INGEGNERIA SENZA FRONTIERE –

Facoltà di Ingegneria

Pisa, 2 aprile 2008

“Costruire in bambu”

Costruzioni tradizionali e prospettive di sviluppo nell’Africa Sub-Sahariana

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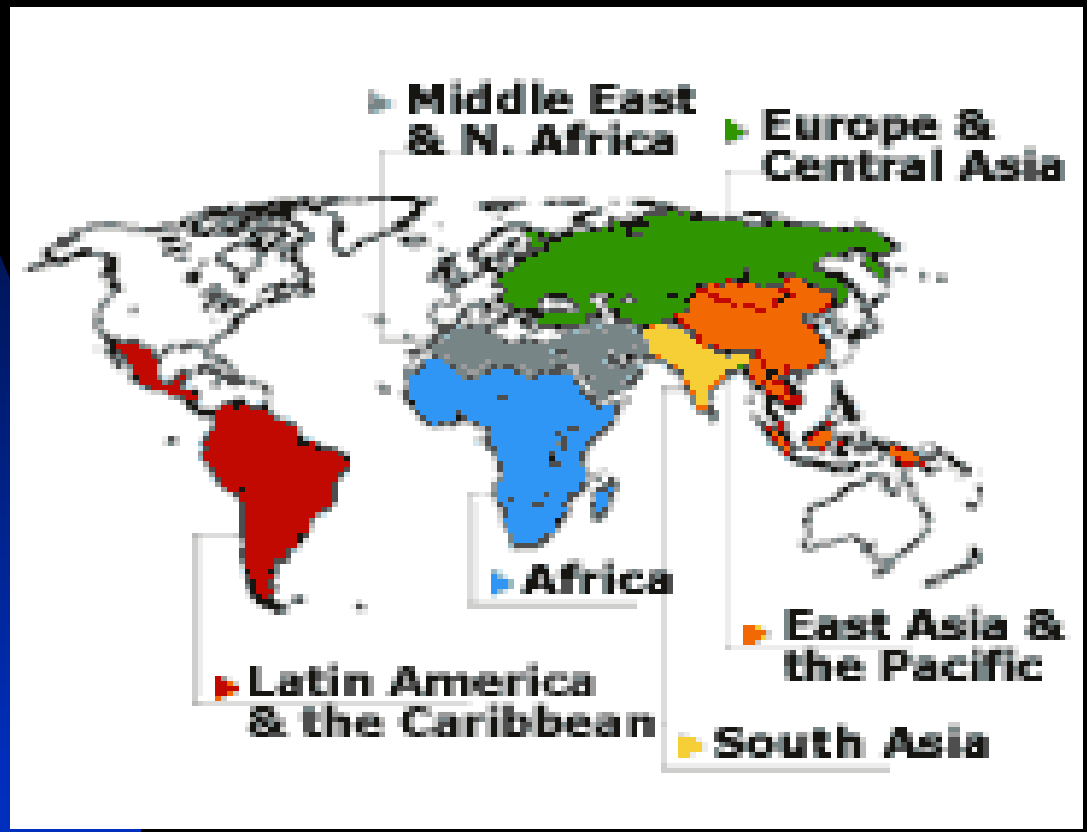
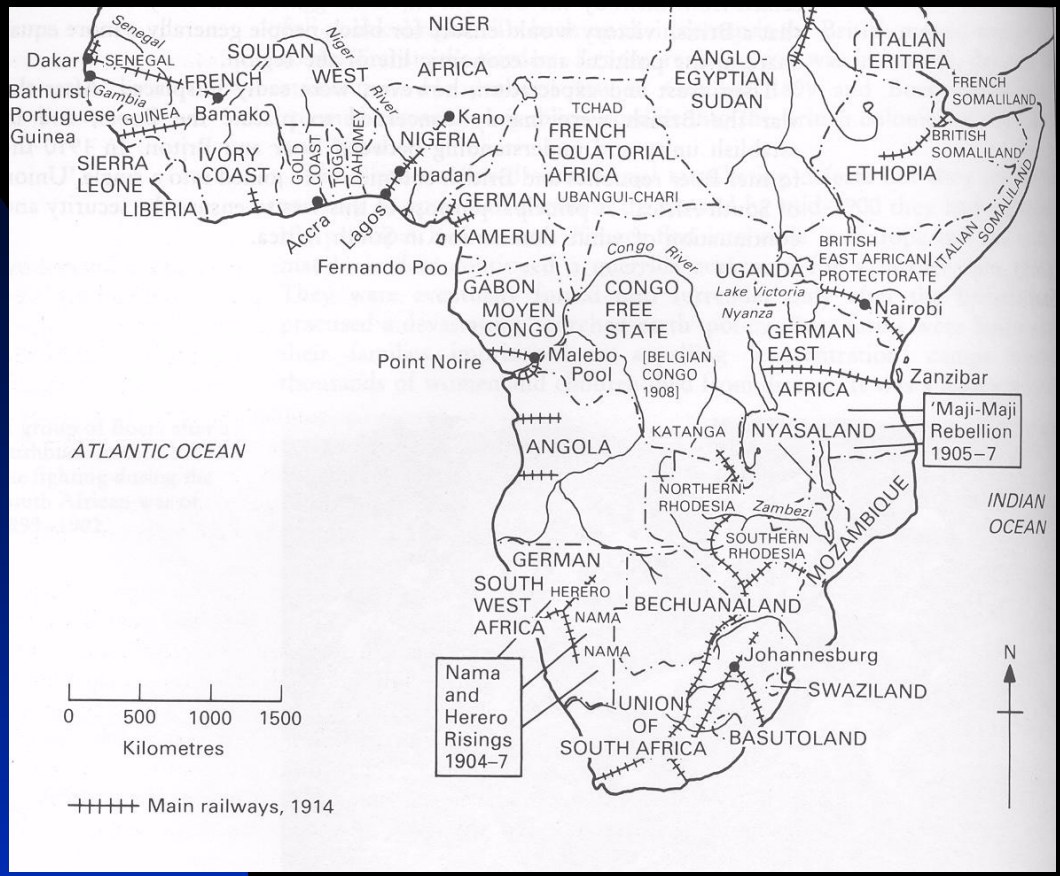
Dipartimento di Ingegneria Strutturale
Università di Pisa

Territori con economie in via di sviluppo

(macro-aree secondo World Bank)



Africa Sub-Sahariana (periodo coloniale)



La Repubblica del Malawi

La Repubblica del Malawi

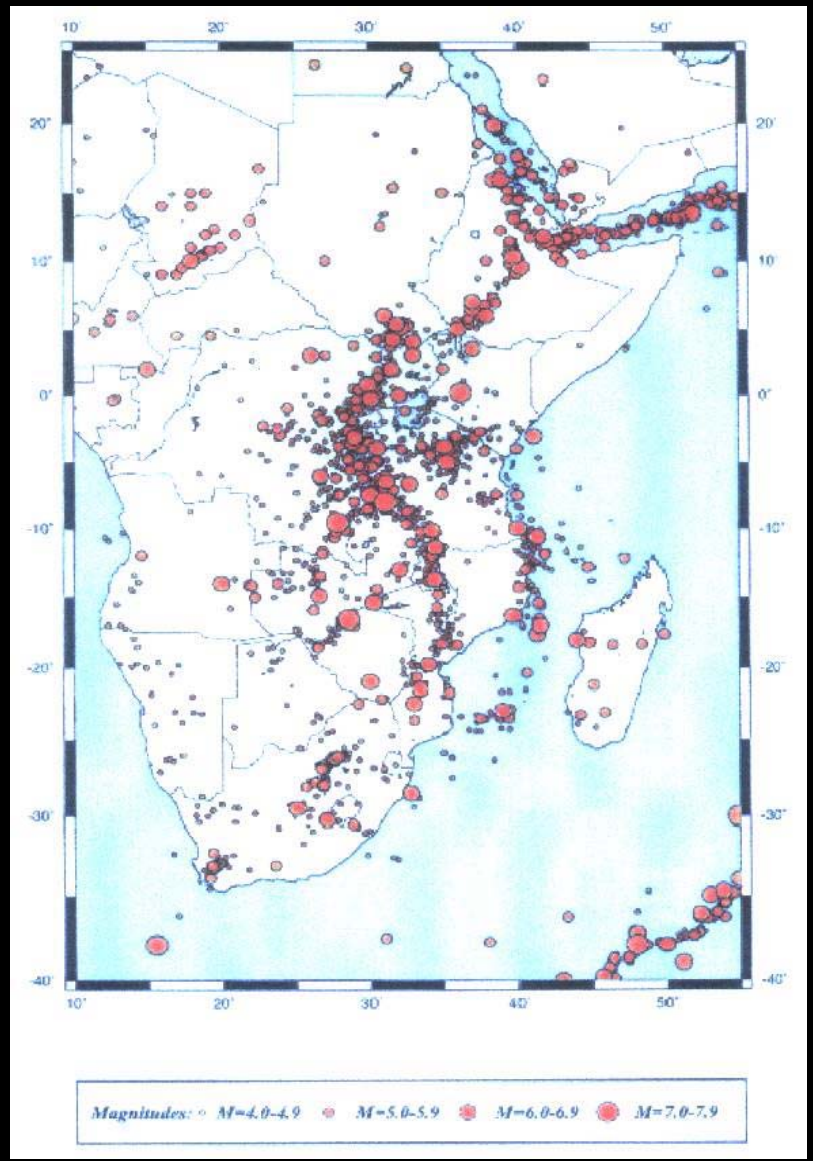
Principali dati socio-economici

- popolazione : 12 milioni
- vita media: 46 anni
- alfabetizzazione: 41%
- mortalità infantile: 18% i primi 5 anni
- reddito pro-capite annuo: 200 US$

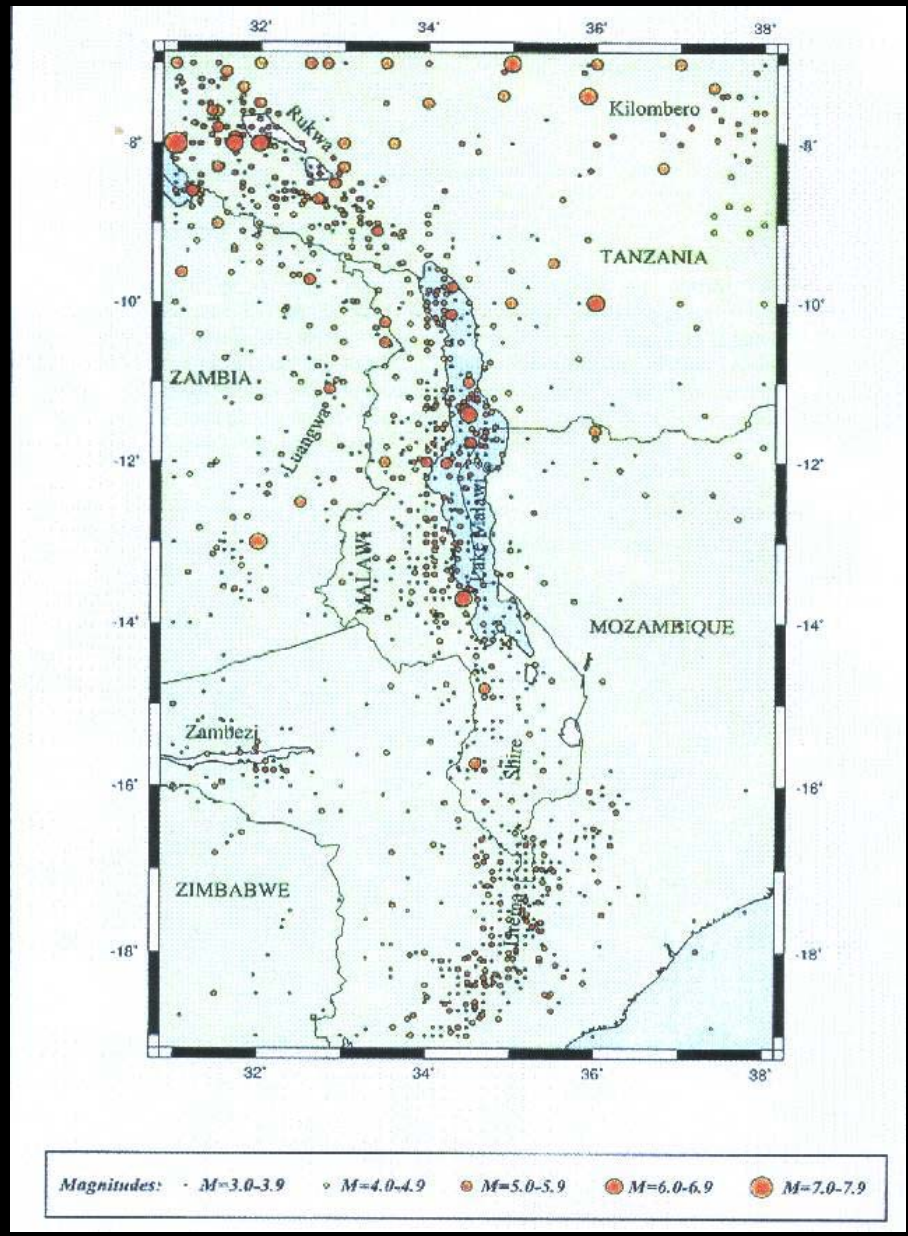
Distribuzione socio-urbanistica

- Economia cittadina (agglomerati urbani): 10% popolazione
- Economia agricola (fattorie – paesi "lineari"): 40% popolazione
- Economia tribale di sussistenza (villaggi – territori): 50% popolazione

Sismicità nell'Africa Sub Sahariana



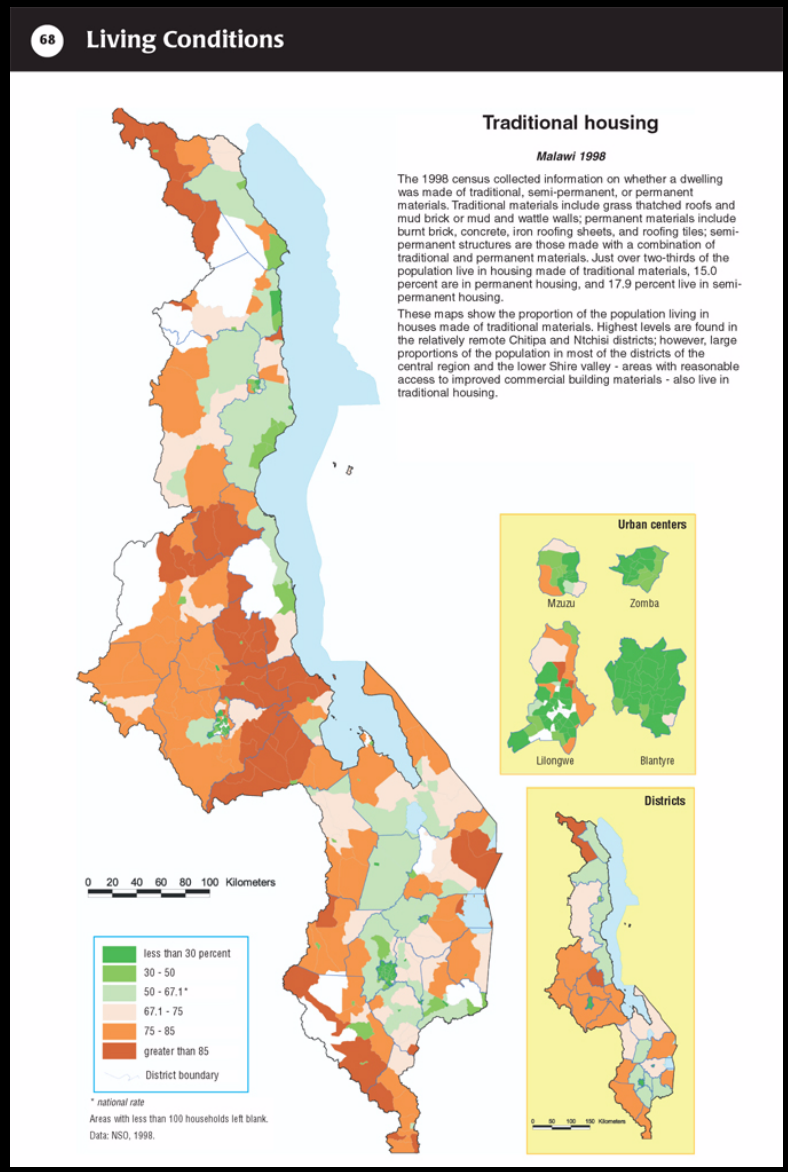
Sismicità nell'Africa Sub Sahariana



Distribuzione delle costruzioni tradizionali nel Malawi

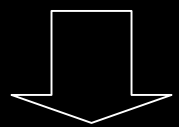
Oltre i 2/3 delle case sono in materiali tradizionali:

- paglia e fango
- mattoni crudi
- canna di bambu



Distribuzione dei territori nel Malawi

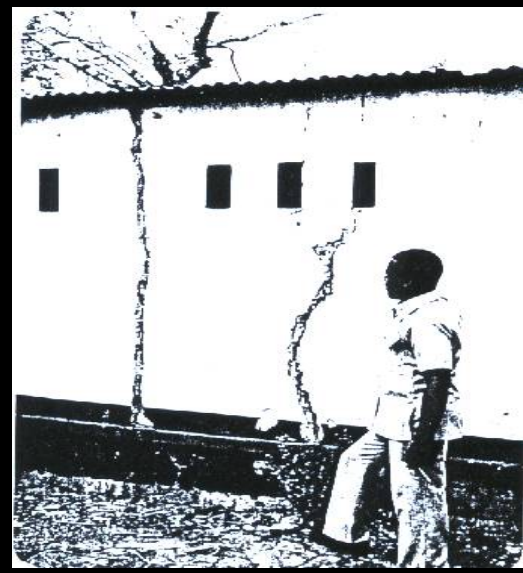
- 12% Terreni pubblici ad utilizzo governativo
- 3% Terreni privati
- 85% Territori amministrati dalle tribù



Esiste l'opportunità economica di sviluppare costruzioni tradizionali

Esame dei danni e perdite dovuti ai terremoti passati

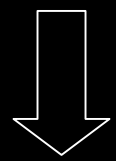
- Danni modesti anche con sismi 6.7 Richter
- Pressoché assenza di perdite umane



Esiste l'opportunità tecnica di costruzioni tradizionali sismoresistenti

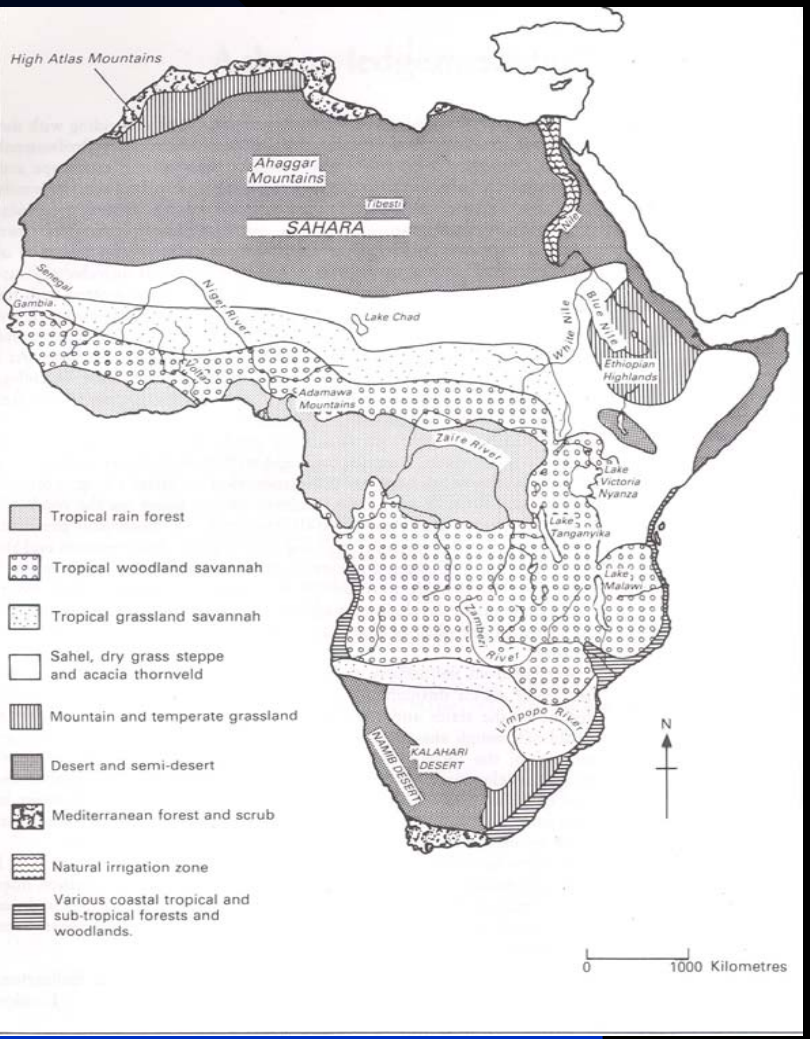
Il problema "povertà" in Africa Sub Sahariana

- Numero di poveri (reddito giornaliero inferiore ad un dollaro) censito nel 2001 è di 314 milioni
- Stima dei poveri nel 2015 è di 366 milioni (circa il 40% della popolazione totale)



- Occorre utilizzare materiali da costruzione "free-holder" e tecniche costruttive di facile apprendimento.

Il problema "deforestazione" in Africa Sub Sahariana



Unità abitativa del villaggio

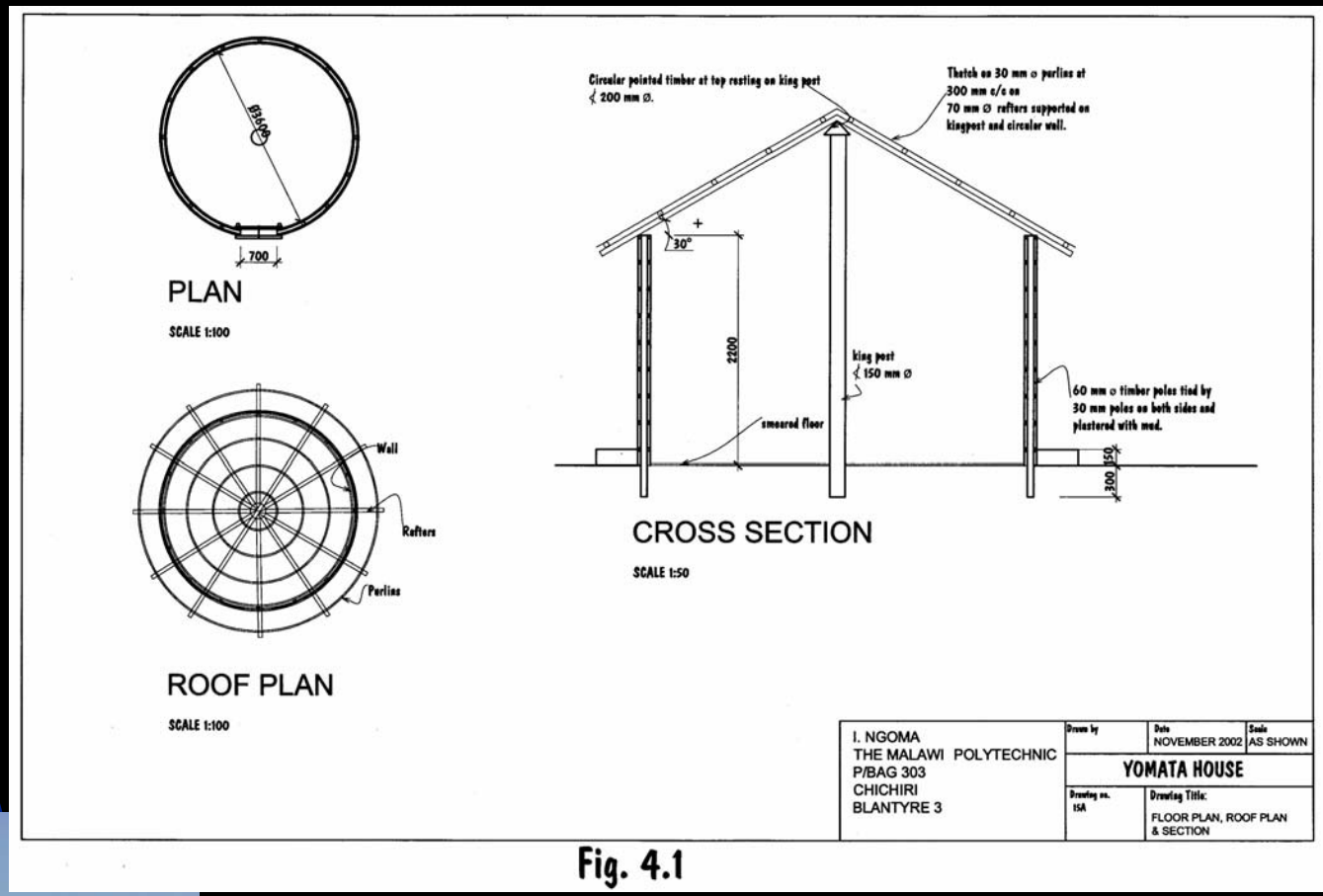
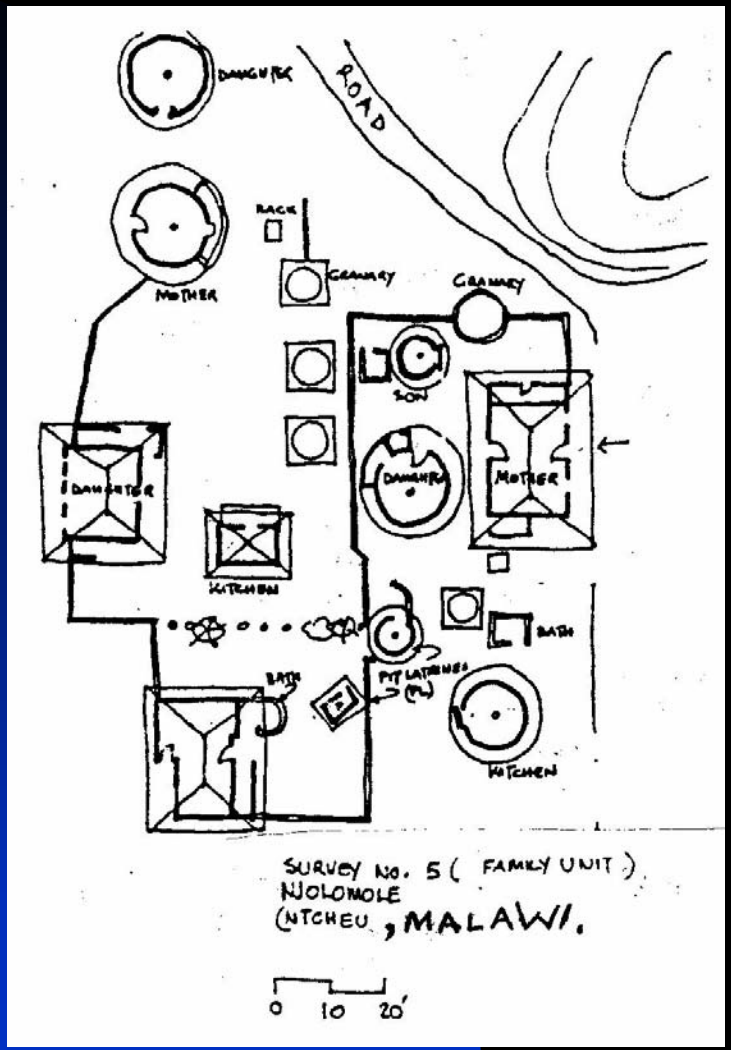
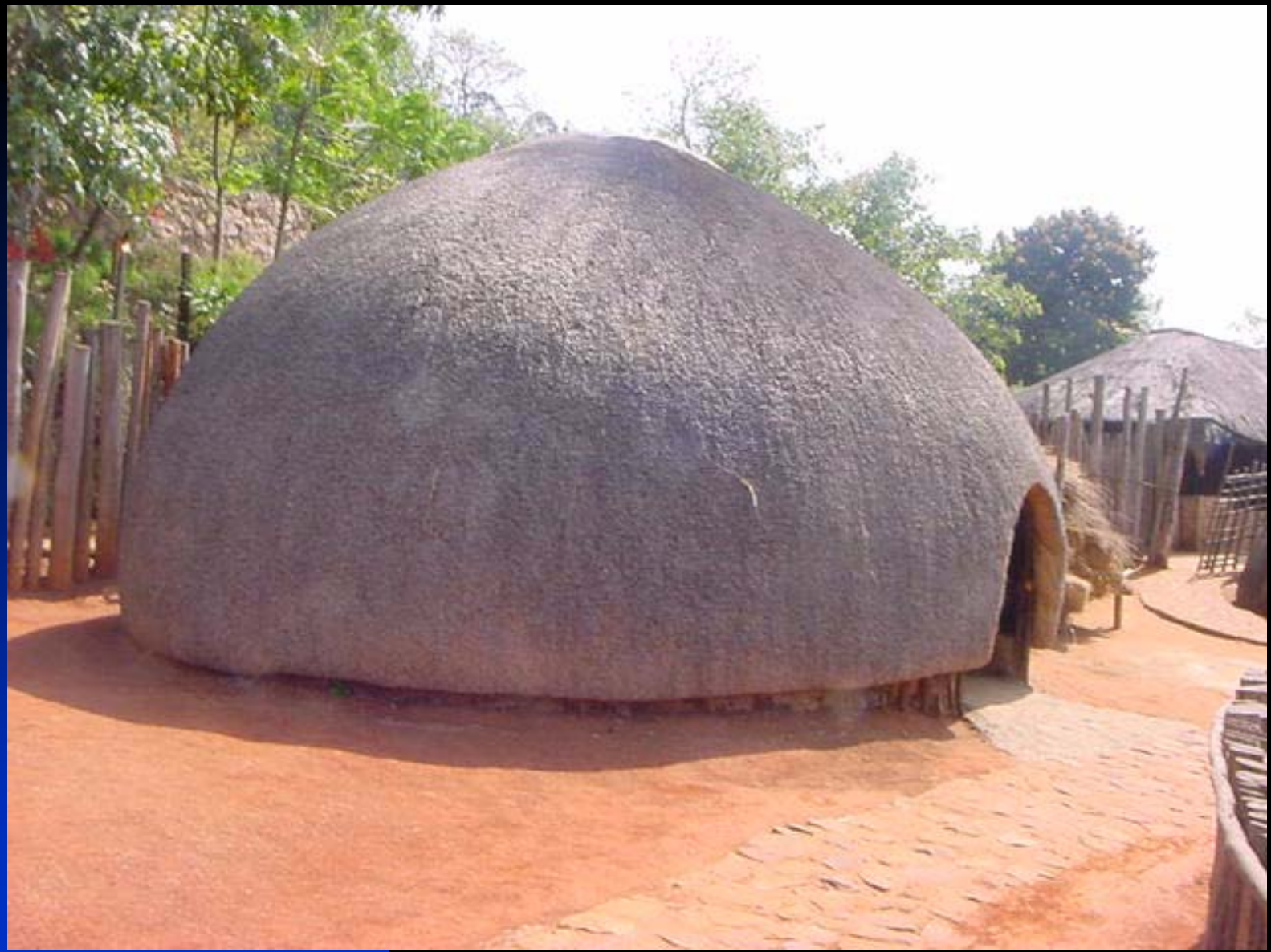


Fig. 4.1

Villaggio come unità familiare





Unità abitativa del paese “lineare”

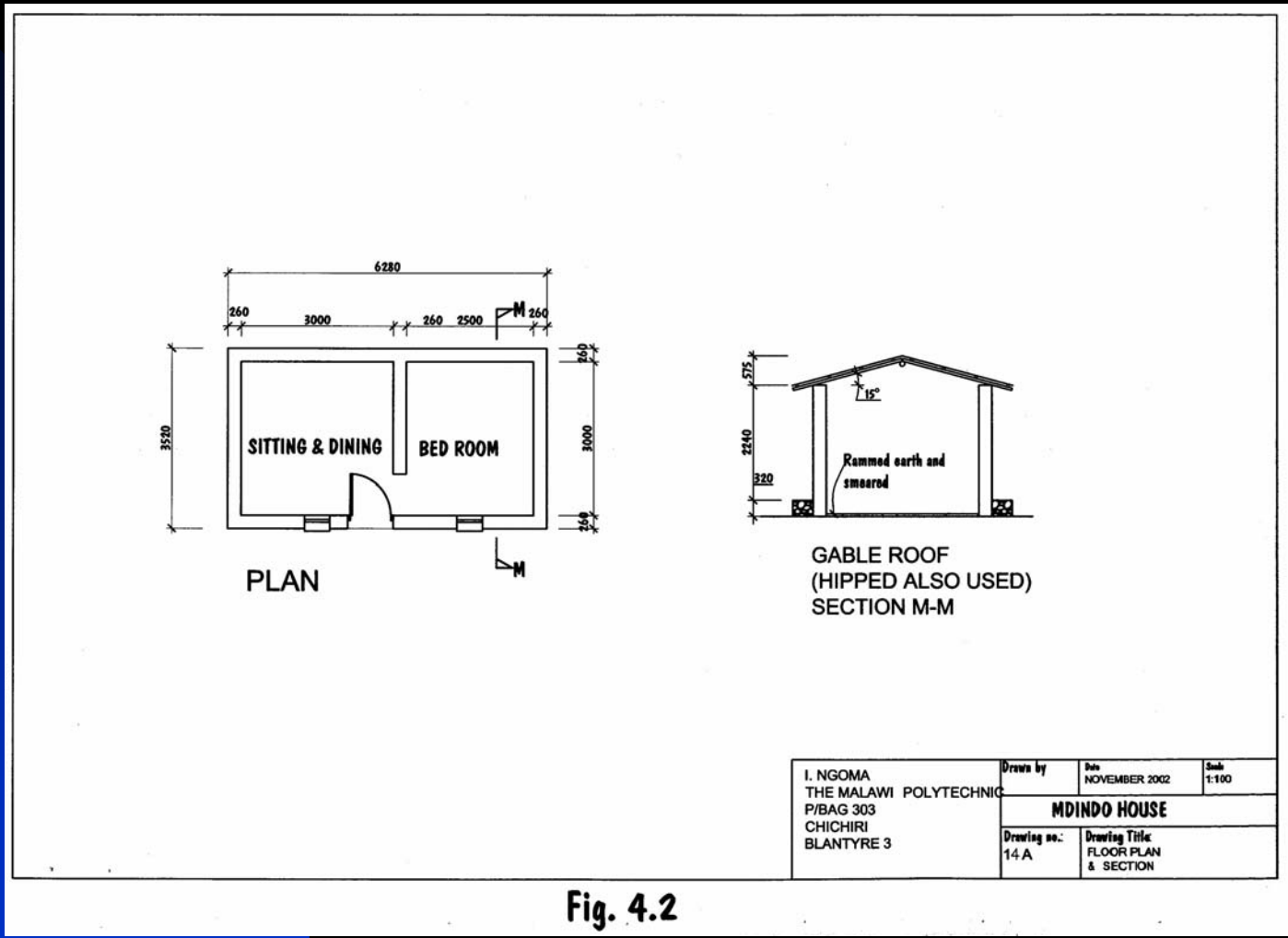
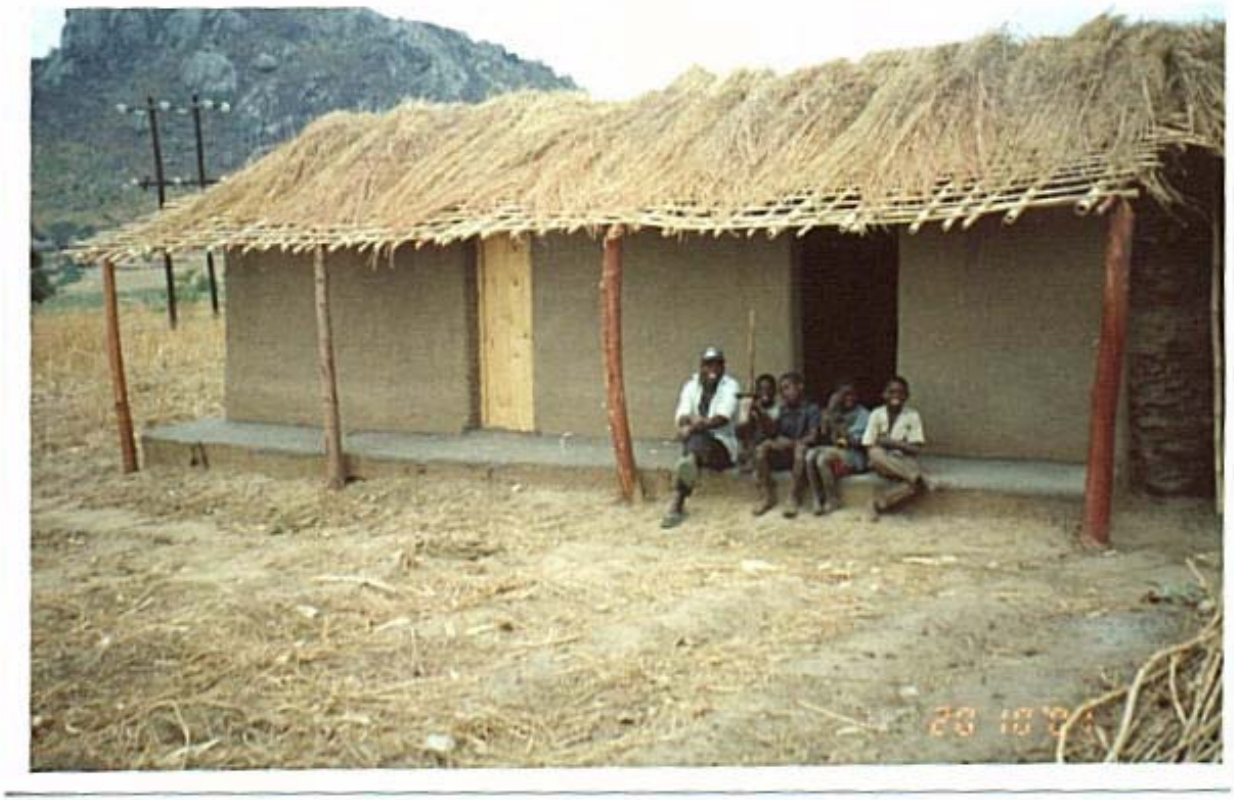
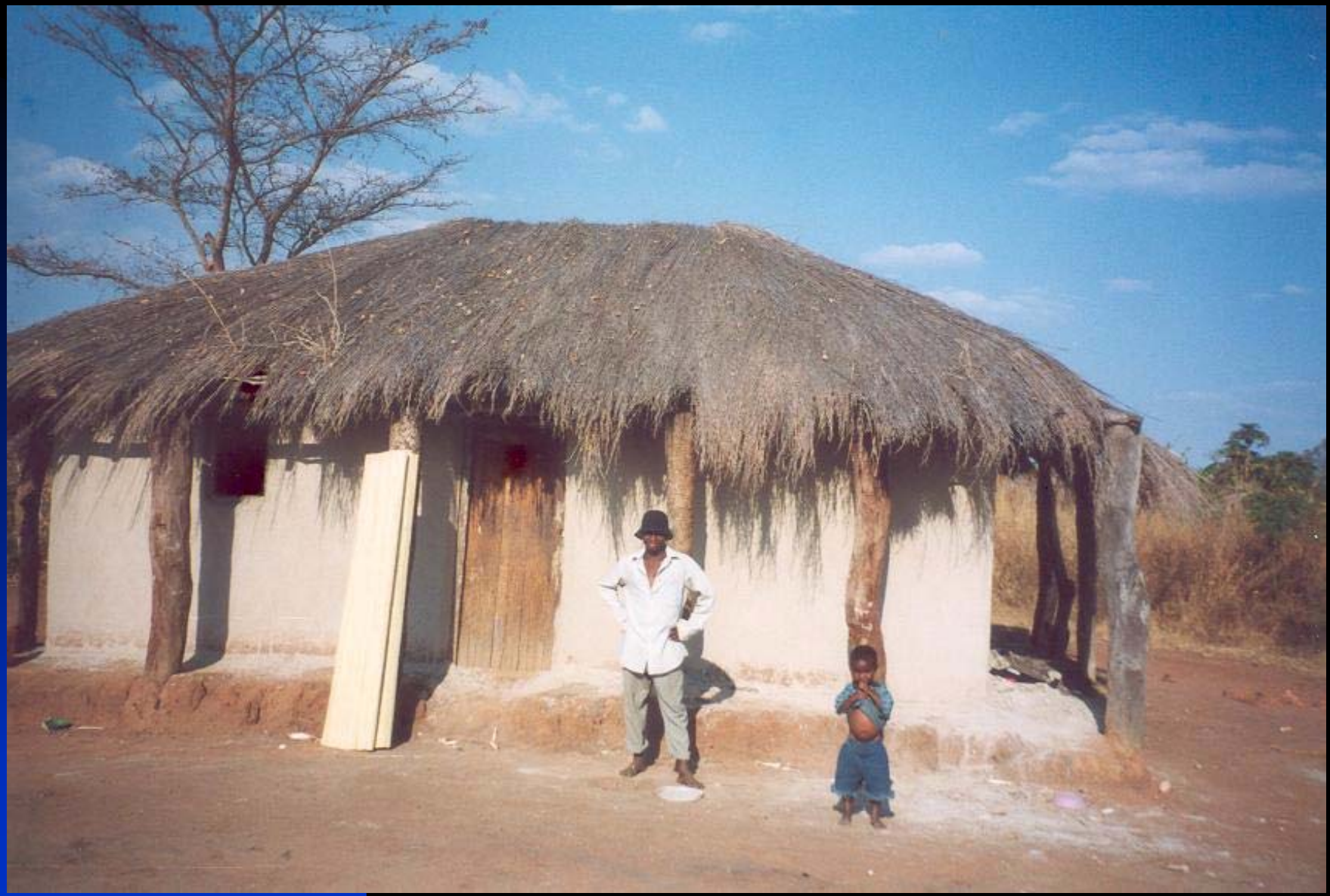


Fig. 4.2





Casa in mattoni cotti al sole

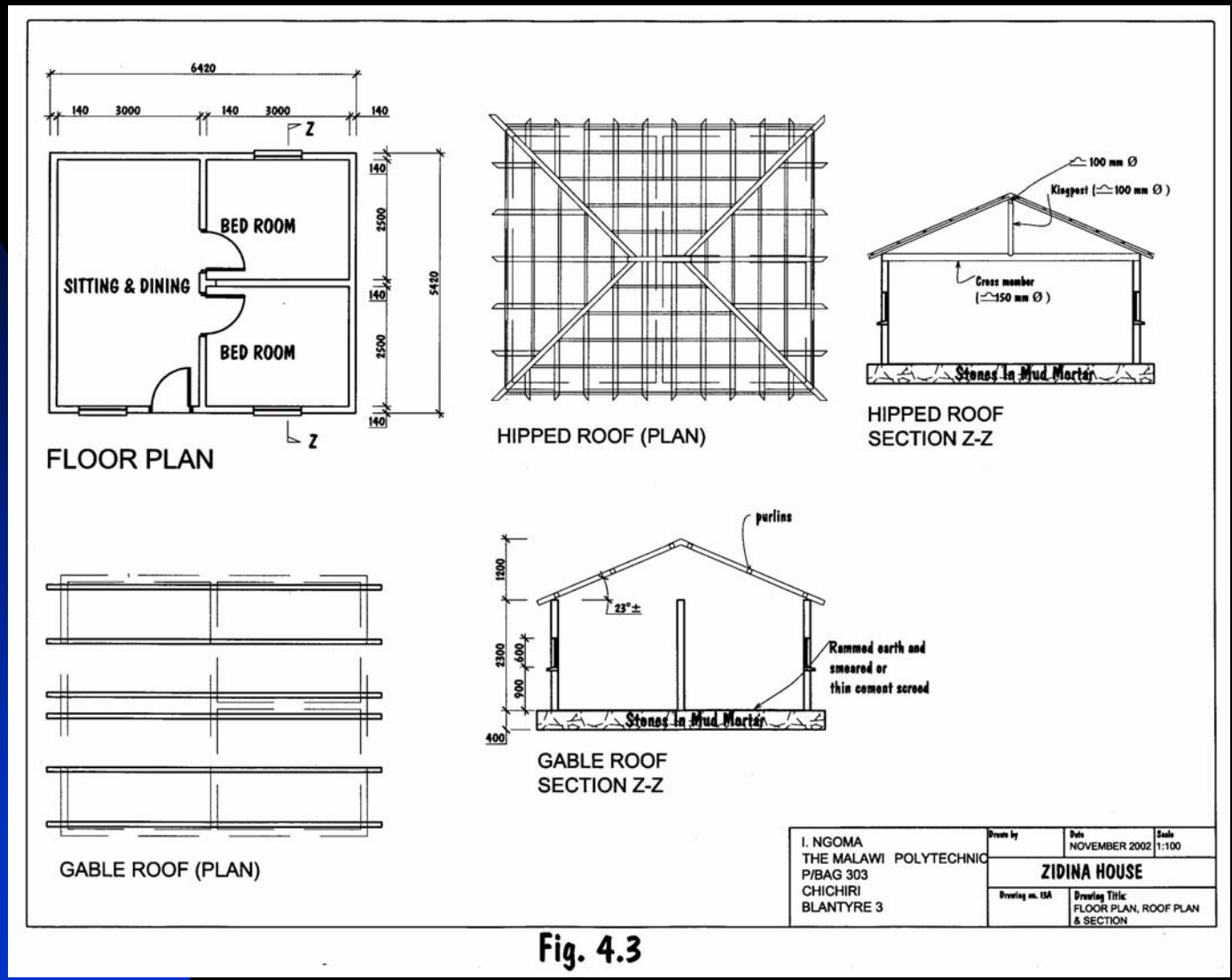
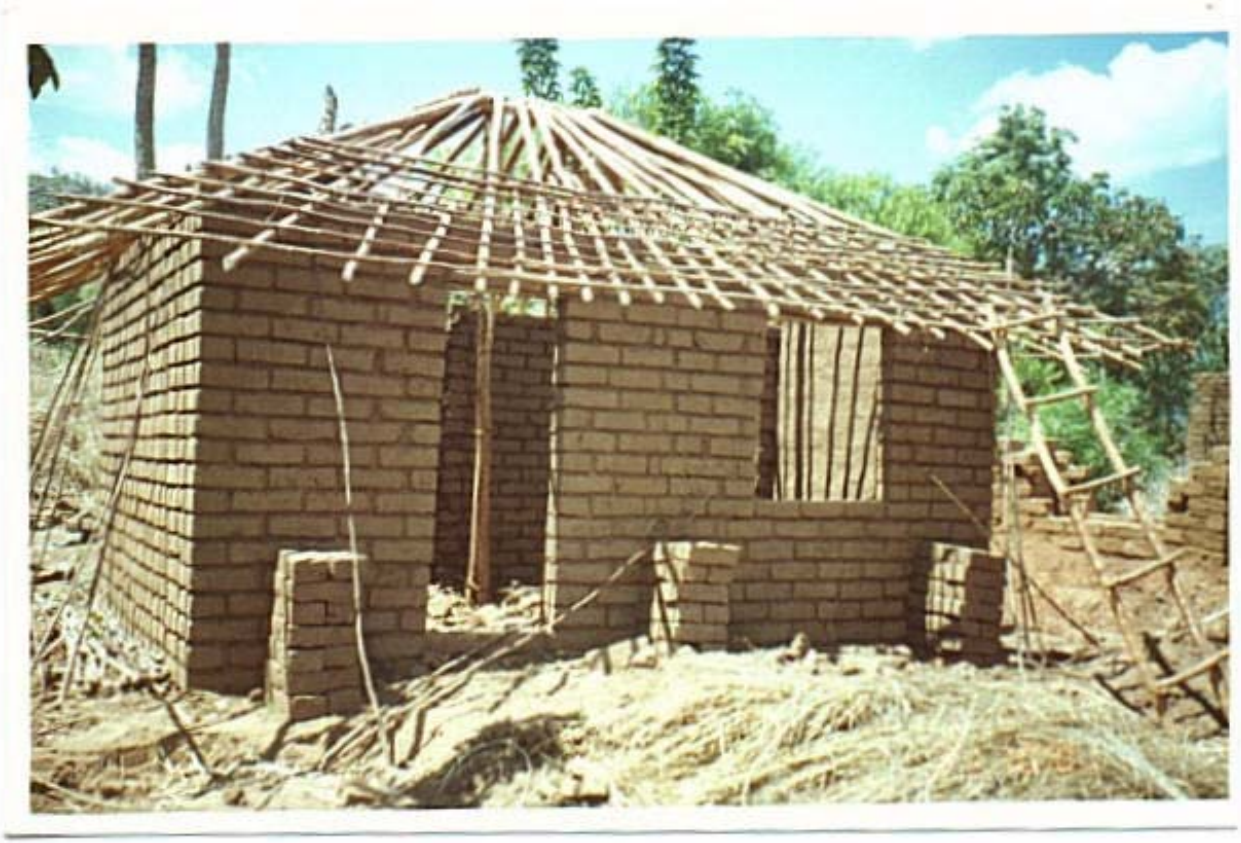
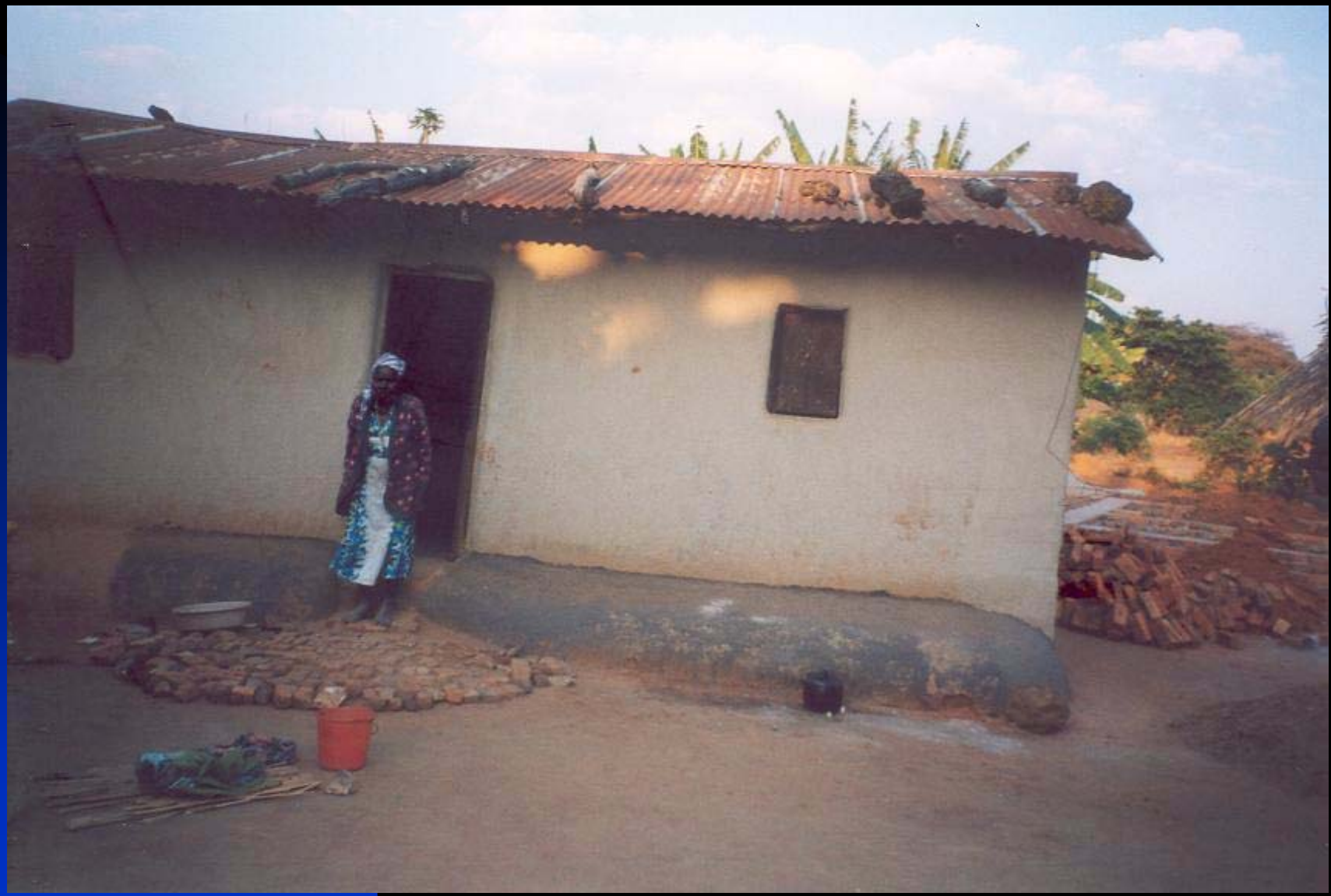


Fig. 4.3





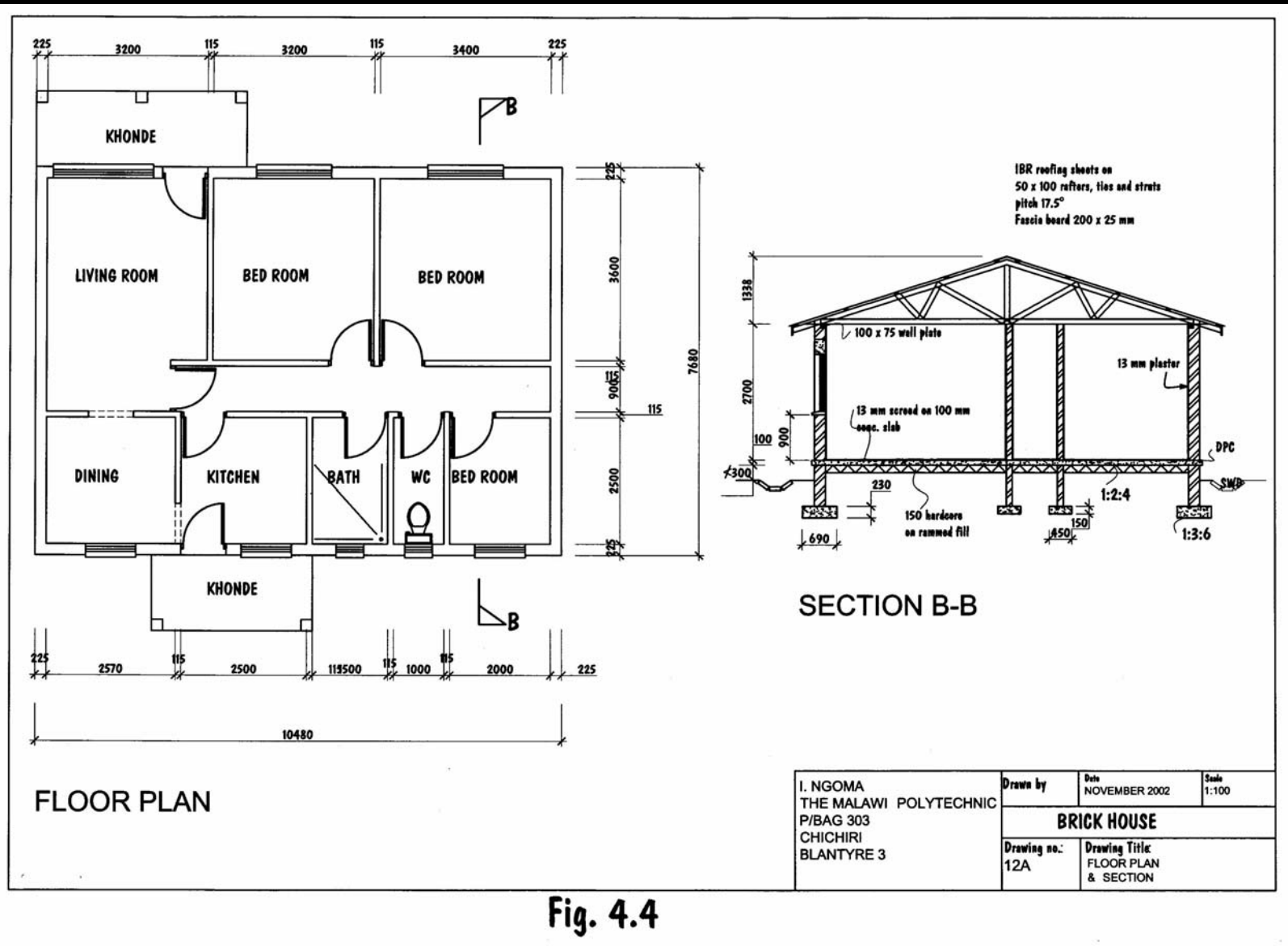
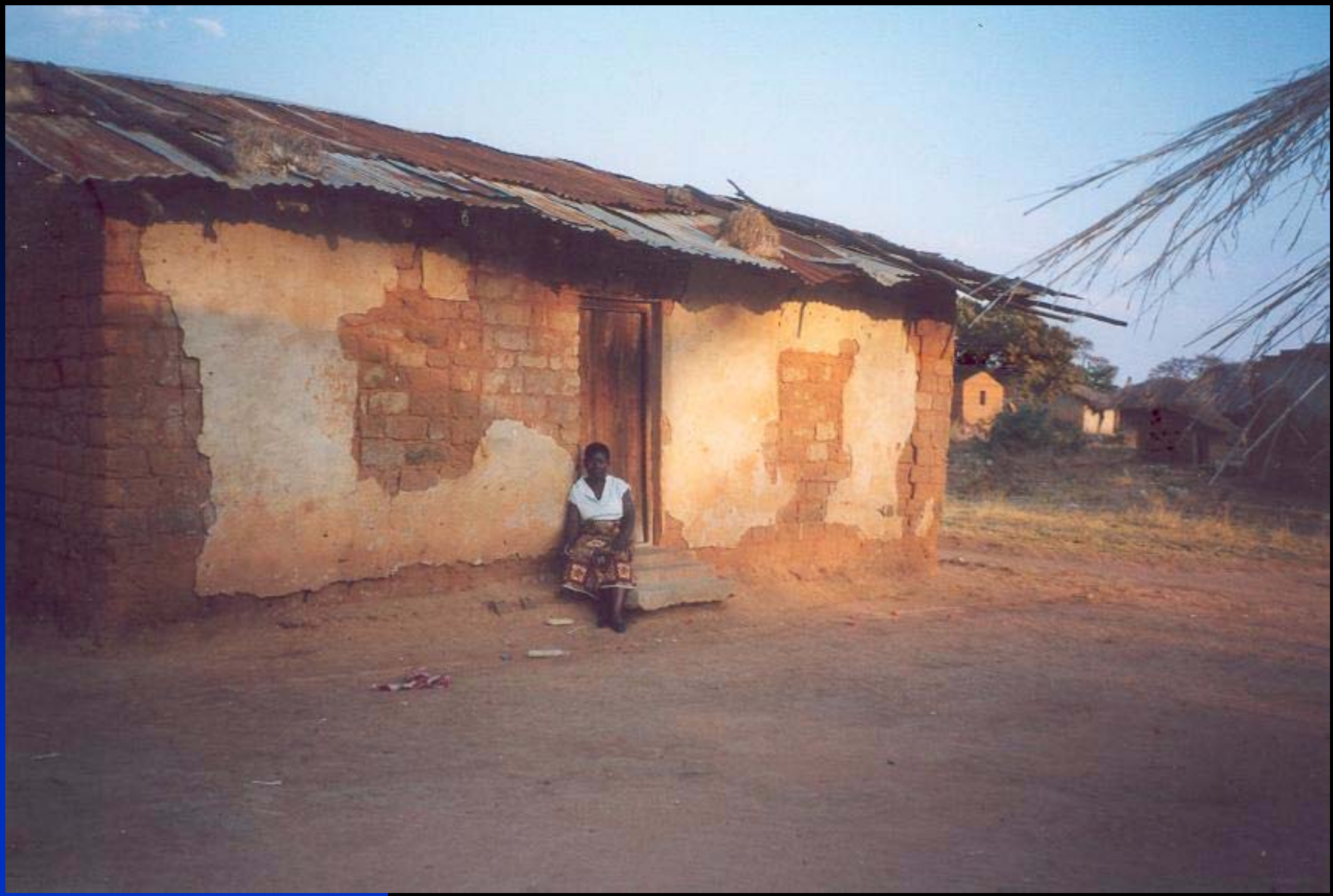
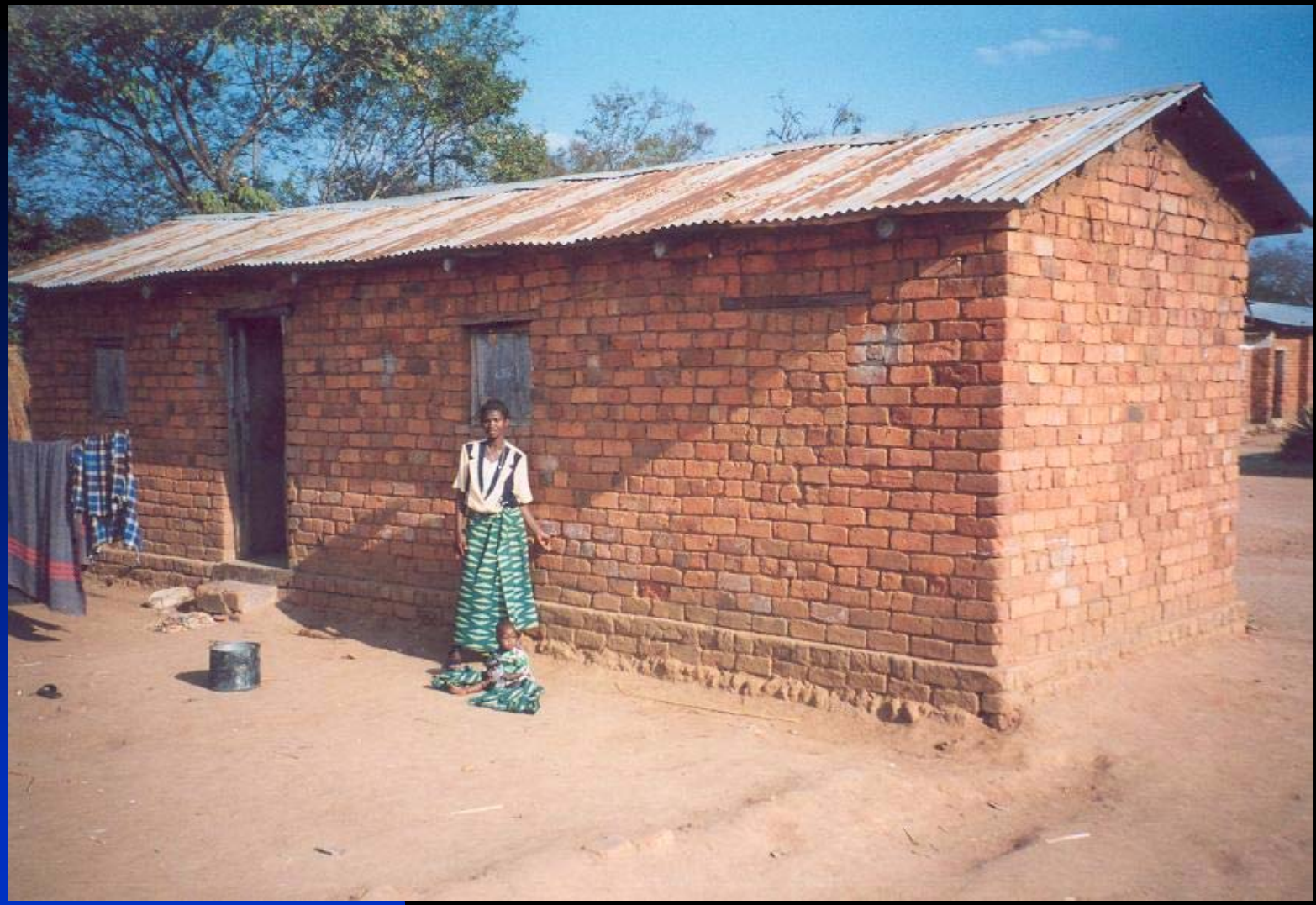

KHONDE
LIVING ROOM
BED ROOM
BED ROOM
DINING
KITCHEN
BATH
WC
BED ROOM
KHONDE
B
B
225
3200
115
3200
115
3400
225
225
3600
115
2500
225
7680
225
2570
115
2500
115
500
115
1000
115
2000
225
10480
FLOOR PLAN
IBR roofing sheets on
50 x 100 rafters, ties and struts
pitch 17.5°
Fascia board 200 x 25 mm
1338
2700
100 x 75 wall plate
13 mm plaster
13 mm screed on 100 mm
conc. slab
100
900
300
DPC
SWD
230
150 hardcore
on rammed fill
690
150
450
1:2:4
1:3:6
SECTION B-B
I. NGOMA
THE MALAWI POLYTECHNIC
P/BAG 303
CHICHIRI
BLANTYRE 3
Drawn by
Date
NOVEMBER 2002
Scale
1:100
BRICK HOUSE
Drawing no.:
12A
Drawing Title:
FLOOR PLAN
& SECTION

Fig. 4.4





PROPRIETÀ MECCANICHE DEL BAMBÙ

Modulo di Young E = 15.000 – 20.000 N/mm^2

Resistenza a trazione σ_t = 100 – 200 N/mm^2

Resistenza a compressione σ_c = 30 – 60 N/mm^2

Resistenza a flessione σ_t = 60 – 100 N/mm^2

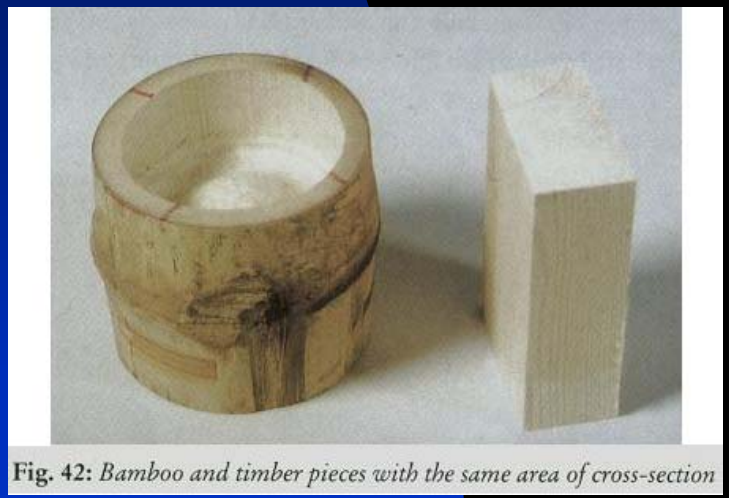


Fig. 42: *Bamboo and timber pieces with the same area of cross-section*

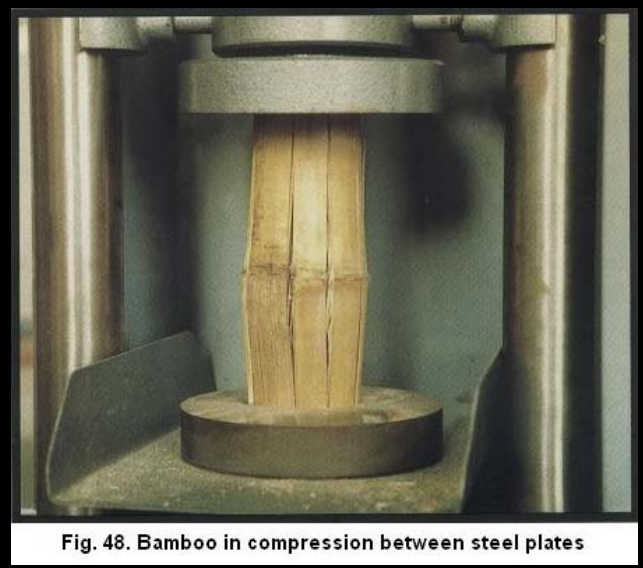
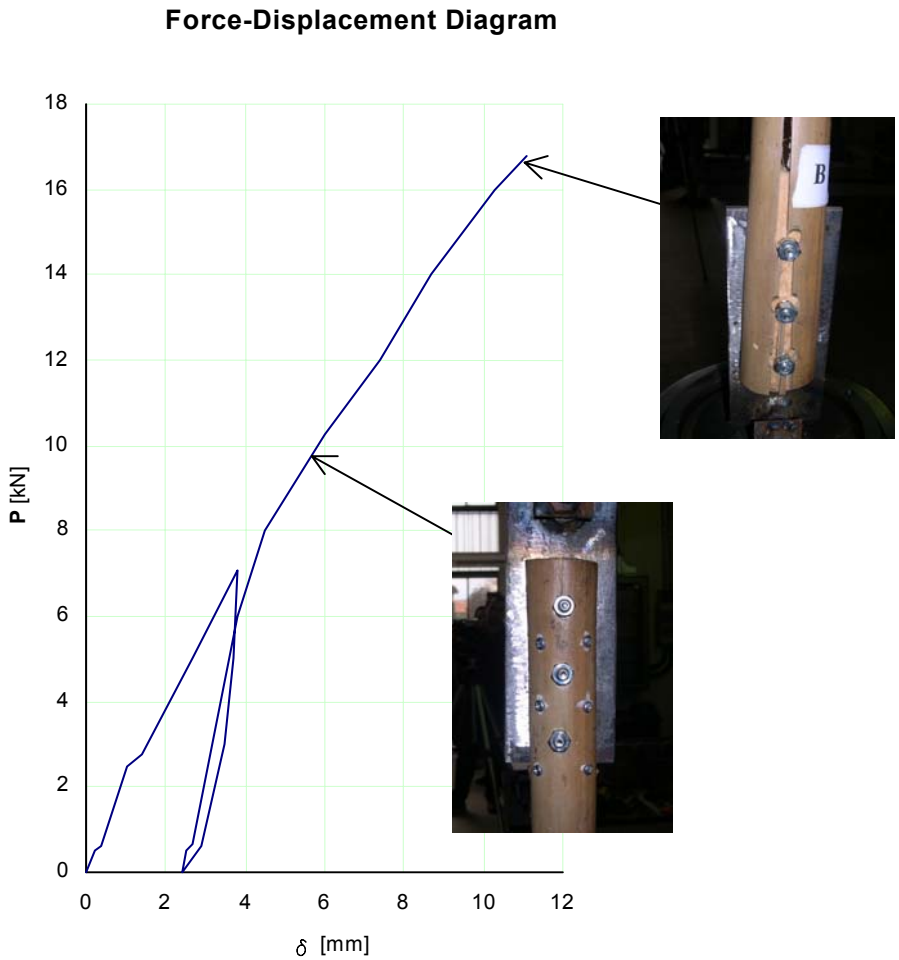


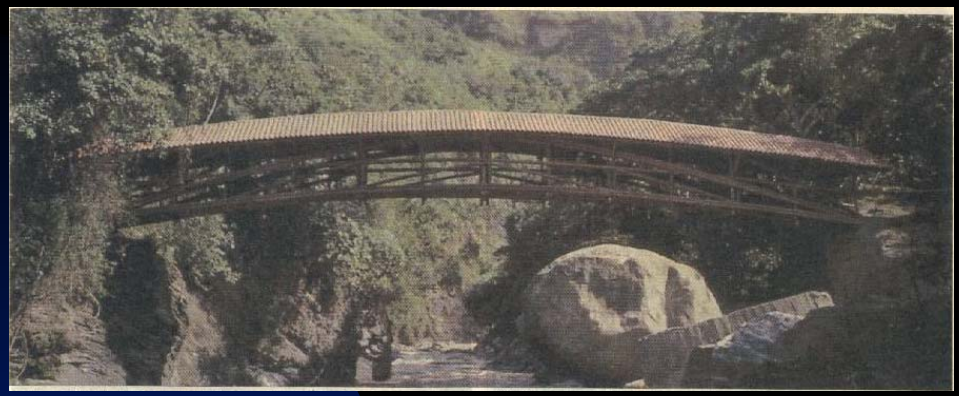
Fig. 48. Bamboo in compression between steel plates

Froli, M., Mariani, G.,
Ngoma, I., Sassu, M. (2003)



Padiglioni – strutture turistiche

Ponteggi – rinforzi di cls



Bambù lamellare

Passerelle pedonali

EL PABELLON DE LA GUADUA EN EXPO HANNOVER 2000

www.ebf-bamboo.org

Fig. 17: *A prototype bamboo house in Costa Rica*

Fig. 18: *Prefab concrete foundation for bamboo column*

da J.Janssen - 2005

Fig. 28: *Preparing culms for producing culm cuttings (Costa Rica)*

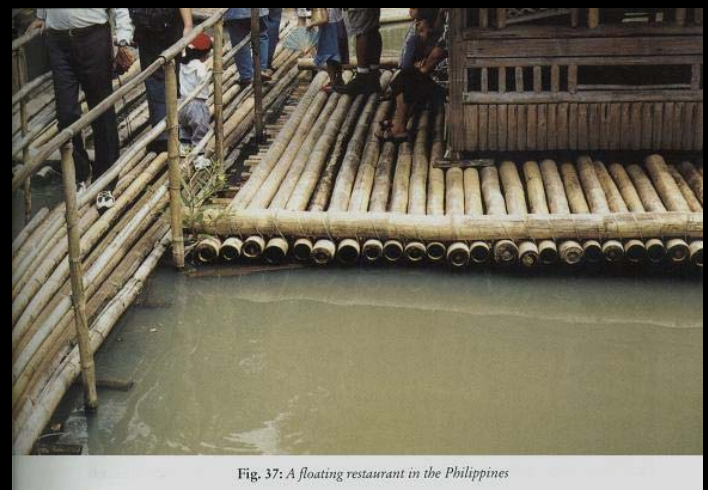


Fig. 37: *A floating restaurant in the Philippines*

Case sismoresistenti in bambù

Fig. 88: *A realistic model of bamboo house*

Fig. 90: *A bamboo house that emerged unscathed from the 1991 earthquake (Costa Rica)*

Fig. 93: *A bamboo corrugated roofing sheet being tested (India)*

Fig. 92: *A well-protected outside wall*

Il “bahareque”

Fig. 95: *A house with solid* bahareque *wall (San José, Costa Rica)*

Fig. 96: *A close-up of the solid* bahareque *wall (the plaster is missing) showing the basic technique*

Fig. 97: *A bamboo-walled house (Debra Dun, India)*

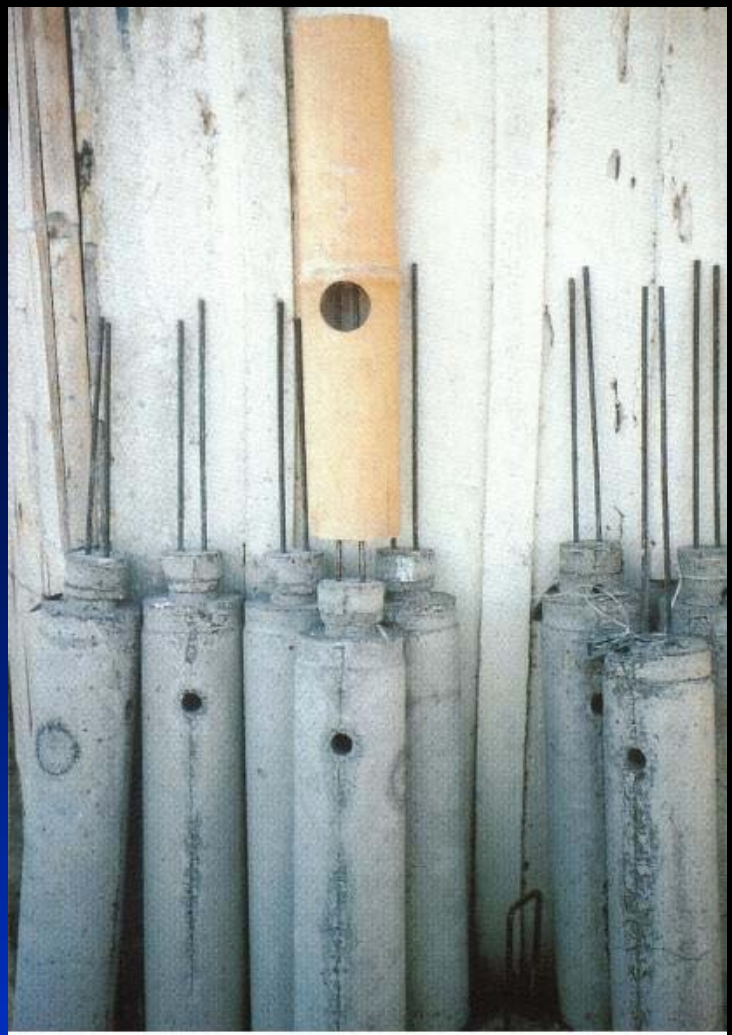


Fig. 100: *Prefabricated foundation parts for bamboo houses*

Fig. 101: *Industrial production of houses*

Fig. 102: *The interior of a prefabricated house*

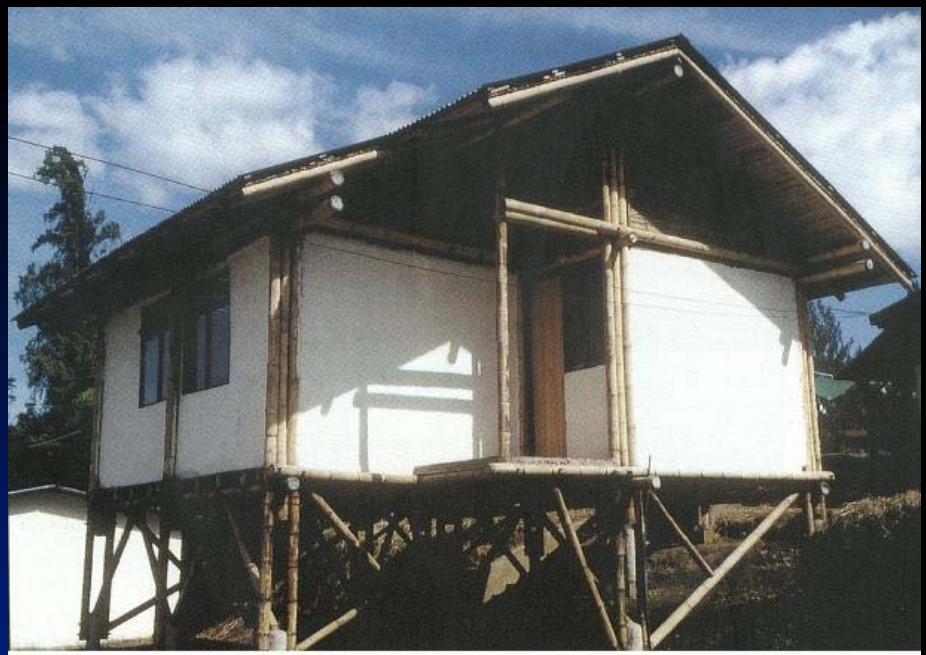


Fig. 103: *Prototype of a bamboo house with elevated floor (Costa Rica)*

Fig. 104: *A demonstration at a prototype house in Dar es Salaam, Tanzania*

http://ambiental.utp.edu.co/guadua
http://www.bambus.de
http://www.bambus.rwth-aachen.de
http://www.inbar.int
http://www.efb-bamboo.org

Il problema delle giunzioni in bambù

Fig. 73: Trusses in a bamboo house

Fig. 74: Connection between truss and column

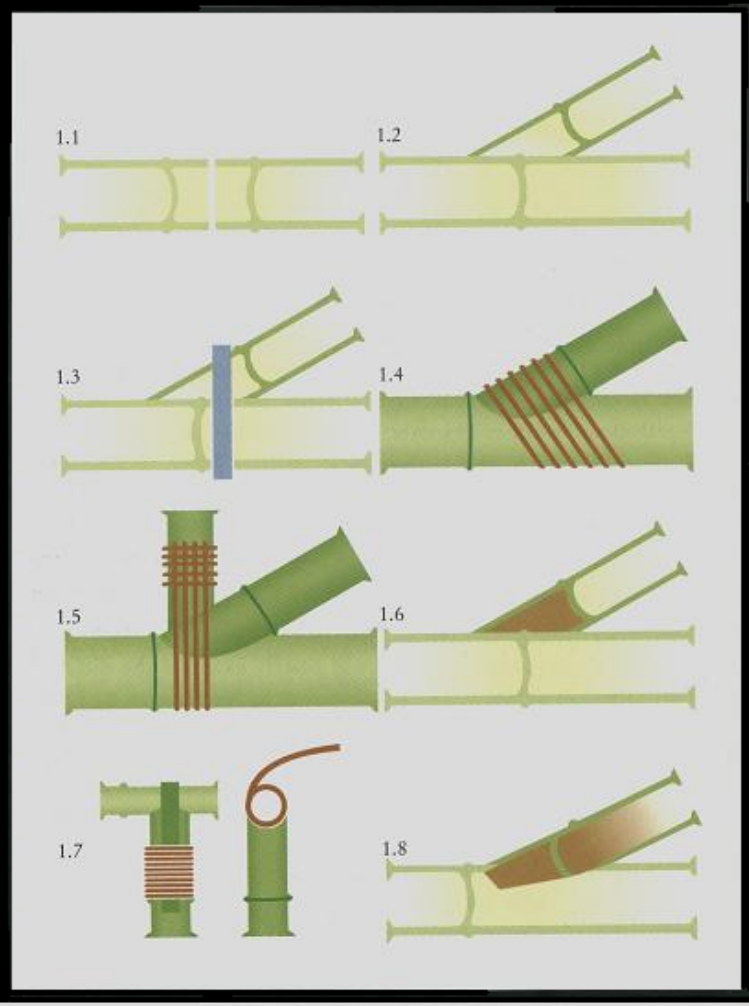


Fig. 55: *Joints with full contact between cross-sections (Janssen 1981)*

Nodi poco efficaci o di complessa tecnologia

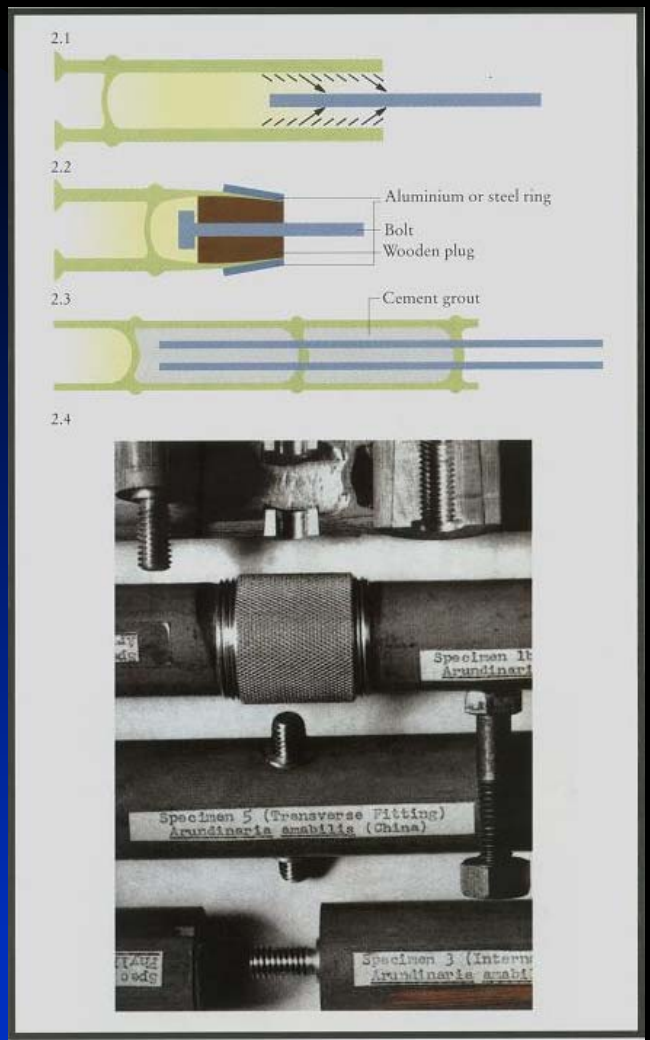


Fig. 56: *Joints from inside to an element parallel (Janssen 1981)*

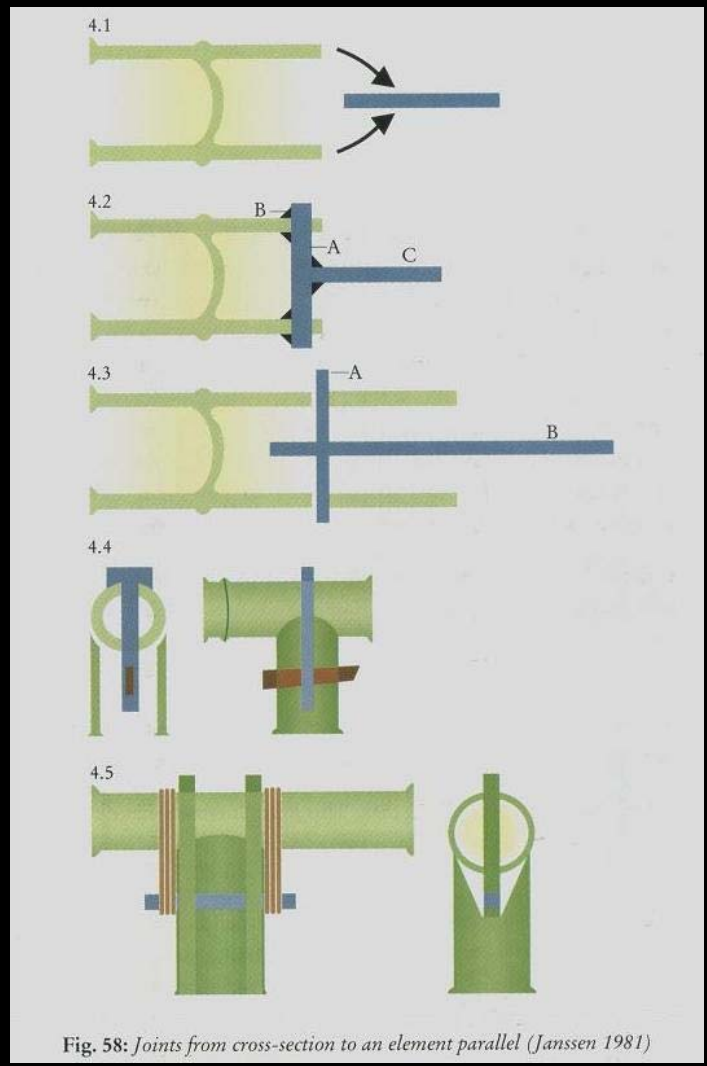
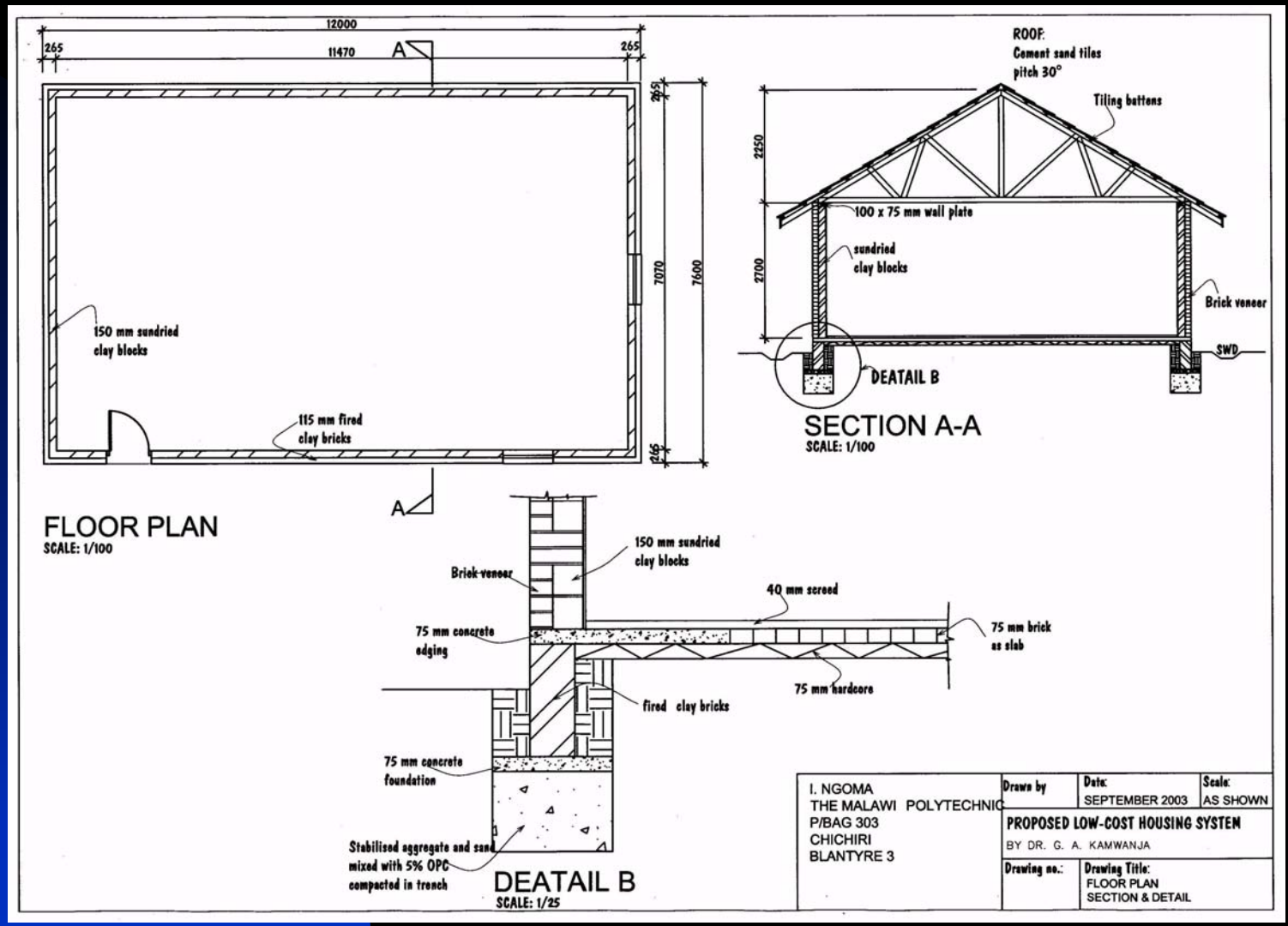
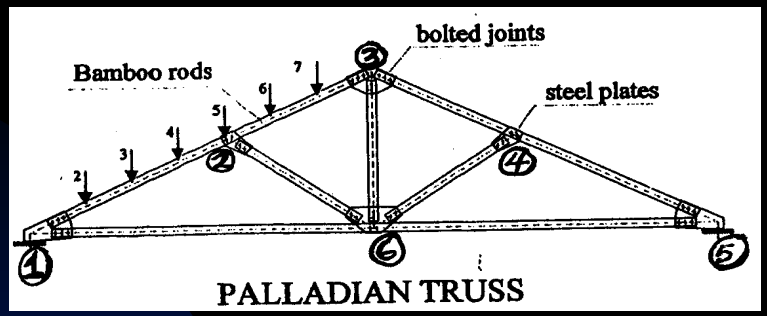


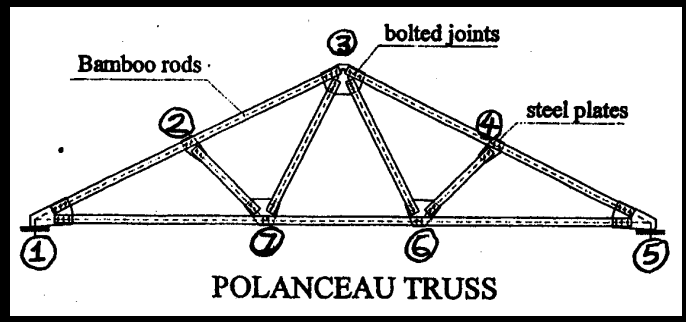
Fig. 58: *Joints from cross-section to an element parallel (Janssen 1981)*


12000
265
11470
265
A
295
7070
7600
265
150 mm sundried clay blocks
115 mm fired clay bricks
FLOOR PLAN
SCALE: 1/100
ROOF:
Cement sand tiles
pitch 30°
Tiling battens
2250
100 x 75 mm wall plate
2700
sundried clay blocks
Brick veneer
SWD
DEATAIL B
SECTION A-A
SCALE: 1/100
A
150 mm sundried clay blocks
Brick veneer
40 mm screed
75 mm concrete edging
75 mm brick ax slab
75 mm hardcore
fired clay bricks
75 mm concrete foundation
Stabilised aggregate and sand mixed with 5% OPC compacted in trench
DEATAIL B
SCALE: 1/25
I. NGOMA
THE MALAWI POLYTECHNIC
P/BAG 303
CHICHIRI
BLANTYRE 3
Drawn by
Date:
SEPTEMBER 2003
Scale:
AS SHOWN
PROPOSED LOW-COST HOUSING SYSTEM
BY DR. G. A. KAMWANJA
Drawing no.:
Drawing Title:
FLOOR PLAN
SECTION & DETAIL


BAMBOO ROOF TRUSSES


2004 1 26



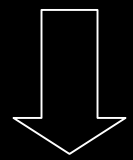


Ngoma, I., Sassu, M. (2004)

Truss Type	Span (m)	Allowable Spacing (m)	Theoretical load (kN)	Theoretical deflection (mm)	Allowable Deflection (mm)
Kingpost	8	0.76	5.7	18	24
	6.5	1.2	5.06	17	19.5
	4.22	1.5	5.46	9	12.7
Fink	8	0.76	6	20	24
	6.5	1.2	6.15	19	19.5
	4.22	1.5	5.74	10	12.7

Utilizzo sostenibile del bambù:

Con giunzioni efficaci, economiche e di facile esecuzione
è possibile realizzare coperture di luci libere maggiori



- case con distribuzioni interne più articolate;
- aule scolastiche;
- ambienti di aggregazione sociale (negozi, infermerie, etc.);
- luoghi di culto e assembleare (chiese, sale riunioni etc.).