AUF HOLZ BAUEN ?

GASTPROFESSOR DR.-ING. JOCHEN STAHL

Fast + Epp itke

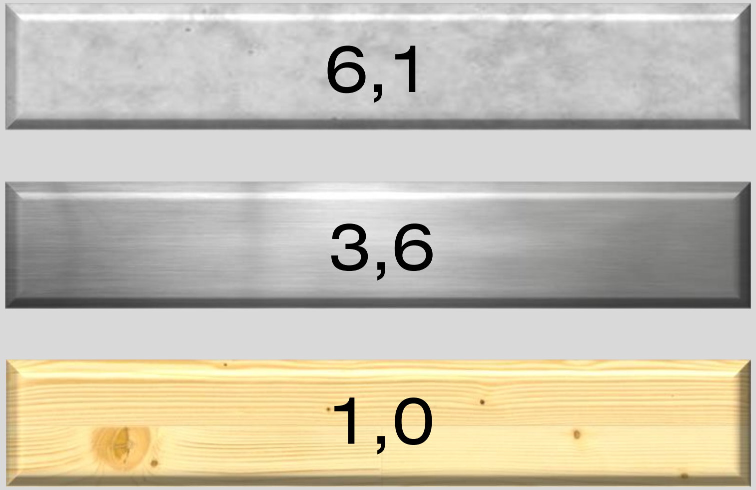
JSTAHL@FASTEPP.COM

WARUM HOLZ?

Warum Holz?

Nachhaltigkeit

- nachwachsender, heimischer Rohstoff
- Klimaschutz (z. B. IEKK): Holz bindet Kohlenstoff und reduziert die Primärenergie der Baukonstruktion
- Wertstoffkette: Holz lässt sich mehrfach recyceln

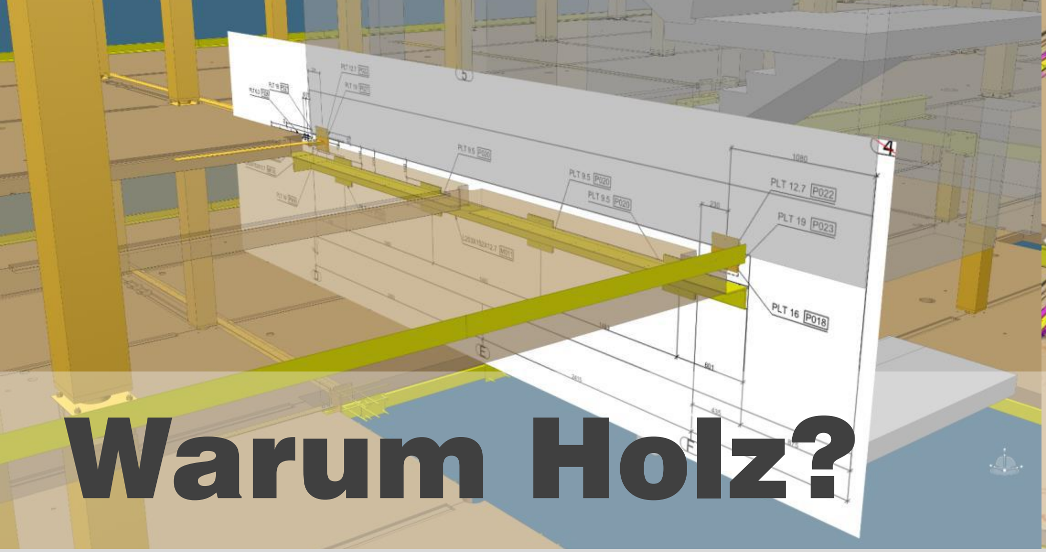


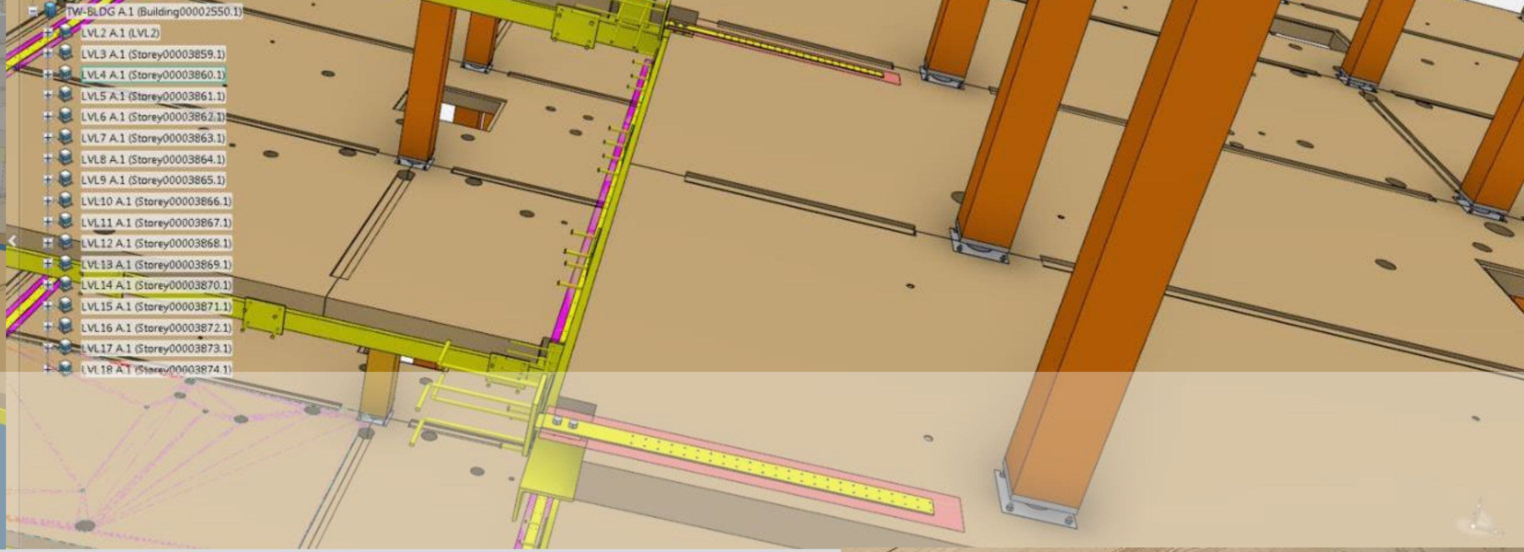
Verhältnis CO_2-Sequestrierung
CO_2-Ausstoß bei vgl. Bauteilen


Warum Holz?

Ambiente & Raumklima

- Holz schafft Wärme und Wohlfühlatmosphäre
- nachgewiesener Beitrag zu einem gesunden Raumklima mit optimaler Luftfeuchtigkeit





Warum Holz?

Integrale Planung und BIM

- bereits heute hoher Digitalisierungsgrad im Holzbau
- integrale Planung gehört zur Holzbau-DNA
- BIM-Koordination durch den Holzbauplaner:
  Abstimmung Fachplaner/Gewerke und Kollisionsprüfung

Warum Holz?

Präzises & serielles Bauen

- höchste Präzision durch maschinelle Vorfabrikation
- zügig und wirtschaftlich realisierbare Konstruktionen
- Ideal für Nachverdichtungsmaßnahmen im urbanen Raum

Warum Holz?

Vorteile Planung & Bau

- Trocknungszeiten entfallen, Baulärm wird reduziert, Baustellenlogistik vereinfacht
- enge Terminpläne, günstige Herstellungskosten
- einfachere Gründung, Vorteile bei Erdbebenbemessung

WEIT GESPANNT

Sport- und Freizeitbad Grandview Heights

Surrey, British Columbia, Kanada
Hughes Condon Marler Architects

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Auch mal gegen den Strich!

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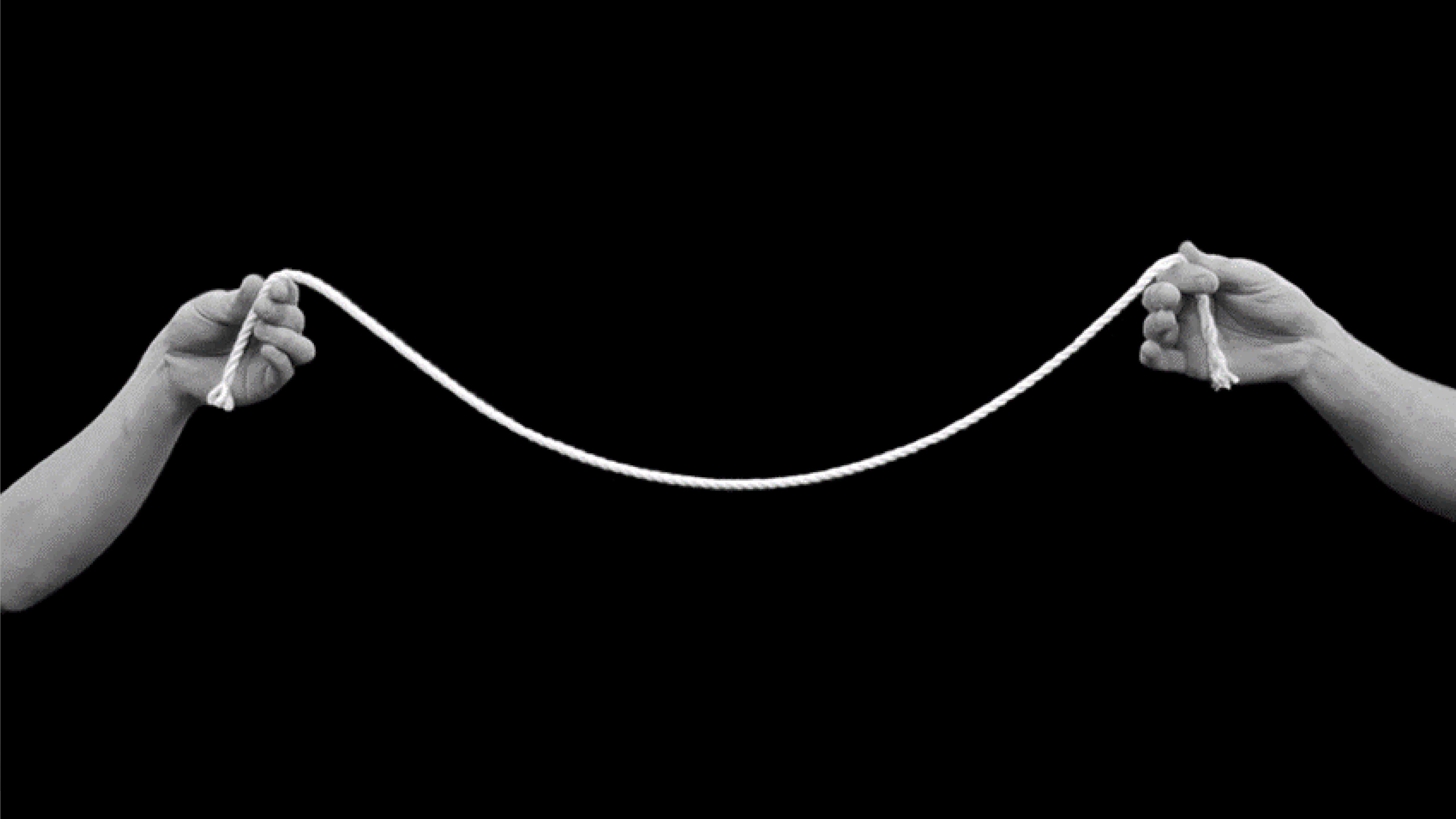
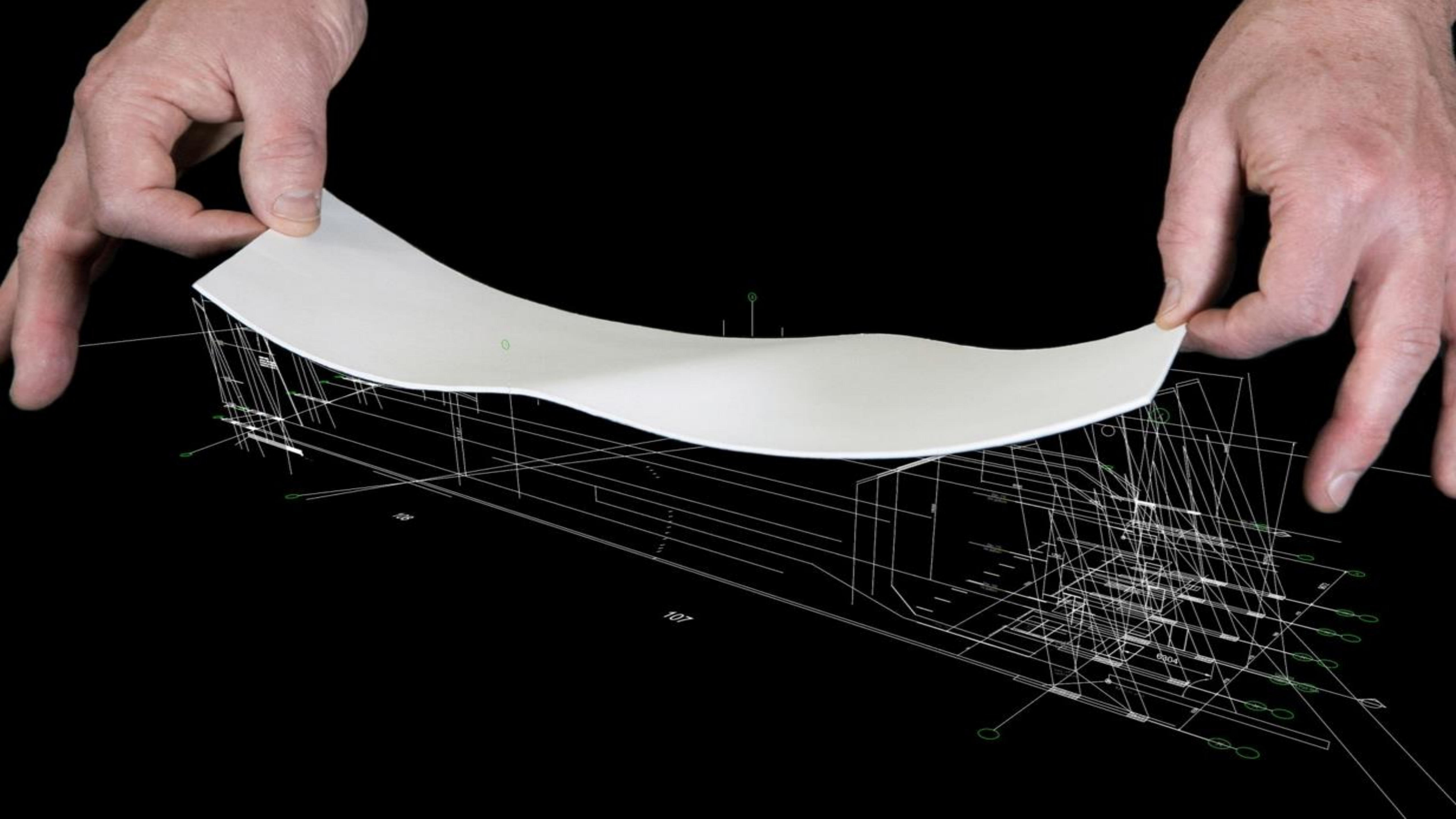
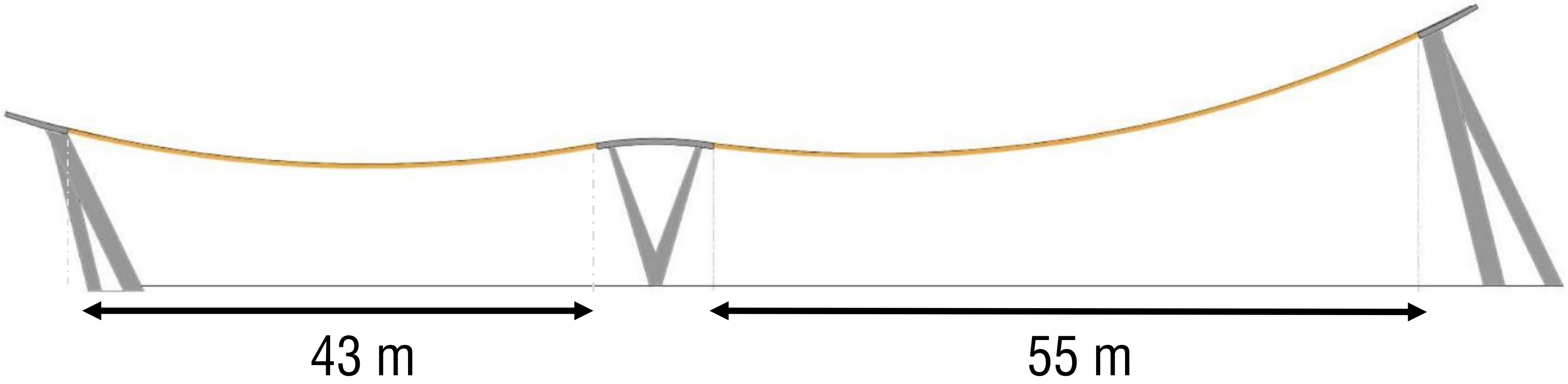
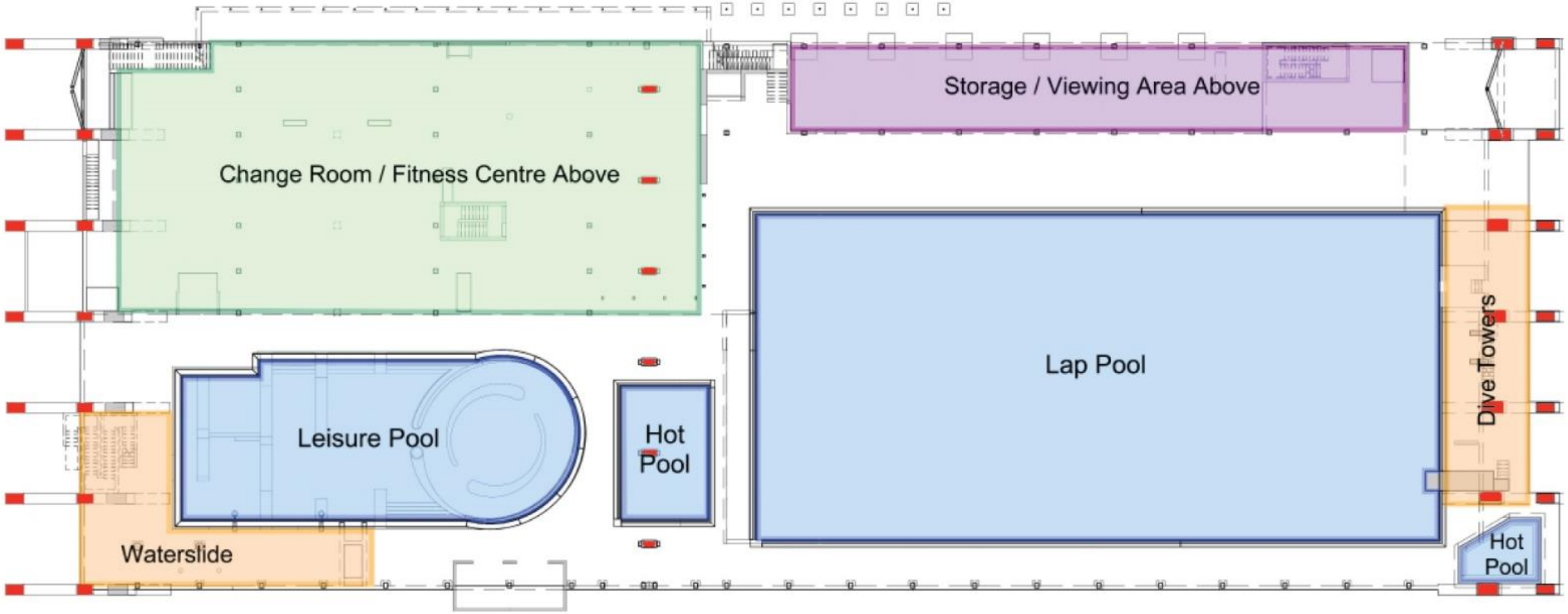
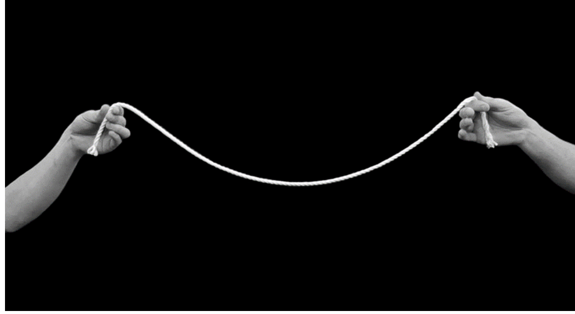
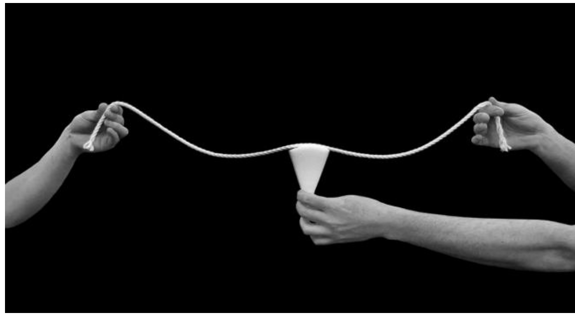


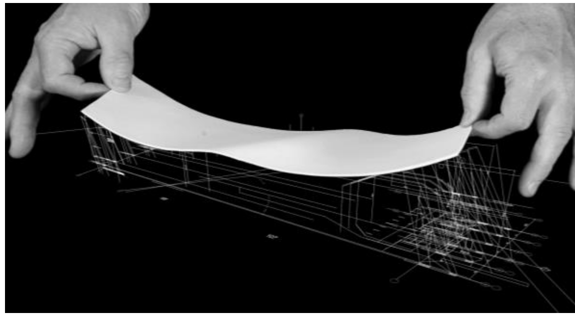


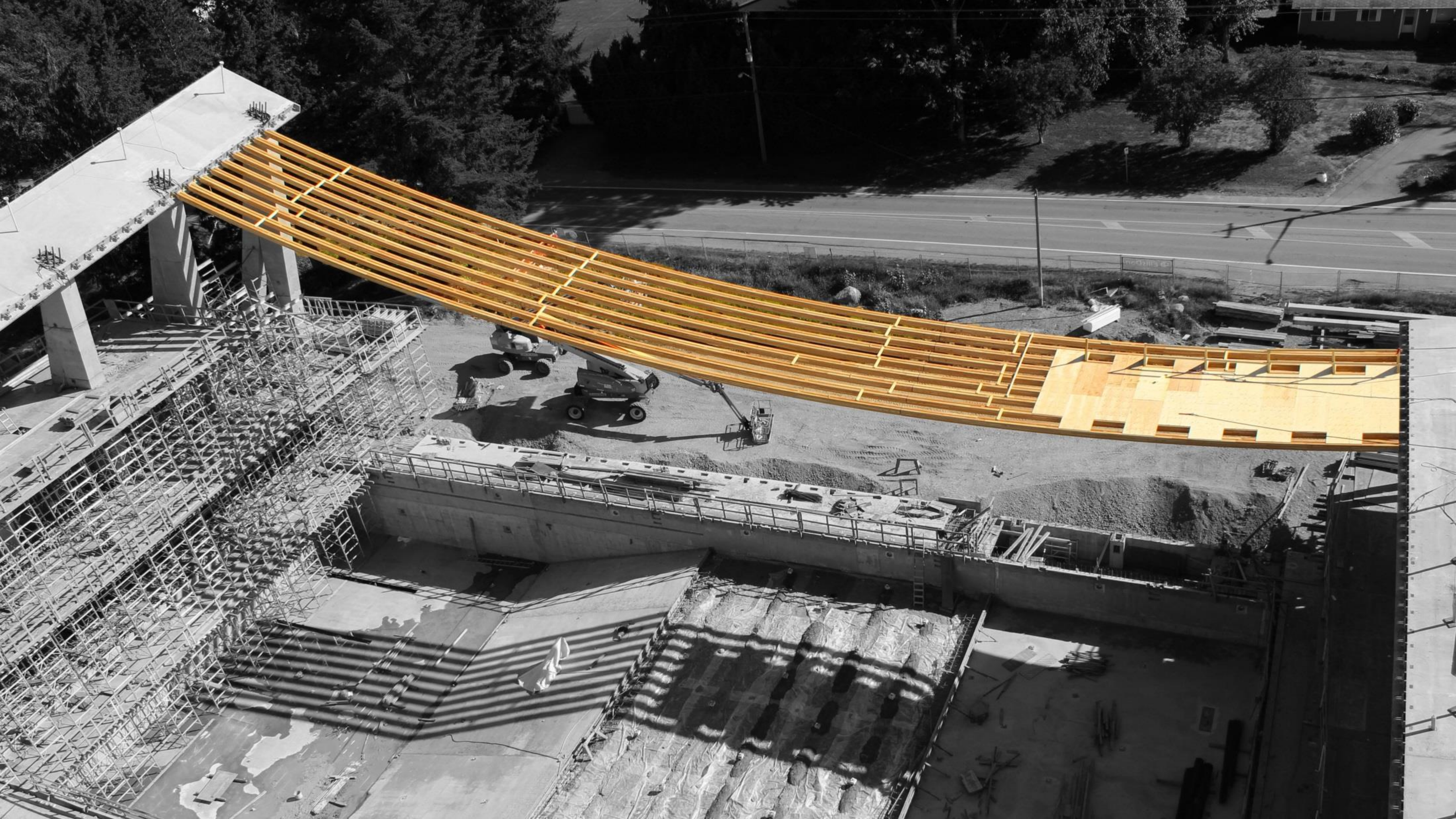

43 m
55 m


Storage / Viewing Area Above
Change Room / Fitness Centre Above
Lap Pool
Dive Towers
Leisure Pool
Hot Pool
Waterslide
Hot Pool









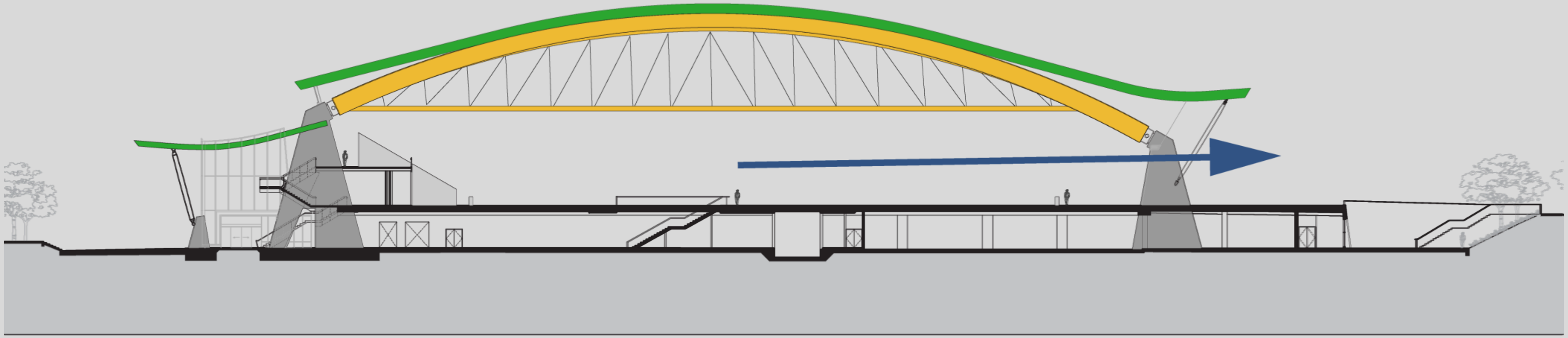
- längstes Holz-Spannband-Dach der Welt mit Spannweiten von bis zu 55 m
- 25 cm hohe Brettschichtholz-Bänder, abgespannt von Betonwiderlagern an den Schmalseiten des Gebäudes
- 2016 durch die Institution of Structural Engineers (GB) mit dem Supreme Award ausgezeichnet

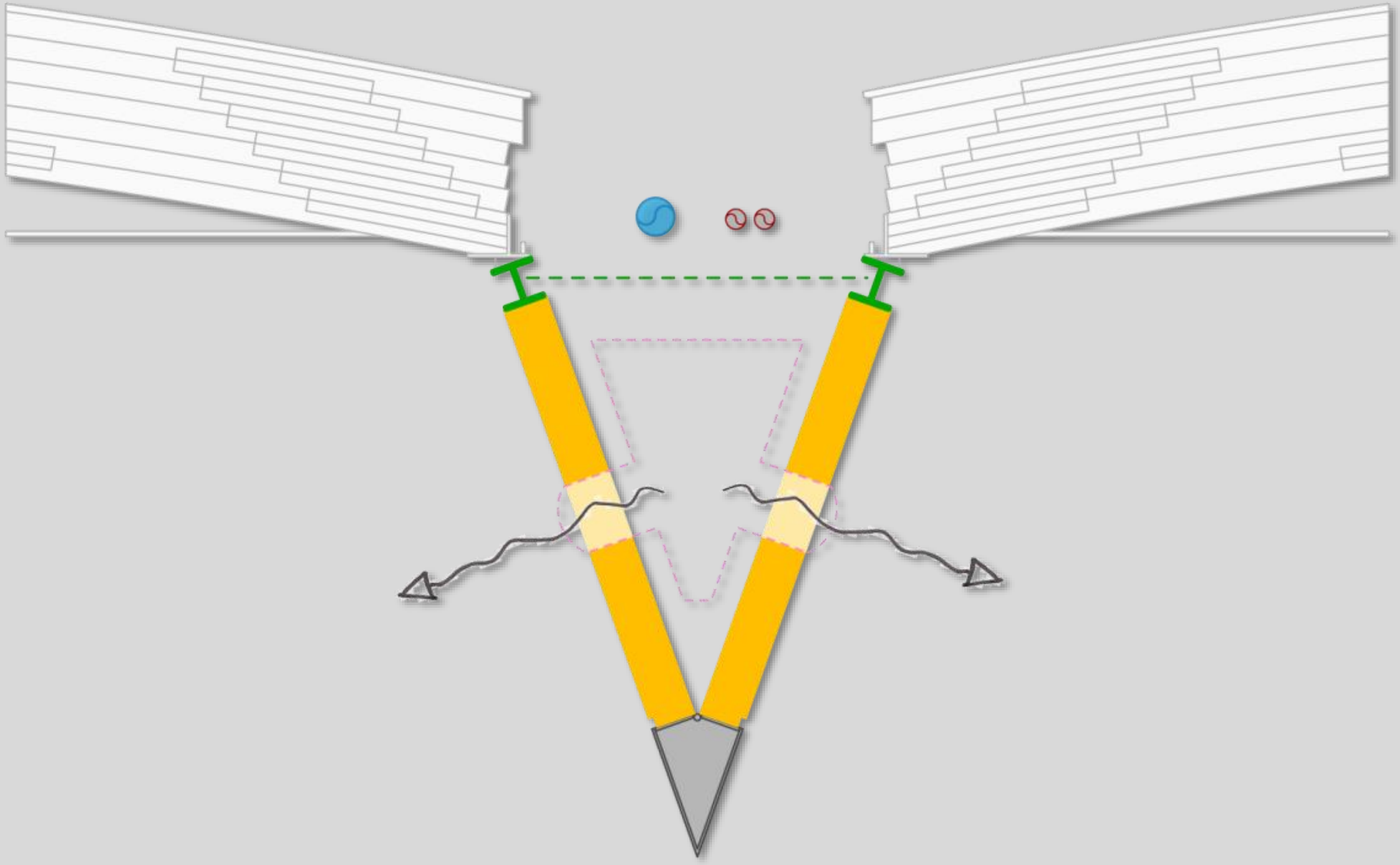
Eissporthalle Olympic Oval

Richmond, British Columbia, Kanada | Cannon Design Architecture

Mehr als Tragwerk







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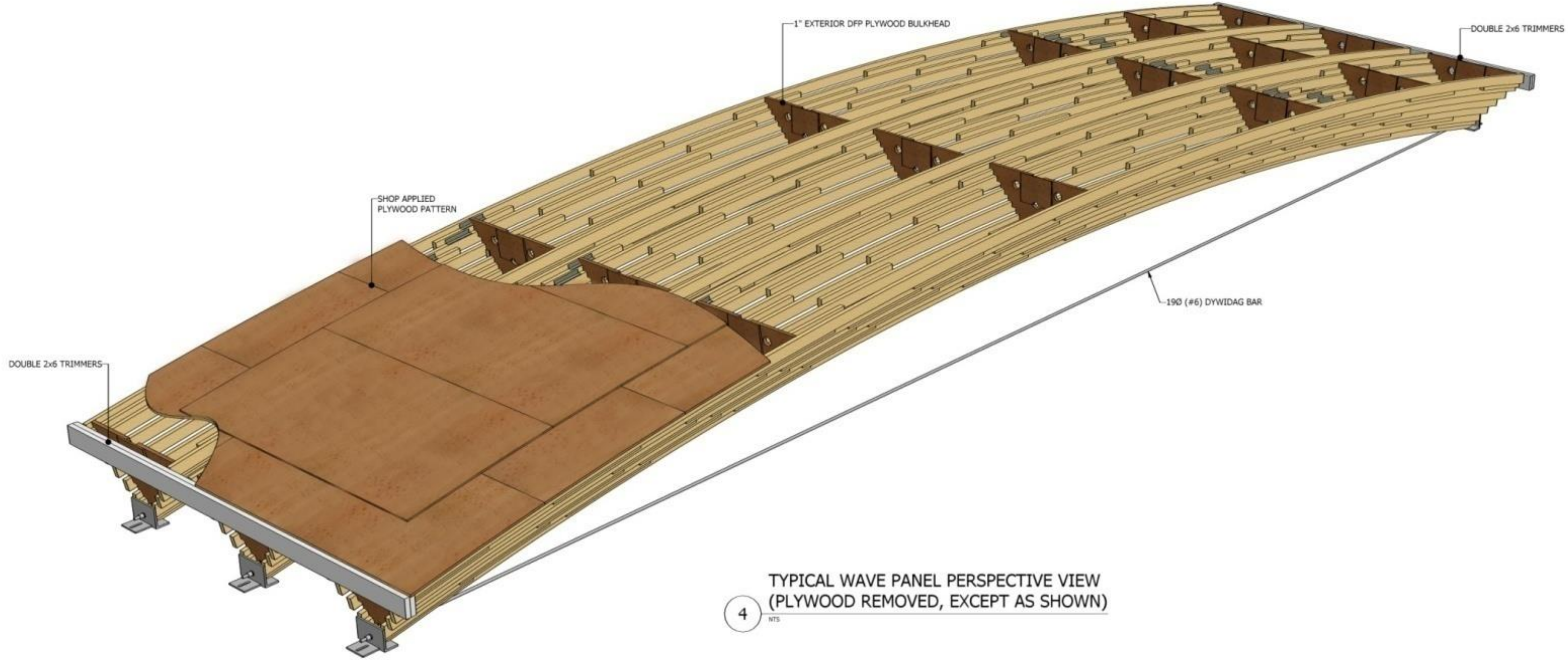
Fast + Epp itke



4 TYPICAL WAVE PANEL PERSPECTIVE VIEW
(PLYWOOD REMOVED, EXCEPT AS SHOWN)
NTS

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ROXUL PLUS

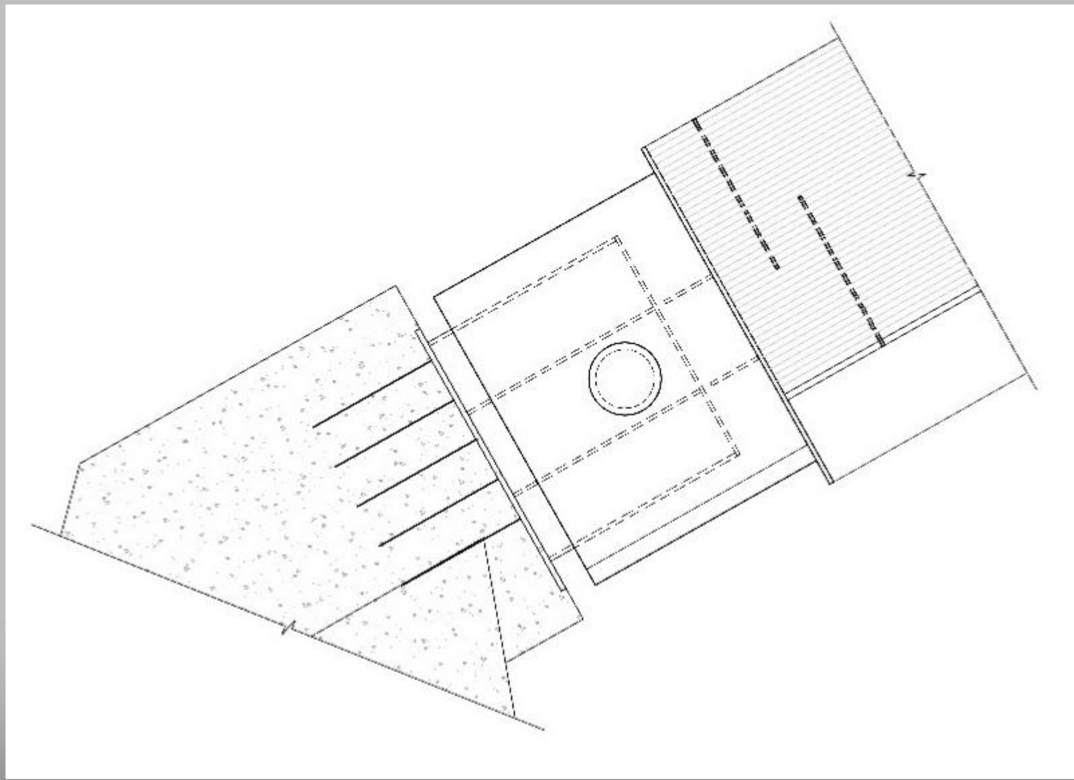

FLOW
VALMONT

Fast + Epp itke


PETRO-CANADA


RICHMOND
OLYMPIC OVAL
CANADA





- vorgefertigte Holzelemente in Wellenform aus Standardquerschnitten 2" x 4"
- Integration von Haustechnik in die dreiecksförmigen Holz-Stahl-Verbundbögen
- 2010 ausgezeichnet mit dem Canadian Consulting Engineer Award of Excellence

HOCH HINAUS

Tallwood House

University of British Columbia
Vancouver, Kanada
Acton Ostry Architects

Mache die Dinge so einfach wie möglich, aber nicht einfacher

Albert Einstein

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Keep it simple.

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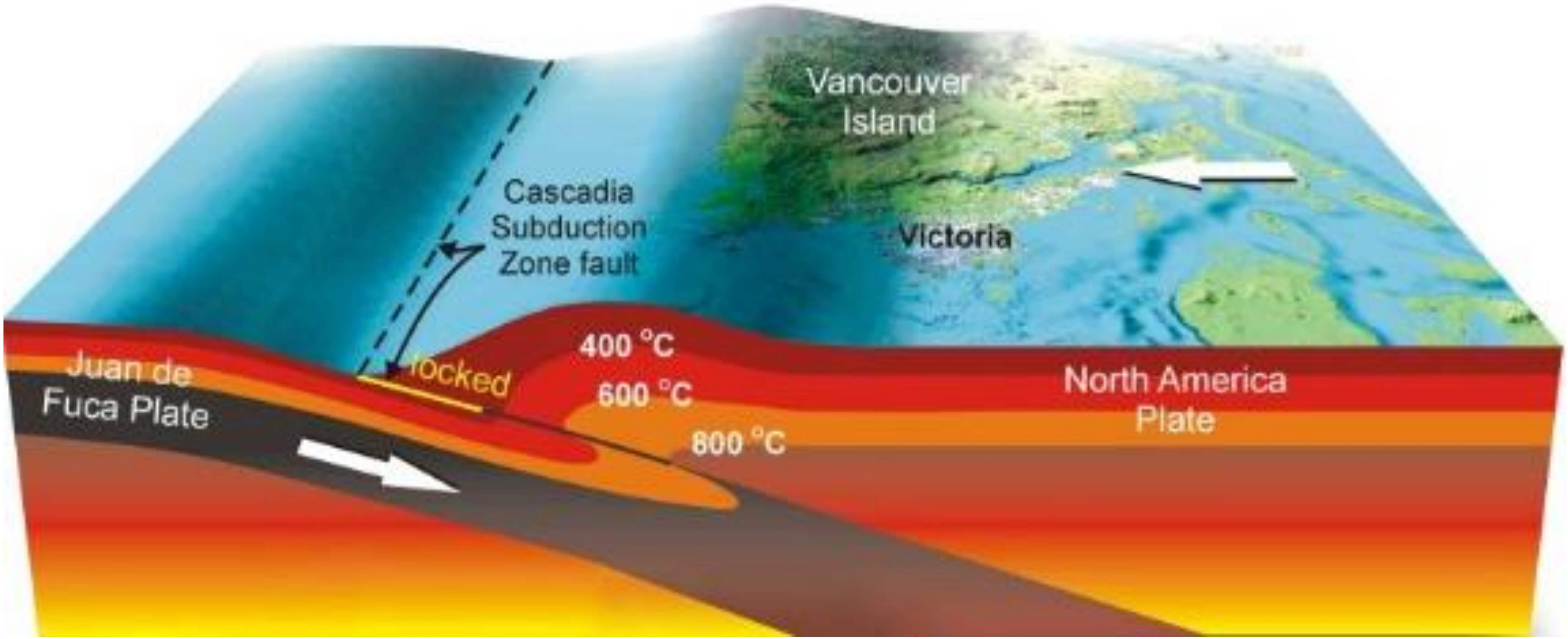
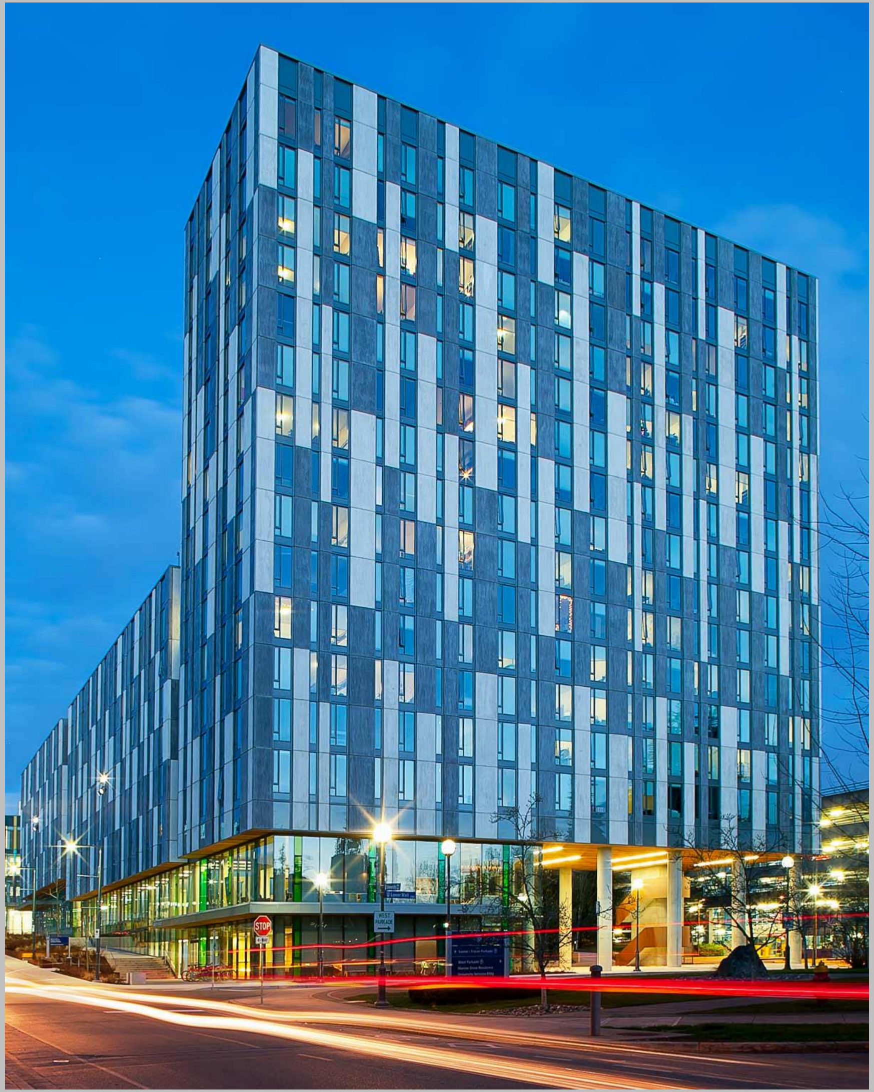
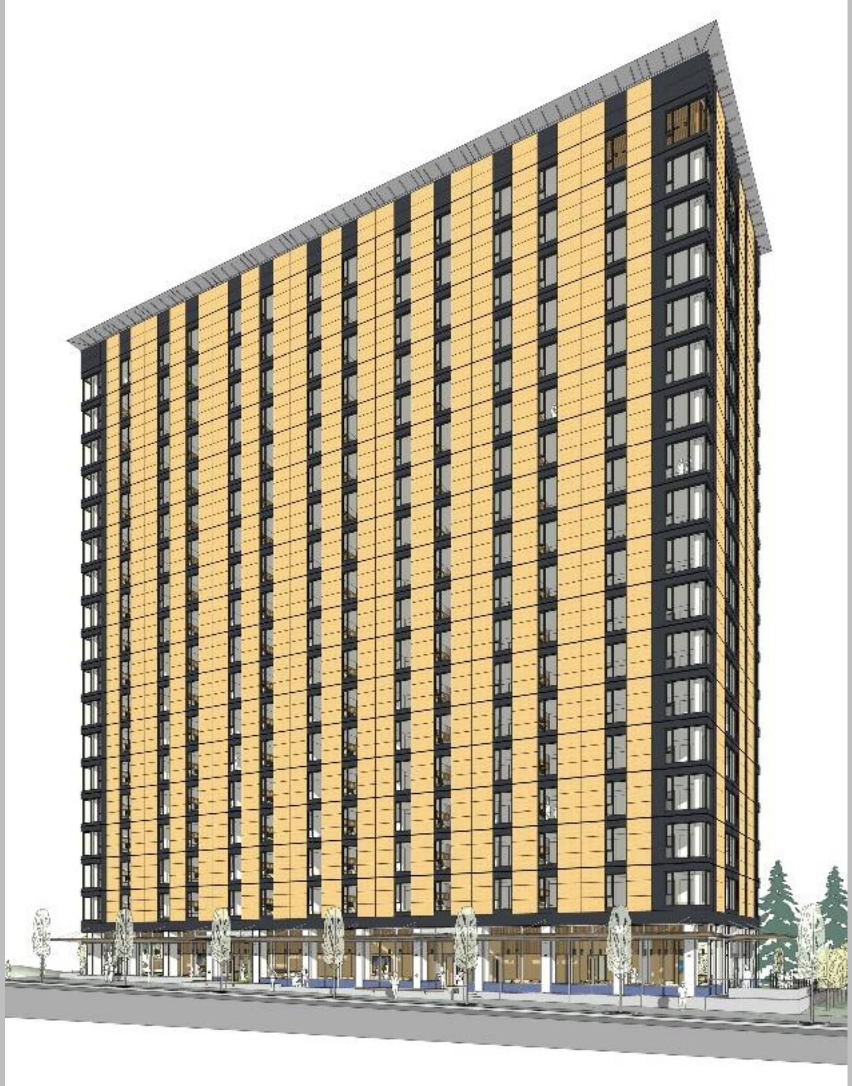
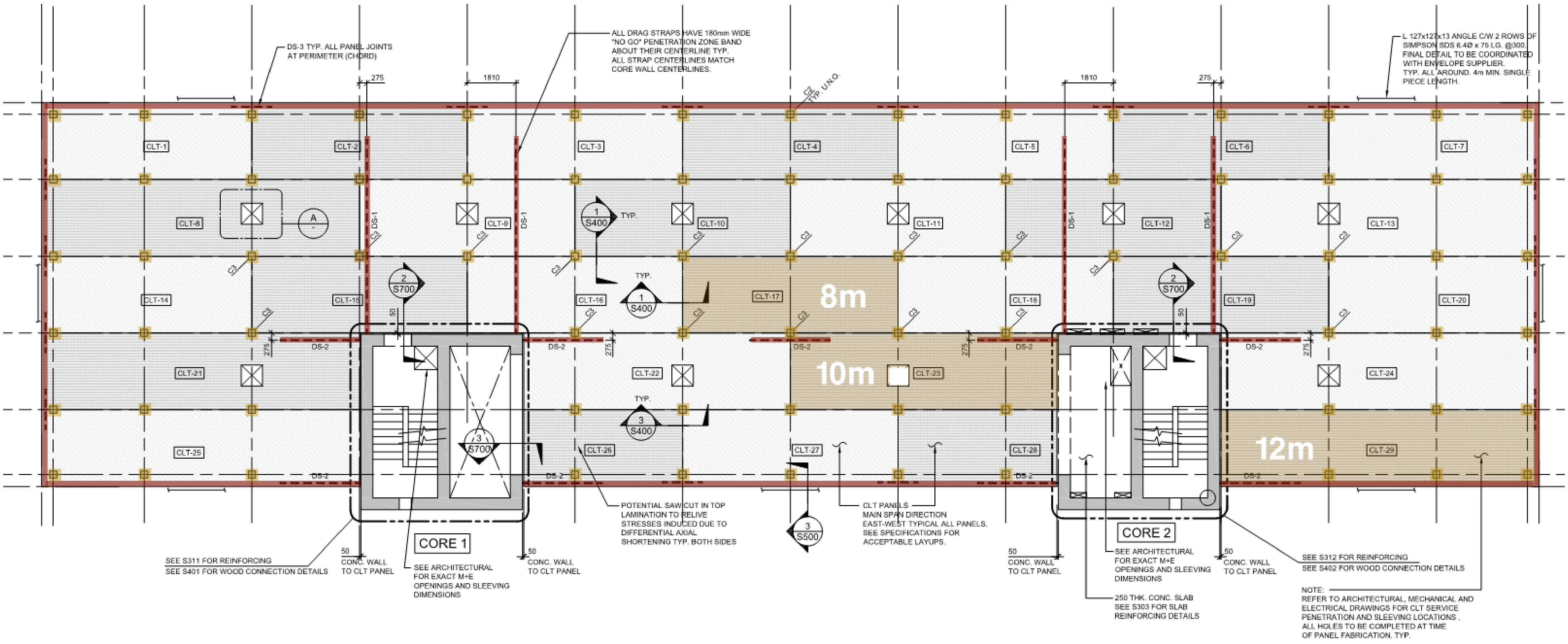

Vancouver Island
Cascadia Subduction Zone fault
Victoria
Juan de Fuca Plate
locked
400 °C
600 °C
800 °C
North America Plate





192 $/ft²

192 $/ft²



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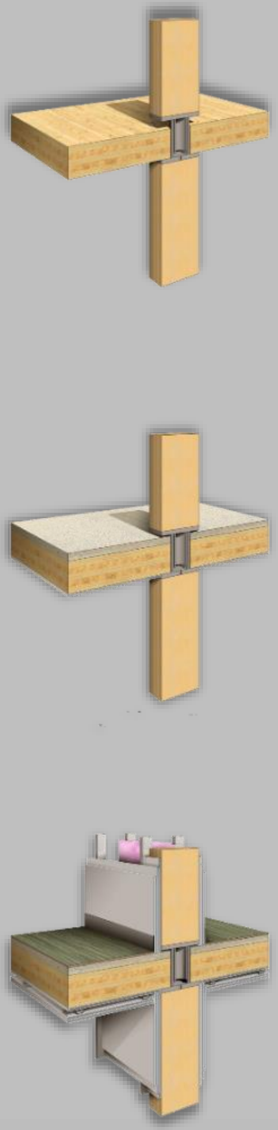
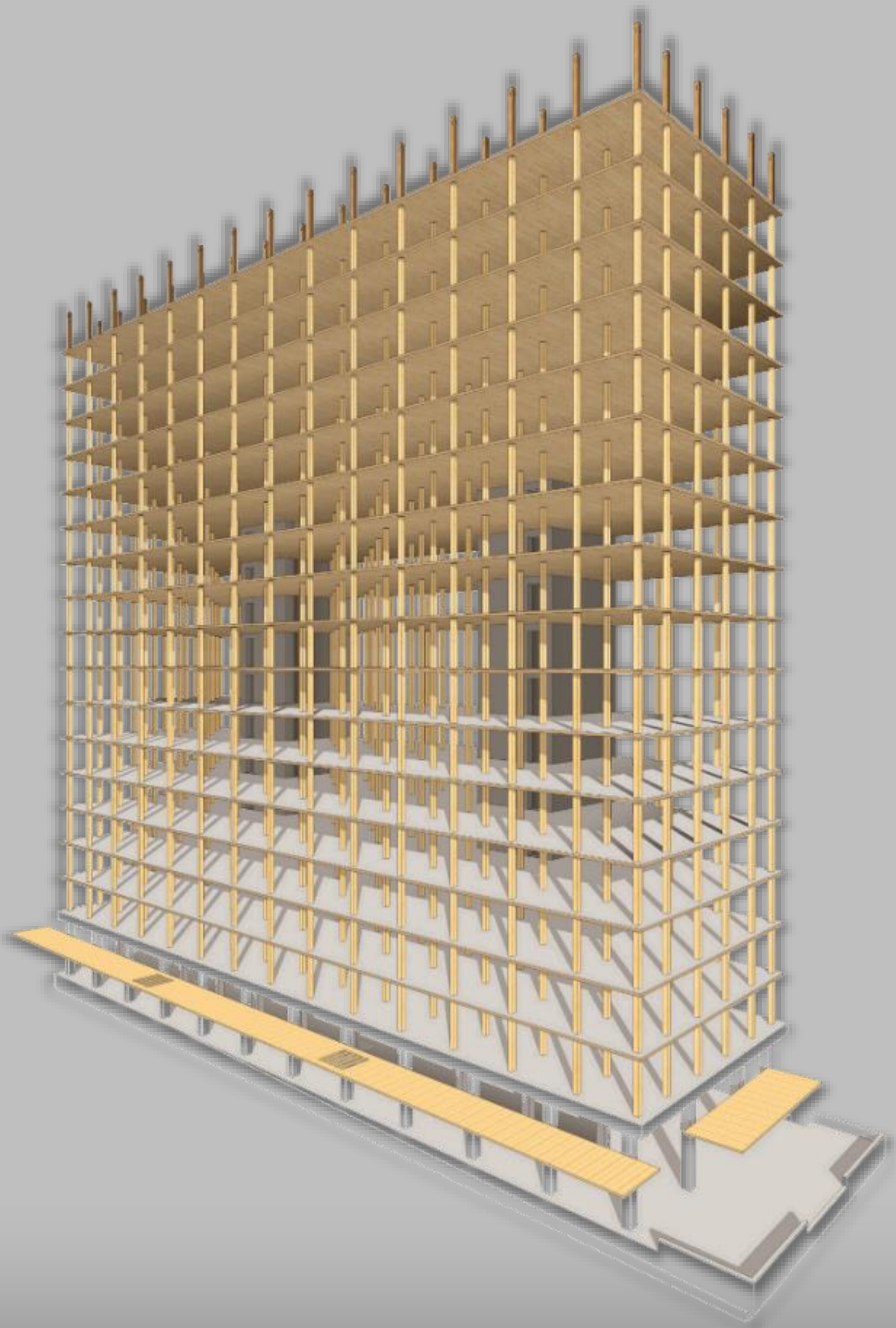
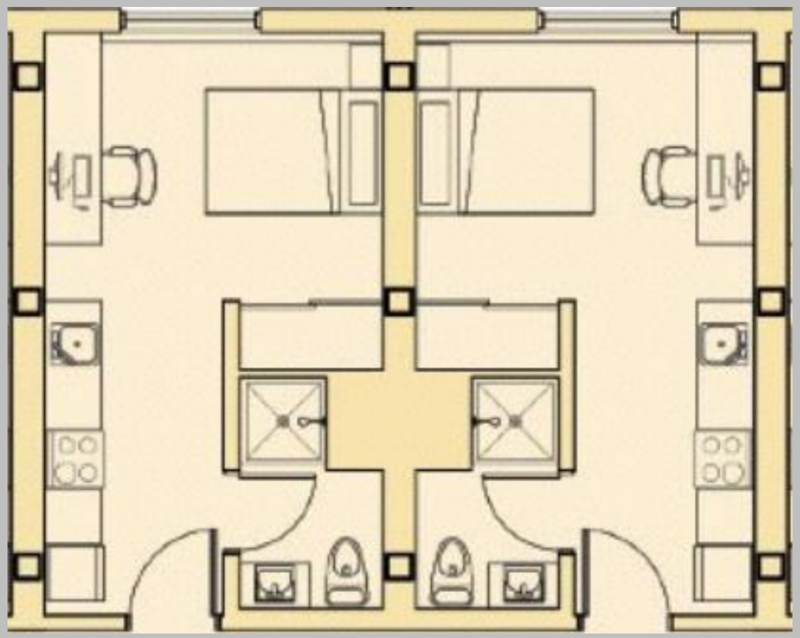
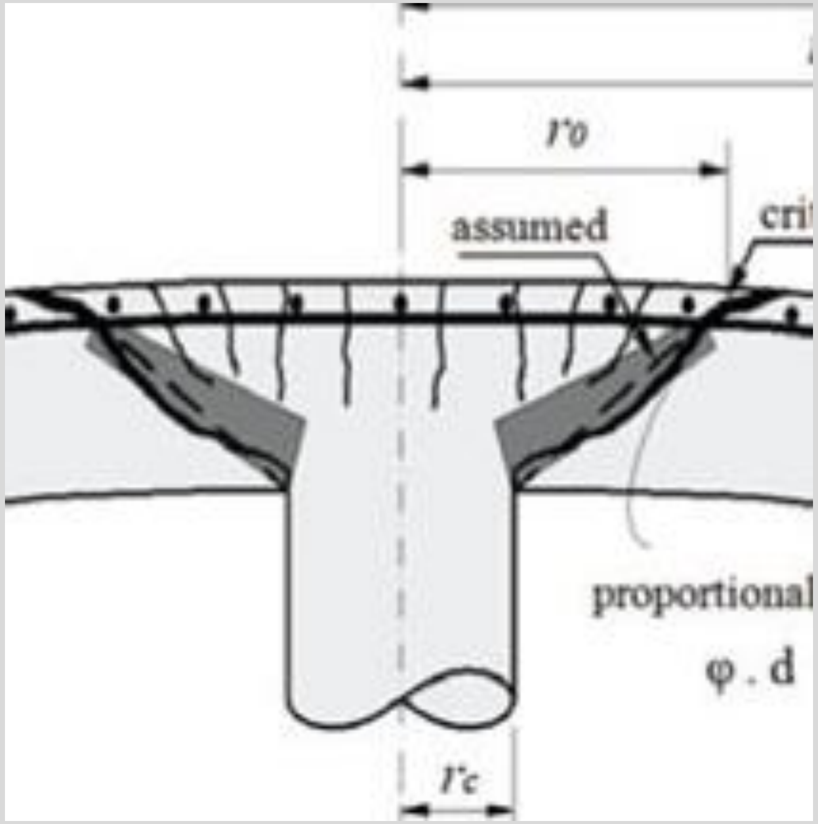


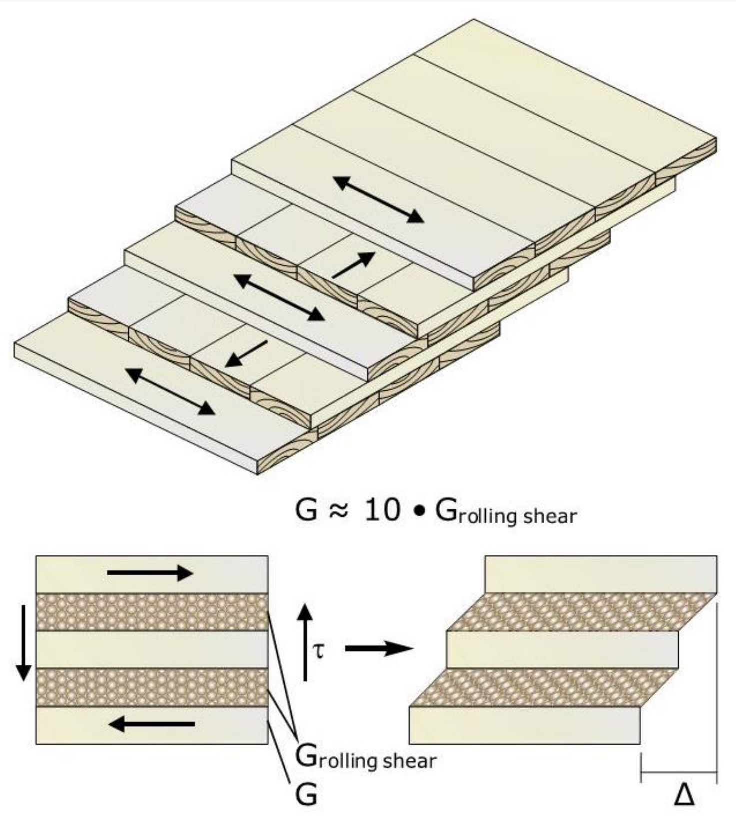




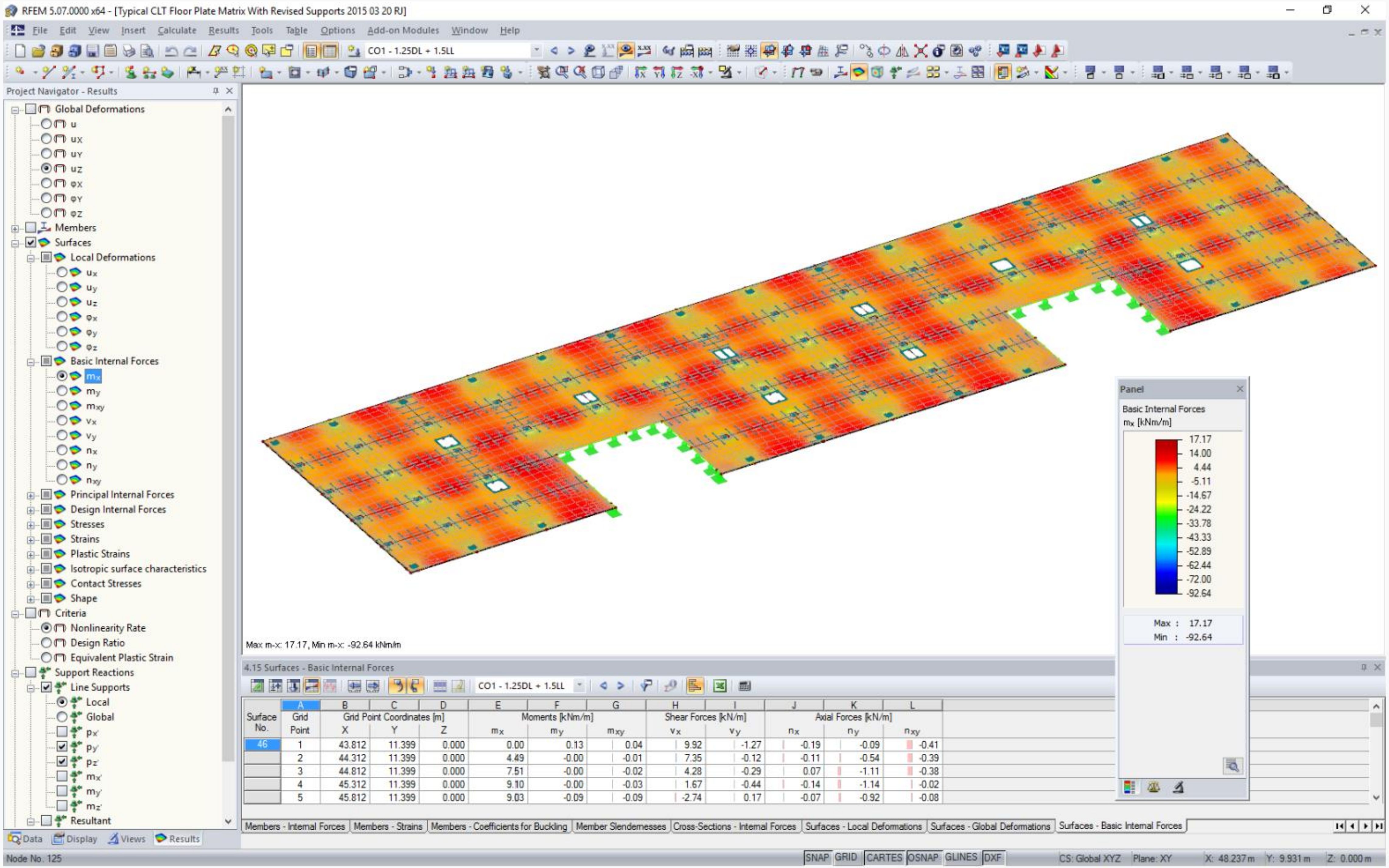


Durchstanzen Stahlbeton

Durchstanzbewehrung



Holzbau: Rollschub


RFEM 5.07.0000 x64 - [Typical CLT Floor Plate Matrix With Revised Supports 2015 03 20 RJ]
File Edit View Insert Calculate Results Tools Table Options Add-on Modules Window Help
CO1 - 1.25DL + 1.5LL
Project Navigator - Results
Global Deformations
u
uX
uY
uZ
φX
φY
φZ
Members
Surfaces
Local Deformations
Basic Internal Forces
mx
my
mxy
vx
vy
nx
ny
nxy
Principal Internal Forces
Design Internal Forces
Stresses
Strains
Plastic Strains
Isotropic surface characteristics
Contact Stresses
Shape
Criteria
Nonlinearity Rate
Design Ratio
Equivalent Plastic Strain
Support Reactions
Line Supports
Local
Global
Resultant
Data Display Views Results
Panel
Basic Internal Forces
mx [kNm/m]
17.17
14.00
4.44
-5.11
-14.67
-24.22
-33.78
-43.33
-52.89
-62.44
-72.00
-92.64
Max : 17.17
Min : -92.64
Max m-x: 17.17, Min m-x: -92.64 kNm/m
4.15 Surfaces - Basic Internal Forces
Surface No. | Grid Point | X | Y | Z | mx | my | mxy | vx | vy | nx | ny | nxy
46 | 1 | 43.812 | 11.399 | 0.000 | 0.00 | 0.13 | 0.04 | 9.92 | -1.27 | -0.19 | -0.09 | -0.41
2 | 44.312 | 11.399 | 0.000 | 4.49 | -0.00 | -0.01 | 7.35 | -0.12 | -0.11 | -0.54 | -0.39
3 | 44.812 | 11.399 | 0.000 | 7.51 | -0.00 | -0.02 | 4.28 | -0.29 | 0.07 | -1.11 | -0.38
4 | 45.312 | 11.399 | 0.000 | 9.10 | -0.00 | -0.03 | 1.67 | -0.44 | -0.14 | -1.14 | -0.02
5 | 45.812 | 11.399 | 0.000 | 9.03 | -0.09 | -0.09 | -2.74 | 0.17 | -0.07 | -0.92 | -0.08
Grid Point Coordinates [m]
Moments [kNm/m]
Shear Forces [kN/m]
Axial Forces [kN/m]
Members - Internal Forces | Members - Strains | Members - Coefficients for Buckling | Member Slendernesses | Cross-Sections - Internal Forces | Surfaces - Local Deformations | Surfaces - Global Deformations | Surfaces - Basic Internal Forces
Node No. 125
SNAP GRID CARTES OSNAP GLINES DXF
CS: Global XYZ Plane: XY X: 48.237 m Y: 9.931 m Z: 0.000 m

Herausforderungen

Brandschutz und Integration der Haustechnik

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Herausforderungen

Brandschutz und Integration der Haustechnik

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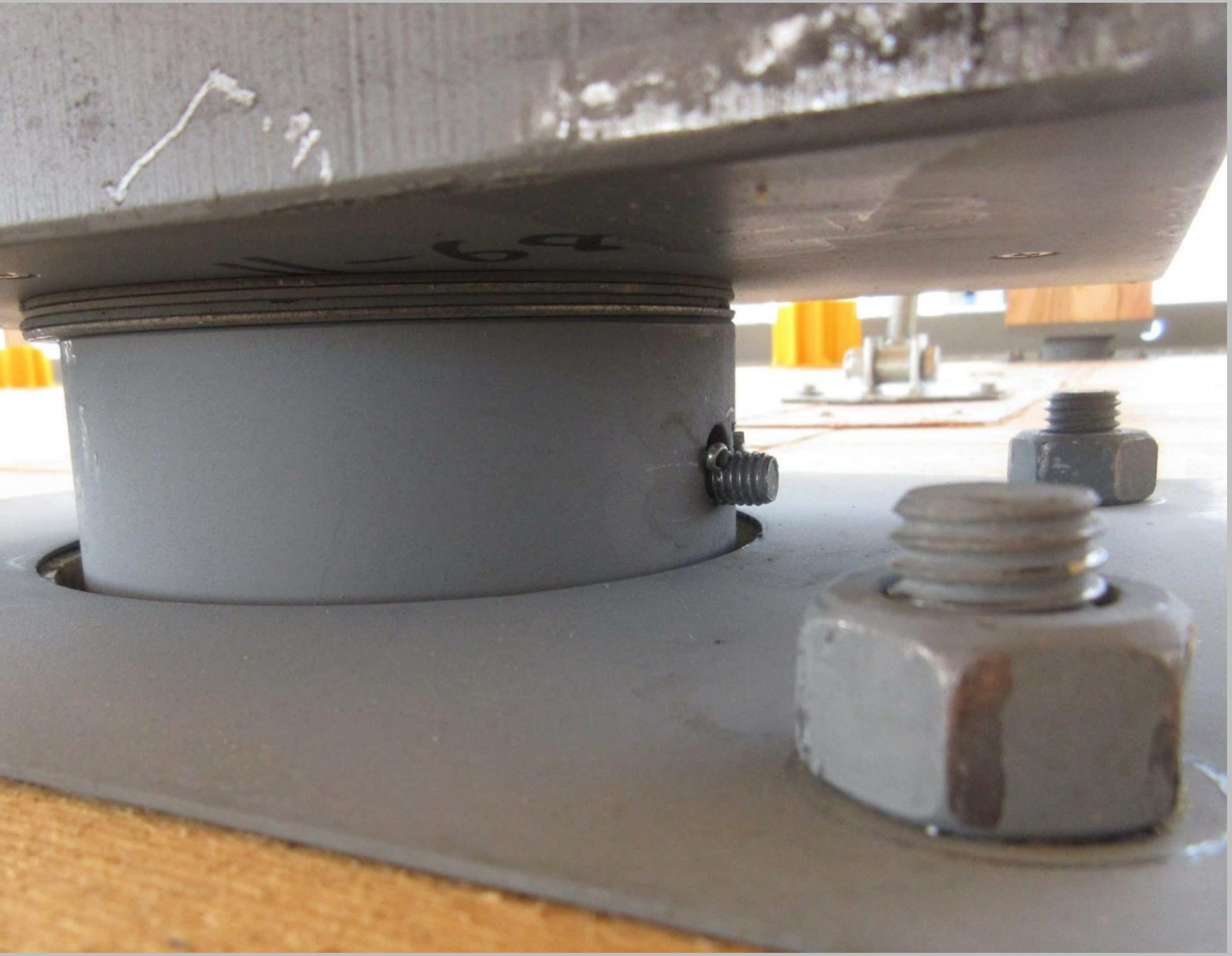
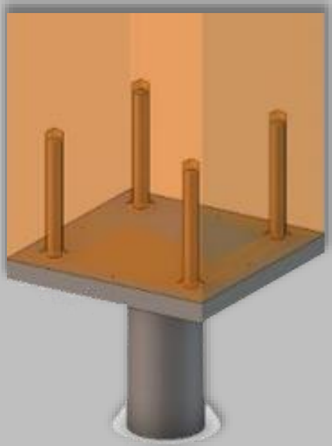
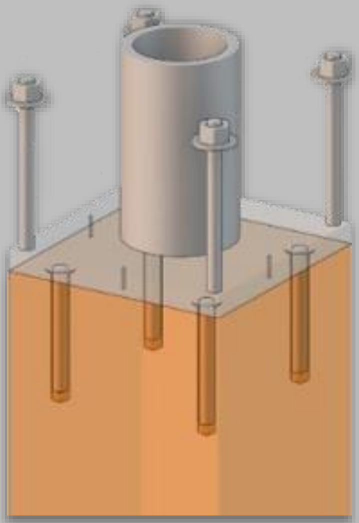
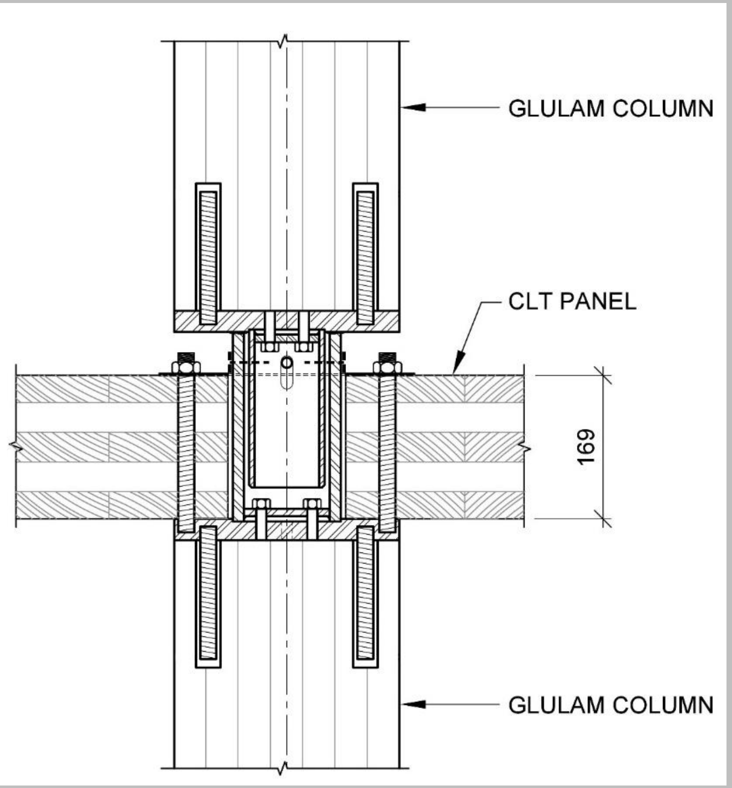
Stützenverbindungen

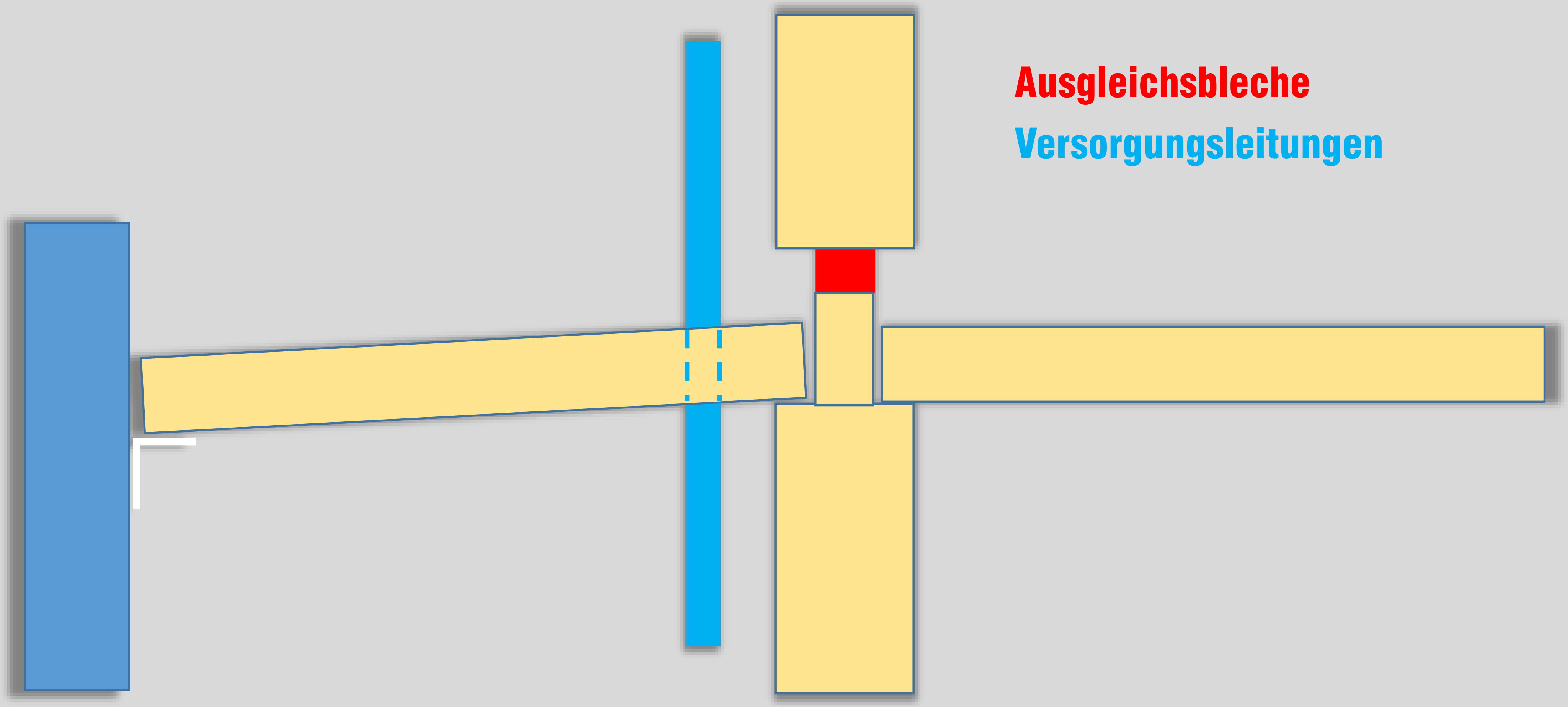




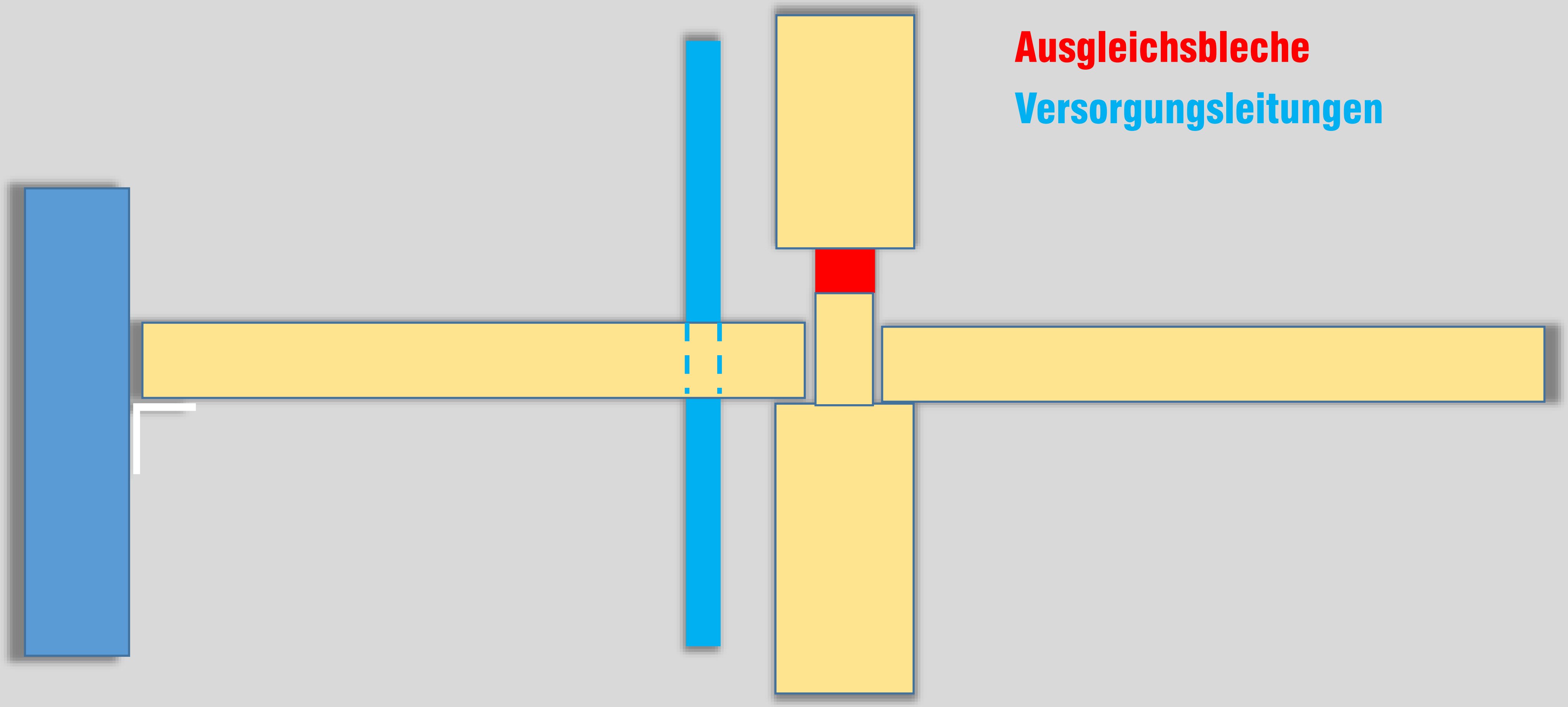




Zustand Bauausführung

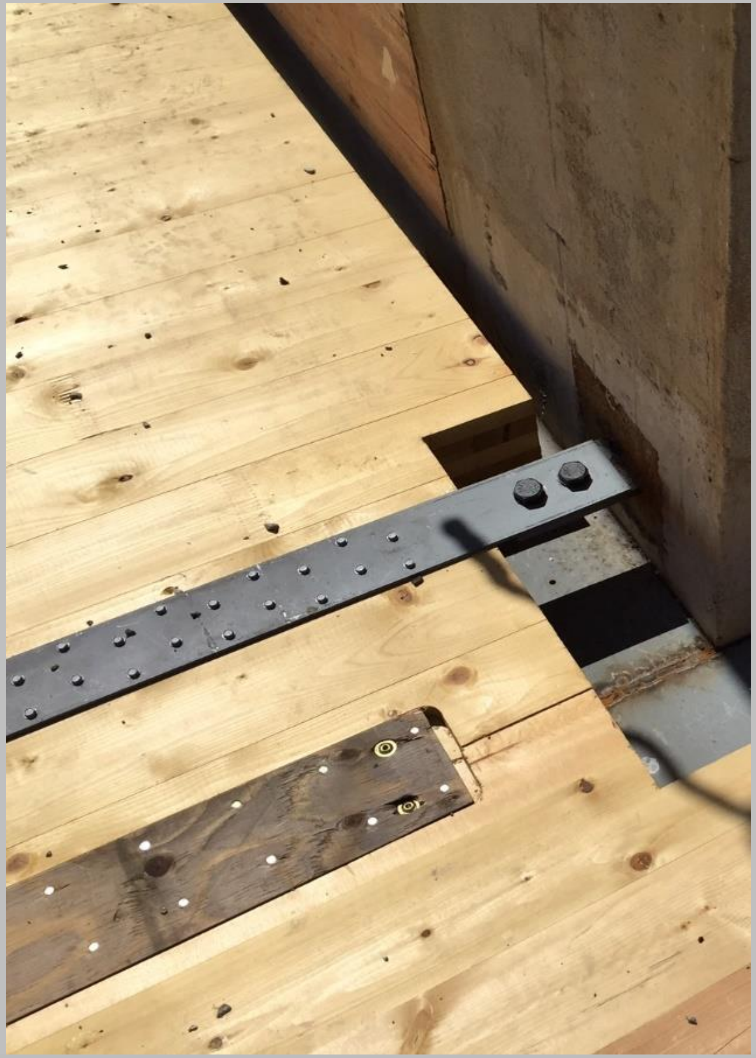


Zustand nach Setzungen



Aussteifung

Deckenscheibenausbildung und Anschluss der CLT-Decken an die Betonkerne



TALL WOOD at UBC BROCK COMMONS: 6 WEEKS MASS WOOD and FACADE

Nachhaltigkeit in Zahlen

Volumen verbautes Holz: 2.233 m^3

Diese Menge wächst in kanadischen Wäldern innerhalb von 6 Minuten.

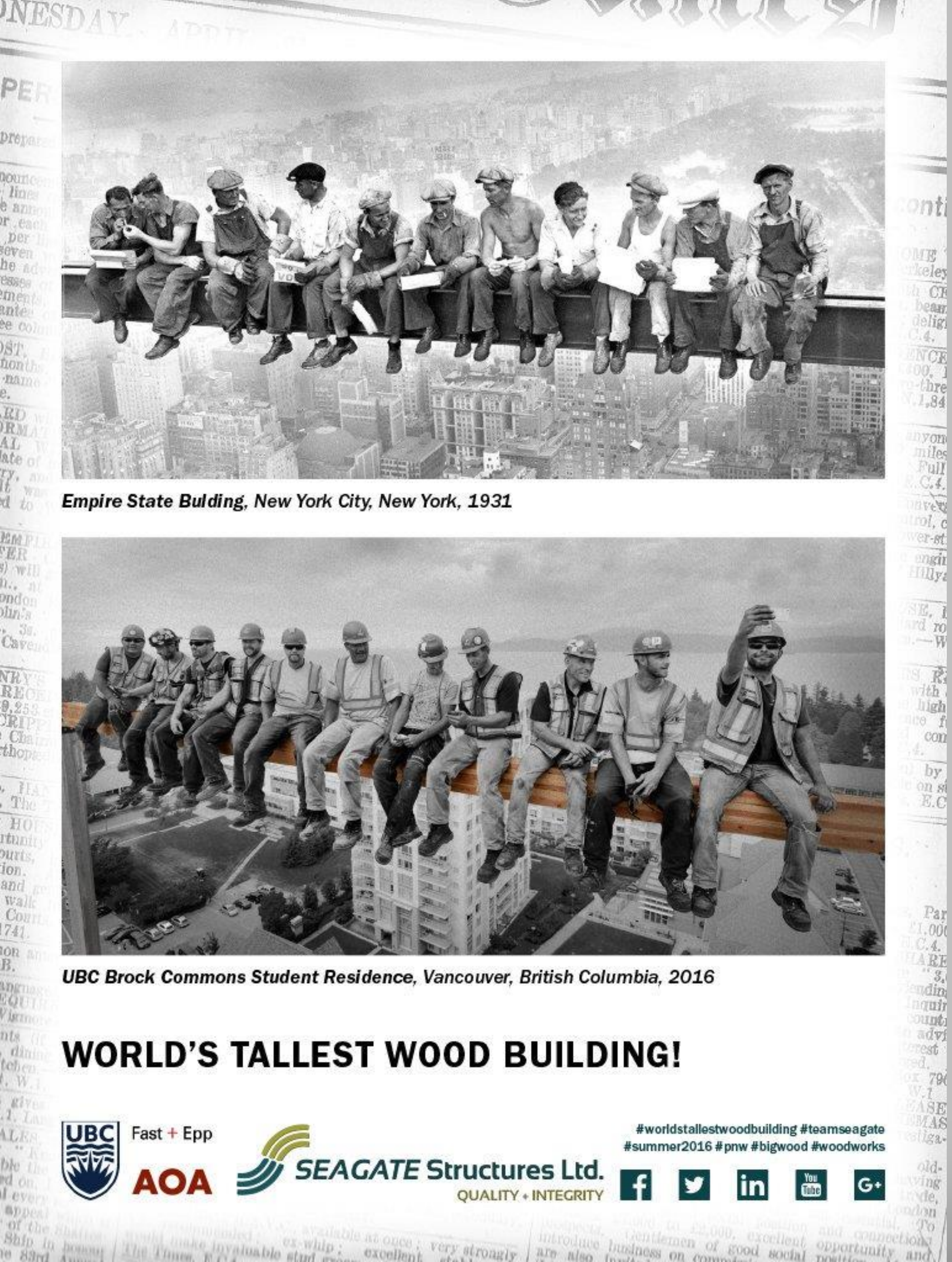
1.581 t Kohlenstoffdioxid werden in dieser Holzmenge gespeichert.

982 t Treibhausgasemissionen können so vermieden werden.

2.536 t mögliche Gesamtersparnis an Kohlenstoffdioxid-Ausstoß

Dies entspricht dem CO_2-Ausstoß von 490 fahrenden Autos in 1 Jahr.

- sehr effizientes Tragsystem
- auch größeres Raster möglich
- Keep things simple!
- Fachplaner und Gewerke früh einbeziehen!
- 3D-Modellierung in der Planungsphase zahlt sich aus!
- Vorfertigung im Baukastenprinzip



- 2017 mit 53 m das höchste Holzgebäude der Welt
- Baukasten-Prinzip
- 70 Tage zwischen Eintreffen der vorgefertigten Elemente und Richtfest
- mehrfach ausgezeichnet:

  2017 Construction Innovation, The Institution of Structural Engineers (GB)

  2018 Premier's Award BC Public Service

The Arbour

George Brown College
Toronto, Ontario, Kanada
Moriyama & Teshima Architects /
Acton Ostry Architects

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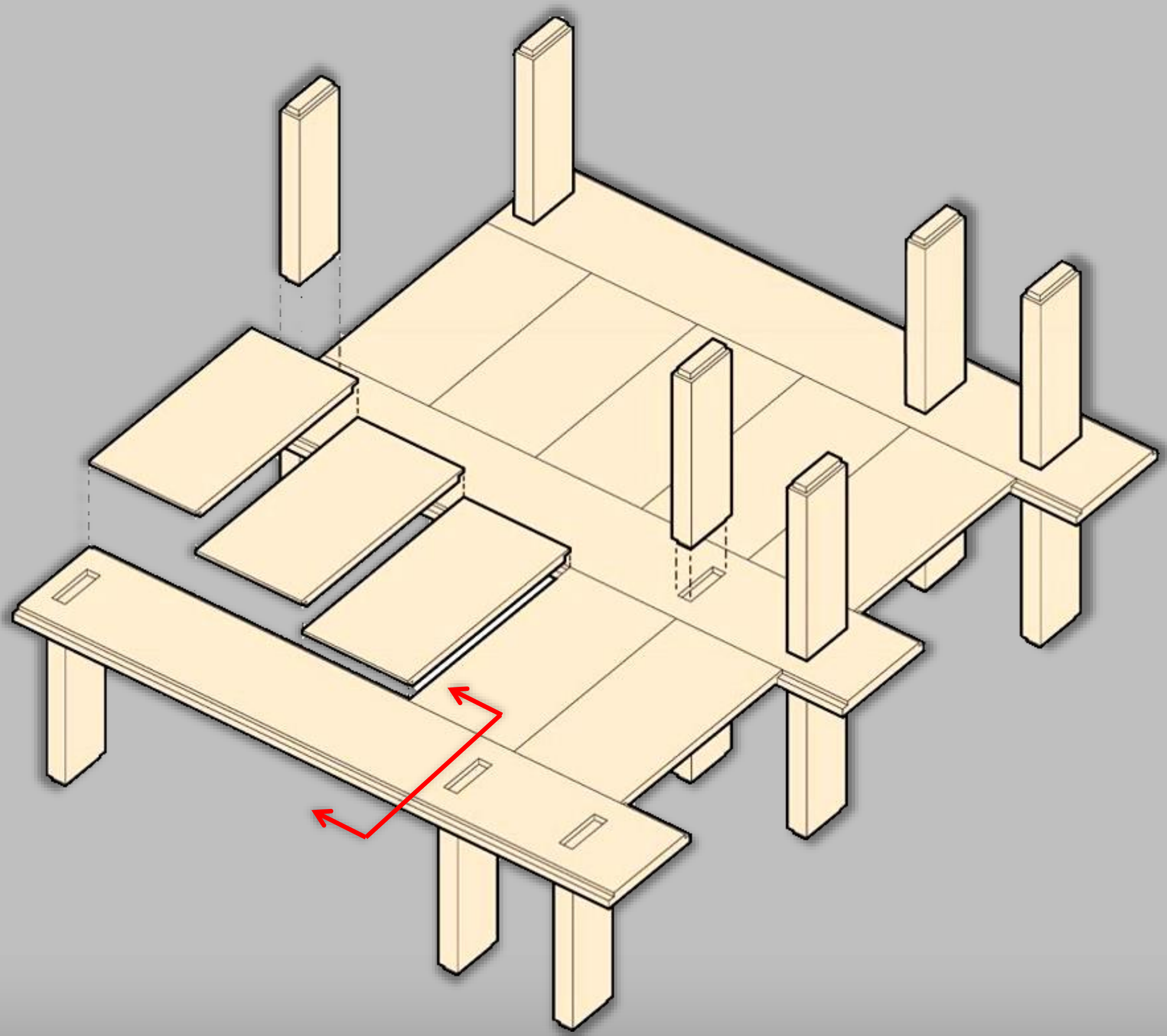

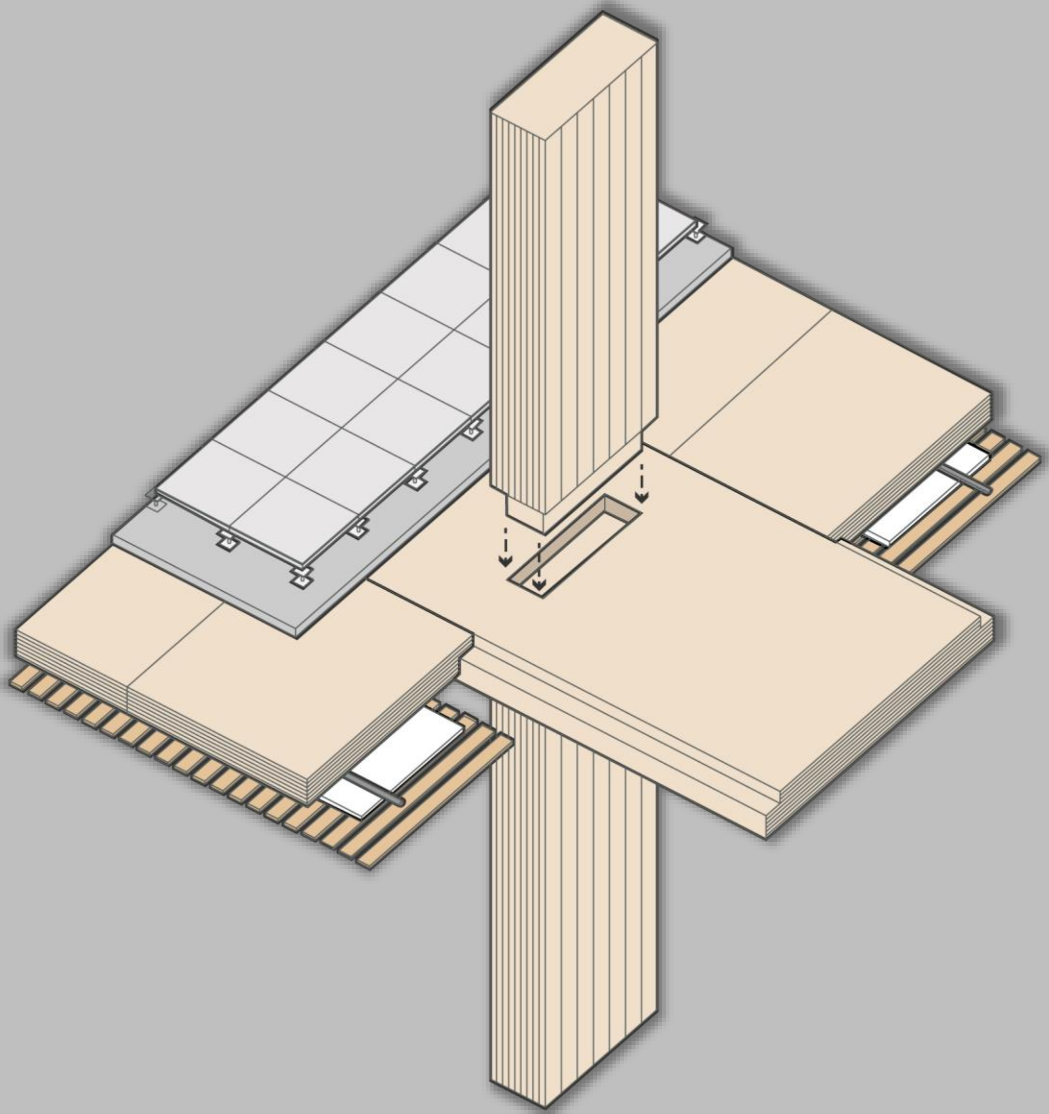

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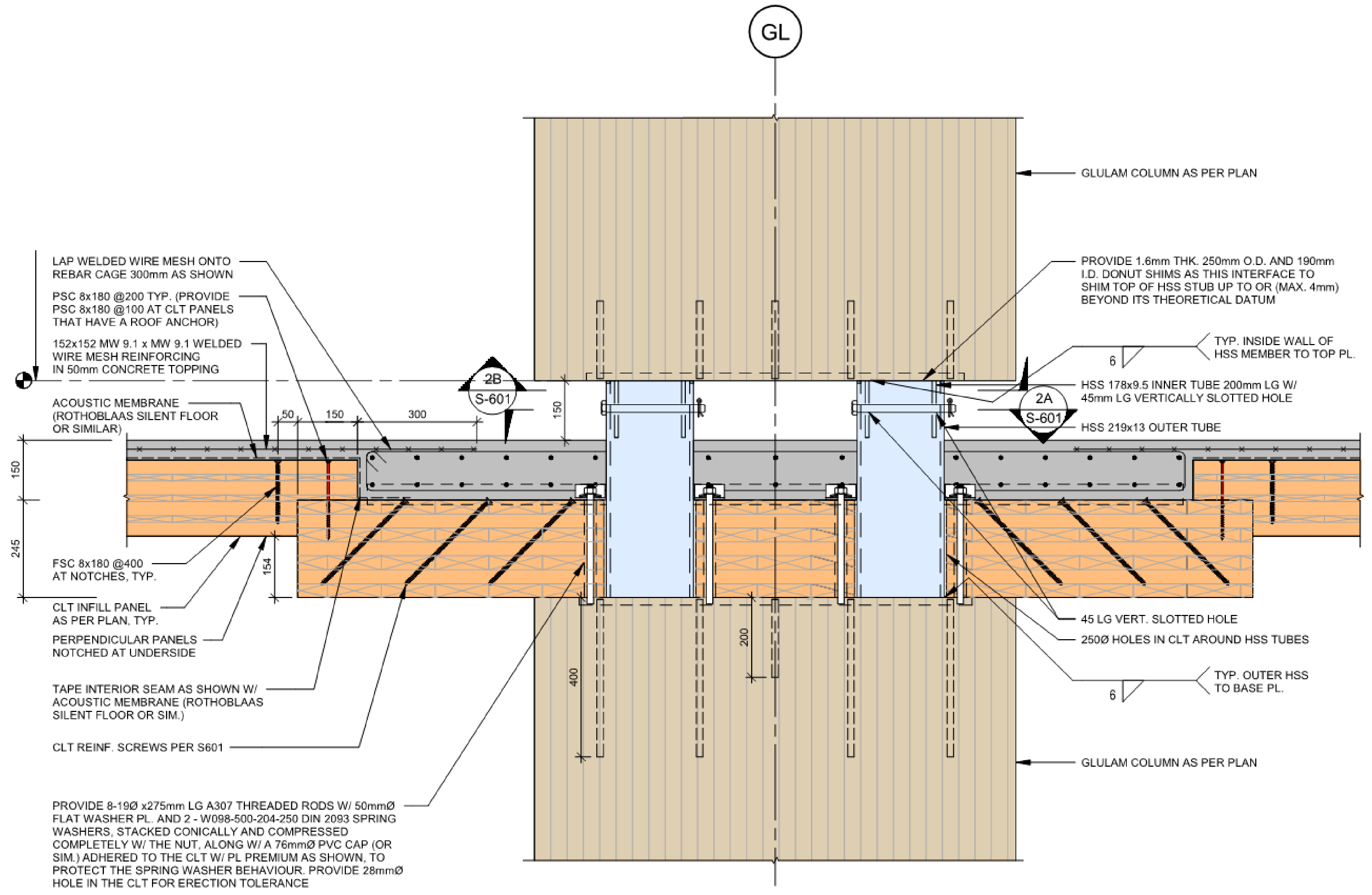
„Slab Band“

Stützenanschluss



Bauteiltests in Zusammenarbeit mit Kooperations-partnern

STRUCTURLAM
Intelligence In Wood

HBC.
HOCHSCHULE
BIBERACH
UNIVERSITY
OF APPLIED SCIENCES

UNBC UNIVERSITY OF NORTHERN BRITISH COLUMBIA

Fast + Epp itke

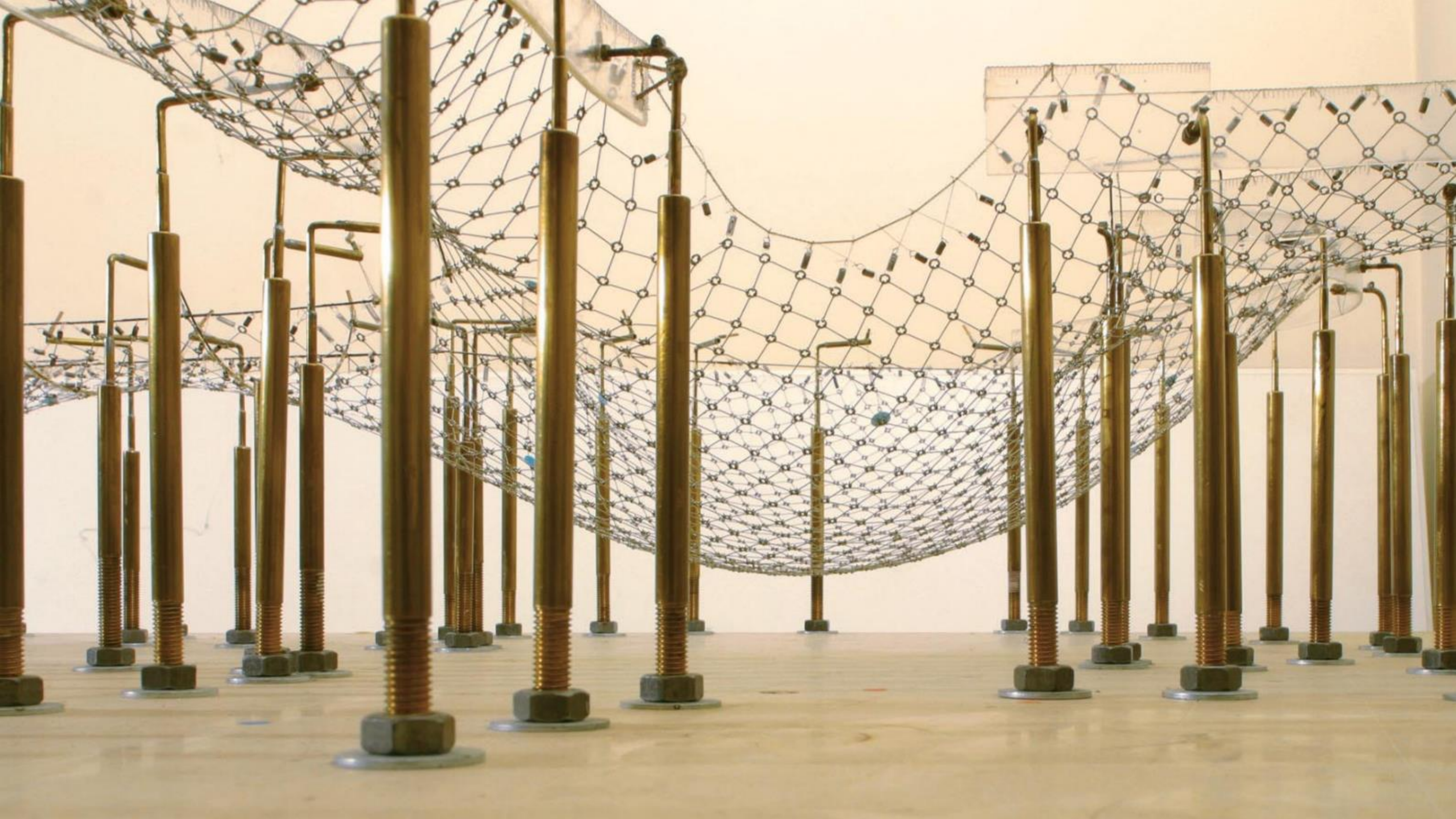

ORGANISCH
GEFORMT

Multihalle im Herzogenriedpark

Mannheim | Carlfried Mutschler, Joachim Langner, Frei Otto

Lass uns mol drübr schwätza!

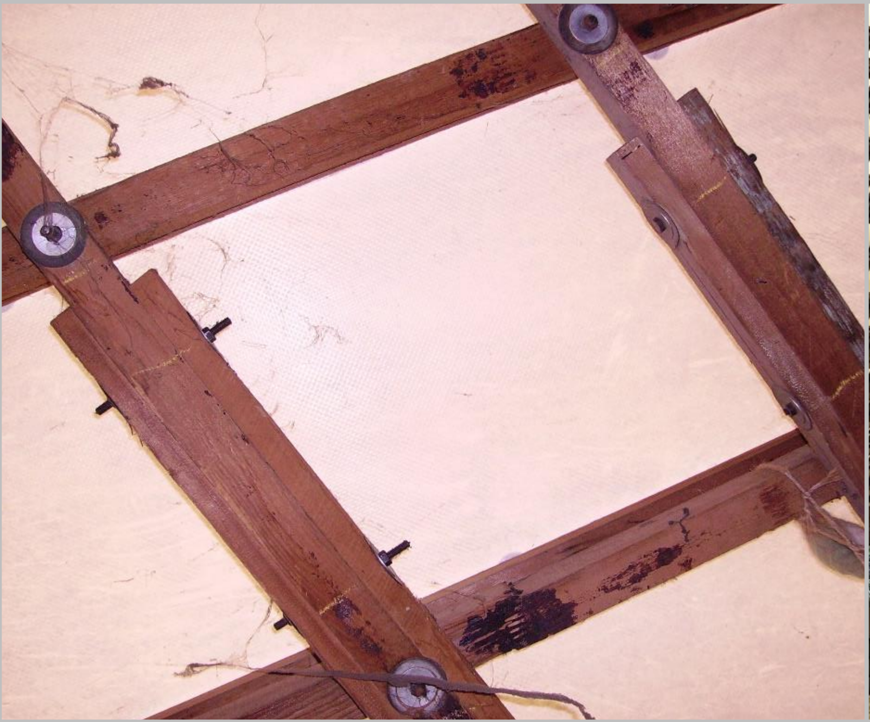
Fast + Epp itke

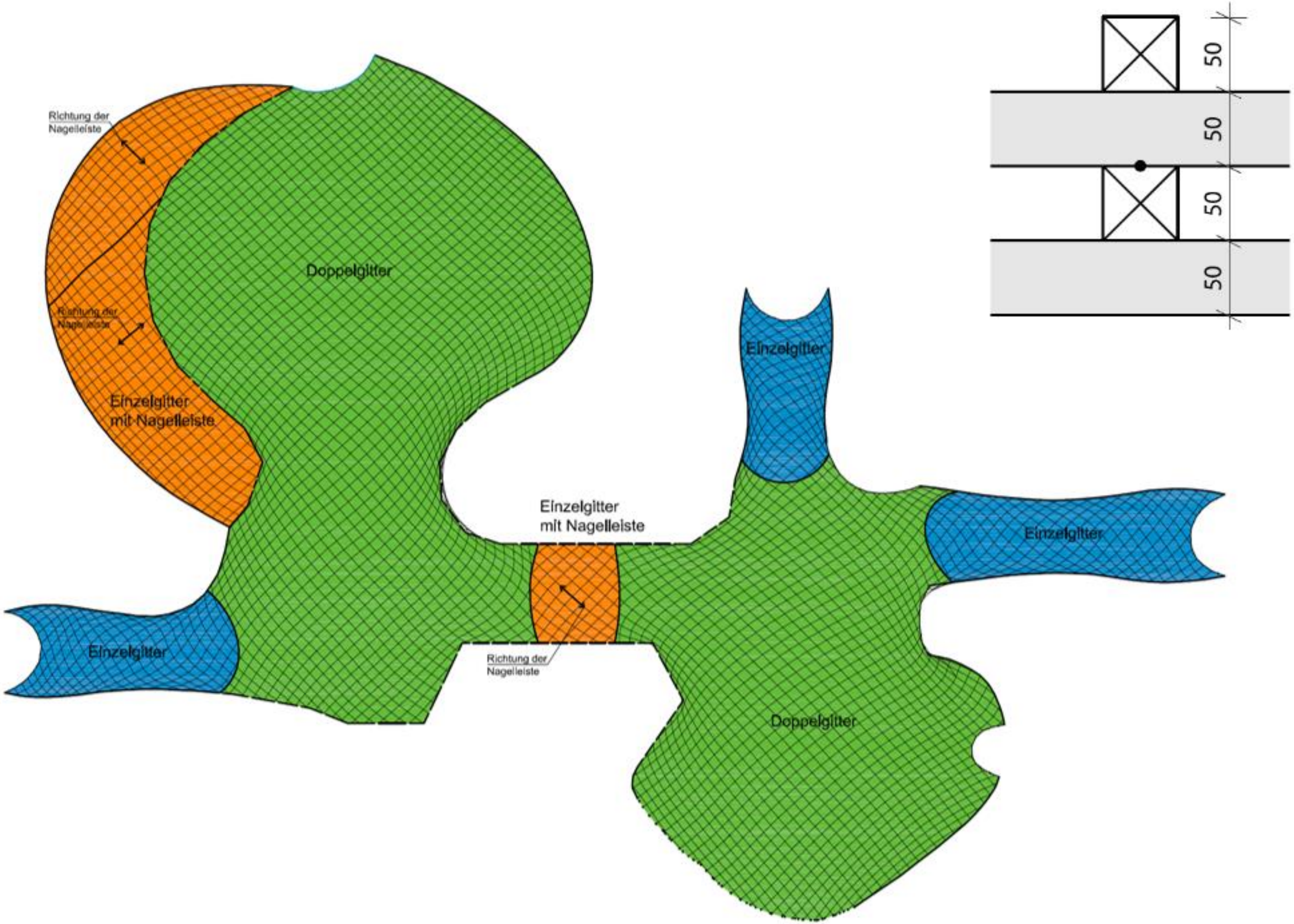



Konservatorische

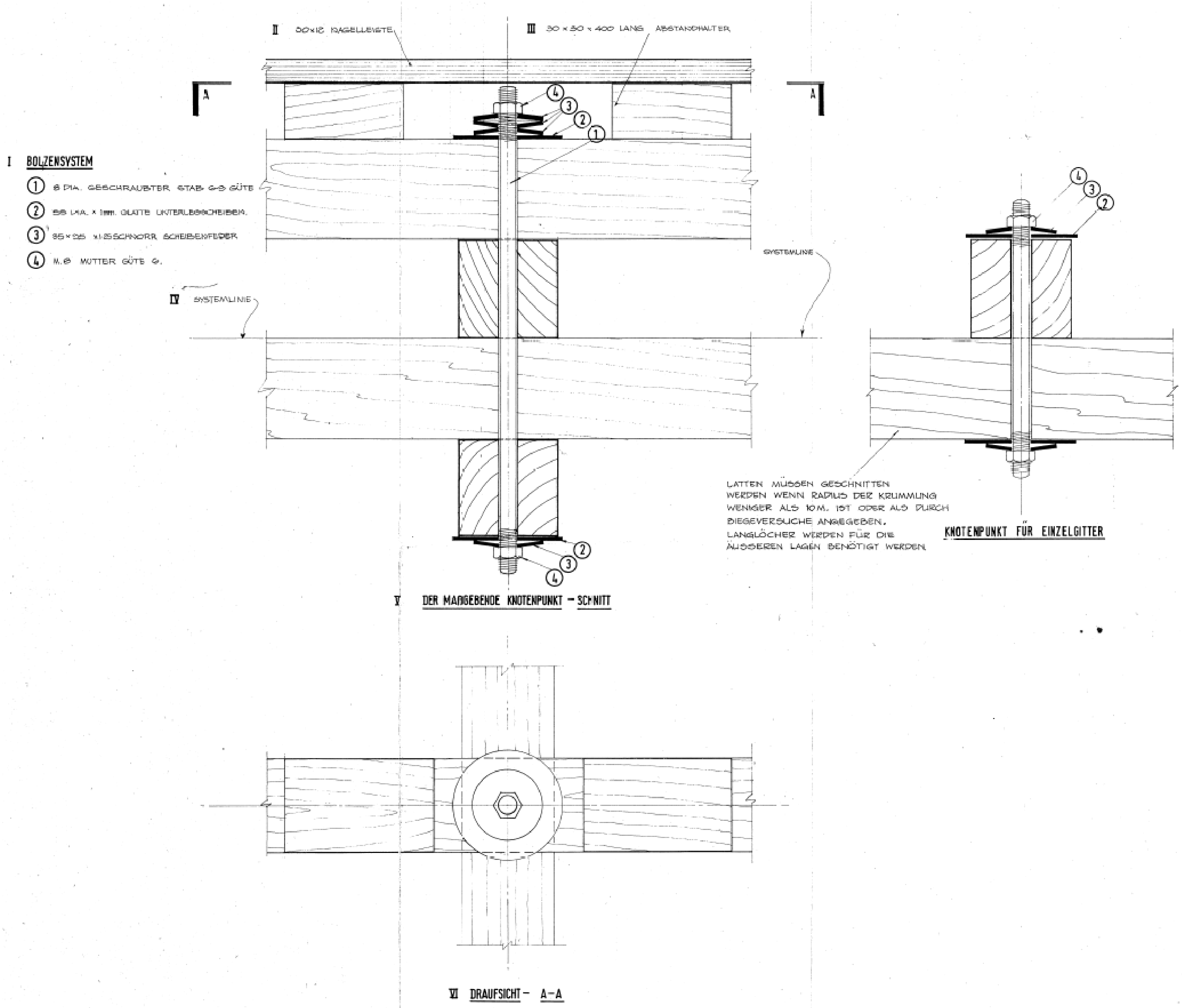
Werte

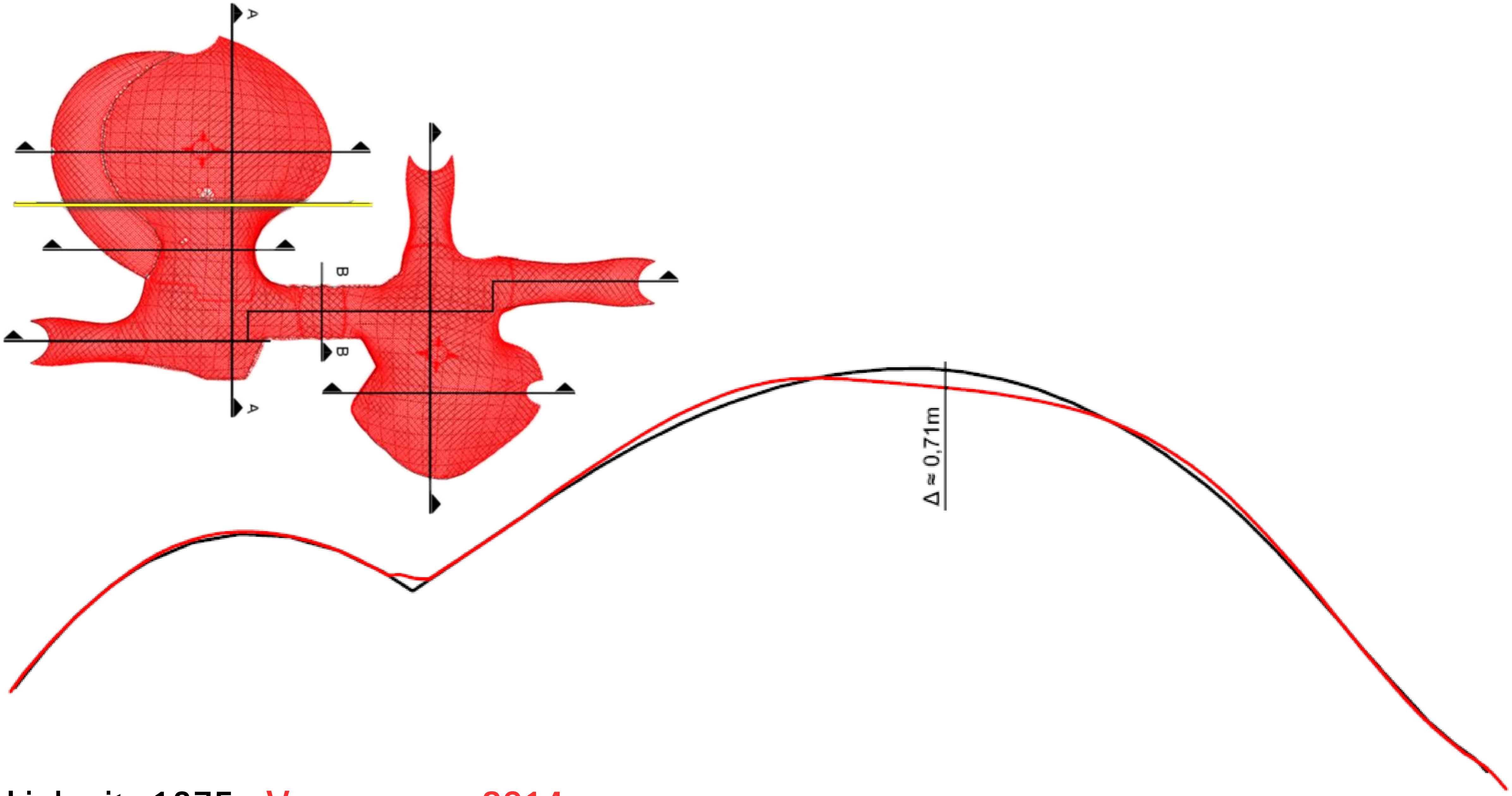
Freiform	Trans-luzenz
Holzraute	Stützen-freiheit





Richtung der Nagelleiste
Doppelgitter
Richtung der Nagelleiste
Einzelgitter mit Nagelleiste
Einzelgitter
Einzelgitter mit Nagelleiste
Einzelgitter
Einzelgitter
Richtung der Nagelleiste
Doppelgitter
50
50
50
50

Bauzeitliche Details und Verstärkungen





Linkwitz 1975 · Vermessung 2014

Schadensaufnahme
aktueller Zustand

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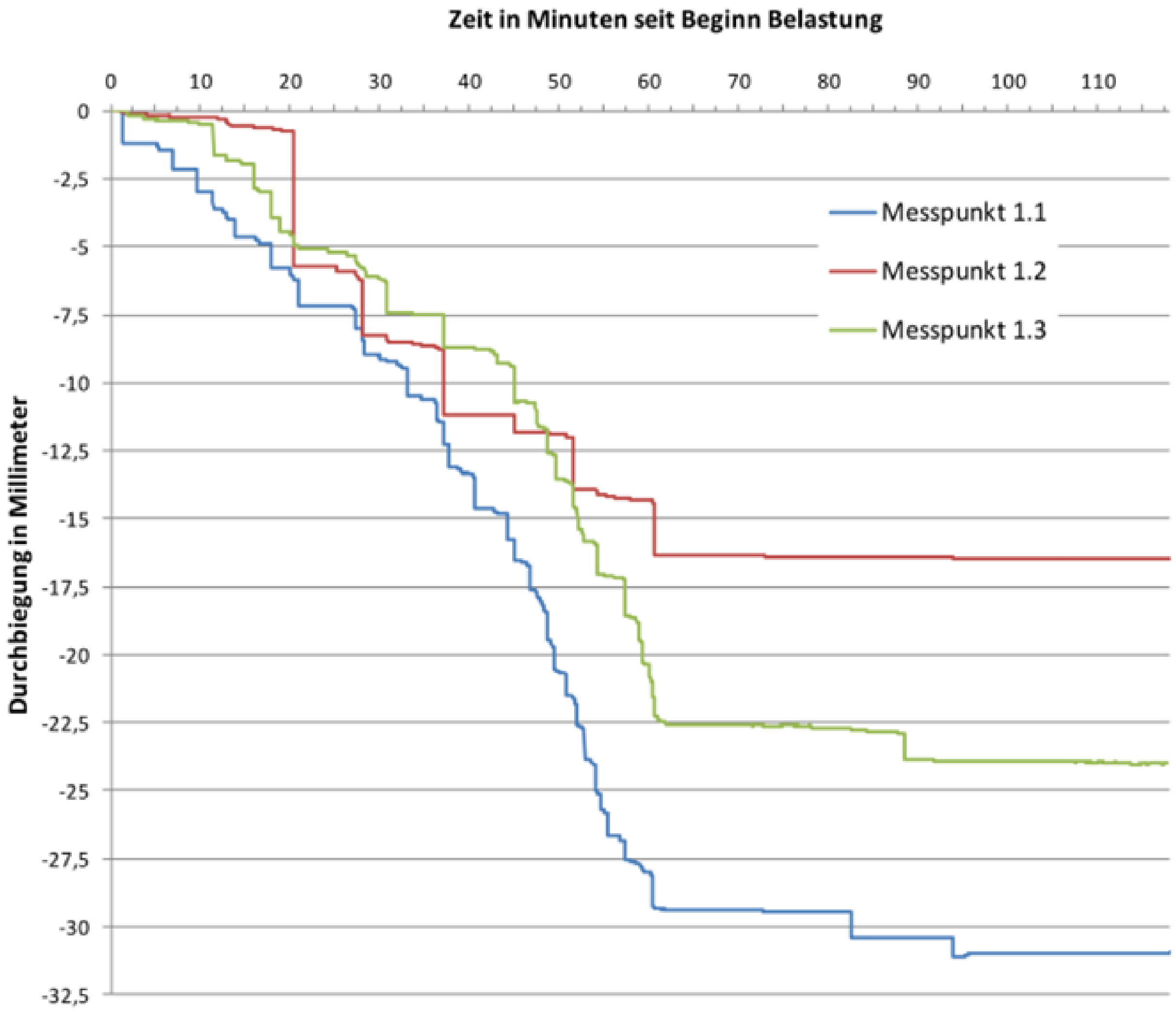
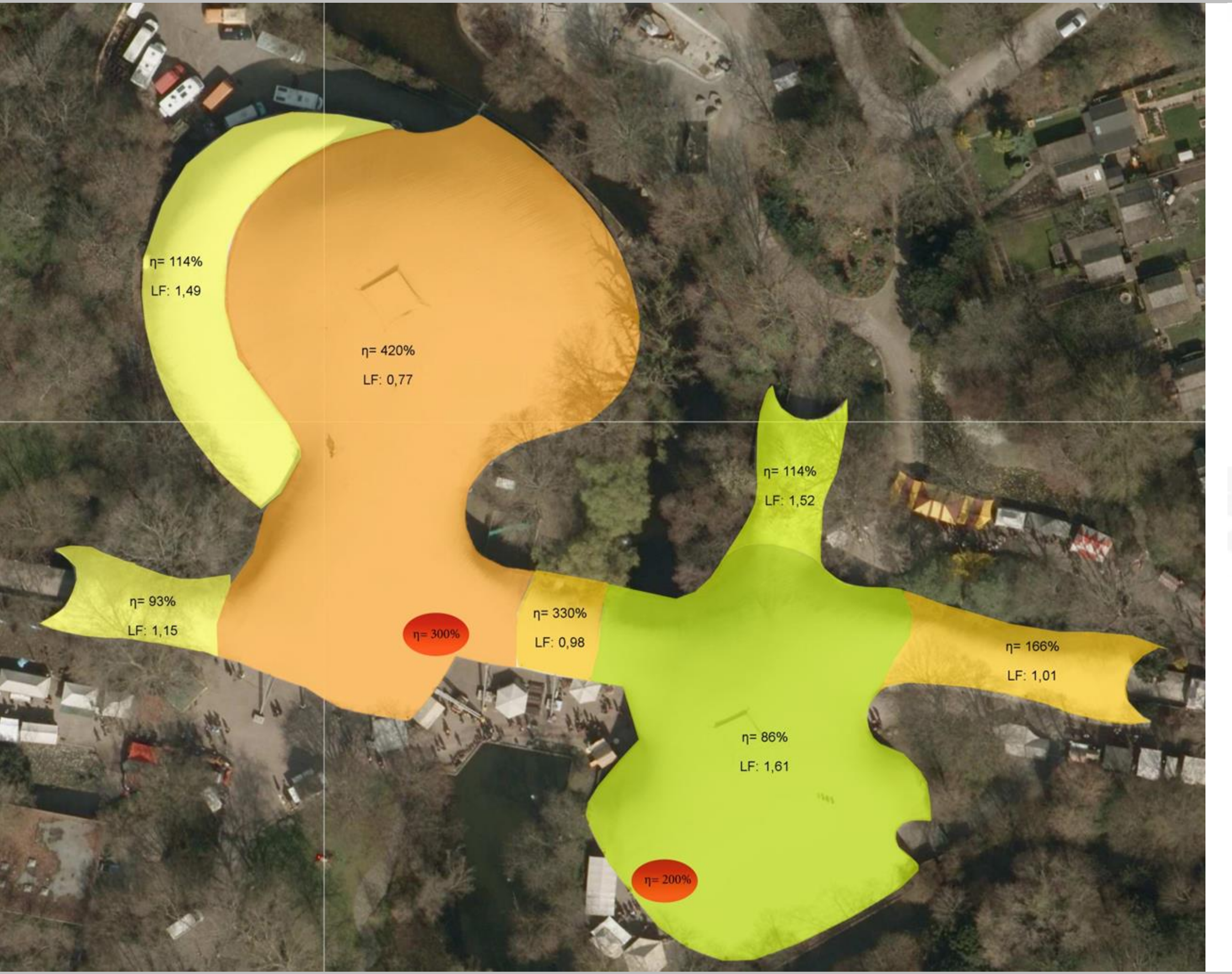
Fast + Epp itke

TH Rosenheim / Prof. Grimminger

Fast + Epp itke


Zeit in Minuten seit Beginn Belastung
0
10
20
30
40
50
60
70
80
90
100
110
0
-2,5
-5
-7,5
-10
-12,5
-15
-17,5
-20
-22,5
-25
-27,5
-30
-32,5
Durchbiegung in Millimeter
Messpunkt 1.1
Messpunkt 1.2
Messpunkt 1.3

Verformtes System



η = 114 %; LF: 1,49

η = 93 %; LF: 1,15

η = 420 %; LF: 0,77

η = 330 %; LF: 0,98

η = 300 %

η = 114 %; LF: 1,52

η = 86 %; LF: 1,61

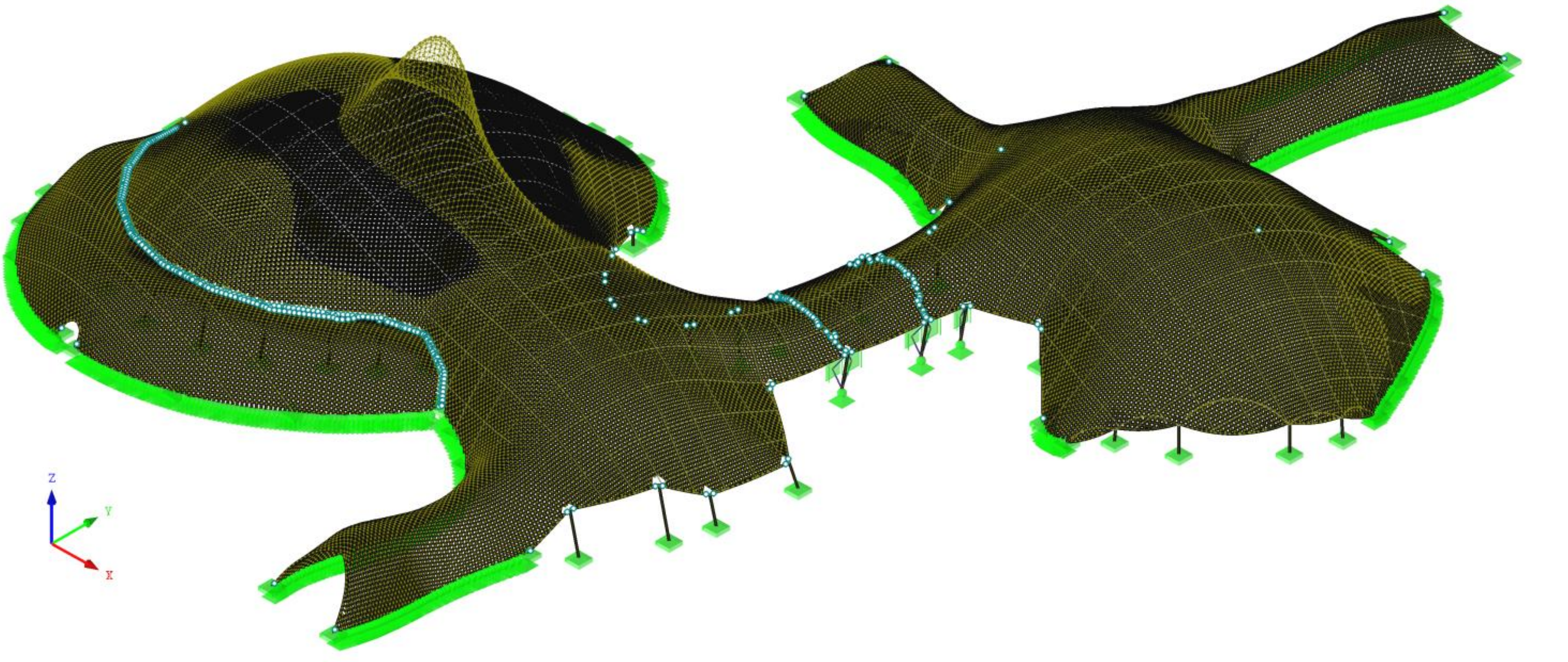
η = 166 %; LF: 1,01

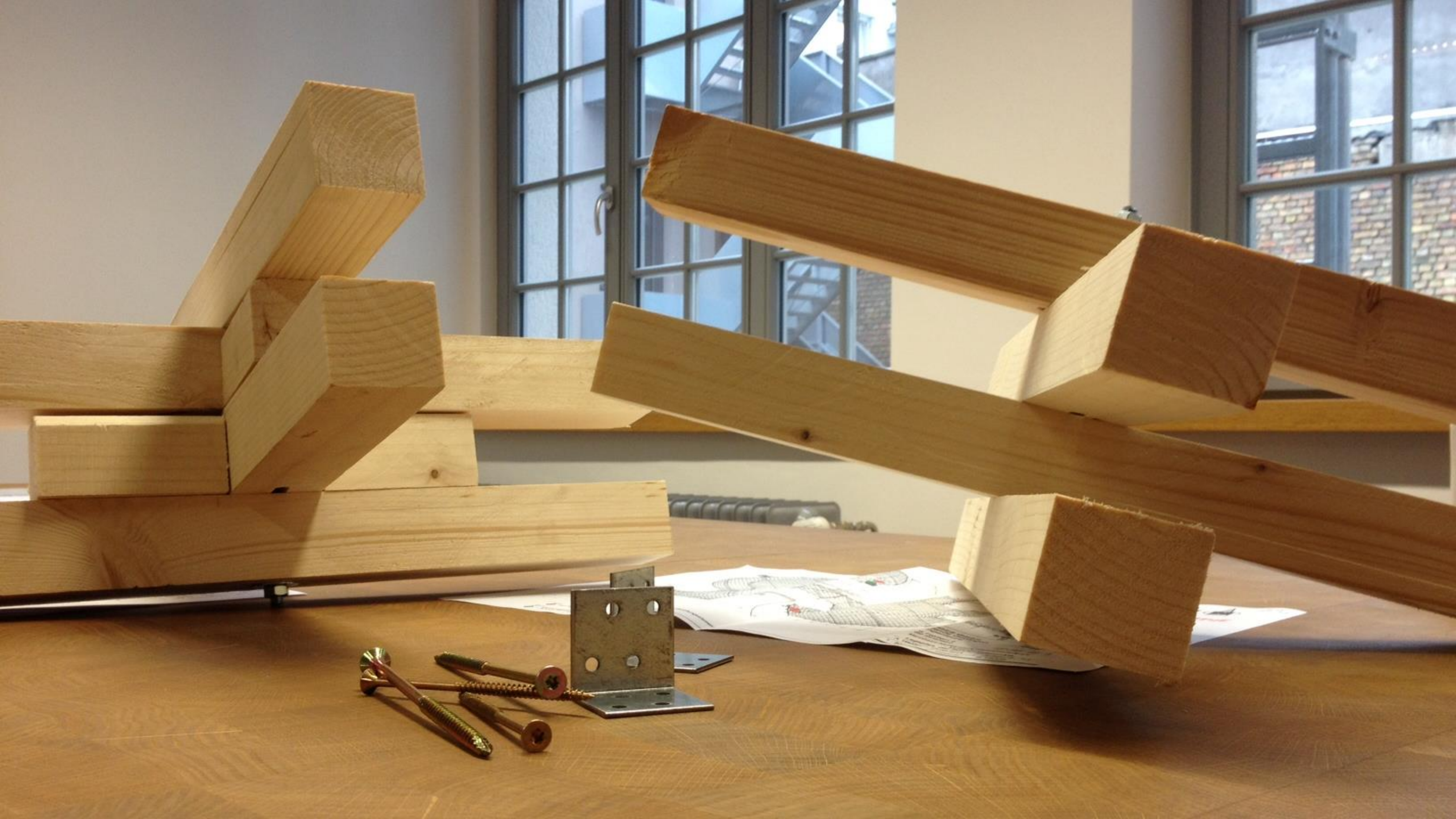
η = 200 %

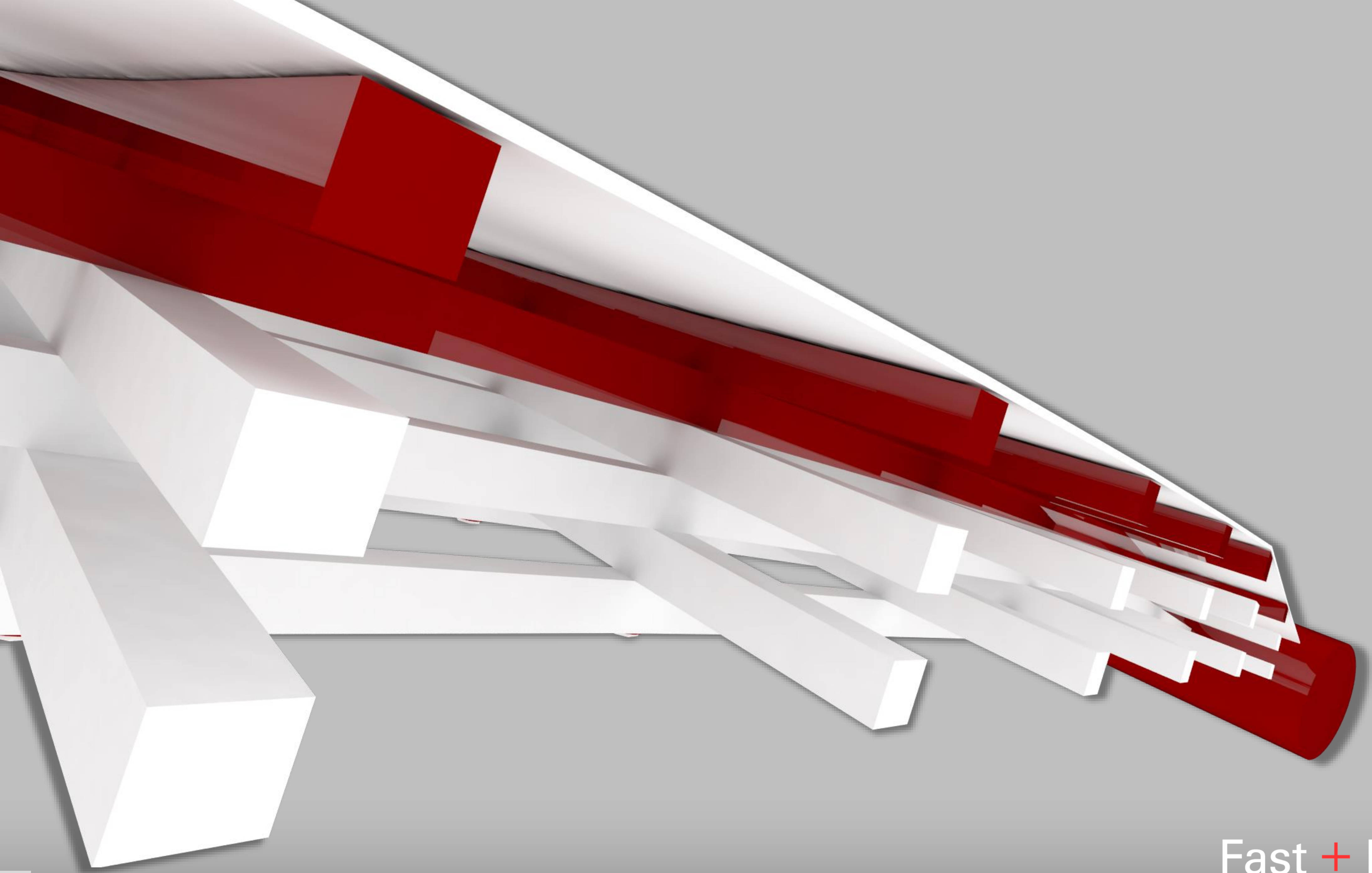
η Ausnutzung
LF Lastfaktor

Tragwerksanalyse

Verformtes System – LK15: 1. Eigenform



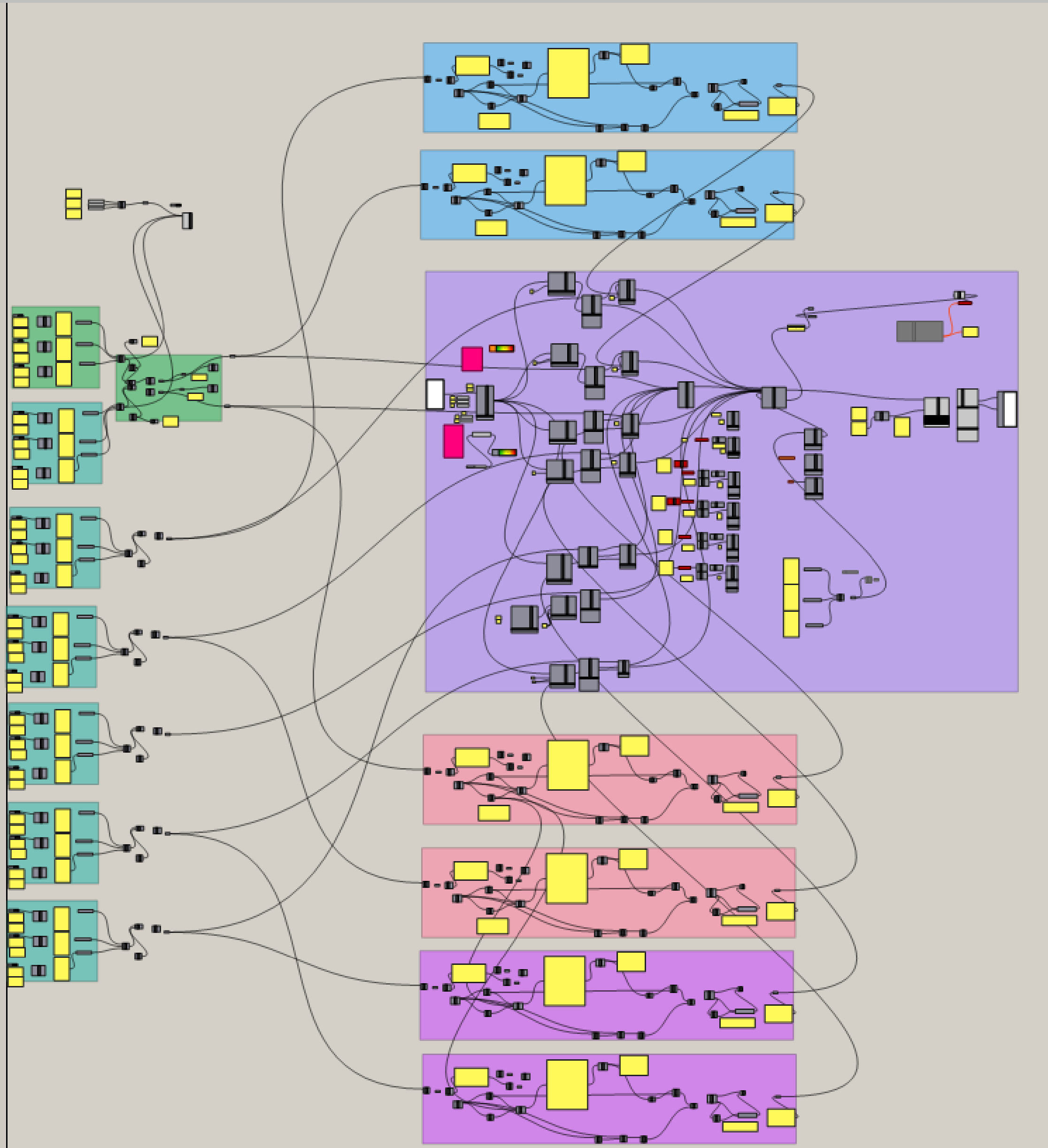


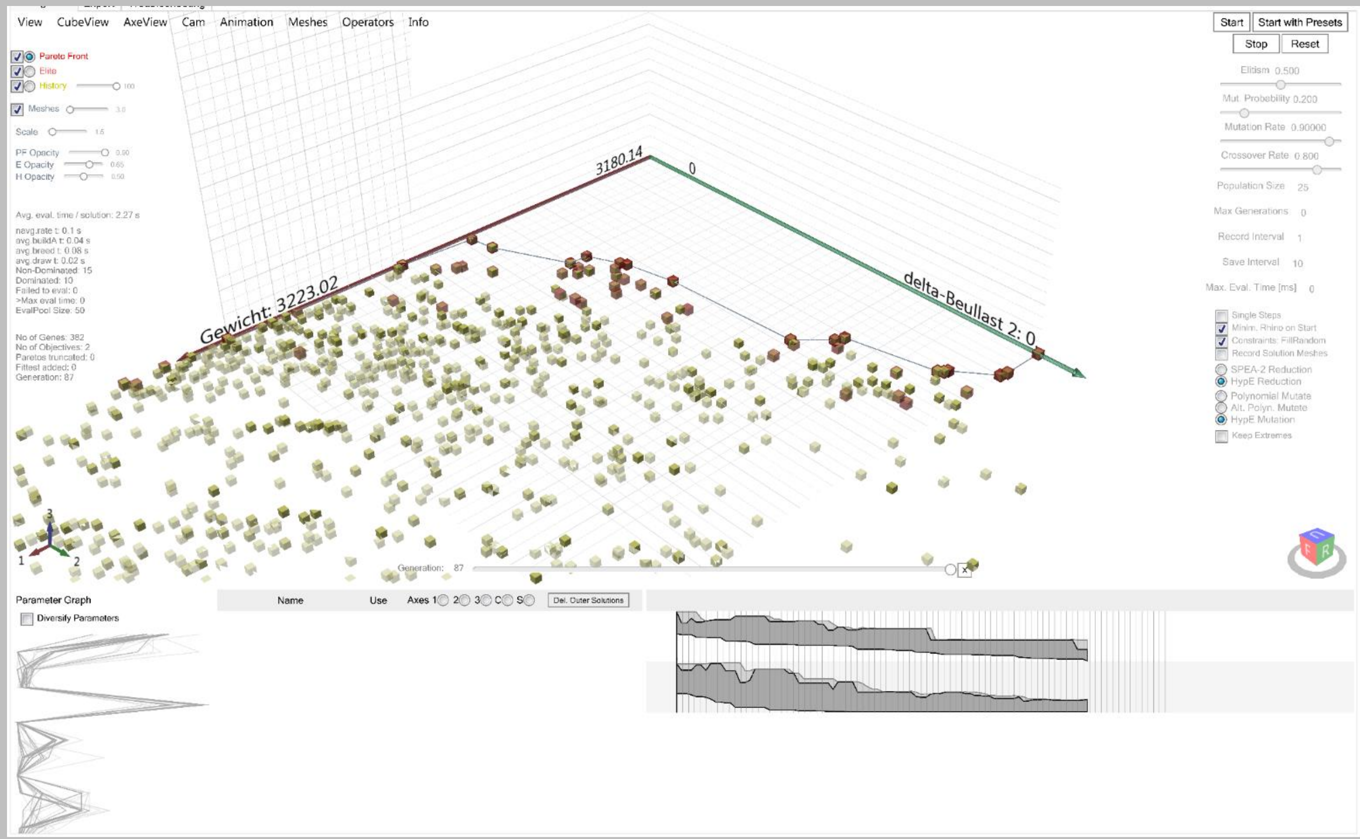


Fast + Epp itke

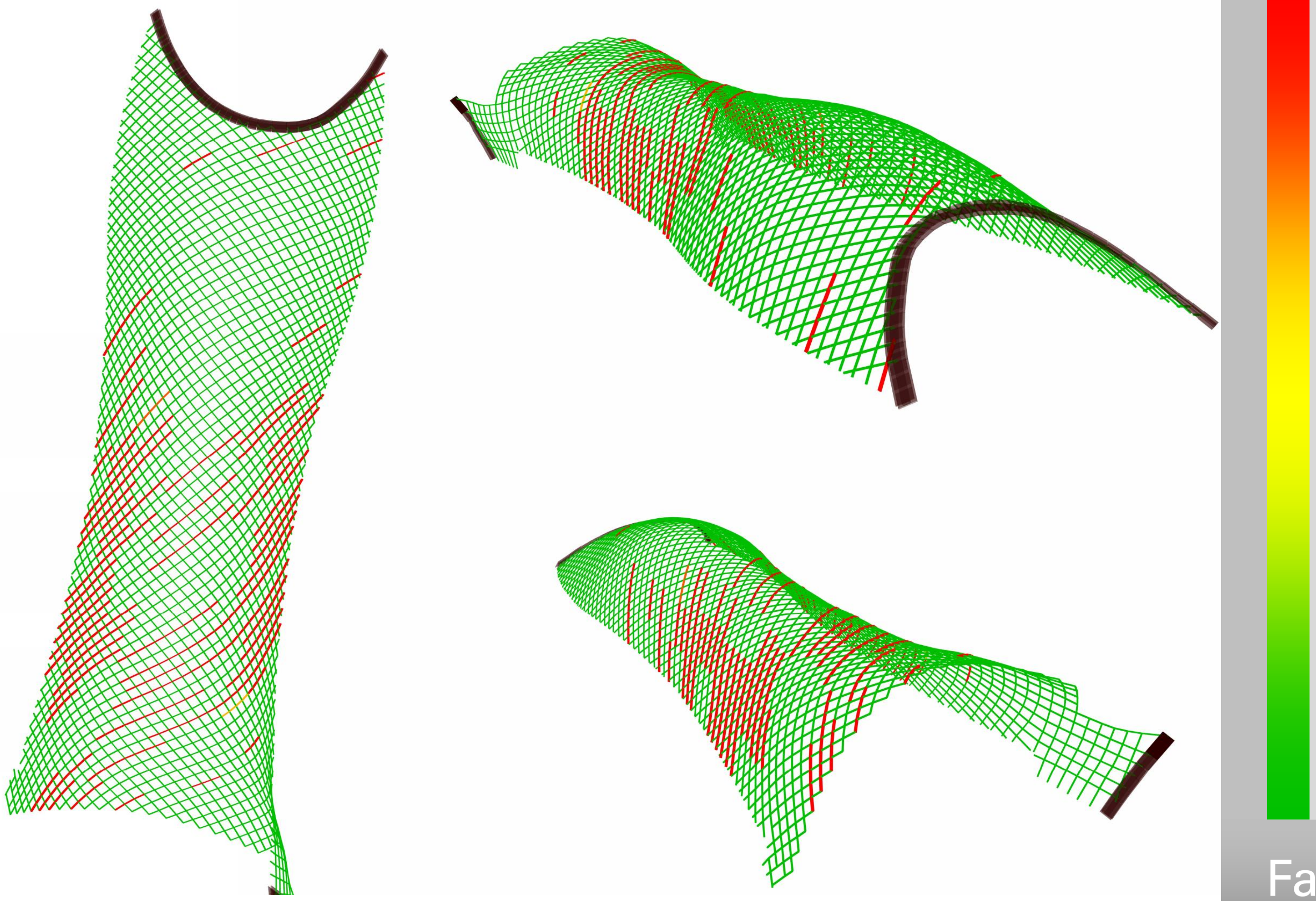
Vorgehensweise

Parametrische Berechnung in Grasshopper und Karamba





- Variation der Querschnittshöhe für einzelne Lattenabschnitte
- Optimierung des Holzgewichtes und der Beullast mittels Solver (Pareto-Optimierung)



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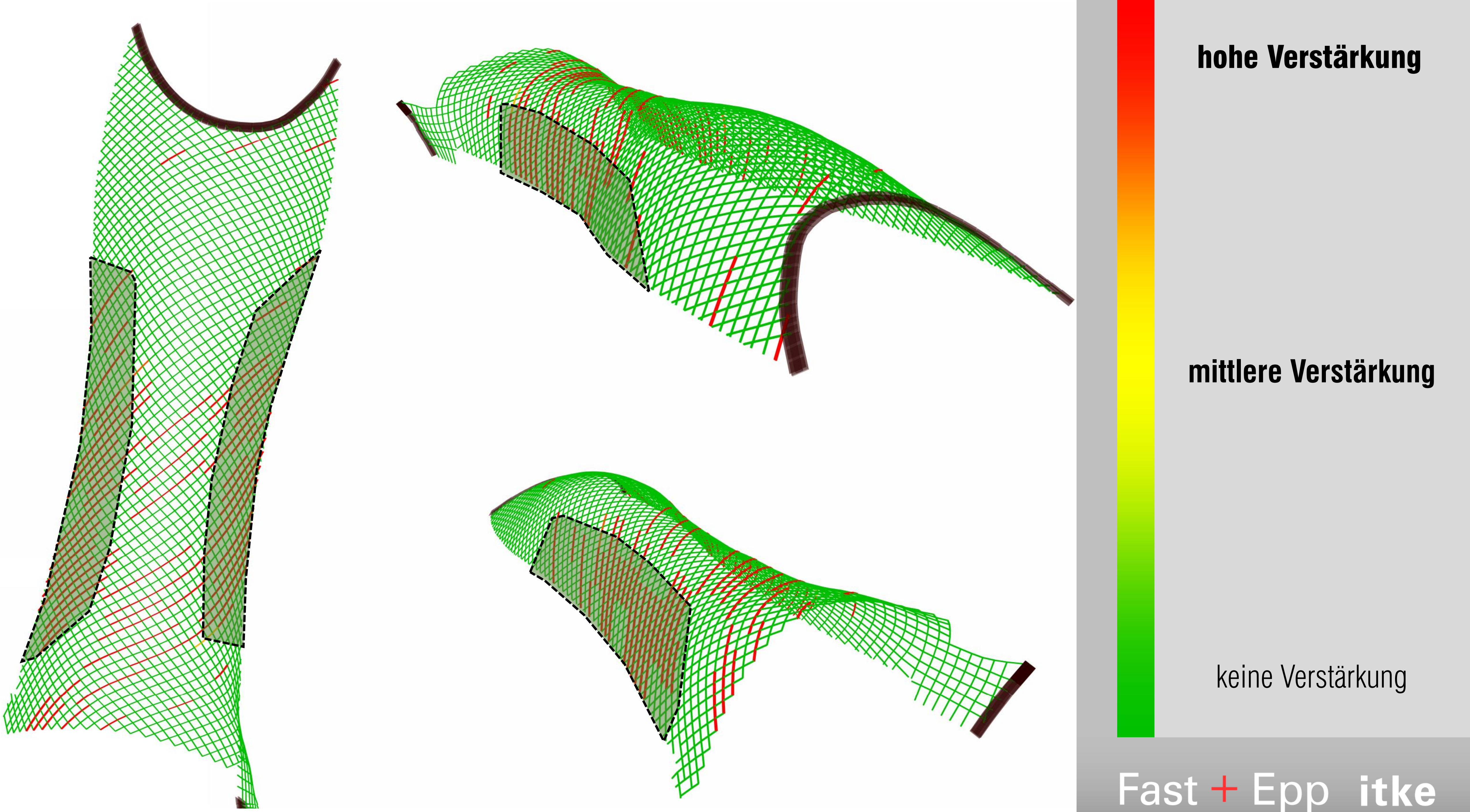

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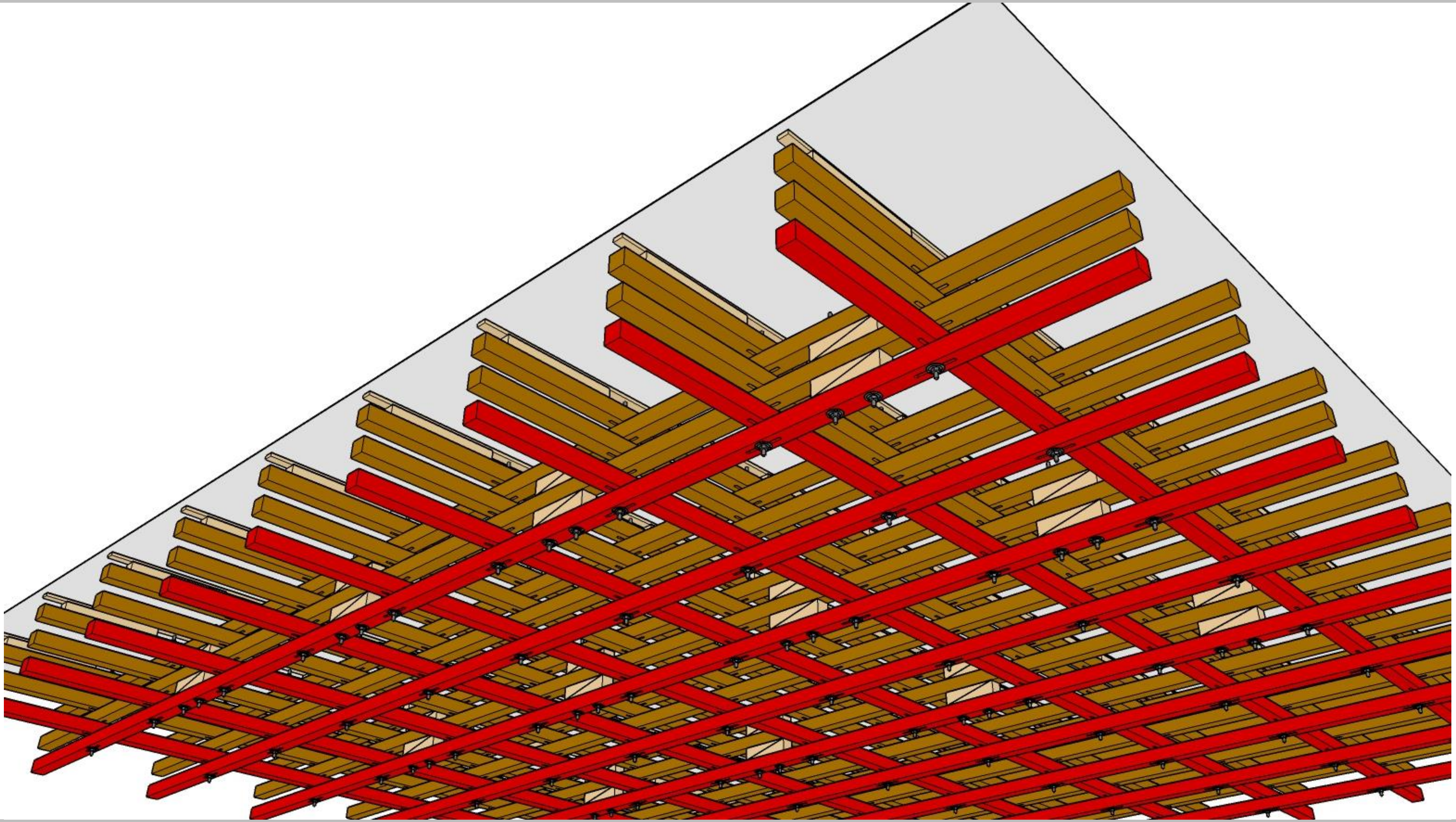
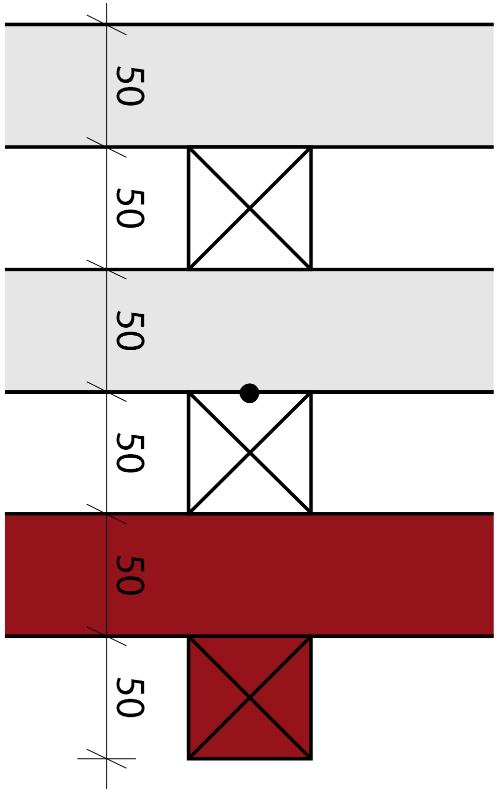
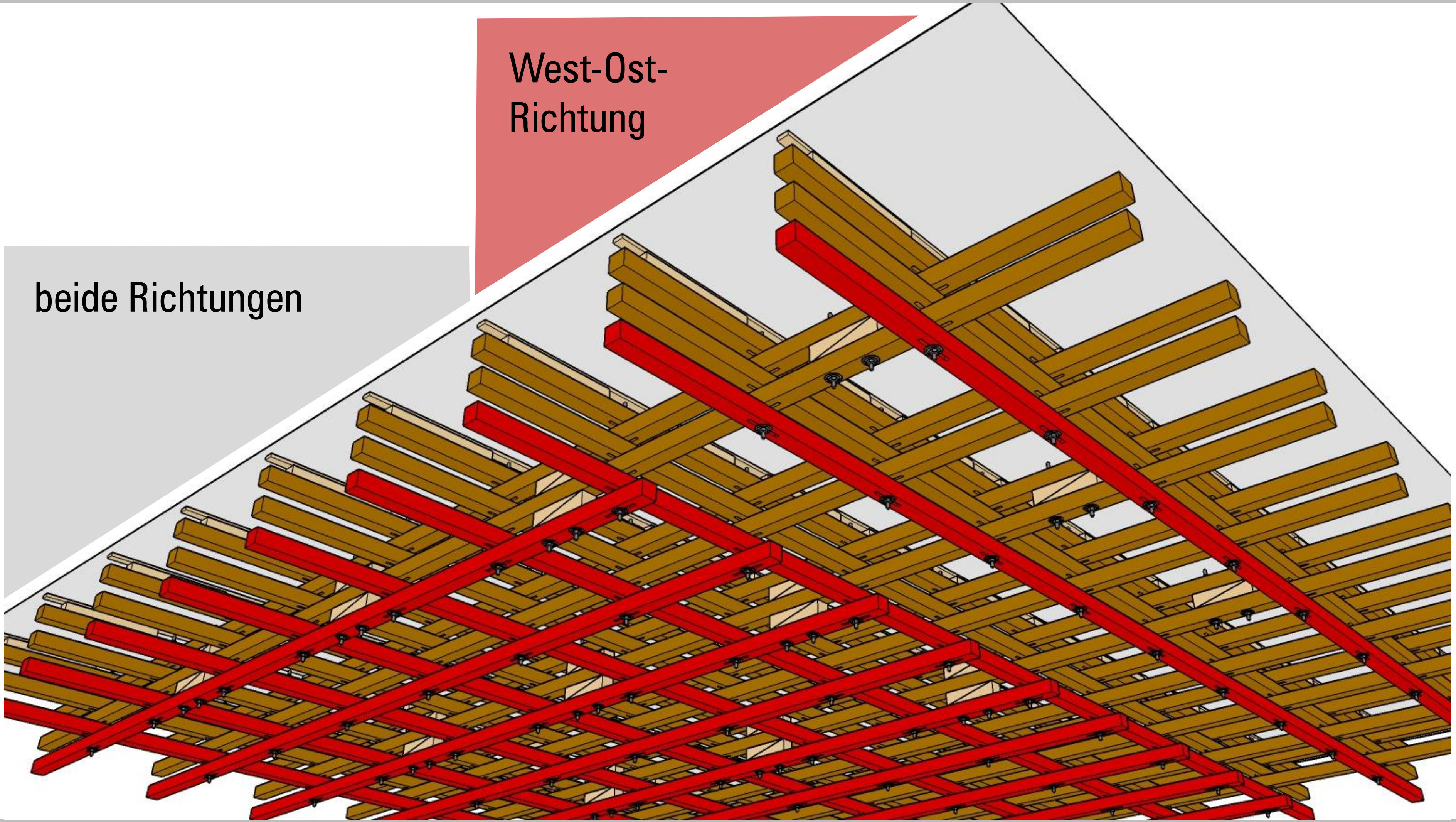
Doppelgitter, von unten verstärkt



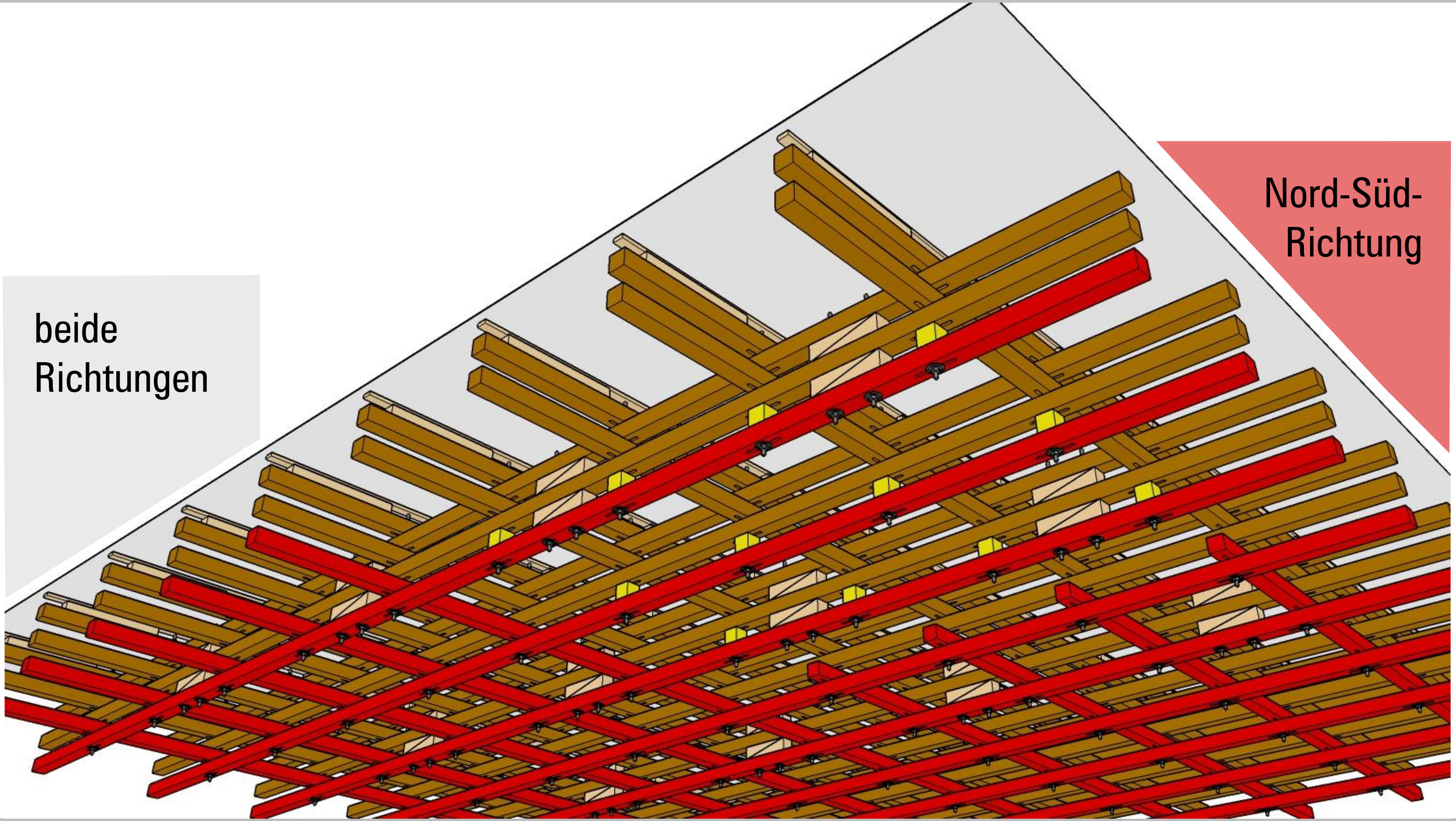


beide Richtungen

Doppelgitter, von unten verstärkt



Doppelgitter, von unten verstärkt



- Instandsetzungsplanung für die größte Holzgitter-schalenkonstruktion der Welt von Frei Otto
- Umsetzung bis zur Bundes-gartenschau 2023 geplant
- Minimierung durch eine parametrische Optimie-rungsrechnung
- mehrere Testflächen, Gutachten und Versuche

Besucherzentrum
Van Dusen Botanical Garden

Vancouver, Kanada | Perkins + Will Canada

Hält und sieht gut aus.

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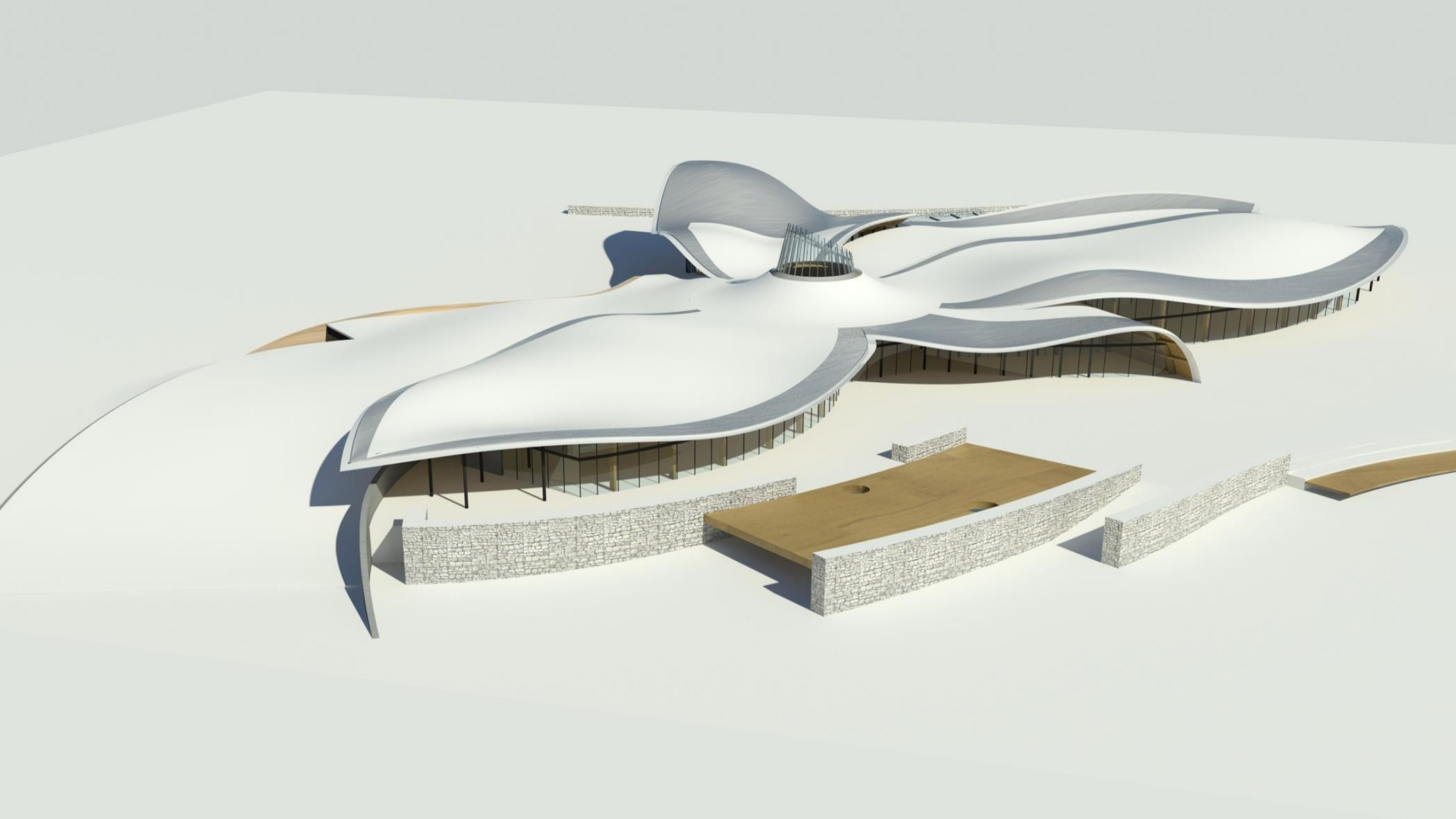
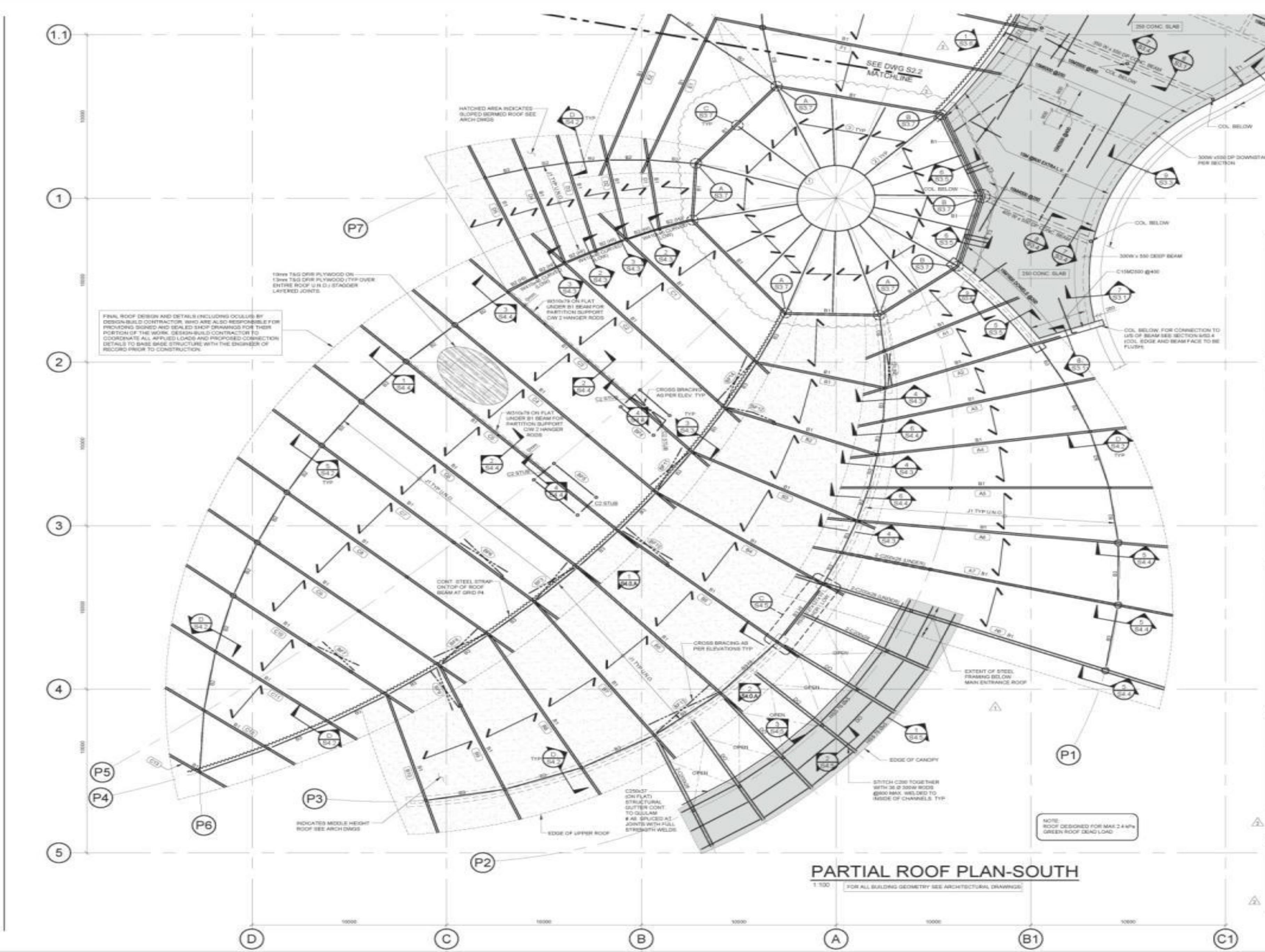




PARTIAL ROOF PLAN-SOUTH

1:100 FOR ALL BUILDING GEOMETRY SEE ARCHITECTURAL DRAWINGS

LEGEND

- REINF. CONCRETE WALL
- LOAD BEARING STUD WALL AS PER SCHEDULE
- NON-LOAD BEARING CMU WALL
- RAMMED EARTH WALL (BY OTHERS)
- CEILING JOIST AS PER PLANS
- INDICATES BEAM, HEADER OR HIP (D) DENOTES DROPPED CONDITION
- BF1 INDICATES BRACE FRAME TYPE, SEE DWG S4.0 & S4.1 FOR DETAILS

COLUMN SCHEDULE

MARK	DIMENSION	REMARKS
C1	230Ø	TURNED D.FIR GLULAM 16c-E
C2	HSS 168Øx6.4	-
C3	350Ø	TURNED D.FIR GLULAM 16c-E
C4	D E L E T E D	
C5	D E L E T E D	
C6	HSS 168Øx13	

JOIST SCHEDULE

MARK	TYPE
J1	38x184 @400 SPF #2
J2	38x140 @600 SPF #2

NOTE:
ALL JOISTS TO BE FSC CERTIFIED

BEAM SCHEDULE

MARK	TYPE
B1	2 - 82x532 D.FIR GLULAMS 24f-EX CURVED & TAPERED AS PER ARCH. LAMINATION THICKNESS TO SUIT CURVATURE. (BEAM STRENGTHENING DETAILS TO BE COORDINATED WITH DESIGN BUILD CONTRACTOR WHERE REQUIRED)
B2	STEEL STRAP AND GLULAM BLOCKING DIAPHRAGM CHORD. (DETAILS TO BE COORDINATED WITH DESIGN BUILD CONTRACTOR)
B3	DRAG STRUT. (DETAILS TO BE COORDINATED WITH DESIGN BUILD CONTRACTOR)

NOTE: A1 B1 C1 D1 E1 F1 INDICATES GLULAM BEAM REFERENCE TAGS AS SHOWN ON ARCHITECTURAL DRAWINGS

ALL GLULAM LAMINATION STOCK TO FSC CERTIFIED

250 SLAB REINFORCEMENT

15M @ 400 EACH WAY BOTTOM PLUS ADDITIONAL REINF SHOWN ON PLANS

BAR PLACING ORDER (U.N.O)

- TOP UPPER LAYER (T.U.L.)
- TOP LOWER LAYER (T.L.L.)
- BOTTOM UPPER LAYER (B.U.L.)

TYP. TOP REINFORCEMENT

T1 = C15M1500 @400
T2 = C15M1500 @200
T3 = 15M @200 U-BARS
1200

LEGEND TO OCULUS FRAMING

1. ALLOW FOR CIRCULAR COMPRESSION RING FORMED BY CURVED 2-C310x31 TOE TO TOE CHANNELS
2. CURVED GLULAM RIBS
3. WOOD FRAME INFILL PANELS BETWEEN GLULAM RIBS TO LATER DETAILS

Fast+Epp
structural engineers

VanDusen Botanical Garden

Vancouver Board of Parks and Recreation

5251 Oak Street
Vancouver BC V6M 4H1

CONTRACT DOCUMENTS

NO	ISSUE	DATE
3	ISSUED FOR STRUCT ?	?
2	ISSUED FOR STRUCT SSI-7	SEPT 8/10
1	ISSUED FOR STRUCT SSI-5	AUG 27/10
-	CONTRACT DOCUMENTS	AUG 13/10
-	ISSUED FOR CONSTRUCT.	JUN 18/10

Sheet Information	
Date	Feb. 23/10
Job Number	1457
Drawn	BLF
Checked	DP
Approved	-

Title

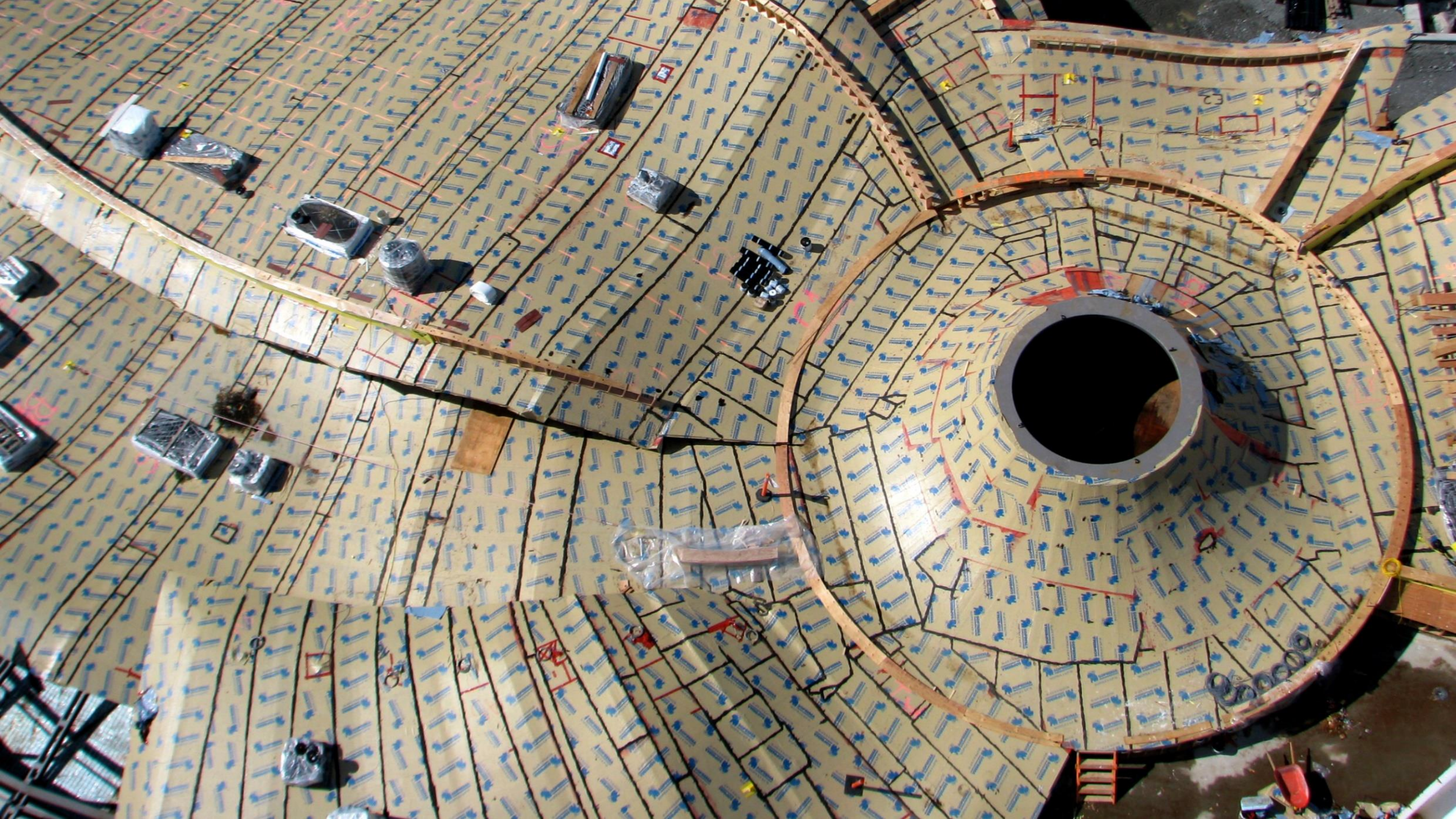
Partial Roof Plan South

Sheet

S2.3

3


HYDRAMACH



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- organische Dachform aus 71 individuell geformten Holzelementen
- integrierte Installationen und fertige Oberflächen
- LEED®-Zertifizierung Platin und Living Building Challenge

AUF HOLZ BAUEN !!!

GASTPROFESSOR DR.-ING. JOCHEN STAHL

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JSTAHL@FASTEPP.COM

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