



Hello!

### **Appropriate Construction Technologies for God's People, their Animals and Grain**

There are many appropriate building technologies available. How environmental friendly are they? Earthquake resistant? Typhoon resistant? How can we introduce new materials to a traditional construction culture? Why would we want to produce our own materials? How can we make production accessible to women? In what cases does it make sense to use a new technology? We'll consider interlocking compressed earth blocks, micro concrete roofing tiles, rice husk ash cement, bamboo and more.



ACTS GOOD STEWARDSHIP => KINGDOM

A large ship is steered by a small rudder. Where do we want to go? What are our goals/ ideals/ principles? Good Stewardship takes us toward the Kingdom of God. Deciding to use ACTs is like turning the rudder to point more towards a green world that reflects Good Stewardship.



Less is more:

Sustainability: Permanence or Renewable materials

If you don't need it, don't build it. Let's be good stewards of our resources.

Let us try not to use resources on a community church building but,

Let us try to use resources for building a church community.

Jesus never built a church. I can find no where in the New Testament where any apostle ever constructed a church building. Today there is a growing house church movement; people worship

in homes and not churches.

## Cathedral of Saint John the Divine a work in progress since 1892



Blessing of  
the animals –  
Feast of Saint  
Francis  
4 October



### PLAN

### ARCHITECT BEYOND YOUR LIFETIME

Making a permanent building takes time. Make a good plan on paper. Imagine (visualize) people using the building. Take time to raise funds; don't rush and end up with something unsatisfactory. A good building takes time to plan. Find an architect who understands your needs and desires. Good architects will know how to design some passive solar heating and cooling that is appropriate to your climate. They'll know how to design a staircase that is comfortable to a human. They'll know how that if you have window area greater than 10% of your floor area you can read without turning on a light during daylight hours. A good architect is worth his weight in copper. Consider working on projects that might take more than your life time to complete. Be far sighted; you'll be blessed.

### Blessing of the Animals

Feast of St. Francis -- first Sunday in October, animals are blessed at the Cathedral of St. John the Divine. This impressive Cathedral is said to be the world's largest Gothic Cathedral and has been a work in progress since 1892.

(2011) Blessing of the Animals - Sammy and the City | Events, Things to do in New York City, Activities, Central Park, Guide. Retrieved 13 September 2013, from [sammyandthecity.com/2011/10/02/blessing-of-the-animals-feast-of-st-francis-cathedral-of-st-john-the-divine-attraction/](http://sammyandthecity.com/2011/10/02/blessing-of-the-animals-feast-of-st-francis-cathedral-of-st-john-the-divine-attraction/)

## Beauty and Permanence are virtues



Church Street School -Tupelo USA built in 1937

“We believe sustainability begins with preservation, that building for permanence is sustainability. Rather than create new buildings using valuable resources, we maintain, rehabilitate, renovate and modernize our existing structures.

. . . as part of an effort to rebuild the damage from one of the worst tornadoes in American history. Both Presidents Roosevelt and Truman visited the school, and a model of it was displayed at Chicago's Century of Progress World's Fair exhibition.

Some Roman aqueducts are still used



**Let us keep embodied energy in buildings through careful maintenance, as opposed to disposable architecture.”** Stephen T. Ayers, Architect of the Capitol of the USA

Demolition. Rebuilding

### **Vitruvius Utilitas, Firmitas and Venustas**

firmitas: the ability of a building to endure based on its own material strength and soundness of construction. Put Firmitas schools and other civic buildings = They'll be disaster resilient and serve as storm shelters.

Firmitas re-visited: Permanence in Contemporary Architecture by Katrina Touw A thesis presented to the University of Waterloo in fulfilment of the thesis requirement for the degree of Master of Architecture in Architecture Waterloo, Ontario, Canada, 2006 ©Katrina Touw 2006



## Renewable Plants in Construction.

On the left, notice the floating home with thatched roof and walls floating on bamboo rafts.

Even the church is bouyed by rafts of bamboo.

Biomass materials are **sustainable**: although they need to be replaced every few years, they are made from fast-growing plants.



1 Billion bamboo houses. Bamboo structures resist earthquakes: when a powerful 7.6 magnitude earthquake hit Limon, Costa Rica in 1992, all of the [30 bamboo houses](#) in the epicenter remained intact. Most of the surrounding concrete homes and hotels around them collapsed.

Bamboo structures resist earthquakes: when a powerful 7.6 magnitude earthquake hit Limon, Costa Rica in 1992, all of the 30 bamboo houses in the epicenter remained intact. Most of the surrounding concrete homes and hotels around them collapsed.

## Meribah coffee shop - Thailand



Thomas Singer good example: more durable New  
Employment desire + knowledge + diligence  
overcame problems, innovated disseminated 2010  
ECHO Notes

With borate treatments, bamboo can reportedly last  
15 to 20 years or longer.

The Bamboo School, The Green School in Bali,  
\*\*\*\*\*show slides ++++++

Dissemination strategies: centers, advocate for adding to school curriculum

# WATTLE & DAUB WALLS

- Stabilized Mud plastering over woven bamboo slats.



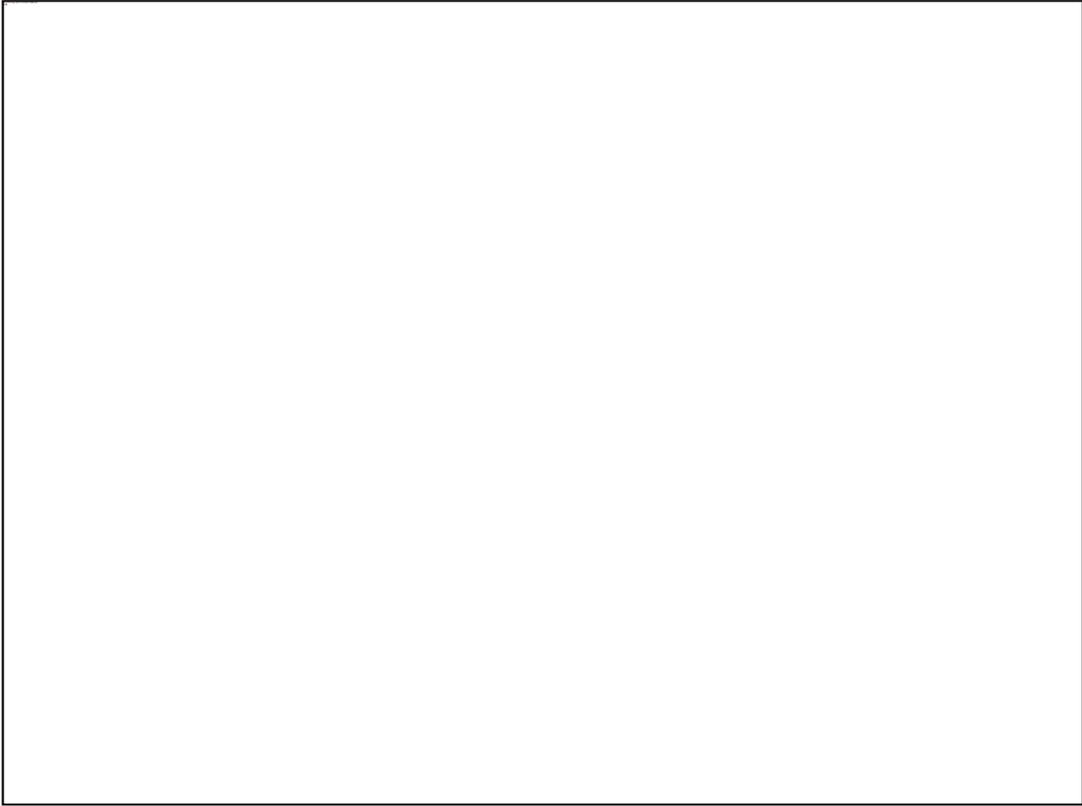
Cost-effective  
Good finish

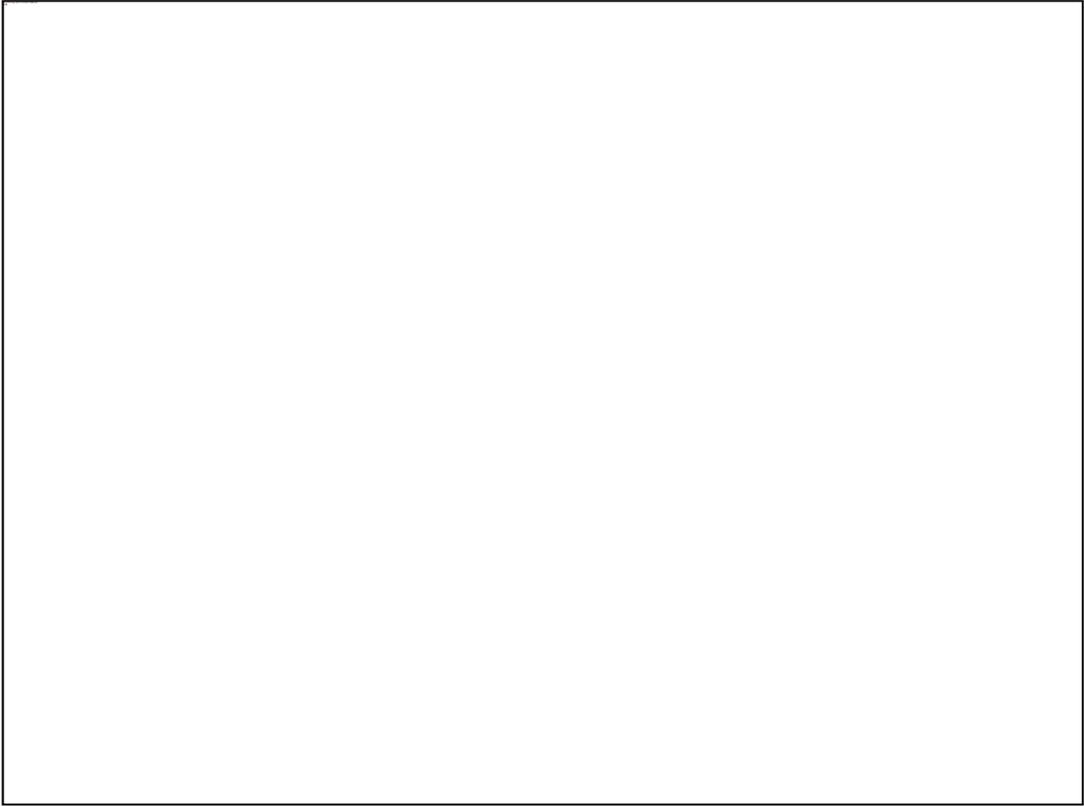


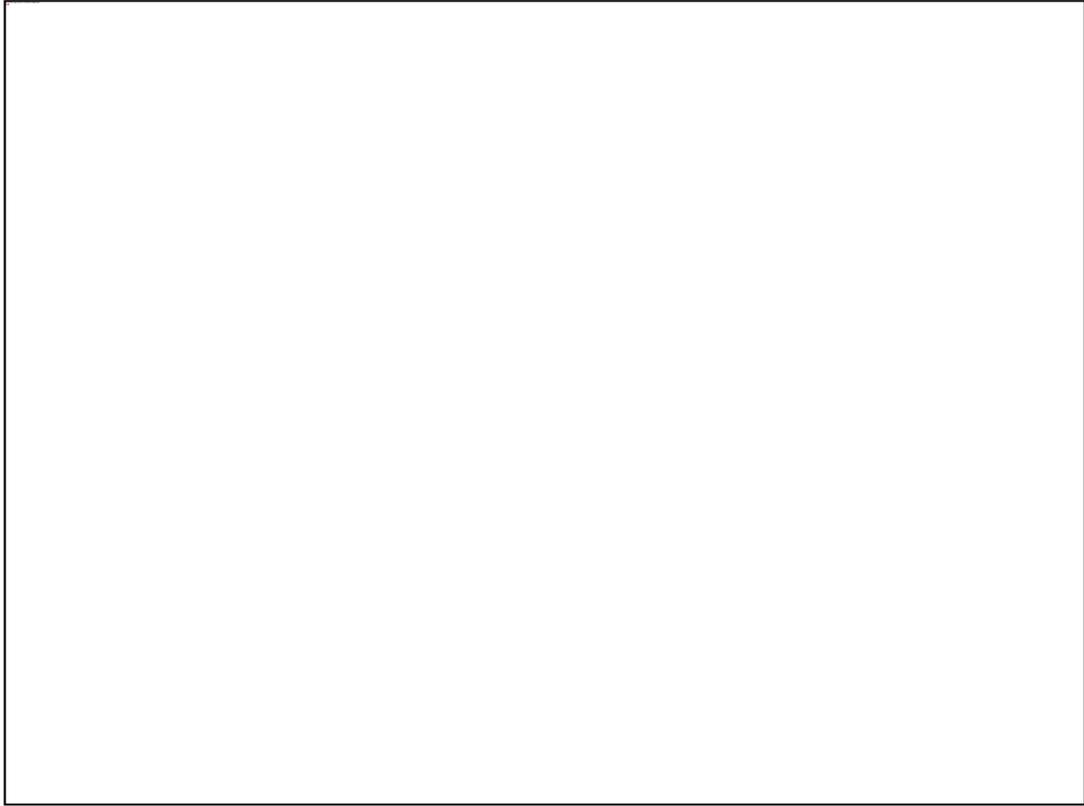
Lao, Indonesia

There are wattle and daub traditions in Lao and Indonesia

Habitat Building Center, Kerala India

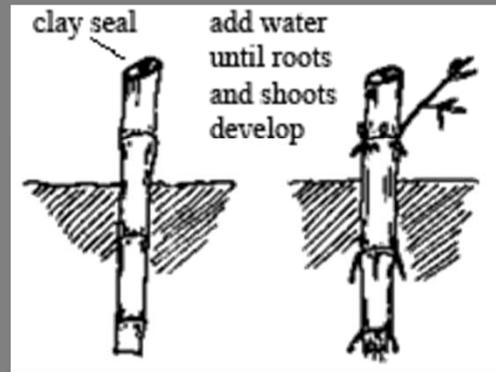






Concrete can be reinforced with bamboo.

# PLANT MORE BAMBOO



EASY TO GROW  
LOCKED

4 YEARS

MORE & FASTER CARBON

MANY VALUE ADDED PROCESSED BY LOCAL COMMUNITY

Bamboo is propagated by taking pieces from a bamboo plant and keeping them alive for long enough to for them to grow and form new plants. This can start almost immediately, though may take as long as a year or two, depending on the bamboo species, the method used and the environmental conditions. Some bamboo species are very easy to propagate, and others are difficult and require great attention to detail. It is important to select well-grown healthy material of the right age and state of development for the propagation method used. It should be free from pests and diseases and protected from drying during transport and storage. Careful balance of moisture and drainage in the propagation medium, and high humidity are essential for good results in all but the easiest to propagate of bamboo species. Warmth and

good light levels are also required.

**Bamboo Against Emissions: BAMBOO GROWING & PROPAGATION.** Retrieved 20 September 2013, from [baghg.blogspot.com/p/links.html](http://baghg.blogspot.com/p/links.html)

[Bamboo](#) is easy to grow and can be harvested annually from about the fourth year after planting. The hollow stems are light, easy to handle and can be split with a large knife. There are many stages of processing between raw material and finished product, and much of the processing can be done by the communities that grow and harvest the bamboo, so a large proportion of the value addition can be retained with them.

(1) its fast growth enables it to sequester significant quantities of carbon dioxide (CO<sub>2</sub>) in a relatively short time period, and (2) the harvesting of selective culms does not kill the tree but rather stimulates further growth.

### 2.3.1

#### Soil rehabilitation

Bamboo protects steep slopes, soils and water ways, prevents soil erosion, provides carbon sequestration and brings many other ecosystem benefits.

A second benefit of bamboo as a resource is that it can thrive on pieces of land where wood may not

(e.g. degraded land on slopes), and due to its extensive root network may help to prevent erosion and

facilitate the restoration of a healthy water table, potentially diminishing the environmental effects of erosion, landscape deterioration and desiccation relating to the environmental problem of ecosystem

deterioration (see table 1.1).

International Network for Bamboo and Rattan. (2012) Retrieved 14 September 2013, from [en.wikipedia.org/wiki/International\\_Network\\_for\\_Bamboo\\_and\\_Rattan](http://en.wikipedia.org/wiki/International_Network_for_Bamboo_and_Rattan)



NOISY UNATTRACTIVE TO TEACHERS  
GHOSTS

Plant replacement trees

CVBT 2000 trees / year. DO LIKEWISE

Wood is the traditional choice for construction in many cultures – but there is not much left.

We need to plant more trees than we cut down. To offset green house gas emissions, individuals and companies are buying carbon credits which reflect an investment in activities that lock carbon in the environment. We can take individual

responsibility to plant trees to take the place of ones we use to build with or wood used in paper we consume.

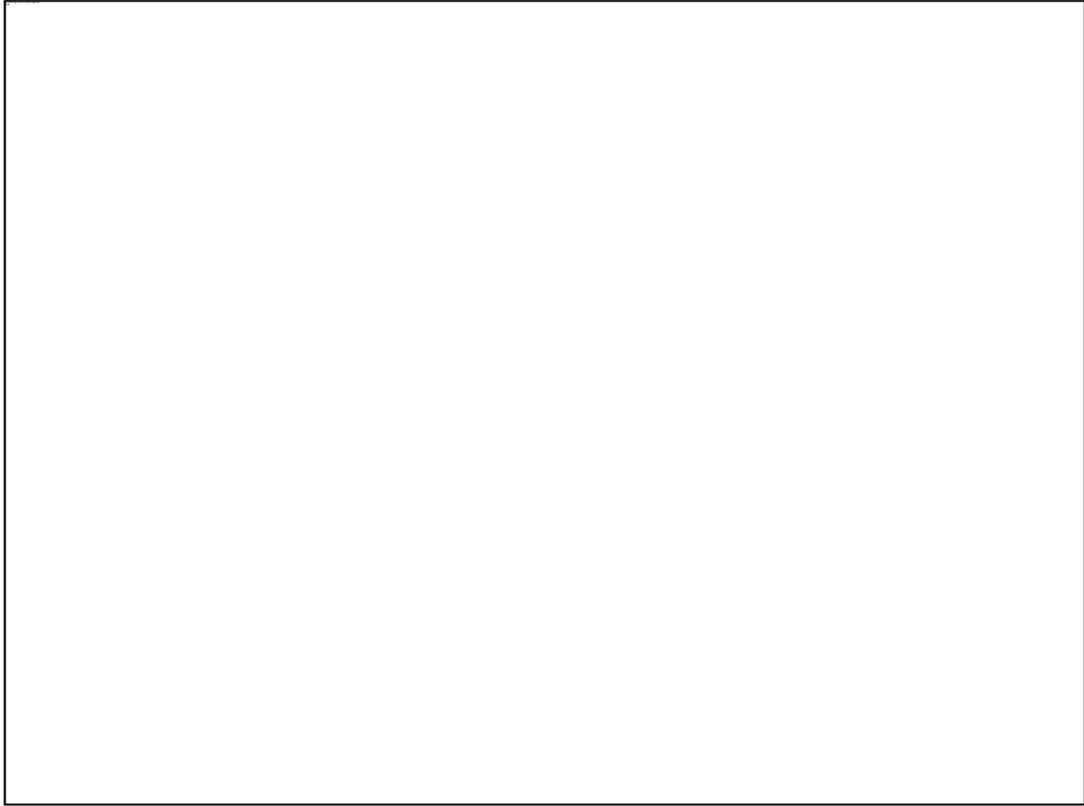
We're distributing up to 2000 seedlings each year at the beginning of the rainy season.



## ROOF STRUCTURE

Wood Replacement for walls

An interlocking compressed earth block school in Lao with no wood in the walls.



Life 70 years

Light weight

Strong



#### Carbon Foot Print

“This single industry accounts for around 5% of global carbon dioxide (CO<sub>2</sub>) emissions. It produces a material so common it is nearly invisible: cement. Cement is the primary ingredient in concrete. Concrete is the second most consumed substance on Earth after water. On average, each year, three tons of concrete are consumed by every person on the planet.” Rubenstein, Madeleine

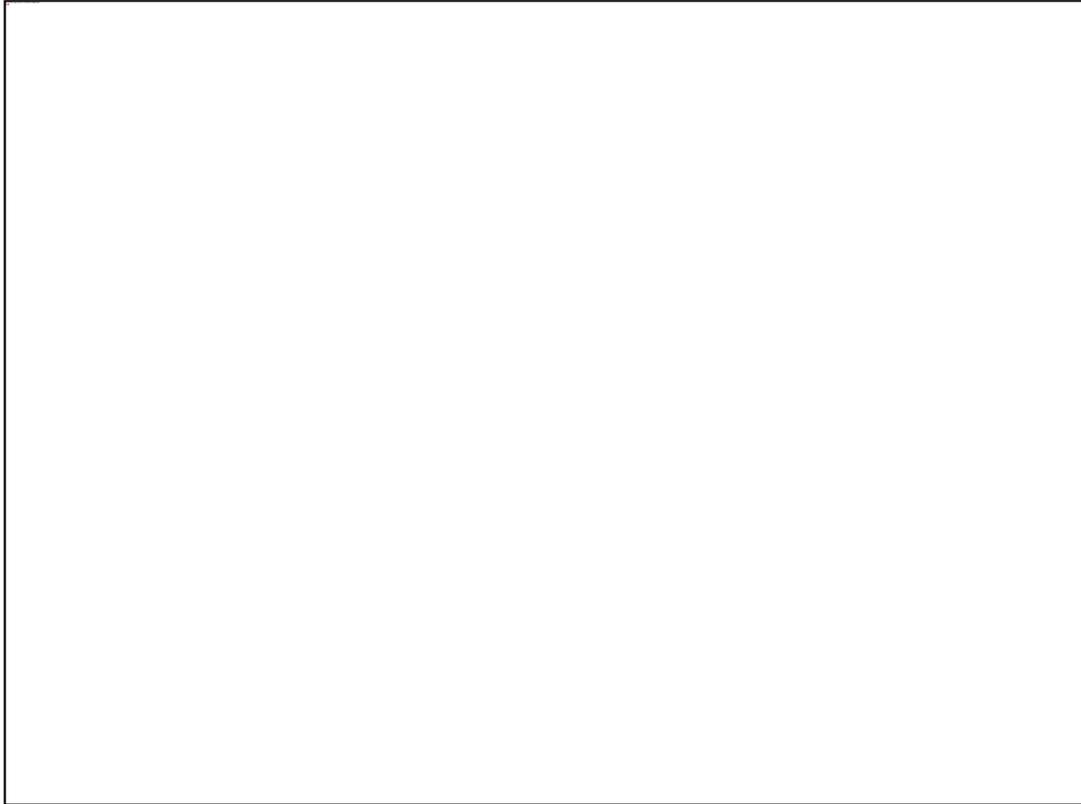
(2012) Emissions from the Cement Industry – State of the Planet. Retrieved 11 September 2013, from [blogs.ei.columbia.edu/2012/05/09/emissions-from-the-cement-industry/](http://blogs.ei.columbia.edu/2012/05/09/emissions-from-the-cement-industry/)

“Due to the large mass of concrete consumed annually and its associated resource and environmental impacts, reducing the use of concrete is a critical problem. . . . **product choice and concrete mix design are the important factors for more responsible consumption**”

Low, Man-Shi. (2005) DSpace@MIT: Material flow analysis of concrete in the United States. Retrieved 12 September 2013, from [dspace.mit.edu/handle/1721.1/33030](http://dspace.mit.edu/handle/1721.1/33030)

- graph -

Tim Plaehn      Comments (938). (2008) For Those Infrastructure Plays, Everything You Ever Needed To Know About Cement - Seeking Alpha. Retrieved 12 September 2013, from [seekingalpha.com/article/91539-for-those-infrastructure-plays-everything-you-ever-needed-to-know-about-cement](http://seekingalpha.com/article/91539-for-those-infrastructure-plays-everything-you-ever-needed-to-know-about-cement)

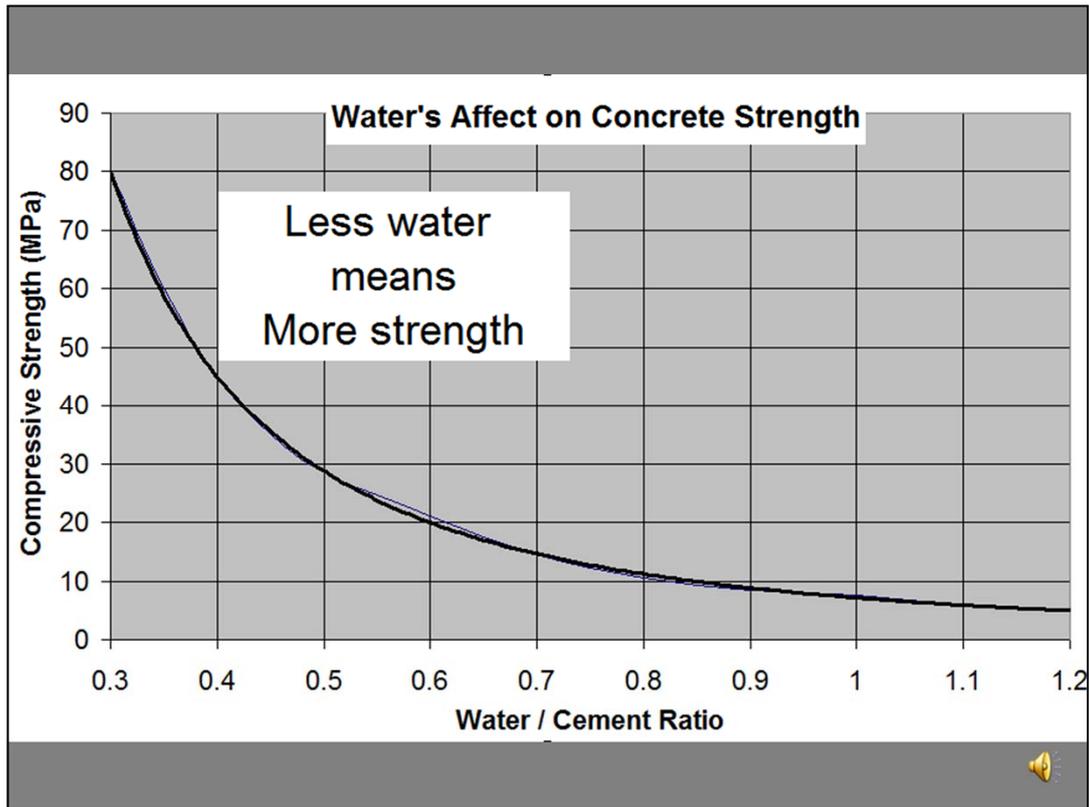


GLUE            .25KG WATER / KG CSH

We use cement in concrete to glue sand and stone together.

Cement is a chemical: We add water to make a glue.

About .25 kilograms of water is needed to completely react with one kilogram of cement.



GLUE .25KG WATER / KG CSH  
 WATER FOR FLOW

Half the water – 4 times the strength

Additional water is needed to increase the flow of concrete. Villagers like to use about .60 kilograms H<sub>2</sub>O/kg cement.



FLOW W/O WATER

3 liters F2 + 6 sacks = 7 sacks/m<sup>3</sup> W/24 MPa strength

SAME STRENGTH BECAUSE LESS WATER

Mechanical mixer is needed

Wiggler is needed.



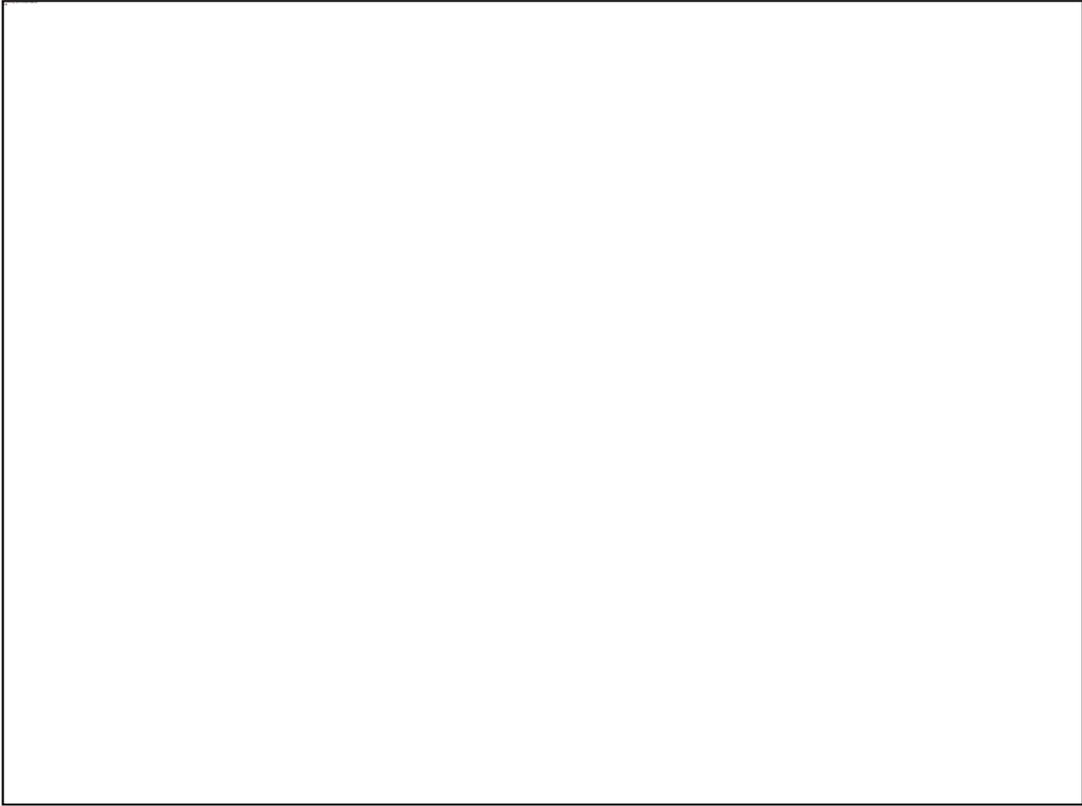
OPC-STRUCTURES  
MORTAR & PLASTER

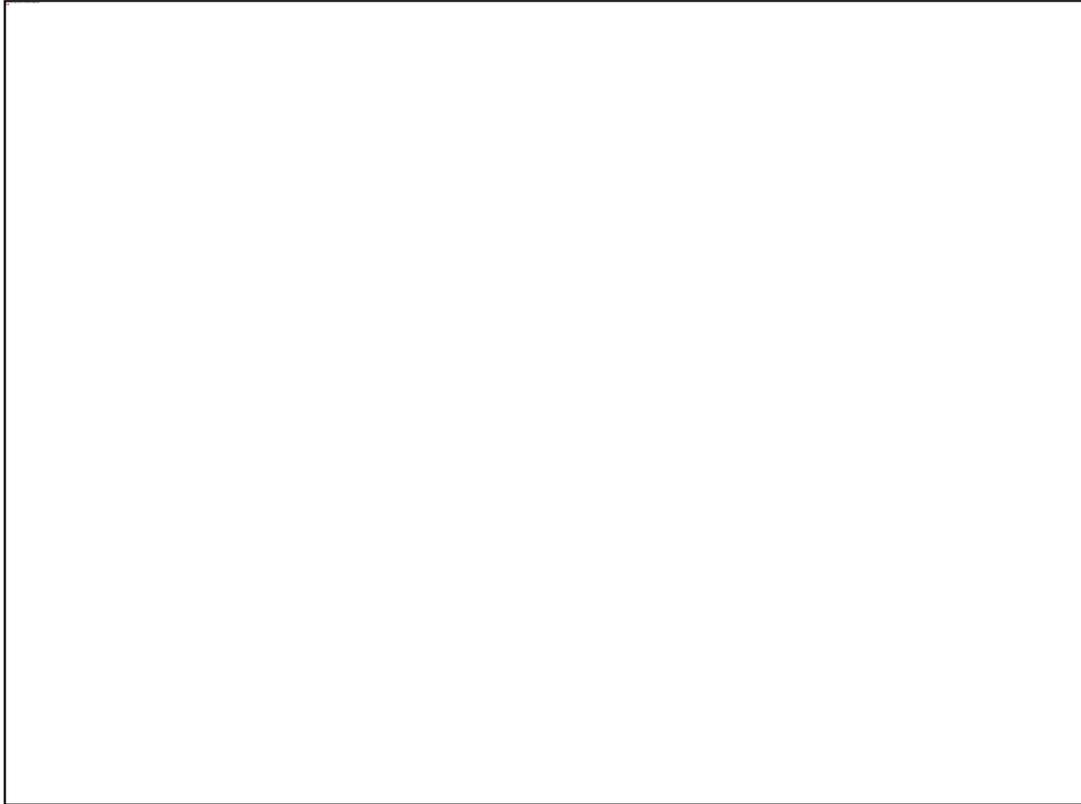
HIGH LIME –

We can use a cement appropriate for our work.

A high-lime cement can be used for mortar work. It is less refined and uses less energy to produce.

Lime putty can be used instead of cement.





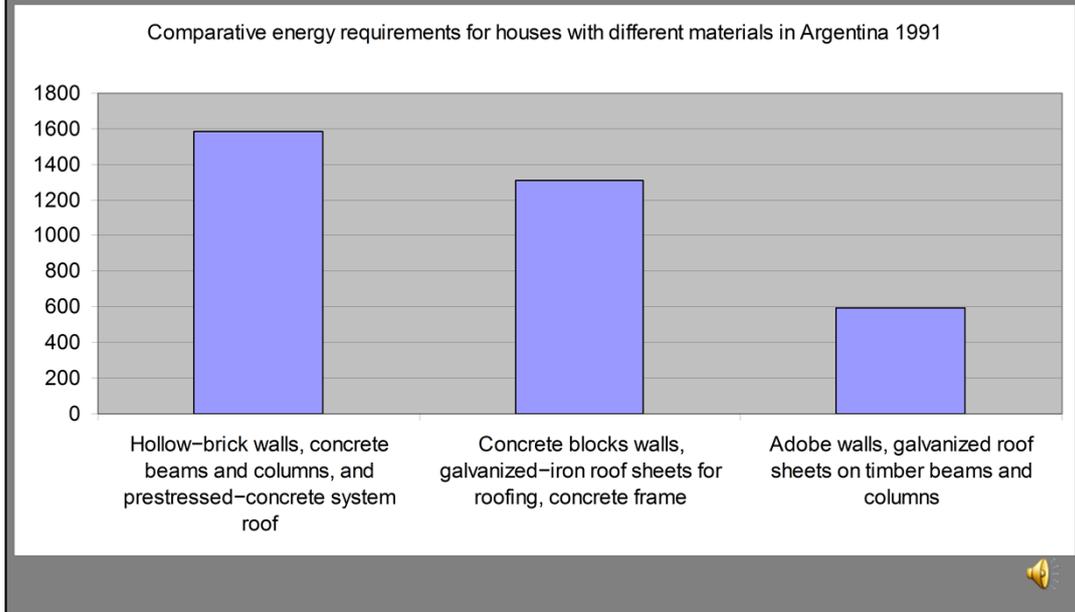
USES WASTE ASH FROM BRICK KILNS AND  
POWER PLANTS                      SMALLER CARBON  
FOOTPRINT THAN OPC

BELOW 600 CELSIUS = AMORPHOUS SILICA  
GROUND FINE 30/70

NEEDS MORE DEVELOPMENT

# Embodied Energy in Houses

( in MegaJoules per square meter)



Double brick walls take even more energy. ICEBs  
CEBs TIMBER STONE  
CARBON FOOT PRINT

People / house Life of house

The Southern Lao Log Hauler Sad Story SCALPED  
MOUNTAINS FOR LUMBER

How to reduce greenhouse gas emissions, save  
money and maintain quality of life Rose, Ben J 2006

In many instances, builders in developing countries  
have a choice between a house made partly or wholly  
of

manufactured materials or one using well-developed traditional building systems which can provide living standards of the same level. The house made of manufactured materials may be no more expensive, because the traditional construction process makes extensive use of manual labour. Table 3.12 shows a breakdown of the energy costs of three houses in Argentina. All three are of the same plinth area ( $80 \text{ m}^2$ ) and

are single storey. The first is entirely built using manufactured materials: hollow-brick walls, concrete beams

and columns, and prestressed-concrete system roof. The second replaces the bricks with concrete blocks in the walls, and uses galvanized-iron roof sheets for roofing, but with a concrete frame. The third uses largely

local materials: adobe walls, galvanized roof sheets on timber beams and columns. The house of

manufactured materials has an embodied energy per unit of floor area of about  $1600 \text{ MJ/m}^2$ , very similar to the two-storey house shown in table 3.11. Changing the roof construction lowers the energy by 17 per cent; the energy can be lowered by a further 25 per cent if local aggregates are used. Using adobe and timber in place of brick and concrete makes a very large difference to energy costs. The total now comes down to

under 600 MJ/m<sup>2</sup>, only a little over one third of the energy required for the most-energy-intensive house, with

a further 25 per cent reduction possible if local aggregates are used. These comparisons show that very large

reductions in the energy requirements for essentially the same building are possible if traditional earth and timber-based materials are used. Conversely, it shows that as the pattern of housing construction in

developing countries changes from one based largely on low-energy rural materials to one based on manufactured materials, the energy requirements rise very steeply.

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Energy for Building – Improving Energy Efficiency in Construction and

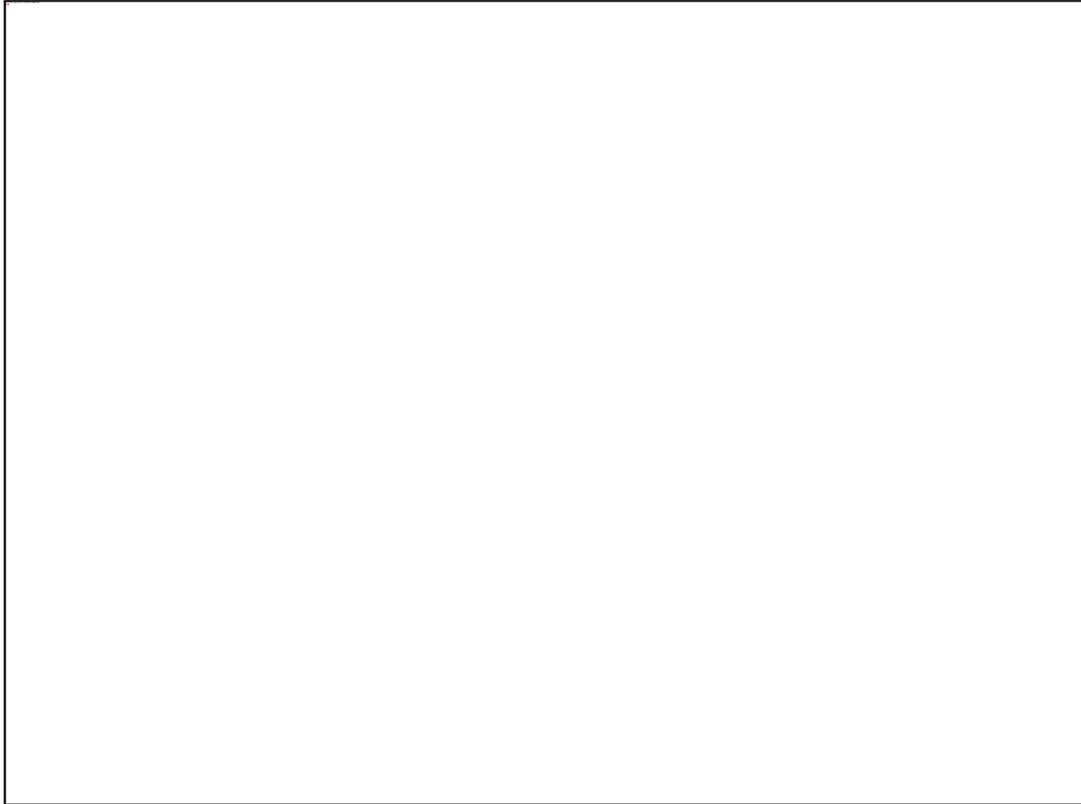
in the Production of Building Materials in Developing Countries

United Nations Centre for Human Settlements (Habitat)

Nairobi, 1991

HS/250/91 E

ISBN 92-1-131 174-8



## FUEL FOR BRICK KILNS – LUANG PRABANG SMOG

There are many ways to burn clay bricks inefficiently and environmentally unfriendly such as with wood here.



In Nepal, A Swiss NGO introduced an efficient way to produce burnt clay bricks. They invited me to a conference in Katmandu and took me to see a VSBK. It's very good. Bricks and coal are loaded in the top and, by a clever mechanism, are taken out the bottom. This moves bricks down the shaft and into the firing zone. I asked my Swiss friends, why don't you just introduce ICEBs, they use far less energy.

By Skat in India or Nepal



## Embodied Energy

Concrete Blocks

60% more than ICEBs

Fired bricks 500% more      RAT TRAP 300% more

Adobe with mud mortar has got to beat all these.

They sent 2 architects and a civil engineer to study this at our Center in Udon Thani. They did the calculations and found out that: (above)

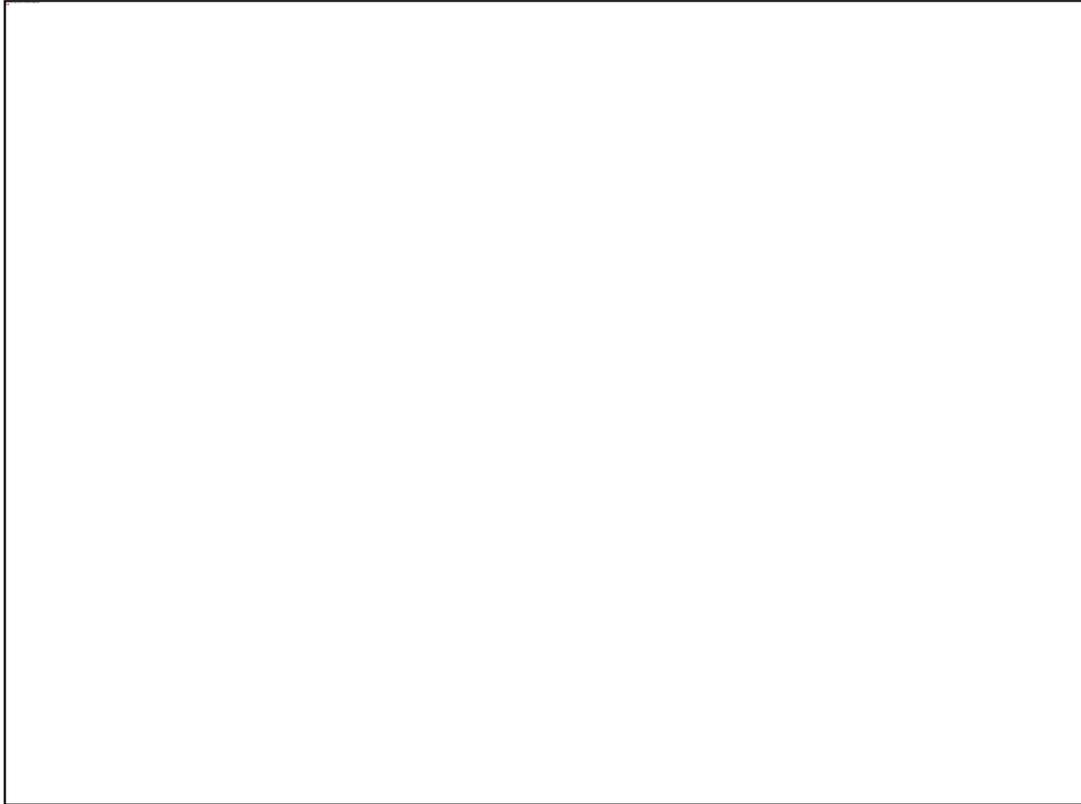
100% 1) ICEB  
=106.4MJ/M<sup>2</sup>

152.65% 2) CHB =162.42MJ/M<sup>2</sup> (8" BLOCK

WITH BOTH SIDES 1/2" PLASTERED)

329.98% 3) RAT TRAP BOND  
=351.1 MJ/M<sup>2</sup> (NOT PLASTERED)

495.95% 4) NORMAL 9" ENGLISH BOND =527.7  
MJ/M<sup>2</sup> (NOT PLASTERED)



INTERLOCKING – GROUT NO MORTAR NO  
PLASTER REINFORCEABLE

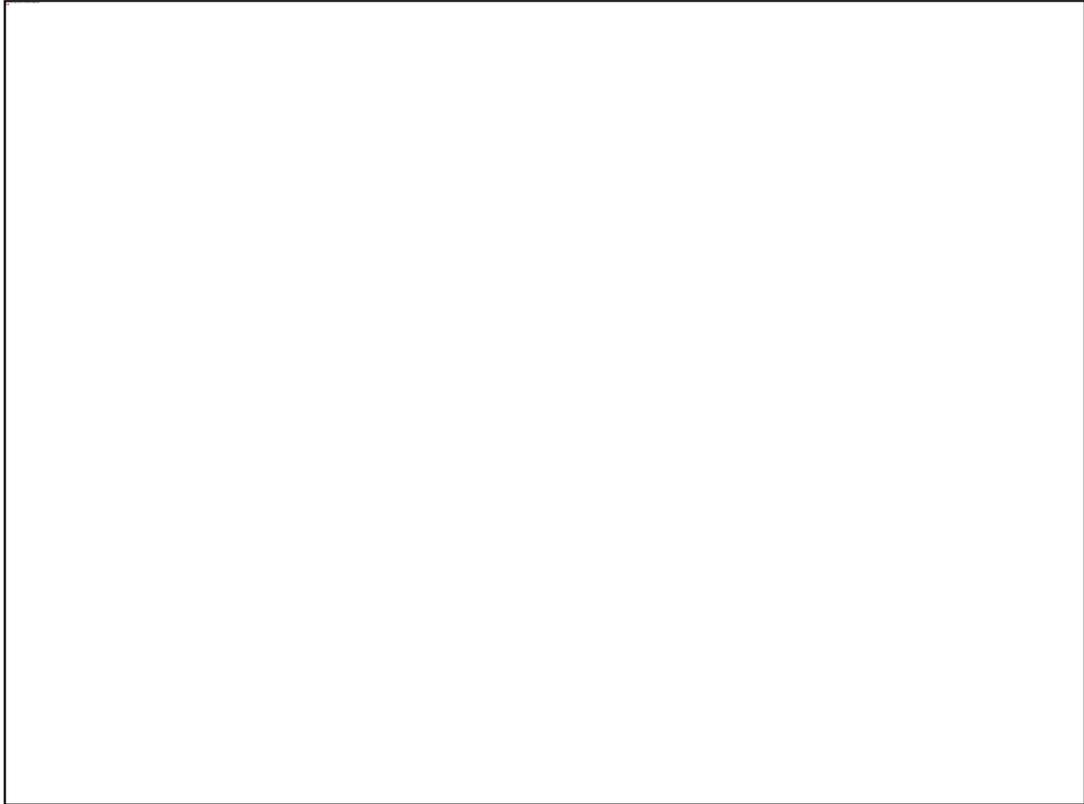
- \* No plastering required. Saves on cement and labor.
- \* Quicker construction - no waiting for cast posts or beams to harden.
- \* No moldboards for cast posts or beams.



Traditional Isan homes are on raised on pillars with the under – house open for day use and socializing.

Interlocking compressed earth blocks are a load-bearing wall technology. It is not usually practical to build them on stilts.

I built my home with a veranda in place of the under-house space. It works nicely to keep us integrated in the social fabric of our community. Last month my neighbors had wake at their home that overflowed onto my veranda.



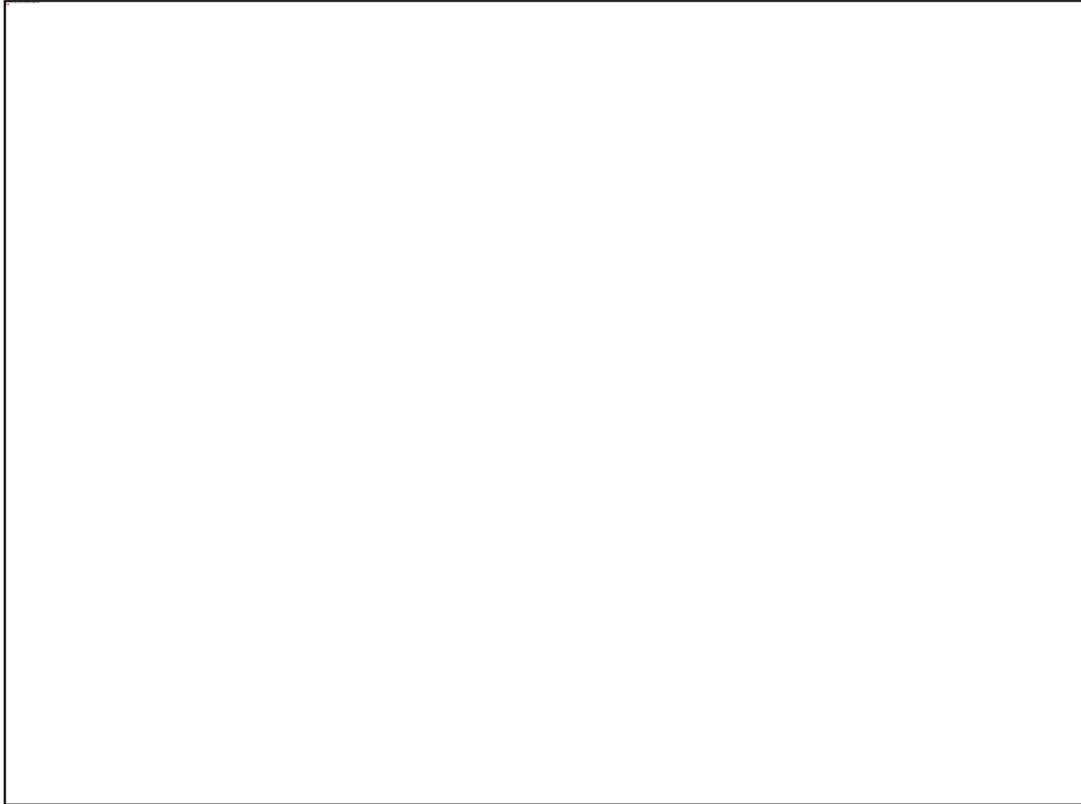
MADE ON SITE – NO MAINS ELEC'  
30 YEARS IN S.E.A.



•QUICK CONSTRUCTION - NO WAITING FOR  
DEMOLDING  
LITTLE MOLD WOOD

- STRENGTH - Blocks are high density and stabilized with cement.
- They have a compressive strength suitable for two or even three story buildings.
- Grout poured in holes permanently bonds blocks together.

\* They are DURABLE- With a good foundation and roof, ICEB buildings can last 200 years or more.



\* Create local employment from both production and construction.

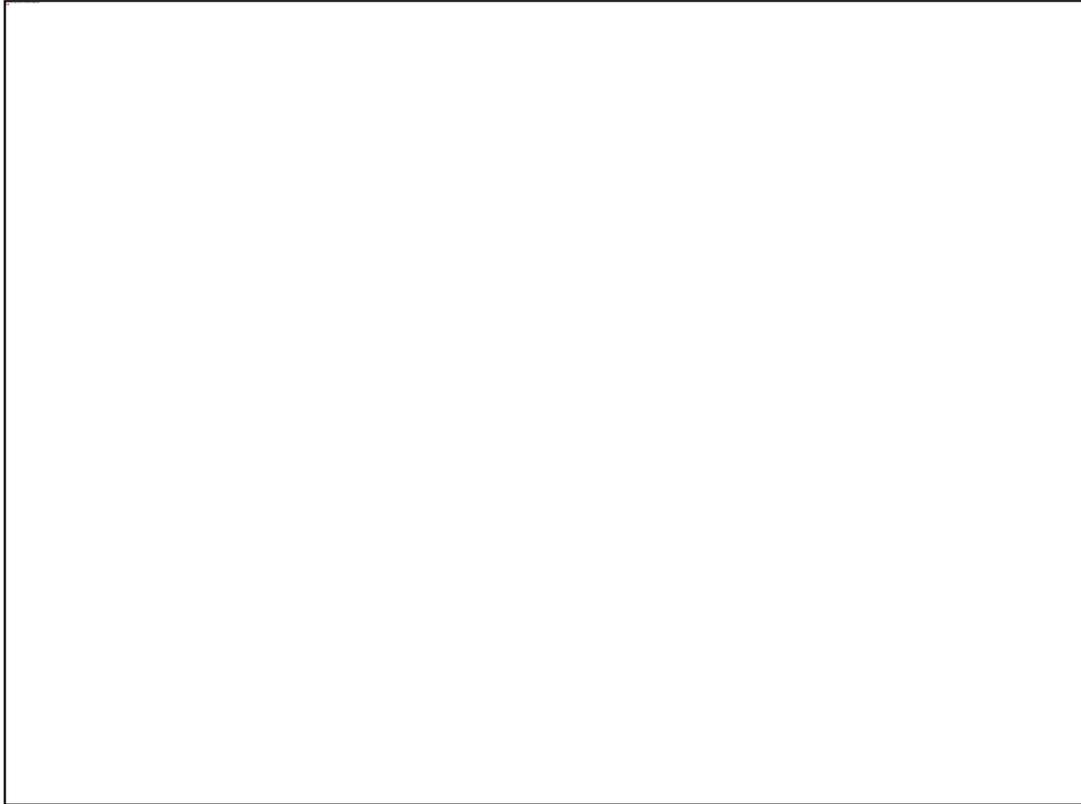
This school was built with both ICEBs and MCR.



- COMFORT AND QUIET

- - The 15-cm (6-inch) thick block provides thermal and sound insulation. A building is comfortable and quiet.

Moo, a musician, built his home with no windows in the second floor – for the rehearsal room for his band.



CREATES FISH PONDS - NOT DESTROY MOUNTAINS

ICEBs can :

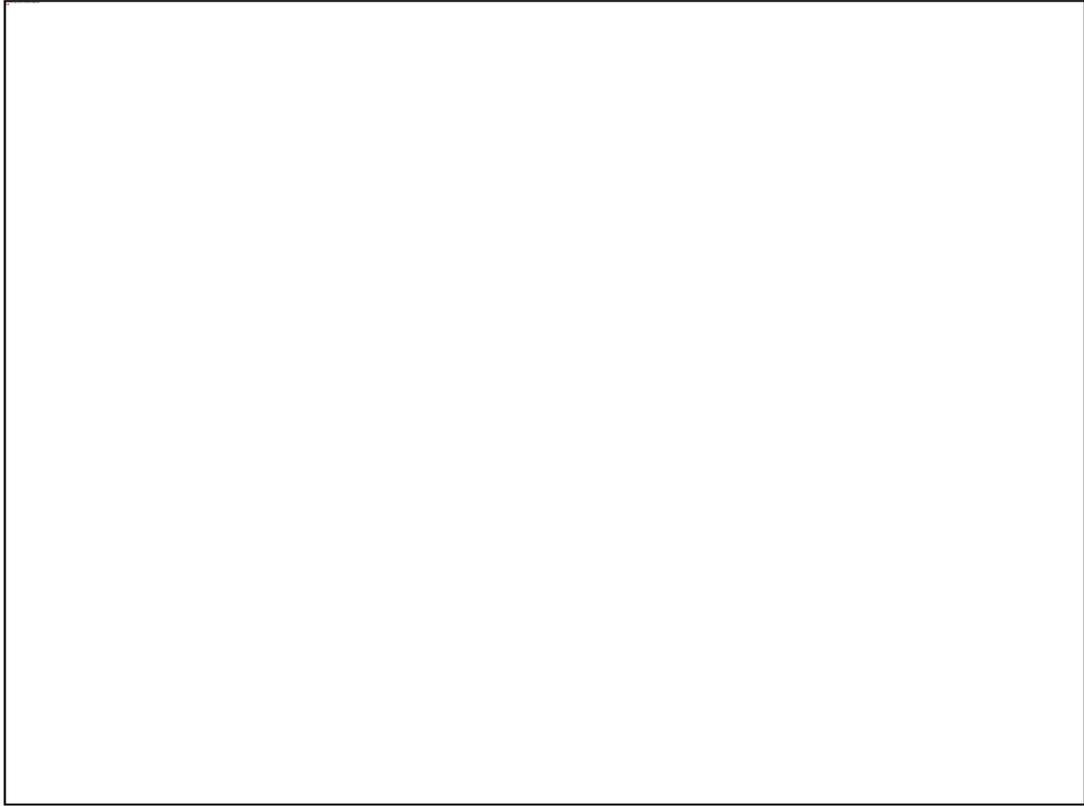
- \* Use soil, a locally available material.
- \* No plastering required. Saves on cement and labor.
- \* Quicker construction - no waiting for cast posts or beams to harden.
- \* No moldboards for cast posts or beams.



More forgiving, more skill, more GHGs

Still close to adobe

Non-interlocking Compressed Earth Blocks are more forgiving but laying them requires greater skill. They are used a lot in India where they are called mud blocks.



Low EE/person/yr, Earthquake damaged

Good Firmitas,



**good boots and a good hat.**

An earth building (be it interlocking compressed earth block or adobe) needs **good boots and a good hat.**

This simple adobe building has a well laid and mortared rock foundation providing an anti-capillary layer to protect the adobe.

It's simple gable roof has enough overhang to protect it from direct rainfall on the top of the walls.

Firmitas:

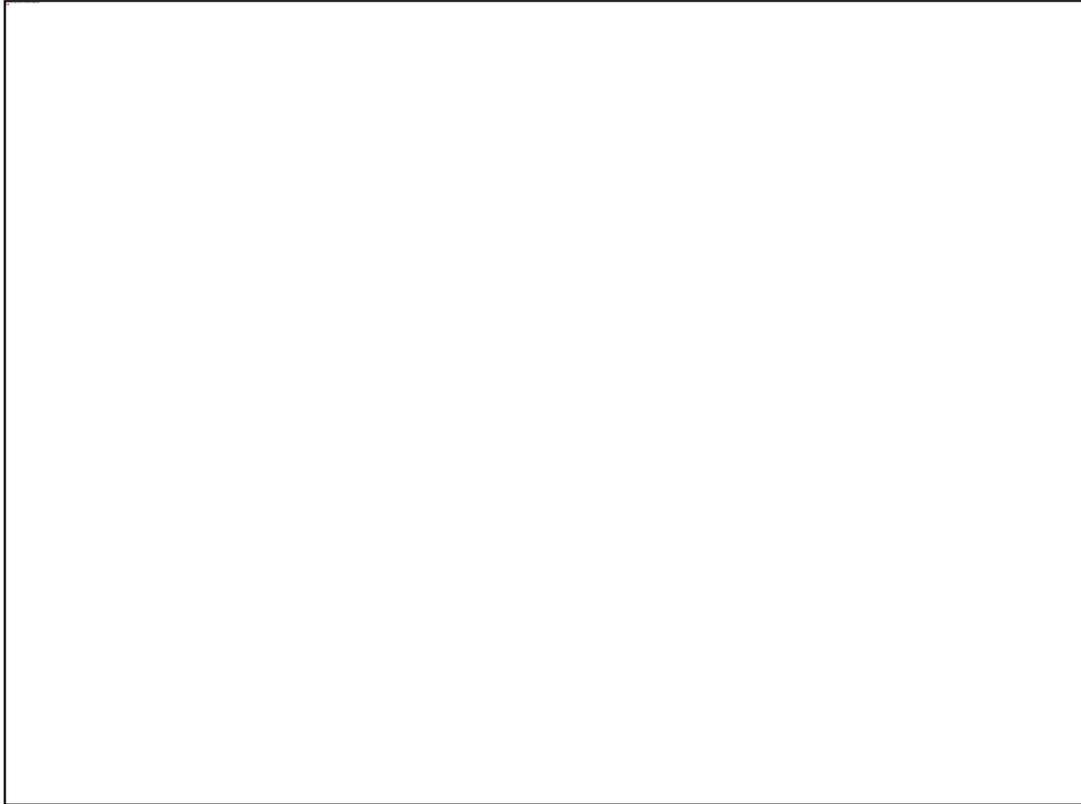


Why produce? Social Concerns      Cost reduction  
Income Generation

Production for disaster reconstruction  
Projects in remote areas

On the Thai - Burma border, residents of a Safe House produce blocks as a daytime activity.

Why not just buy them?



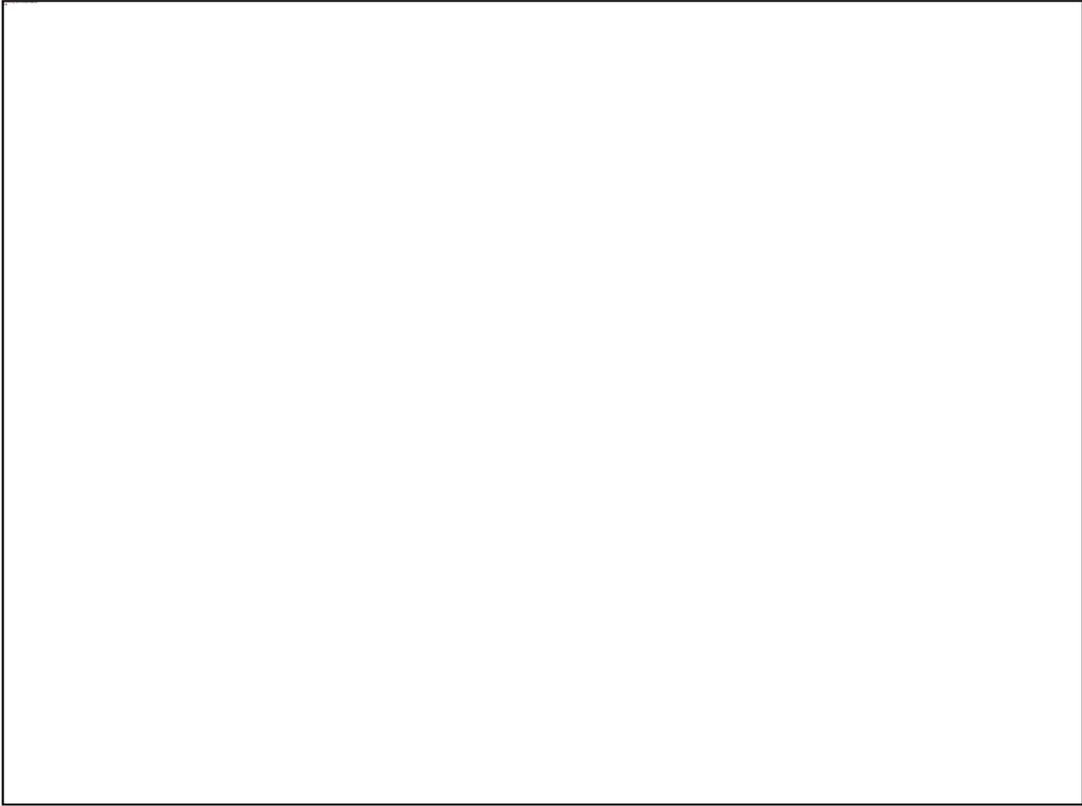
HIGH QUALITY BUILDING MATERIAL  
CERTIFIABLE ON-SITE

EDF Lao Team Hydraulic vs. Manual presses

Hydraulic presses are available but manual presses are simpler to maintain and repair. The EDF foundation ( ) has built about 30 interlocking compressed earth block schools in the past 20 years.

We are their 3<sup>rd</sup> supplier of manual block presses. After they had bought presses 4 or 5 times to replace worn ones I finally refused to sell them more and asked for some back to repair. Exhibit pride – don't advertise..... What to look for in a ;press. We rebuilt them for 1/3 the cost of a new press. In rural development, reparability is more important than efficiency.

This is Ban Saeng Alun Laos. Six men here made blocks for an EDF school. They worked from dawn to dusk, drink herbal tea and hold the world record for the most number of blocks from one hand press per day. 1000 blocks.

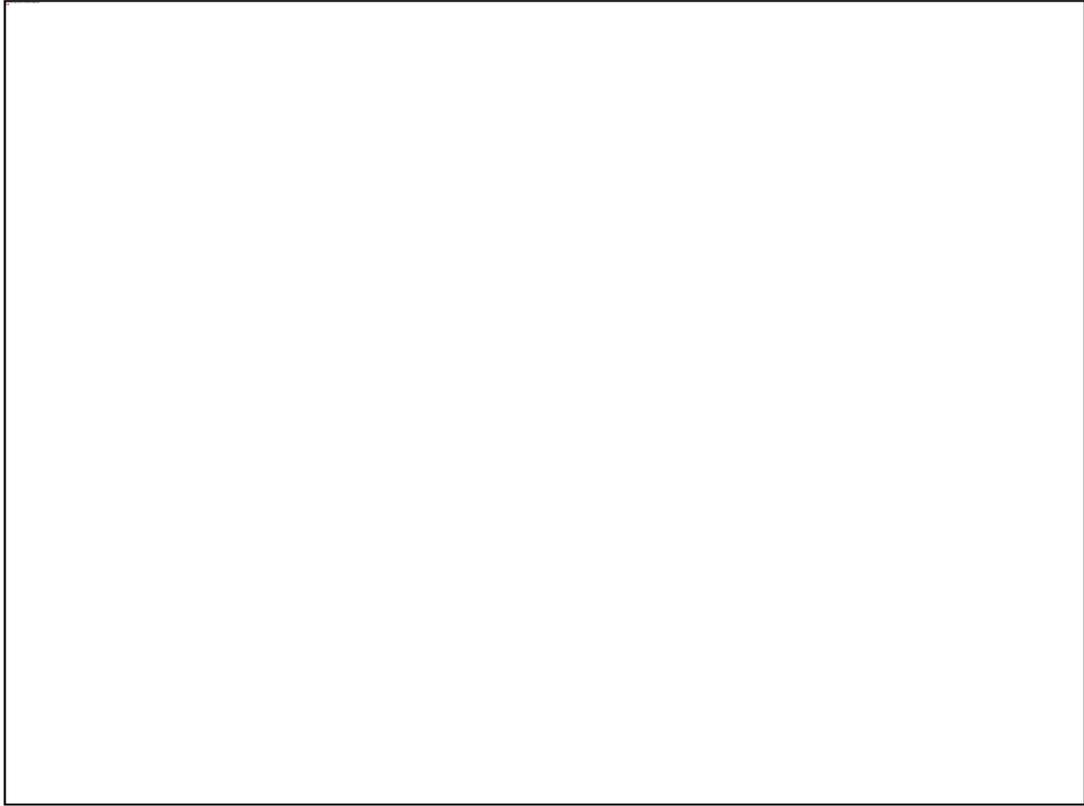




## Soils Gender

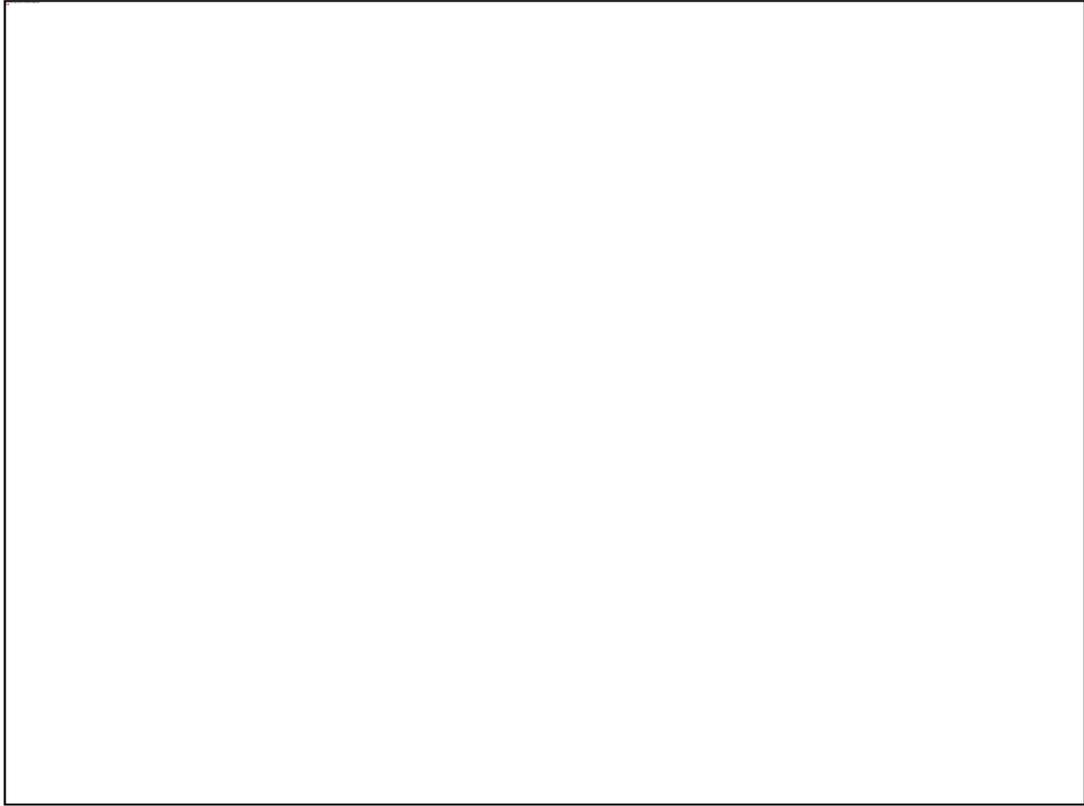
Talk about soils.

Can make a compressed block almost anywhere.



Gender Culture Penetrometer/Scale

Penetrometer is used for testing green density.



35 YEARS

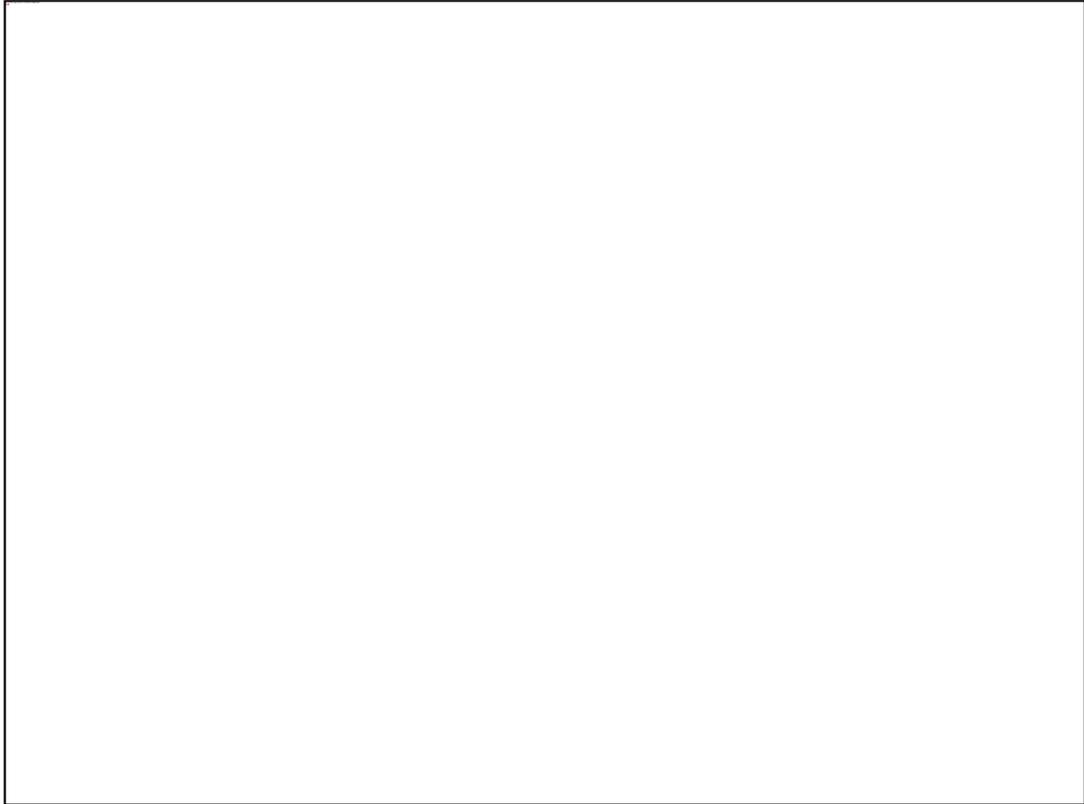


BEAUTY

PIGMENTS PAINT

What's good about Micro Concrete Roof Tiles?

**They're Attractive:** They can be pigmented for a dull matte finish or painted with acrylic paint for a glossy shiny finish.



ANY ANGLE MORE BEAUTIFUL FOR THAI'S

DON'T PLASTER RIDGE'S Yai Aew

This neat ridge tile system on this home was developed at our Center.



**They're Cool** in hot weather

**They're Durable**: they'll last 50 years or more

**Quiet** during rain Ban Vinai



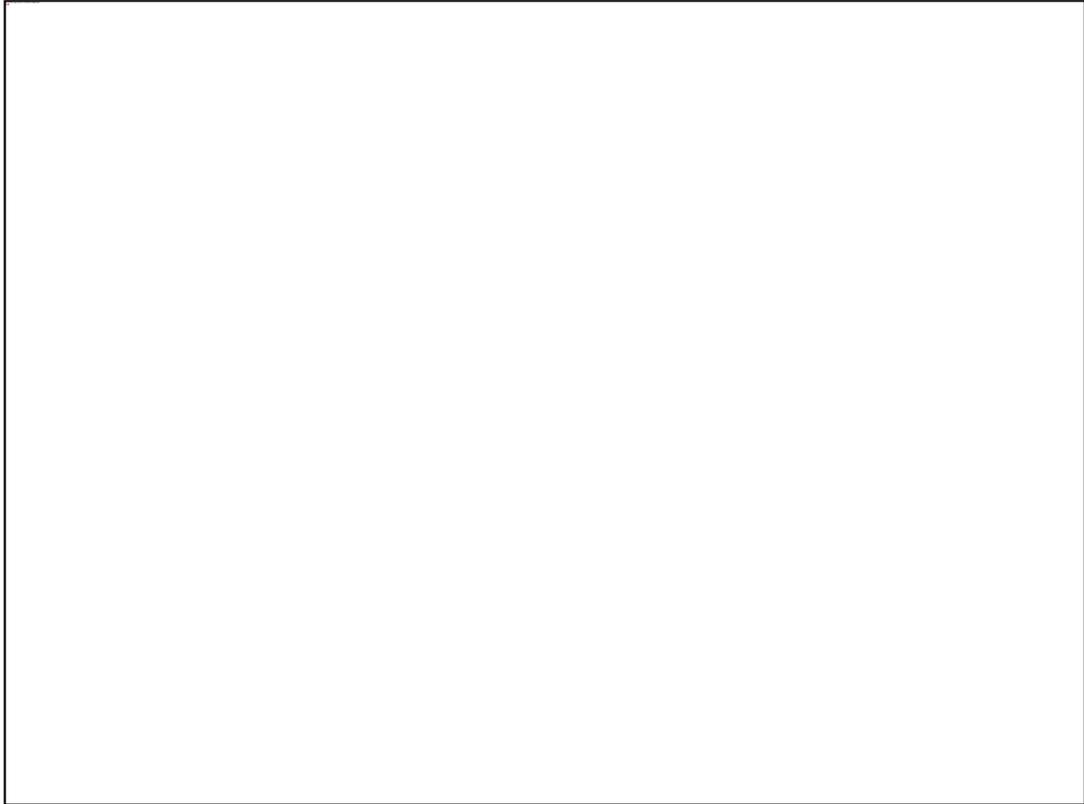
## ACCESSIBLE TO VILLAGERS

Bought block press. subsidized MCR equipment

Built own home, library . . .

**They use a Simple Production Technology:** 12-volt or hand-powered vibrating tables are easy to maintain. Solar curing is also environmentally friendly.

๓tell kumpong's story



**They are Development Friendly:** NGOs and community groups use MCR production for an income generation activity or to meet development goals.



JUST SAY NO                      MCR is safe  
MCR STRONGER THAN ASBESTOS  
MEETS INDUSTRIAL STANDARD

**They're Worker Safe:** No asbestos fibers or other hazardous materials needed.

Say NO to asbestos-cement roof tiles. There are many alternatives. Concrete Roof Tiles are Stronger than Asbestos-Cement Tiles

The tiles made by villagers at the CVBT have been certified as meeting an industrial standard.



They pass village standards – Fr. Chai and the sling shot story

They endure hailstones better – The Udon hail storm story



They endure 100 km winds better

– The tsunami reconstruction story



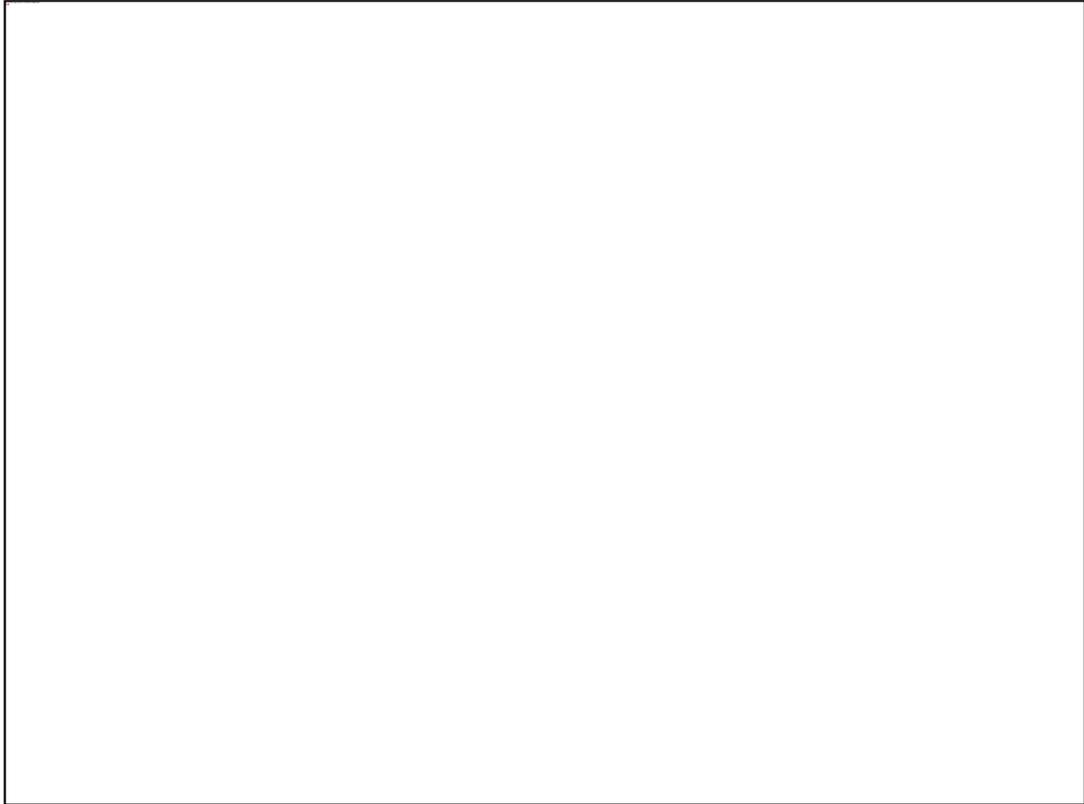
## GET TRAINING IN ROOF TILE LAYING

### **What do we need to make and use micro-concrete roofing?**

Roof tile laying training is a must for rain-proof roofs. Good packing and careful driving are needed for tile transportation.



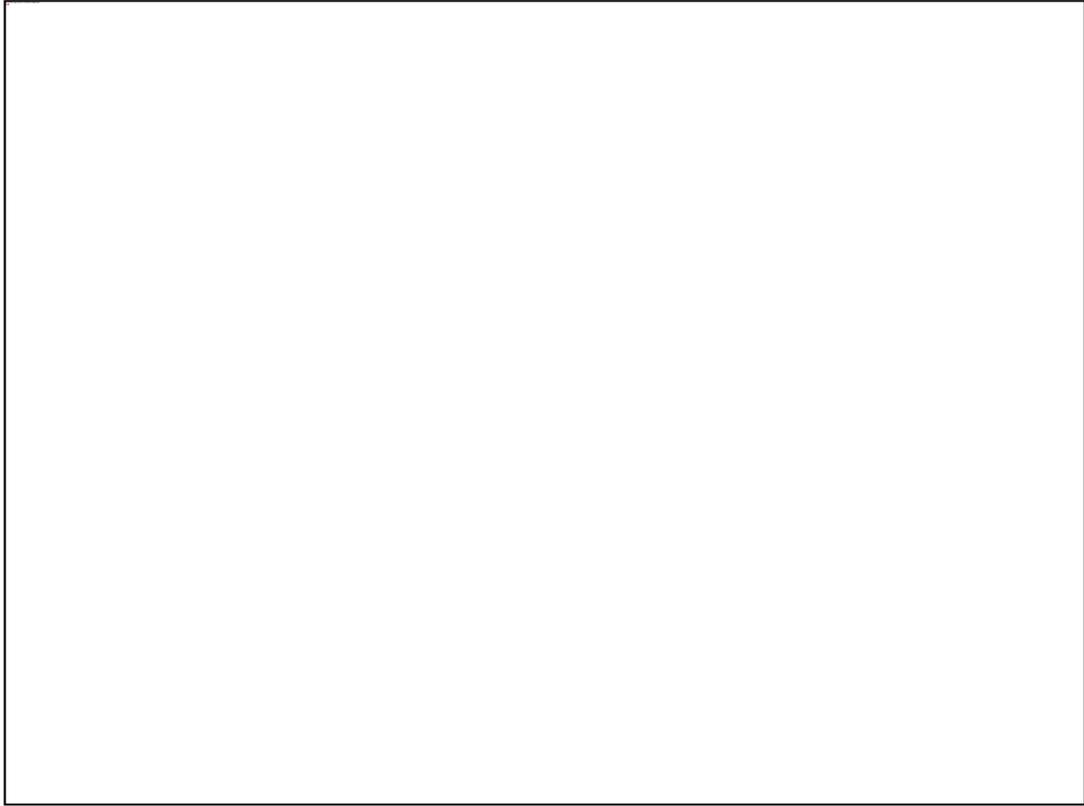
re=relmfu



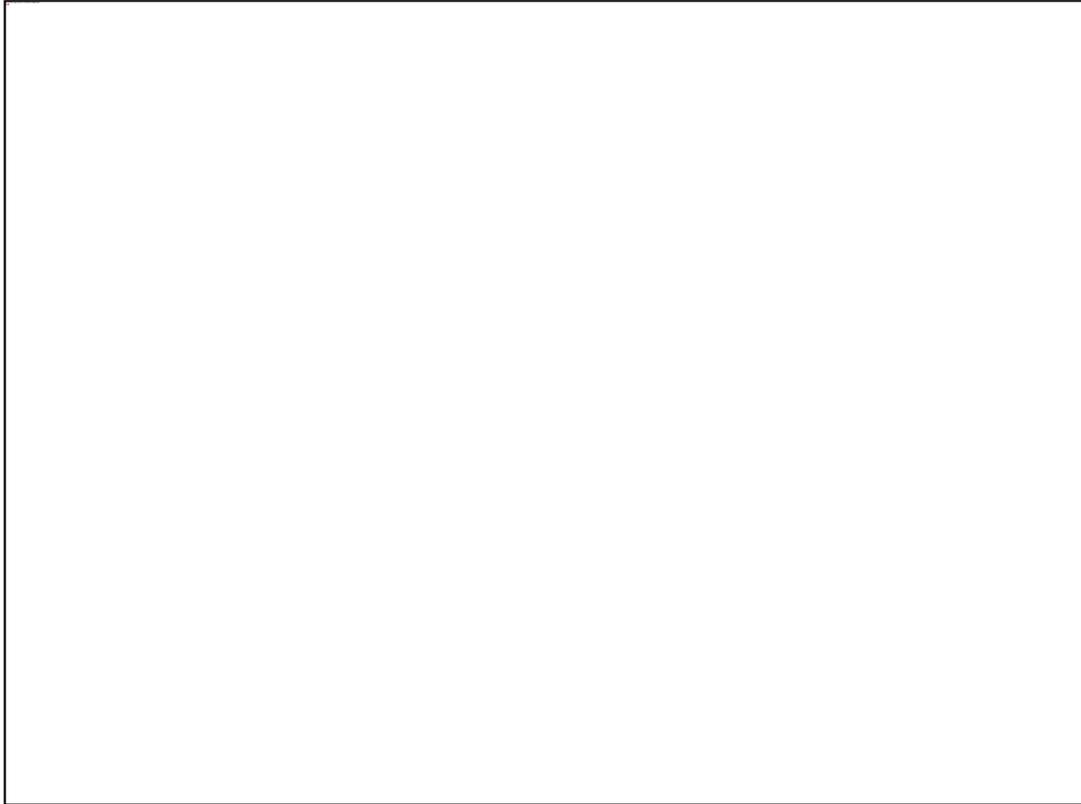
20 year+ molds

The flat screed is moved to a mould.

Our Parry Roman II molds have lasted more than 20 years,



The tiles are cured in the molds over night.



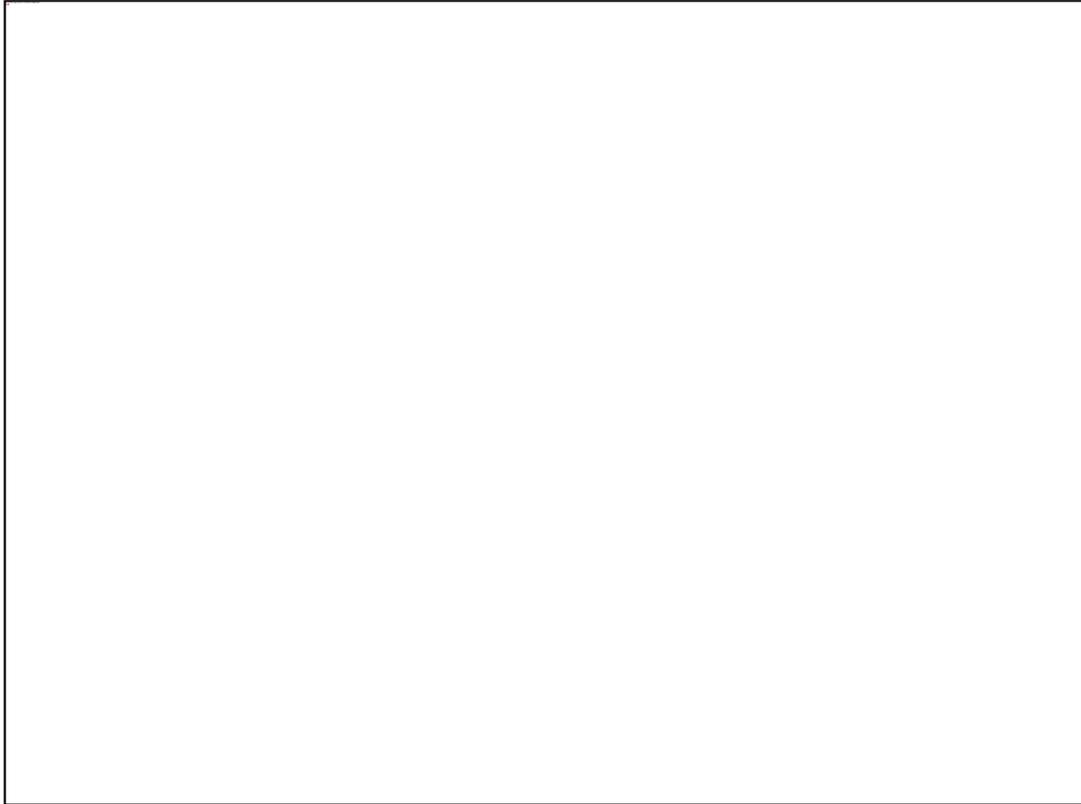
7 days, trough, Shade curing

Curing continues for 7 days in a solar high-humidity curing chamber.

The tiles are covered with the clear plastic tarp.

The tarp catches the sun's energy heating the tiles.

The water in a trough under the tiles evaporates providing moisture for the chemical reaction.



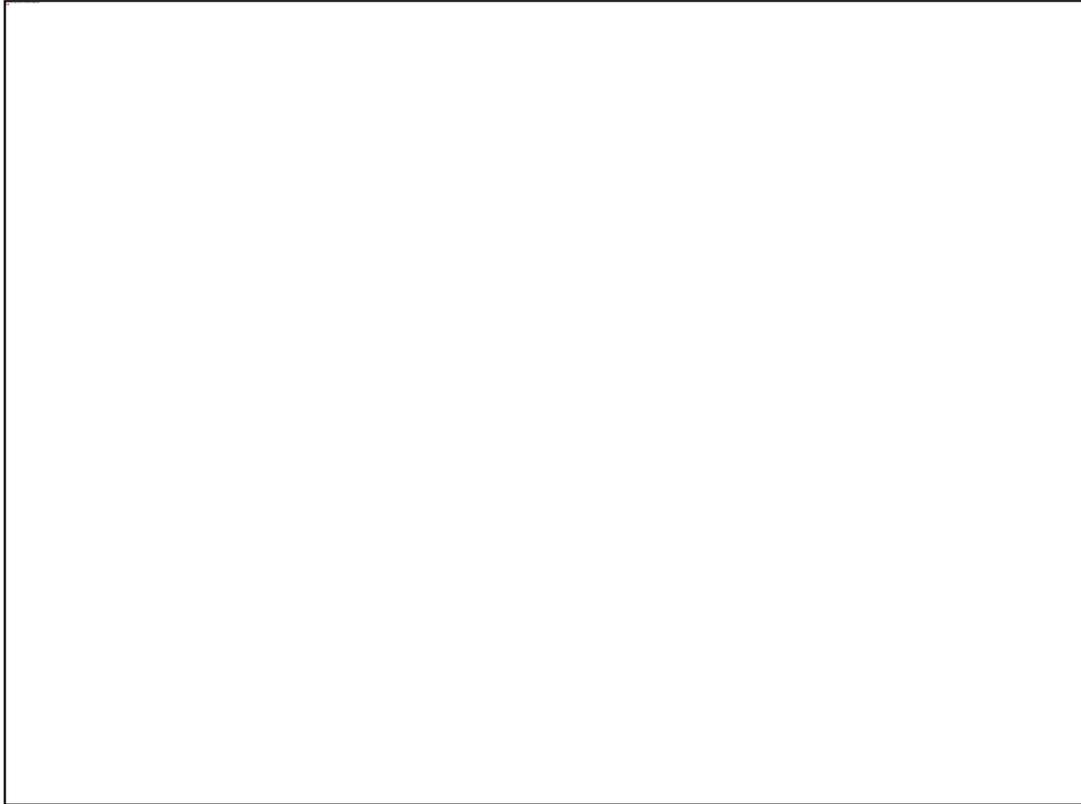
## Training, Maintenance, Equipment - Parry

Production training and maintenance are a must to ensure good quality tiles.

Good molds and vibrating tables are needed for quality tiles. – we recommend Parry.

**Parry** equipment can be used by men and women to make strong beautiful roof tiles.

There are many distributors of Parry equipment all over the world – I am one of them.



Earthquake, Typhoon, Tsunami, Flood, Fire, Conflict

- a) Earthquake Resistant Construction
- b) Typhoon Resistant Construction
- c) Tsunami Resistant Construction
- d) Flood Resistant Construction
- e) Fire Conflict

The fewer buildings we have to rebuild, the less cement we'll use, the smaller our carbon foot print will be.



Adobe and unreinforced masonry held up better tell it as a story



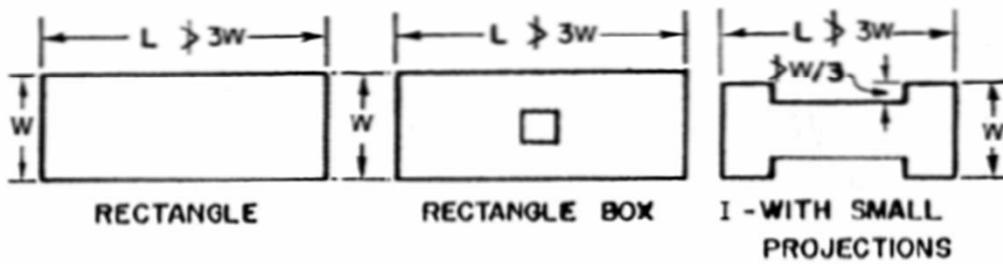
Good configuration, Shear Walls, Thick Walls

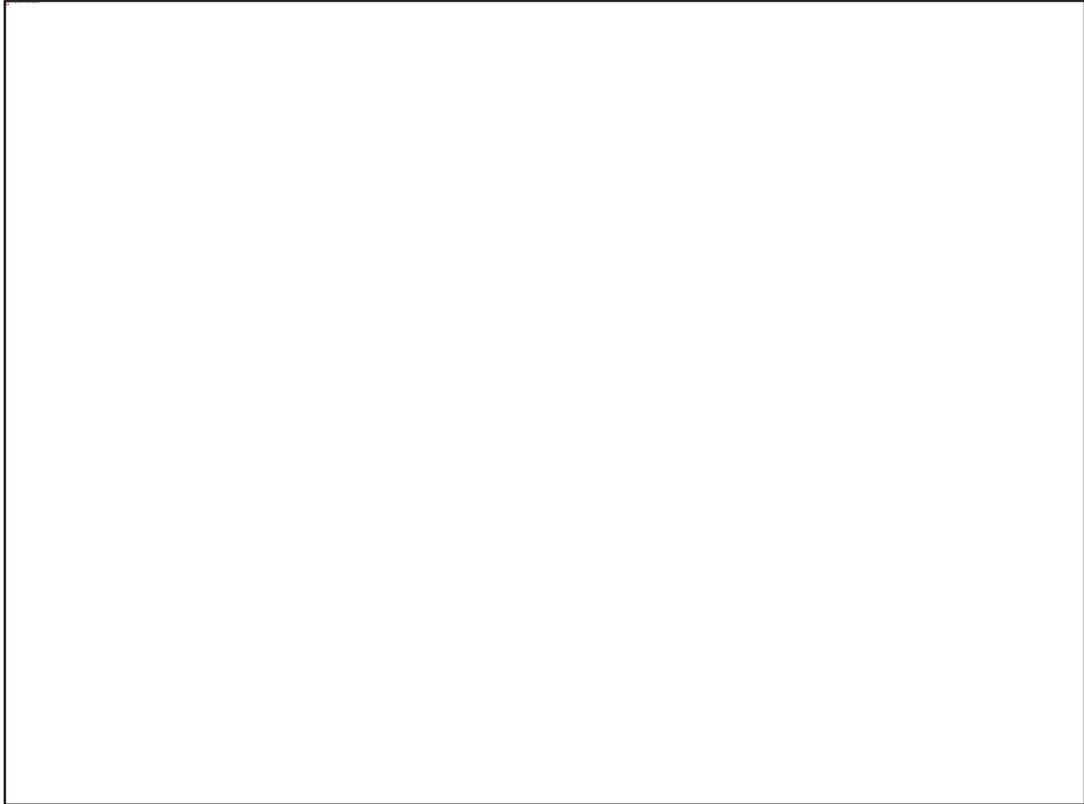
Traditional Adobe and unreinforced brick structures stood up because of good configuration and good bond patterns 2-3 layers thick.

This **simple symmetrical rectangular** configuration resists earth movement with 5 solid shear walls with no openings to.

Stick with local traditional materials, technologies and architecture where practical. They've lasted because they're tried and true.

# Rectangular Buildings are Earthquake Resistant

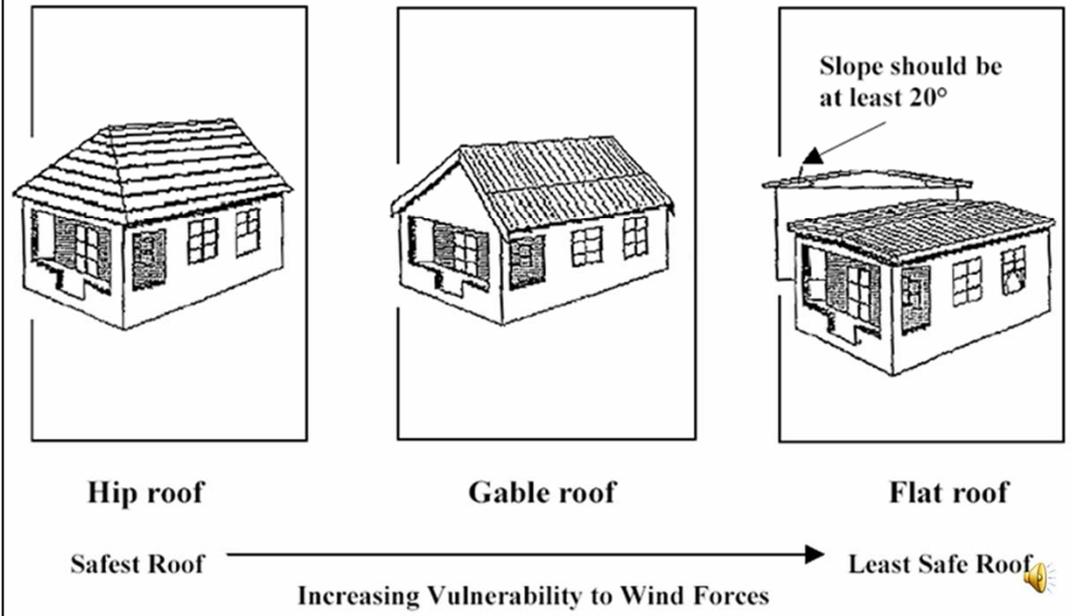




Resources.

“permanent change in construction practice”

# Make roof shape typhoon resistant



Watch Gables

# Typhoon resistant verandas

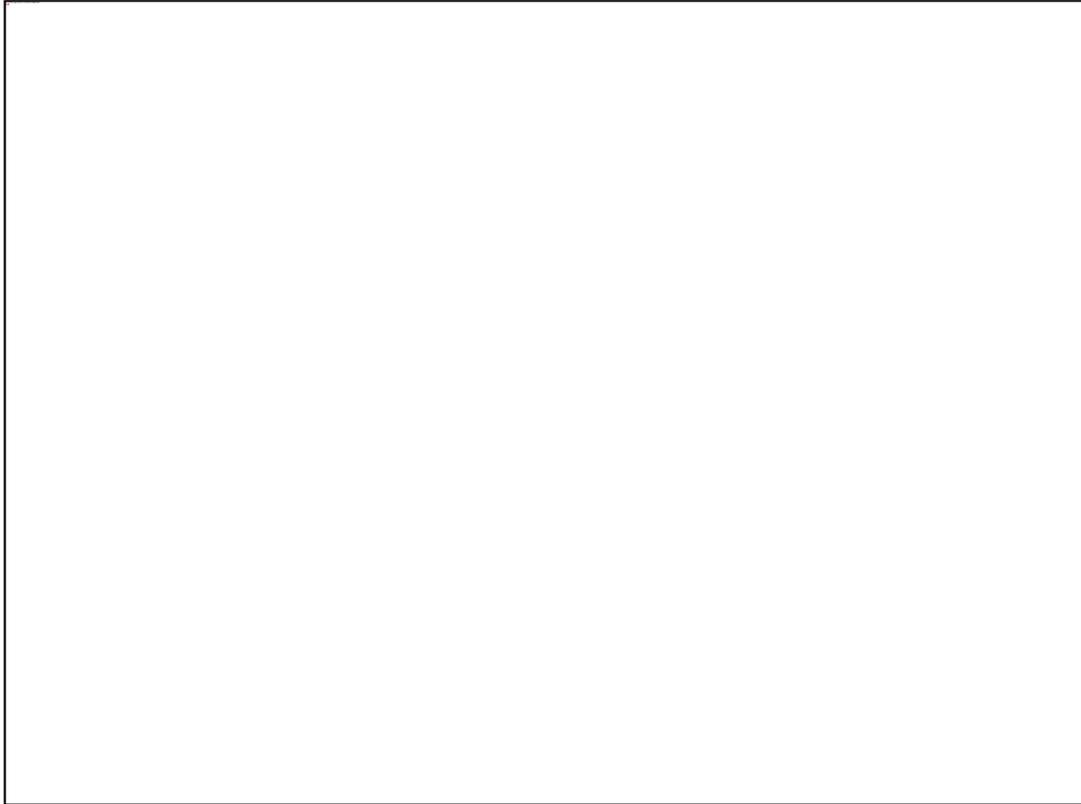
Roof overhangs attached to the main structure.



Roof overhangs as separate structure.



18" overhang max

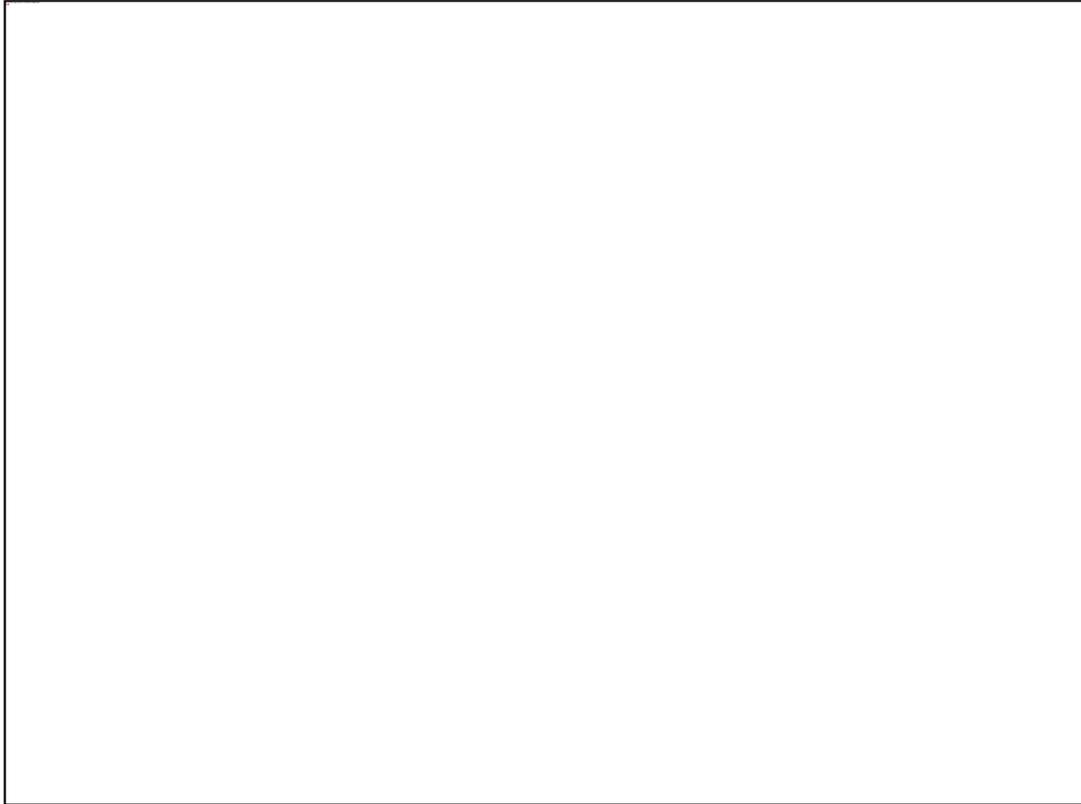


Flush toilets are such bad news. Please don't build any more.

This technology is so needed. No disease in ground water No water needed

Macro 2.6 Billion flush toilets Micro  
Produces 2 kinds of fertilizer ECOSAN

46,800,000,000.0 litres H<sub>2</sub>O/day

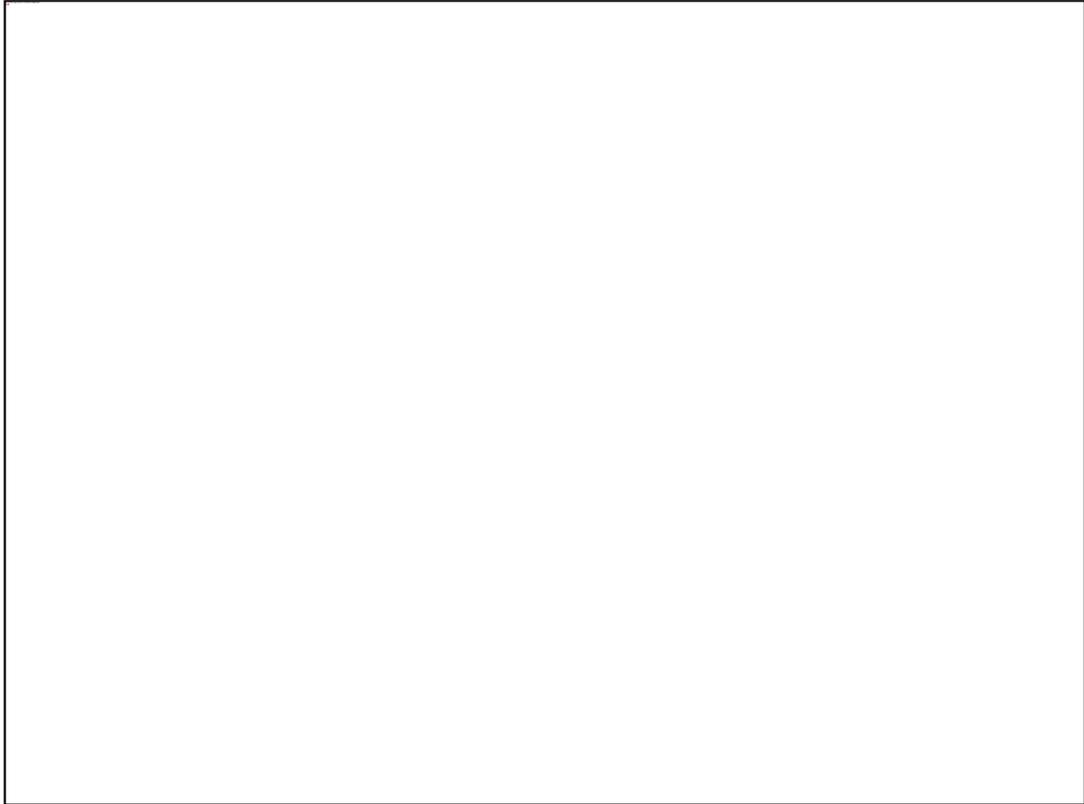


The Kachin and Chinese love them. WID Proven  
Challenge COME TO MY WORKSHOP

It's proven – it works. We can use it now.  
It takes time to introduce but it is worth the effort.

Take the DCT challenge:  
Plan to use one yourself on a regular basis  
Get your organization to commit to DCTs.

I pray that you want to know more and will come to my  
DCT workshop tomorrow.



Simple Separate wiring Works w/o mains,  
Inexpensive, bulbs last

## Please remember

- Less is more. Where possible - don't build. Renovate
- Build sustainably: use permanent or renewable materials. Choose materials that use less cement. Mix concrete lean with Sika F2.
- Build disaster resistant buildings: The fewer buildings we have to rebuild, the smaller our carbon foot print will be.
- Use Appropriate Construction Technologies wherever practical - help redeem the world





BOOTH                      Building Material Forum  
Building Specifications, Architects              DIY

# Thanks to

- Danny Mostrales - Illigan Institute of Technology
- Gertrudes Samson - Columban Missionaries
- Siam City Cement Company
- Sika Cement Additives
- The Timber Research and Development Association (TRADA)
- Gopal Shankar - Habitat Technology Group
- The Bamboo School
- Blue Scope Steel
- Ross Eisenberg of Build Change
- Thomas Singer – Meribah Ram Pumps
- Dr. Thanad Katpradit - Engineo



## Resources



History Non profit

Projects in Laos, Vietnam, Cambodia, Thailand,  
China, Philippines, Indonesia

Tsunami reconstruction, ?'s in other session this  
afternoon