FCP

KliNa Tag 2024

Materialeffiziente Rippendecken mittels digitaler Fertigungstechnologien

Tobias Huber
Joris Burger
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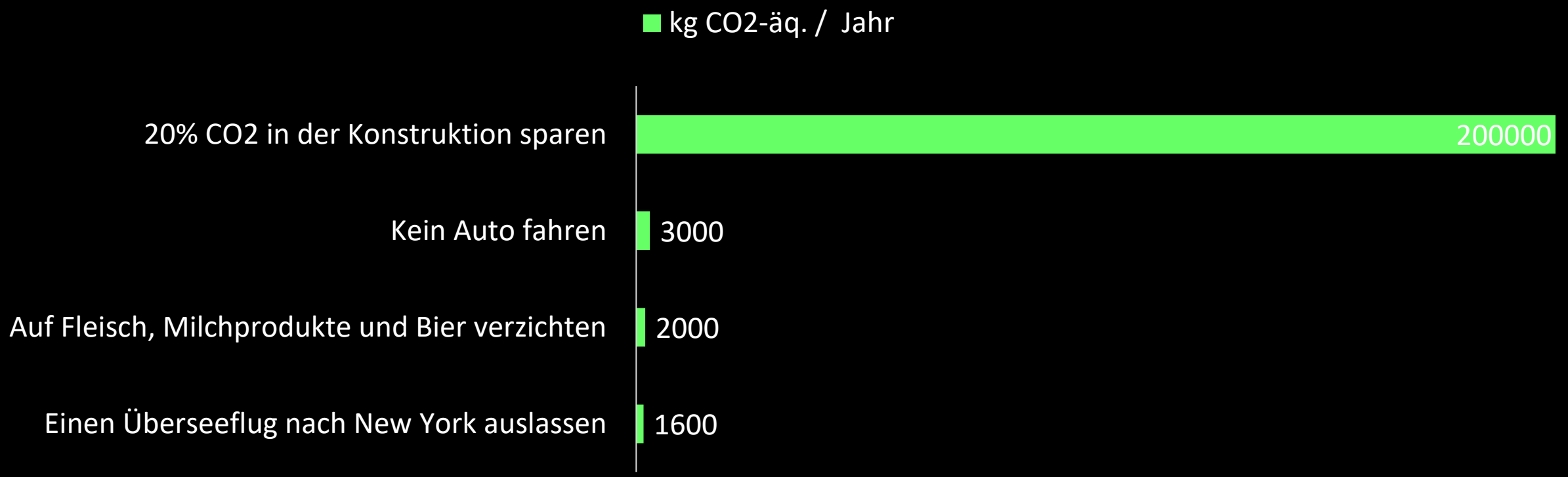
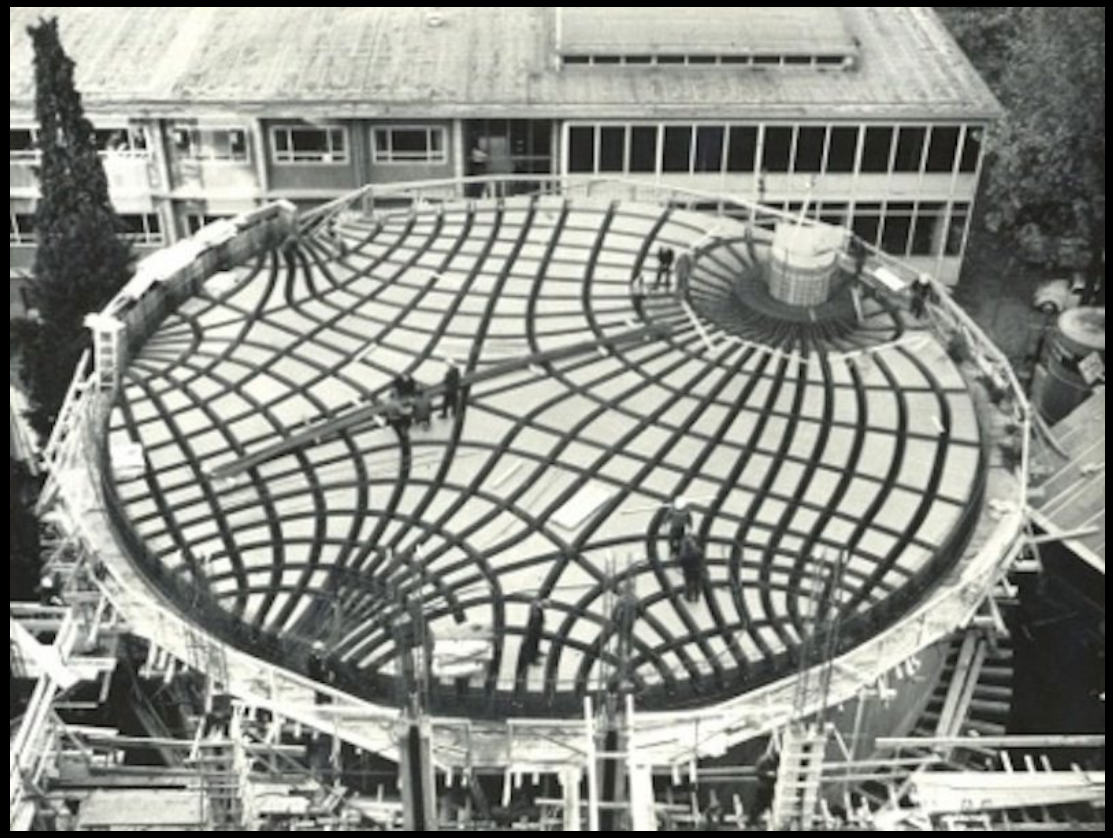
Was kann ich als Bauingenieur_in für das Klima tun?



How to calculate the embodied carbon (2022). The Institution of Structural Engineers (UK)

Wo finde ich diese ~~20%?~~ 40%!

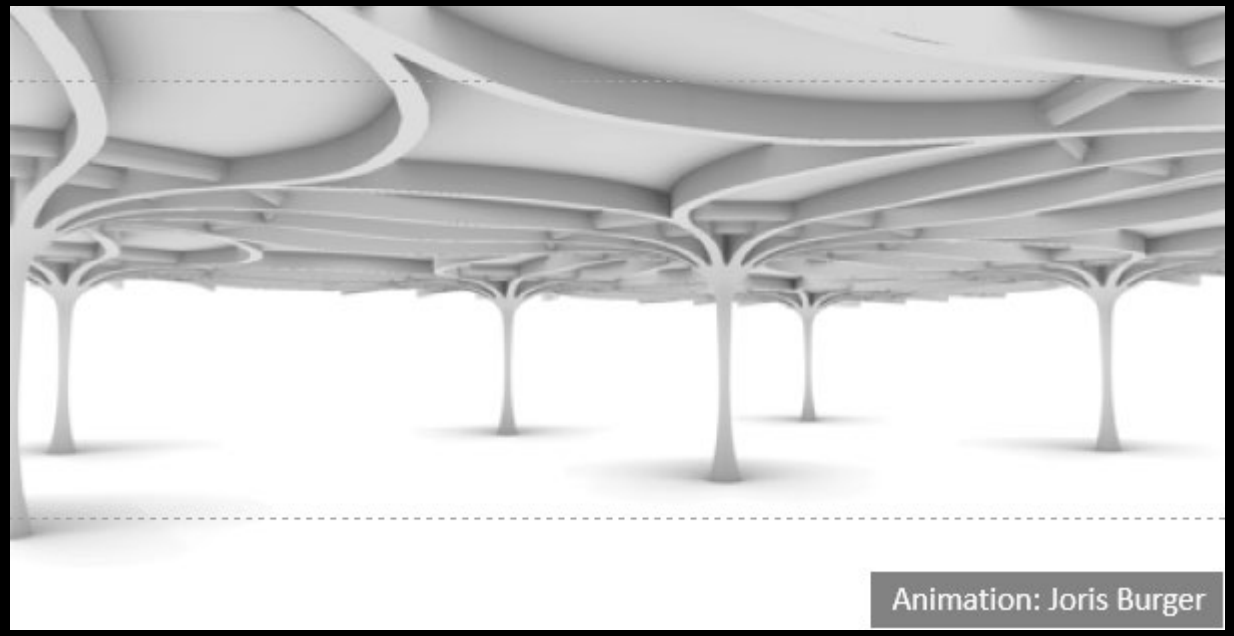
Gatti Wool Factory - Pier Luigi Nervi (1953)



Hörsaal Zoologisches Institut Universität Freiburg – Hans Dieter Hecker (1968)

RIBB3D
Nachhaltige Rippendecken mit 3D-gedruckter Schalung

Fallstudie: 8x8 m punktgestützte Bürodecke



Animation: Joris Burger

Startpunkt:

Eggshell – Gramazio Kohler Research (mit Prof. Flatt und Prof. Kaufmann)

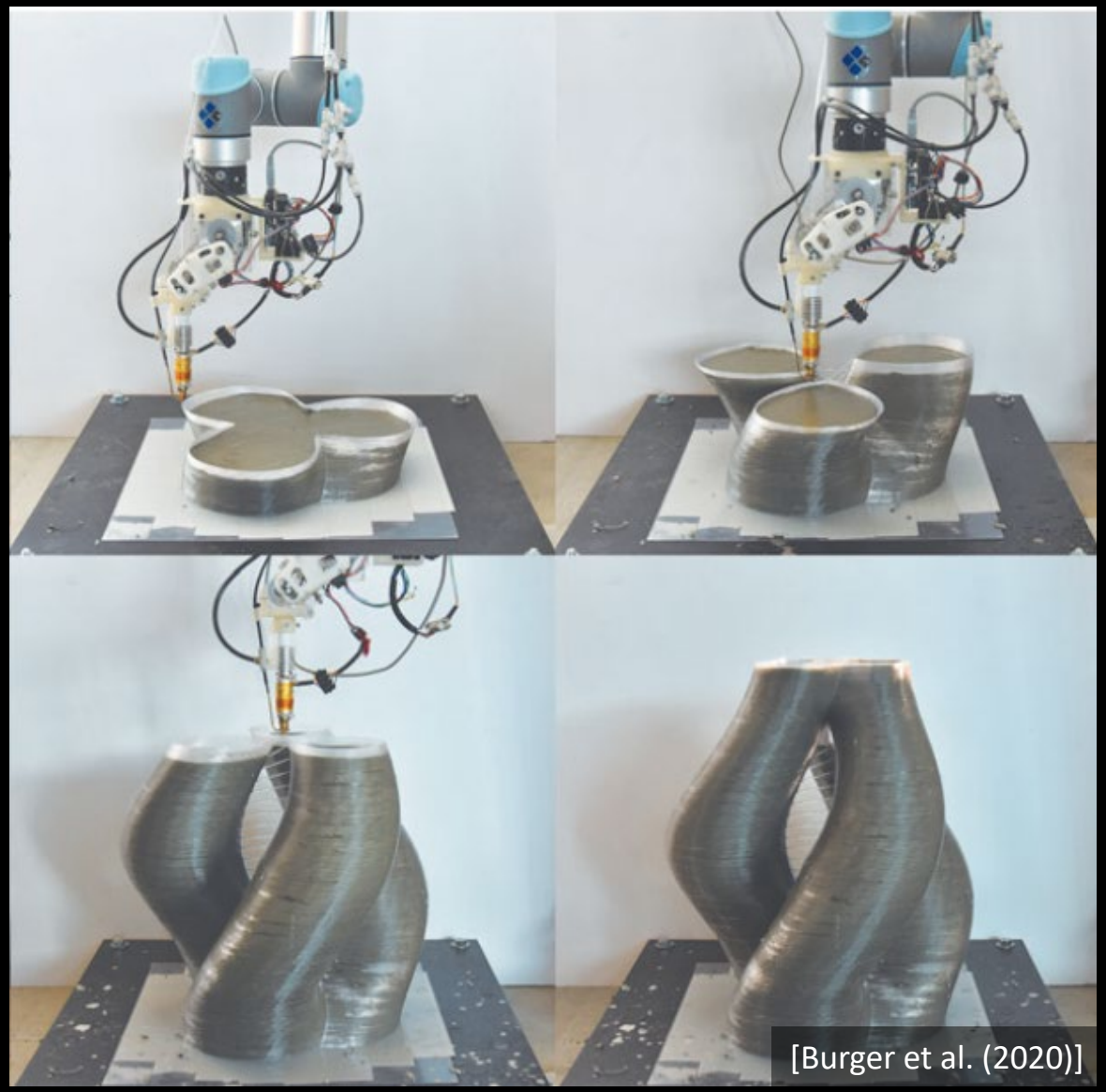
- 3D-gedruckte Polymer-Schalung (1…2 mm)
- Set-on-demand casting: Minimieren des Betondrucks

Ziele:

→ Skalierung auf Deckenelemente, da größeres Optimierungspotential

→ Standard- (Öko-)Betone verwenden, um CO_2-Emissionen zu reduzieren

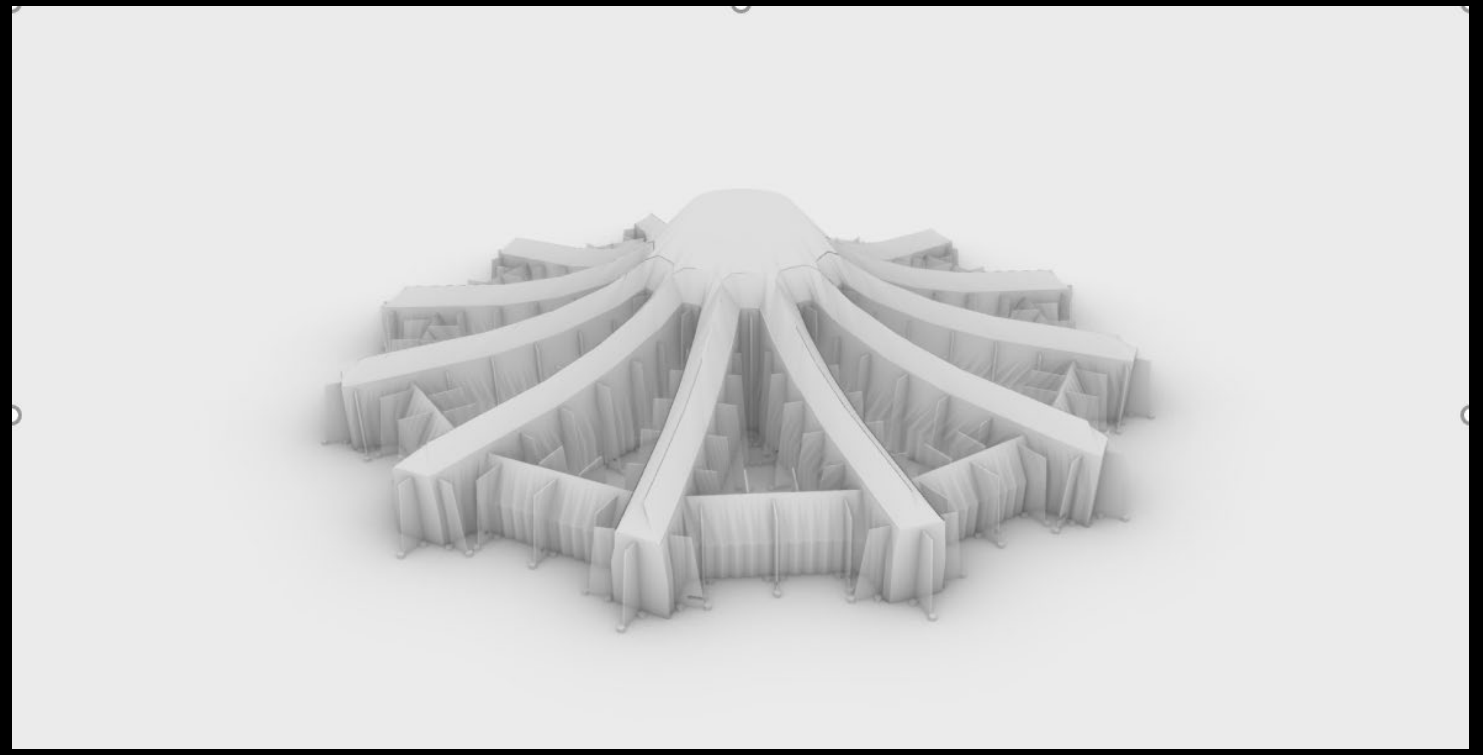
→ File-to-factory innerhalb einer Software abbilden – Vernetzen der Disziplinen



File-to-factory workflow

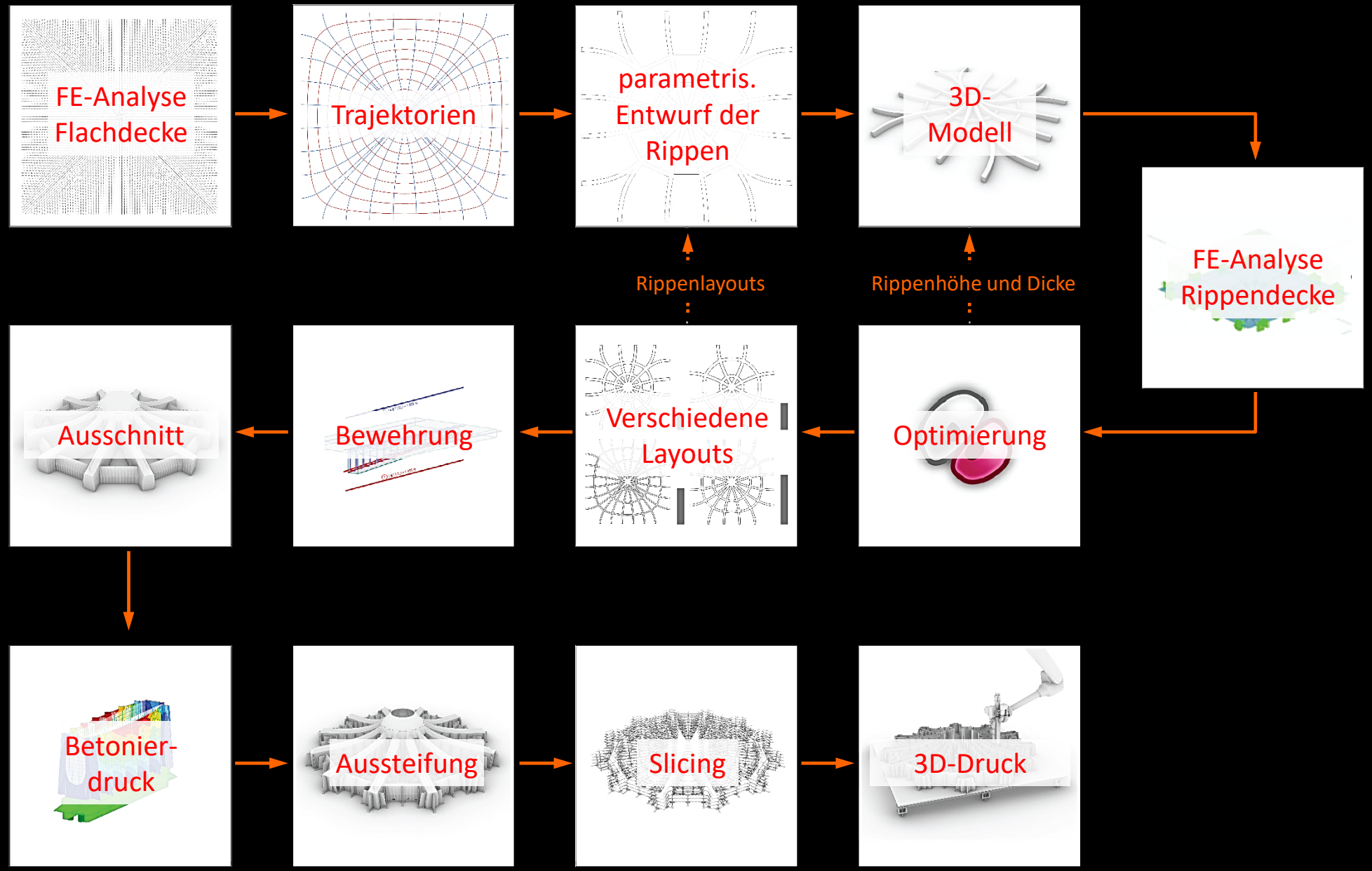
- Entwurf
- Statik
- Optimierung
- Druckdaten

innerhalb von Grasshopper (Rhino)

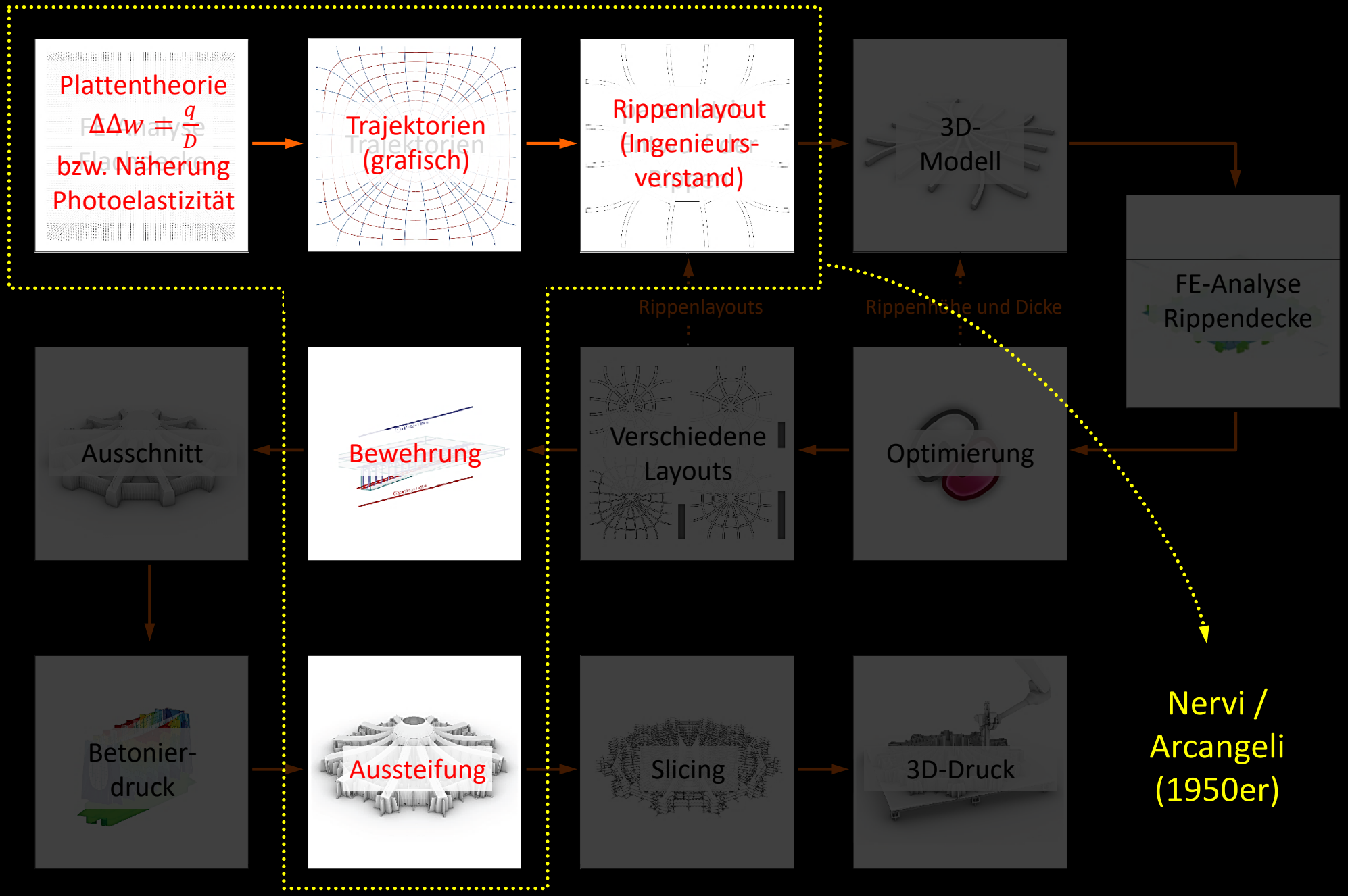


Animation: Joris Burger

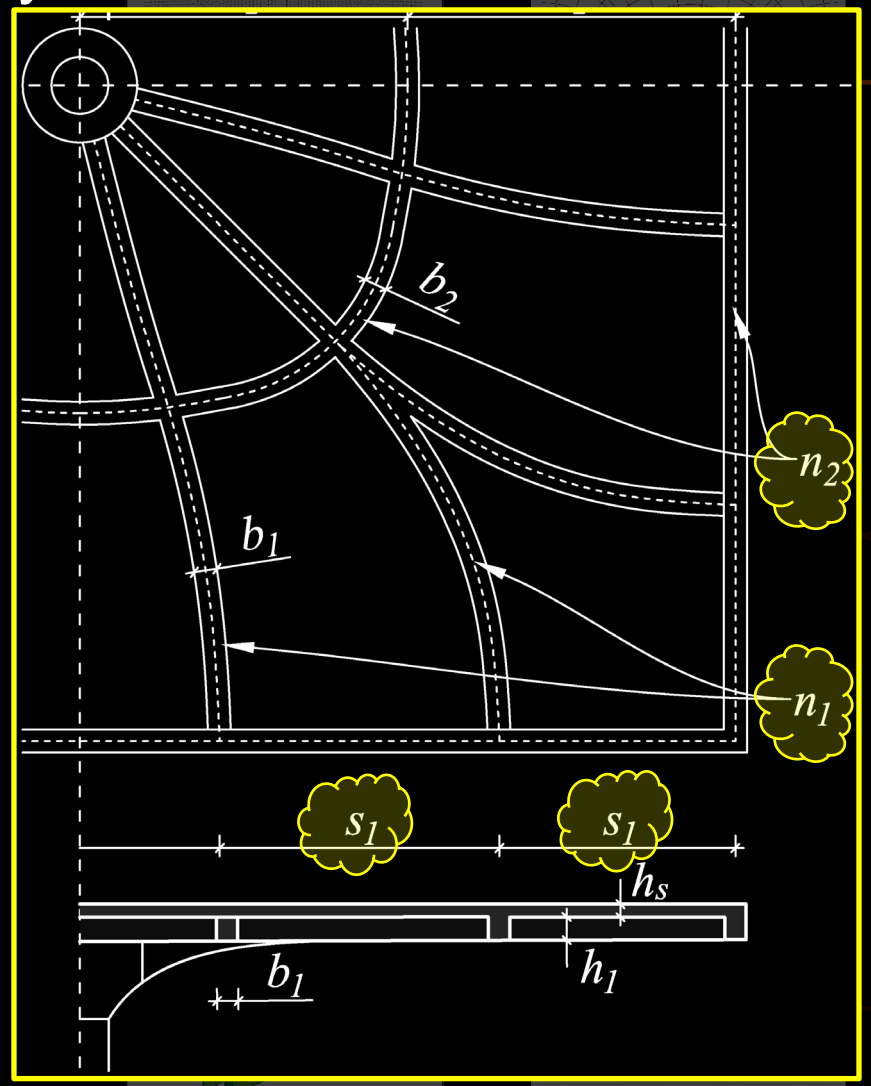
File-to-factory workflow



File-to-factory workflow



File-to-factory workflow



parametris. Entwurf der Rippen

3D-Modell

FE-Analyse Rippendecke

Rippenlayouts

Rippenhöhe und Dicke

Verschiedene Layouts

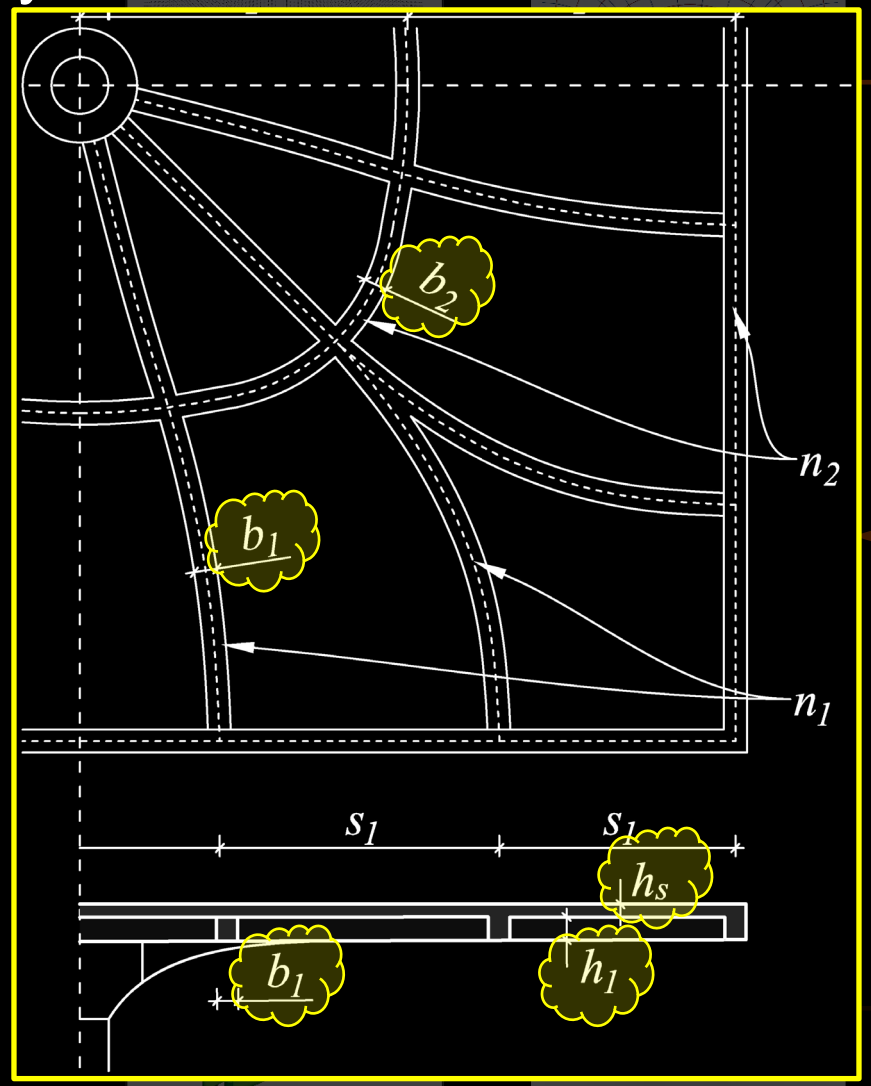
Optimierung

Slicing

3D-Druck

Parametrisierter Entwurf

File-to-factory workflow



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Rippenlayouts

Verschiedene Layouts

Slicing

3D-Druck

3D-Modell

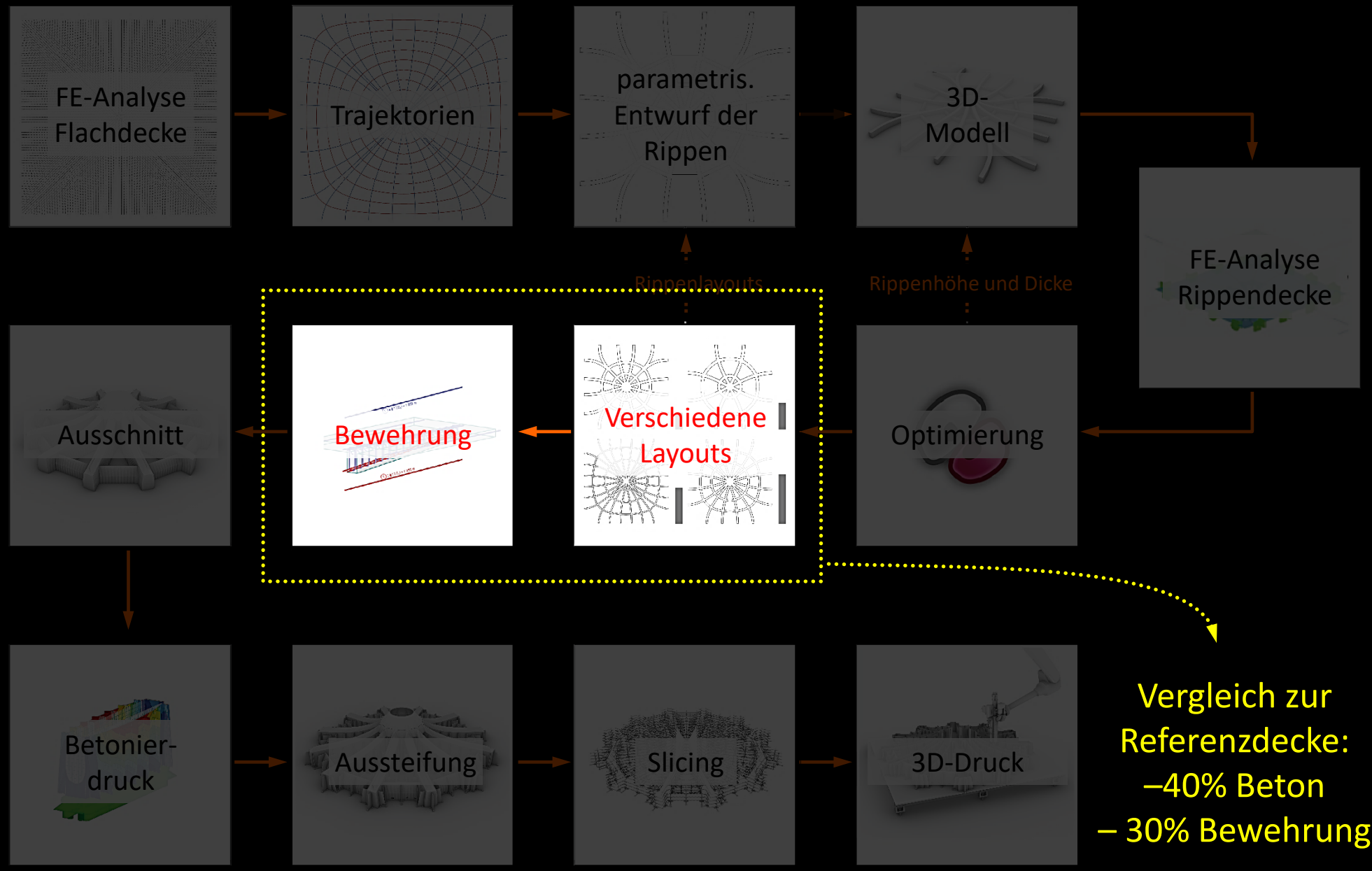
Rippenhöhe und Dicke

Optimierung

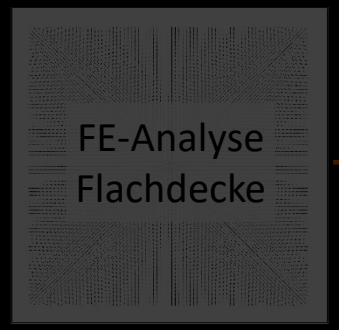
FE-Analyse Rippendecke

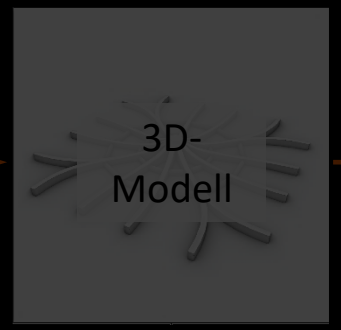
Optimierung berücksichtigt Nachweise (Festigkeit, Brand, Durchbiegungen)

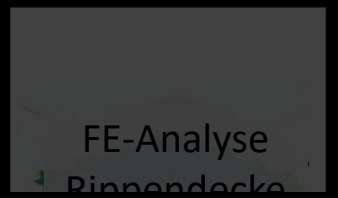
File-to-factory workflow



File-to-factory workflow

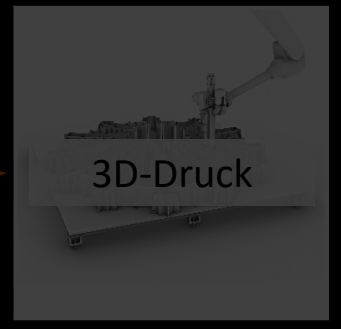






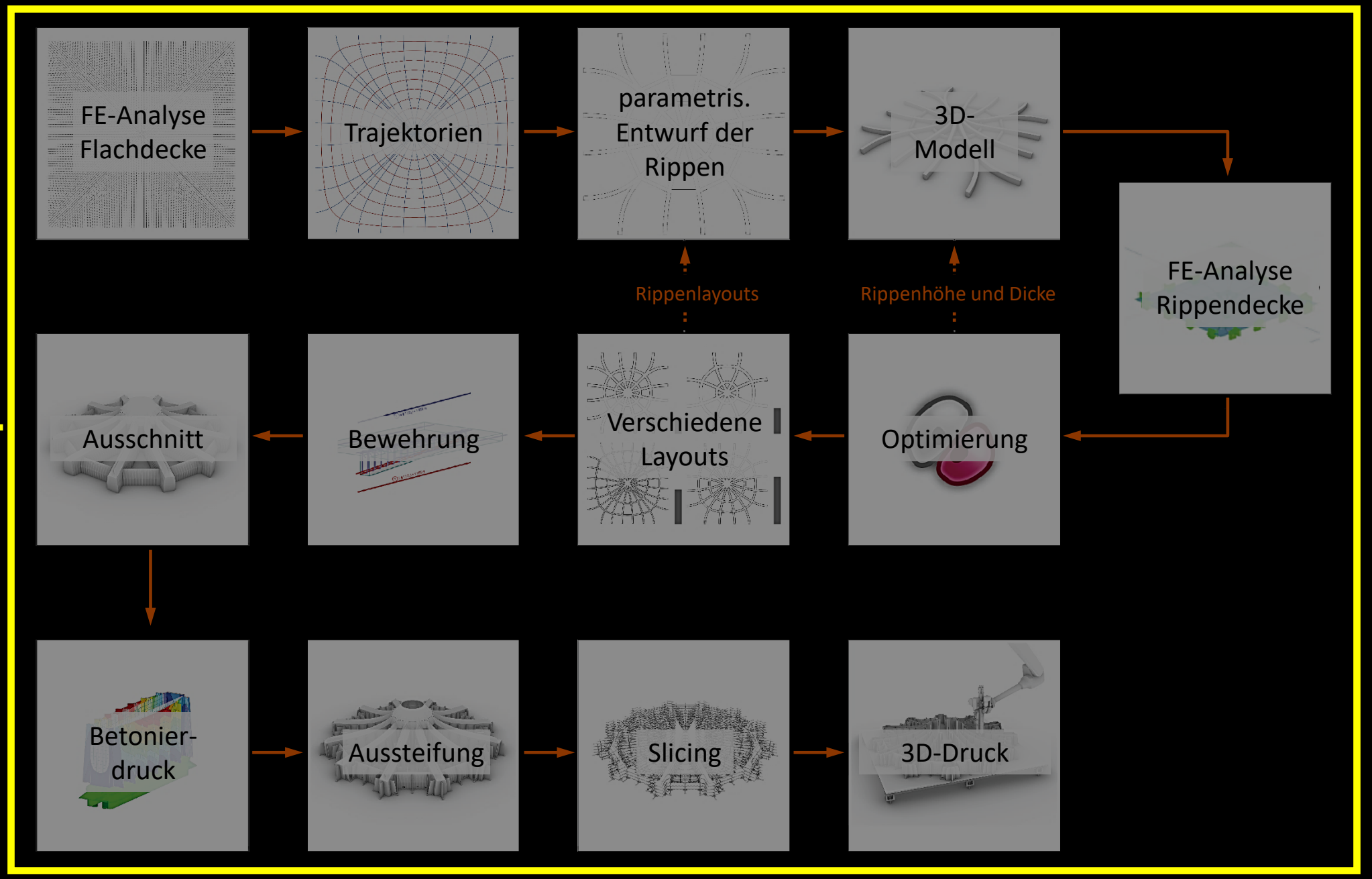
Rippenlayouts

Rippenhöhe und Dicke



Selbstverdichtender Beton

File-to-factory workflow



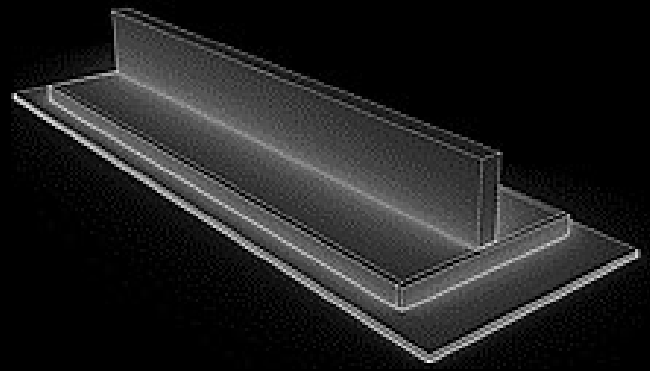
Bewehren

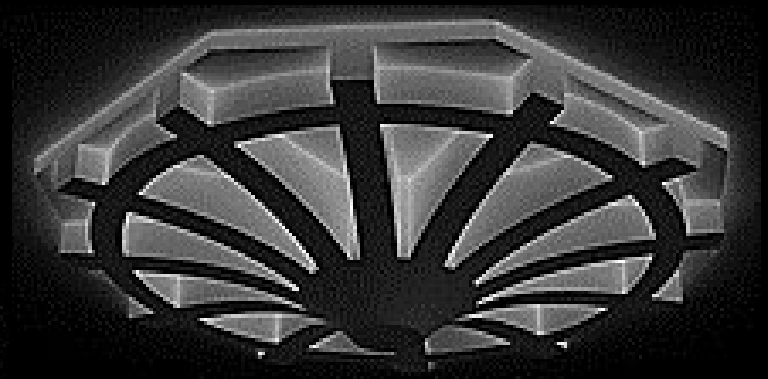
Betonieren

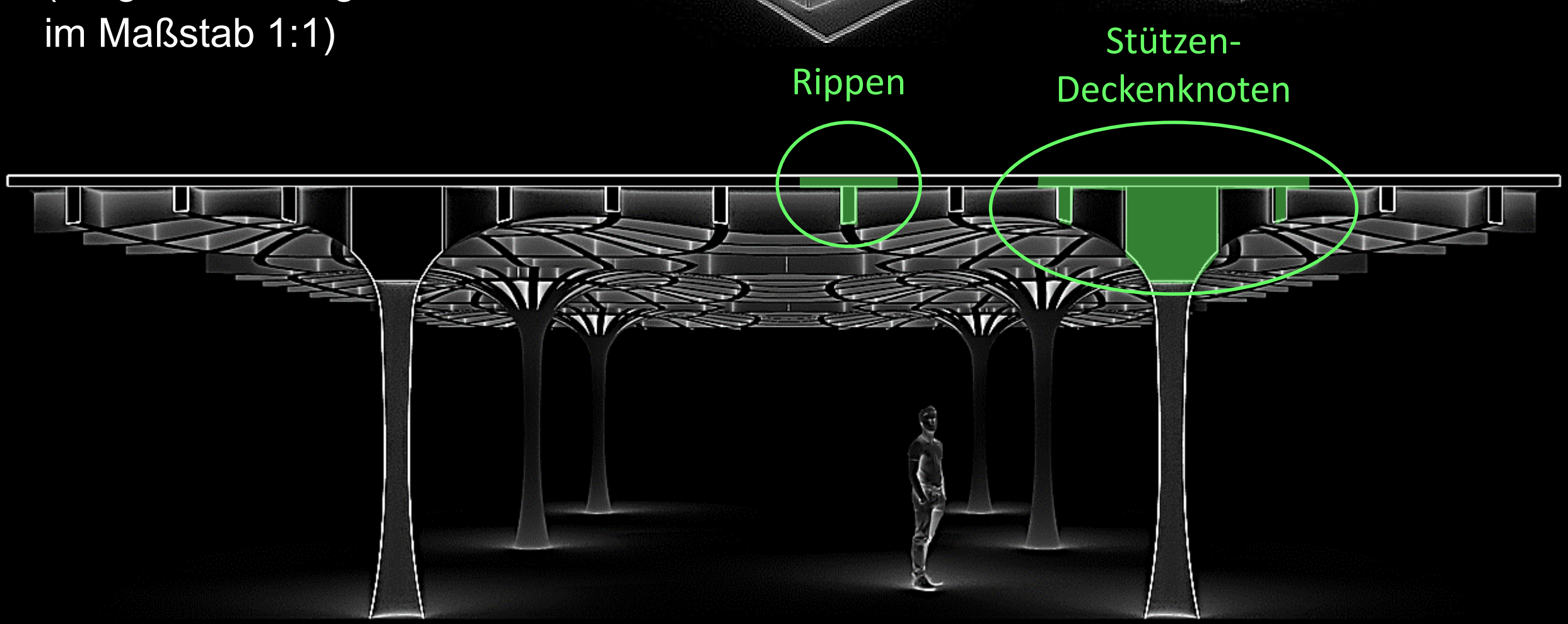
Belastungs-versuche

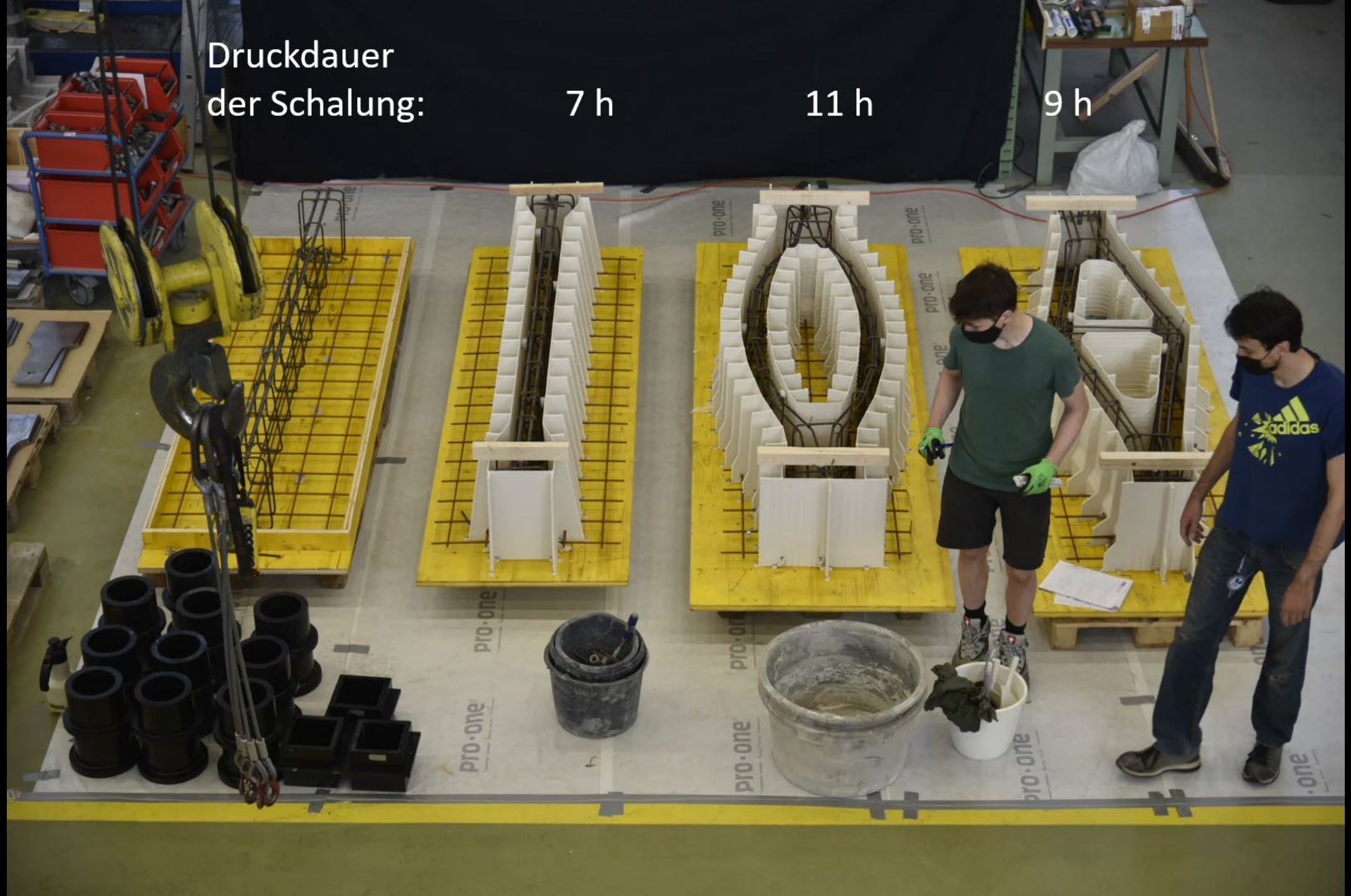
Representative Ausschnitte

(hergestellt und getestet im Maßstab 1:1)








Druckdauer
der Schalung:
7 h
11 h
9 h
pro·one
adidas

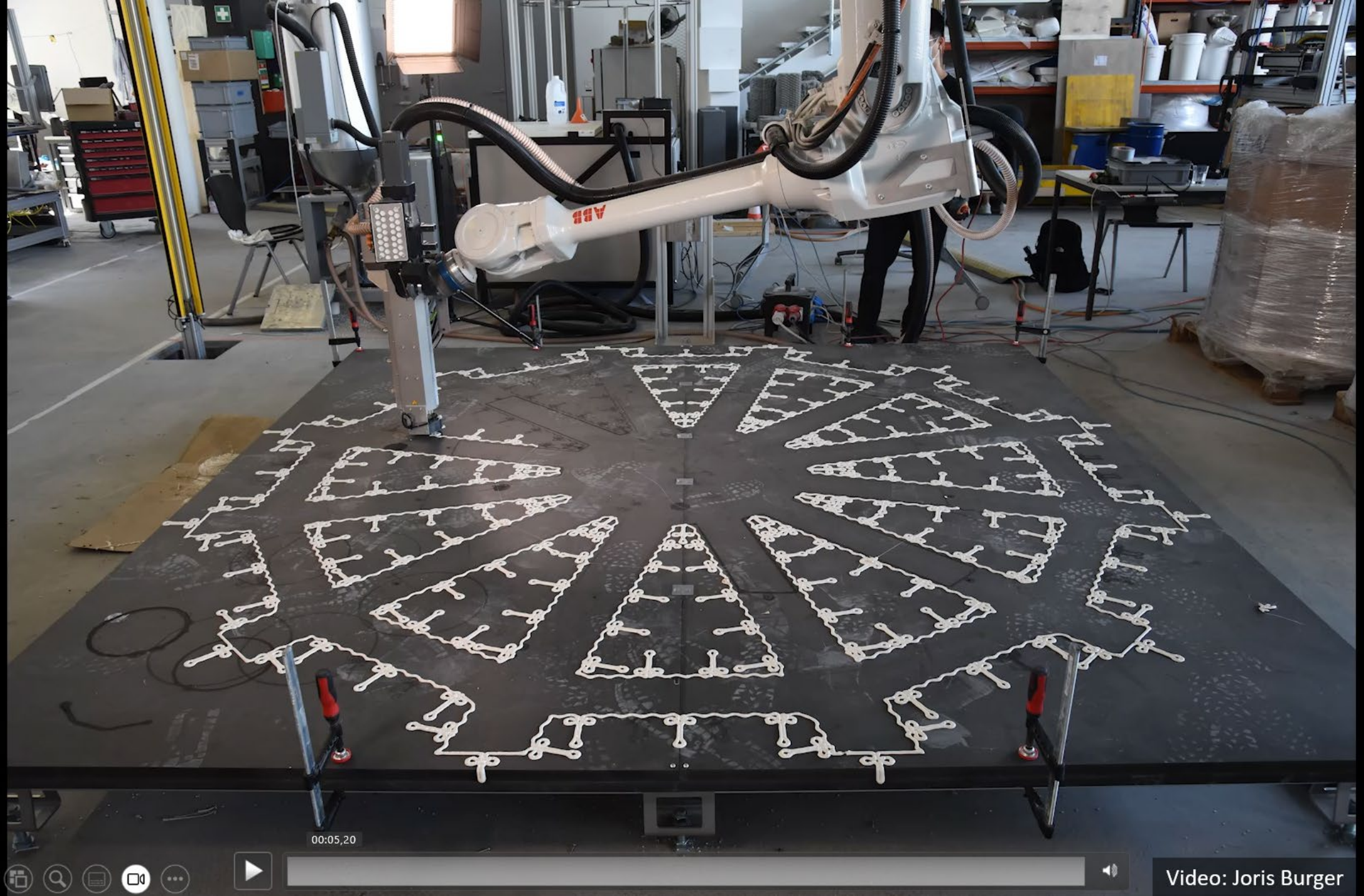
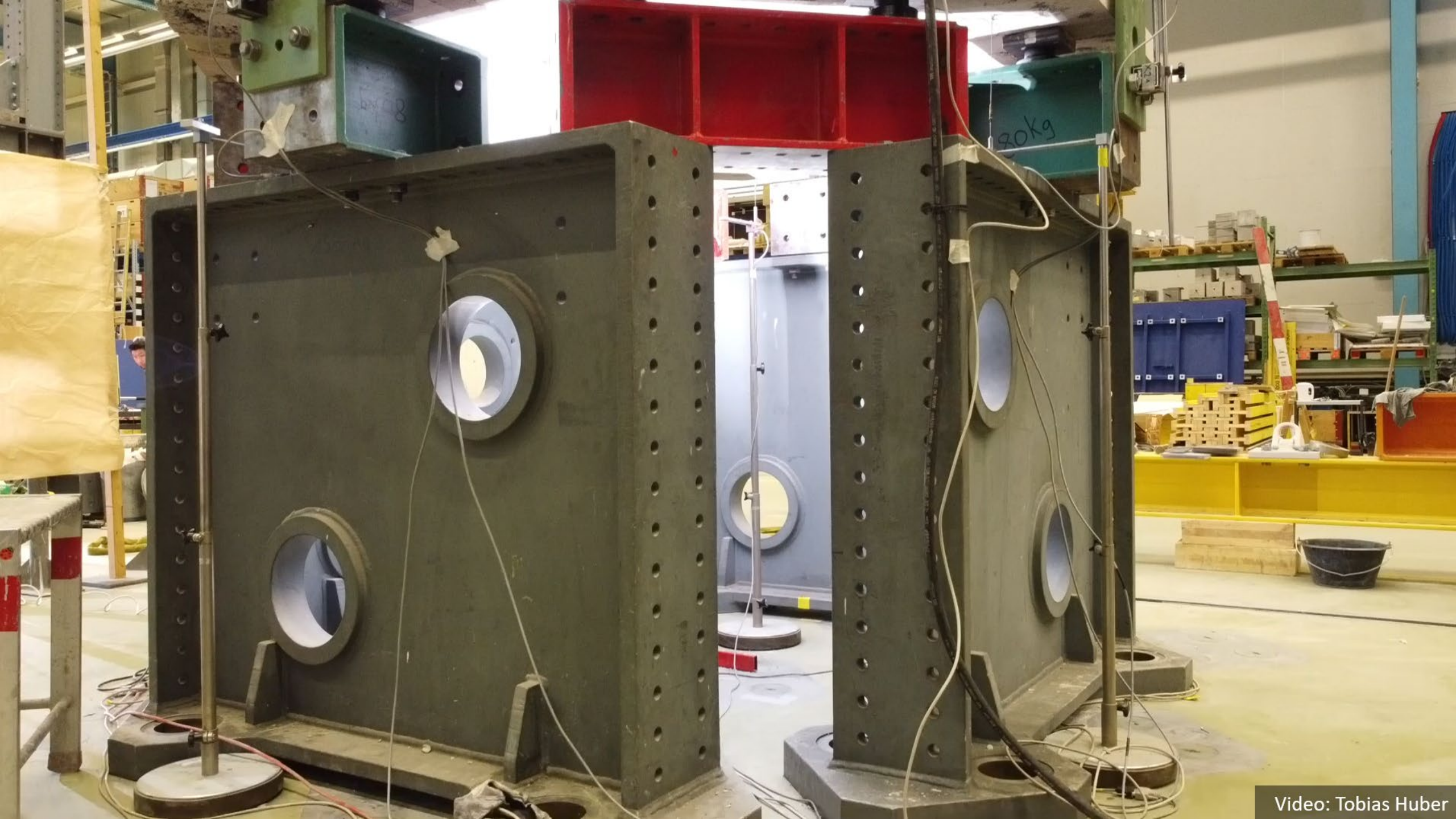


ABB
00:05,20
Video: Joris Burger

Bild: Joris Burger


Video: Tobias Huber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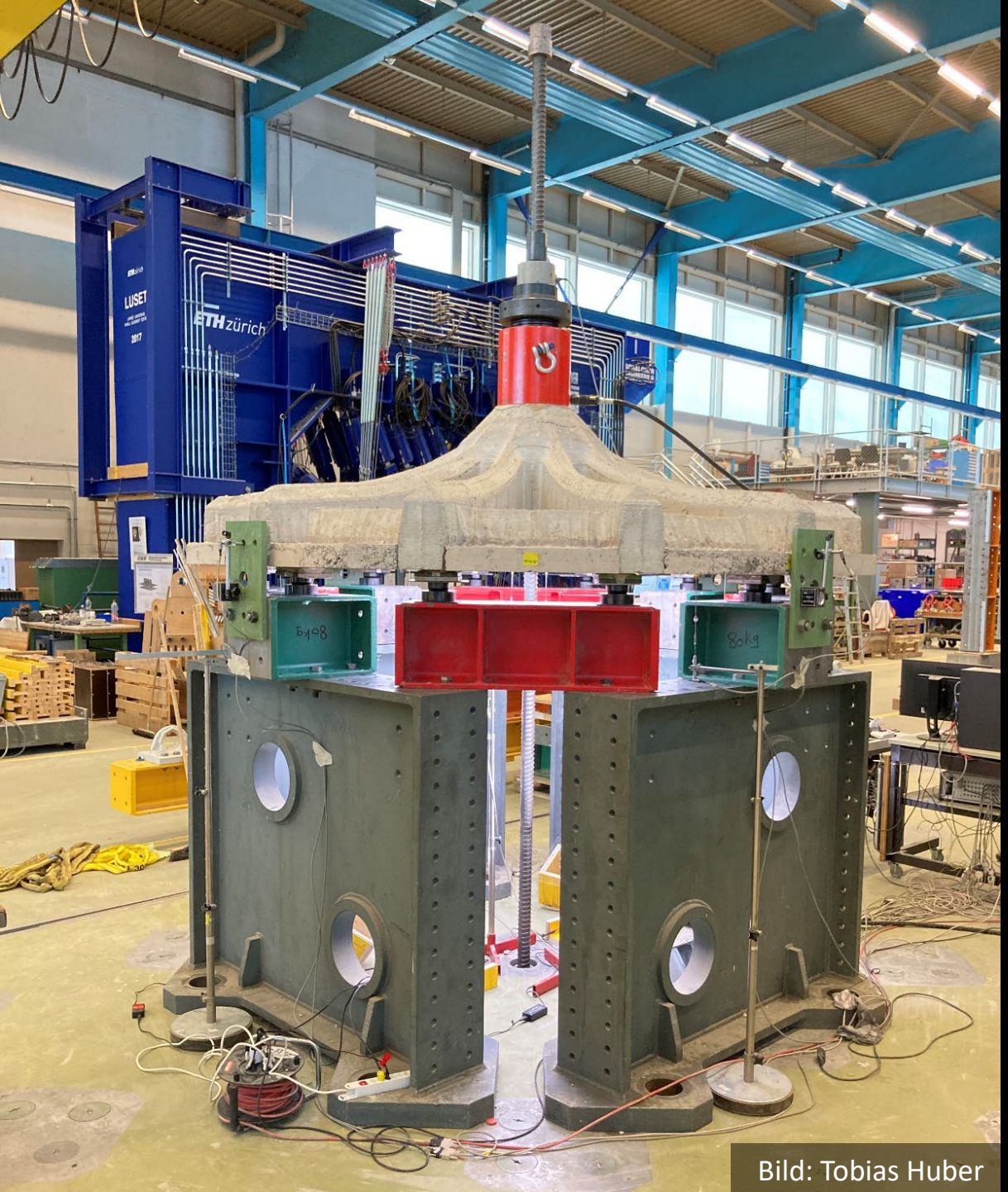
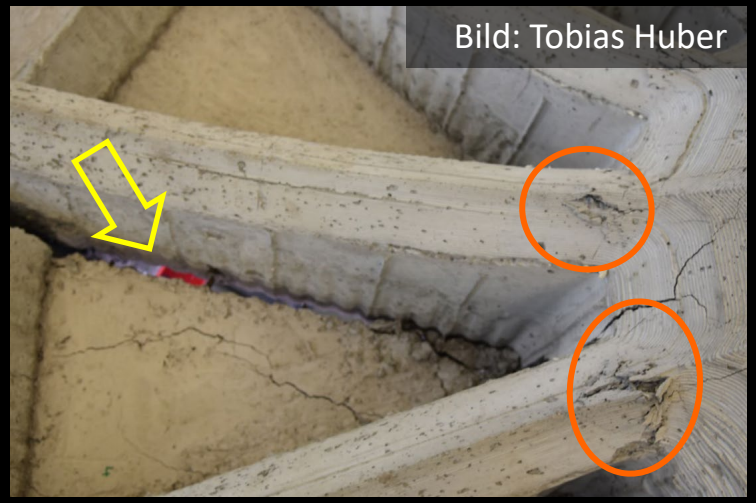

LUSET
ETH zürich
Bild: Tobias Huber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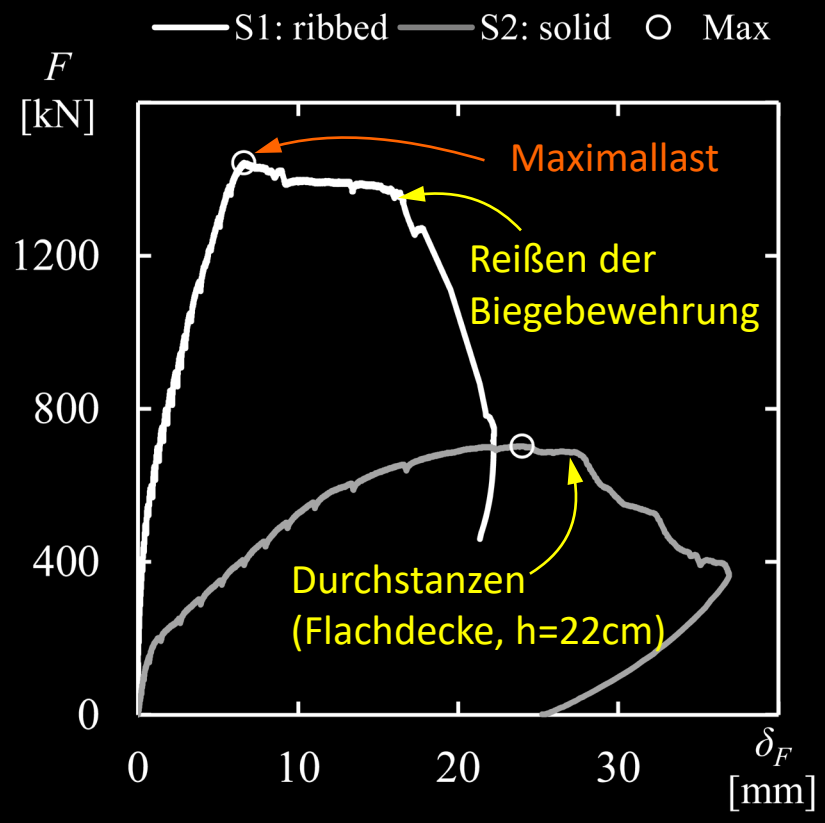
S1: ribbed
S2: solid
Max
F
[kN]
1200
800
400
0
Maximallast
Reißen der
Biegebewehrung
Durchstanzen
(Flachdecke, h=22cm)
0
10
20
30
δ_F
[mm]

Bild: Gramazio Kohler Research

“**Eggshell Pavilion**“
Vitra Design Museum, Weil am Rhein, 2022
MAS Architecture and Digital Fabrication at ETH Zurich

Bild: Gramazio Kohler Research

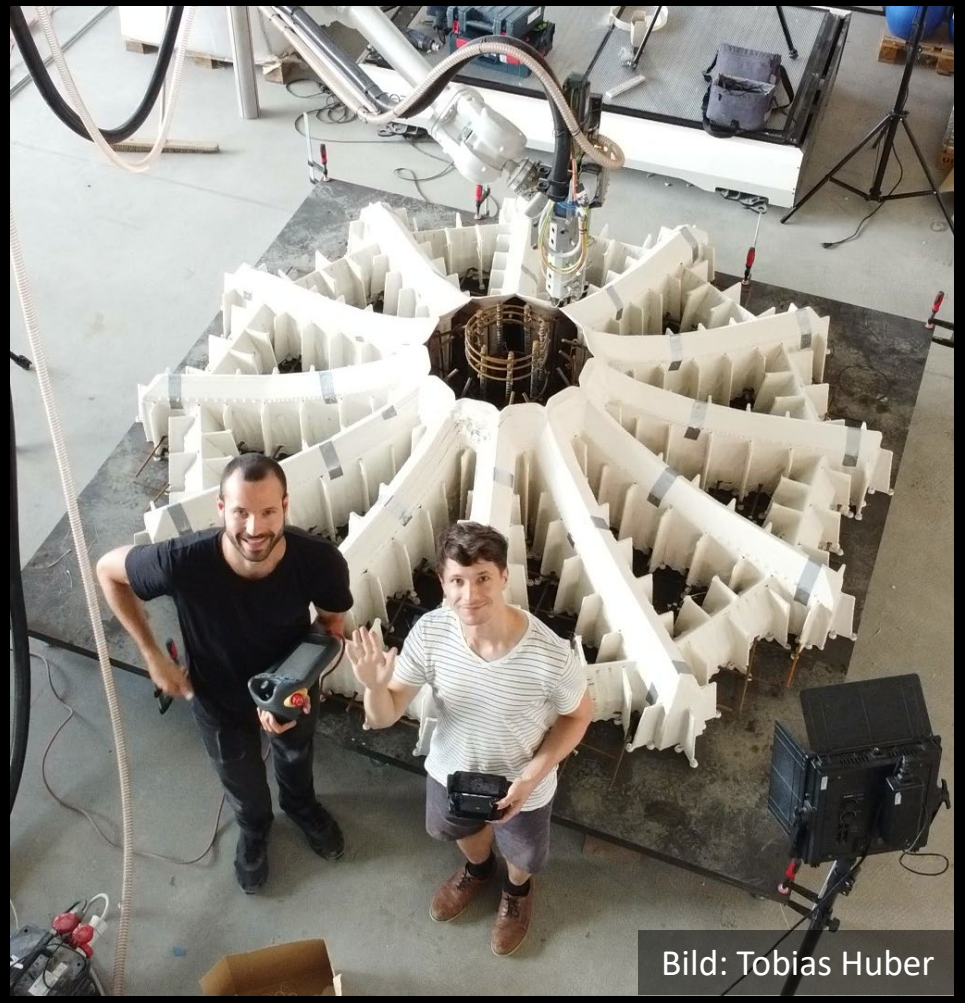
Bild: Tobias Huber

Massiv- und Brückenau
Prof. Walter Kaufmann, D-BAUG, ETH Zürich

Gramazio Kohler Research
Prof. Fabio Gramazio + Matthias Kohler, D-ARCH, ETH Zürich

Projektteam: Tobias Huber, Joris Burger,
Jaime Mata-Falcón, Ena Lloret-Fritschi, Ping-Hsun Tsai

ETH Labore: Robotic Fabrication Laboratory (RFL),
IBK-Bauhalle, ITA Betonlabor

Unterstützer: SACAC AG, Debrunner Acifer Bewehrungen,
TU Wien

Finanzierung: ETH Foundation, Siemens, Geberit, NCCR
Digital Fabrication

SACAC Debrunner Acifer TU WIEN ETH Foundation SIEMENS GEBERIT

Plastikschalung nicht nachhaltig genug?
„File-to-factory“-Ansatz kann für andere Technologien adaptiert werden

Video: Tobias Huber

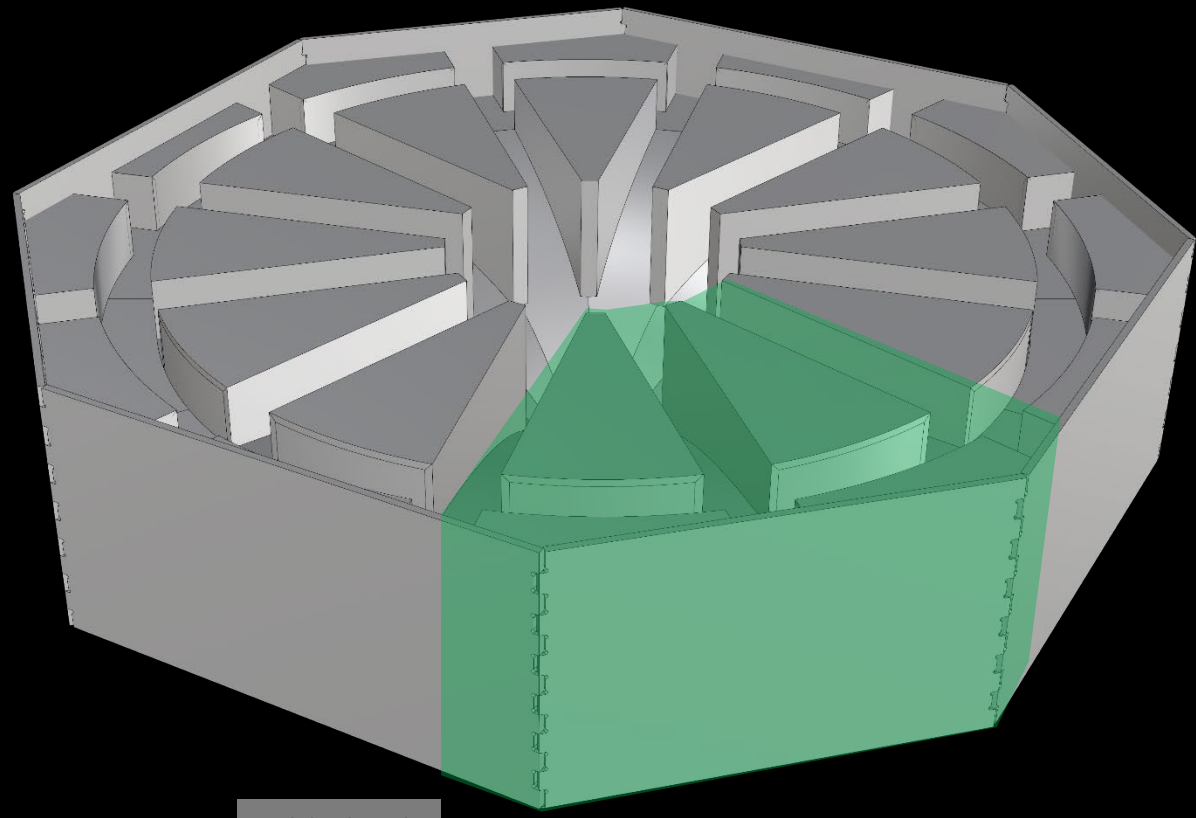

Bild: datab

datab
DATA BASED PRODUCTION

TU WIEN