WORLD BAMBOO CONGRESS
ANTWERP, BELGIUM APRIL 10-15, 2012

Low CO_2 construction using Bamboo-Guadua in Colombia

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Department of Mechanical Engineering

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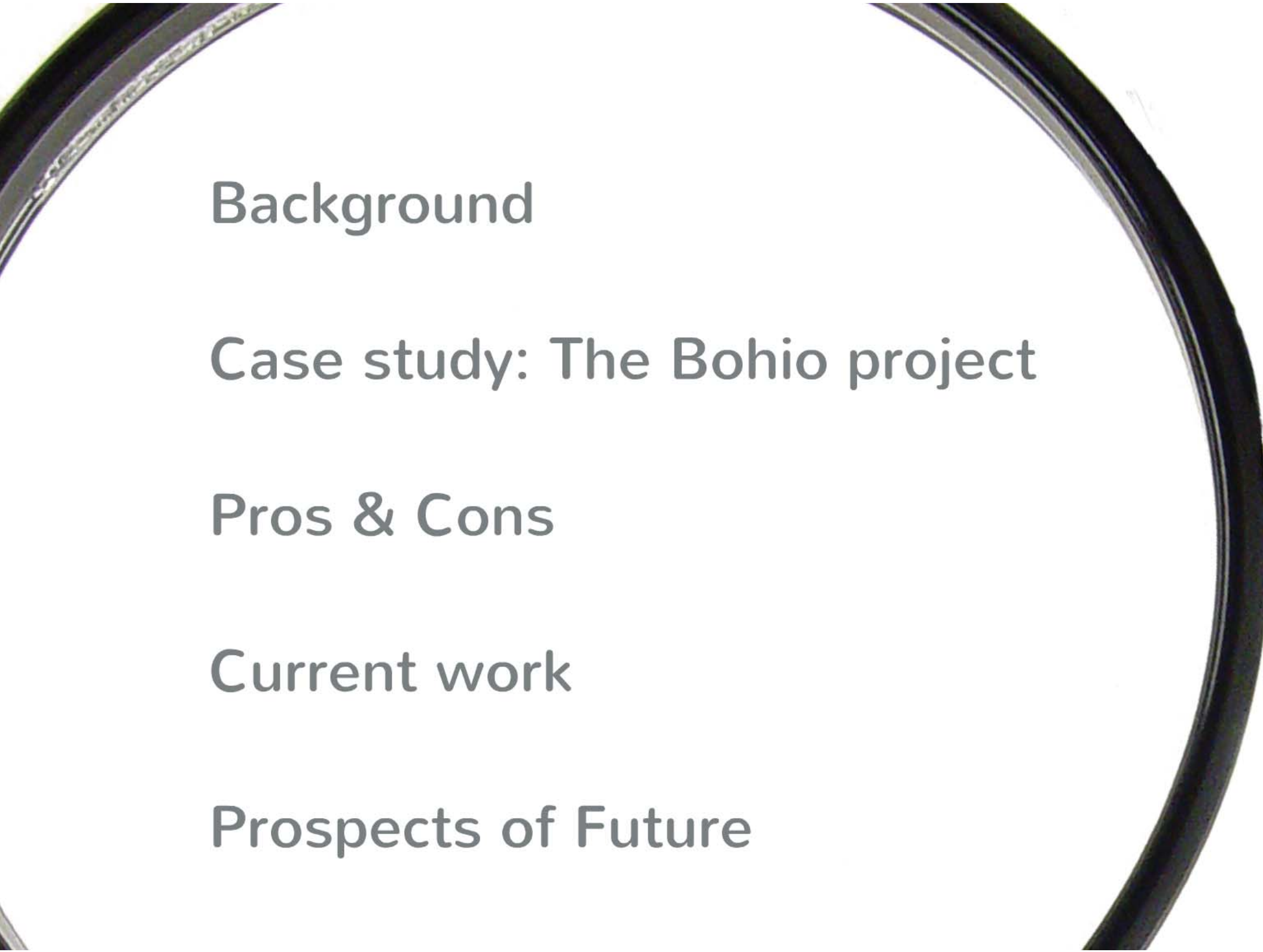
PhD Researcher

Dr. Martin P. Ansell
Prof. Pete Walker
Dr. Wen-Shao Chang

Outline


Background
Case study: The Bohio project
Pros & Cons
Current work
Prospects of Future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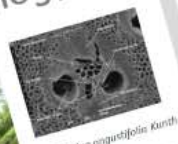
Bamboo-Guadua

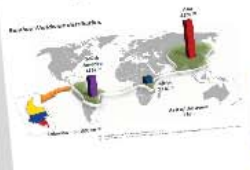
Anatomy & Morphology





Guadua angustifolia Kunth

Distribution, growth and renewability




NWFP: FRA 2010-FAO

Reduce pressure on wood forests

Wood substitute

Construction material



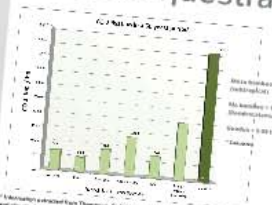

Structures

Bahareque encementado

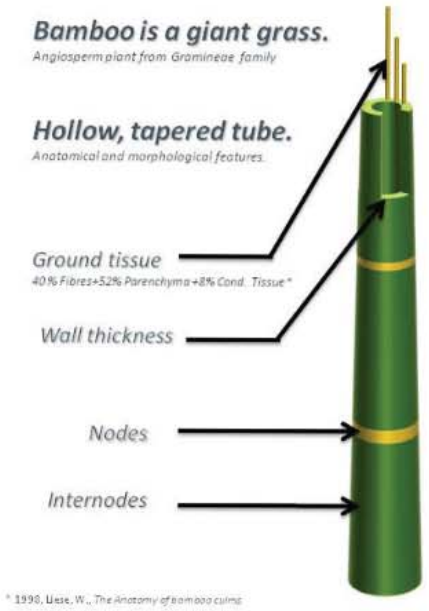
Environmental services

Water conservation
Land slides
Erosion

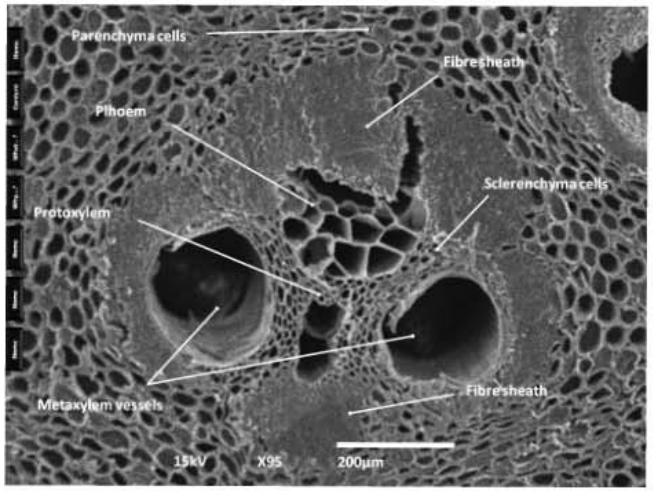
CO2 sequestration



Anatomy & Morphology



* 1998, Liese, W., *The Anatomy of bamboo culms*



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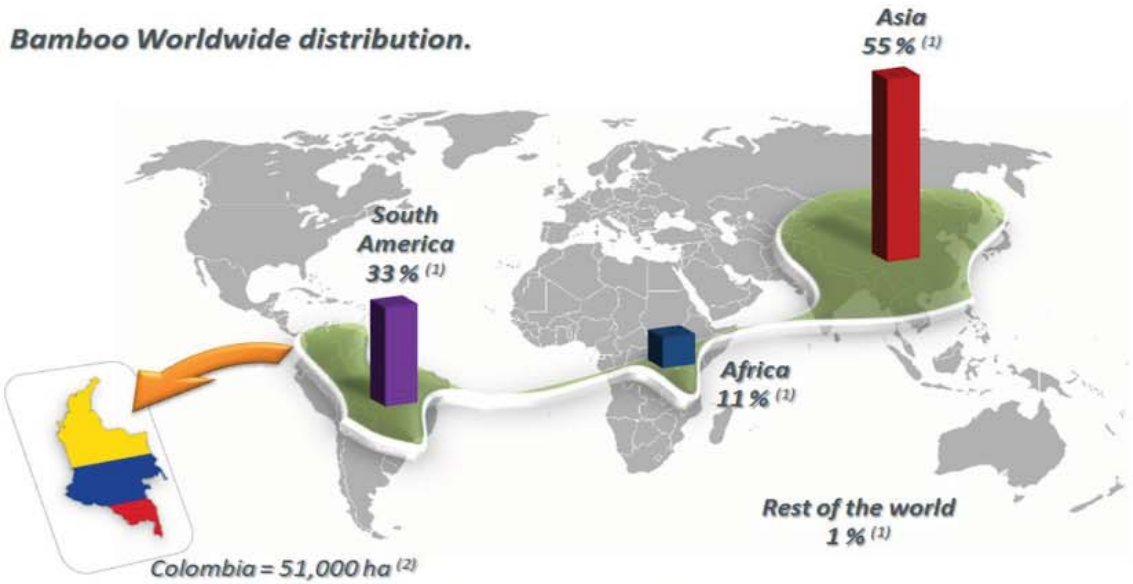
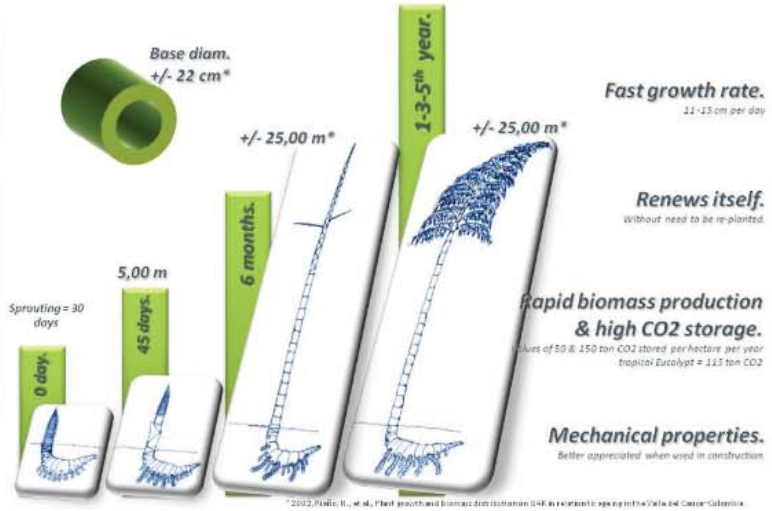
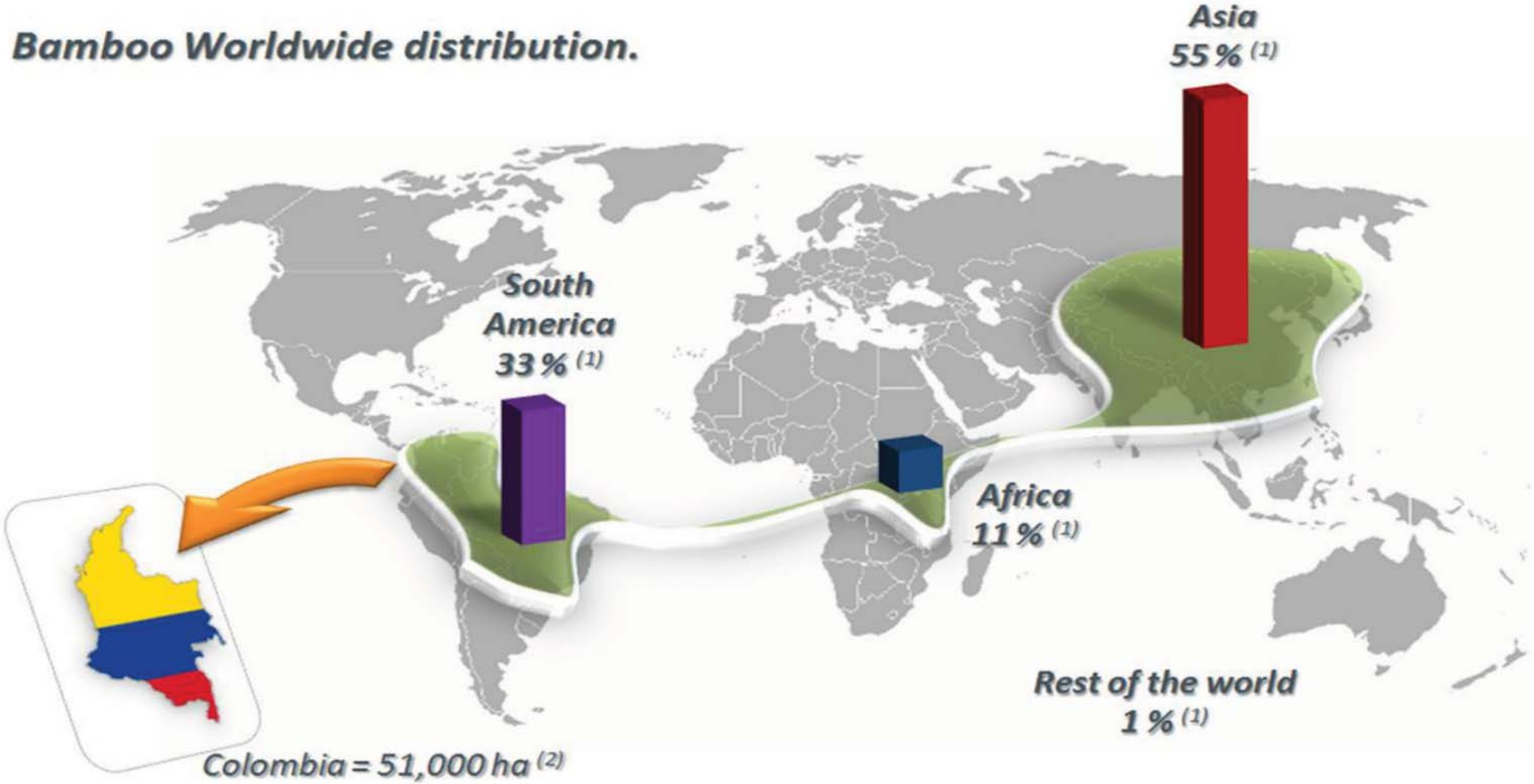


(1) 2010, FAO, Global Forest Resources Assessment 2010.
(2) 2002, Riaño, N., et al., Plant growth and biomass distribution on GAK in relation to ageing in the Valle del Cauca–Colombia.



Bamboo Worldwide distribution.



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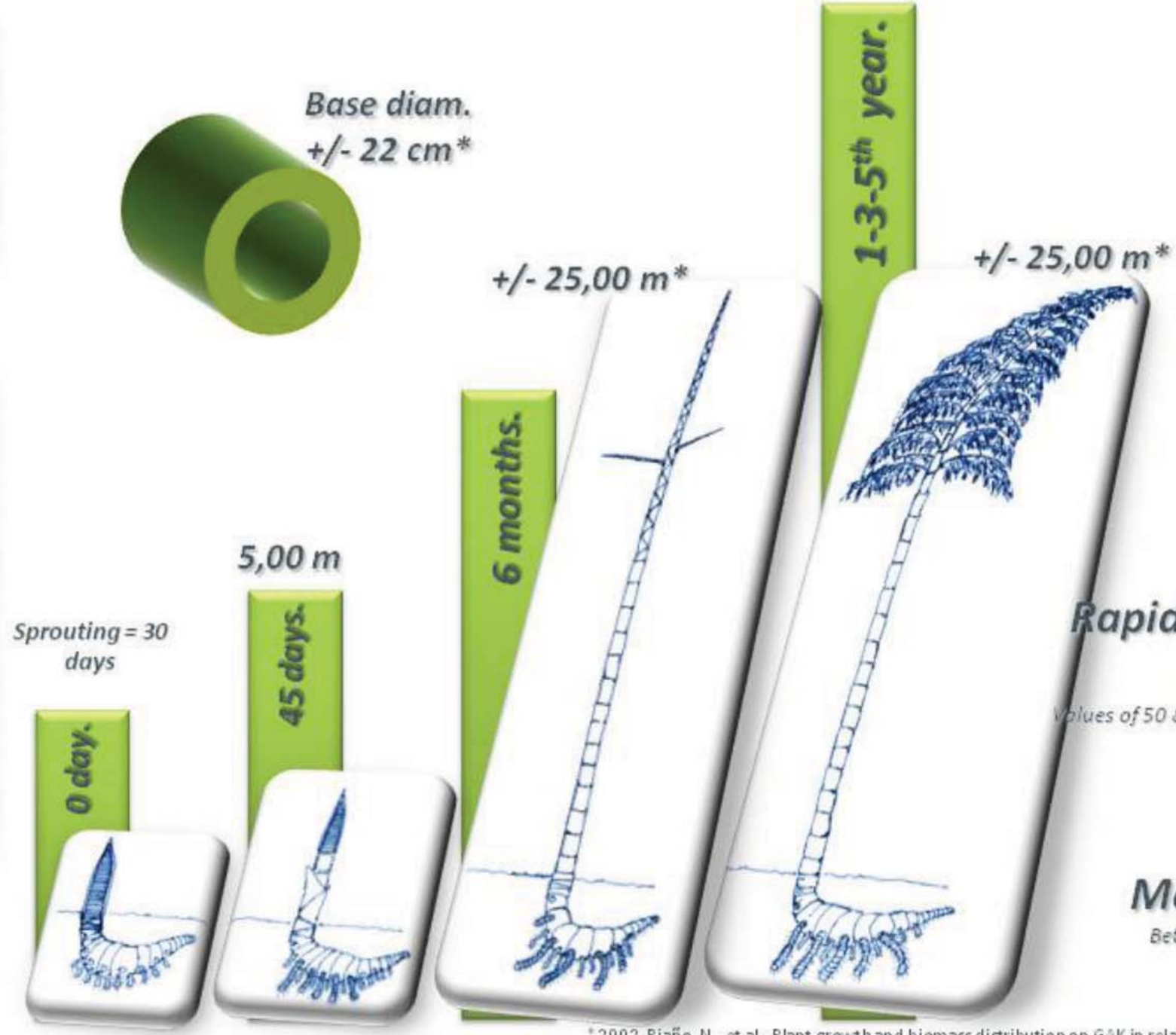


Fast growth rate.

11 -15 cm per day

Renews itself.

Without need to be re-planted.

Rapid biomass production & high CO2 storage.

Values of 50 & 150 ton CO2 stored per hectare per year
tropical Eucalypt = 115 ton CO2

Mechanical properties.

Better appreciated when used in construction.

*2002, Riaño, N., et al., Plant growth and biomass distribution on GAK in relation to ageing in the Valle del Cauca–Colombia.

Environmental services

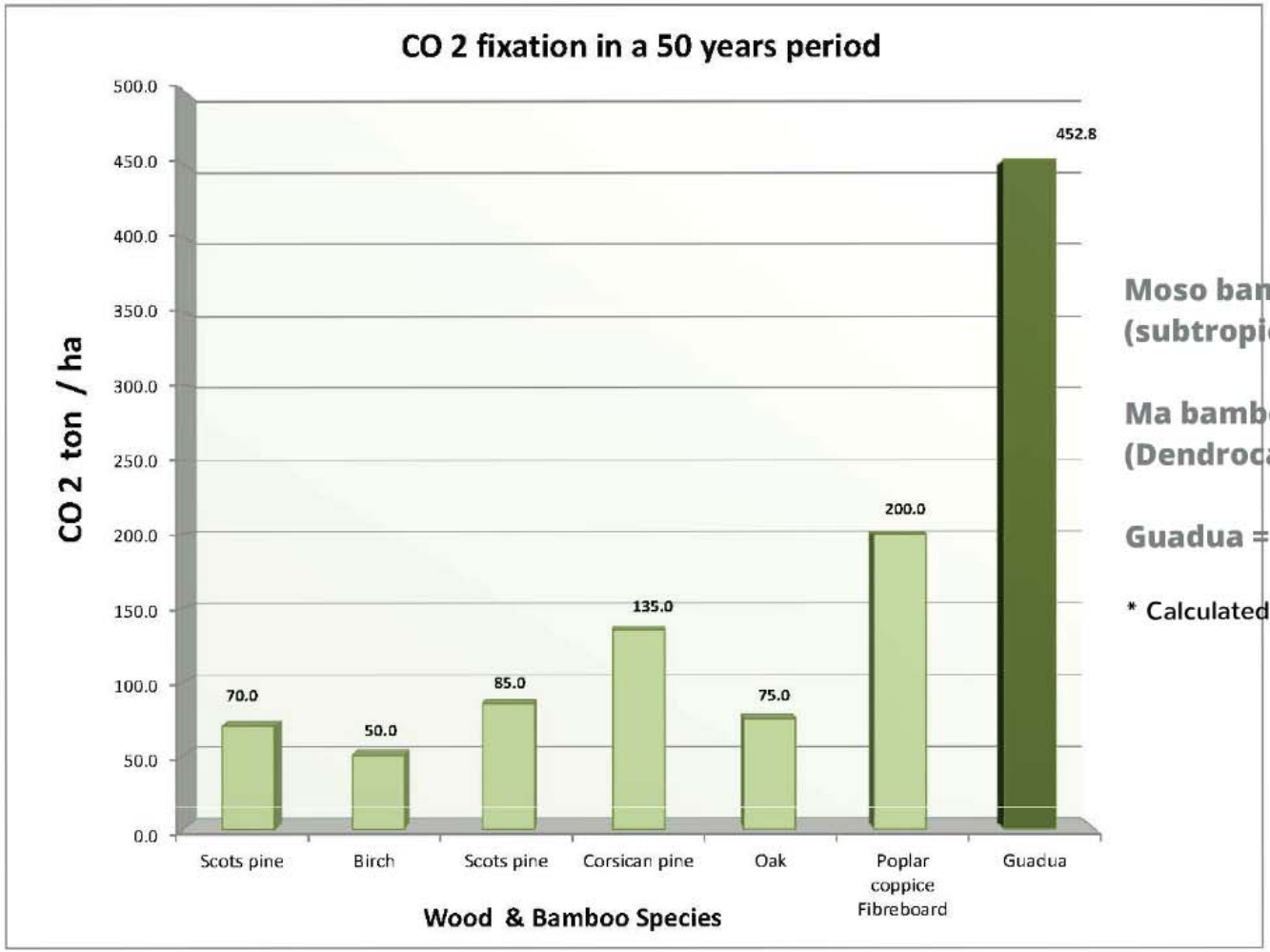
Water conservation
Land slides
Erosion

NWFP: FRA 2010-FAO

Reduce pressure on wood forests

Wood substitute

CO2 sequestration



Moso bamboo = 3.1 tons C/ha/year* (subtropical)

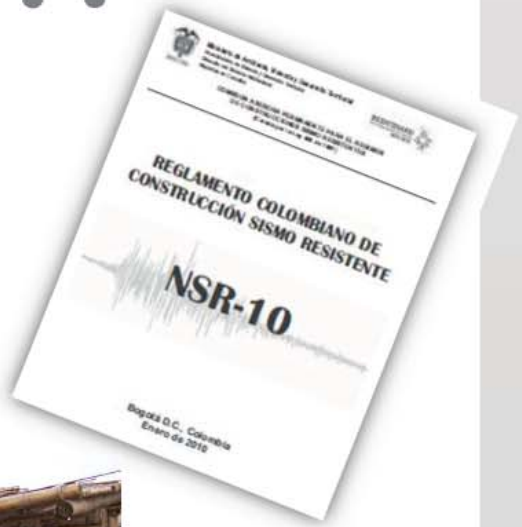
Ma bamboo = 12.8 tons C/ha/year* (Dendrocalamus latiflorus -tropical)

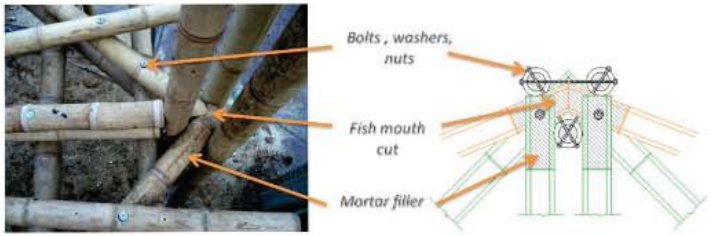
Guadua = 9.08 tons C/ha/year

* Calculated

* Information extracted from Thompson, D. & Matthews, R. (1989) and Riaño, N. et al. (2002), INBAR's report: Bamboo and climate change mitigation (Lou, et al., 2010),

Construction material



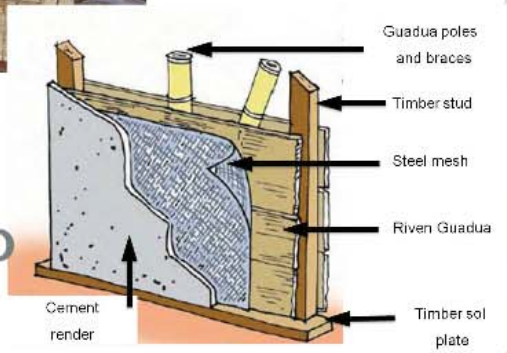


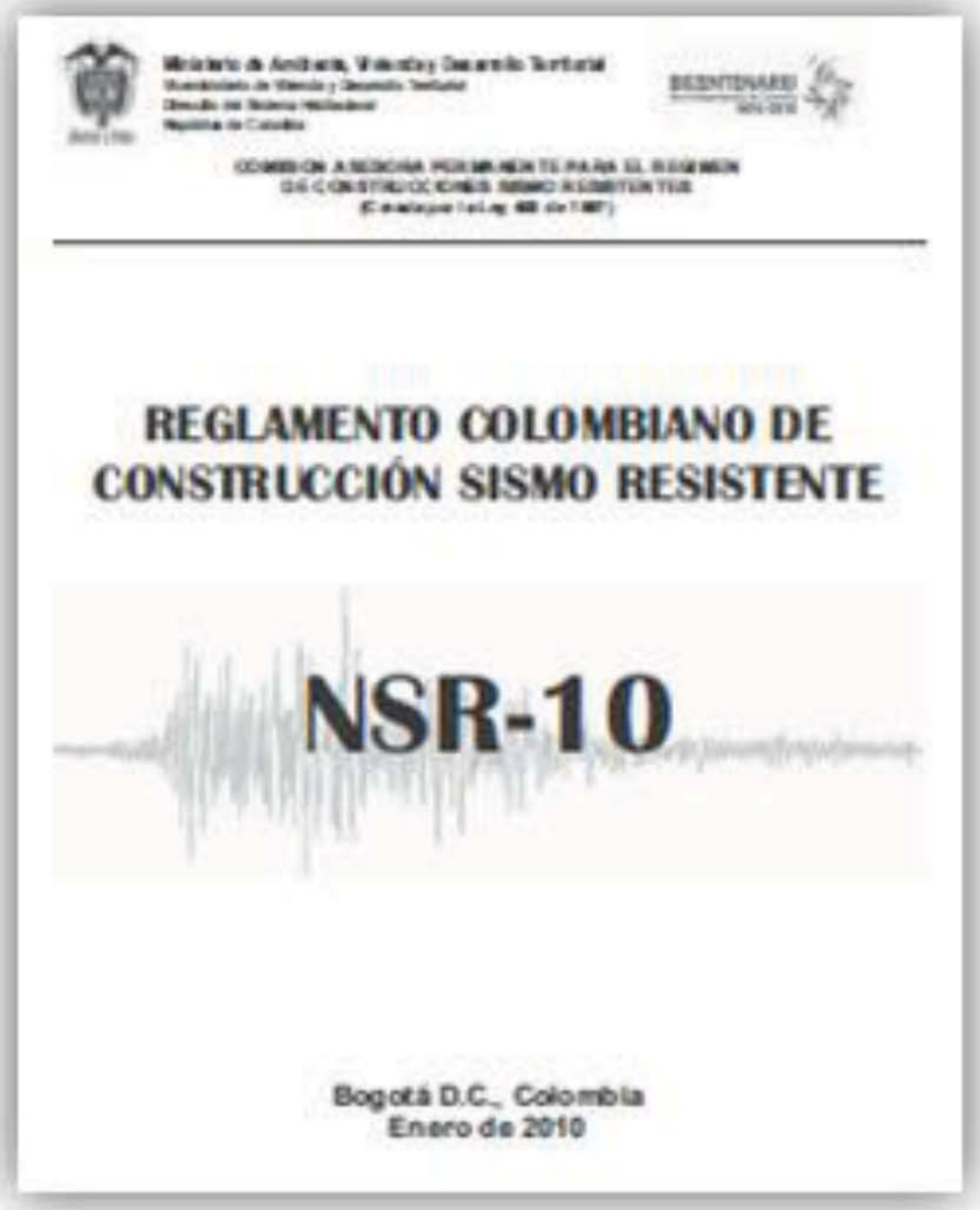
Structures

For commercial, institutional, educational and residential uses.

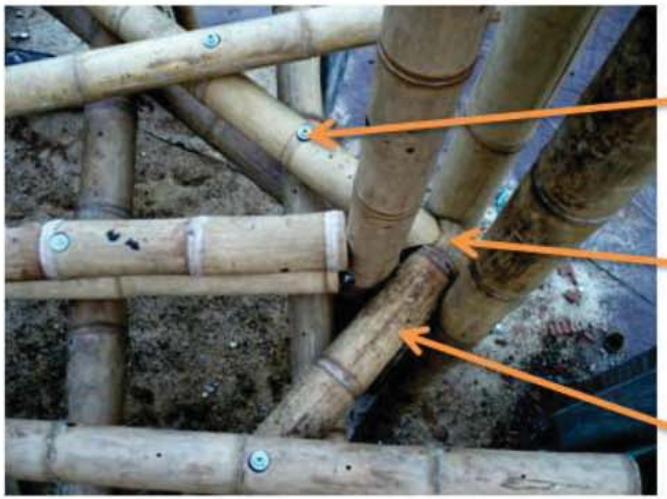
Bahareque encementado

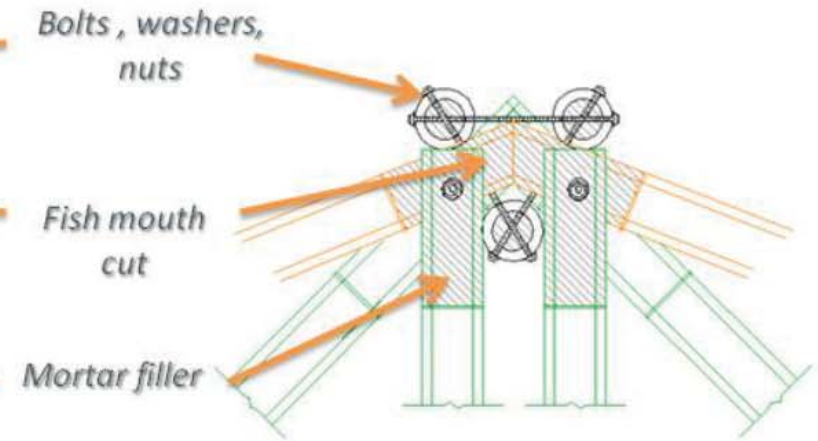
One & two storey guadua frame dwellings.




REGLAMENTO COLOMBIANO DE
CONSTRUCCIÓN SISMO RESISTENTE
NSR-10
Bogotá D.C., Colombia
Enero de 2010

Guadua structure.
2000 sq meters, Warehouse in Bogotá D.C., Colombia





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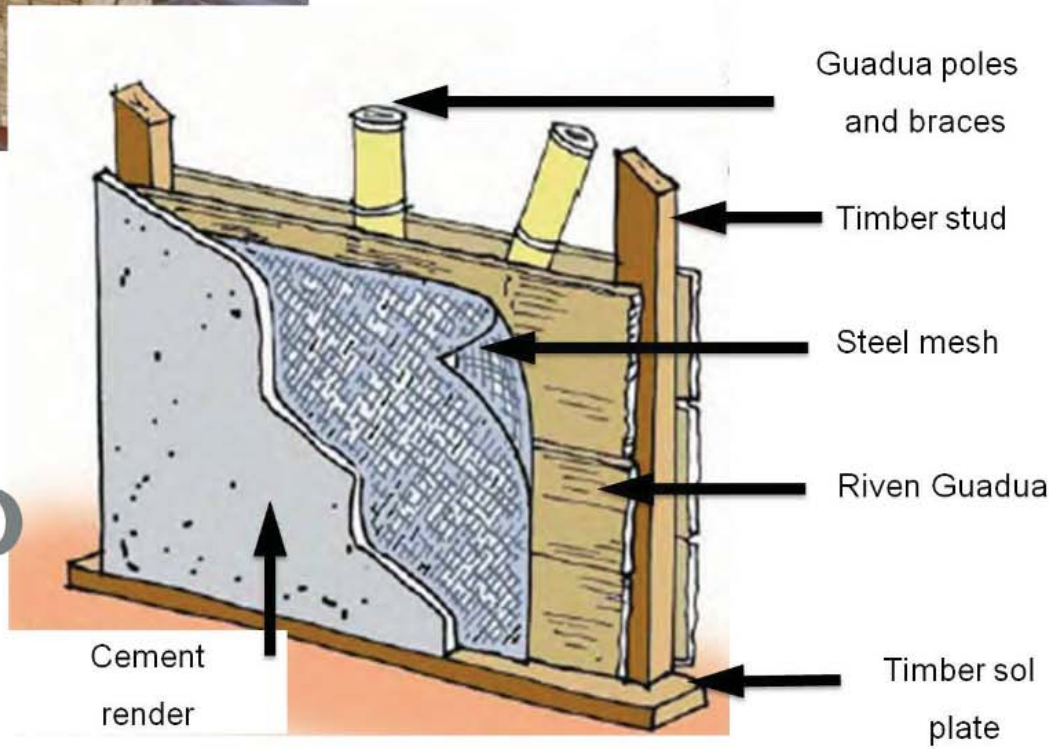


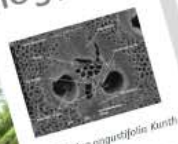
Bahareque encementado

One & two storey guadua frame dwellings.

Bamboo-Guadua

Anatomy & Morphology





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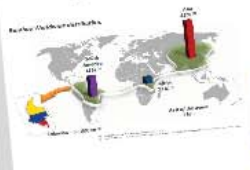


NWFP: FRA 2010-FAO

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Wood substitute

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Water conservation
Land slides
Erosion

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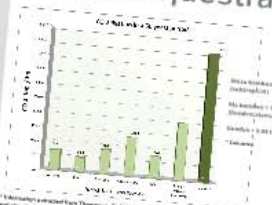

construction

using

oo-Guadu


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Guadua structure.

2000 sq meters, Warehouse in Bogotá D.C., Colombia

Bahareque + Structures system

Frame

Sheathing

Riven Guadua

Steel mesh

Cement

Foundations

But...

CO2...?

85 % wall mass = cement + steel*

95 % negative impact = other materials*

*Murphy et al., 2004

&

Questions...?

The Bohio Project

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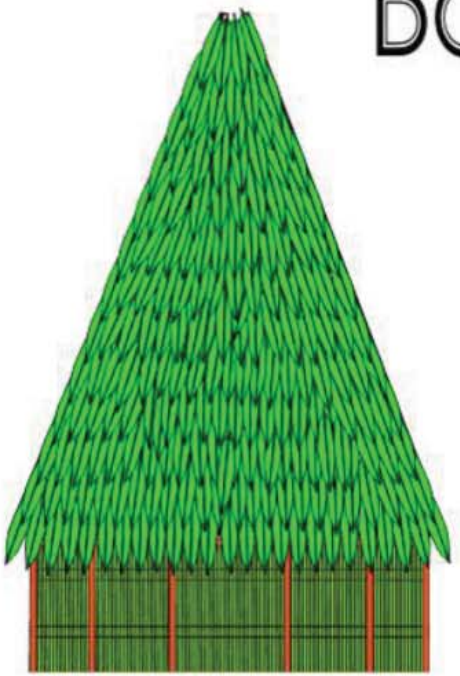
Low CO_2 construction

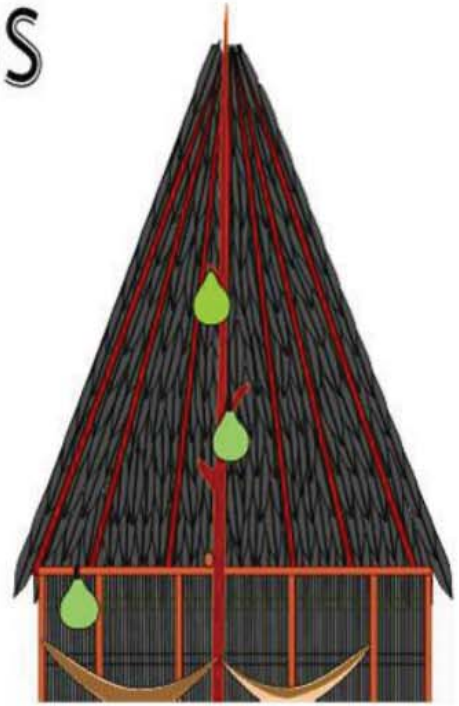
using

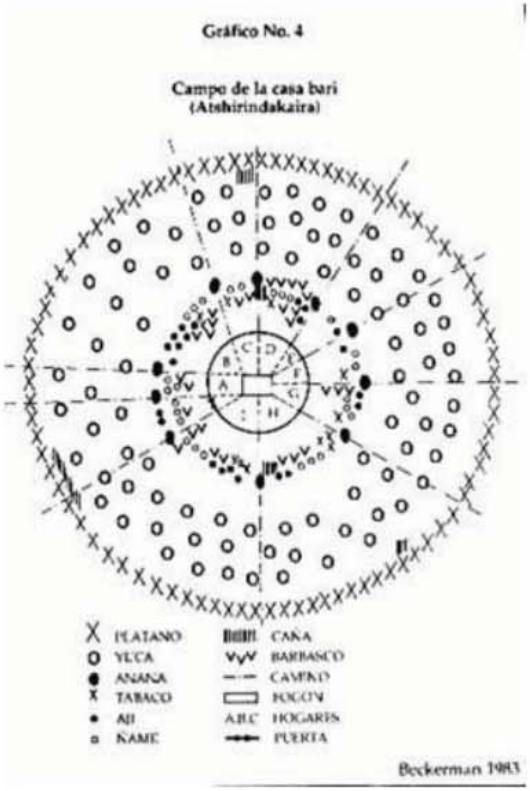
The concept

Vernacular architecture - Local materials - Communal space - Structure

Bohios

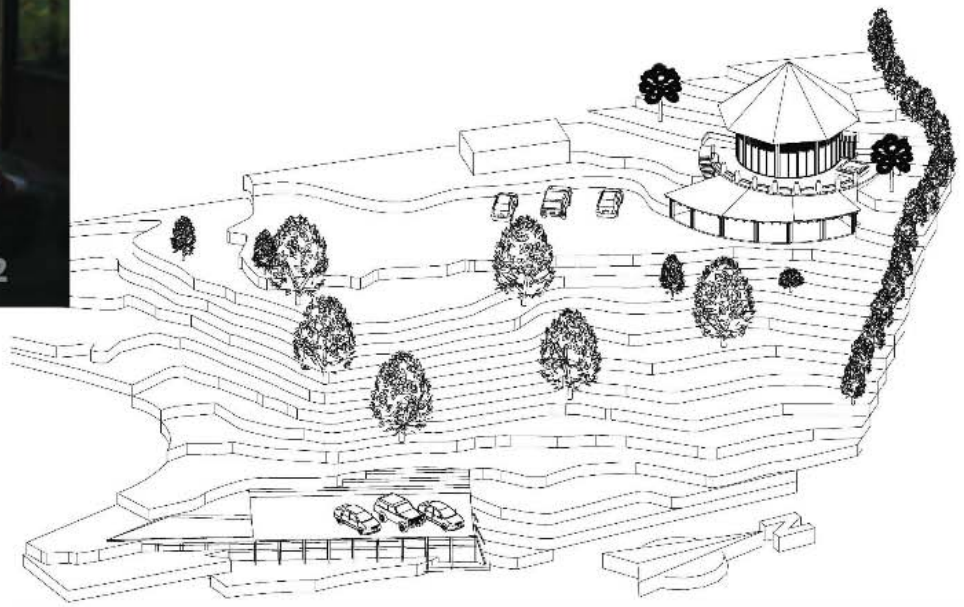






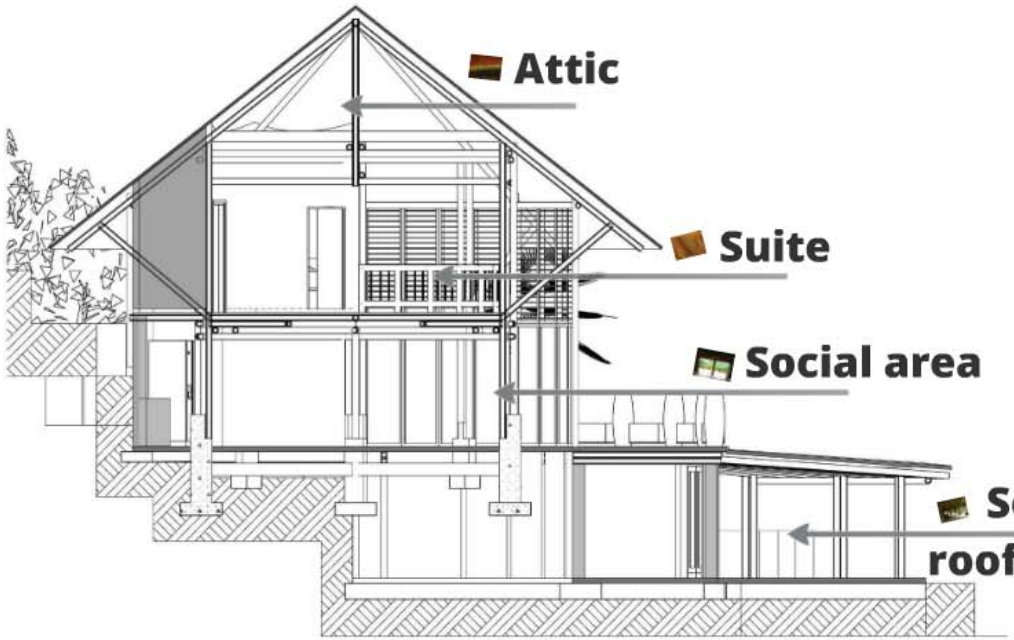
The Bohio I

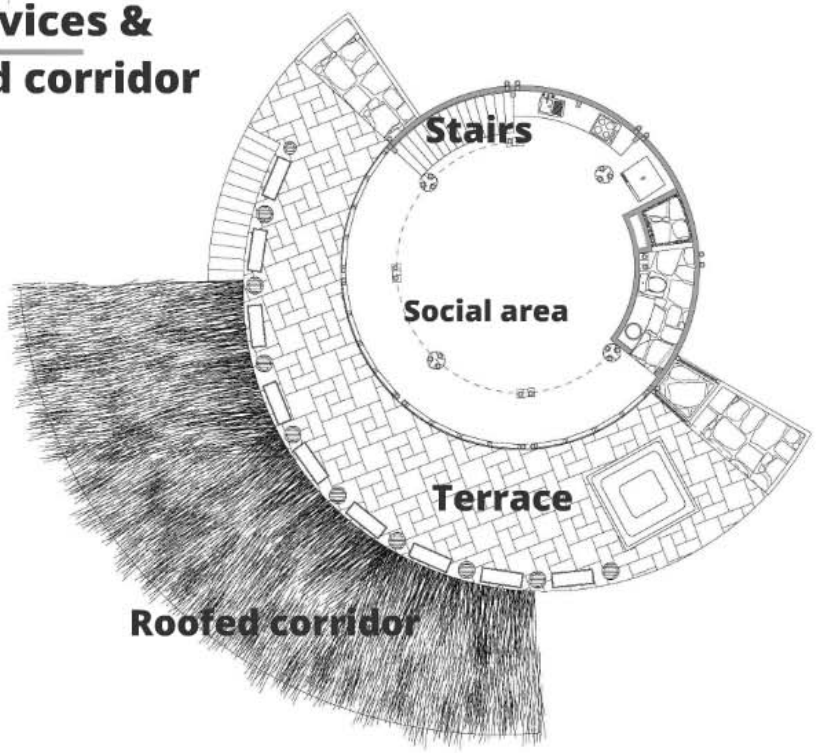
Location, views & Landscape



Plan & section

Functional - Structural





First floor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Materials


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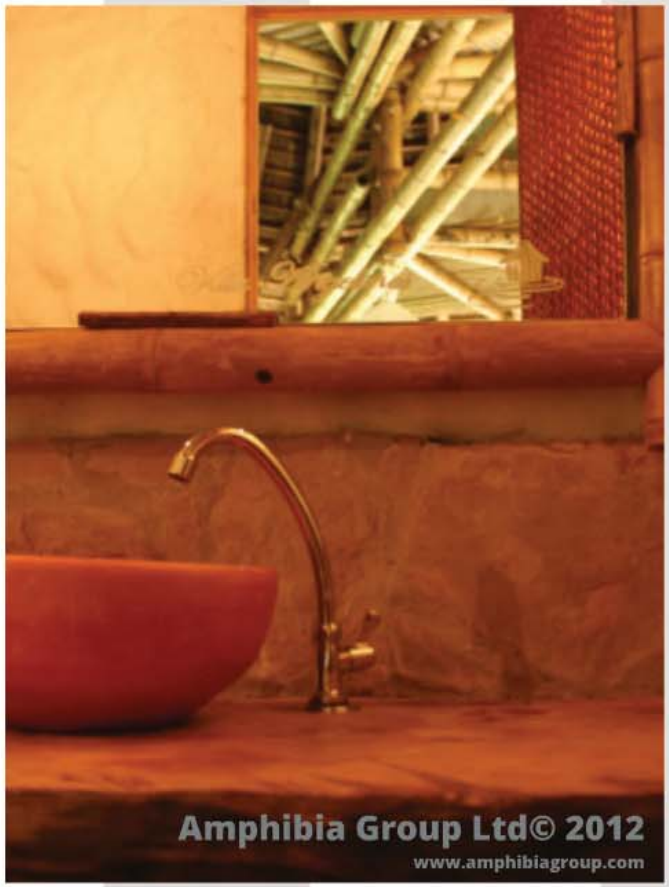
Ma

ateria



12
com

IS

Result

Beautiful
Inspirational
Full of identity
Meaningful
Challenging
Handcraft
Prestige
"Cheap"

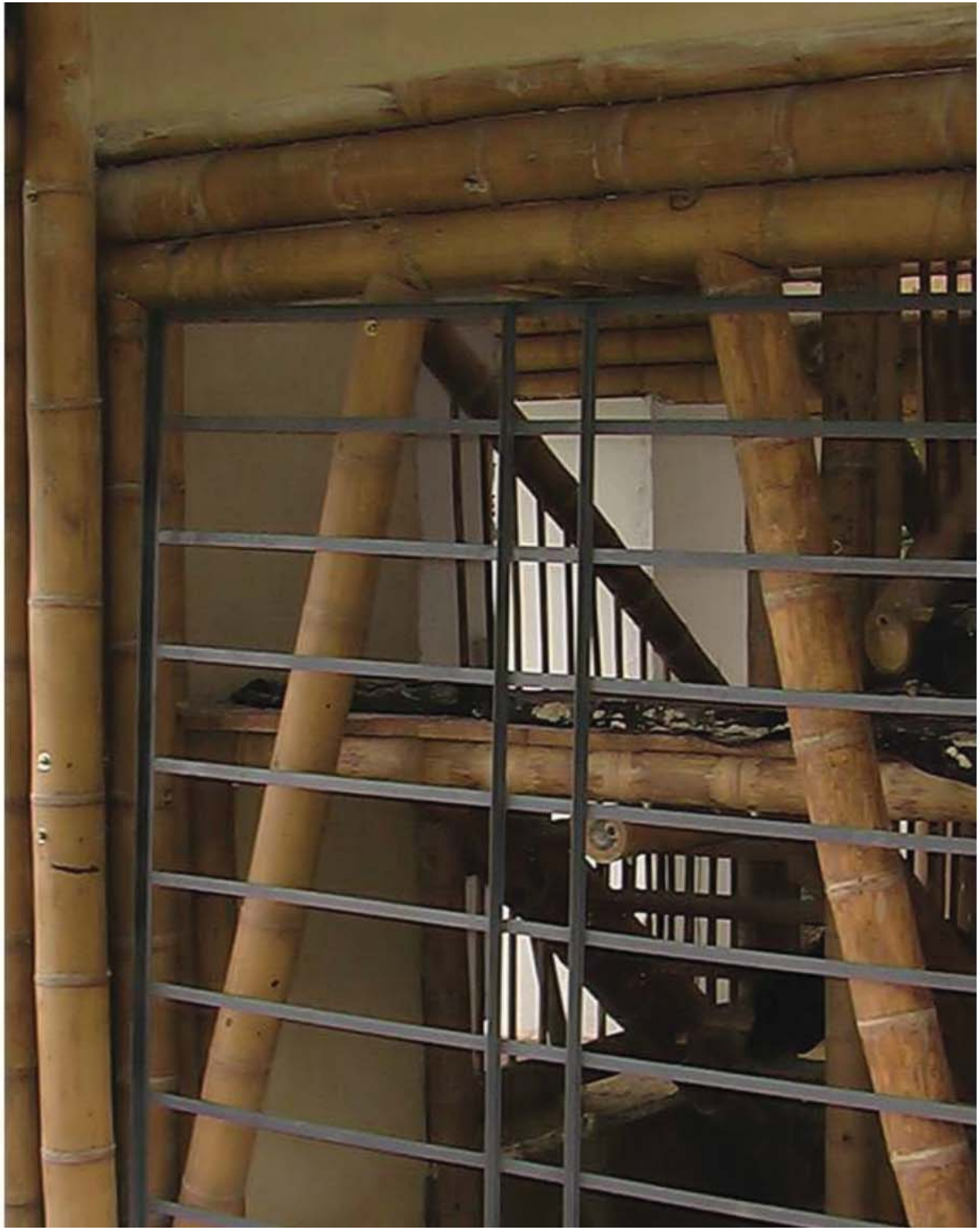
But...

Challenges

Irregularity
(diameter, linearity, waste)

Intensive handicraft process
(Verticality & Horizontality)

Incompatibility with building elements



Bracing with Guadua culms

Thick cement renders =
Negative environmental impact

Biodeterioration
(plagues, weather exposure
and humidity)

Time

Eco-cost (straw)

Non-fire proofing

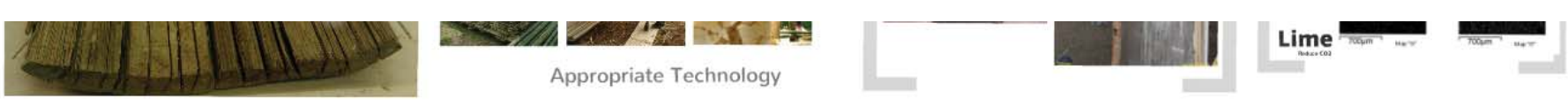
Increased maintenance

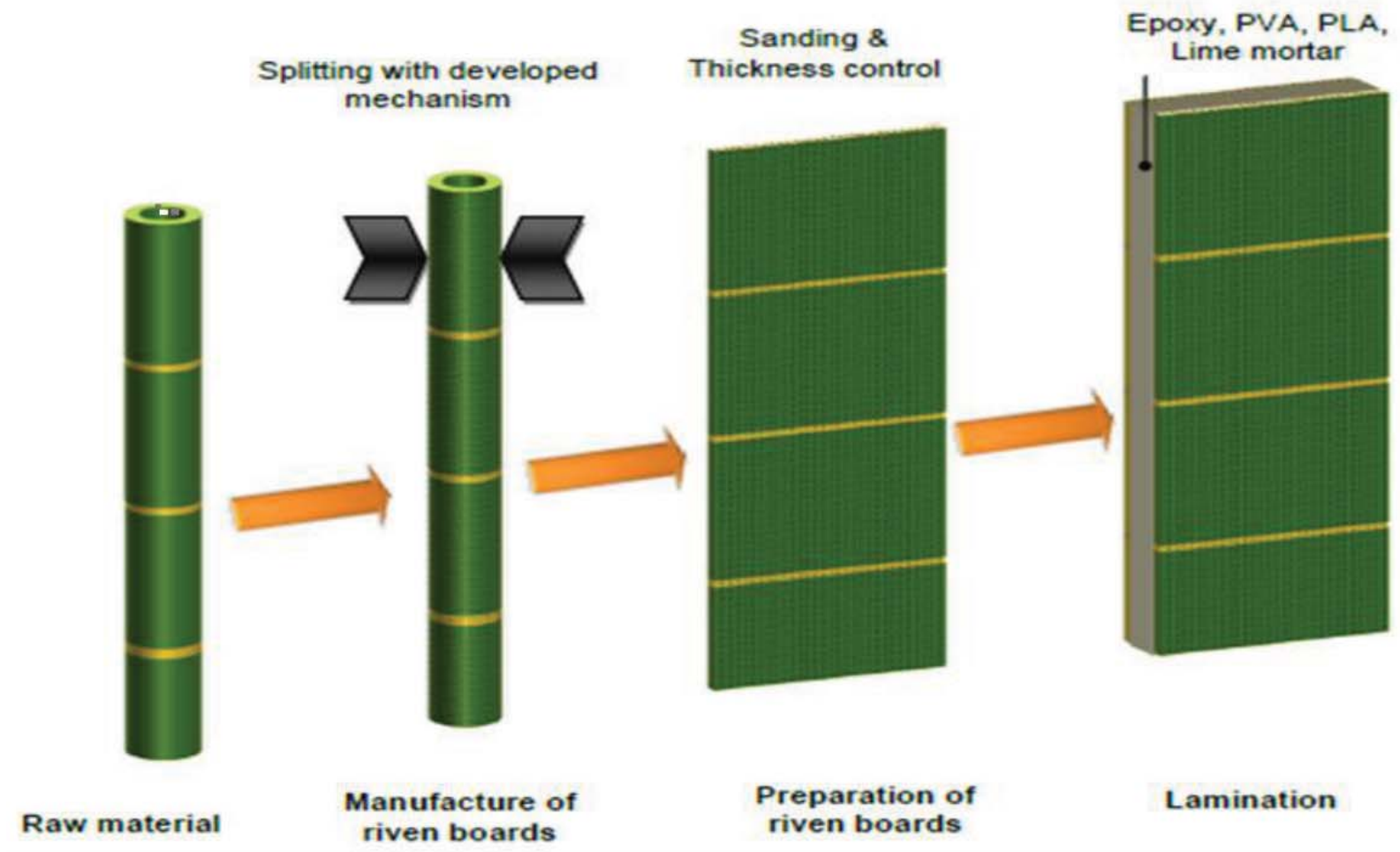
Restricted (height & capacity)

Rudimentary appeal

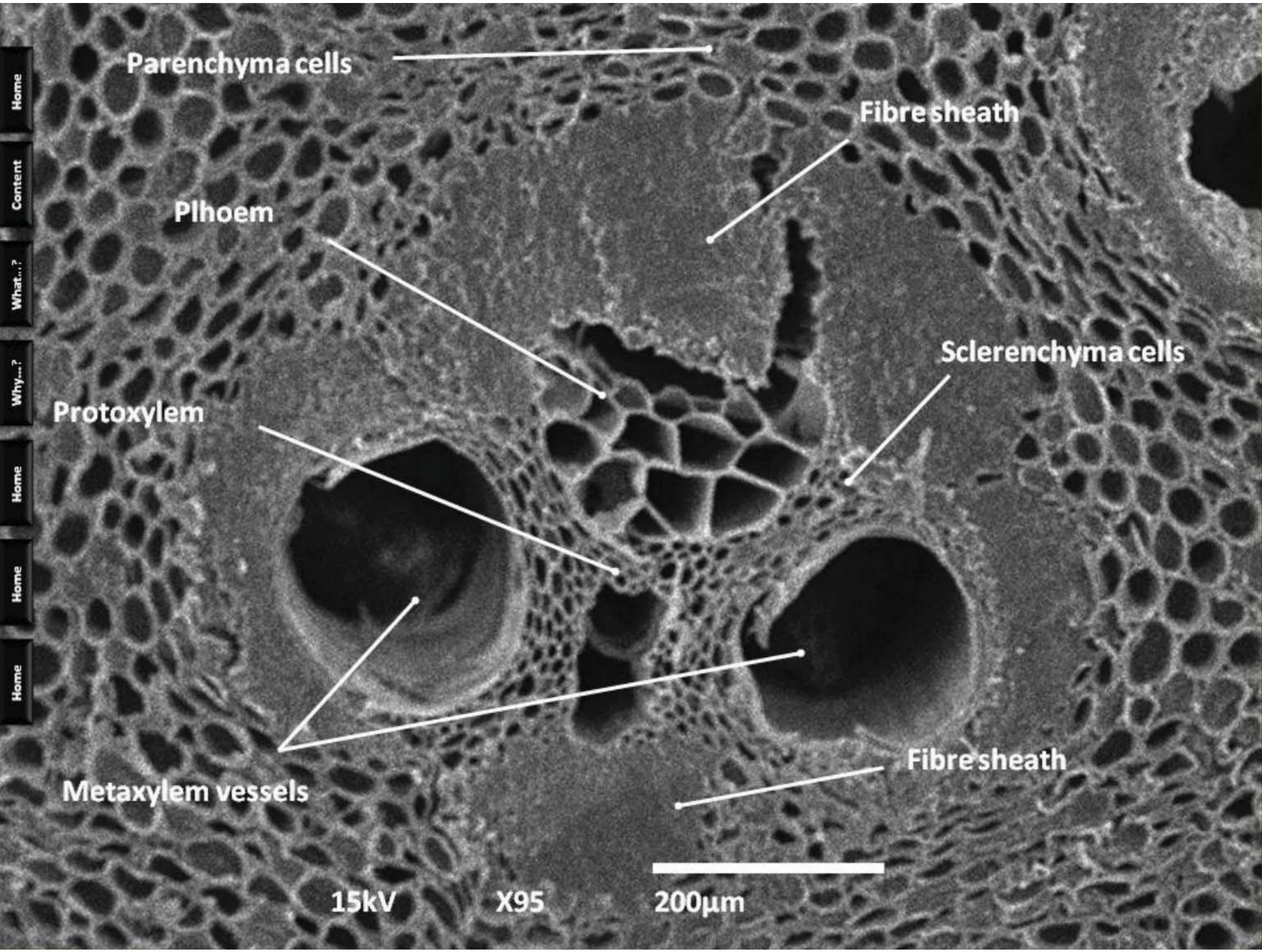
UNIVERSITY OF BATH

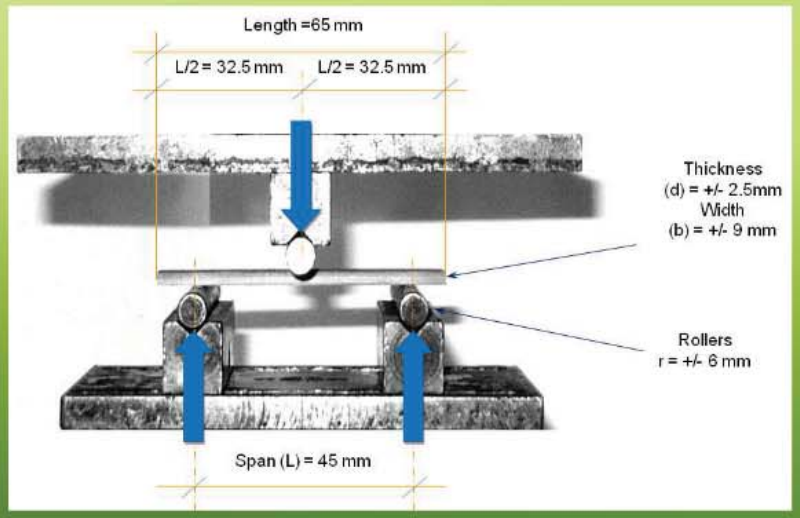
Proposal

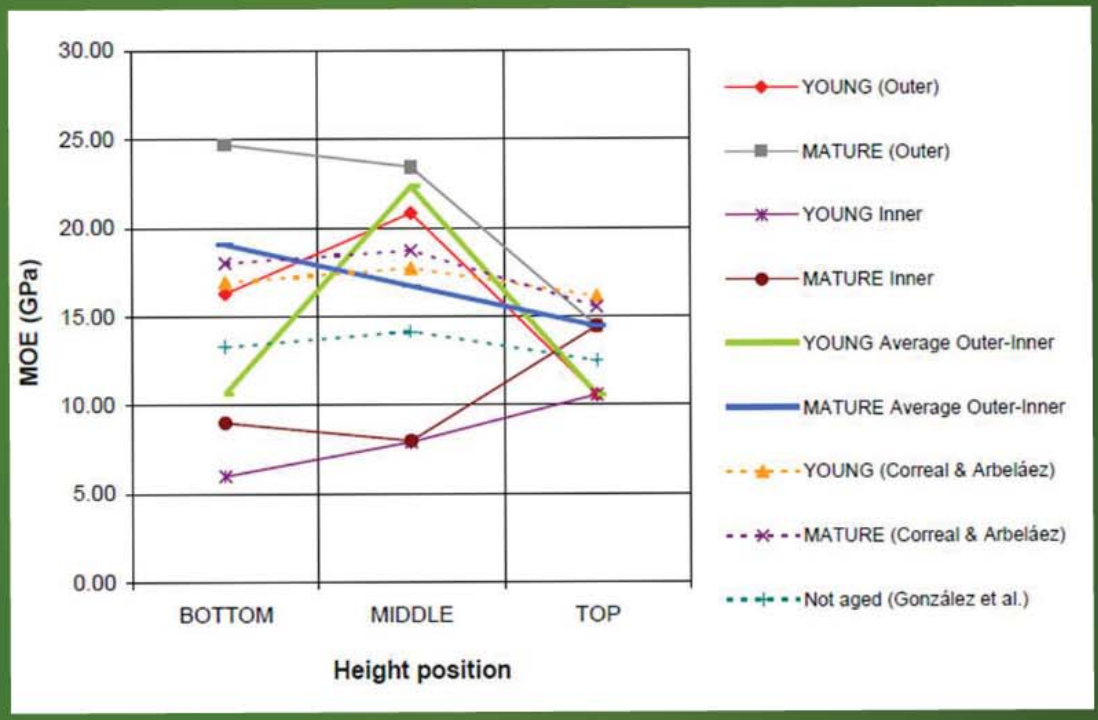




Development of structural panels with riven Guadua boards


Parenchyma cells
Fibre sheath
Plhoem
Sclerenchyma cells
Protoxylem
Metaxylem vessels
Fibre sheath
15kV
X95
200µm


Length =65 mm
L/2 = 32.5 mm
L/2 = 32.5 mm
Thickness
(d) = +/- 2.5mm
Width
(b) = +/- 9 mm
Rollers
r = +/- 6 mm
Span (L) = 45 mm

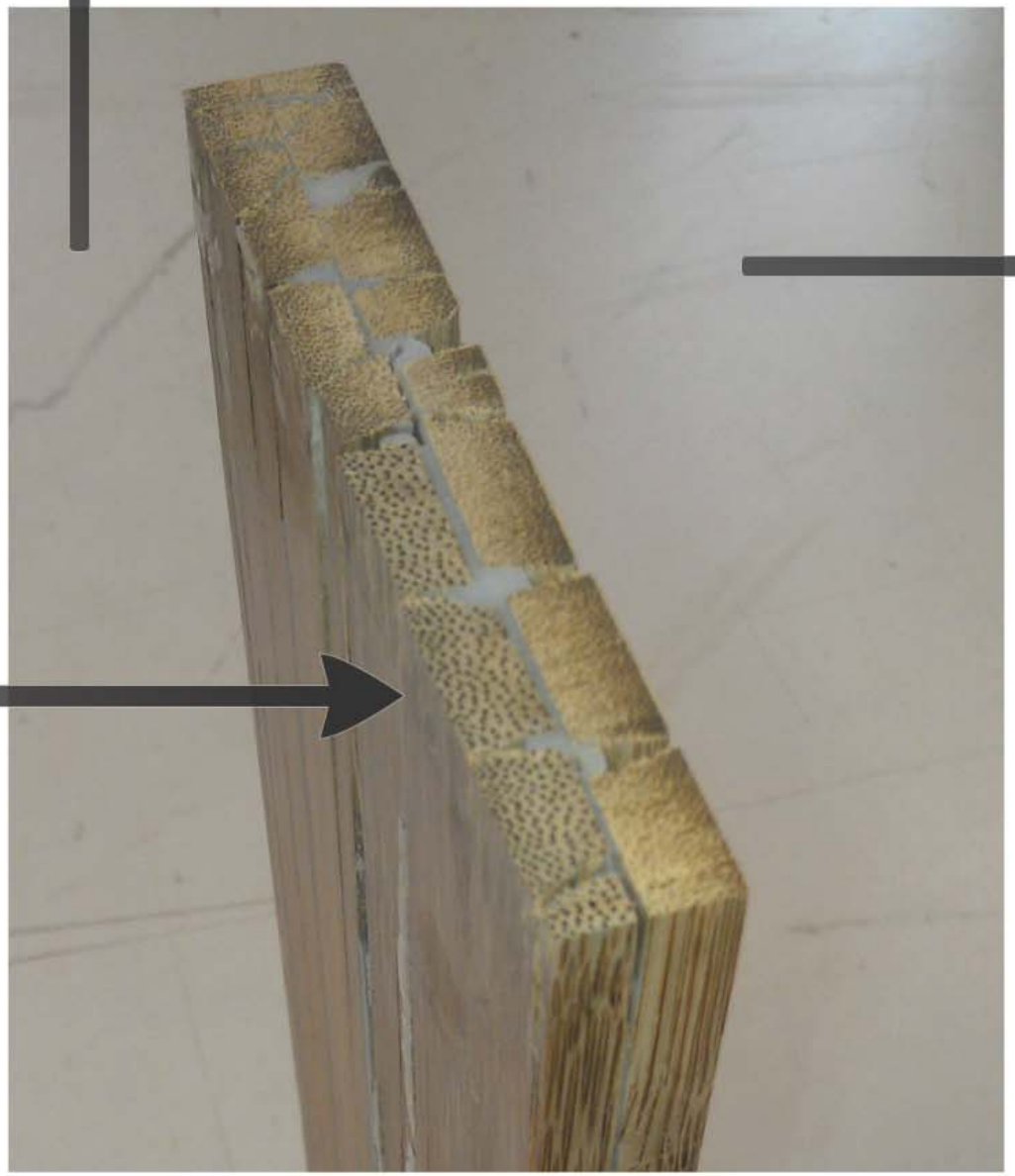

30.00
25.00
20.00
15.00
10.00
5.00
0.00
MOE (GPa)
BOTTOM
MIDDLE
TOP
Height position
YOUNG (Outer)
MATURE (Outer)
YOUNG Inner
MATURE Inner
YOUNG Average Outer-Inner
MATURE Average Outer-Inner
YOUNG (Correal & Arbeláez)
MATURE (Correal & Arbeláez)
Not aged (González et al.)

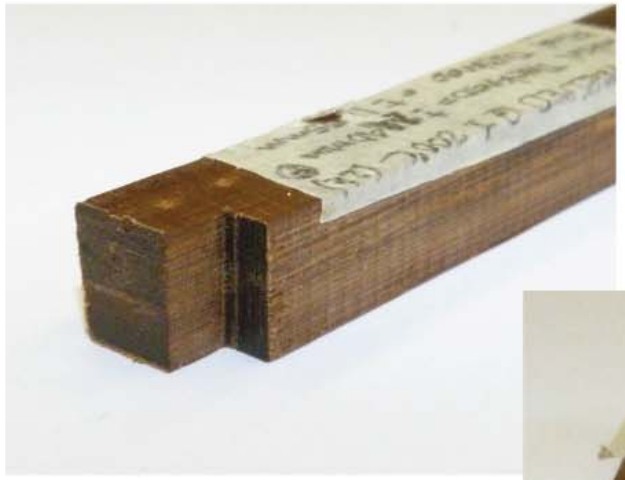
Appropriate Technology

Splitting with developed mechanism

Incompatibility with building elements

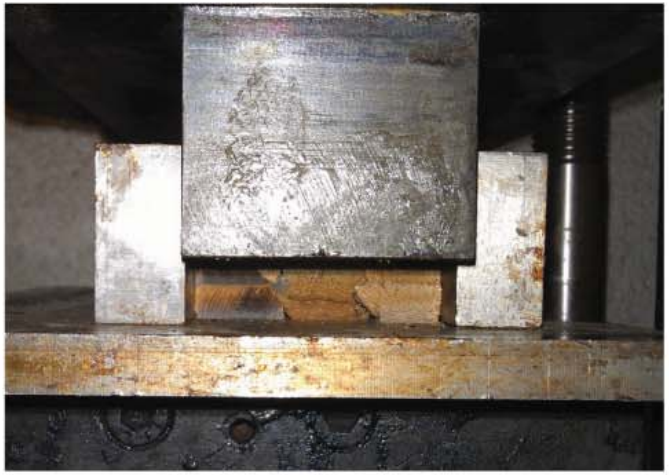
Irregularity (diameter, linearity, waste)



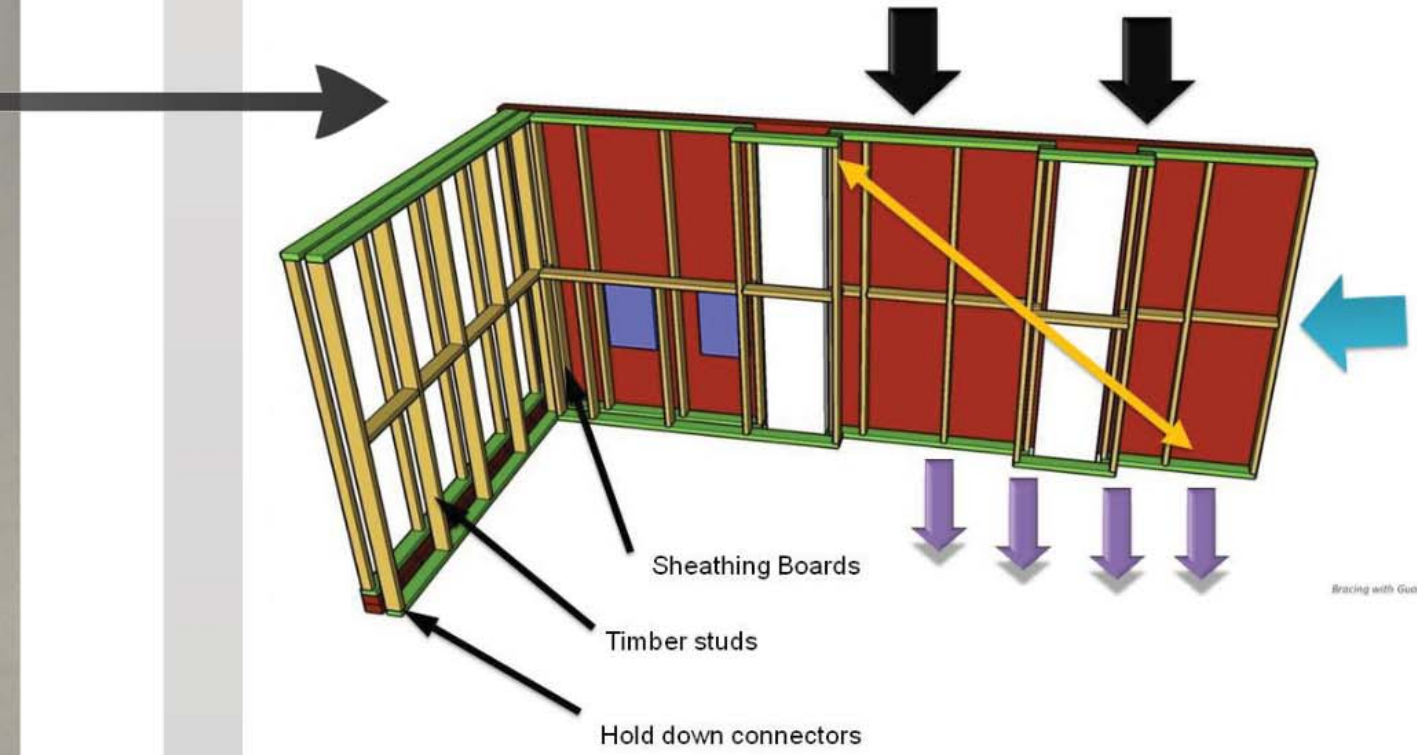


Self-binding

Epoxy

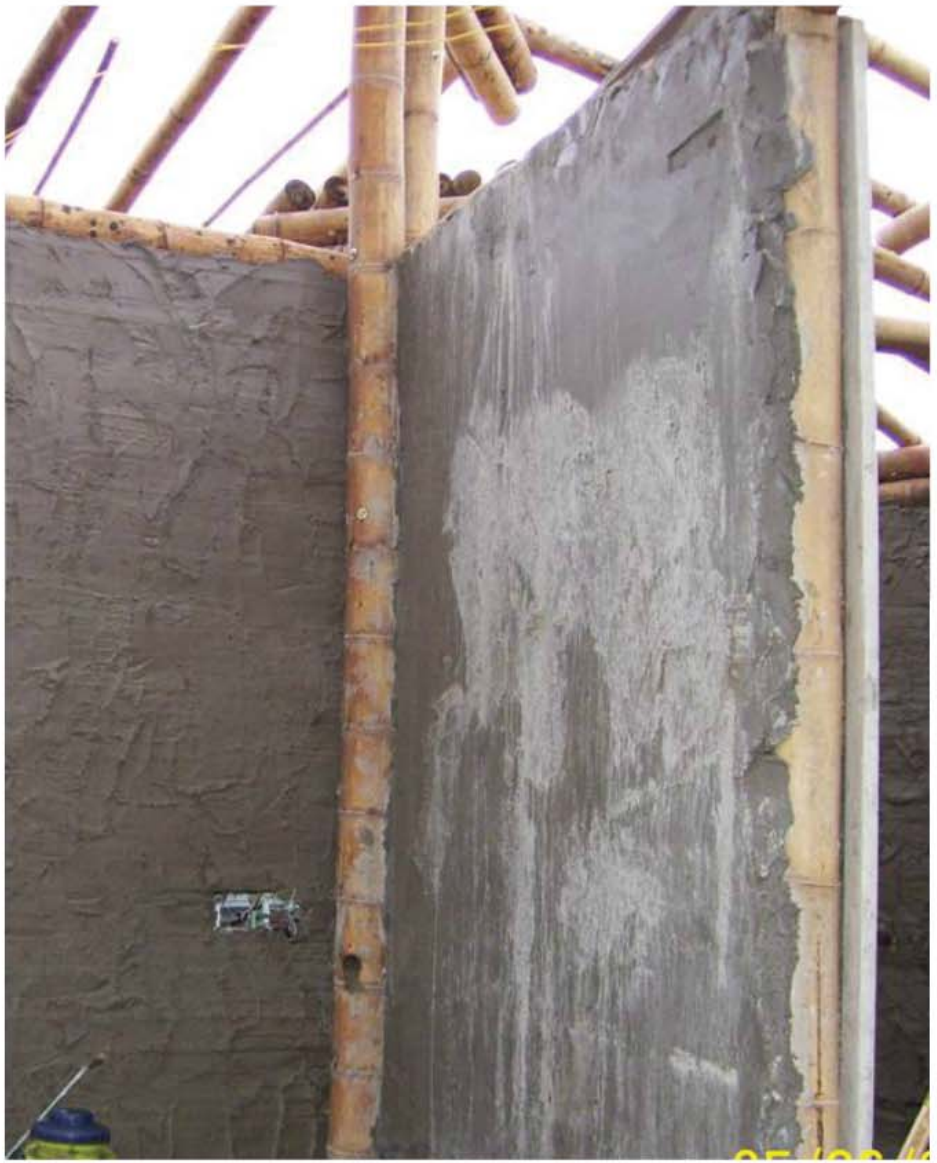


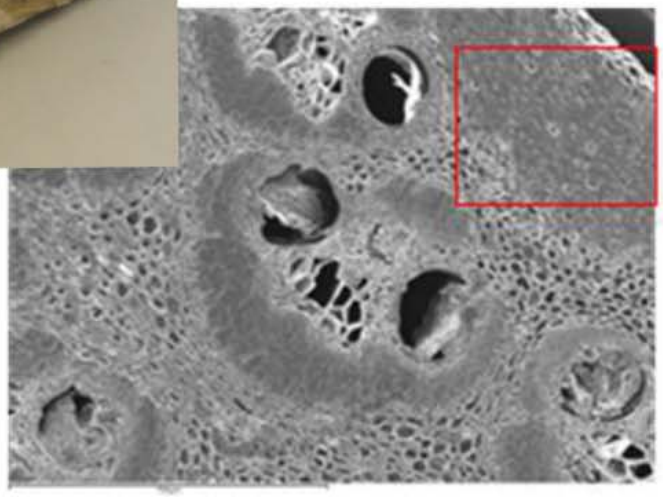
Intensive handicraft process
(Verticality & Horizontality)

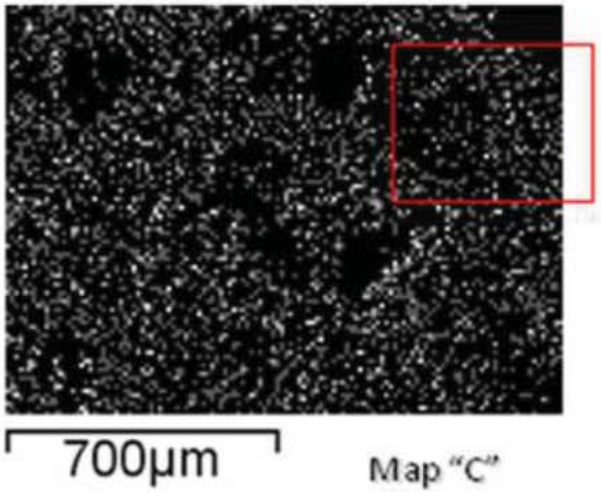


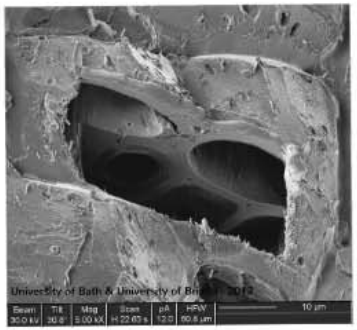
Bracing with Guadua culms

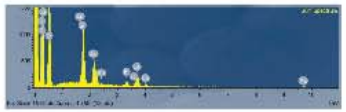
Conventional material

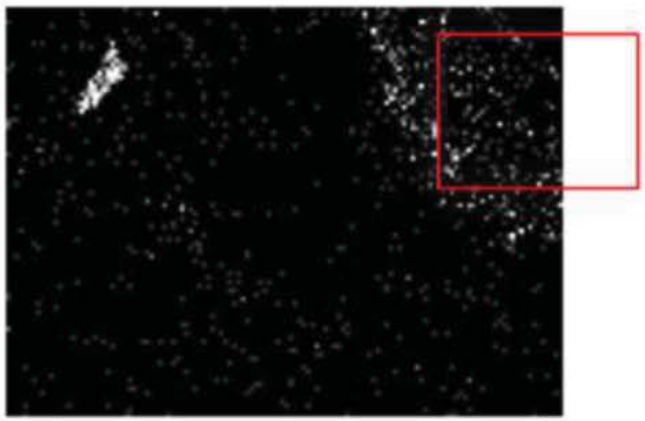


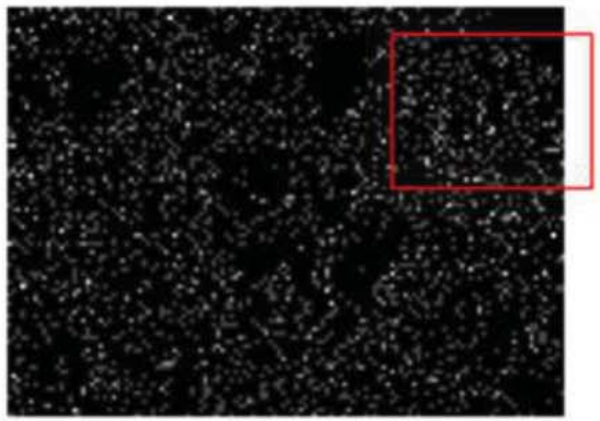










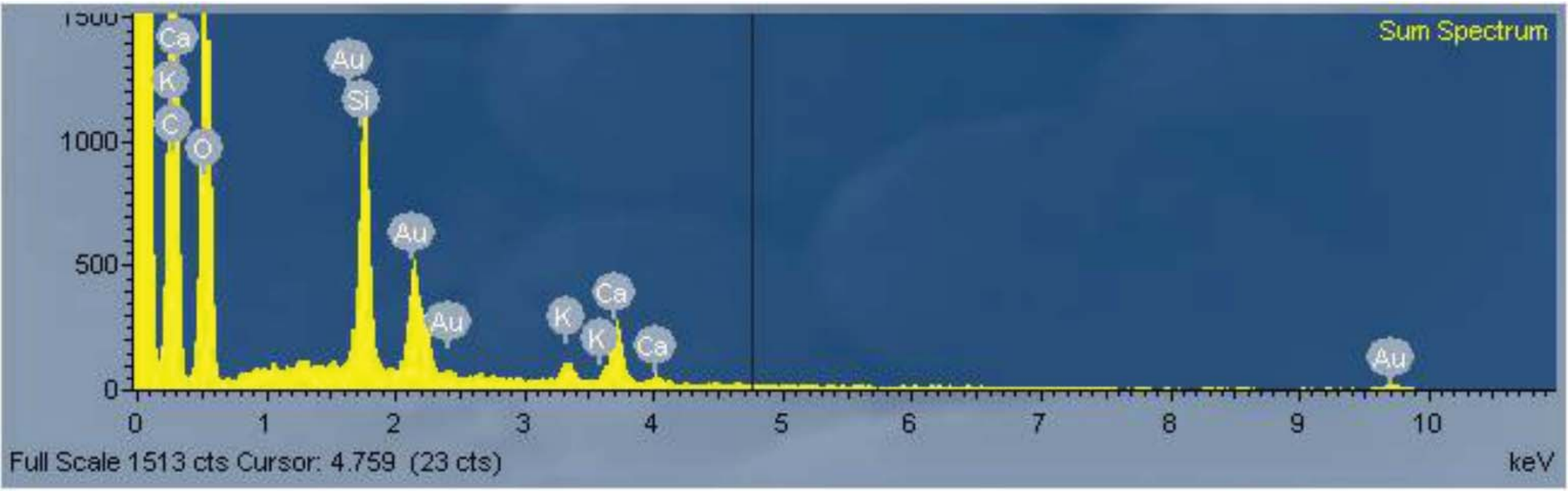


Lime

Reduce CO2


University of Bath & University of Bristol - 2012
Beam
30.0 kV
Tilt
30.8°
Mag
5.00 kX
Scan
H 22.63 s
pA
12.0
HFW
60.8 µm
10 µm

Beam	Tilt	Mag	Scan	pA	HFW	10 µm
30.0 kV	30.8°	5.00 kX	H 22.63 s	12.0	60.8 µm	



nothing new...!

Not the only way...

Nano-coatings

THM Modifications

Acetylation

Steam explosion

Future prospects

Foster research

Stop seeing it as the material for the poor..

Add value

Push the boundaries

Balance technical & natural materials

Thanks...!

&

Questions...?

BRE Centre for Innovative Construction Materials
Telephone +44(0) 1225 385943
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