

# ARCHITECTURE ORIENTED AND INNOVATIVE ENGINEERING

Konferanse for trearkitektur

AHO

13.11.2019



**GAUTE MO**

PARTNER / DIRECTOR

## EXPERIENCE

- 16 years of experience within buildings, bridges and special structures
- NTNU (Trondheim), Aadnesen (Oslo), UTP (Panama City), Price & Myers (London), Santiago Calatrava (Valencia)
- Designer's Representative for the Samuel Beckett bridge awarded "Engineering Project of the Year" in 2010 by Engineers Ireland
- In 2012 awarded the "John Henry Garrood King Medal" from the Institute of Civil Engineers in London for the best article of the year within bridges, tunnels and geotechnics
- Founded Degree of Freedom in 2009

## EDUCATION

- |           |   |
|-----------|---|
| 2017      | RIF-approved adviser Civil structural engineering |
| 2007      | The Spanish Education Department. Civil engineer, |
| 1998-2003 | NTNU, Civil engineer, Structural engineering      |
| 2002      | UPV, Valencia, Erasmus Exchange Program           |

# DEGREE OF FREEDOM

- An architecture oriented, international and flexible structural engineering firm
- Offices in Oslo, Valencia and Athens
- Work across borders both physically and mentally
- Experts in steel bridges and structures, timber constructions, complex geometries and erection
- Focus on sustainable solutions
- Core team worked together for Santiago Calatrava in Valencia on structures around the world



PHOTO: SINDRE ELLINGSEN



D E G R E E   O F   F R E E D O M  
P R O J E C T S



STAVANGER, NORWAY

# SR-BANK HEADQUARTER

CLIENT:

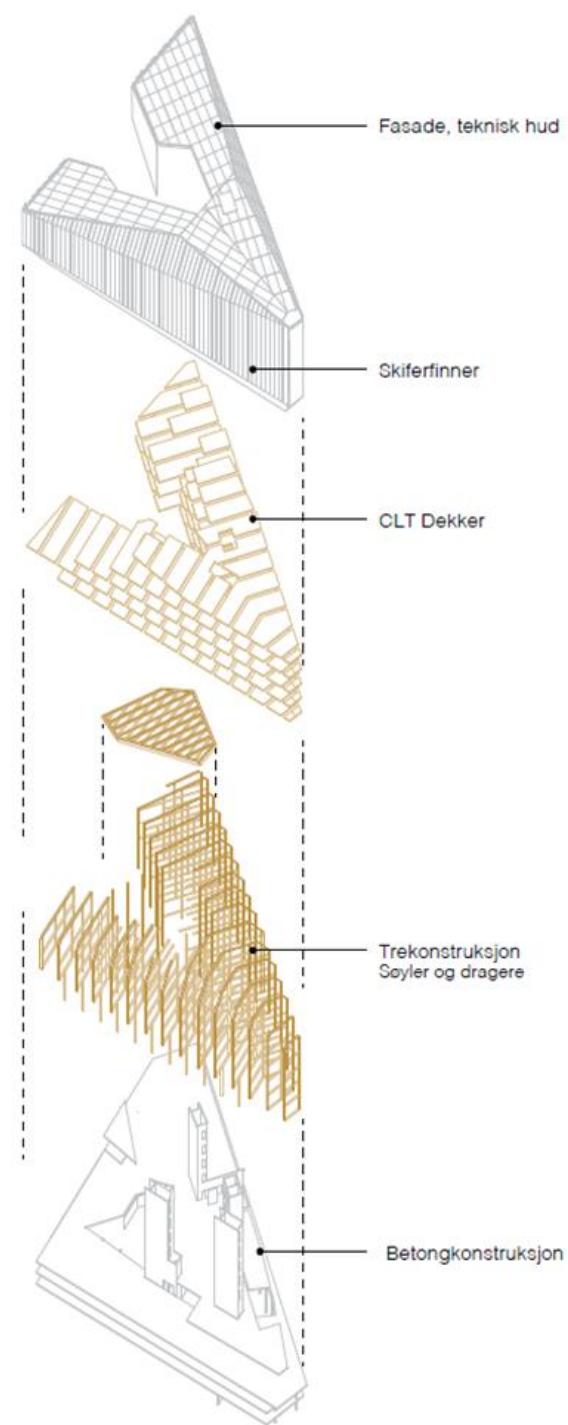
FINANSPARKEN BJERGSTED (SR-BANK)  
/ VEIDEKKE

TIMELINE:

2014-2019

PARTNERS:

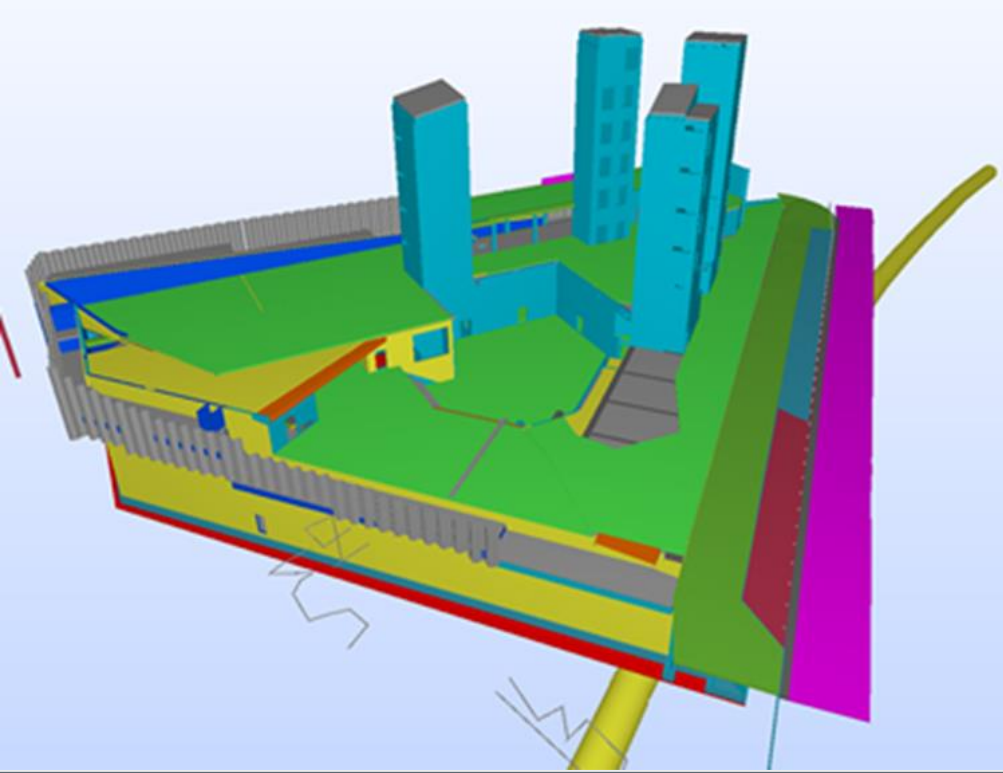
HELEN & HARD, SAAHA, CREATION  
HOLZ, SMI, IARK, KRAFTVÆRK,  
RAMBØLL, LANDSKAPSFABRIKKEN,  
MULTICONSULT



# MASSIVE TIMBER

## STRUCTURAL DESIGN MAIN PRINCIPLES

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

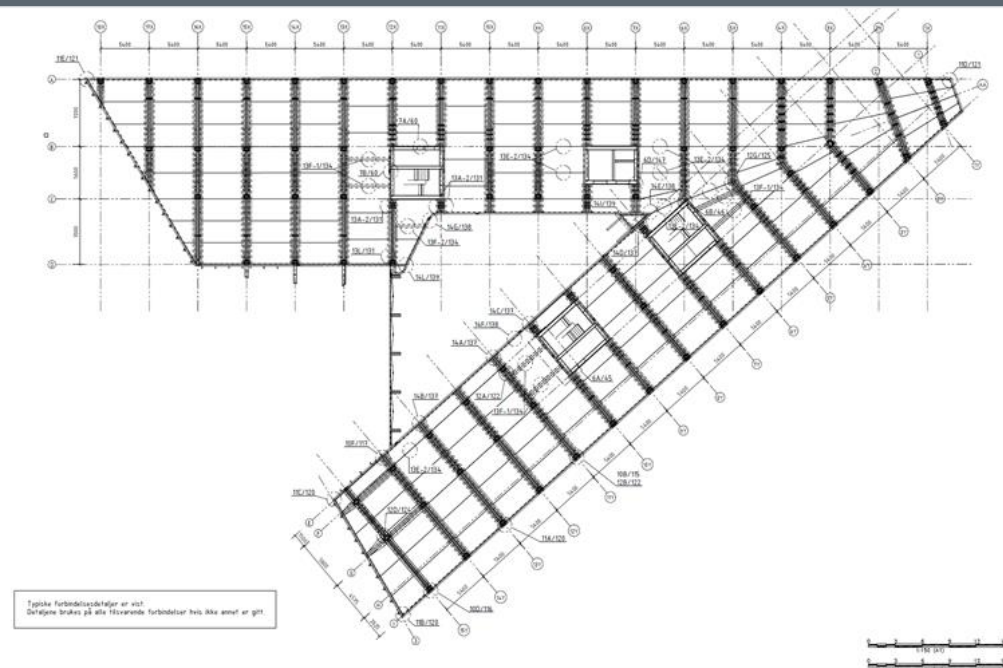


# OVERALL STABILITY AND HORIZONTAL STIFFNESS

The three basement levels are of reinforced concrete, and from ground level four services and communication cores extend up to the roof level also in reinforced concrete.

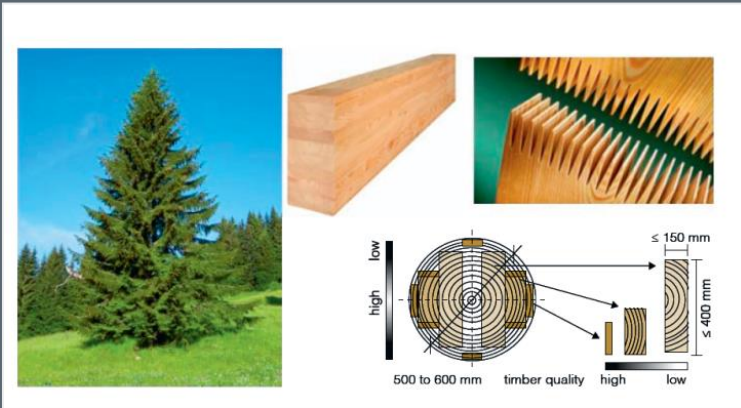
These elements provide the overall lateral stability to the structure.

Horizontal loads are transferred to these cores via the diaphragm action of 200mm CLT timber floor slabs.



# MODERN TIMBER PRODUCTS

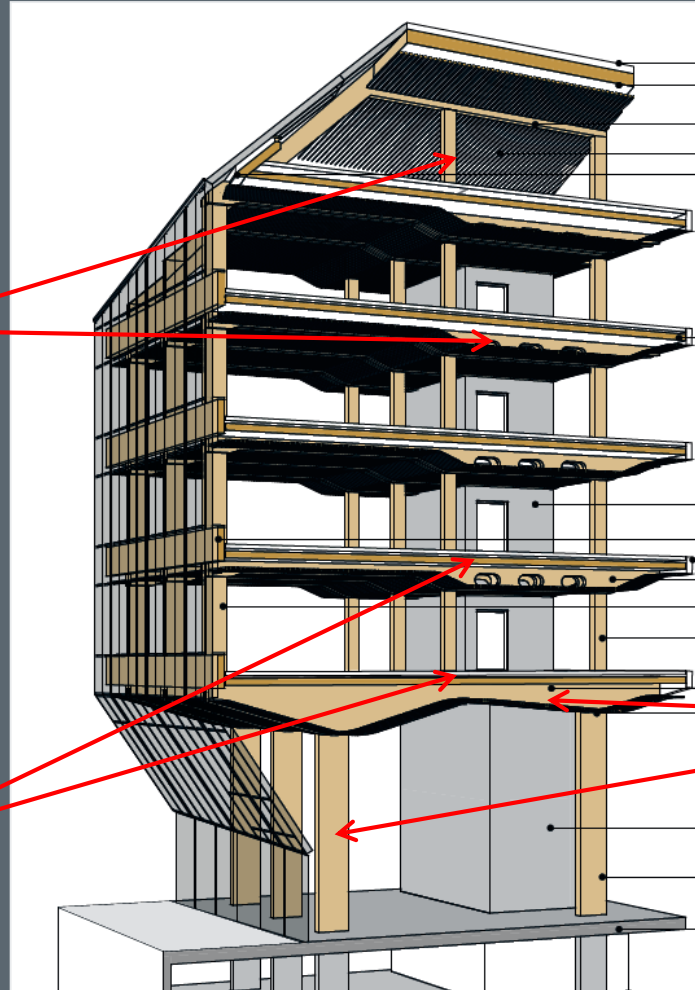
GLULAM MADE FROM SPRUCE



CLT PANELS MADE FROM SPRUCE

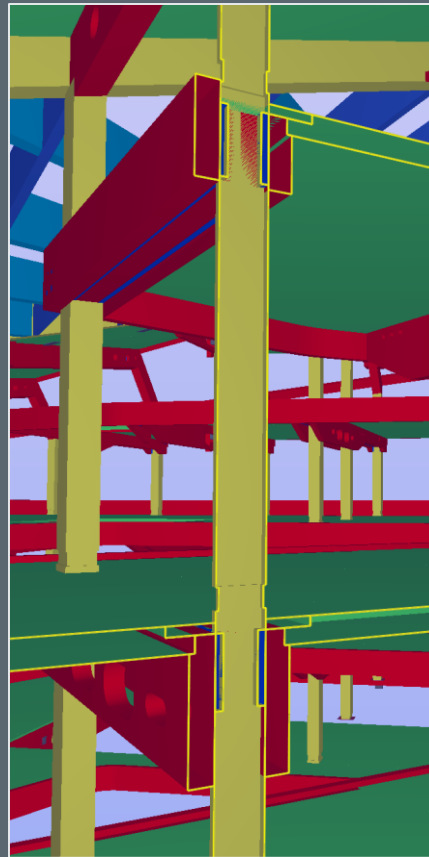


LVL MADE FROM BEECH



# TIMBER STRUCTURE

## CONNECTIONS TIMBER DIRECT CONTACT



Use of LVL beech (Baubuche) glued  
insertions in beams

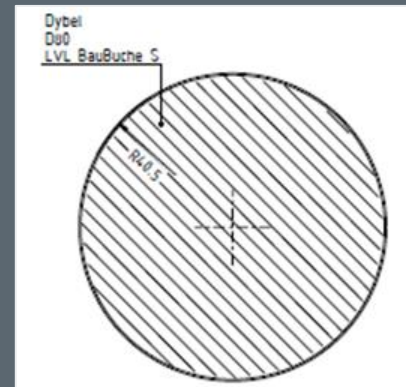
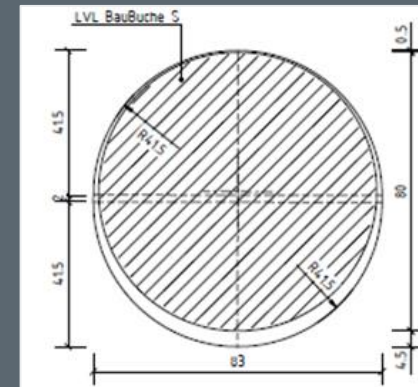
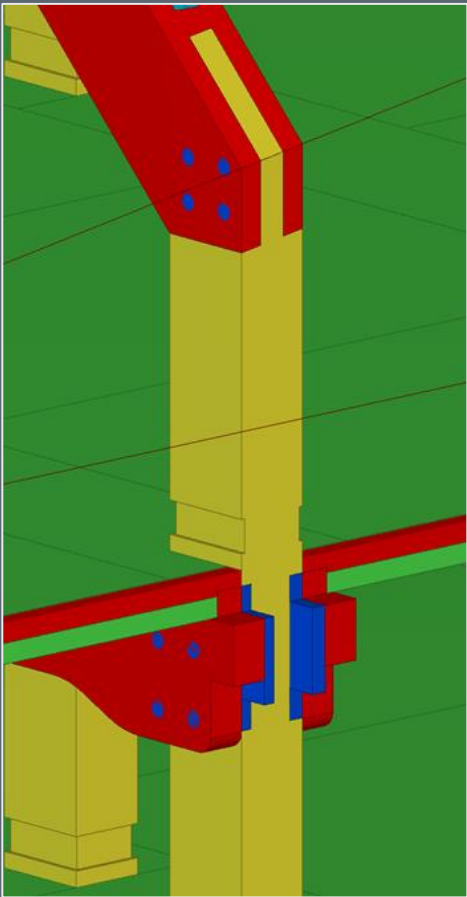
Cut-out at glulam columns

Direct bearing from beams  
insertions to columns

The fabrication requires high  
precision

# TIMBER STRUCTURE

## CONNECTIONS WITH HARDWOOD DOWELS



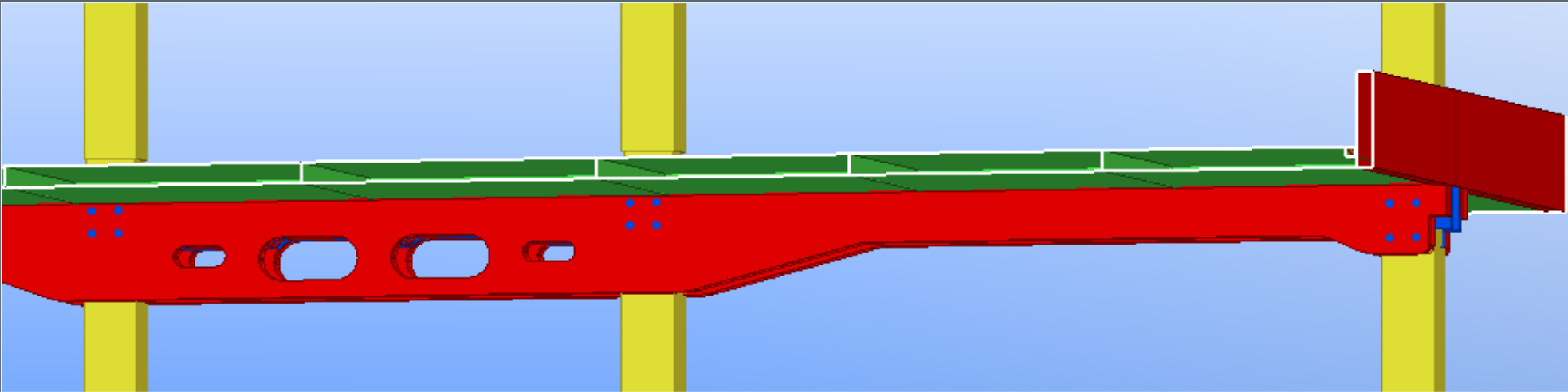
Different diameter in beams/columns

Holes cannot be done on site

The model requires high precision

# DIRECT MANUFACTURING FROM TEKLA MODEL

MINIMIZE DRAWING PRODUCTION



“No” drawings

Glulam beam into CNC machine

Shape of the elements from 3D model

Drawings only show details

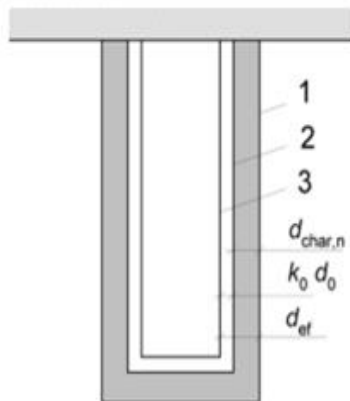


# TIMBER STRUCTURE

FIRE BEHAVIOR RF 90 MIN

Char layer

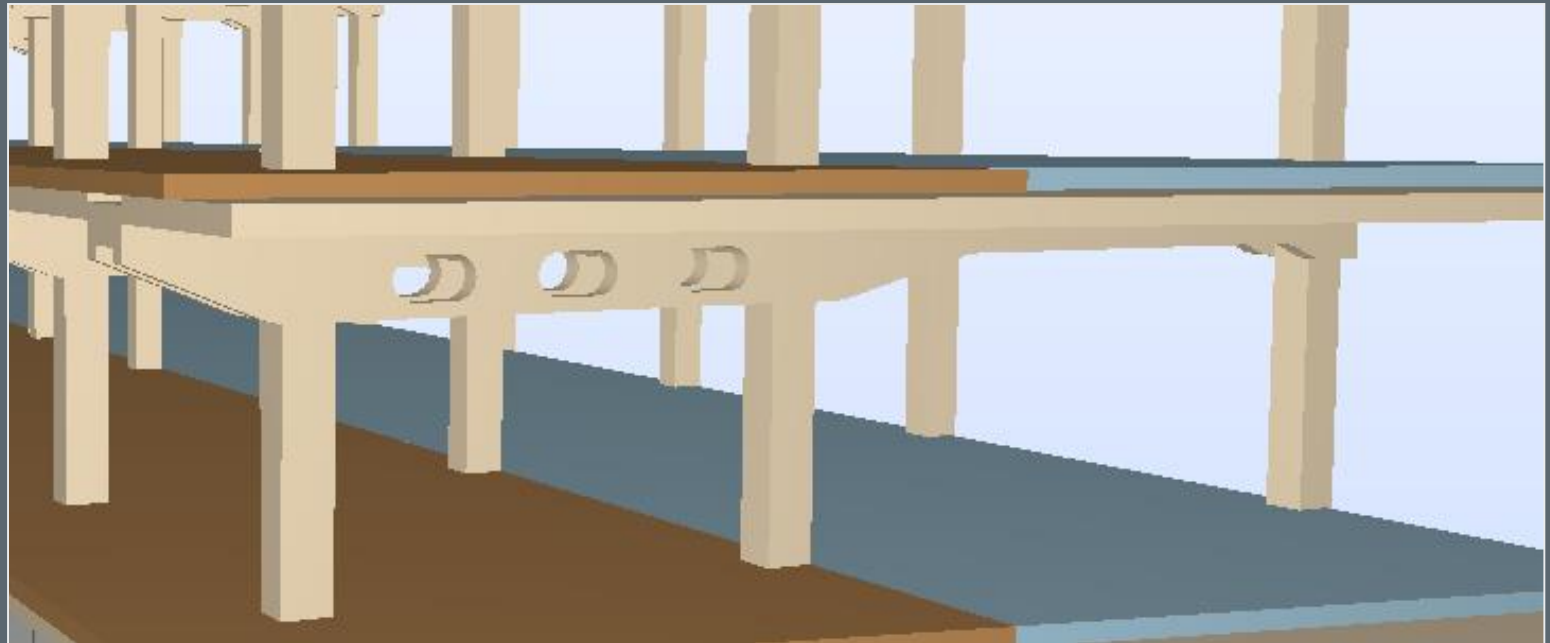
Well defined and predicable fire behavior is an intrinsic property of mass timber elements and all the principal structural elements are designed to guarantee a fire bearing resistance of 90 minutes



Key

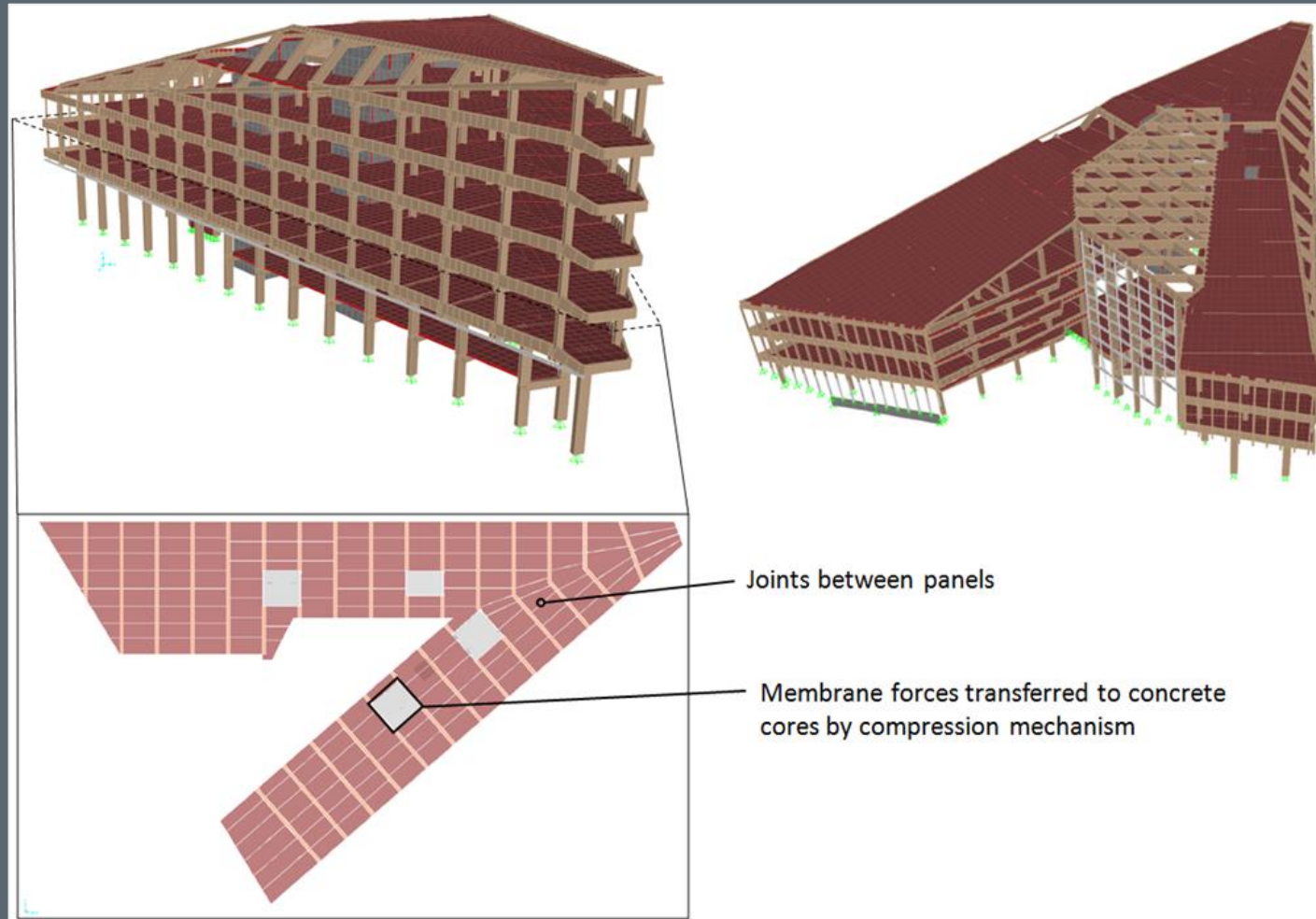
- 1 Initial surface of member
- 2 Border of residual cross-section
- 3 Border of effective cross-section

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



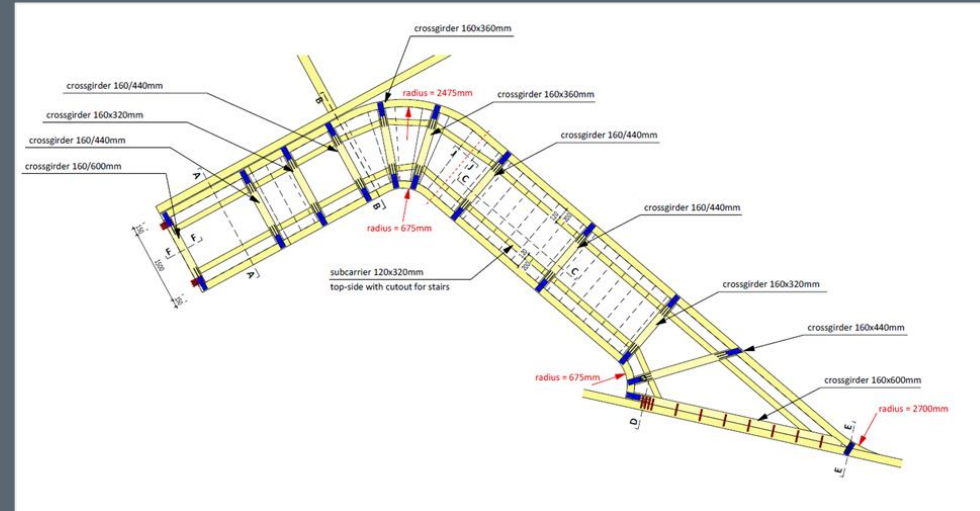
# ANALYSIS AND VERIFICATIONS

## GLOBAL FEM MODEL

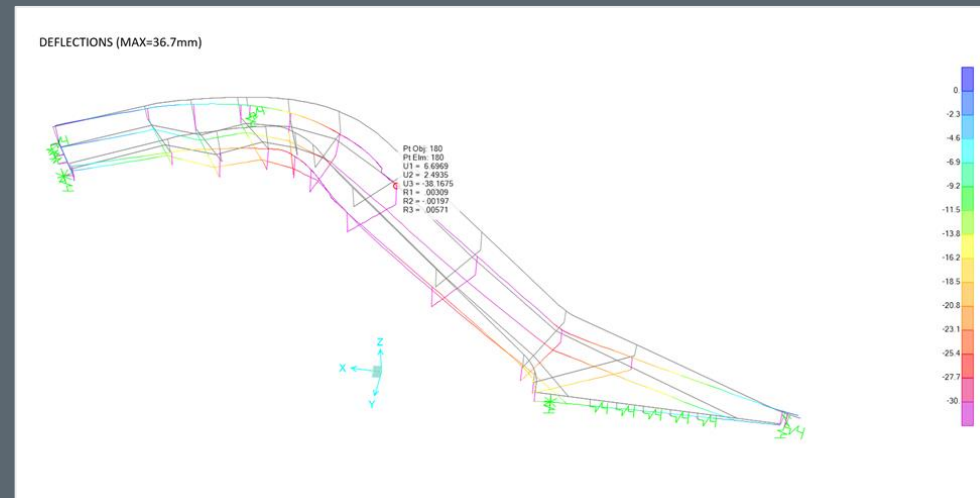


# SPECIAL AREAS DOUBLE CURVATURE STAIRCASE

ATRIUM  
STAIRS



DOUBLE  
CURVATURE  
BEAMS



CONTROL  
OF  
DEFLECTIONS











SAND, NORD-ODAL, NORWAY

# SAMLING

CLIENT:  
NORD-ODAL MUNICIPALITY

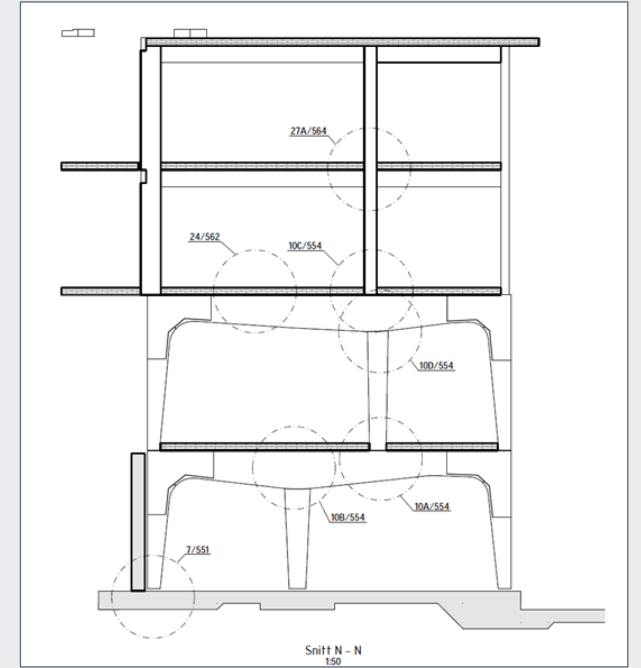
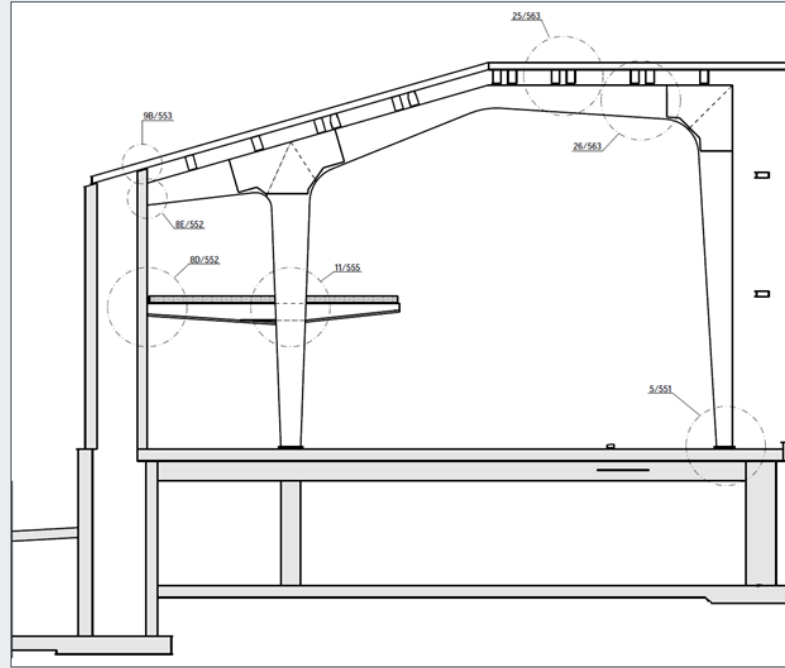
TIMELINE:  
2017- ONGOING

PARTNERS:  
HELEN & HARD, CREATION HOLZ

# SPECIAL SHAPES

RIGID PORTAL FRAMES COMBINED WITH CLT WALLS AND SLABS

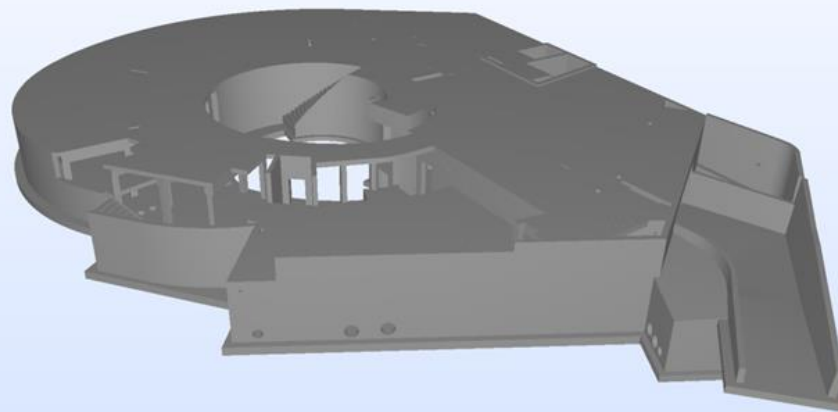
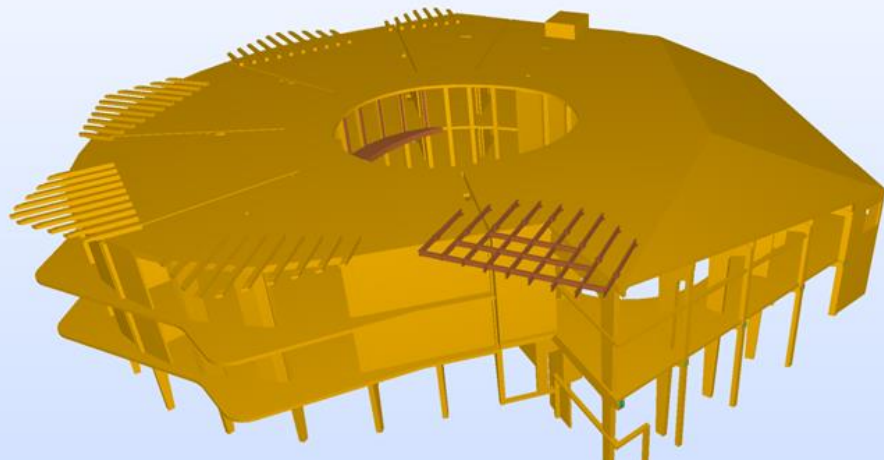
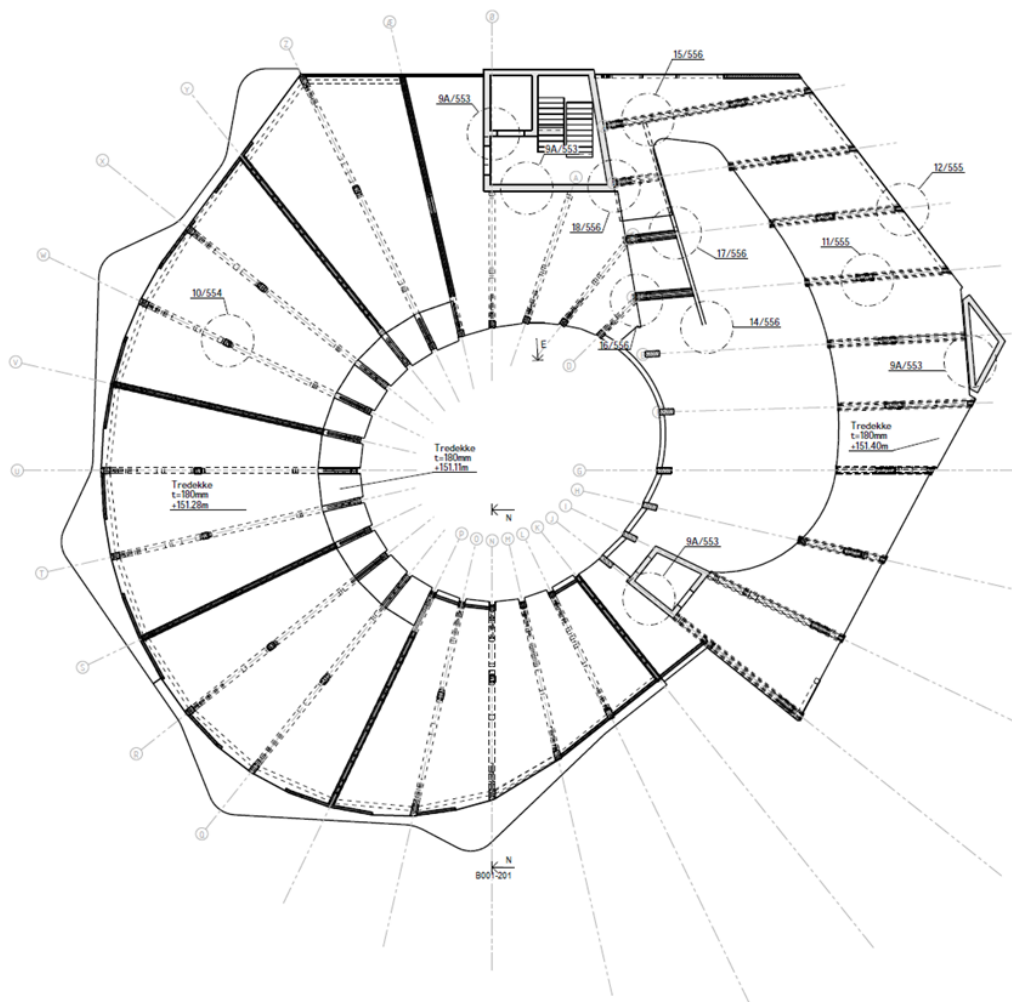
## RIGID PORTAL FRAMES COMBINED WITH CLT WALLS AND SLABS



BILDE: HELEN&HARD

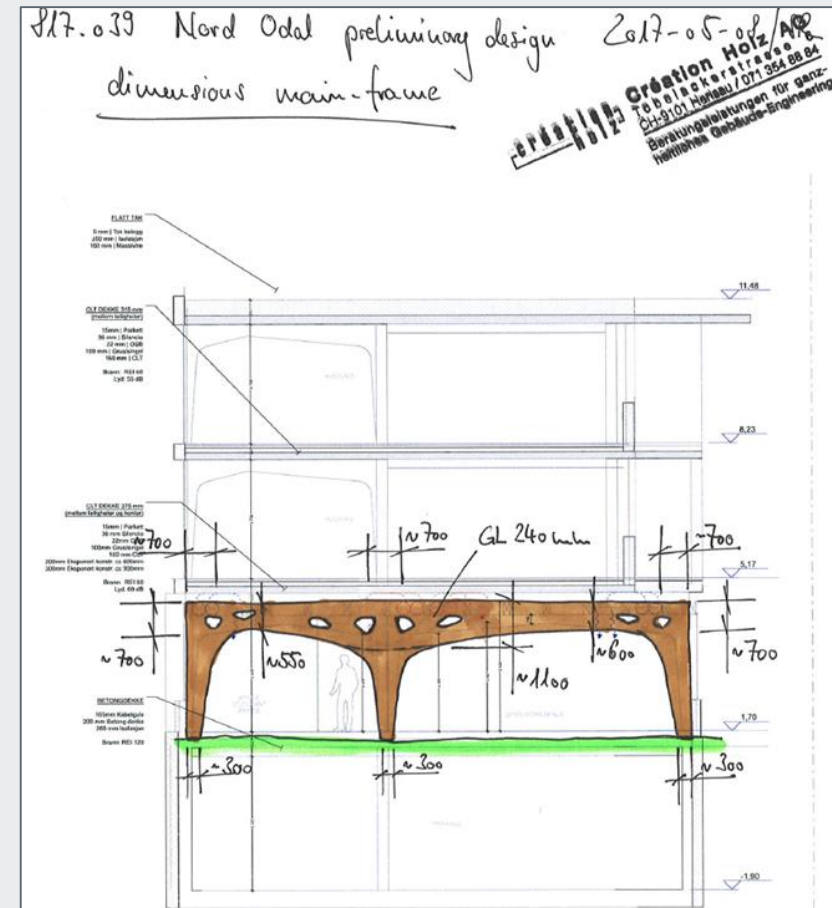
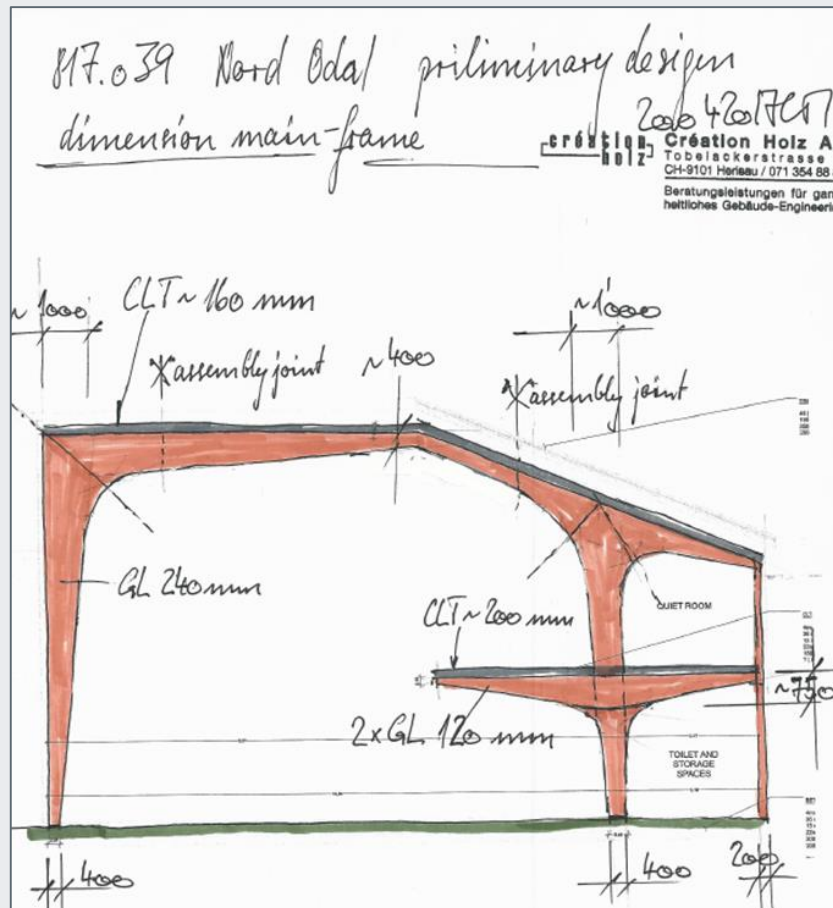
# BIM

## DETAILED MODELS FOR CONCRETE AND TIMBER



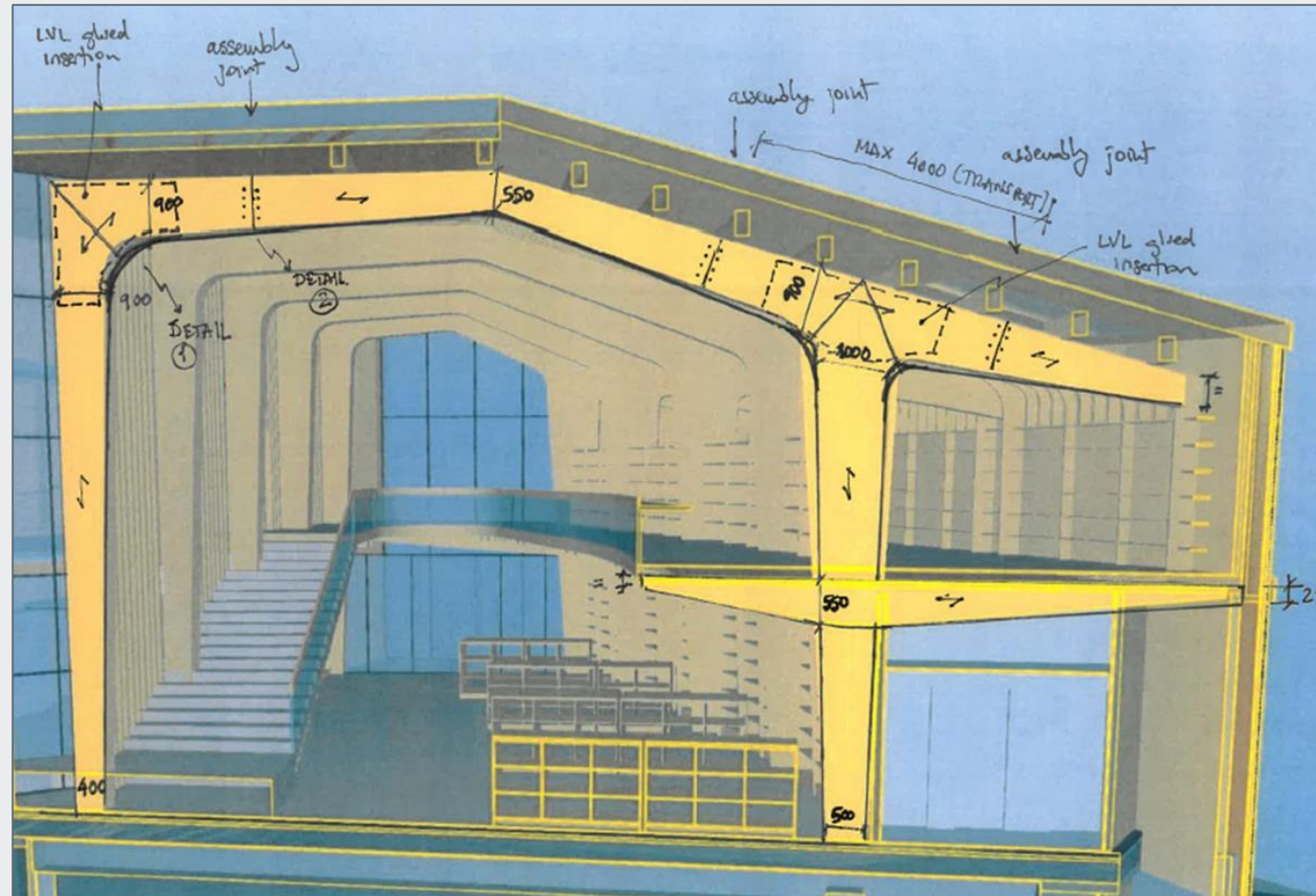
# CONCEPTUAL DESIGN - CRÉATION HOLZ

## LIBRARY AND BANK PORTAL FRAMES



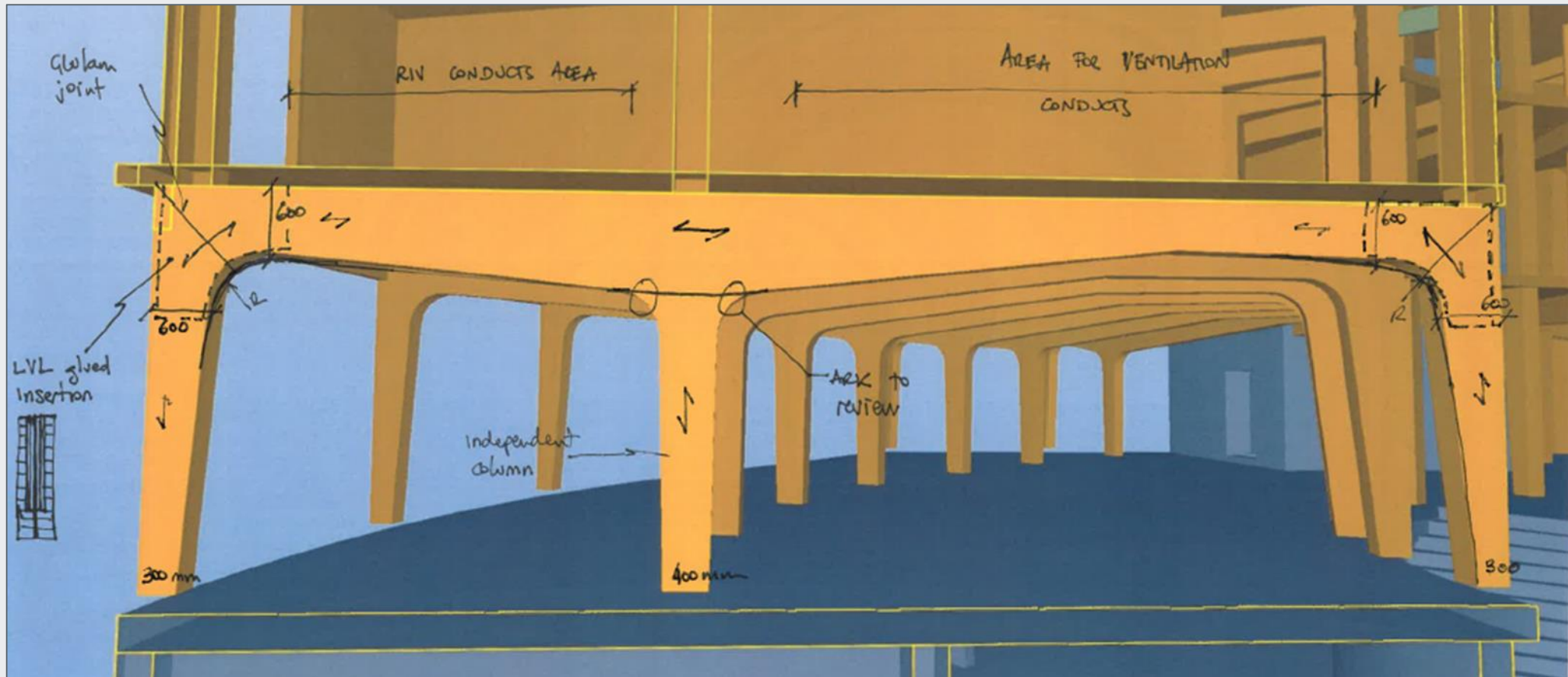
# DEVELOPING CONCEPT – DEGREE OF FREEDOM

## LIBRARY PORTAL FRAME



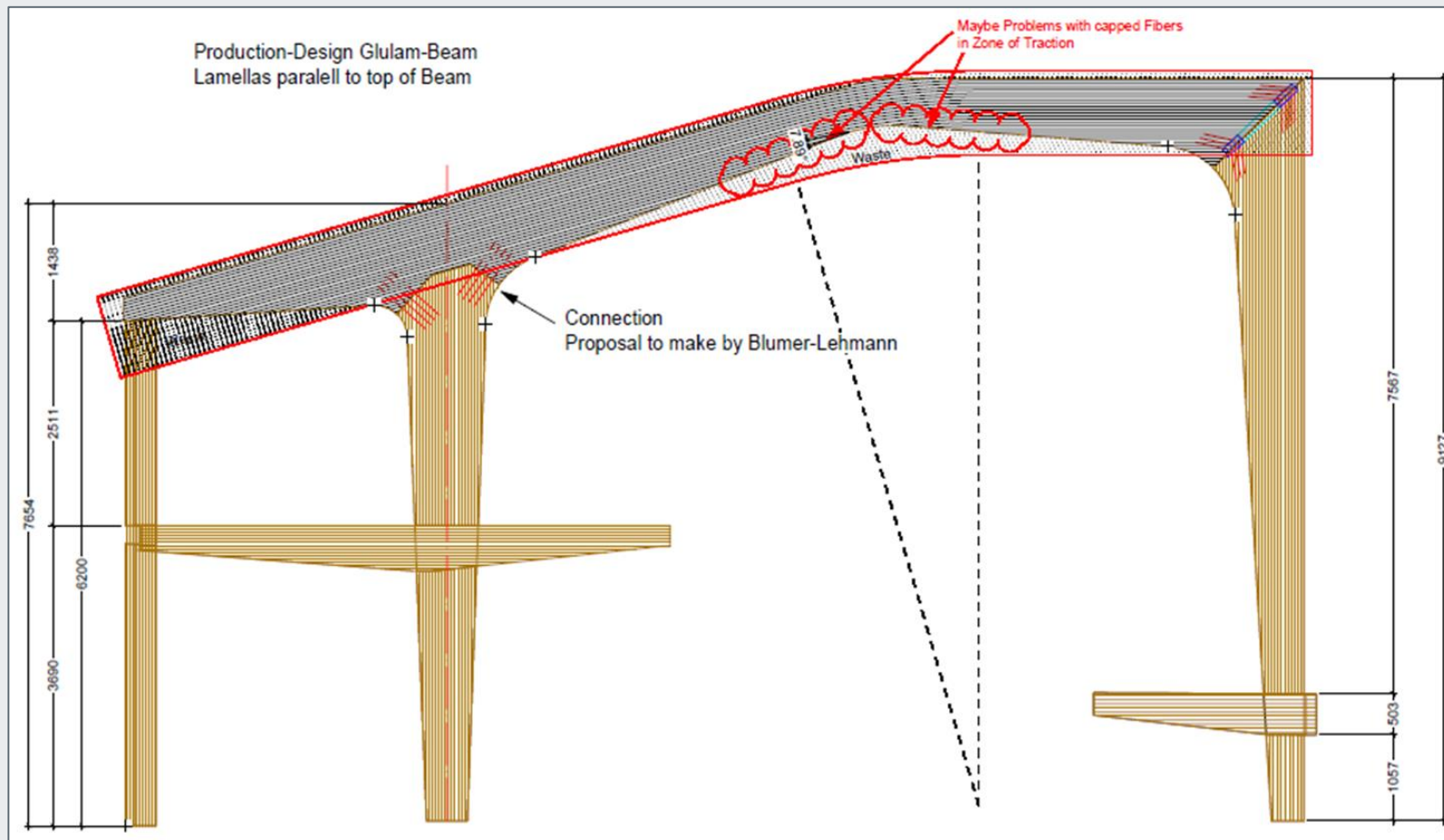
# DEVELOPING CONCEPT – DEGREE OF FREEDOM

## BANK PORTAL FRAME

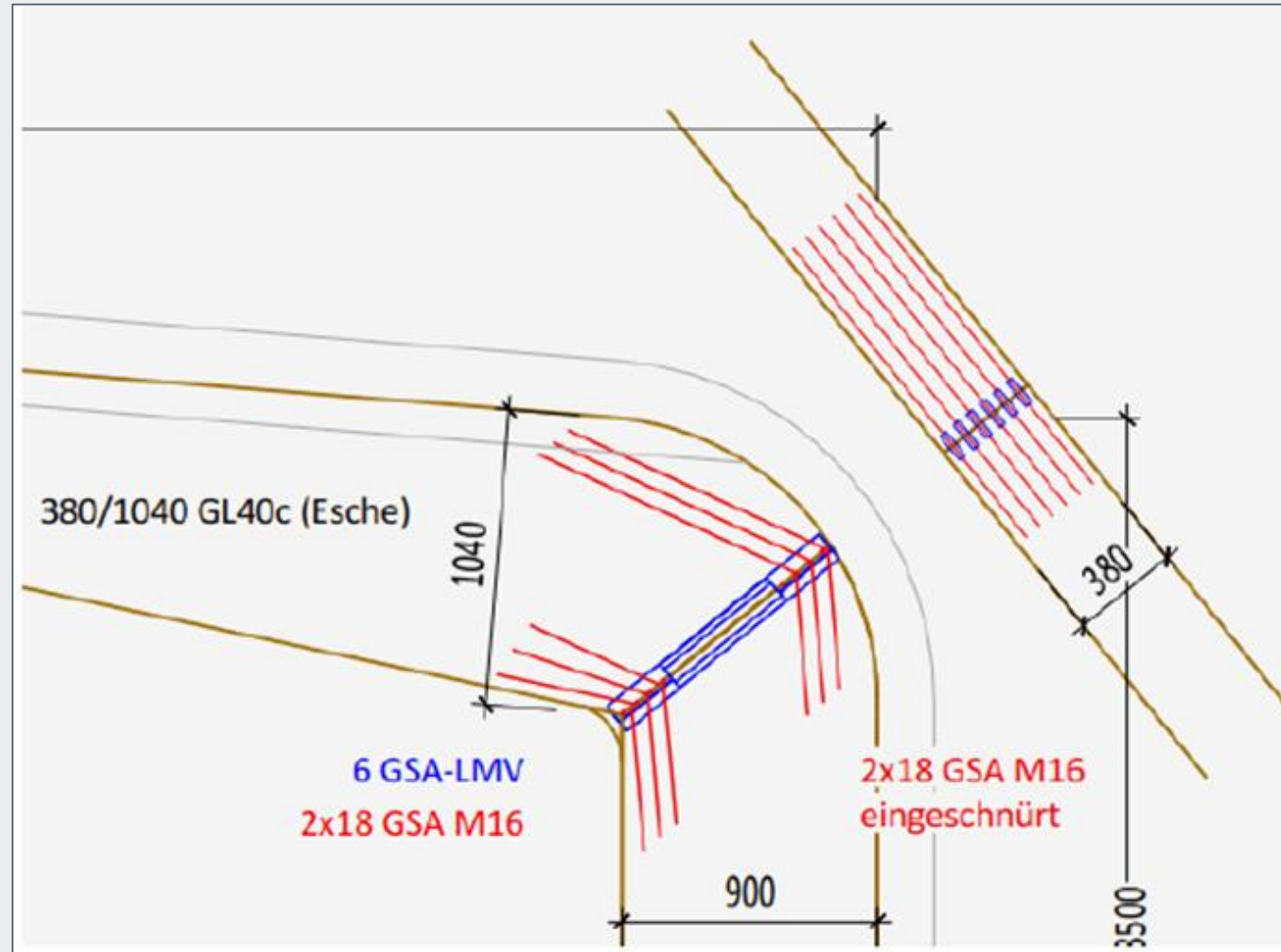


# DESIGN PROPOSAL AANESLANDS LIMTRE & BLUMER-LEHMANN

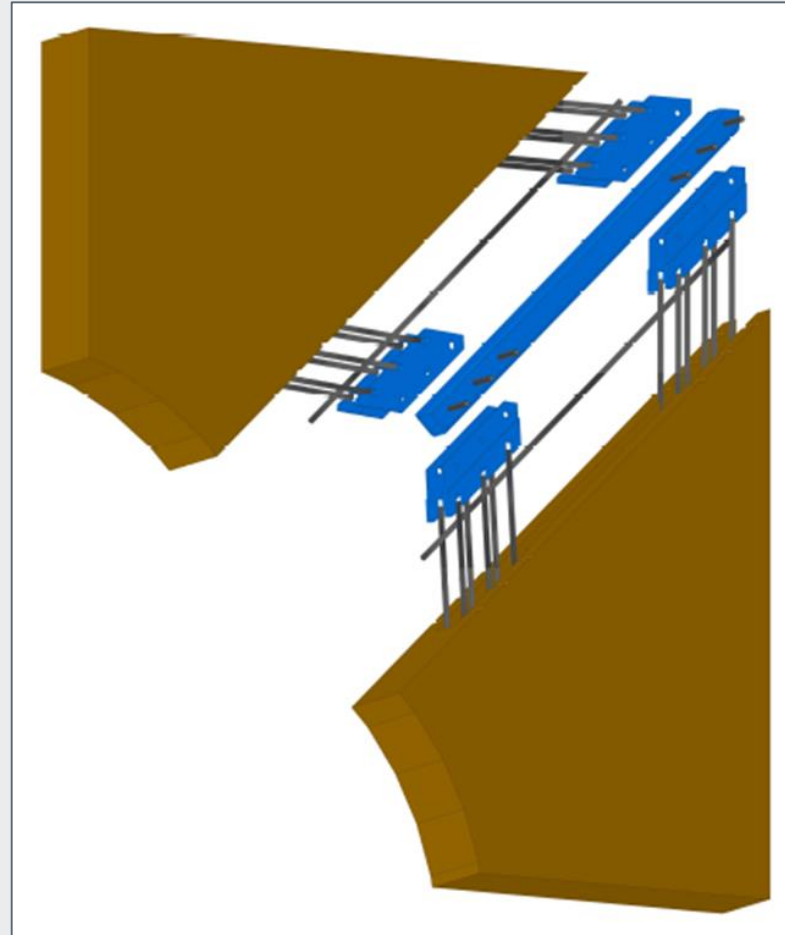
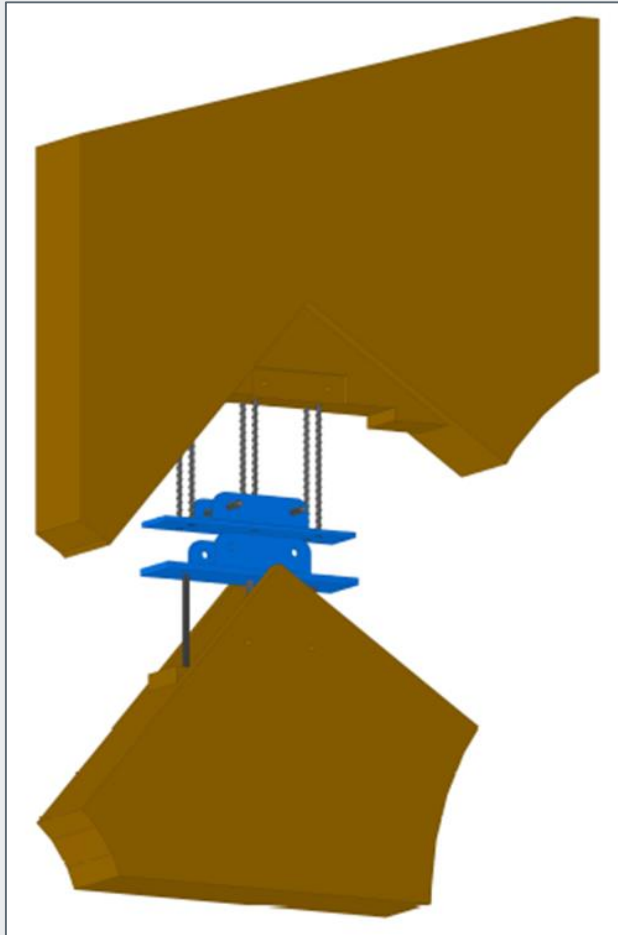
## LIBRARY PORTAL FRAME



# CORNER DETAIL



# CORNER DETAIL



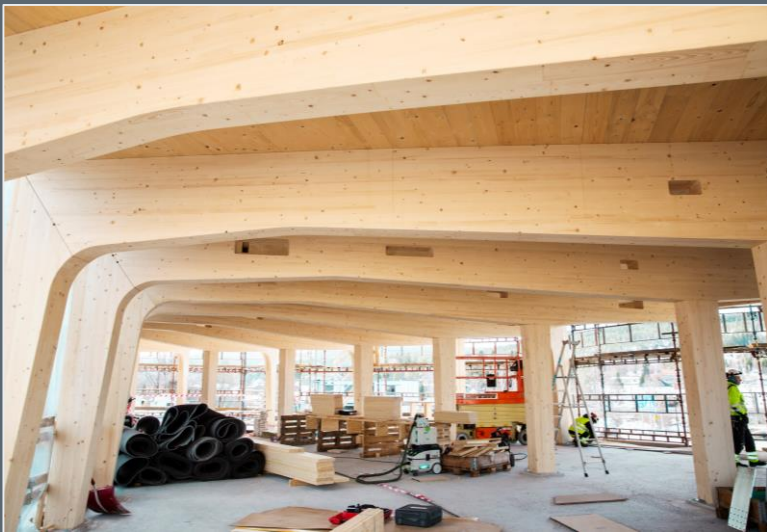
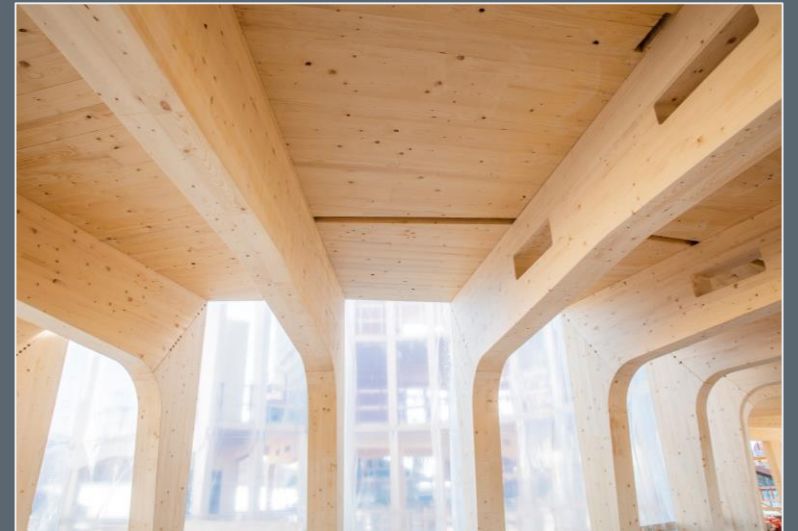
# CORNER DETAIL











OSLO, NORWAY

# BOOMERANG AND JUNGLE FOOT BRIDGES



WINNER NORWEGIAN STEEL CONSTRUCTION PRICE 2017

FINALIST WAN BEST BRIDGE AWARD 2017

FINALIST OSLO CITY ARCHITECTURE PRICE 2018

FINALIST EUROPEAN STEEL BRIDGE AWARD 2018



The project consisted of two adjacent footbridges. Boomerang footbridge is an 83 meter long continuous weathering steel box girder structure with four spans. Jungle footbridge is a 36m span suspension bridge crossing a small valley.



## TIMELINE

CONSTRUCTION PERIOD – 2015-2016, OPENED - 2016, AWARDED - 2017



## CLIENT

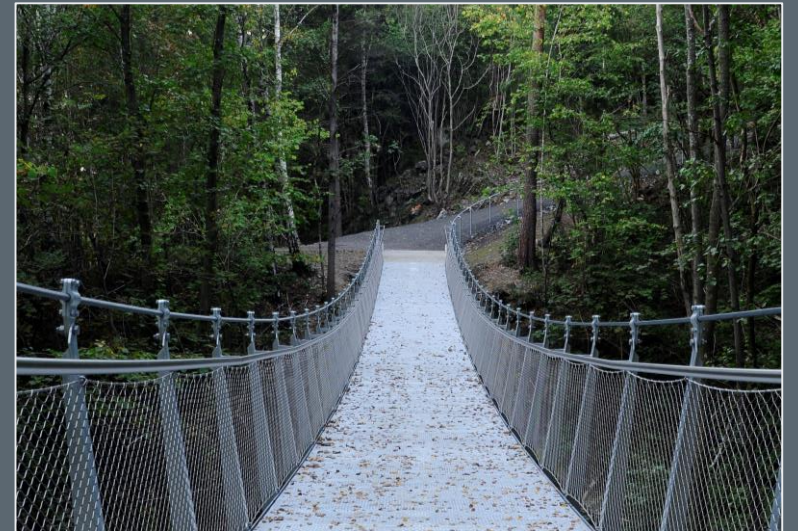
OSLO MUNICIPALITY



## FACTS

BOOMERANG BRIDGE: TONNAGE OF STEEL: 94.9 TONNES / STEEL COST: NOK 5.2 MILL

JUNGLE BRIDGE: TONNAGE OF STEEL: 4.0 TONNES / STEEL COST: NOK 1,4 MILL



NORRTÄLJE, SWEDEN

# NORRTÄLJE BRIDGE

CLIENT:  
NORRTÄLJE MUNICIPALITY

TIMELINE:  
2016 – 2018

NUNO ARKITEKTUR, WSP SWEDEN,  
STING











KRISTIANSAND, NORWAY

# KUNSTSILO

CLIENT:

KRISTIANSAND MUNICIPALITY /  
SØRLANDETS KUNSTMUSEUM (SKMU)

TIMELINE:

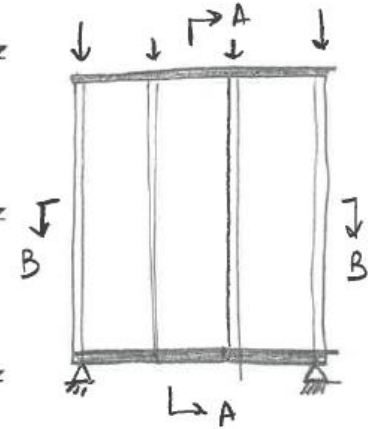
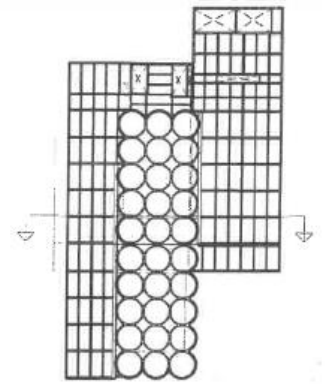
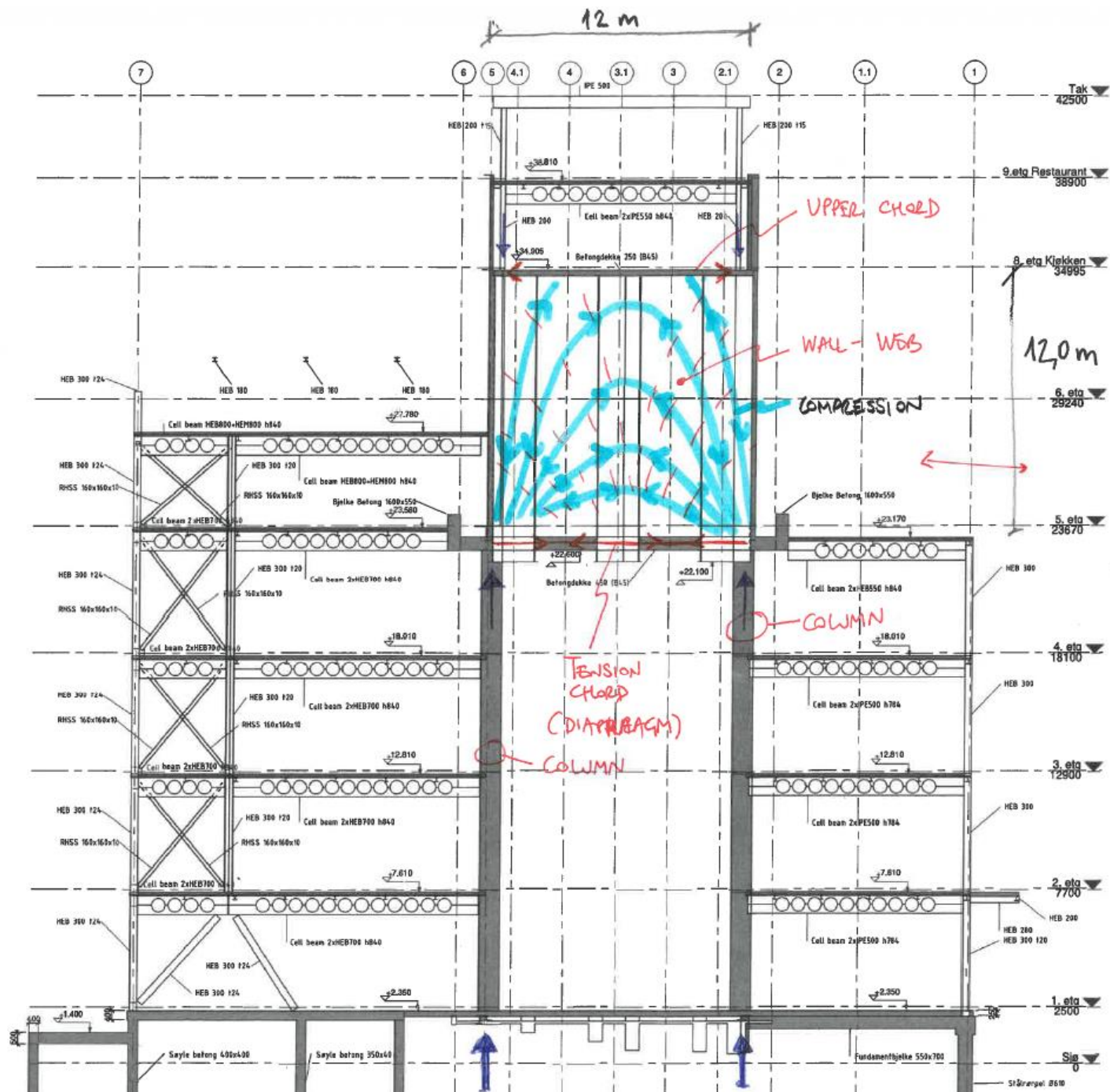
2017-2019

PARTNERS:

MESTRES WÅGE, BAX STUDIO, MENDOZA  
PARTIDA, MULTICONSULT, RAMBØLL,  
KRUSE SMITH







B-B



BERGEN, NORWAY

# TRENZIA

CLIENT:  
BOB

TIMELINE:  
2019

PARTNERS:  
WAUGH THISTLETON ARCHITECTS,  
INGREEN INNOVACIÓN.





# DEGREE OF FREEDOM

O s l o | V a l e n c i a | A t h e n s

W W W . D O F E N G I N E E R S . C O M