BAMBOO, THE BUILDING MATERIAL OF THE FUTURE!

COEN KAMPINGA

DELT, JANUARY 29TH, 2016
> CONTENT

> DEFINITION GRADUATION PROJECT
  > SCOPE
  > TECHNICAL RESEARCH
  > PROGRAMMATIC RESEARCH

> CONCEPT
  > COMMUNITY ENGAGEMENT
  > SUSTAINABLE KAMPUNG DEVELOPMENT

> GRADUATION PROCESS
  > P1 - P4
  > FIELD TRIP
  > PROTOTYPING

> RESEARCH RESULT

> DESIGN RESULT
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

| CONCEPT | GRADUATION PROCESS | RESEARCH RESULT | DESIGN RESULT |

- prefab housing elements
- local people
- material
- knowledge
- tools
- money
- skilled people
> 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
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.

BAKAR, E.S.

SURVEYS

TEXTUAL

VISUAL

VOCAL

PROTOTYPING

DEFINITION GRADUATION PROJECT | CONCEPT | GRADUATION PROCESS | RESEARCH RESULT | DESIGN RESULT
CONCEPT
COMMUNITY ENGAGEMENT

-知識
-工具
-有技能的人
-材料
-現成的住宅
-當地人
-資金

DEFINITION GRADUATION PROJECT | CONCEPT | GRADUATION PROCESS | RESEARCH RESULT | DESIGN RESULT
GRADUATION PROCESS
BAMBOO, THE BUILDING MATERIAL OF THE FUTURE!

An experimental research on glueless lamination of bamboo in order to develop a building system for kampung housing.

COEN KAMPINGA

DELFT, DECEMBER 4TH, 2015
RESEARCH RESULT
> CULM TO STRIP

> BAMBOO SPLITTING (KNIVES)

> THICKNESS PLANER

DEFINITION GRADUATION PROJECT | CONCEPT | GRADUATION PROCESS | RESEARCH RESULT | DESIGN RESULT
> STRIP TO PIN

> RADIAL STRIP
> FLATTENED STRIP
> CUT TO SIZE
> RECTANGULAR PINS
> SWALLOWTAIL PINS

- BY THICKNESS PLANER
- BY CIRCULAR SAW
- BY MILLING OR 4 SIDE SHAVING
STRIP TO PIN
> STRIP TO PIN
> STRIPS TO BEAM

1. STACKING STRIPS

2. HORIZONTAL & VERTICAL CLAMPING

3. SWALLOWTAIL DRILLING
   > NOTICE HORIZONTAL CLAMPS REMOVED

4. DECLAMPING RESULT

5. CUTTING TO SIZE

5. RESULT
> 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
9. STACKING ON PALLET
> DISTRIBUTION
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 IMPOSITIONS
> 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

> MAIN STRUCTURE IN 1 PLANE
> THE BUILDING SYSTEM

> 2 PRINCIPAL TYPES

> BASIC UNIT

> BALCONY UNIT
INNER KNOT / CONSOLE

COLUMNS ROOF
TAPERED FOR IMPOSITION KNOT

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

OUTER KNOT / CONSOLE

COLUMNS RAISED FLOOR
TAPERED FOR IMPOSITION KNOT

FOUNDATIONS
CONCRETE BASE

CONSTRUCTION
DEFINITION GRADUATION PROJECT | CONCEPT | GRADUATION PROCESS | RESEARCH RESULT | DESIGN RESULT
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

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

COMPOSITE KNOT >
D. 490x90x200mm

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

FLOOR BEAMS >
C.S. 40x200mm

EDGE BEAMS >
C.S. 70x200mm

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. 490x90x200mm

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

FRAME

INFILL
> WALL ELEMENTS

> STABILITY WALL

> CONVERTIBLE WALL
> 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

Roof area: $6x6m = 36m^2$

Yearly rainfall Bandung: $\pm 1700L/m^2$

Average per month*: $1700/12 = \pm 140L/m^2$

Collection via roof: $36 \times 140 = \pm 5000L$

Size storage: $3x3x5/9 = 3000 \times 3000 \times 560mm$

* source: worldweatheronline.com
### Electricity Use

**Sufficient for Household Use**

<table>
<thead>
<tr>
<th>Power</th>
<th>Daily use**</th>
<th>Daily electricity use</th>
<th>Yearly electricity use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000W</td>
<td>1h</td>
<td>1kW</td>
<td>360kWh</td>
</tr>
<tr>
<td>1000W</td>
<td>1½h</td>
<td>0,5kW</td>
<td>180kWh</td>
</tr>
<tr>
<td>5W</td>
<td>6h</td>
<td>30W</td>
<td>111kWh</td>
</tr>
<tr>
<td>180W</td>
<td>1½h</td>
<td>0,1kW</td>
<td>37kWh</td>
</tr>
<tr>
<td>180W</td>
<td>1½h</td>
<td>0,1kW</td>
<td>37kWh</td>
</tr>
<tr>
<td>180W</td>
<td>1½h</td>
<td>0,1kW</td>
<td>37kWh</td>
</tr>
<tr>
<td>250W</td>
<td>1½h</td>
<td>0,2kW</td>
<td>91kWh</td>
</tr>
<tr>
<td>1200W</td>
<td>1½h</td>
<td>0,6kW</td>
<td>219kWh</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3655W</strong></td>
<td><strong>2,53kWh</strong></td>
<td><strong>924kWh</strong></td>
</tr>
</tbody>
</table>

*Based on average product value

**Estimated**

Energy supply by solar panels:

1m² = 120kWh yearly (average)***

924kWh (yearly consumption) / 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...
BAMBOO, THE BUILDING MATERIAL OF THE FUTURE!

THANKS FOR YOUR ATTENTION!