HOUSING NOW!

EIN BAUSYSTEM ZUR VERANTWORTBAREN NACHVERDICHTUNG

EINFÜHRUNG

STROH
KERN

WOHNRAUMMANGEL

- Klimawandel
- Preissteigerungen
- Soziale Spaltung

LÖSUNGSANSATZ?

- Persönliche Werte
- Realistische Optionen

WERTE

ANFORDERUNGEN

- Klimaneutral
- Erschwinglich
- Skalierbar

AUFSTOCKUNG

- Nachhaltige Materialien
- Vorfertigung + Selbstbau
- Wohnformen

BAUKASTENSYSTEM

- Lokale Gegebenheiten
- Rechtliche Vorgaben

ENTWURFSPROJEKTE

- Minderbebauung
- Zeilenbauten

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Foto: Marcus Lenk, https://unsplash.com/de/fotos/zwei-hohe-gebaude-mit-fenstern-und-balkonen-OabSEzXARM4

550.000

Wohnungen fehlen aktuell in Deutschland

https://www.zdf.de/nachrichten/politik/deutschland/studie-wohnungsnot-buendnis-soziales-wohnen-100.html

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38%

Der globalen CO2-Emissionen werden vom Gebäudesektor verursacht

https://globalabc.org/resources/publications/2020-global-status-report-buildings-and-construction

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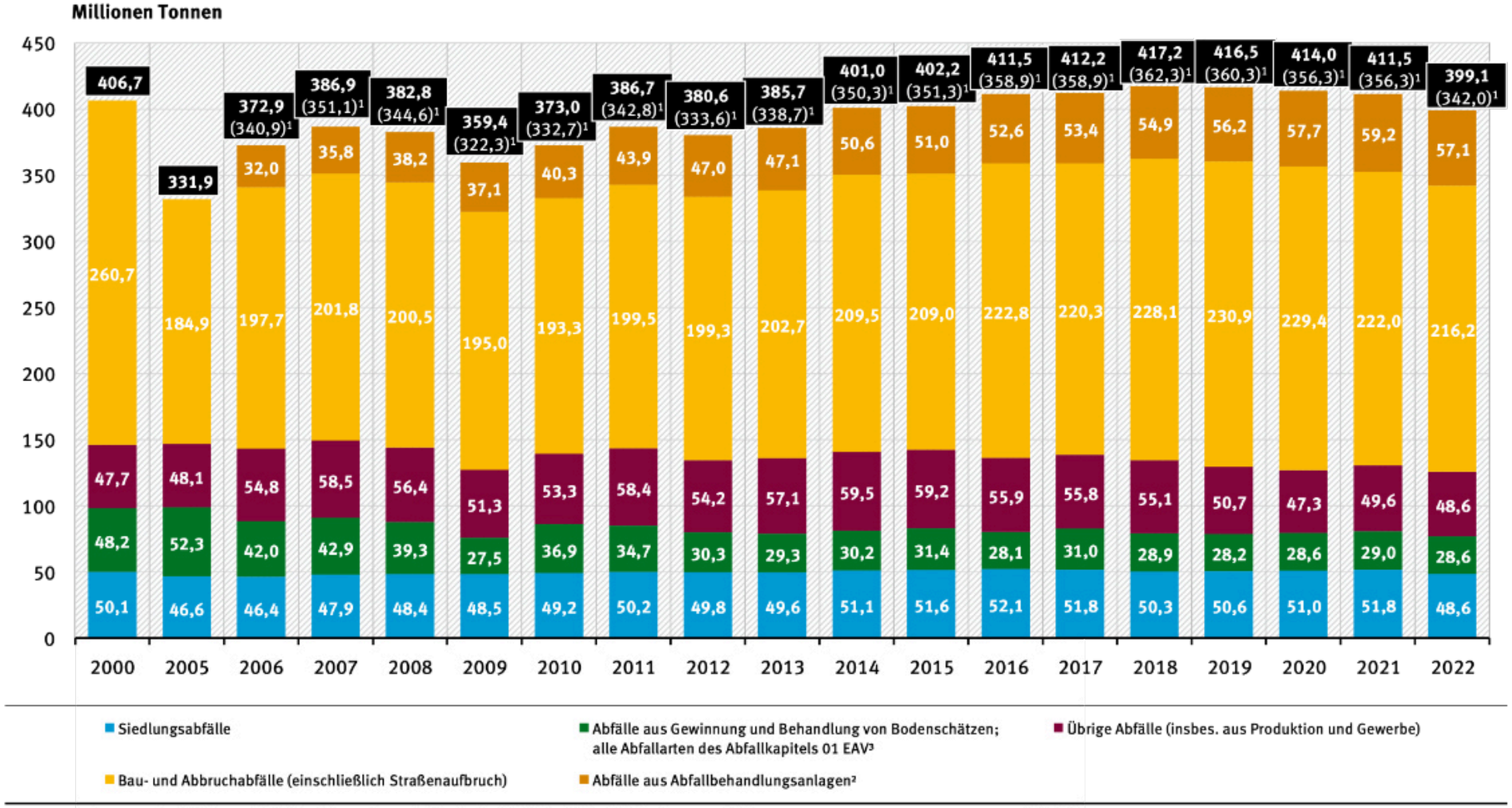
Abfallaufkommen (einschließlich gefährlicher Abfälle)



¹ Nettoabfallaufkommen, ohne Abfälle aus Abfallbehandlungsanlagen; 2006 erstmals als Bestandteil des Abfallaufkommens erhoben.
² Ohne Abfälle aus Abwasserbehandlungsanlagen (EAV 1908), Abfälle aus der Zubereitung von Wasser für den menschlichen Gebrauch oder industriellem Brauchwasser (EAV 1909), Abfälle aus der Sanierung von Böden und Grundwasser (EAV 1913) und Sekundärabfälle, die als Rohstoffe/Produkte aus dem Entorgungsprozess herausgehen.
³ Abfälle aus Gewinnung und Behandlung von Bodenschätzen.

Quelle: Statistisches Bundesamt, Abfallbilanz, Wiesbaden, verschiedene Jahrgänge

54%

Des deutschen Abfallaufkommens Bau- und Abbruchabfälle

https://www.umweltbundesamt.de/daten/ressourcen-abfall/abfallaufkommen#deutschlands-abfall

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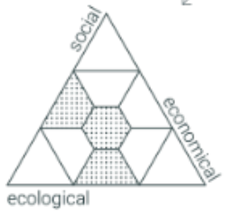

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ENTWURFSPROJEKTE
- Minderbebauung
- Zeilenbauten

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30%

Kostenersparnis bei Aufstockung statt Neubau

Aus: Deutschlandstudie 2019
Wohnraumpotenziale in urbanen Lagen,
Technische Universität Darmstadt

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1,5-1,9 Mio.

Wohnungen durch Aufstockung von Wohngebäuden möglich

Deutschlandstudie 2019
Technische Universität Darmstadt
Wohnraumpotenziale in urbanen Lagen

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WOHNRAUMMANGEL
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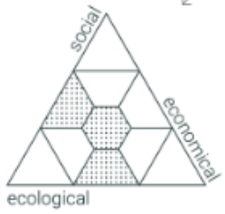
- Realistische Optionen

WERTE



ANFORDERUNGEN
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- Rechtliche Vorgaben

ENTWURFSPROJEKTE
- Minderbebauung
- Zeilenbauten

Foto: Eigenes Bild

BRITTA SCHEBESTA

- Architekturstudium an der RWTH Aachen, Master mit Auszeichnung
- Auszeichnungen: wa-award 2024, Baunetz Campus Jury Award
- Stellvertretende Vorsitzende der architektinneninitiative
- Juniorarchitektin mit Fokus auf Bauen im Bestand
- Arbeit an unserem Projekt „Strohkern“ basierend auf unserer Masterarbeit

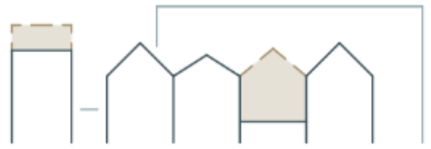
FRANZISKA MÜLLER

- Architekturstudium an der RWTH Aachen und TU Wien, Master mit Auszeichnung
- Auszeichnungen: wa-award 2024, Baunetz Campus Jury Award, EXIST Women-Stipendium, Hands-On-Stipendium
- Ehrenamtliche Arbeit bei socialarchitecture e.V.
- Freiberufliche Arbeit in verschiedenen Architekturbüros mit Fokus auf nachhaltiges Bauen
- Arbeit an unserem Projekt „Strohkern“ basierend auf unserer Masterarbeit

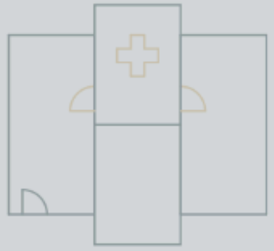
RECHERCHE

STROH
KERN

RECHERCHETHEMEN



Bauen im Bestand



Wohnformen

Systembau

Geogene und nachwachsene Rohstoffe

Foto: Ruslan Khadyev, https://unsplash.com/de/fotos/beige-backsteingebaude-12Aqz3b3fxE

Abriss vermeiden!

Werte neu entdecken!

Ausgleich von Nachteilen!

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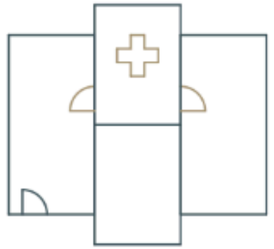
RECHERCHETHEMEN

Bauen im Bestand



Wohnformen

Systembau

Geogene und nachwachsene Rohstoffe

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58 %

Der Haushalte in Aachen sind Single-Haushalte-Tendenz in ganz NRW steigend

Wohnungsmarktbericht 2020, Stadt Aachen

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Foto: Toa Heftiba, https://unsplash.com/de/fotos/menschen-die-tagsuber-in-der-cafeteria-essen-6bKpHAun4d8

Teilen, was weder privat noch ständig in Gebrauch ist!

Reine Verkehrsflächen vermeiden!

Mehrfach-nutzung von Räumen ermöglichen!

So minimalistisch wie möglich, so großzügig wie nötig!

Partizipation schafft Identifikation schafft Stabilität!

Gemeinschaft kann nicht erzwungen, aber gefördert werden!

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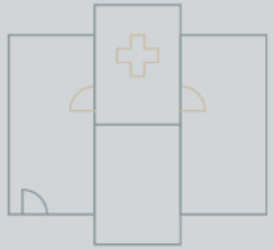
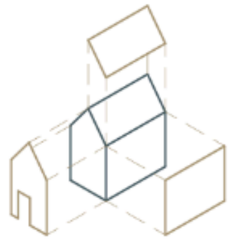
Bauen im Bestand



Wohnformen



Systembau

Geogene und nachwachsene Rohstoffe

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15 %

Kostenersparnis beim serielles Bauen gegenüber konventionellen Bauweisen

https://www.tagesschau.de/wirtschaft/serielles-bauen-100.html

ANFORDERUNGEN AN DAS BAUSYSTEM

Wärmeschutz

Building component	max. U-value [W/(m²K)]
Roof surfaces, top floor ceiling	0,14
Windows and other transparent parts	0,90
Roof windows	1,00
Exterior walls, storey ceilings downwards against the outside	0,20
Other opaque building components (basement ceilings, walls and ceilings to unheated rooms, wall and floor surfaces against the ground, etc.)	0,25
Doors (cellar and external doors)	1,20

Fig. 15: Maximum U-values of building components according to KfW-55 standard

Schallschutz

Component	required R'_w value [dB] (minimum)
ceilings partitioning apartments	54
walls partitioning apartments	53
ceilings below/above playrooms or similar communal spaces	55
walls of playrooms or similar communal spaces	55
doors directly leading from building corridors or staircases to living rooms of apartments, except for hallways and corridors	37

Fig. 17: Sound insulation requirements according to DIN 4109[61]

Brandschutz

	Building class				
	1	2	3	4	5
Definition	free standing building	not free-standing; OKF <= 7m; <= 2 NE; ∑NE <= 400m² without cellar	other buildings; OKF <= 7m; + NE > 400m²	OKF <= 13m; NE each <= 400m² without cellar	OKF > 13m; NE > 400m²
Wall to neighbouring building	-	in -> out: fh out -> in: fb	in - out: fh out - in: fb	hfh + m	fb + m
Ceiling	-	fh	fh	hfh	fb
Wall between use units (Nutzungseinheit, NE)	-	fh	fh	hfh	fb
Cellar ceiling	fh	fh	fb	fb	fb

Fig. 16: Fire protection requirements according to building class

Weitere Anforderungen

Integrationskapazität:

Die Möglichkeit zur Integration von Leitungen (Strom, Abwasser, Frischwasser etc.)

Gewicht: Aufstockung benötigt möglichst leichte Materialien und Bauweisen

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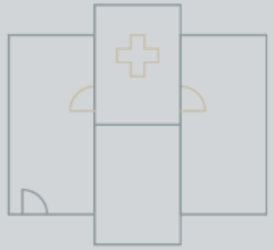
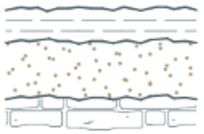
RECHERCHETHEMEN

Bauen im Bestand



Wohnformen

Systembau



Geogene und nachwachsene Rohstoffe

Foto: Jonas Horsch, https://unsplash.com/es/fotos/una-pequena-planta-verde-brota-del-musgo-OlexUO10-wM

Lokale Verfügbarkeit

Erneuerbarkeit

Global Warming Potential

Wiederverwend-barkeit

Eignung für Selbstbau und Vorfertigung

Kosten

UNTERSUCHUNG VERSCHIEDENER NATÜRLICHER DÄMMMATERIALIEN

		Local availability / origin of raw materials[31]	Dismantling capability[32]	Re-use potential[33]	ÖKOBAUDAT	Global warming potential (GWP) (kg CO2-equev.), reference 1m³ (volume)				possible additional ingredients	Product example	Application	Suitability for DIY	Building physics data						Price (€/m² (with insulation thickness/ U-value 0.15)[34]
						Manufacture (A1-A3)	Dismantling/ waste treatment ®	Recycling potential (energetic) (D)	Total (production and energy recovery)					Fire Class	Density [kg/m³]	Heat capacity [kJ (kg/K)]	Thermal conductivity [W/mK]	Water vapor diffusion resistance µ	required insulation thickness for a U-value of 0.15 W/m²K (mm) (approximated to product thickness)	
Plant-based fibre insulation materials	Straw	Farmer's by-product throughout Germany	low effort as usually not glued	Reuse possible, also compostable or energetically recyclable	FASBA Construction Straw (2.23.01) Straw bales[35]	-127	140,21	-63	-49,79	Polypropylene cords	istraw Einblasdämmung[36]	Blow-in insulation, fill	no	B2	90-105	2,1	0,043	3/4	280	25,00 €
											Baustroh[37]	Filling of timber stud walls, external insulation, inter-rafter insulation	yes	B2	95-167	2	0,05	2,3	350	9,00 €
	Cellulose	Product made from waste paper, accumulates everywhere	low effort as usually not glued	take-back system, otherwise it can be used to generate energy	Loose cellulose insulation (2.11.01)[38]	-73,37	99,21	-30,51	-4,67	Pressure residues, boric acid, polyolefin fiber, ammonium polyphosphate	ISOCELL-Zellulosefaser[39]	Blow-in insulation, fill	no	B2	28-65	2,11	0,037	3	250	20,40 €
	Wood fibre	Sustainable forest management or production from residual wood and recycling possible	low effort if not glued, high effort with WDVS	Reuse usually not practiced, energy recovery	Wood fibre blow-in insulation material (2.10.01)[40]	-37,63	48,68	-22	-10,95	Polyester fiber, ammonium polyphosphate, aluminum phosphate, borates, paraffin, PUR	STEICOzell[41]	Blow-in insulation	no	B2	32-45	2,1	0,038	1/3	260	11,50 €
					Wood fibre insulation board (2.10.01)[42]	-182,2	335,14	-88,66	64,28		STEICOflex[43]	Stuffing insulation, inter-rafter insulation	no	B2	60	2,1	0,036	2	240	24,56 €
											STEICOtherm[44]	Pressure-resistant insulation	no	B2	110	2,1	0,037	3	260	44,86 €
	Hemp	Local cultivation possible, but not widespread	low effort as usually not glued	take-back system, otherwise it can be used to generate energy	Hemp fleece (2.13.01)[45]	19,16	86,28	-12	93,44	Polyester fiber, soda, ammonium phosphate, boron salts	Thermohanf Stopfwolle[46]	Stuffing insulation, inter-rafter insulation	yes	B2	30-50	2,3	0,04	1 bis 2	310	25,60 €
											Thermohanf Hanffilz[47]	Stuffing insulation, inter-rafter insulation	yes	B2	133-175	2,3	0,043	1 bis 2	280	42,68 €
											Thermohanf Combi Jute[48]	Stuffing insulation, inter-rafter insulation	yes	B2	37	2,3	0,041	1 bis 2	260	39,93 €
	Cork	Mediterranean region, recycling material also possible (wine corks)	low effort if not glued	Recycling into cork grist (soil loosening), otherwise it can be used for energy purposes	Expanded cork (2.9.01)[49]	-96,9	151,72	-38,83	15,99	/	ISO CORK 040[50]	Pressure-resistant insulation	yes	B2	100	1,85	0,036	5 bis 10	240	91,20 €
	Burlap	Tropical areas, recycling material is also possible (coffee or cocoa bags)	low effort as usually not glued	take-back system, otherwise it can be used to generate energy							Jute-Dämmplatten[51]	Stuffing insulation, inter-rafter insulation	yes	B2	32	2,32	0,039	1/2	260	39,93 €
	Coconut Fibre	Tropical areas, there waste product	low effort if not glued	Reuse possible, also compostable or energetically recyclable							Ziro Kokosfaserdämmplatte[52]	Pressure-resistant insulation	yes	B2	109-131	1,3	0,045	1	250	170,00 €
	Seaweed	Mediterranean Sea or Baltic Sea, only in coastal region	low effort as usually not glued	Reuse possible							Seegrashandel.de[53]	Tamping insulation, fill	yes	B2	40	2	0,045	1 bis 2	290	29,00 €
	Reed	Harvest needed to care for the ecosystem, shores of inland waters	low effort if not glued	Reuse possible, also compostable or energetically recyclable						Wire	Hiss Reet Platten[54]	External insulation, internal insulation	yes	B2	155	1,2	0,055	2	390	194,65 €
Animal fibre insulation materials	Sheep Wool	Possible European origin	low effort as usually not glued	take-back system, otherwise compostable or energetically recyclable							Isolena Optimal[55]	Stuffing insulation, inter-rafter insulation	yes	B1	18	1,769	0,038	1	260	61,06 €

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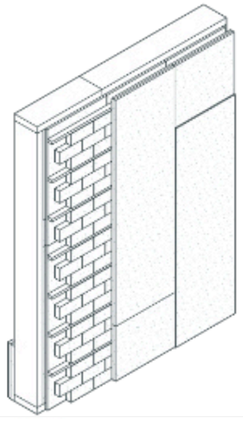
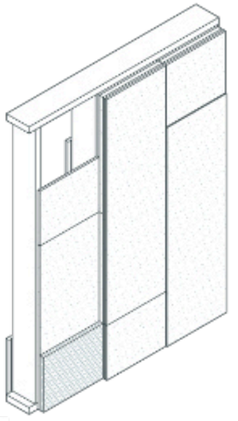
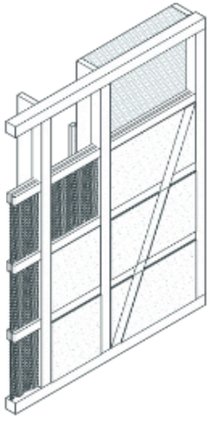
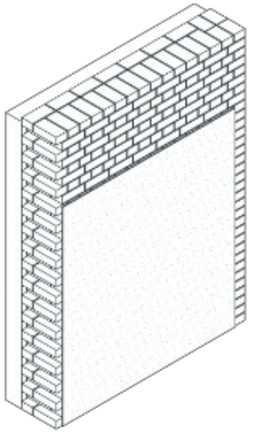
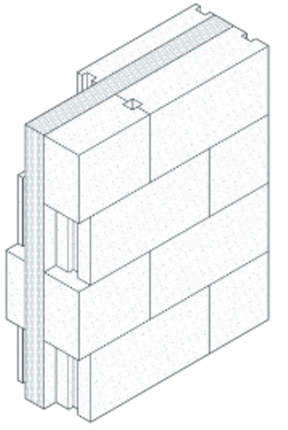
UNTERSUCHUNG VERSCHIEDENER WANDAUFBAUTEN

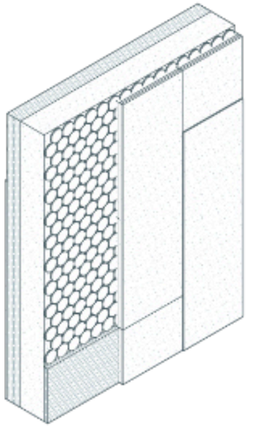


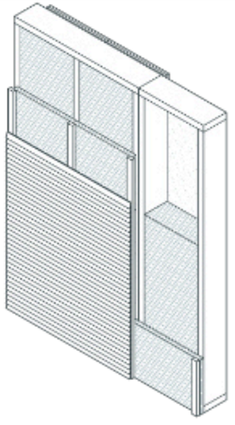


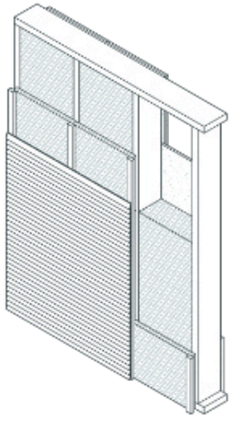


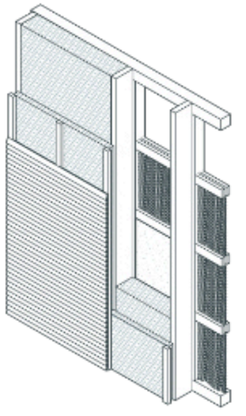


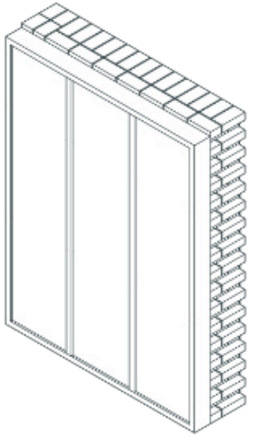


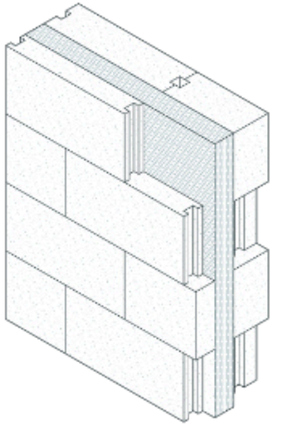


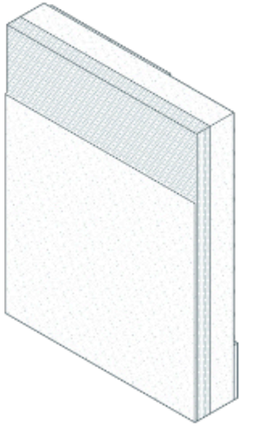












Prefabricated timber frame
Clayboard 20mm
Clayboard 20mm
Wood fiber insulation board 50mm
Clayboard 20mm
Straw blow-in insulation 240mm
Wood fiber insulation board 40mm
Rear ventilation 30mm
Waether board 50mm

Timber frame
Clayboard 20mm
Clayboard 20mm
Extruded clay blocks DF 56mm
Clayboard 20mm
Straw blow-in insulation 240mm
Wood fiber insulation board 40mm
Rear ventilation 30mm
Waether board 50mm

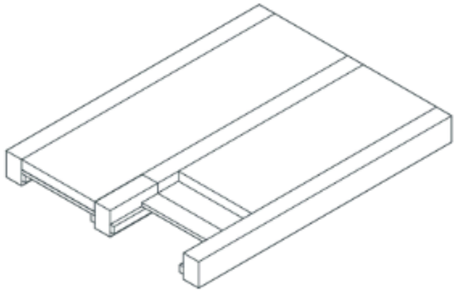
Traditional half-timbered construction
Clay plaster 20mm
Straw loam 120mm
Straw blow-in insulation 200mm
Wood fiber insulation board 50mm
Rear ventilation 30mm
Waether board 50mm

Clay bricks
Clay plaster 20mm
Clay blocks (1800) 365mm
Air layer 100mm
Triple glazing 36mm

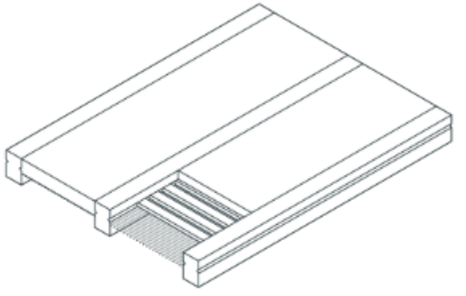
Prefabricated rammed earth blocks
Rammed earth blocks 365mm
Cork filling 250mm
Rammed earth blocks 200mm

Bottle wall
Clayboard 20mm
Clayboard 20mm
Wood fiber insulation board 50mm
Clay-filled PET bottles, clay mortar 230mm
Wood fiber insulation board 140mm
Clay plaster 10mm

UNTERSUCHUNG VERSCHIEDENER DECKENAUFBAUTEN



Filler joist ceiling (Einschubdecke)



Wattle ceiling (Stakendecke)

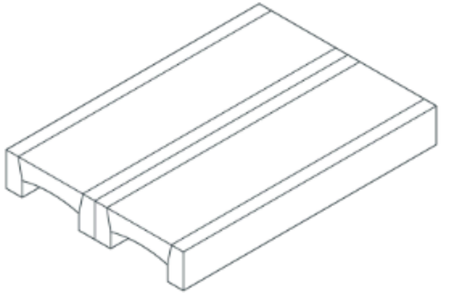


Fig. 8: "Kappendecke 2.0"

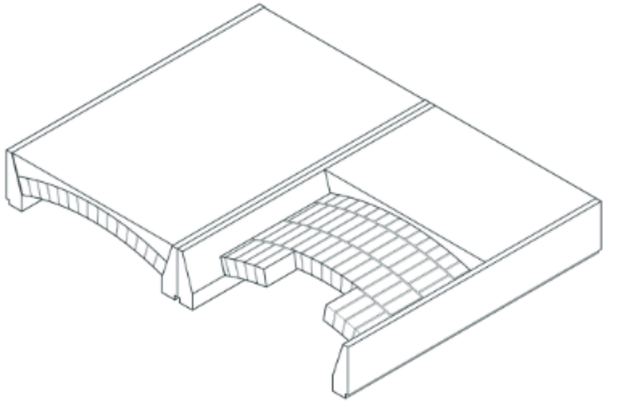
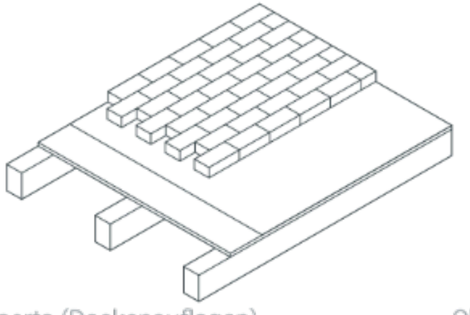
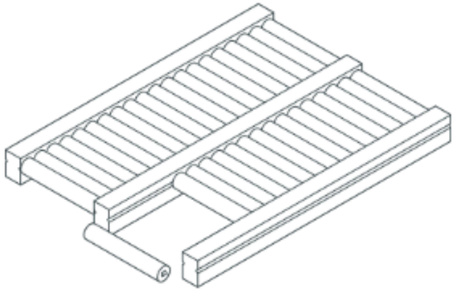


Fig. 7: "Kappe+"



Ceiling inserts (Deckenauflagen)



Clay timber struts (Wickelstakendecke)

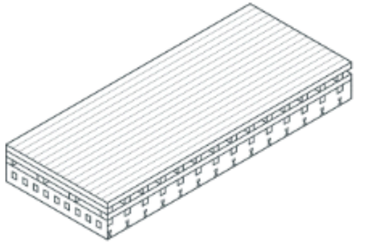


Fig. 9: "Timber Earth Slab"

STROH
KERN

BRANDSCHUTZ

Schutzdauer Lehmputz:

t = 1.1 * hp – 5.9

hp= **35 mm**

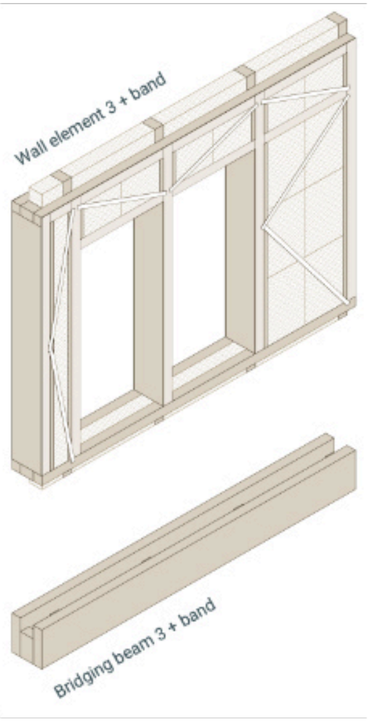
t [min] = 1,1 * 35 - 5,9 = 32,6

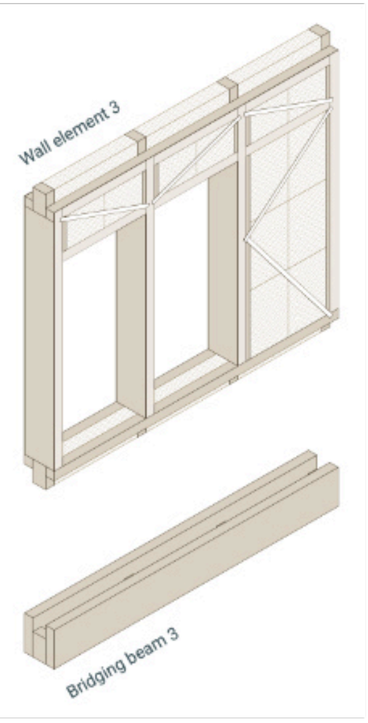
Für F60 also zusätzlich 30 min. Verkohlungsdauer notwendig, dafür bei Verkohlungsrate von 0,65mm/min **+2cm** Holzquerschnitt in jeder Richtung

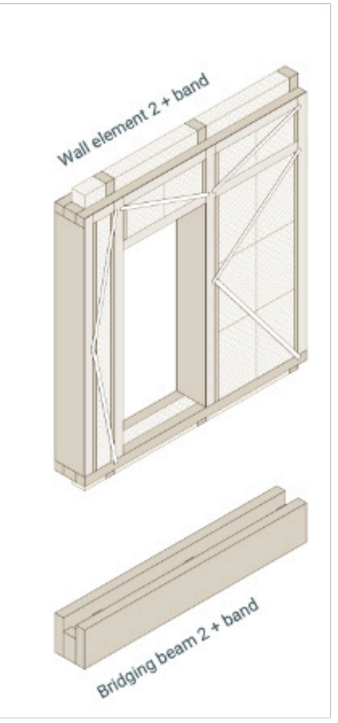
DAS BAUSYSTEM

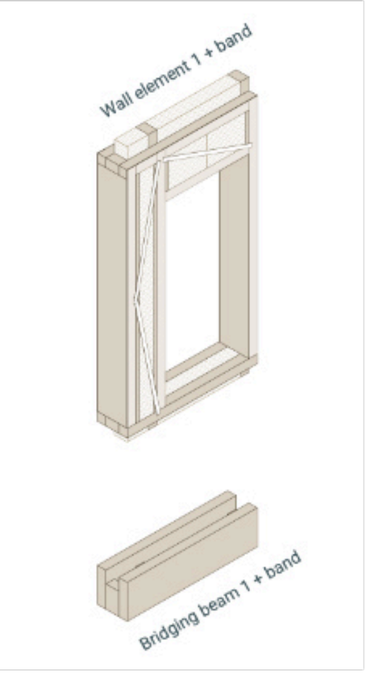
STROH
KERN

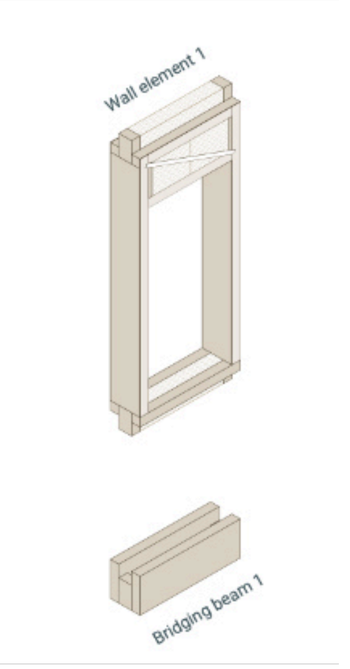
TRAGENDE BAUTEILE

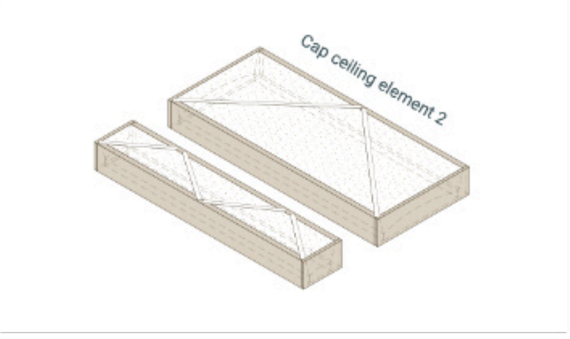


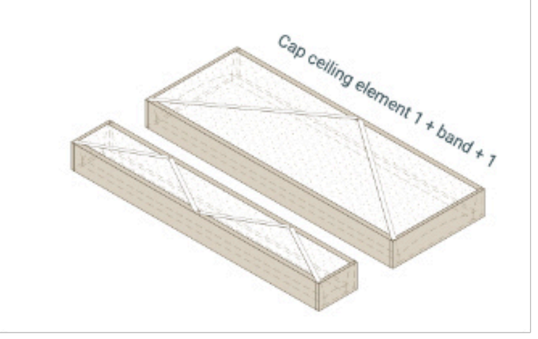


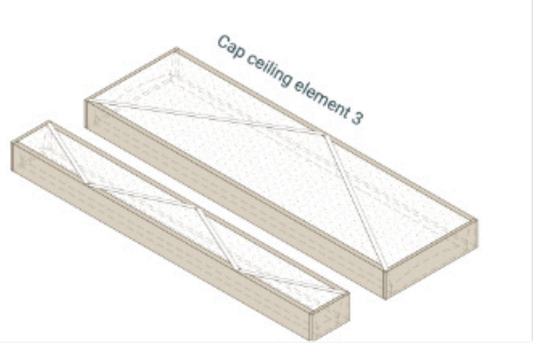


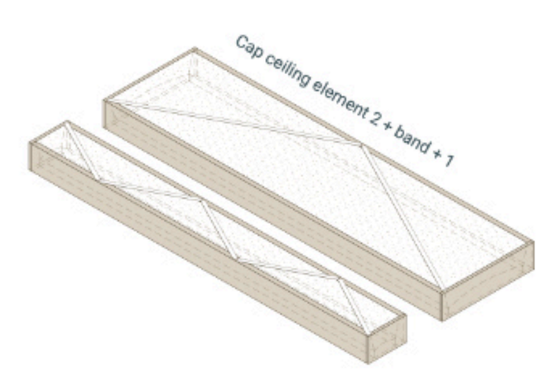












STROH
KERN

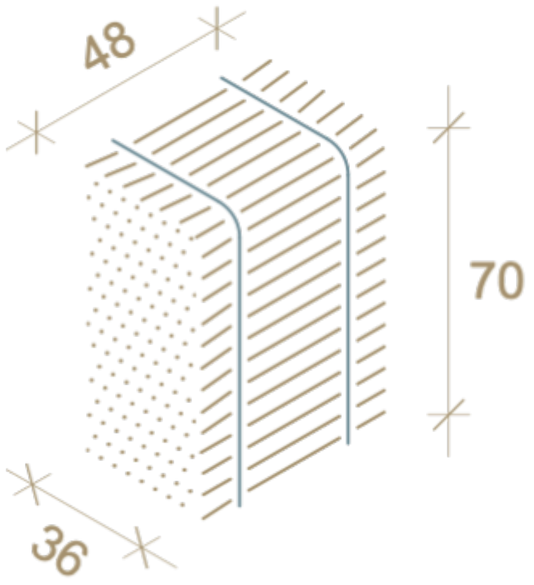
DIE WAND

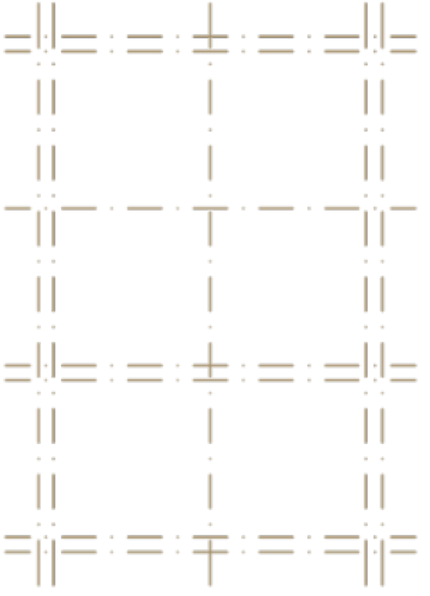
Strohballenmaße als Grundlage

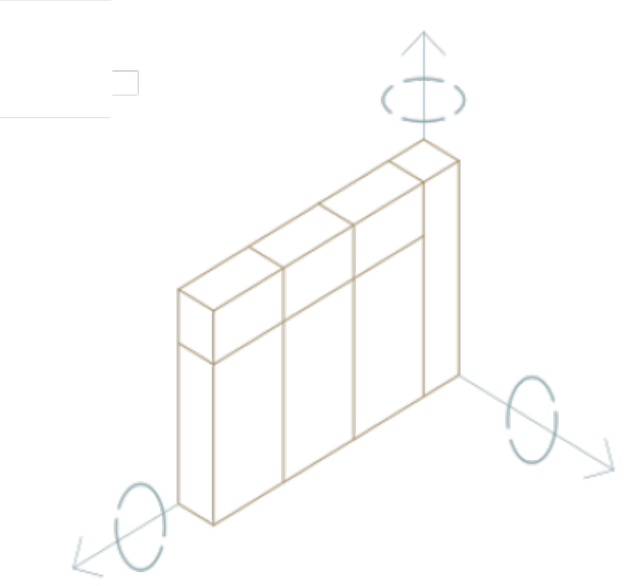
Modulares Bandraster

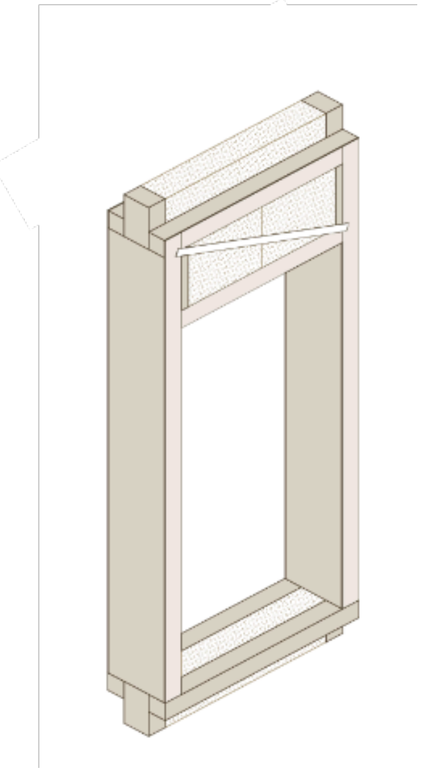
Einbaurichtung drehbar

Querpressung vermeiden







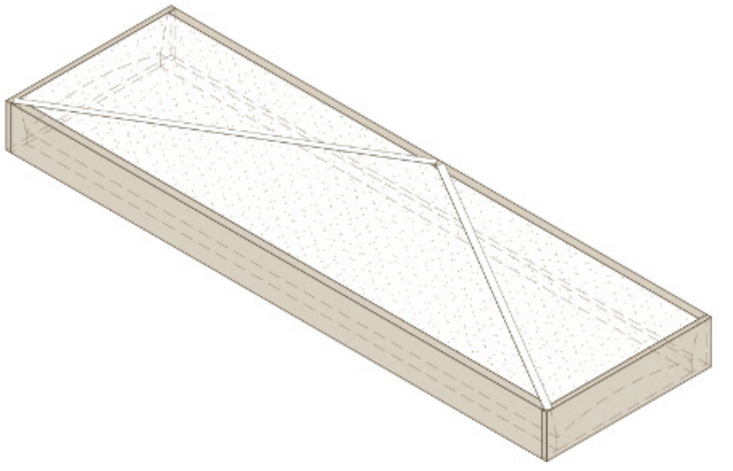


STROH
KERN

DIE DECKE

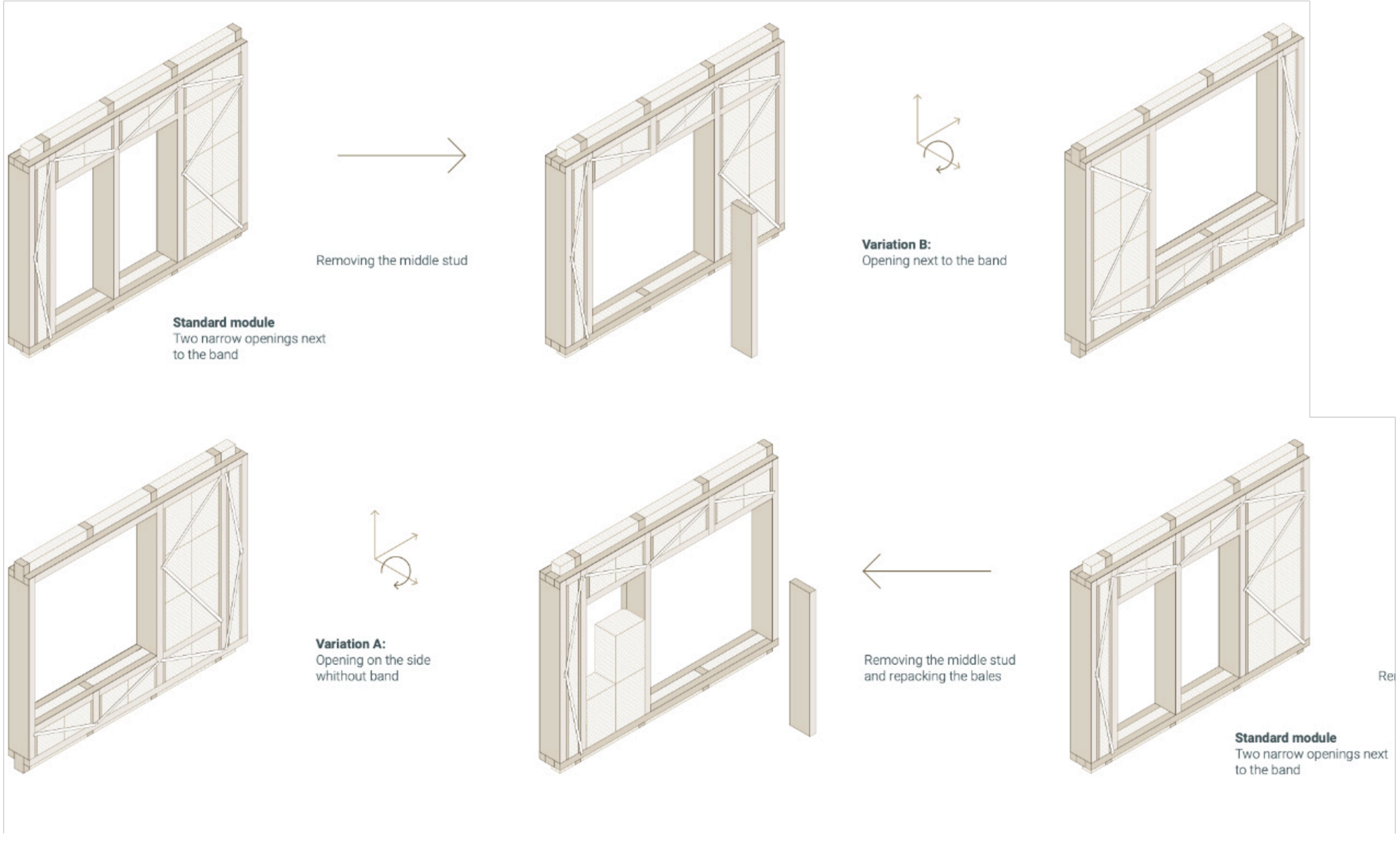
Beispielhafte Berechnung einer Lehmsteinkappendecke

Variable/Name	Abbreviation	Unit	Value	Formula
Payload	q	kN/m²	5	
Dead load	g	kN/m²	3,698	
Widths of the caps	l	m	2,7	
Stitch hight	f	m	0,085	
Compressive strength clay brick per m²	çRd1	MN/m²	2	
Hight of clay stones in the cap	h	m	0,071	
Total laod	p	kN/m²	8,698	p=q+g
Safety factor			1,4	
Edited total load (with saety factor)	ped	kN/m²	12,177	ped=1,4*p
Vertical load at the bearing	Av	kN/m	16,439	Av=(ped*l)/2
Horizontal load at the bearing	Ah	kN/m	130,547	Ah=(ped*l²)/8*f
Resulting bearing force	Ares	kN/m	131,578	Ares=WURZEL(Av²+Ah²)
		MN/m	0,132	
Compressive strength clay brick per meter çRd2 must be > Ares	çRd2	MN/m	0,142	çRd2=çRd1*h



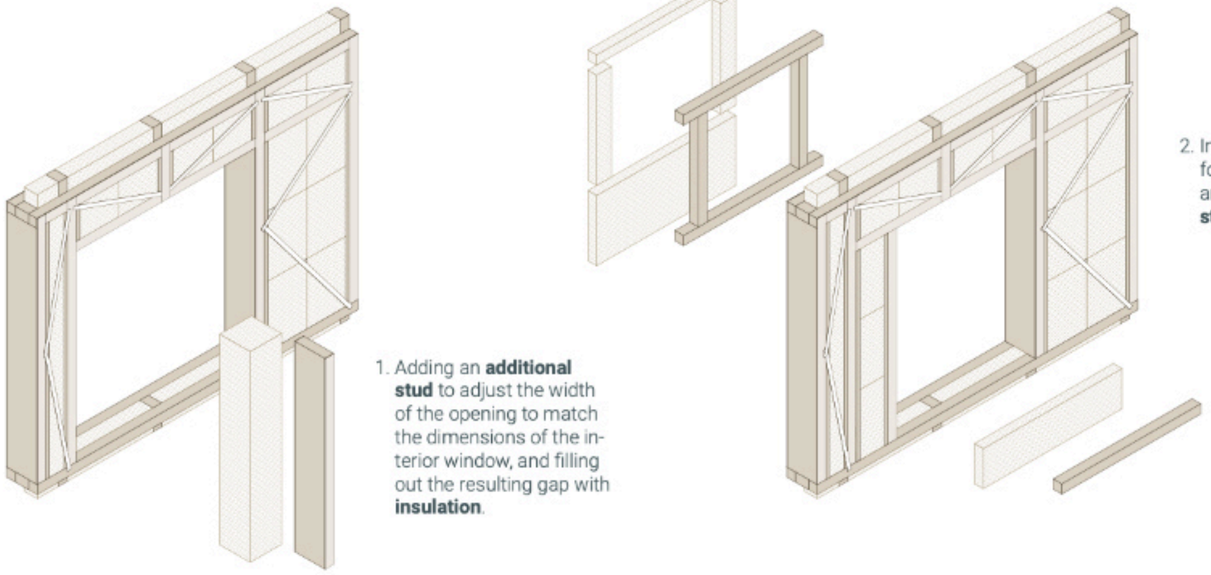
STROH
KERN

AUSRICHTUNG WANDMODUL



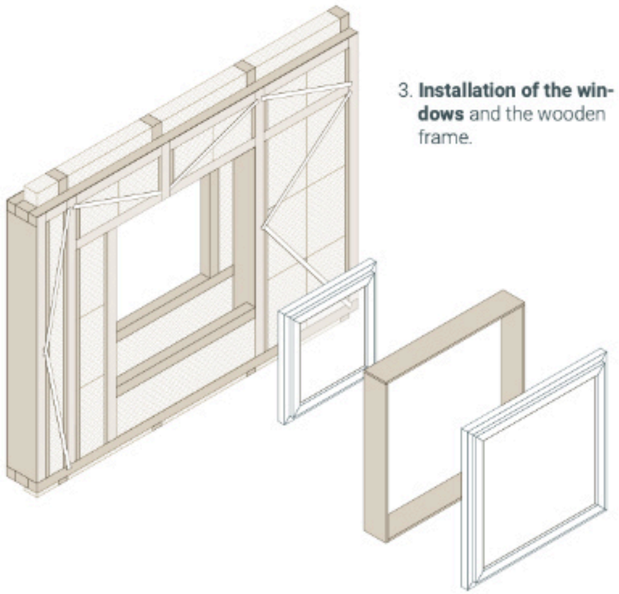
STROH
KERN

EINBAU VON ÖFFNUNGS-ELEMENTEN

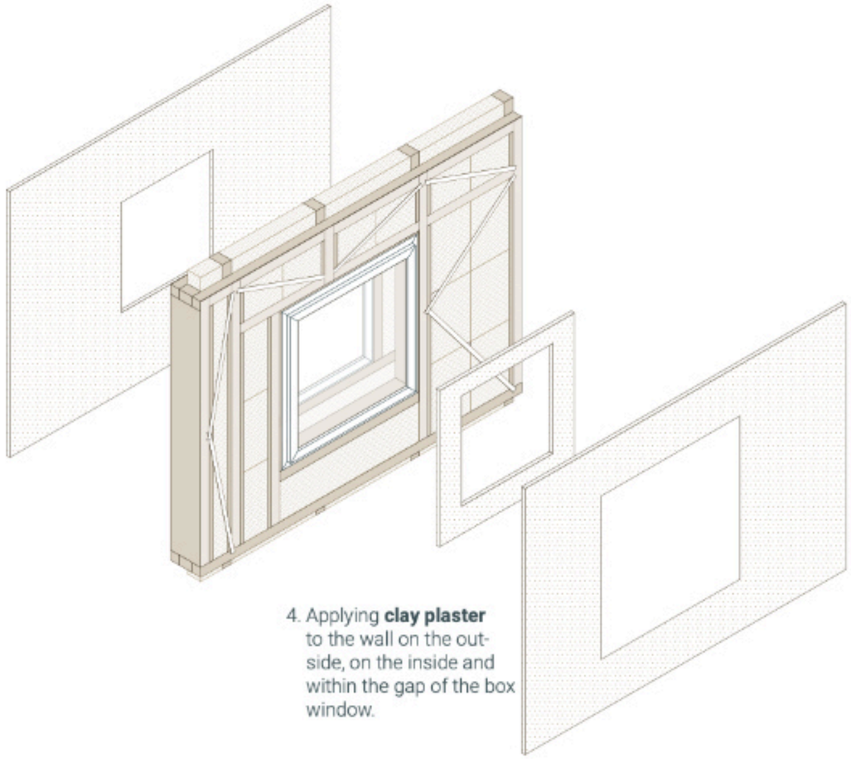


1. Adding an **additional stud** to adjust the width of the opening to match the dimensions of the interior window, and filling out the resulting gap with **insulation**.

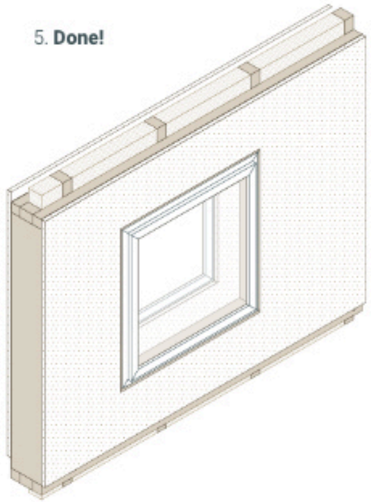
2. Inserting a **timber frame** for the exterior window and filling the gaps with **straw panels**.



3. **Installation of the windows** and the wooden frame.



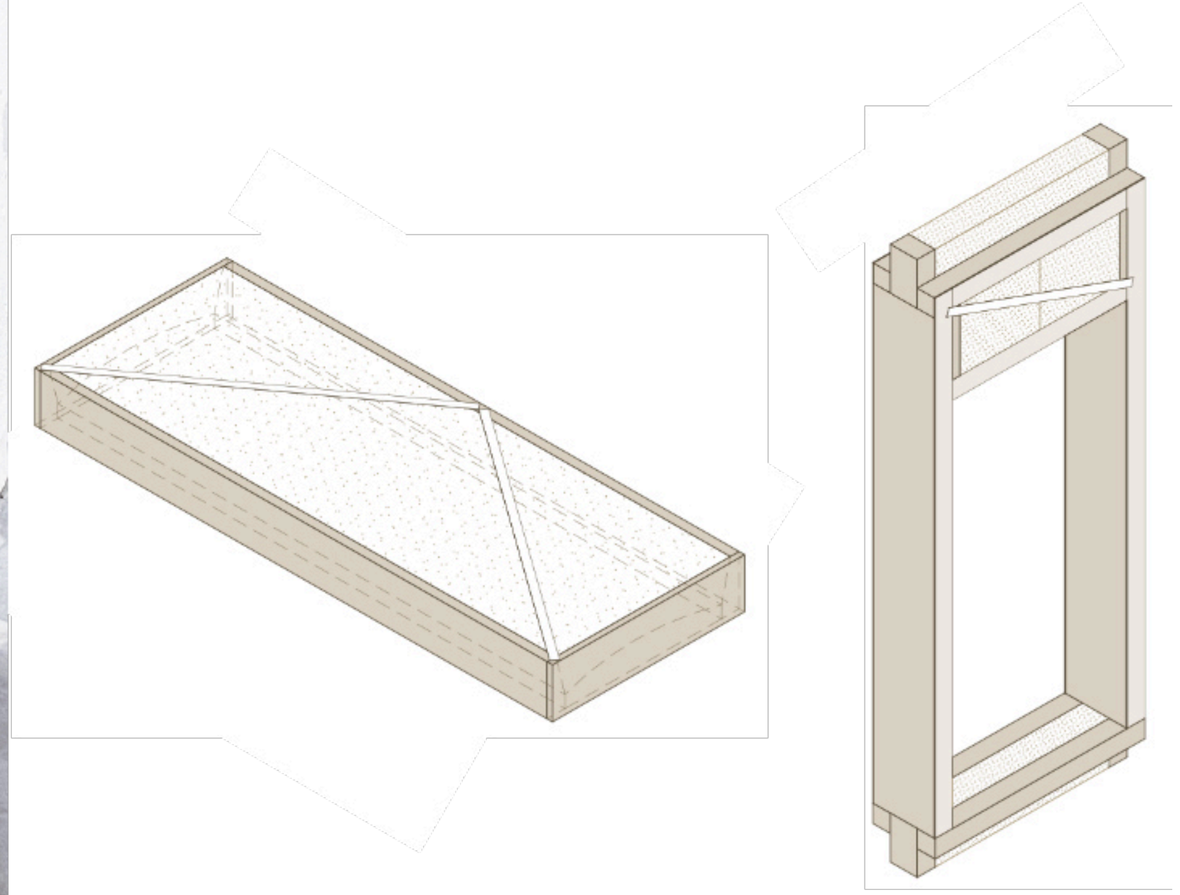
4. Applying **clay plaster** to the wall on the outside, on the inside and within the gap of the box window.



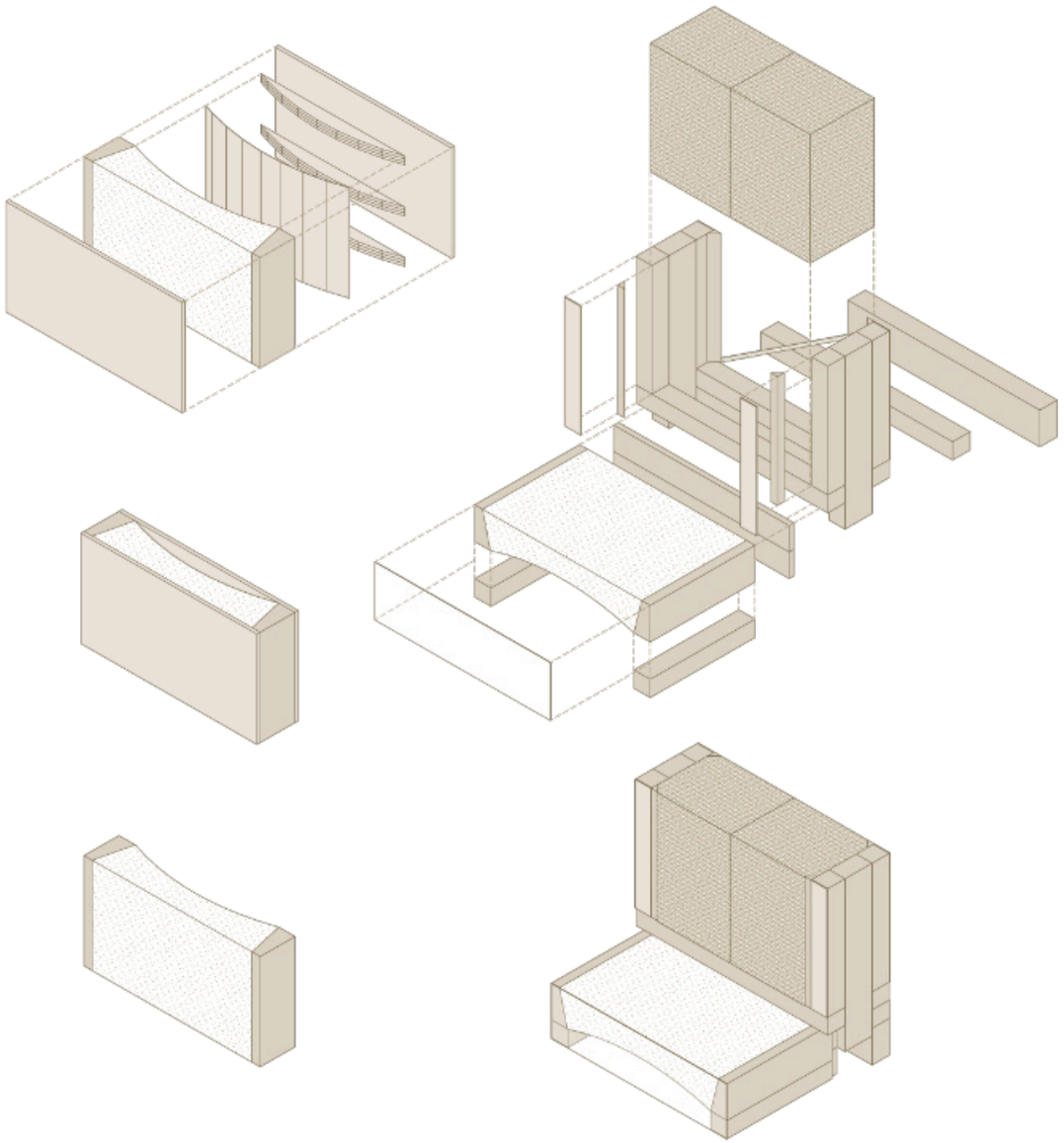
5. **Done!**

STROH
KERN

MODELLBAU M 1:1

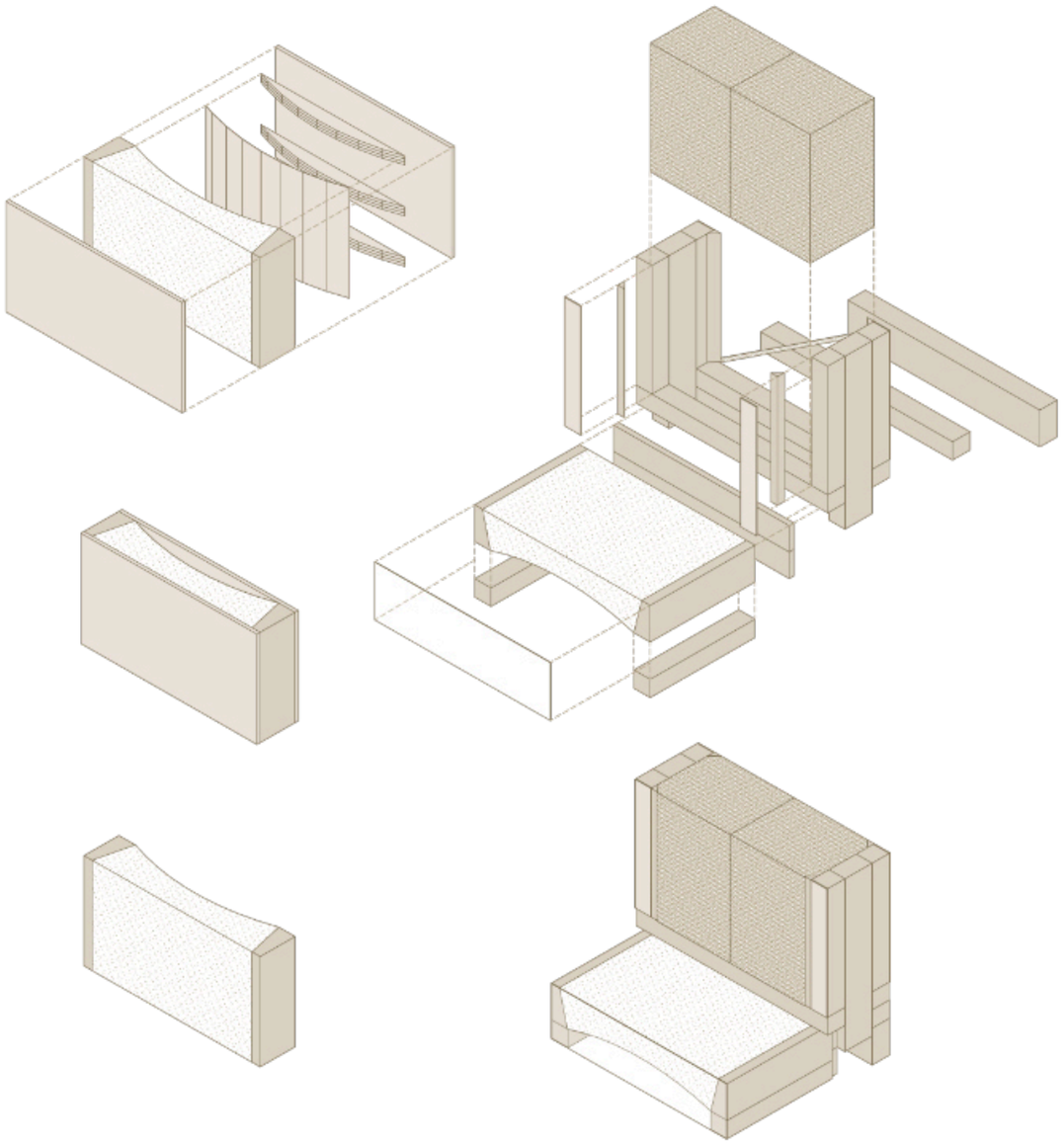


MODELLBAU M 1:1

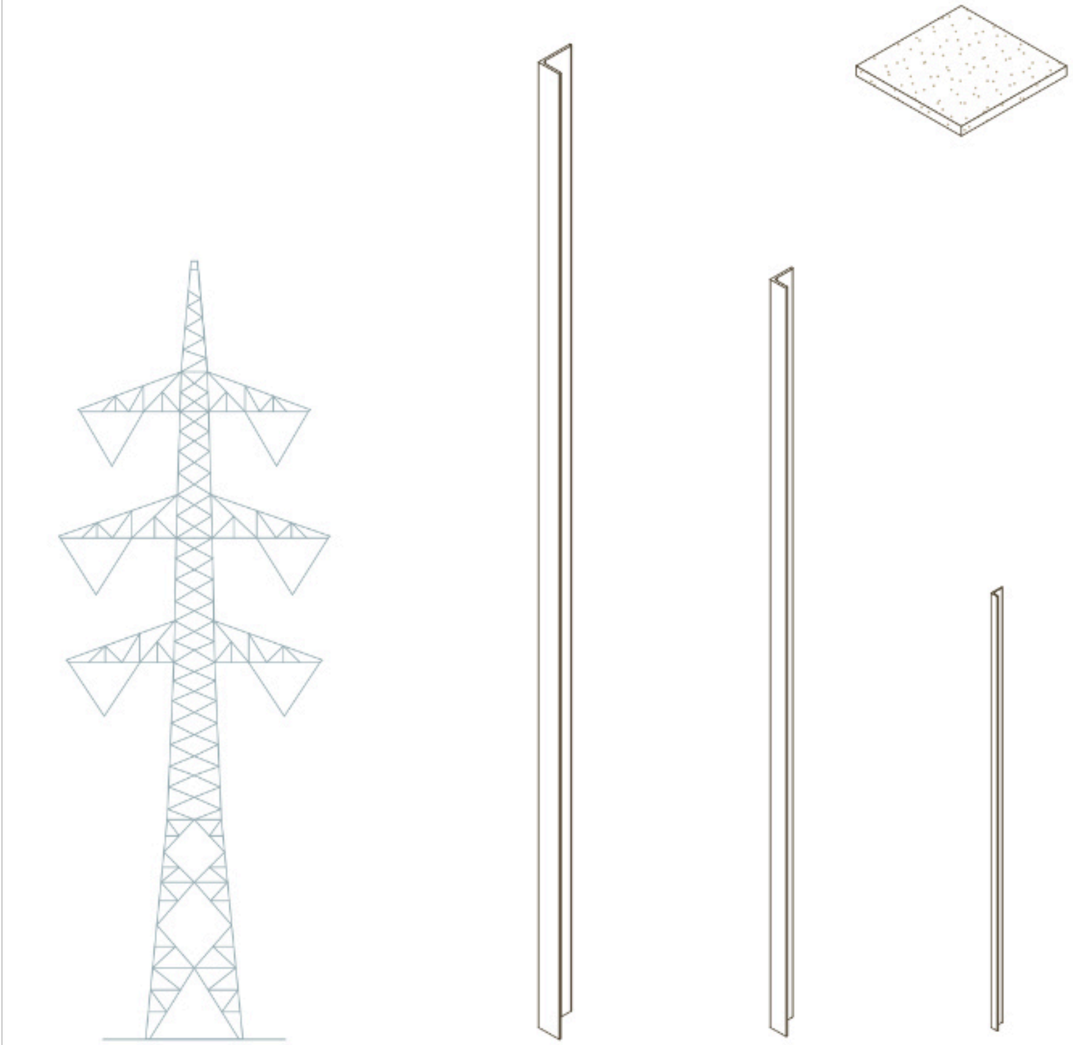


STROH
KERN

MODELLBAU M 1:1

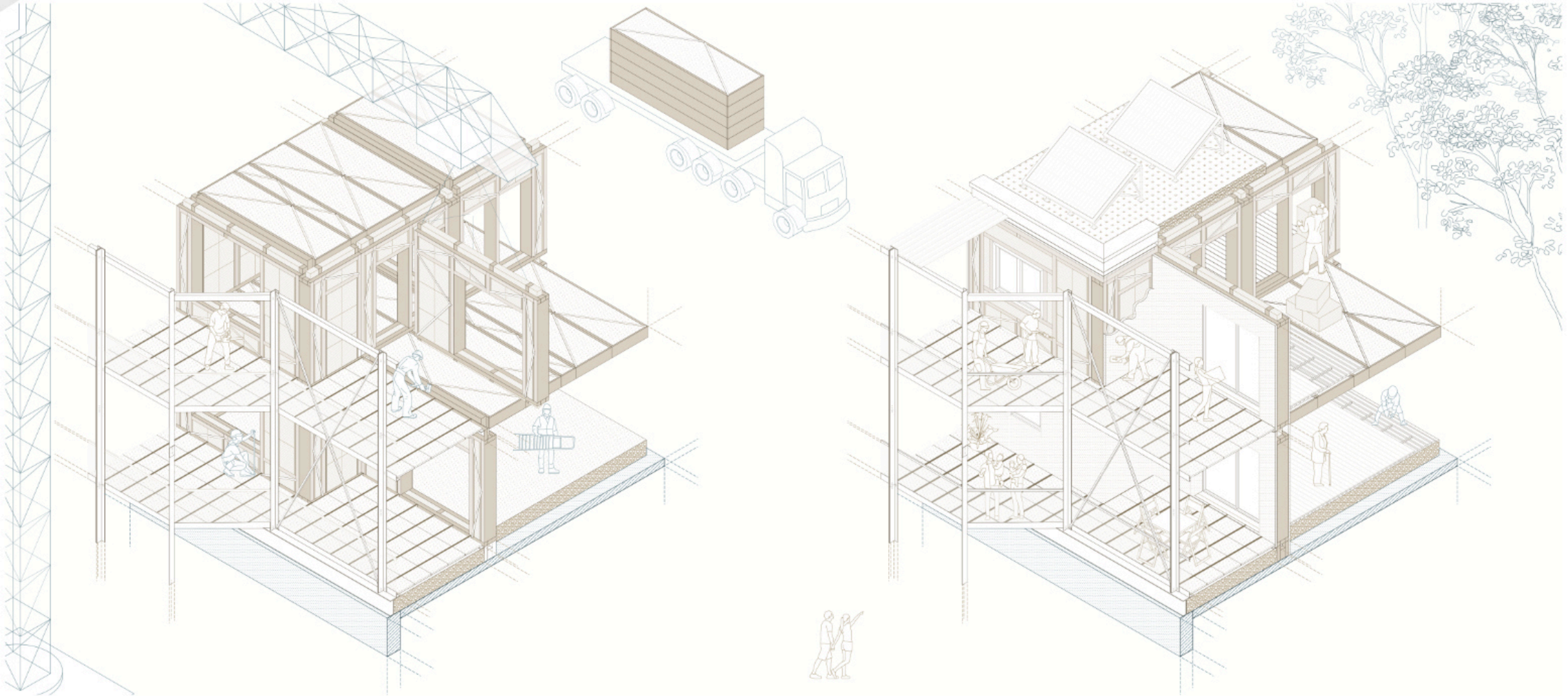


ÄUSSERE STRUKTUR



STROH
KERN

MAST-CHANGE!



Isometric View Building System . 1:50

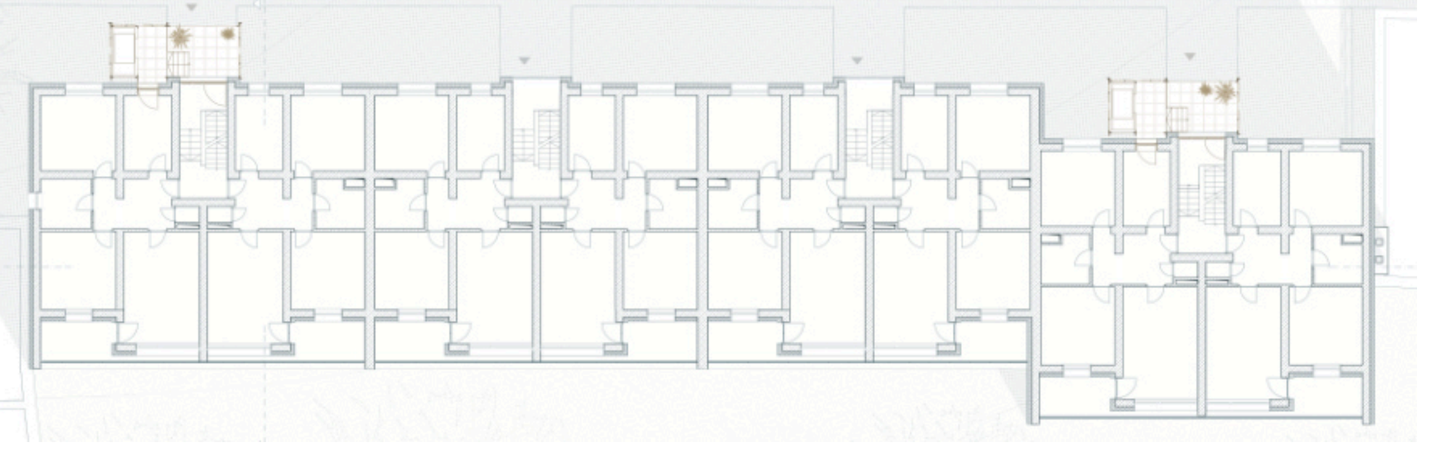
ANWENDUNG IM ENTWURF


81
33
30
27
25
2
Nizzaallee 73
Roermonder Str. 64
Roermonder Str. 64-76
Löwenbergstr. 59
Kühlwetterstraße
Krefelder Str. 17
Kardinalstr. 13
Alkenstraße
Jülicher Str. 352
Jülicher Str. 273
Jülicher Str. 269 A
Jülicher Str. 196
Pontdriesch 155
Veltmanplatz 15
Friesenstr. 8
Bergstr. 16
Jülicher Str. 91
Dennewartstr. 2-18
Joseph-von-Görres-Straße
Heinzenstr. 24
Jülicher Str. 71
Jülicher Str. 56-58
Jülicher Str. 40
Reimarstr. 7
Pontstr. 33
Alexanderstr. 94
Heinrichsallee 72
Heinrichsallee 64
Mozartstr. 8
Sollgraben 11
Grenzbahnstr. 47, 51
Pontstr. 22
Antoniusstraße
Grüneckerstr. 8
Karlstr. 4-12
Gaskanstr. 5-7
Templergraben 26
Stolberger Straße
Peilnerkerstraße
Heidtberg Straße
Lemierser Straße
Albertstr. 57
Adalbertstr. 60
Stiftstr. 22
Heinrichsallee 17
Mauerstr. 3
Kaiserplatz 23
Jülicher Str. 73
Adalbertsteinweg 75
Adalbertsteinweg 74
Adalbertsallee 4-8
Hermannstr. 28
Oligsbendergasse 4-6
Viktoriastr. 43
Dippelstr. 34
Hallfaststraße
Kleinmarschierstr. 53
Hanscampstr. 57
Leyhengerstr. 9
Leyhengerstr. 45
Luisenstr. 5
Viktoriastr. 51
Adalbertsteinweg 242
Heidelberger Str. 6
Vaalser Str. 101
Vaalser Str. 52
Jakobstraße 3
Hubertusstr. 12-14
Aurelianstr. 29
Mühlenstr. 96
Mühlenstr. 185
Beverstr. 29
Beverstr. 21
Prinzenstr. 4
Turpinstr. 121
Rolfeld
Sabbstr. 25
Rachstr. 22
Turpinstr. 23-25
Turpinstr. 28
Kronenberg
Pyrmonter Str. 7
Klosterwalle
Engelbertstraße
Lintertstraße (1)
Lintertstraße (2)
Amyasstraße
Heilbergstr. 19
Ambrosiusstraße

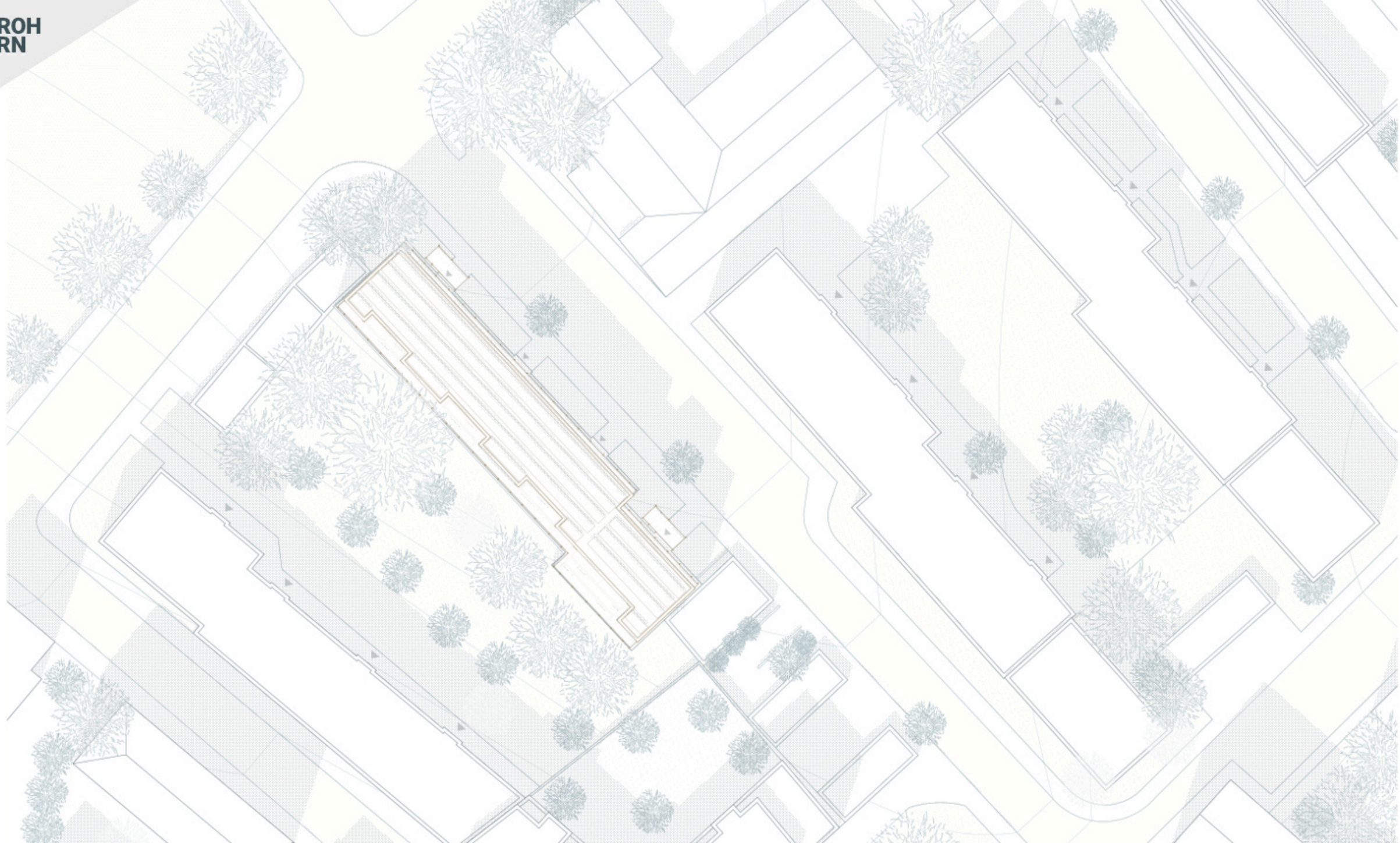
AUFSTOCKUNG VON 60ER JAHRE ZEILENBAUTEN

STROH
KERN

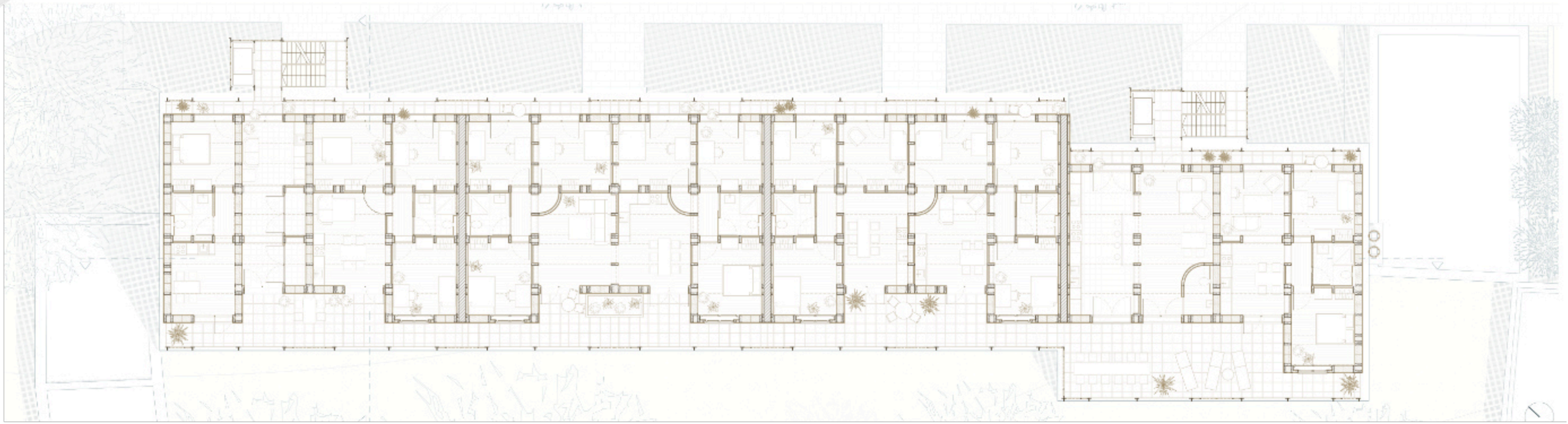
BENDPLATZ

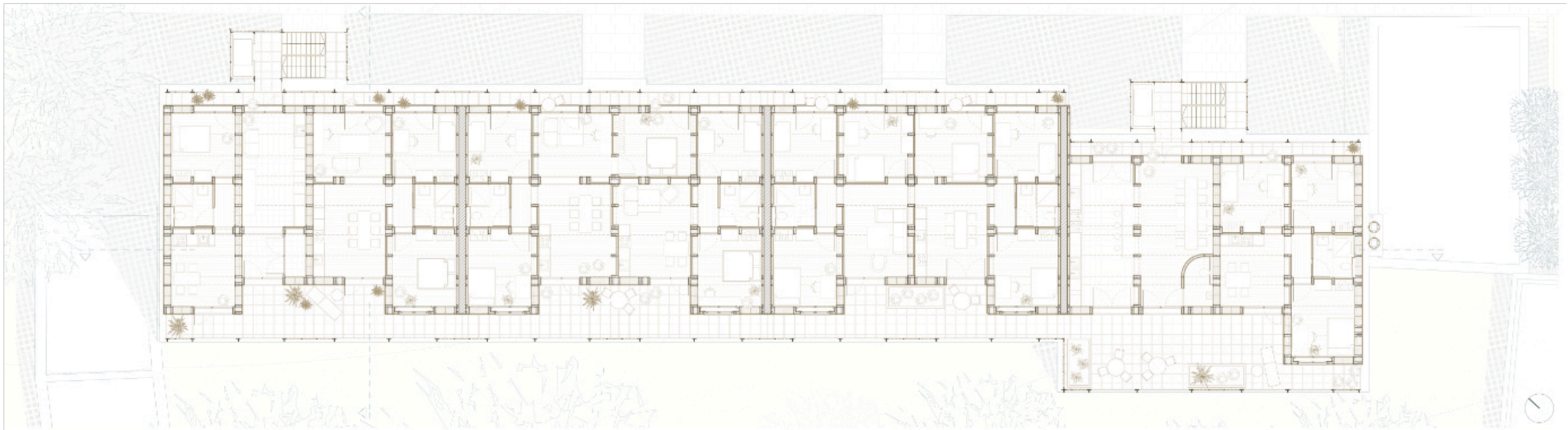


STROH
KERN



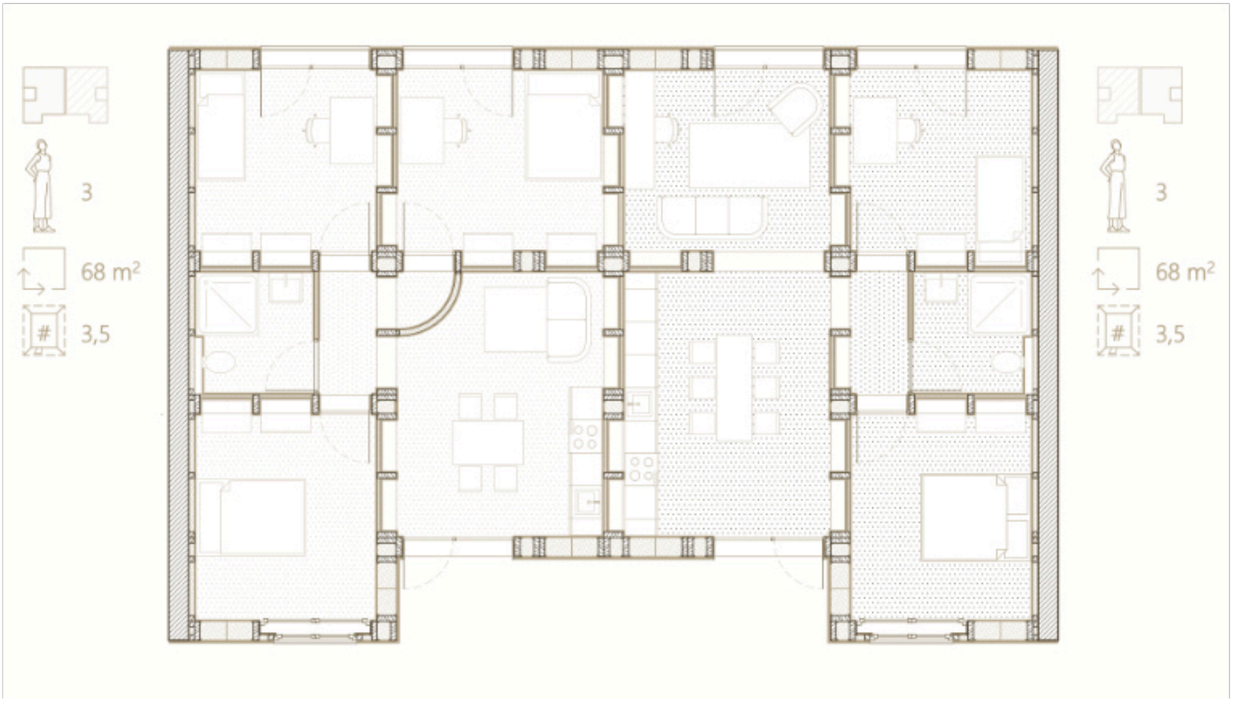
STROH
KERN

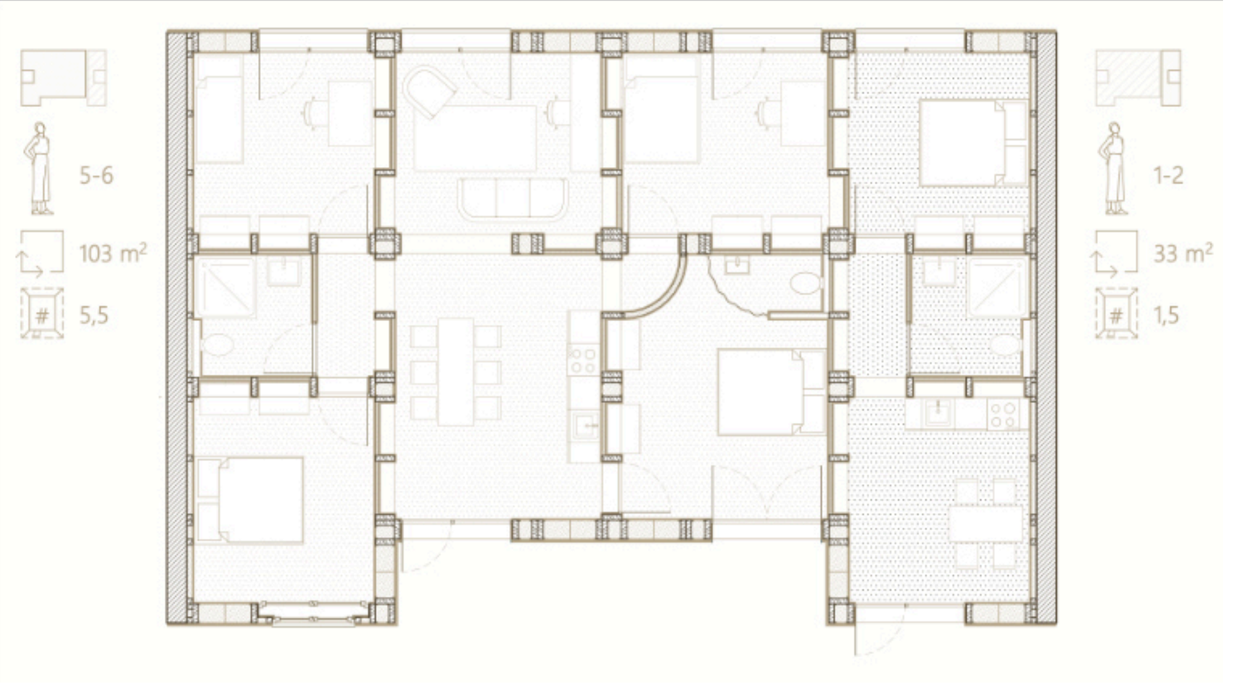




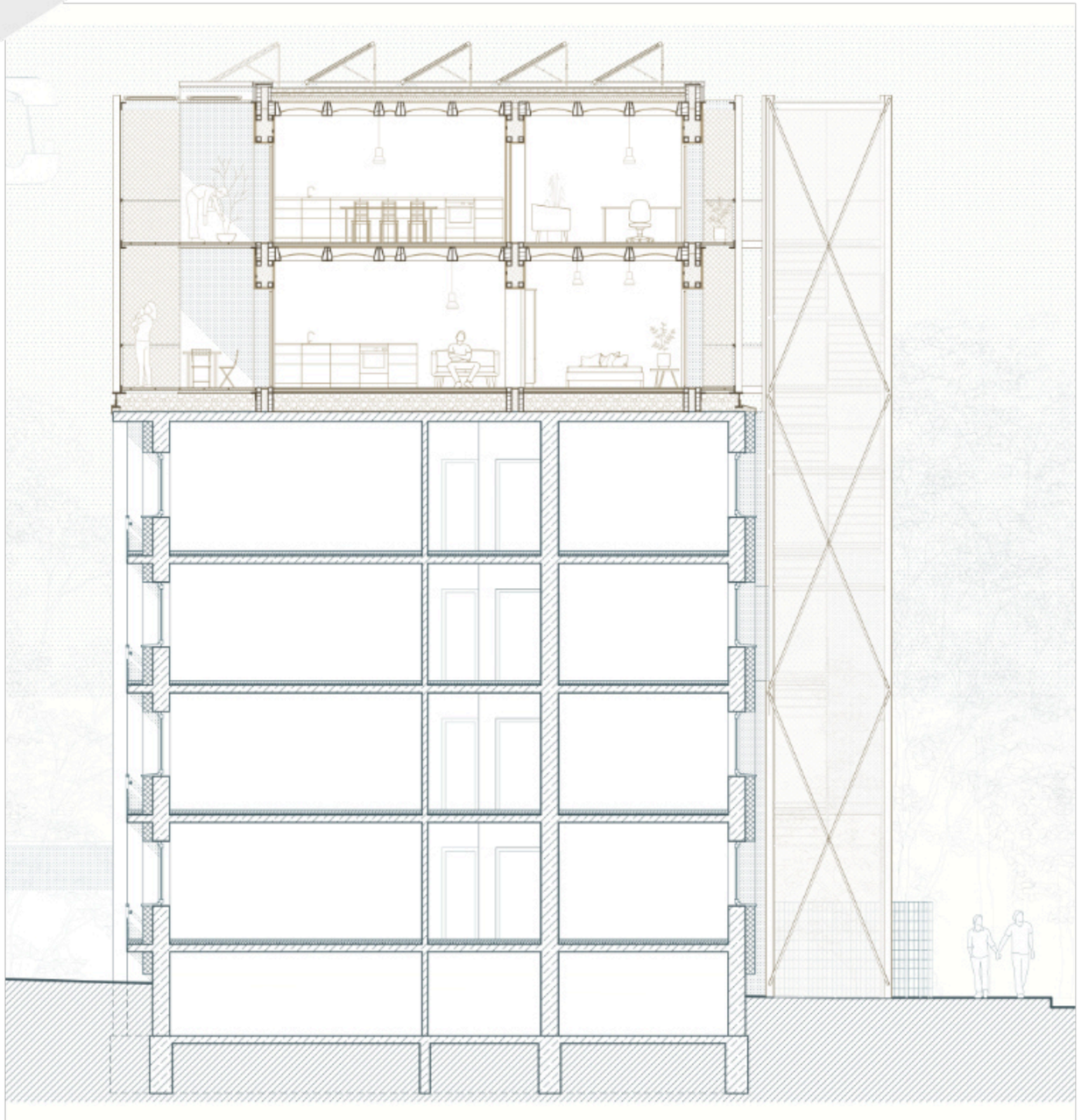
fth floor plan , 1:100

STROH
KERN

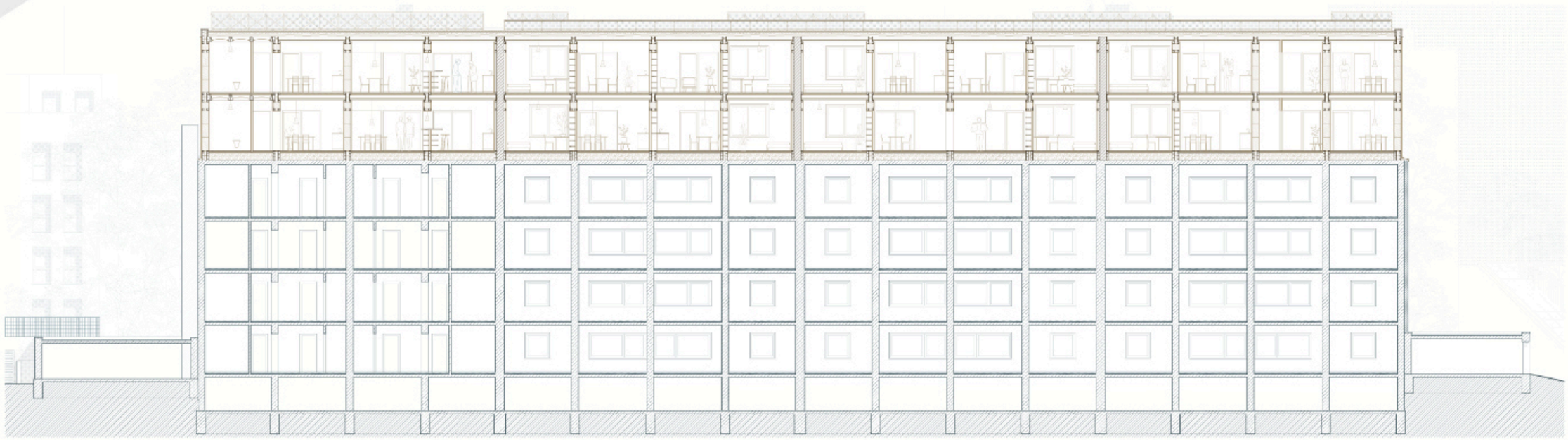




STROH
KERN



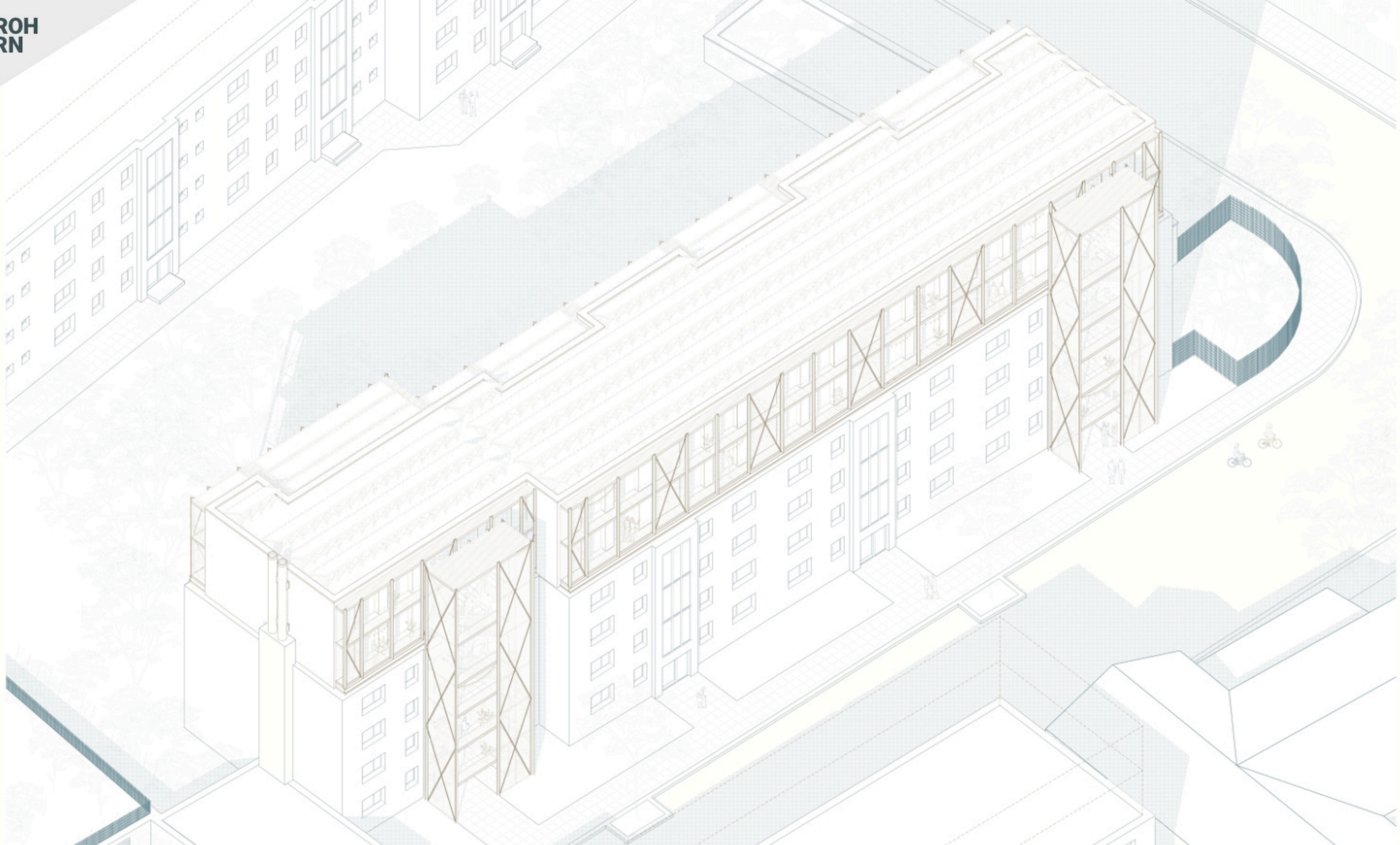
STROH
KERN



Section . 1:100

Elevation North . 1:100

STROH
KERN



STROH
KERN

STROH
KERN

STROH
KERN

AUFSTOCKUNG VON MINDERBEBAUUNGEN

STROH
KERN

MINDERBEBAUUNG ADALBERTSTRASSE

Ground floor plan of the existing stock . 1:500

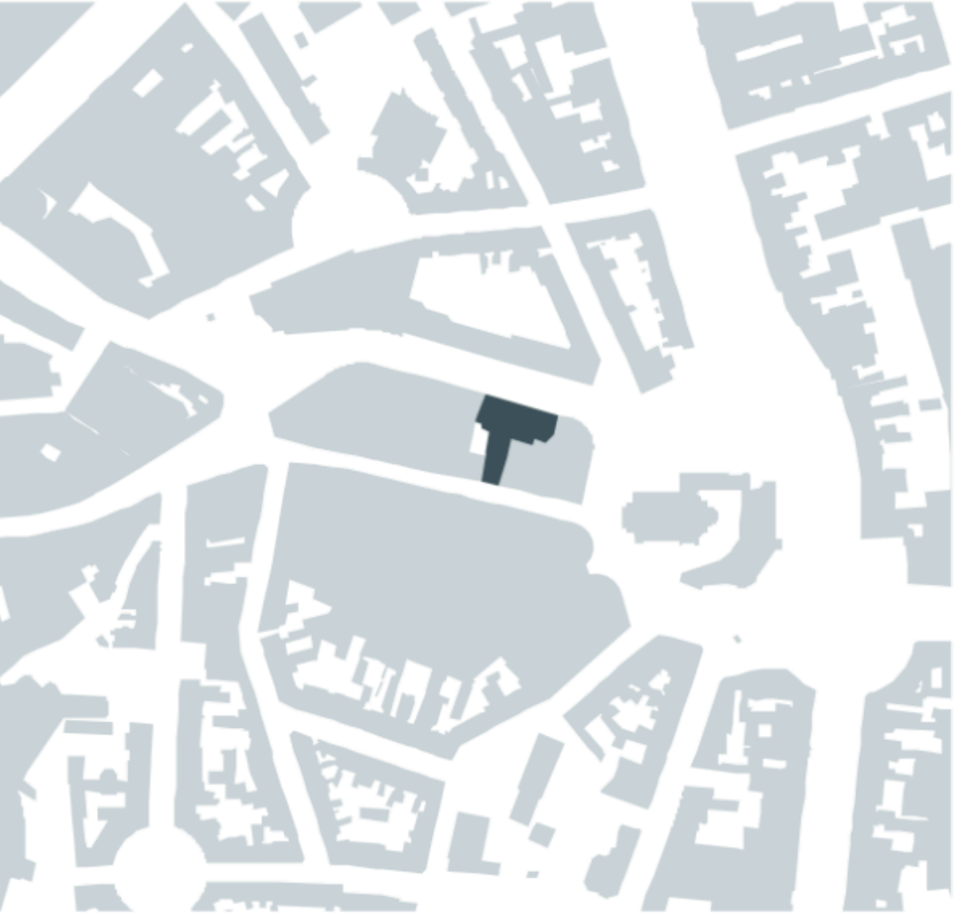
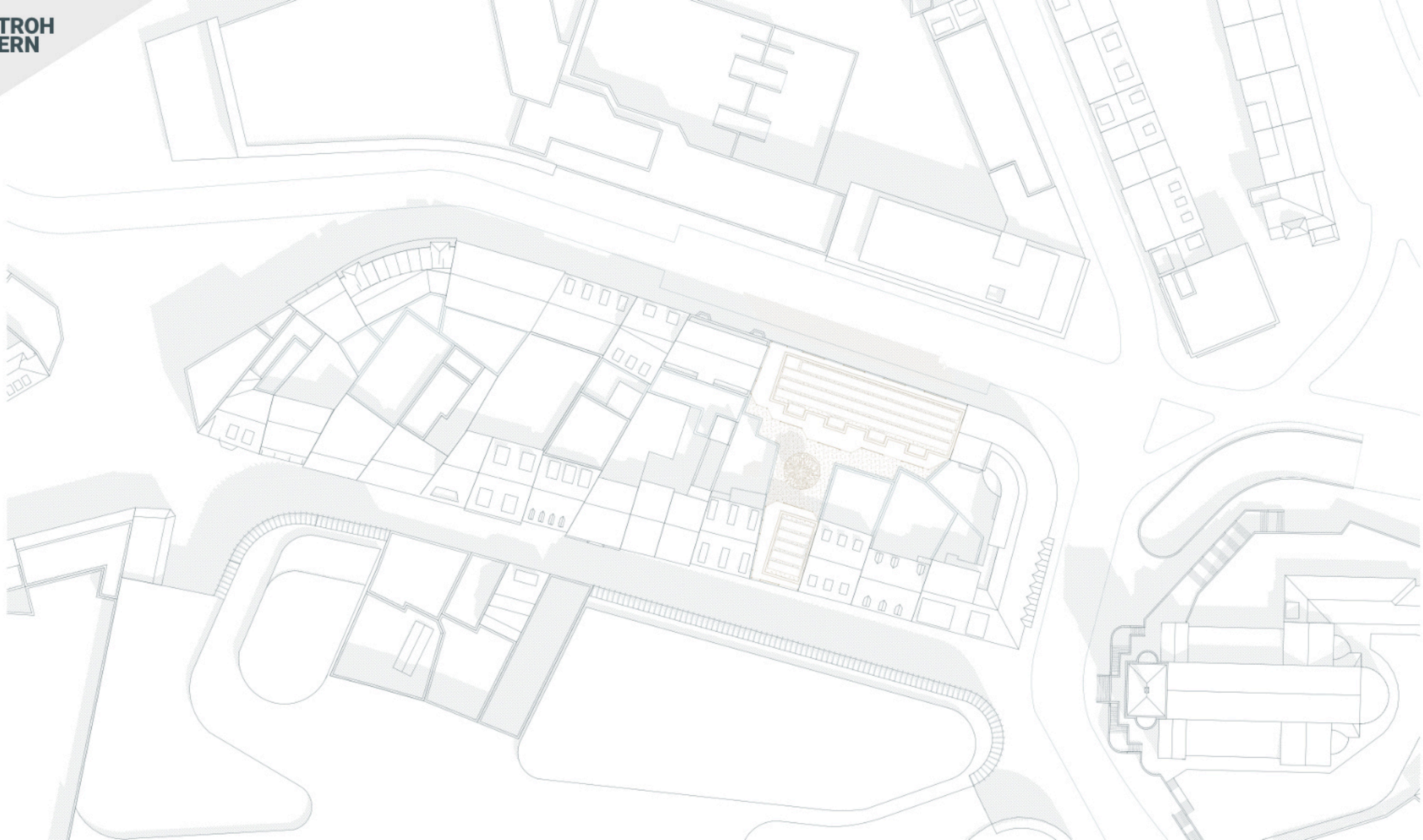


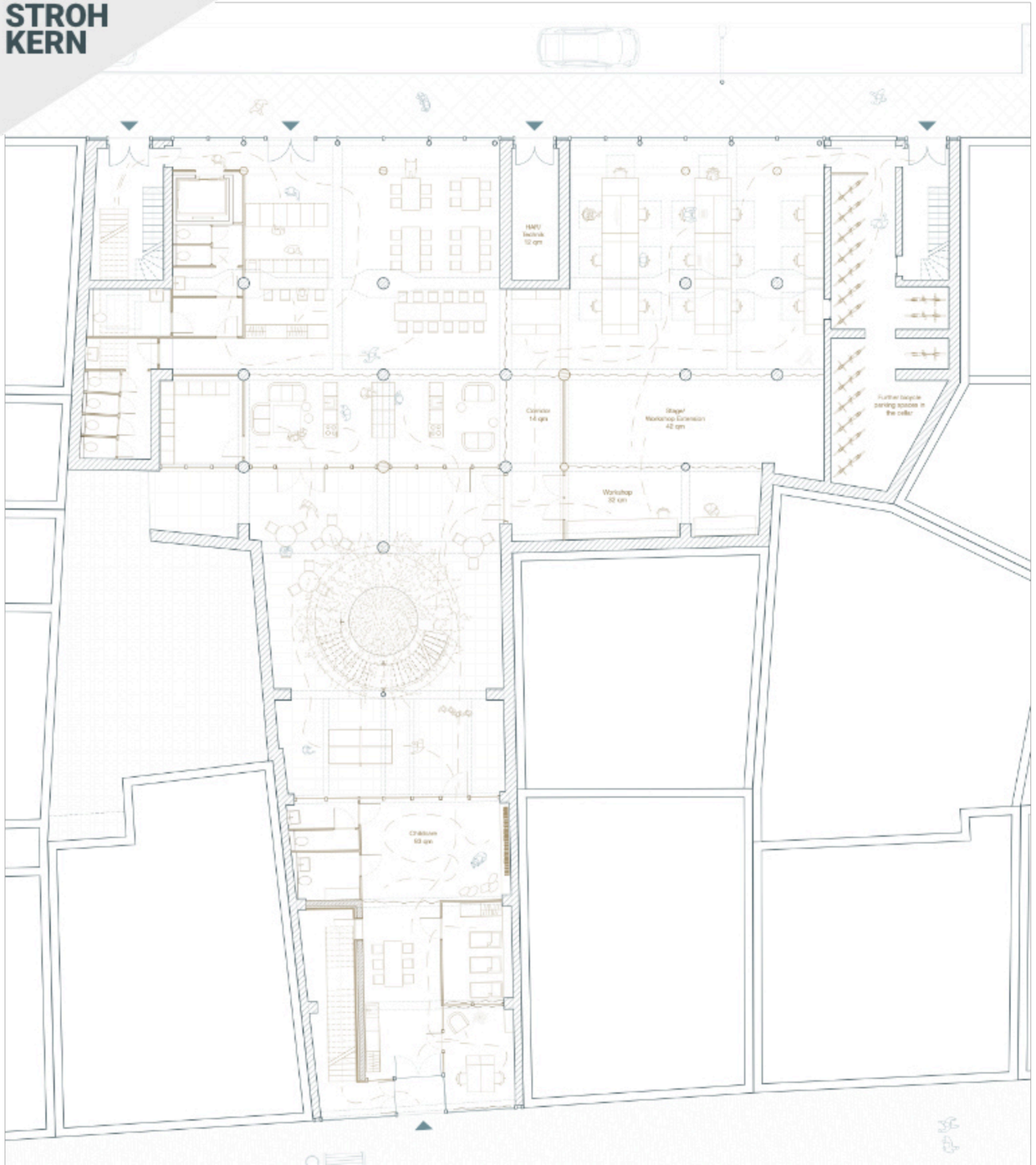
Figure ground plan . 1:5000

STROH
KERN

STROH
KERN



STROH
KERN

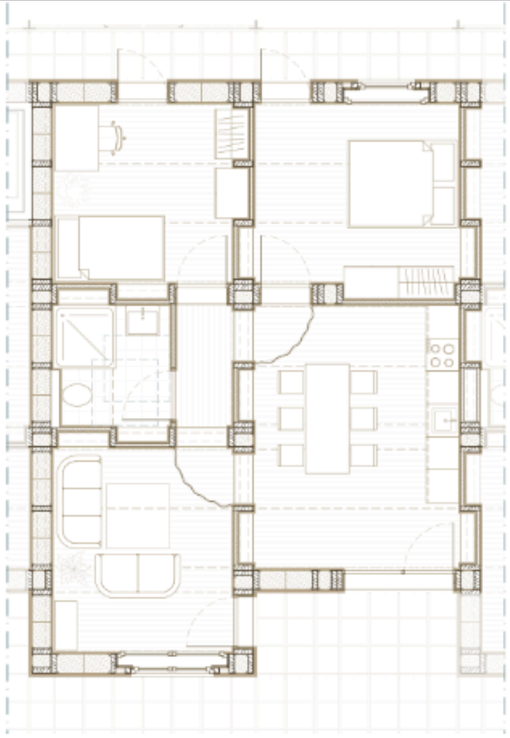

HMV
backrooms
12 qm
Corridor
14 qm
Stage/
Workshop Extension
42 qm
Workshop
32 qm
Further bicycle
parking spaces in
the cellar
Childcare
63 qm

STROH
KERN

2 guests

34 m²

1,5



3

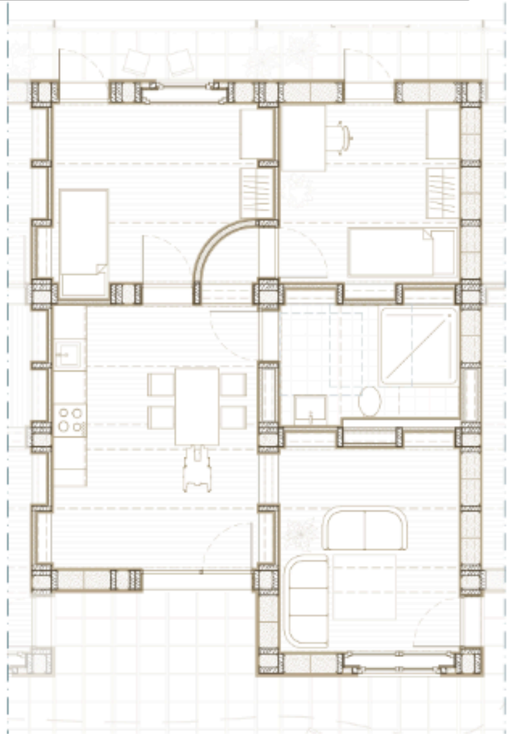
68 m²

3,5

2

68 m²

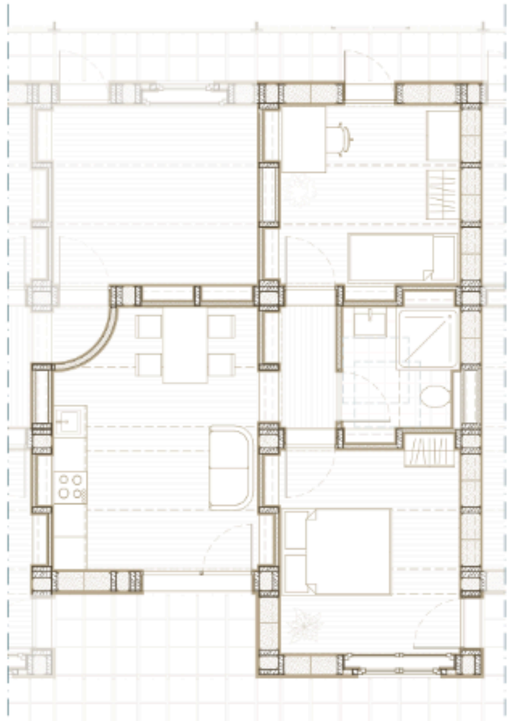
3,5



2-3

52 m²

2,5

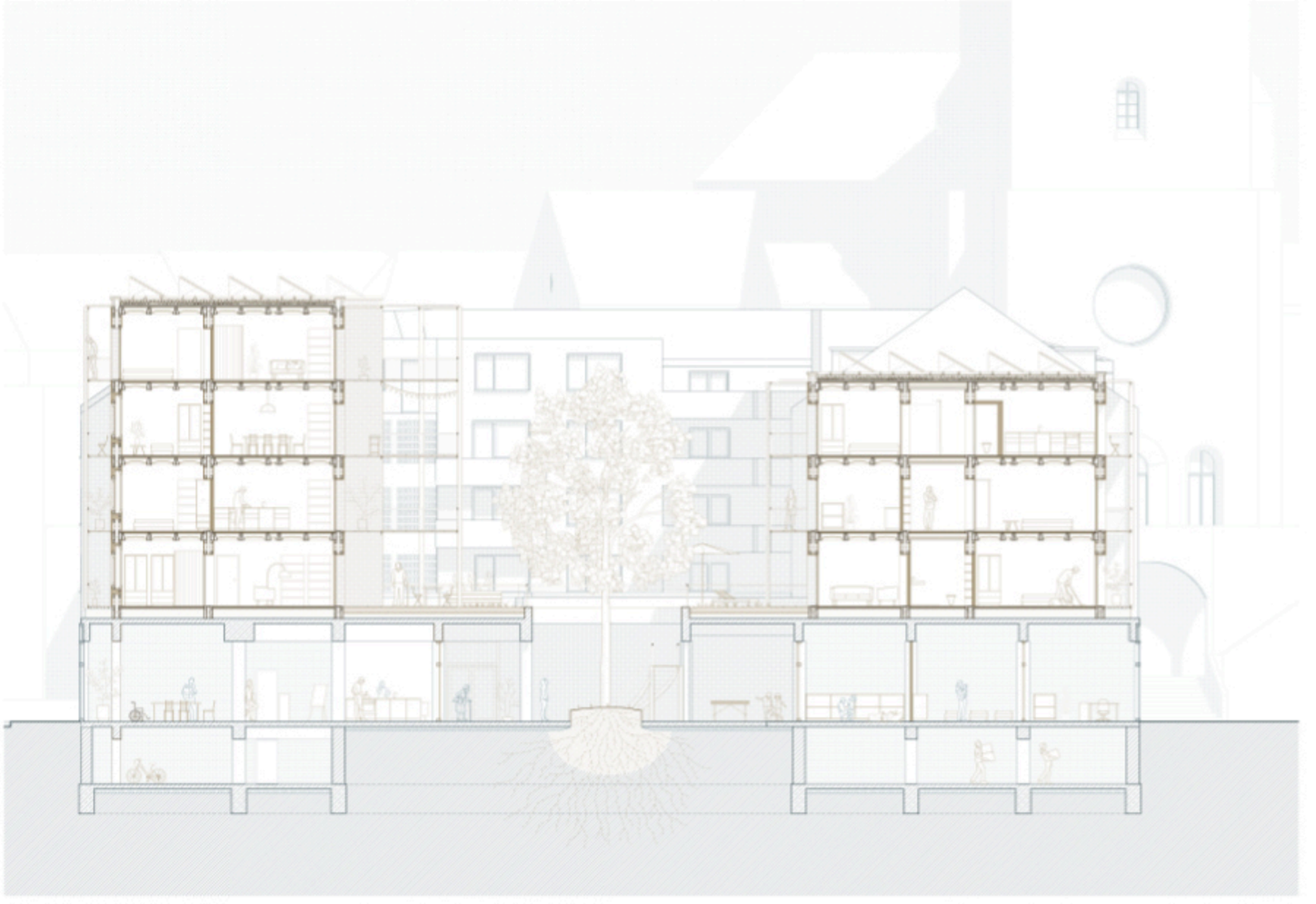


STROH
KERN

North elevation . 1:100

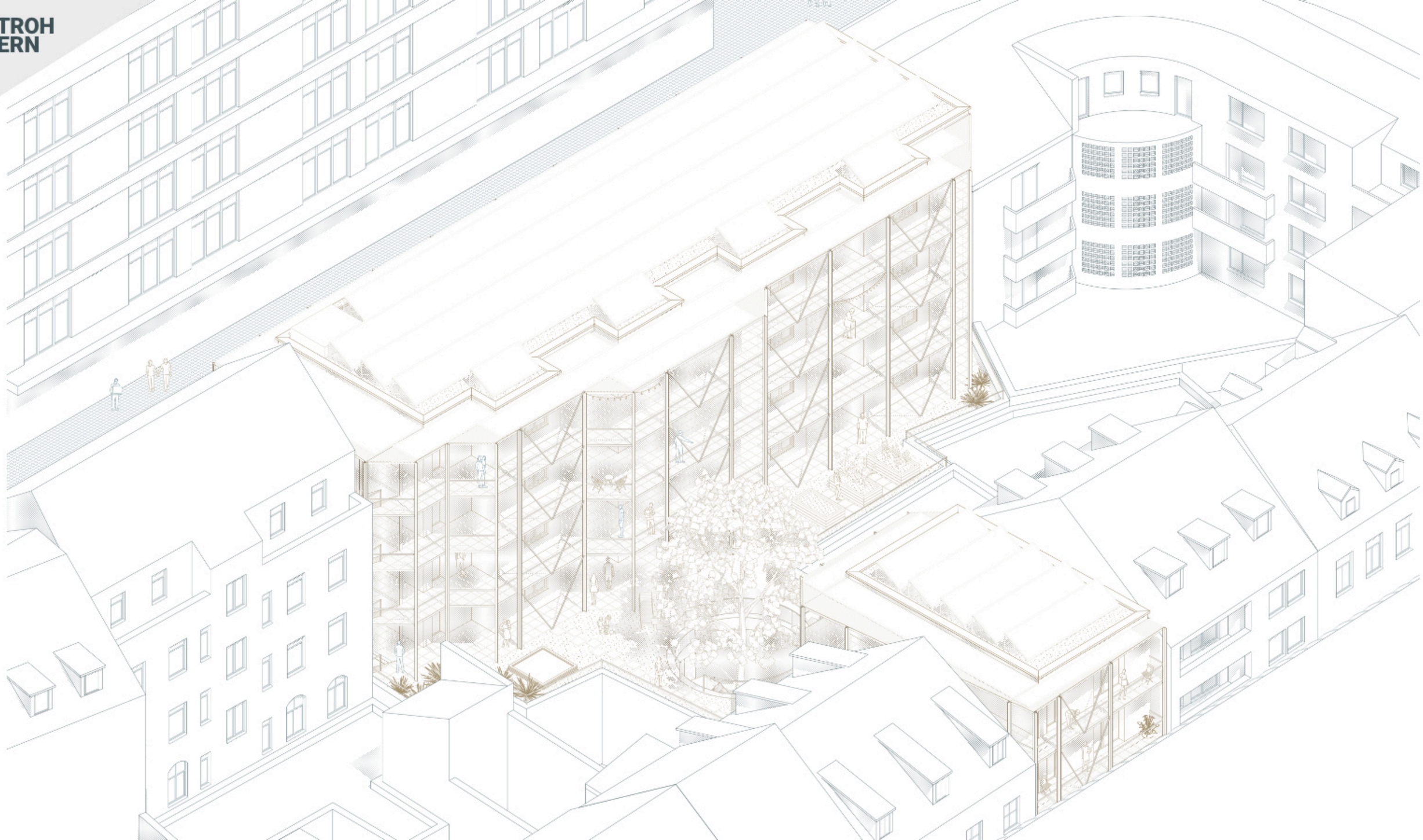
South elevation . 1:100

STROH
KERN



Section . 1:100

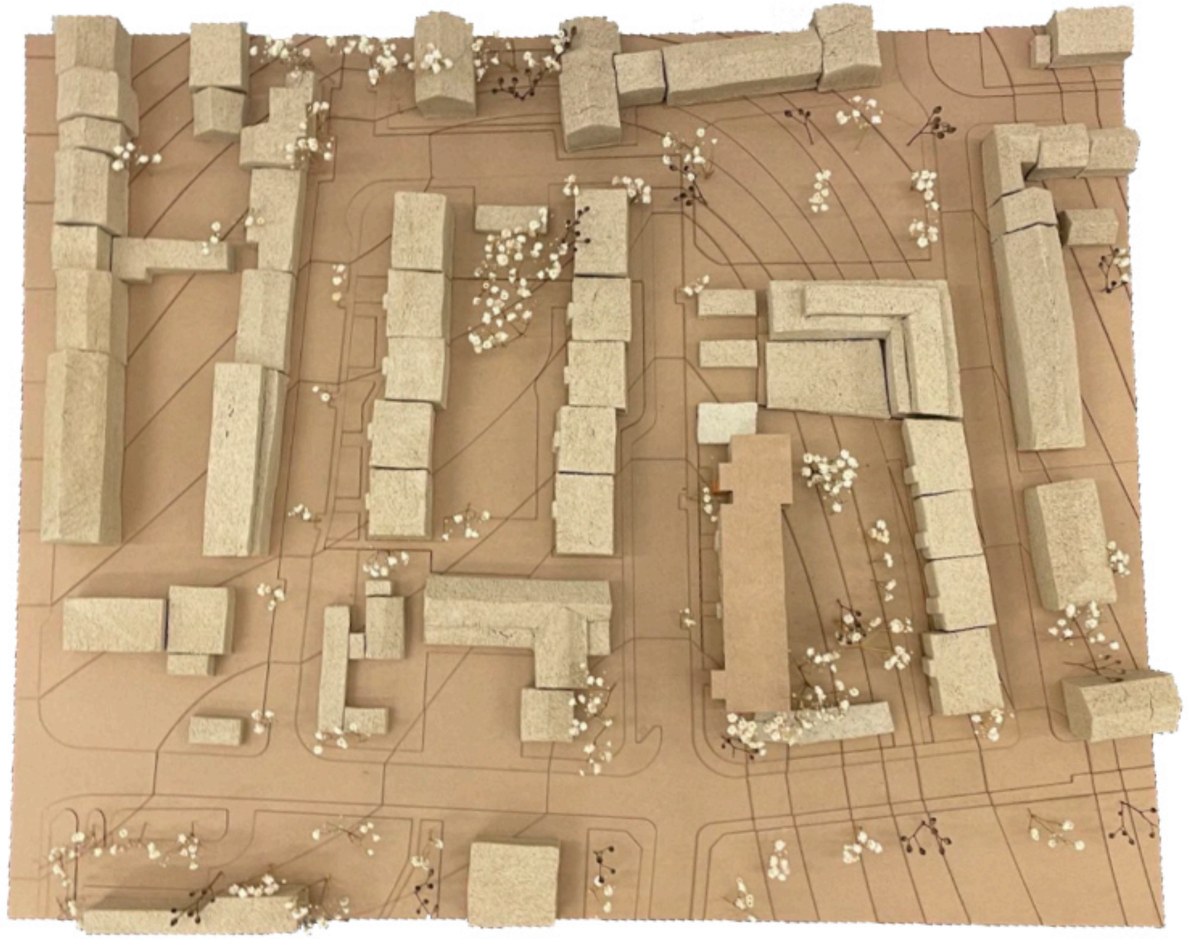
STROH
KERN

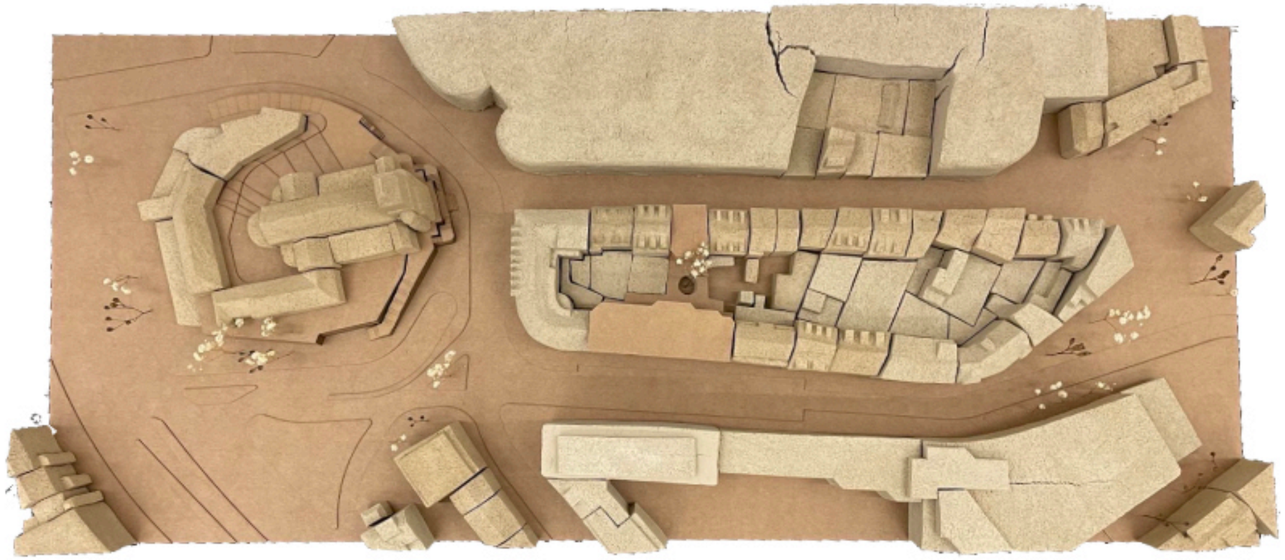


STROH
KERN

STROH
KERN

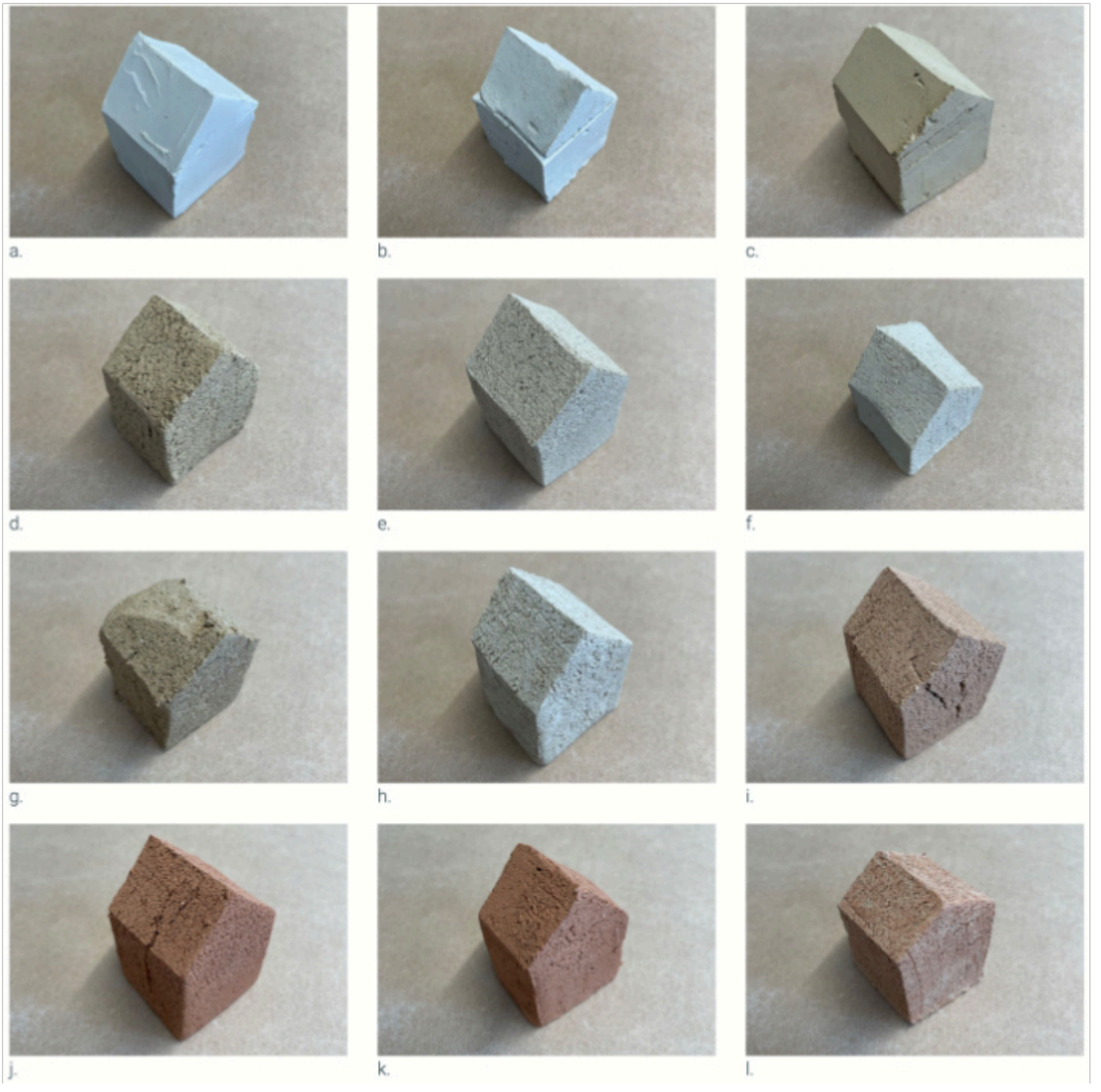
MODELLBAU M 1:333





MODELLBAU M 1:333

#	Ingredients	Amount [parts]	Evaluation of processability	Shrinkage and cracking behaviour	Surface quality
a.	Light clay	1	-	+	-
b.	Light clay Sand	2 1	-	+	-
c.	Rammed earth powder Water	4 1	-	+	+
d.	Mortar Water	4 1	+	o	o
e.	Mortar Light clay Water	12 5 3	+	+	+
f.	Mortar Light clay Water	12 6 4	-	+	o
g.	Mortar Rammed Earth powder Water	20 1 6	-	o	-
h.	Mortar Light clay Water	12 6 3	+	+	+
i.	Mortar Light clay Terracotta clay Water	15 3,5 1,5 3	+	-	+
j.	Mortar Terracotta clay Water	15 5 3	+	+	+
k.	Mortar Terracotta clay Water	20 5 3	+	-	+
l.	Mortar Light clay Terracotta clay Water	15 2,5 2,5 3	o	+	o



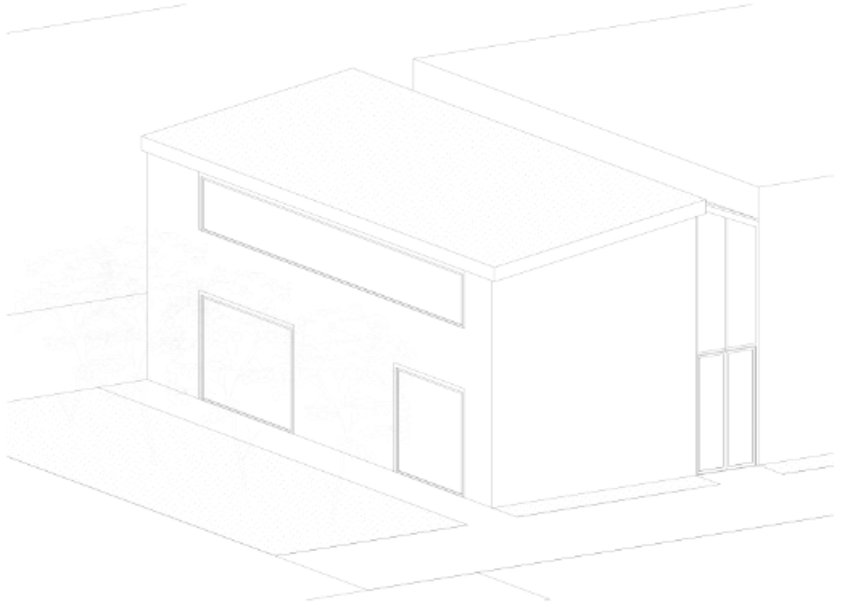
1 Teil Wasser
5 Teile Ton
6,5 Teile Lehmmörtel

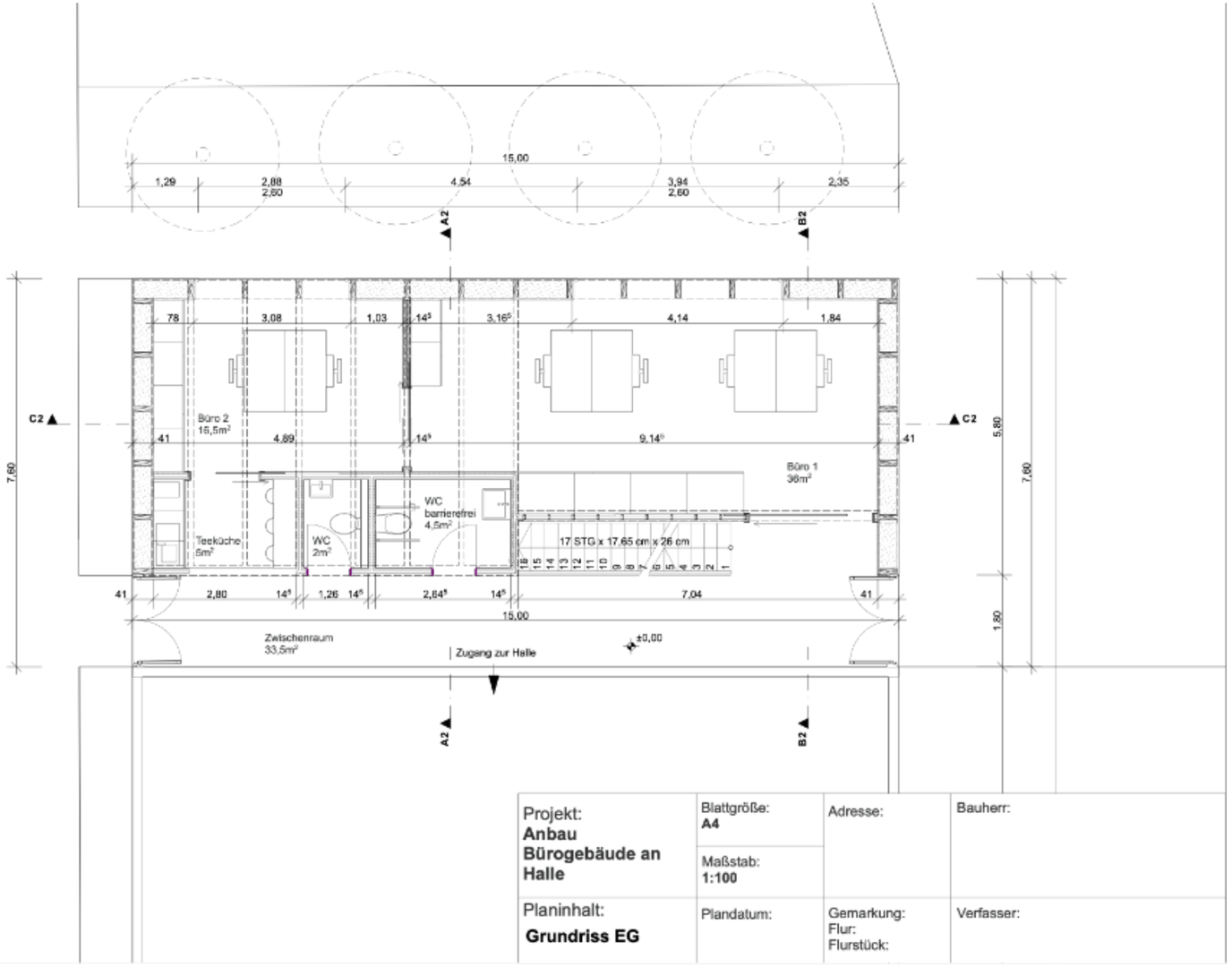
FAZIT & AUSBLICK

WAS SEITDEM GESCHAH...

STROH
KERN

WAS SEITDEM GESCHAH...





STROH KERN

Ein Bausystem zur verantwortbaren Nachverdichtung

Vielen Dank!
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