

The benefits and challenges of wood in high corrosive surroundings

30.11.2023 - The 27th International Timber Construction Forum



Tim Skotheimsvik
M.Sc. Structural engineering
Multiconsult



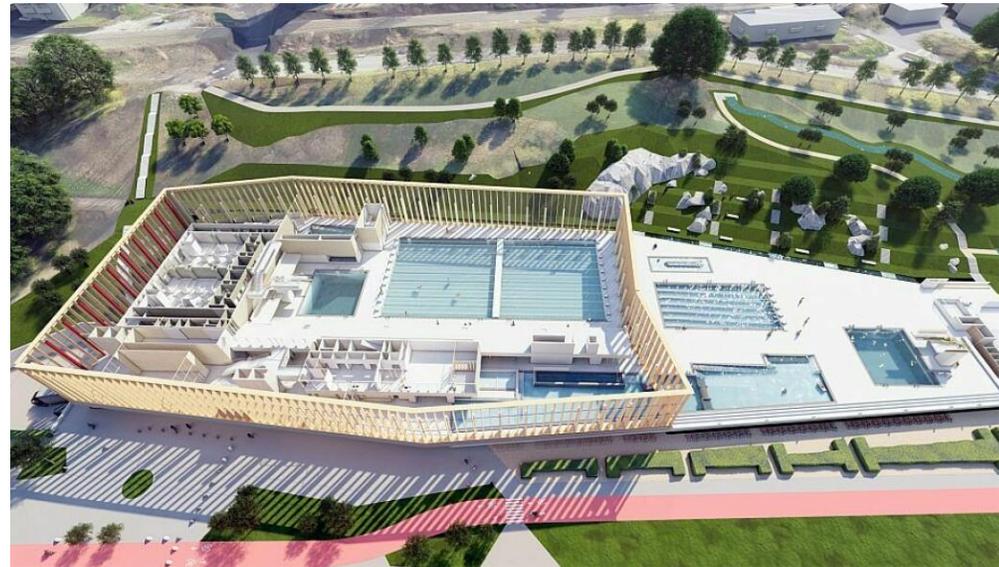
Sigurdur Gunnarsson
Dr. engineer Structural design
asplan viak



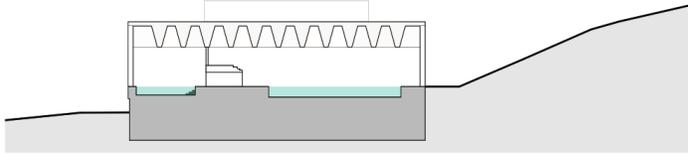
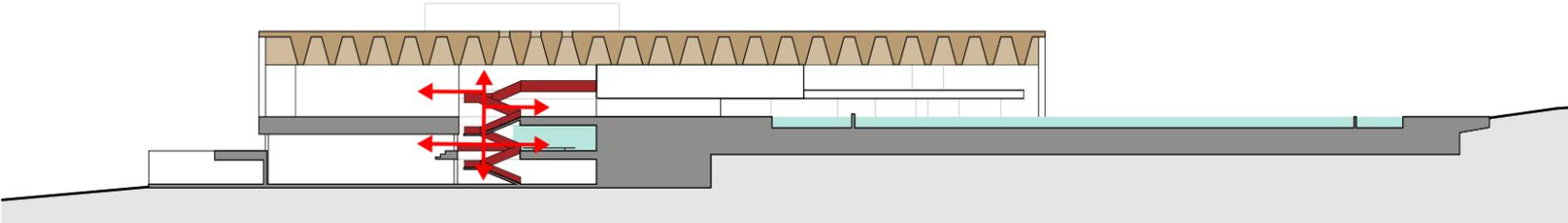
1976



2024



The architects vision

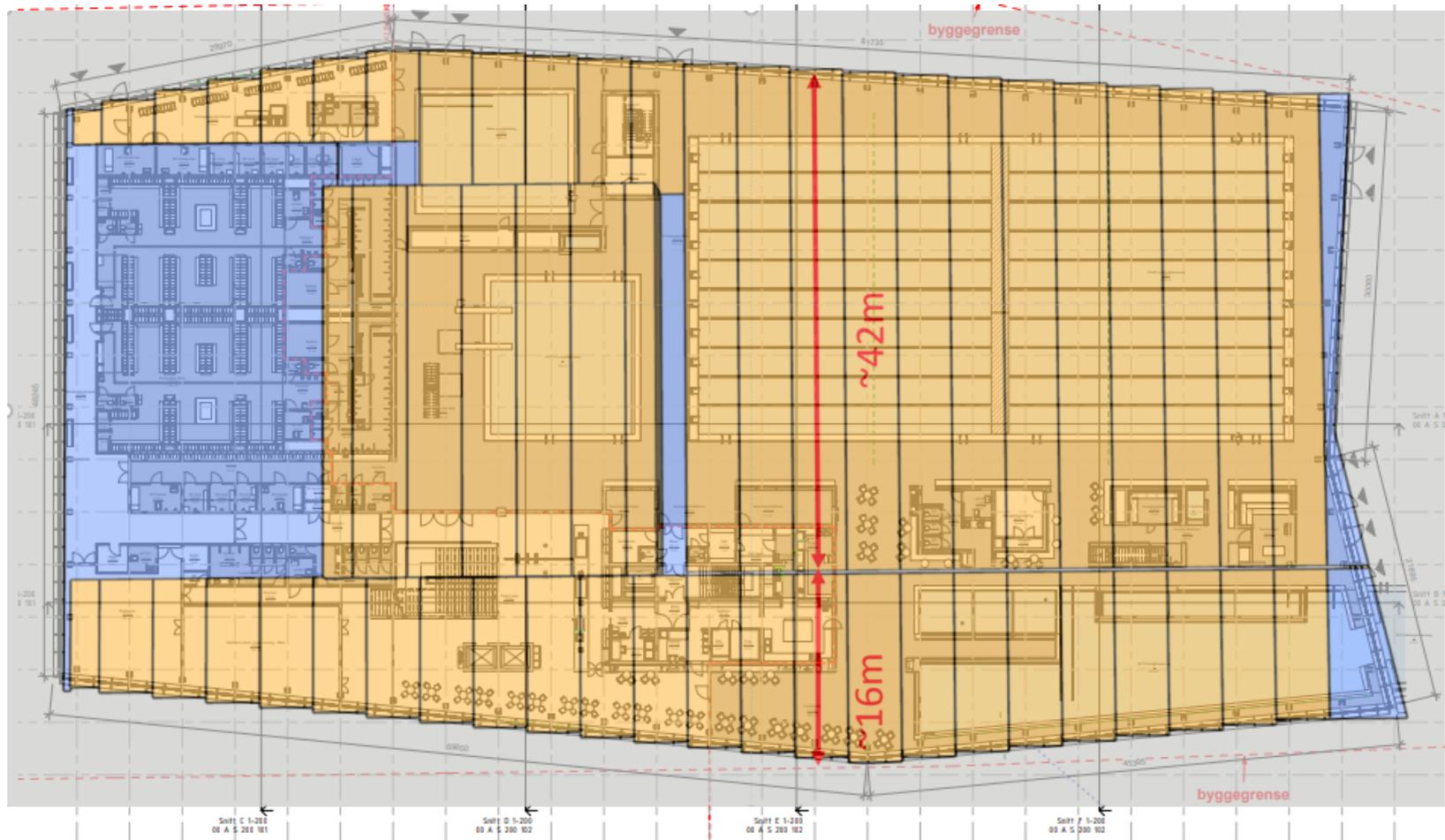


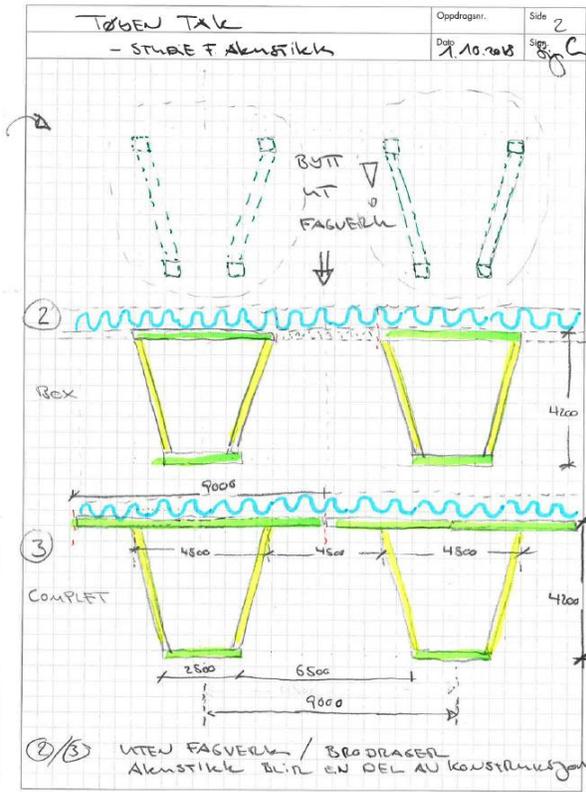
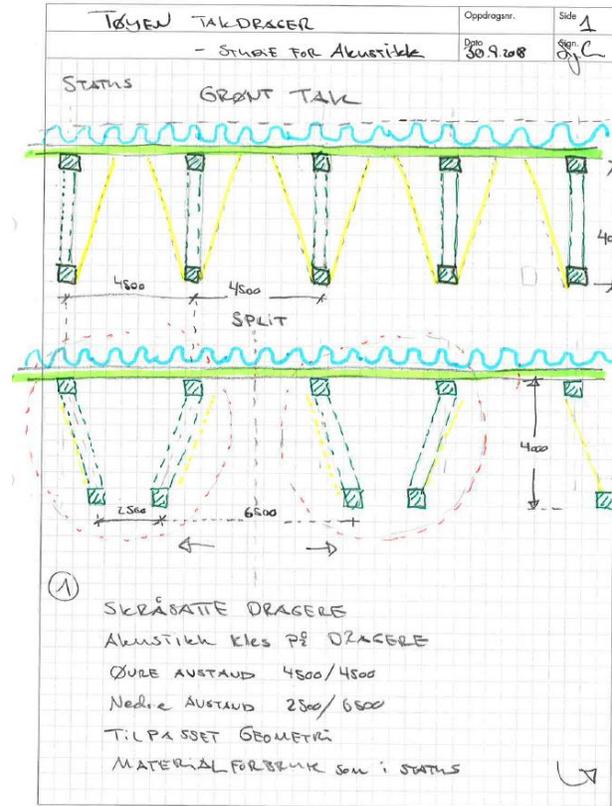
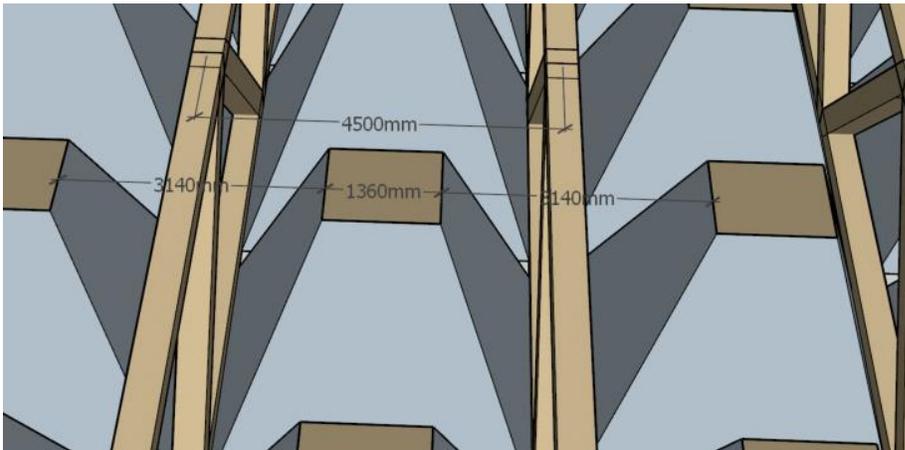
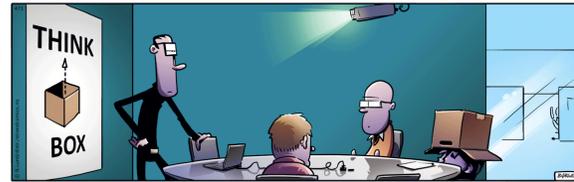
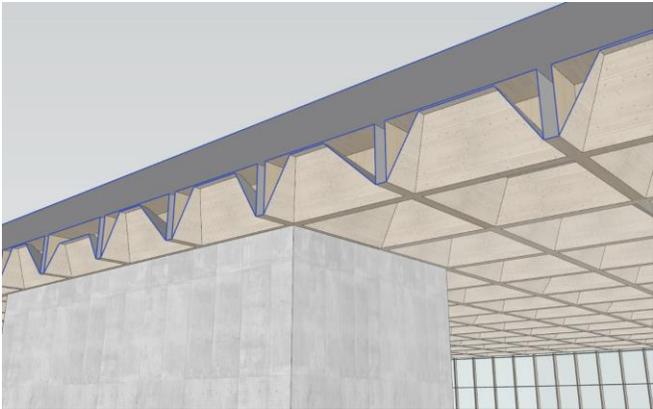
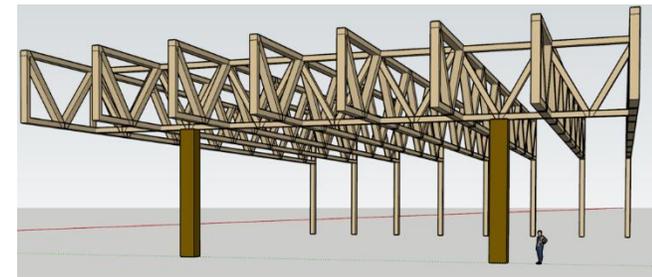
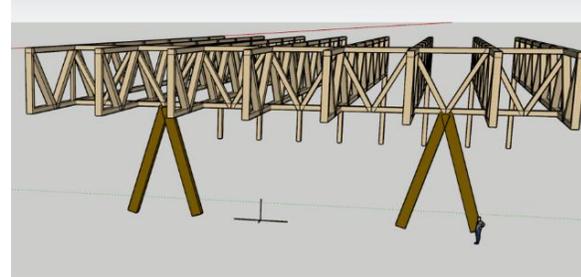
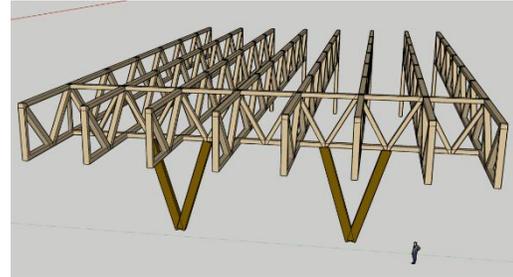
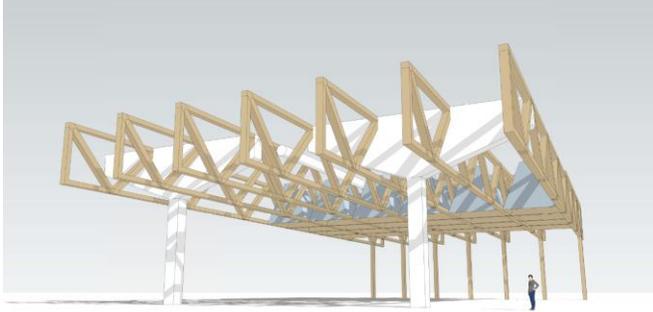




Preliminary design

Floor plan and span width

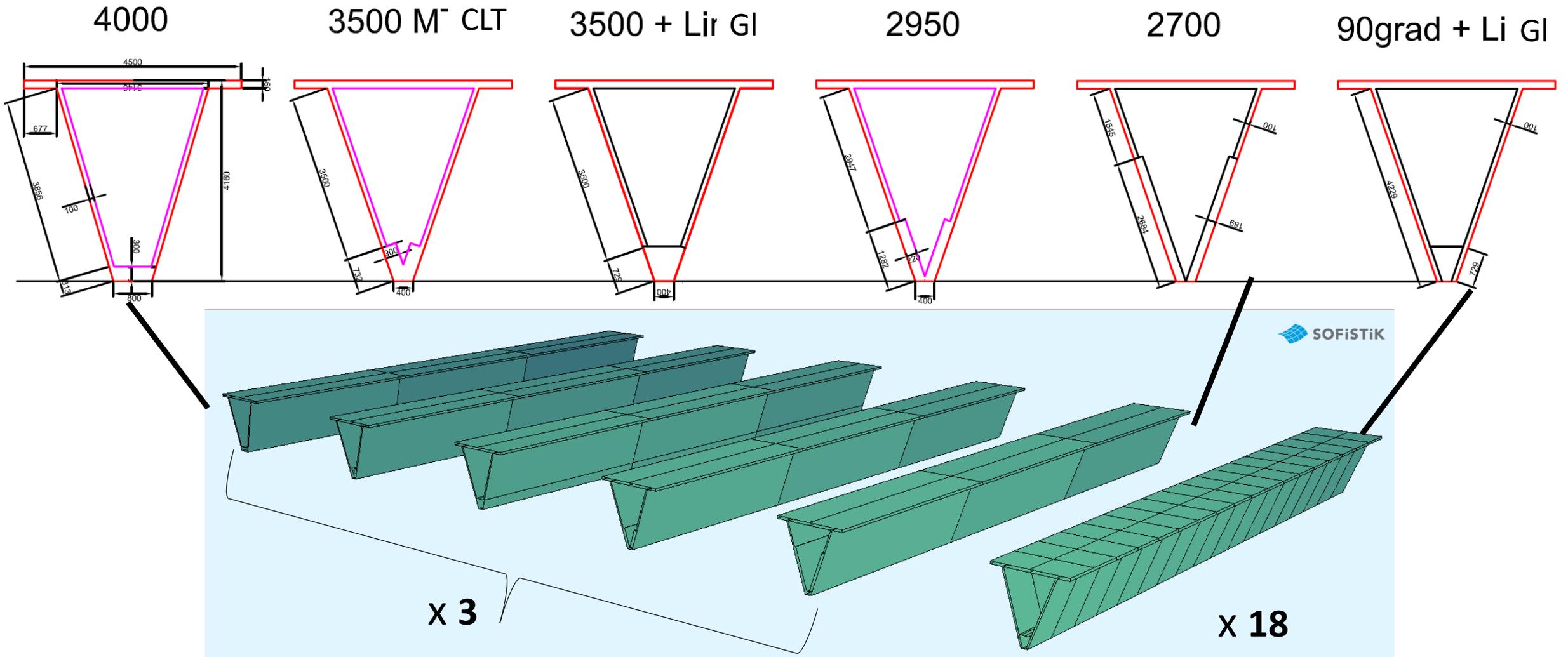




Clarification against manufacturers

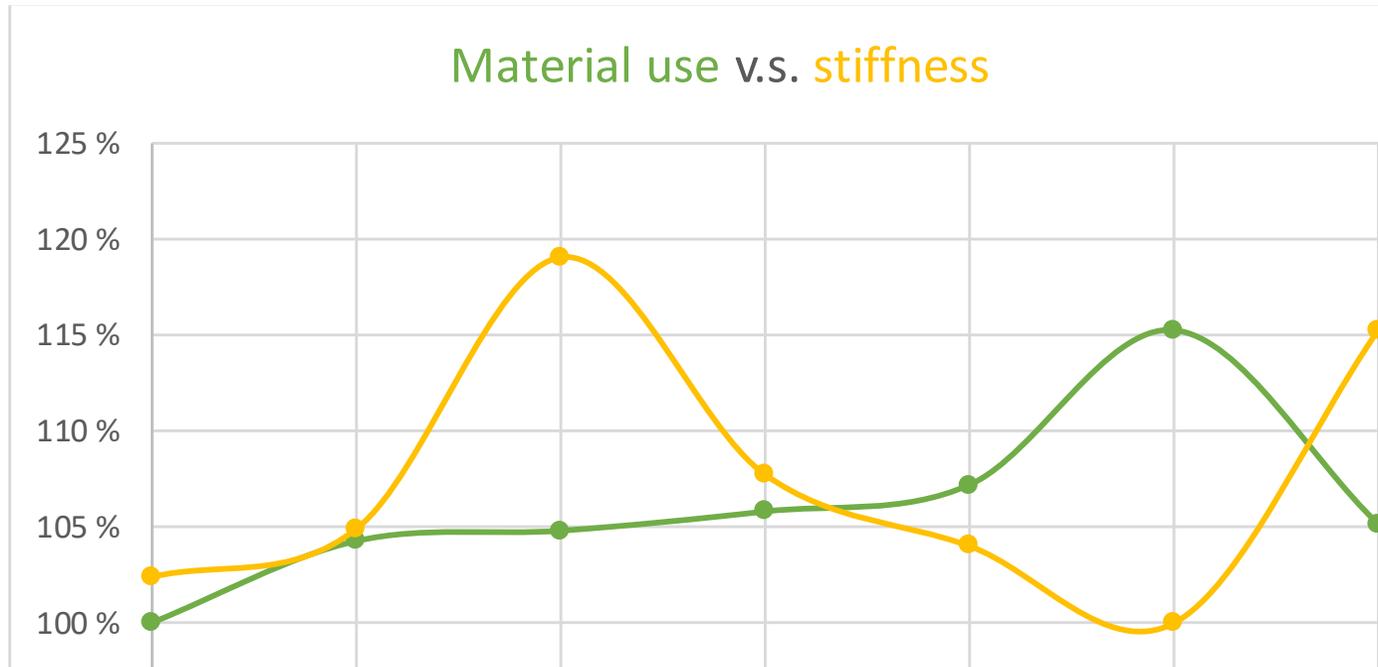
Country	Manufacturers	Height [mm]	Length [mm]	Thickness [mm]
T	Züblin	4800	20000	310
N	Splitkon	3550	16000	360
∅/T	Binderholz	3500	22000	340
∅/T	Mayr Melnhof	3500	16500	500
T	Derix	3500	17800	400
T/F	Pfeifer	3100	14500	300
S/∅/T	Stora Enso	3500	16000	320
∅/T	KLH	2950	16500	500
N	Moelven	-	20000	2400

Design in production sizes



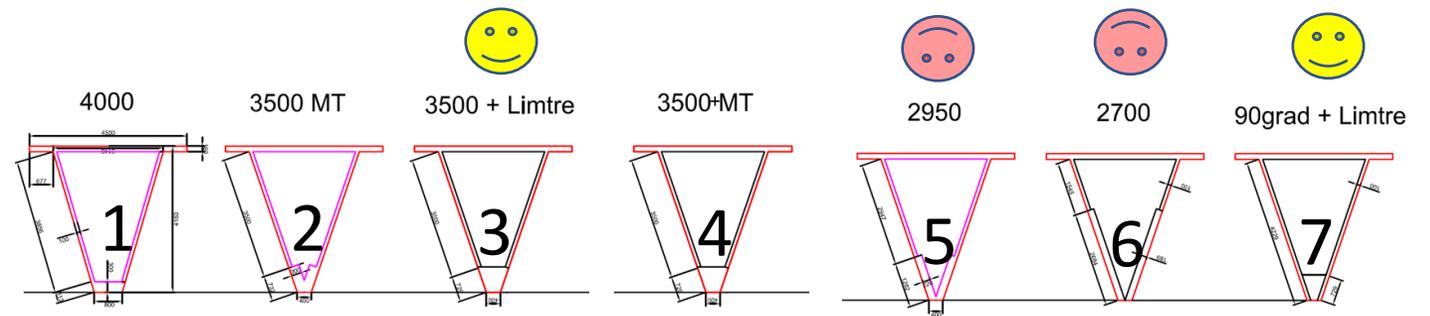
What does this mean in **cash** and **statics**?

No	material	stiffness
1	100 %	102 %
2	104 %	105 %
3	105 %	119 %
4	106 %	108 %
5	107 %	104 %
6	115 %	100 %
7	105 %	115 %

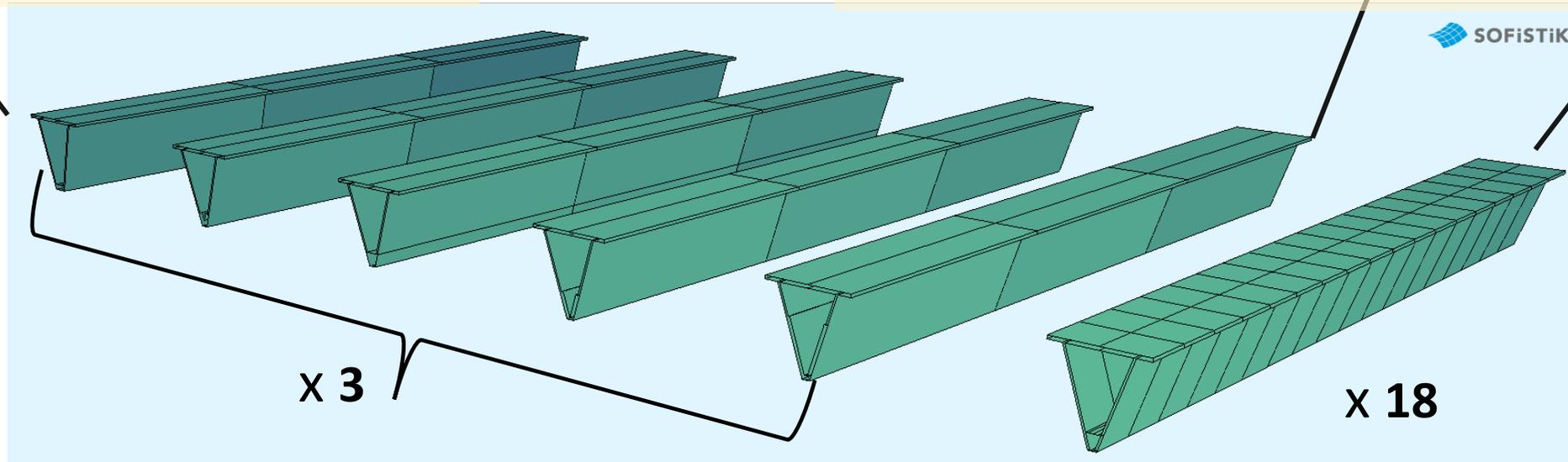
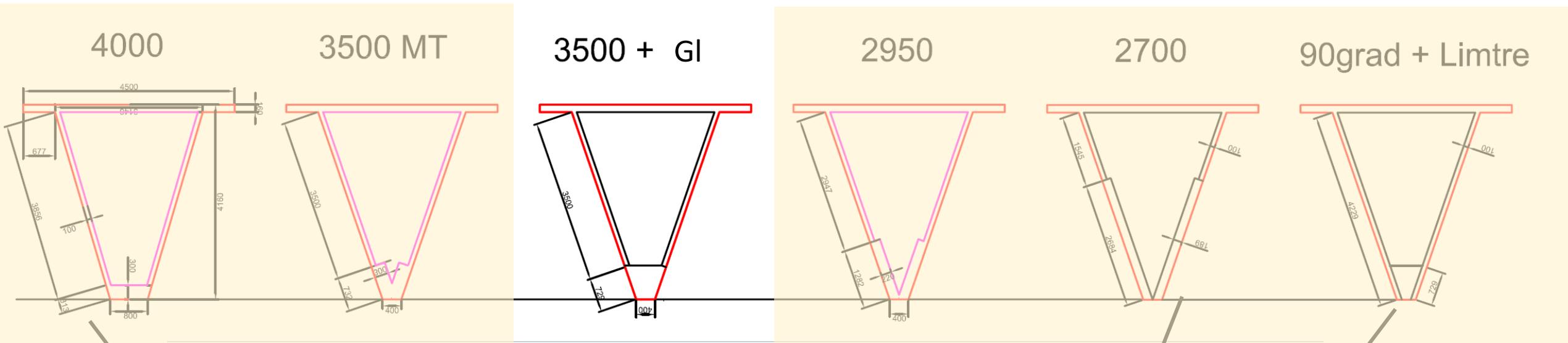


😊 **Good** when stiffness is above material

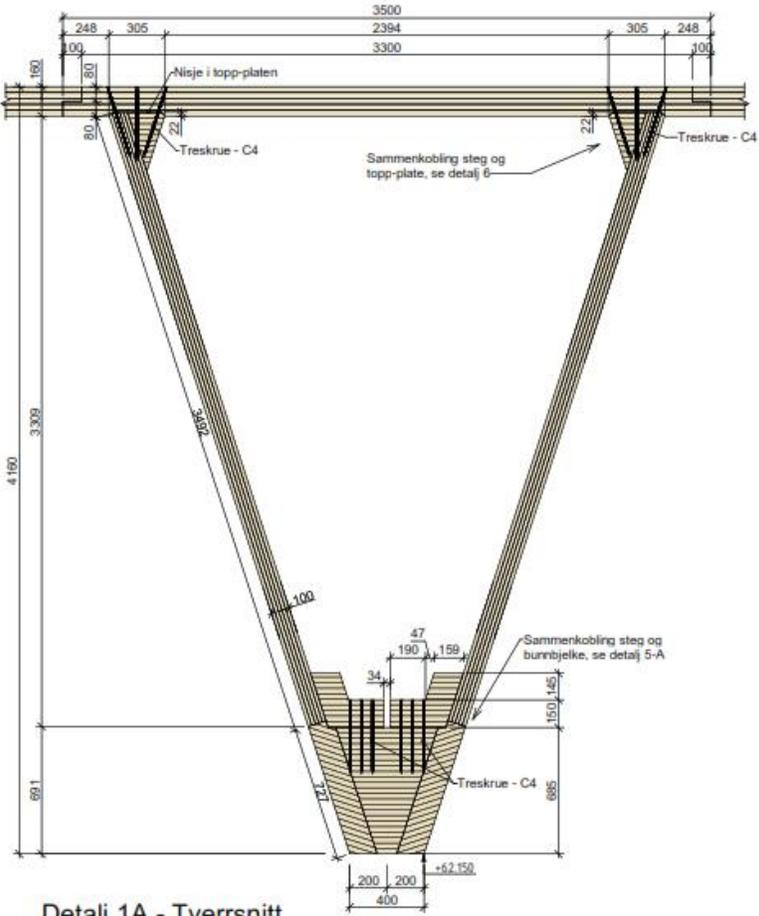
😞 **Bad** when material is less then stiffness



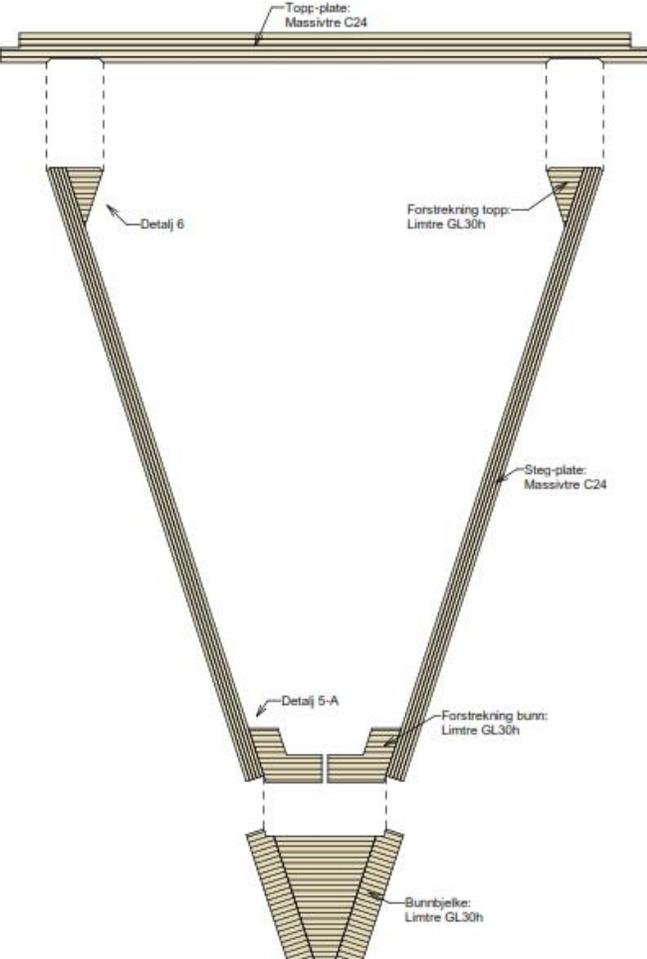
The chosen design



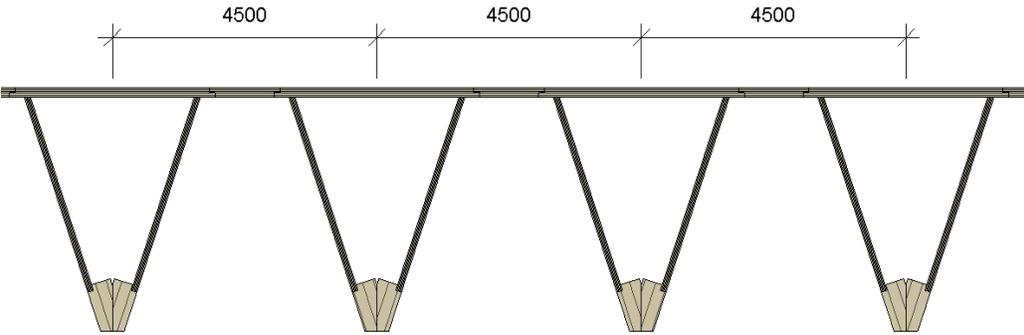
The cross section



Detalj 1A - Tverrsnitt
1 : 20

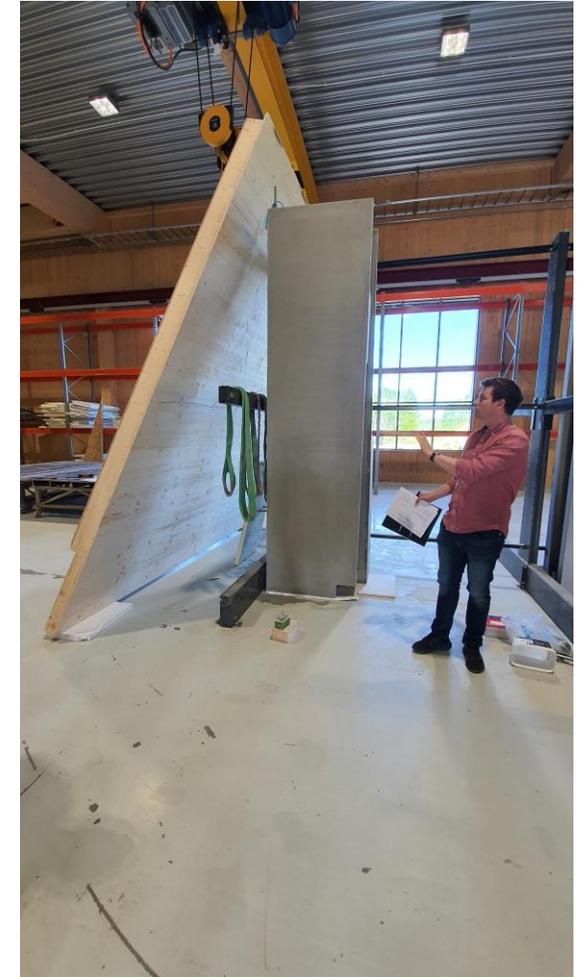


Detalj - vist oppdelt



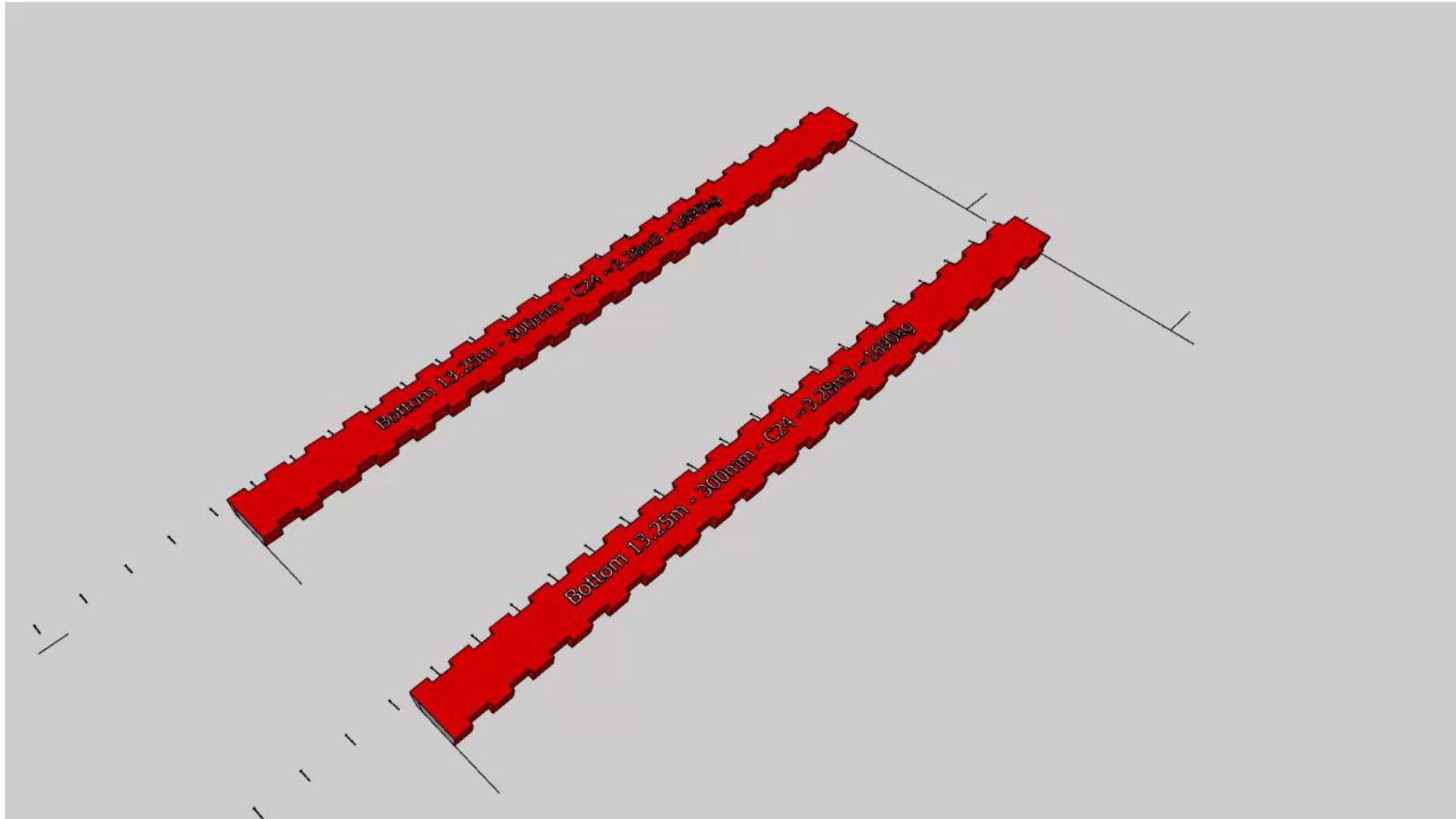
Development of the project

- Field trips
- Bachelor thesis
- Seminars with tre-klyngen
- Dialogue with contractors, suppliers and entrepreneurs

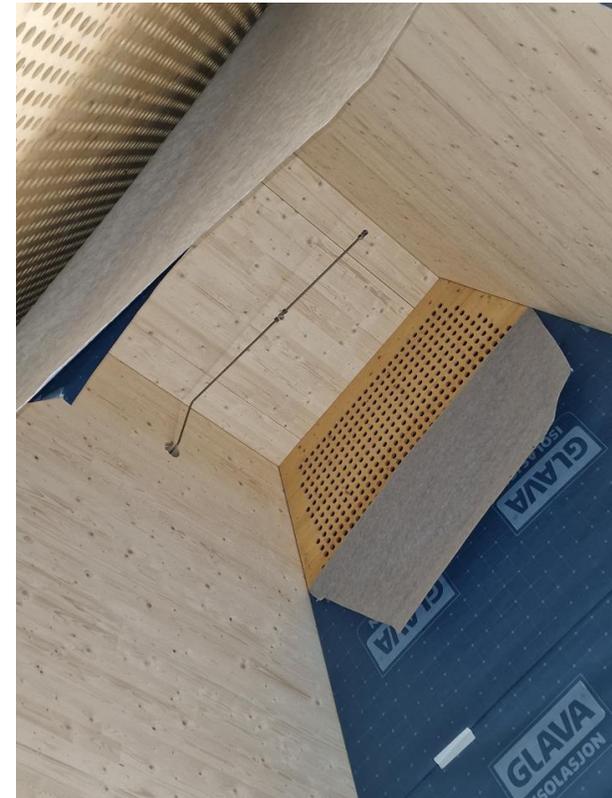
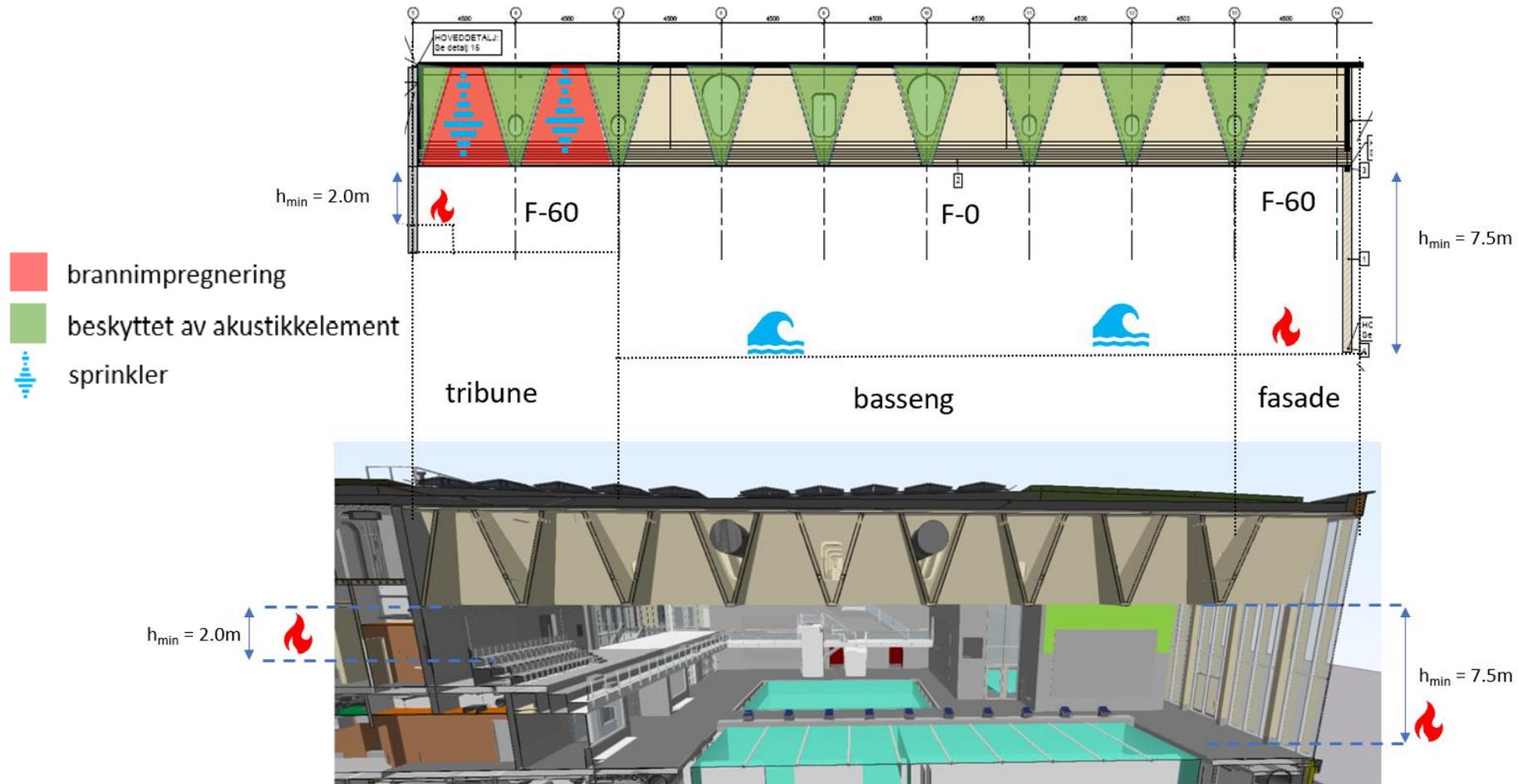


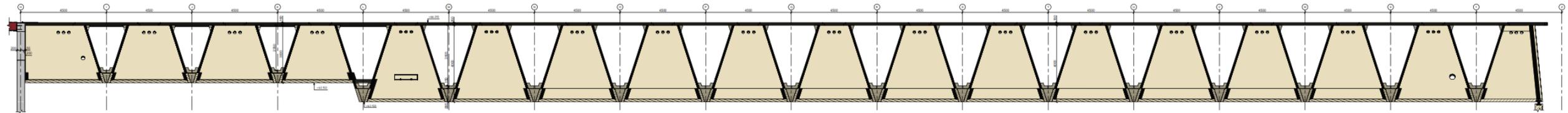
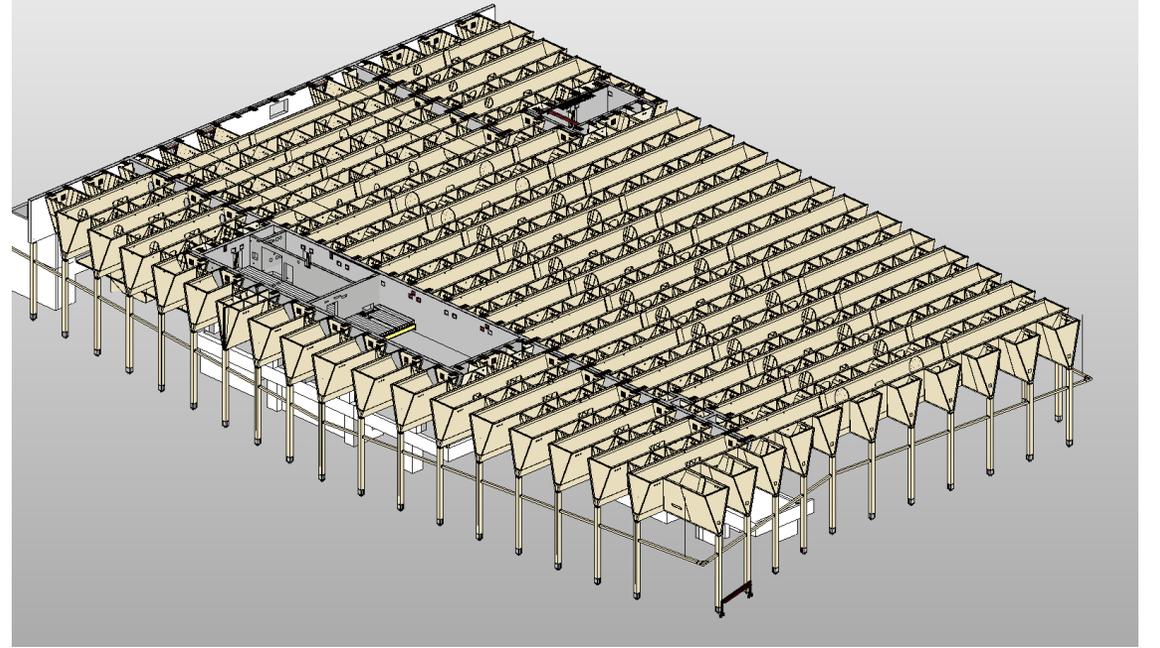
Knut Sjøvold – Prosjektsjef KID
Magnus XXXYYY – Stema Rådgivning
Trond Bøhlerengen – SINTEF
Per Lind – Treteknisk
Andreas Stenstad – Treteknisk
Kristine Nore – Splitkon
Terje Strand – Woodcon
Daniel Ertresvåg – Oslo Met
Christoffer Jacobsen – Asplan Viak AS - ARK
Roar Lund-Johnsen - Asplan Viak AS – ARK
Håkon Tennøe - Asplan Viak AS – RIBfy
Stein-Ove Hekkeback Vike - Asplan Viak AS – RIB
Tim Skotheimsvik - Asplan Viak AS - RIB
Sigurdur Gunnarsson - Asplan Viak AS - RIB

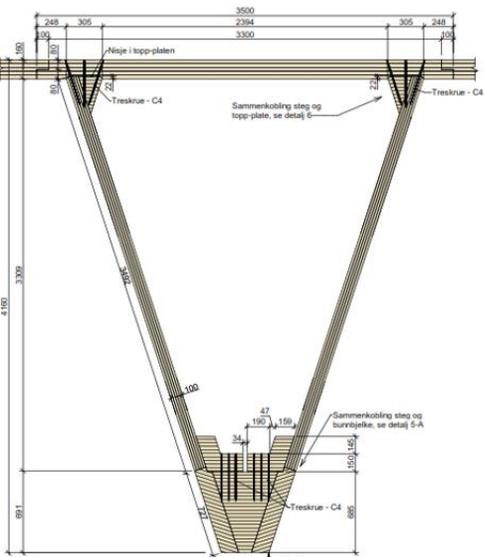
Sketches – Sizes – Weight



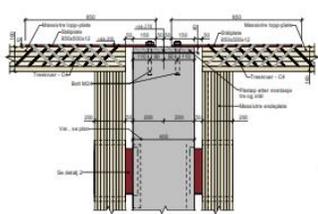
Fire protection



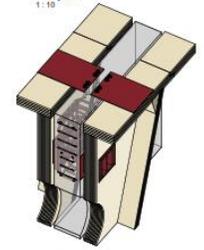




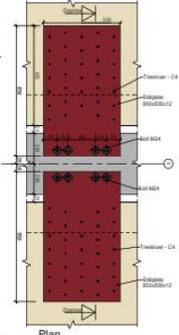
Detail 1A - Tverrsnitt
1:20



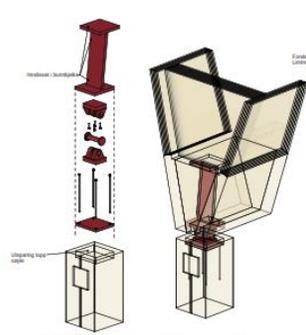
Detail 16
1:10



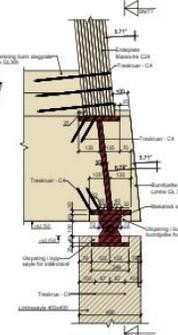
Hoveddetalj 16 - 3D - Sammensatt



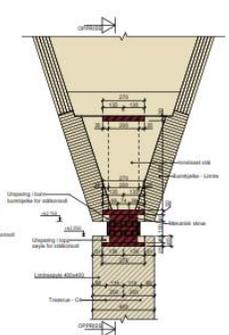
Plan
1:10



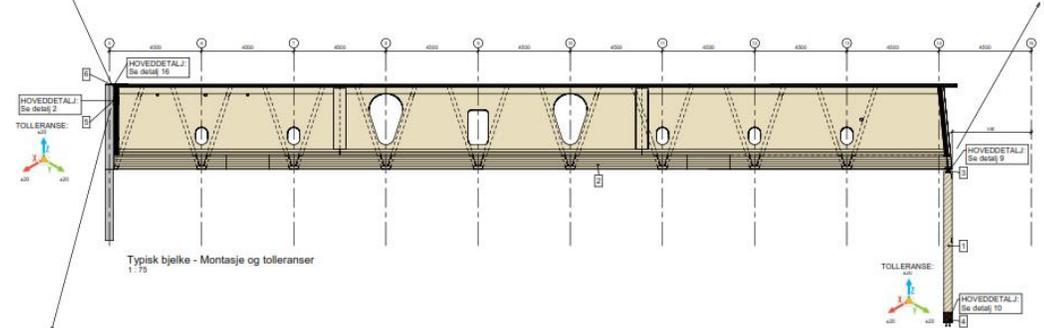
3D vist fra hverandre 3D sammensatt



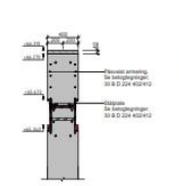
Detail 9
1:10



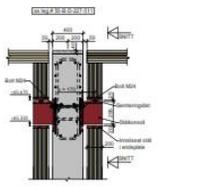
Snitt
1:10



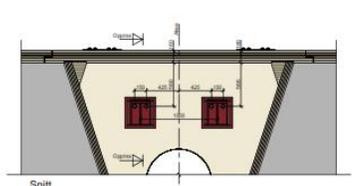
Typisk bjelke - Montasje og tolleranser
1:15



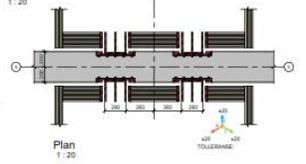
Detail 2 - Del 1: Stålplate i betong
1:20



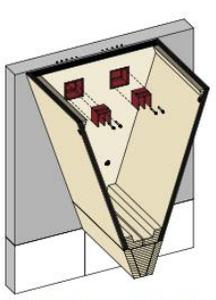
Detail 2 - Del 2: Bjelke hengt opp i betong
1:20



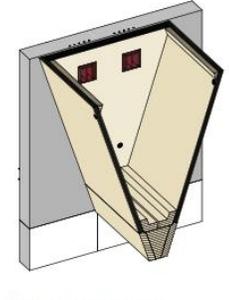
Snitt
1:20



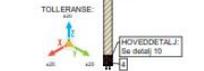
Plan
1:20



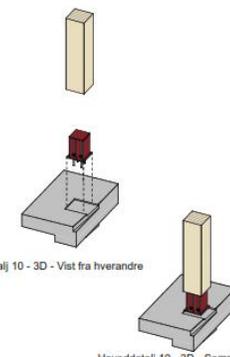
Hoveddetalj 2 - 3D - vist fra hverandre



Hoveddetalj 2 - 3D - Sammensatt

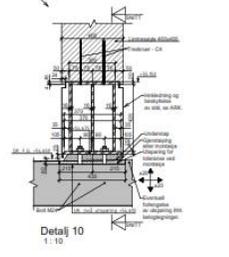


TOLLERANSE



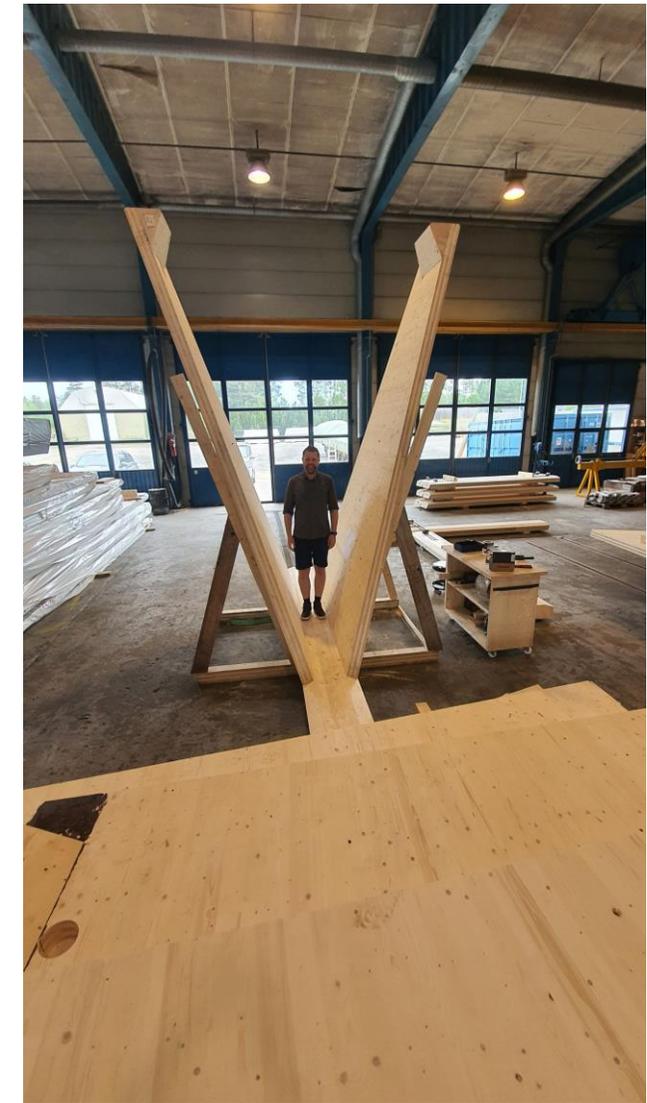
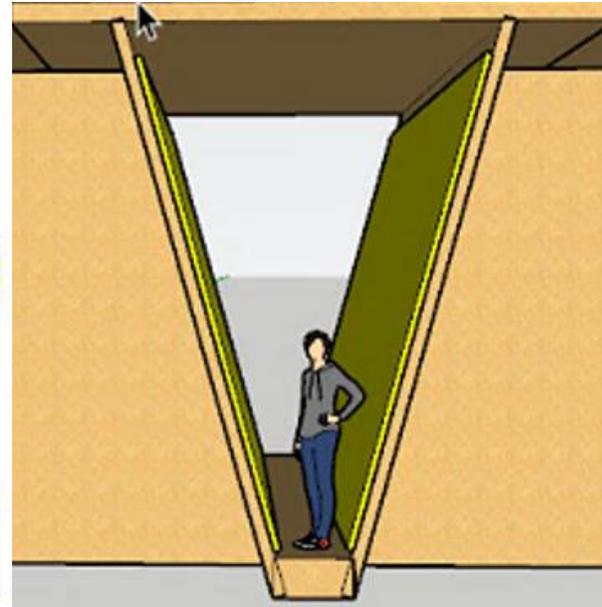
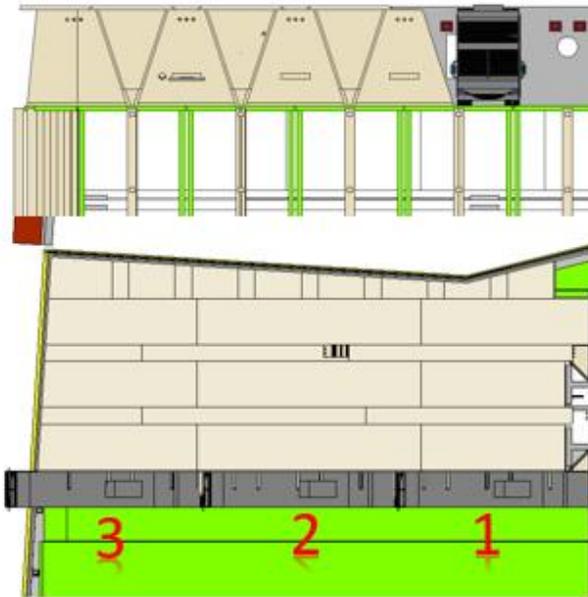
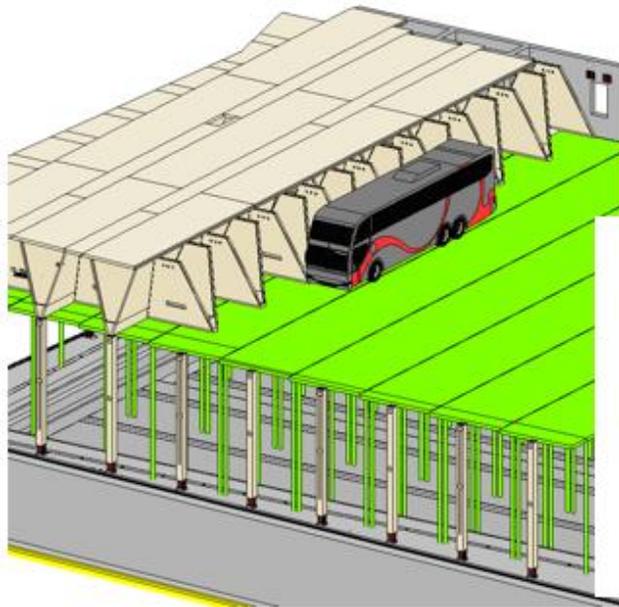
Hoveddetalj 10 - 3D - Vist fra hverandre

Hoveddetalj 10 - 3D - Sammensatt



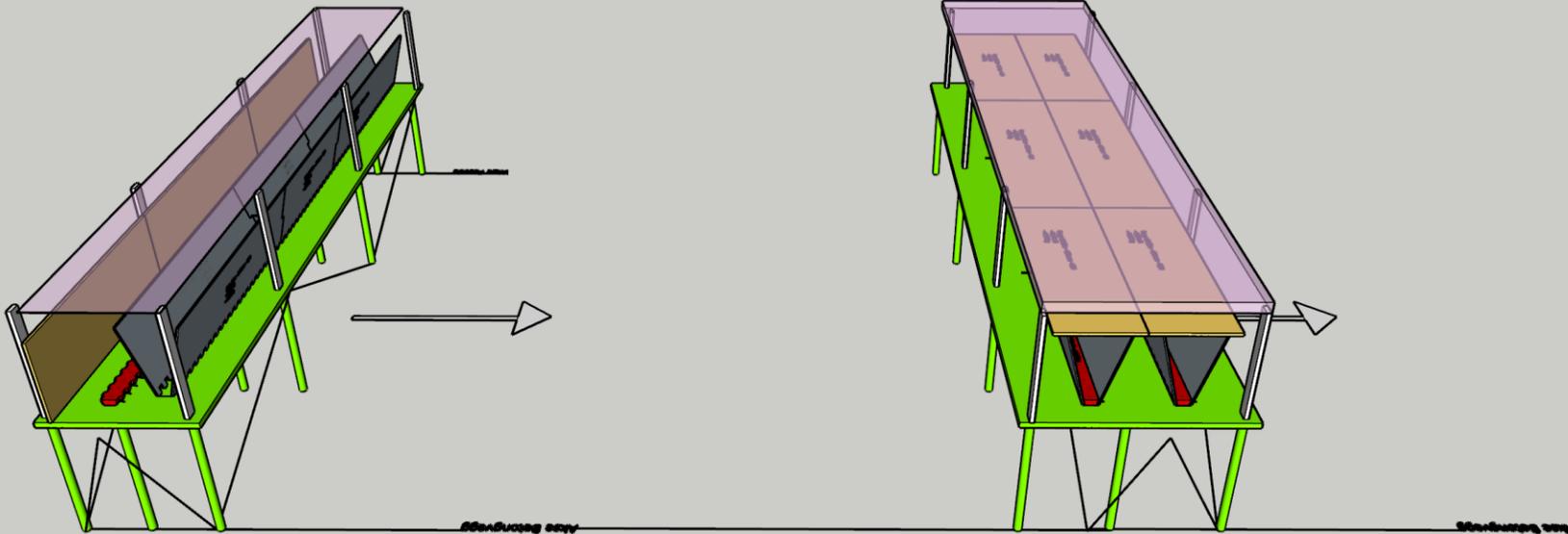
Detail 10
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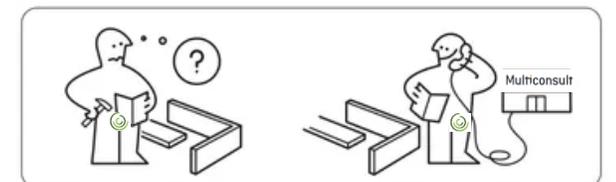
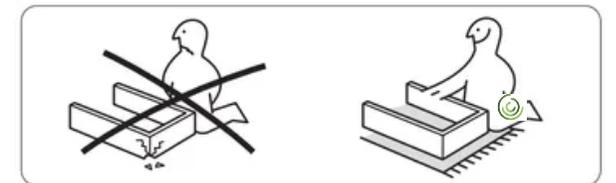
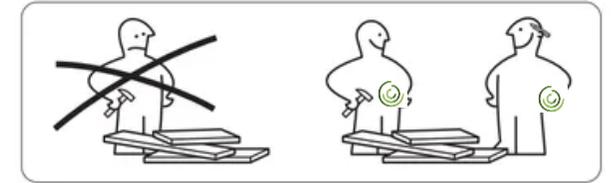
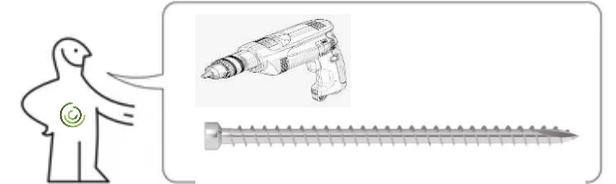


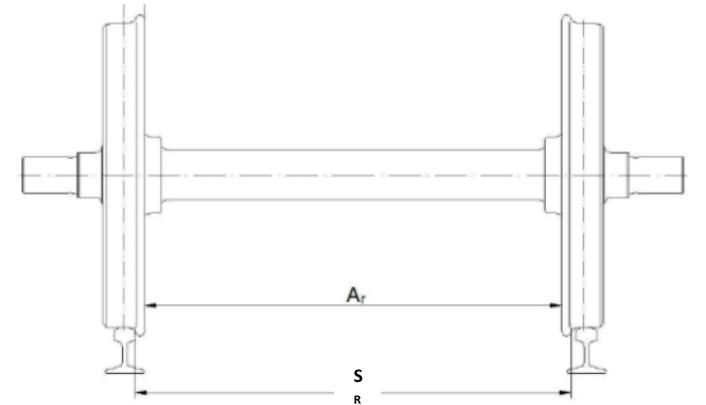
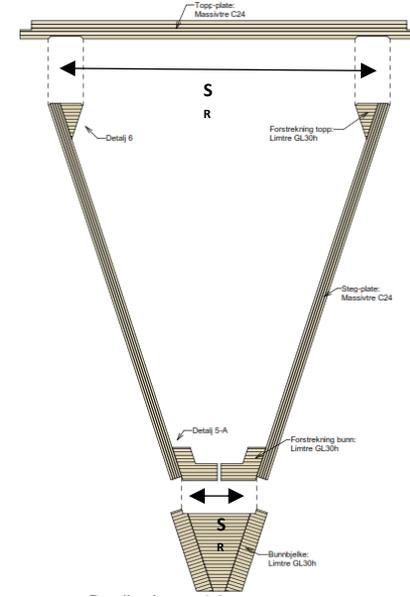
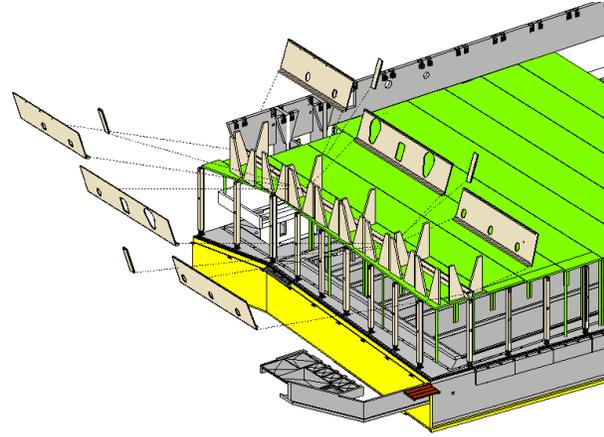
Combined structure

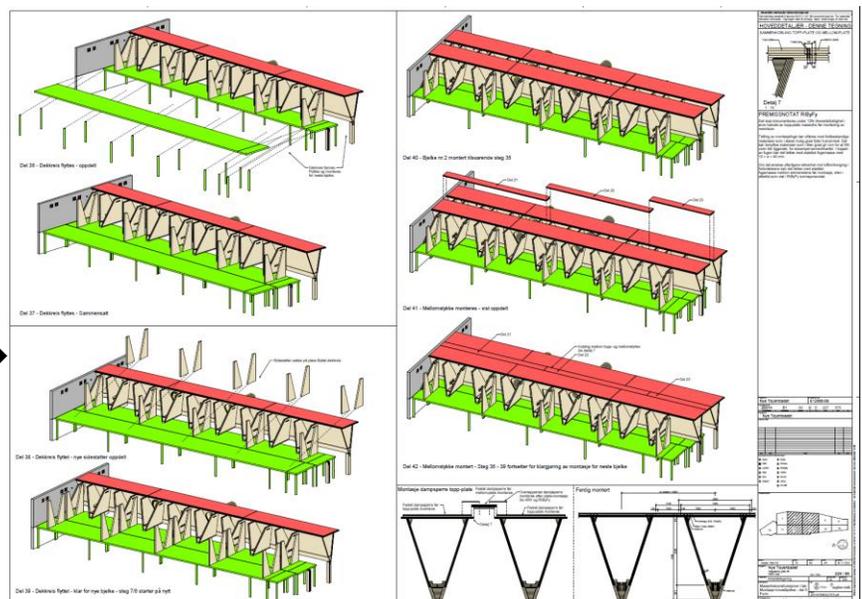
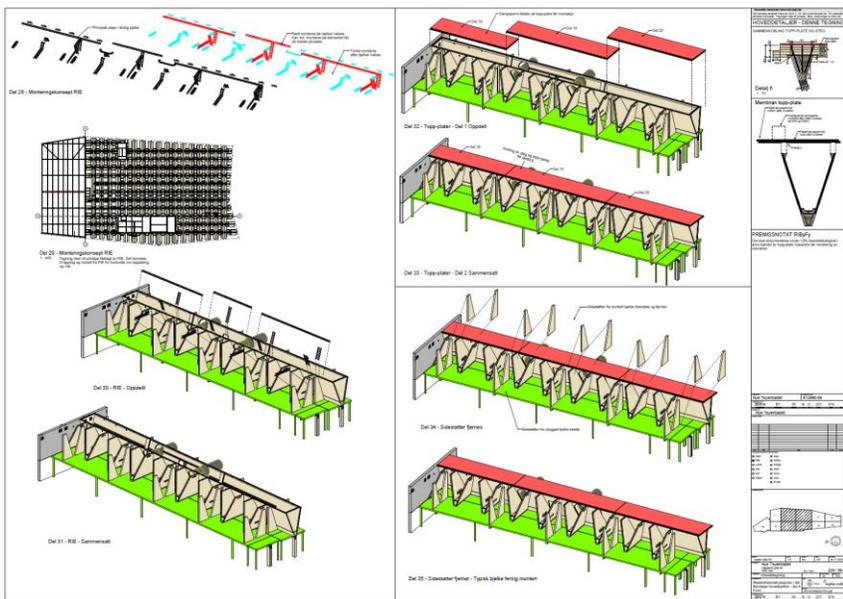
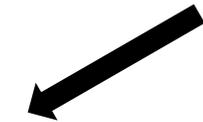
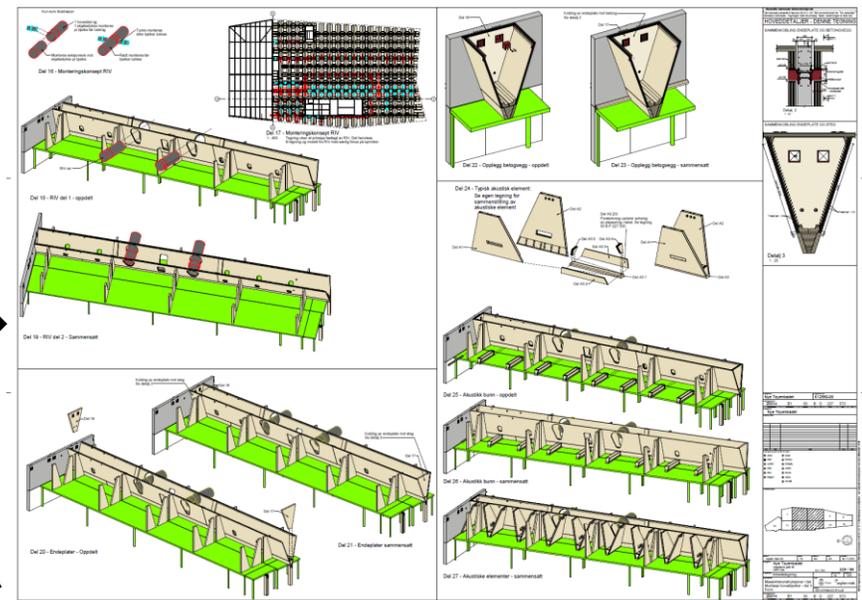
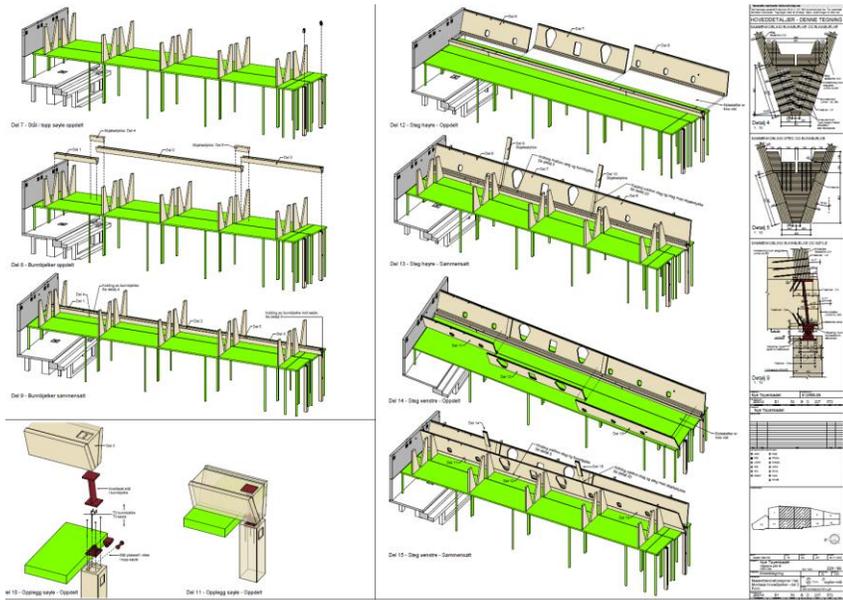
How should this be assembled?

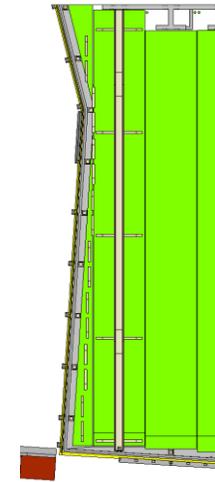
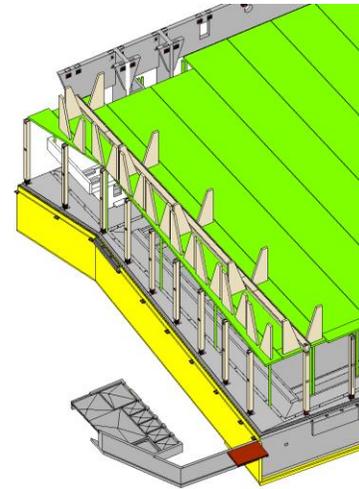
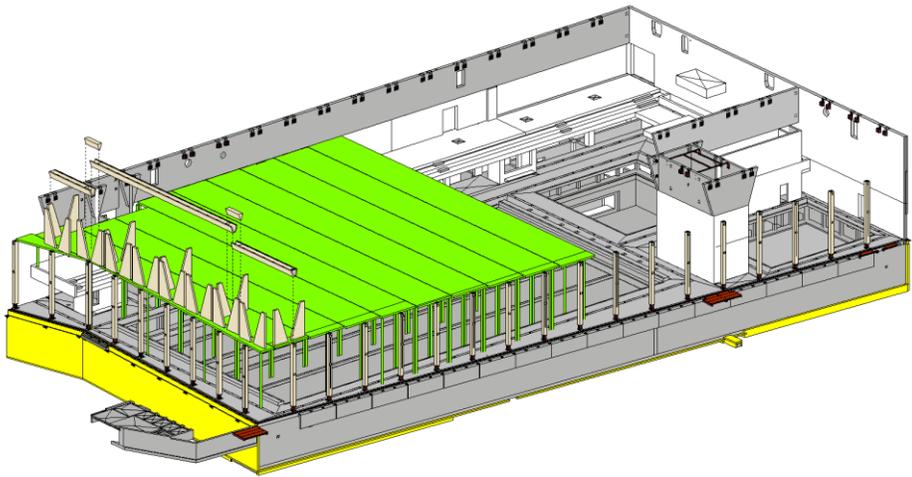
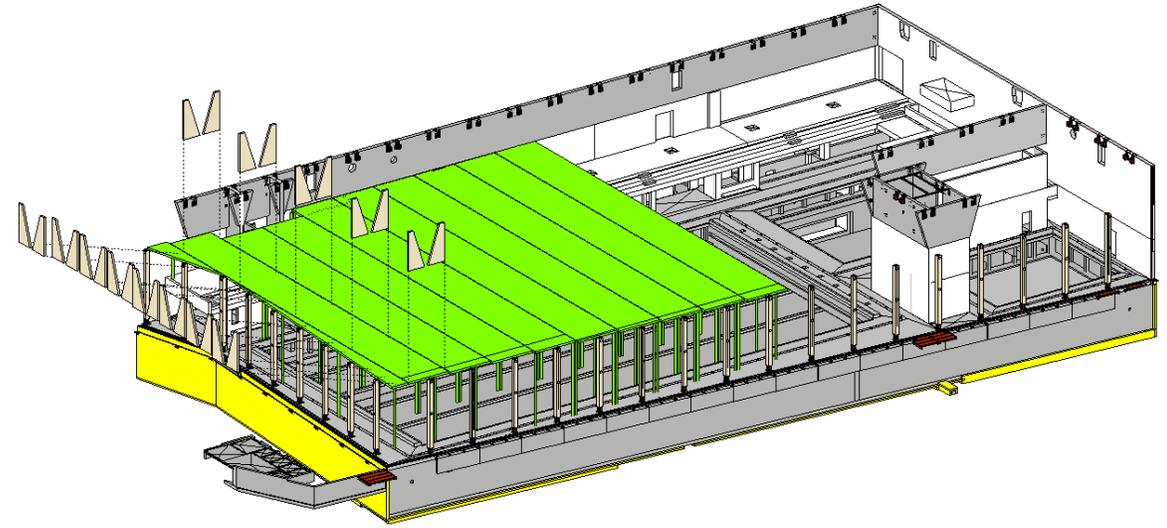
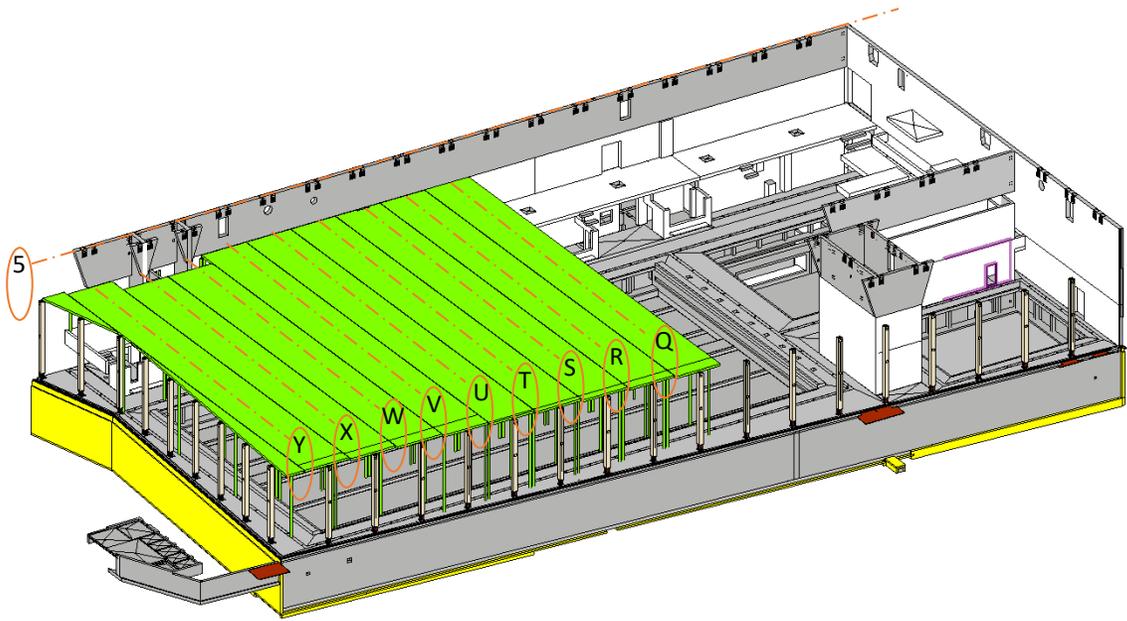


Building - Montage

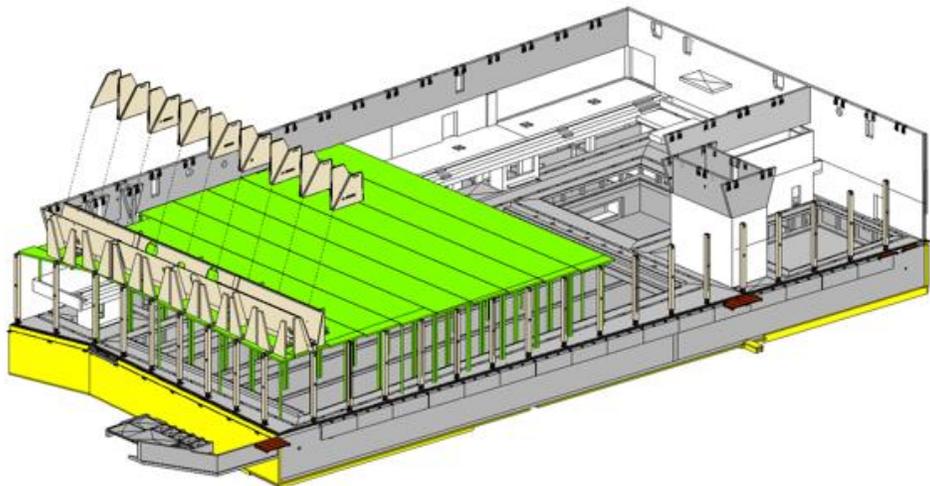
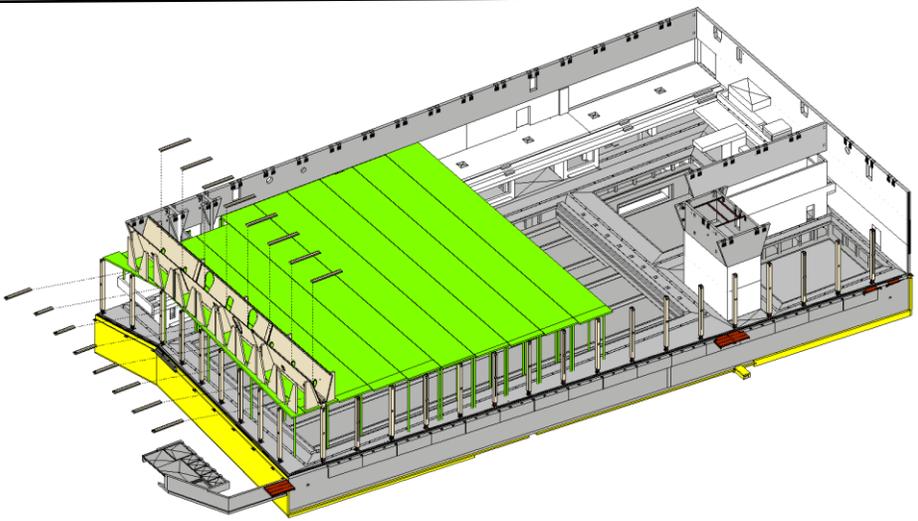
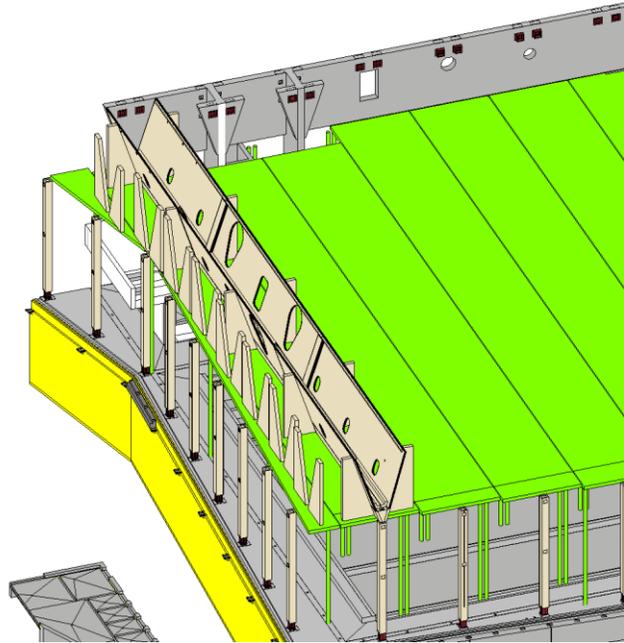
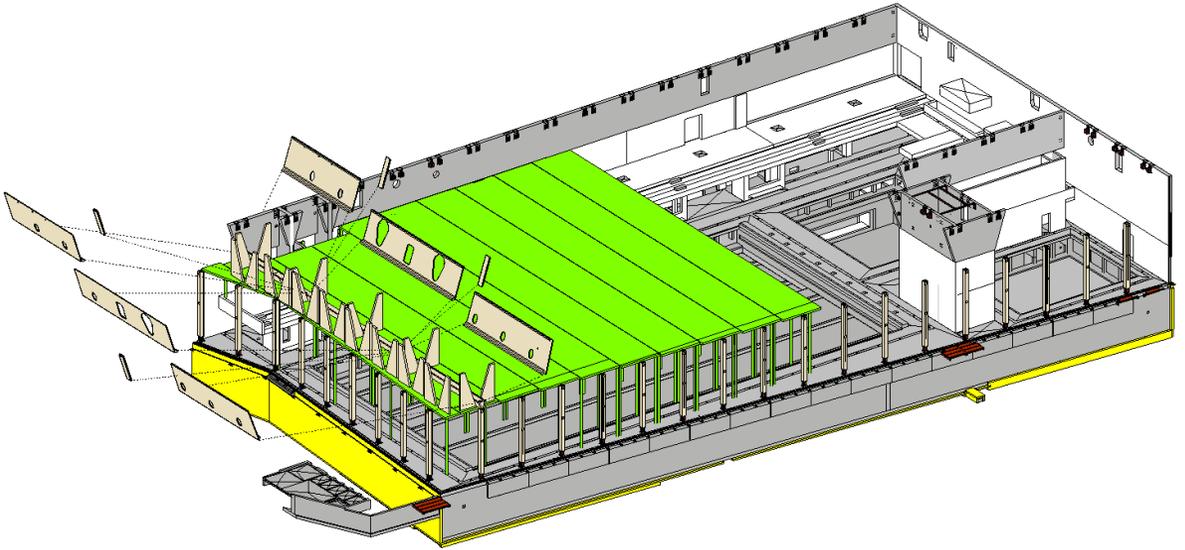


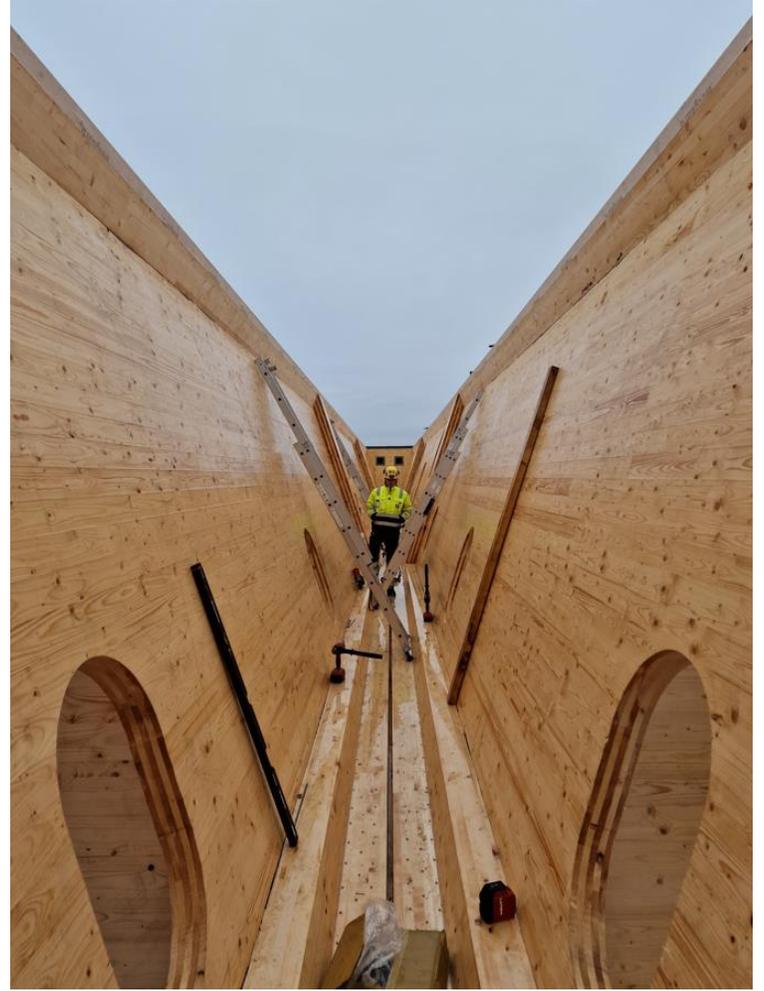


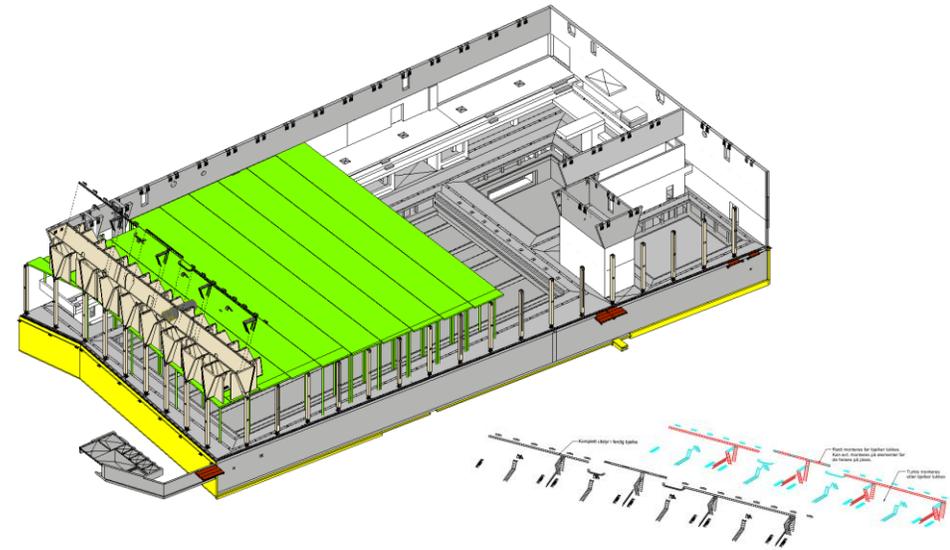
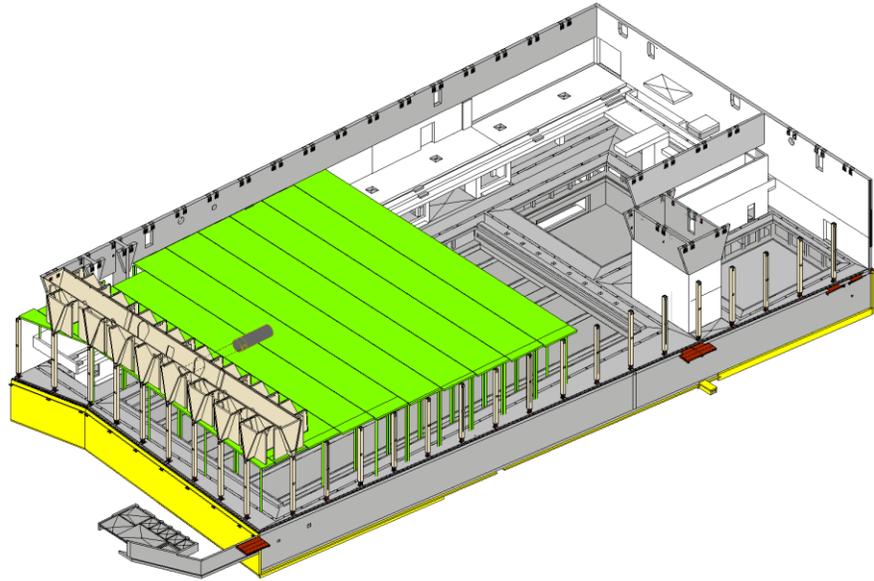
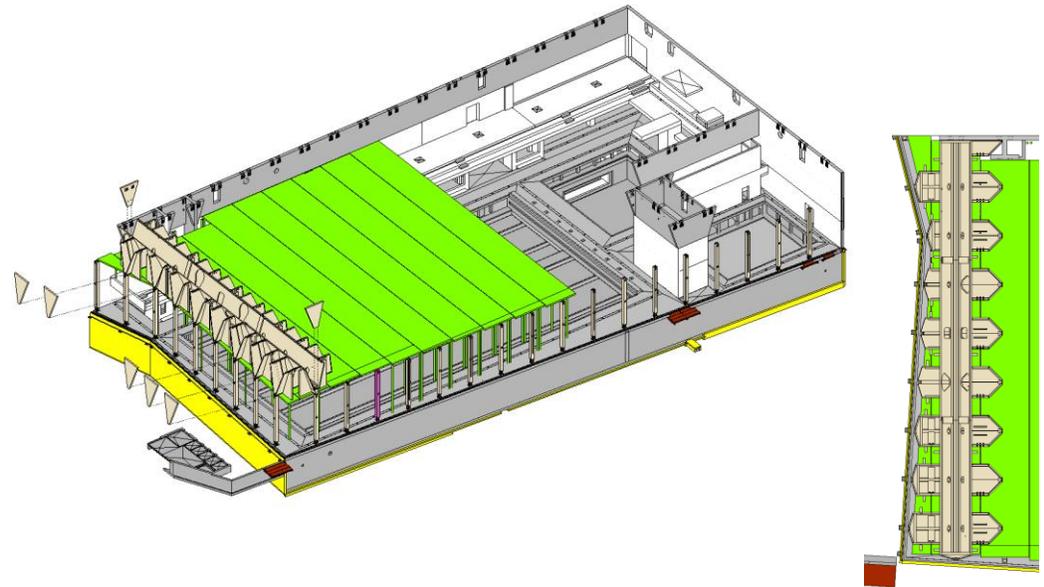
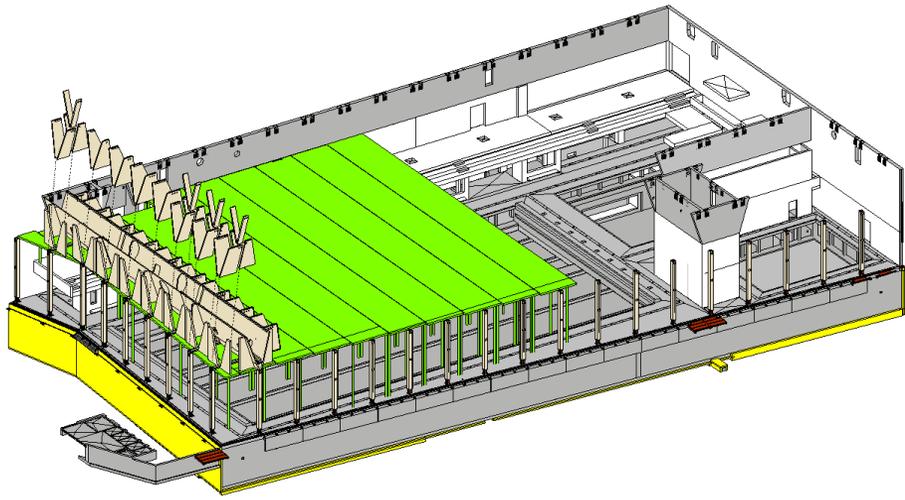


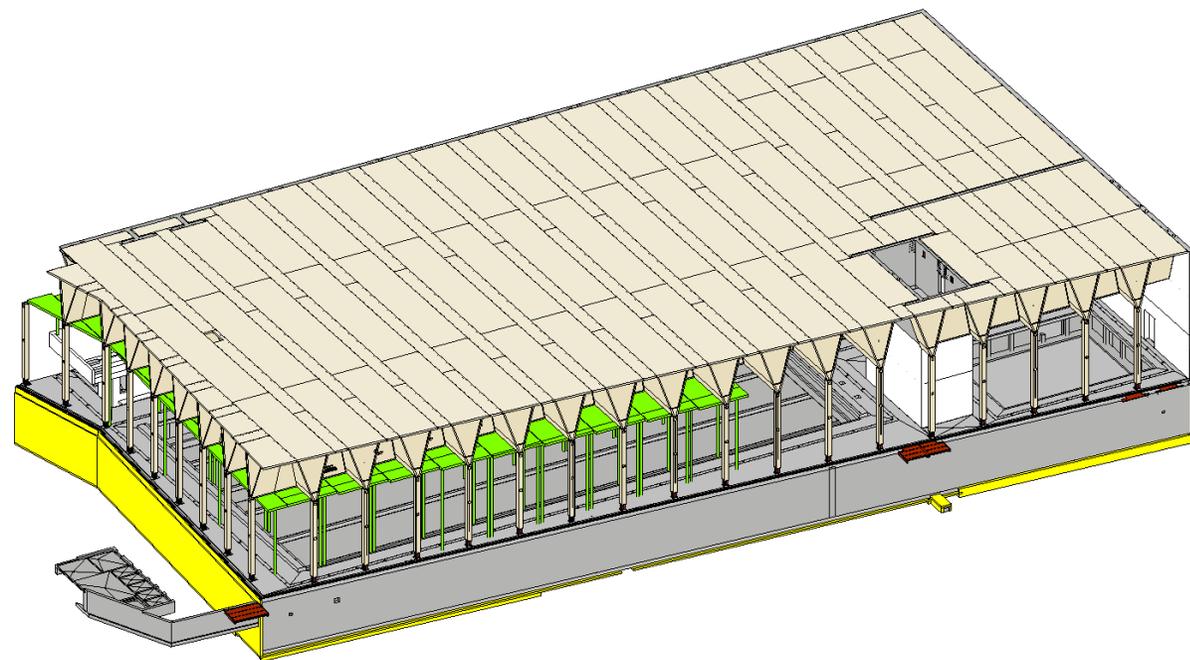
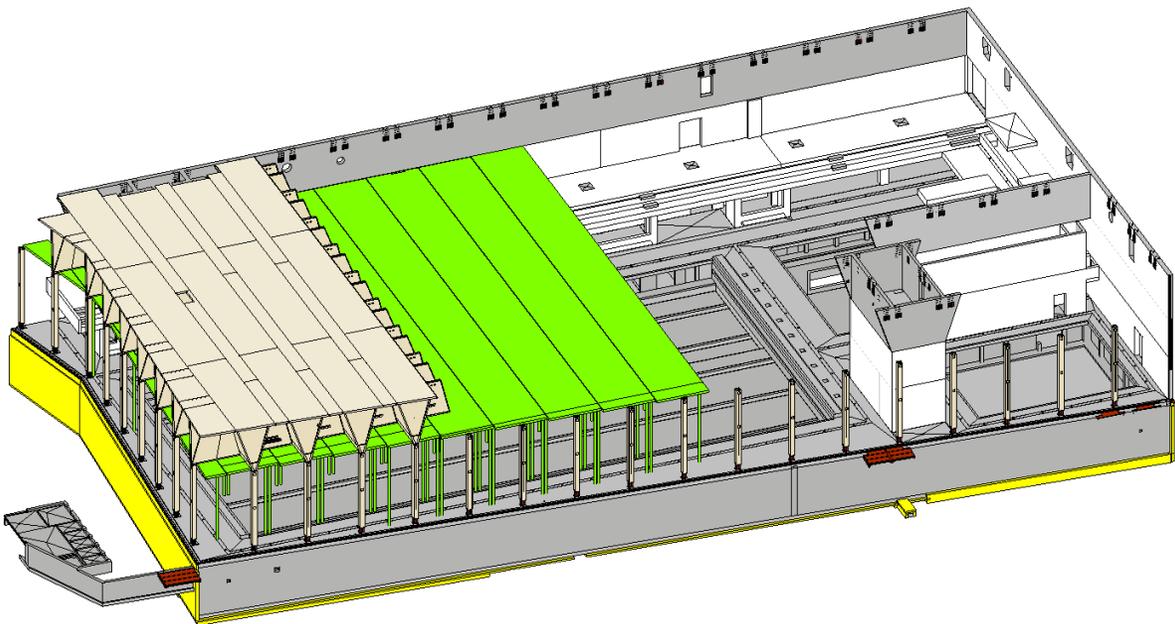




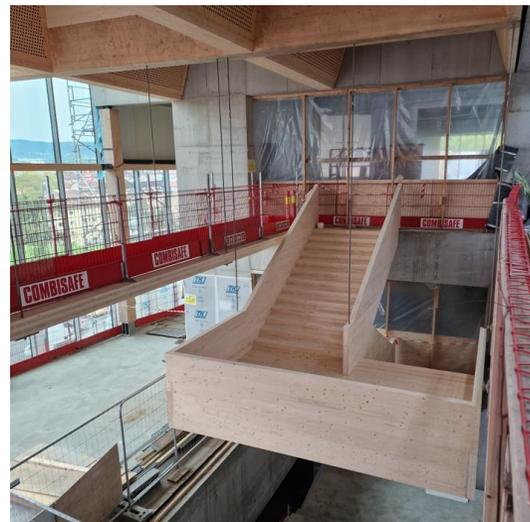
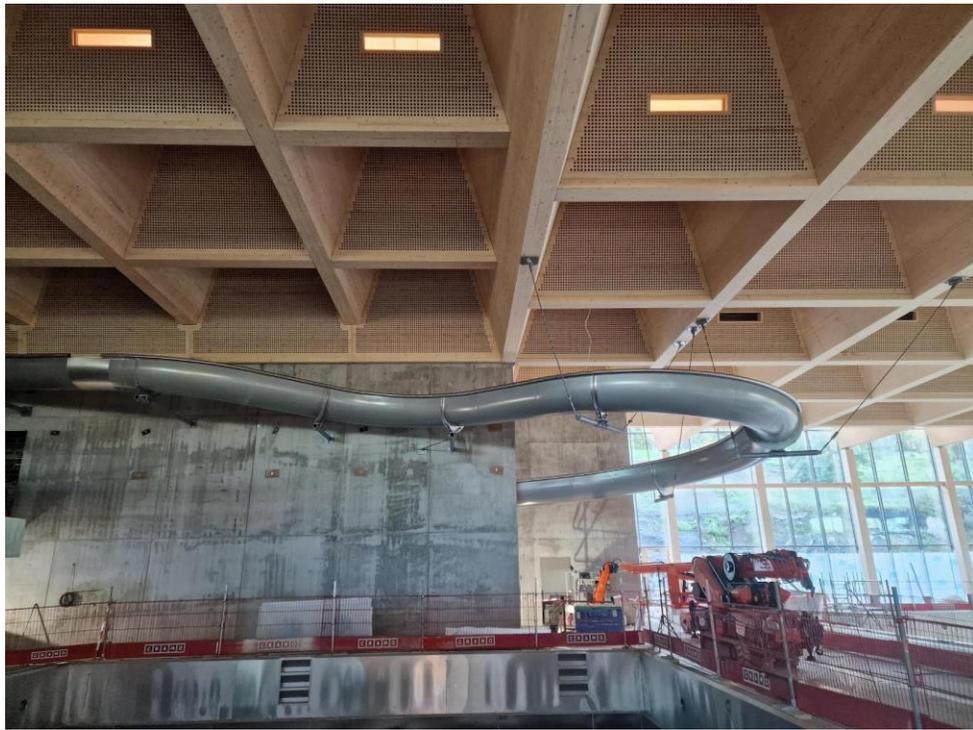








Suspended from the roof



DESIGNING FOR CORROSIVE ENVIRONMENT AND STIFFNESS



Norsk Standard
NS-EN ISO 12944-2:2017

ICS 87 020; 91.080.13
Språk: Engelsk

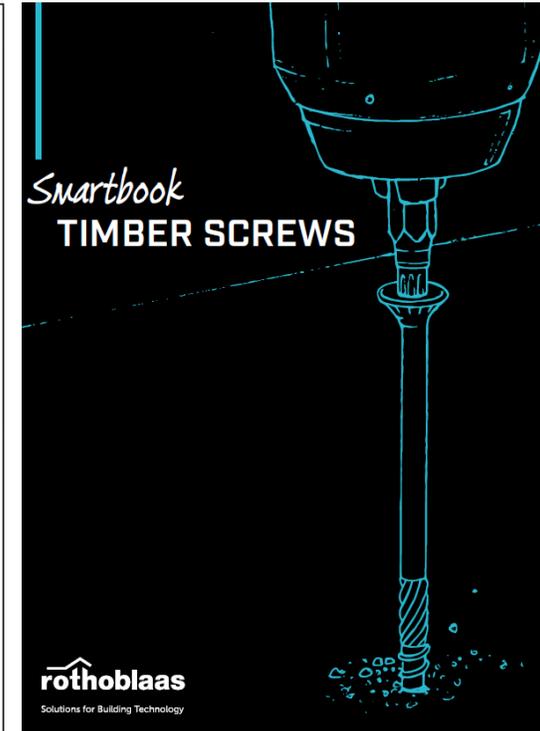
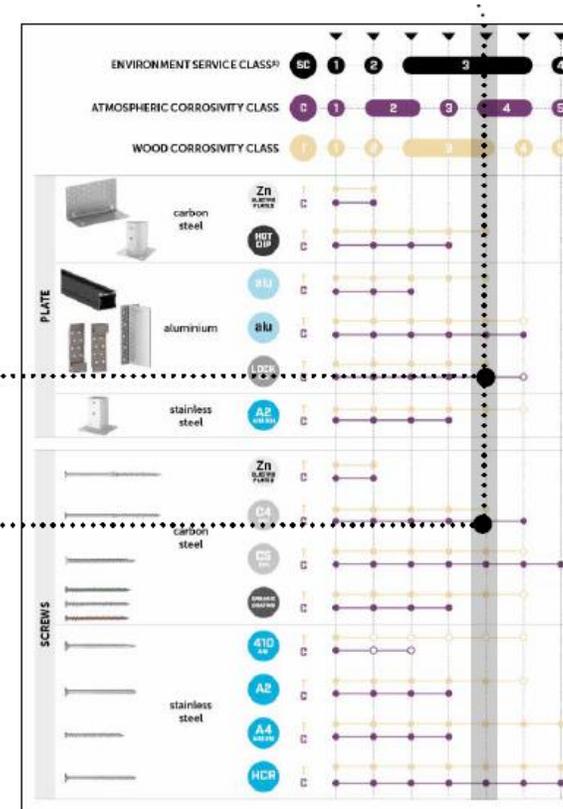
Maling og lakk
Korrosjonsbeskyttelse av
stålkonstruksjoner med beskyttende
malingsystemer
Del 2: Klassifisering av miljøet
(ISO 12944-2:2017)

Paints and varnishes
Corrosion protection of steel structures by protective paint systems
Part 2: Classification of environments
(ISO 12944-2:2017)



Schlussbericht für das Forschungsvorhaben:

Gebäudeklima - Langzeitmessung zur Bestimmung der
Auswirkungen auf Feuchtgradienten in Holzbauteilen



Tabell 1: Grunnmaterial										
Ståltype (1)		Struktur (2)	Festhetsklasser og produktformer (3)					Korrosjonsklasse (5)		
Navn	W-nr		S235	S275	S355	S460	S690			
X2CrNi12	1.4003	F	B, Ba, H, P	D, H, S, W	D, S	D, S	-	1 / VELDIG LAV	C1	
X6Cr17	1.4016	F	D, S, W	-	-	-	-	-	-	
X5CrNi18-10	1.4301	A	B, Ba, D, H, P, S, W	B, Ba, D, H, P, S	B, Ba, D, H, S	Ba, D, H, S	S	2 / LAV	C2	
X2CrNi18-9	1.4307	A	B, Ba, D, H, P, S, W	B, Ba, D, H, P, S	B, Ba, D, H, S	Ba, D, H, S	S	-	-	
X3CrNiCu18-9-4	1.4567	A	D, S, W	D, S	D, S	D, S	-	-	-	
X6CrNiTi18-10	1.4541	A	B, Ba, D, H, P, S, W	B, Ba, D, H, P, S	Ba, D, H, S	Ba, D, H, S	-	-	-	
X2CrNi18-7	1.4318	A	-	-	Ba, D, H, P, S	B, Ba, H	-	-	-	
X5CrNiMo17-12-2	1.4401	A	B, Ba, D, H, P, S, W	B, Ba, D, H, P, S	Ba, D, H, S	Ba, D, H	S	3 / MIDDELS	C3	
X2CrNiMo17-12-2	1.4404	A	B, Ba, D, H, P, S, W	B, Ba, D, H, P, S	Ba, D, H, S	Ba, D, H, S	D, S	-	-	
X3CrNiCuMo17-11-3-2	1.4578	A	D, S, W	D, S	D, S	D, S	-	-	-	
X6CrNiMoTi17-12-2	1.4571	A	B, Ba, D, H, P, S, W	B, Ba, D, H, P, S	Ba, D, H, S	Ba, D, H, S	D, S	-	-	
X2CrNi23-4	1.4362	FA	-	-	-	B, Ba, D, S, W	D, S	-	-	
X2CrNi22-2	1.4062	FA	-	-	-	B, Ba, D, S, W	D, S	-	-	
X2CrMnNi21-5-1	1.4162	FA	-	-	-	B, Ba, D, S, W	D, S	-	-	
X2CrNiMnMoCuN24-4-3-2	1.4662	FA	-	-	-	B, Ba, D, S, W	D, S	-	-	
X2CrNiMo17-13-5	1.4439	A	-	B, Ba, D, H, S, W	-	-	-	4 / STERK	C4	
X2CrNiMo22-5-3	1.4462	FA	-	-	-	B, Ba, D, P, S, W	D, S	-	-	
X1NiCrMoCu25-20-5	1.4539	A	B, Ba, D, H, P, S, W	B, Ba, D, P, S	D, P, S	D, S	D, S	5 / SVÆRT STERKT	C5	
X2CrNiMnMoNbN25-18-5-4	1.4565	A	-	-	-	B, Ba, D, S	-	-	-	
X1NiCrMoCuN25-20-7	1.4529	A	-	B, D, S, W	B, D, H, P, S	D, P, S	D, S	-	-	
X1CrNiMoCuN20-18-7	1.4547	A	-	B, Ba	B, Ba	-	-	-	-	

- 1) ETTER DIN NS-EN 10088-1:2014
- 2) A = AUSTENIT, F = FERRIT, FA = FERRIT-AUSTENIT (DUPLX)
- 3) B = BLEKK, Ba = BÅND, D = TRÅD, H = HULLPROFIL, P = PROFIL, S = STANG, W = VALSET
- 4) GJELDER FOR METALL MED BLANKE OVERFLATER
- 5) DETTE ER ASPLAN VIAK SIN TOLKNING AV KORROSJONSKLASSENE I IENHOLD TIL NS-EN 12944

Grunnmaterial	
Sammenligning Z.30.3-6 og Deutsche Edelstahlwerke Z.30.3-6 2014	dew-stahl.com ref. korr.notat
W-nr	W-nr
1.4003	-
1.4016	-
1.4301	1.4301
-	1.4303
-	1.4305
-	1.4306
1.4307	1.4307
-	1.4310
-	1.4567
1.4541	1.4541
1.4318	-
1.4401	1.4401
1.4004	1.4004
1.4578	1.4578
1.4571	1.4571
1.4362	-
1.4062	-
1.4162	-
1.4662	-
-	1.4429
-	1.4435
-	1.4436
1.4439	-
1.4462	-
1.4539	1.4539
1.4565	-
1.4529	1.4529
1.4547	-

- Veldig lav / C1
- Lav / C2
- Middels / C3
- Sterk / C4
- Svært sterk / C5



Tabelle 2: Beispiele für Mindestanforderungen an die Baustoffe bzw. den Korrosionsschutz von stoffförmigen Verbindungsmitteln nach DIN EN 1995-1-1 [2], DIN EN 1995-1-1 / NA [3] und DIN SPEC 1052-100 [4]

Regelwerk	Korrosionsbeanspruchung / Korrosivitätskategorie	Nutzungs-kategorie ^c	Nägel d ≤ 4 mm Schrauben d ≤ 4 mm	Nägel d > 4 mm Schrauben d > 4 mm Stabdübel; Bolzen Scheiben + Muttern eingeklebte Stahlstäbe	Klammern
DIN EN 1995-1-1	unbedeutend / gering	C 1 / C 2	-	-	Fe/Zn 12/c ^a
DIN SPEC 1052-100	mäßig	C 3	NKL 1	Fe/Zn 12/c ^a	nichtrostender Stahl ^b
	stark	C 4	NKL 2	Fe/Zn 25/c ^a	nichtrostender Stahl ^b
	sehr stark	C 5	NKL 3 ^c	55 µm	55 µm
DIN EN 1995-1-1/NA	gerbstofffreie Hölzer [zB Eiche, Bongossi]		nichtrostender Stahl ^b	nichtrostender Stahl ^{b,*}	nichtrostender Stahl ^b
	chemische Holzschutzmittel		siehe Mindestanforderungen „sehr starke“ Korrosionsbeanspruchung		

^a Bei Feuerverzinkungen ist in der Regel FE/Zn 12/c durch Z275 und FE/Zn 25/c durch Z350 nach DIN EN 10346 zu ersetzen
^b Verwendung geeigneter nichtrostender Stähle für die entsprechende Korrosionswiderstandsklasse z.B. nach Z-30.3-6 → s. Tabelle 3
^c In NKL 3 müssen im sichtbaren Bereich (z.B. Balkone, Terrassen, Außenwandbekleidungen) ausschließlich nichtrostende Verbindungsmittel verwendet werden
^d Außenliegende Bleche: Nägel und Schrauben mit einer mittleren Zinkschichtdicke von mindestens 7 µm
^e Bei Verbindungsmitteln, die in ihrem für die Tragfähigkeit relevanten Bereich vollständig umschlossen sind (z.B. Stabdübel, Vollgewindeschrauben), ist eine mittlere Zinkschichtdicke von mindestens 55 µm ausreichend.
 Exemplarische Erläuterung der Abkürzungen:
 DIN EN ISO 2081 – Fe/Zn12/c galvanischer Zinküberzug (Zn) mit einer Mindestschichtdicke von 12µm und einem insisierenden Chromatüberzug (c) auf Eisenwerkstoff (Fe)
 DIN EN 10346 – Z275 Feuerverzinkt (Z) mit einer Mindest-Zinkauflage von 275 g/m²

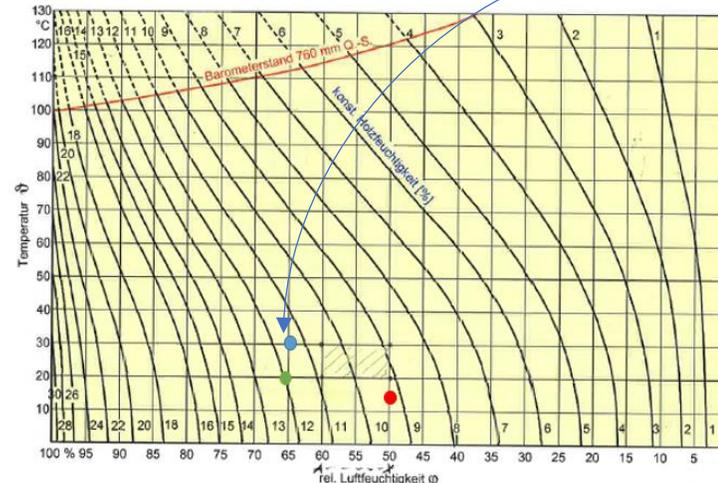
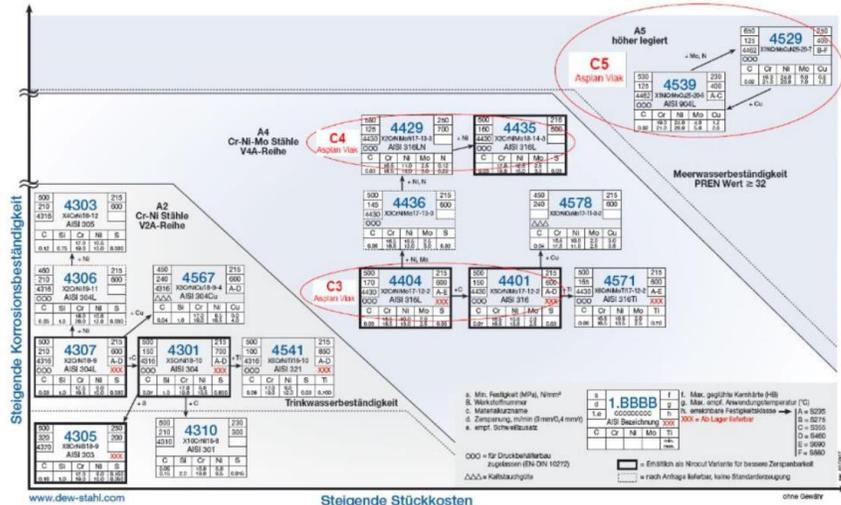


Bild 2.30. Hygroskopische Isothermen für Fichtenholz (Zusammenhang zwischen Umgebungsklima und sich einstellender Holzfeuchte ω) nach Loughborough/Kaylert (gilt mit hinreichender Genauigkeit für alle Holzarten, s. [Kollmann 1951])

Korrosion stoffförmiger Verbindungsmittel im Holzbau

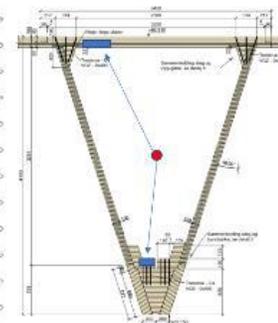
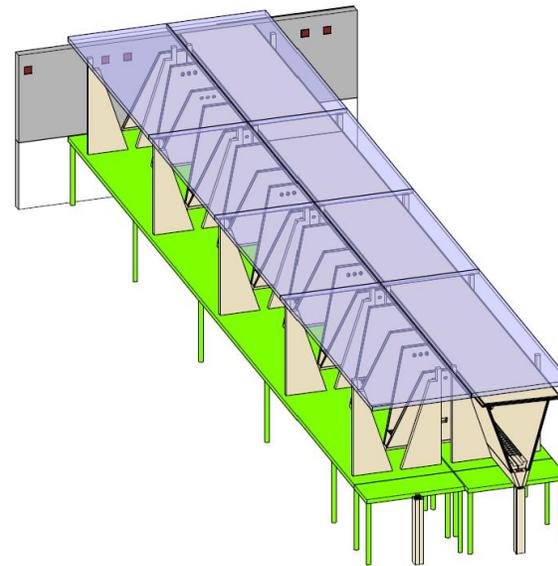
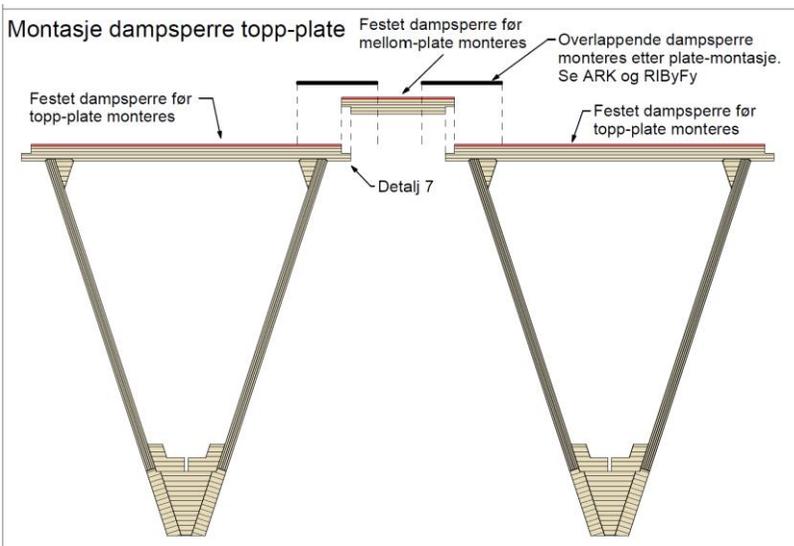
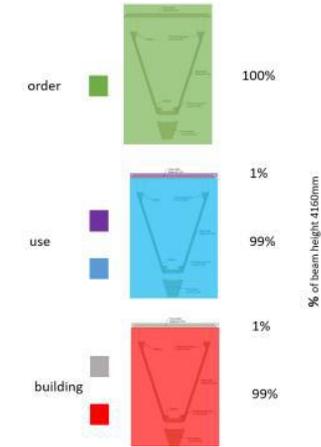
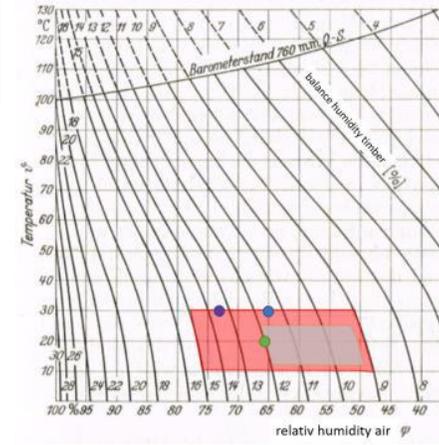
Dipl.-Ing. Anke Blume
 Kronenstraße 55-58
 10117 Berlin
 Website: http://www.institut-holzbau.de

Korrosionsschutz – Was regelt die Norm?

Die Suche nach dem geeigneten Korrosionsschutz für metallische Verbindungsmittel gleicht einer Schnitzeljagd:

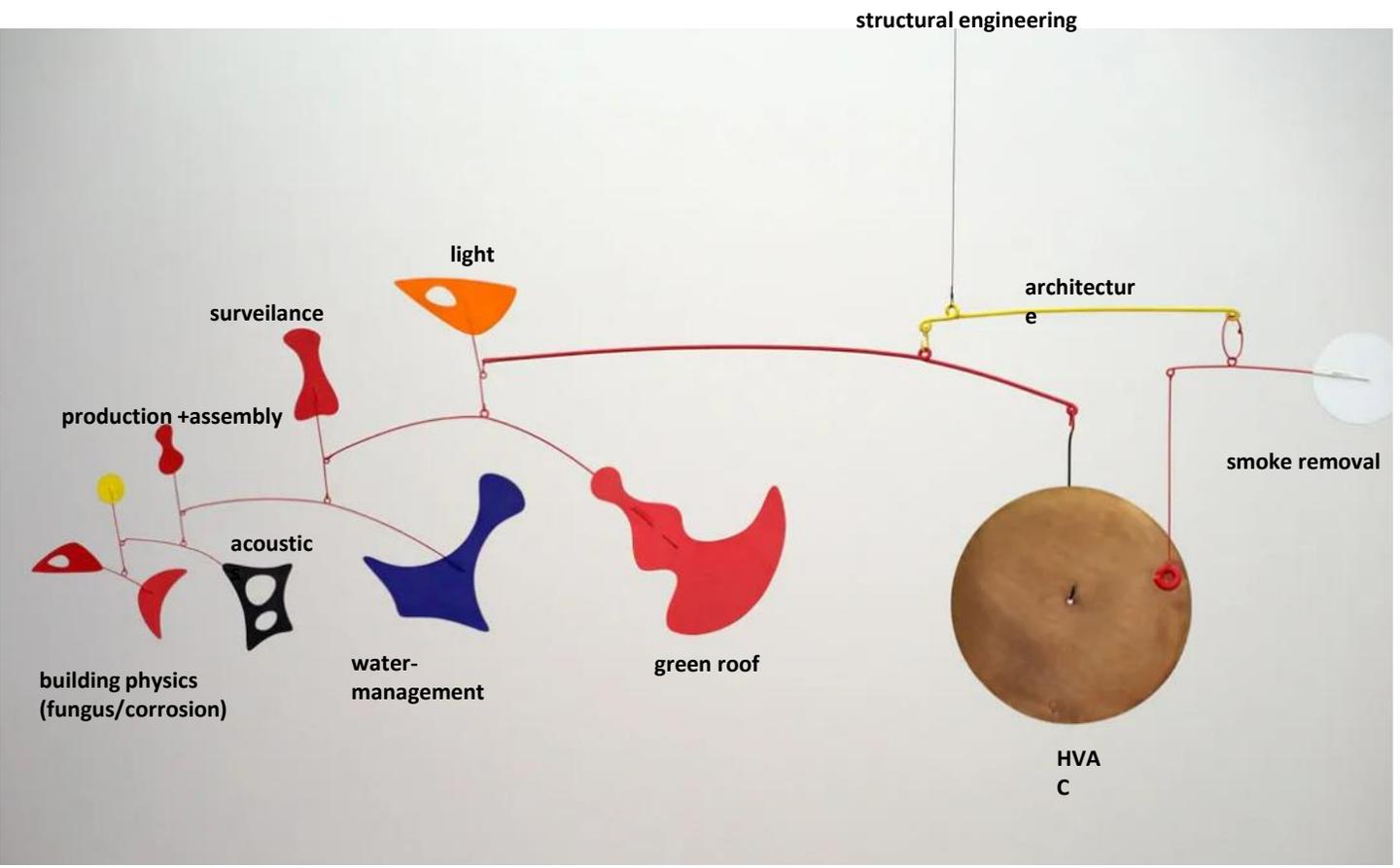
- Die Mindestanforderungen nach DIN EN 1995-1-1: 2010-12 [2], Abschnitt 4.2 gelten nur für unbedeutende oder geringe Korrosionsbelastungen (Korrosivitätskategorie C1 / C2 nach Tabelle 1).
- Ergänzend dazu werden in DIN SPEC 1052-100: 2013-08 [4] Mindestanforderungen an den Korrosionsschutz für mäßige, starke und sehr starke Korrosionsbelastungen (C3 / C4 / C5 nach Tabelle 1) angegeben.
- Der Nationale Anhang DIN EN 1995-1-1/NA: 2013-08 [3], Abschnitt 4, NCI zu 4.2 regelt die Anforderungen an den Korrosionsschutz der Verbindungsmittel bei Verwendung gerbstoffreicher und imprägnierter Hölzer.

	Top of the top-plate		Side web	Bottom
Order	12,0	12,0	12,0	12,0
Operation	14,5	11,5	11,5	11,5
Montage -Calculated	9,5	9,5	9,5	9,5
Montage -max allowable	12,0	18,0	18,0	18,0



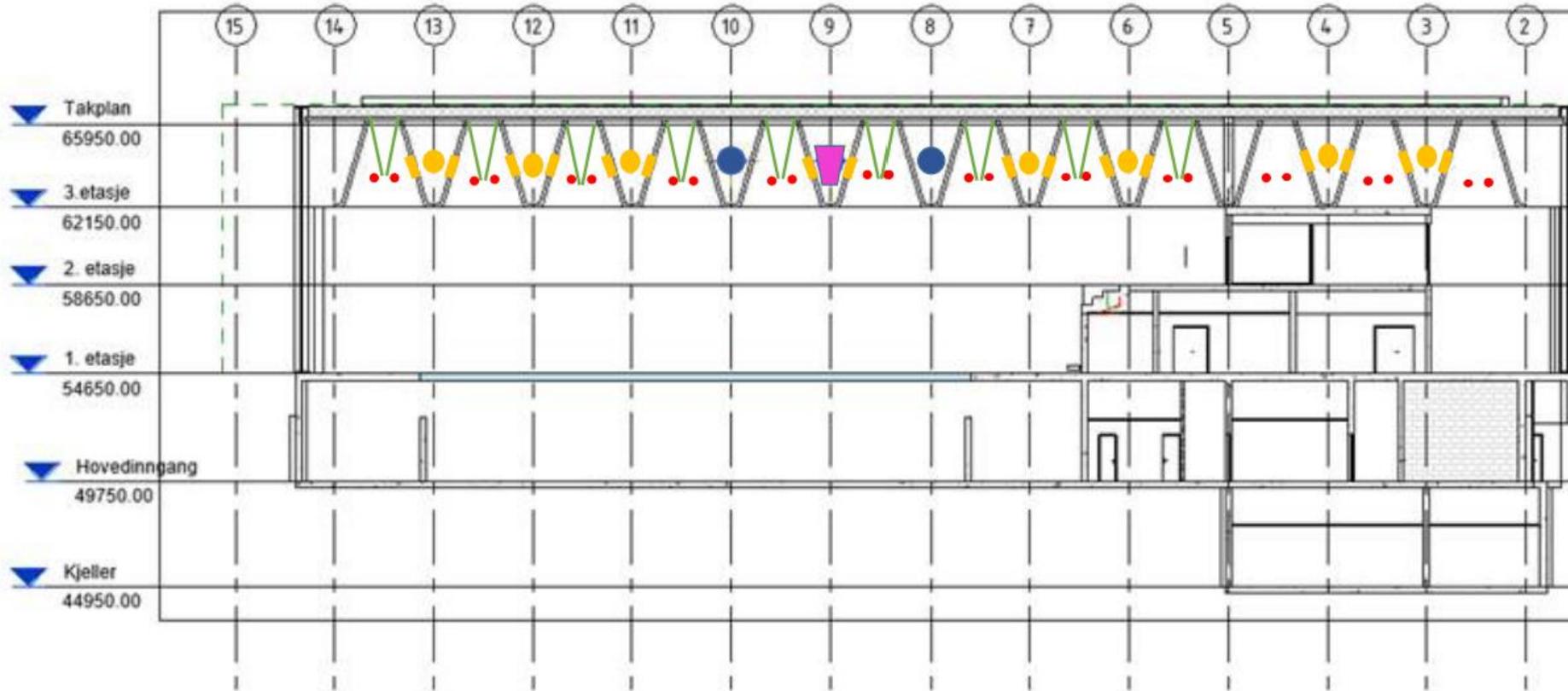
Integrated Structure

Alexander Calder, *Dispersed Objects with Brass Gong*, 1948



HULL

BRANN - RIV - RIE - RIAKU - KORRIDOR



BRANN: PER "HATT"

Annen hver rad: 0,25 m²

Hver rad: ~ 0.15 m²

- 2 synlige hull à 300mm = ~ 0.15 m²

RIV

2 store usynlige hull med 1250mm diameter.

RIE: HVER ANNEN "HATT"

2 synlige hull à 600mm x 600mm i tverr-panel

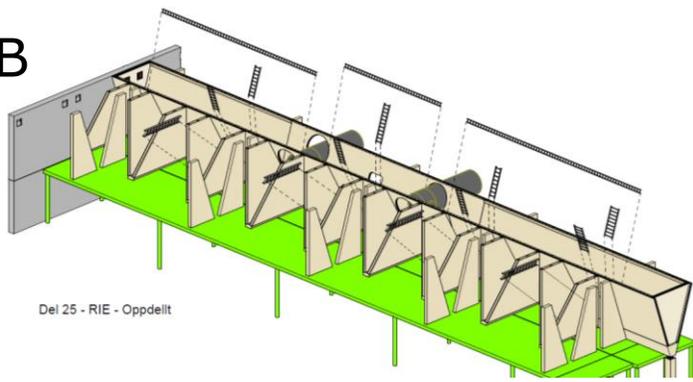
1 usynlig hull à 600mm i c.a. 30cm i høyde over i indre gulv.

KORRIDOR / DØR

100cm x 180cm i



RIB



Del 25 - RIE - Oppdelt

1 pizza base, ready-made or from 300g bread mix

RIB

Spicy pepperoni & pepper

75g passata

RIV

1 green pepper, deseeded and sliced

RIE

handful parsley, roughly chopped

RIE

100g mozzarella, torn

RIV

1 red chilli, sliced

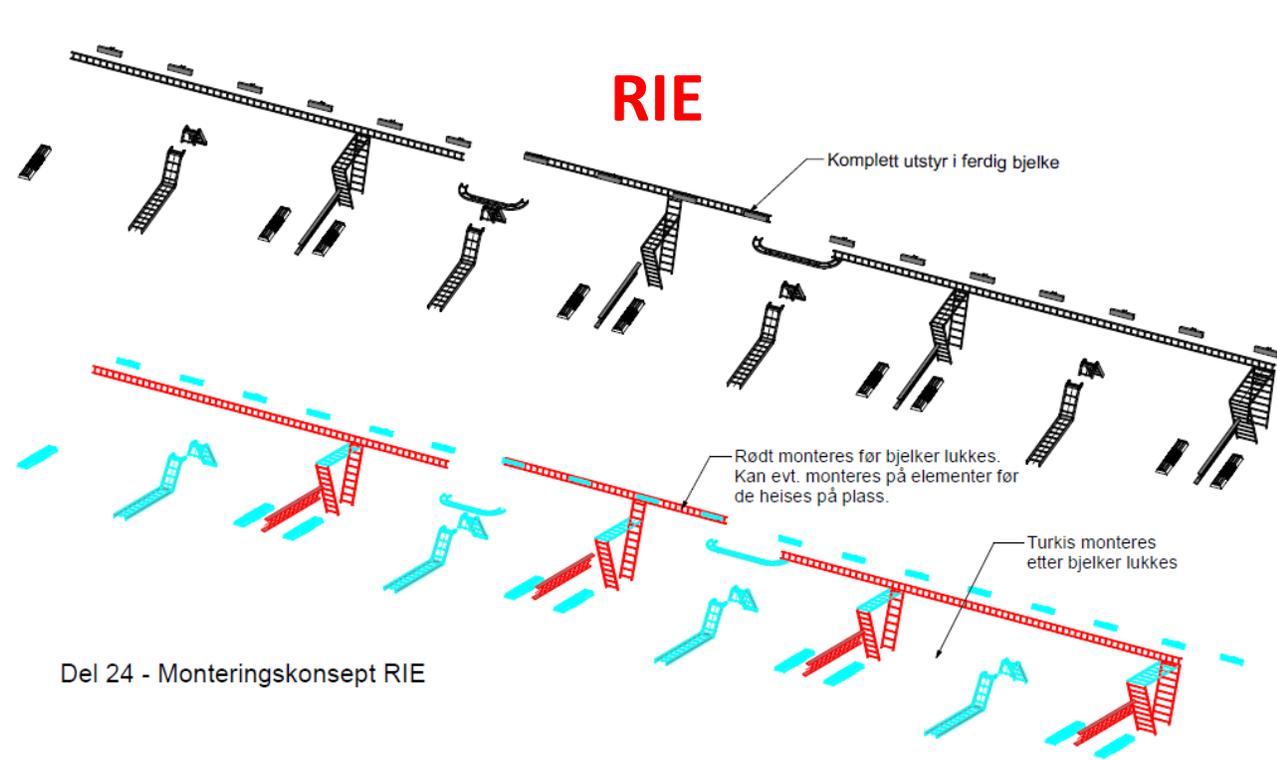
RIE

40g pepperoni, sliced

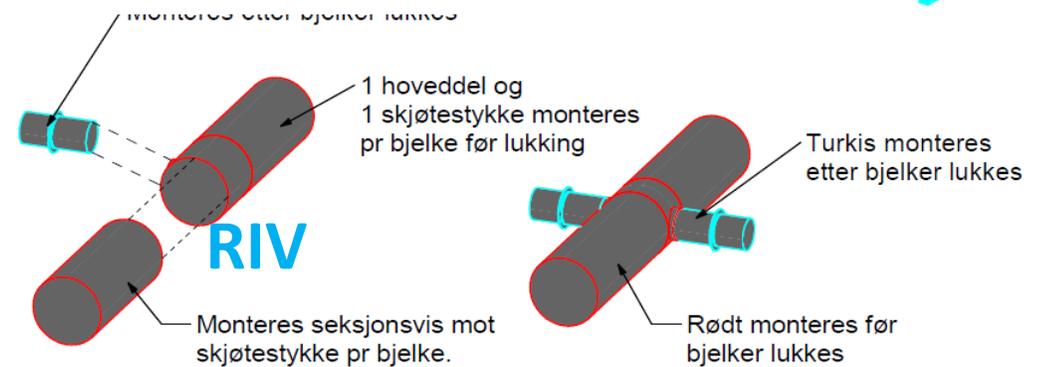
RIE



Ingredients

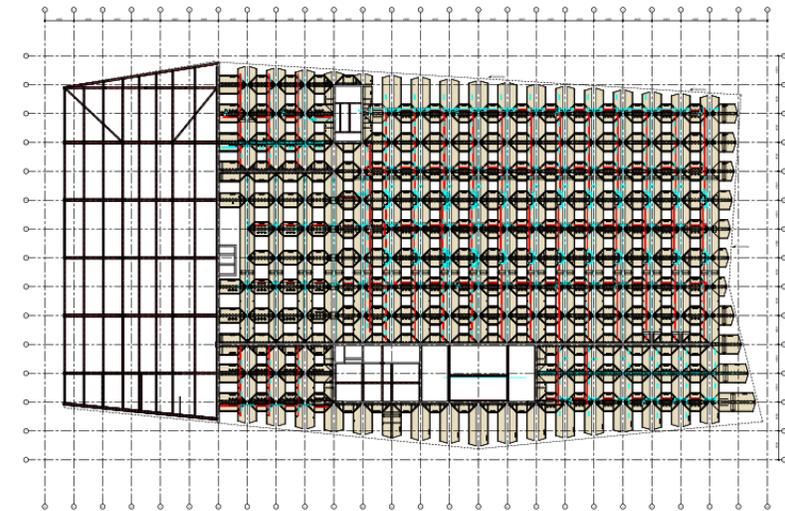
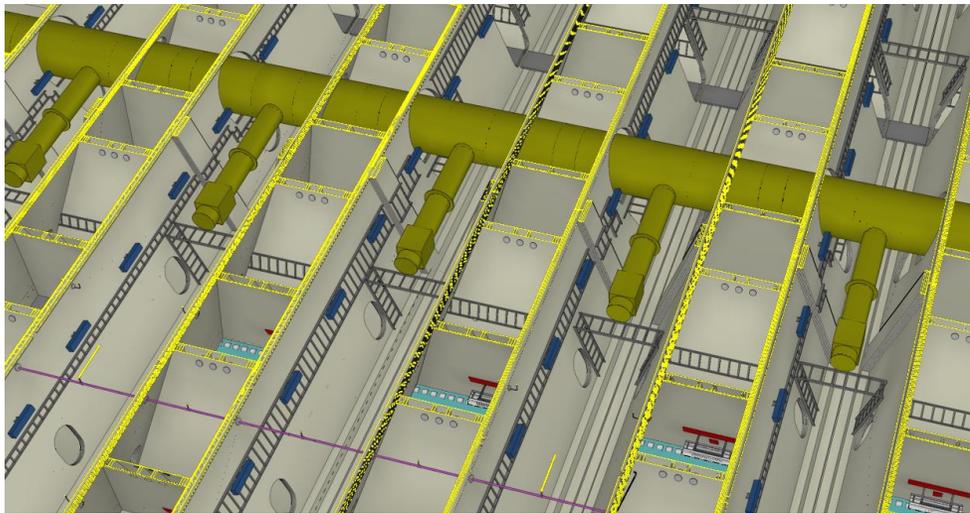
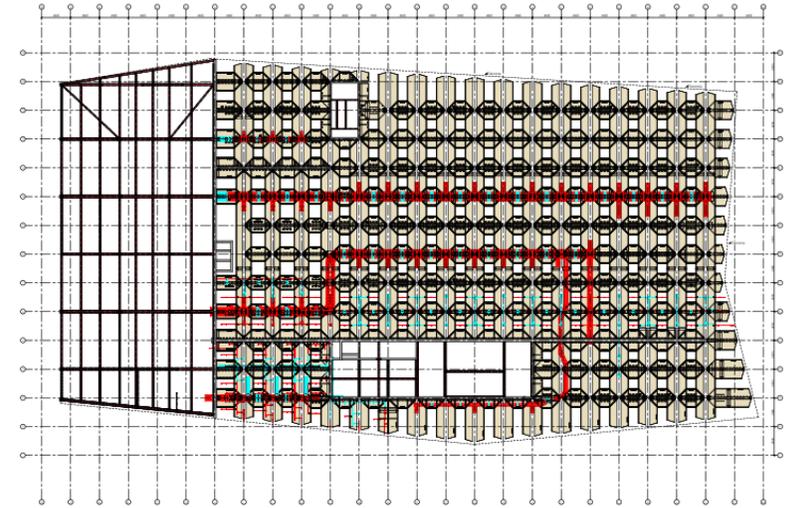
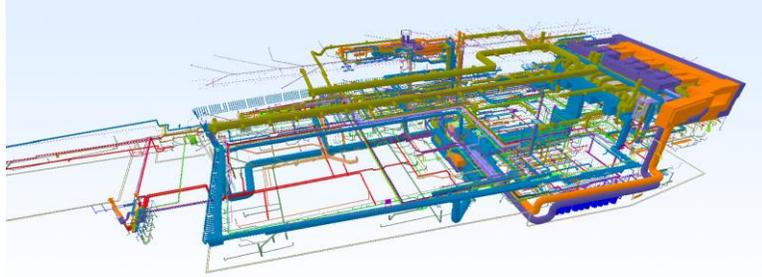


Del 24 - Monteringskonsept RIE

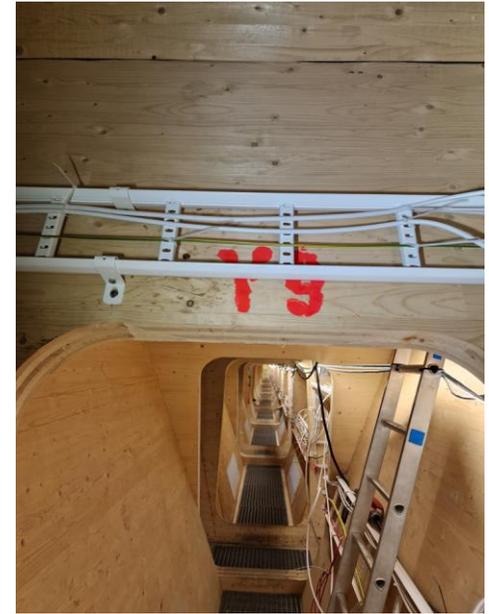
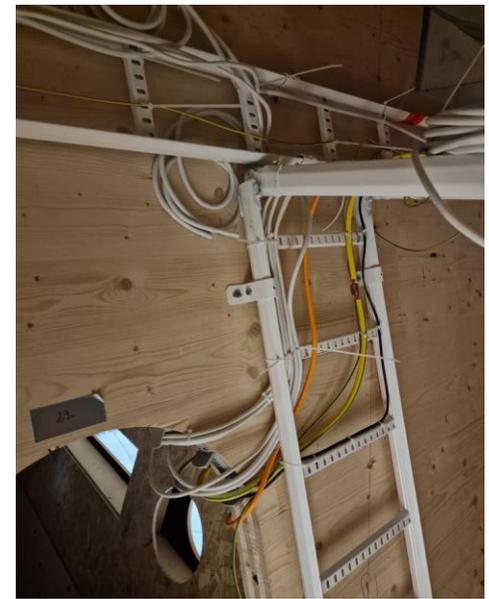


Del 13 - Monteringskonsept RIV

Technical

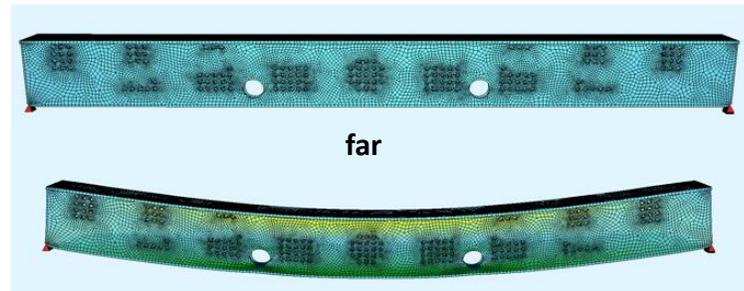
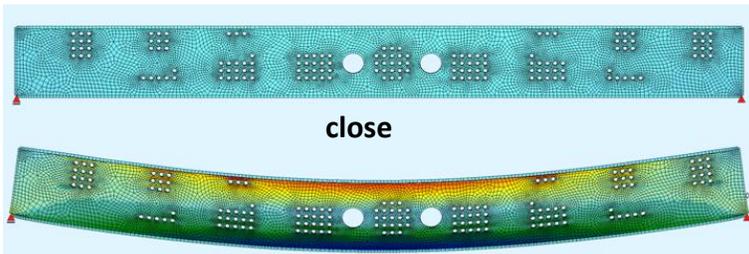
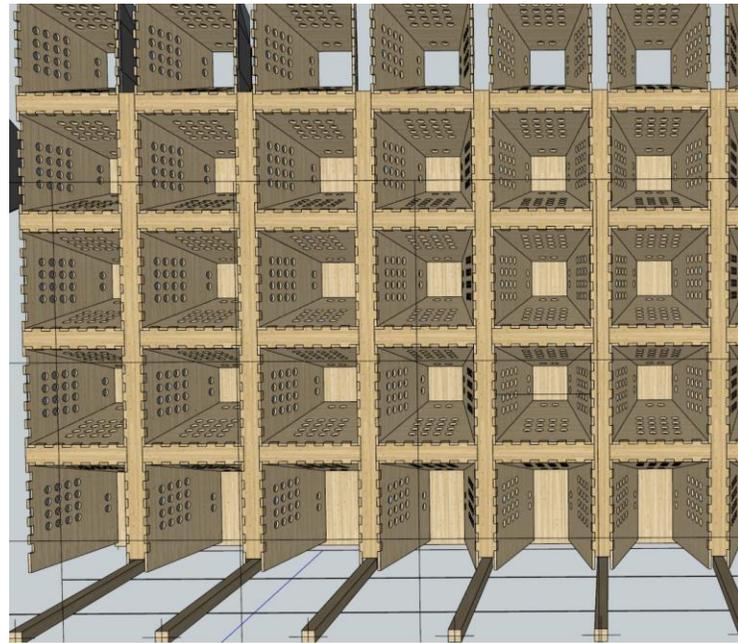


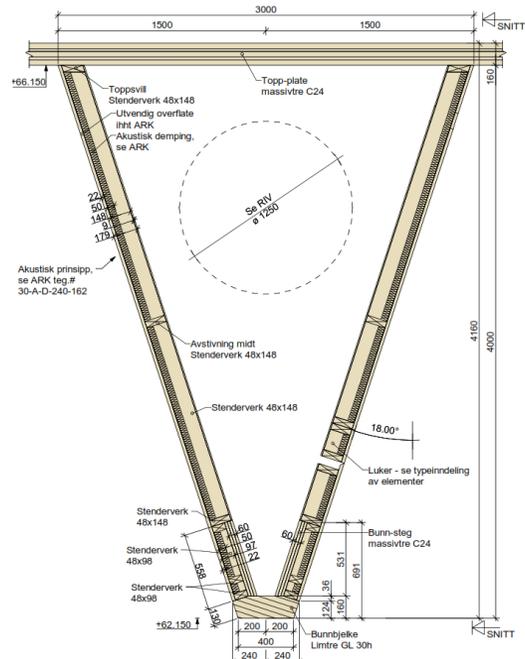
Technical



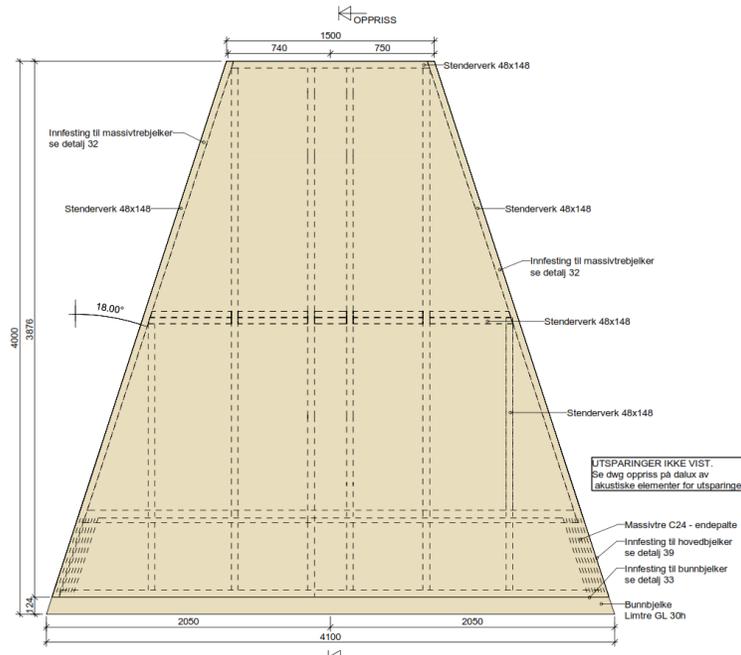
Acoustic elements





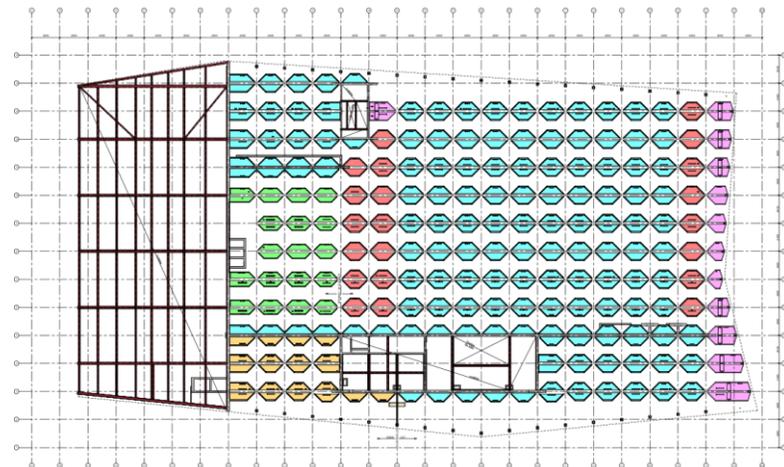
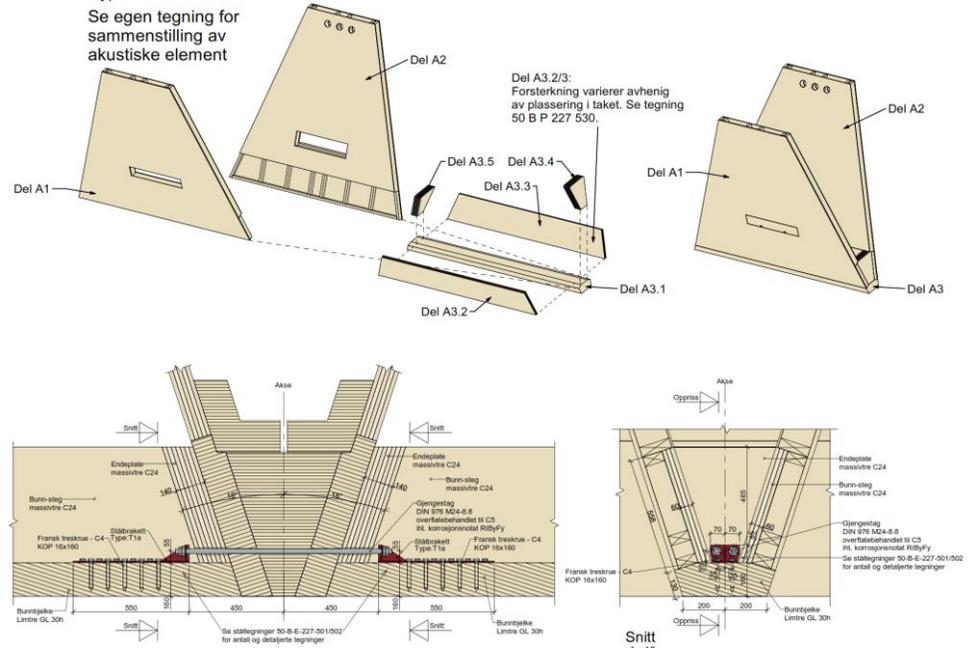


Detalj 30 - Akustikk type T1/V1
1 : 20

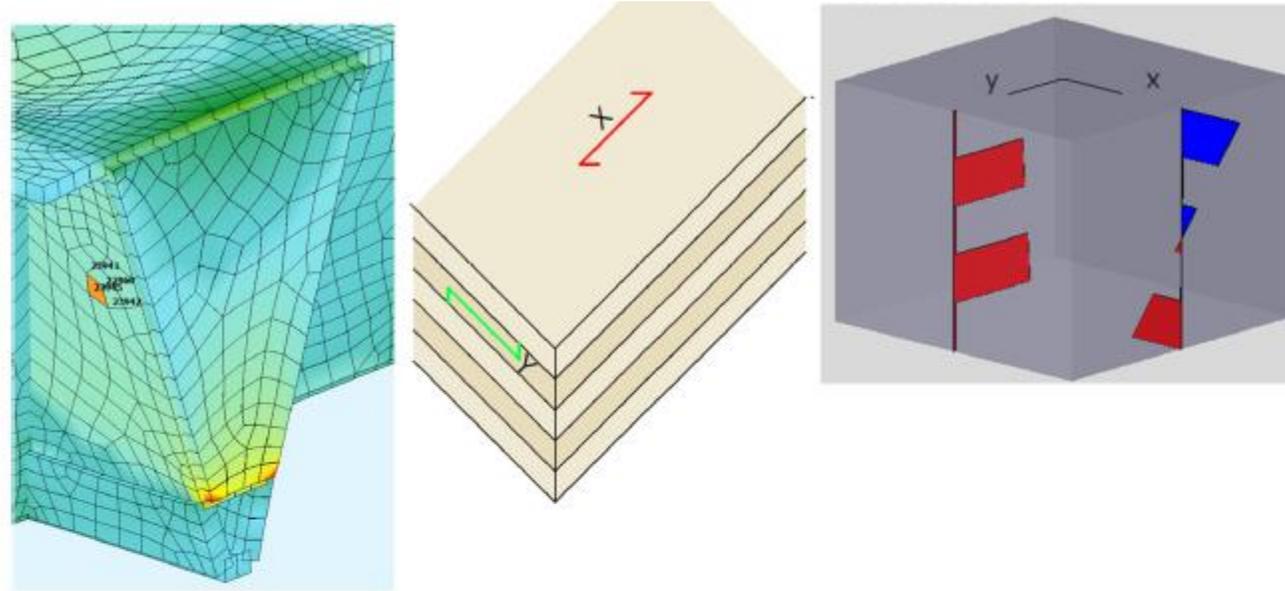


Snitt - Kun element vist
1 : 20

Del 24 - Typisk akustisk element:
Se egen tegning for sammenstilling av akustiske element



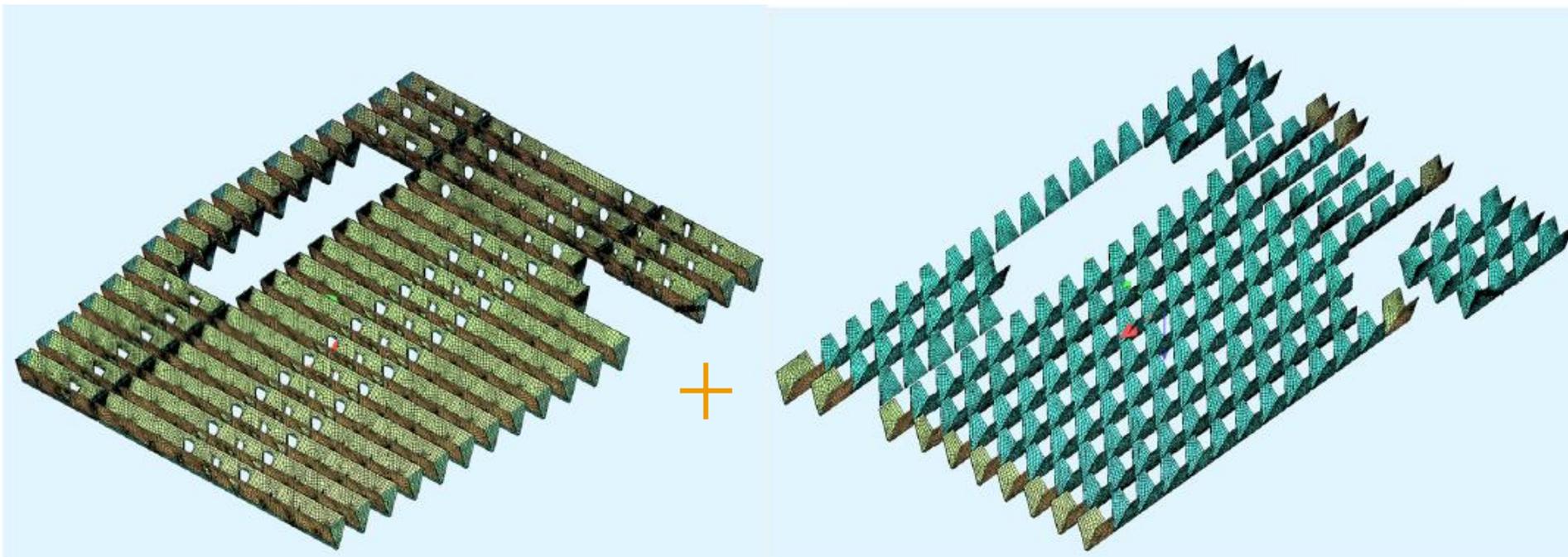
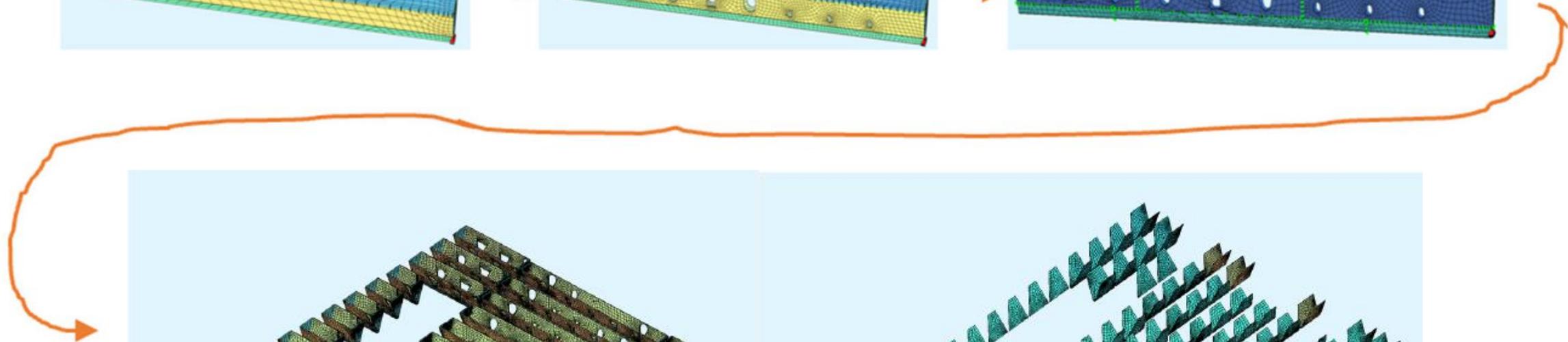
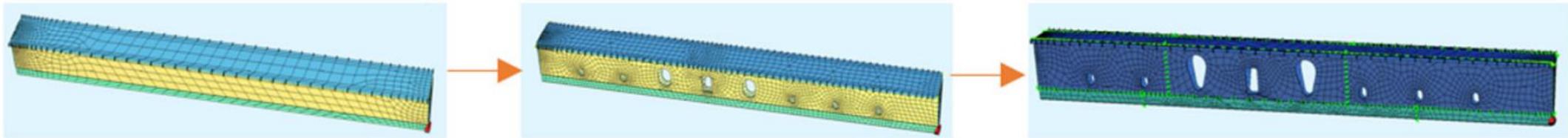
Structural finite element model

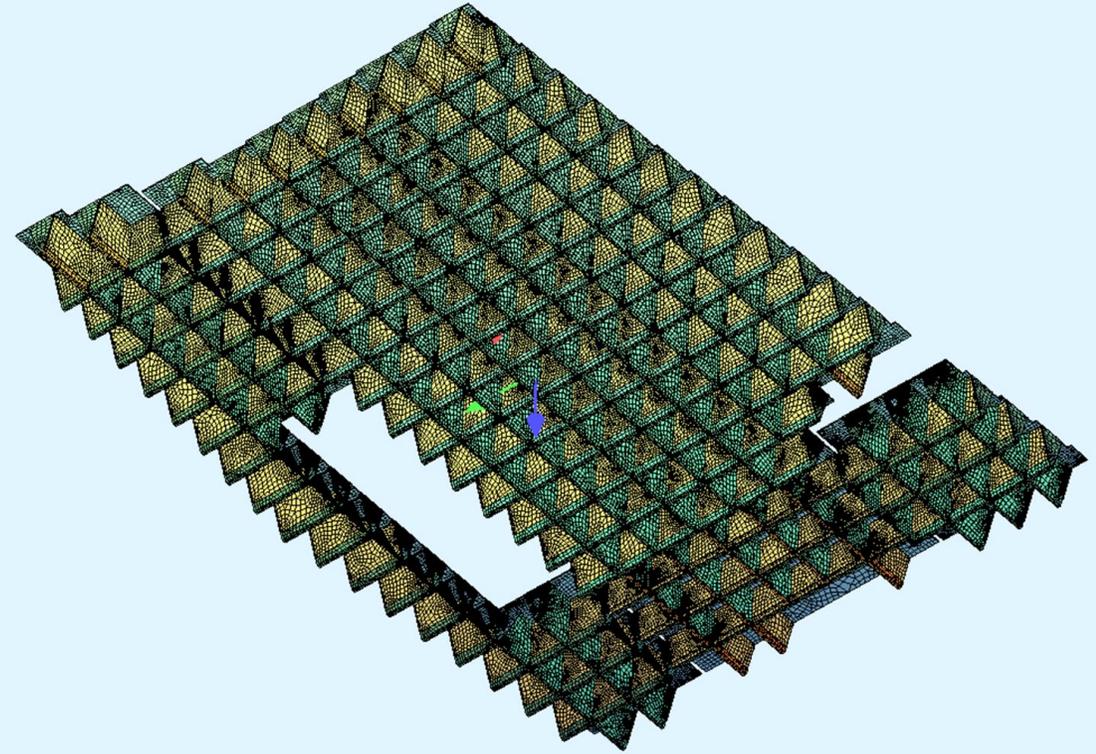
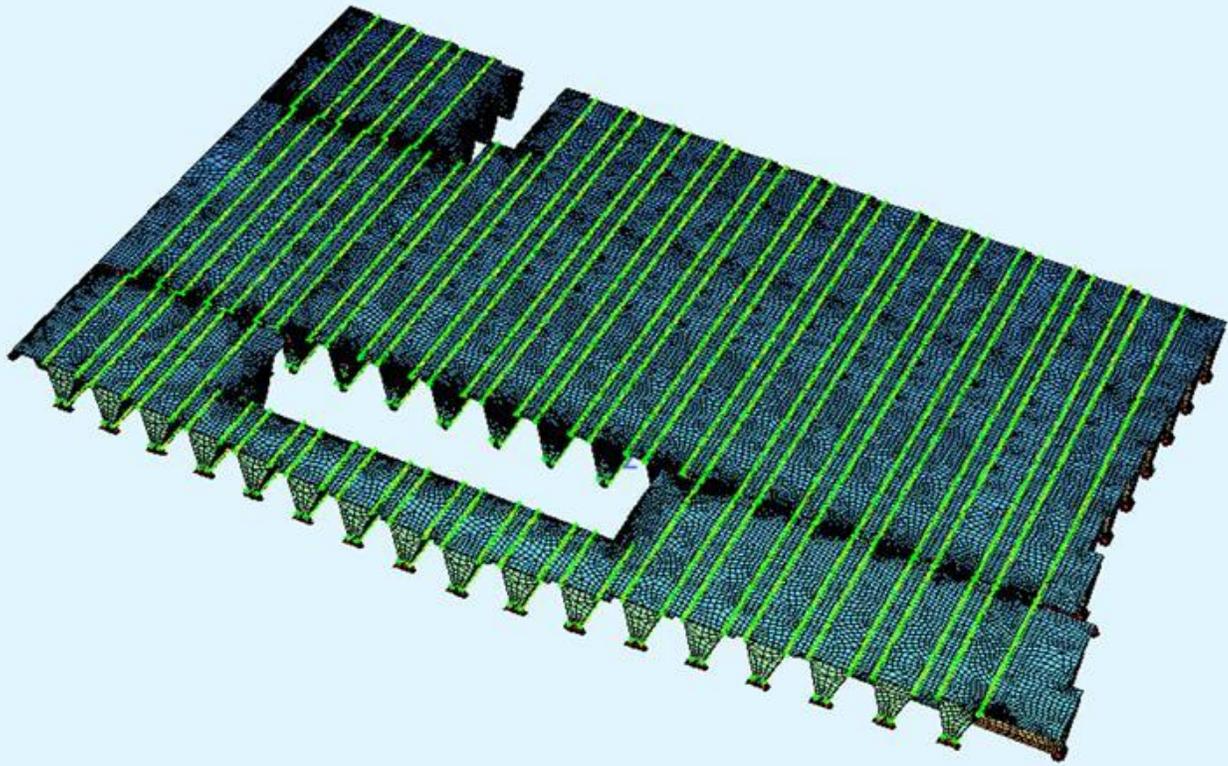


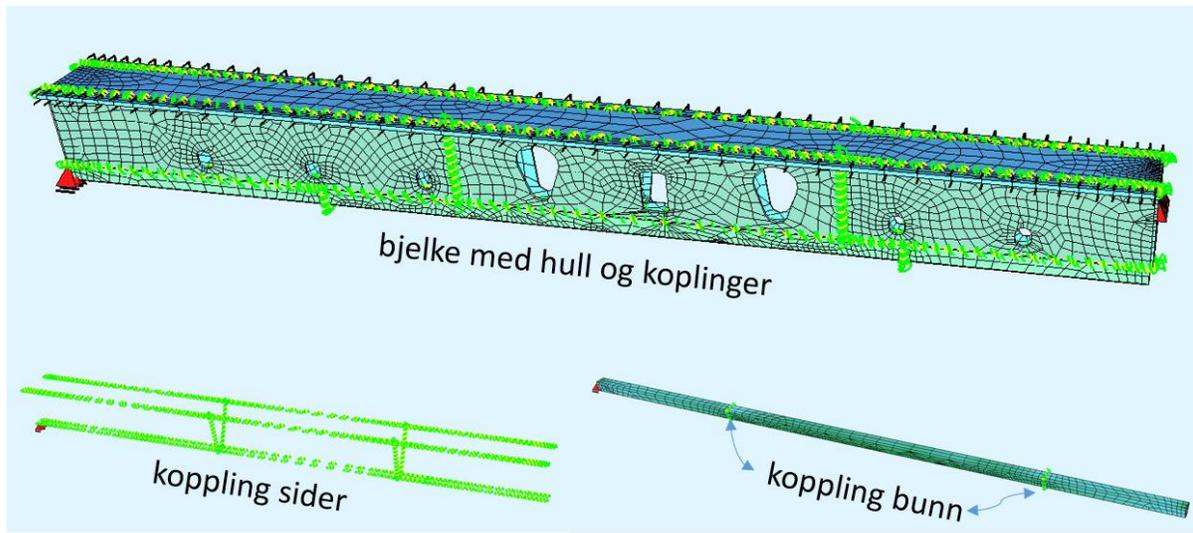
The input values to the finite element model

Topp

Young's modulus	E	8343	[N/mm ²]	Safety factor	1.13	[-]
Poisson's ratio	μ	0.00	[-]	calc strength fy	24.00	[MPa]
Shear modulus	G	690	[N/mm ²]	ult. strength ft	14.50	[MPa]
Compression modulus	K	123	[N/mm ²]			
Nominal Weight	γ	5.0	[kN/m ³]			
Weight buoyancy	γ_a	3.5	[kN/m ³]			
Elongation coefficient	α	0.00E+00	[1/K]			
Young's modulus	E-90	3028	[N/mm ²]			
Layer thickness		40.0	[mm]	Material No.	1 C 24 Cl.1 (EN 1995	
Layer thickness		20.0	[mm]	Material No.	9 C 24 Cl.1 (EN 1995	
Layer thickness		40.0	[mm]	Material No.	1 C 24 Cl.1 (EN 1995	
Layer thickness		20.0	[mm]	Material No.	9 C 24 Cl.1 (EN 1995	
Layer thickness		40.0	[mm]	Material No.	1 C 24 Cl.1 (EN 1995	

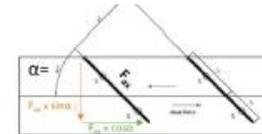






Stivhetsmodul K_{ser} skruer - Rothoblaas

Diameter skruer $d = 9$
 Lengde skruer topp-plate $l_{ef} = 235$
 Stivhetsmodul $K_{ser} = 7800 \cdot d^{0.2} \cdot l_{ef}^{-0.4} \frac{N}{mm}$ $K_{ser} = 10.75 \frac{kN}{mm}$

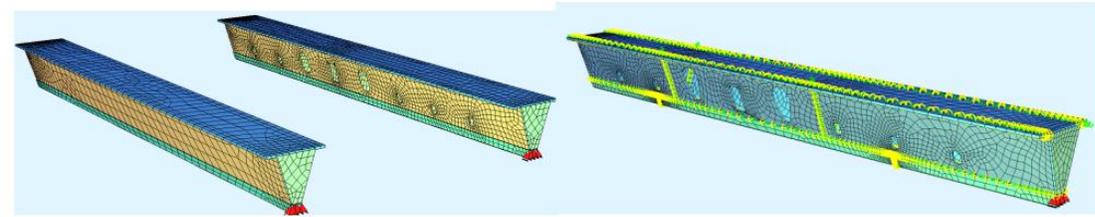


Produkt	Stivhetsmodul [kN/mm]	Sone 1		Sone 2		Sone 3		Sone 4		Total
		Lengde [m]	Antall skruer [stk i sone]	Lengde [m]	Antall skruer [stk i sone]	Lengde [m]	Antall skruer [stk i sone]	Lengde [m]	Antall skruer [stk i sone]	
Rothoblaas	10,75	14	150,5	72	774	56	602	52	559	4171
Wuerth	10,75	14	150,5	72	774	56	602	52	559	4171
Fischer	10,75	14	150,5	72	774	56	602	52	559	4171

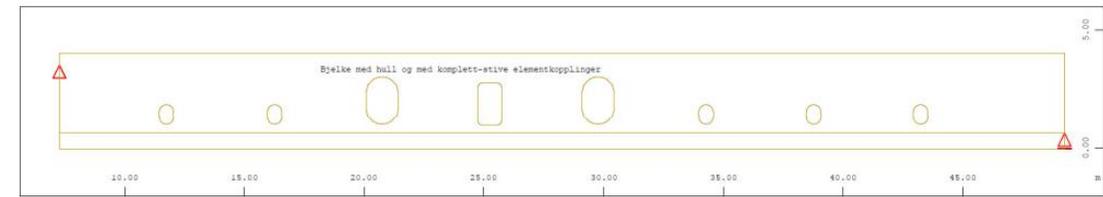
$$K_{ser,axial} = 4171 \text{ kN/mm} / 100 \text{ mm} = 41,71 \text{ kN/mm}^2 = 41.710.000 \text{ kN/m}^2$$

$$\rightarrow K_{ser,horisontal} = K_{ser,axial} * \cos 45 = 29.500.000 \text{ kN/m}^2$$

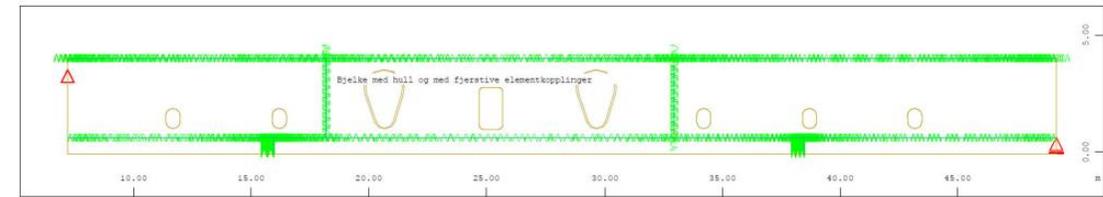
Allgemein		Vernetzung	Auflager/Bettung	Geometrie	Kanten	Lasten					
Plattendicke	transversale Anschluss-Feder	axiale Anschluss-Feder	Momenten Anschluss-Feder	u-x	u-y	u-z	phi-x	phi-y	phi-z	Parallele Knotenreihe im Absta	
1 0.0 mm	0.00 kN/m ²	29500000.00 kN/m ²	0.00 kNm/m/rad	<input checked="" type="checkbox"/>	<input type="checkbox"/>	0.0 mm					
2 0.0 mm	0.00 kN/m ²	0.00 kN/m ²	0.00 kNm/m/rad	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0.0 mm	
3 0.0 mm	0.00 kN/m ²	29500000.00 kN/m ²	0.00 kNm/m/rad	<input checked="" type="checkbox"/>	<input type="checkbox"/>	0.0 mm					
4 0.0 mm	0.00 kN/m ²	0.00 kN/m ²	0.00 kNm/m/rad	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0.0 mm	



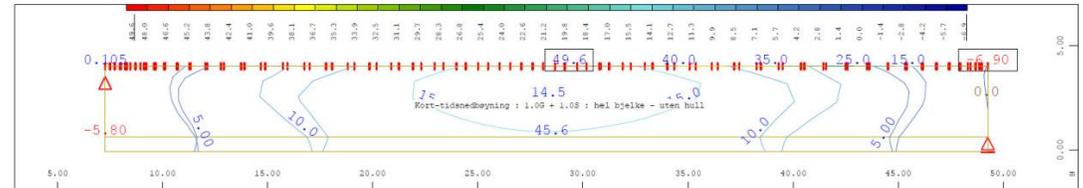
Sector of system Spring Elements,Quadrilateral Elements,Supporting Lines
 Contour M 1 : 179



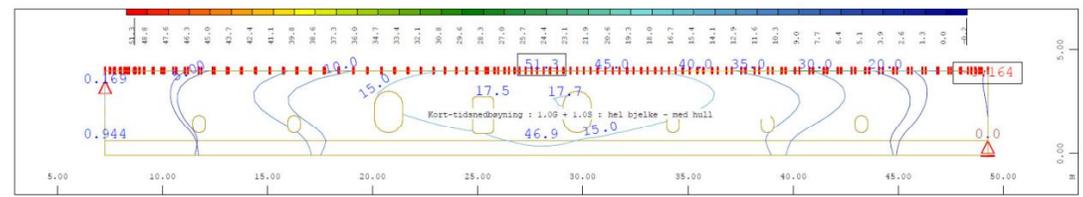
Sector of system Spring Elements,Quadrilateral Elements,Supporting Lines
 Contour M 1 : 179



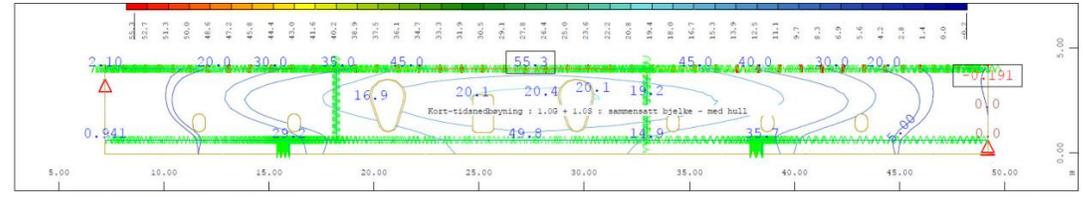
Sector of system Spring Elements,Quadrilateral Elements,Supporting Lines
 Contour M 1 : 182



Sector of system Spring Elements,Quadrilateral Elements,Supporting Lines
 Quadrilateral Elements , Displacement in local z in Node, Loadcase 1005 SLS Egenvekt + Sne , from -6.90 to 49.6 step 5.00 mm M 1 : 200

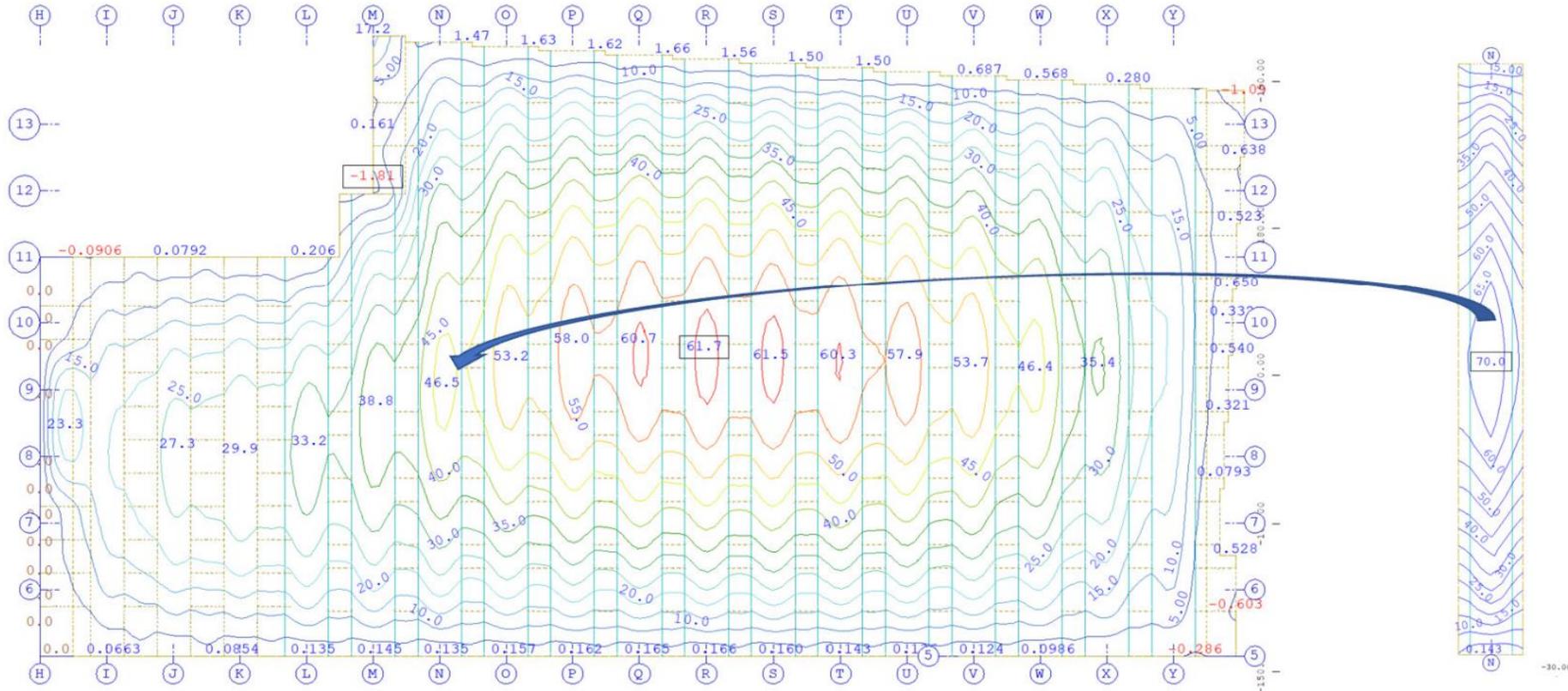


Sector of system Group 0 21 23 24 29
 Quadrilateral Elements , Displacement in local z in Node, Loadcase 1005 SLS Egenvekt + Sne , from -0.164 to 51.3 step 5.00 mm M 1 : 200



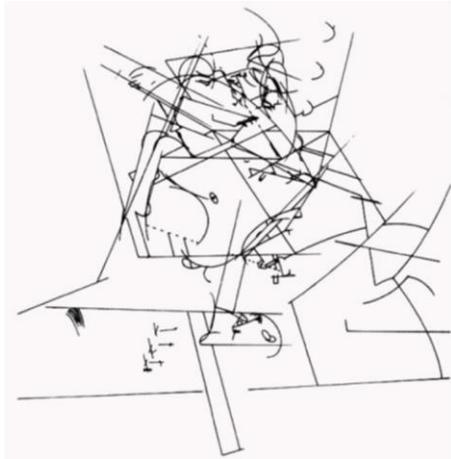
Sector of system Group 0 21 23 24 29
 Quadrilateral Elements , Displacement in local z in Node, Loadcase 1005 SLS Egenvekt + Sne , from -0.191 to 55.3 step 5.00 mm M 1 : 200

N - Topp		
Enkelt bjelke	70.0	
Samlet modell	46.5	66%



The image shows the equalizing influence of cross beams on the deformation plott of the complete structure - here shown for axis N.

Lots of small details

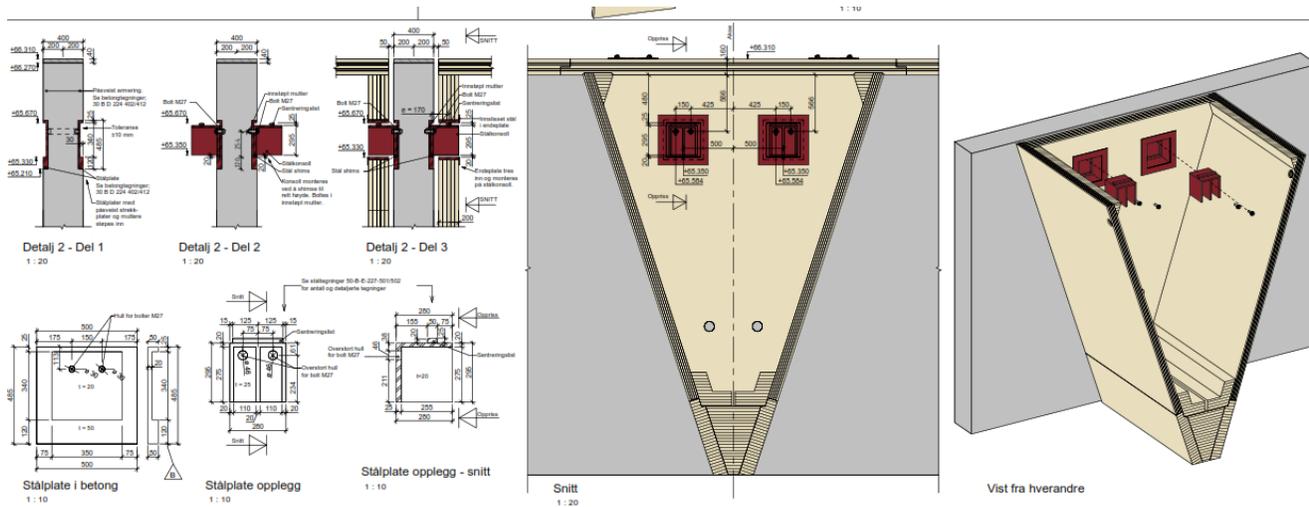
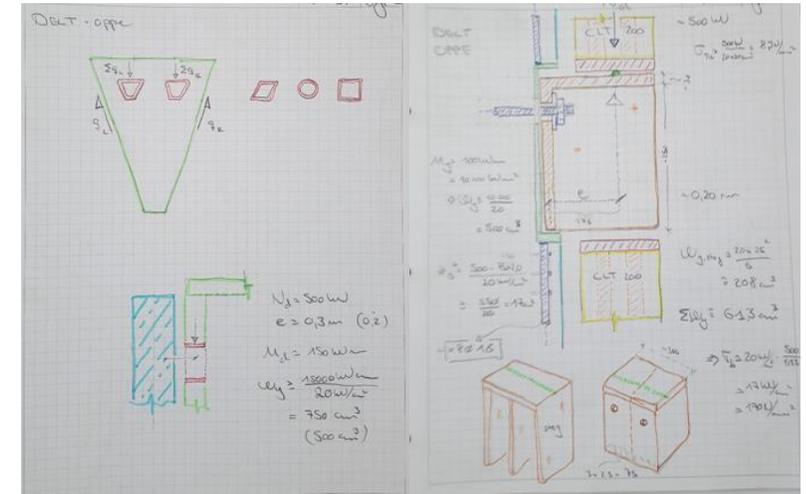
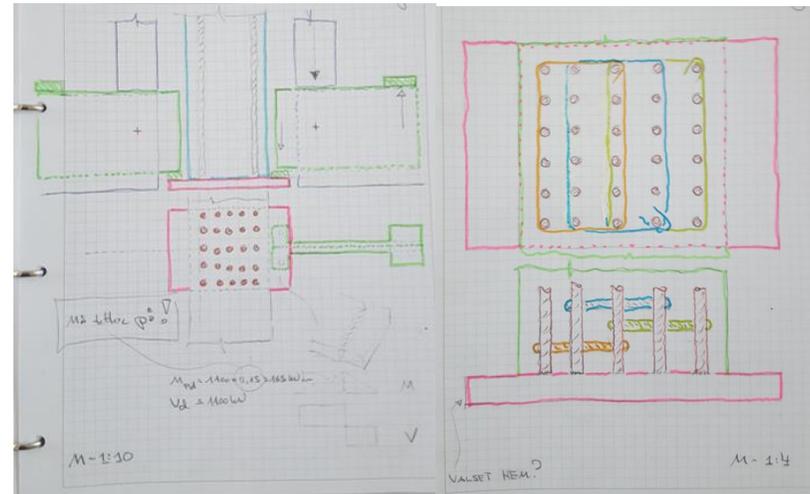
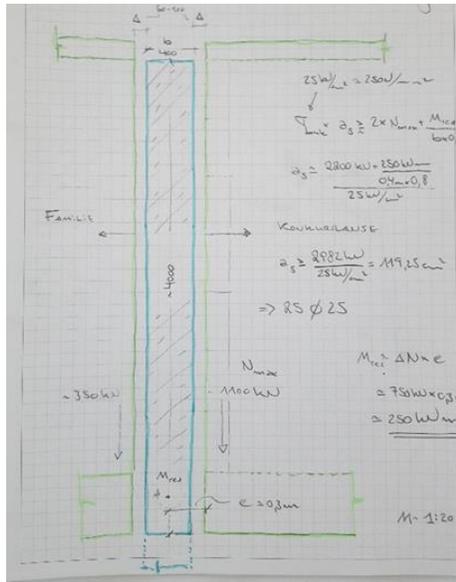


Beam to concrete wall

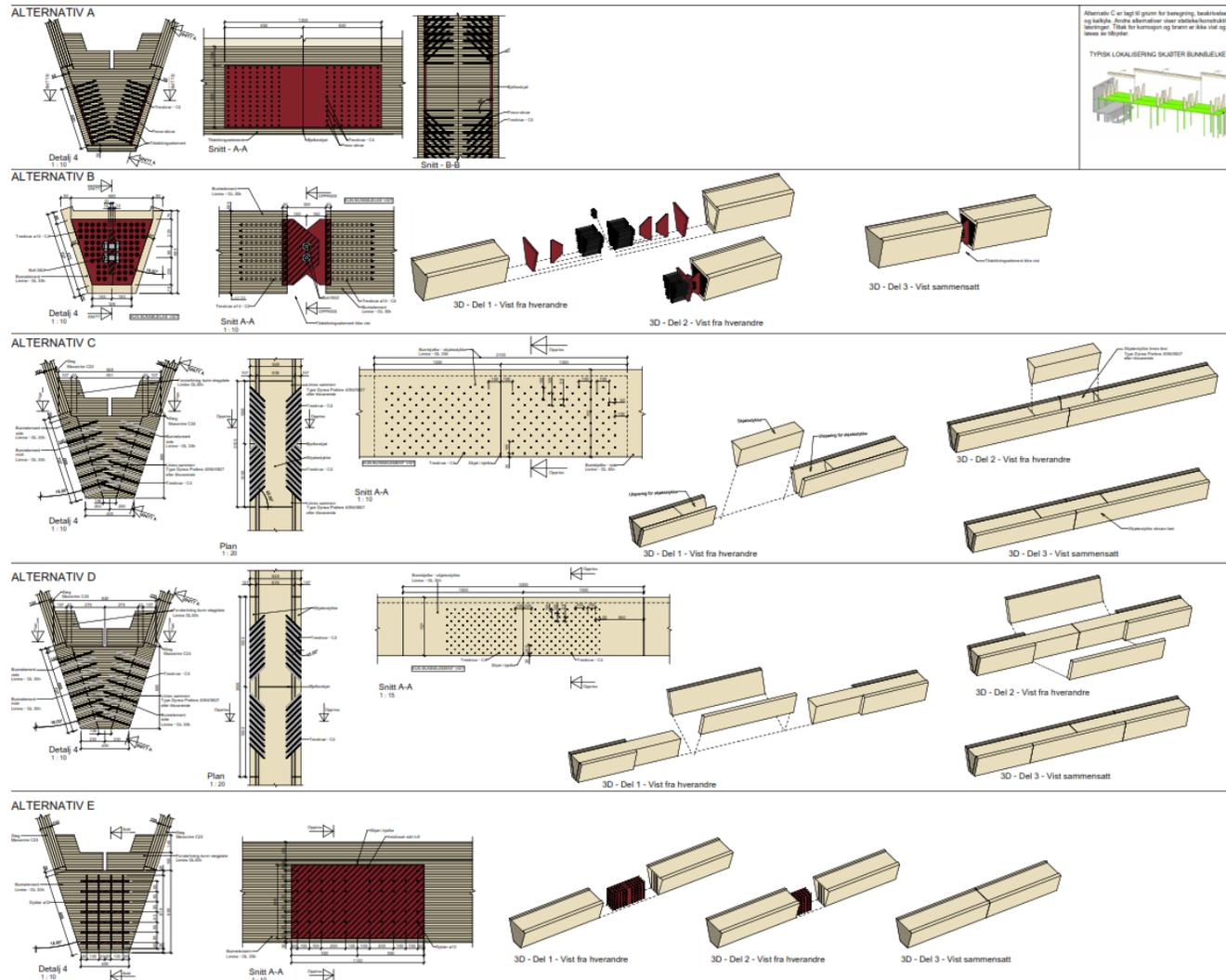
Top or bottom??

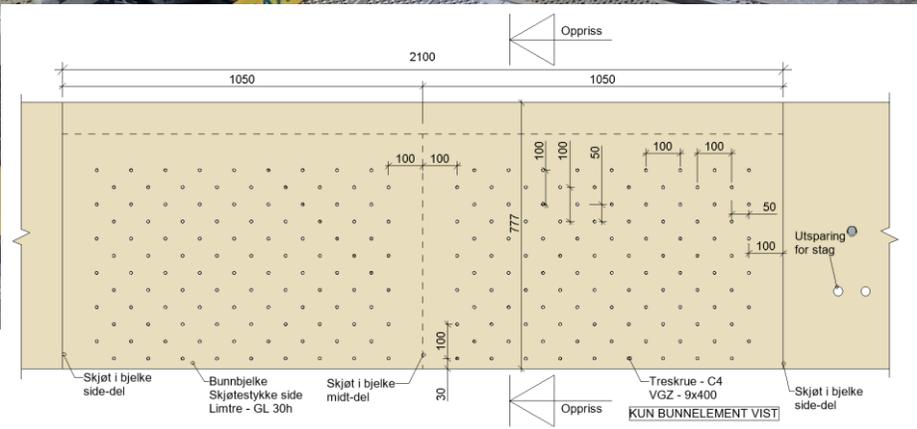
Bottom

Top

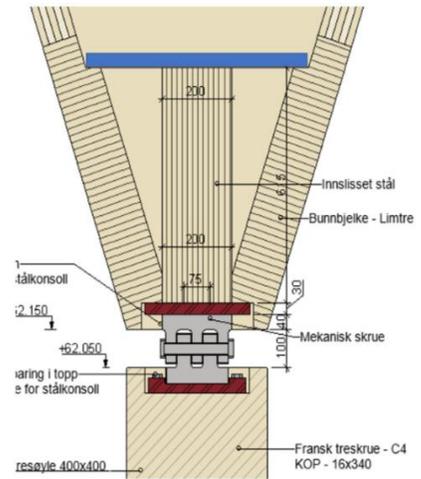
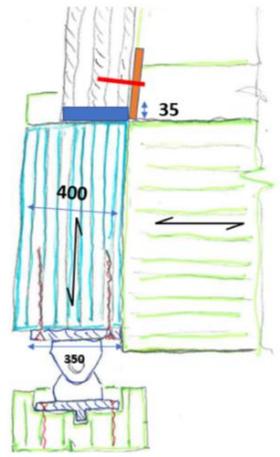
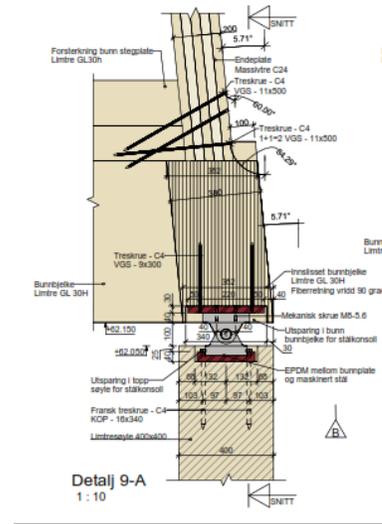
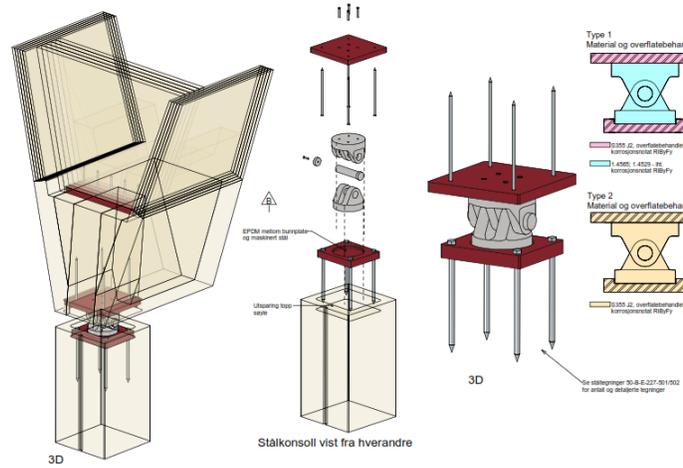
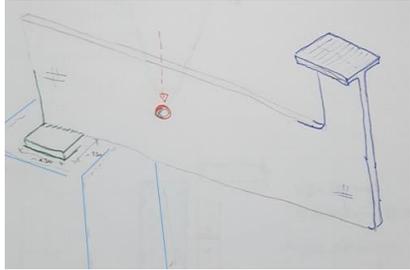


Joint of the bottom beam

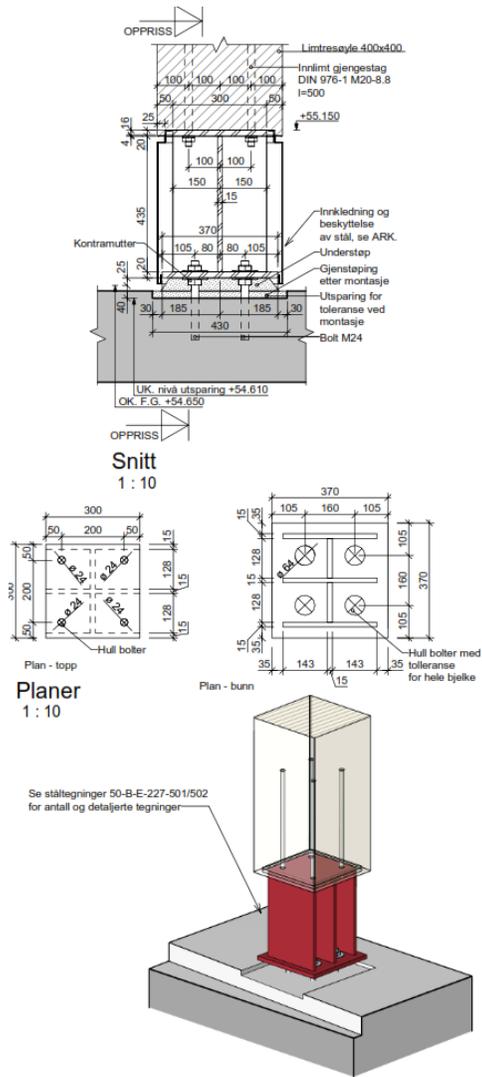




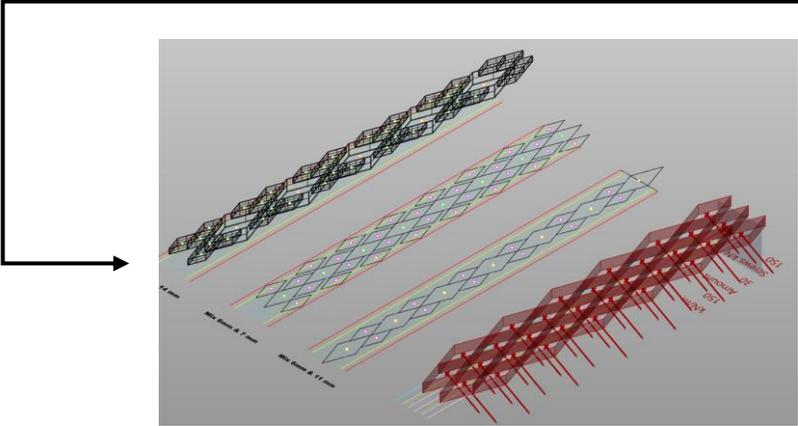
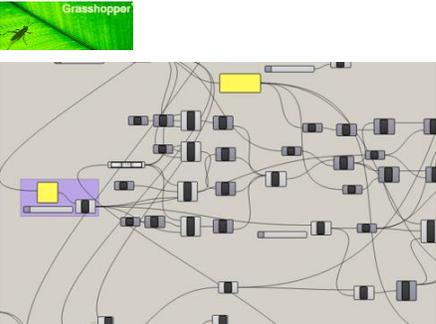
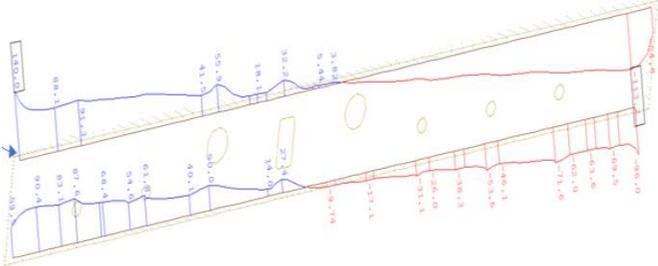
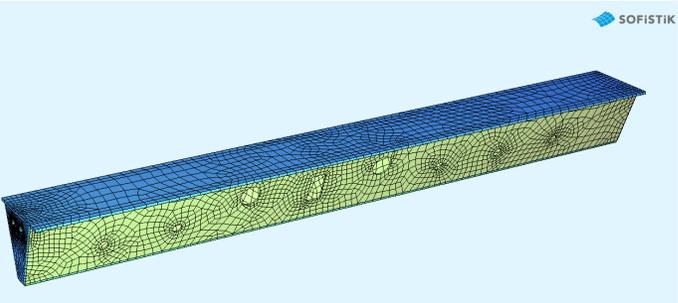
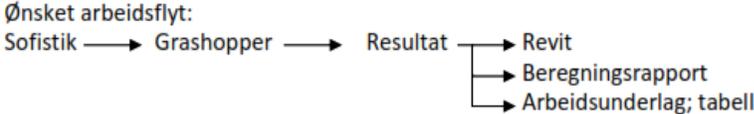
Beam to column



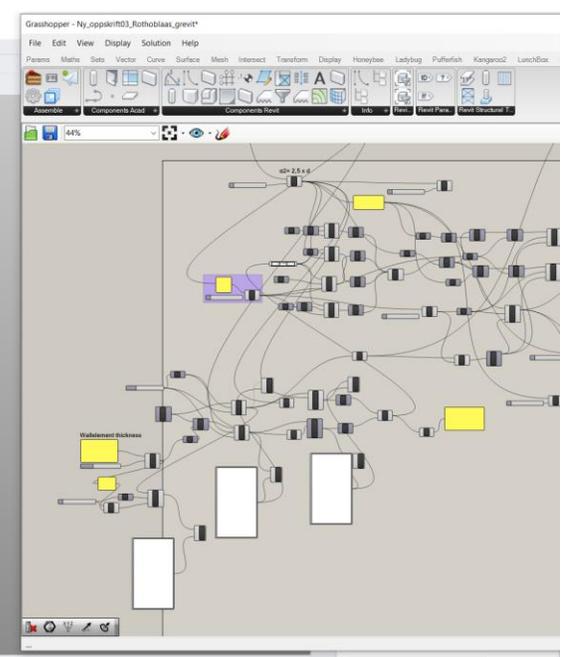
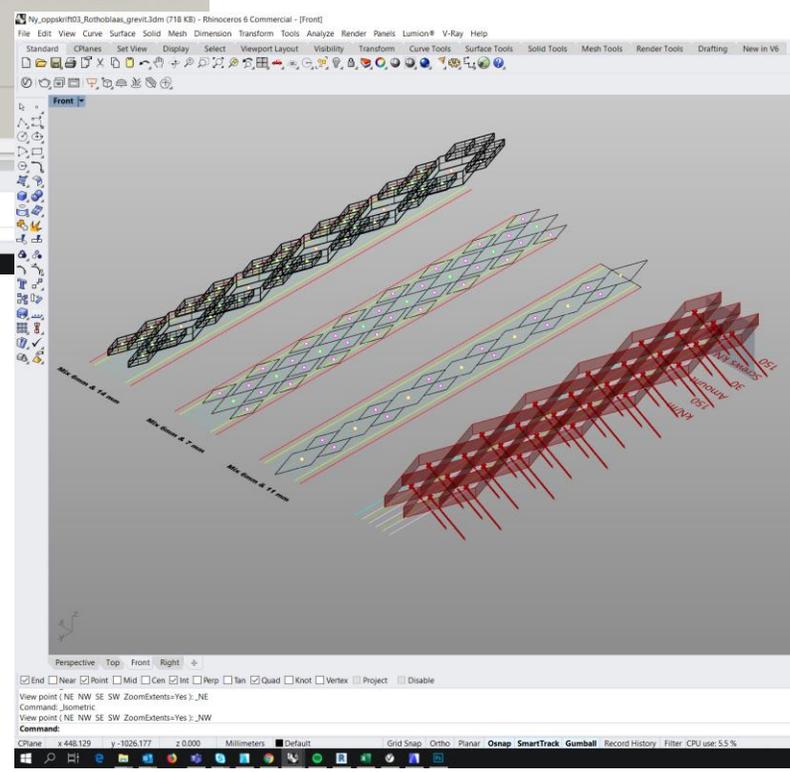
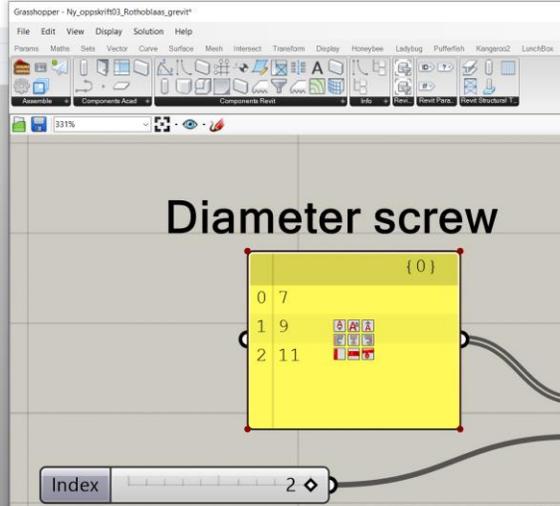
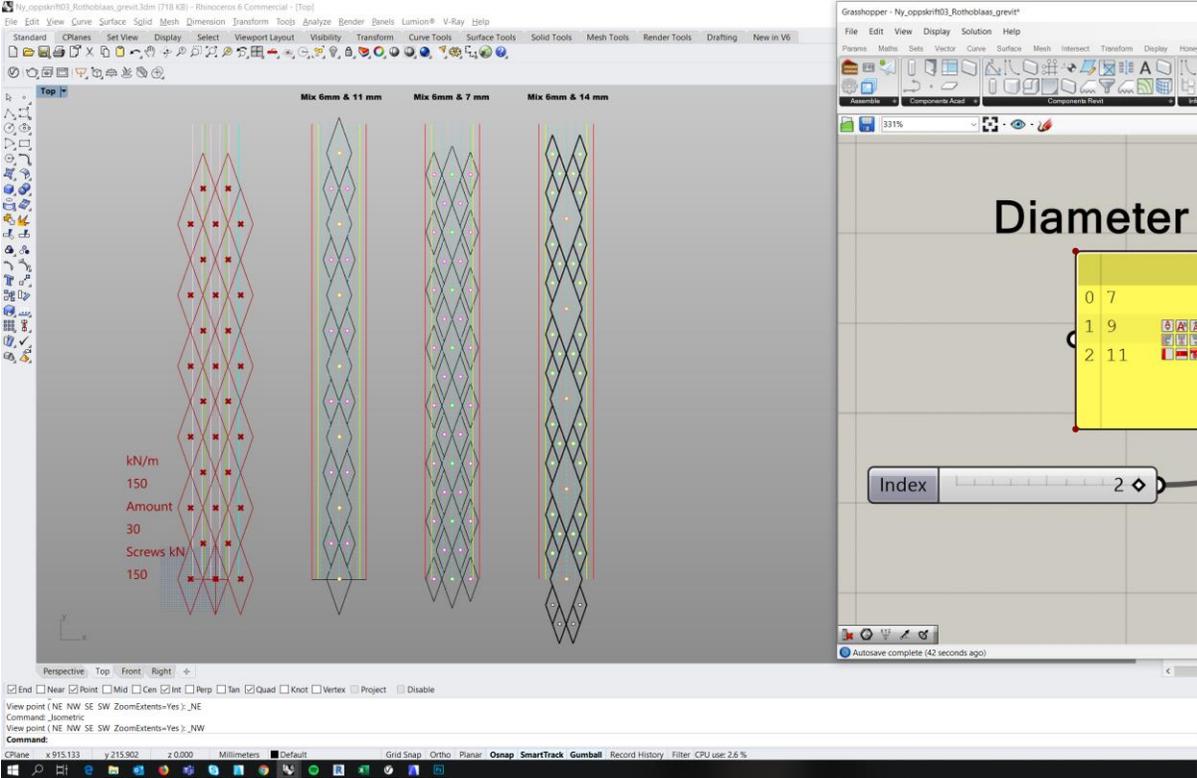
Column to base

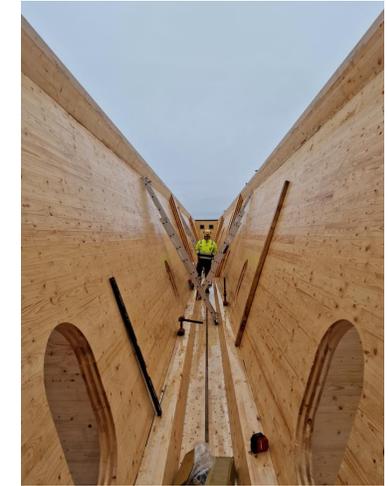
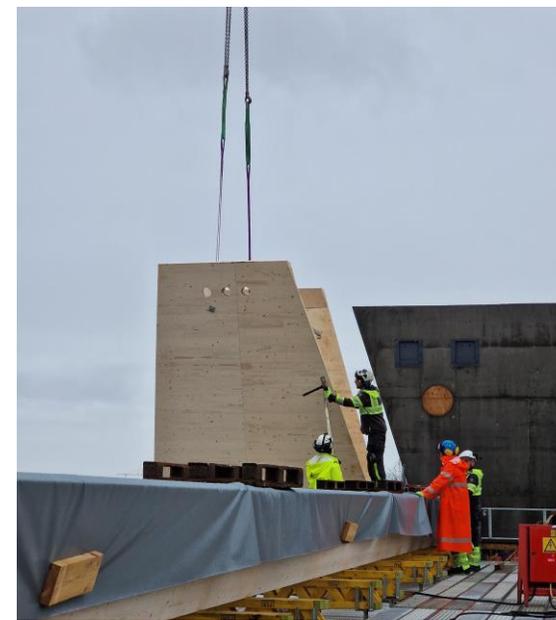


Grashopper – Visual programming



Prosjektnavn	Prosjektnr	Tegningsnavn	Tegningsnr	Revisjonsnr	Detalj	Detalj ref.	Beskrivelse	Varenr.	EAN Code	C/C avstand	Individuell avstand	Kantavstand	Kommentar
Nye Tøyenbadet	612990	Skisser skruerforbindelser takkonstruksjoner	20014	Rev01		6	FFP-ZT 10x400	659314	4 048 962 135 213	85	42		30











Vielen Dank für die Aufmerksamkeit!

- 270 000+ screws
- 620 m³ glulam GL30H
- Around 3000 wood pices
- 1425 m³ CLT C24



The client



Oslo

The main entrepreneur



The wood entrepreneur



CLT elements



Glulam elements



Fastners/screws



Steel elements



On site glue



Acoustic elements



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