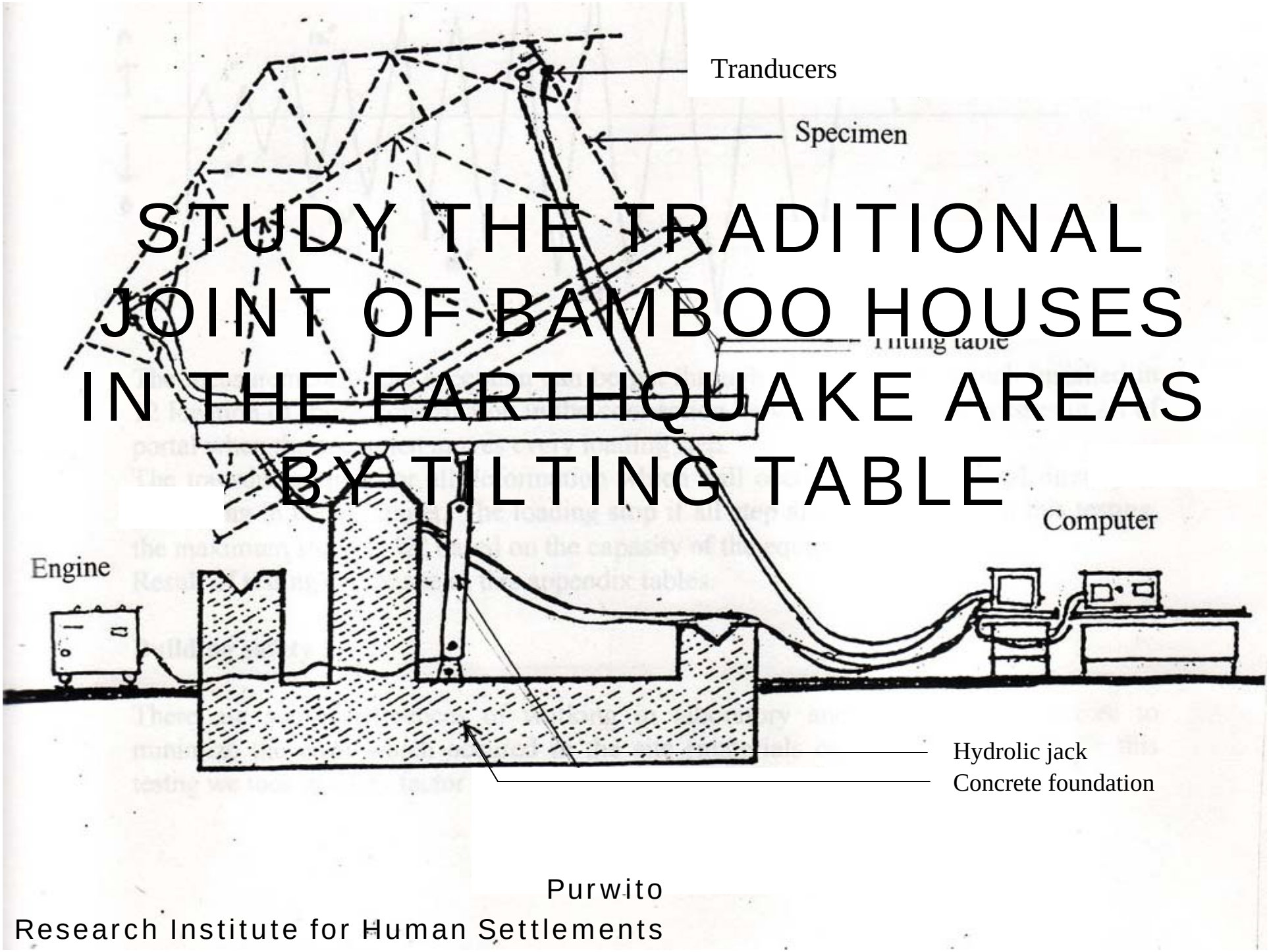
# STUDY THE TRADITIONAL JOINT OF BAMBOO HOUSES IN THE EARTHQUAKE AREAS BY TILTING TABLE




Purwito
Research Institute for Human Settlements

Most of the earthquake that occurred in Indonesia destroying **non engineer buildings** which had been built without calculated the strength and safety.

**Caused by;** ***error construction -------was not appropriate with the rule of structure endure earthquake and Variety of the materials used.***

bad construction

f the house with **bamboo construction**

ttle bit damaged and it was not collapsed although

nection system that used

y simply

ope string and dowel/pin connections)

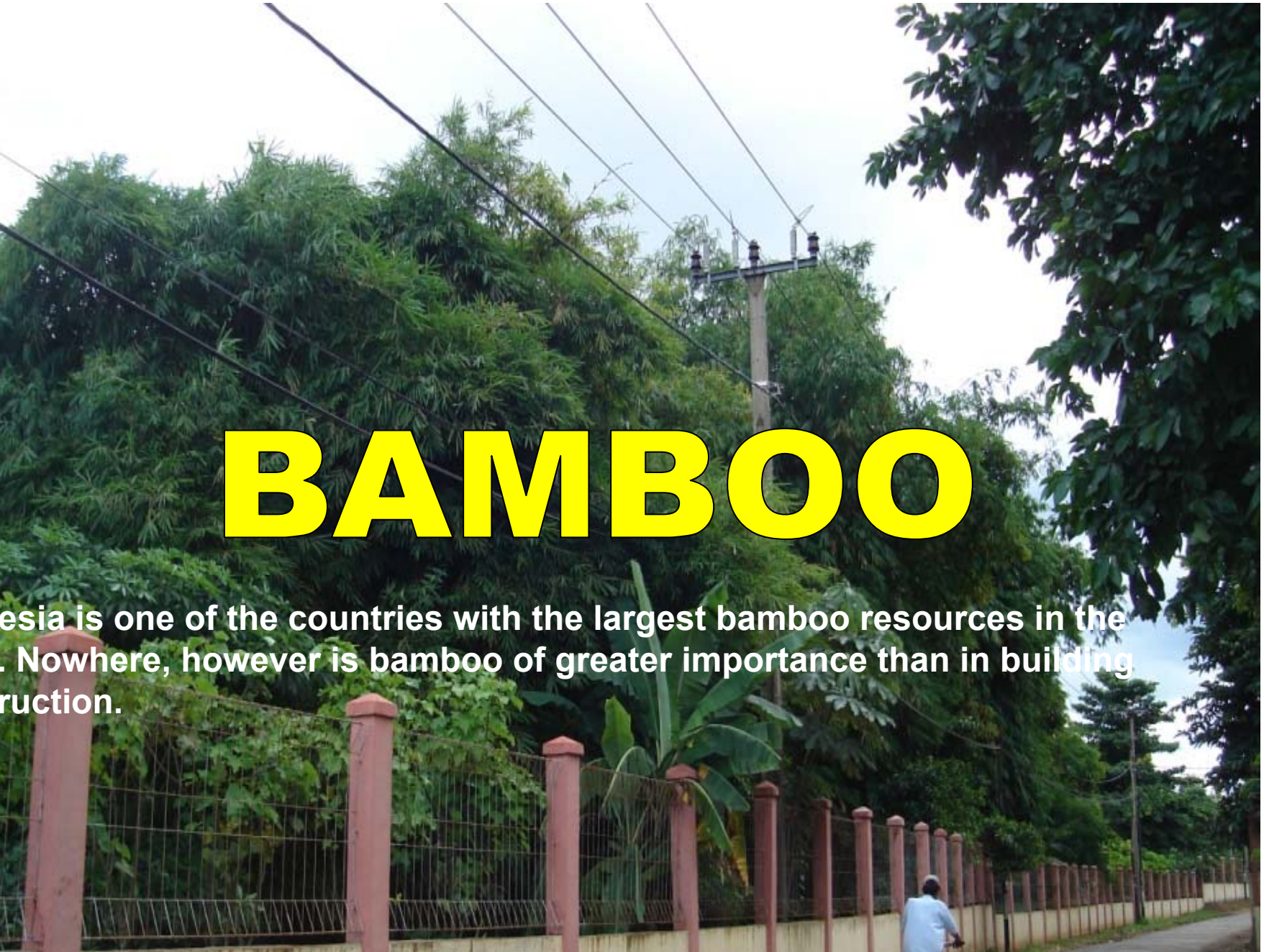
mboo or wood that is legacy of our great-grandparents.

**In 1980 Jakarta and Surabaya that 41.5% of dwellings of the low income groups were still being constructed from bamboo.**

**Bamboo can tolerate high values of deformations in the elastic range i.e. possesses high elasticity. Therefore bamboo houses when properly constructed are ductile i.e. being able to sway back and forth during an earthquake, without any damage to the bamboo poles. The construction materials for building a bamboo house should be readily available and accessible. The bamboo based house has a very low weight therefore foundation can be minimized.**

# Therefore

**We tried to perform experiments on the strength of traditional connections in a bamboo house**


BAMBOO
esia is one of the countries with the largest bamboo resources in the
. Nowhere, however is bamboo of greater importance than in building
ruction.

# TYPE OF BAMBOO

i duri atau bambu duri

Awi tutul

Awi krisik atau bambusa multiplex

Awi bitung atau bambu betung

Awi ampel (warna kuning) .. haur koneng

Awi Awi cangkoreh Awi tali atau bambu tali

Awi hideung atau Bambu hitam

Awi temen atau bambu ater

Awi Tela atau awi Lengka atau Bambu Lengka

Awi Gombong atau bambu Gombong

Awi mayan atau bambu mayan

Awi eul – eul

Awi Tali Koneng atau Bambu Lemang.

Awi Tamiyang atau Bambu Suling

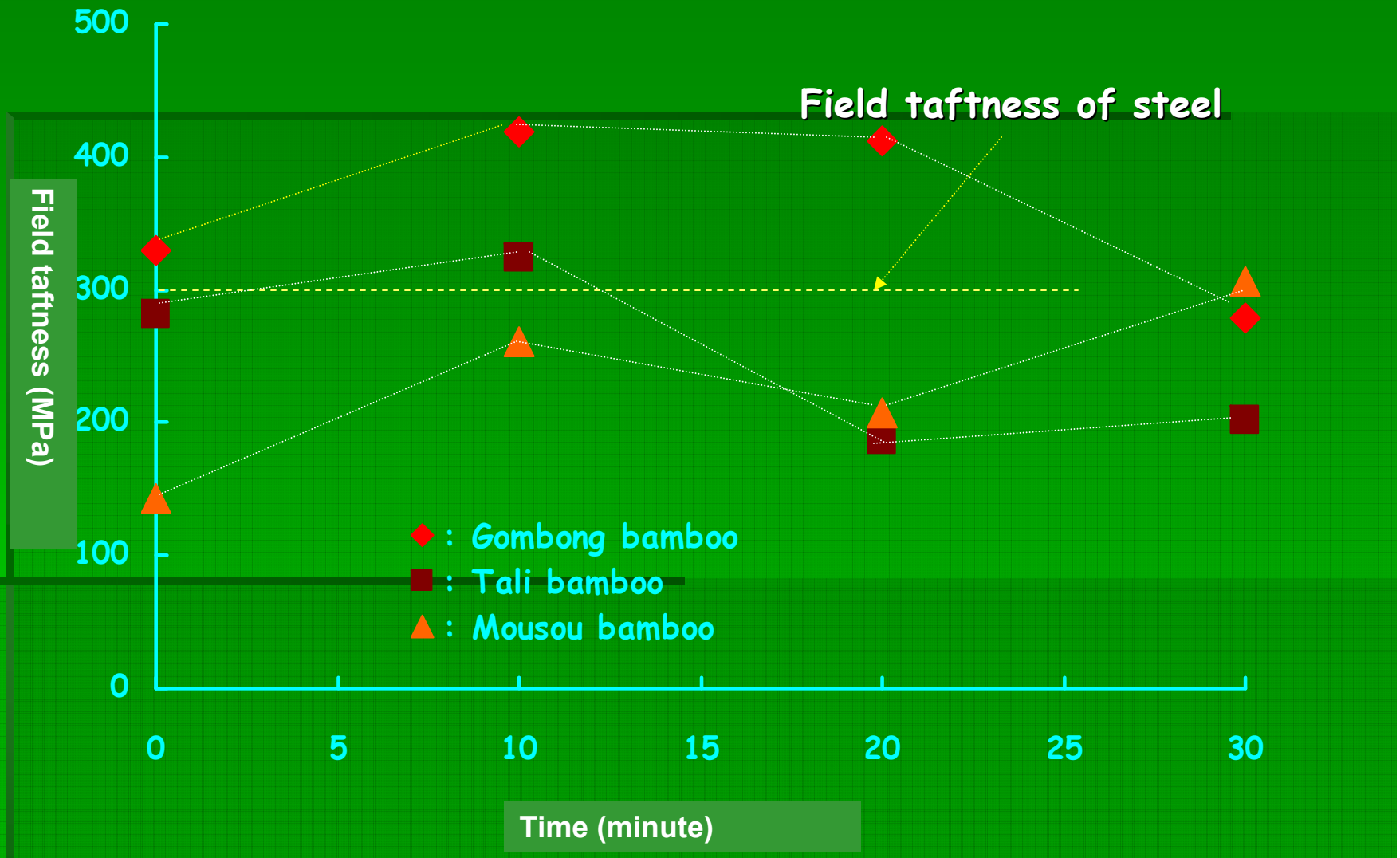
Awi Jepang atau Bambu Bangkok

AWI = BAMBOO

# BAMBOO BETUNG

# BAMBOO ROPE/STRING

# Strength of Bamboo

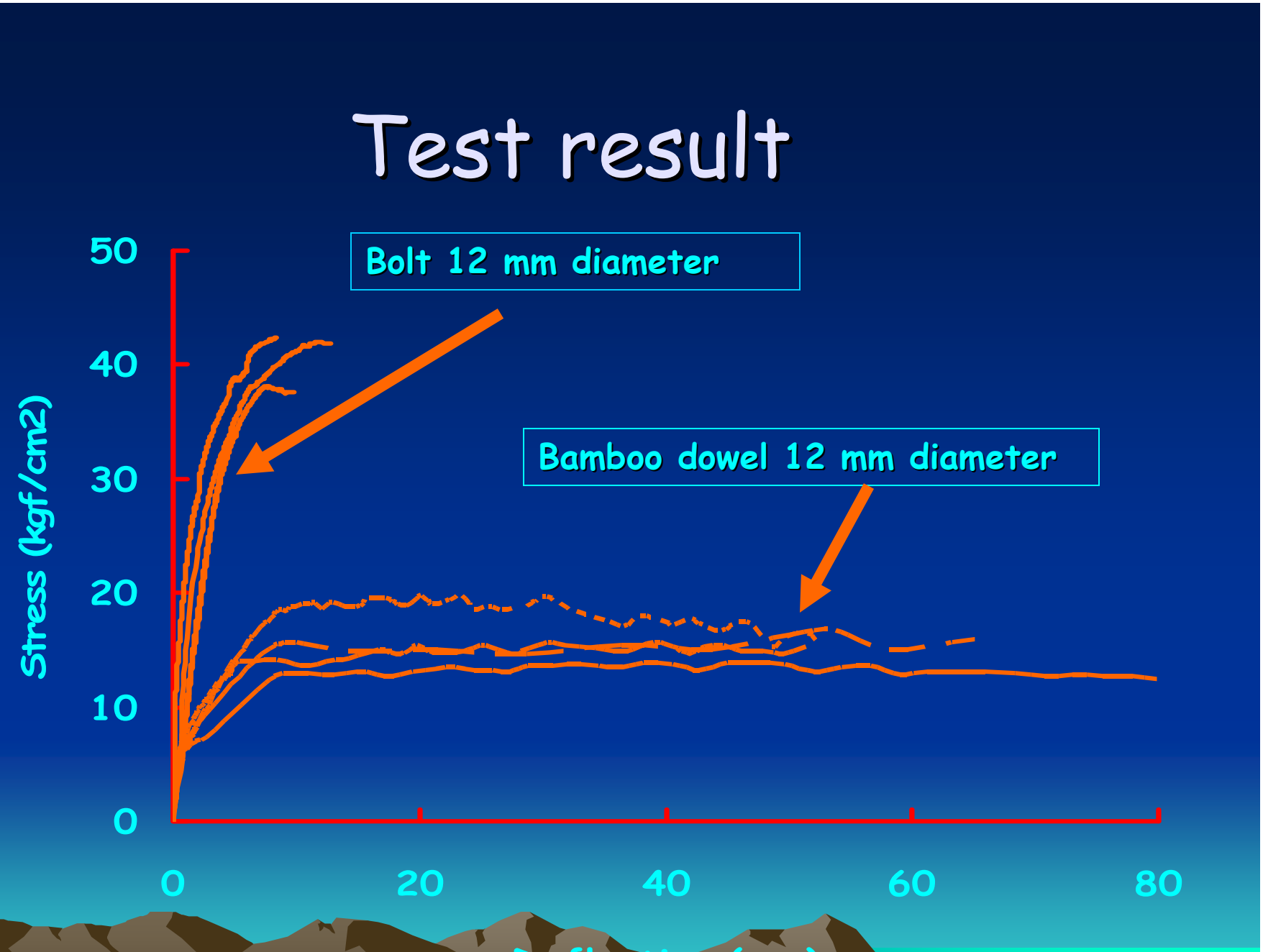


# THE APPLICATION and TESTING OF DOWEL/PIN

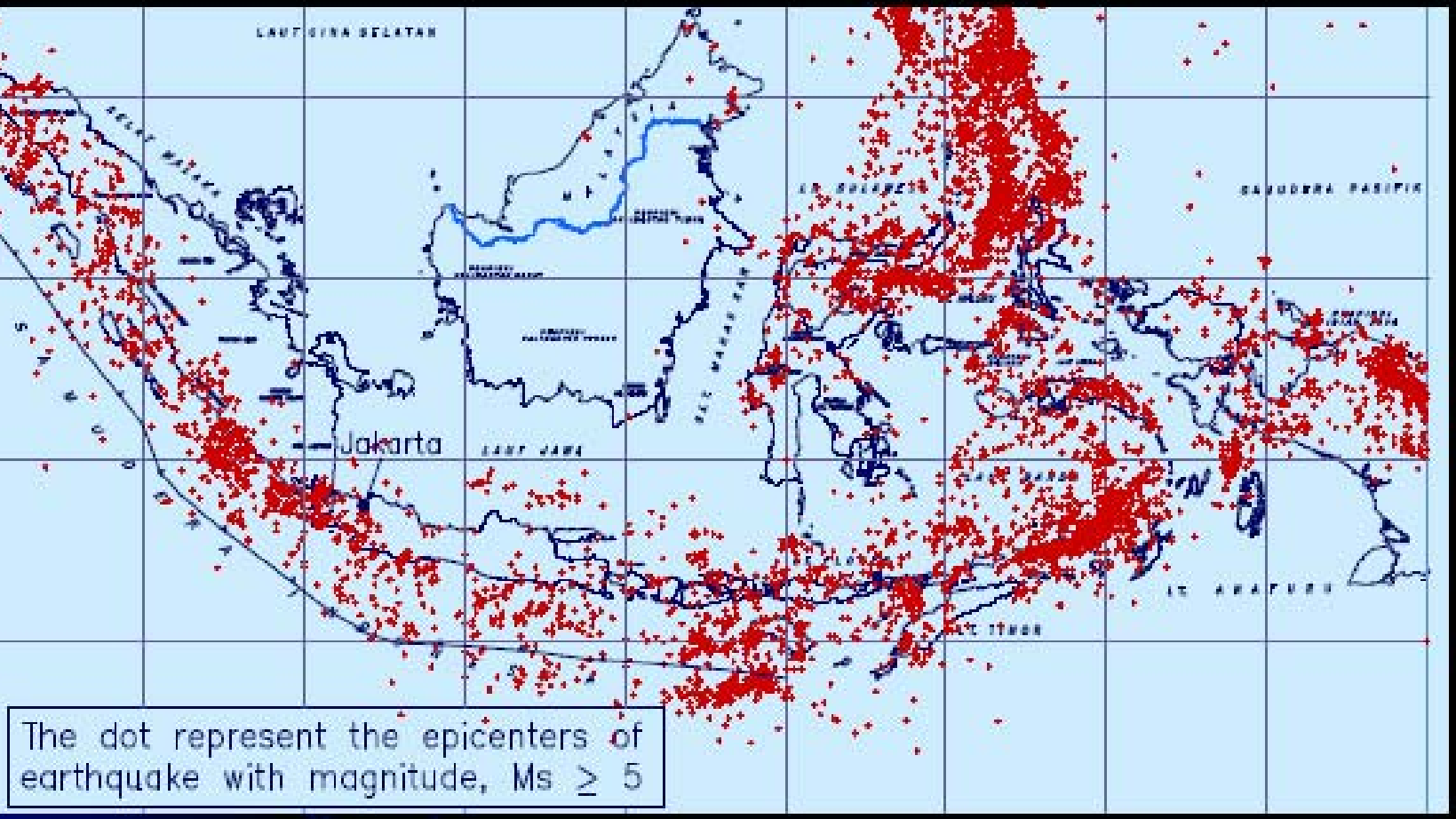

Penggunaan pantek dalam sambungan sederhana

Pengujian keteguhan tarik

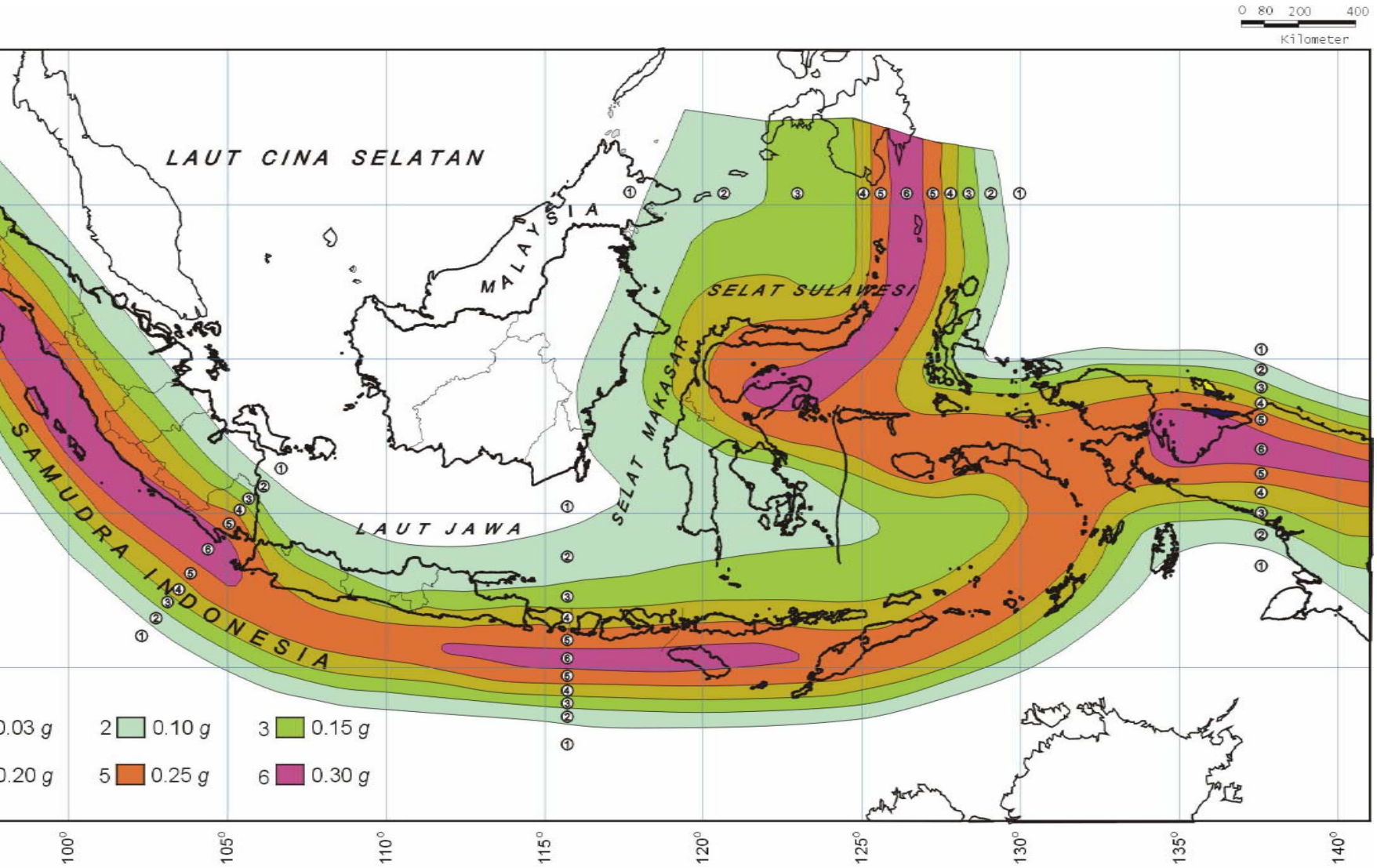
# Test result


Bolt 12 mm diameter
Bamboo dowel 12 mm diameter
Stress (kgf/cm2)
50
40
30
20
10
0
0
20
40
60
80

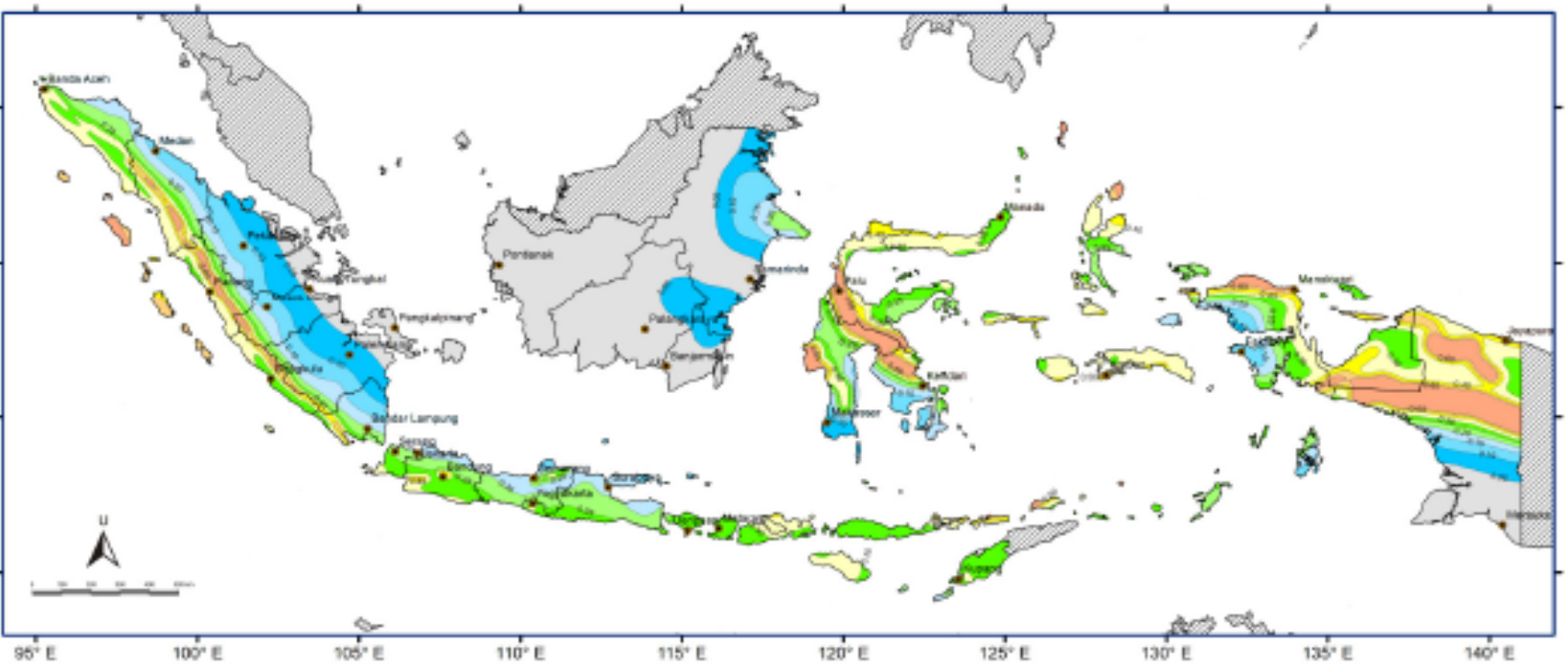
# Identification of Seismic Sources



# PETA WILAYAH GEMPA INDONESIA SNI 2002



# EARTHQUAKE ZONE OF INDONESIA 2010




**KETERANGAN :**

Percepatan puncak di batuan dasar $S_B$ untuk probabilitas terlampaui 10 % dalam 50 tahun

**Tim Penyusun :**

Prof. Ir. Masyhur Irsyam, MSCE. Ph.D., Ir. I Wayan Sengara, MSCE. Ph.D., Fahmi Aldiamar, ST.,MT., Prof. Dr. Sri Widiyantoro, Wahyu Triyoso, MSc. Ph.D., Ir. Engkon Kertapati, Dr. Ir. Danny Hilman Natawidjaja, MSc., Dr. Ir. Irwan Meilano, MSc., Drs. Soehardjono Dipl. Sein., Ir. M. Asrurifak, MT., Ir. Mohamad Ridwan, Dipl.E. Eng.

## PETA ZONASI GEMPA INDONESIA

KEMENTERIAN PEKERJAAN UMUM

Jakarta, Juli 2010

MENTERI PEKERJAAN UMUM,

DJOKO KIRMANTO

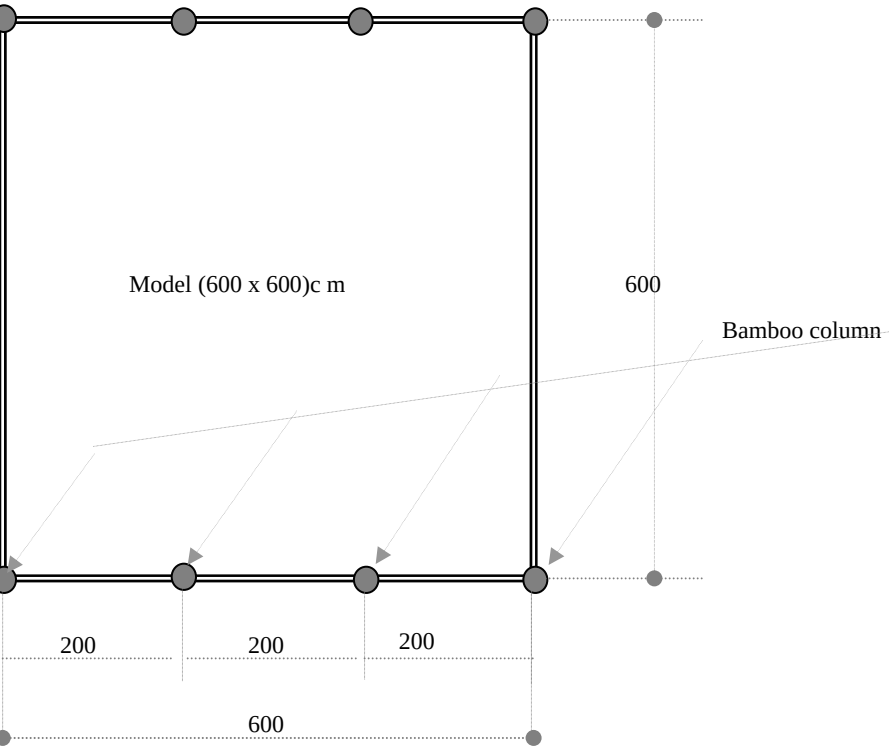


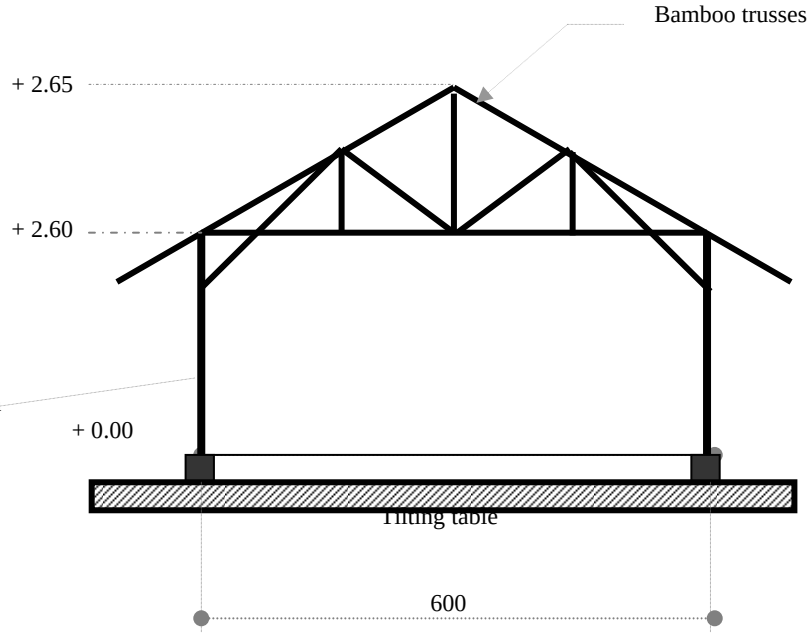



# TEST EQUIPMENT FOR BUILDING STRUCTURE

# TILTING TABLE


| | | | |
|---|---|---|---|
| **e .....** | **=** | 700 | **cm** |
| **gth .....** | **=** | 800 | **cm** |
| **ckness of the table plate** | **=** | 8.8 | **mm** |

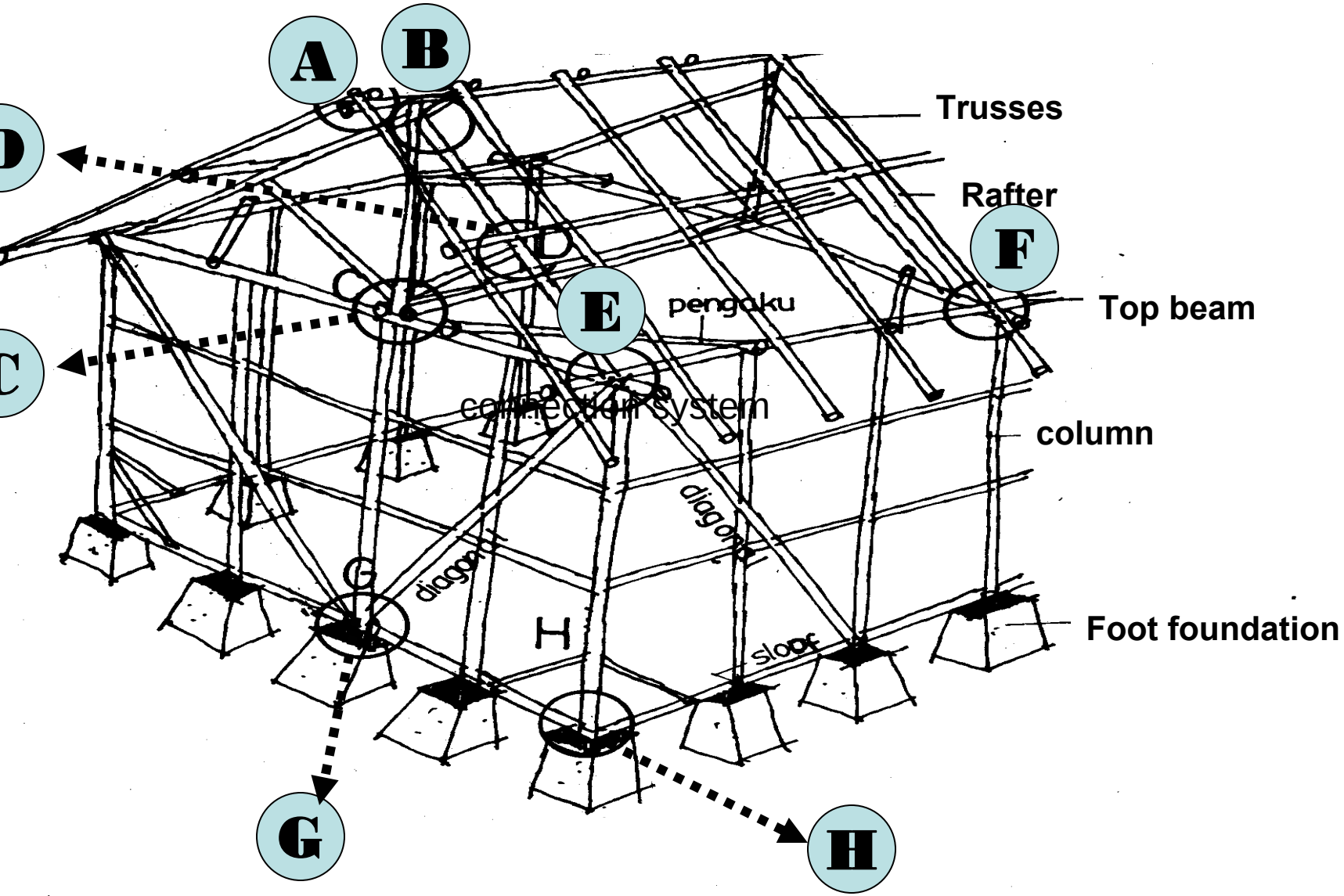


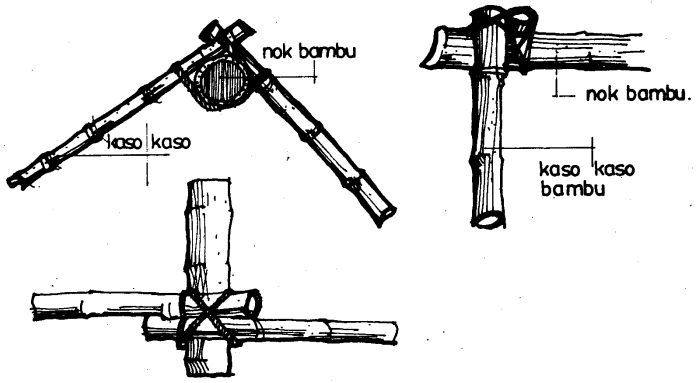

# MODEL OF SPECIMENTS

- **Size = (6 x 6) m**
- **Height of ceiling = 2.6 m**
- **Column and trusses included purlins use: Bamboo betung ǿ 12 cm.**
- **Bracing beams : String Bamboo (bambu tali) ǿ 10 cm**
- **Joint connectors : coco rope and dowel/jig from bamboo.**
- **Roofing covers : corrugated zink**

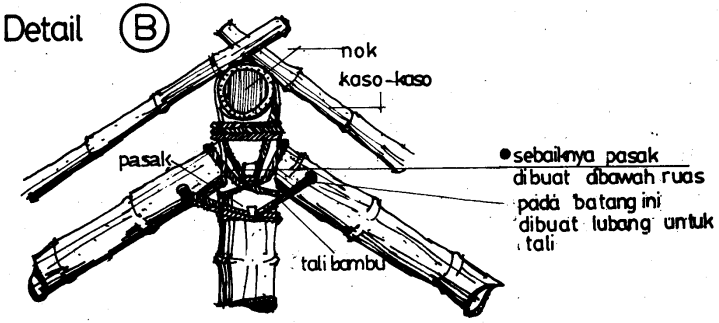
# NNECTION SYSTEM



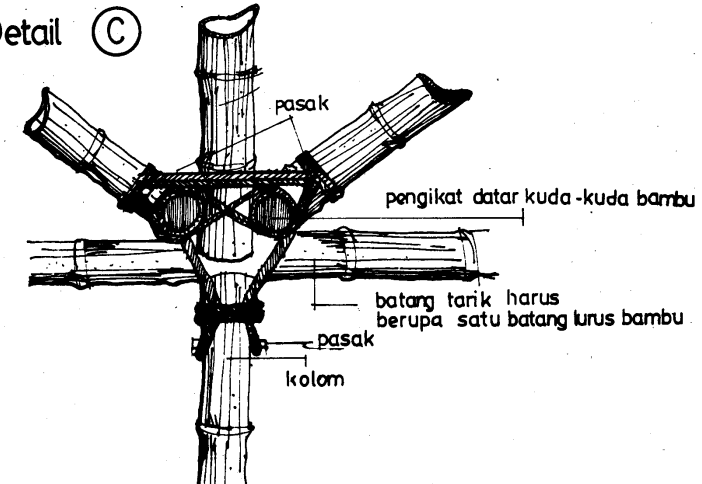
Detail (A)



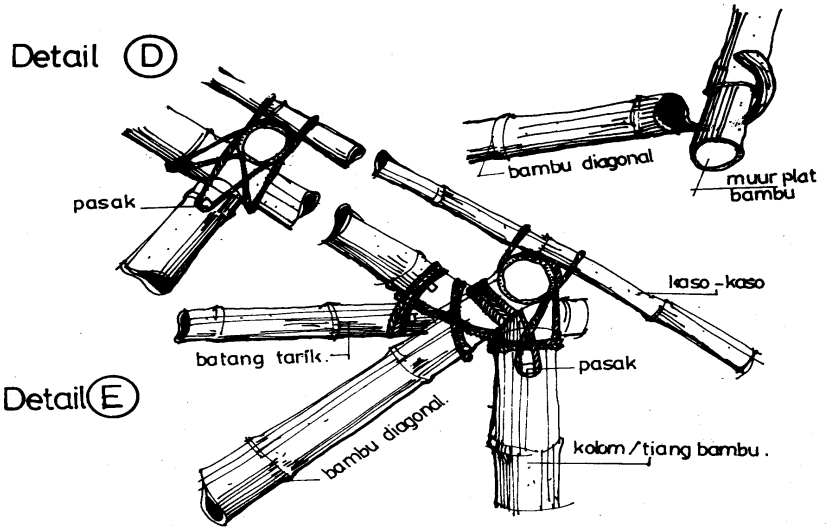

Detail (B)




Detail (C)



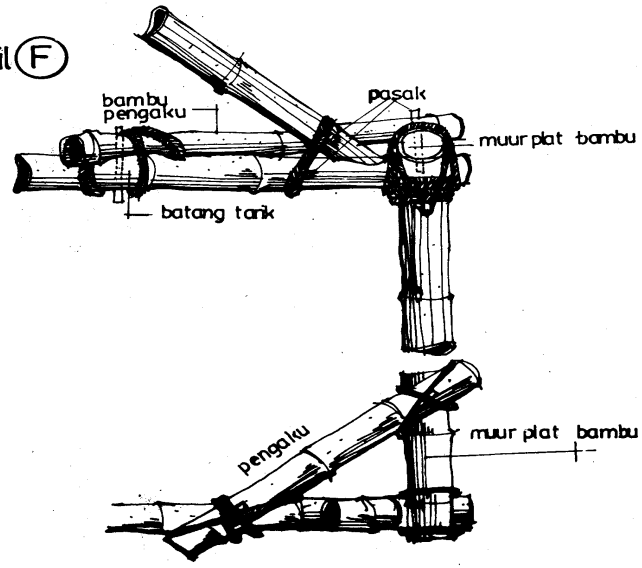

Detail (D)

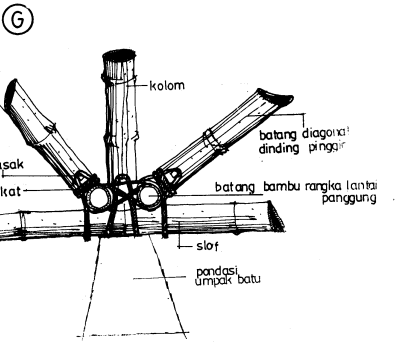


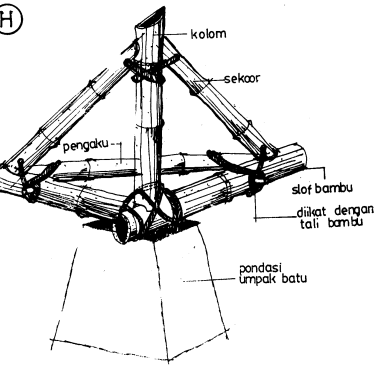

Detail (E)




Detail (F)

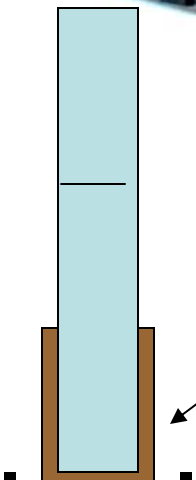


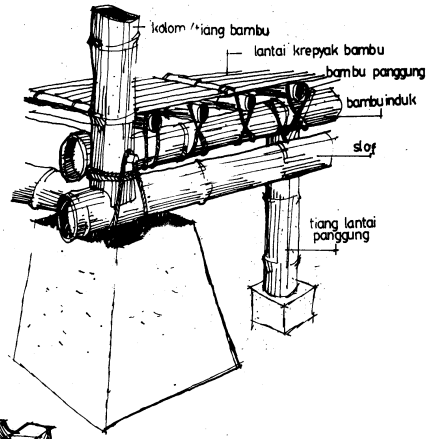


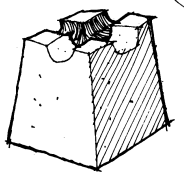



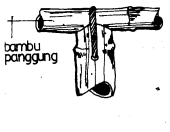


# FOUNDATION FOR TESTING SAMPLE



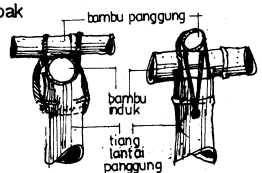



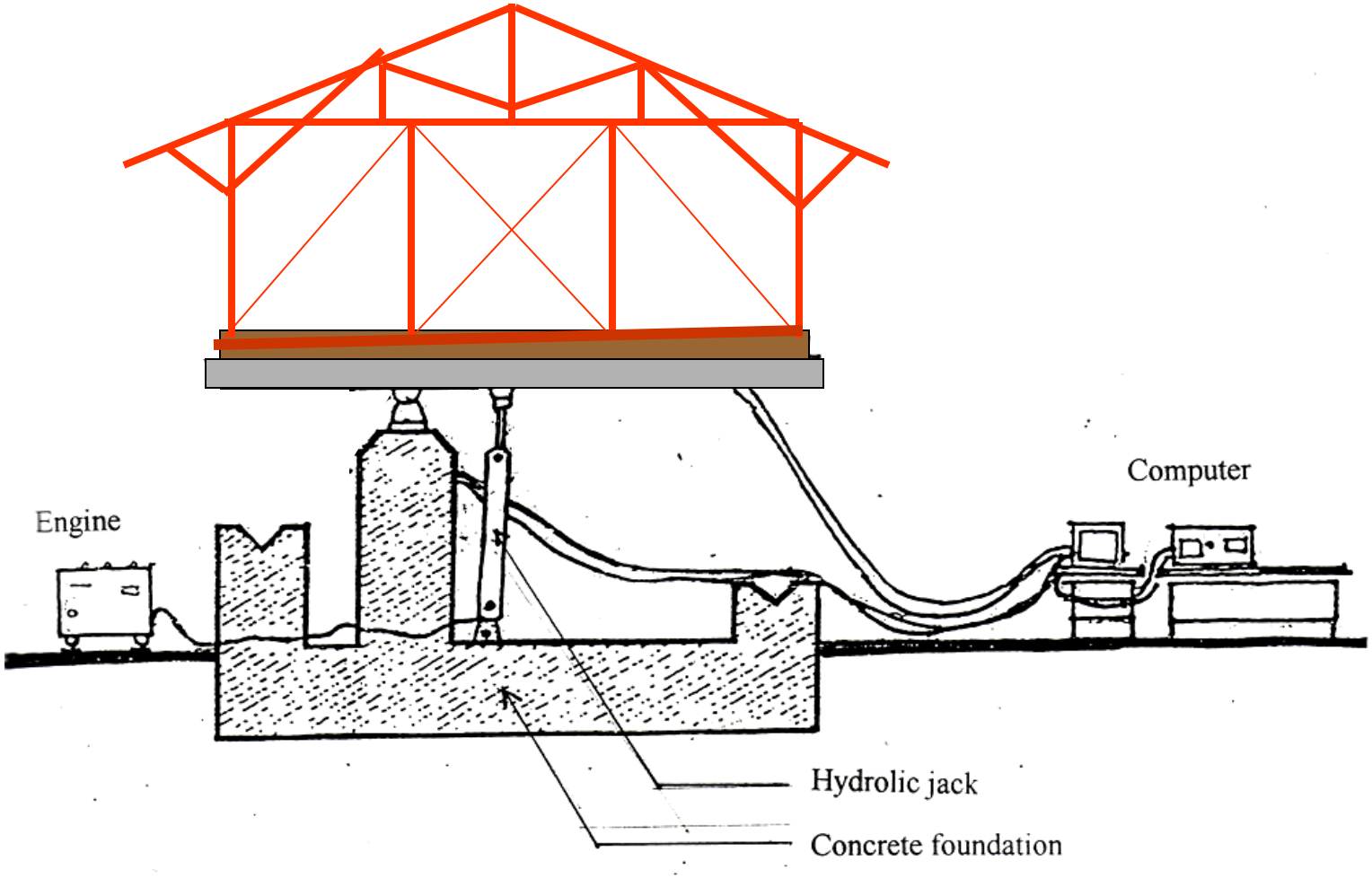





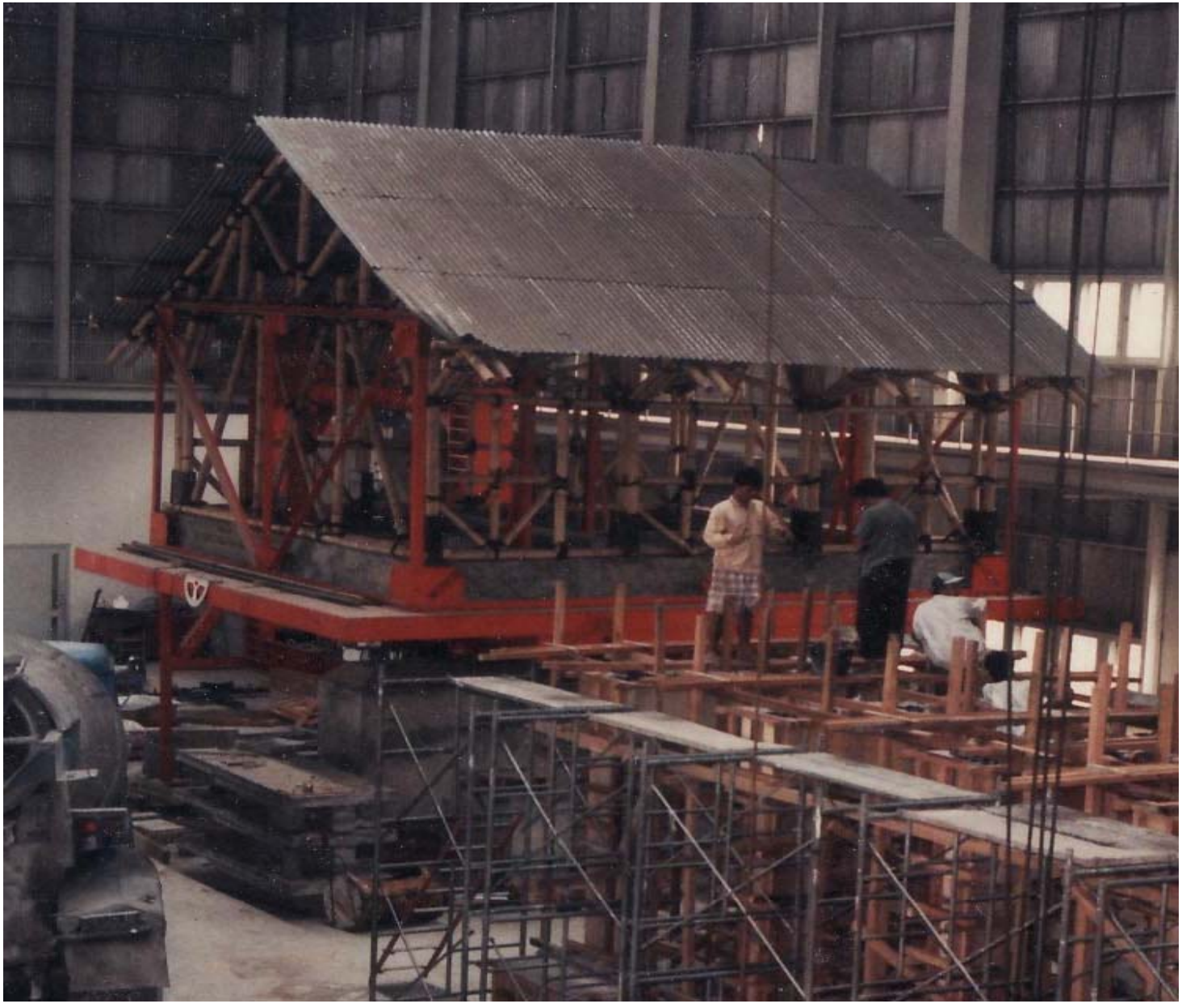


• pondasi umpak batu kali

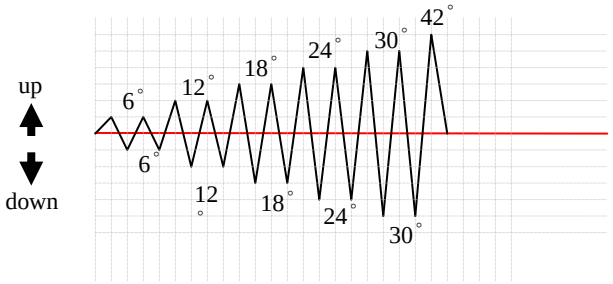


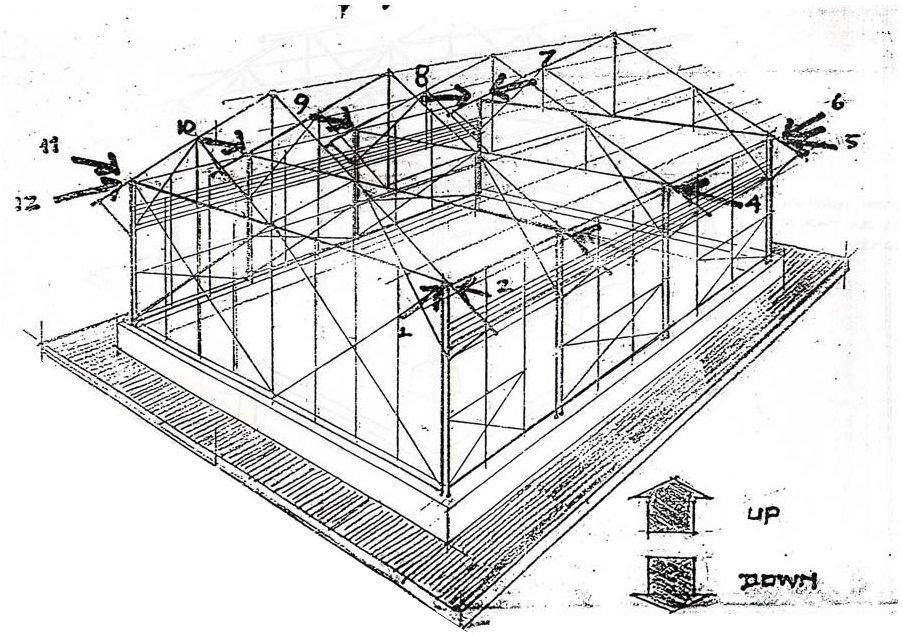



**e lateral forces will active if the table moved by tilting to the left and right. Power ven with two hydraulic jack with a capacity 60 ton. The lateral force of gravity uaals the weight of the mass of the building when it is moved. All of the data m all processed transducers mounted on all of the joint between components**



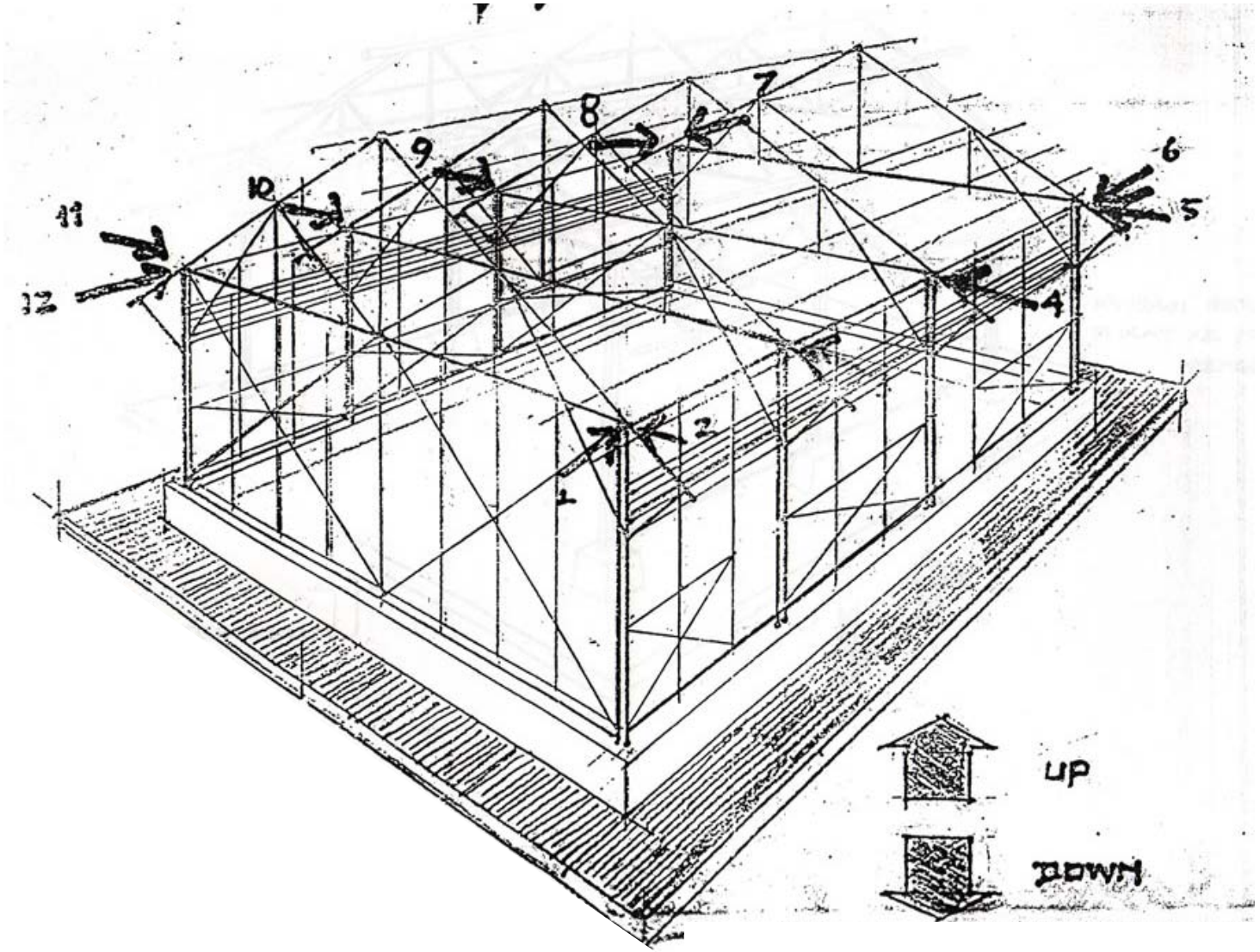
# METHODE OF TEST




The loading step :

Step 1 = 0° - 6°
Step 2 = 0° - 12°
Step 3 = 0° - 18°
Step 4 = 0° - 24°
Step 5 = 0° - 30°
Step 6 = 0° - 42°


1
2
4
5
6
7
8
9
10
11
12
UP
DOWN

Transducers Tr-10, Tr-9, Tr-8, Tr-5, Tr-4, Tr-3 which located in the ction parts and in slope direction of the building can be represent for the results.

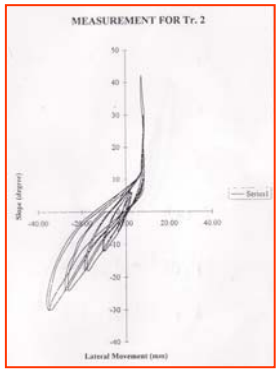
displacement of the frame construction determined 1.5 % from the ceiling height = 1.5 % x 2.60 m = 3.90 m.

Transducers Tr-10, Tr-9, Tr-8, Tr-5, Tr-4, Tr-3 indicates the splacement be read < 3.9 cm after the end of testing (slope reach 42˚).

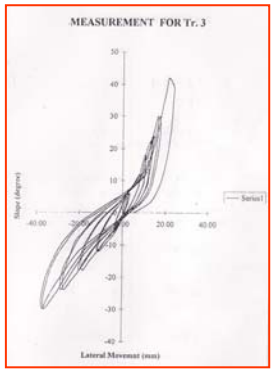
This mean the building is earthquake resistant category. With a plain of view, there are not severe damages in all of joint ween column and trusses components. The quality of bamboo still n a good condition although because we selects qualities of all mboo before used like age of bamboo must be 3 years and water contents less the 15%.

**Not all behavior of the transducers clear to be read because some reasons as explain from the diagram of the relation between displacement and lateral forces below.**

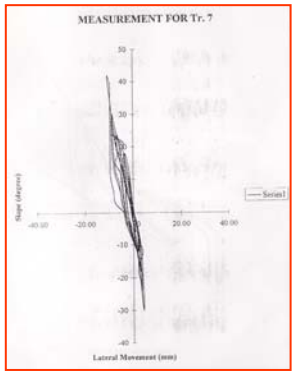
r - 1



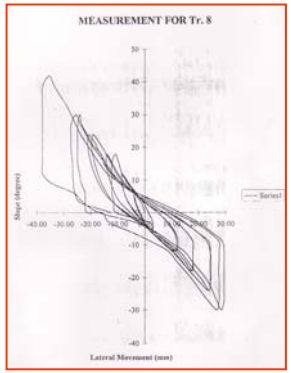

Tr - 2



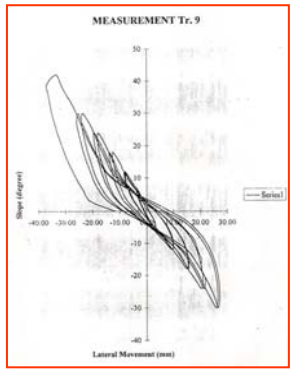

Tr - 3



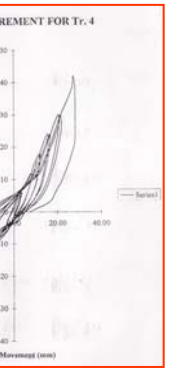

Tr - 4



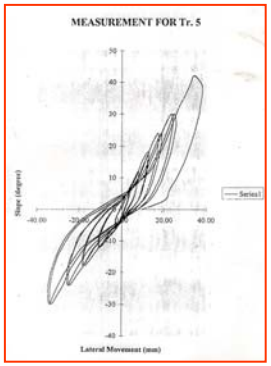

Tr - 5



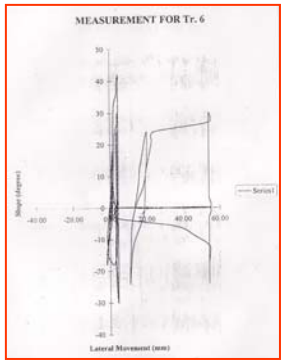

Tr - 6

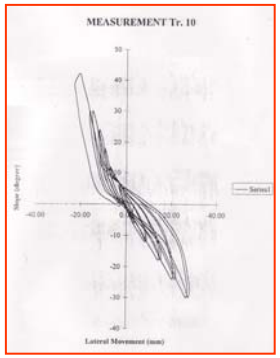


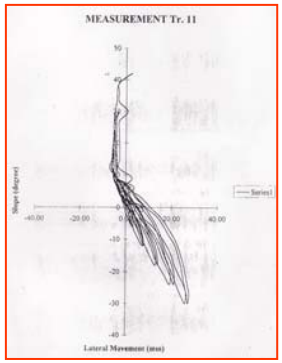
r - 7

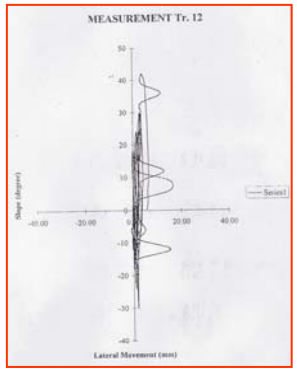



Tr - 8



Loading test was carried out in the cross section same as structure analysis calculation and in this direction the shear strength of building supported by four (4) portal trusses.

- Same as some previously test for masonry houses the building safety determined = 3 to anticipate the difference quality works and building materials used (in laboratory and fields).

- The result of testing based on data logger and computer calculation maximum response spectra = 0.67 G.

- Using the Building Planning Resistant Code SNI 03-1726-2002 explains that this house model can be

# CONCLUSION

**The connection use coco rope and bamboo dowel is a good system for materials with tubular shapes in particular bamboo,**

**The structures design is available used in earthquake areas because the test result shows the displacement < from 3.9 cm (1.5 % from the height of ceiling = 2.60 m) and in plain view the frame construction still in a good condition (not crack and collapse) up till the testing finish.**

**Bamboo can tolerate high values of deformations in the elastic range i.e. possesses high elasticity. Therefore bamboo houses when properly constructed are ductile i.e. being able to sway back and forth during an earthquake, without any damage to the bamboo poles.**

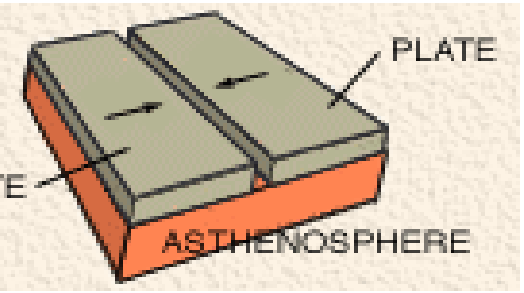
**The quality of bamboo must be more then 3 years old and the water contents < 10 % because very influence the construction strength.**

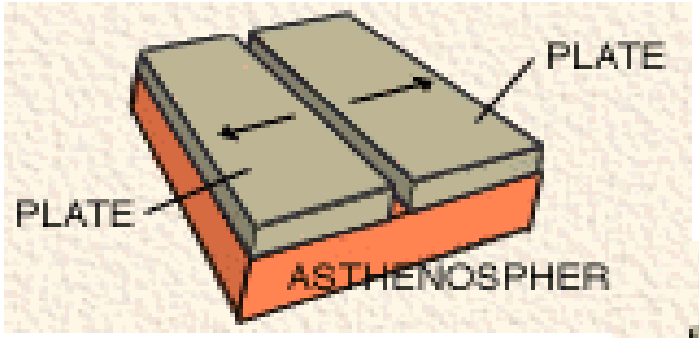
# ACKNOWLEDGMENTS

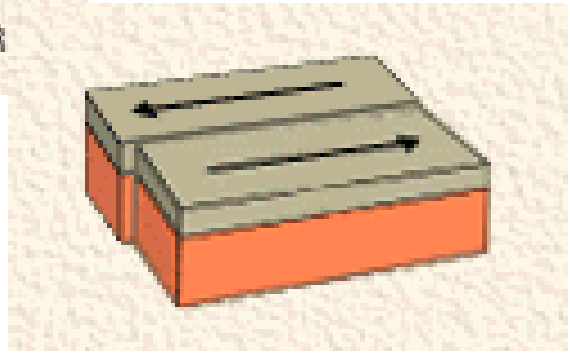
***I would like to thanks for  Prof Dr. Suryono Suryokusumo, Ir. Gunawan as a Project officers from PT. Bina Karya and Head offices of Research Institute for Human Settlements***

***who assisted and sources of financial support in this activities.***

# THANK YOU



# BAMBOO SPECIFICATION

Tensile strength varying results from 1000 – 4000 kg/cm2
Compression strength  yarying result from 250 – 1000 kg/cm2
Bending strength varying result from 700 – 3000 kg/cm2
dulus elasticity varying result from 100.000 – 300.000 kg/cm2.

# The response spectra earthquake

| Condition | Earthquake Zone | | | | | |
|---|---|---|---|---|---|---|
| Soil | 1 | 2 | 3 | 4 | 5 | 6 |
| Hard | C = 0.33 | C = 28 | C = 0.24 | C = 0.18 | C = 0.12 | C = 0.04 |
| | Ok | Ok | Ok | Ok | Ok | Ok |
| Soft | C = 0.38 | C = 0.36 | C = 0.60 | C = 0.30 | C = 0.20 | C = 0.08 |
| | Ok | Ok | Ok | Ok | Ok | Ok |

Note :
C = Coefficient of earthquake, calculate by gravitation
Ok = Building in the elastic condition

△ = Building in the inelastic condition
X = Building is collapse

**(SNI 03-1726-2002)**