

FINANSPARKEN

STAVANGER

HELEN & HARD + SAAHA + DEGREE OF FREEDOM + MULTICONSULT

INTRODUCTION



Thor Olav Solbjør

siv.ark MNAL

SAAHA

Partner, Founding Architect



Mario Rando

MSc ETSIIM

DEGREE OF FREEDOM ENGINEERS

Senior Engineer

Finansparken i Bjergsted

- Byggherre Finansparken Bjergsted AS
- Leietaker Sparebank 1 SR-Bank
- ARK Helen & Hard, SAAHA
- RIB Degree of Freedom
- Trerådgiver Hermann Blümer

Kontorbygg.

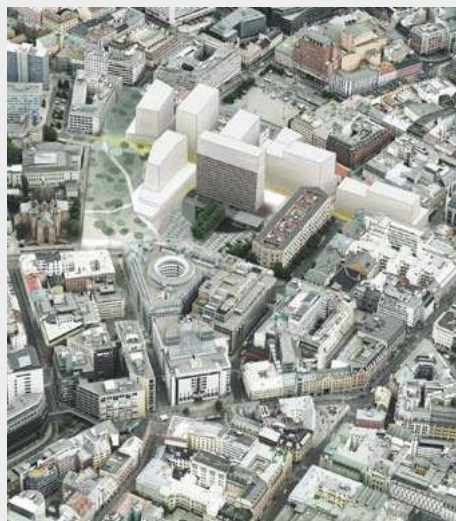
7 etasjer over terreng ca. 13.400 m² BTA

3 etasjer under terreng ca. 9.200 m² BTA

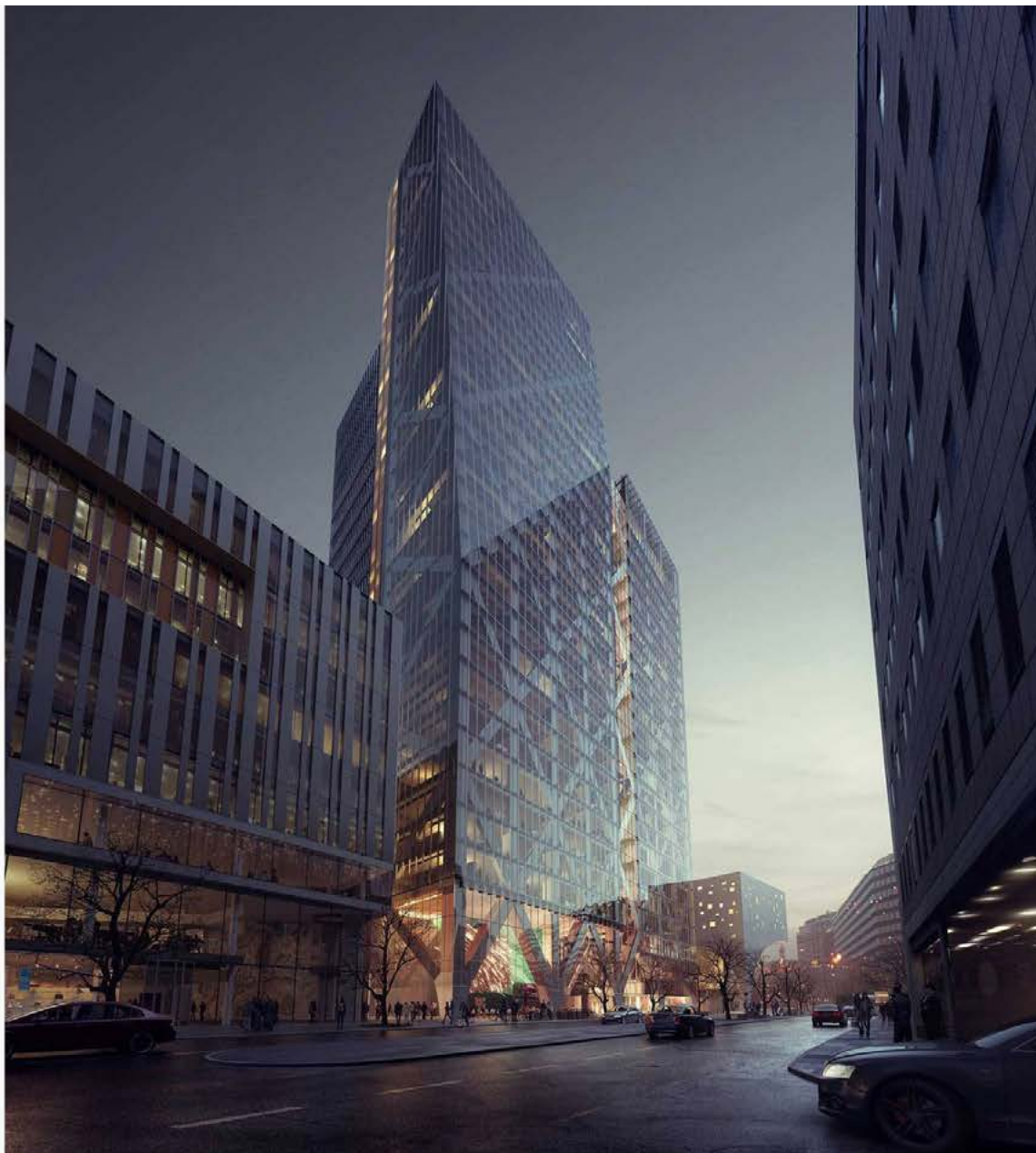
INTRODUCTION



INTRODUCTION



NORDIC BUILT CHALLENGE, HARVEST



URBAN+ LILLETORGET



FUTUREBUILT NYDALSVEIEN



FINANSPARKEN



PROJECT TIMELINE

COMPETITION
MAR 2014



SKETCH PHASE
JAN 2014



PRELIMINARY PHASE
AUG 2015



DETAIL PHASE
MAY 2016



CONSTRUCTION
NOV 2016



COMPLETE
ULTIMO 2018

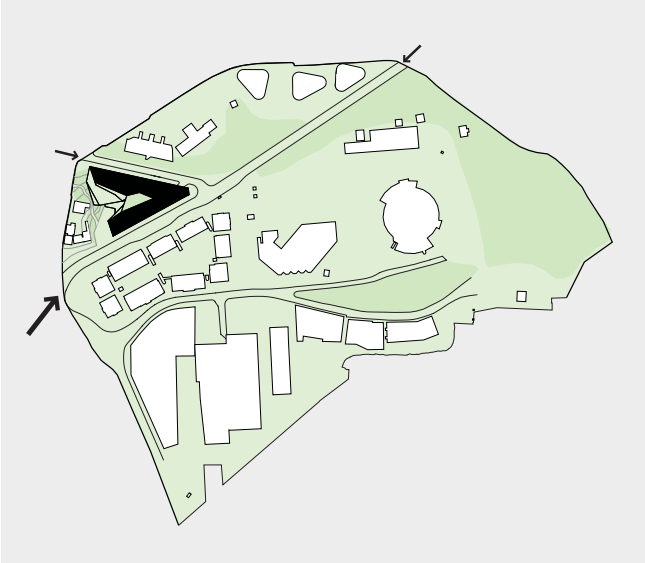
SITE



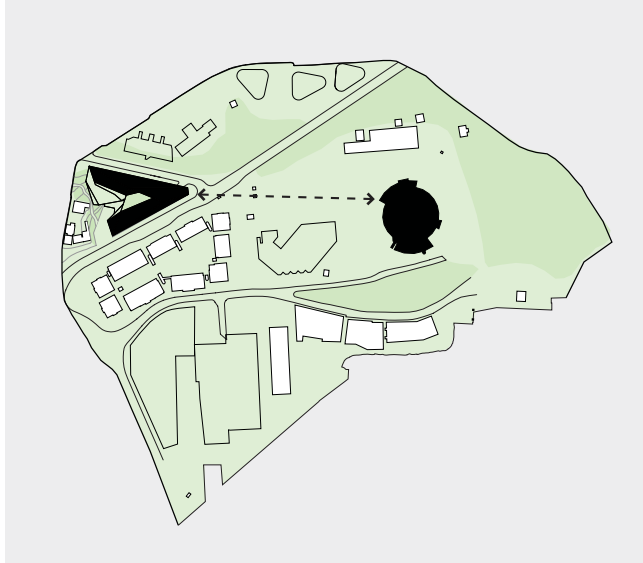
SITE



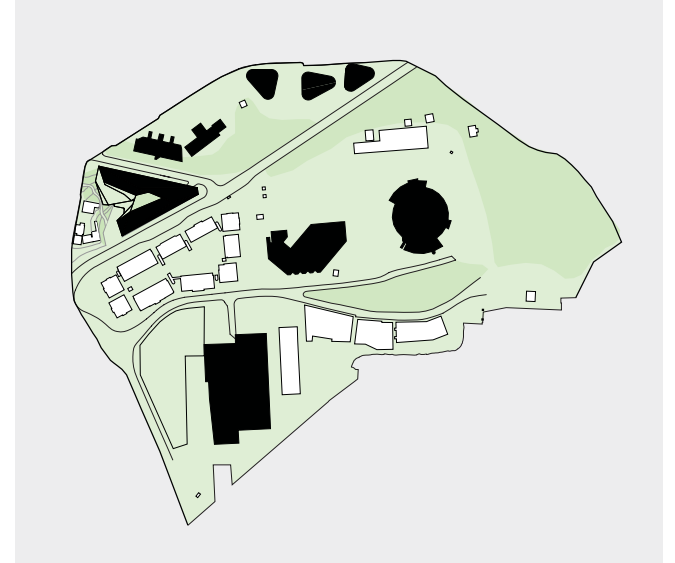
CONTEXT STUDIES



ACCESS

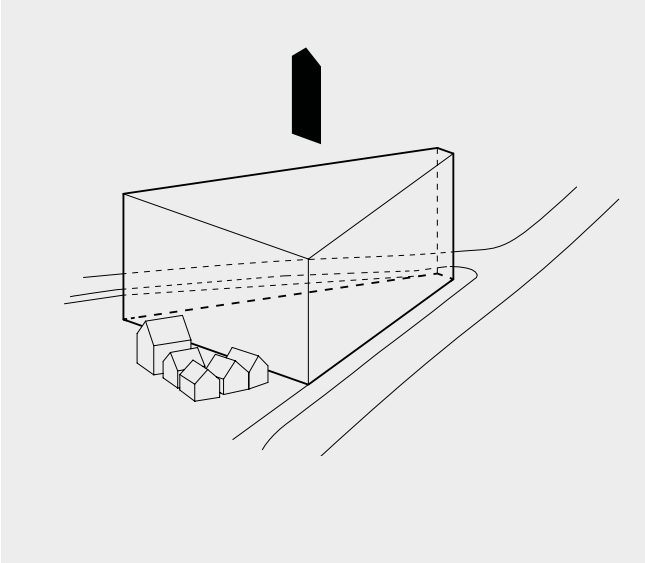


DIALOGUE

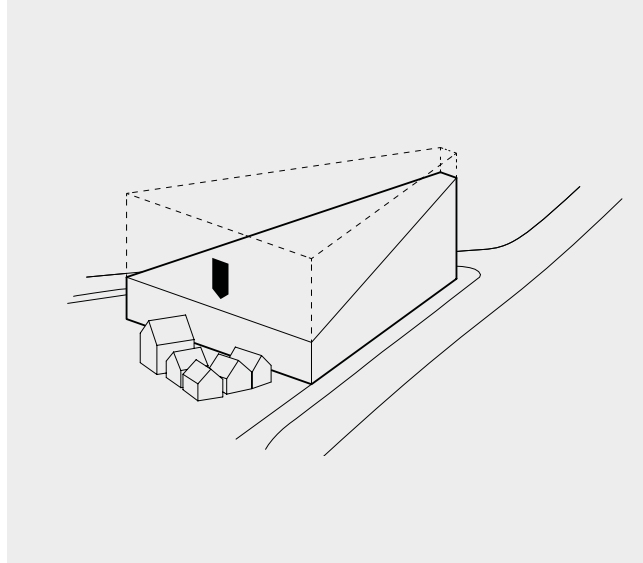


CONTEXT

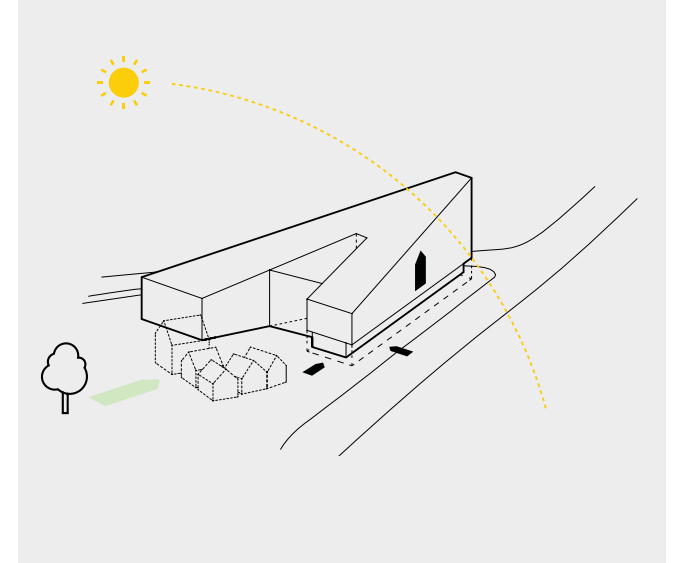
VOLUME STUDIES



VOLUME



LOCAL ADAPTION

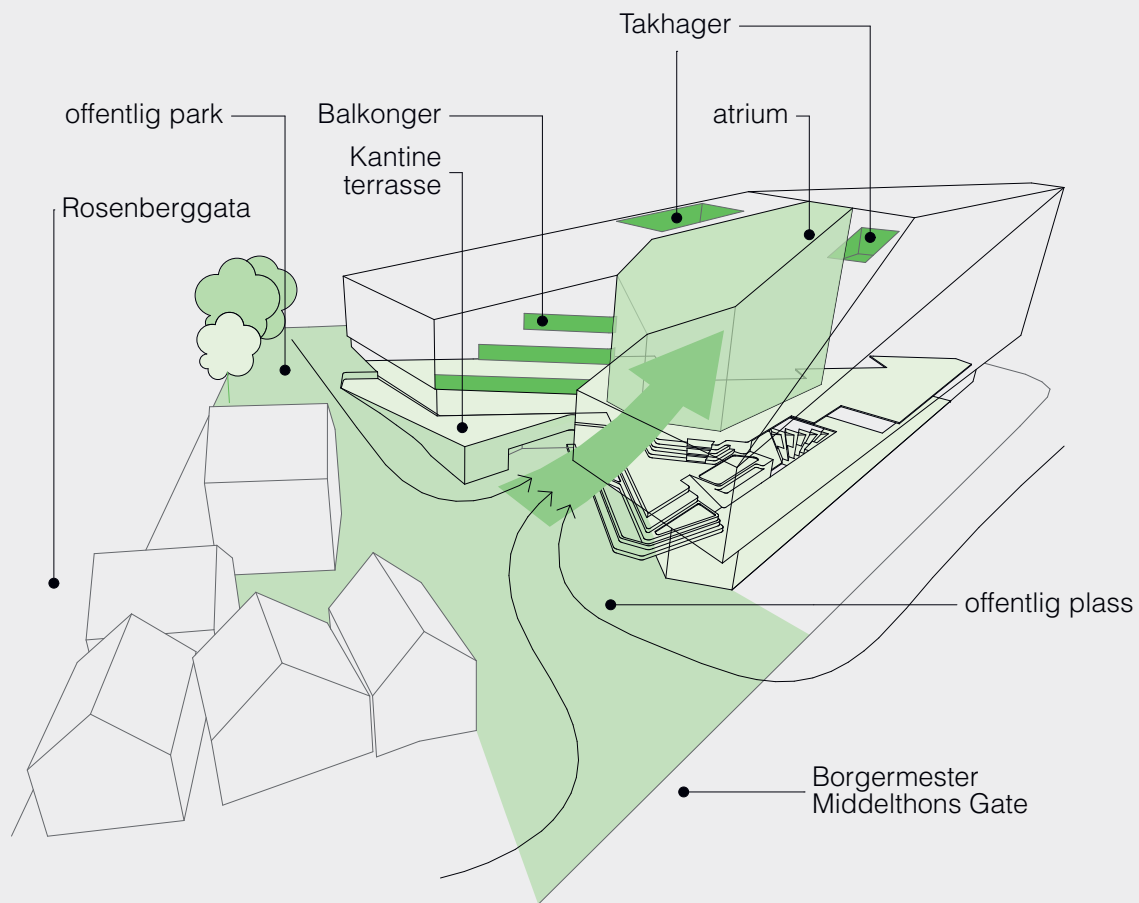


ADJUSTMENTS

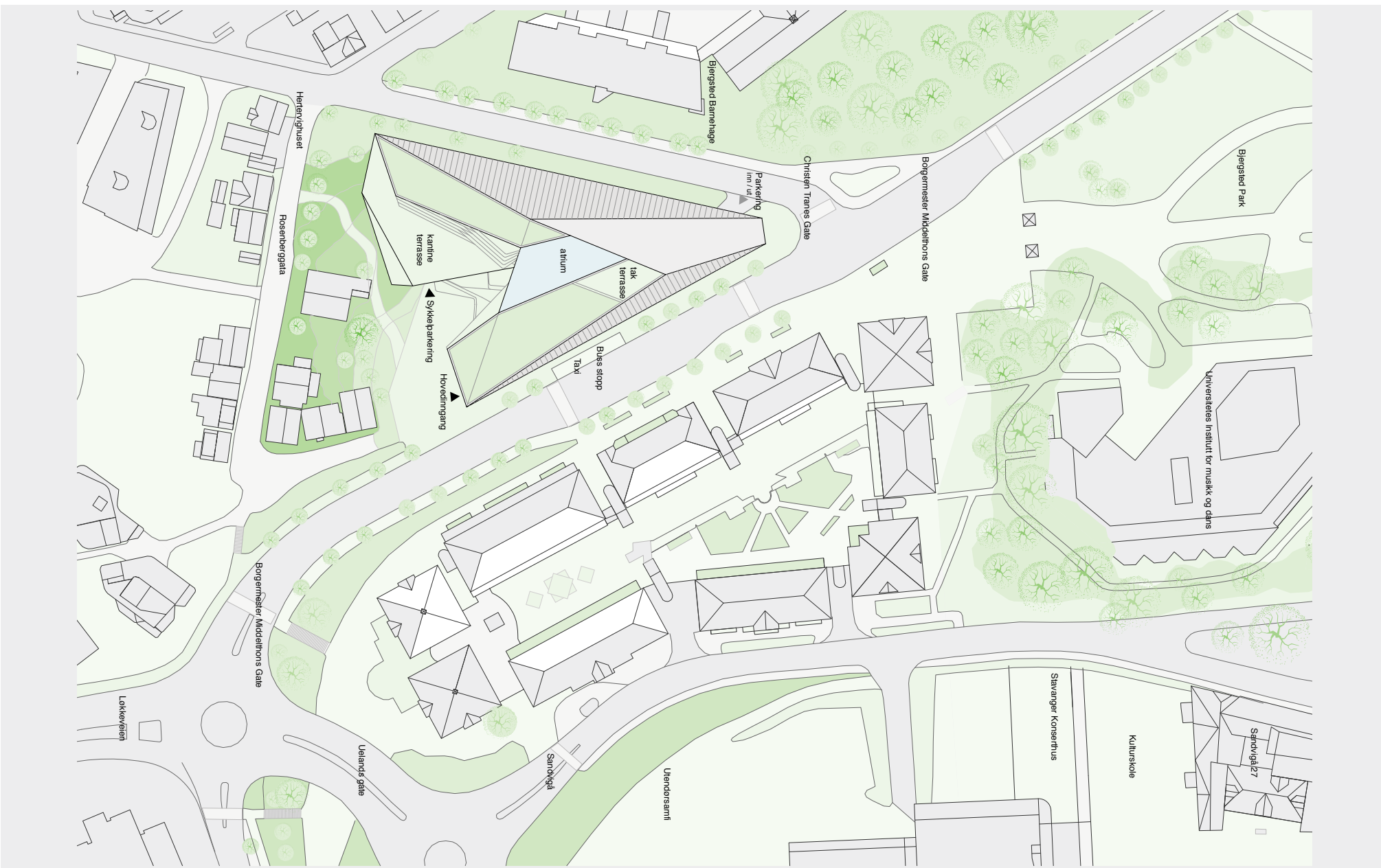
LANDSCAPE

LANDSKAP

Den offentlige park samt byggets private utearealer orienterer seg mot sør og skaper opplevelsen av et felles grønt drag.

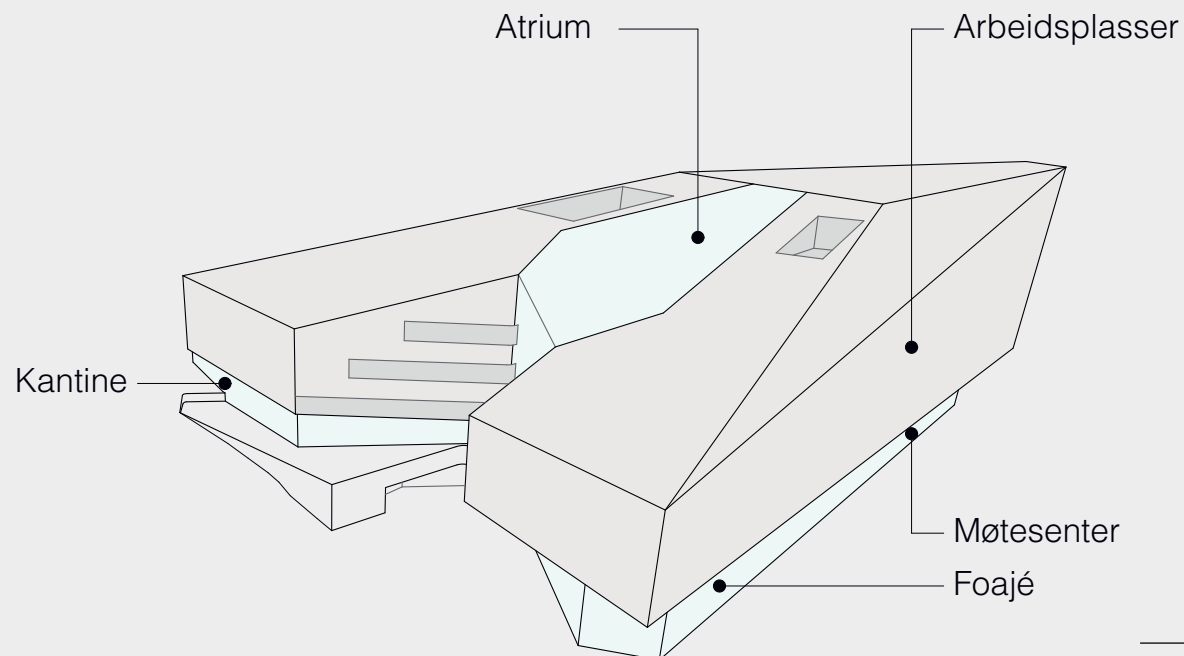


SITE PLAN



AERIAL OVERVIEW

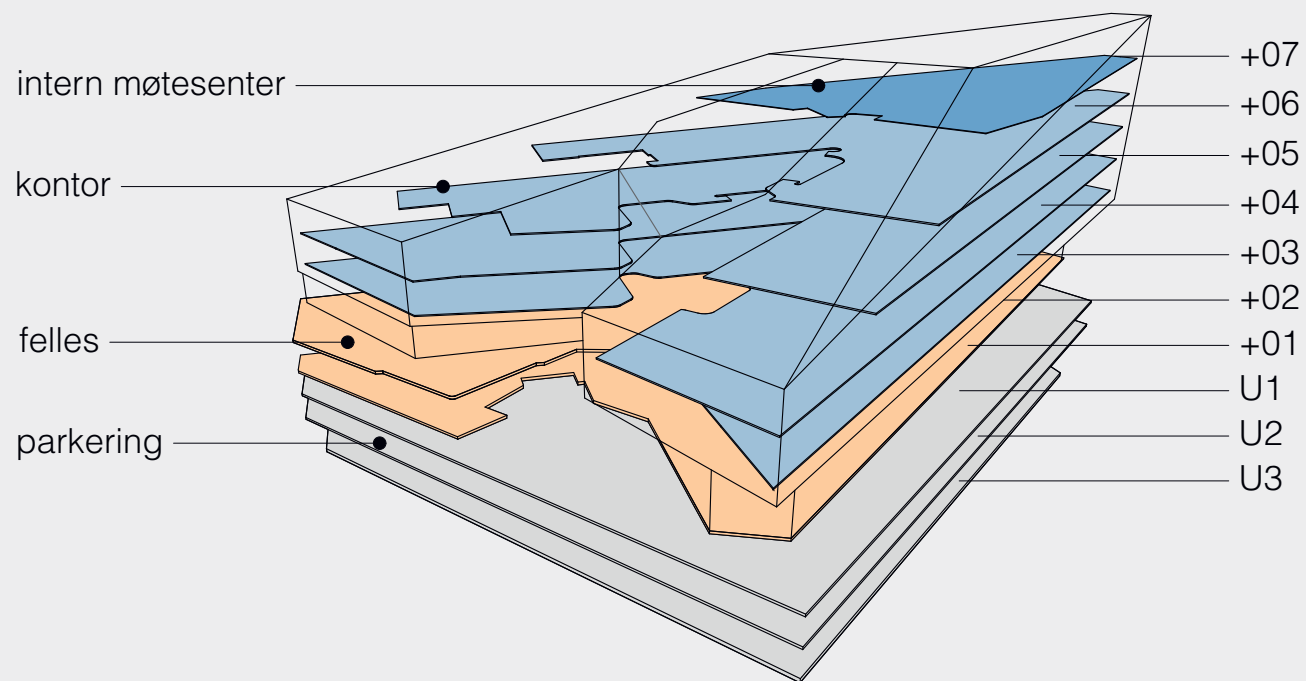


MAIN VOLUME

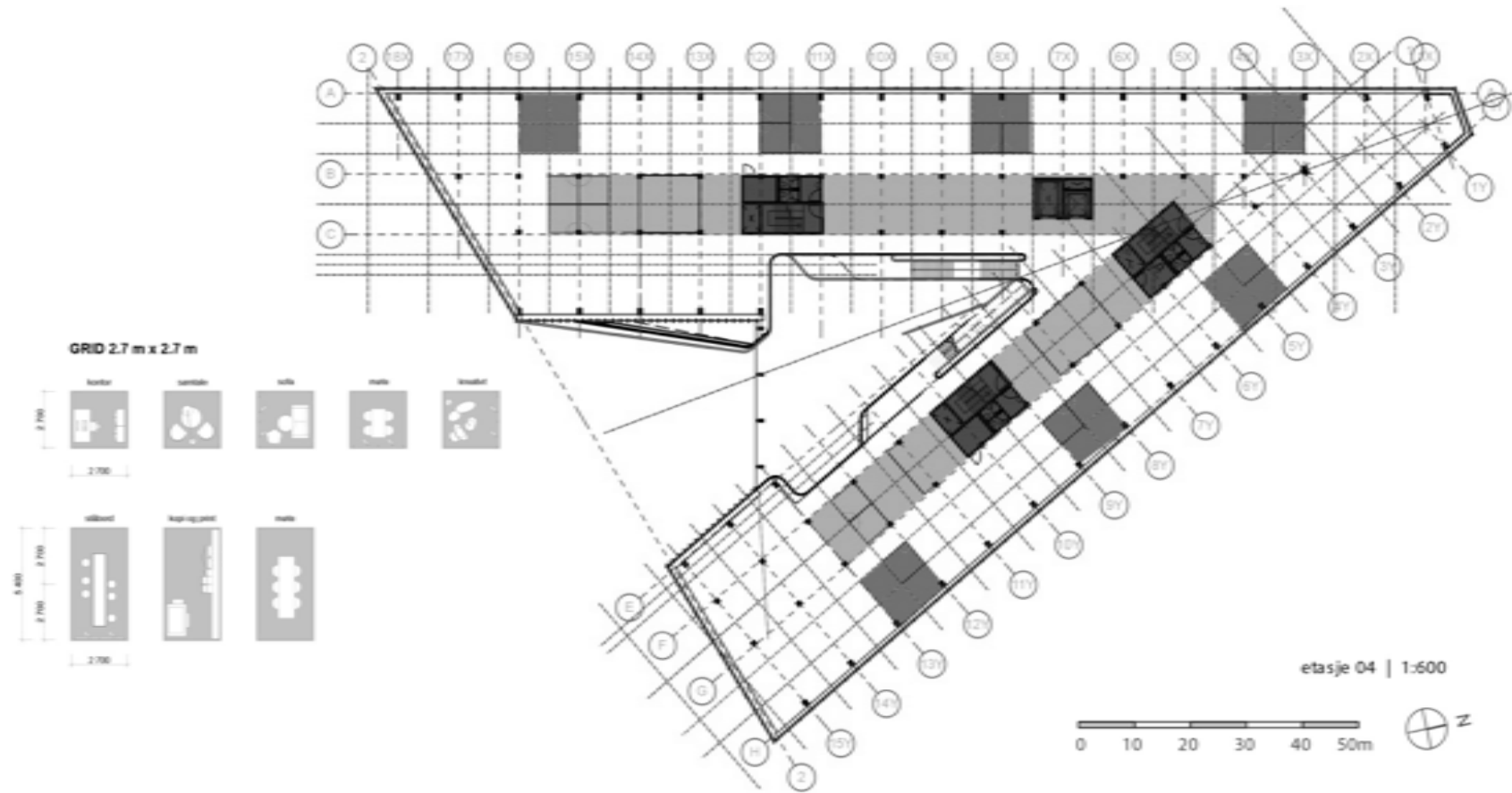
HOVED OPPDELING

Alle felles funksjoner samles i de to nederste etasjer av bygget og arbeidsetasjene fordeler seg rundt et atrium fra 3.-7. etasje .

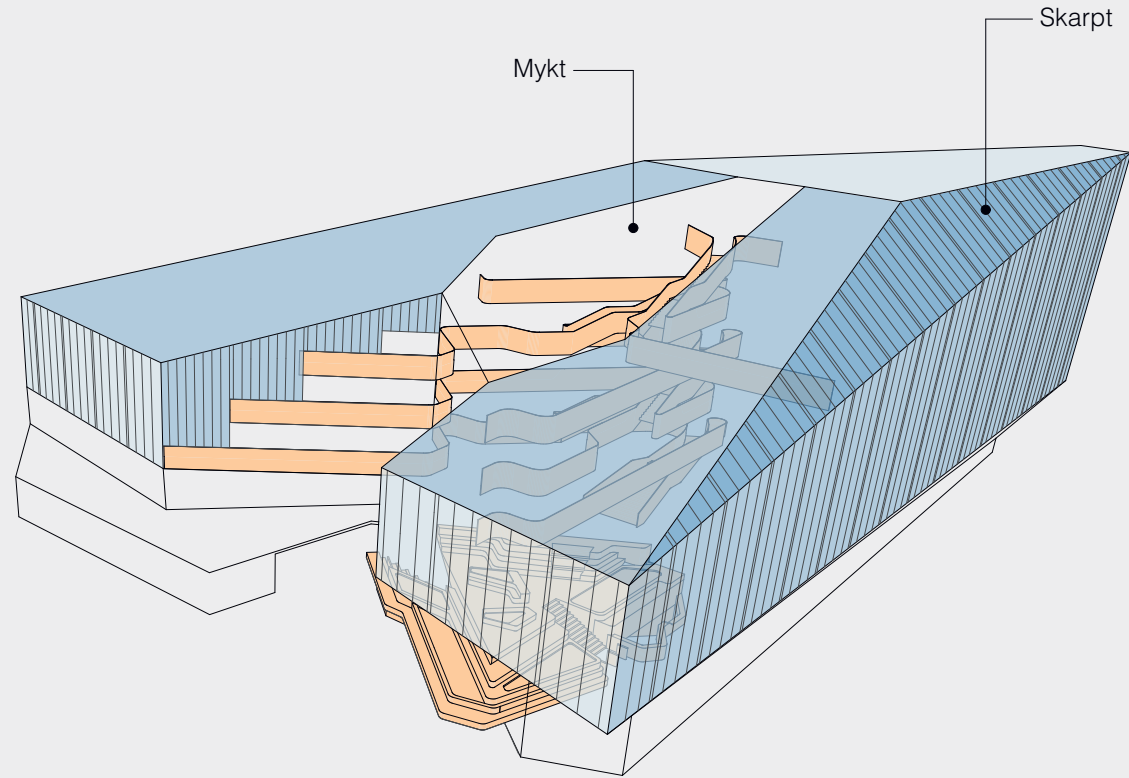
VERTICAL ARRANGEMENT



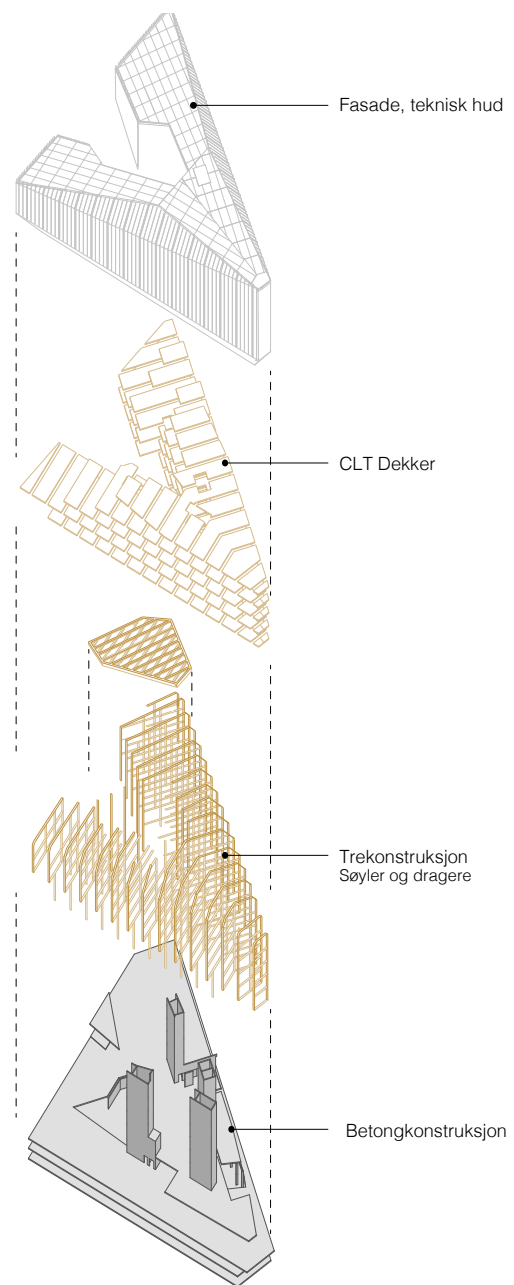
OFFICE STRUCTURE



DUALITY IN MATERIALITY



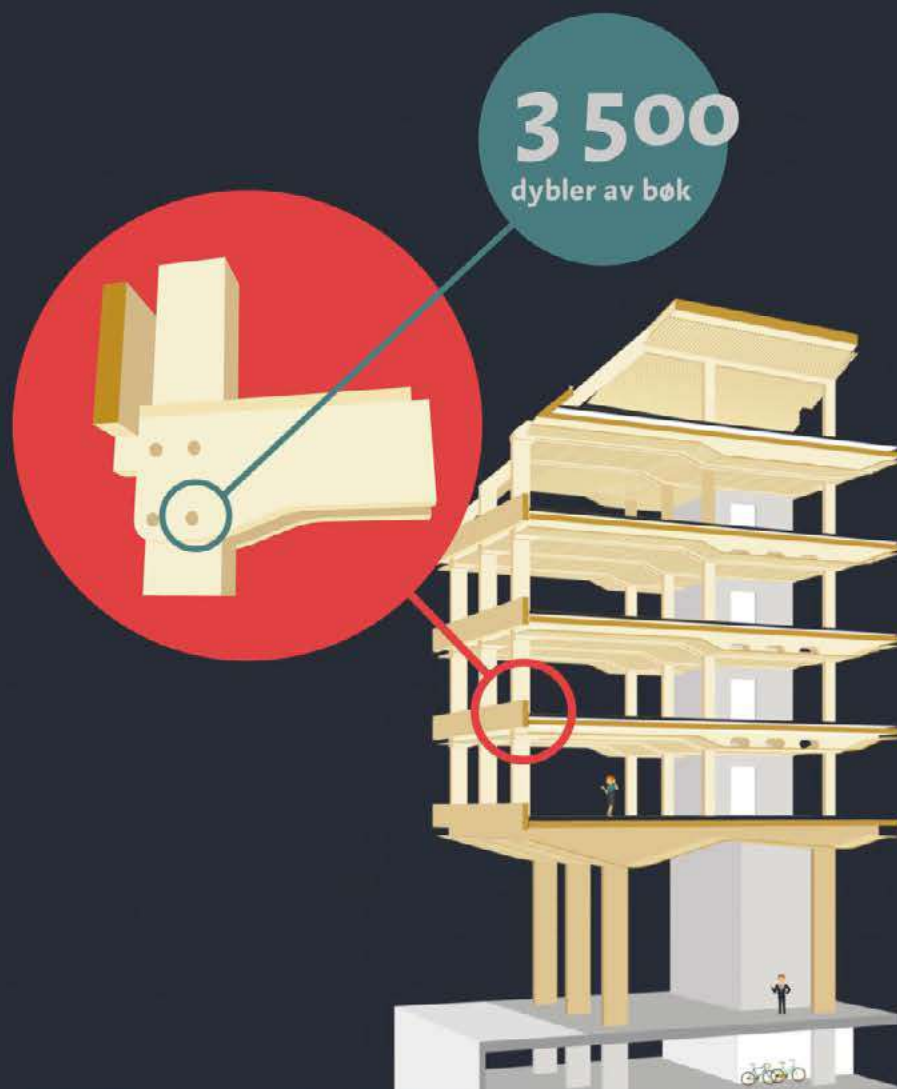
CONSTRUCTION PRINCIPLE



FINANSPARKEN



WOOD AS THE OBVIOUS CHOICE

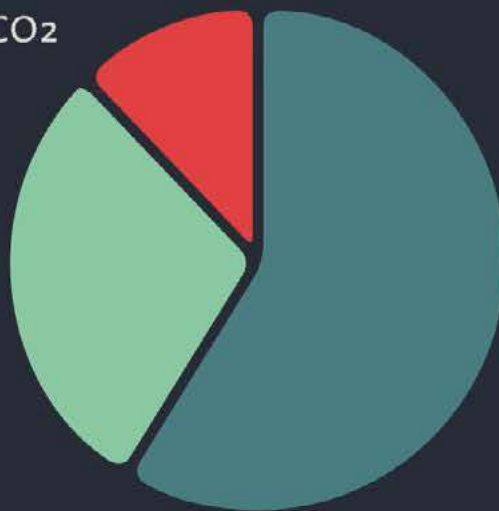


FINANSPARKEN  Block Berge

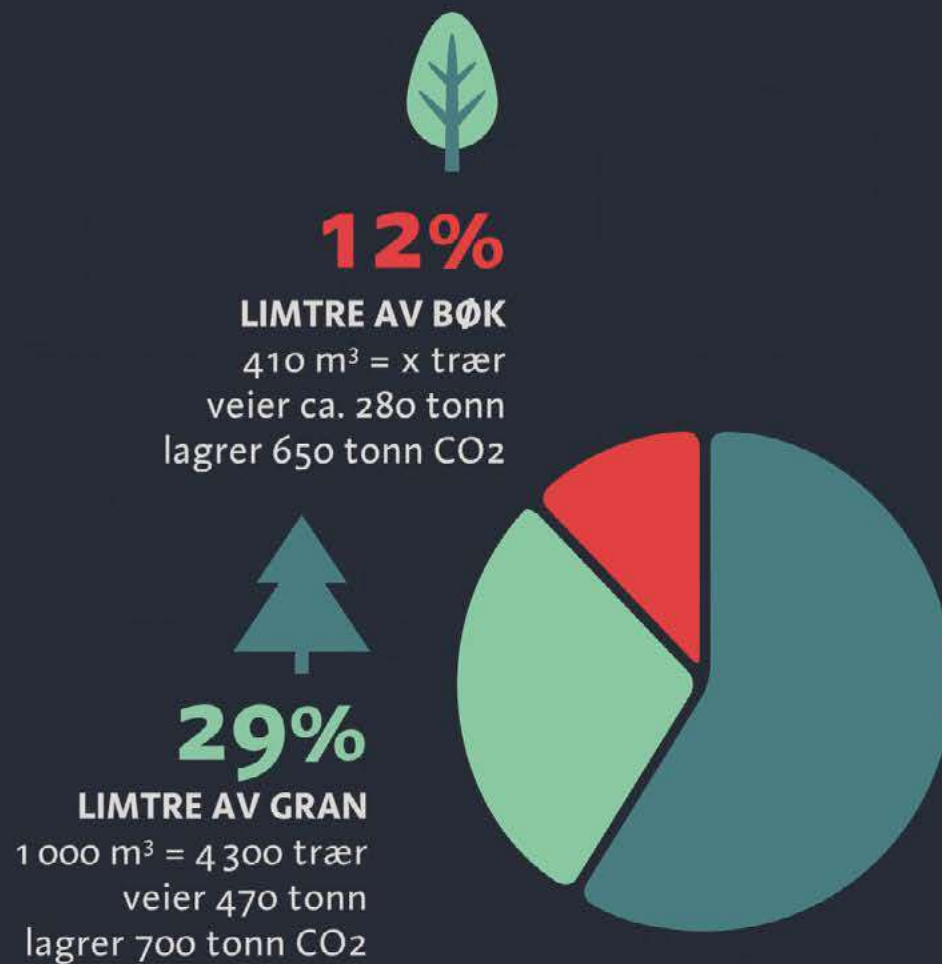
WOOD AS THE OBVIOUS CHOICE

**12%****LIMTRE AV BØK**

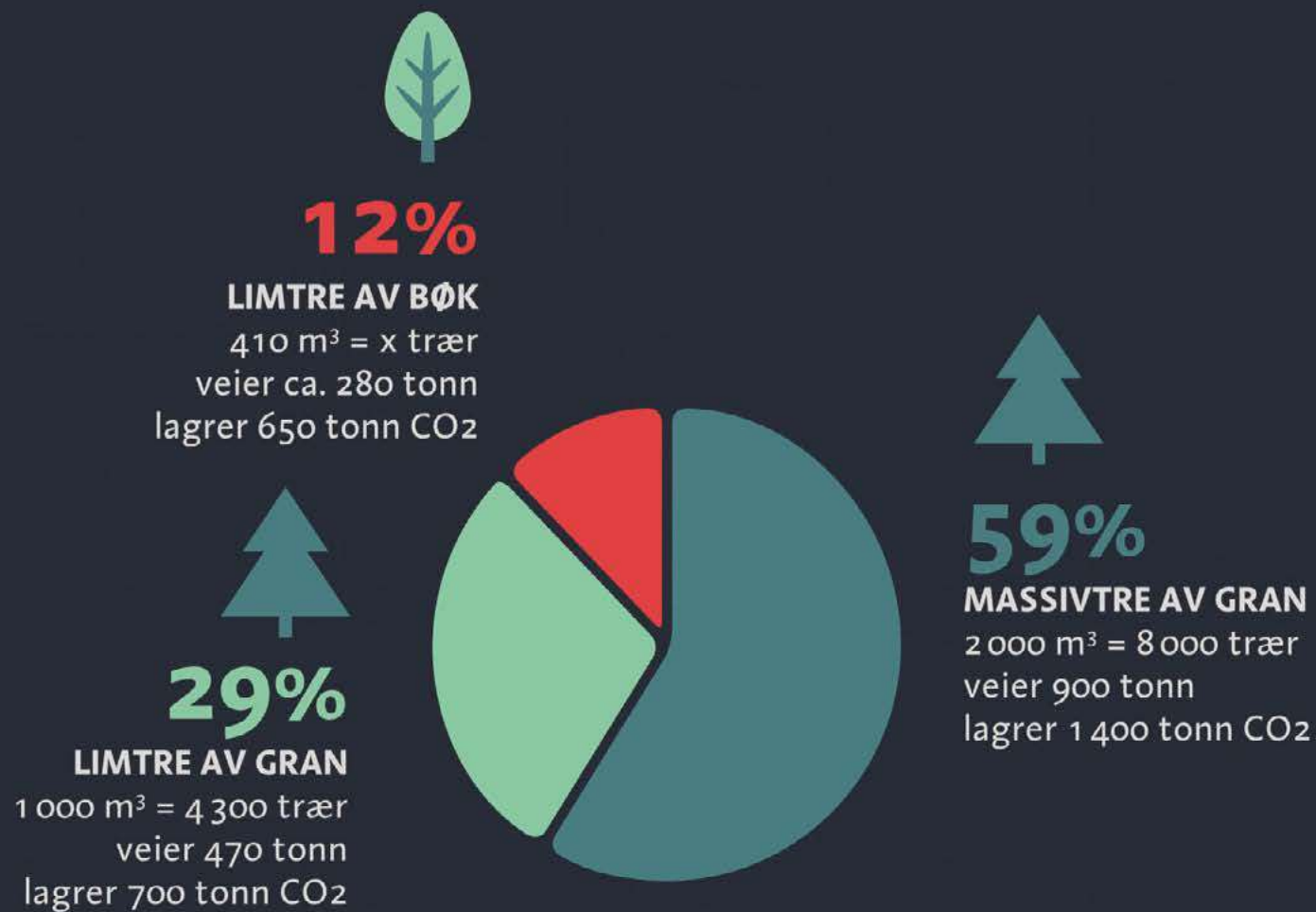
410 m³ = x trær
veier ca. 280 tonn
lagrer 650 tonn CO₂



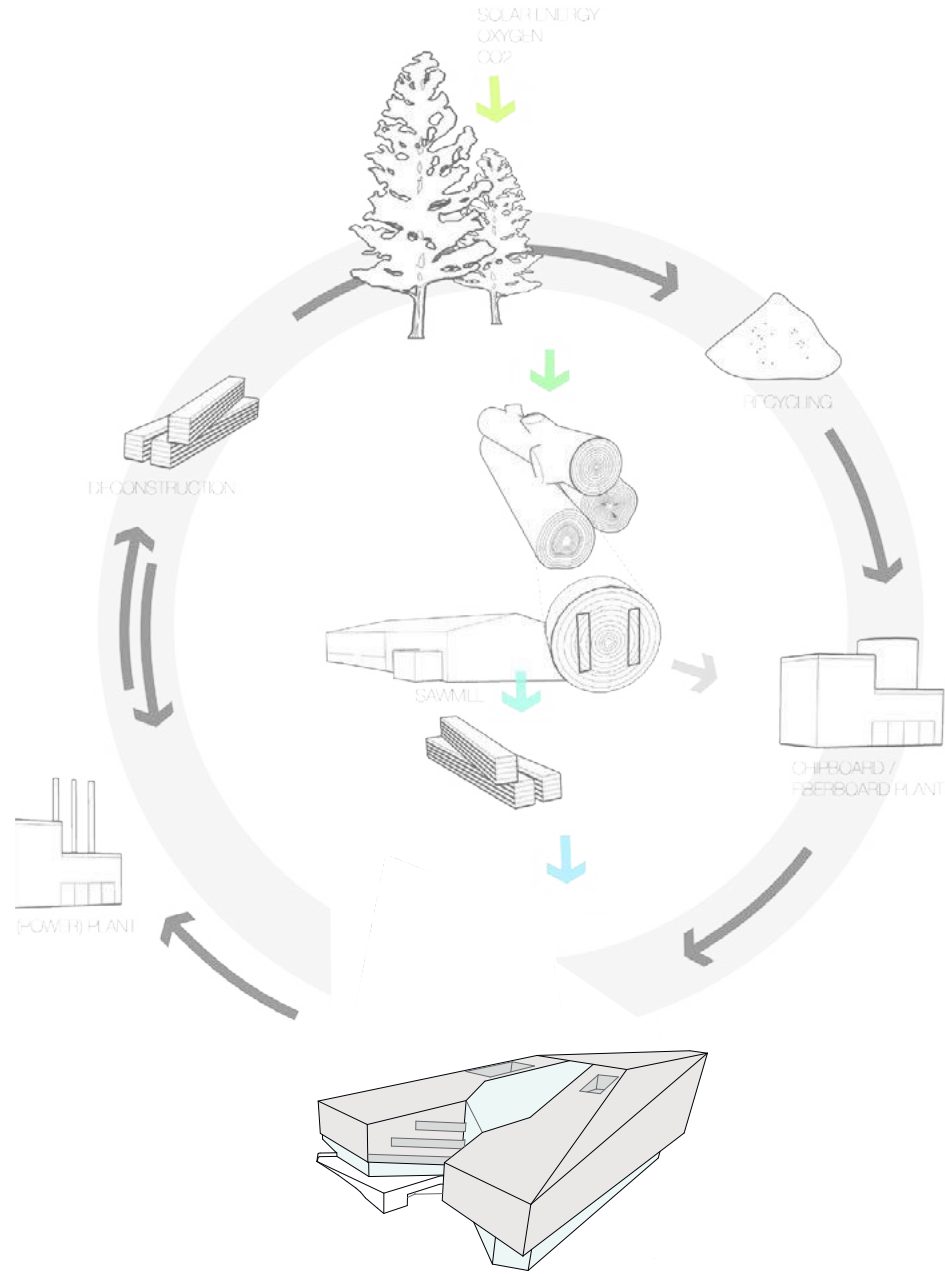
WOOD AS THE OBVIOUS CHOICE

FINANSPARKEN  Block Berge

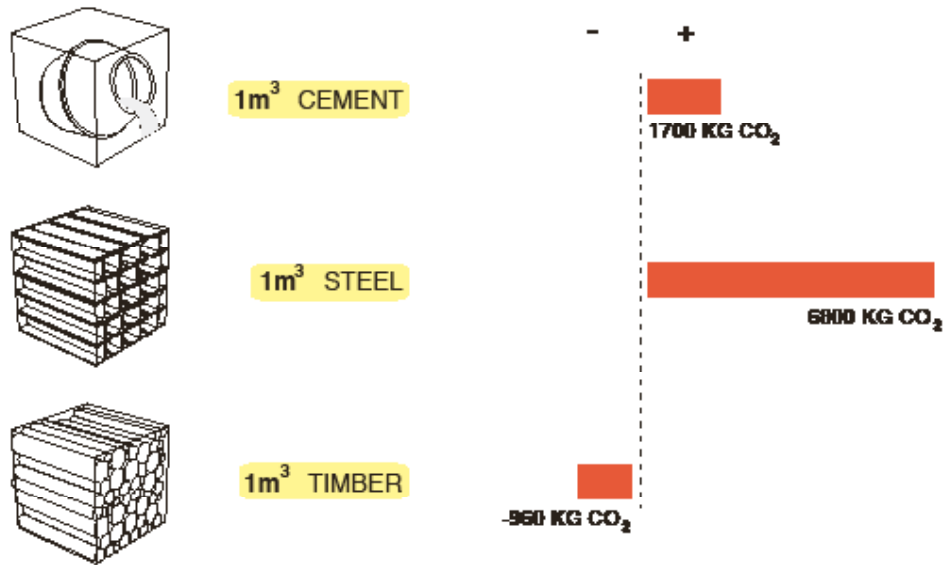
WOOD AS THE OBVIOUS CHOICE

FINANSPARKEN  Block Berge

CARBON CYCLE



CARBON FOOTPRINT

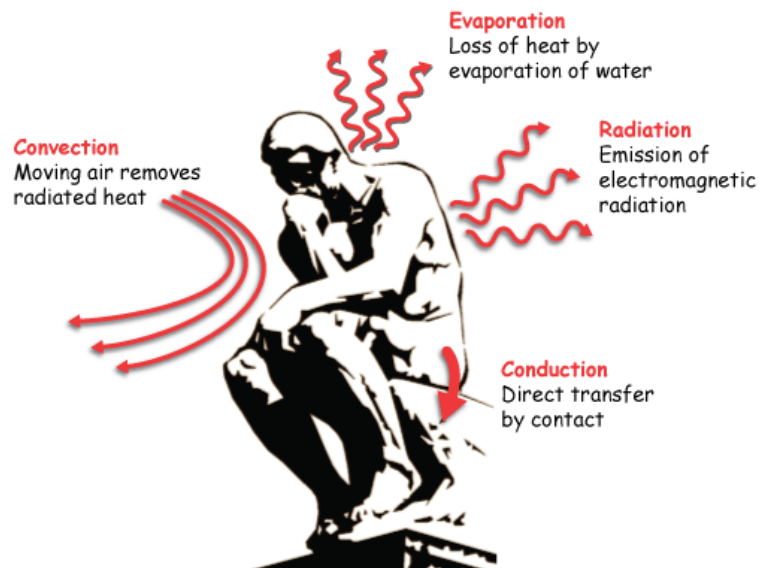


CO₂ for utvalgte byggematerialer

Resultat:

Alternativ	Klimagassutslipp	Forsuring	Eutrofiering
Tre	111 tonn CO2e	900 kg SO2e	125 kg PO4e
Betong	224 tonn CO2e	1070 kg SO2e	151 kg PO4e
Differanse	113 tonn CO2e (50 %)	170 kg SO2e (16 %)	26 kg PO4e (17 %)

HYGROTHERMAL MASS

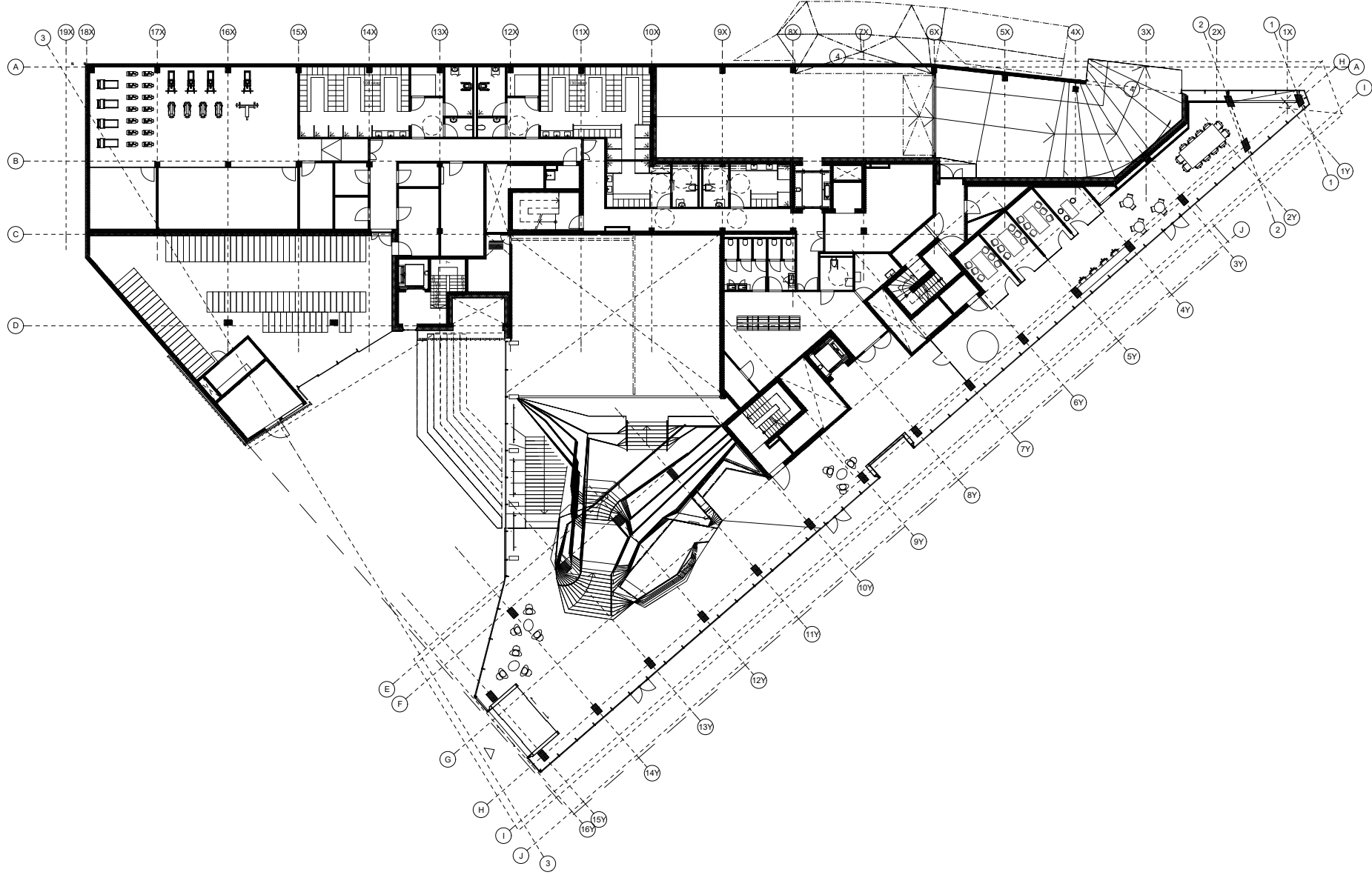


WOOD AS THE OBVIOUS CHOICE

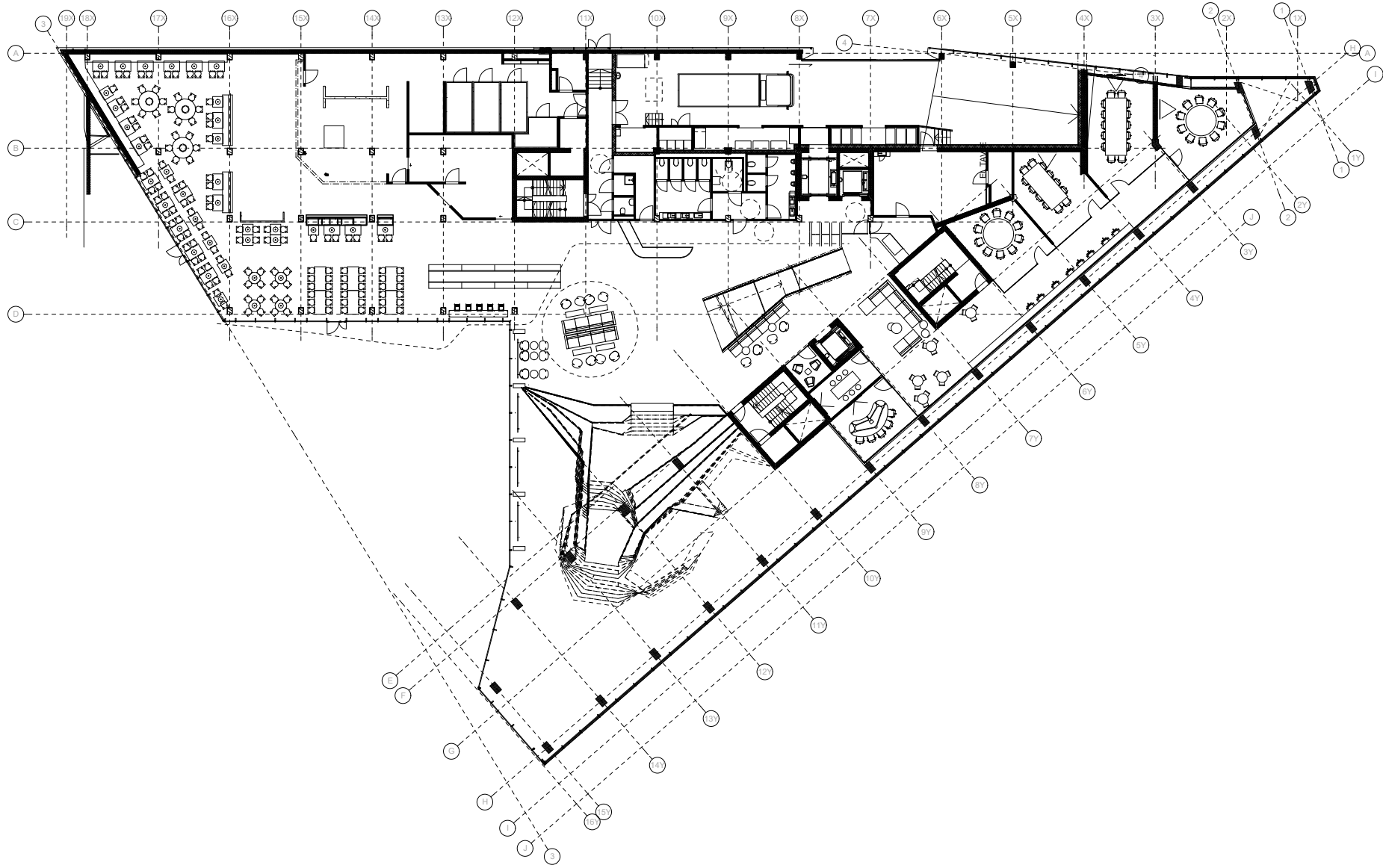
Excellent
BREEAM[®] NOR

FINANSPARKEN  **Block Berge**

PLAN I



PLAN 2



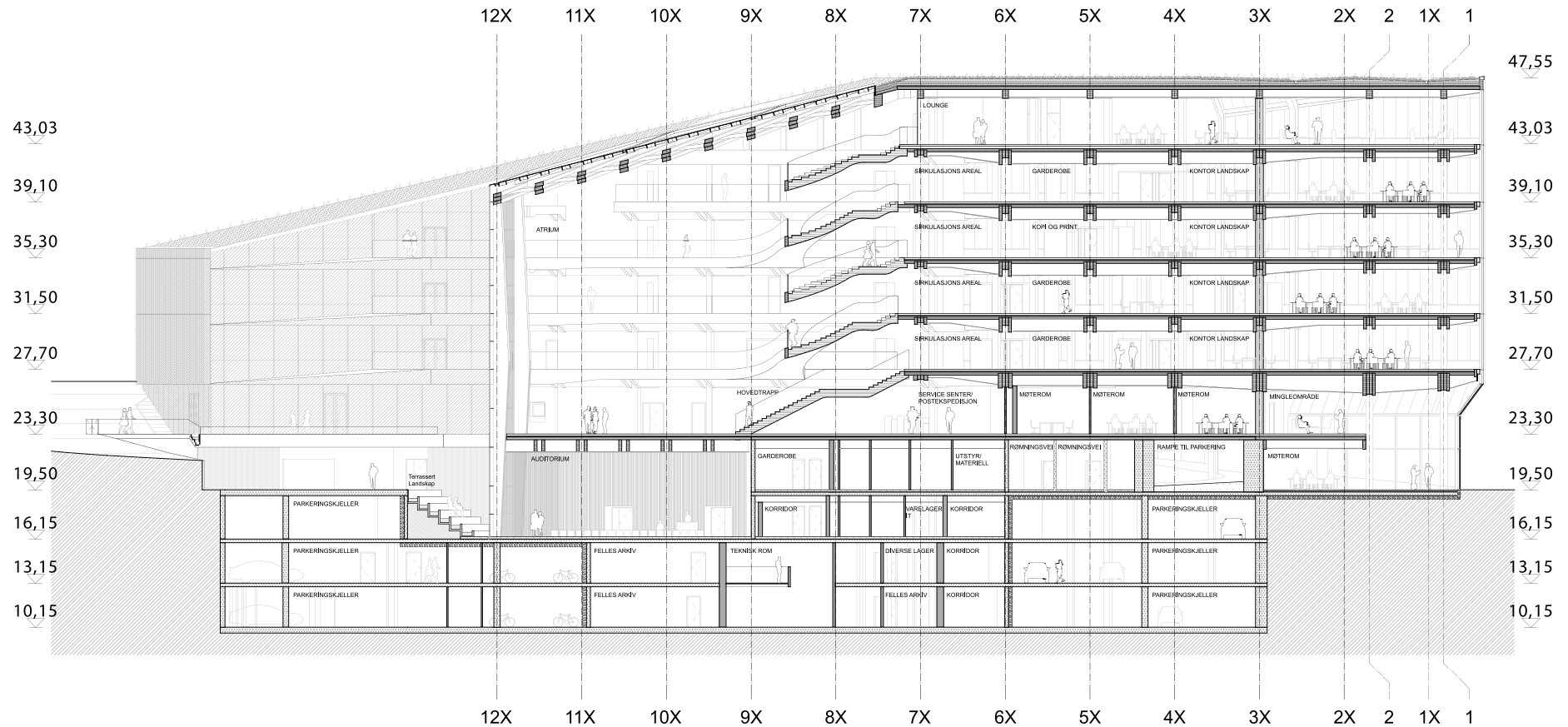
PLAN 4



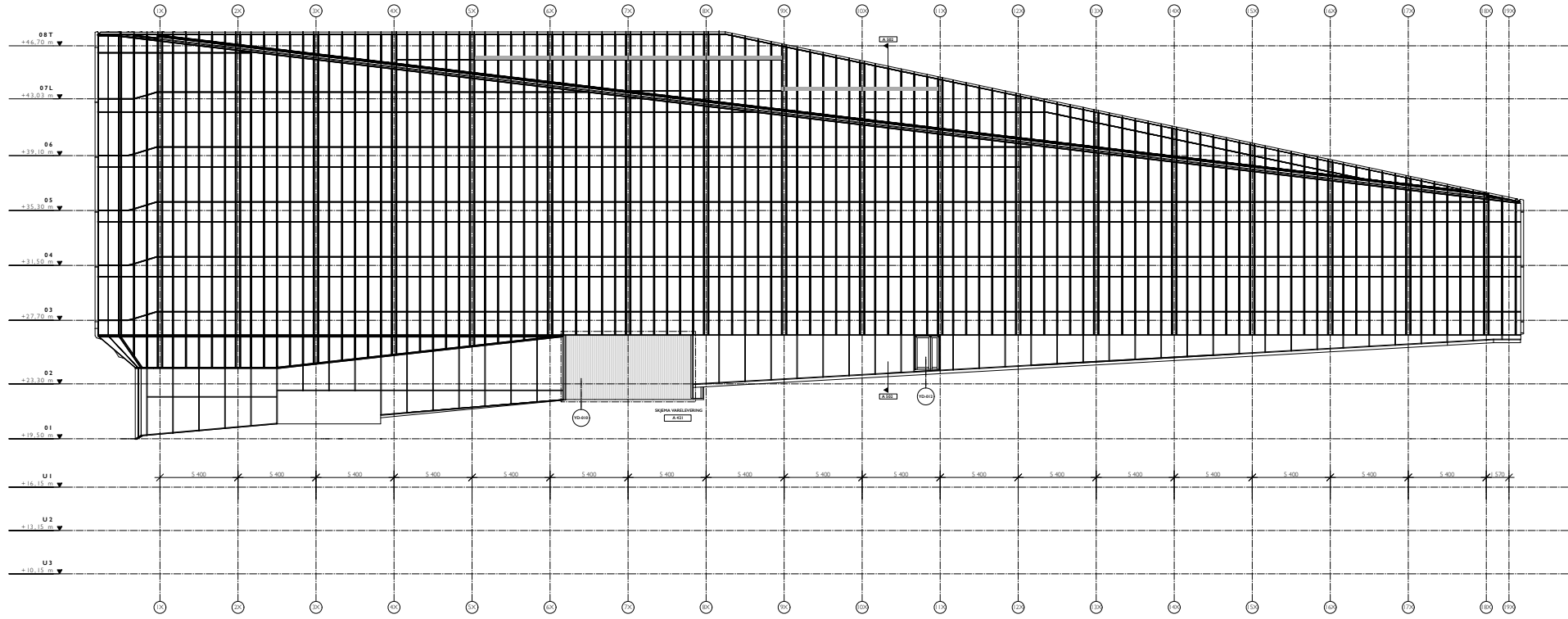
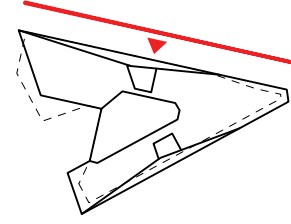
SECTION AA



SECTION BB



WEST FACADE

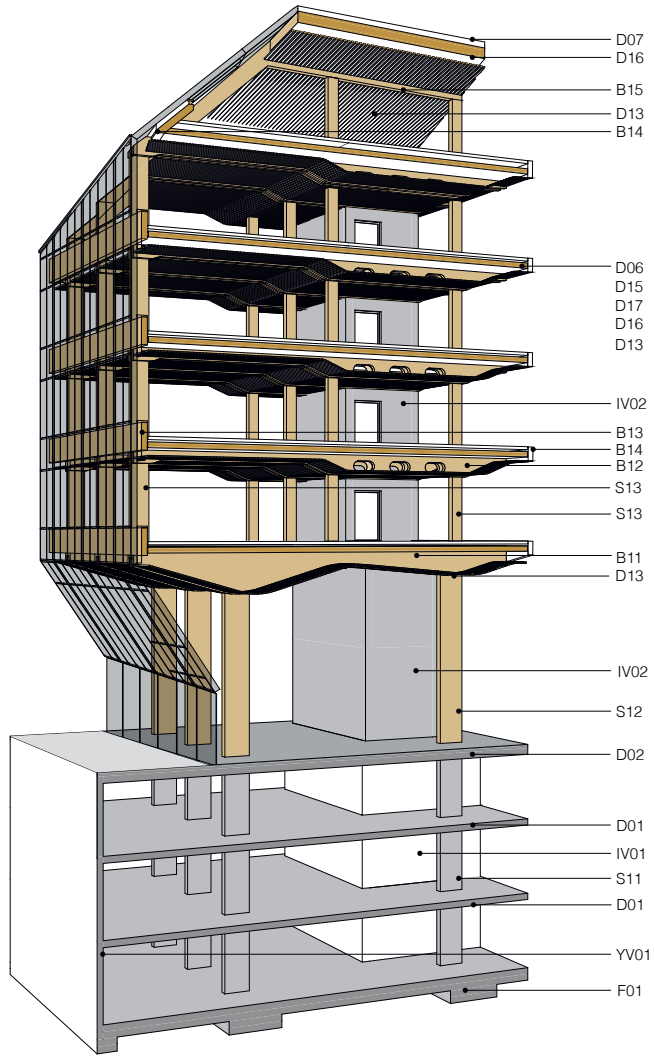


SOUTH PERSPECTIVE

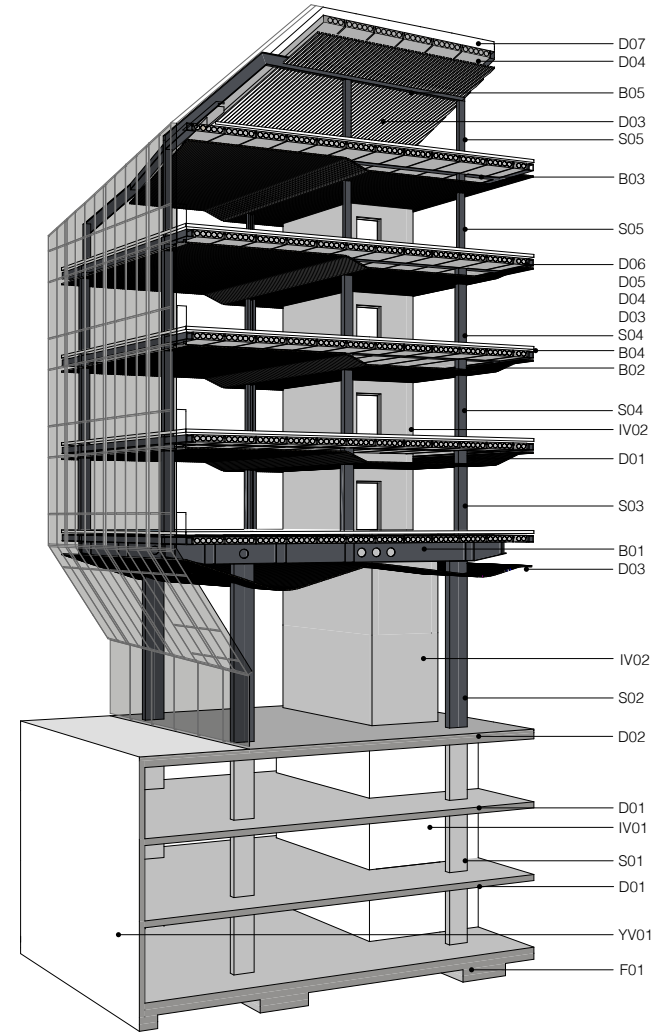


HELEN & HARD / SAAHA

COMPARISON STUDY



WOOD/CONCRETE



STEEL/CONCRETE

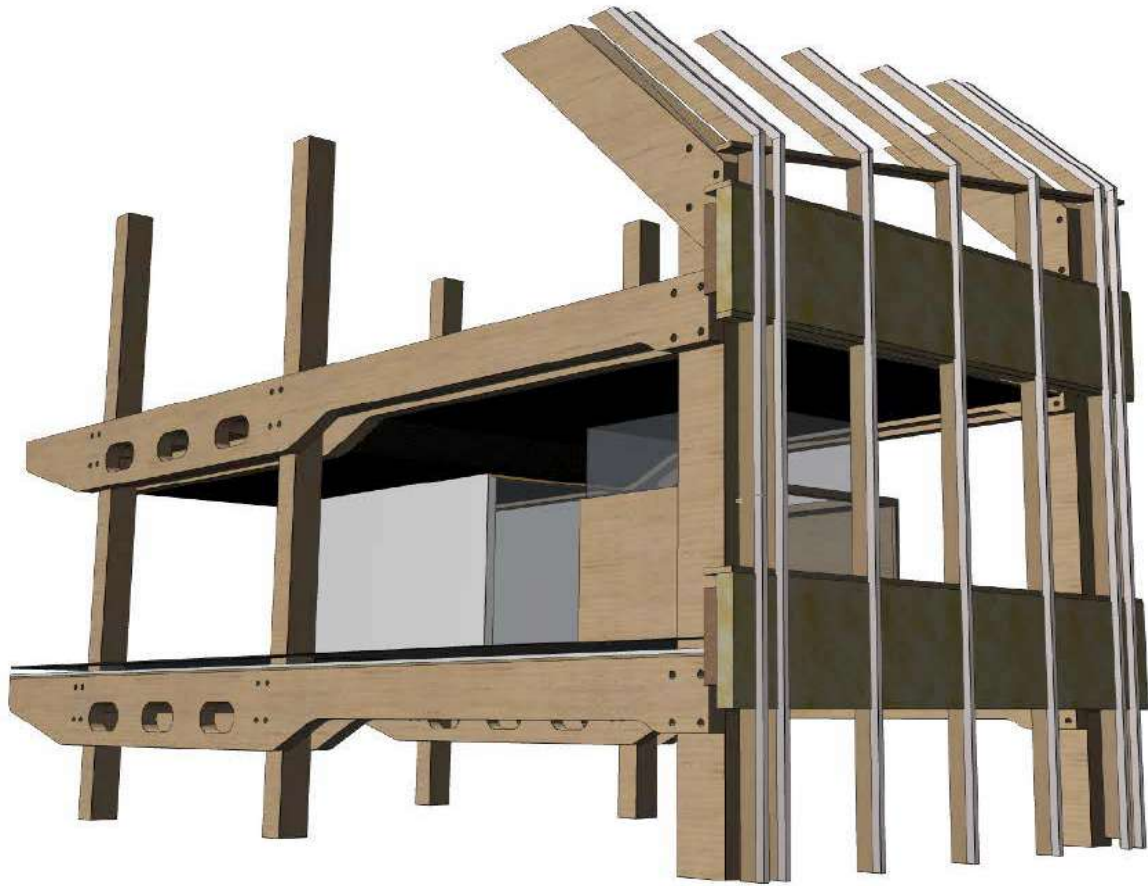
COMPARISON STUDY, NUMBERS

Tabellene under viser kostnadene pr kvm:

Sammenlignende tall for stål/betong og trekonstruksjon kr pr kvmBTA

#	Konto	Type	Stål/Betong Kontorbygg m/P-kjeller	TRE_Kontorbygg m/P-kjeller	Diff
2.0	Riving og forberedende arbeider	Total pris pr. m2	0	0	8,5 %
2.1	Grunn og fundamenter	Total pris pr. m2	323	323	
2.2	Bæresystemer	Total pris pr. m2	1 362	1 478	
2.3	Yttervegger	Total pris pr. m2	2 038	2 038	
2.4	Innervegger	Total pris pr. m2	1 201	1 201	
2.5	Dekker	Total pris pr. m2	3 176	3 373	
2.5.1	Dekke	Total pris pr. m2	1 152	1 489	
2.5.2	Belegg	Total pris pr. m2	764	764	
2.5.3	Himling	Total pris pr. m2	1 260	1 120	
2.6	Yttertak	Total pris pr. m2	117	187	
2.7	Fast inventar	Total pris pr. m2	0	0	
2.8	Trapper, balkonger m.m.	Total pris pr. m2	0	0	
2.9	Malerarbeider. Diverse	Total pris pr. m2	0	0	
2	SUM : Bygning	Total pris pr. m2	8 218	8 600	4,6 %
Entrepreniskost (konto 2 antatt 50% av konto 1-7)			kr 16 436	kr 16 818	2,3 %
Prosjektkost (konto 2 antatt 30% av konto 1-9-RM)			kr 27 393	kr 27 775	1,4 %

MOCKUP



MOCKUP



MOCKUP



MOCKUP



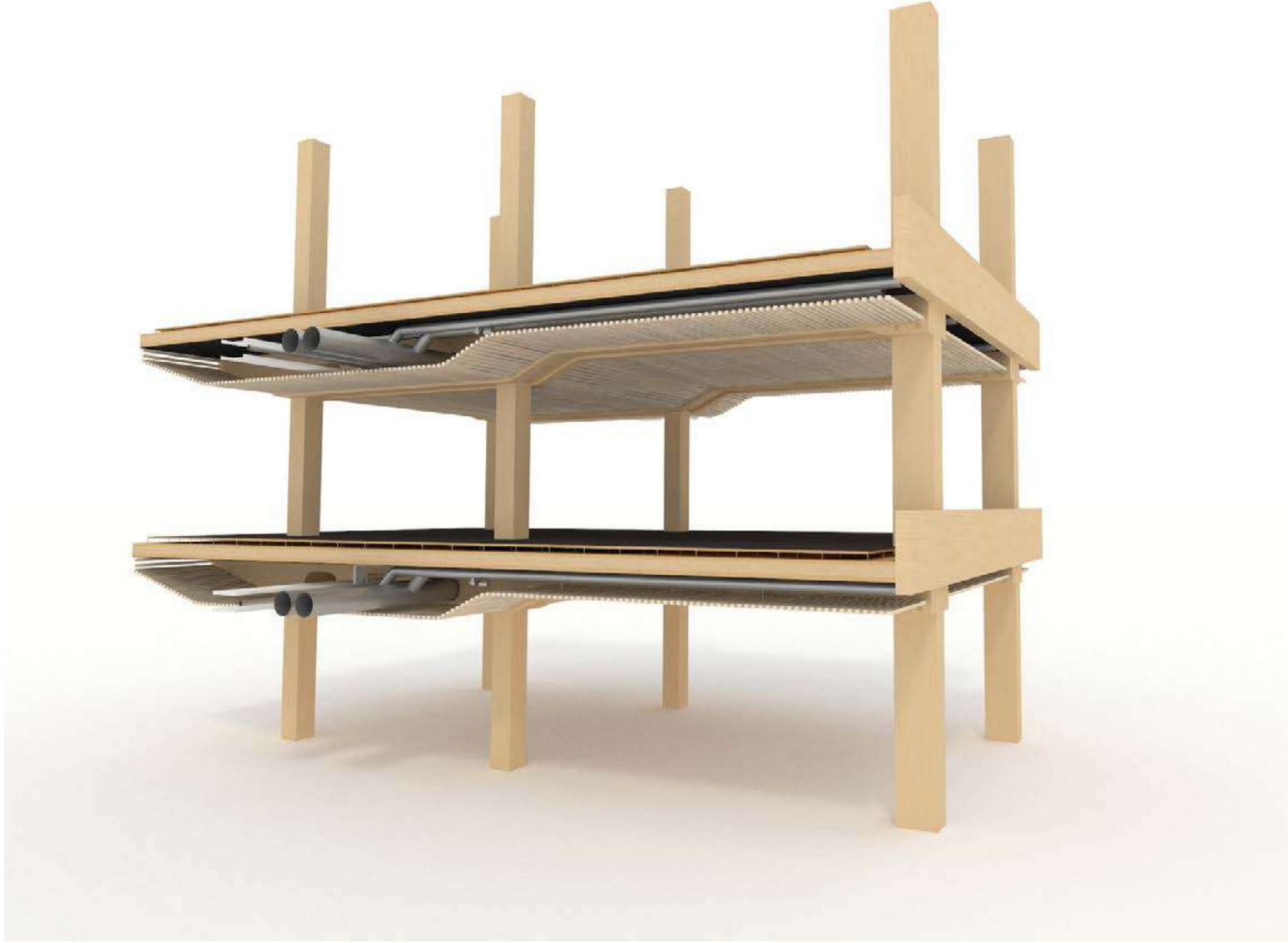
MOCKUP



MOCKUP



MOCKUP



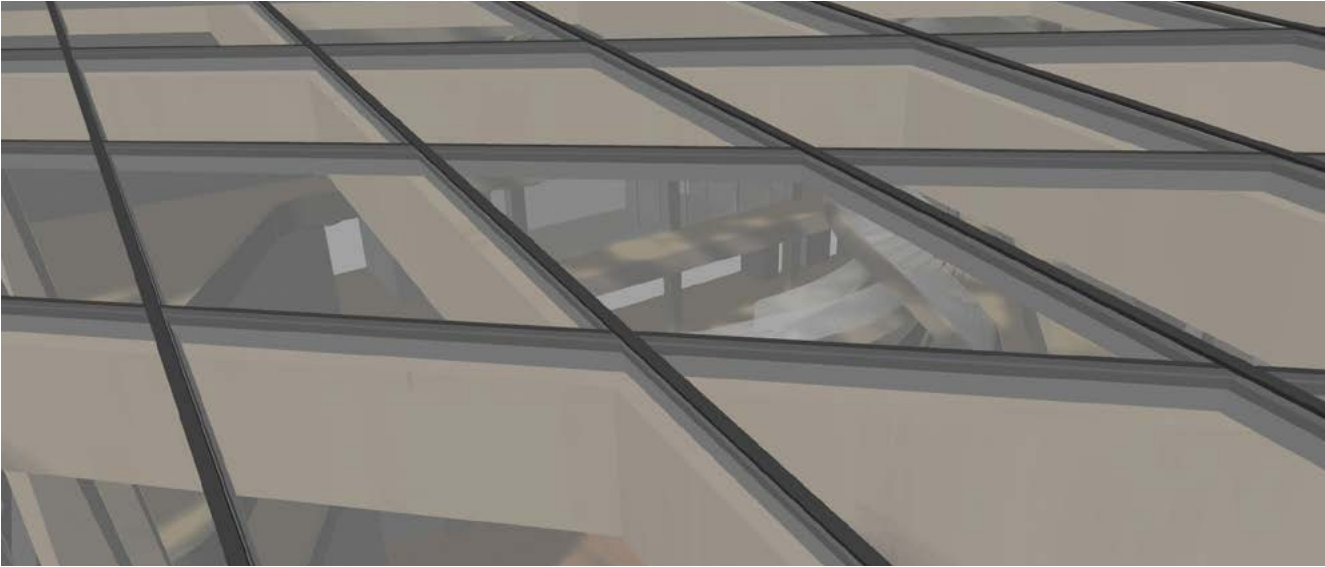
MOCKUP



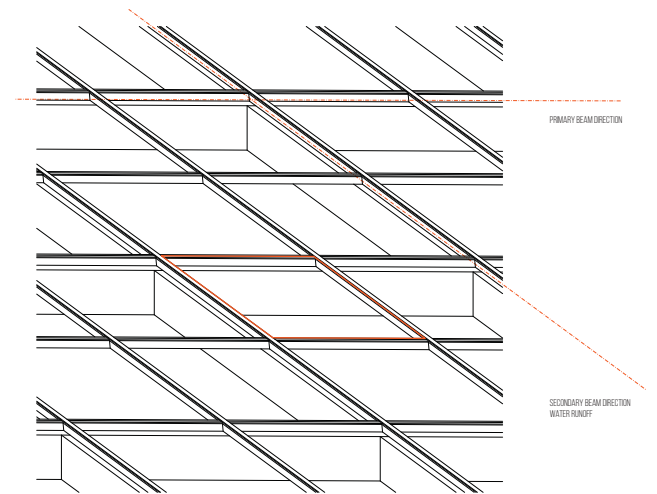
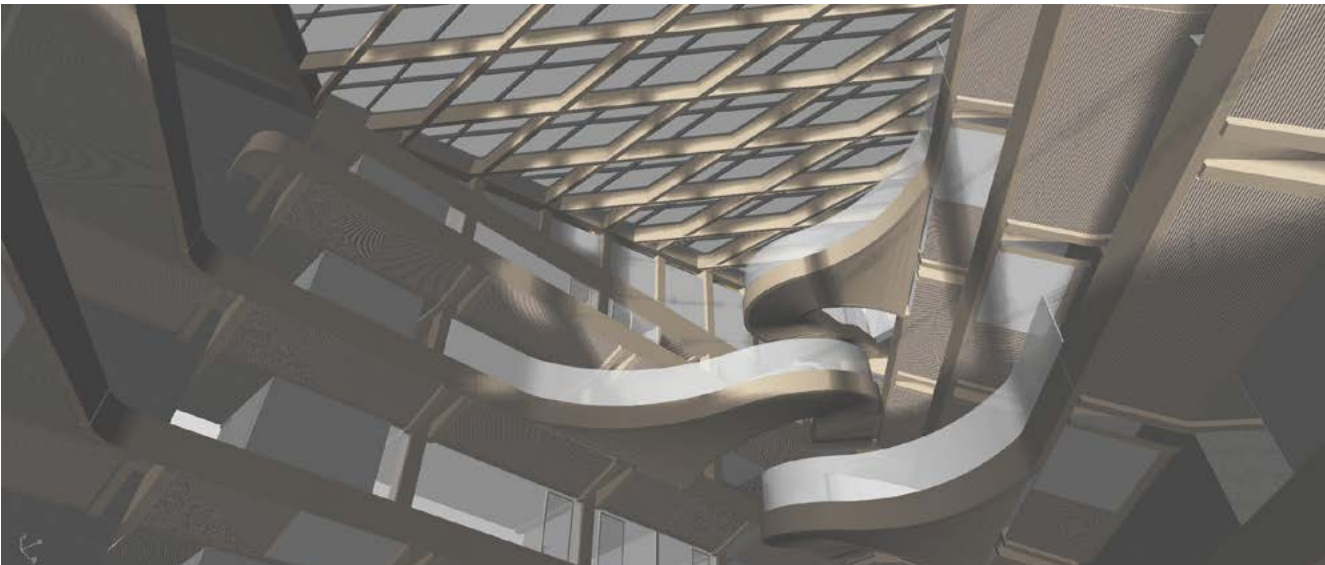
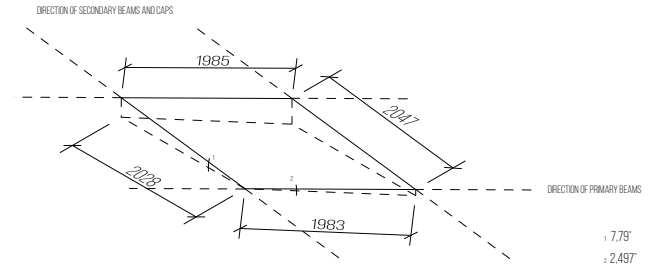
MOCKUP



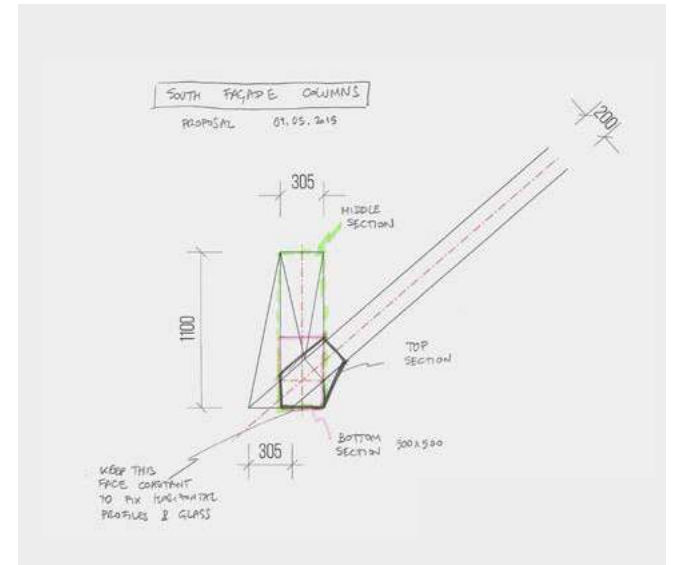
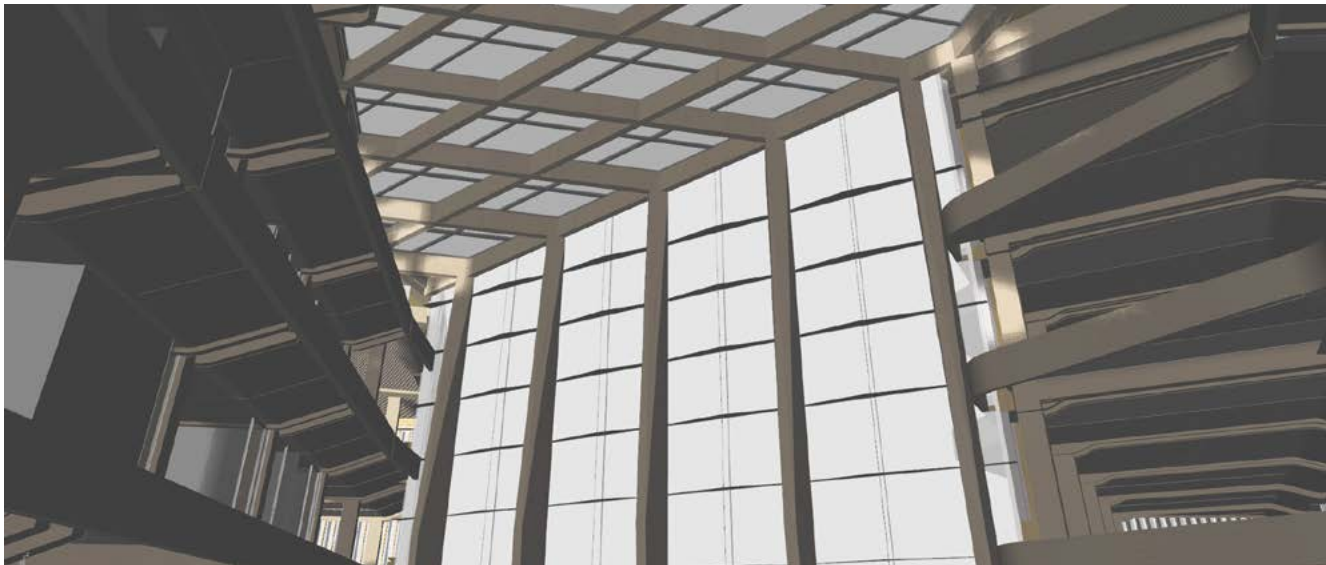
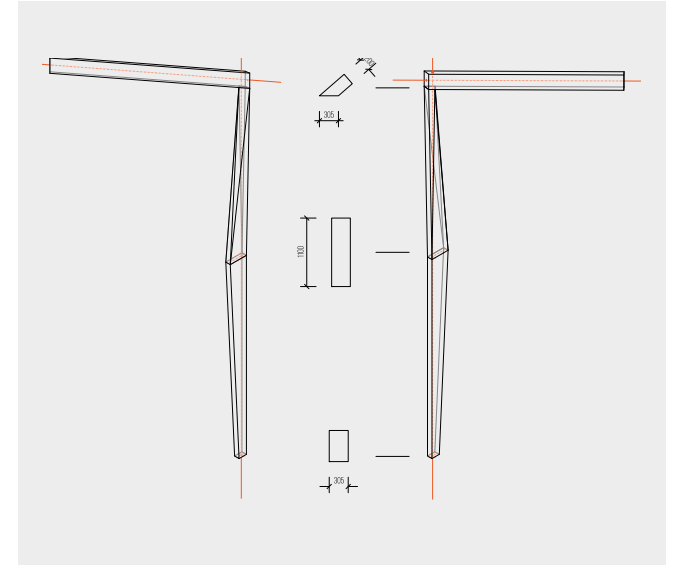
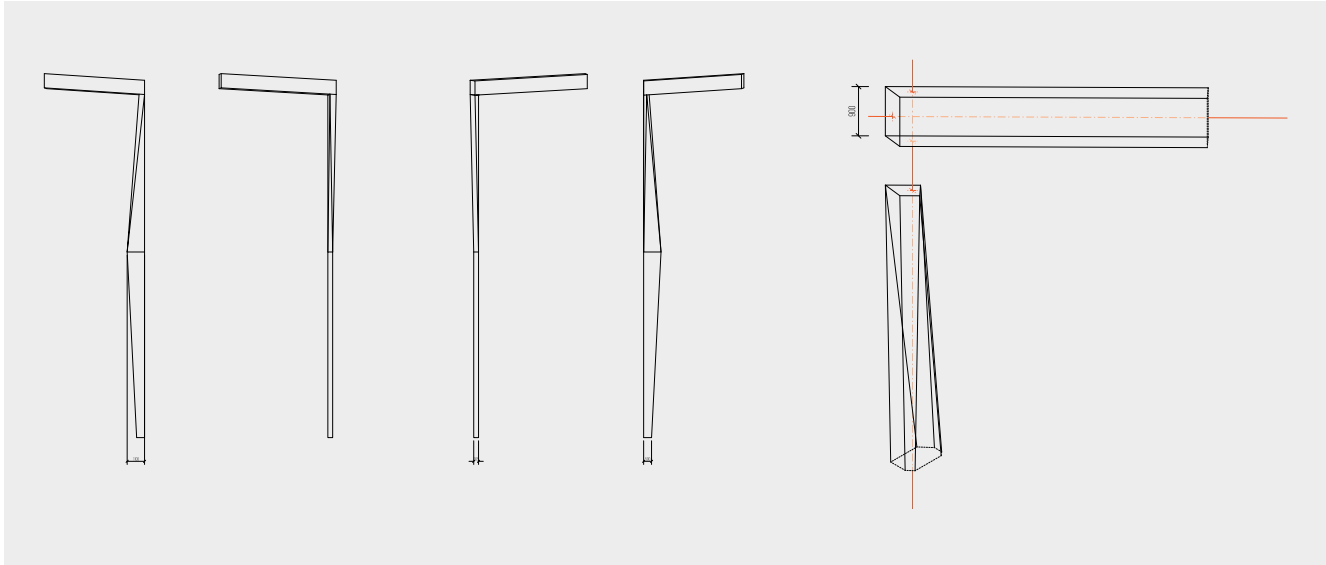
ATRIUM BEAM STRUCTURE



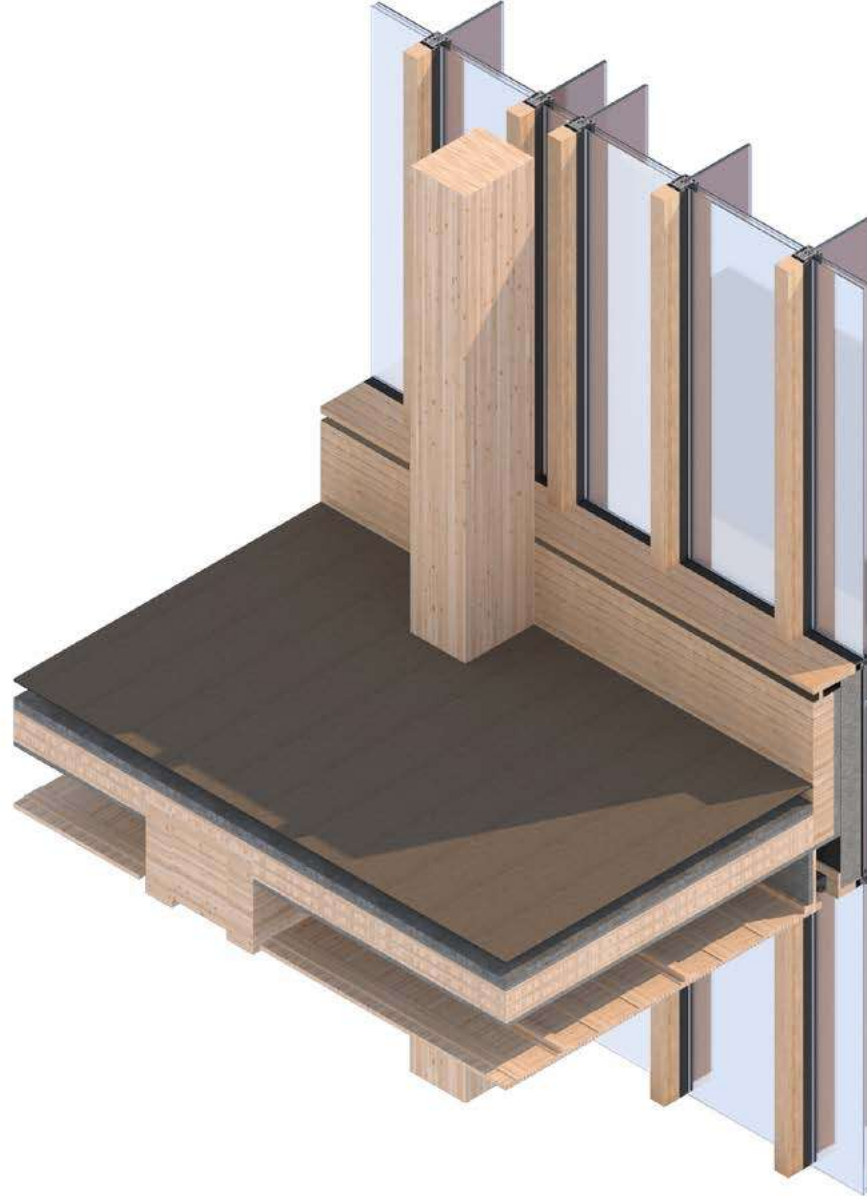
AEROGEL PANEL



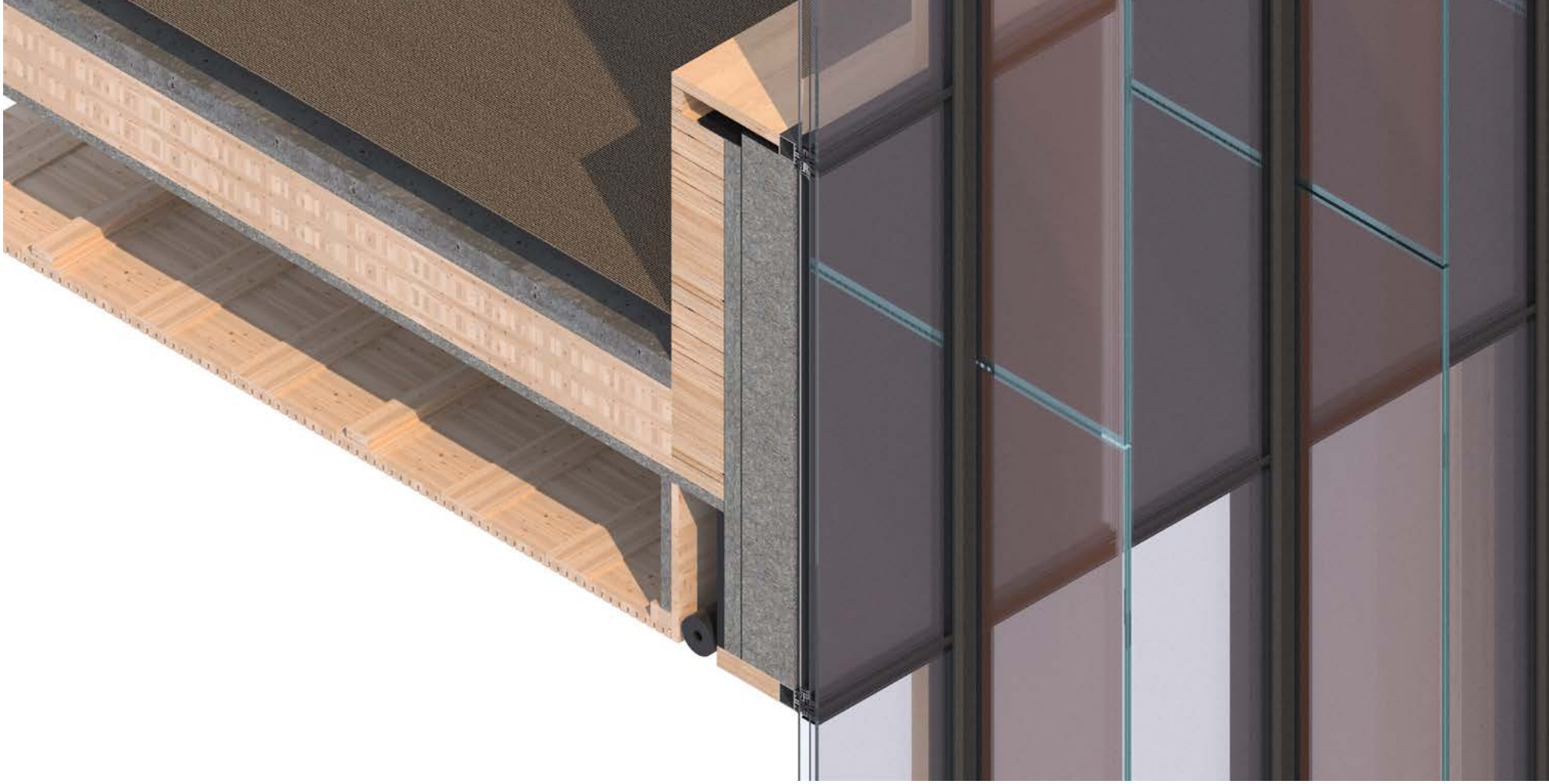
ATRIUM COLUMN STUDIES



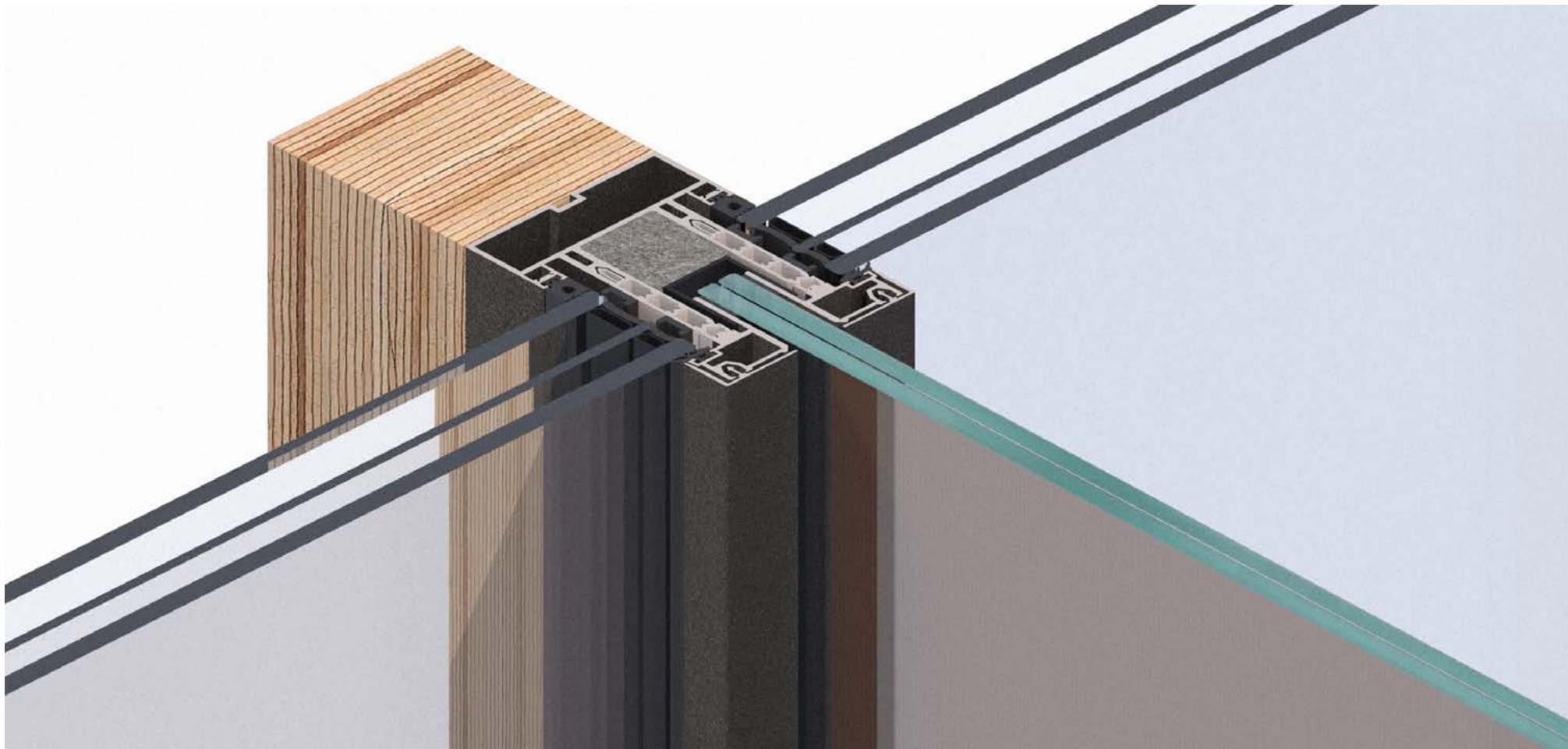
FACADE ELEMENTS



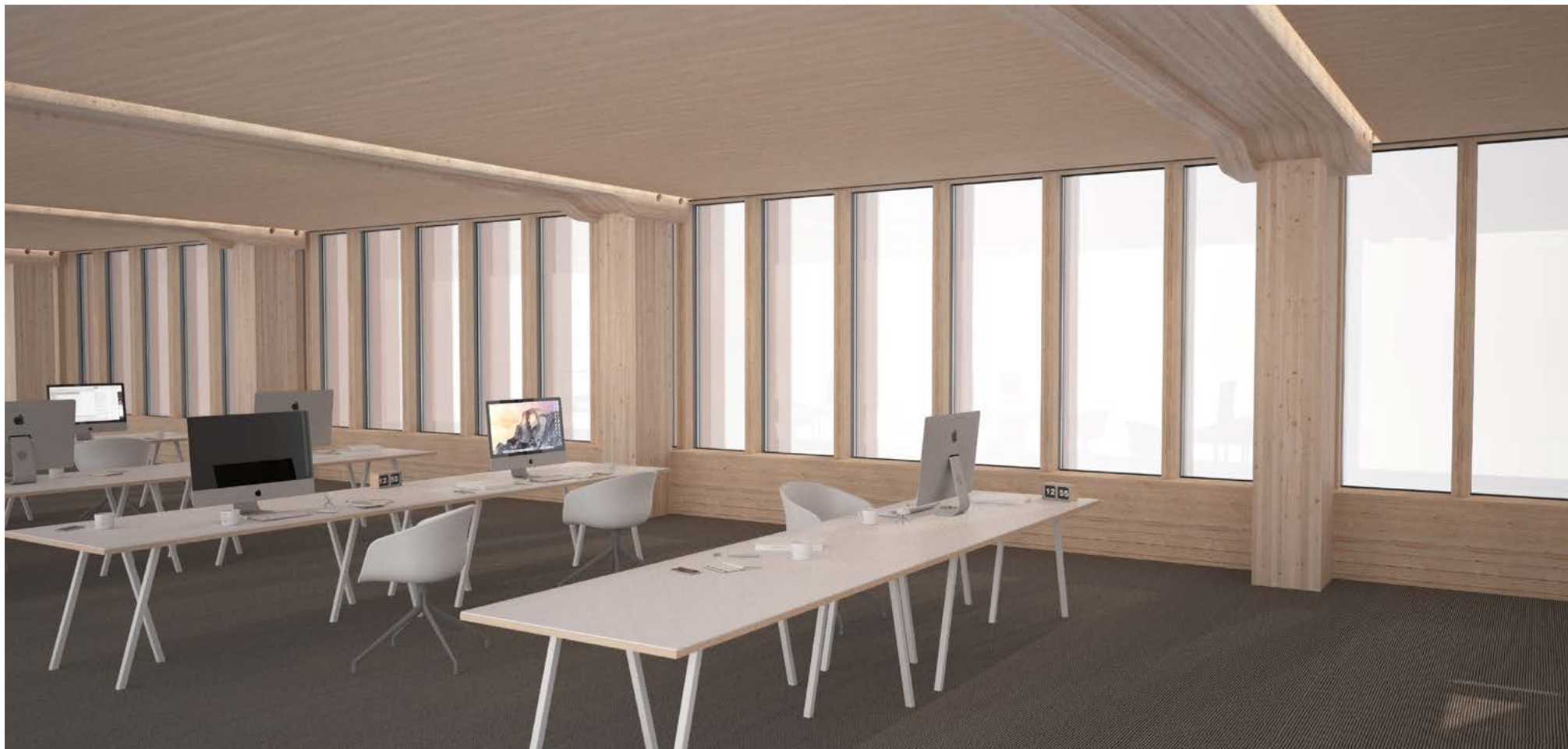
FACHADE CONNECTIONS



FACADE WOOD PURLINS



OFFICE INTERIOR



ATRIUM INTERIOR



SECTION EAST FACADE

L01

30 MM SKIFER
100 MM PÅSTØP
20 MM TRINNLYDPLATE
250 MM BETONG
250 MM ISOLASJON - MYK

L02

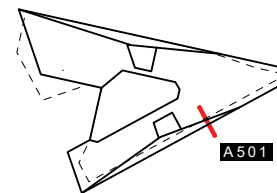
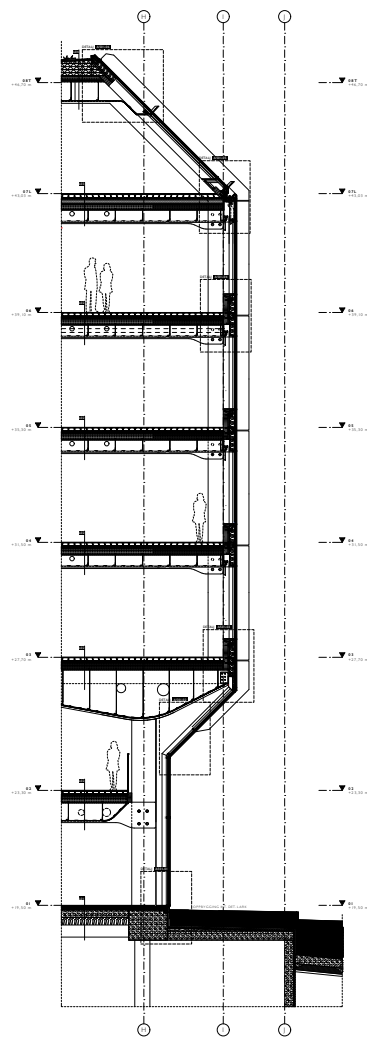
60 MM SKIFER
200 MM BETONG
370 MM DRENERENDE MASSER
1 LAG BESKYTTELSESSJIKT
2x5 MM ISOLASJON - TRYKKFAST
1 LAG MEMBRAN
300 MM BETONG
250 MM ISOLASJON - MYK

L03

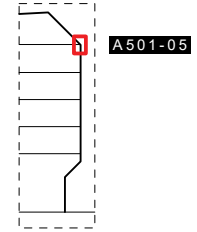
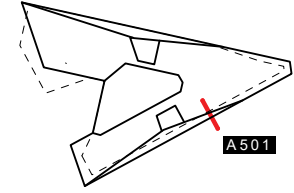
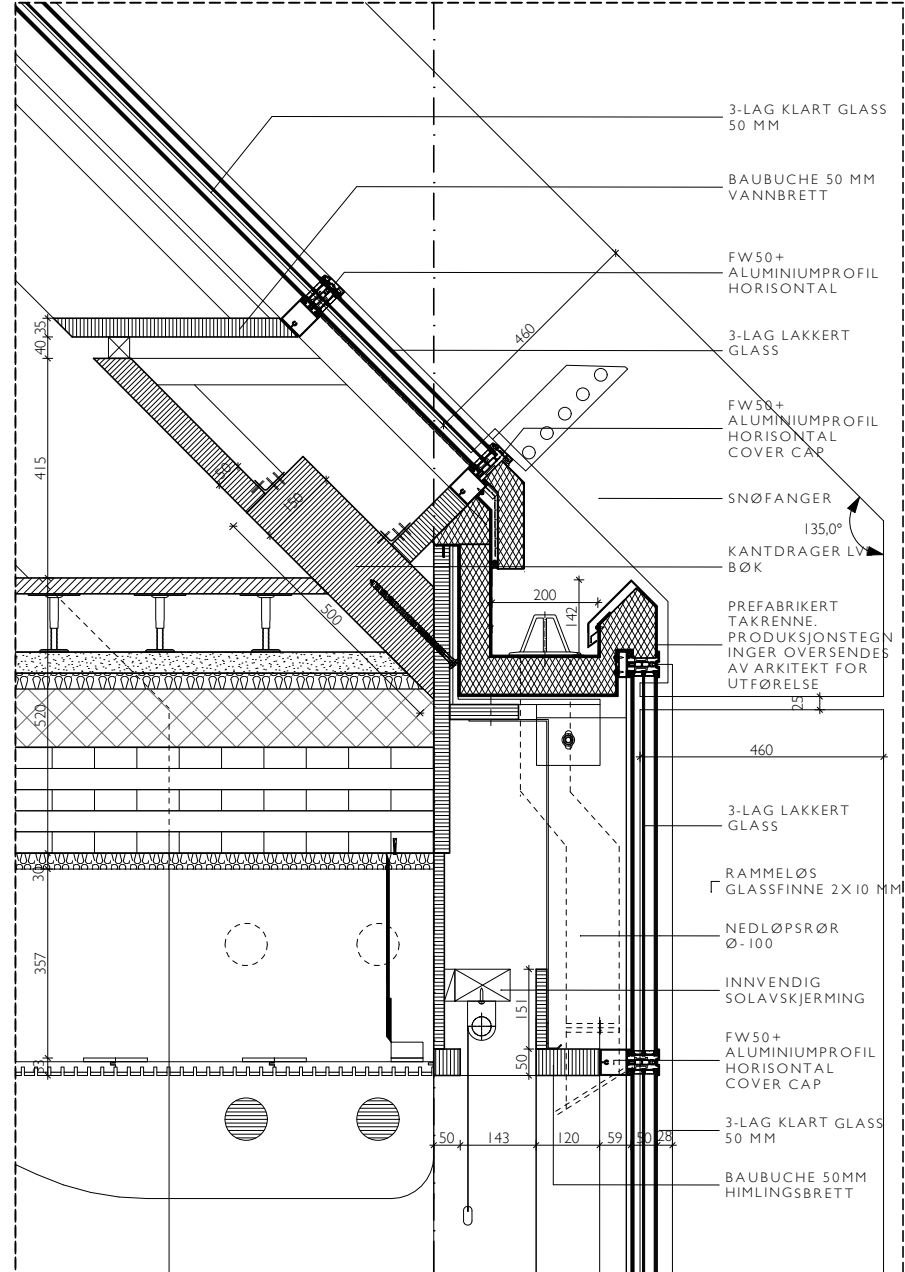
30 MM PARKETT
110 MM TEKNISK GULV
70 MM SCREED/TRINNLYD (SKAL BESTEMMES SENERE)
110 MM ISOLASJON TRYKKFAST
200 MM CLT PANEL
30 MM BRANNBESKYTTELSE
357 MM FOR INSTALLASJON
33 MM NEDSENKET HIMLING LIGNO AKUSTIK LIGHT 3S-33 E

L04

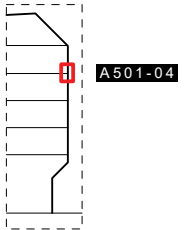
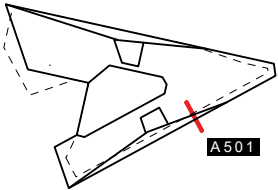
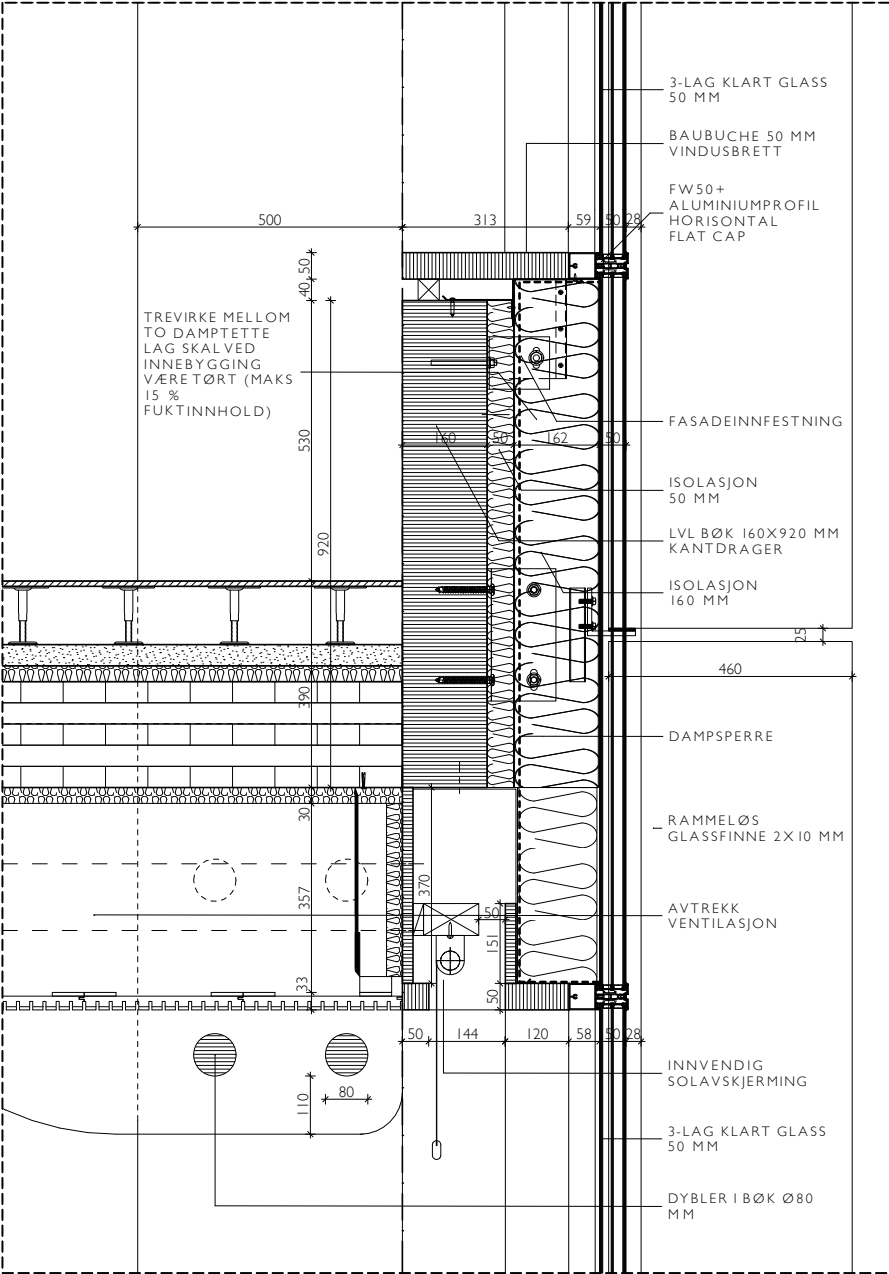
30 MM VEKSTLAG MED NORSK VILL SEDUM
20 MM DRENS MATTE PÅ FLATTAK
TAKBELEGG
1 LAG MIGRERINGSSPERRE
200 MM FOR FALL 1:40
100 MM ISOLASJONSLAG
100 MM ISOLASJONSLAG
100 MM ISOLASJONSLAG
1 LAG DAMPBREMS/SPERRE
200 MM CLT PANEL
30 MM BRANNBESKYTTELSE
484 MM FOR INSTALLASJON
33 MM NEDSENKET HIMLING LIGNO AKUSTIK LIGHT 3S-33 E



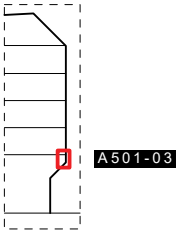
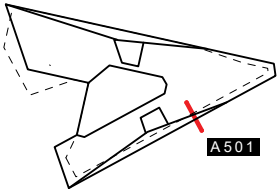
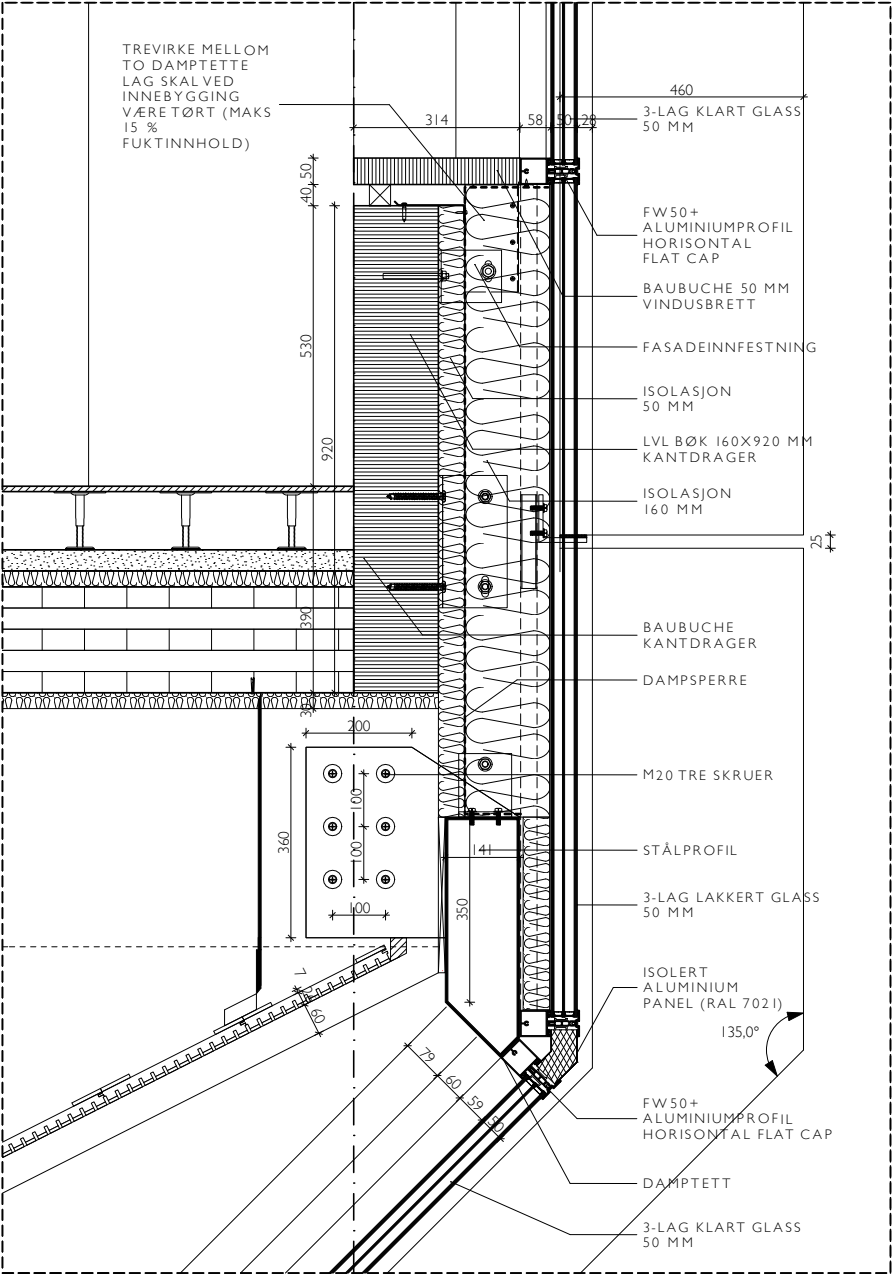
RAFTER DETAIL



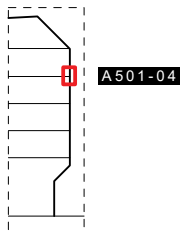
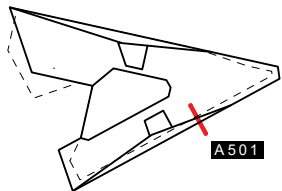
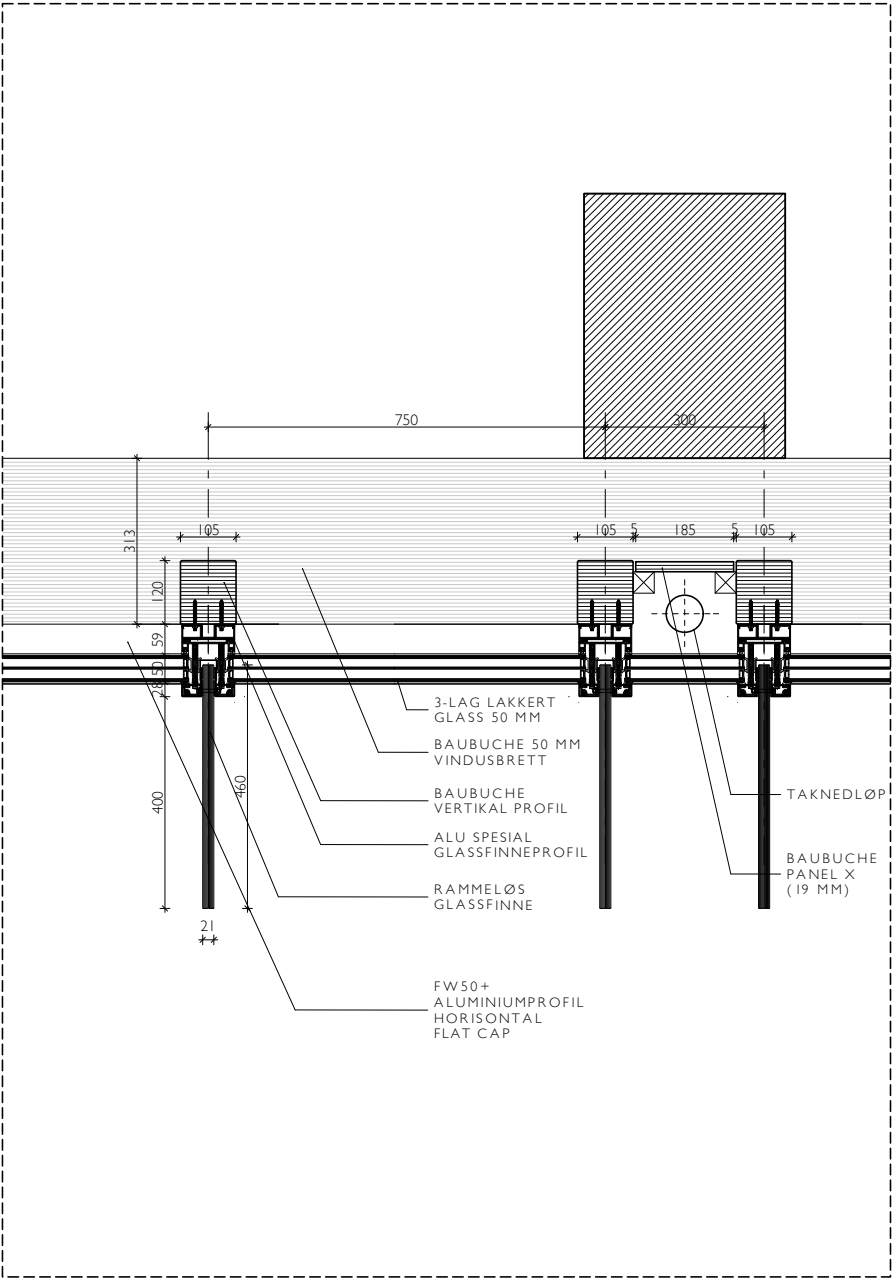
GENERAL FLOOR



TRANSITION LEVEL

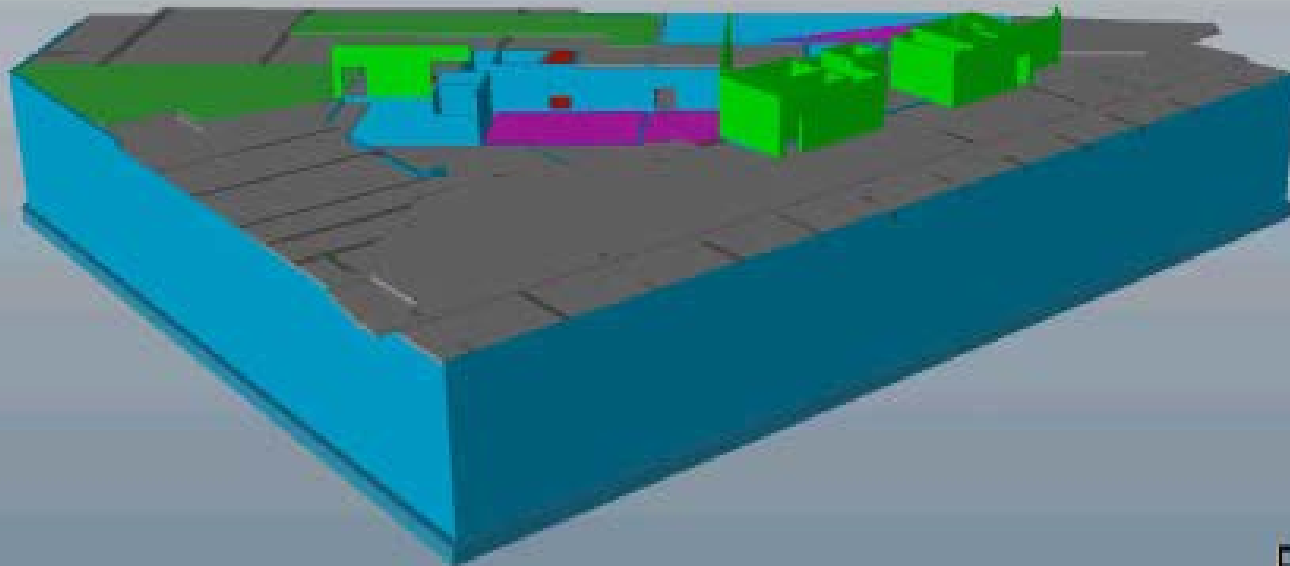


WOOD STRUCTURE / FACHADE DETAIL



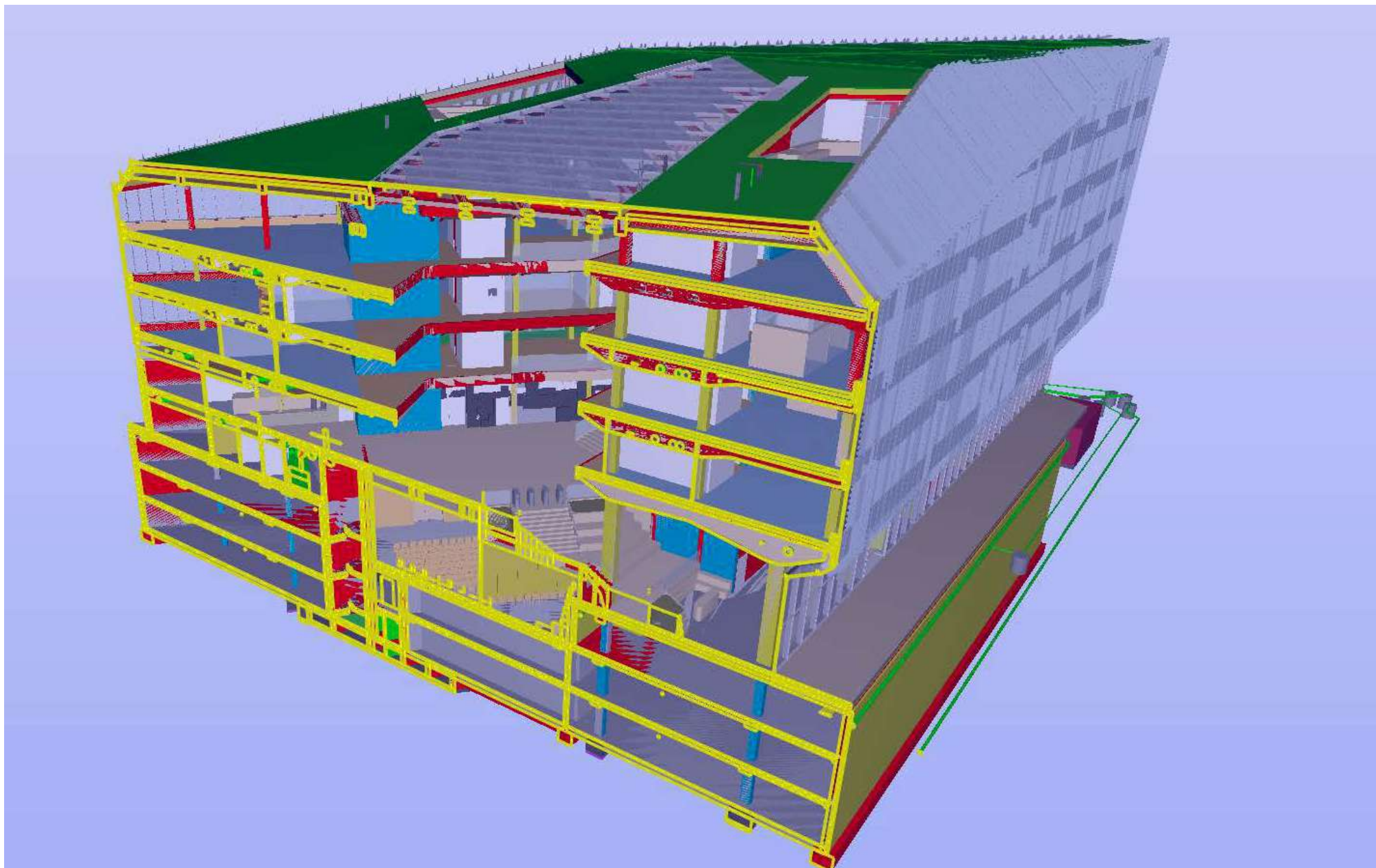
ERECTION PROCESS OF BUILDING

07.07.2017
Week: 54

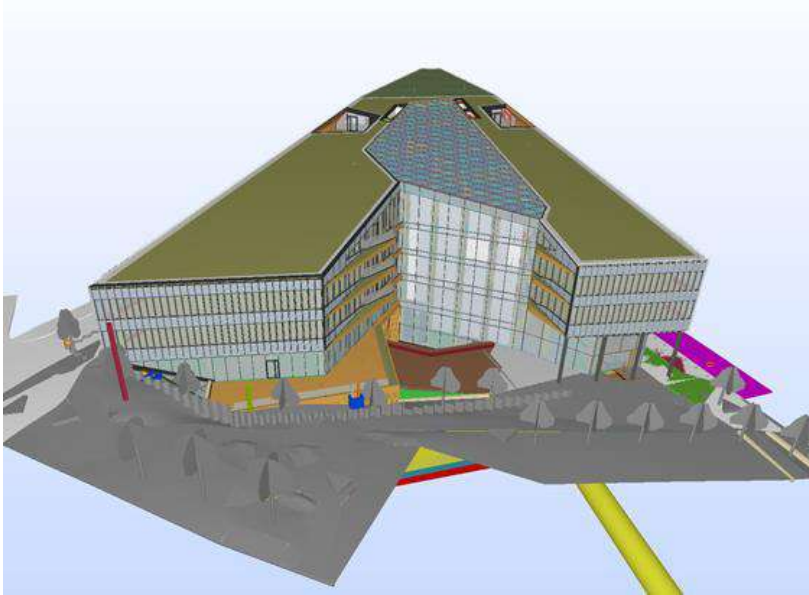


Finansparken
Block Berge

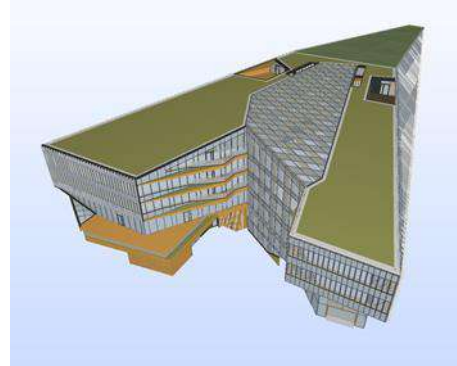
COLLABORATION IN BIM



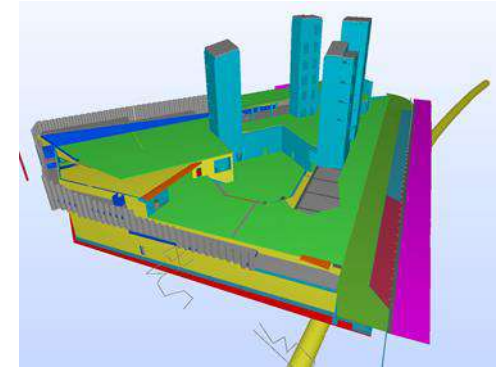
Multidisciplinary project BIM



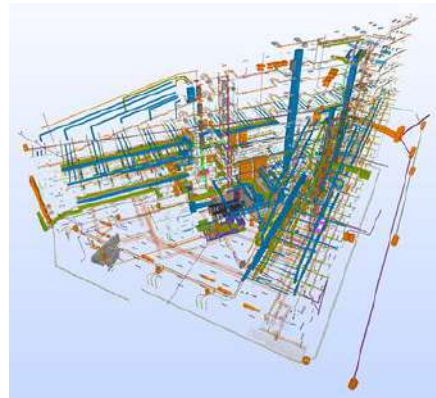
COORDINATION MODEL



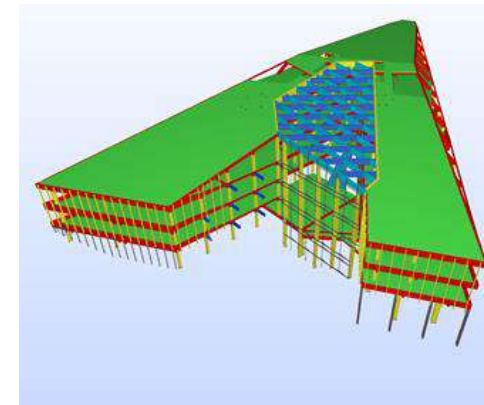
ARK + ARK fasade



RIB Betong



RIV+RIE



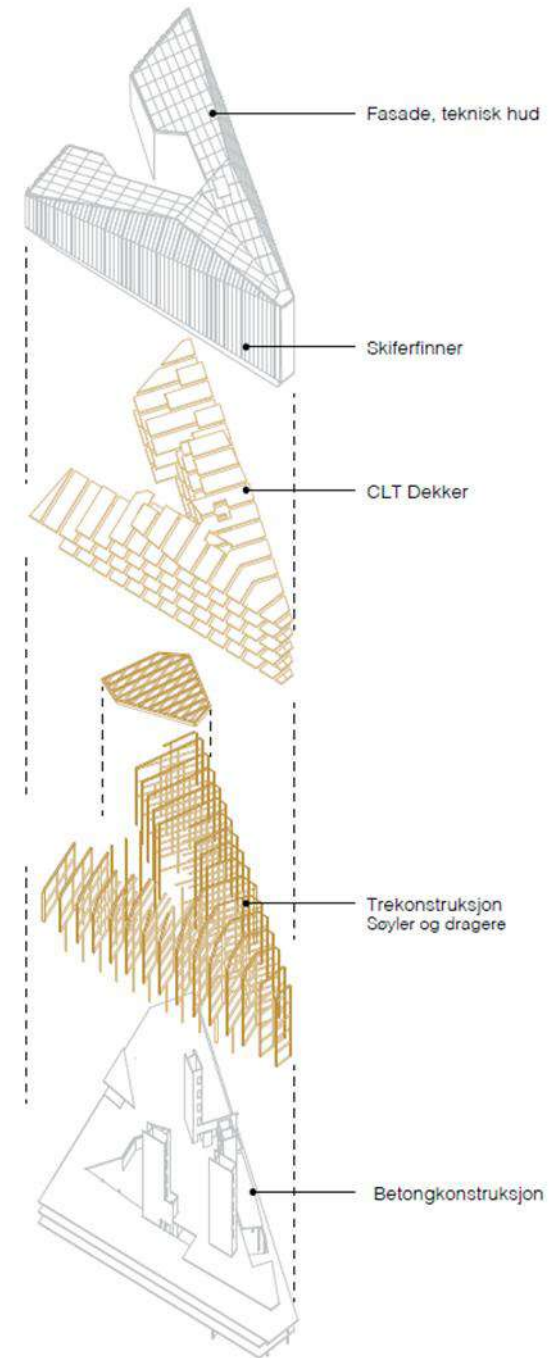
RIB Tre

DISCIPLINE MODELS

MAIN PRINCIPLES

Main principles

- Structural system with massive timber elements from level 01 upwards
- Reinforced concrete for underground levels and communication cores
- Modern timber engineering products: CLT, LVL made of spruce and beech, Glulam: High resistance, strict fabrication tolerances and well defined fire behaviour
- Connections made by direct contact timber-timber
- Users to experience wood construction

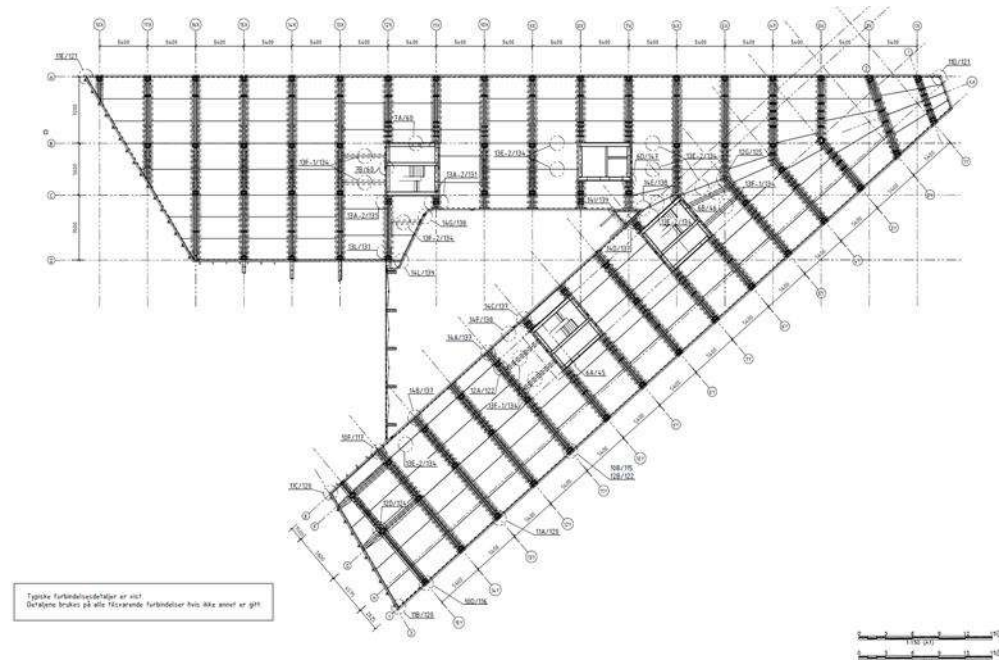
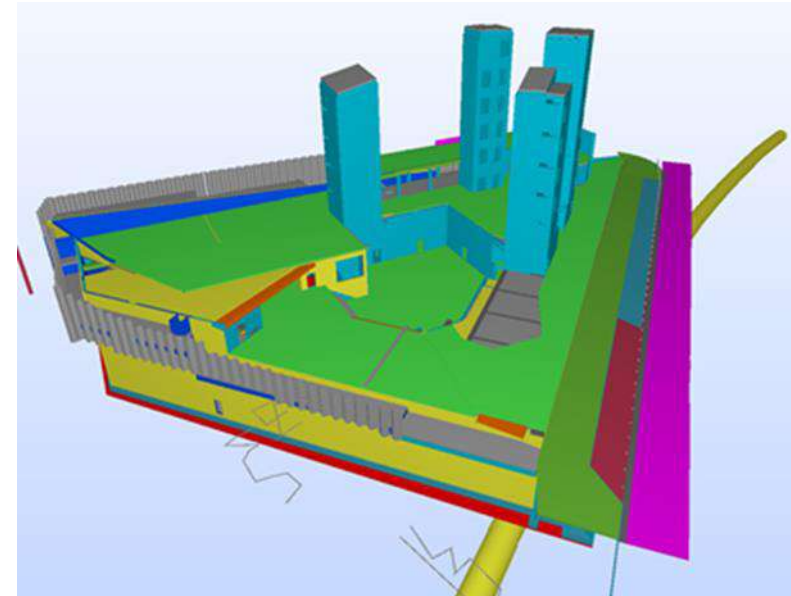


Eksploderte aksonometri av konstruksjonselementer

OVERALL STABILITY

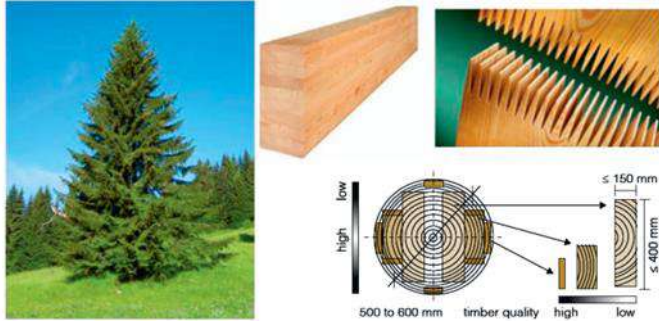
Overall stability and Horizontal stiffness

- The three basement levels are of reinforced concrete and from ground level four services and communication cores extend up to roof level also in reinforced concrete. These elements provide the overall lateral stability to the structure. Horizontal loads are transferred to these cores via the diaphragm action of 200mm CLT timber floor slabs.



MODERN TIMBER PRODUCTS

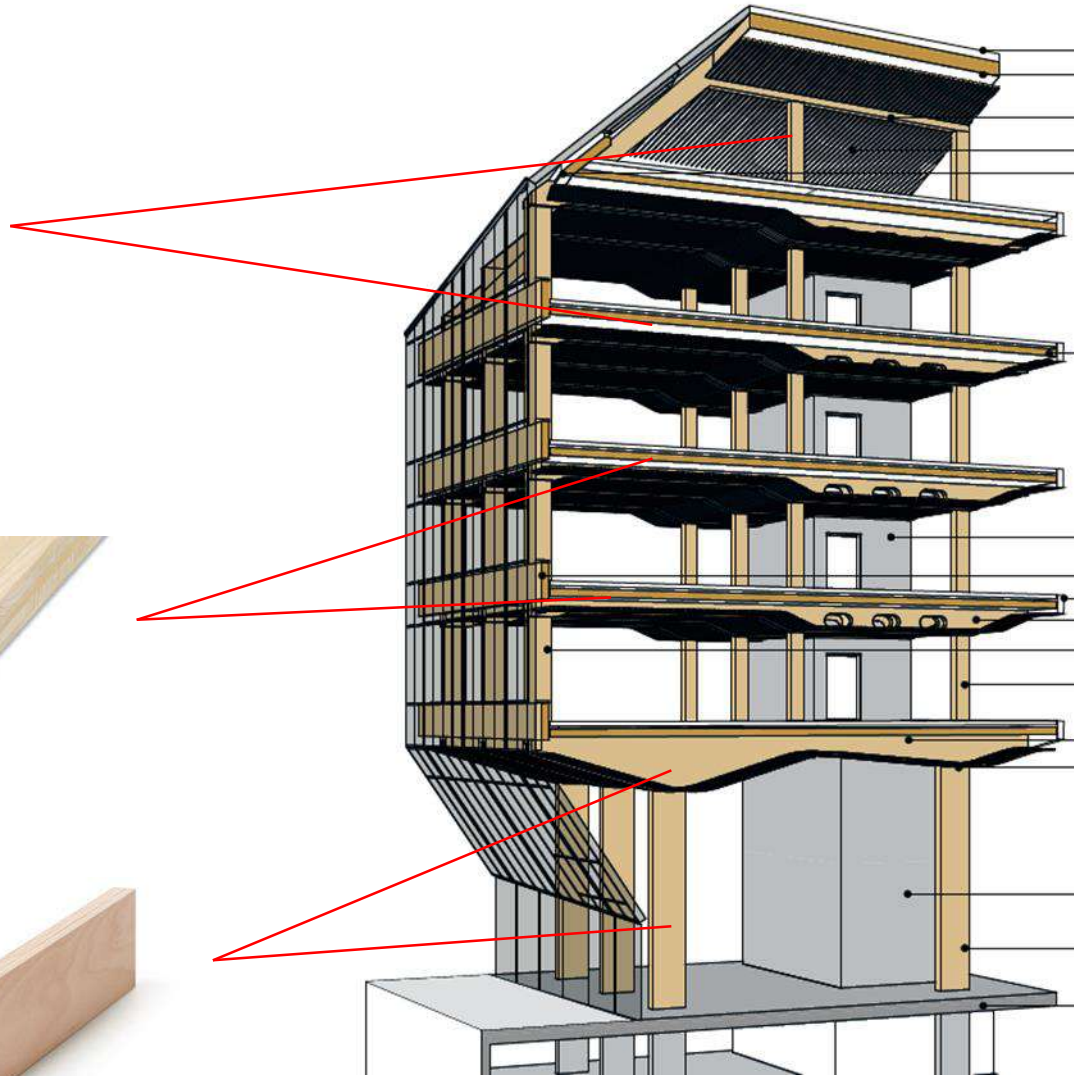
- Glulam made from Spruce



- CLT panels, made of Spruce



- LVL made of Beech - Baubuche



MODERN TIMBER PRODUCTS

Glulam , made of spruce GL30c

Table 5 — Characteristic strength and stiffness properties an N/mm² and densities in kg/m³ for homogeneous glulam

Property	Symbol	Glulam strength class						
		GL 20h	GL 22h	GL 24h	GL 26h	GL 28h	GL 30h	GL 32h
Bending strength	$f_{m,g,k}$	20	22	24	26	28	30	32
Tensile strength	$f_{t,g,k}$	16	17,6	19,2	20,8	22,3	24	25,6
Compression strength	$f_{c,g,k}$	0,5						
	$f_{c,90,g,k}$	2,5						
	$f_{c,90,g,k}$	20	22	24	26	28	30	32
Shear strength (shear and torsion)	$f_{v,g,k}$	3,5						
Rolling shear strength	$f_{r,g,k}$	1,2						
Modulus of elasticity	$E_{0,g,mean}$	8 400	10 500	11 500	12 100	12 600	13 600	14 200
	$E_{0,g,05}$	7 000	8 800	9 600	10 100	10 500	11 300	11 800
	$E_{90,g,mean}$	300						
	$E_{90,g,05}$	250						
Shear modulus	$G_{g,mean}$	650						
	$G_{g,05}$	540						
Rolling shear modulus	$G_{r,g,mean}$	65						
	$G_{r,g,05}$	54						
Density	$\rho_{g,k}$	340	370	385	405	425	430	440
	$\rho_{g,mean}$	370	410	420	445	460	480	490



LVL made of beech - Baubuche

Type of load	BauBuche S Laminated veneer lumber Beech LVL with longitudinal layers
Nominal thickness in mm	20 ≤ B ≤ 80
Strength values	
Flatwise bending	
Bending $f_{m,0,k}$	65
Compression $f_{c,90,k}$	10
Shear $f_{v,0,k}$	8
Shear (rolling) $f_{v,k}$	not declared
Edgewise bending	
Bending ^{al} $f_{m,0,k}$	70
Tension to the grain $f_{t,0,k}$	60
Tension ⊥ to the grain $f_{t,90,k}$	1.5
Compression to the grain $f_{c,0,k}$	41.6
Compression ⊥ to the grain $f_{c,90,k}$	14
Shear $f_{v,0,k}$	8
Stiffness values	
Modulus of elasticity $E_{0,mean}$	16,800
Modulus of elasticity $E_{0,05}$	14,900
Modulus of elasticity $E_{90,mean}$	470
Shear modulus, edgewise G_{mean}	760
Shear modulus, flatwise G_{mean}	850
Density ρ_k	680



CLT, made of spruce C24

MECHANICAL STRENGTH	VERIFICATION PROCEDURE	NUMERICAL VALUE
Load applied parallel to facing grain		
Modulus of elasticity		
— Parallel to the direction of the panel grain $E_{0,mean}$	$E_{0,mean}$ Annex 4, CUAP 03.04/06, 4.1.1.1	12,000 MPa
— Normal to the direction of the panel grain $E_{90,mean}$	EN 338	370 MPa
Shear modulus		
— Parallel to the direction of the panel grain G_{mean}	EN 338	690 MPa
— Normal to the direction of the panel grain, Roll shear module $G_{R,mean}$	CUAP 03.04/06, 4.1.1.1	60 MPa
Bend strength		
— Parallel to the direction of the panel grain $f_{m,k}$	$W_{0.05}$ Annex 4, CUAP 03.04/06, 4.1.1.1	24 MPa
Tensile strength		
— Normal to the direction of the panel grain $f_{t,90,k}$	EN 1194, reduced	0.12 MPa
Compressive strength		
— Normal to the direction of the panel grain $f_{c,90,k}$	EN 1194	2.7 MPa
Shear strength		
— Parallel to the direction of the panel grain $f_{v,k}$	EN 1194	2.7 MPa
— Normal to the direction of the panel grain (Roll shear strength) $f_{v,R,k}$	$A_{0.05}$ Annex 4, CUAP 03.04/06, 4.1.1.3	1.5 MPa
Load applied in the plane of facing grain		
Modulus of elasticity		
— Parallel to the direction of the panel grain $E_{0,mean}$	$A_{0.05}$ Inet, Annex 4, CUAP 03.04/06, 4.1.2.1	12,000 MPa
Shear modulus		
— Parallel to the direction of the panel grain G_{mean}	$A_{0.05}$ Annex 4, CUAP 03.04/06, 4.1.2.3	250 MPa
Bend strength		
— Parallel to the direction of the panel grain $f_{m,k}$	$W_{0.05}$ Annex 4, CUAP 03.04/06, 4.1.2.1	23 MPa
Tensile strength		
— Parallel to the direction of the panel grain $f_{t,0,k}$	EN 1194	16.5 MPa
Compressive strength		
— Parallel to the direction of the panel grain $f_{c,0,k}$	EN 1194	24 MPa
— Concentrated, parallel to the direction of the panel grain $f_{c,0,k}$	CUAP 03.04/06, 4.1.2.2	30 MPa
Shear strength		
— Parallel to the direction of the panel grain $f_{v,k}$	$A_{0.05}$ Annex 4, CUAP 03.04/06, 4.1.2.3	5.2 MPa



EXPOSED WOOD SURFACES



EXPOSED WOOD SURFACES

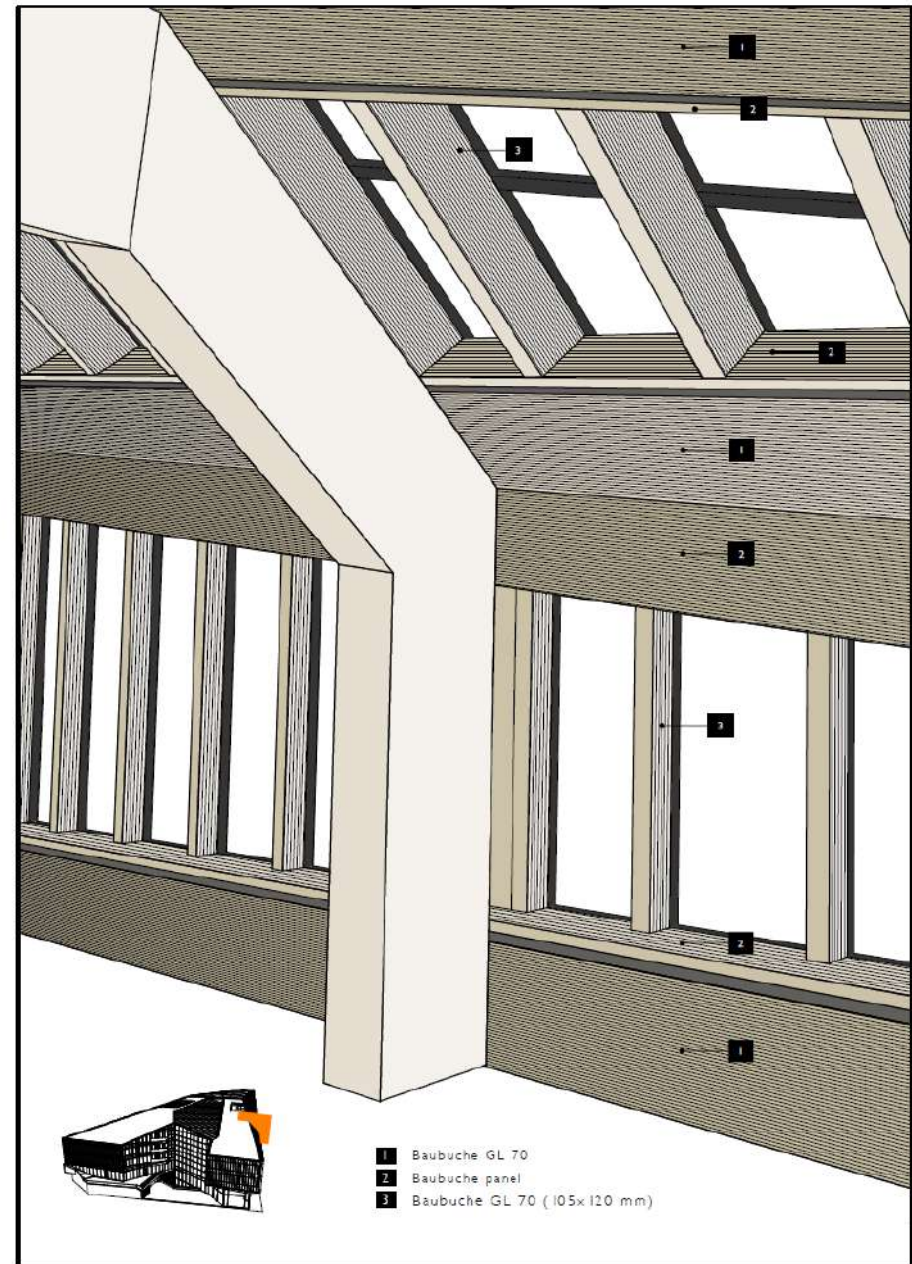
Timber construction: Glulam, LVL , CLT and timber ceiling

Good and healthy working environment



EXPOSED WOOD SURFACES

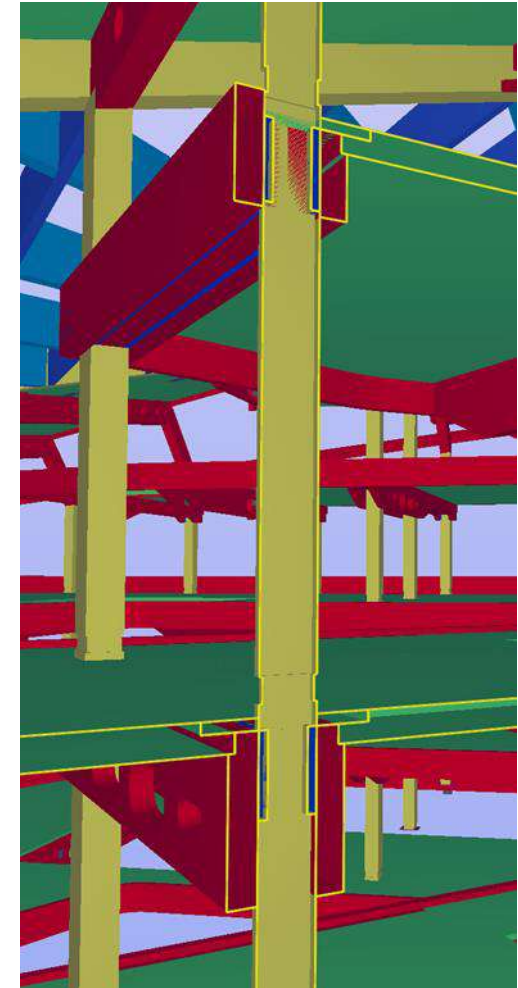
Fibre orientation : Glulam structure
Baubuche façade , ceiling



TIMBER CONNECTIONS

Timber Structure: Connections timber direct contact

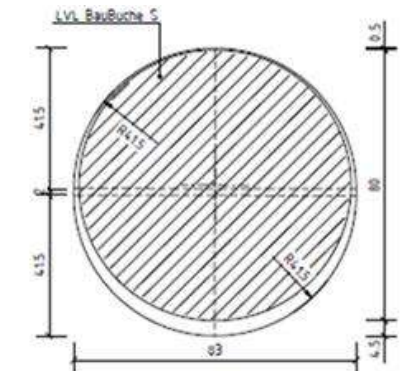
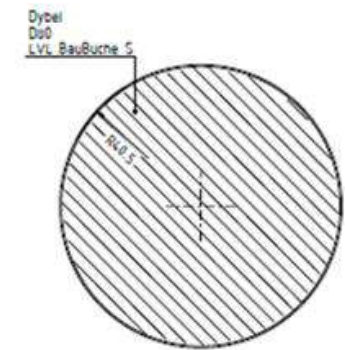
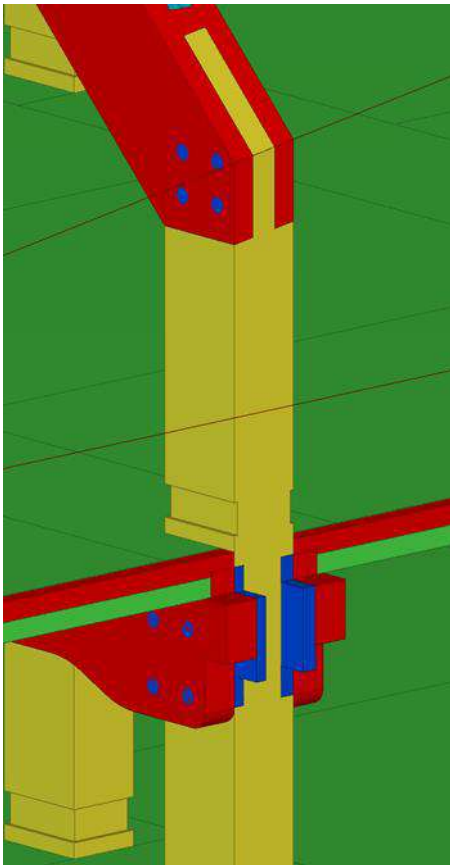
- Use of LVL beech (Baubuche) glued insertions in beams
- Cut-out at glulam columns
- Direct bearing from beams insertions to columns
- The fabrication requires high precision



TIMBER CONNECTIONS

Timber Structure: Connections with hardwood dowels

- Different diameter in beams/columns. Dowels safety system
- Holes cannot be done on site
- The model requires high precision



TIMBER CONNECTIONS

Timber Structure

- Connections with hardwood dowels
- Direct contact

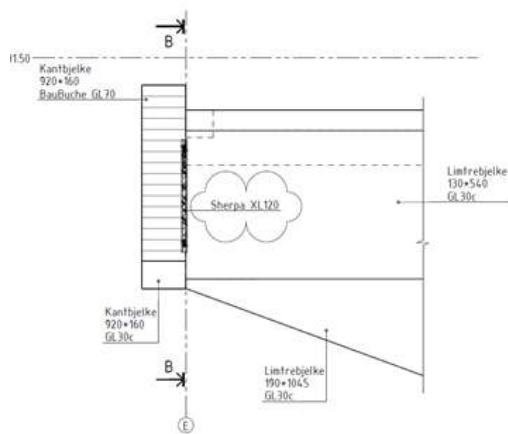


TIMBER CONNECTIONS

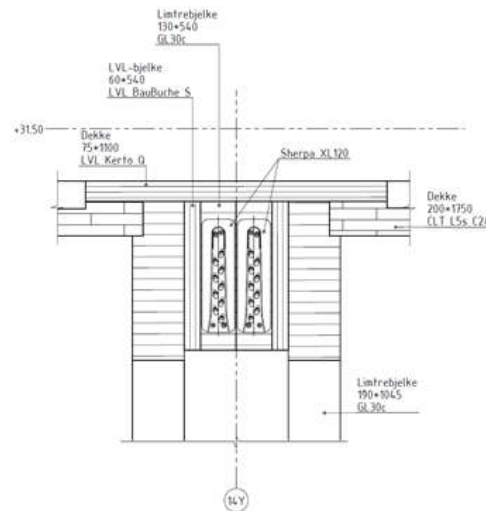
Timber Structure: Use of screws and metal connectors

Only where necessary, due to structural or erection reasons, the following types have been used (not visible):

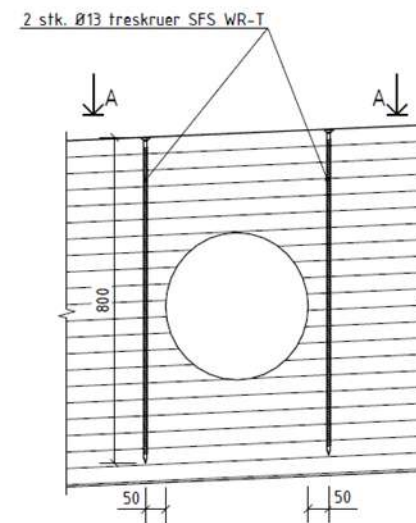
- Self-tapping timber screws
- Proprietary timber connectors – Sherpa
- Threaded steel rods – for reinforcement at openings or notches



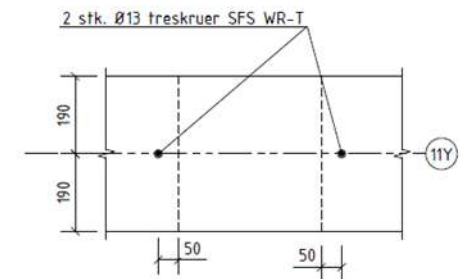
Detalj type 10F



Snitt B - B

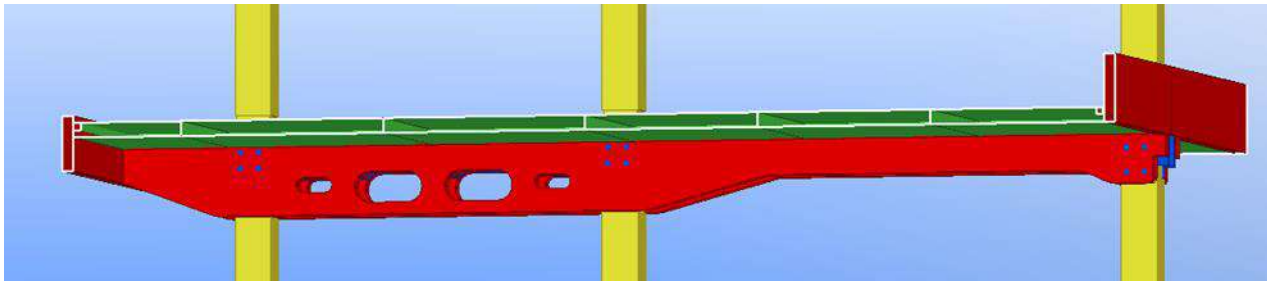


Detalj typisk
A1= 1:10
A3=1:20



Snitt A - A
A1= 1:10
A3=1:20

Direct manufacturing from Tekla model



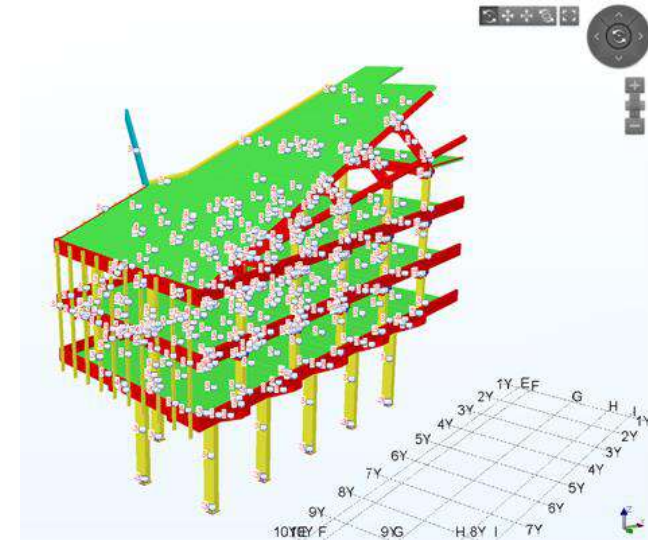
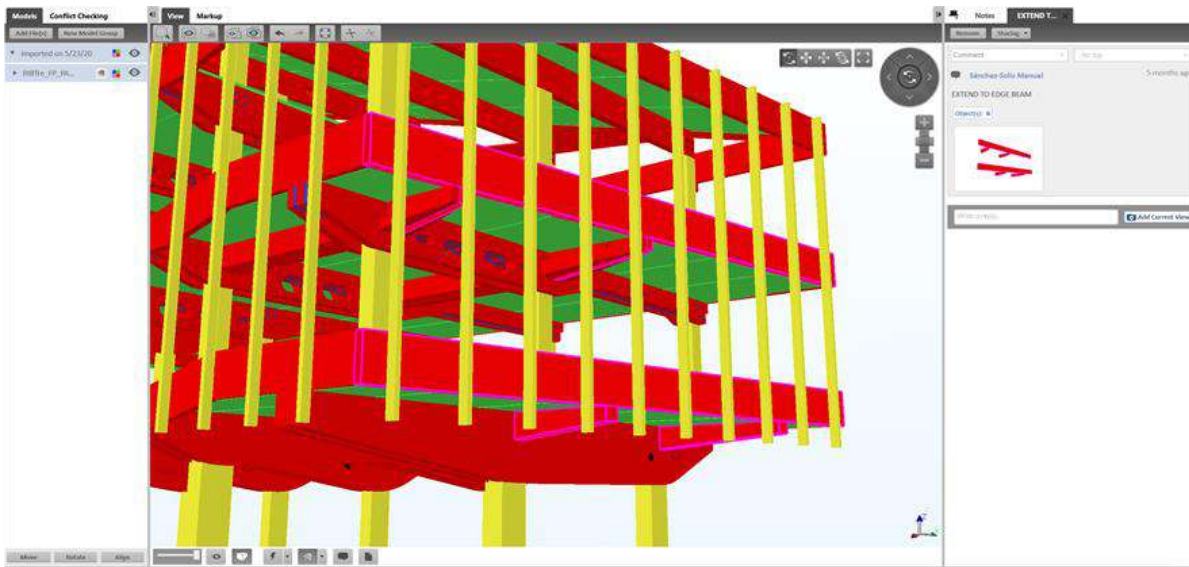
MINIMIZE DRAWING PRODUCTION

- No form drawings
- Shape of the elements from 3D model
- Drawings only show details
- [Glulam beam into CNC machine](#)



QUALITY CONTROL BIM

Control of the submitted information with Tekla BIMsight



FIRE BEHAVIOUR

Timber Structure: Fire behaviour RF 90 min

- Char layer
- Well defined and predicable fire behaviour is an intrinsic property of mass timber elements and all the principal structural elements are designed to guarantee a fire bearing resistance of 90 minutes
- Connections protected from fire



Figure 1 : Char layer and virgin wood with full strength.
Source: Treteknisk Institutt

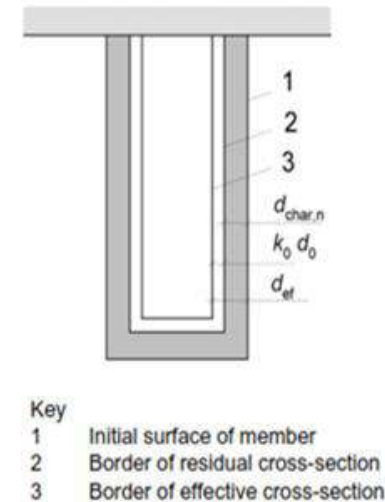
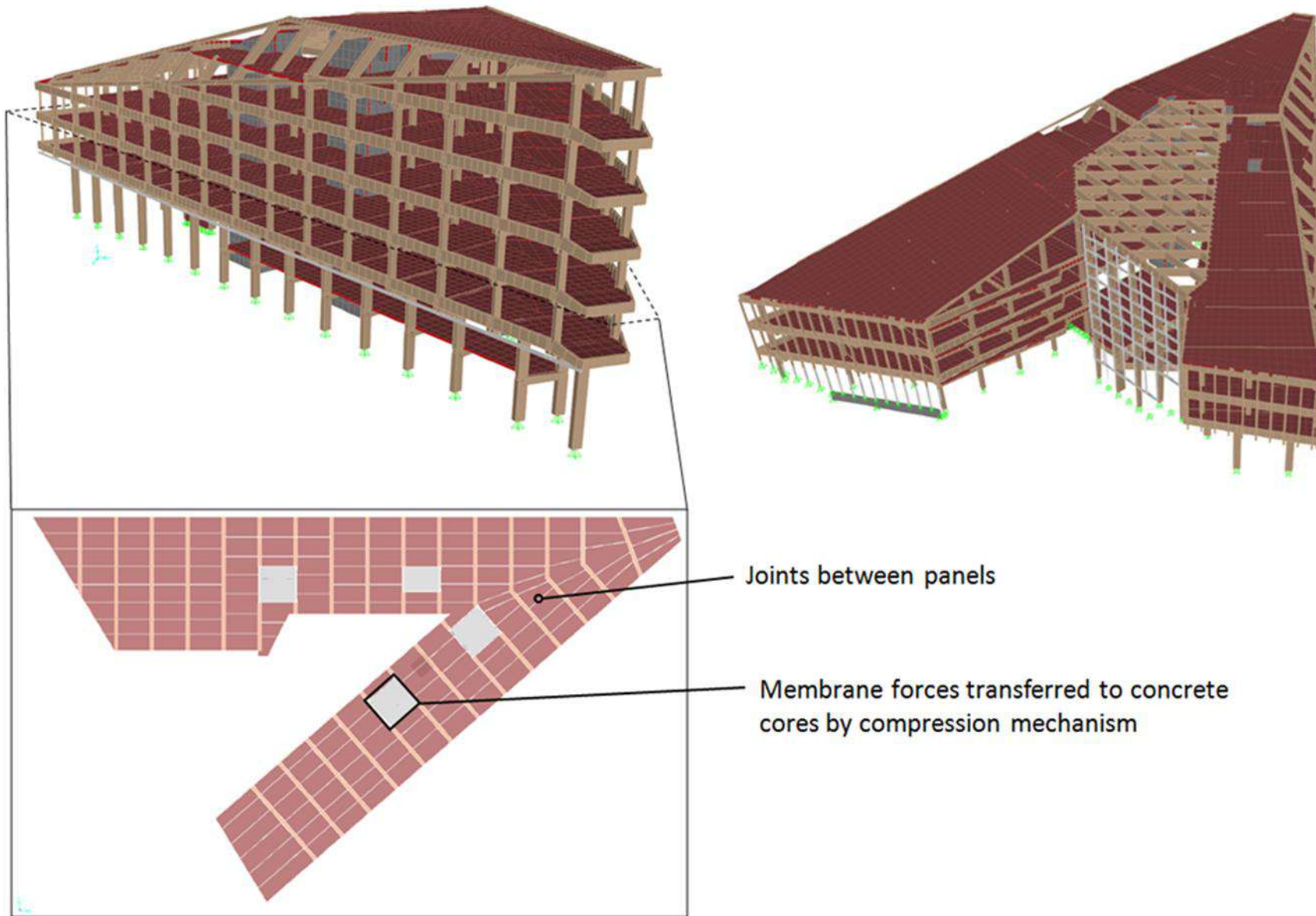


Figure 4.1 — Definition of residual cross-section and effective cross-section

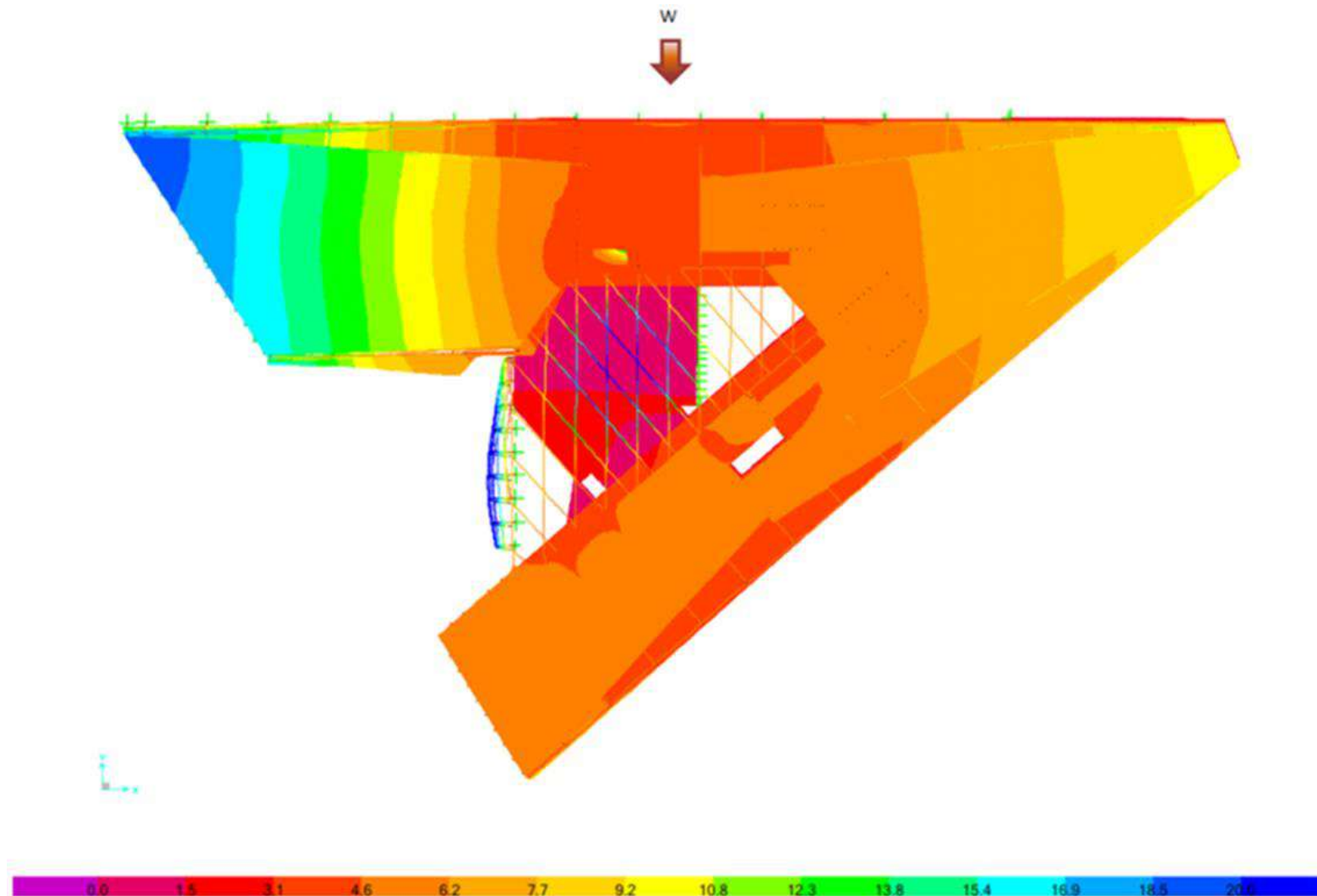
STRUCTURAL ANALYSIS. FEM MODEL



STRUCTURAL ANALYSIS. FEM MODEL

Global results: Deformations

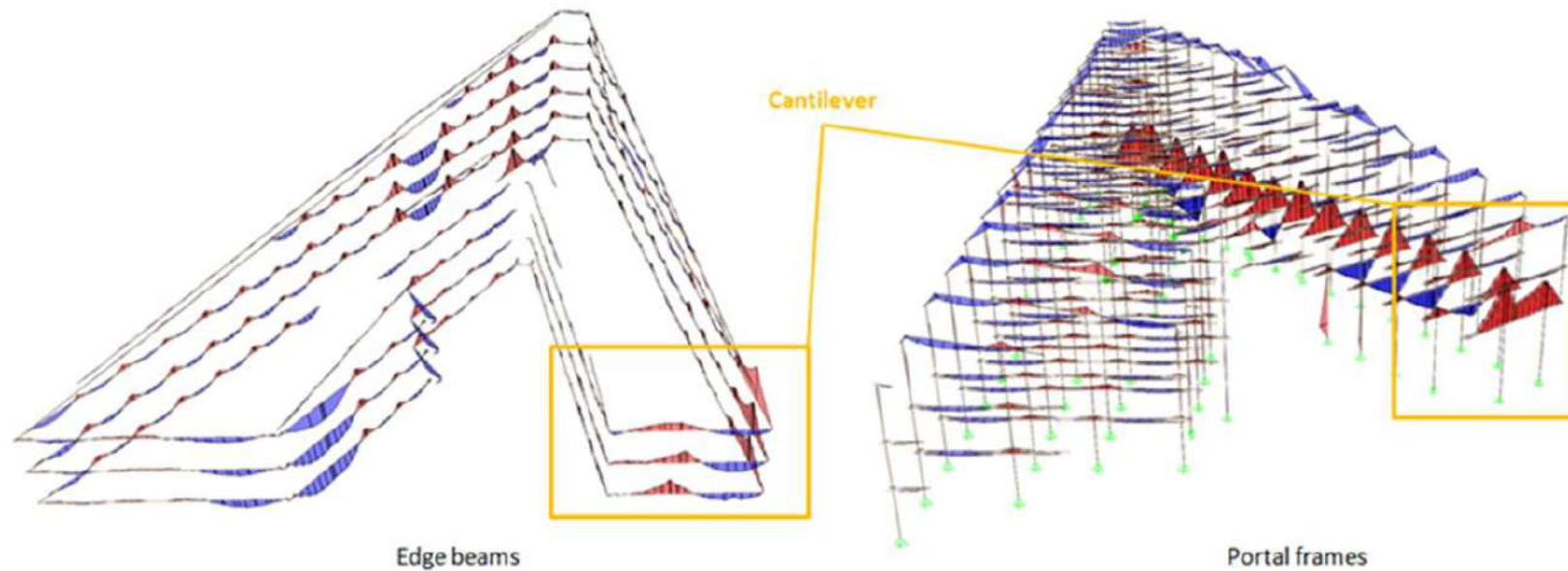
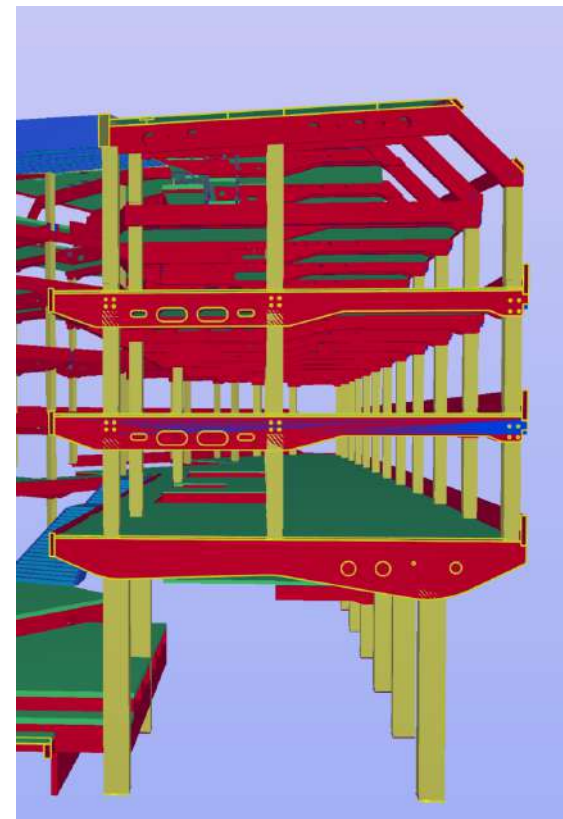
- Horizontal displacements due to wind
- Importance of Roof as a diaphragm



STRUCTURAL ANALYSIS. FEM MODEL

Global results: Forces

- Bending moments
- Large forces at transference beams level 03



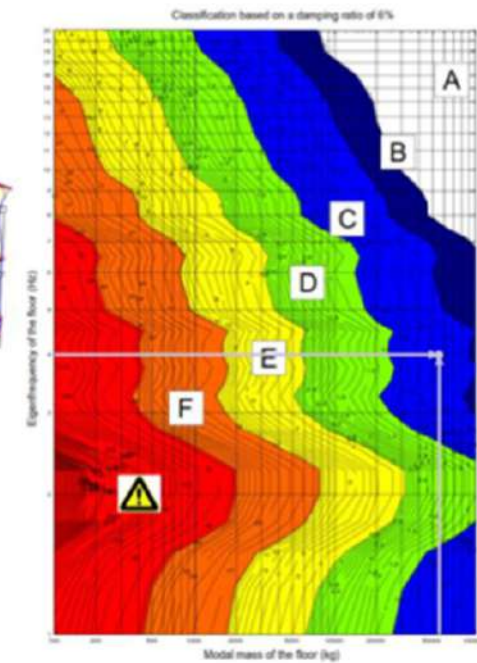
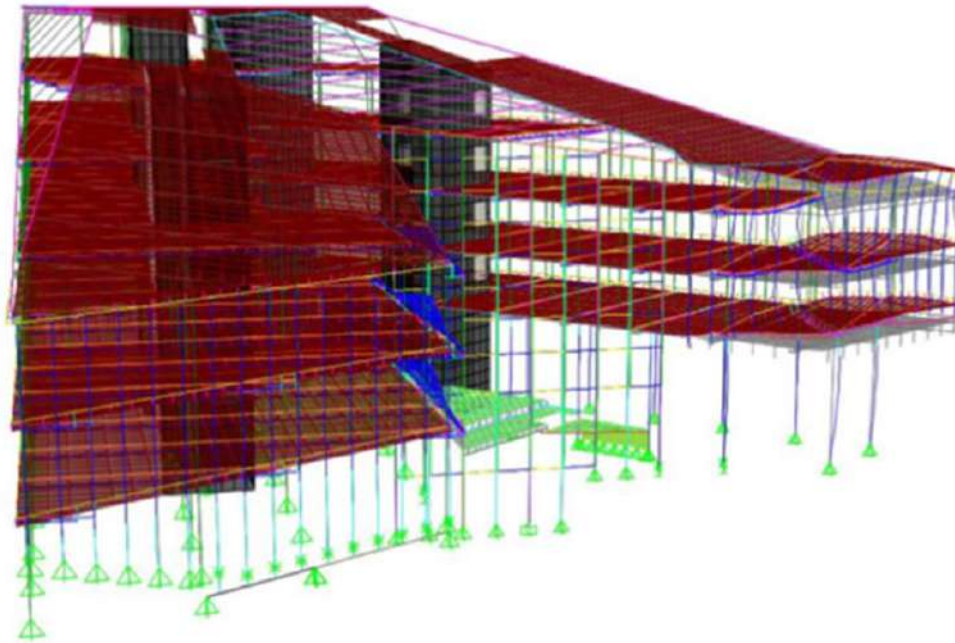
STRUCTURAL ANALYSIS. FEM MODEL

Especial areas:

- Cantilever over entrance at South East
- Deflection & vibration analysis



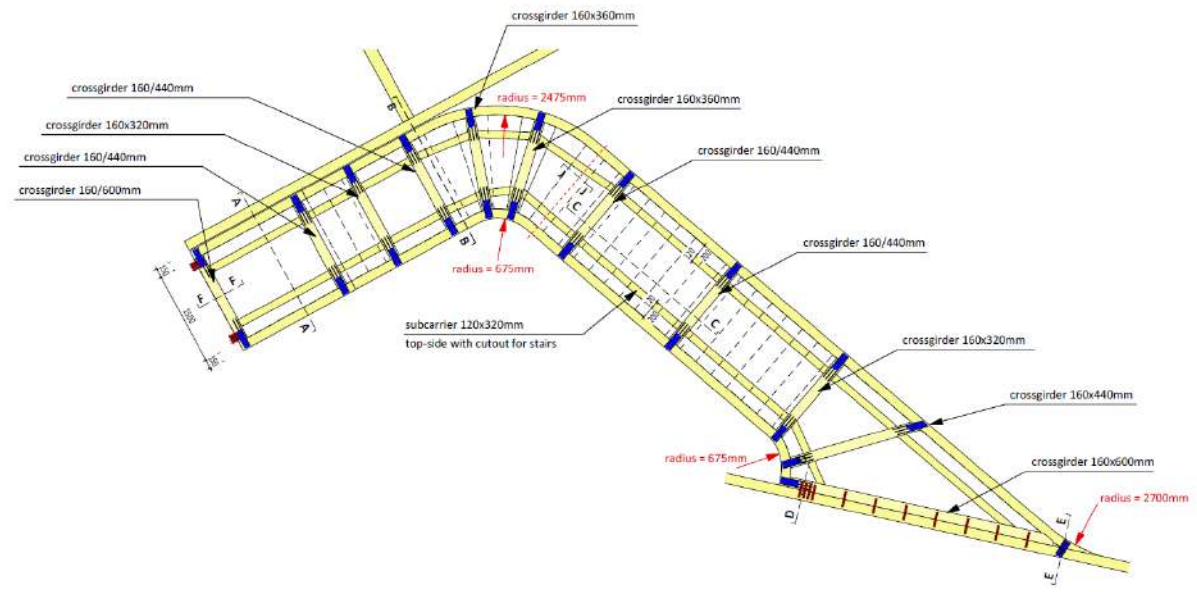
Mode 58 (3.99 Hz)



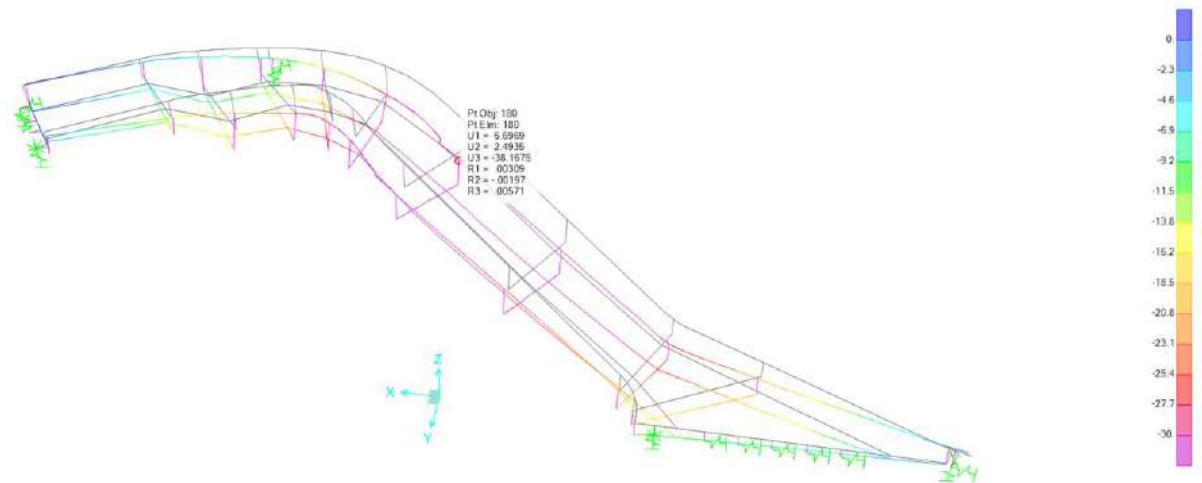
STRUCTURAL ANALYSIS. FEM MODEL

Especial areas:

- Main atrium stairs
- Double curvature beams
- Control of deflections

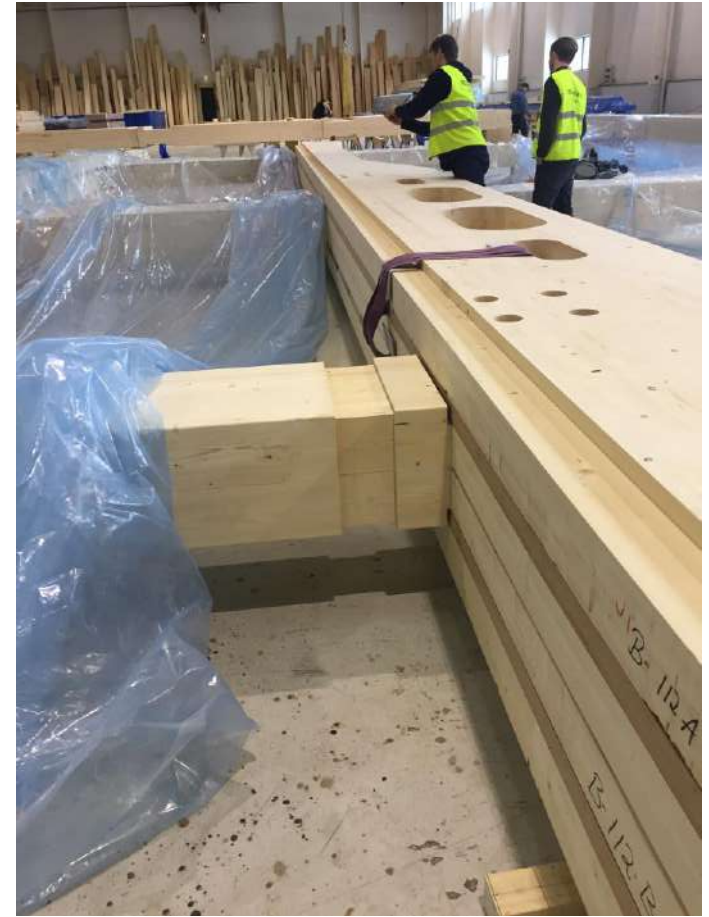


DEFLECTIONS (MAX=36.7mm)



CURRENT SITUATION : TIMBER FABRICATION AND SITE WORKS

- www.finansparken.no
- MOELVEN Limtre



CURRENT SITUATION : TIMBER FABRICATION AND SITE WORKS

- www.finansparken.no
- Site works: Block Berge Bygg





THANK YOU FOR THE ATTENTION

HELEN & HARD + SAAHA + DEGREE OF FREEDOM + MULTICONSULT