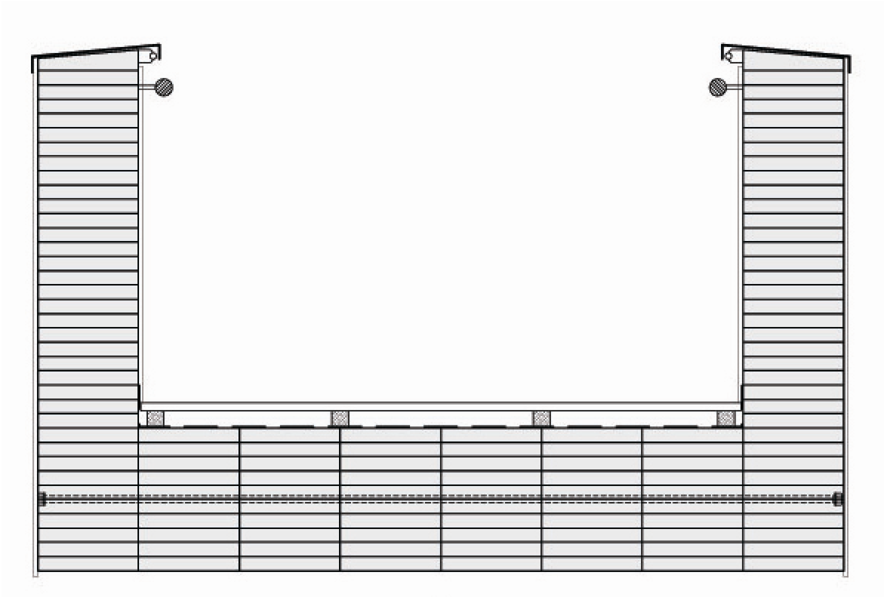
Timber Constructions

Prof. Yves Weinand

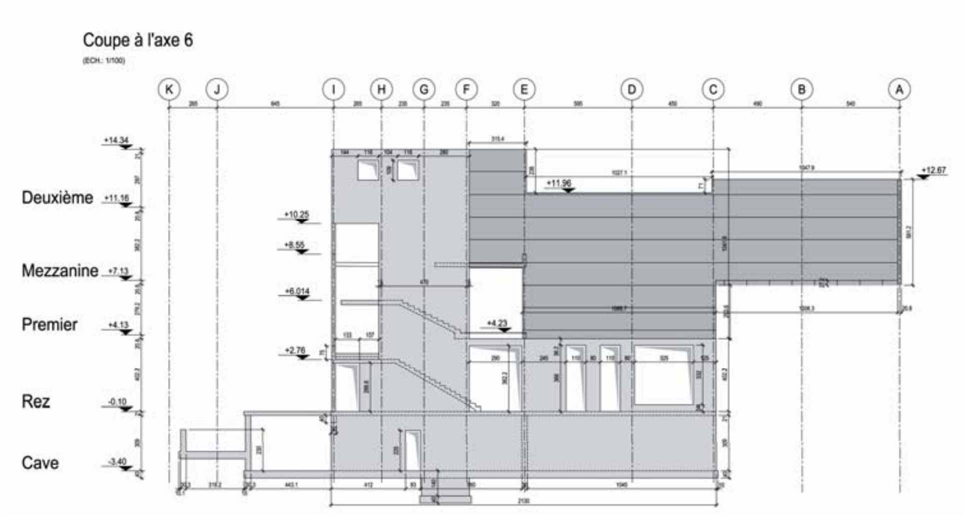
IBOIS

EPFL
ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

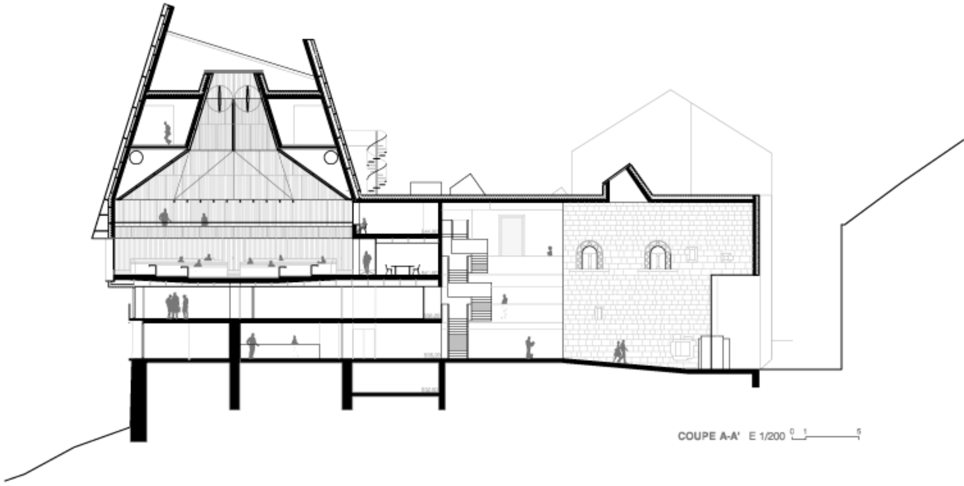
2007 Pont pédestre sur l'Our,
Burg Reuland
Maître d'ouvrage : Commune de Burg-Reuland
Architecte: association momentanée
Michaelis-Weinand, Espeler
Ingénieur: bureau d'études Weinand



L'architecture de l'extension du musée de la photographie à Charleroi est un exemple d'application innovante d'architecture et d'application du matériau bois. Des panneaux en bois massif et contrecollés sont mis en oeuvre pour réaliser un étage en porte-à-faux. Sur le plan économique la variante bois bat la variante en béton initialement prévu. Il s'agit d'une approche interdisciplinaire qui lie les réflexions d'espace à celle relatives à la structure du bâtiment.



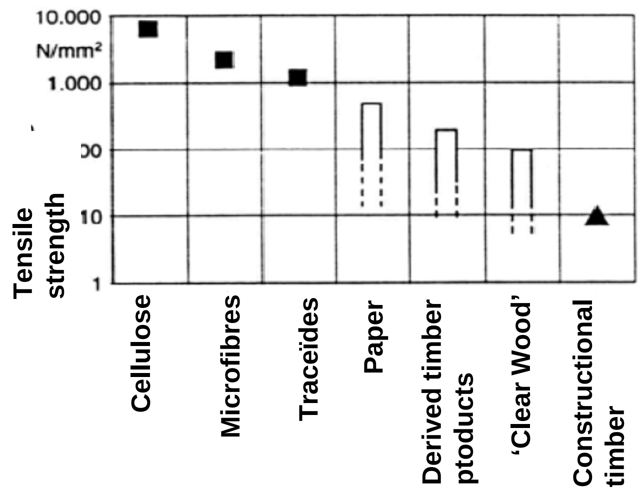
2009, Parlement
Maître d'ouvrage : Canton de Vaud
Architecte: Atelier Cube / Bonell & Gil
Ingénieur: Bureau d’Etudes Weinand

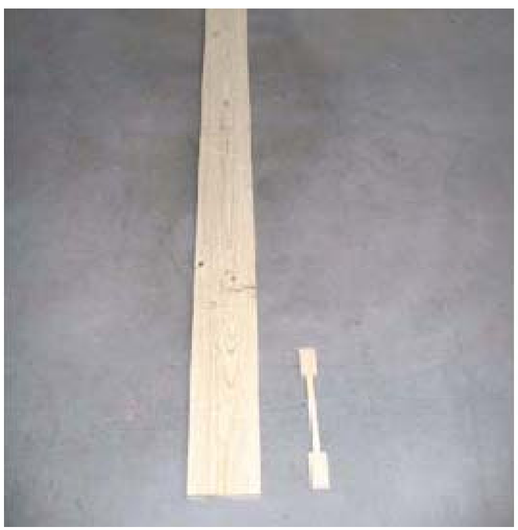


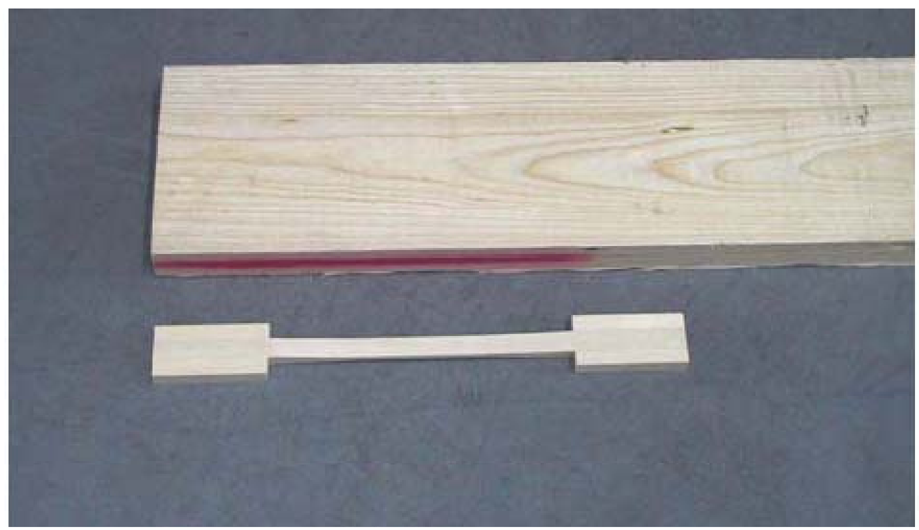
Caracteristic values of spruce
[P. Niemz, 1993 and P. Glos, 1981)

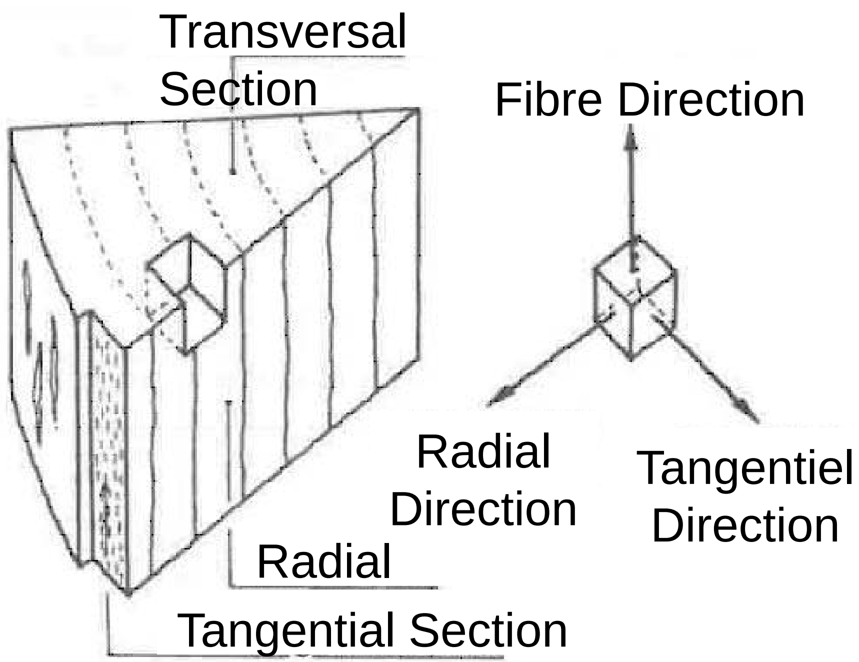
Characteristic properties	Small Specimen	Constructional Element	Difference to the small specimen
Bending Strength (mean value [N/mm2])	68	37	46%
Tensile Strength parallel to fibers (mean value [N/mm2])	80	30	63%
Compression Strength parallel to fibers (mean value [N/mm2])	40	32	20%

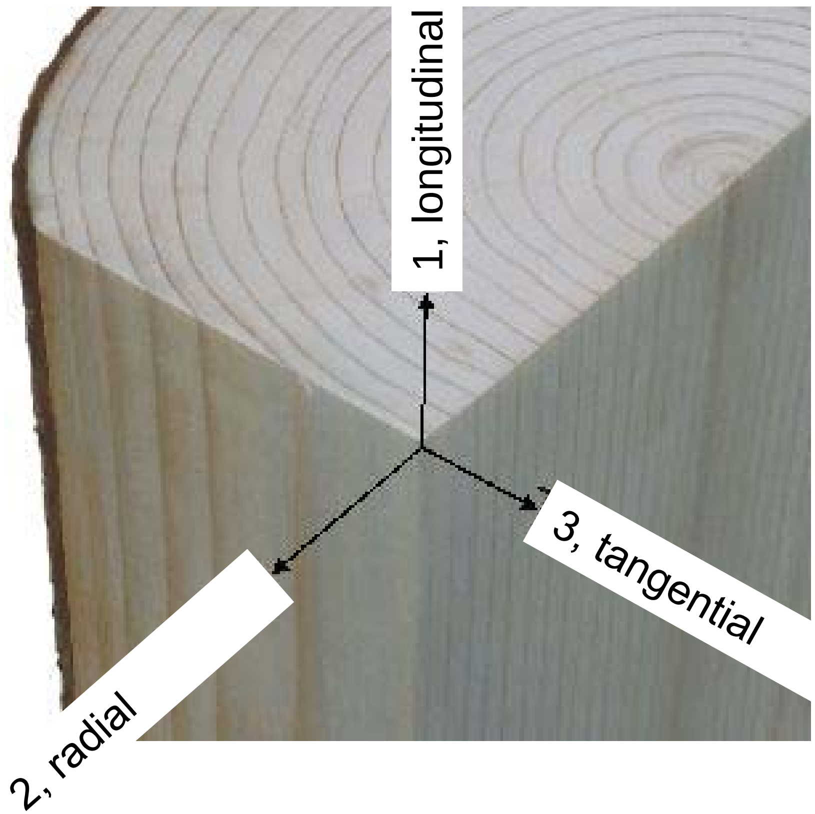
Mecanical Properties [Glos 1999]





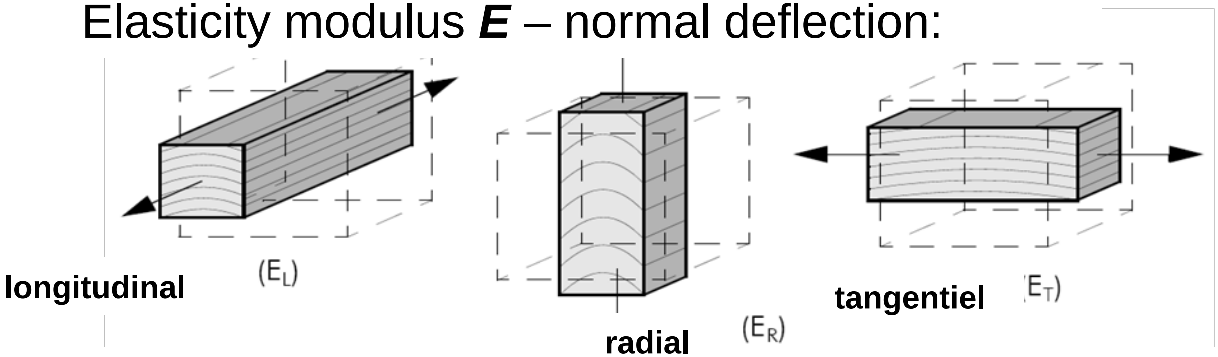




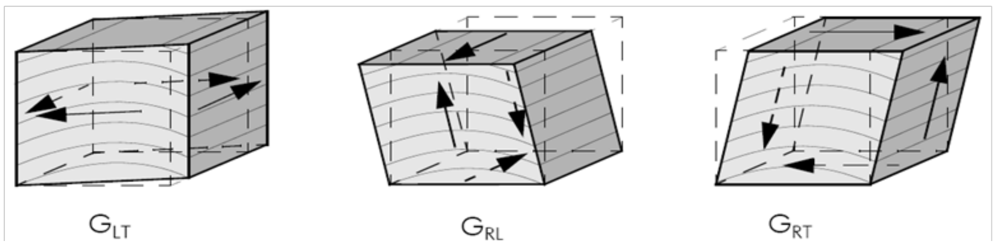


Definition of the circular orthotropic coordinate system [Schickhofer 2005]

Elasticity modulus *E* – normal deflection:



Shear modulus *G* – shear deflection:



Elasticity Modulus ***E*** (in **T**angential, **L**ongitudinal and **R**adial direction)

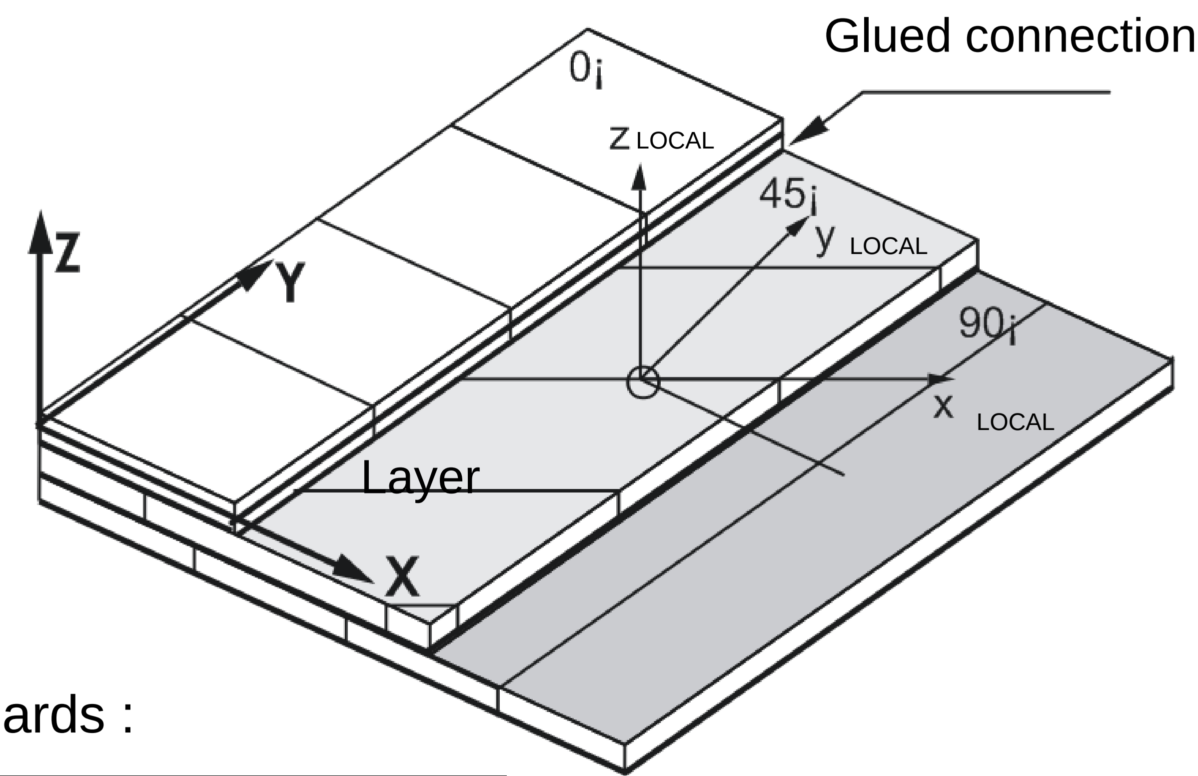
$$E_T \div E_R \div E_l = 1 \div 1,7 \div 20$$ (Soft Wood)

$$E_T \div E_R \div E_L = 1 \div 1,7 \div 13$$ (Hard Wood)

Shear Modulus ***G*** (in **T**angential, **L**ongitudinal and **R**adial

$$G_{LR} \div G_{LT} = 1 \div 1$$ (Soft Wood)

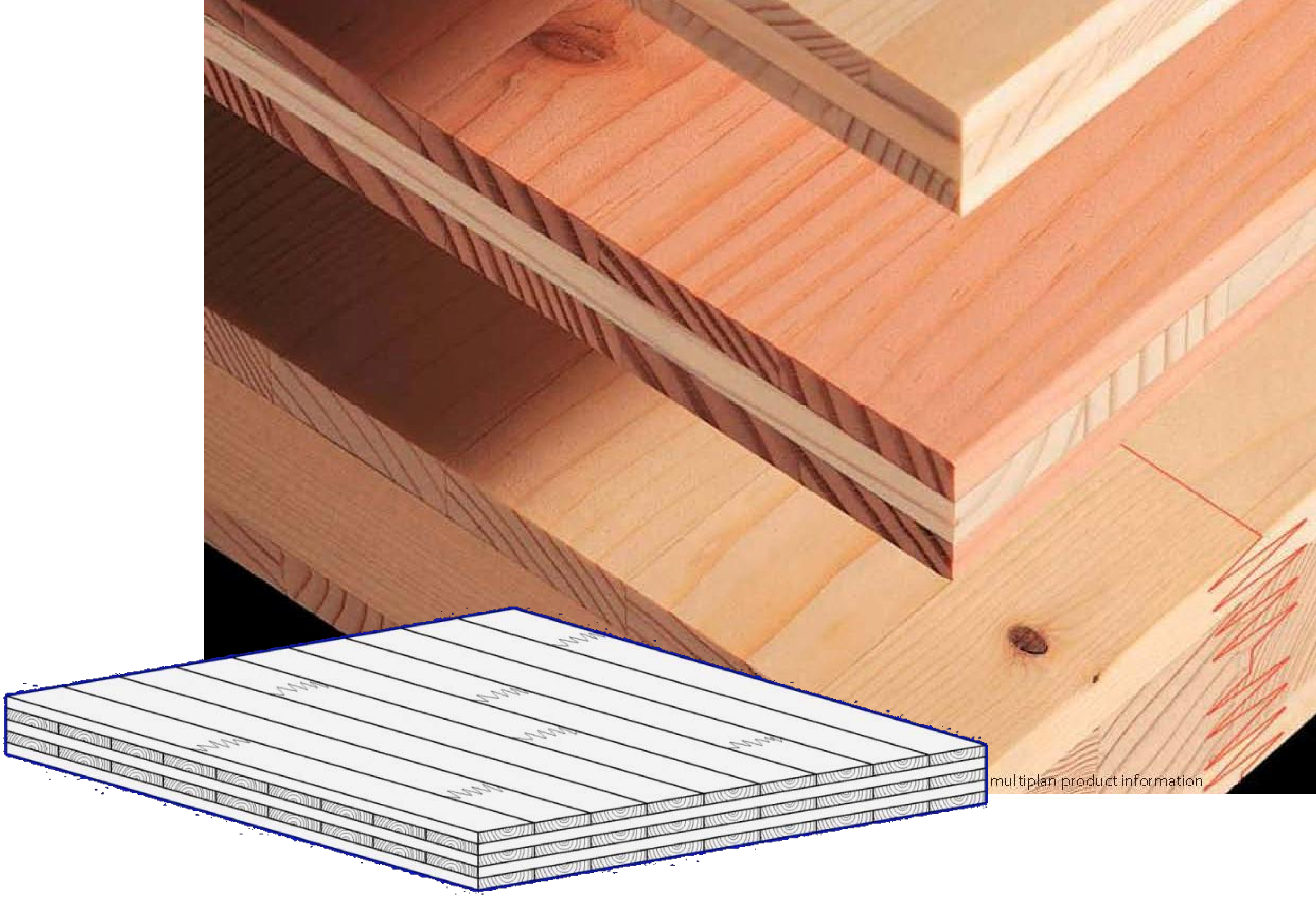
$$G_{LR} \div G_{LT} = 1,3 \div 1$$ (Hard Wood)

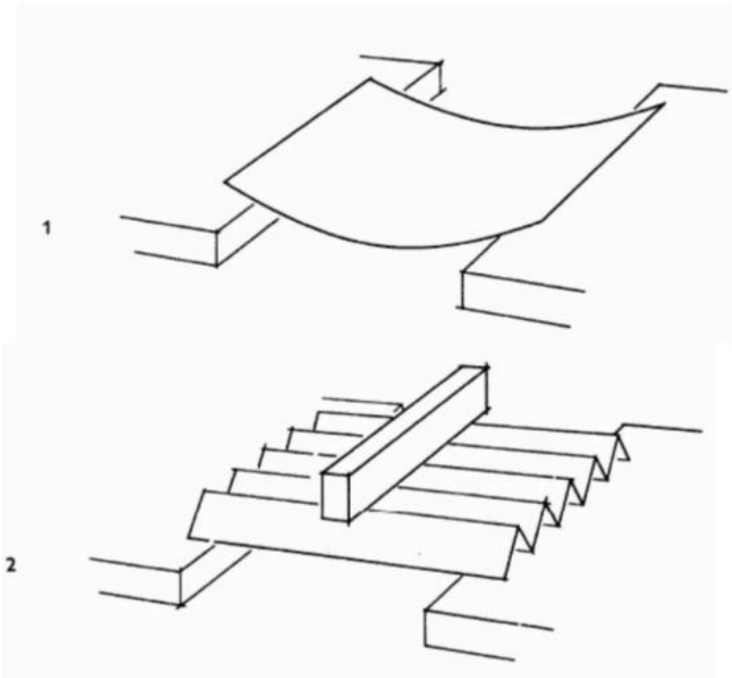


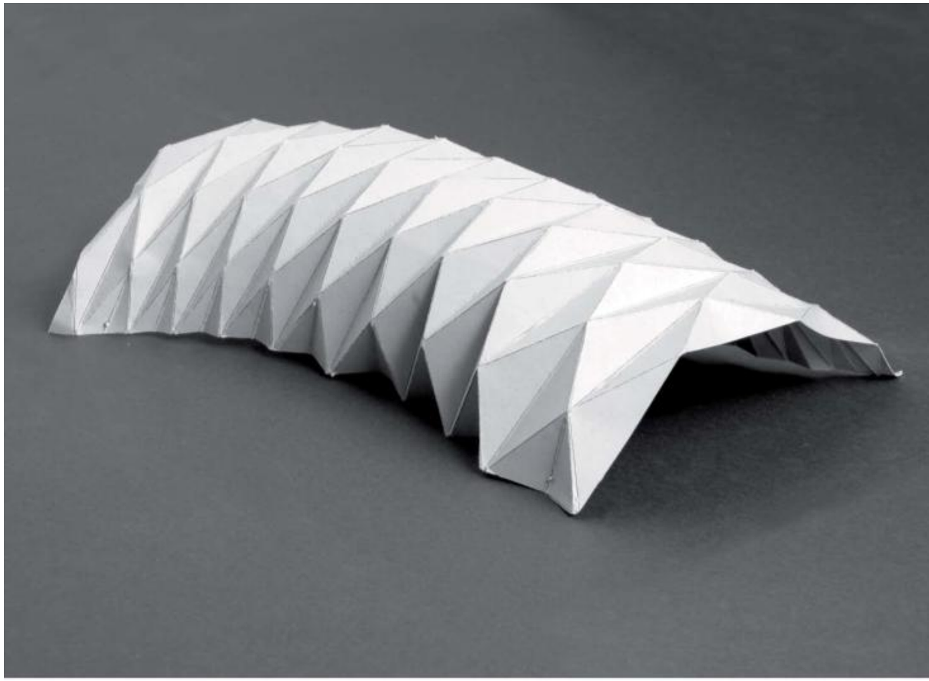
Three-layered timber boards :

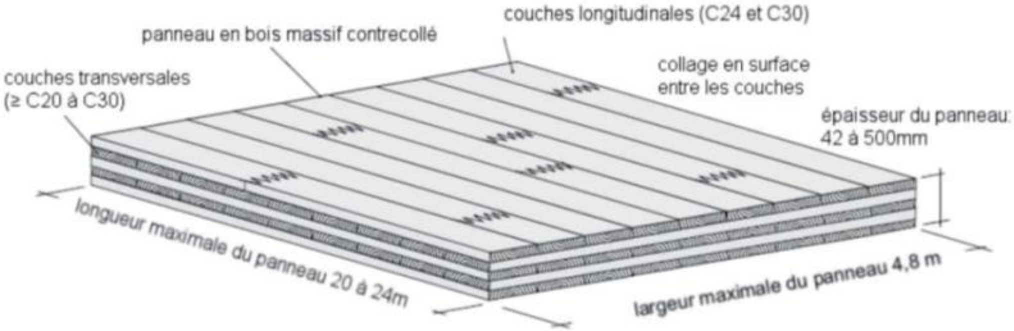
E Modulus [N/mm^2]	Thickness [mm]	Fiber Orientation [deg]
$E_1 = 12000$	$t_2 = 24$	$a_1 = 0$
$E_2 = 10000$	$t_2 = 15$	$a_2 = 45$
$E_3 = 12000$	$t_3 = 24$	$a_3 = 90$

[Schickhofer 2005]


multiplan product information







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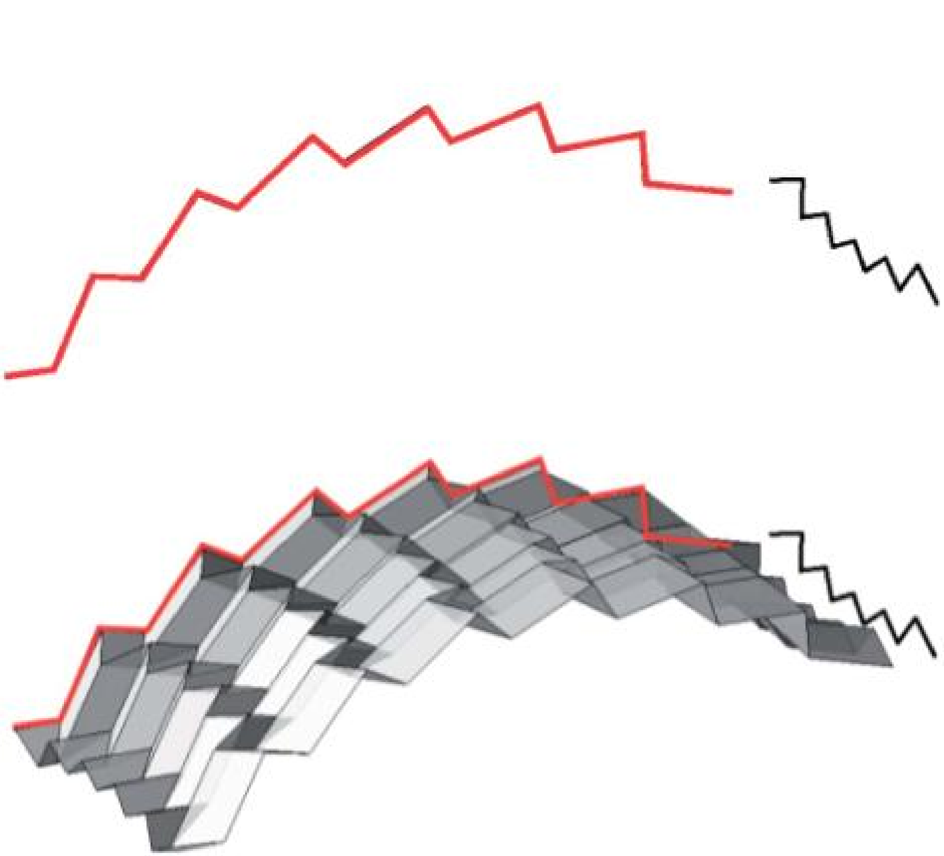
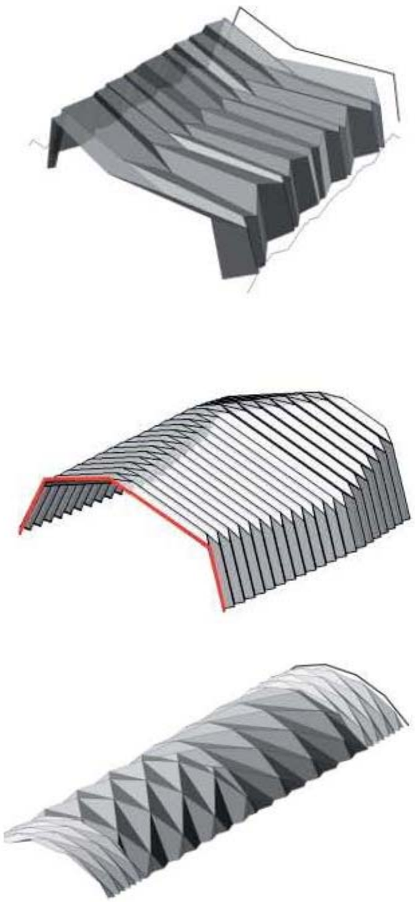
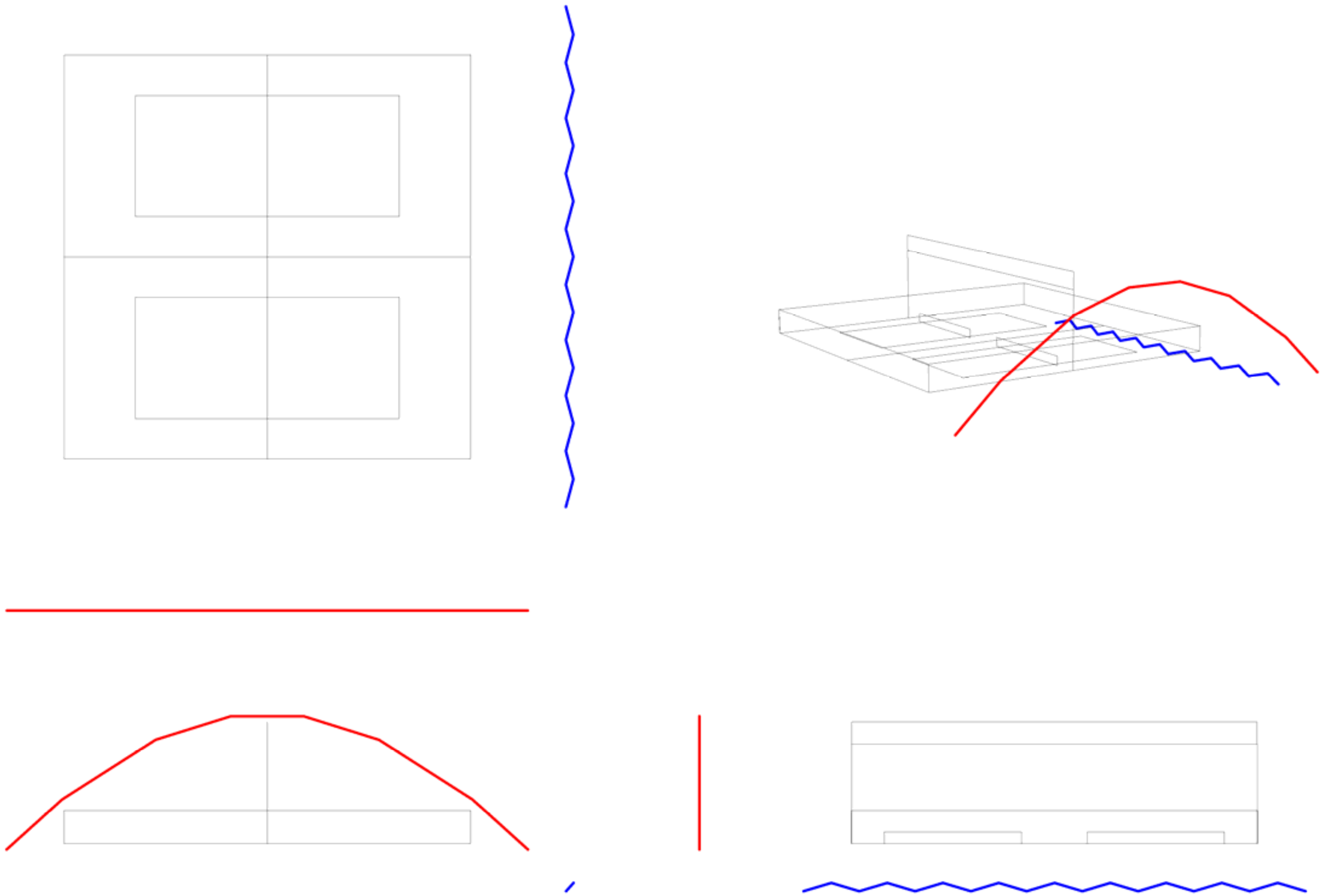
Numerical pattern generation

Two profiles generate a folding pattern







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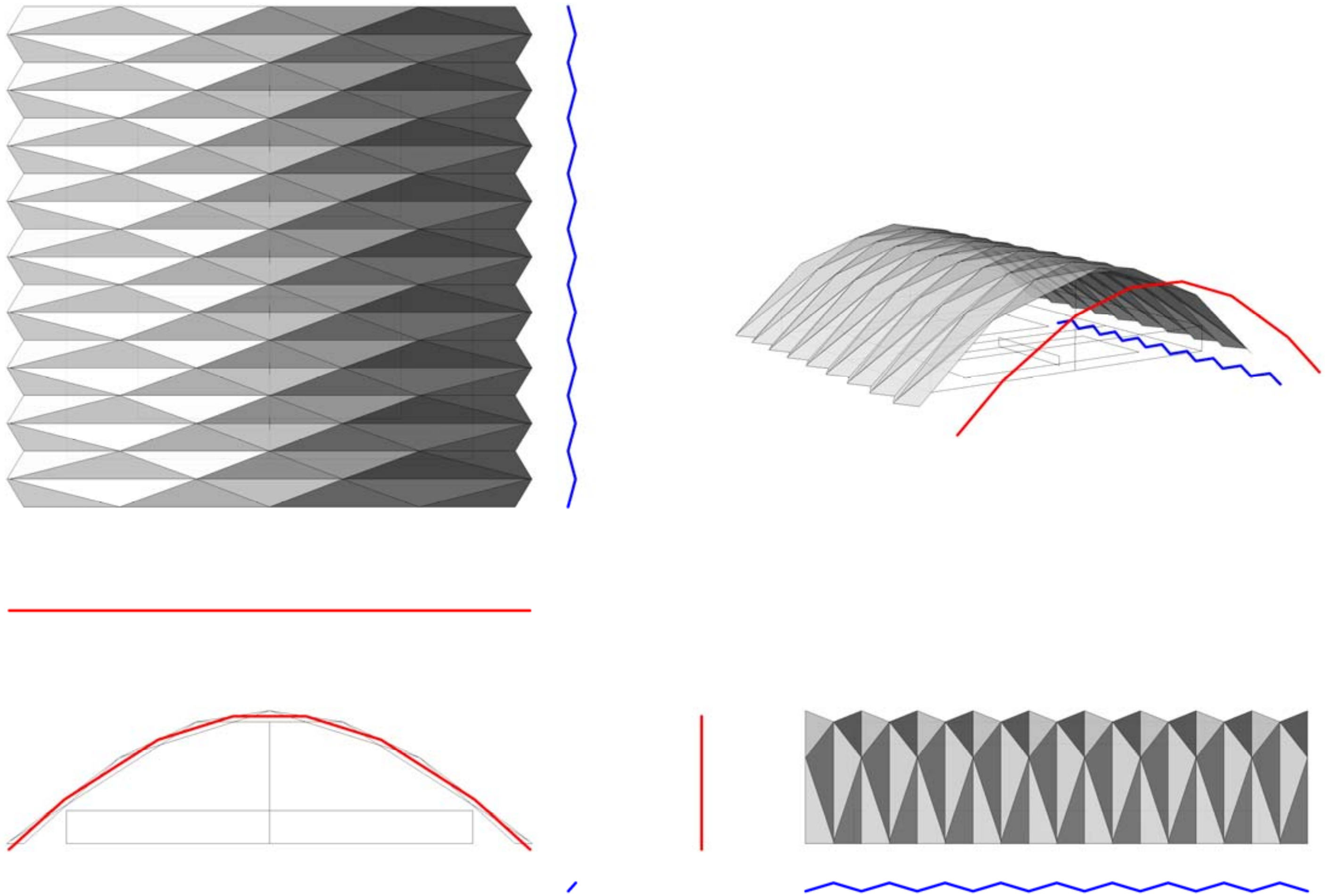

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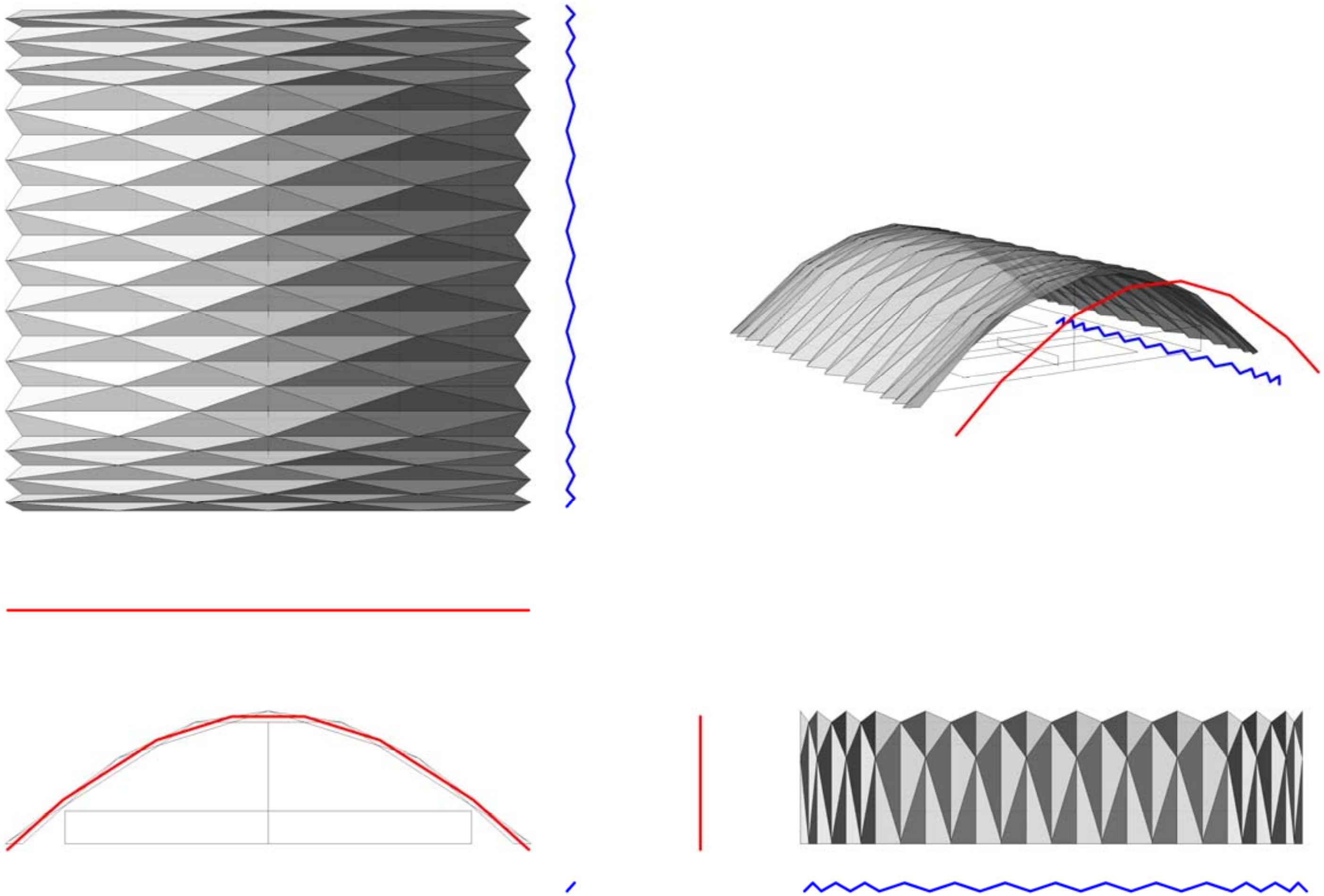

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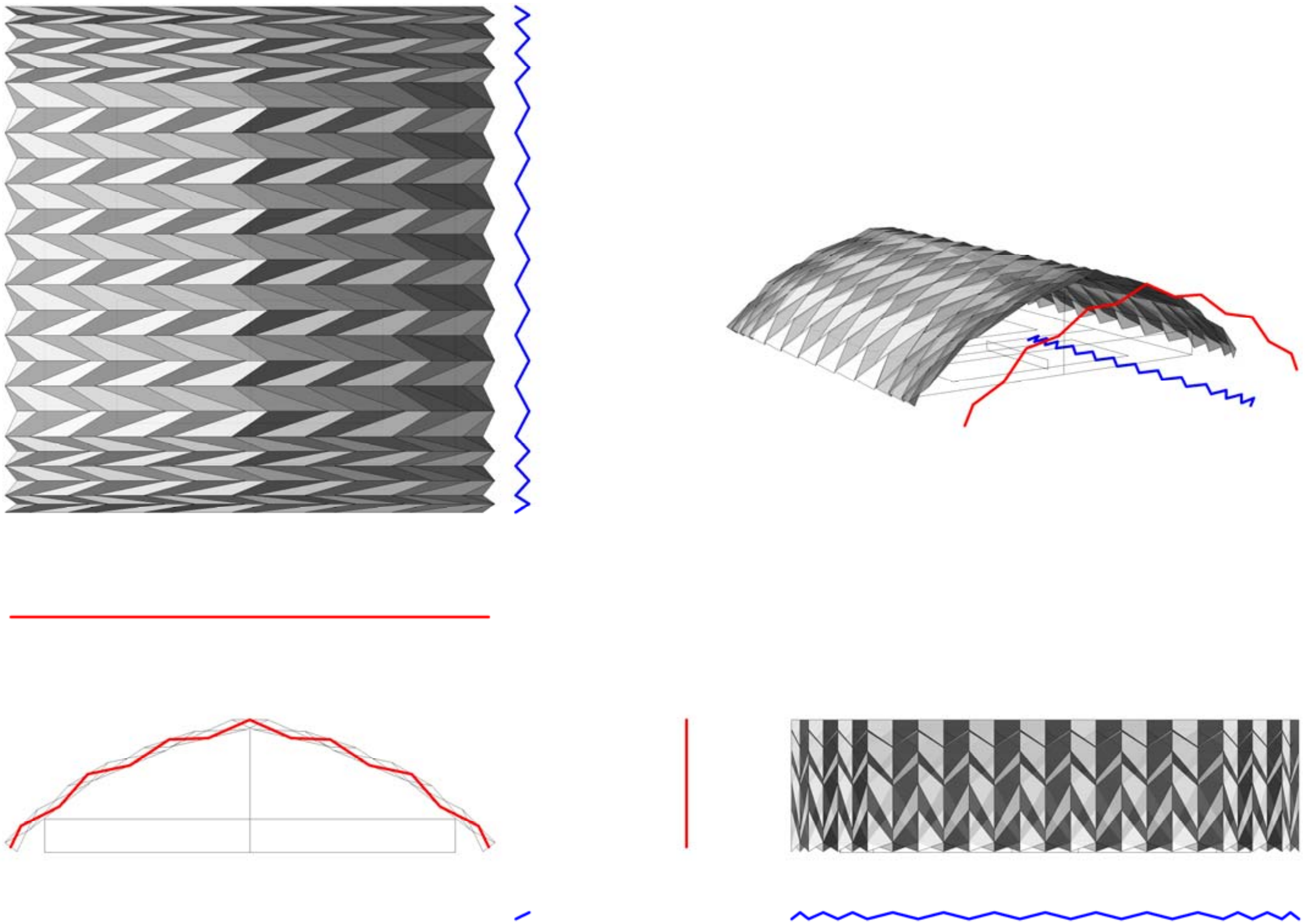
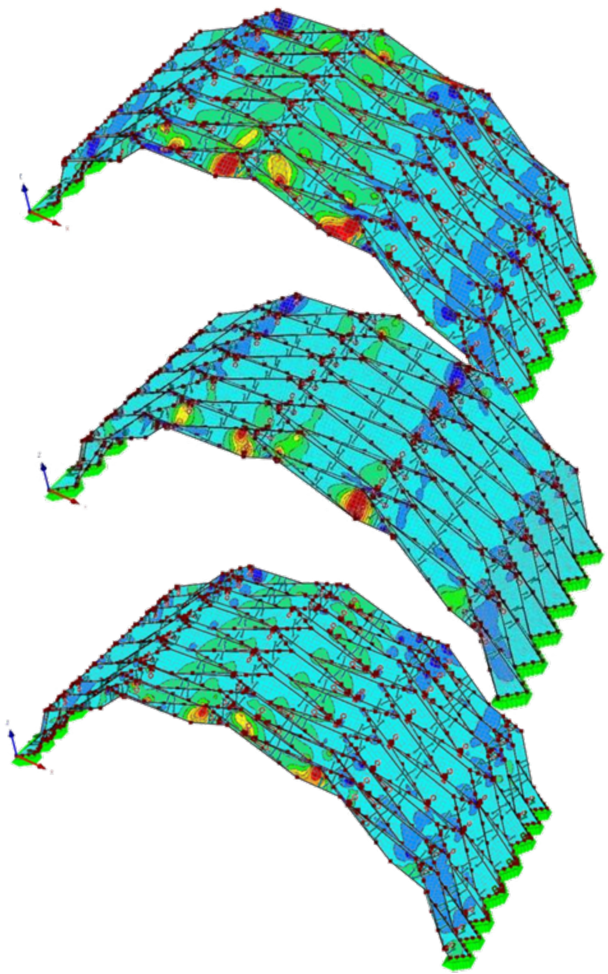
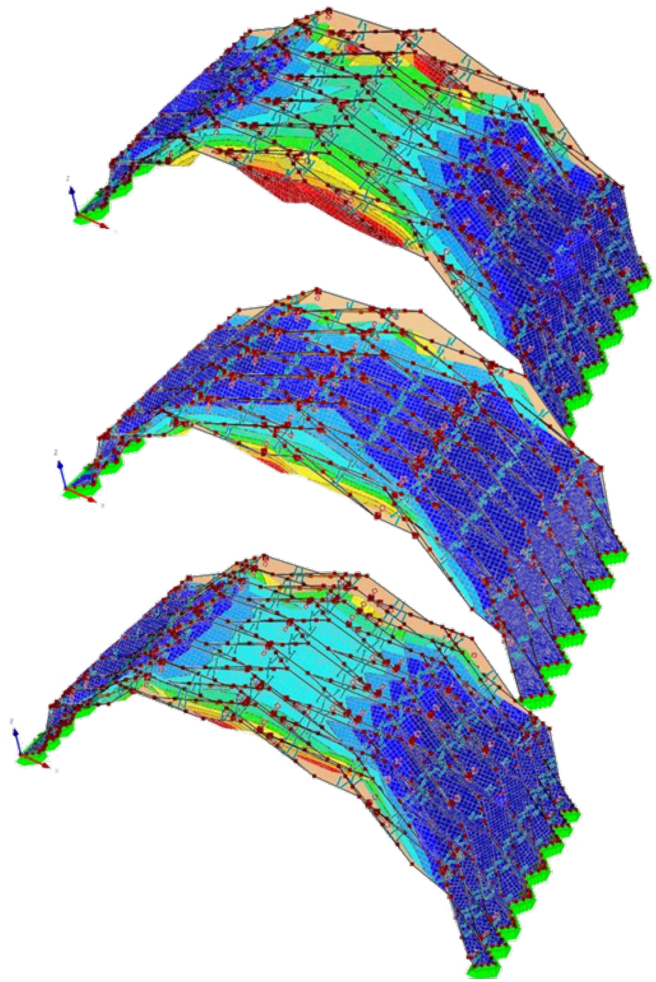


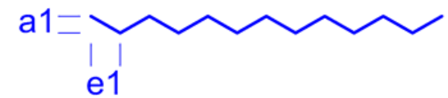
Internal forces



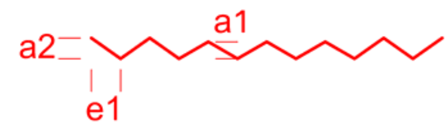
Deformations



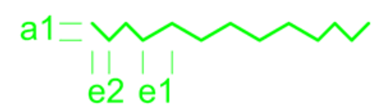
1. Max vectorial displacement 3.3 mm



2. Max vectorial displacement 2.2 mm



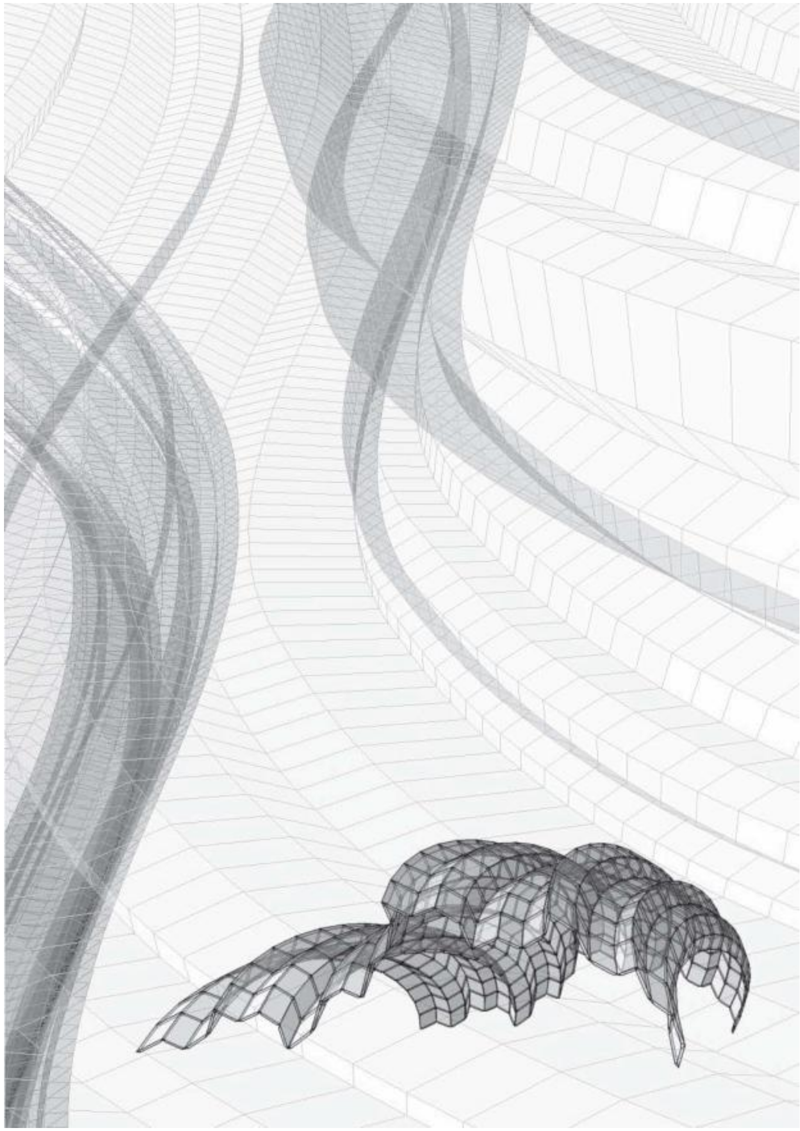
3. Max vectorial displacement 1.9 mm



Hani Buri, Johannes Natterer

IFS surface design for timber constructions

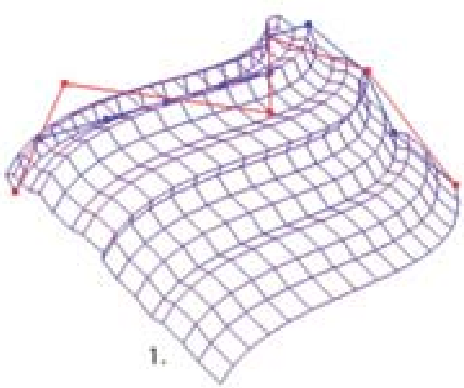
An interdisciplinary research between architects, mathematicians and computer scientists



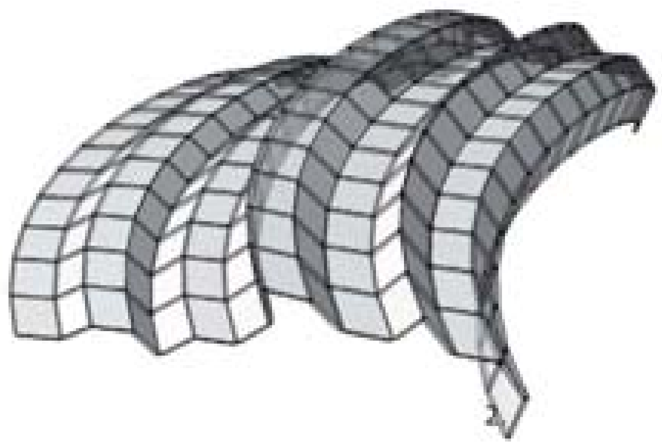
Gilles Gouaty, Ivo Stotz

Goal

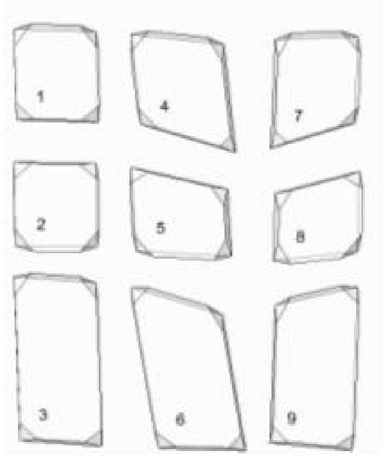
Computer-aided solutions for the production of
complex free-form architecture



1.



2.



3.

```
%prog2
N1 G90
N2 G71 T1 M6
N3 G0 X93.0203260604704 Y62.5742002389265
N4 G1 Z-3
N5 G1 X92.5173637881376 Y32.3964638989584
N6 G1 Z6
N7 G0 X108.361877416248 Y60.3013778158484
N8 G1 Z-3
N9 G1 X107.858915143915 Y30.1236414758803
N10 G1 Z6
N11 G0 X96.8557138994148 Y62.005994633157
N12 G1 Z-3
N13 G1 X96.352751627082 Y31.8282582931889
N14 G1 Z6
N15 G0 X104.526489577304 Y60.8695834216179
N16 G1 Z-3
N17 G1 X104.023527304971 Y30.6918470816498
N18 G1 Z6
```

5.

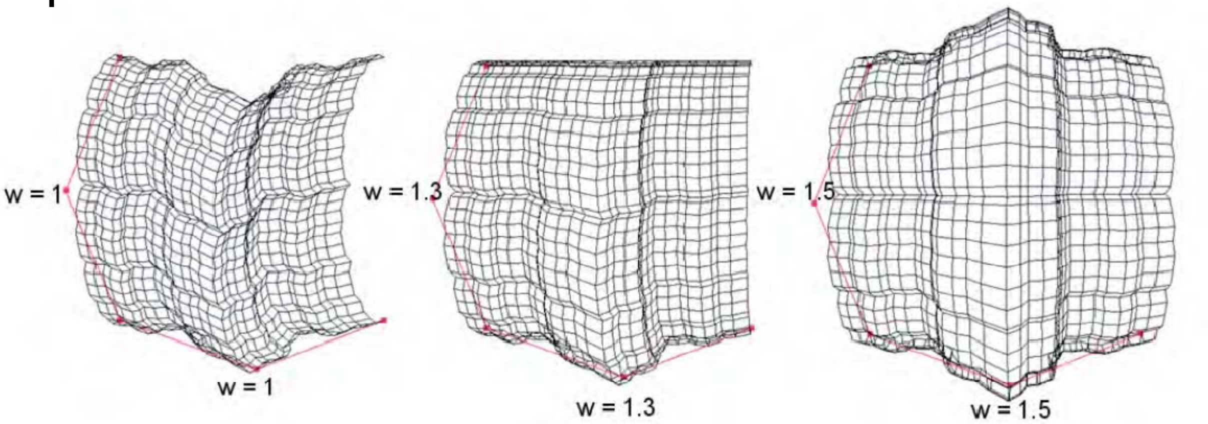
Digital production of free-form architecture

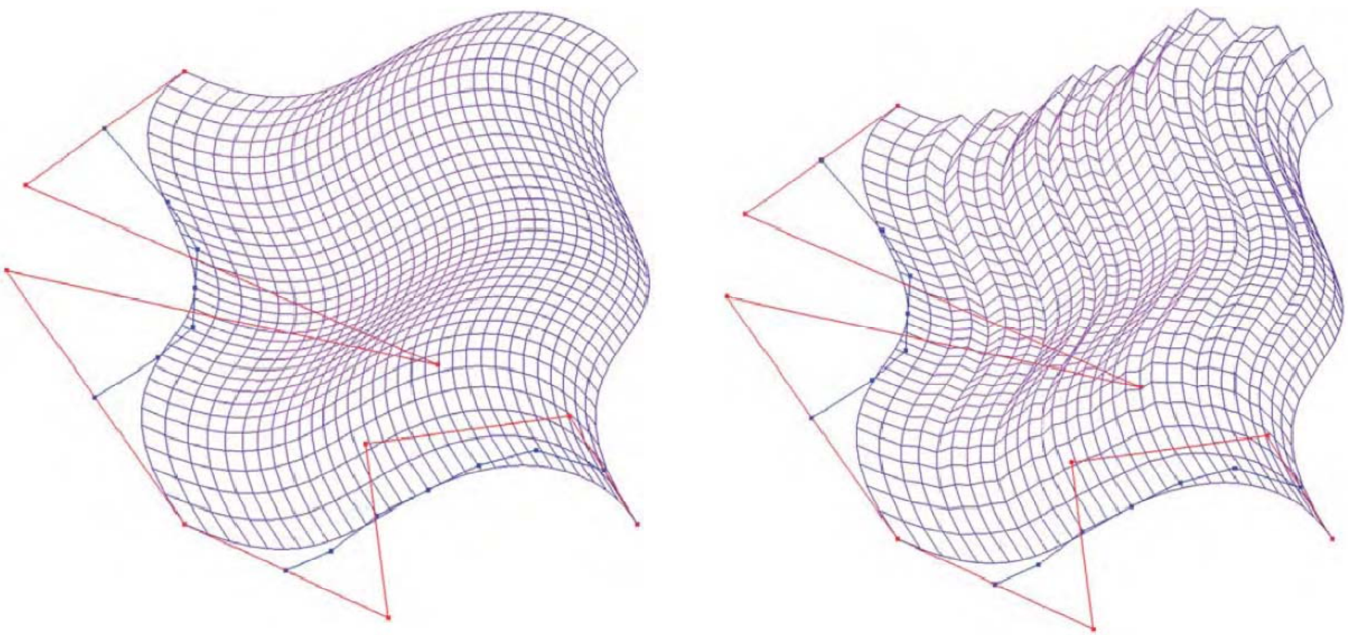
1. Free Sufrace design
2. Computing the constructional elements
3. Adressing and lay out of the elements
4. Machine code generation
5. Integrated manufactoring

Gilles Gouaty, Ivo Stotz

Software Development

A new surface model





Gilles Gouaty, Ivo Stotz

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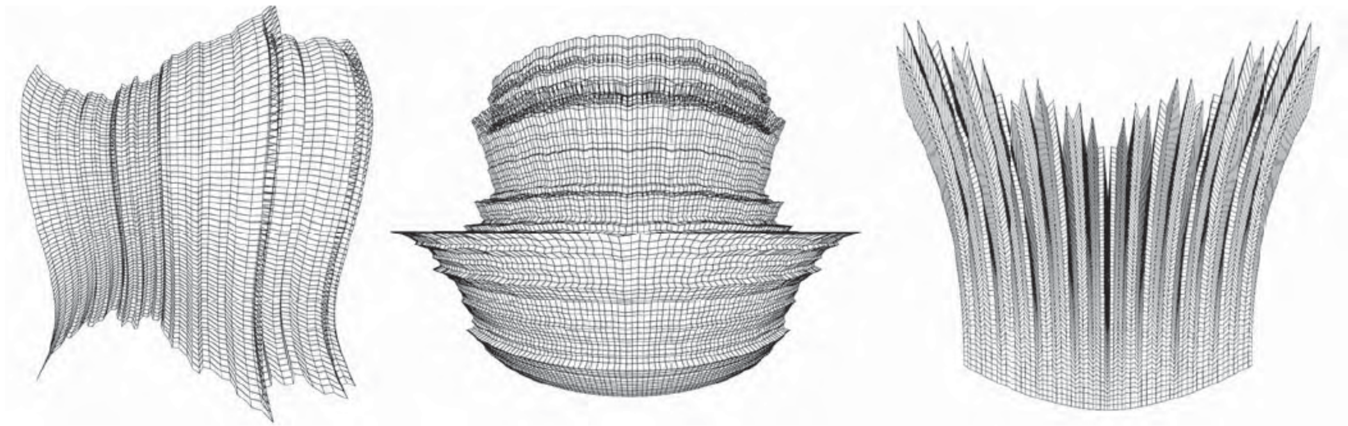
Design Possibilities



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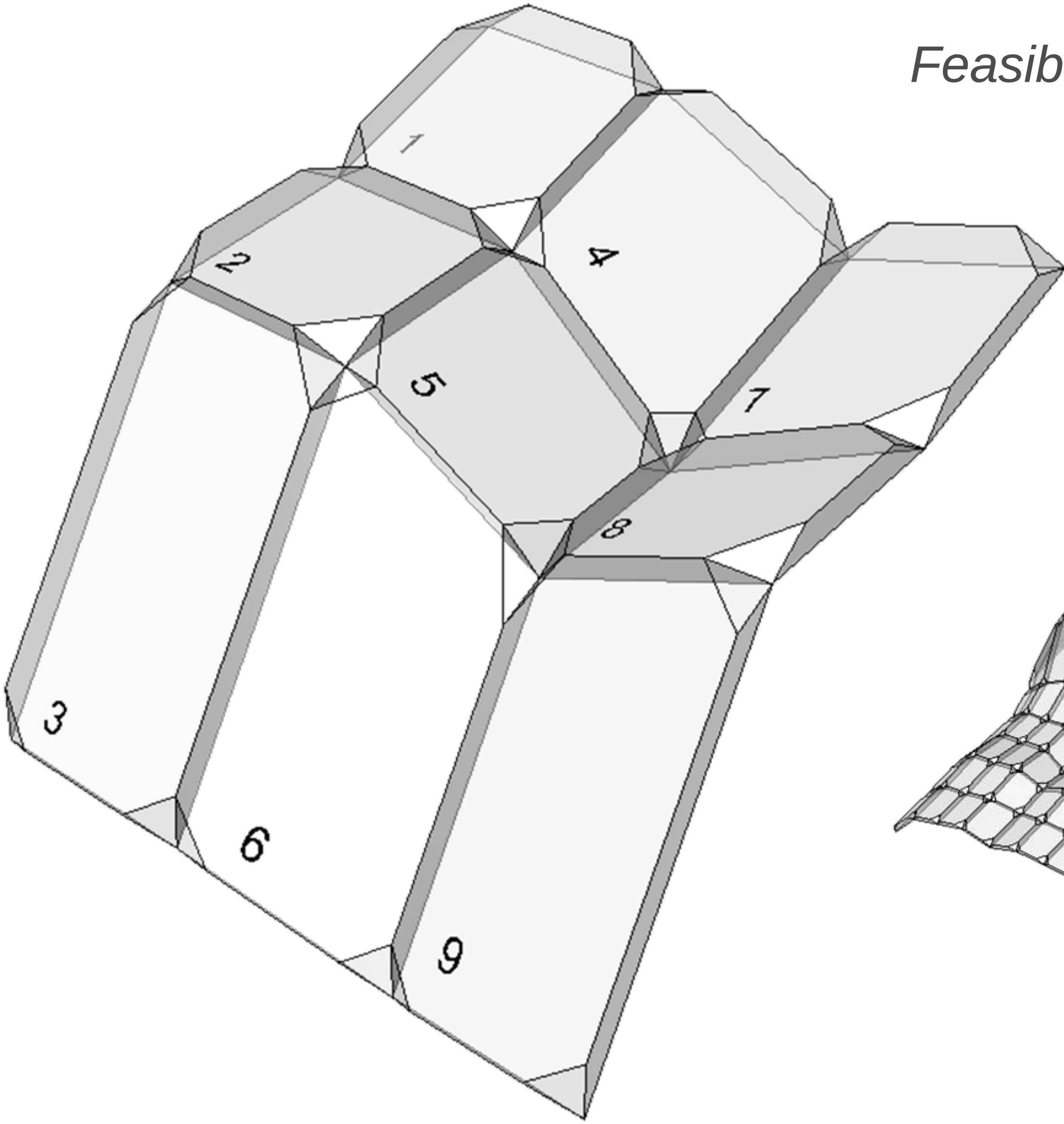
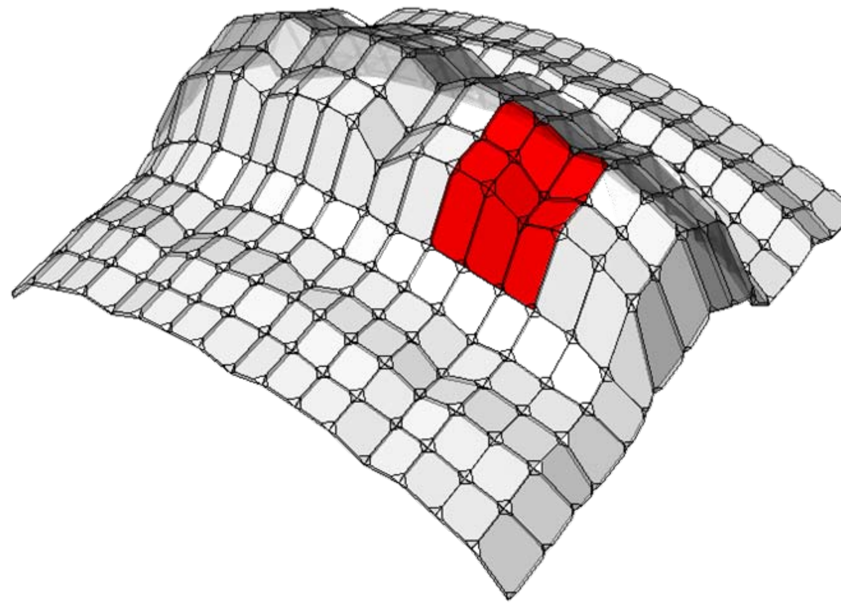
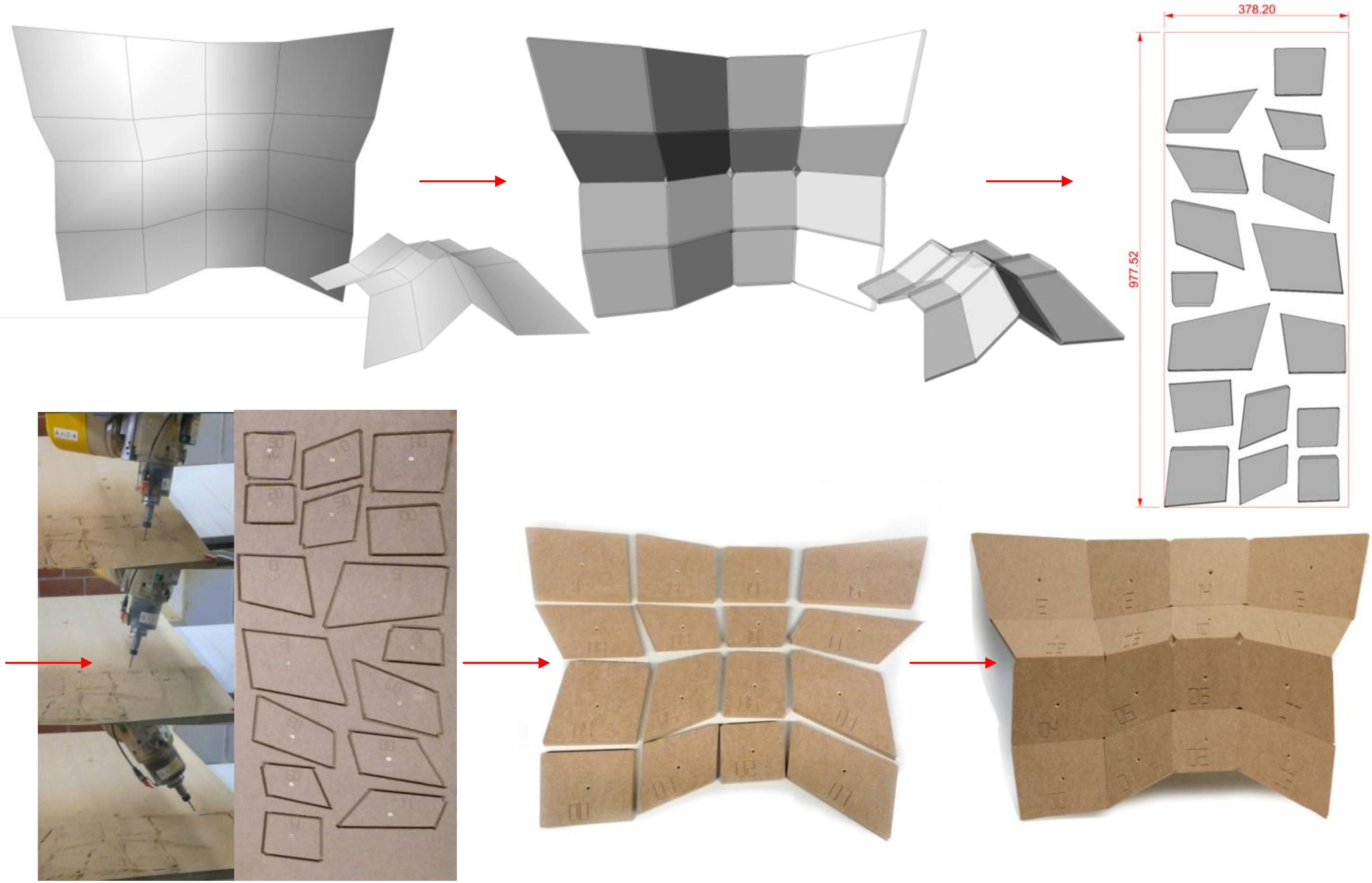
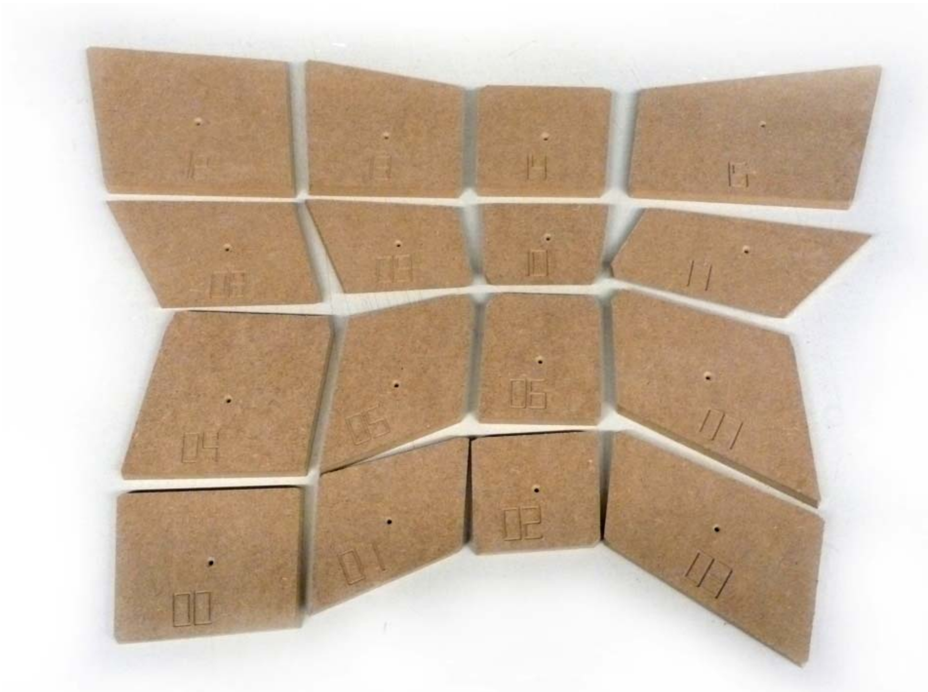
Feasibility study: Partial production

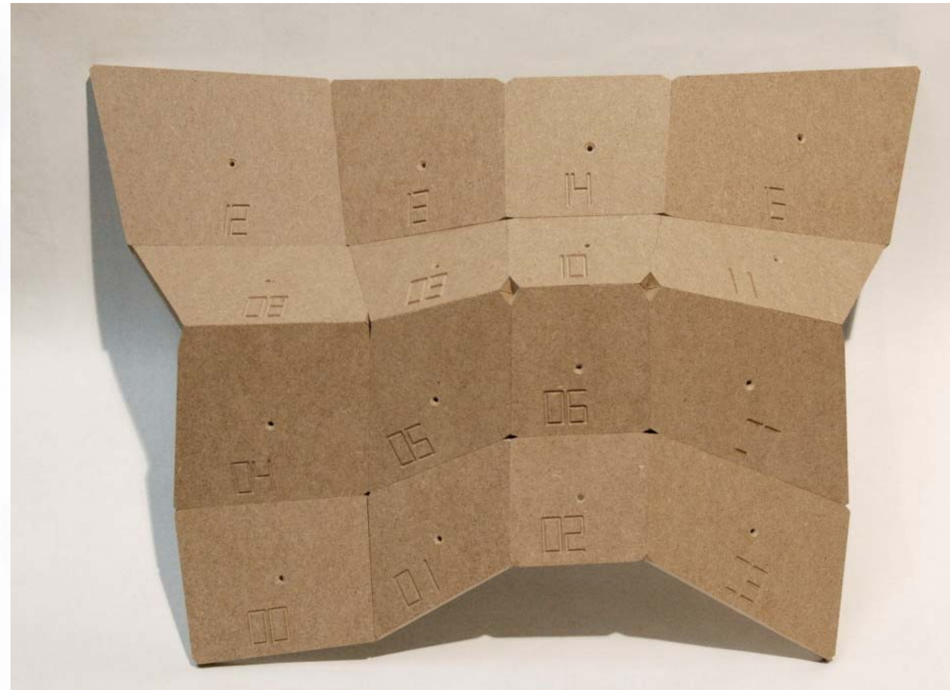


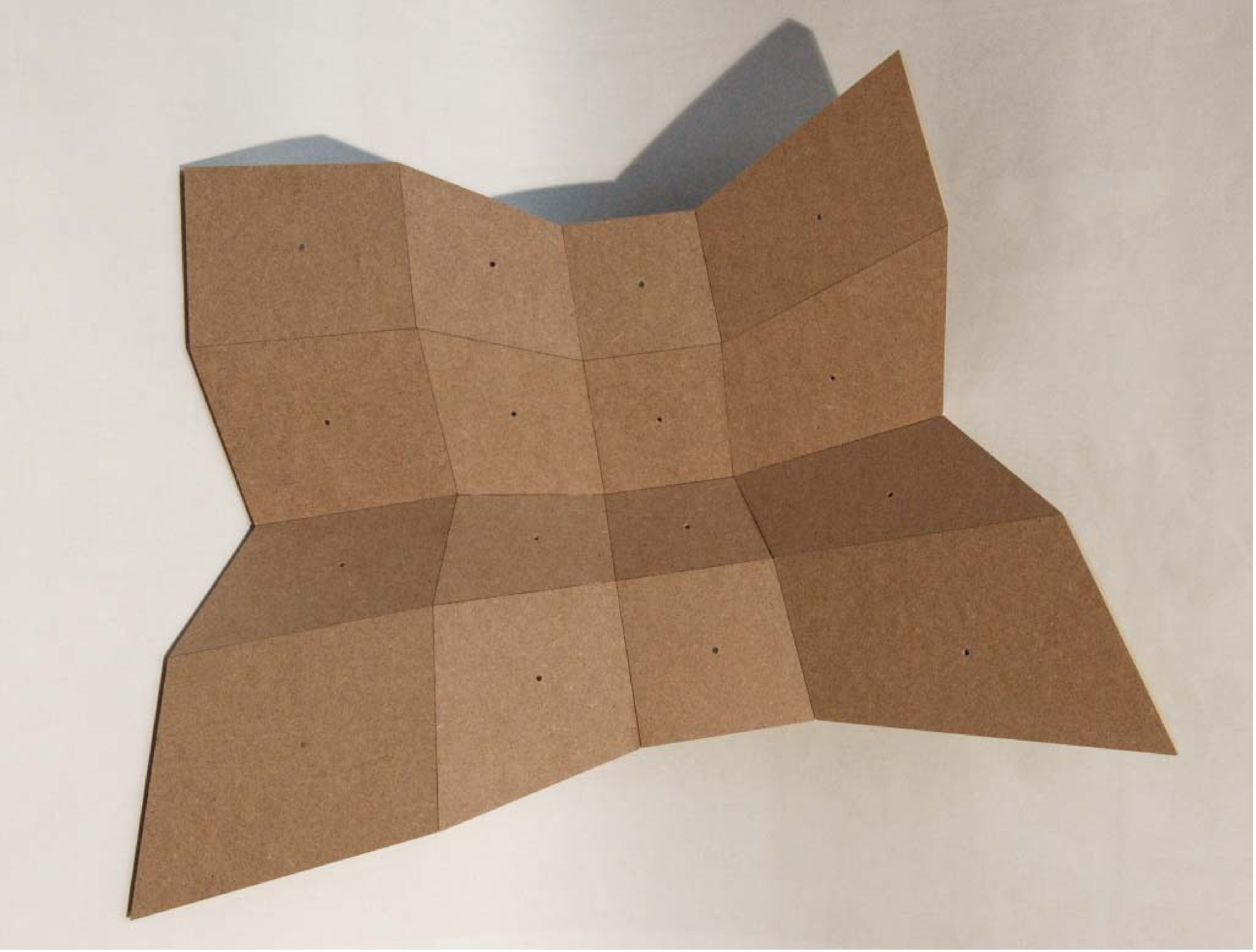



378.20
977.52

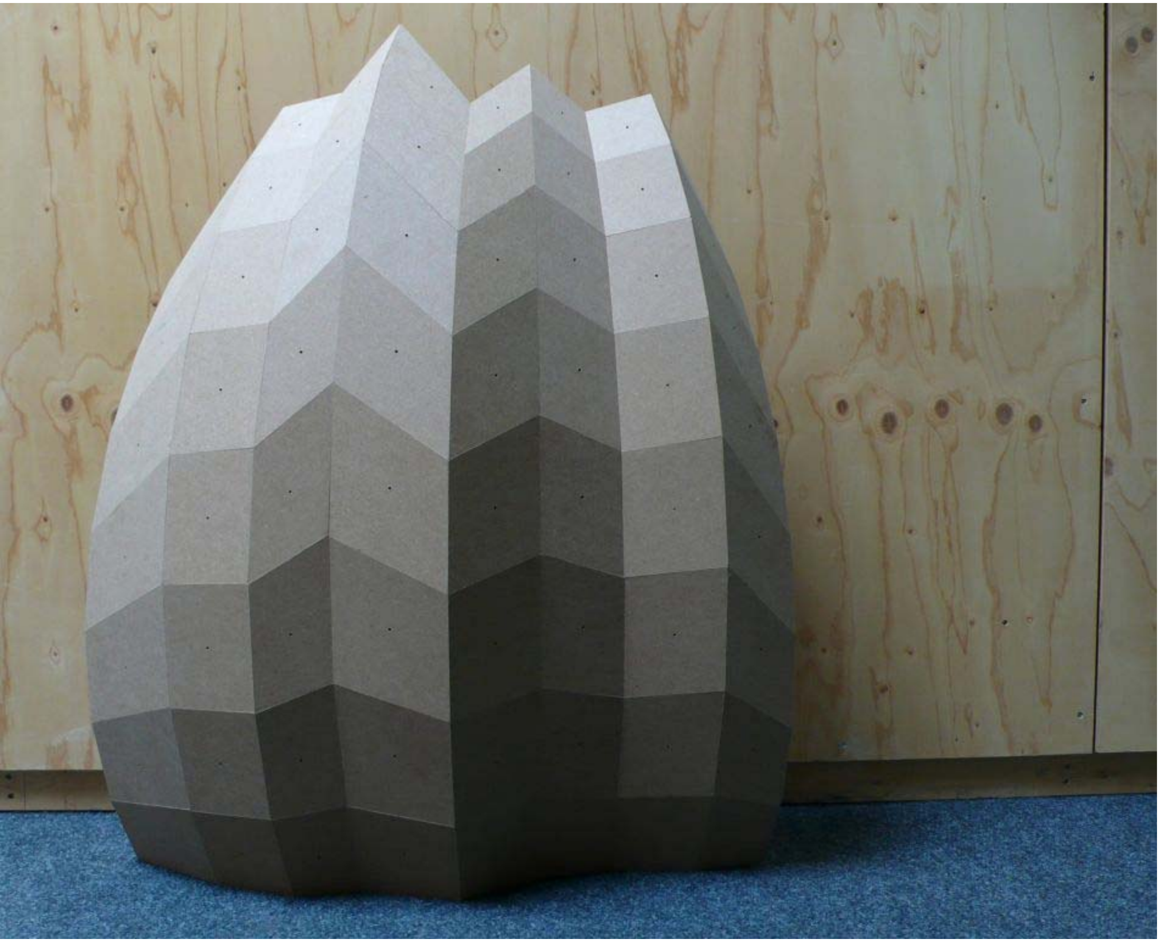
Feasibility study: 4x4 Prototype

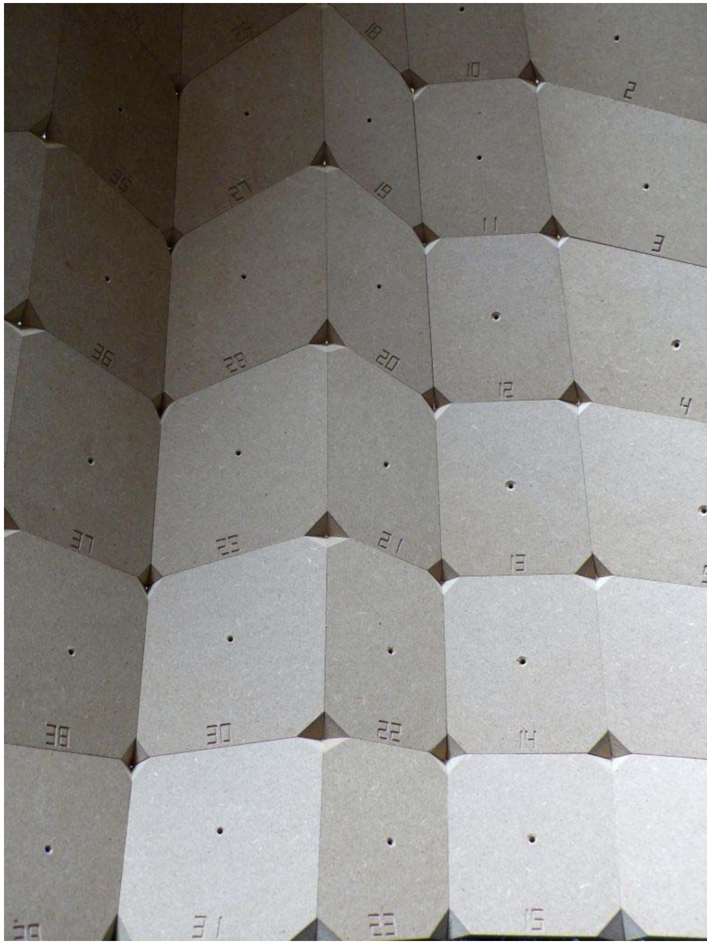






Feasibility study: 8x8 Prototype





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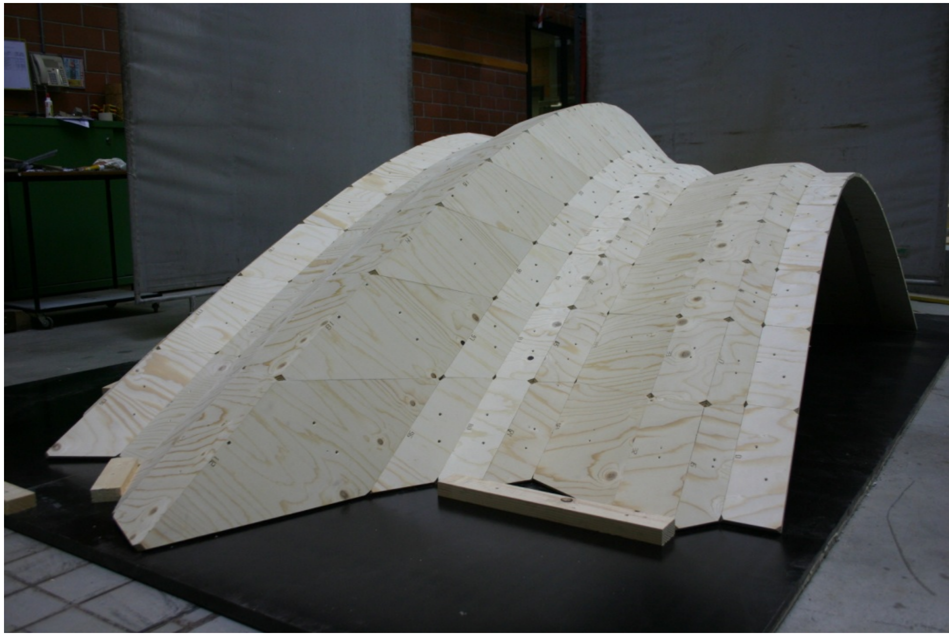
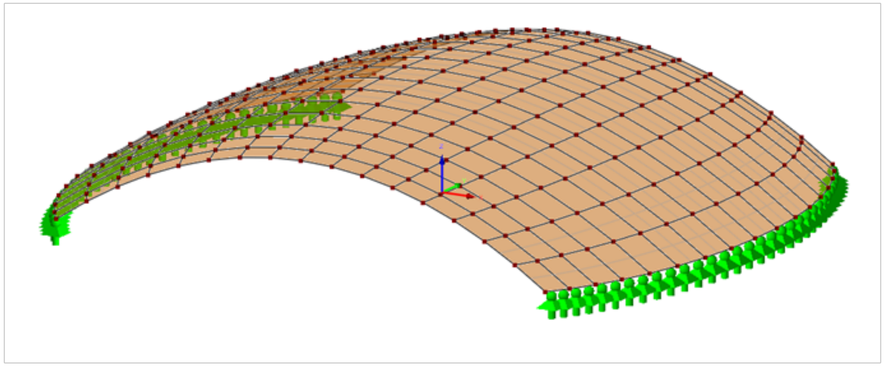
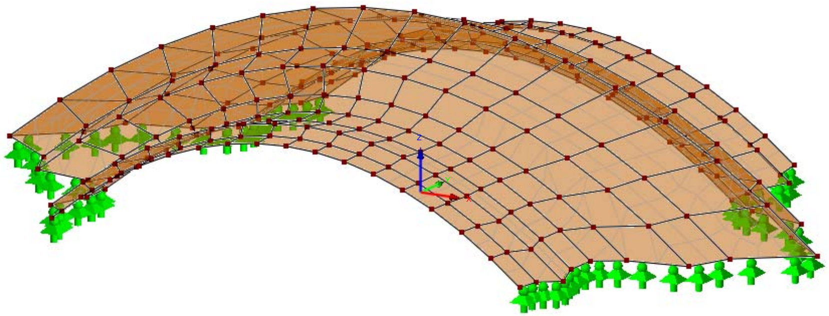
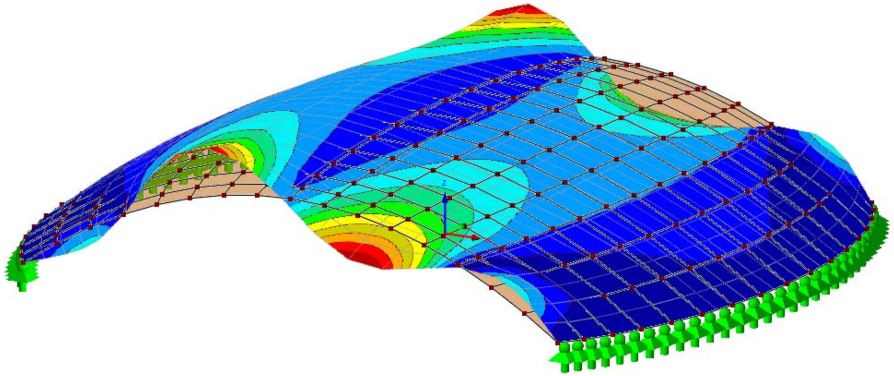



Gilles Gouaty, Ivo Stotz

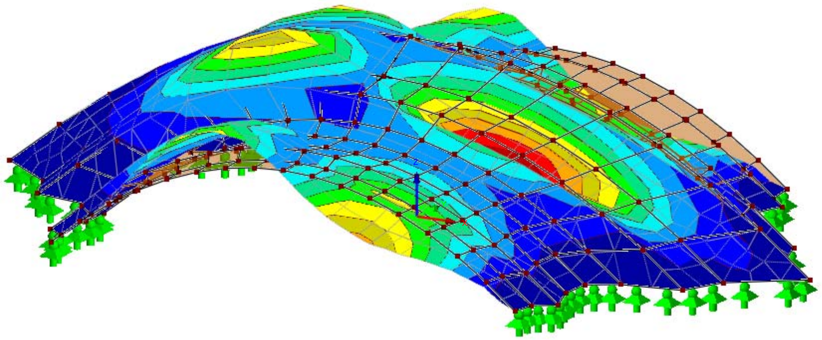
Exemple d'une coque mince (20mm) de 12m de portée sous un cas de charge asymétrique (neige) :







dZmax = 220mm



dZmax = 45mm

Gilles Gouaty, Ivo Stotz

Origami, architecture
Goal

Foldet plate structures with cross laminated timber panels

Structural timber fabric

Applying textile principles to building scale

Markus Hudert

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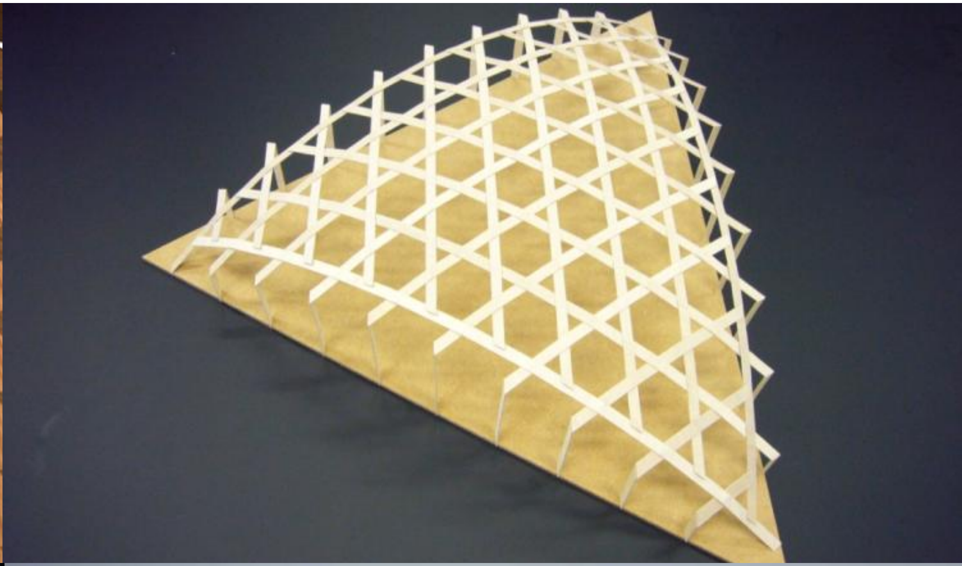

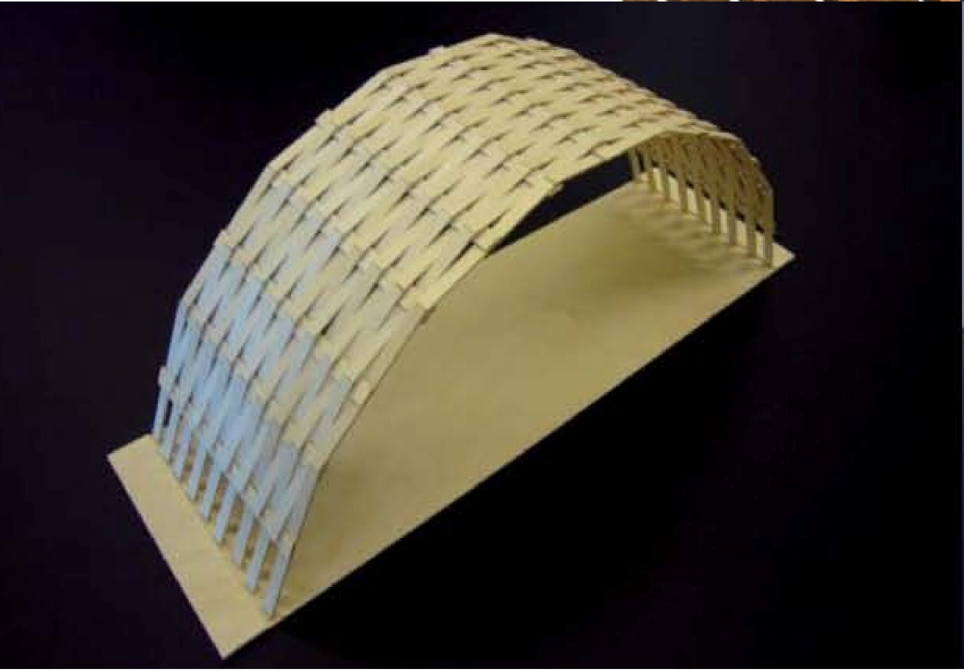

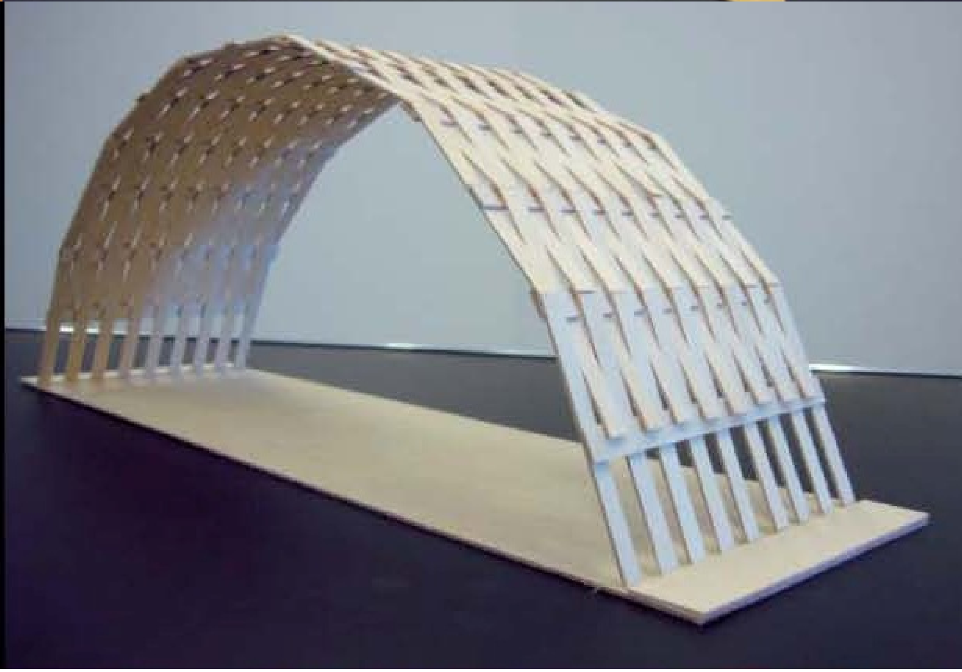

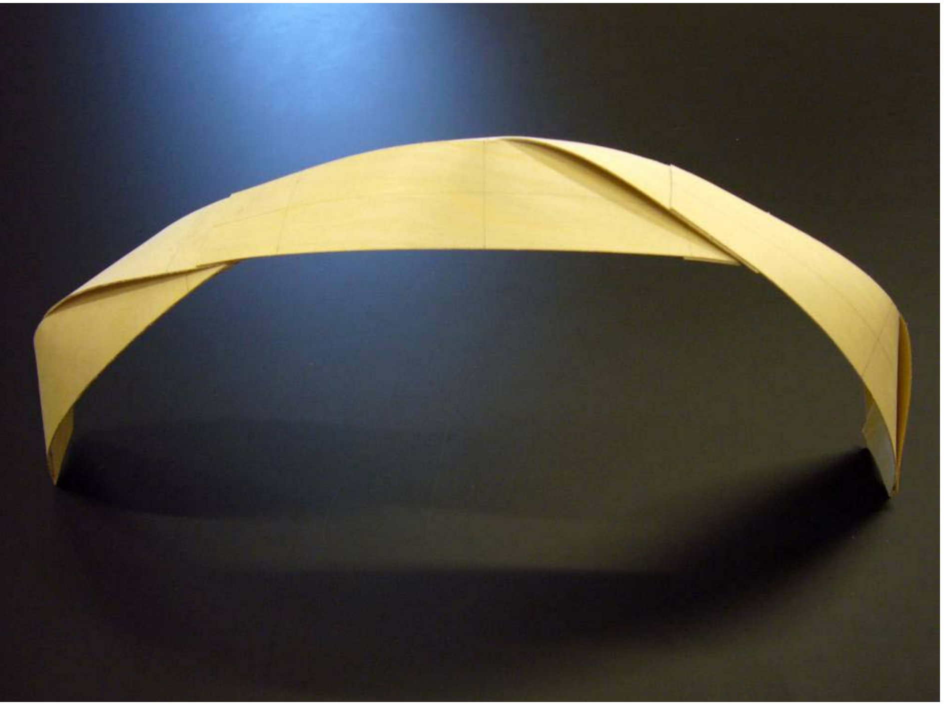

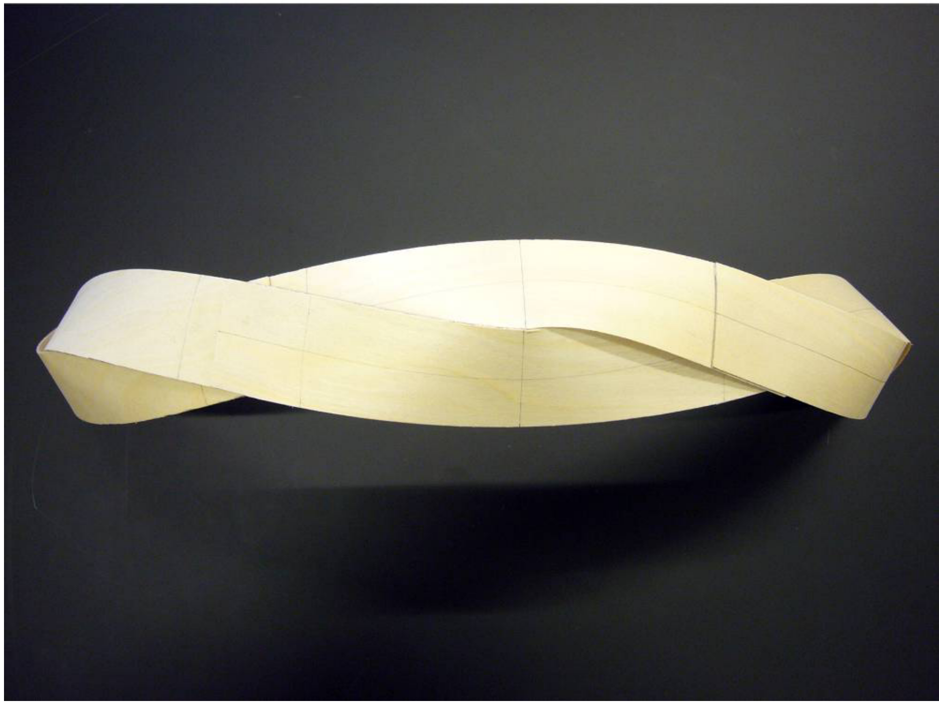

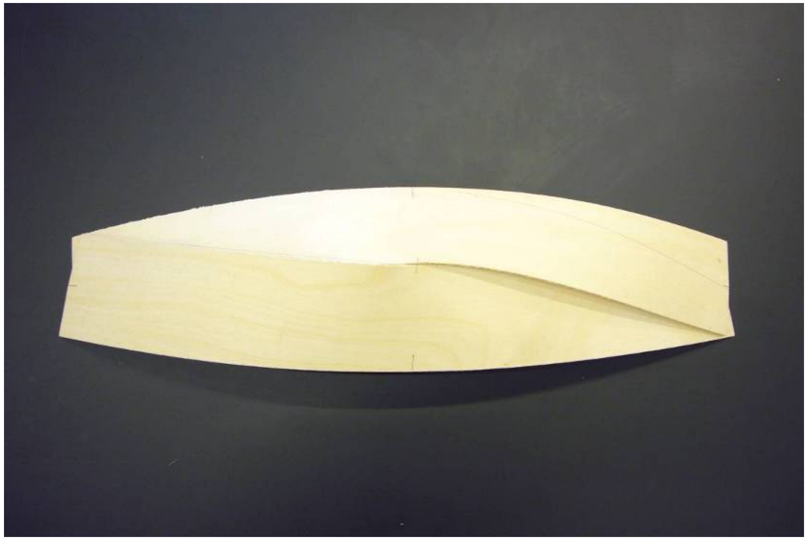

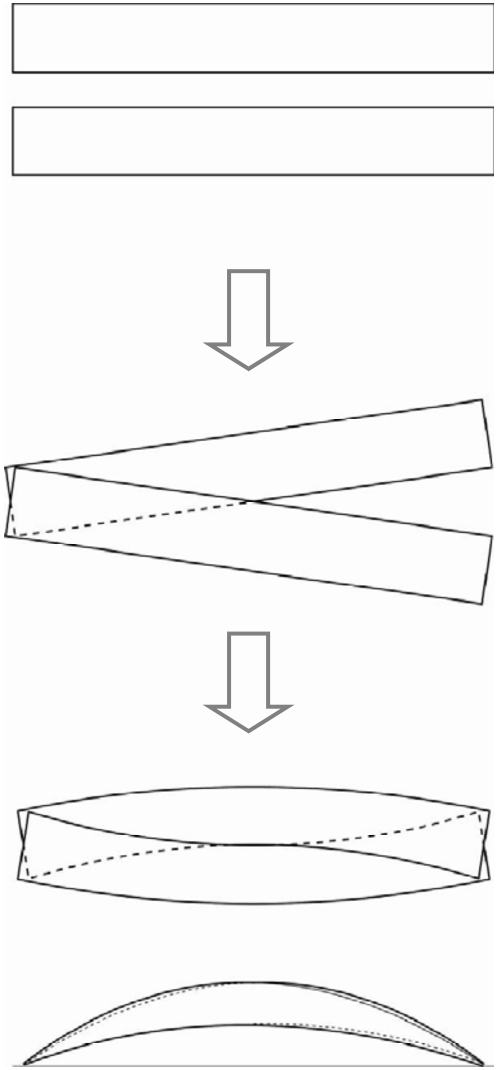

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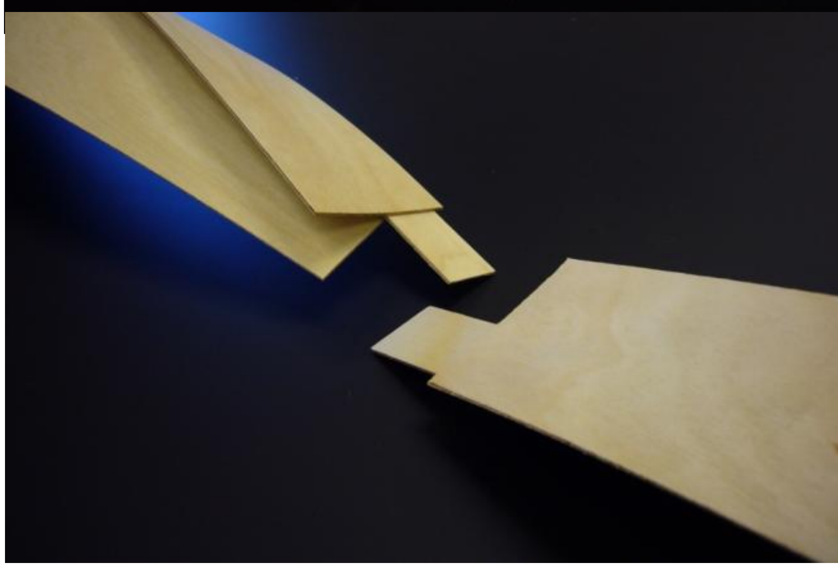

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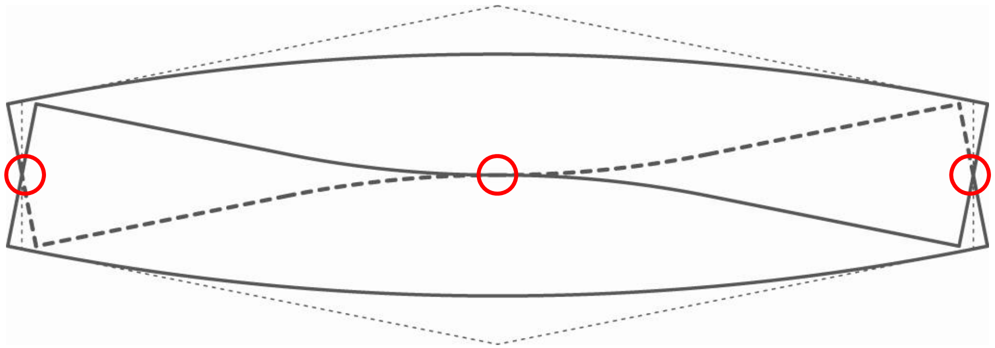
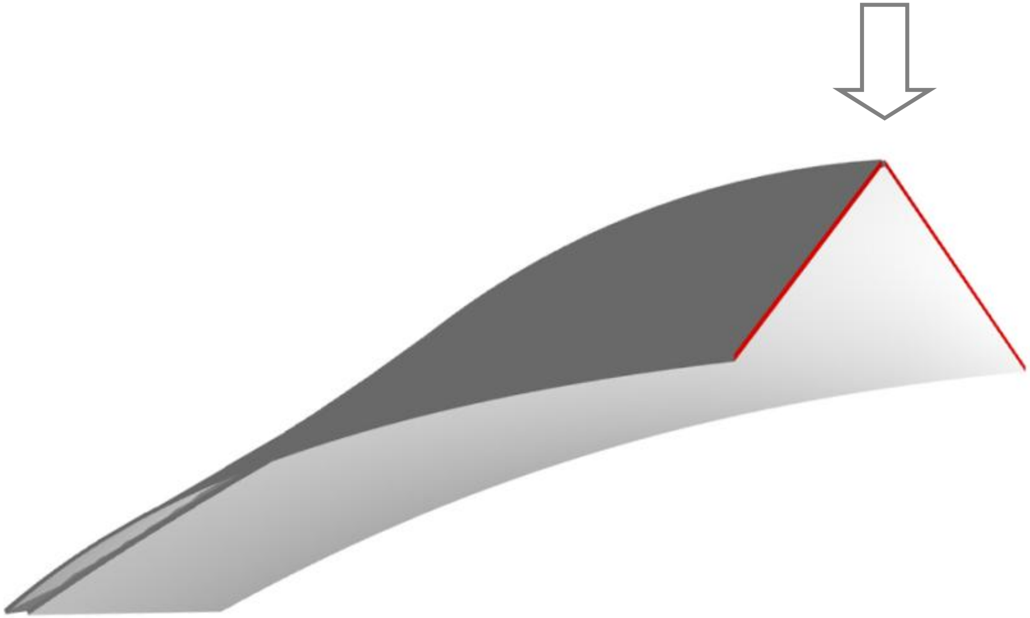
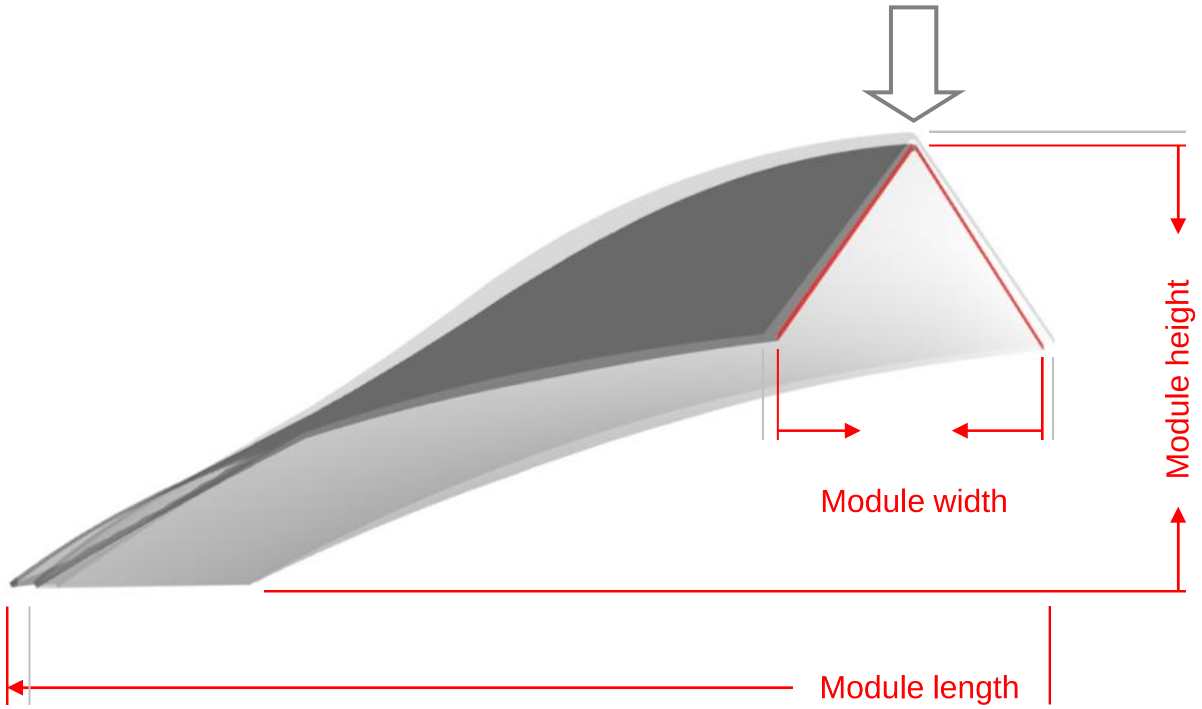
Fixpoints



Markus Hudert, Masoud Sistaninia



Markus Hudert, Masoud Sistaninia

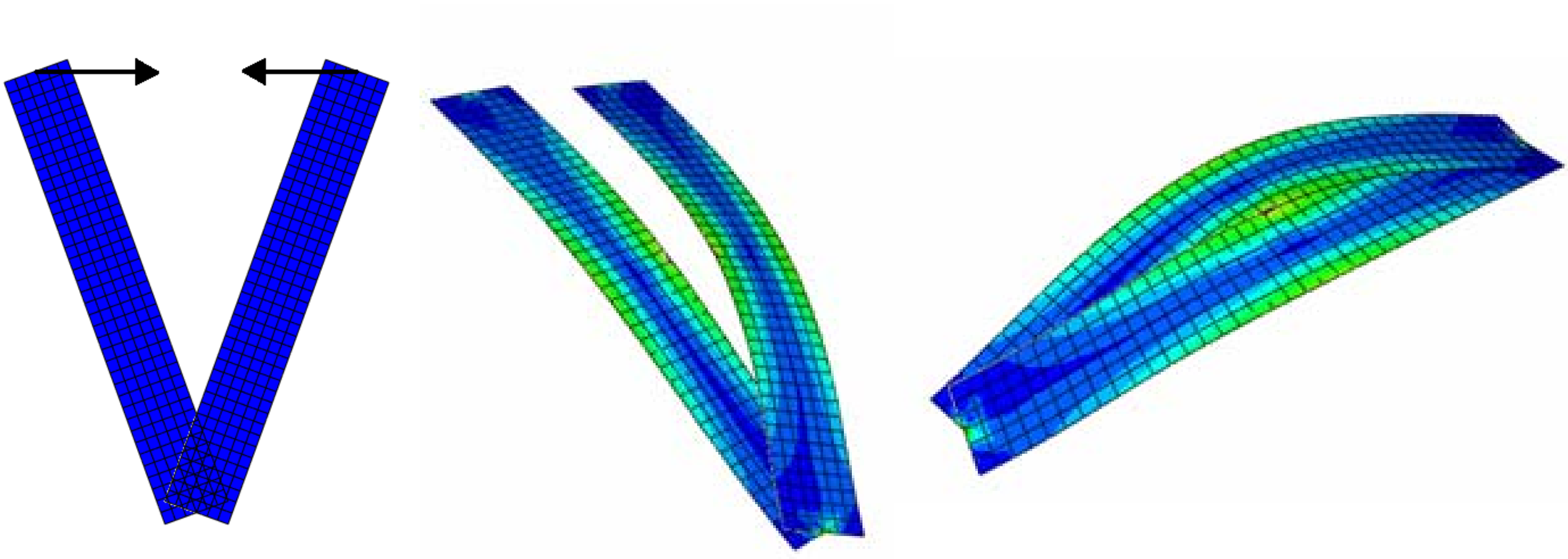


Markus Hudert, Masoud Sistaninia

Calculation of internal stresses in textile modulus

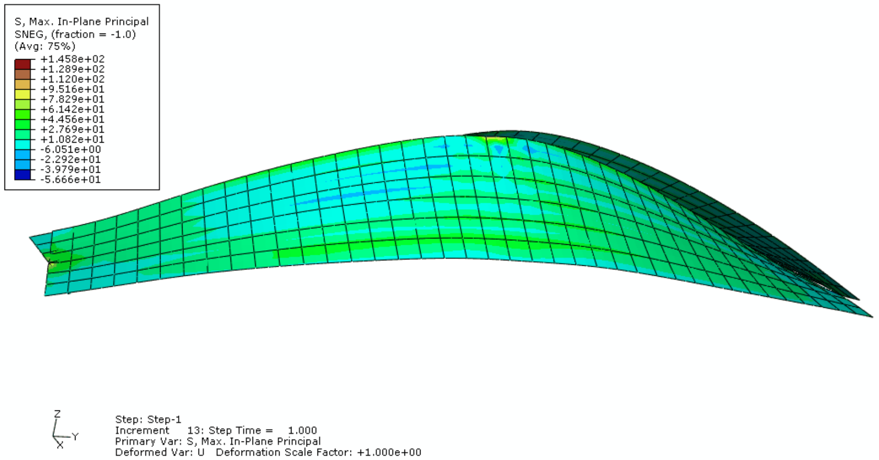
Finite Element software (ABAQUS 6.7-1) was used for this analysis

Simulated by FEM software:



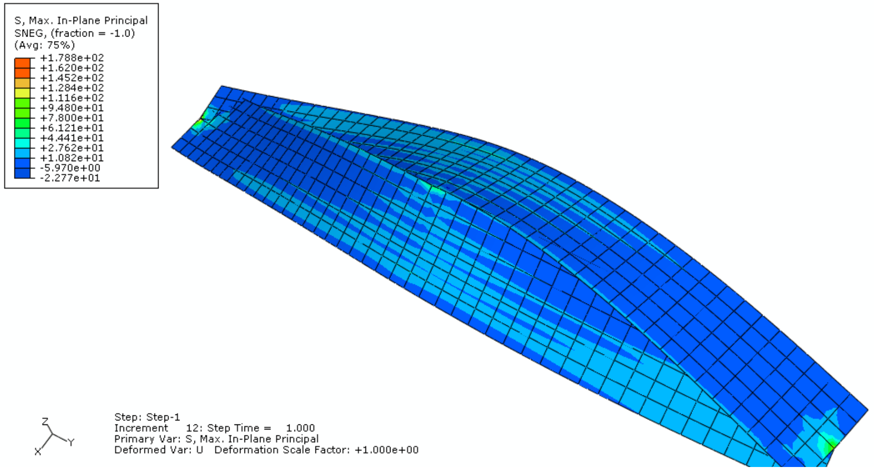
Maximum principal internal stresses for two proportion

Proportion (length/width)= 7
Length= 11.55 m, Width= 1.65 m

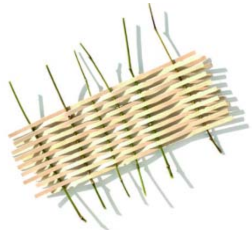


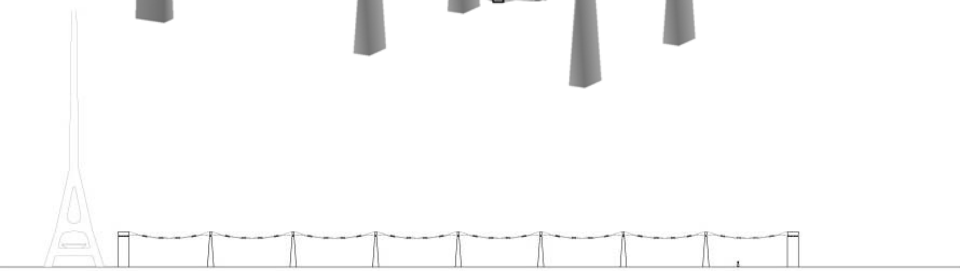
Maximum Principal stress= 46 MPa

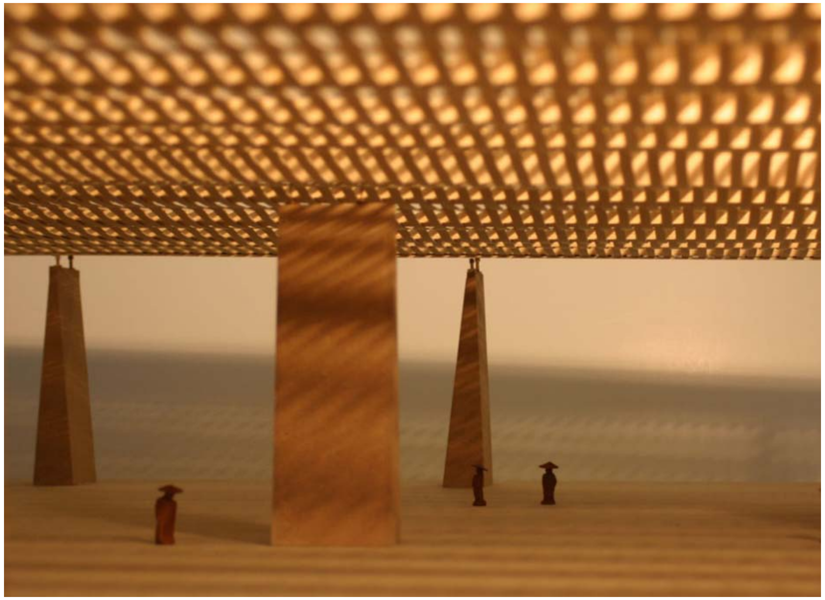
Proportion (length/width)= 8.7
Length= 11.55 m, Width= 1.32 m

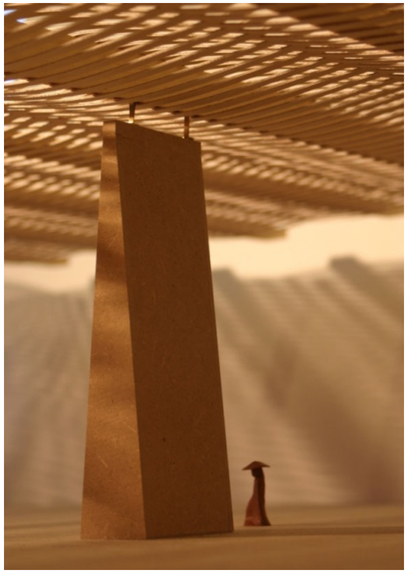


Maximum Principal stress= 29 MPa



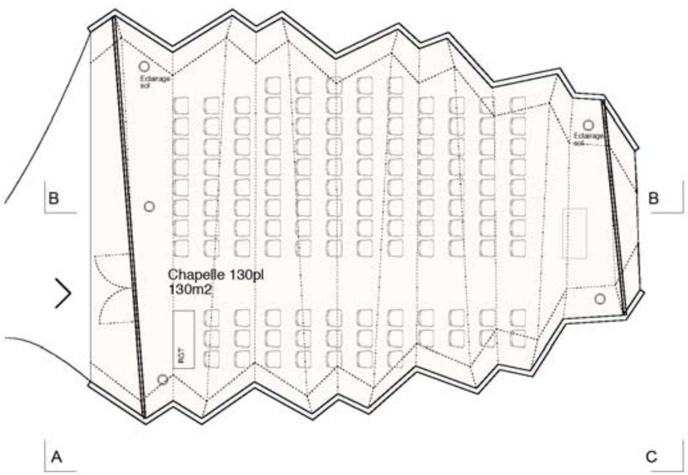


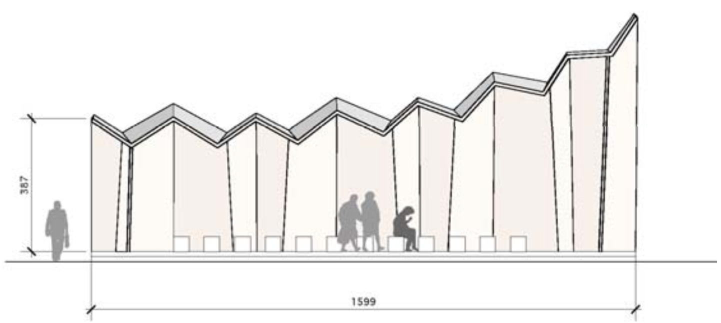


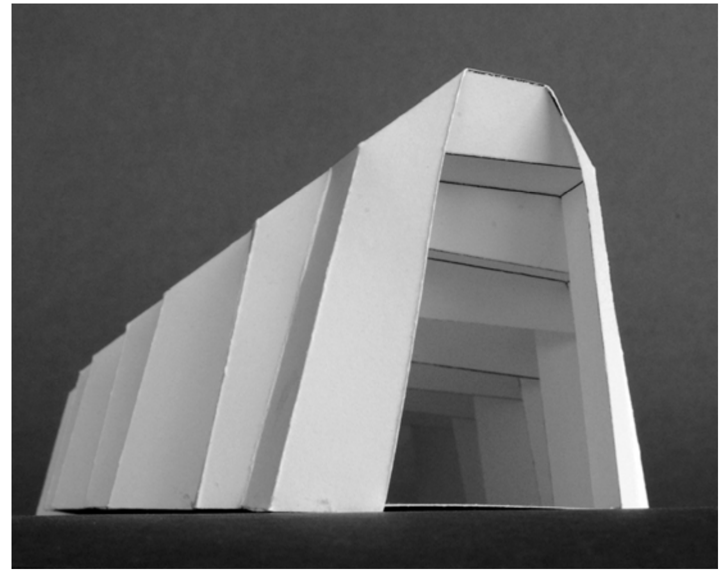


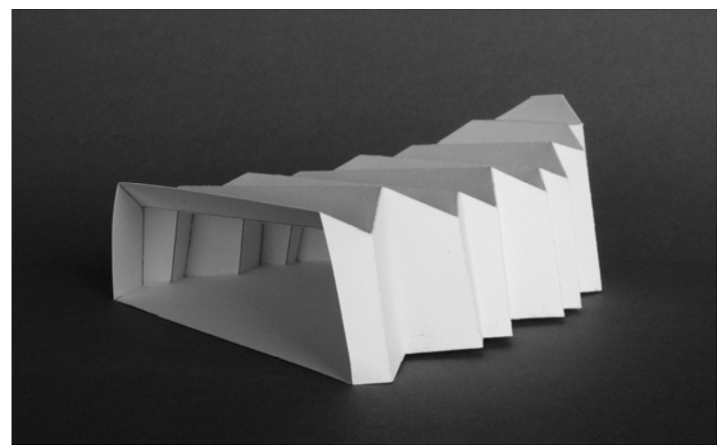
Atelier Weinand Spring 07 Prof. Yves Weinand, Hani Buri, Ivo Stotz
Student Sophie Carpentieri

2008, Chapelle St-Loup
Maître d'ouvrage : Communauté de diaconesses de Saint Loup
Architecte: Localarchitecture / Atelier d’architecture Danilo Mondada, Shel (Hani Buri, Yves Weinand; Architecture, engineering and production Design)



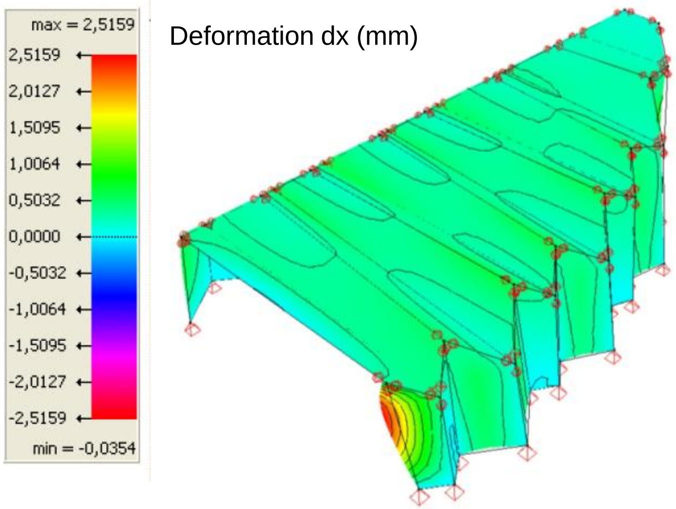


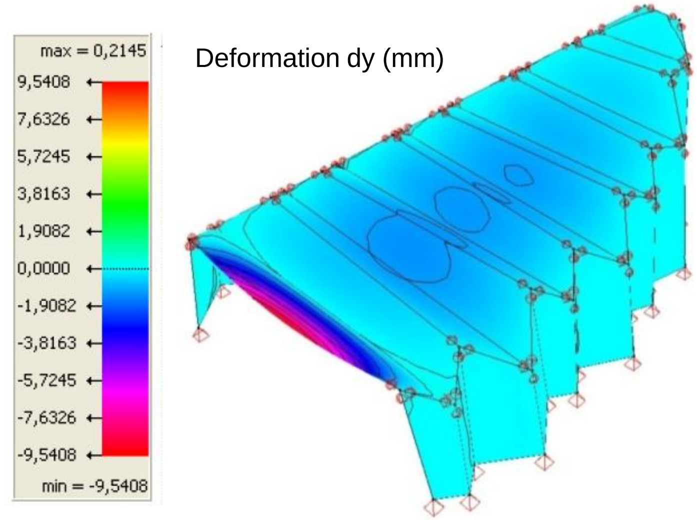




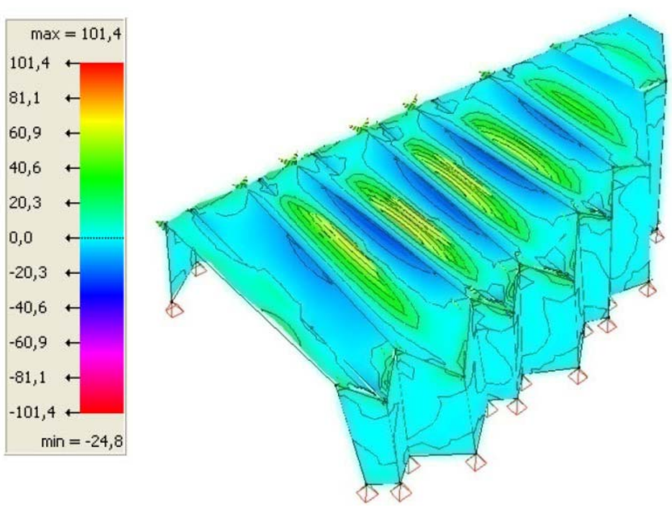
GROUPEMENT D’ARCHITECTES
Localarchitecture, Atelier d’architecture Danilo Mondada

SHEL (architecture, engineering, production design
Hani Buri, Yves weinand

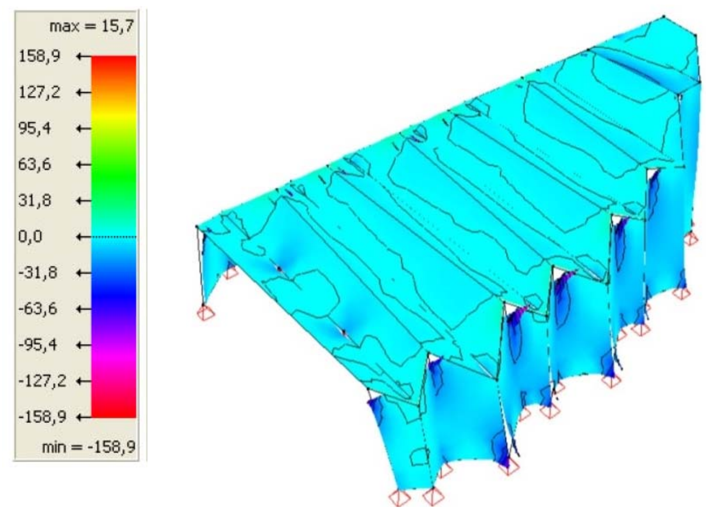




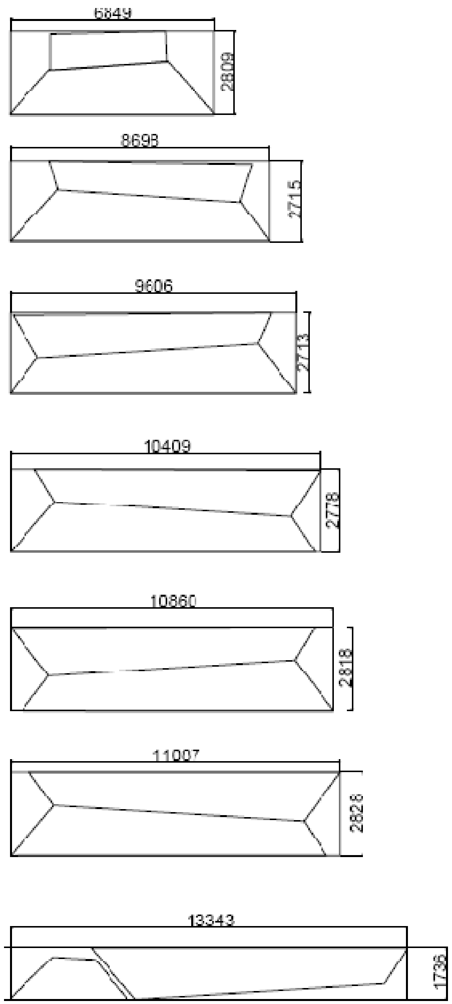
Membrane effort Nx



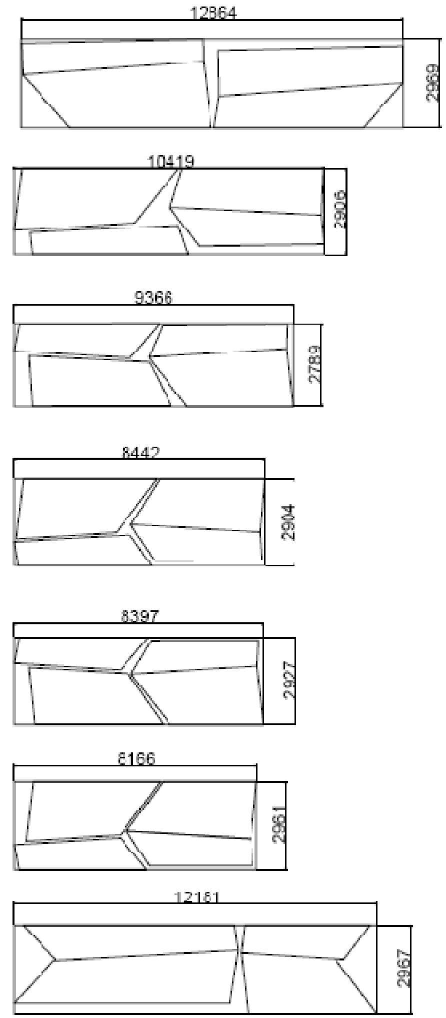
Membrane effort Nz

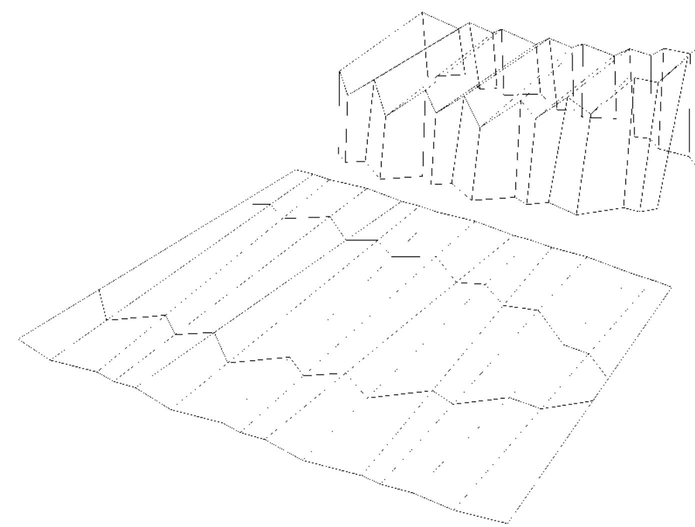


Timber block panels horizontal 60mm 151m2 net



Timber block panels vertical 40mm 175m2 net





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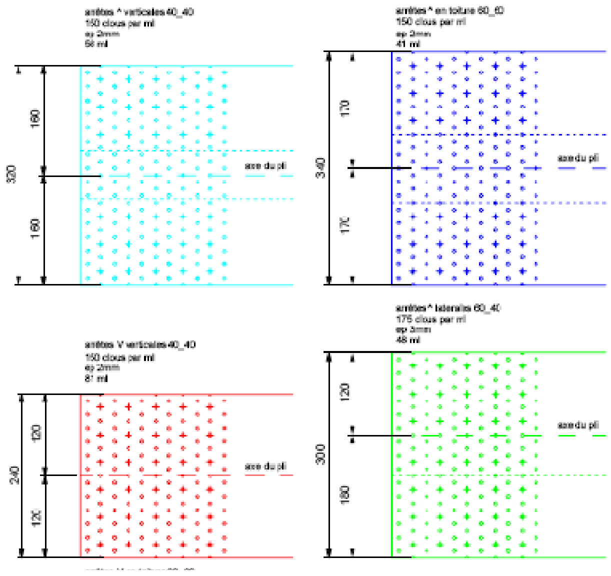
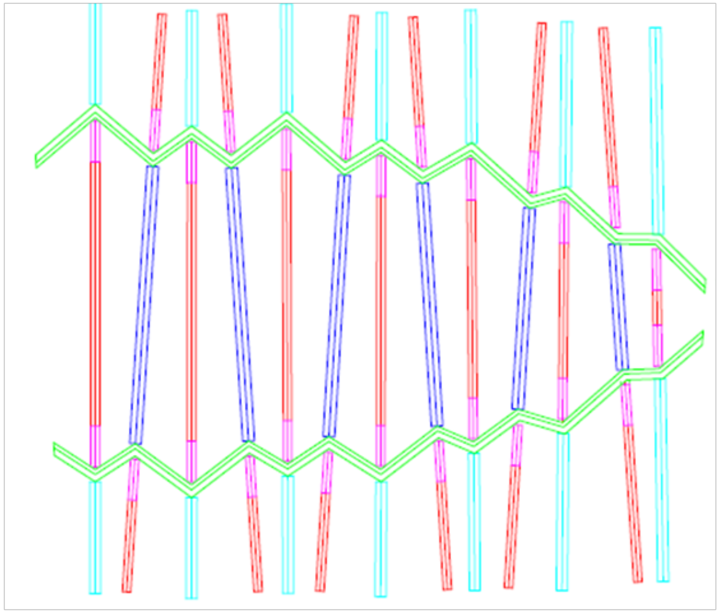
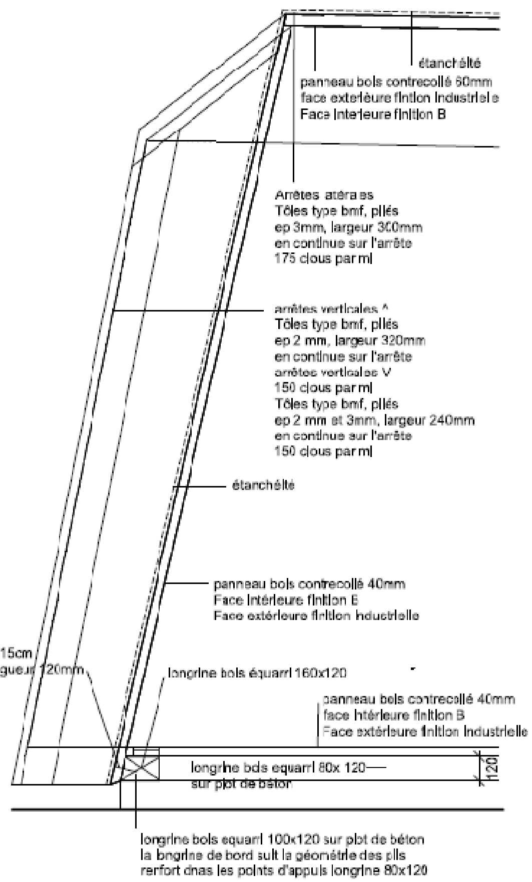


arêtes ^ verticales 40_40
150 clous par ml
ep 2mm
58 ml
160
160
320
axe du pli
arêtes ^ en toiture 60_60
150 clous par ml
ep 3mm
41 ml
170
170
340
axe du pli
arêtes V verticales 40_40
150 clous par ml
ep 2mm
81 ml
120
120
240
axe du pli
arêtes ^ latérales 60_40
175 clous par ml
ep 3mm
48 ml
120
180
300
axe du pli





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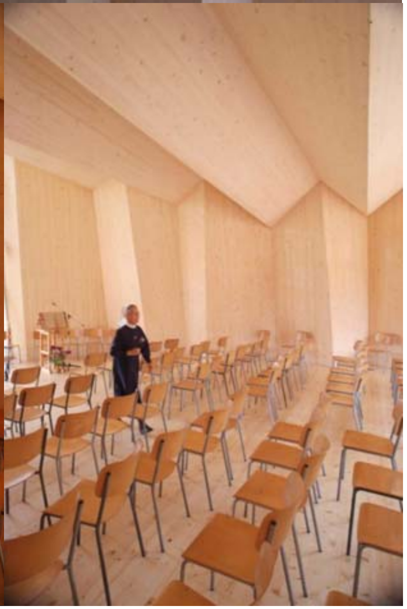

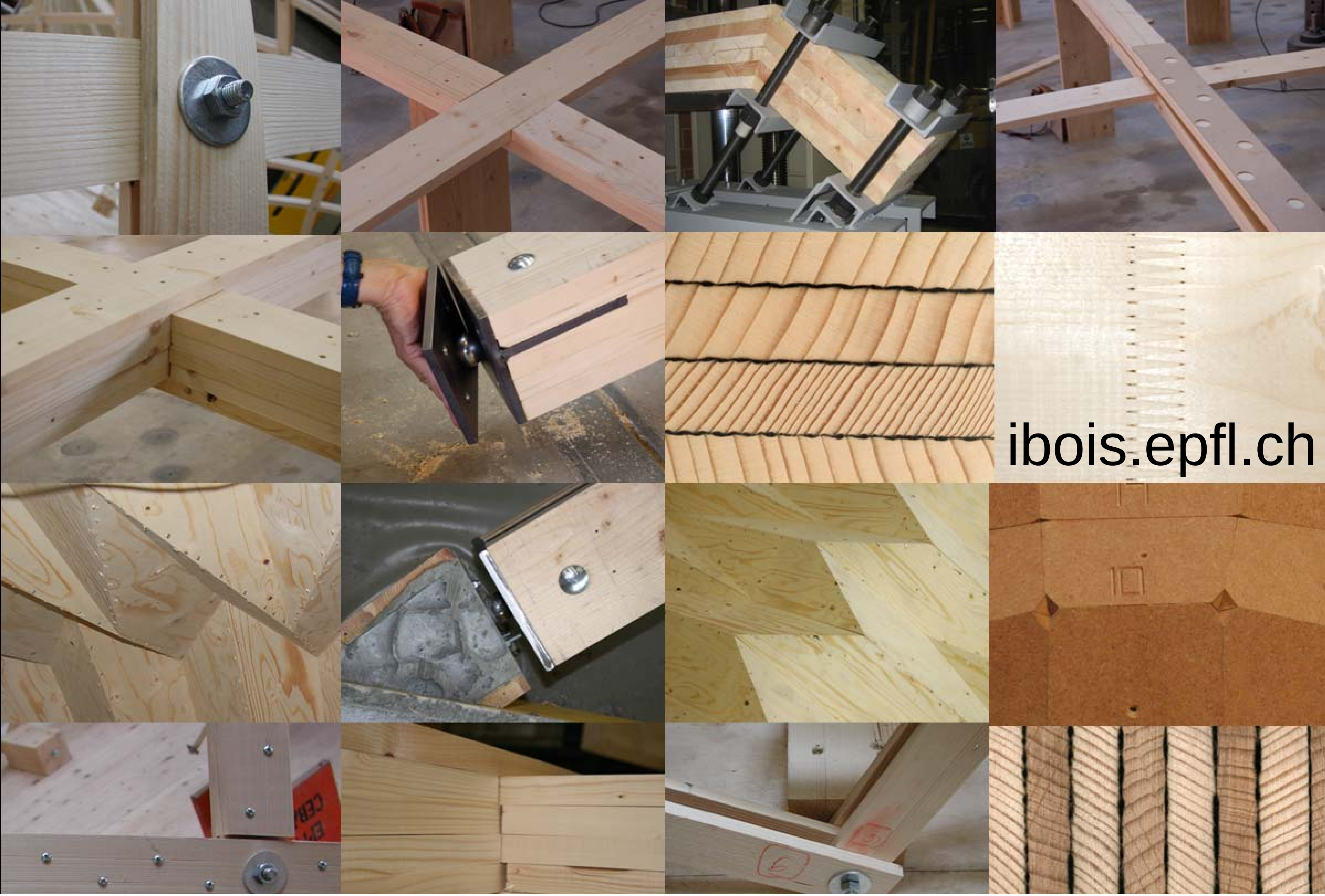

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