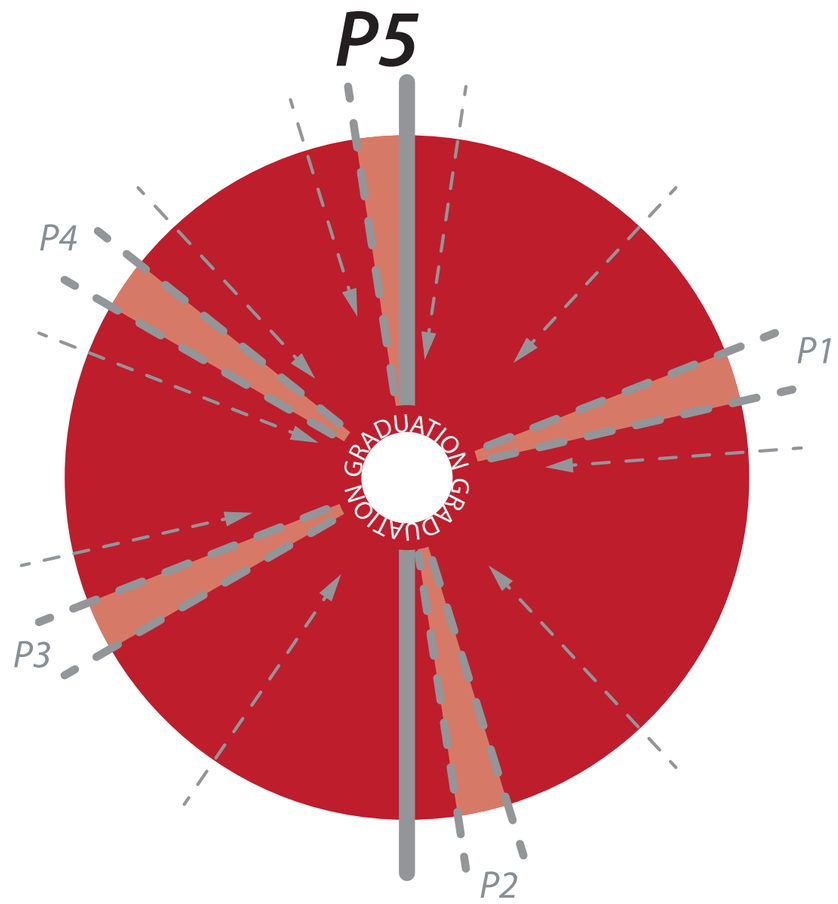
BAMBOO, THE BUILDING MATERIAL OF THE FUTURE!

COEN KAMPINGA

DELFT, JANUARY 29TH, 2016

> CONTENT



SCOPE

> FIELD OF RESEARCH

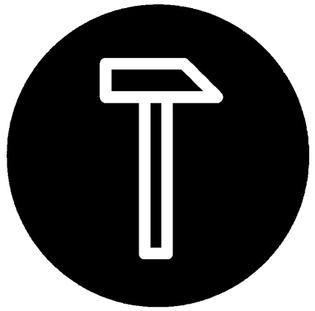
> TU DELFT

> FACULTY OF ARCHITECTURE AND THE BUILT ENVIRONMENT

> IN BETWEEN DEPARTMENT OF BUILDING TECHNOLOGY & ARCHITECTURE

> ARCHITECTURAL ENGINEERING STUDIO

> GRADUATION FIELD: MAKE

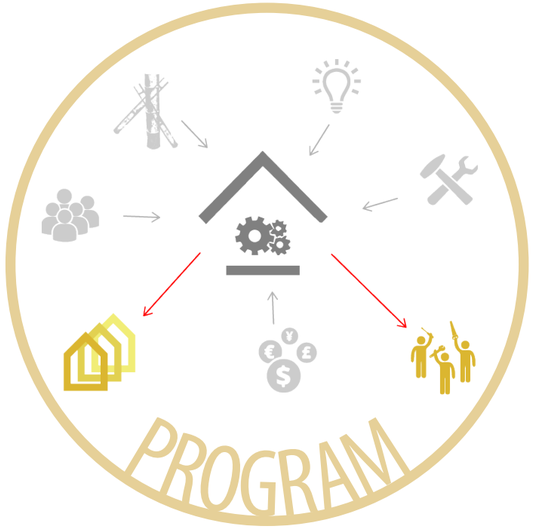


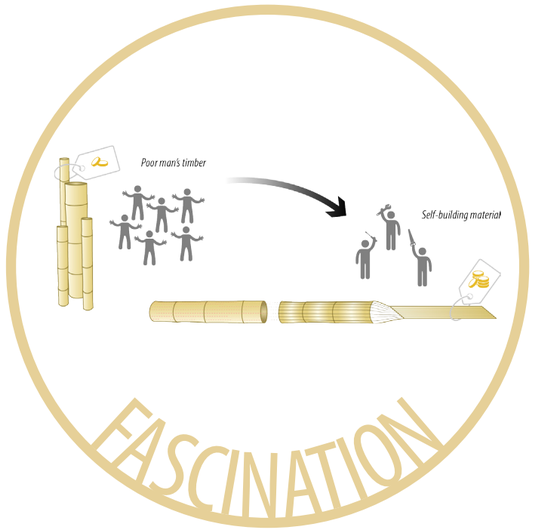
MAKE

STOCK

FLOW

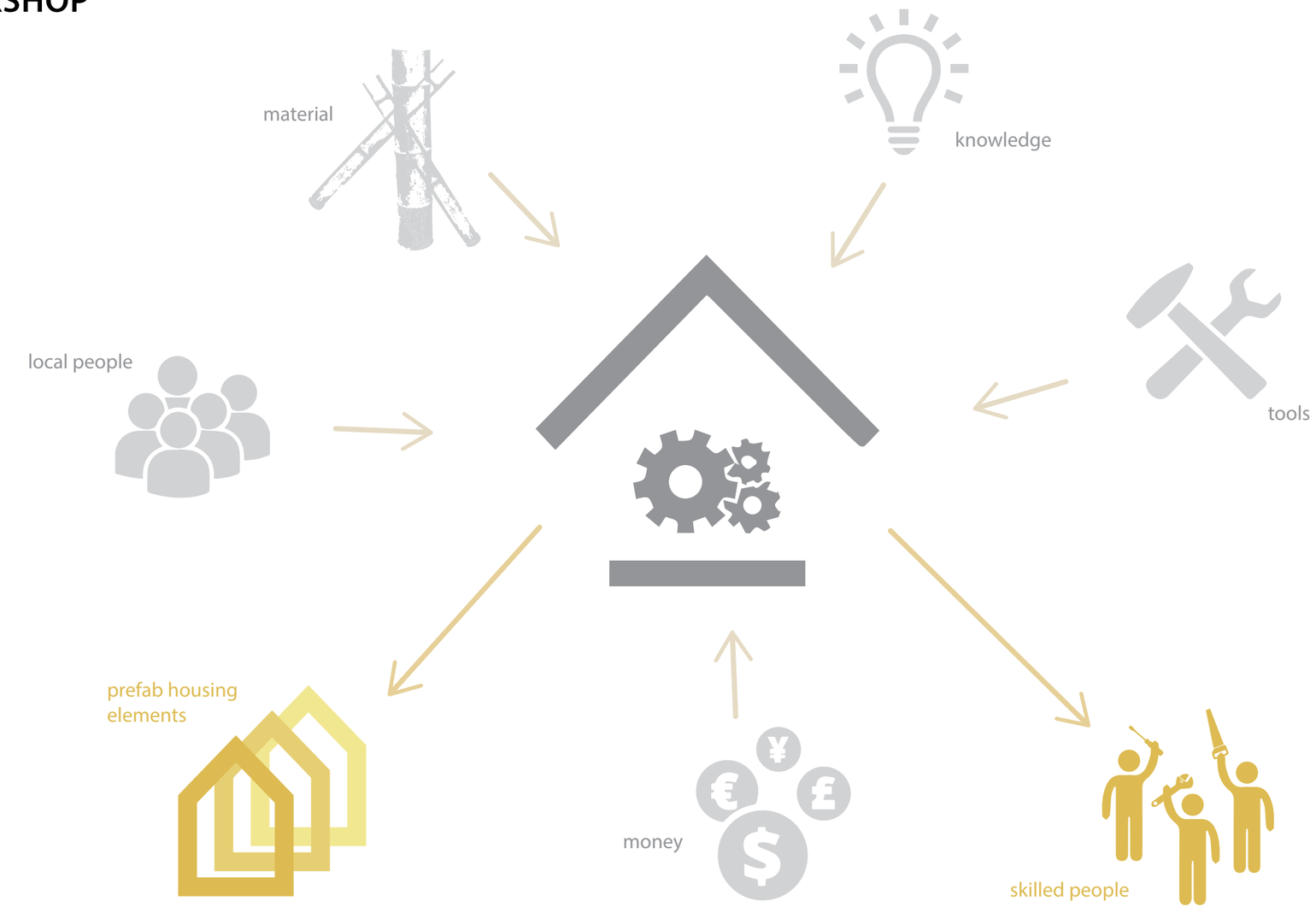
> aE FRAMEWORK





> PROGRAM

> PUBLIC WORKSHOP



> CONTEXT

> INDONESIA

> CONTEXT

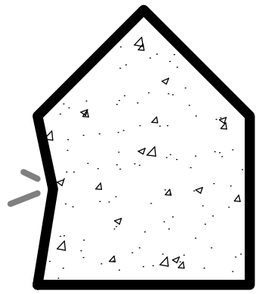
> JAVA

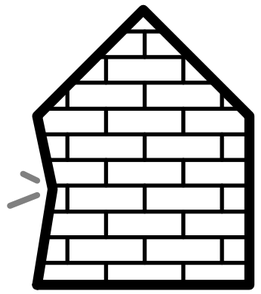
> BANDUNG

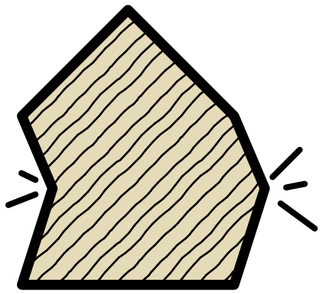
> KAMPUNG CIGONDEWAH

> CONTEXTUAL FRAMEWORK

> 3 PRINCIPLE TYPES

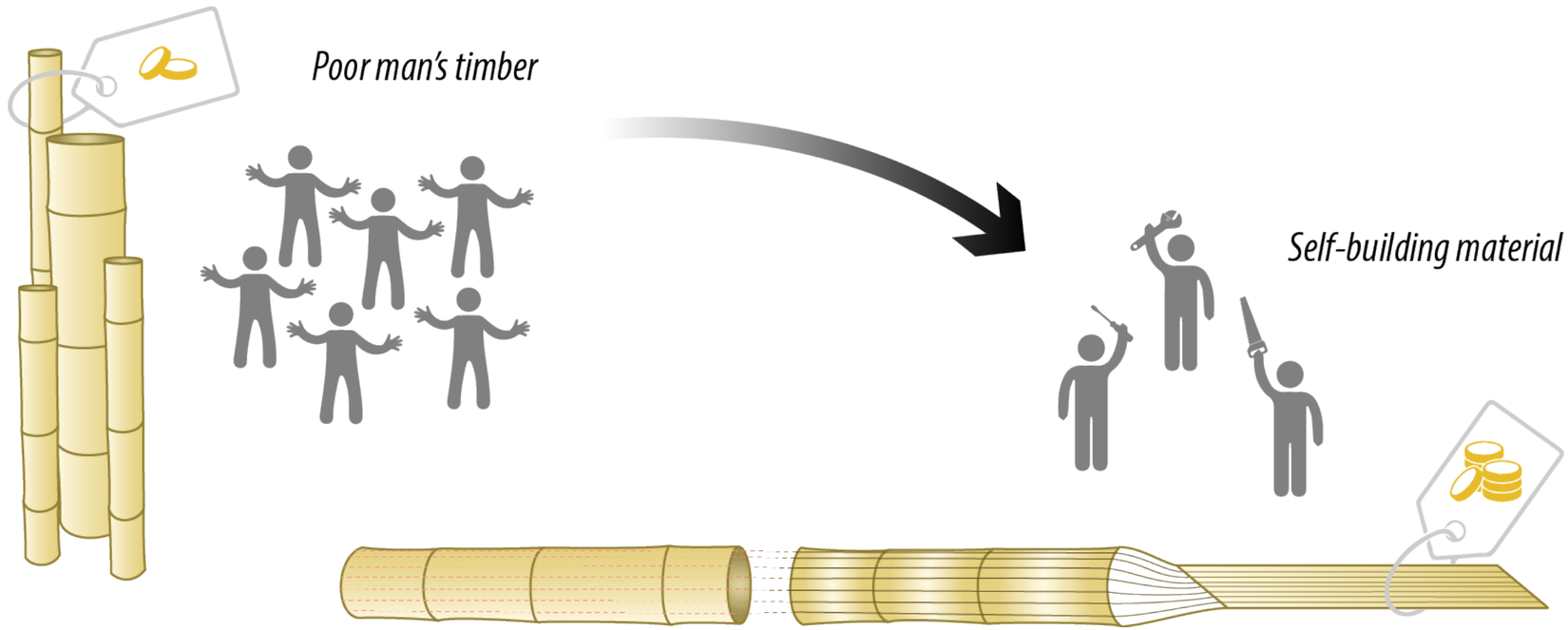






> FASCINATION

> OBJECTIVE:

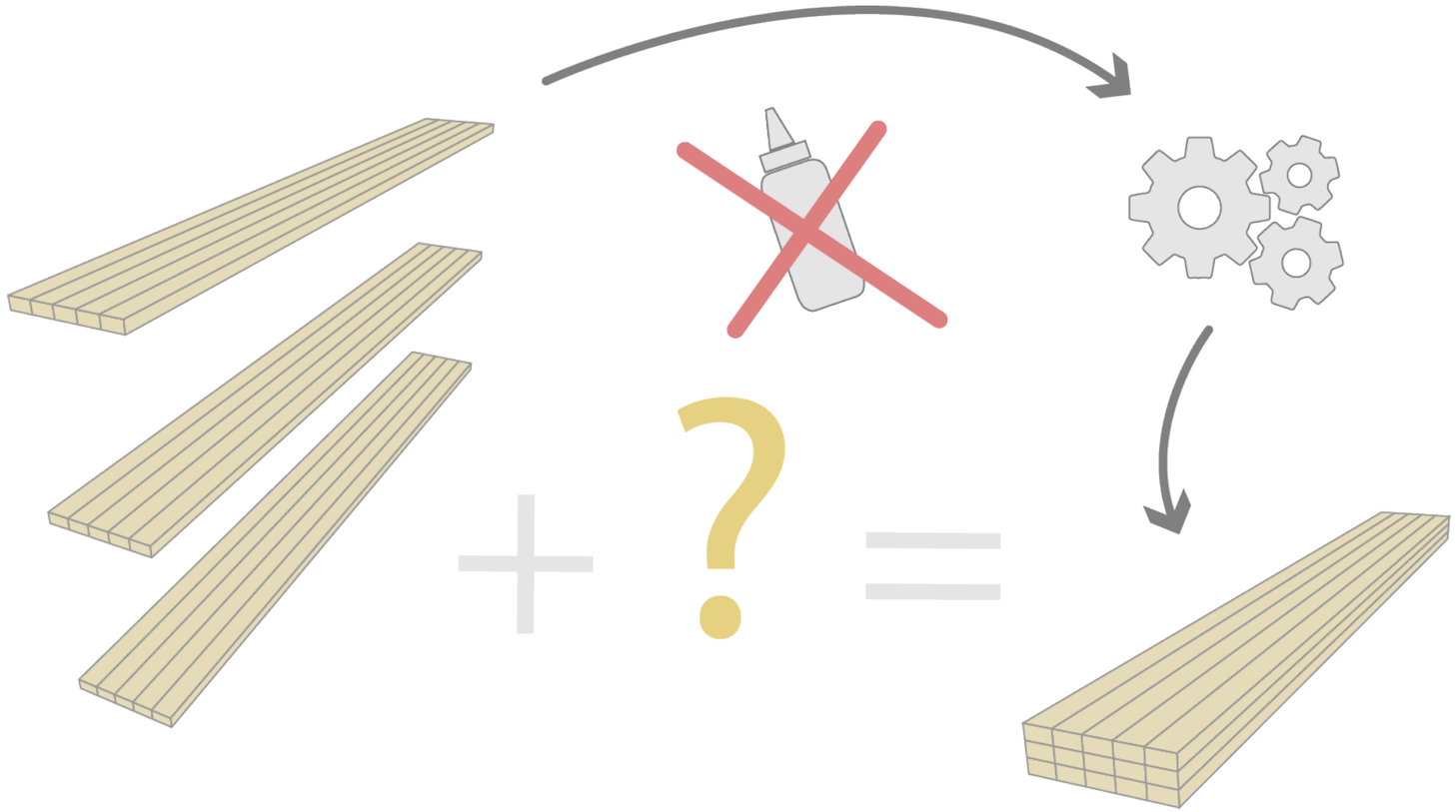


SHIFTING THE INDONESIA KAMPUNG'S APPROACH OF BAMBOO FROM

POOR MAN'S TIMBER TO SUSTAINABLE **SELF-BUILDING MATERIAL**

TECHNICAL RESEARCH

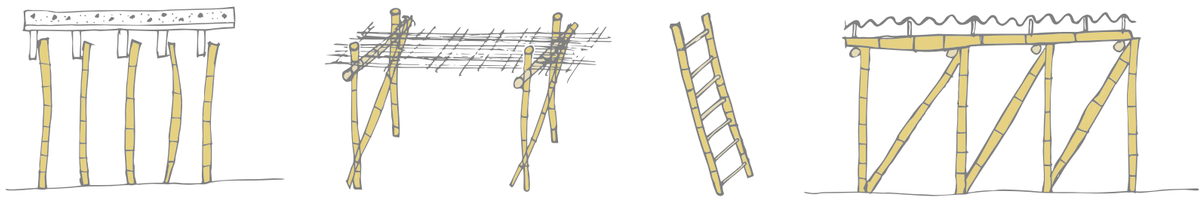
> TECHNICAL RESEARCH QUESTION

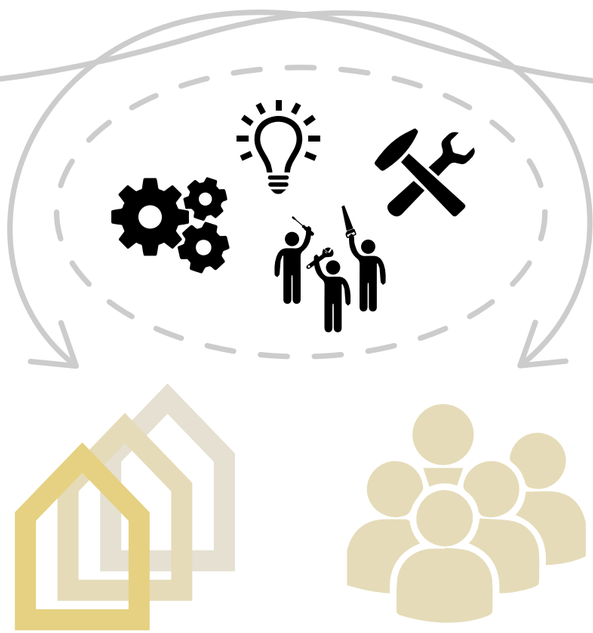


HOW TO ENGINEER A **GLUELESS LAMINATED** BAMBOO STRUCTURE IN ORDER TO CHANGE THE IMAGE OF BAMBOO, FROM THE POINT OF VIEW OF KAMPUNG RESIDENTS, AS A POOR MAN'S BUILDING MATERIAL?

PROGRAMMATIC RESEARCH

> OVERALL DESIGN QUESTION





IN WHAT WAY CAN WE REINVENT BAMBOO AND USE IT AS A STRUCTURAL BUILDING MATERIAL TO

PRODUCE SAFER HOUSING UNITS AND INCREASE LOCAL CRAFTSMANSHIP?

> RESEARCH METHODS

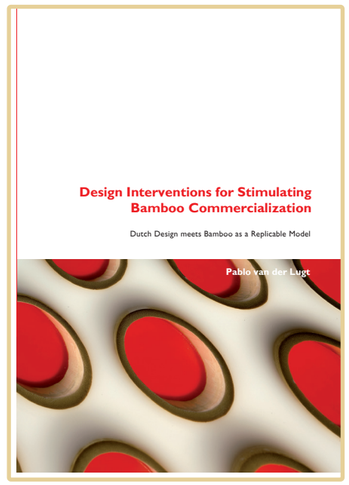
> FIELD TRIP

> LITERATURE STUDY

> JANSSEN, J.J.A.

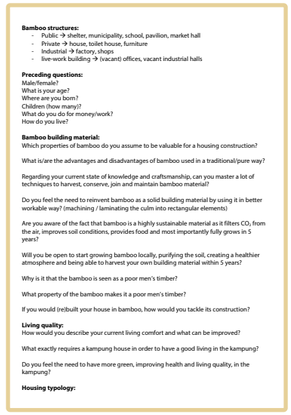
> LUGT, v.d. P.

> BAKAR, E.S.



> SURVEYS

> TEXTUAL



Bamboo structures:
- Public → shelter, municipality, school, pavilion, market hall
- Private → house, toilet house, furniture
- Industrial → factory, shops
- live-work building → (vacant) offices, vacant industrial halls

Preceding questions:
Male/female?
What is your age?
Where are you born?
Children (how many)?
What do you do for money/work?
How do you live?

Bamboo building material:
Which properties of bamboo do you assume to be valuable for a housing construction?

What is/are the advantages and disadvantages of bamboo used in a traditional/pure way?

Regarding your current state of knowledge and craftsmanship, can you master a lot of techniques to harvest, conserve, join and maintain bamboo material?

Do you feel the need to reinvent bamboo as a solid building material by using it in better workable way? (machining / laminating the culm into rectangular elements)

Are you aware of the fact that bamboo is a highly sustainable material as it filters CO_2 from the air, improves soil conditions, provides food and most importantly fully grows in 5 years?

Will you be open to start growing bamboo locally, purifying the soil, creating a healthier atmosphere and being able to harvest your own building material within 5 years?

Why is it that the bamboo is seen as a poor men's timber?

What property of the bamboo makes it a poor men's timber?

If you would (re)built your house in bamboo, how would you tackle its construction?

Living quality:
How would you describe your current living comfort and what can be improved?

What exactly requires a kampung house in order to have a good living in the kampung?

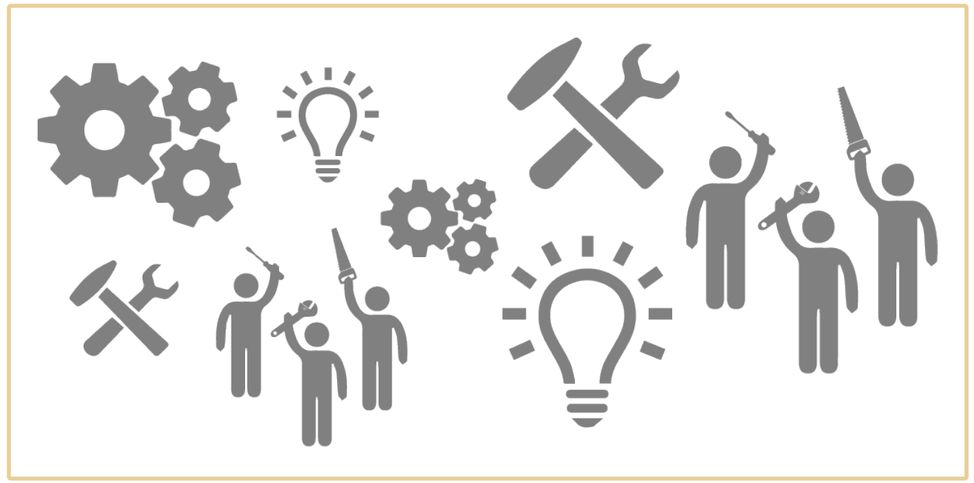
Do you feel the need to have more green, improving health and living quality, in the kampung?

Housing typology:

> VISUAL

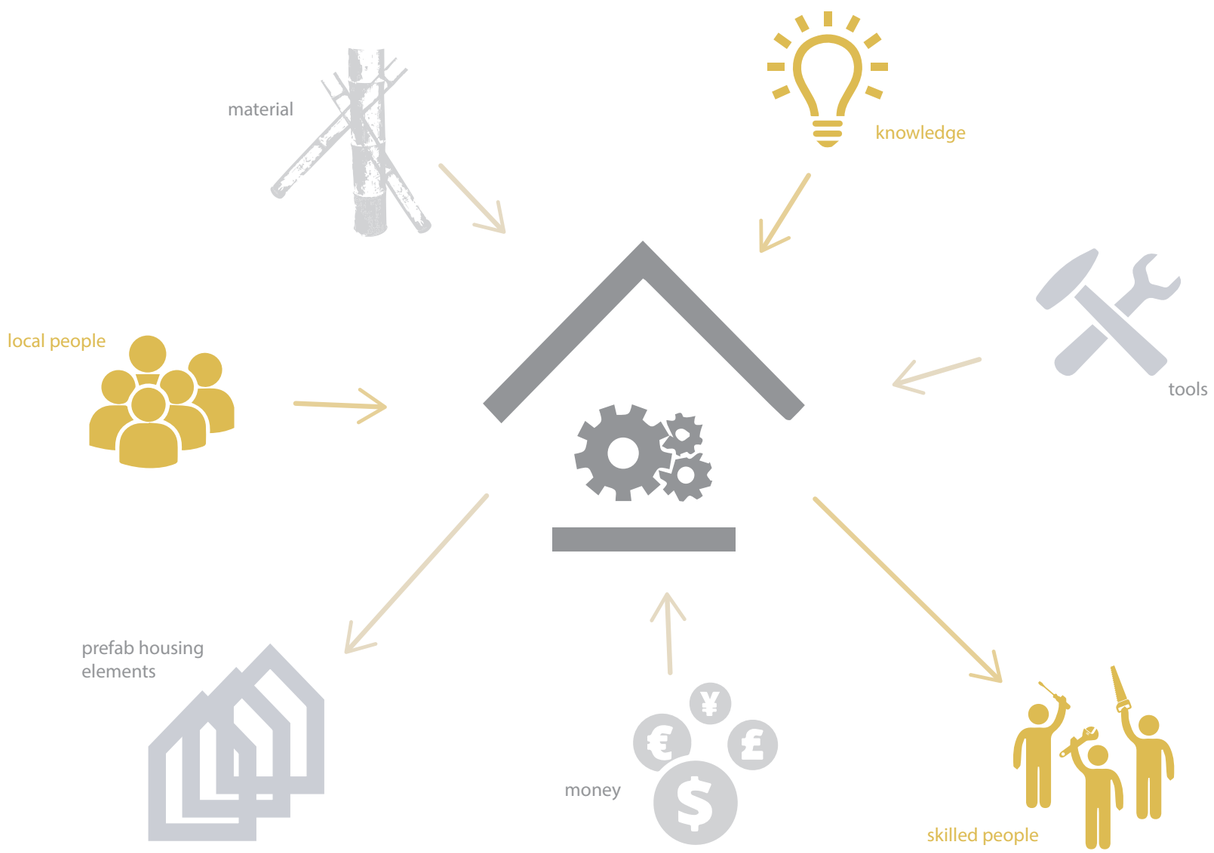
> VOCAL

> PROTOTYPING

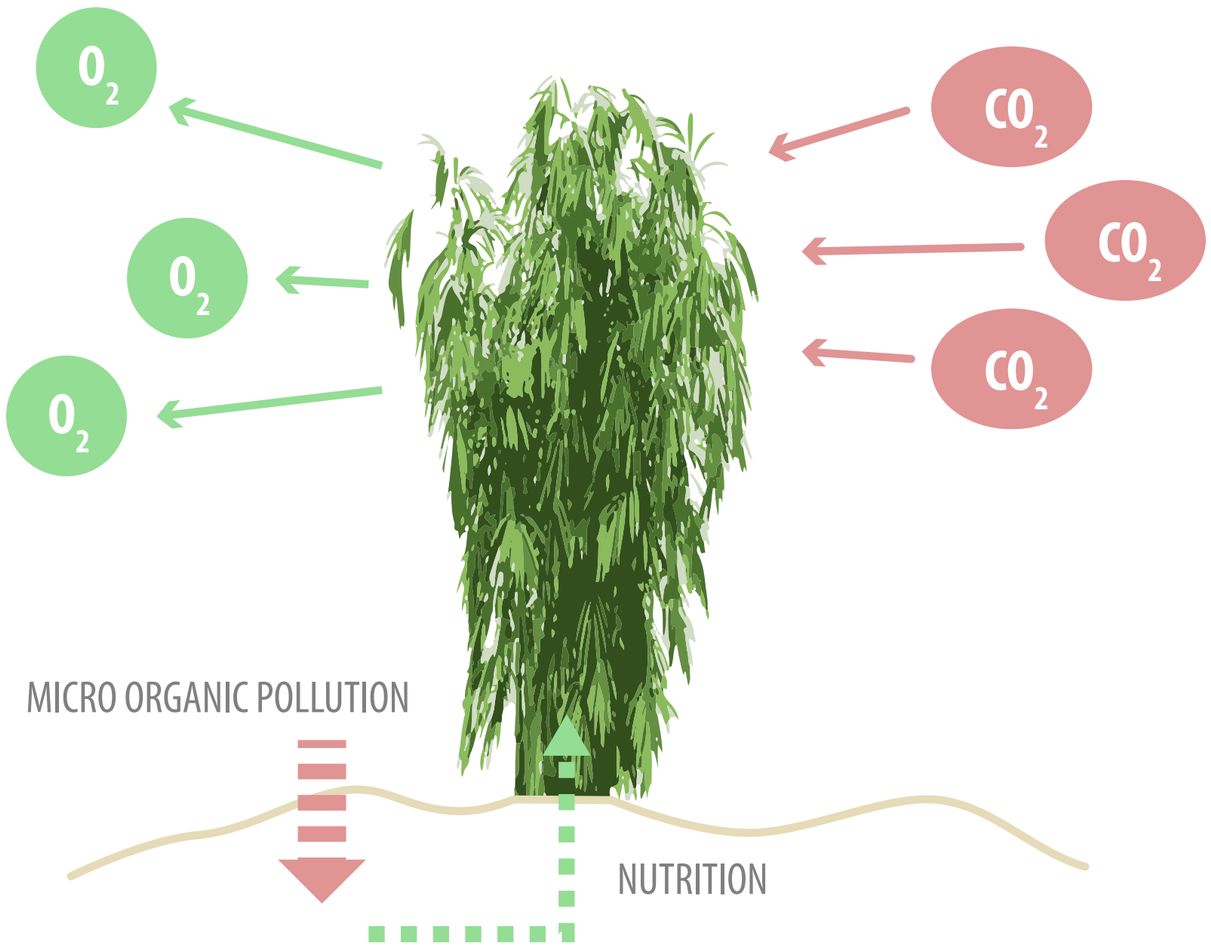


CONCEPT

> COMMUNITY ENGAGEMENT



> SUSTAINABLE KAMPUNG DEVELOPMENT



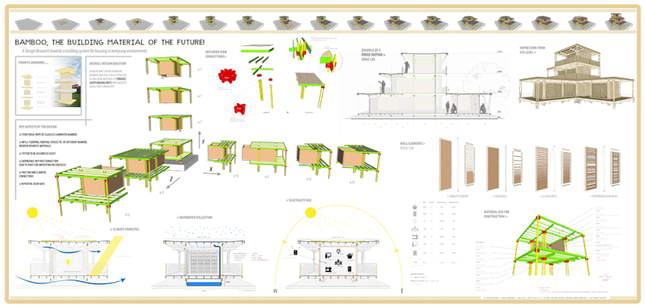
GRADUATION PROCESS

> P1 - P4

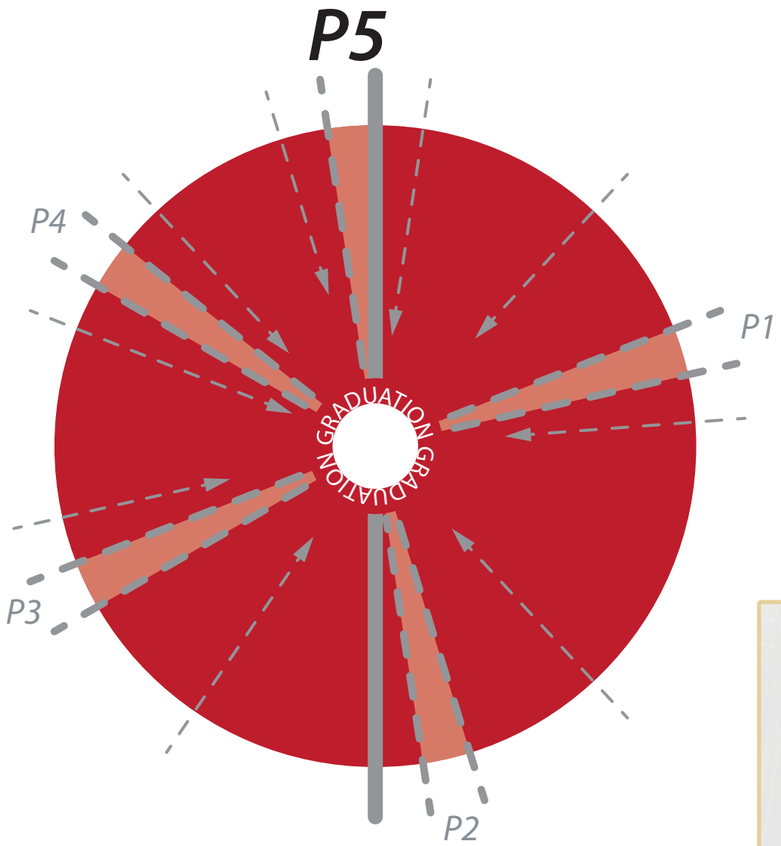
> P4

> PRESENTATION

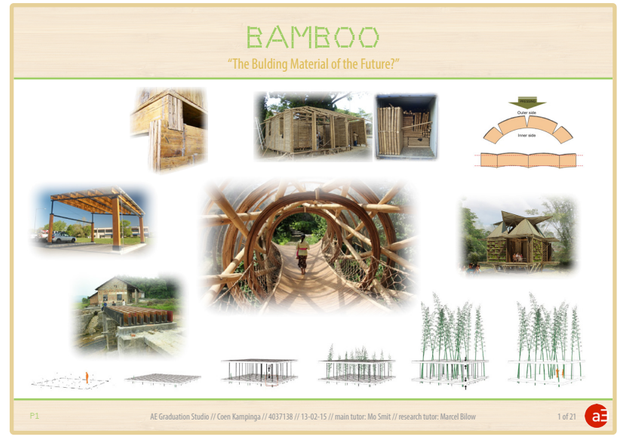
> P3



> POSTER



> P1

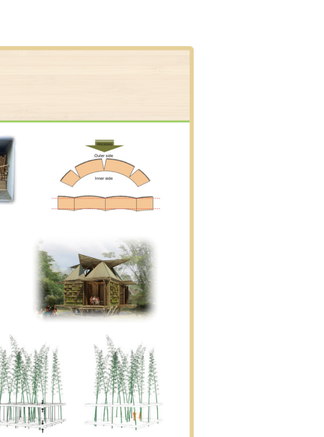


> PRESENTATION

> P2

> PRESENTATION

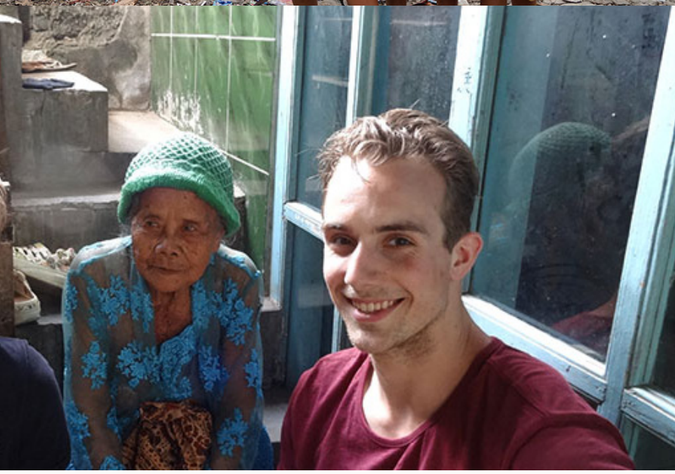
+



> PAPER


CIKAMPEK
CIKAMPEK

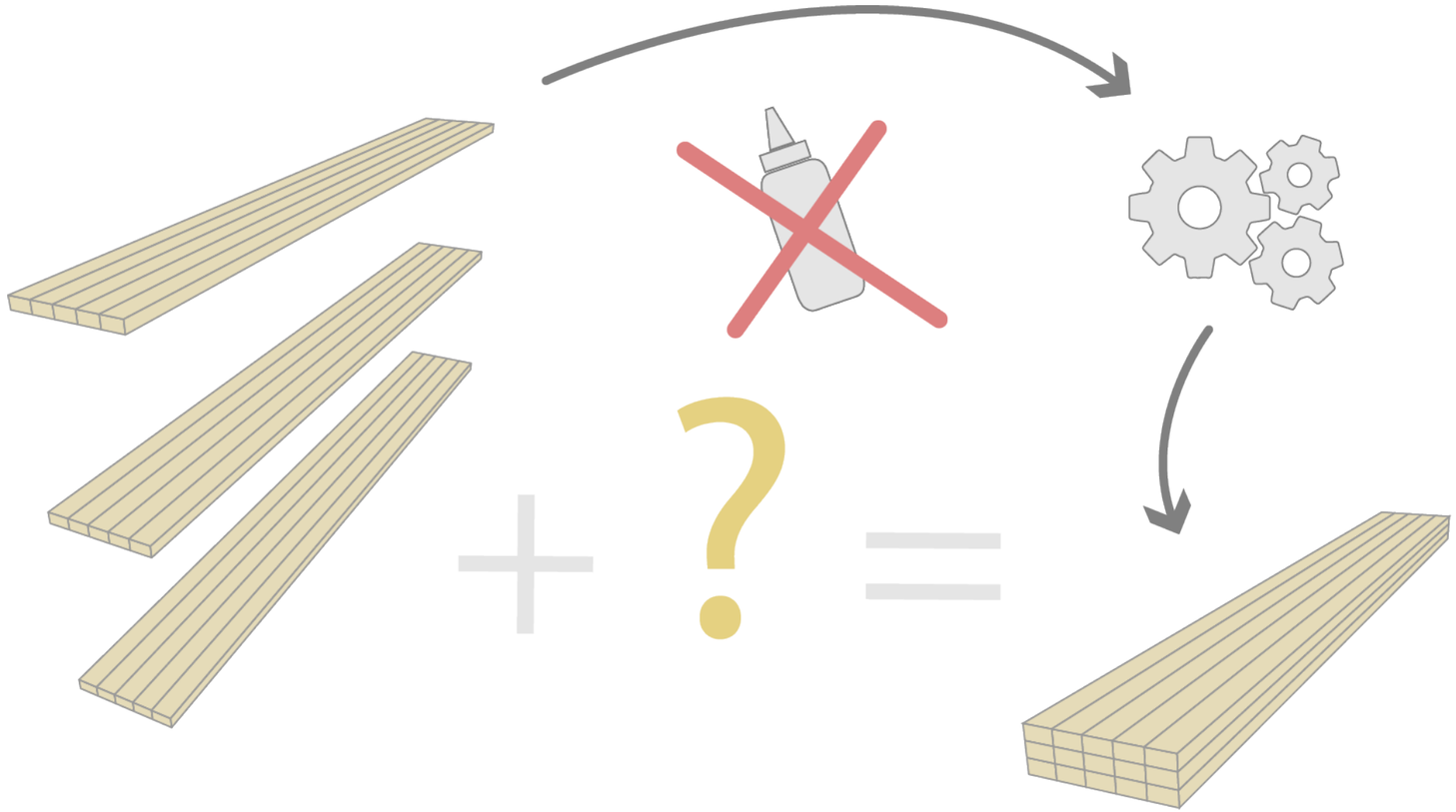
PEMERINTAH KOTA BANDUNG
KECAMATAN BANDUNG KULON
CIGONDEWAH KALER



> PROTOTYPING

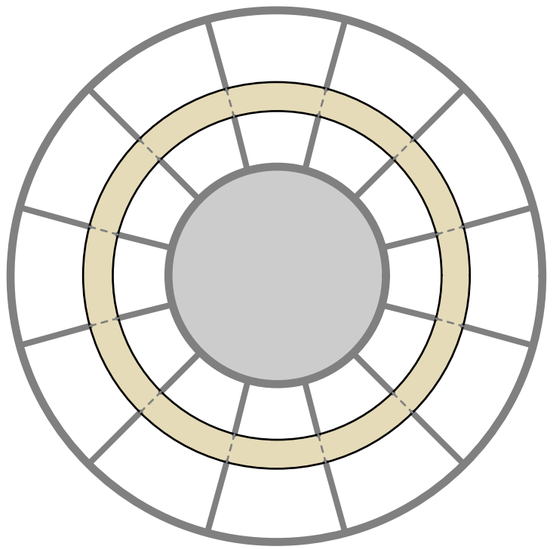
RESEARCH RESULT

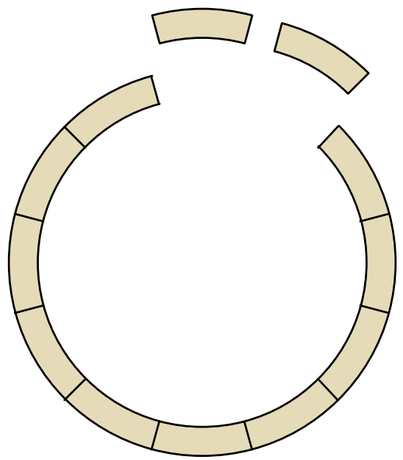
> RESUMÉ

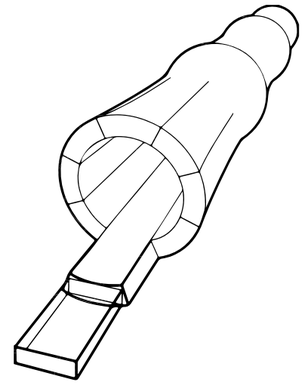


> CULM TO STRIP

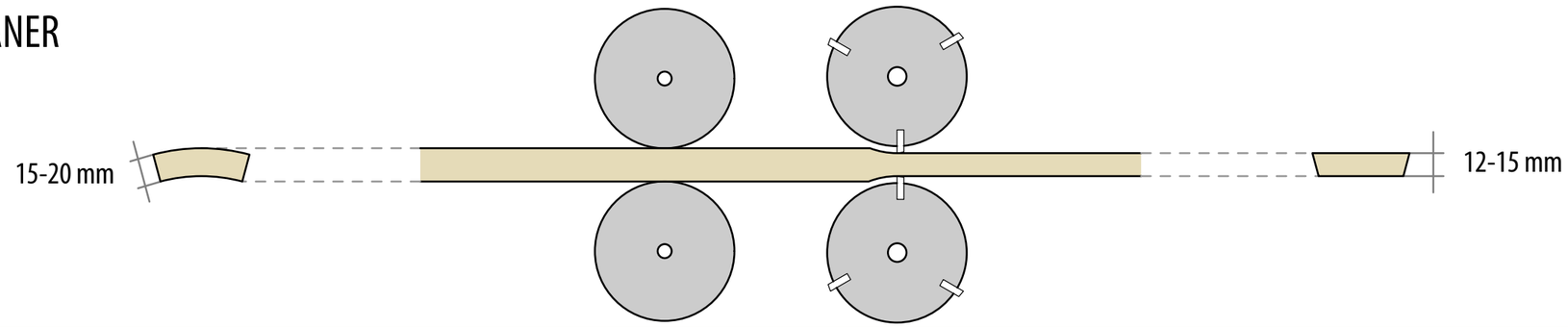
> BAMBOO SPLITTING
(KNIVES)







> THICKNESS PLANER



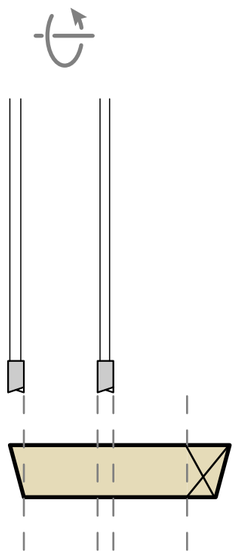
> CULM TO STRIPS

> STRIP TO PIN

> RADIAL STRIP

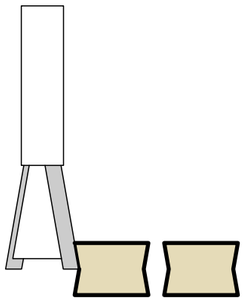
> FLATTENED STRIP
BY THICKNESS PLANER

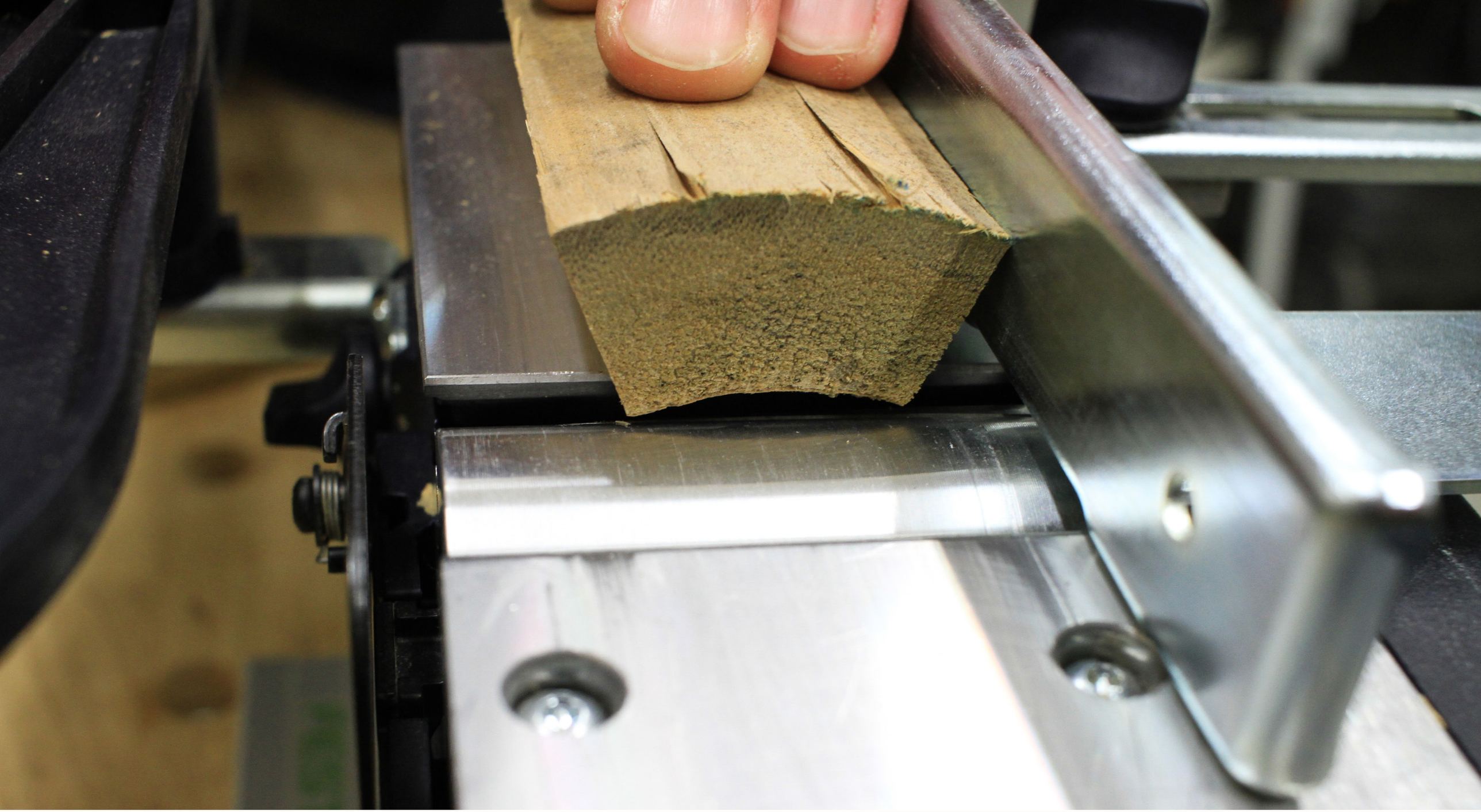
> CUT TO SIZE
BY CIRCULAR SAW



> RECTANGULAR PINS

> SWALLOWTAIL PINS
BY MILLING OR
4 SIDE SHAVING





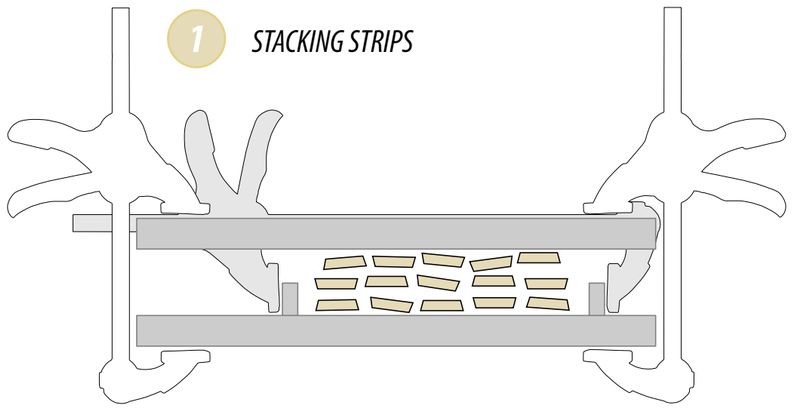
> STRIP TO PIN

> STRIP TO PIN

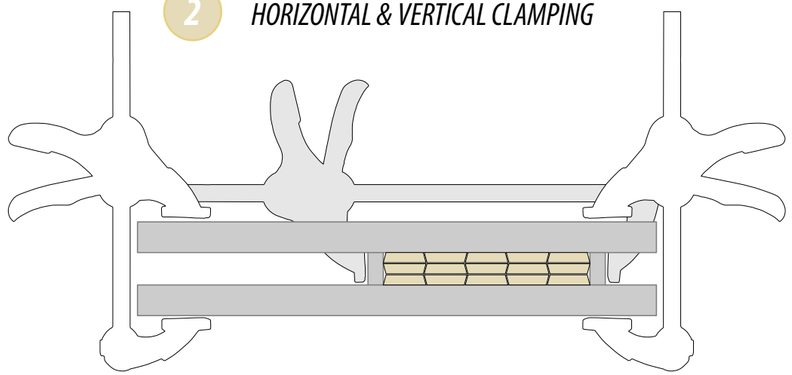
> STRIP TO PIN

> STRIPS TO BEAM

1 *STACKING STRIPS*

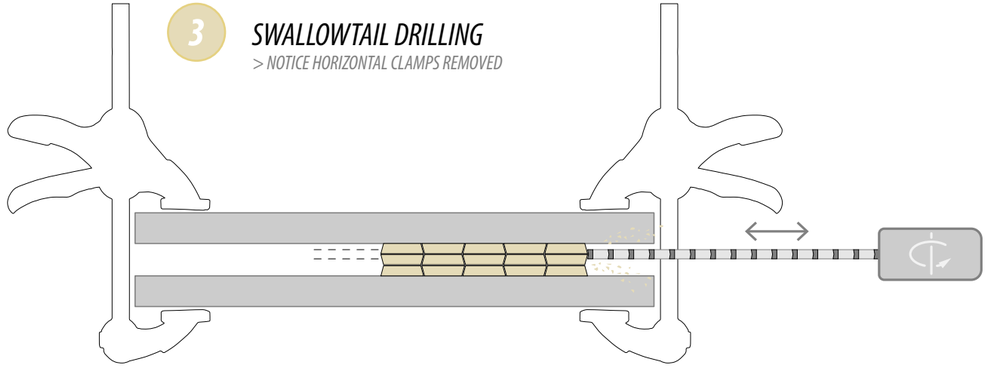


2 *HORIZONTAL & VERTICAL CLAMPING*

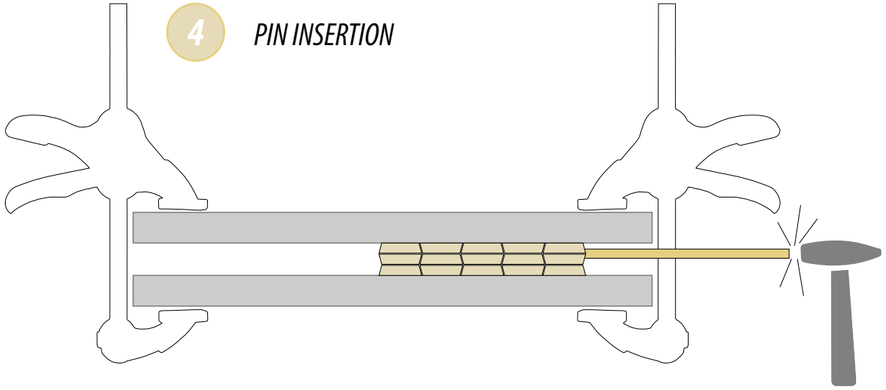


3 *SWALLOWTAIL DRILLING*

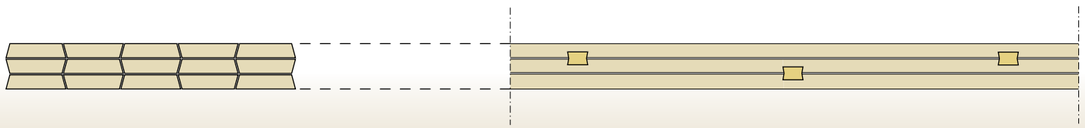
> NOTICE HORIZONTAL CLAMPS REMOVED



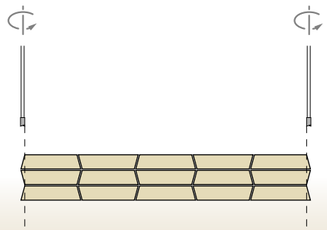
4 *PIN INSERTION*



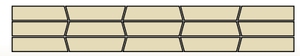
4 *DECLAMPING RESULT*



5 *CUTTING TO SIZE*



5 *RESULT*



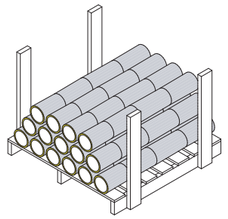
> STRIPS TO BEAM

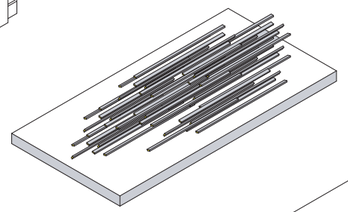
> STRIPS TO BEAM

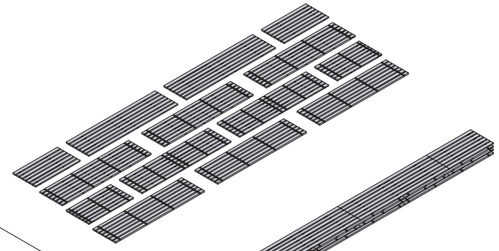
> STRIPS TO BEAM

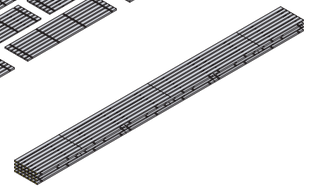
INDUSTRIALIZATION

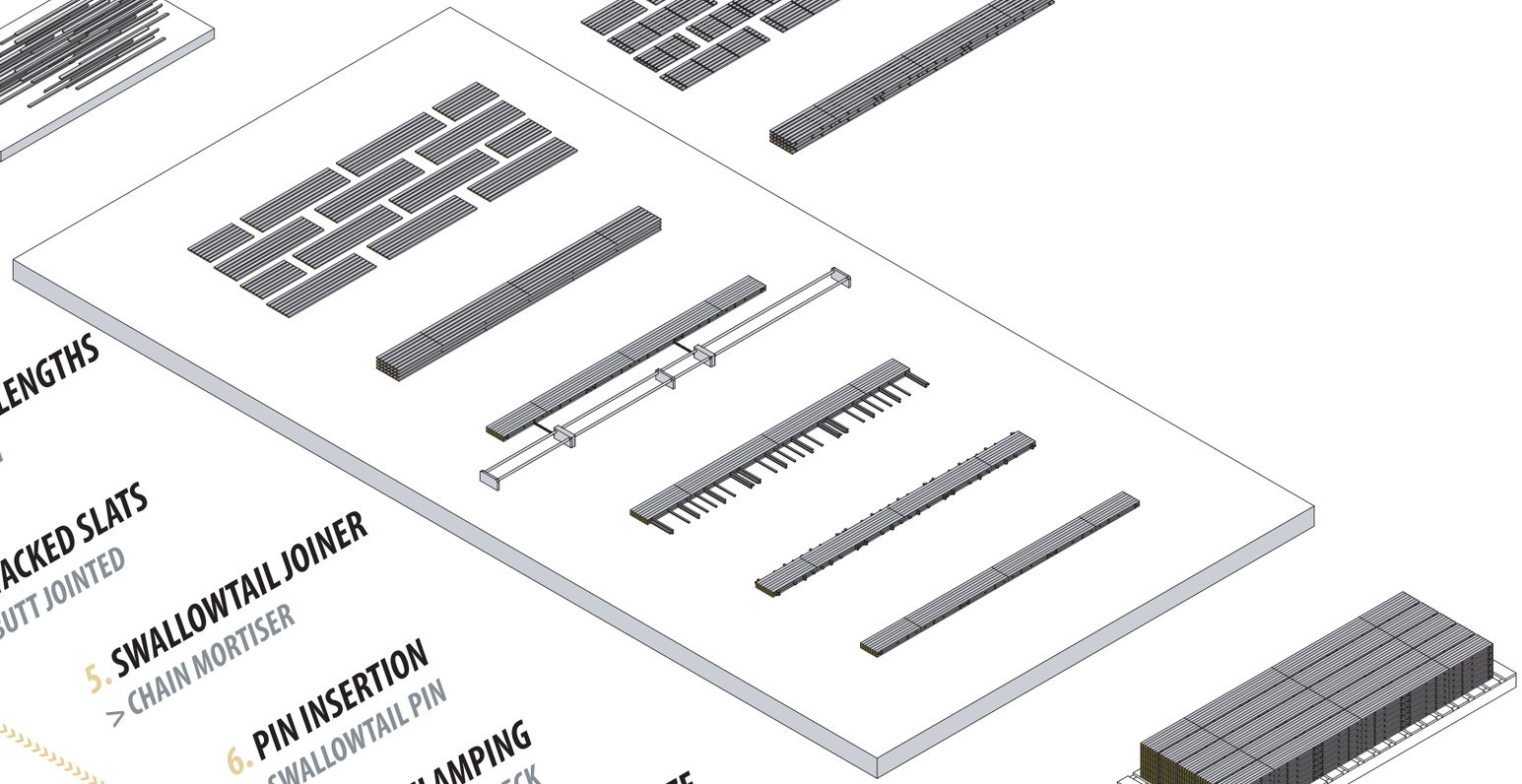
> FACTORY PRODUCTION

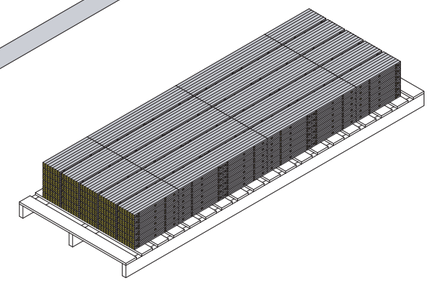












1. RAW CULMS
> 12MM WALL THICKNESS

2. SPLITTED SLATS
> THICKNESS PLANED

3. OVERLAPPING LENGTHS
> ± 1000MM EACH

4. STACKED SLATS
> BUTT JOINTED

5. SWALLOWTAIL JOINER
> CHAIN MORTISER

6. PIN INSERTION
> SWALLOWTAIL PIN

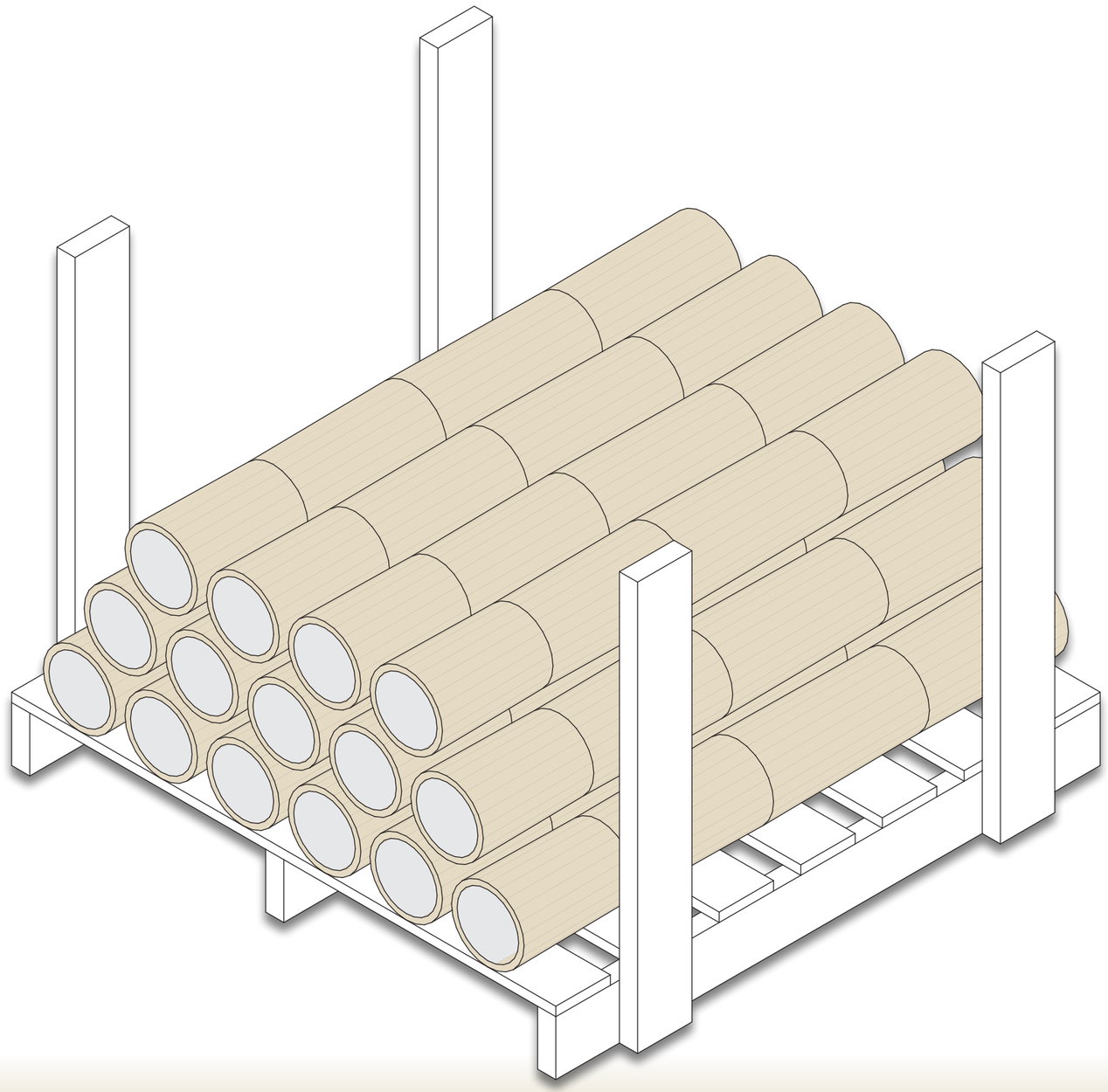
7. DECLAMPING
> QUALITY CHECK

8. CUTTING TO SIZE
> LONG SIDE

8. STACKING ON PALLET
> DISTRIBUTION

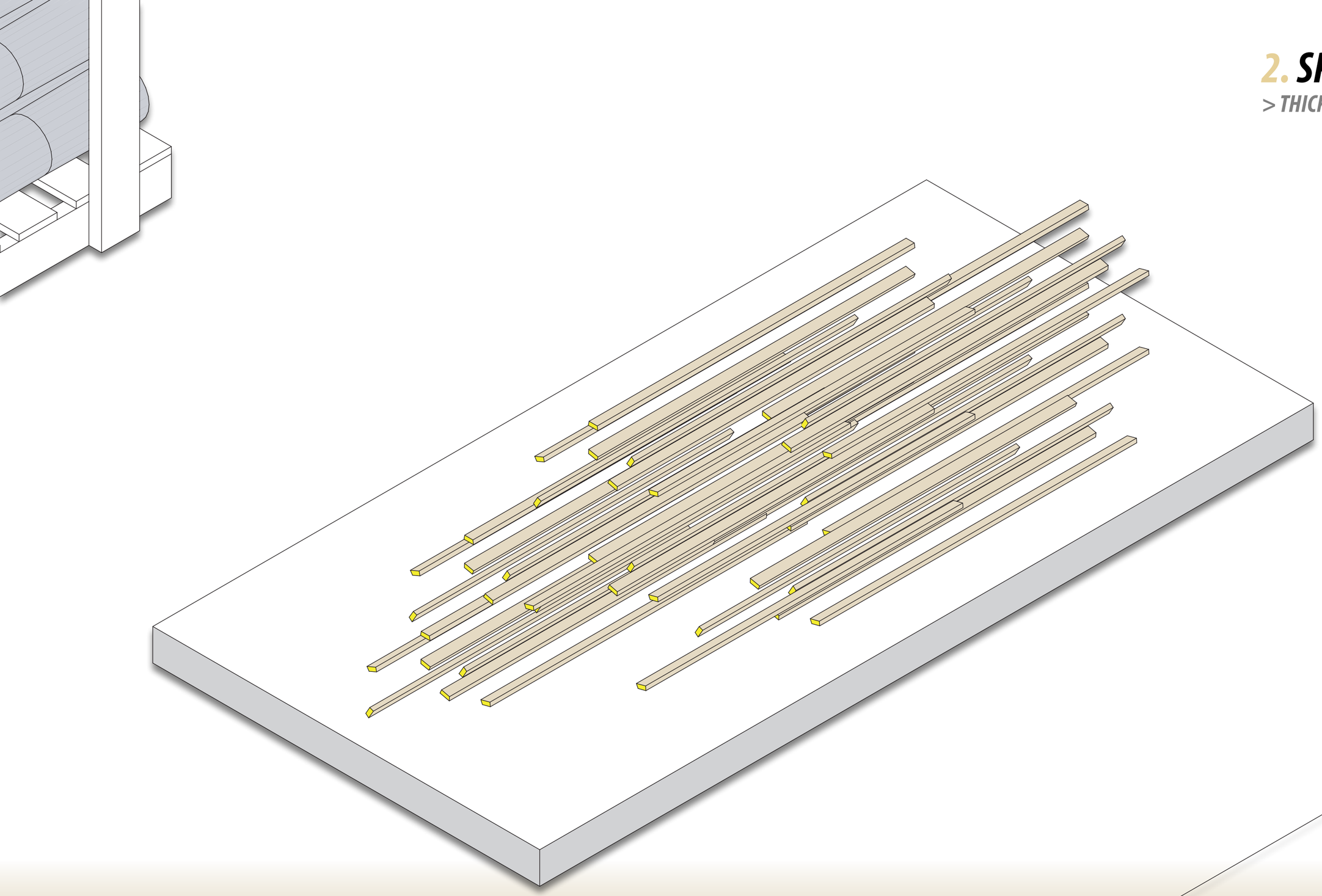
1. RAW CULMS

> 12MM WALL THICKNESS



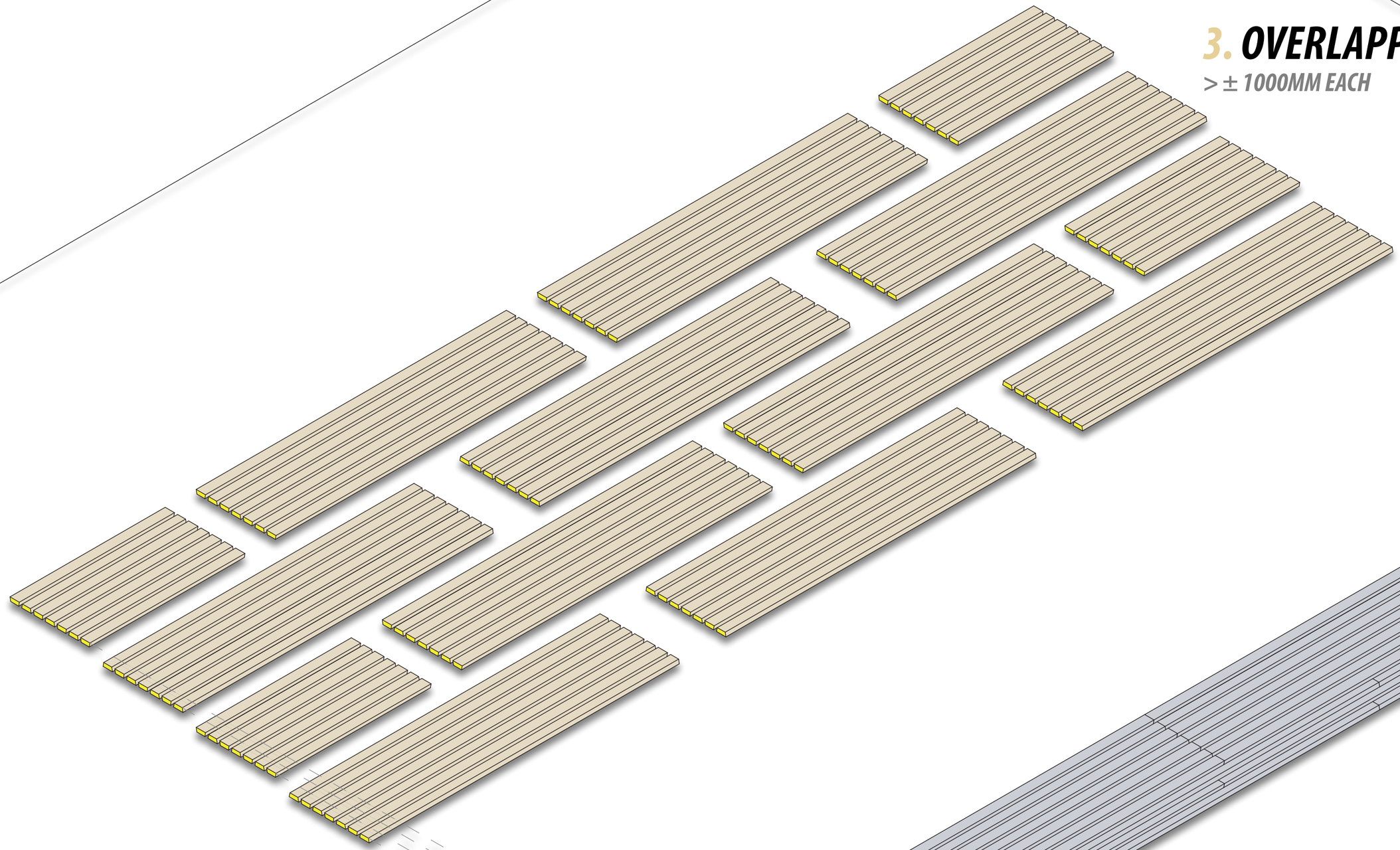
2. SPLITTED SLATS

> THICKNESS PLANED



3. OVERLAPPING LENGTHS

> ± 1000MM EACH

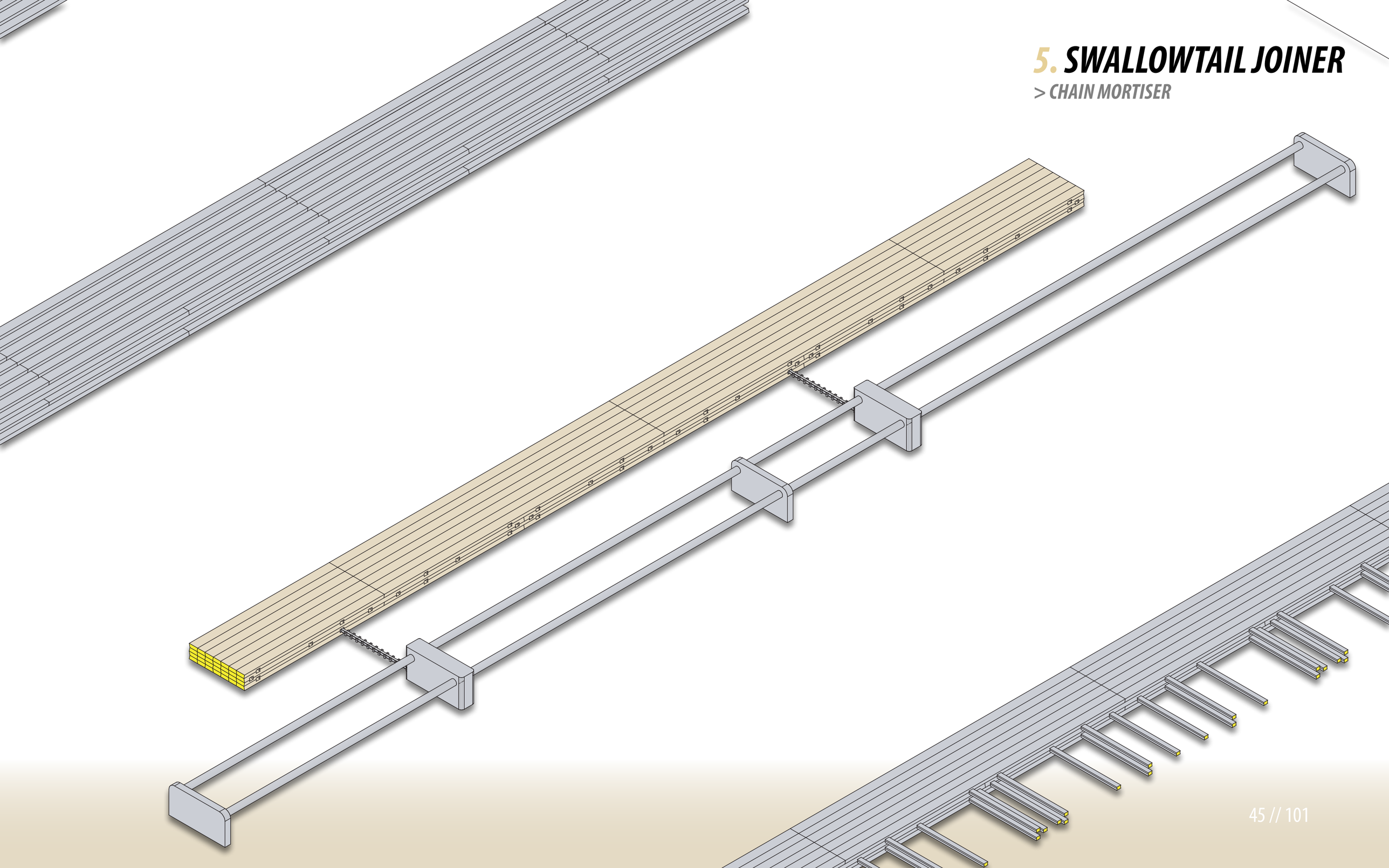


4. STACKED SLATS

> BUTT JOINTED

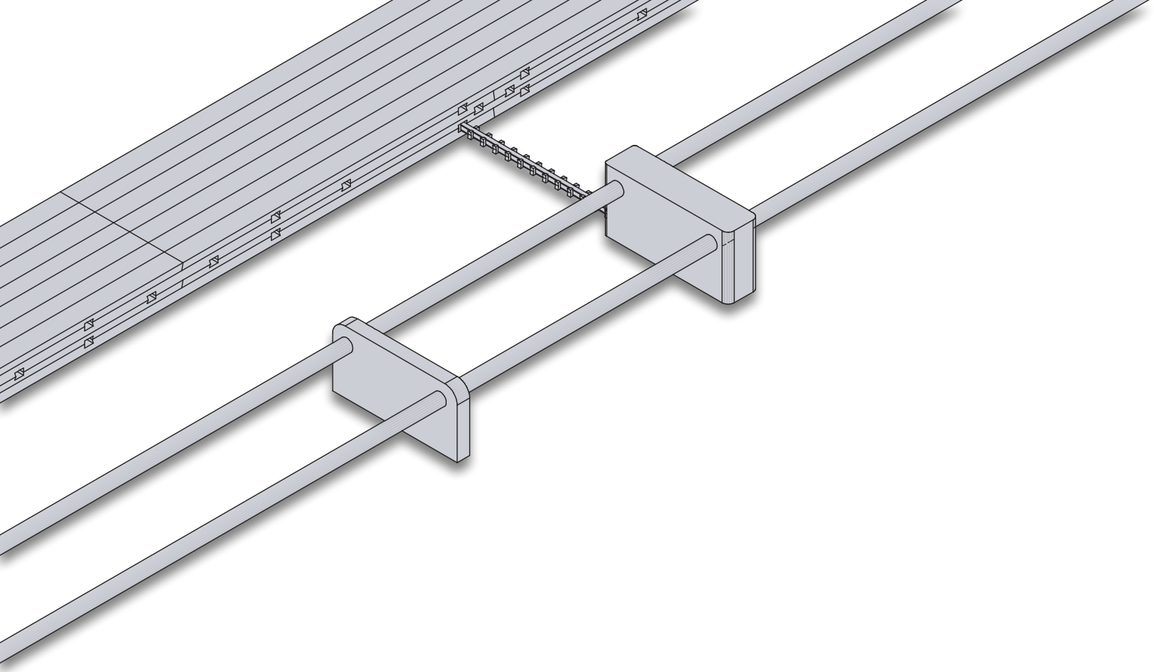
5. SWALLOWTAIL JOINER

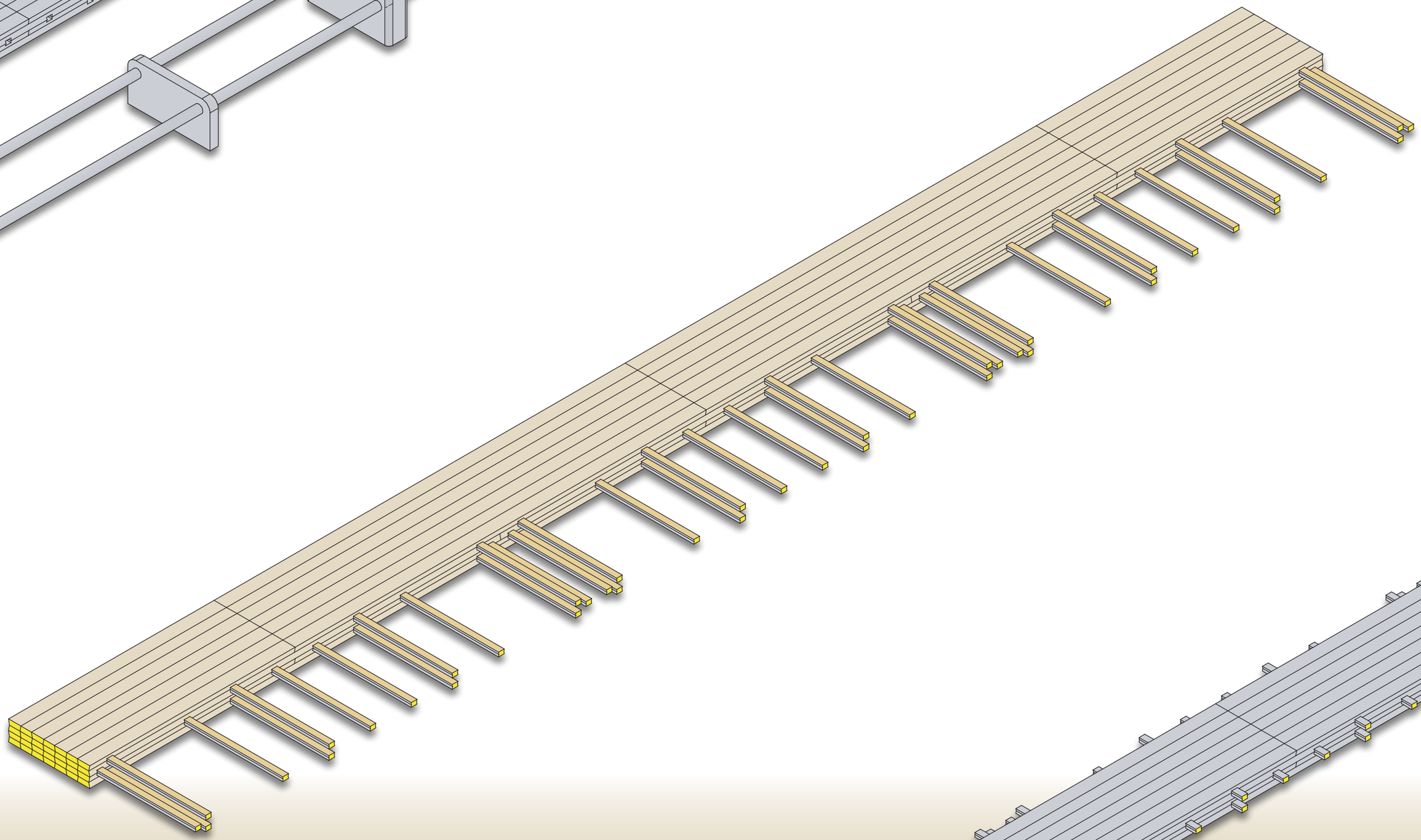
> CHAIN MORTISER

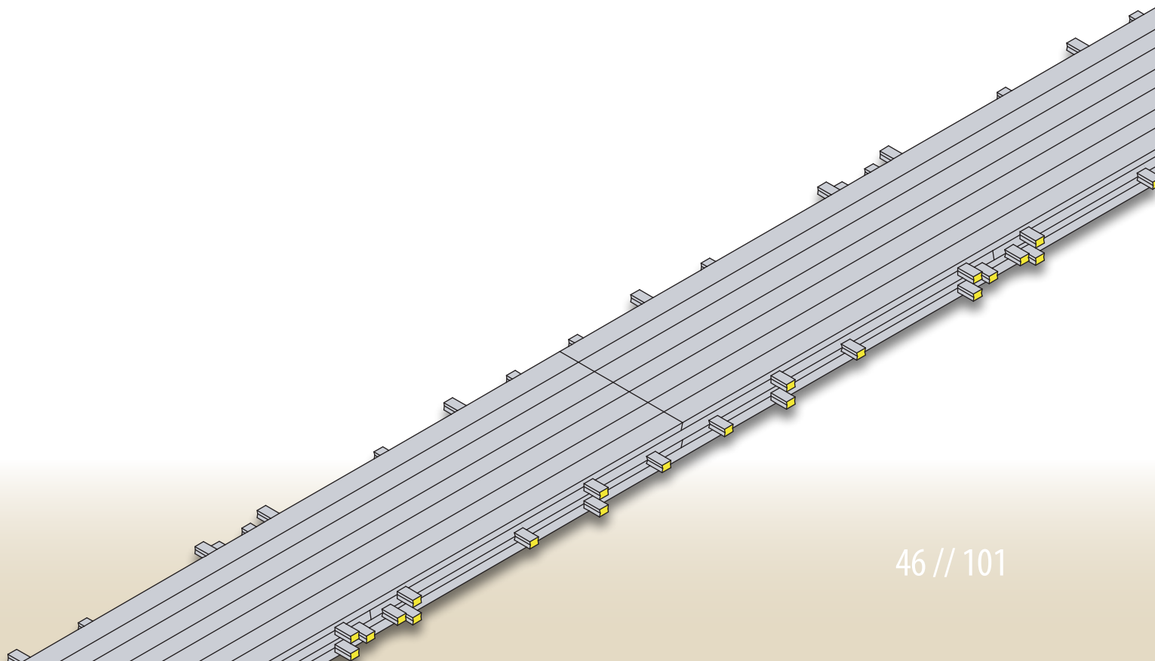


6. PIN INSERTION

> SWALLOWTAIL PIN

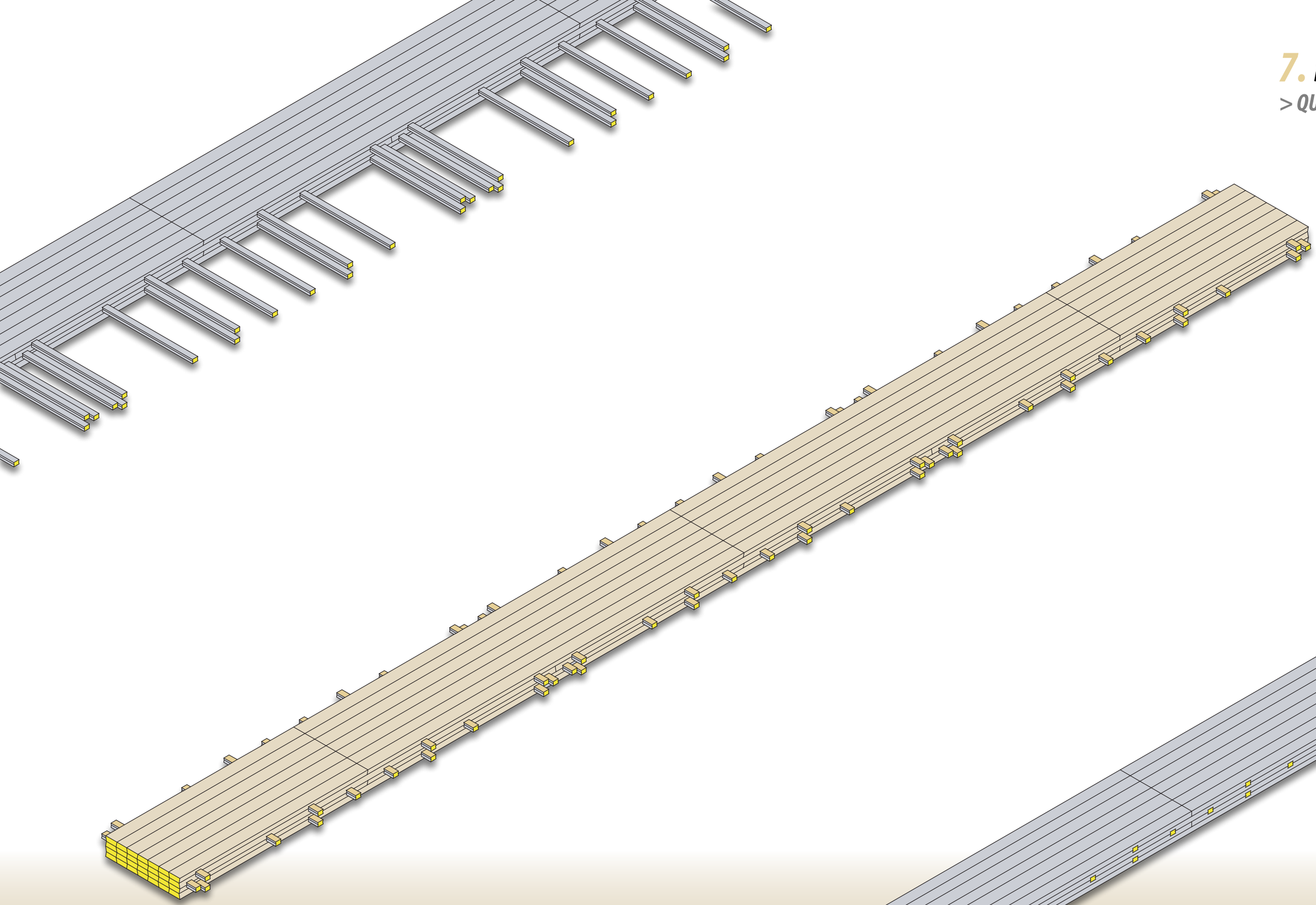






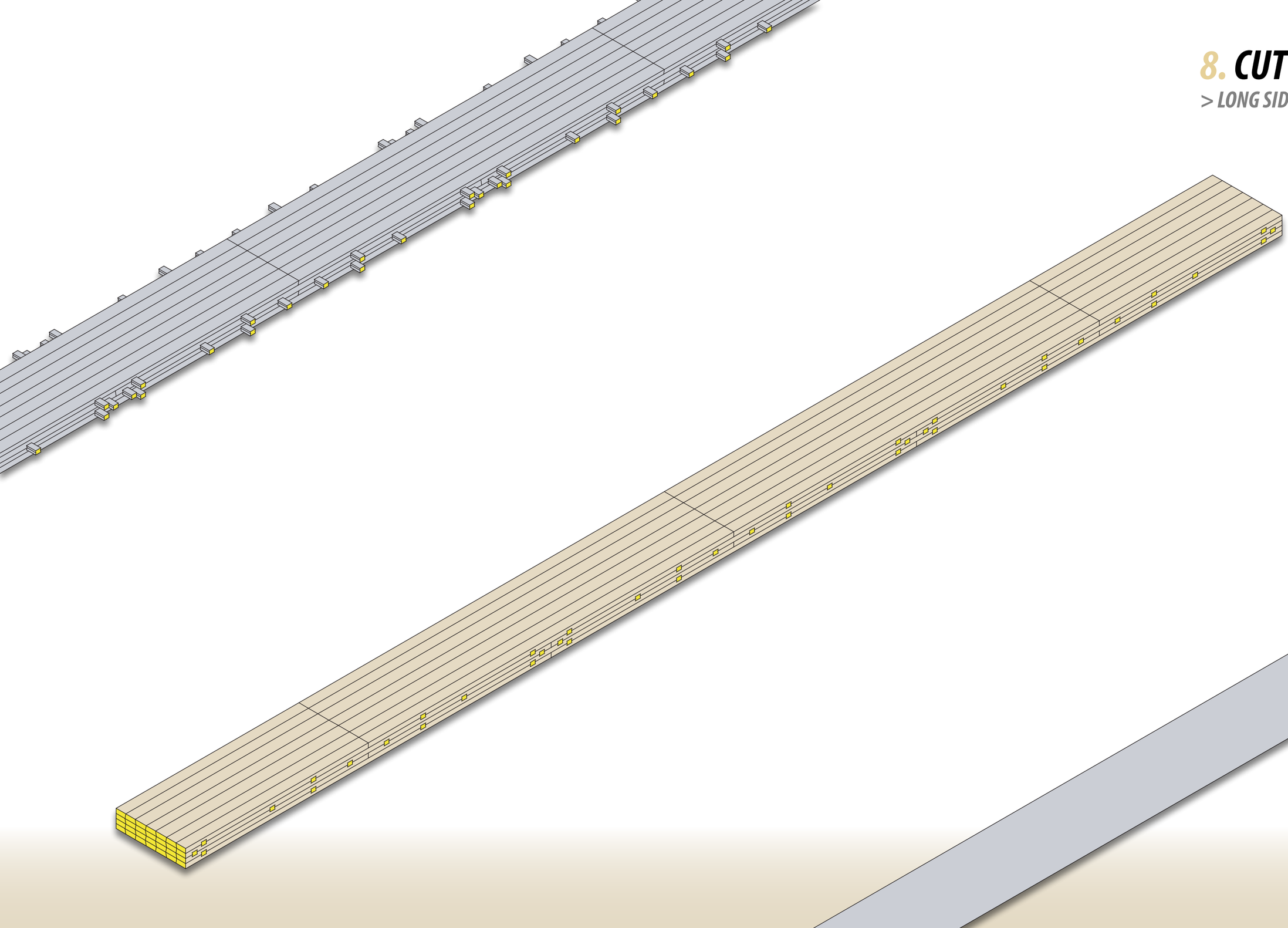
7. DECLAMPING

> QUALITY CHECK



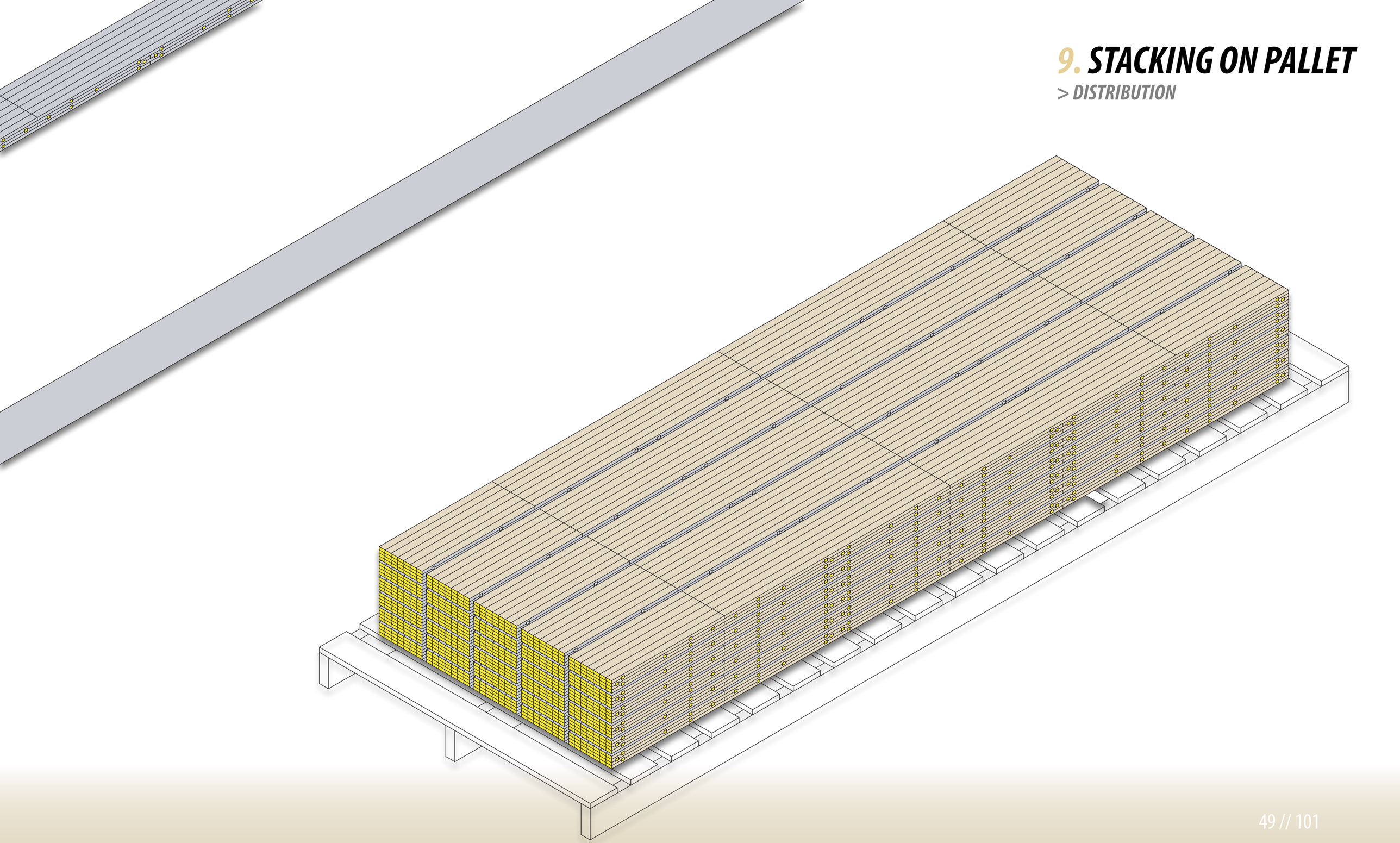
8. CUTTING TO SIZE

> LONG SIDE

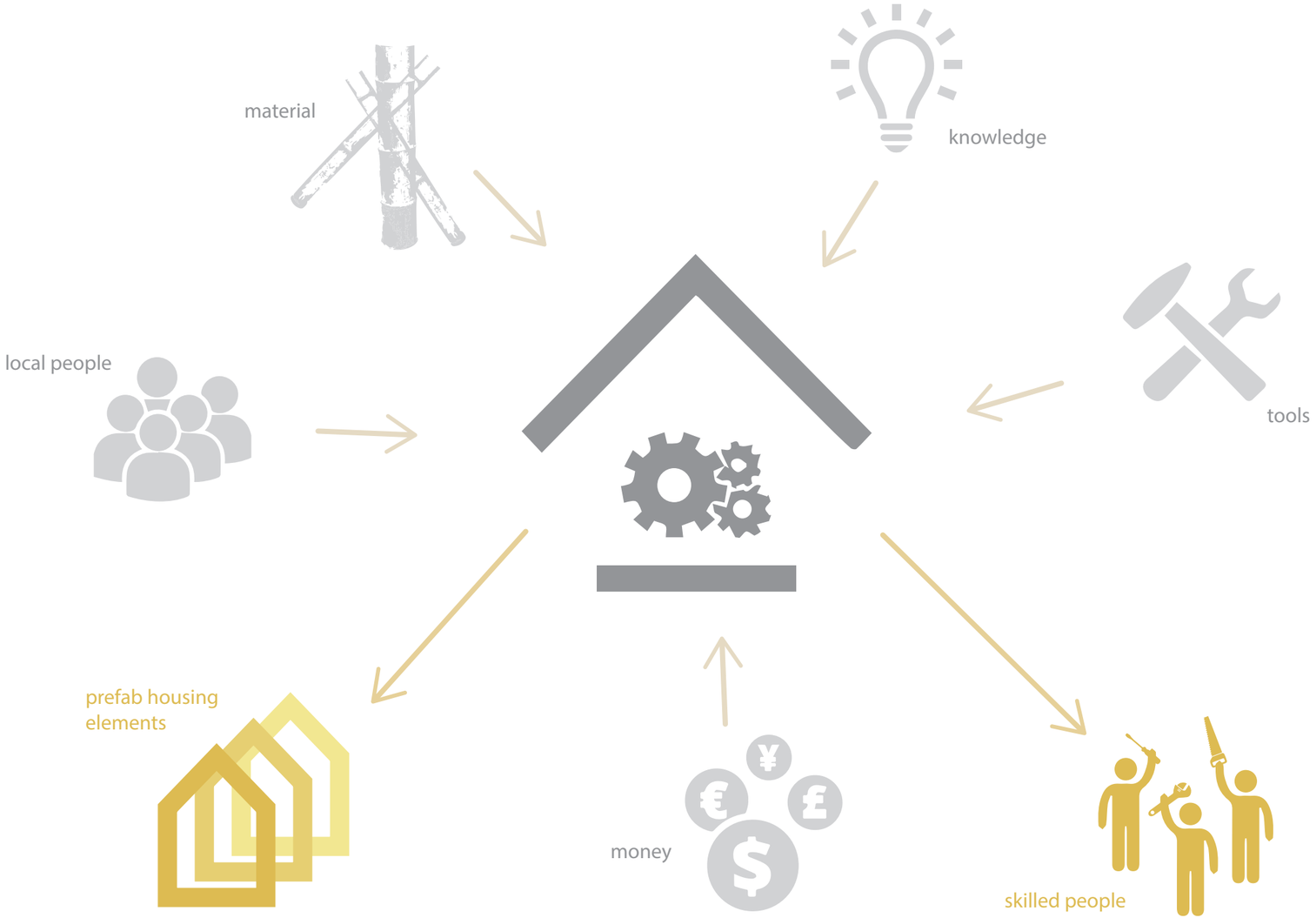


9. STACKING ON PALLET

> DISTRIBUTION



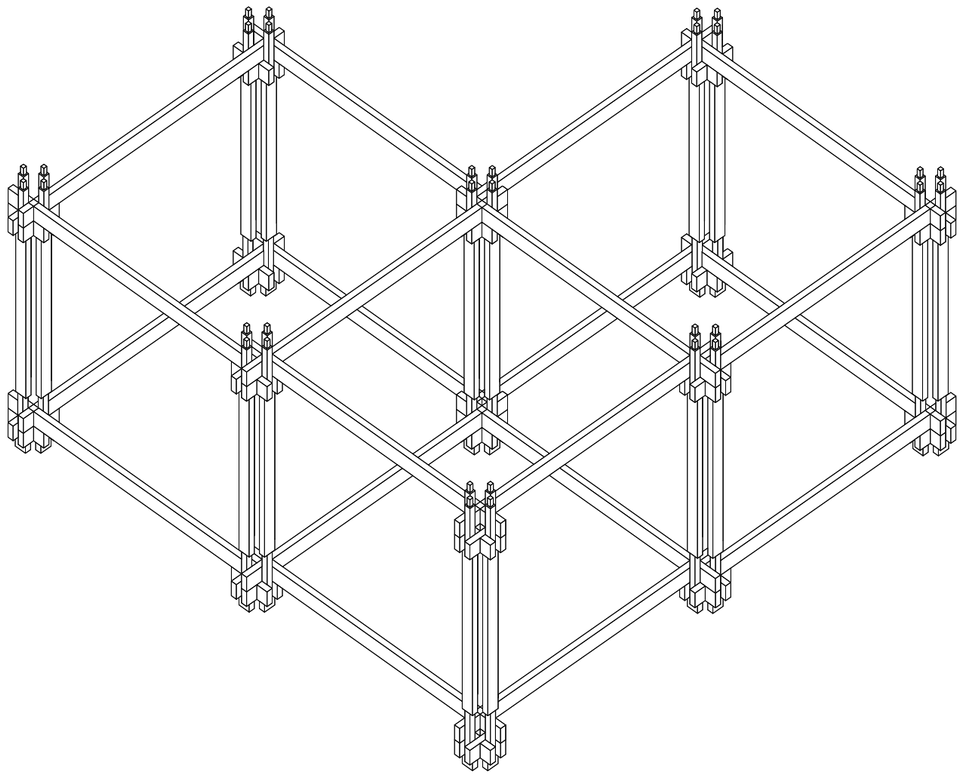
> PUBLIC WORKSHOP



DESIGN RESULT

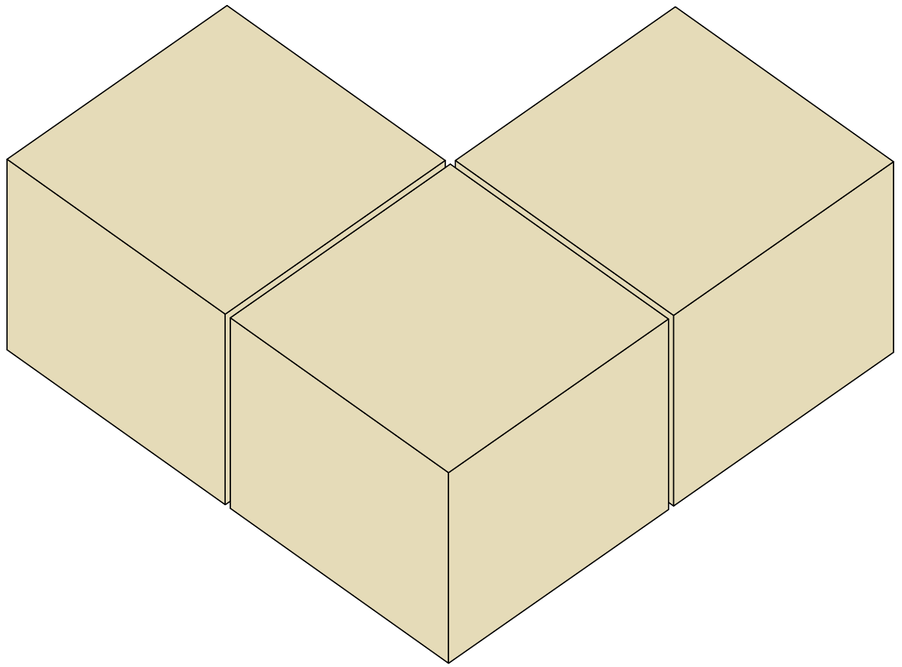
> A BUILDING SYSTEM

> FRAME



+

> INFILL



> REPEATING STRUCTURE

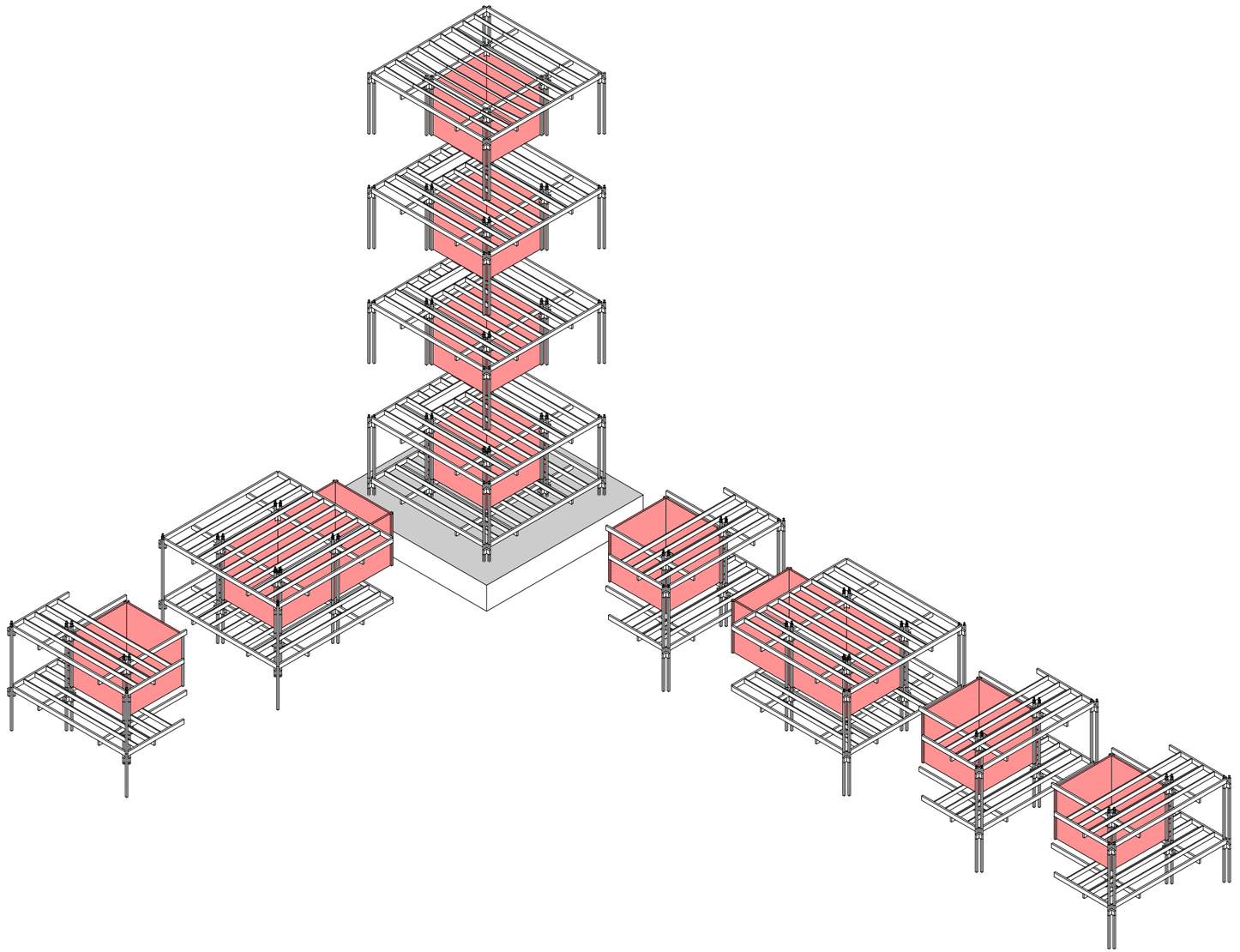
> EXPANDABLE

> CUSTOMIZABLE

> ALL BAMBOO

> SELF-BUILT

> GRID STRUCTURE



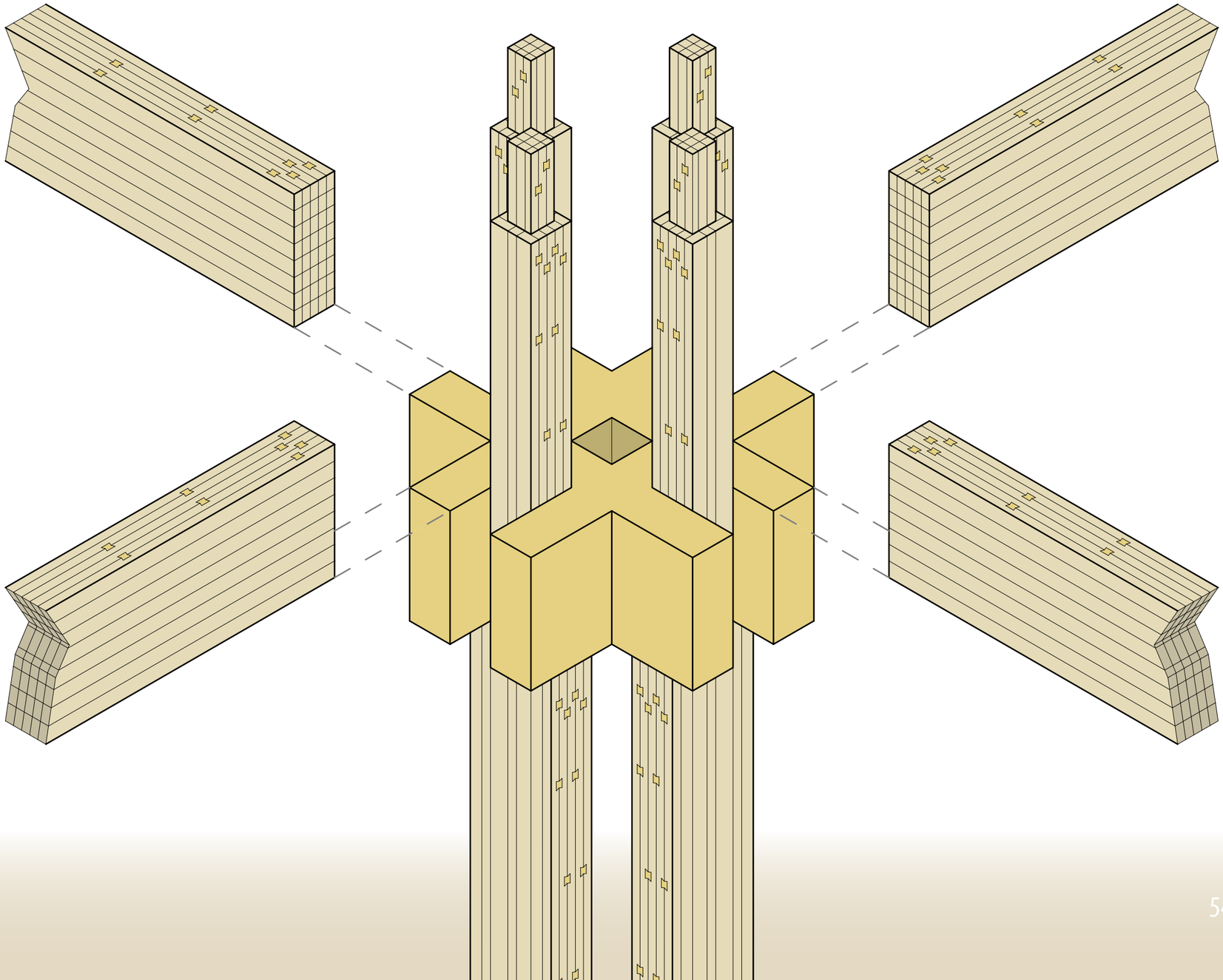
> THE KNOT

> KEY ELEMENT

> SAFE IMPOSITION

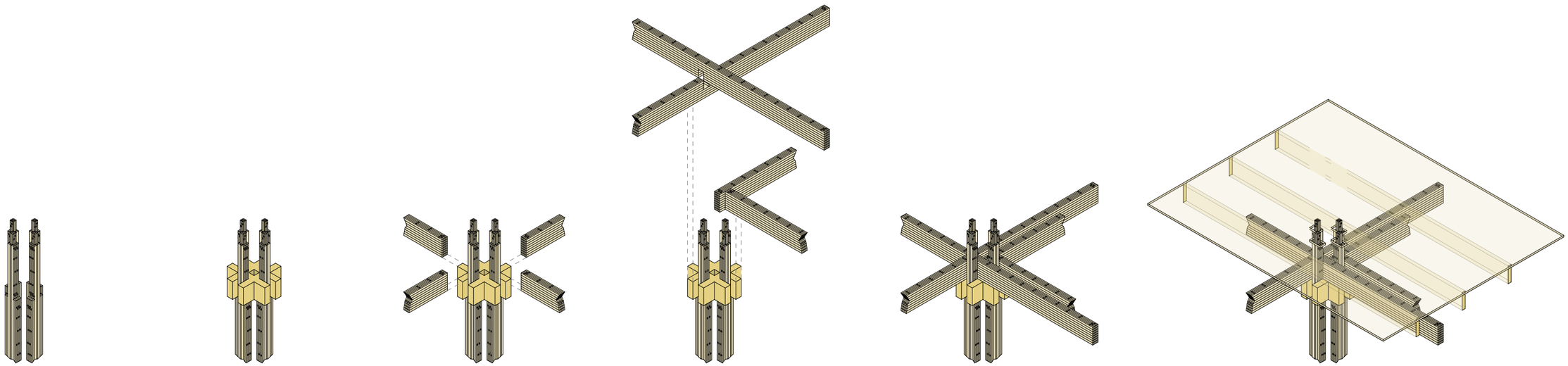
> MATERIAL:
BAMBOO COMPOSITE

> EXPANDABLE
MULTIPLE IMPOSITONS



> IMPOSITION KNOT

> OVERVIEW



1.

4 TAPERED
COLUMNS

2.

IMPOSITION
KNOT

3.

4 IMPOSITIONS
MAIN BEAMS

4.

HALF-LAPPING /
CROSS JOINT

5.

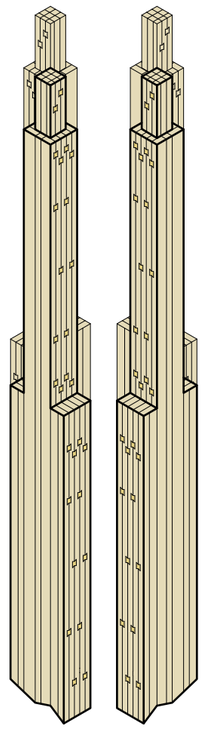
MAIN STRUCTURE
IN 1 PLANE

6.

PIN-HOLE
CONTINUATION

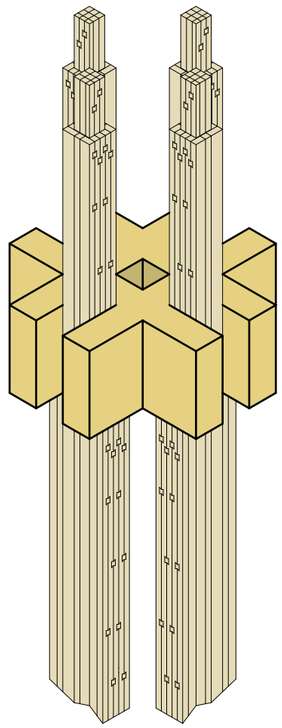
> KNOT BUILD-UP

> 4 TAPERED COLUMNS



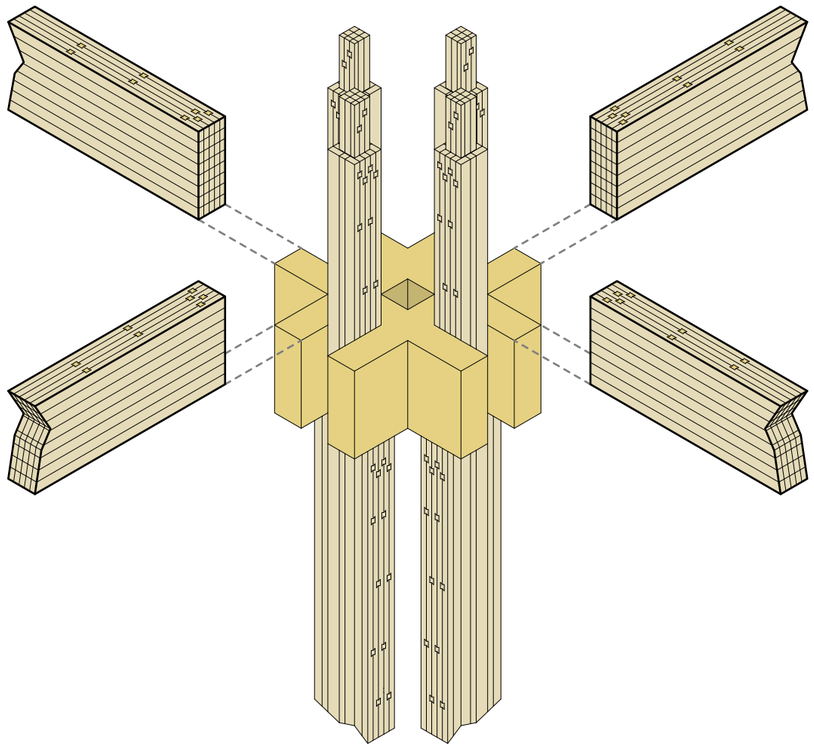
> KNOT BUILD-UP

> IMPOSITION KNOT



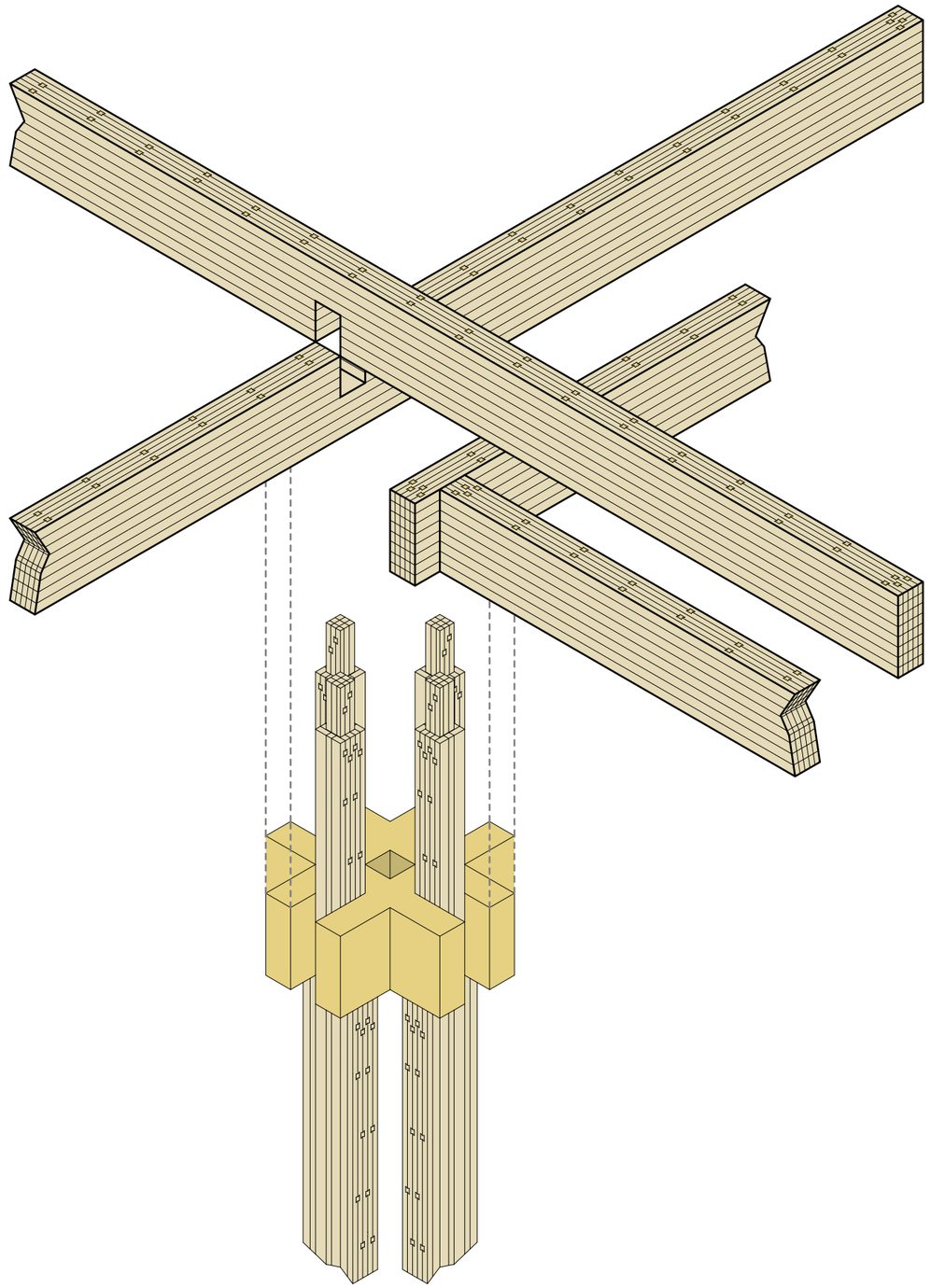
> KNOT BUILD-UP

> IMPOSITIONS MAIN BEAMS



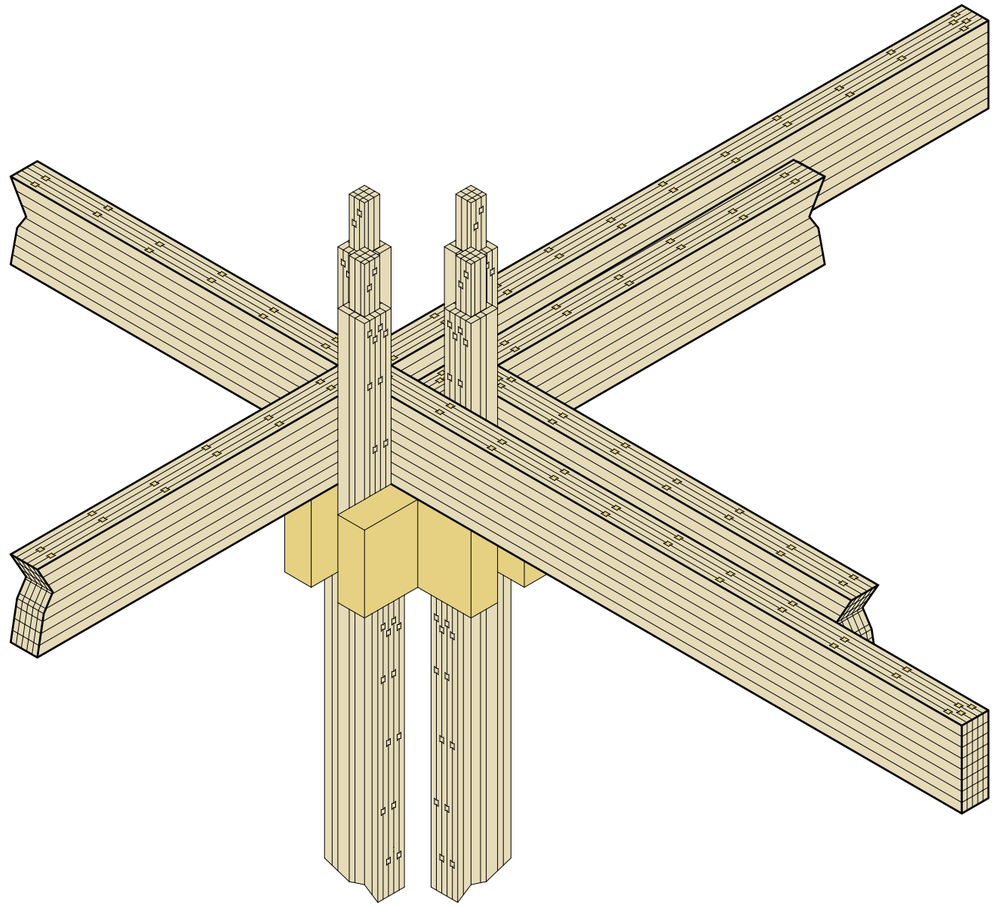
> KNOT BUILD-UP

> HALF-LAPPING / CROSS JOINT



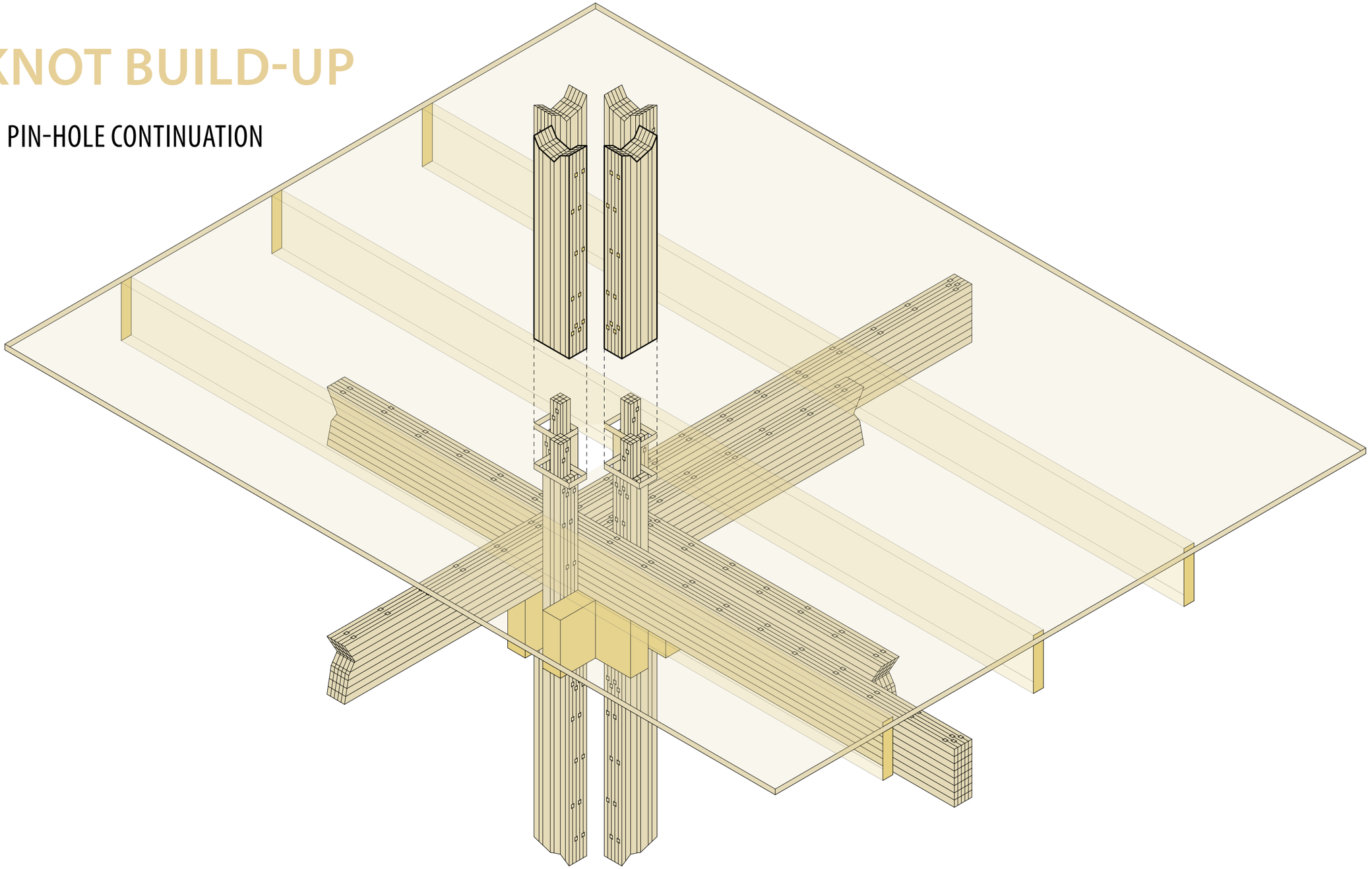
> KNOT BUILD-UP

> MAIN STRUCTURE IN 1 PLANE



> KNOT BUILD-UP

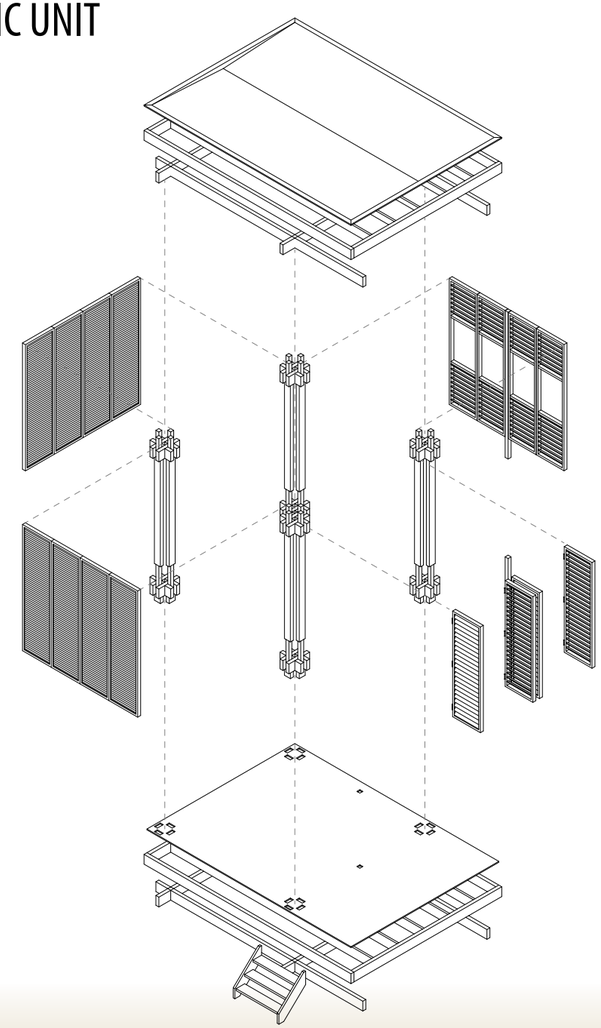
> PIN-HOLE CONTINUATION



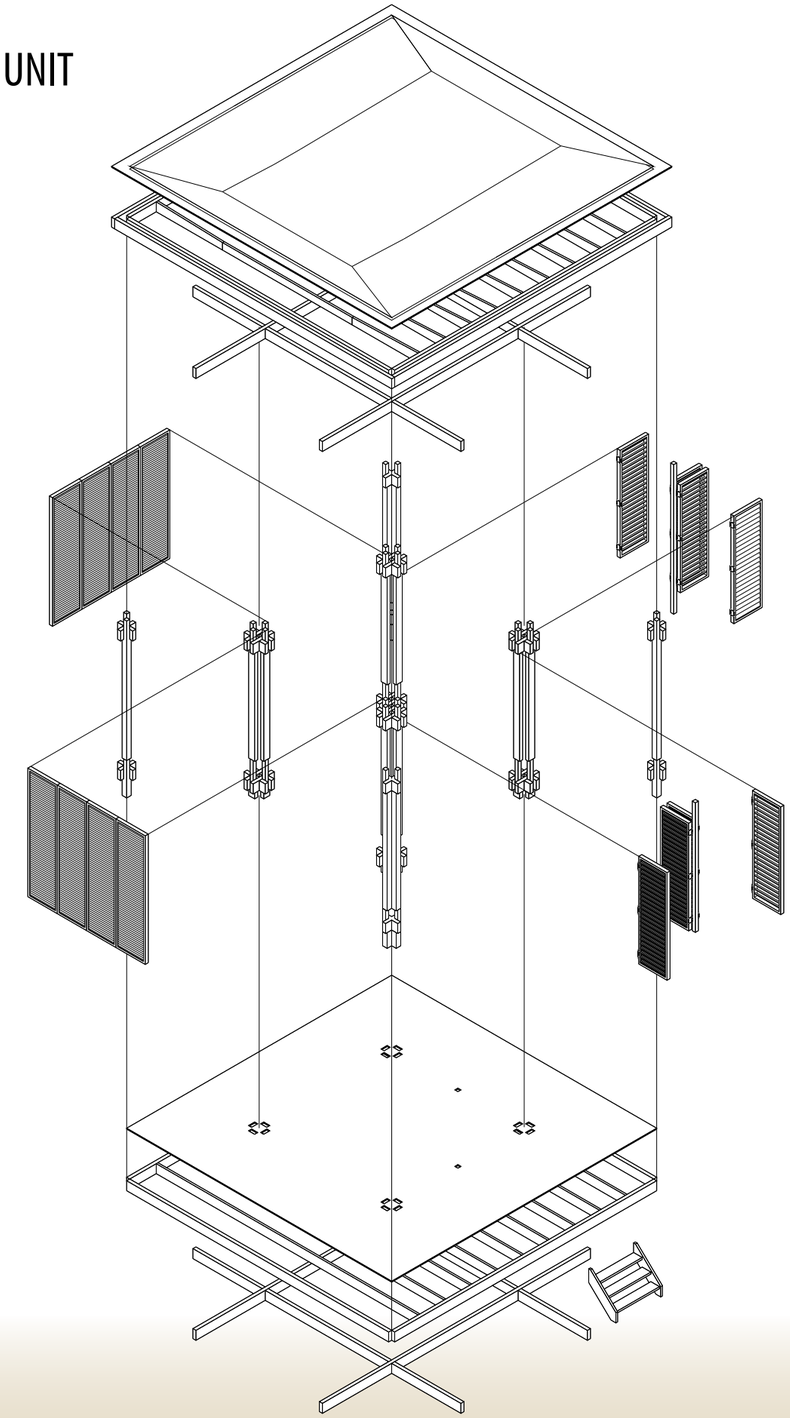
> THE BUILDING SYSTEM

> 2 PRINCIPAL TYPES

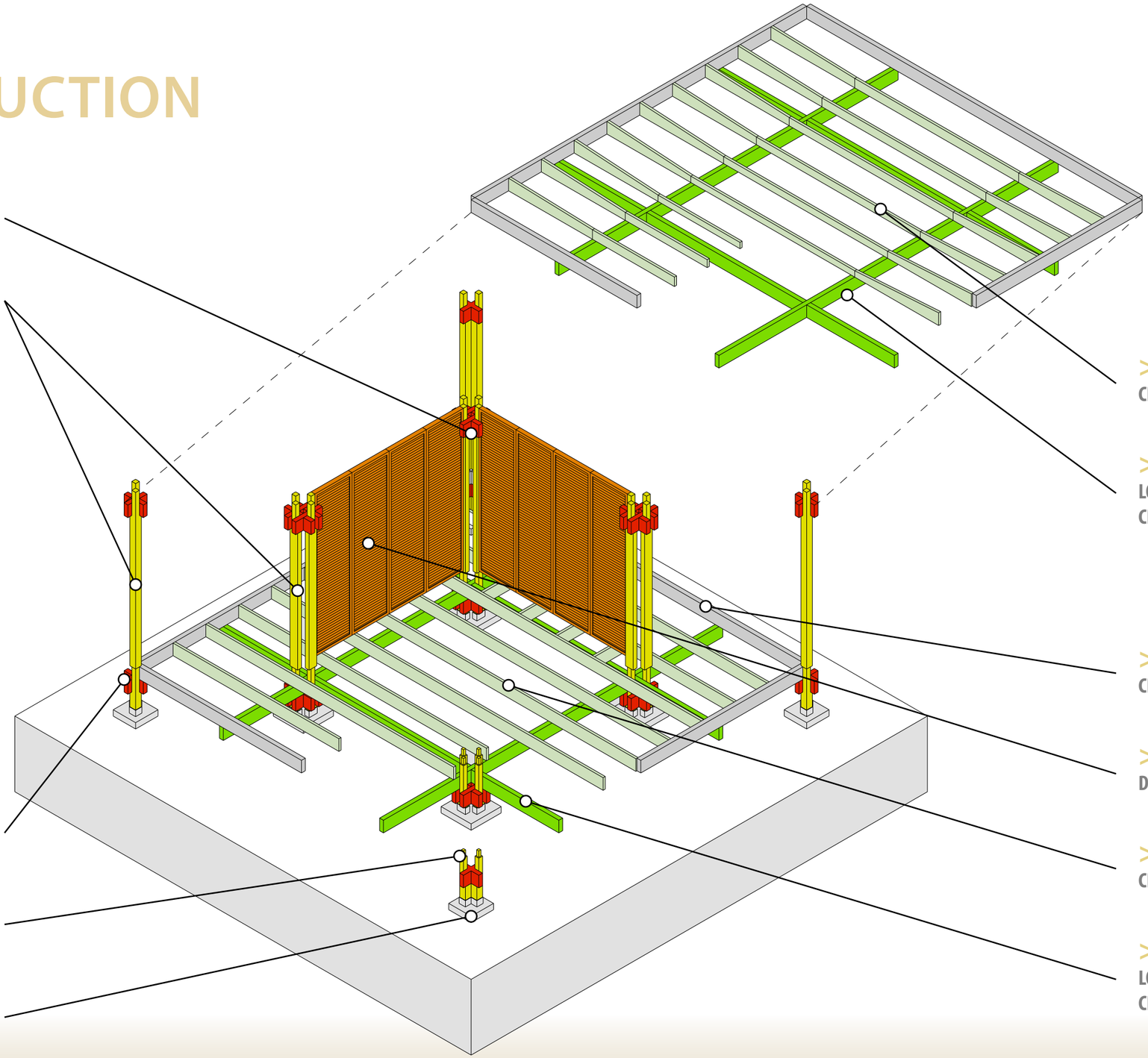
> BASIC UNIT



> BALCONY UNIT



> CONSTRUCTION



> **INNER KNOT** / CONSOLE

> **COLUMNS ROOF**
TAPERED FOR IMPOSITION KNOT

> **OUTER KNOT** / CONSOLE

> **COLUMNS RAISED FLOOR**
TAPERED FOR IMPOSITION KNOT

> **FOUNDATION**
CONCRETE BASE

> **SECONDARY ROOF BEAMS**
CROSS SECTION: 40x200mm

> **MAIN ROOF BEAMS**
LOAD BEARING STRUCTURE
CROSS SECTION: 70x200mm

> **EDGE BEAMS**
CROSS SECTION: 70x200mm

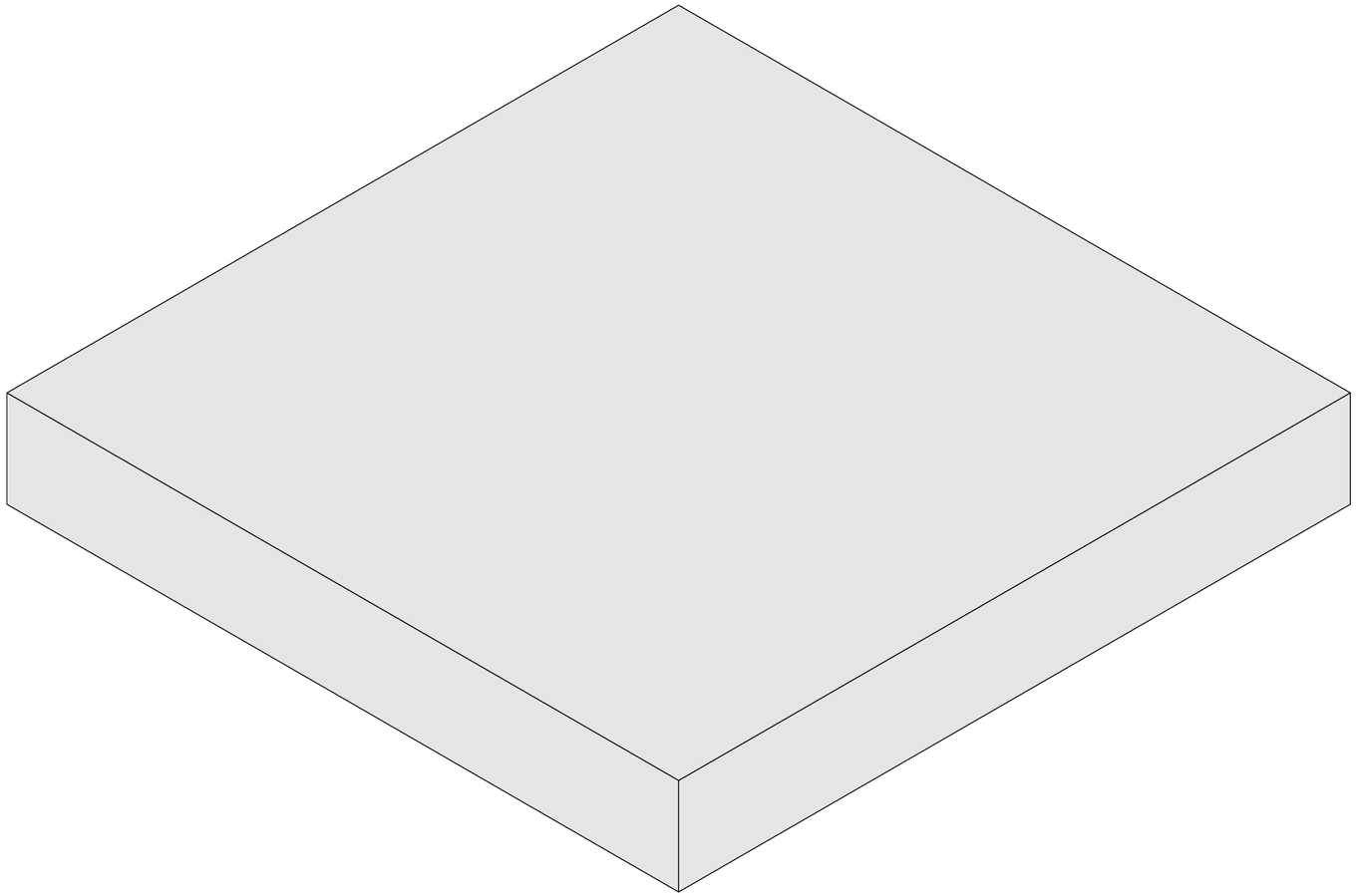
> **STABILITY WALL PANELS**
DIMENSION: 680x2580mm

> **SECONDARY FLOOR BEAMS**
CROSS SECTION: 40x200mm

> **MAIN FLOOR BEAMS**
LOAD BEARING STRUCTURE
CROSS SECTION: 70x200mm

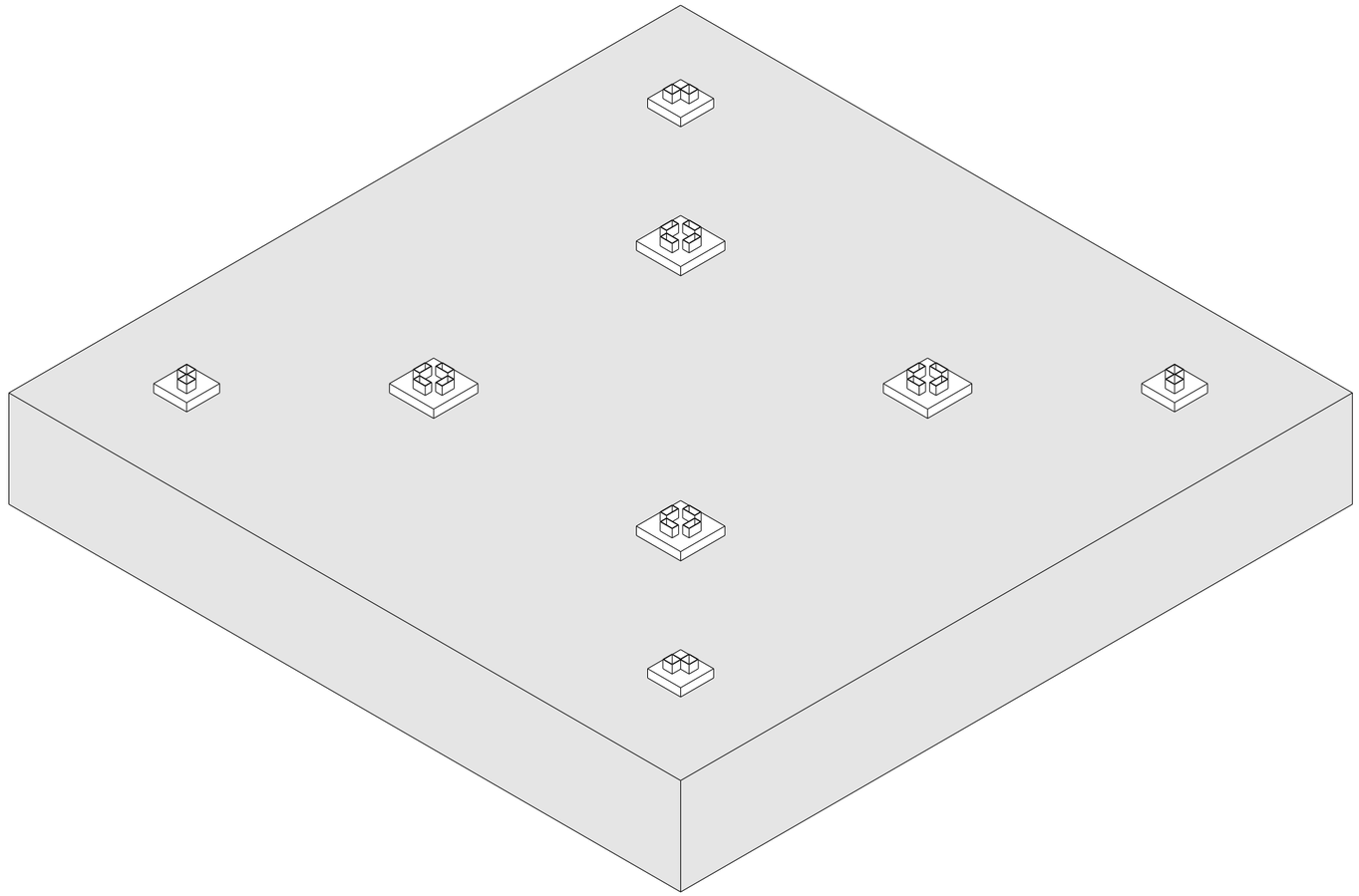
> ASSEMBLY ORDER

> STEP 1 - EMPTY PLOT



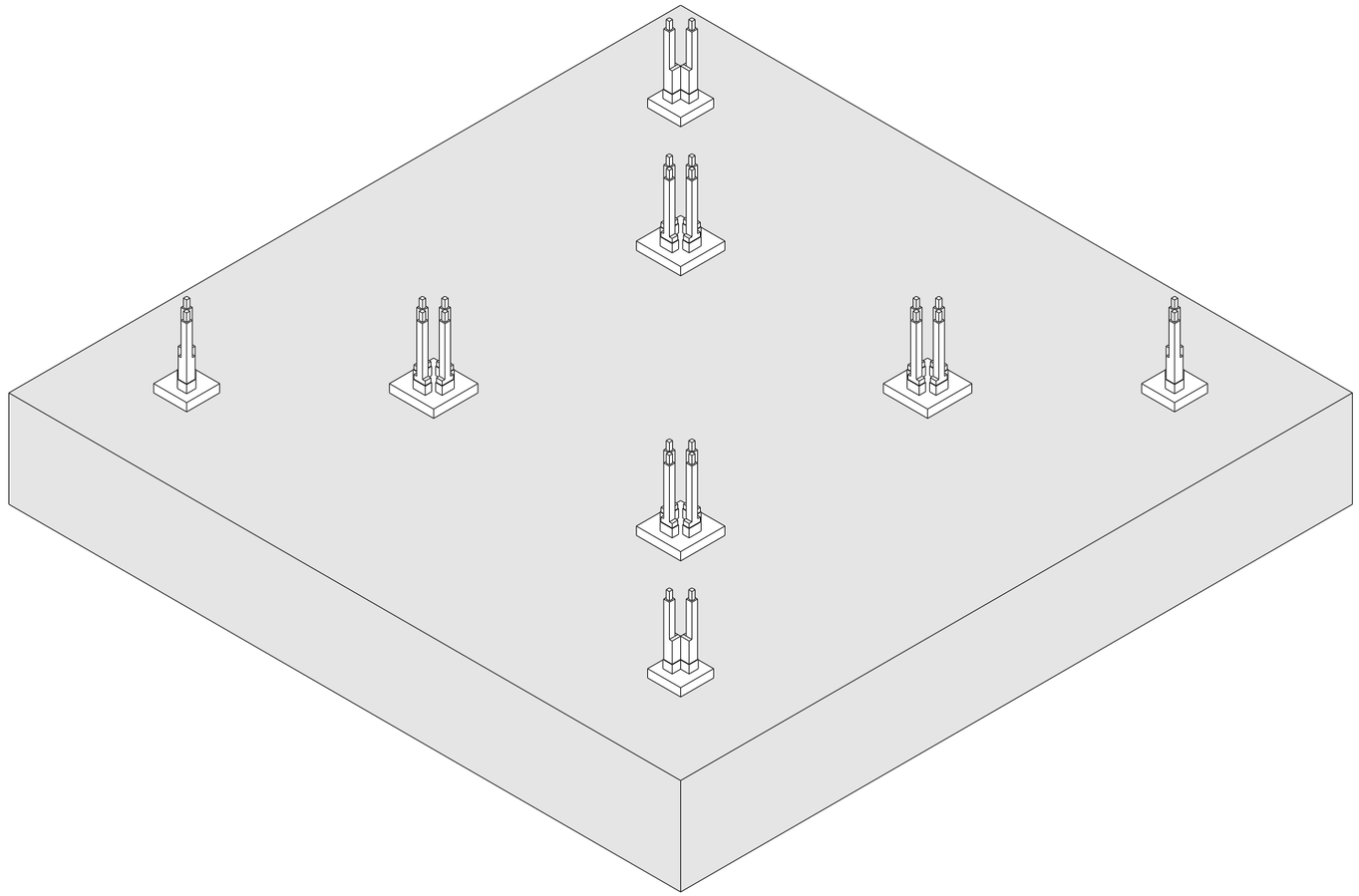
> ASSEMBLY ORDER

> STEP 2 - FOUNDATION



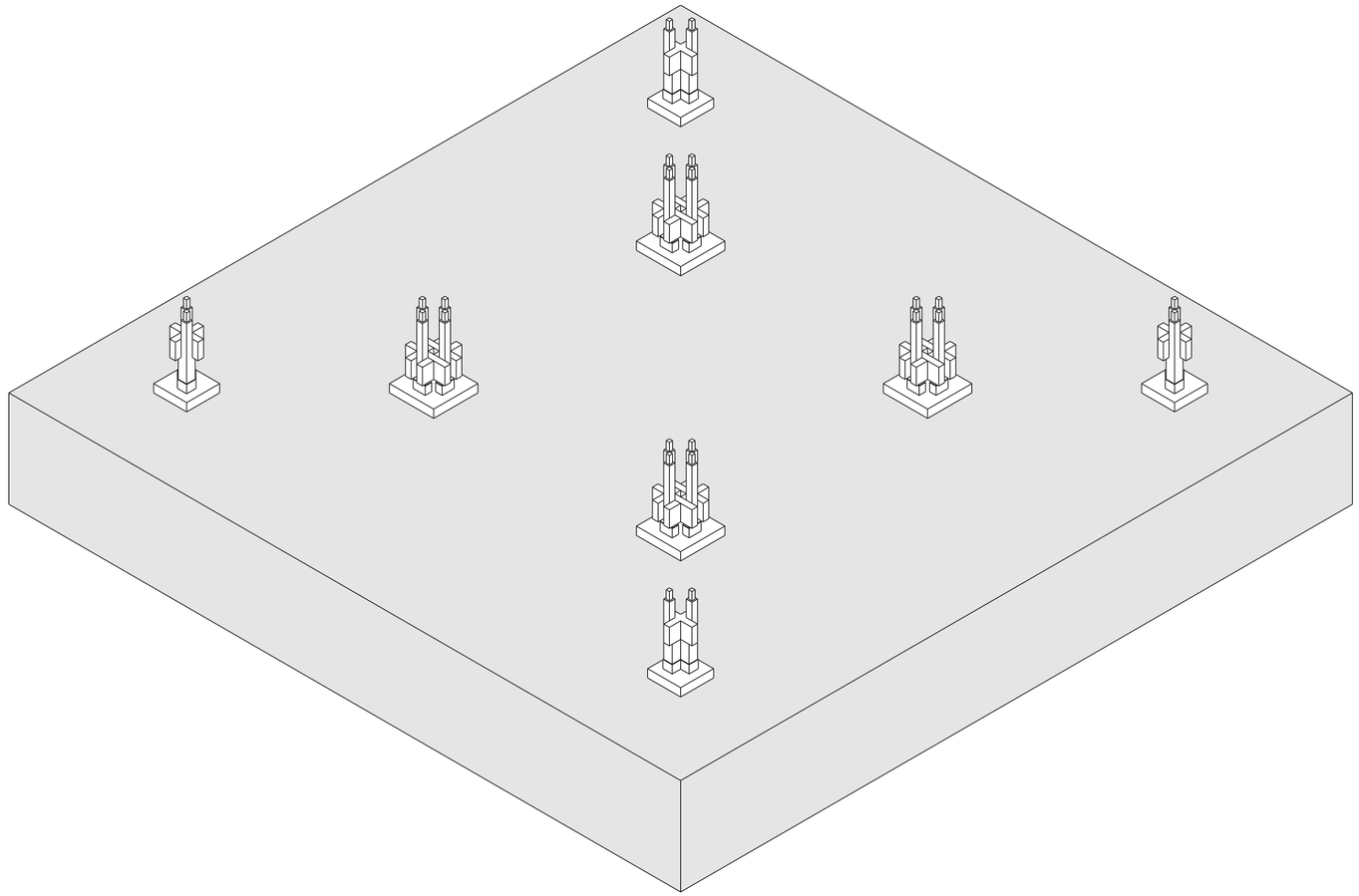
> ASSEMBLY ORDER

> STEP 3 - COLUMNS (RAISED FLOOR)



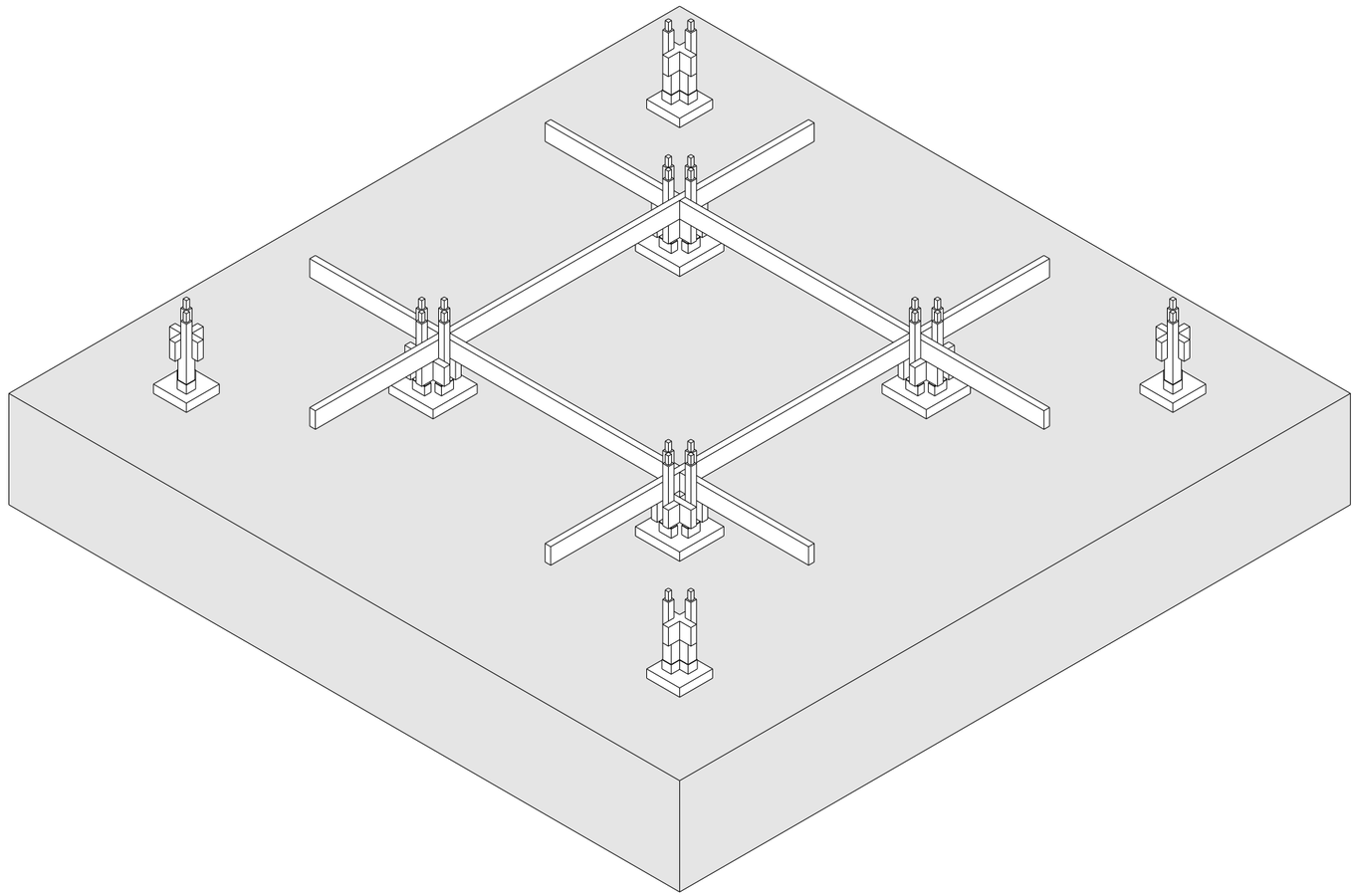
> ASSEMBLY ORDER

> STEP 4 - KNOT/CONSOLE (RAISED FLOOR)



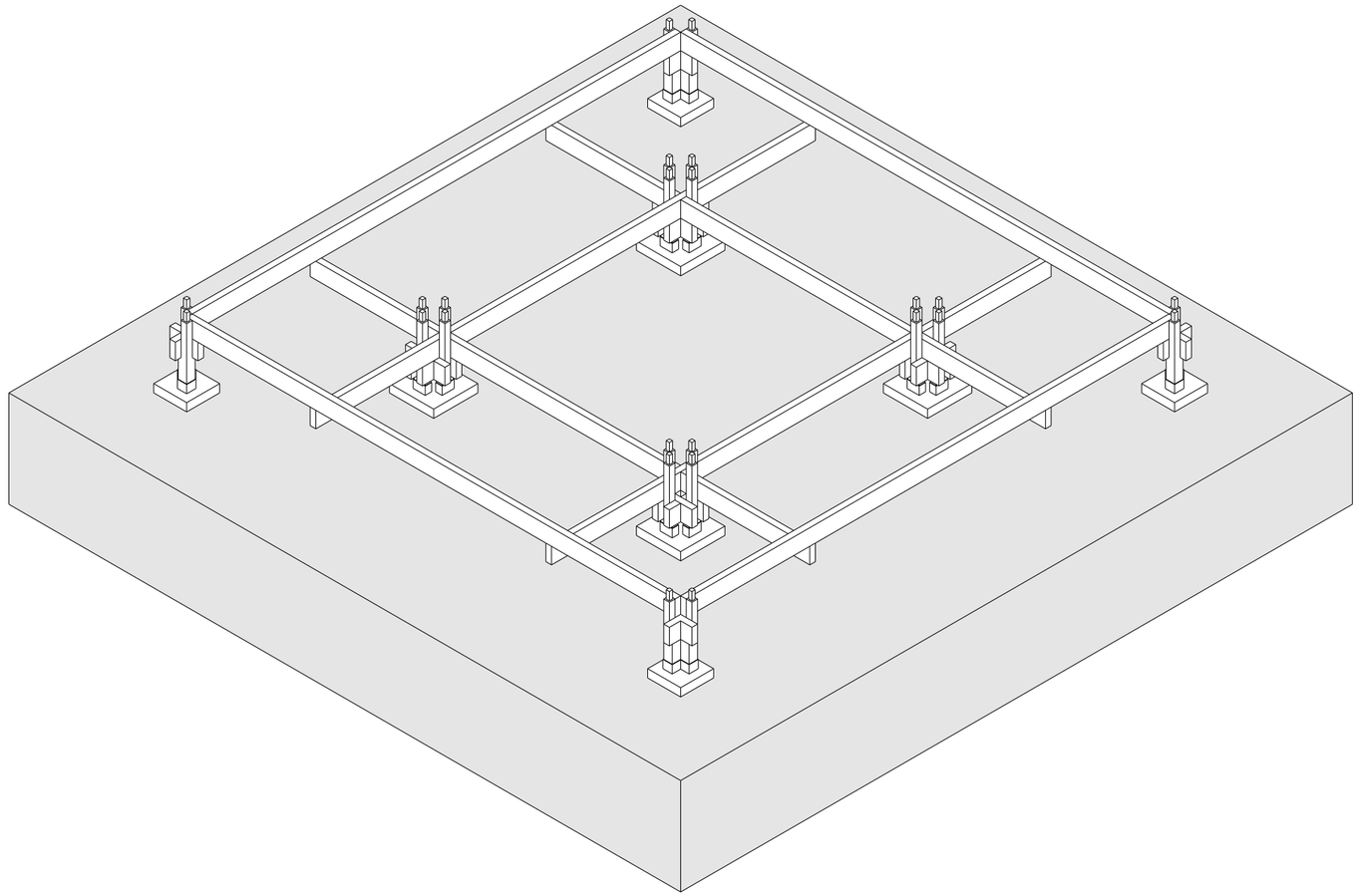
> ASSEMBLY ORDER

> STEP 5 - MAIN BEAMS (RAISED FLOOR)



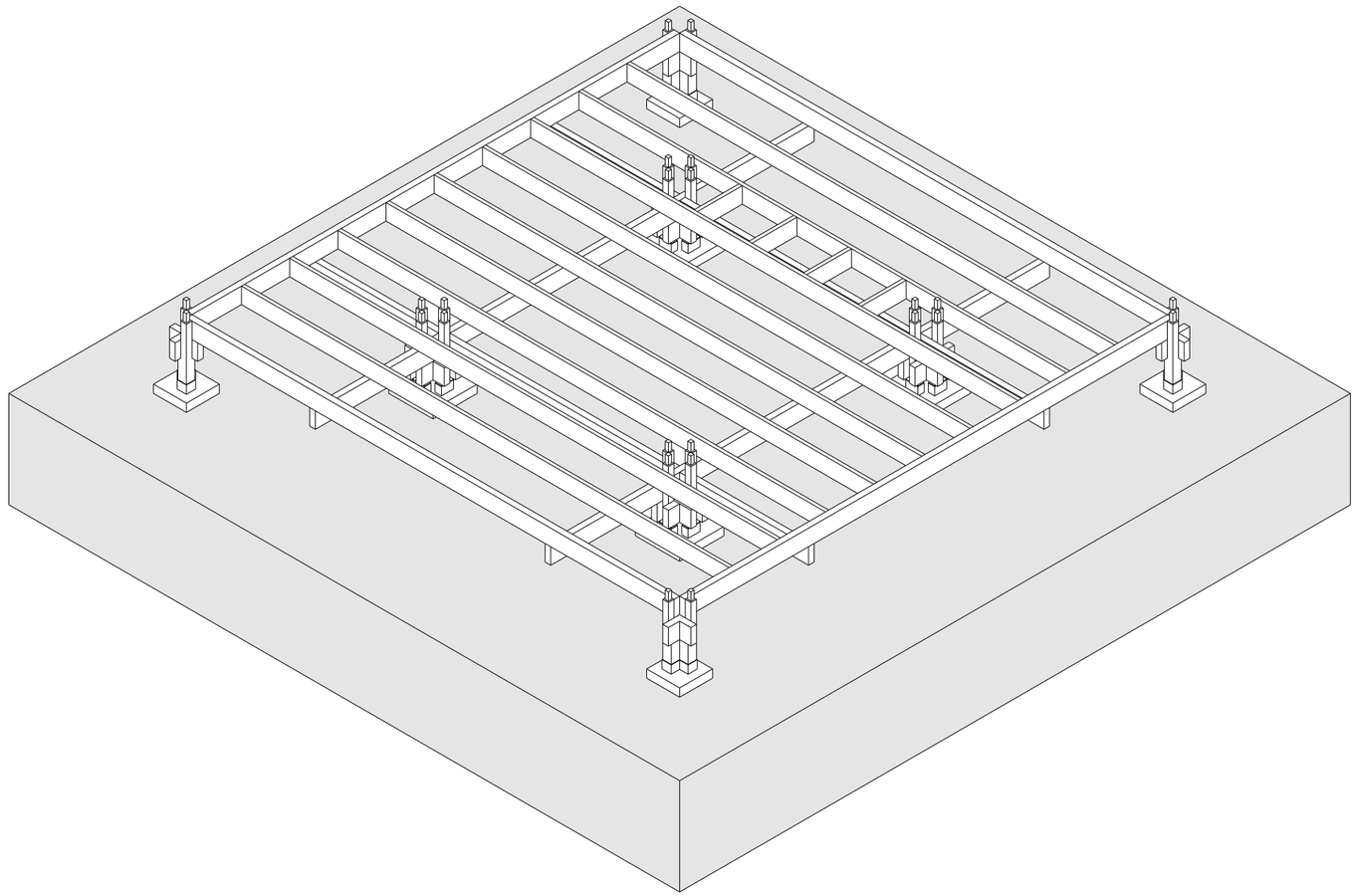
> ASSEMBLY ORDER

> STEP 6 - EDGE BEAMS (RAISED FLOOR)



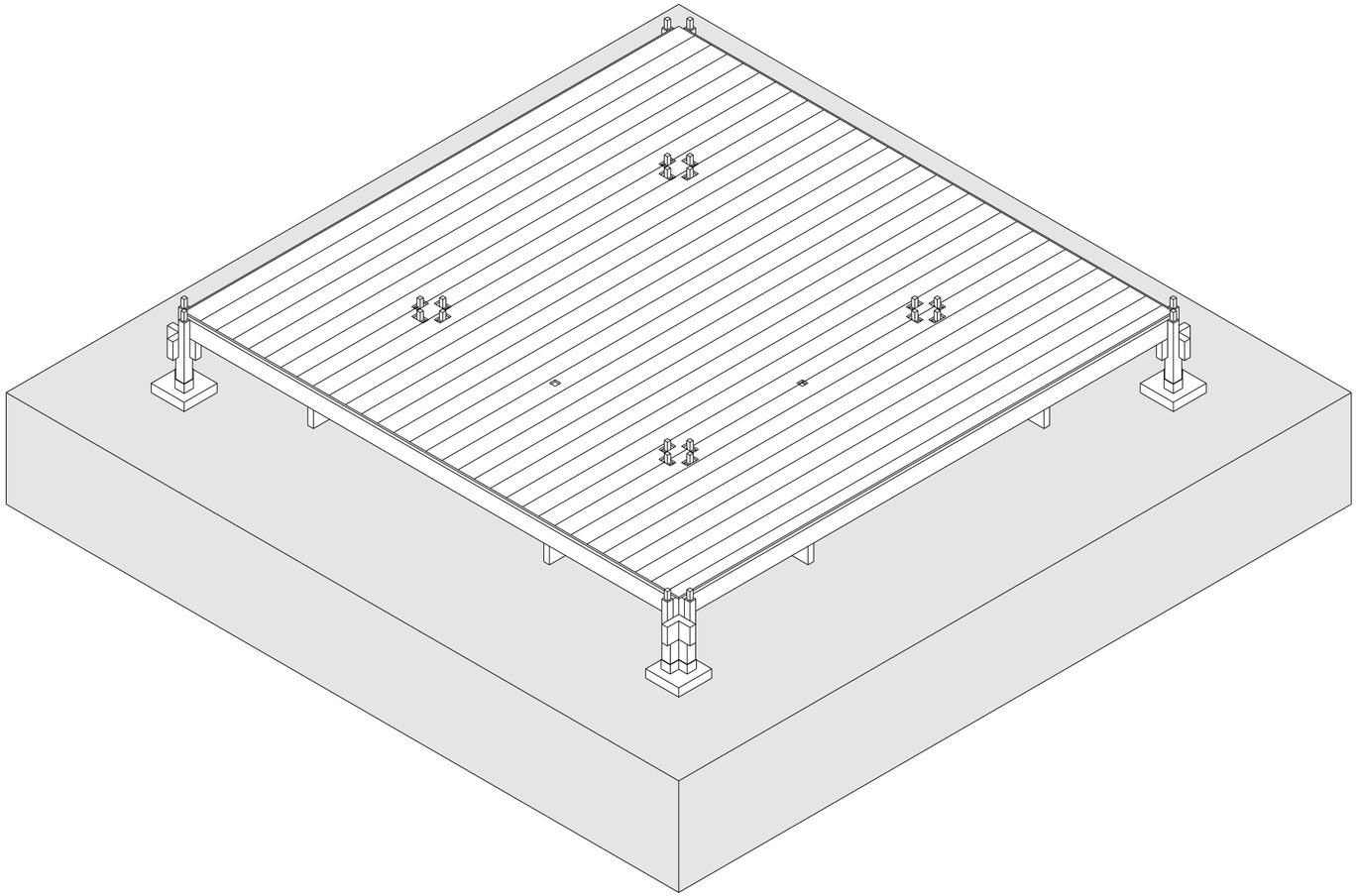
> ASSEMBLY ORDER

> STEP 7 - FLOOR BEAMS (RAISED FLOOR)



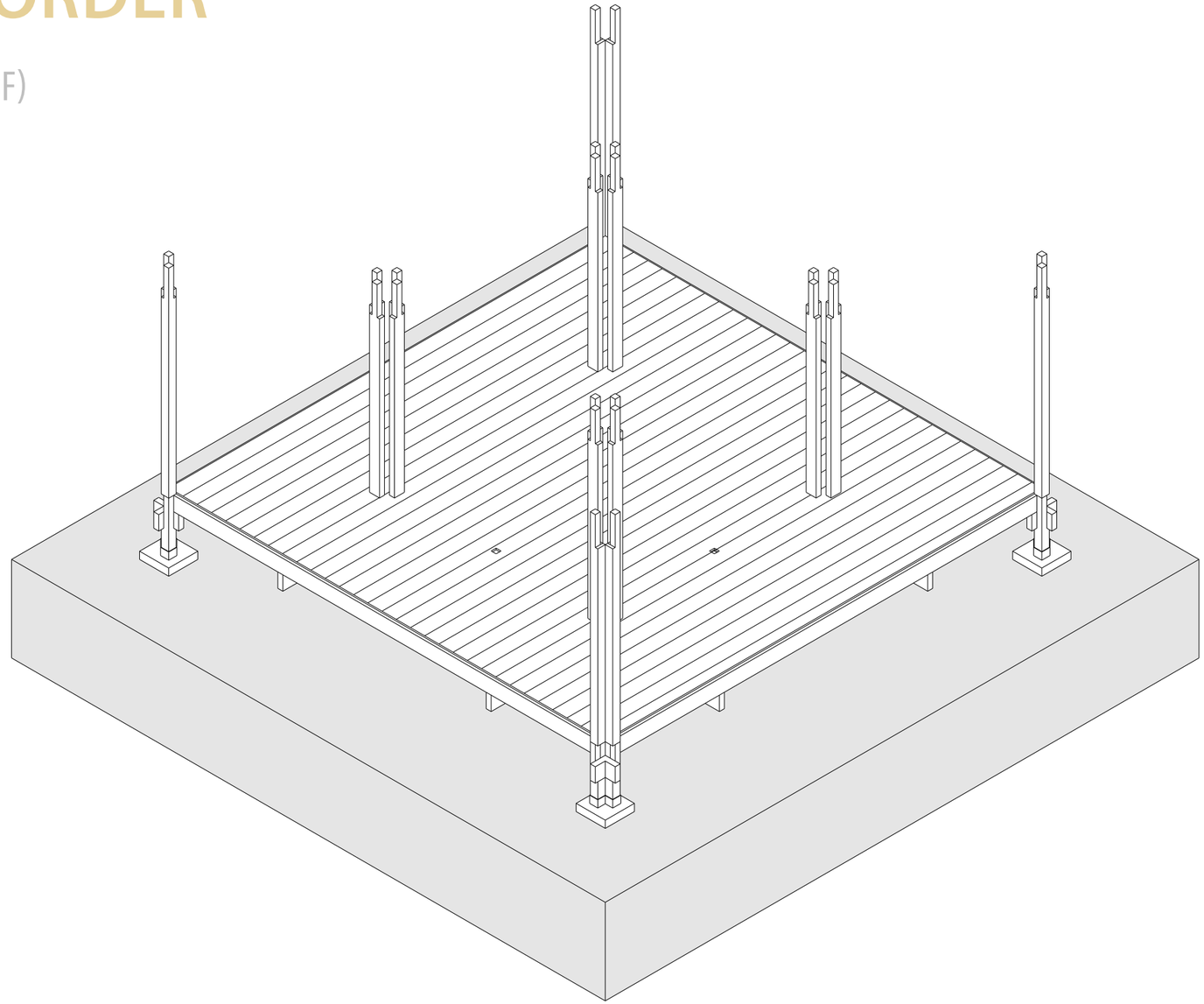
> ASSEMBLY ORDER

> STEP 8 - FLOORBOARDS (RAISED FLOOR)



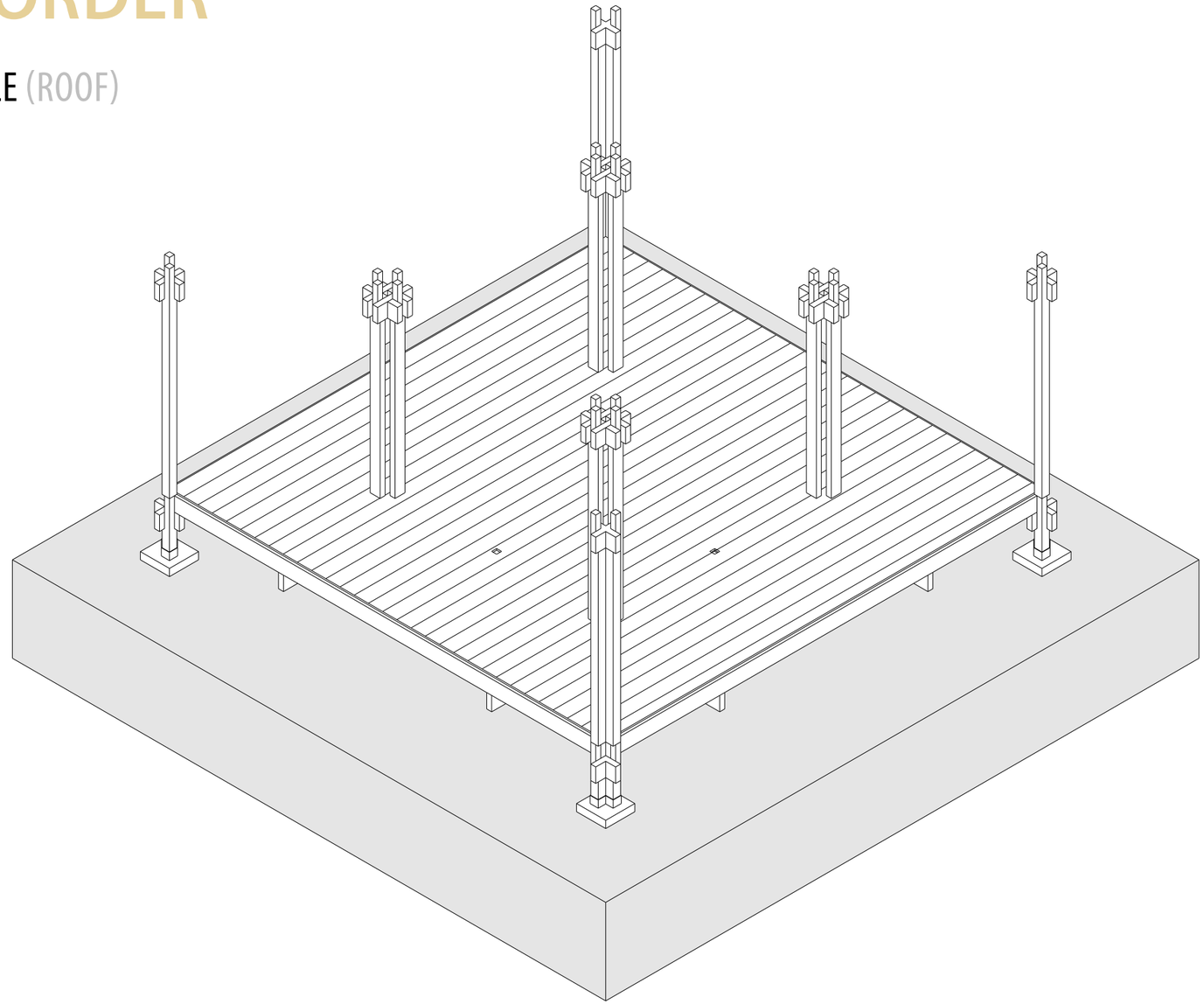
> ASSEMBLY ORDER

> STEP 9 - COLUMNS (ROOF)



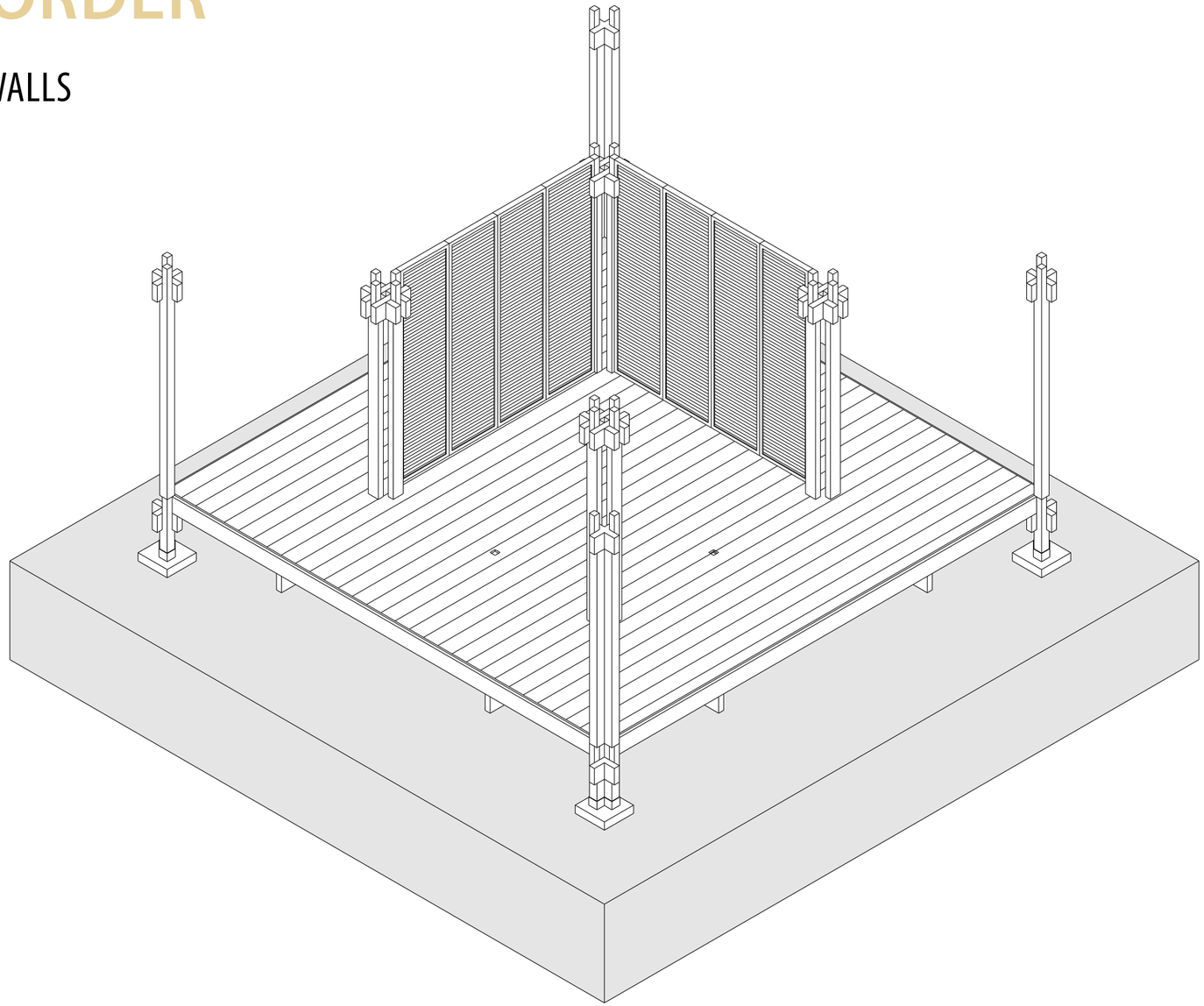
> ASSEMBLY ORDER

> STEP 10 - KNOT/CONSOLE (ROOF)



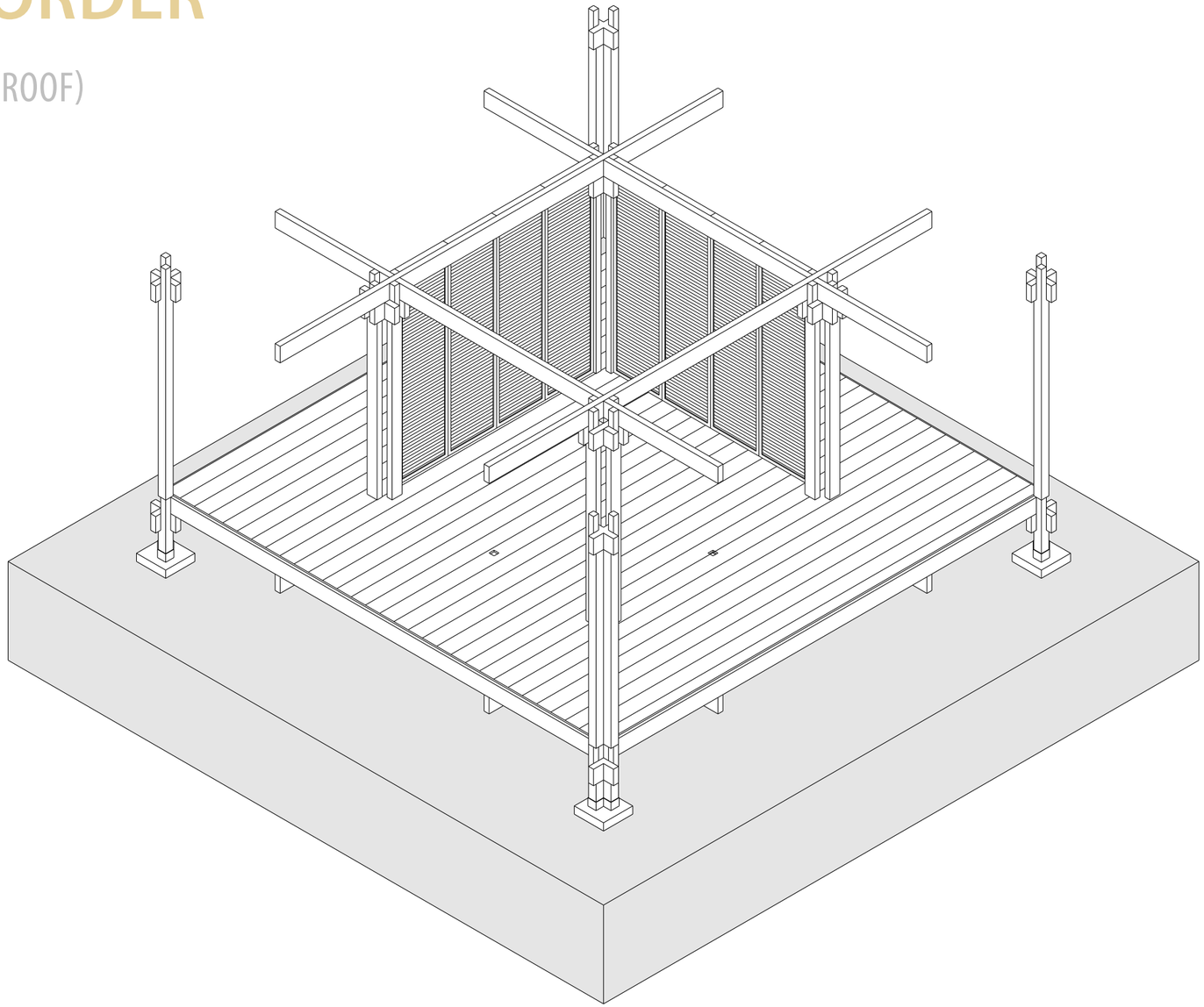
> ASSEMBLY ORDER

> STEP 11 - STABILIZING WALLS



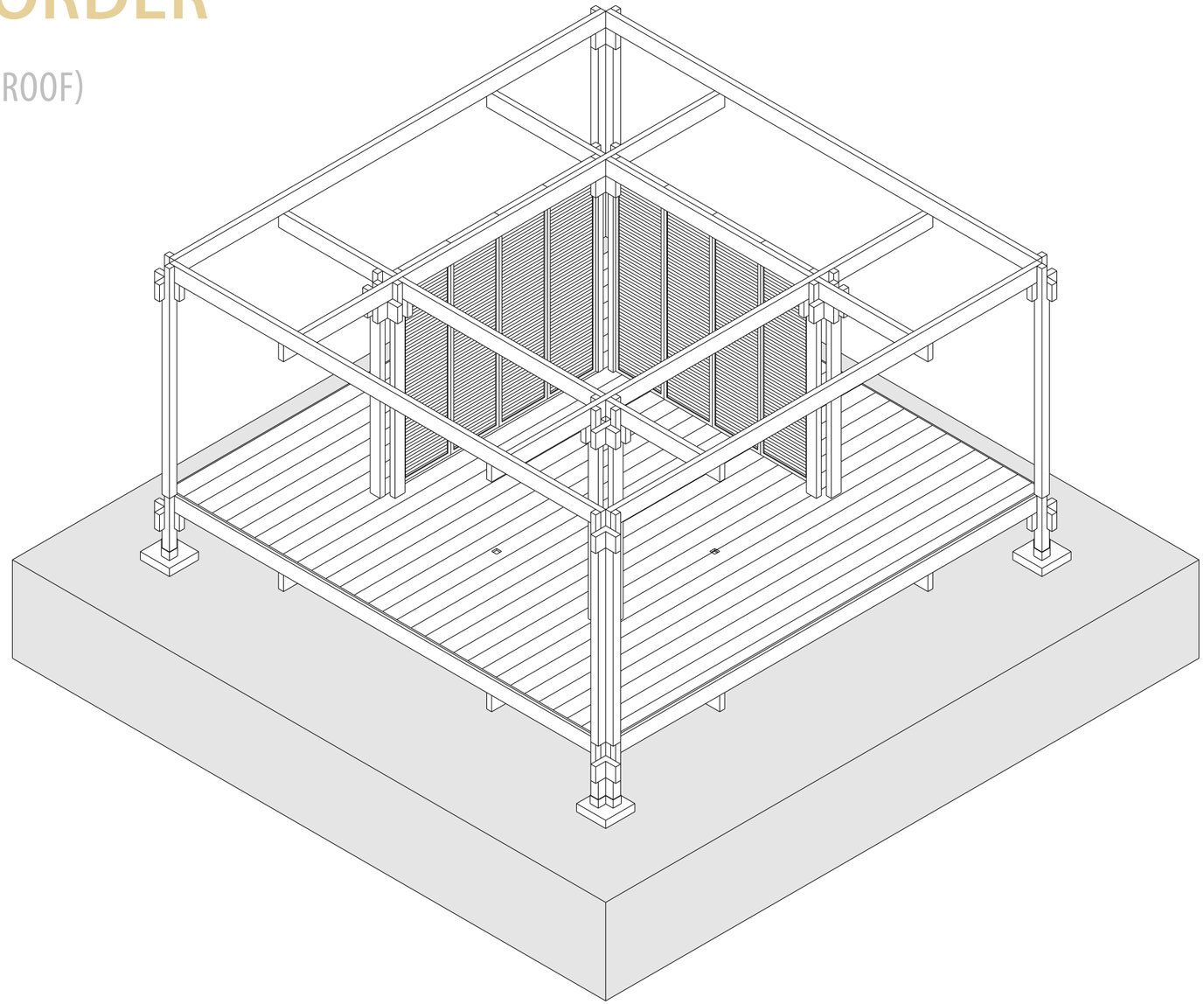
> ASSEMBLY ORDER

> STEP 12 - MAIN BEAMS (ROOF)



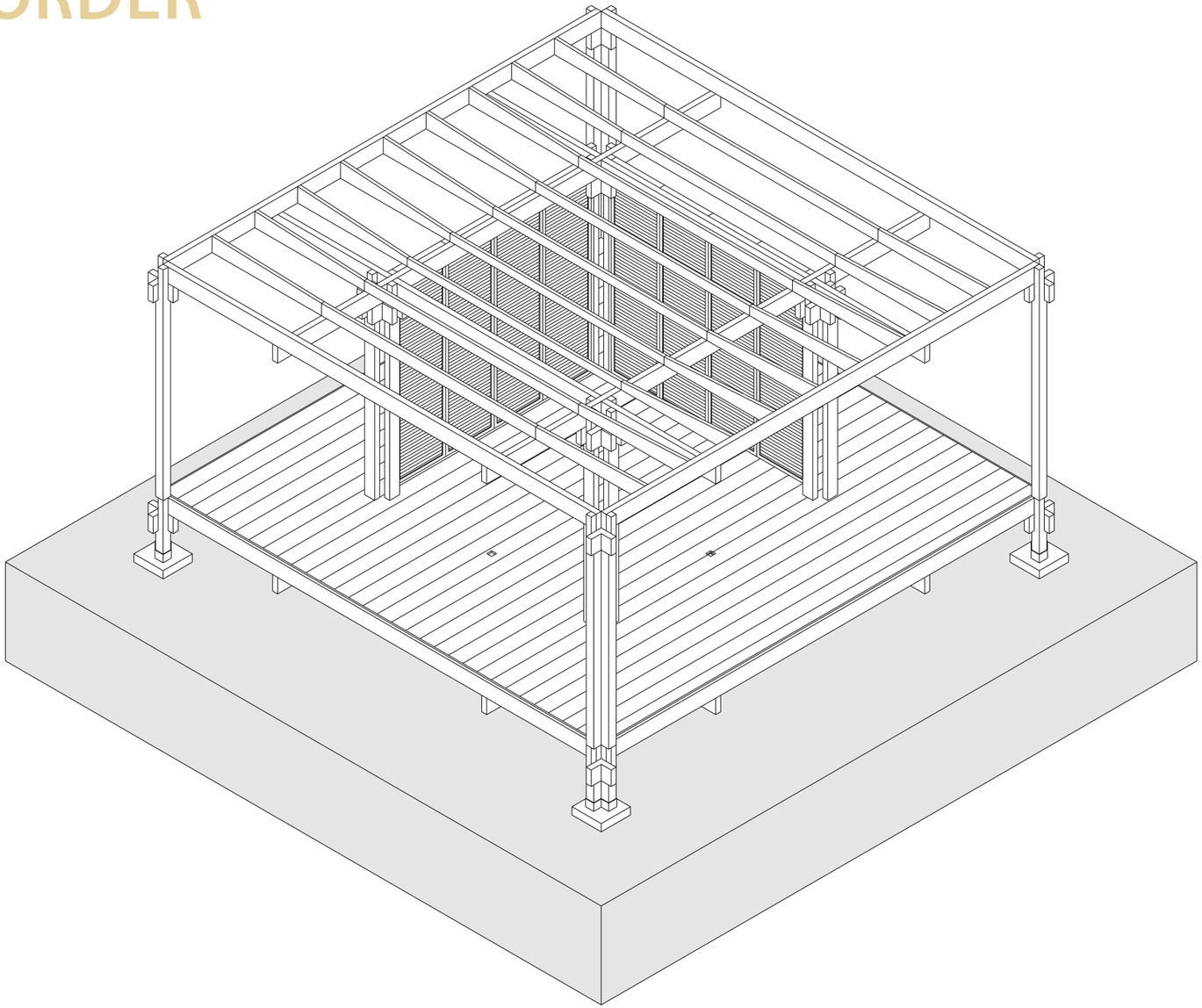
> ASSEMBLY ORDER

> STEP 13 - EDGE BEAMS (ROOF)



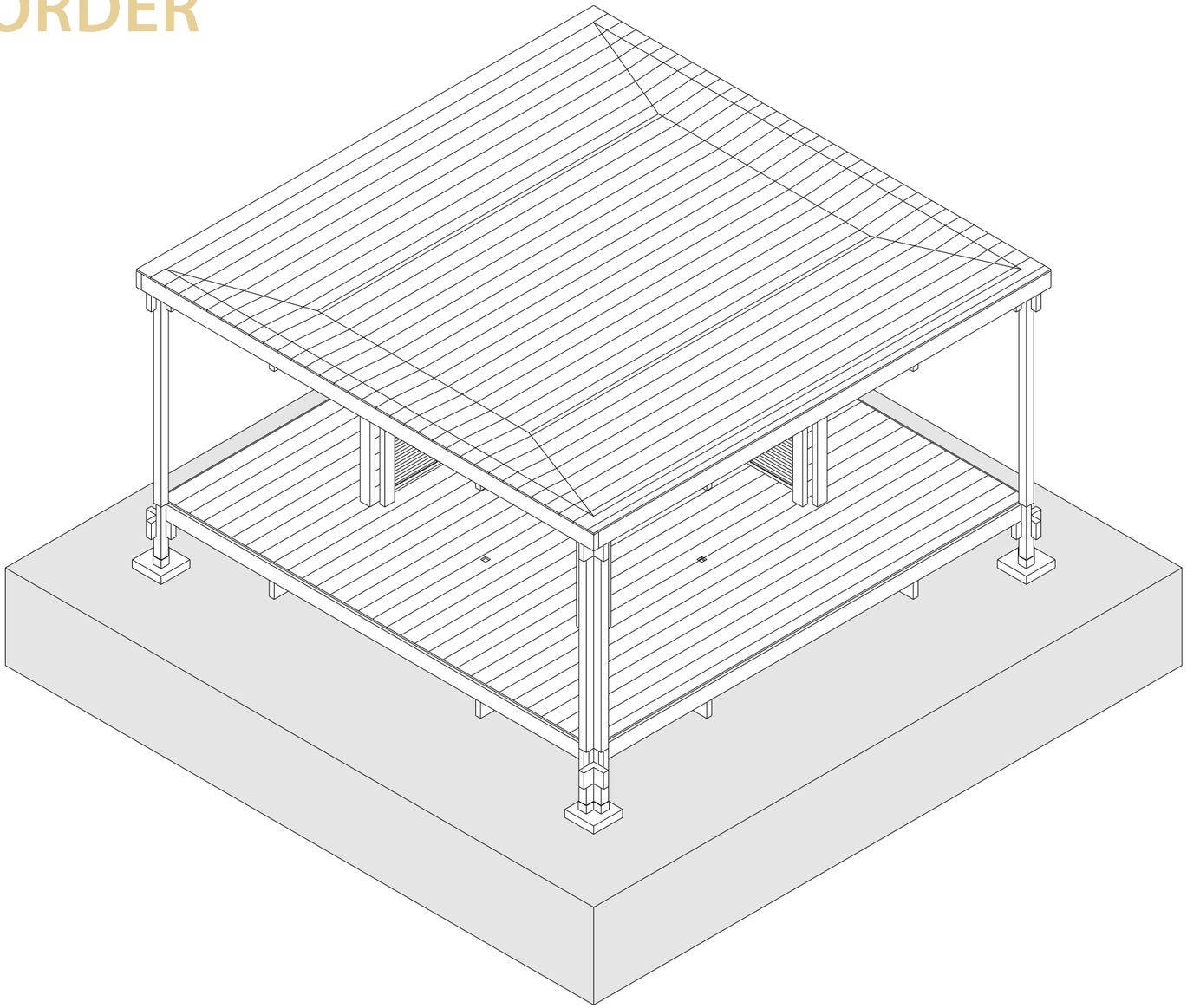
> ASSEMBLY ORDER

> STEP 14 - ROOF BEAMS



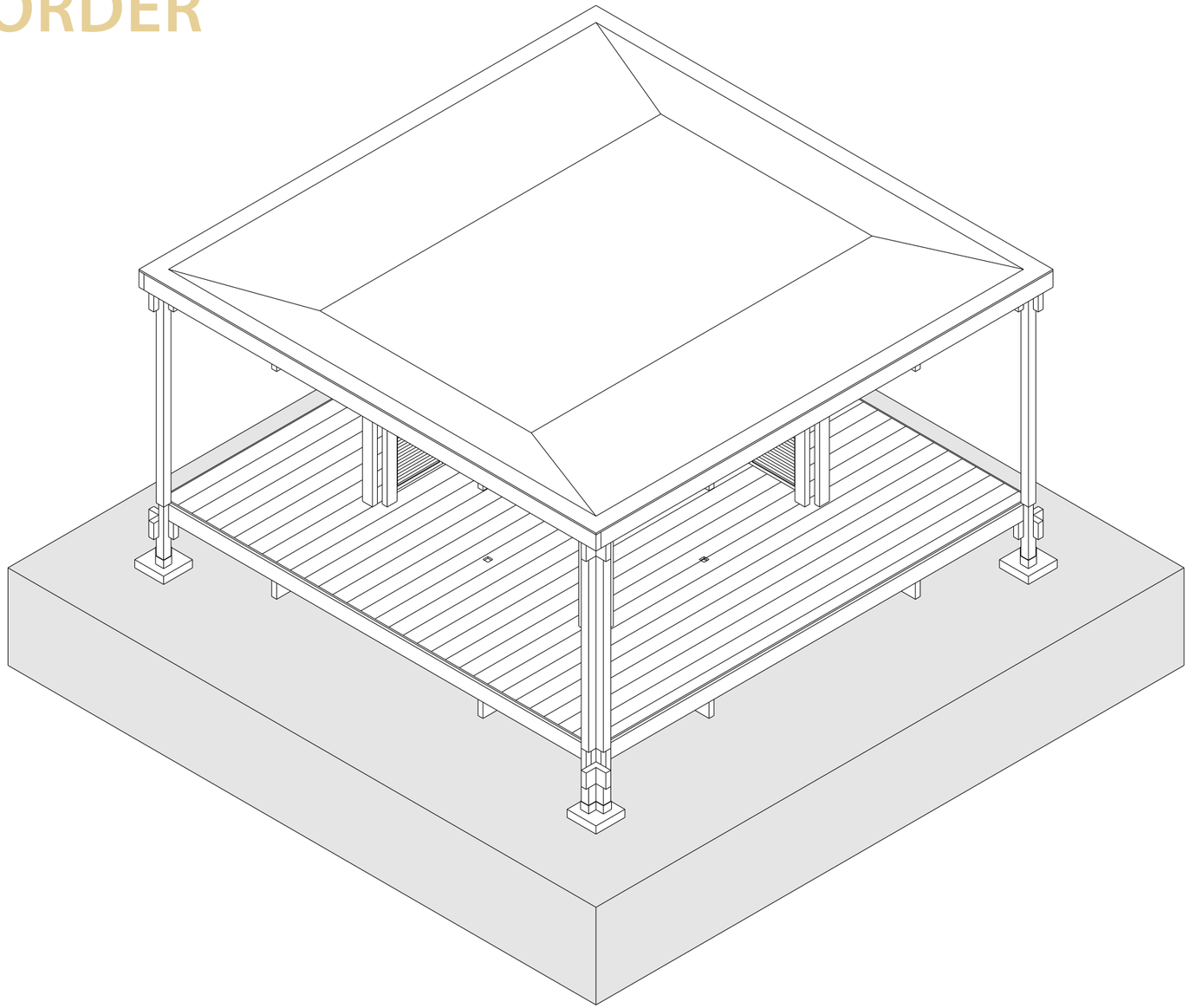
> ASSEMBLY ORDER

> STEP 15 - ROOF BOARDS



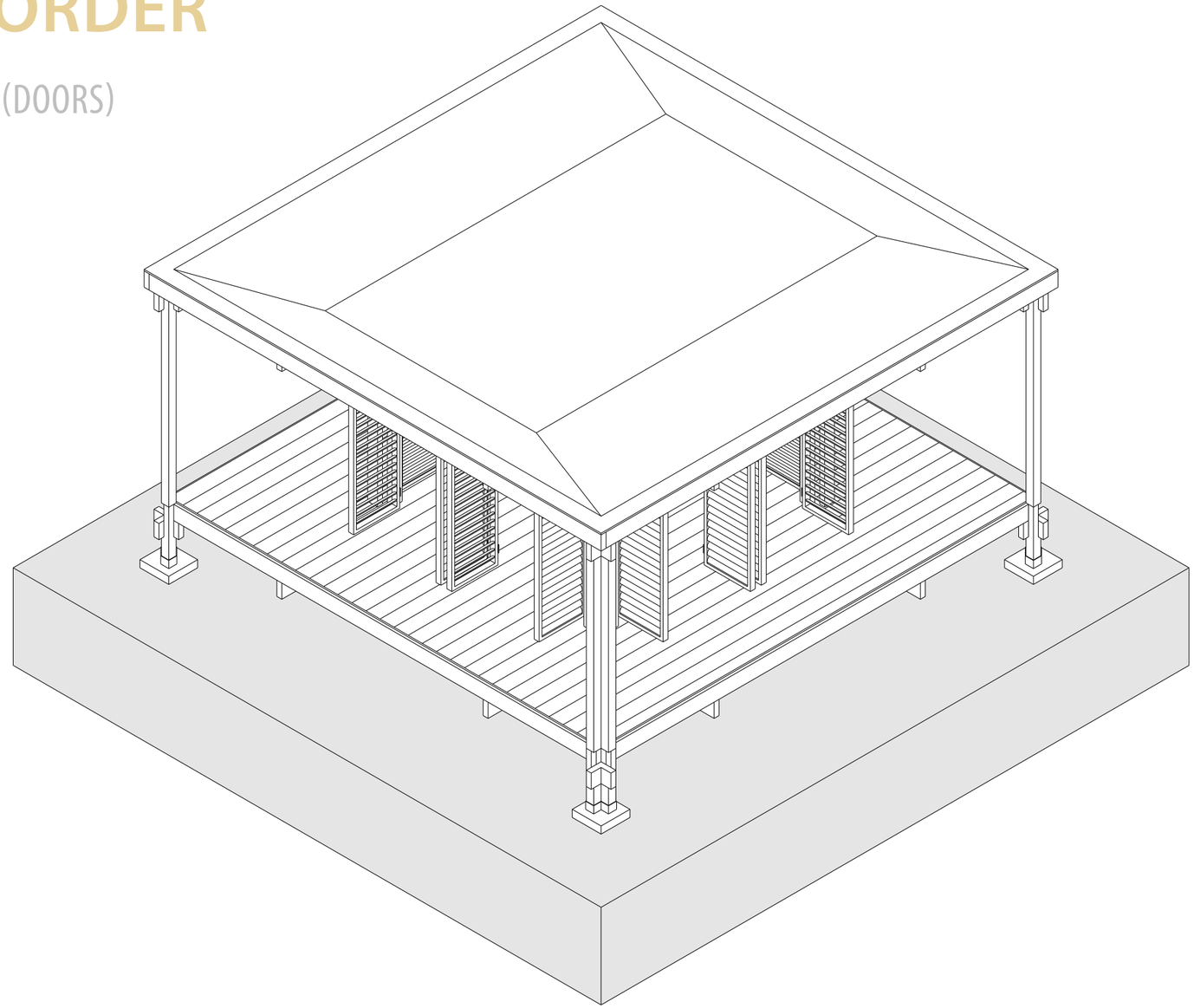
> ASSEMBLY ORDER

> STEP 16 - ROOF FOIL



> ASSEMBLY ORDER

> STEP 17 - WALL INFILLS (DOORS)



> DETAIL CORNER

FLOOR SLATS >
C.S. 20x200mm

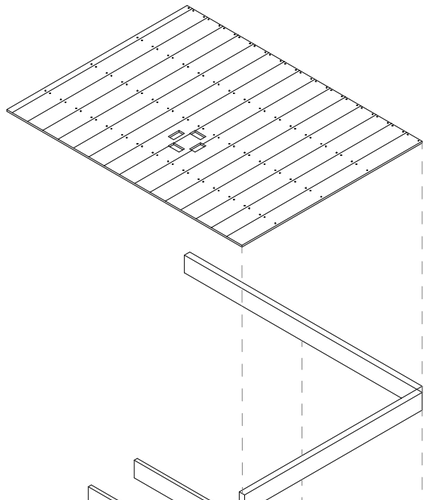
EDGE BEAMS >
C.S. 70x200mm

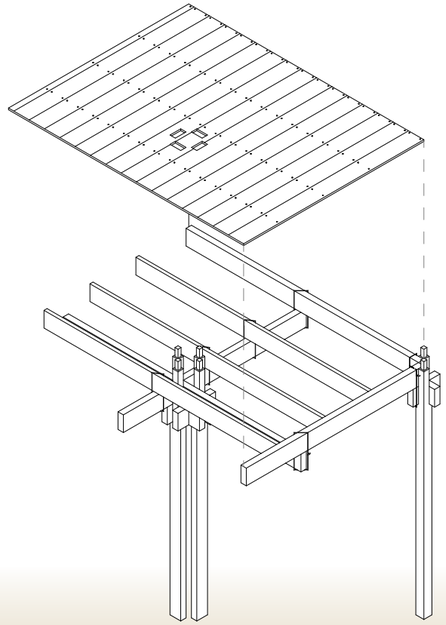
FLOOR BEAMS >
C.S. 40x200mm

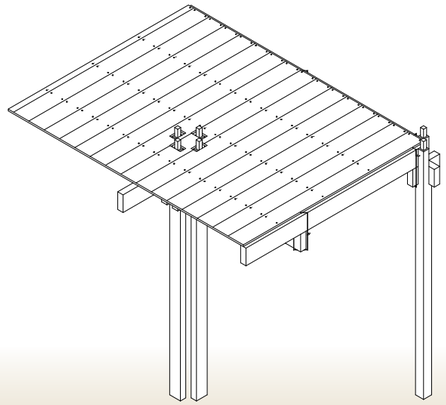
MAIN BEAMS >
LOAD BEARING STRUCTURE
C.S. 70x200mm

COMPOSITE KNOT >
D. 490x490x200mm

TAPERED COLUMNS >
C.S. 70x140mm > 70x70mm

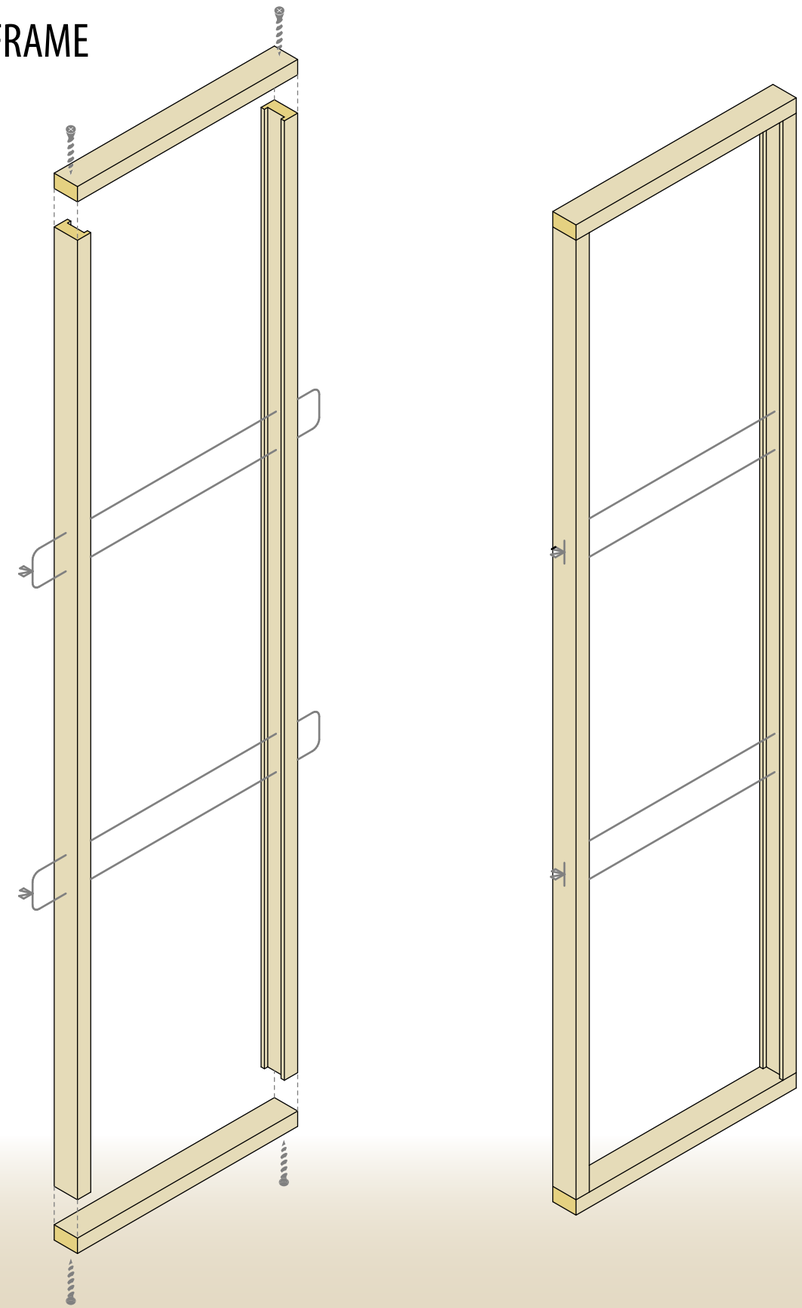






> WALL ELEMENTS

> FRAME



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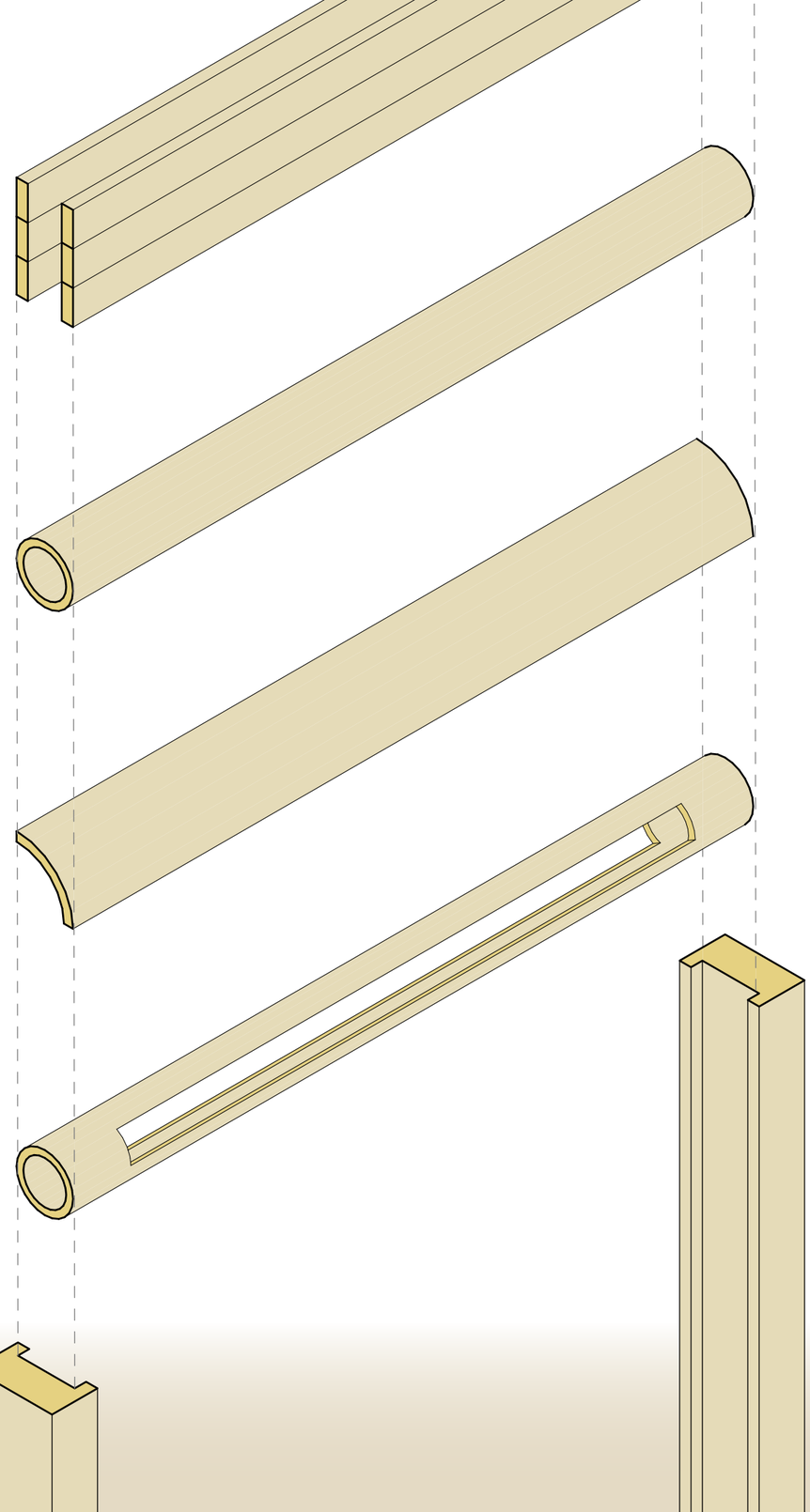
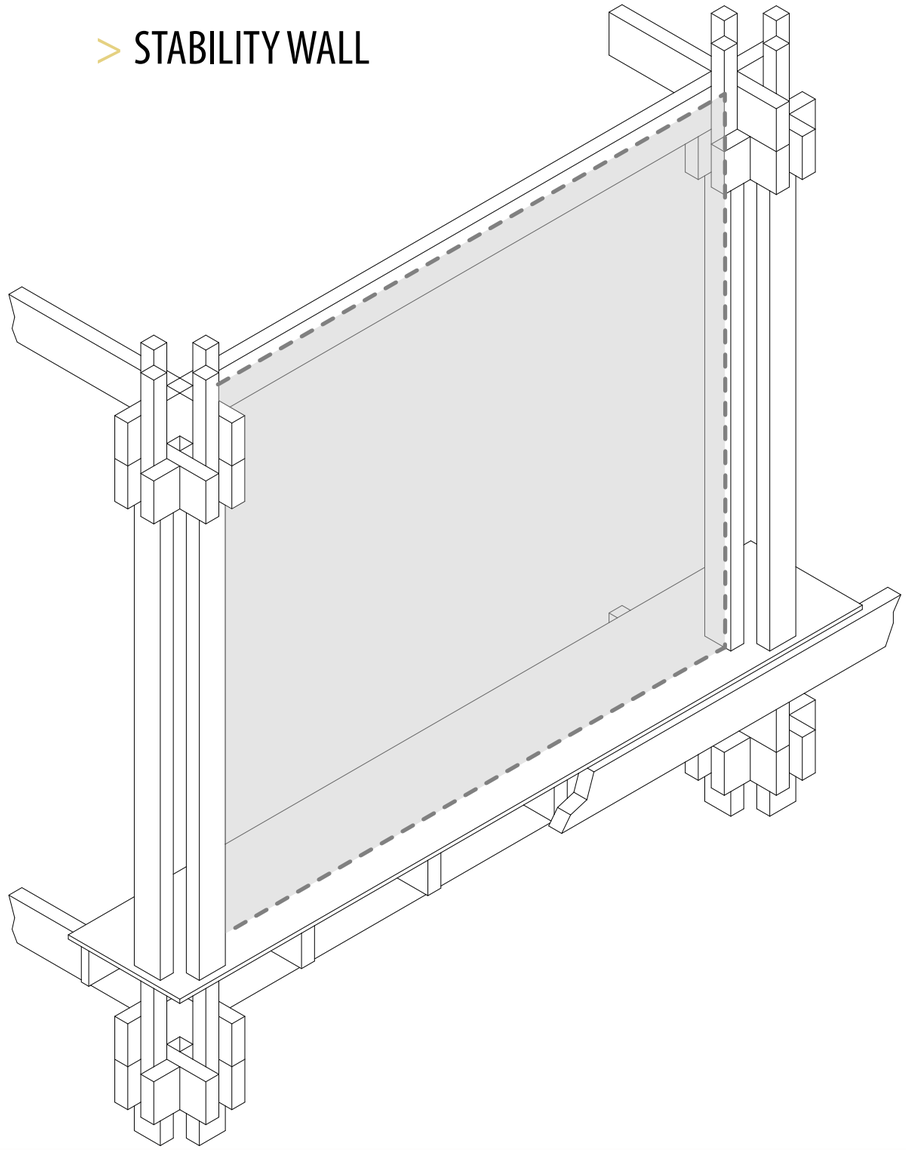
> INFILL

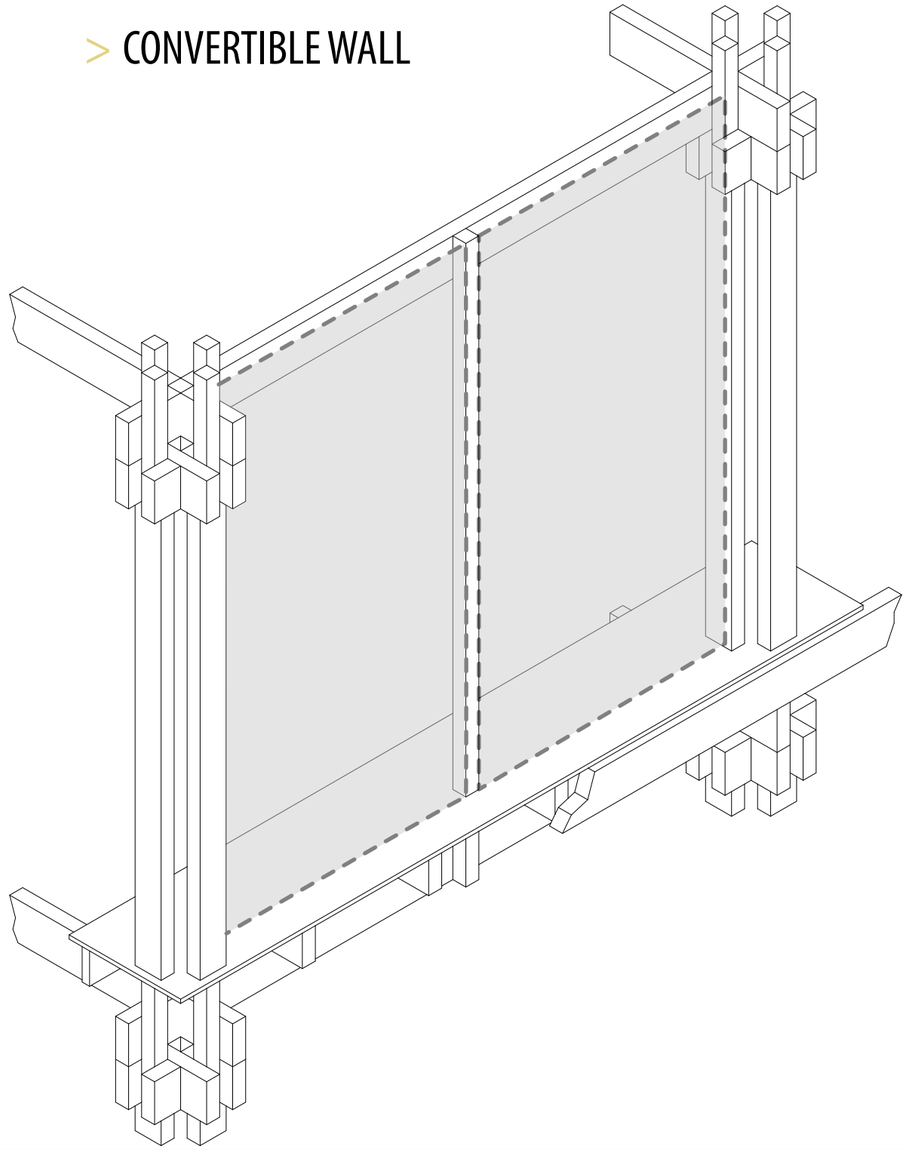


> WALL ELEMENTS

> STABILITY WALL

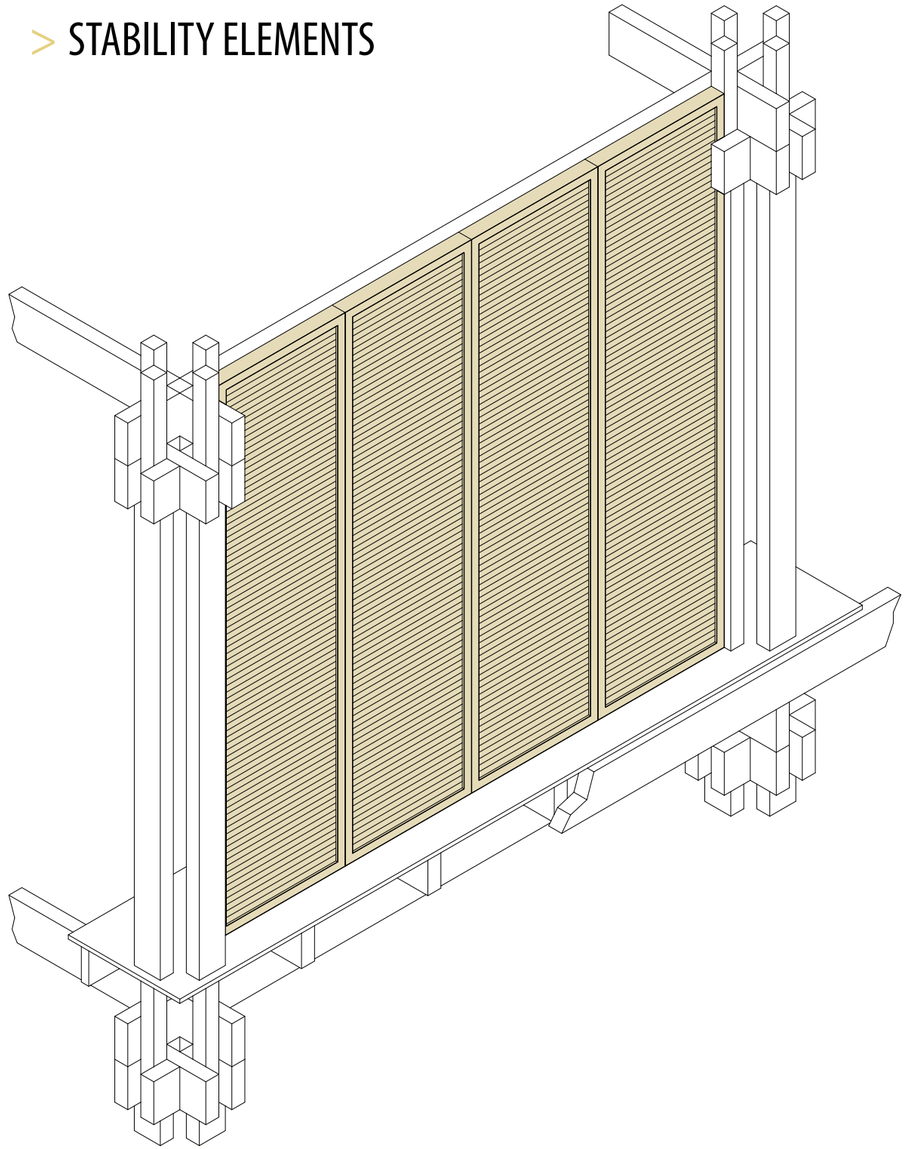


> CONVERTIBLE WALL



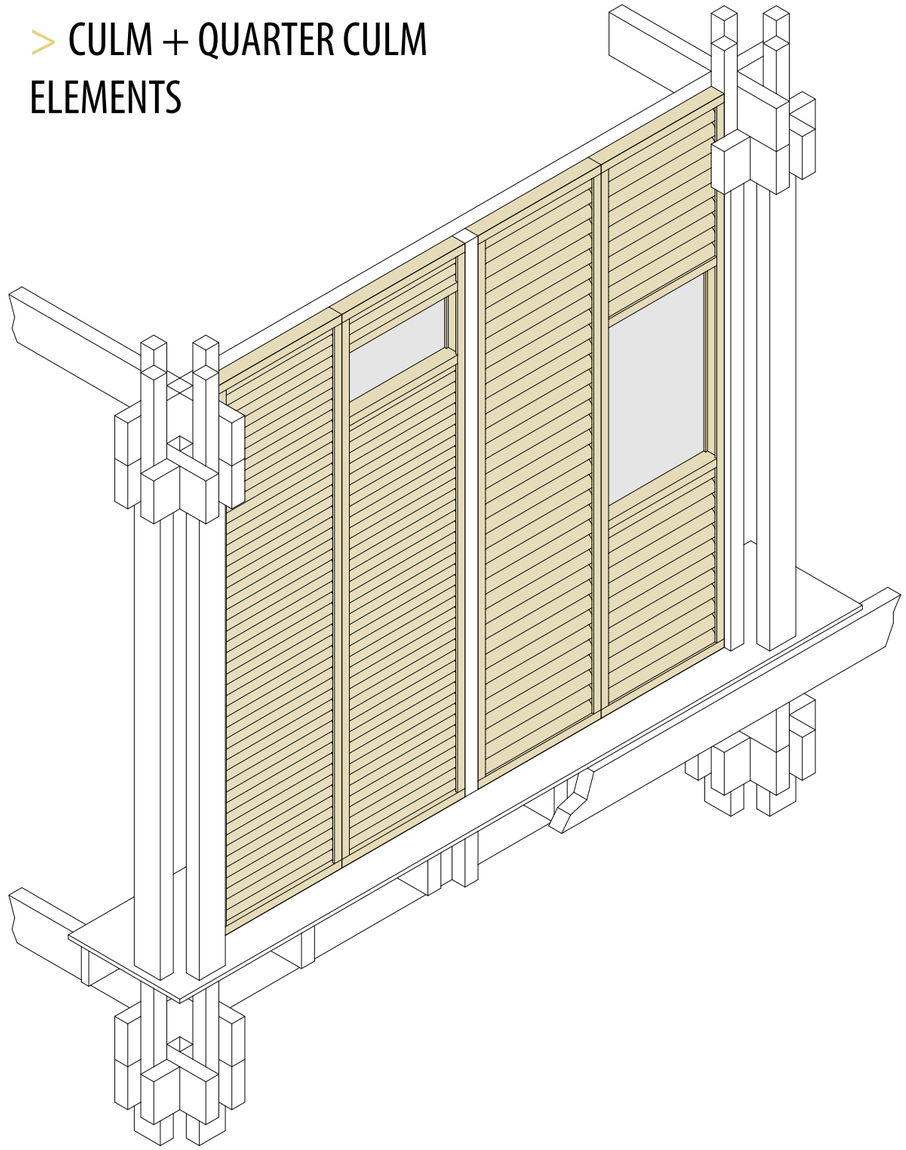
> WALL ELEMENTS

> STABILITY ELEMENTS

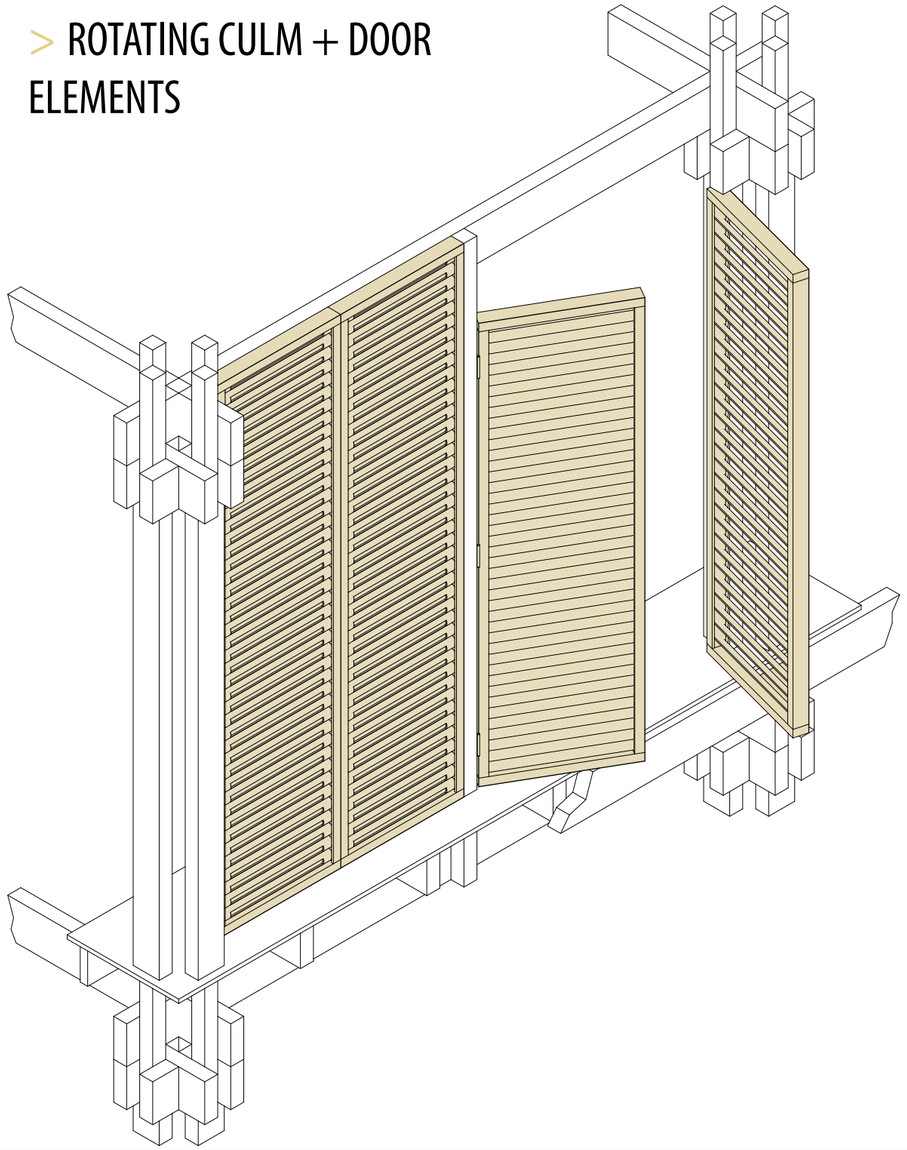


> WALL ELEMENTS

> CULM + QUARTER CULM ELEMENTS



> ROTATING CULM + DOOR ELEMENTS

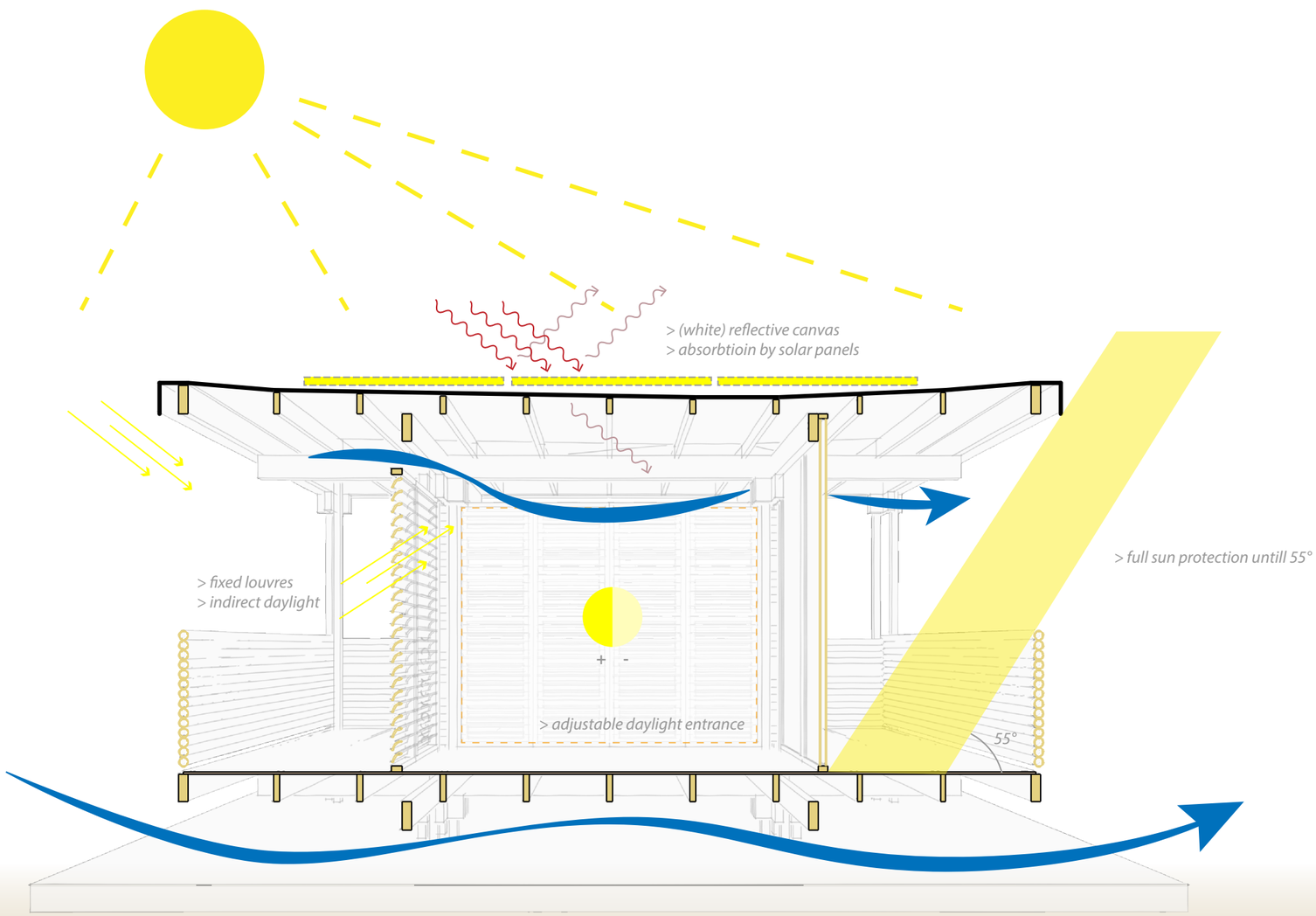


THE IDEAL SITUATION...

> CLIMATE PRINCIPLE

> IDEAL DIAGRAM

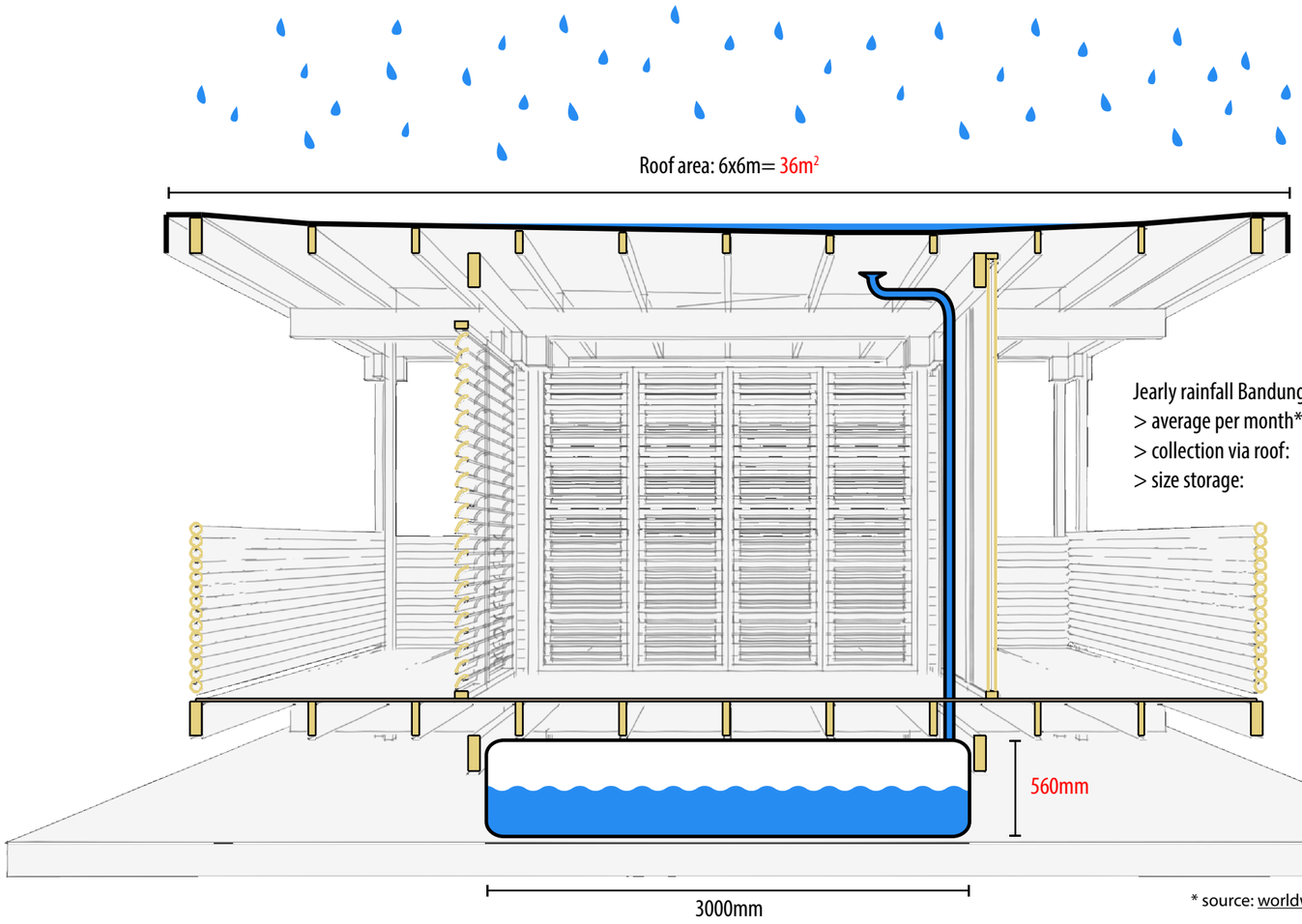
> LIKELY TO BE UNFEASIBLE IN KAMPUNG ENVIRONMENTS



> RAINWATER STORAGE

> MAKING USE OF LARGE ROOF AREA

> USE FOR: TOILET FLUSHING - LAND IRRIGATION - COOKING

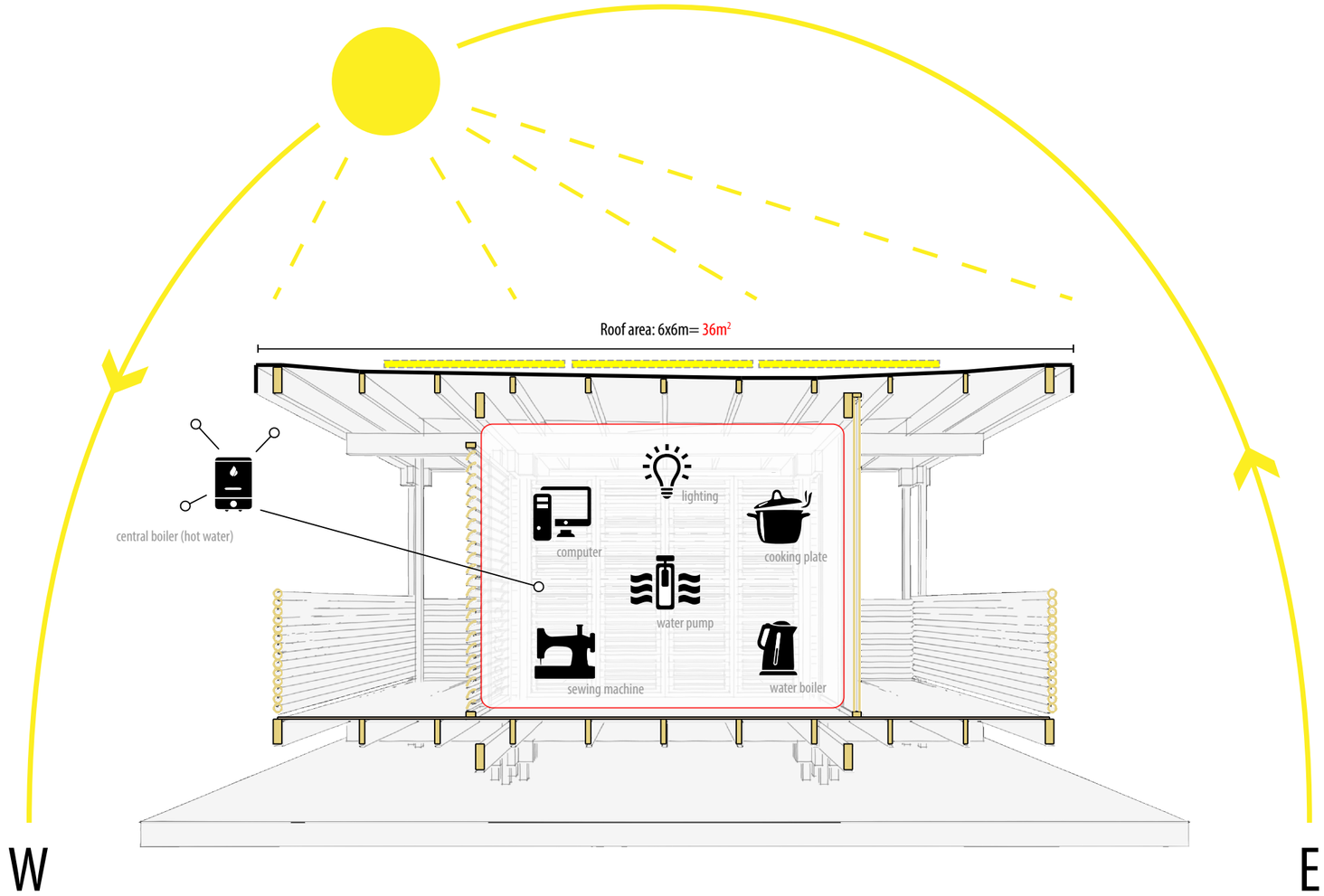


Jearly rainfall Bandung:	±1700L/m²
> average per month*:	1700/12= ±140L/m²
> collection via roof:	36*140= ±5000L
> size storage:	3x3x5/9= 3000x3000x560mm

* source: worldweatheronline.com

> ELECTRICITY USE

> SUFFICIENT FOR HOUSEHOLD USE



	Power*	Daily use**	Daily electricity use	Yearly electricity use
	1000W	1h	1kWh	365kWh
	1000W	½h	0,5kWh	183kWh
	5W	6h	0,03kWh	11kWh
	100W	1h	0,1kWh	37kWh
	100W	½h	0,05kWh	18kWh
	250W	1h	0,25kWh	91kWh
	1200W	½h	0,6kWh	219kWh
Total	3655W		2,53kWh	924kWh

** based on average product values*
*** estimated*

Energy supply by solar panels:

1m² = 120kWh yearly (average) ***

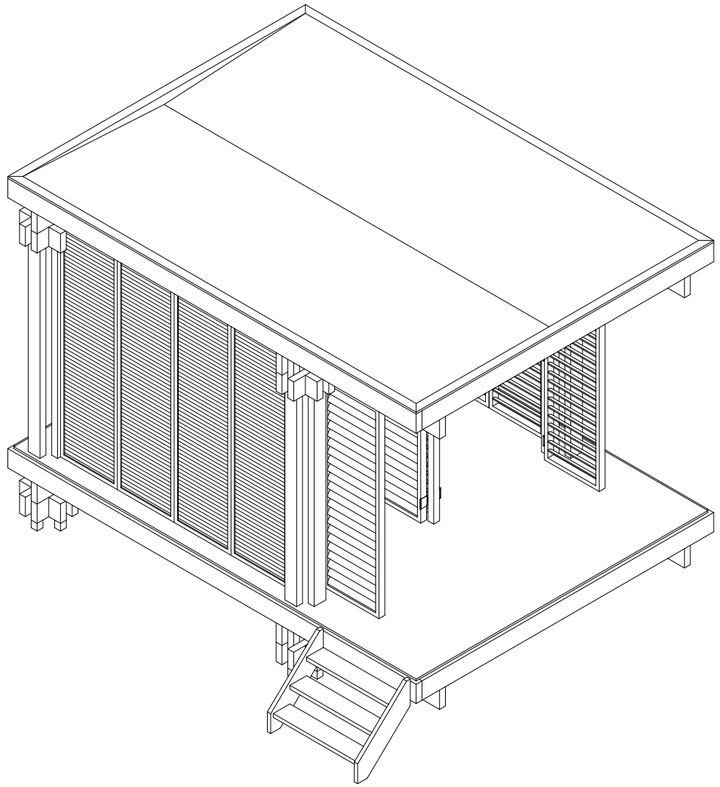
924kWh (yearly comsumption) / 120 = 7,7 > 8 panels > 8m²

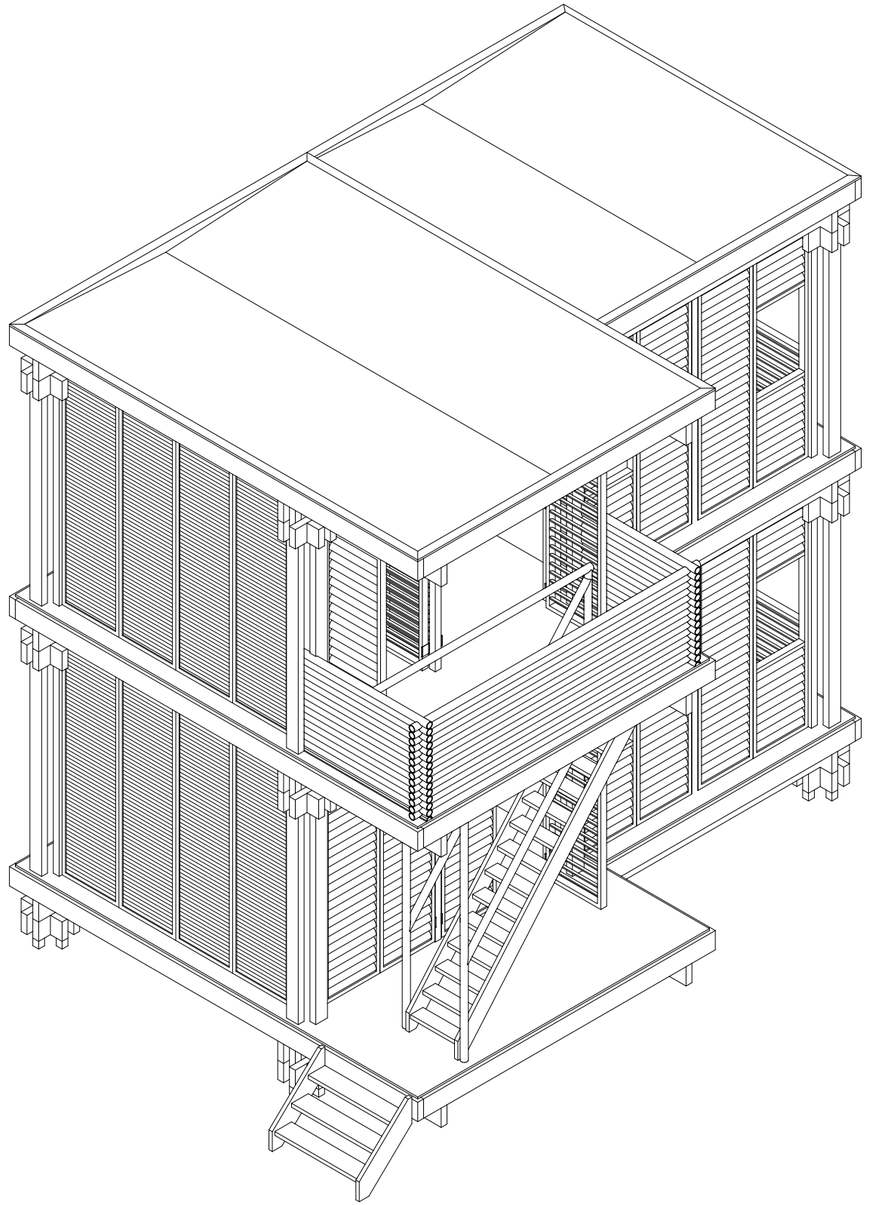
**** source: energieleveranciers.nl*

HOUSING VARIATIONS

> HOUSING TYPES

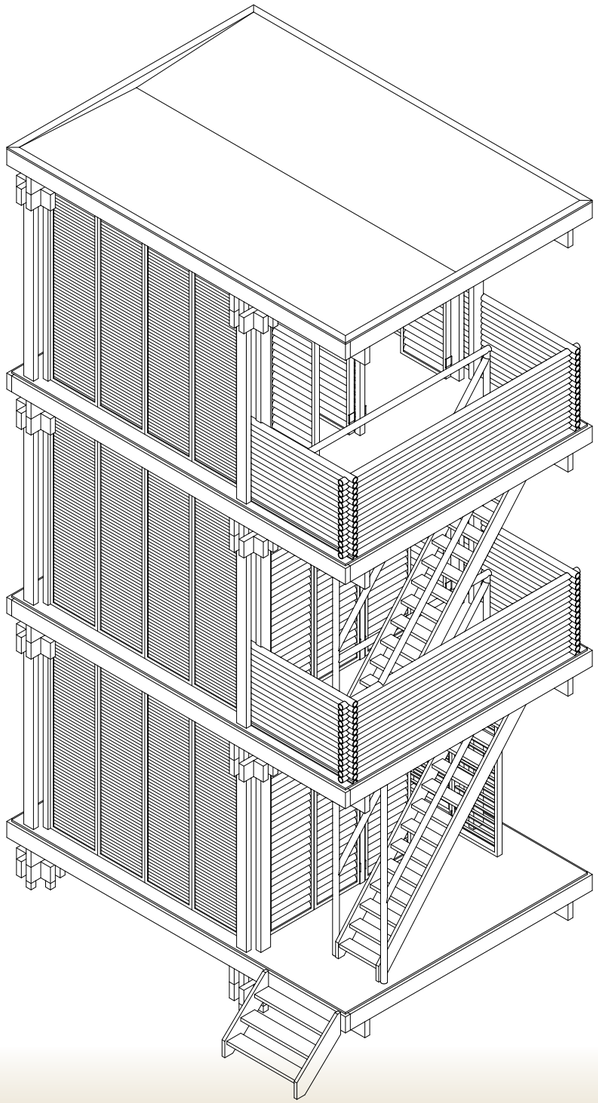
> SMALL FAMILY HOUSES

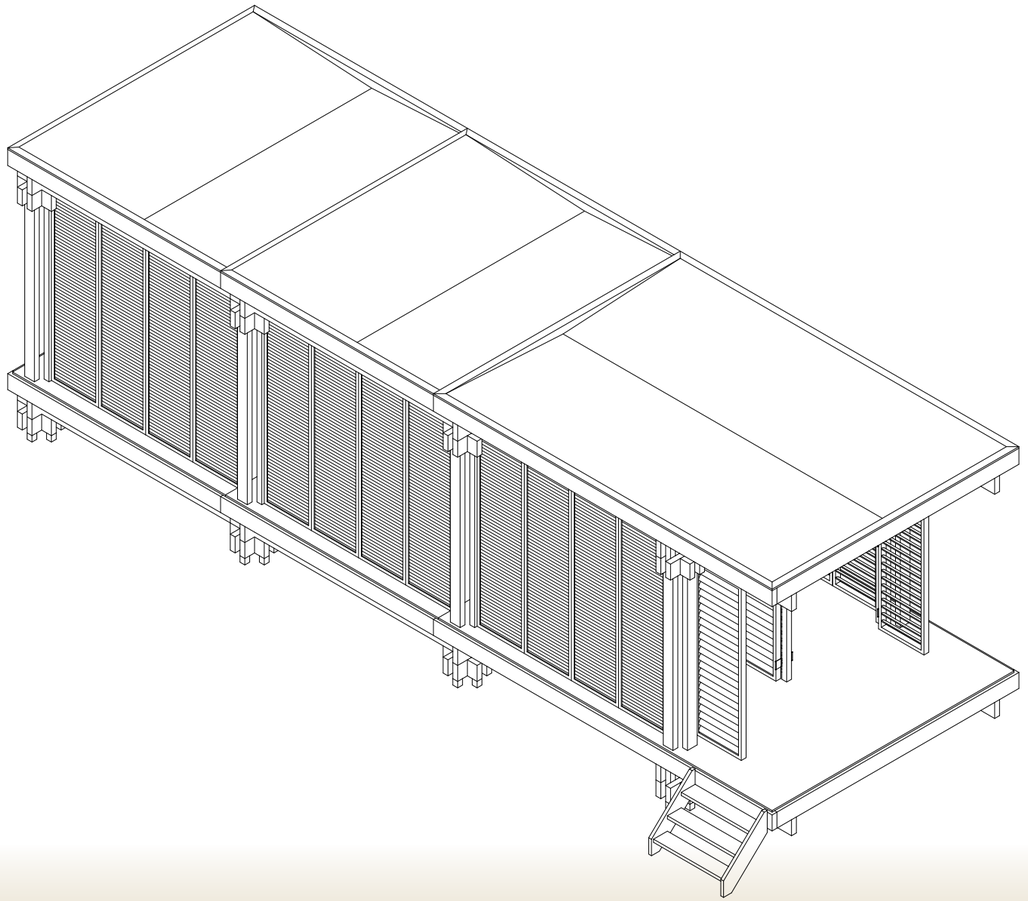




> HOUSING TYPES

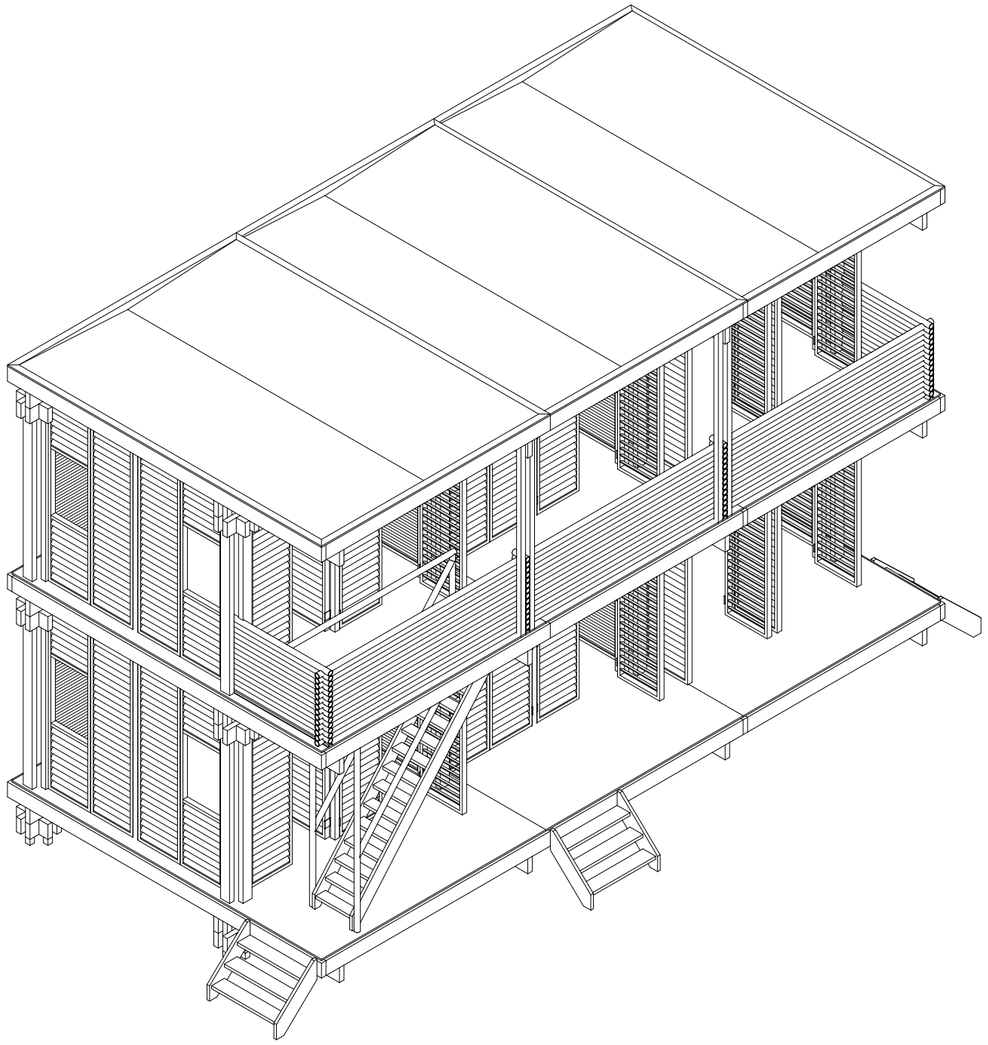
> HOME-SHOP HOUSES

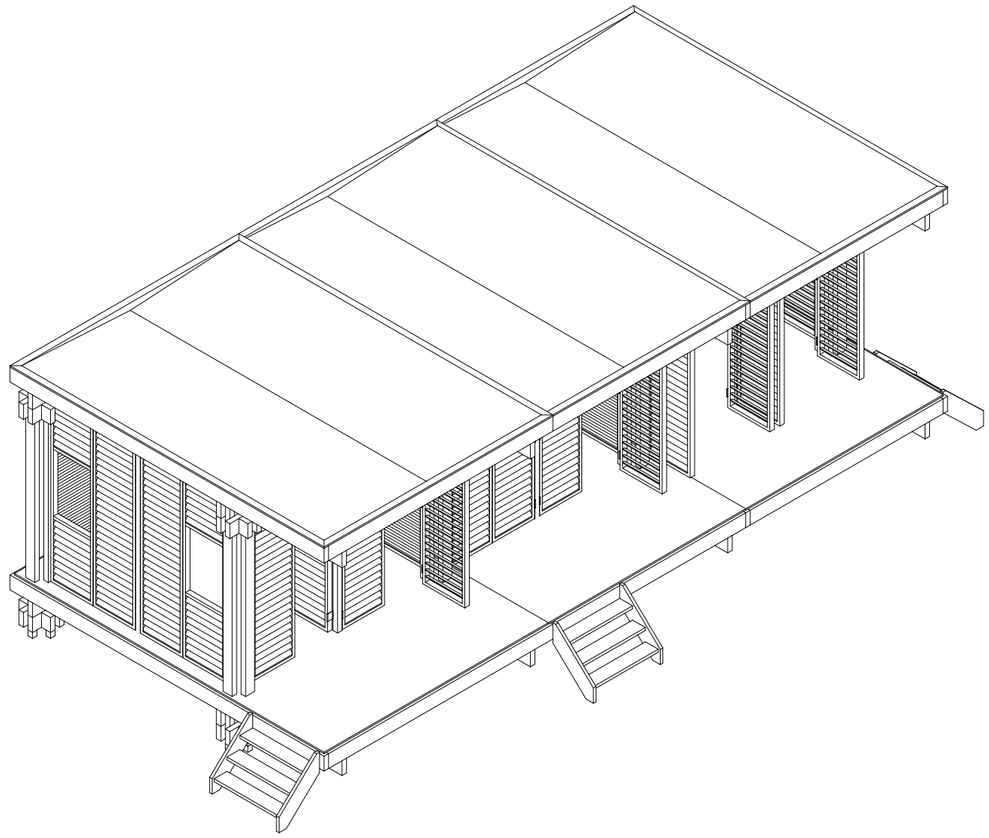




> HOUSING TYPES

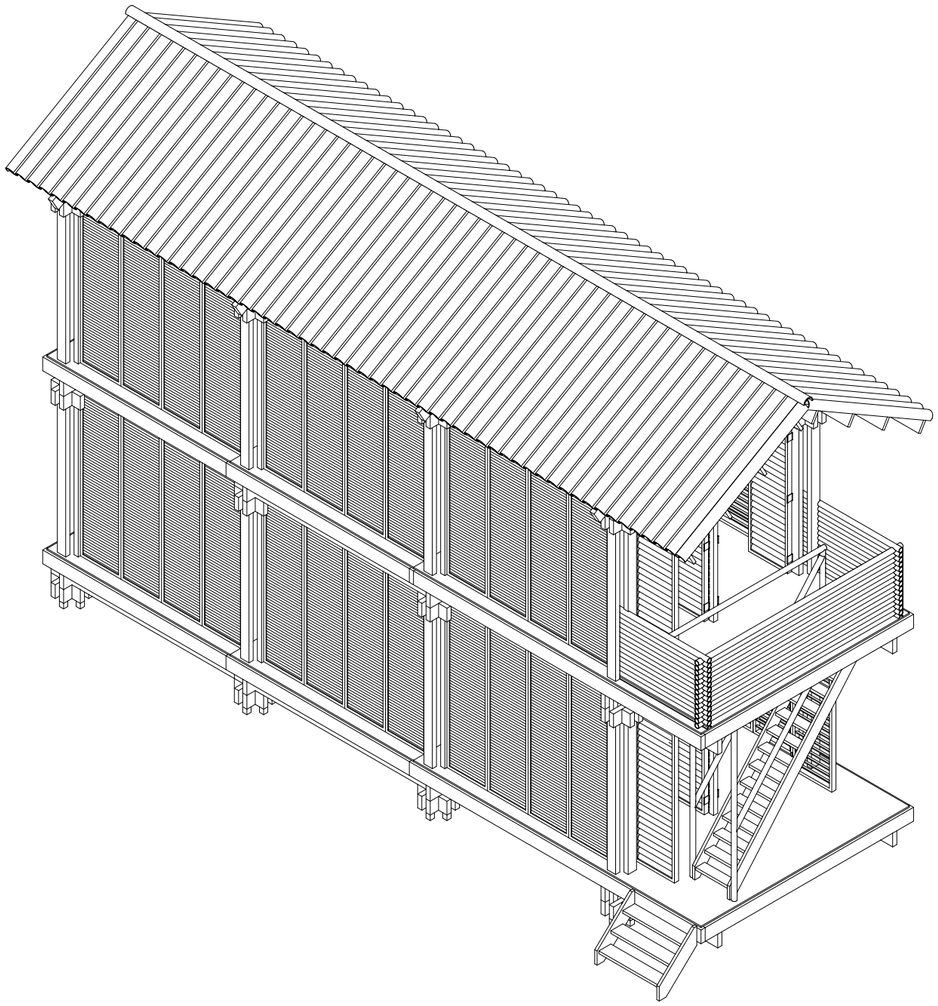
> MIGRANT WORKER HOUSES

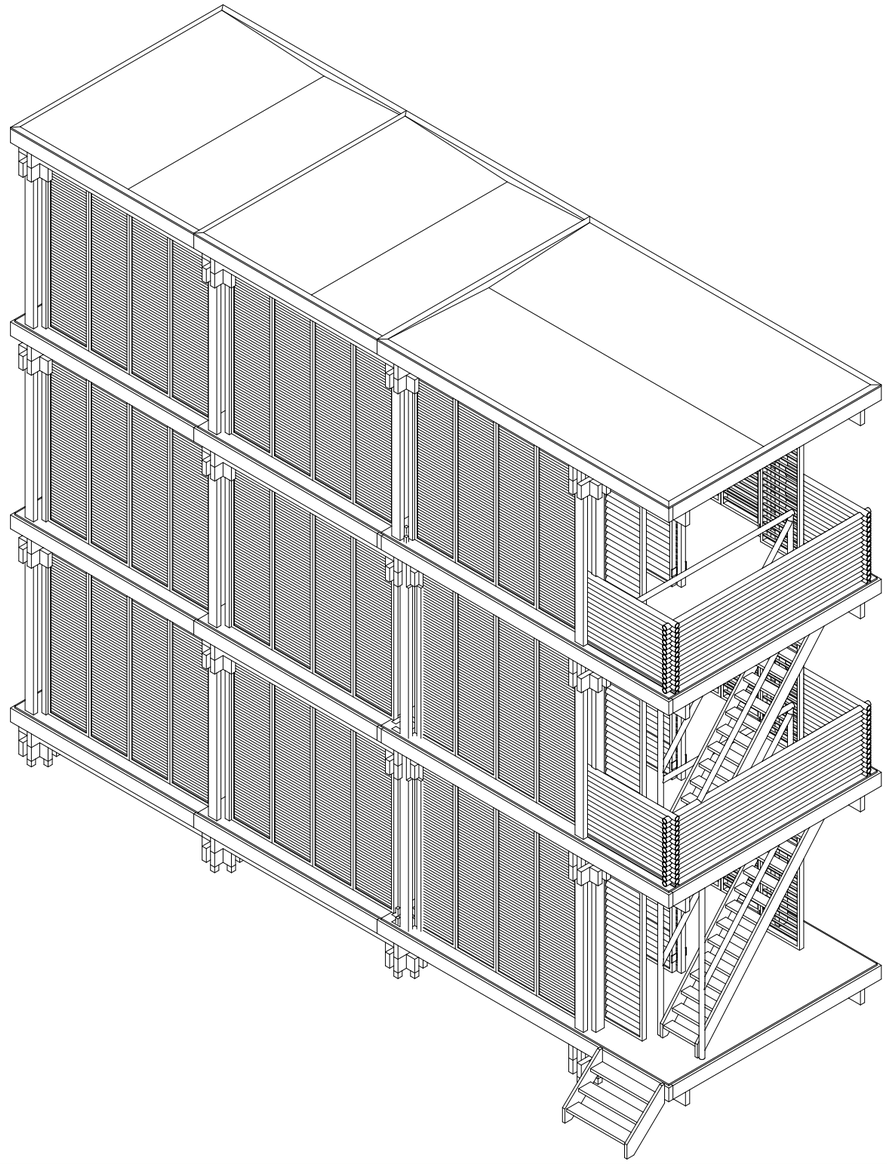




> HOUSING TYPES

> LARGE FAMILY HOUSES



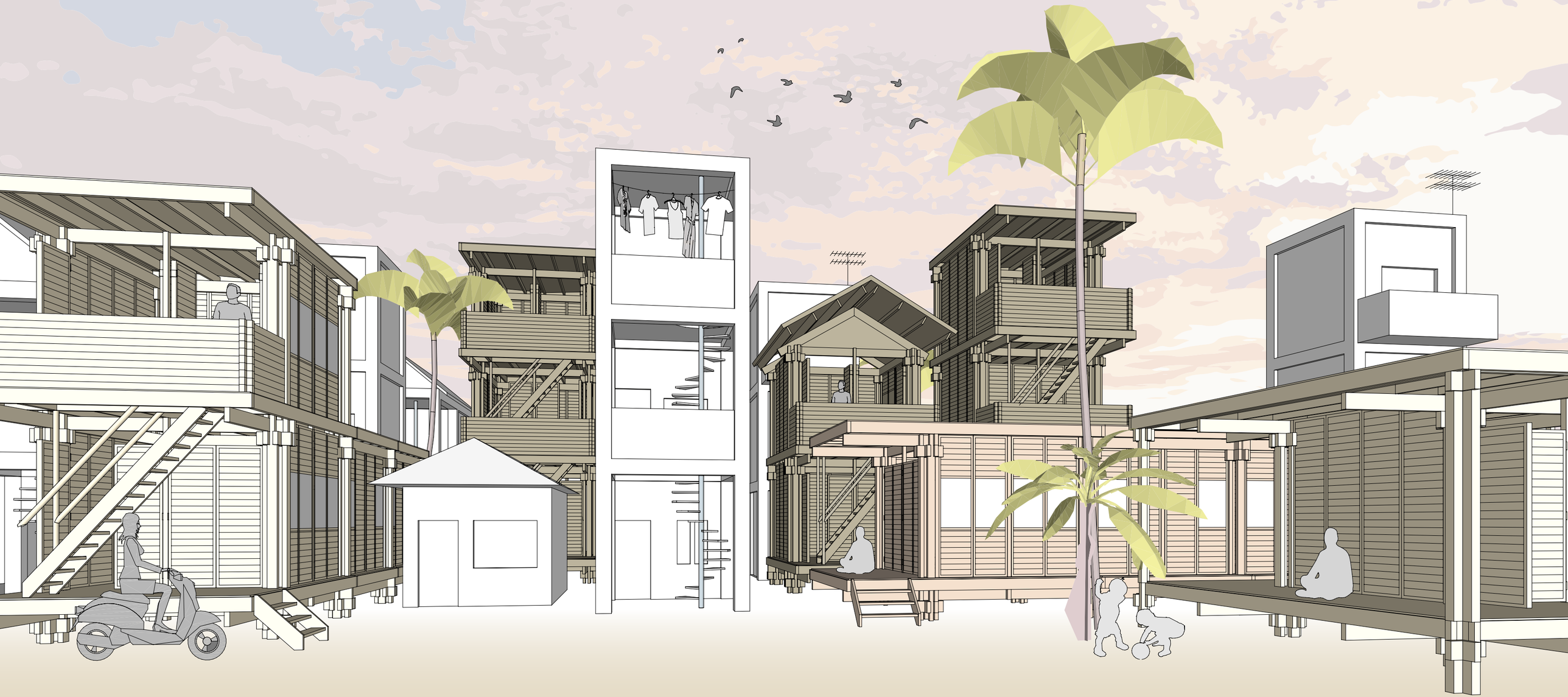


A GROWING KAMPUNG...

> PHASE 01

> PHASE 02

> PHASE 03



> PHASE 04

> PHASE 05

BAMBOO, THE BUILDING MATERIAL OF THE FUTURE!

THANKS FOR YOUR ATTENTION!