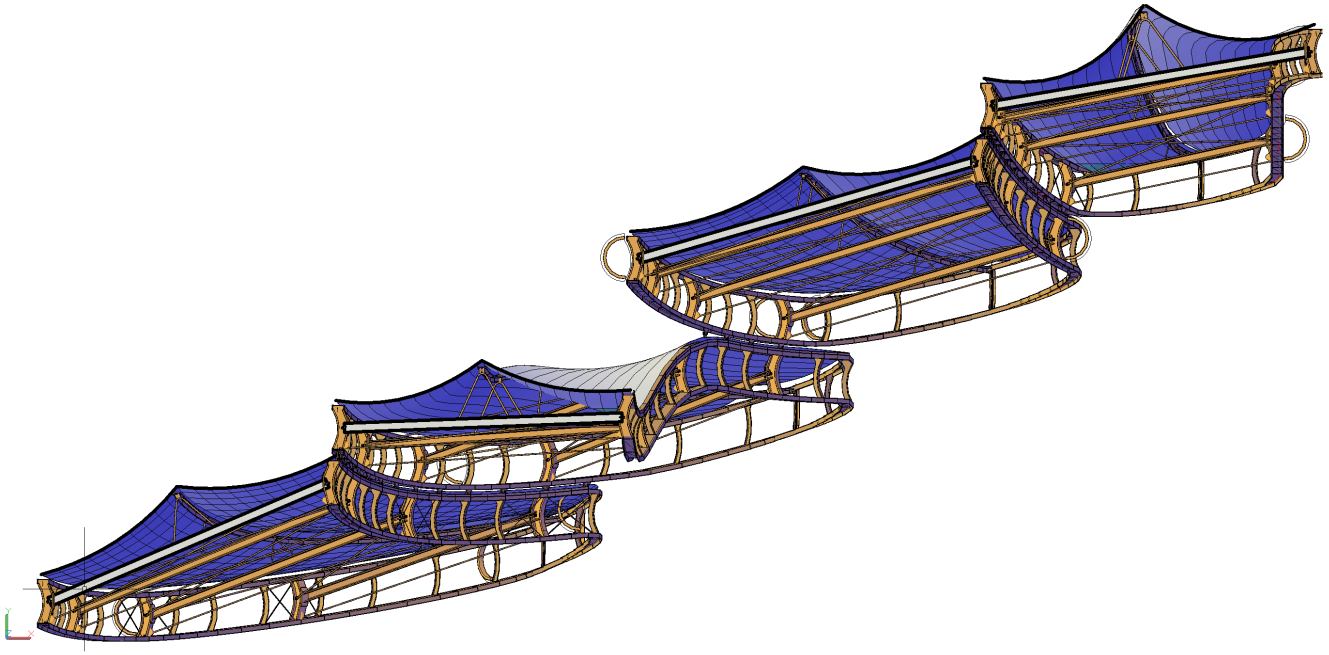
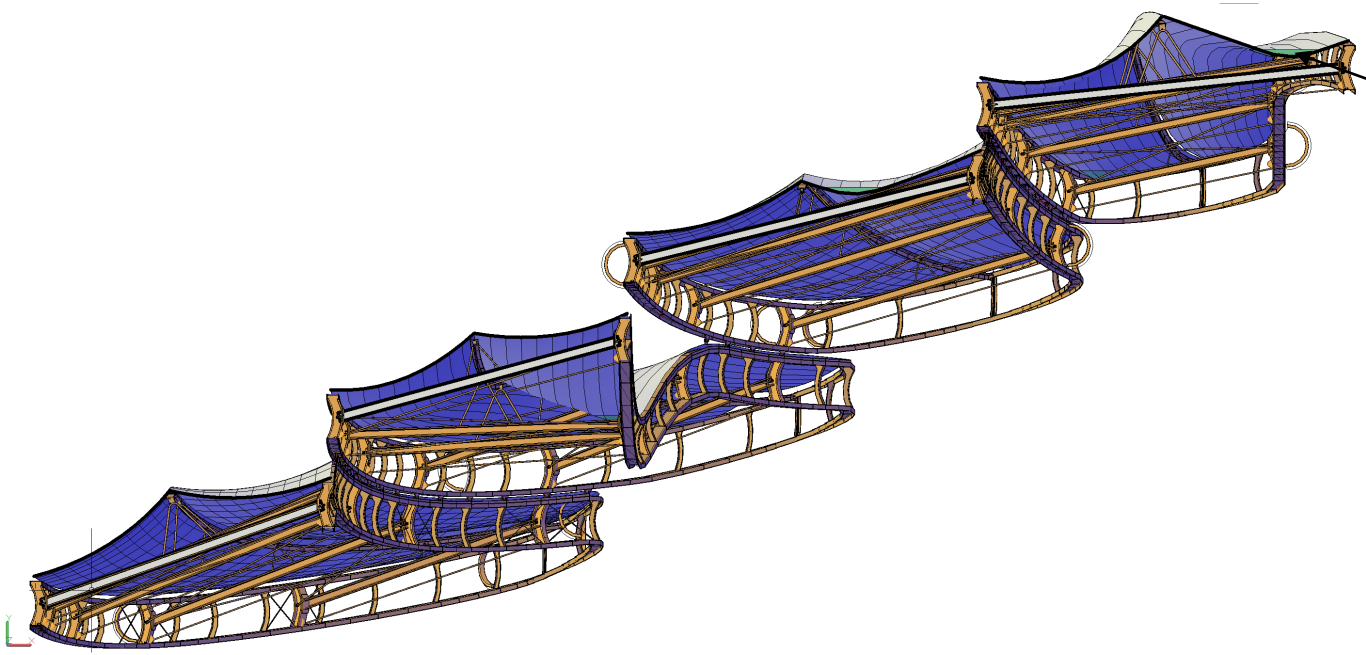
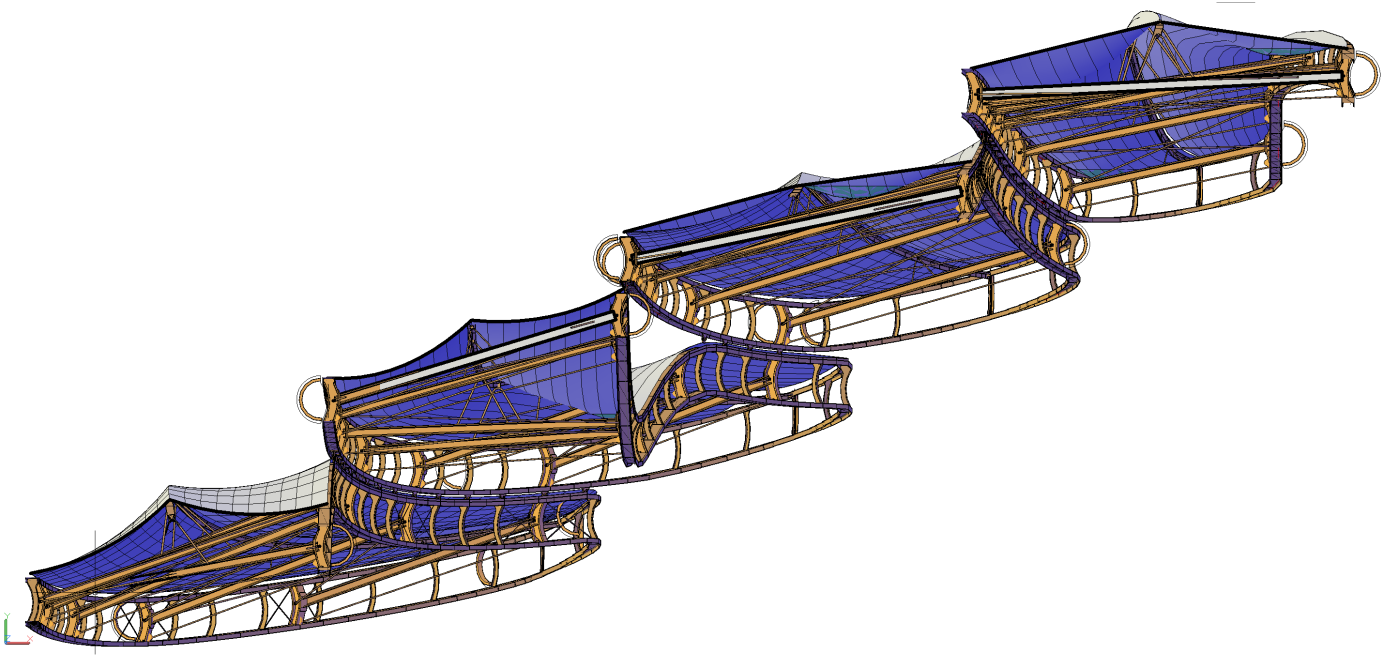


Non contact avec la charpente – poches d'eau



Non contact avec la charpente – poches d'eau



Non contact avec la charpente – poches d'eau

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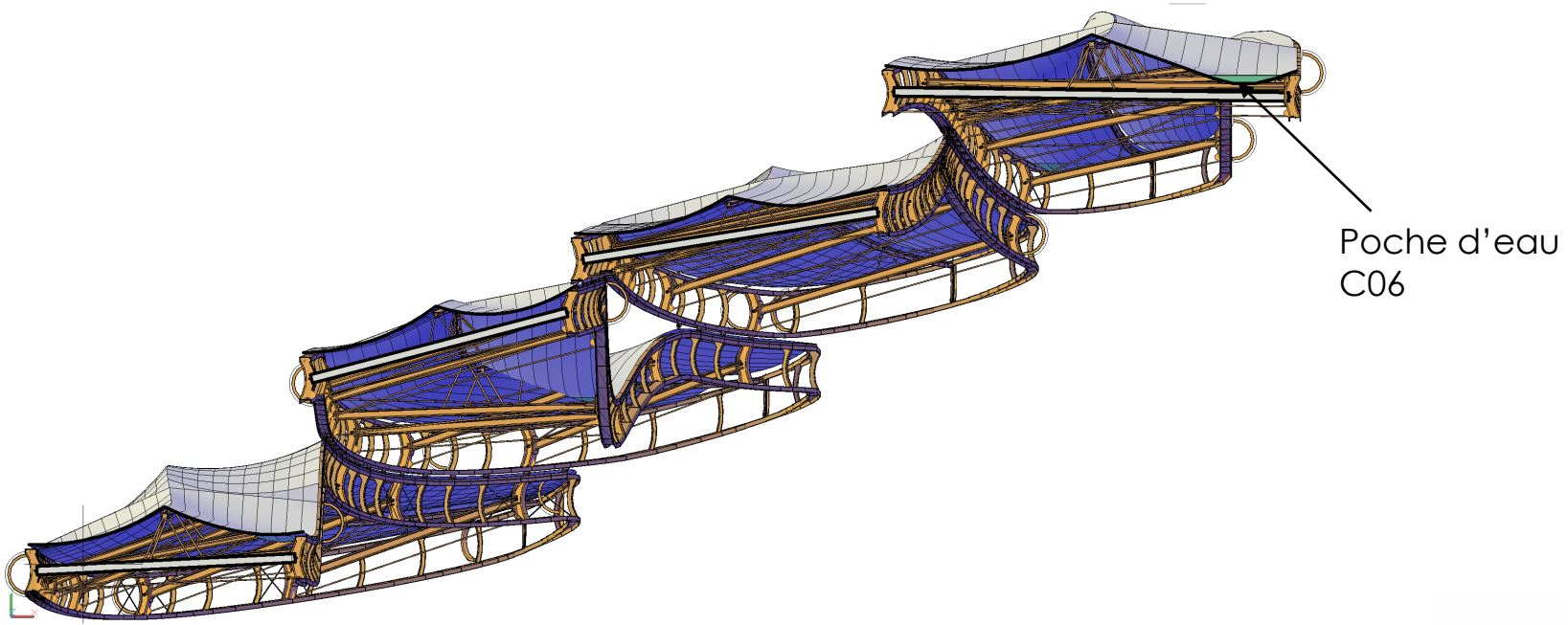
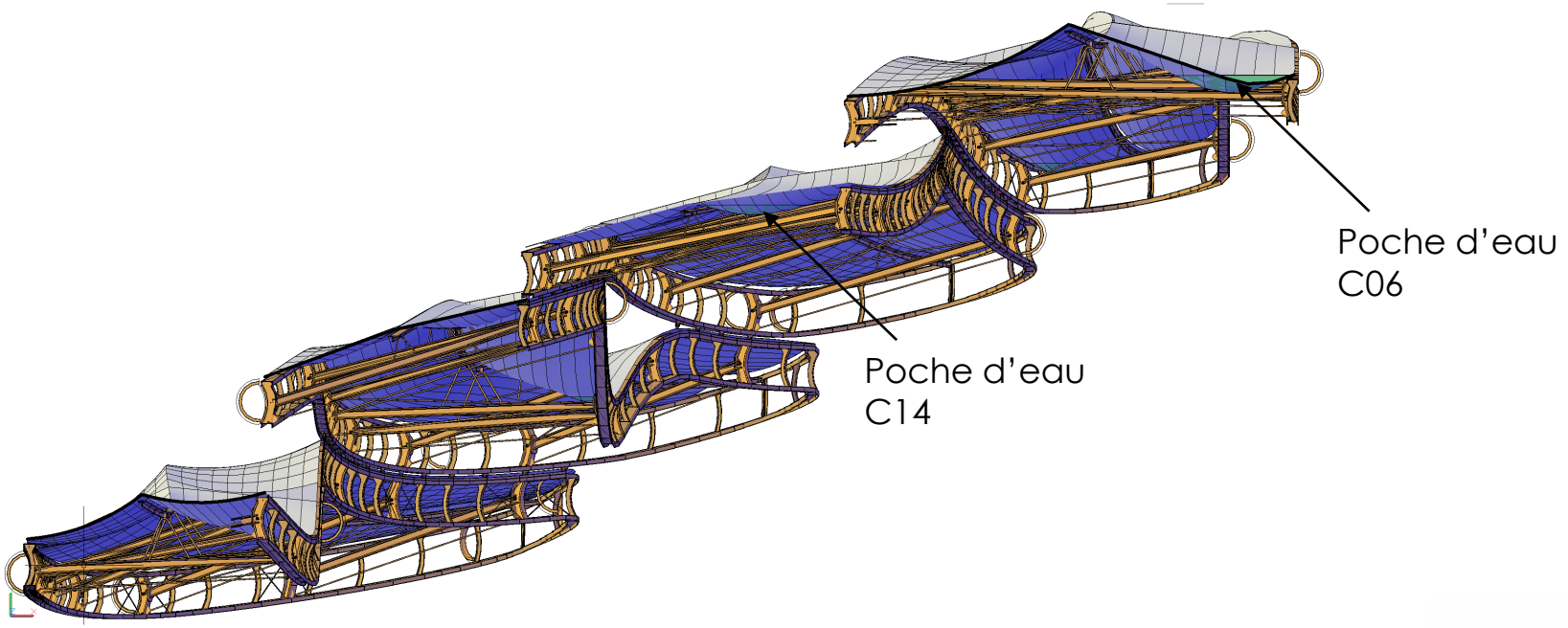
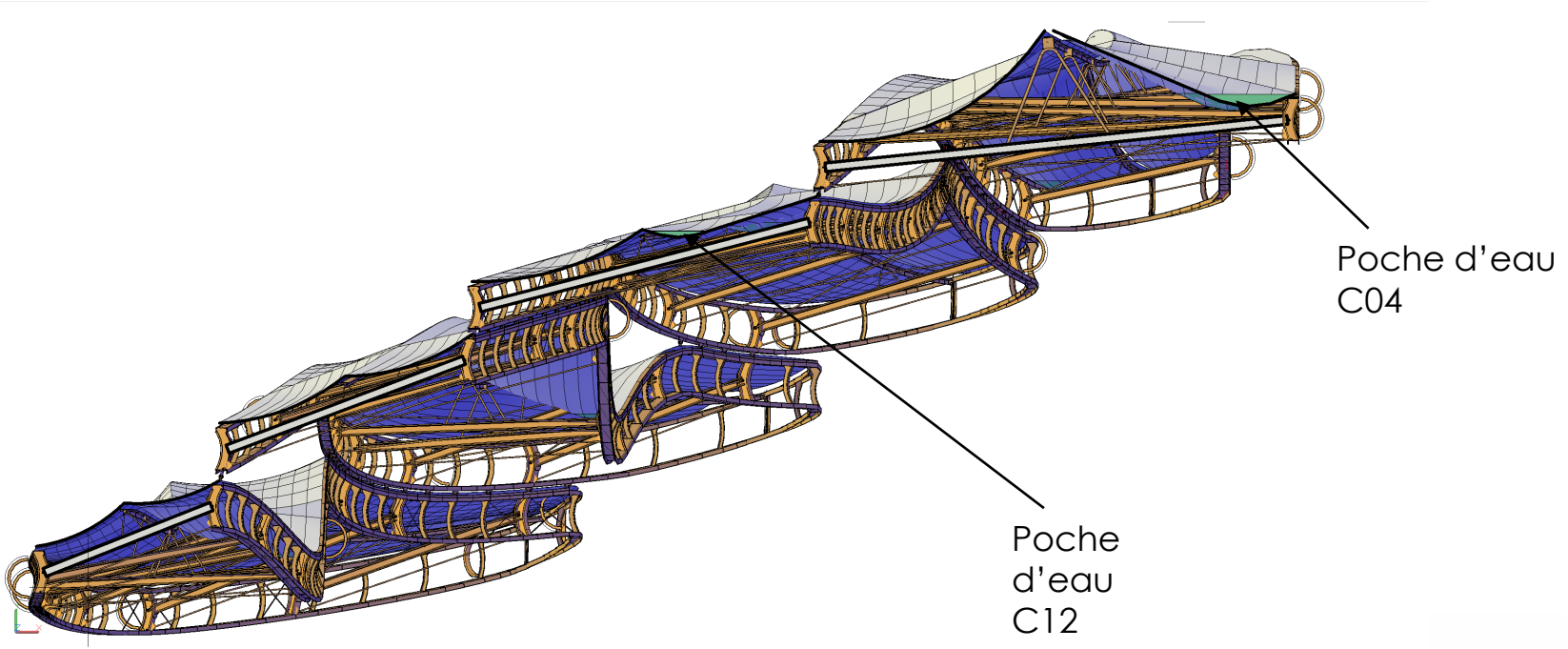


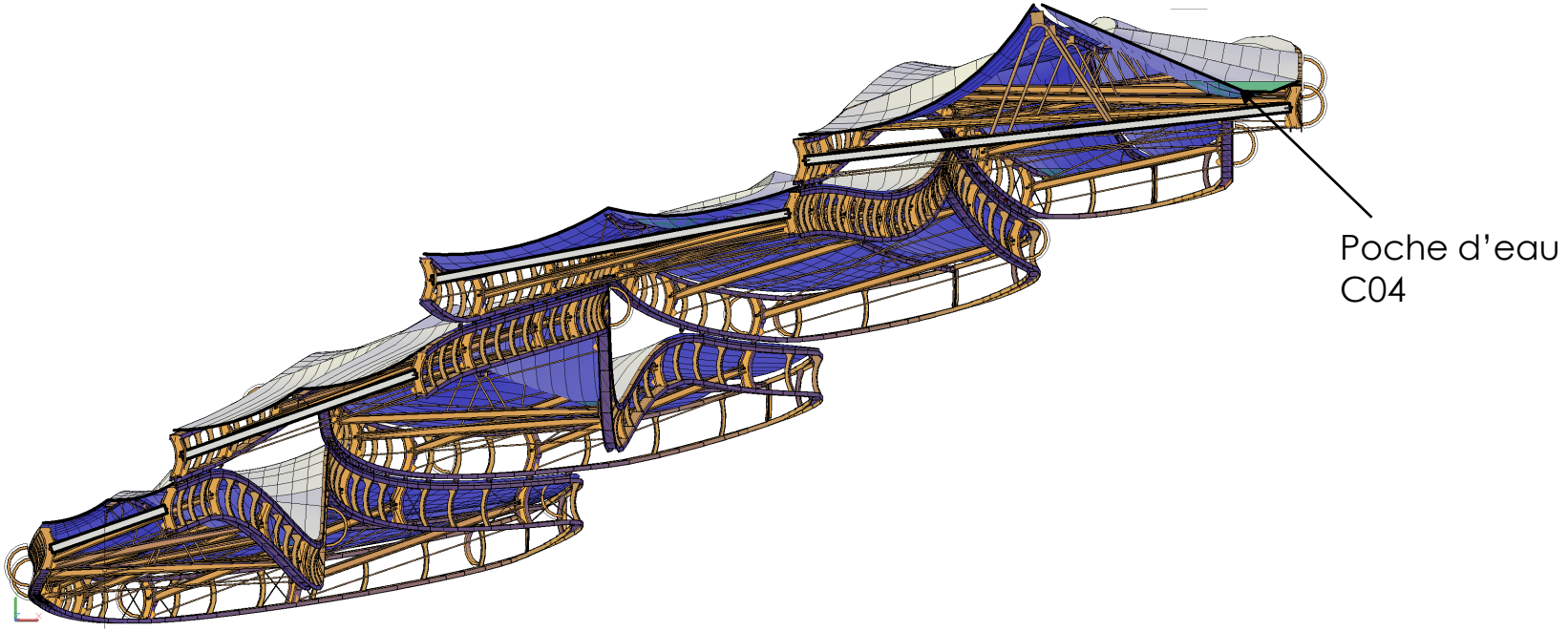
Non contact avec la charpente – poches d'eau



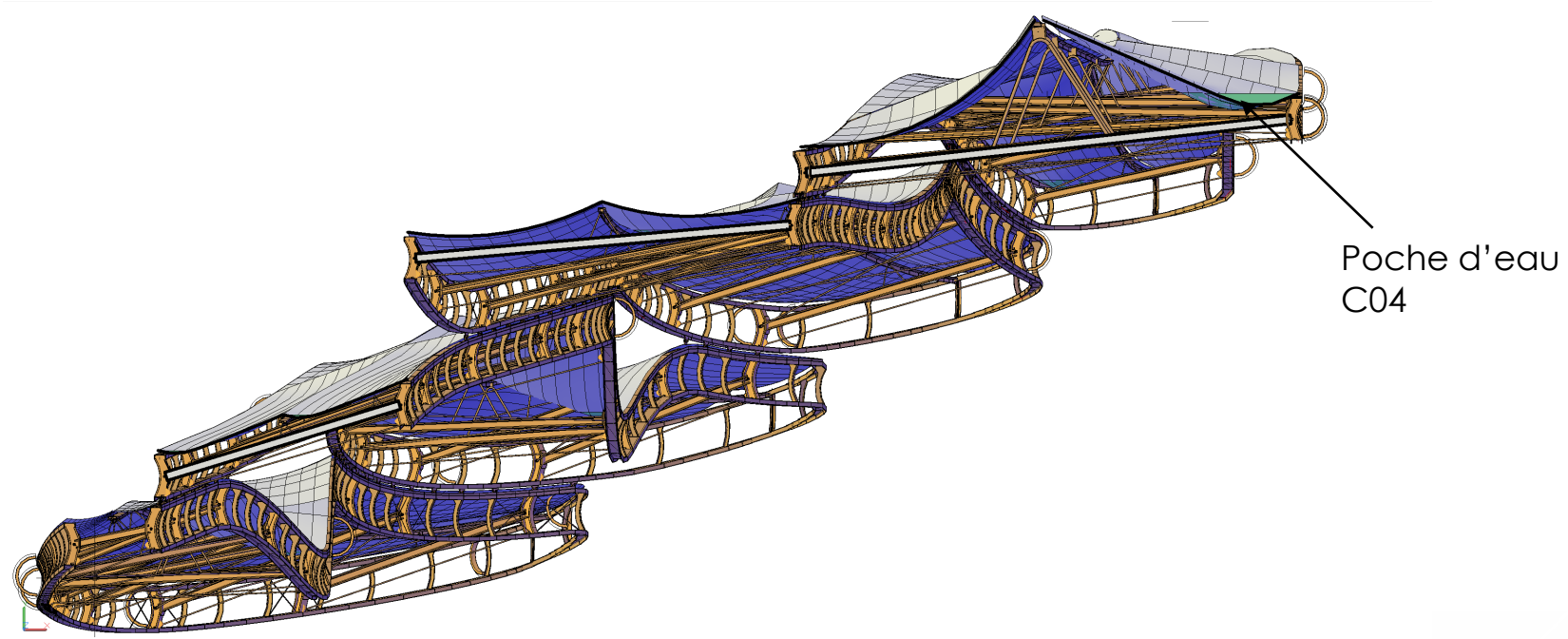
Non contact avec la charpente – poches d'eau



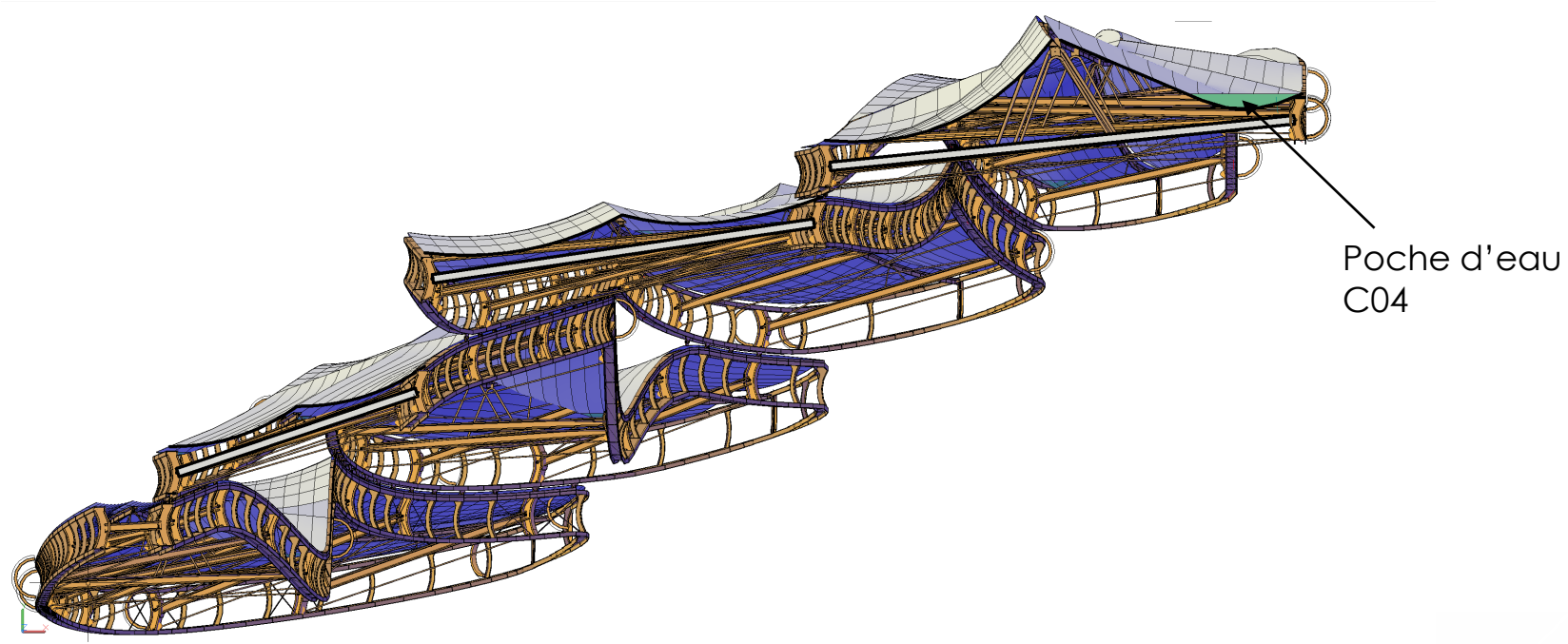
Non contact avec la charpente – poches d'eau



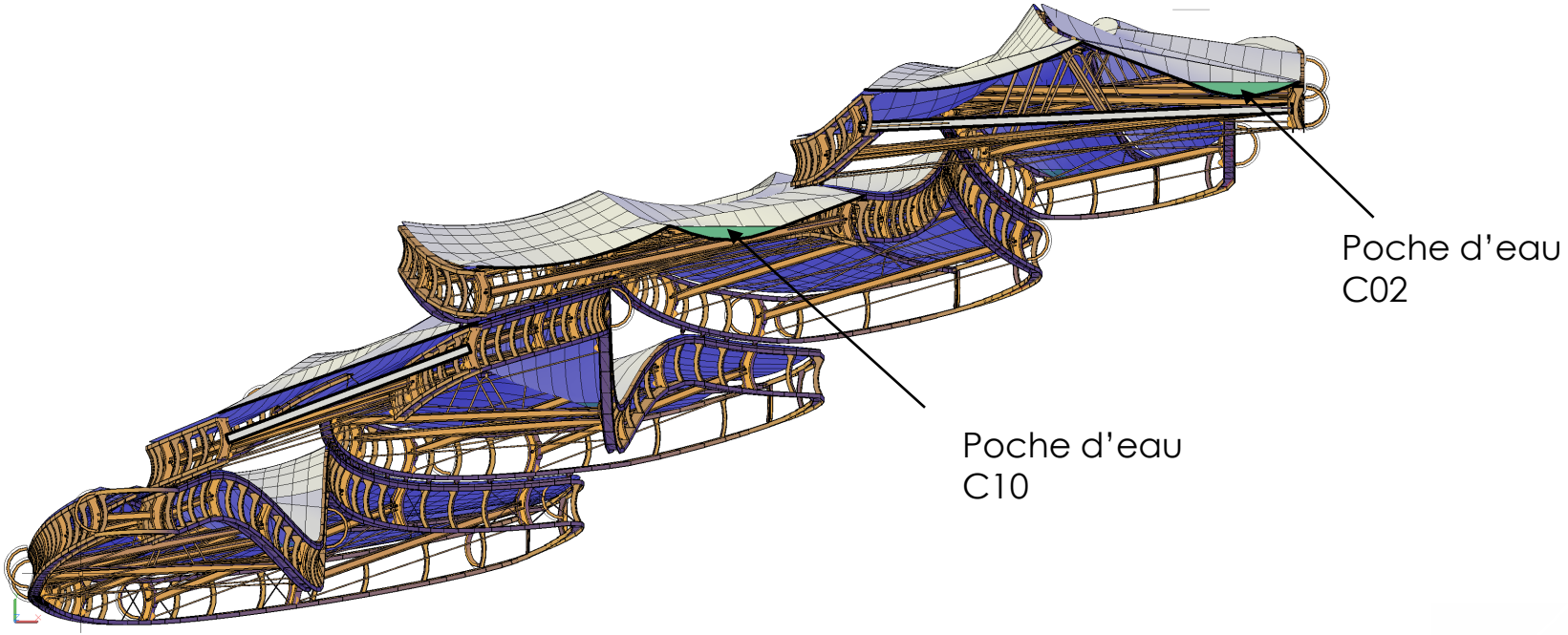
Non contact avec la charpente – poches d'eau



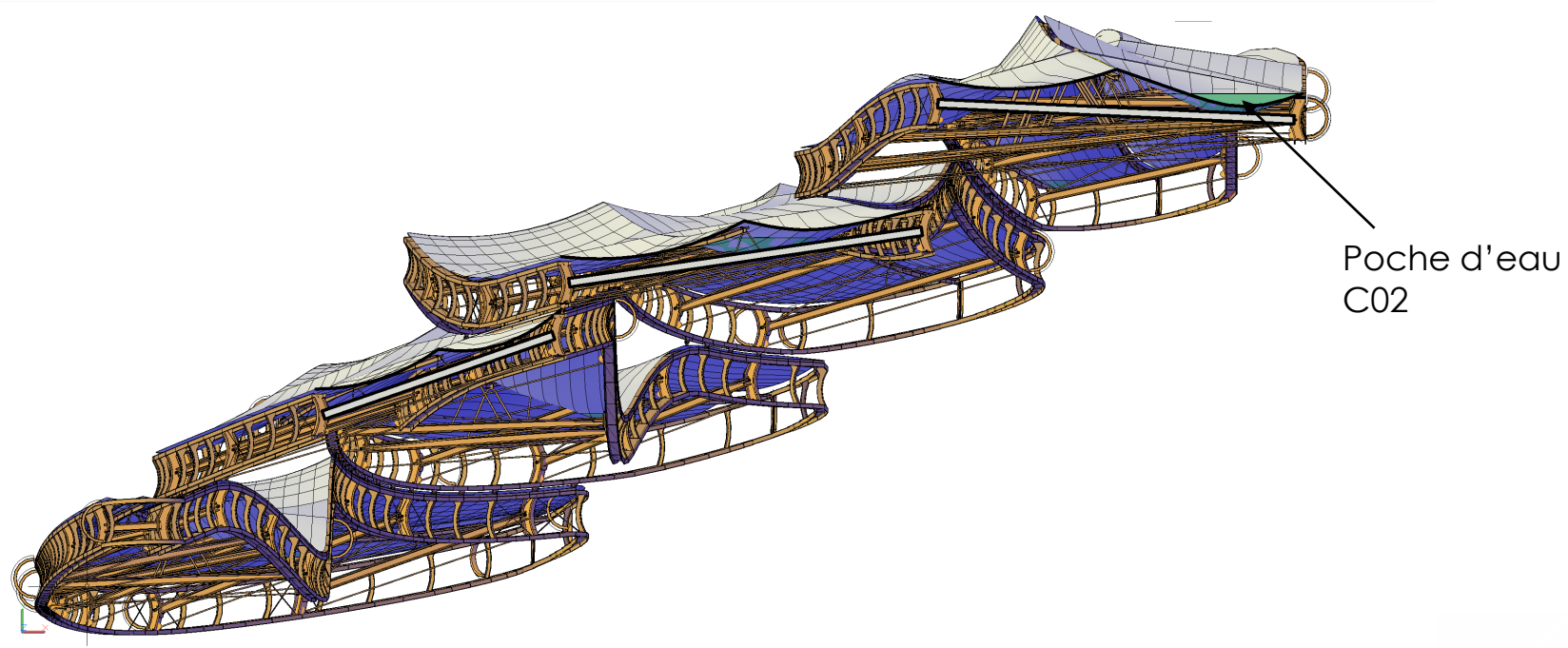
Non contact avec la charpente – poches d'eau



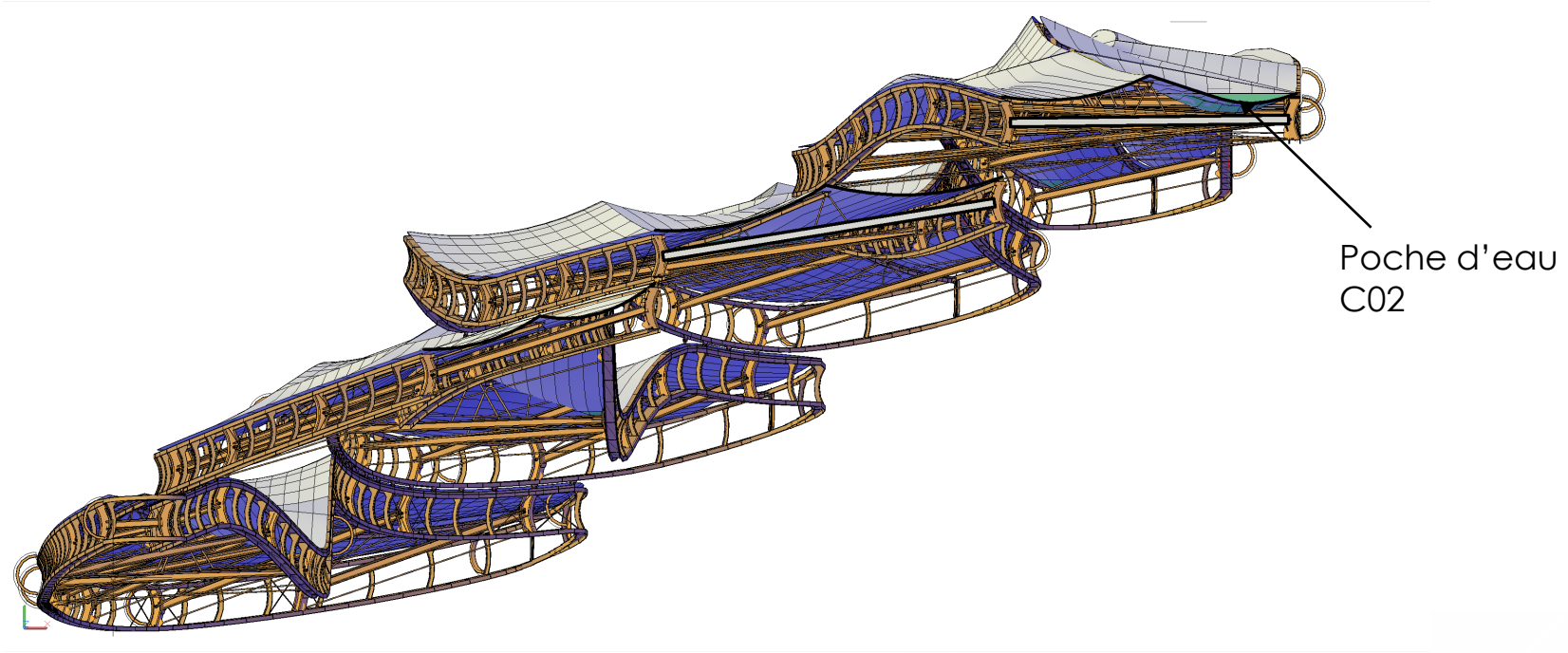
Non contact avec la charpente – poches d'eau



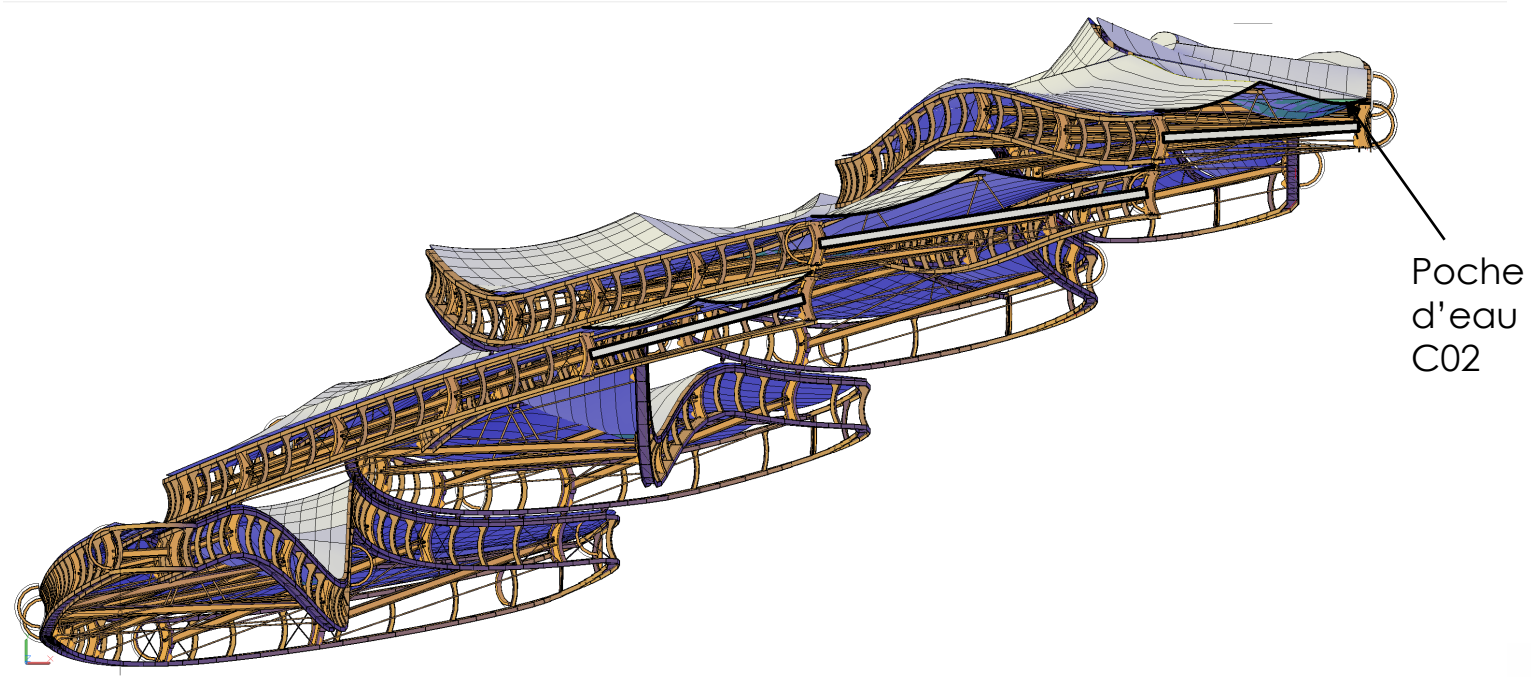
Non contact avec la charpente – poches d'eau



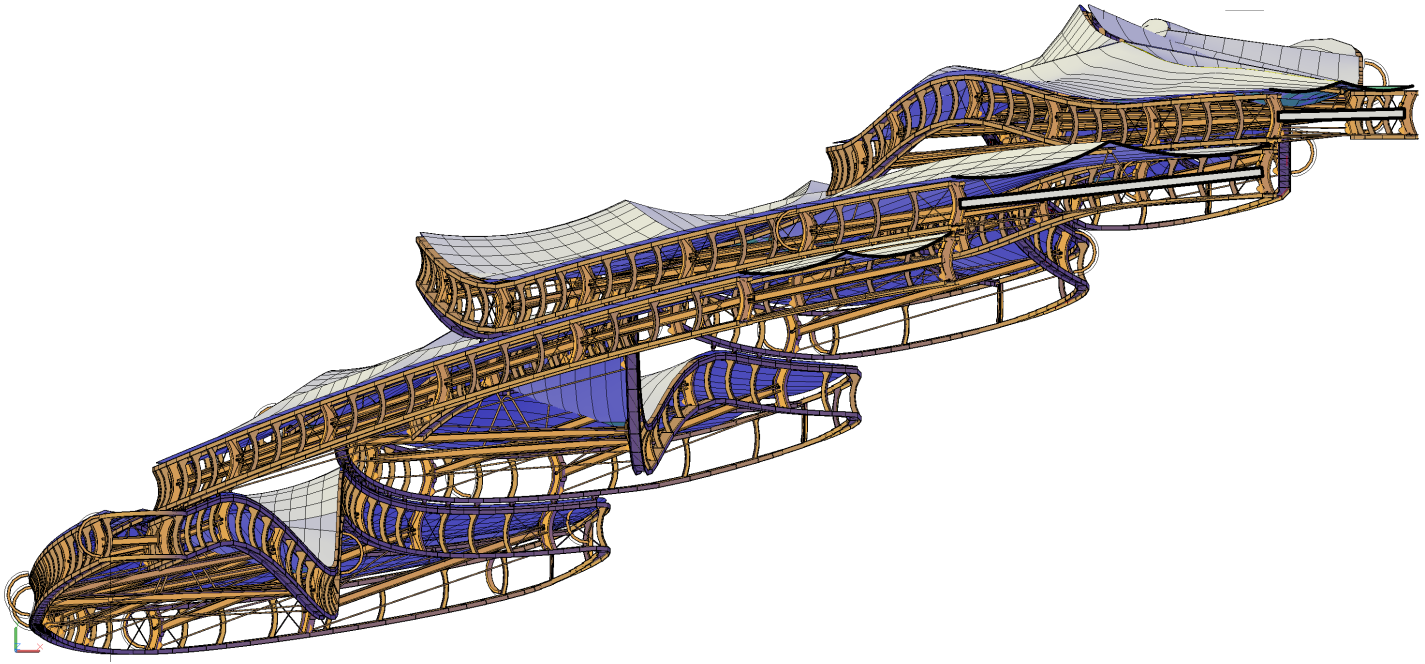
Non contact avec la charpente – poches d'eau



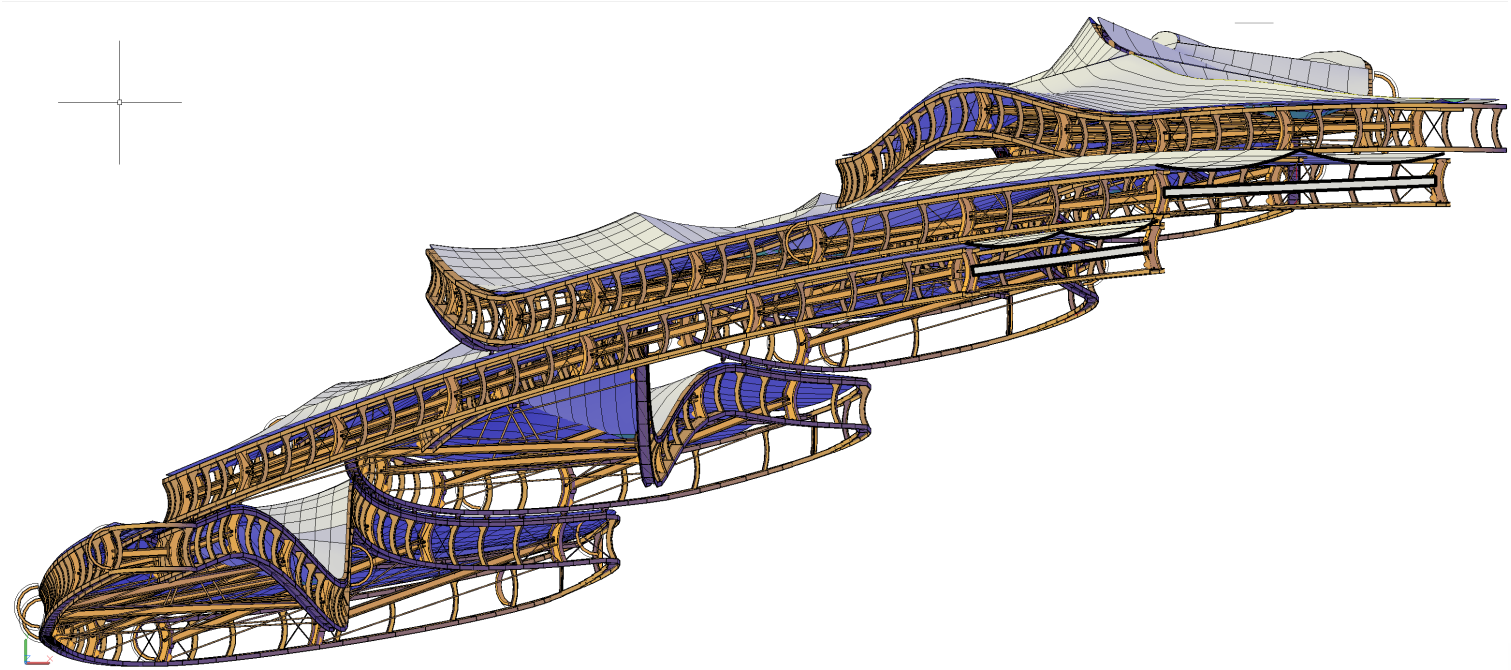
Non contact avec la charpente – poches d'eau



Non contact avec la charpente – poches d'eau



Non contact avec la charpente – poches d'eau



Travaux

Travaux

Travaux

Travaux

Travaux

Travaux

Travaux

Travaux

Travaux

Travaux

Travaux – lien urbain

Travaux – paysage construit

Travaux – Escaliers hall

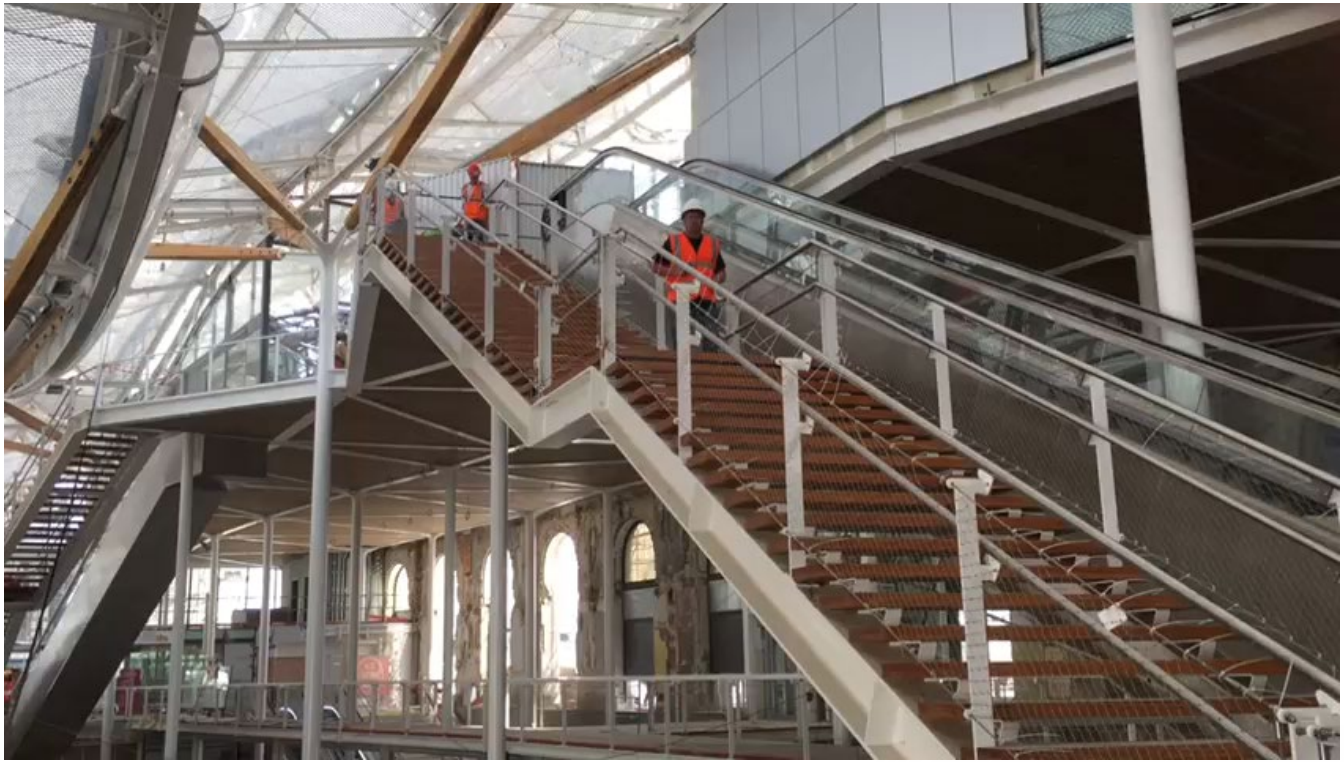
Portée : 17 m
Hauteur : 7 m
HEB 360
Elancement : L/50
Plan en ligne brisée

Encastrement en pied

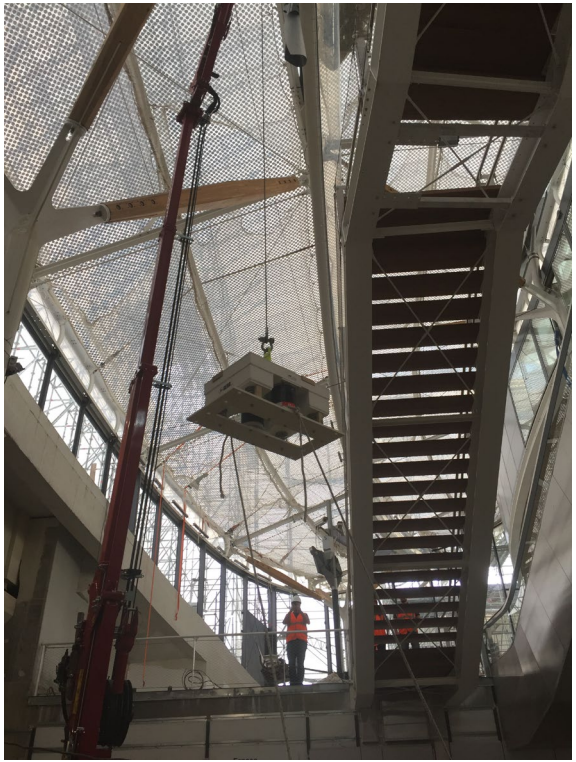
Fréquence : 3 Hz

Travaux

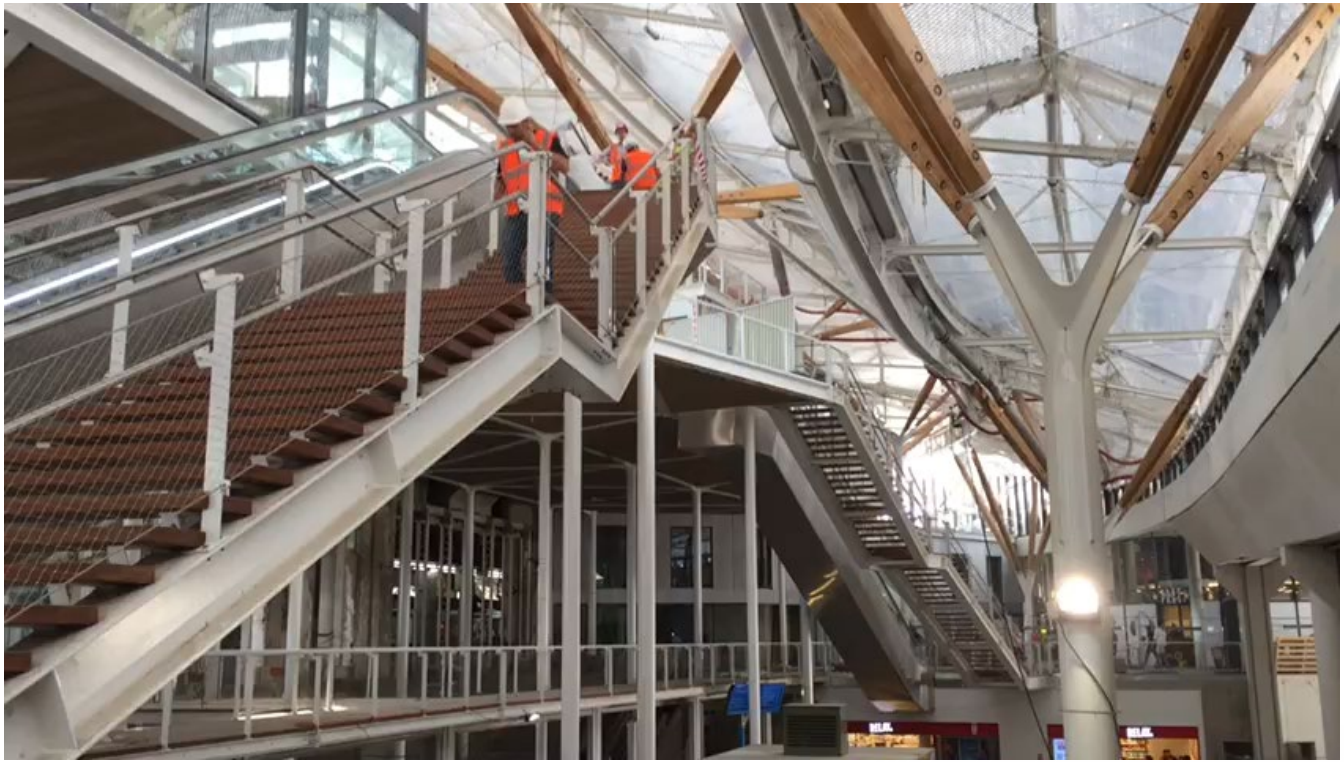
Travaux – Escaliers hall



Travaux – Escaliers hall



Travaux – Escaliers hall



MERCI !