WHY AND HOW?
FOR SAFER HOUSING
Implementing Construction Work In Field

Confined Brick Masonry House
For Mason

Third Edition 2010

JAPAN PLATFORM

SNS Sar Nevesht Saz

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SUPPORTED BY:
Masons from Pakandangan Village, Enam Lingkung - Padang Pariaman District
West Sumatra Province, Indonesia

FUNDED BY:
Japan Platform

Third Edition, 1st edition, August 2010
ISBN :

3D & SETTING:
Ed Sumardi

PUBLISHER:
Published by Kaliwangi Offset
Jl. Monumen Jogja Kembali No. 93 Yogyakarta
Phone. +62-274-566307

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In the last five years, the west coast of the island of Sumatera has been devastated by powerful earthquakes, from the earthquake in Aceh on December 26, 2004 (9.3 Mw) to the last deadly earthquake in the province of West Sumatera on September 30, 2009, at a magnitude of 7.6 SR (Mw). According to BMKG, the coordinate of the epicenter was at 0.84°LS and 99.65° BT and at a depth of 71 kilometers, about 57 kilometers off the west shore of Pariaman City.
That devastating earthquake has striken 13 cities and districts namely Padang Pariaman, Pariaman City, Padang City, West Pasaman , Agam, Pesisir Selatan, Bukit Tinggi, Solok City, Padang Panjang, Solok, Pasaman, Tanah Datar and The Mentawai Islands.

The earthquake caused the deaths of more than 1,100 people, injuring 3,000 people (BNPB, 2000), and destroying 279,432 buildings. Among those buildings, it was also recorded that 114,797 residential houses were categorized in a major damage, 67,198 in medium damage, and 67,839 in minor damage (The Center of Study for Disasters, Andalas University).
Most of those residential houses are both unconfined brick masonry and confined brick masonry. Thus, it is very important to conduct mitigation programs to reduce the impacts of earthquakes in the future. One program that particulary needs to be put into practice is the construction of earthquake -safer residential houses using a confined brick masonry method.

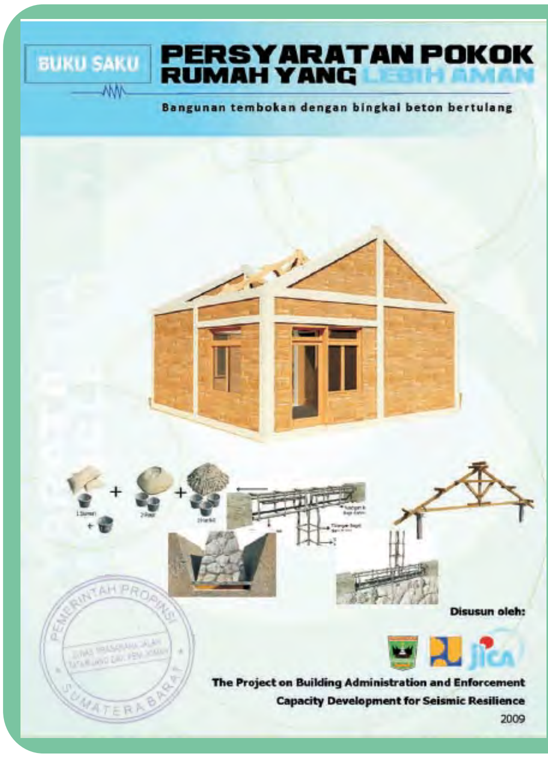
This guidance book was compiled according to the analysis of the damage of housing and the survey results on the mason's behavior in brick masonry building, along with the inspection of field implementation in Nagari Pakandangan, Subdistrict of Enam Lingkung, district of Padang Pariaman. The survey was conducted towards 110 masons before the rehabilitation and after-earthquake-house reconstruction program being implemented in West Sumatera in 2009.
Based on the interviews with masons, both the good practices and bad practices in brick masonry buildings were gathered and complied with the key requirement from the collaboration between the government of the province of West Sumatera, Public Works Department, and JICA (2009) version.

As the result, several events have been organized, as follows:

1. Capacity building training for masons, aimed to share the knowledge about earthquake safer confined brick masonry. The training package is held in 5 sessions, whereas each session consists of both theory and simulation attended by 110 builders.
2. The knowledge from the training is applied in the field implementation during the ongoing process of 5 (five) house pre-reconstruction projects in West Sumatera.
3. The documentation of both the training and implementation above and the dissemination of the results through this guidance book.

This guidance book is to complete the principal key requirement of the earthquake-safer house. This book consists of guidelines about how to construct earthquake-safer confined brick masonry, which have been adjusted with the custom of the respective masons. This book is intended for construction supervisors, foremen, carpenters, masons, and unskilled workers as the field executors in building earthquake-safer houses.

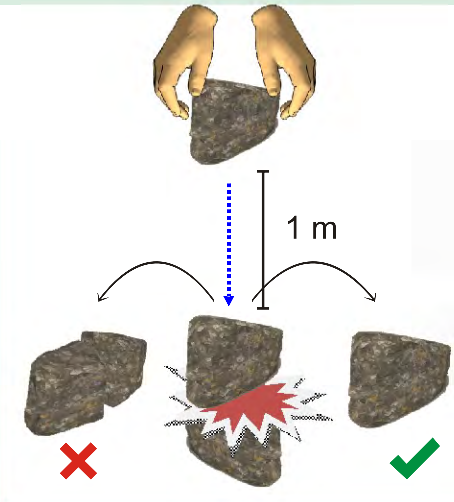
This book has also been improved through interview with local masons, training sessions, discussions, and field implementation by the local masons in Nagari Pakandangan, Subdistrict of Enam Lingkung, Regency of Padang Pariaman, West Sumatera, organized by SNS Japan and funded by Japan Platform.



1. Materials for Housing Construction

1. Stone for Foundation

- Hard mountain or river stone
- Crushed stone (Good)
- Commonly used river stone (local)



Drop the stone from a height of 1 m on top of the other stone. A good stone will not break, it will remain intact.

2. Brick

The size of the local brick
10 cm x 21 cm x 5 cm

Poor Quality brick

Good Quality brick

3. Timber

The Timber used must be of good quality, namely:
- Hard, dry, of dark colour, with no defects, and straight.

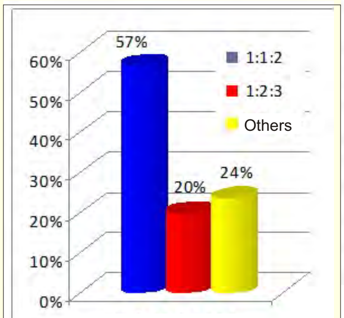
Note for local practices:
Coconut Timber is generally used. The drying process should be as follows:
after the timber is cut to size, a period of one month should be set aside for the timber to be placed, standing in the shade, then a further month should be set aside for the timber to be soaked in water, before it is used.
Timber is easy to work with and can last for more than 50 years.

4. Mortar

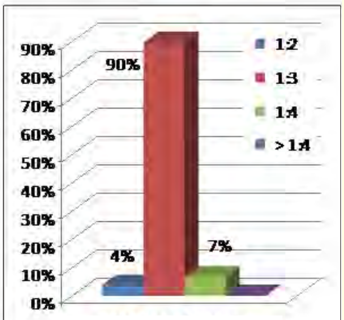
Comparison of volume used in the mortar mix should be as follows: 1 part cement: 4 parts clean sand and a sufficient amount of water.
Mortar should be used no more than 45 minutes after mixing.

1. Materials for Housing Construction

From a survey of 110 respondents:
Masons and carpenters in the Sub-district of Enam Lingkung, as many as 78% masons have been accustomed to using the mixture composition as follows:
mortar 1:3, and only 14% of masons use 1:4. For concrete composition as many as 58% of masons usually used the 1:1:2, and only 11% of masons use 1:2:3 (refer to the graphics on the right)



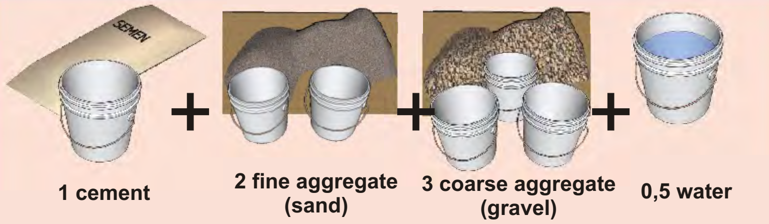
Concrete Ratio



Mortar Ratio

Source : SNS International, 2010

5. Concrete for Reinforced Concrete



1 sack of cement weighing 50 kg of type I is required maximum of 0.5 x 50 = 25 liters of clean water

Portland Cement Type I (50 kg)

Clean water in the container paint bucket 20 L

This fresh concrete mix contains too much water.

(incorrect)

This fresh concrete mix has a consistency of plasticity

(correct)

The practice of mixing concrete simple test has been adopted from Teddy Boen manual.

Crushed Gravel sifted with a wire-mesh size of ¾ of an inch (20 mm)

1. Materials for Housing Construction

Concrete mortar Making Process

Doc. SNS International (2010)

1. Pour 2 parts of sand and then pour 1 part of cement into the intended mixing place.
2. Add two parts of sand and 1 part of cement, and mix thoroughly until the two colours blend evenly together.
3. Horizontally spread out the cement and sand mixture.
4. Pour in 3 parts of gravel into the already mixed cement and sand.
5. little by little pour in 0.5 parts of water.
6. mix together all the materials until a texture of plasticity is obtained.
7. Check with a simple test.

Remember : for every one sack of 50 kg cement used, maximum 25 lt of water should be used.

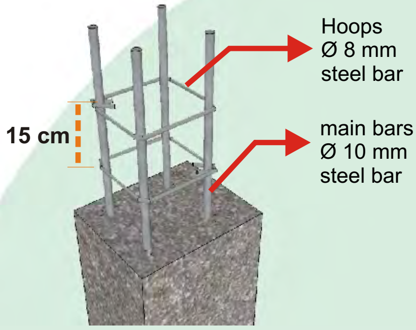
New mold beam formwork can be taken down after 14 days.

Safety aspects for masons/ carpenters/ workers

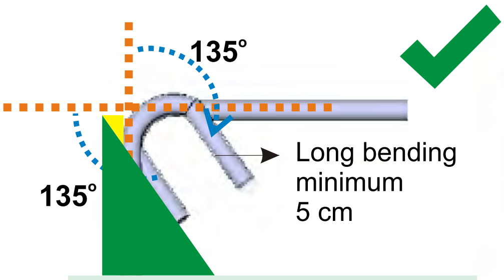
6. Steel bars for reinforced concrete

Table 1. Minimum size of main bars or hoop Reinforcement

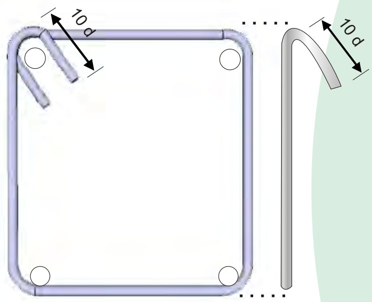
Structure element	Size (in cm)	Main bars	Hoop - spacing
Gable beam	12 x 15	4 Ø 10 mm	Ø 8mm – 15 mm
Ring beam	12 x 15	4 Ø 10 mm	Ø 8mm – 15 mm
Column	15 x 15	4 Ø 10 mm	Ø 8mm - 15 mm
Plint Beam	15 x 20	4 Ø 10 mm	Ø 8mm - 15 mm

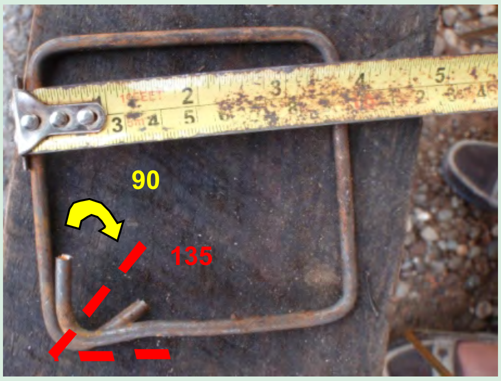


Hoop



* Has a larger concrete strength area, to counter the steel bar breaking free.
* Stronger
* More difficult for the Hoop bar to break free





This ø 8 mm hoop should be enhanced by bending it round until 135 degrees.

Right Fig. Simple resistance test of the Tensile Hoops
hoops tested in this way: this hoop was linked to one steel bar which was detained by several people, then withdrawn by a person in two conflicting directions Resulting in the hoop, which was bent 90 degrees easily snapped off (left) while the hoop with no bending 135 degrees can not be separated and remain intact (right).

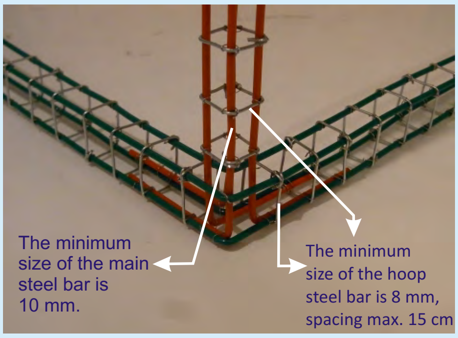
HOOP MAKING PROCESS

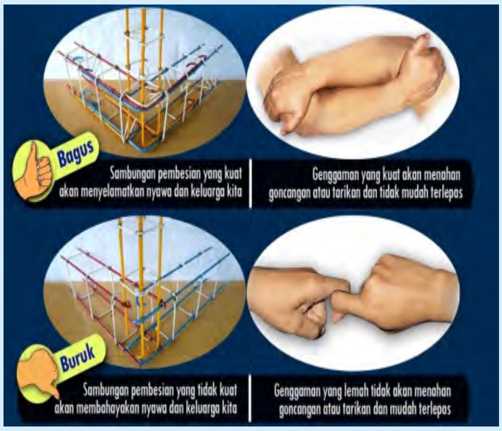
1 and 2. Create a template hoop in accordance with mall sizes.
3. Measure the 8mm steel bar and cut to the required size
4. Bend the steel bar with a bending tool.
5. The Bending should be 135 degrees.

1. Materials for Housing Construction

CONNECTION JOINT PRINCIPLES

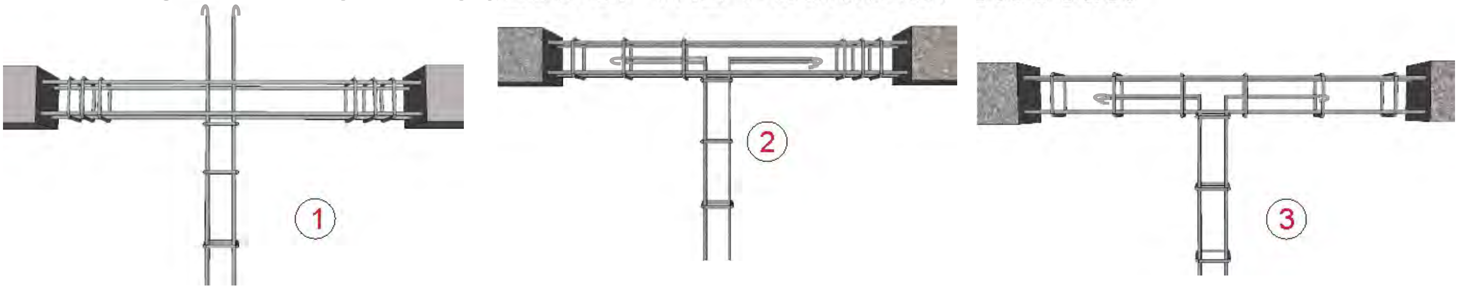
The minimum bending of the main bar length is 40 times the diameter of the main bars (40 cm).



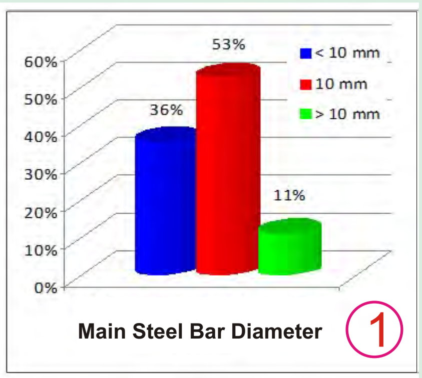


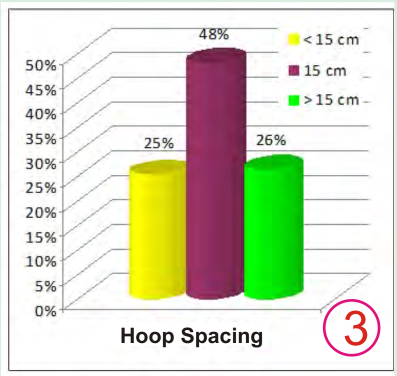
Re-plotted from Build Change

THE INSTALLATION PROCESS OF THE T-CONNECTION JOINT

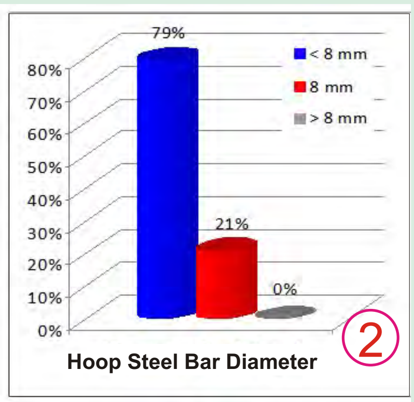


1. Slide hoops along 50 cm (left, right) into place. Bending for the main steel bars.
2. The main steel bars should be hooked along the minimum length of 40D (40cm), slide the hoops back and tie tightly with a wire bonding. Each Hoops should be tied at a spacing of 15 cm.
3. Check the Hoop spacing, and the connecting of the steel bars is now complete.





The process of making T connections
Note: The column has to be in the foundations.



From a survey of 110 masons respondents in the Enam Lingkung Sub-district. we discovered the following facts:

Graphic 1. 61% of masons have been accustomed to using main steel bars with of diameter of 10 mm size or more, and 39% masons use 8 mm size steel.

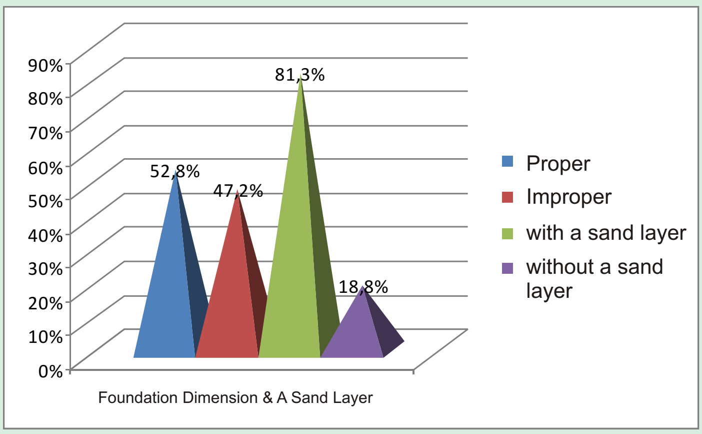
Graphic 2. as many as 75% of builders used an hoop less than 8 mm in diameter, and only 25% of masons use 8 mm steel for hoop.

Graphic 3. as many as 31% masons are accustomed to installing hoop with a spacing gap of more than 15 cm, and 69% masons usually install hoops with a spacing gap of 15 cm or less.

2. Foundation

Foundation Damage due to Earthquake

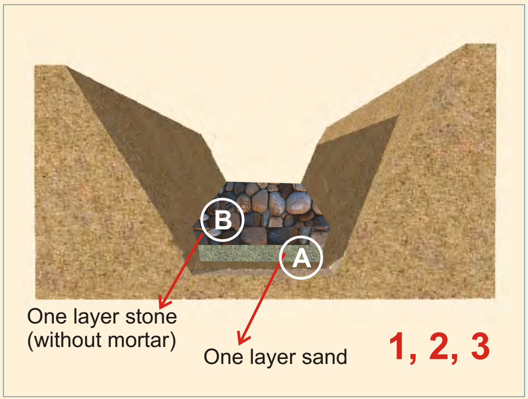
Commonly this building is damaged because the foundations didn't fulfill the needed requirements, such as the material isnt hard stone, the foundation size isn't big enough and the soil conditions are poor (such as fields, marches, ground which is prone to move i.e. soft soil or situated on sloping ground.)

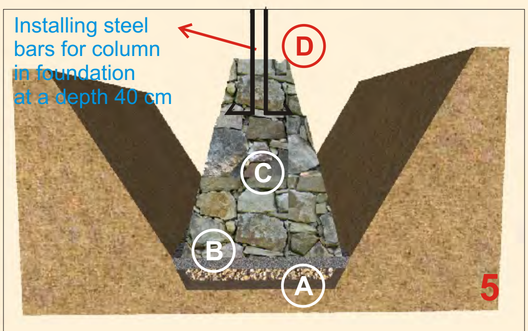


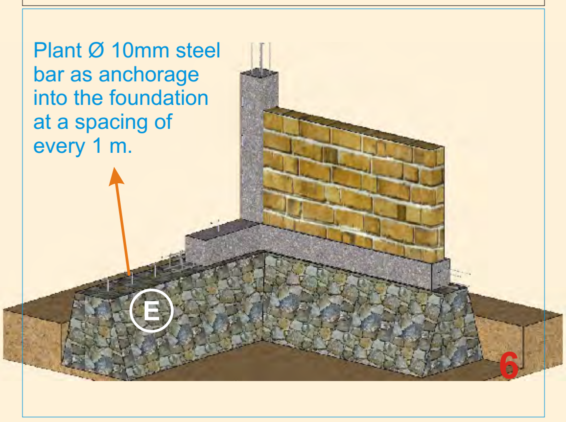
! Ground prone to moving is very dangerous for a house if an earthquake happens

From a survey of 110 respondents Masons and carpenters in the Enam lingkung Sub-district, it is known that: A total of 53% of builders created a foundation which conformed to the size requirements and 47% masons not fit the requirements.
As many as 81% masons usually use one layer of sand couples under the foundation and only 19% make without any layers of sand underneath the foundation

Foundations Making Process







1. Prepare bow Plank with the width of the foundation a minimum of 60 cm
2. The soil must be dug to a depth of 60 cm
3. Put the sand as deep as 10 cm (A) above the soil excavated and a layer of stone (with out motar) (B)

4. Place the stones into the foundation (C) with plaster 1 part cement to 4 parts sand. (Usually 1 part cement to 3 parts sand)
5. Plant Ø 10 mm steel bars column in foundation at a depth of 40 cm. Bend inside the foundation at a depth of 40 cm bending (D). Cast the concrete column with a 1:2:3 concrete ratio.

6. Plant the Ø 10mm steel bar as anchorage (E) into the foundation at a spacing of every 1 m.

3. Plint Beam

Damage house without plint beam due to earthquake

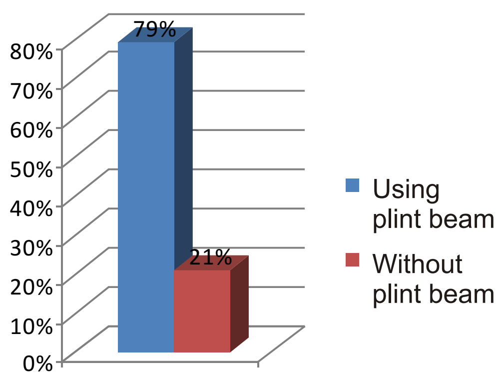
This damage occurred if the house has no plint beam.

Because of the earthquake, the column Which was not tied by the plint beam, moved from its position and caused the building to collapse.

Improper connection between plint beam and column will be easily separated if earthquake happen.

The foundation is assembled from stones which is unable to hold the column in case of shaking.

Source. SNS International (2010)

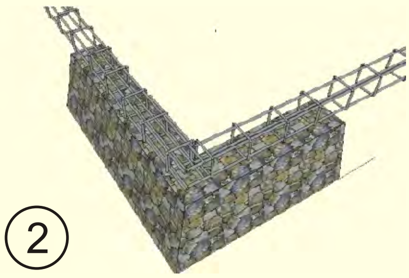


The importance of plint beam

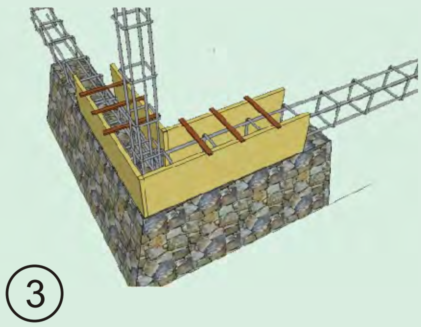
Based on the survey, more than 27% of residential houses do not use plint beam.

The Process for Making Plint Beams

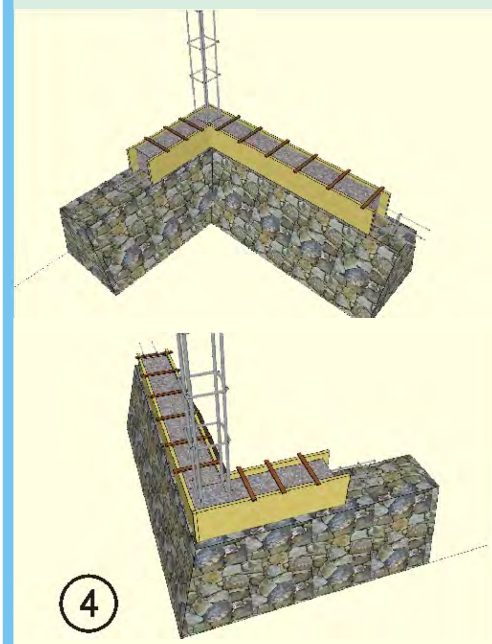
1. Tie the 8 mm diameter hoops with rope at a distance of 15 cm between each Hoop. At the end of the bars will be a connection, reserving the main bar along 40 cm.



2. At the corner connection the tip of the main bar should be bent as long as 40 cm. Then using bonding wire tie both of the main bars.



3. Create a formwork using board timber at a width of 15 cm and a height of 20 cm. The formwork must be strong and sturdy. Next cover the formwork cavity with wet paper cement. To maintain a thick 2 cm concrete cover, make the concrete 2 cm thick or alternatively, cover with 2 cm of gravel.



4. Do casting with the already prepared concrete mixture. The concrete must the be compacted. You can do this by using a stick or by knocking the side of the formwork. After 3 days the Plint beam formwork can be opened

4. Brick Masonry

Photographs of damage brick masonry walls due to earthquake

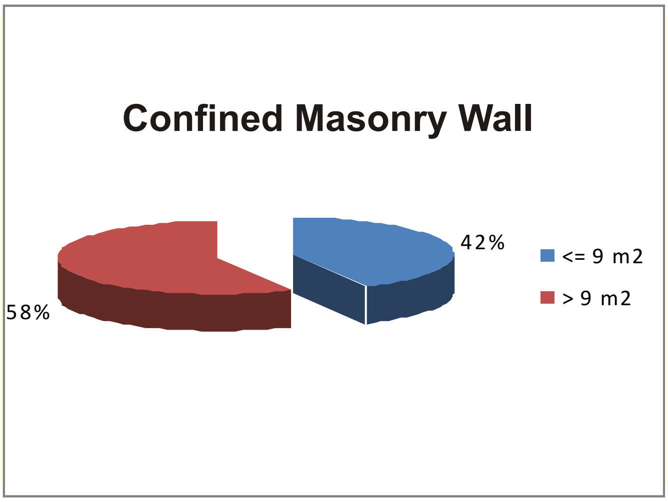
Wall damage occurred when the area of the confined masonry was more than 9 m2

The damage that occurs when there are no lintel beams at the opening of doors and windows.

No anchor were put between the columns with masonry walls, so when an earthquake occurred the wall easily collapsed despite the main structure of the house still standing.

When an earthquake occurs, cracks in buildings usually start from the point of opening doors or windows.

Source. SNS International (2010)



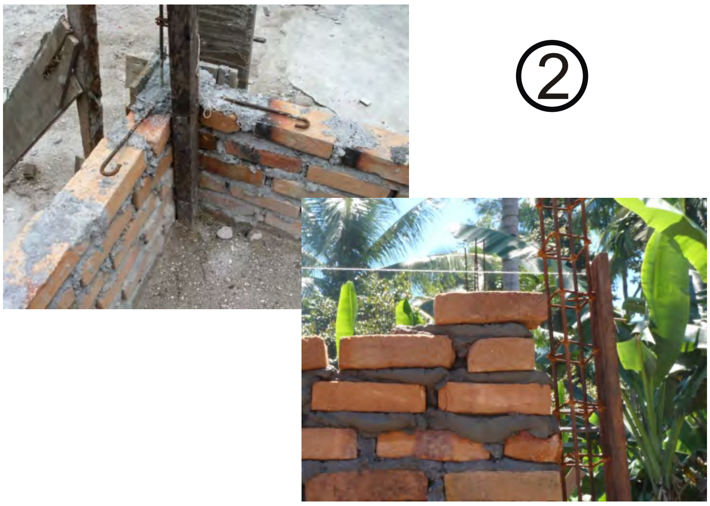
Based on data from interviews with foremen and masons, most of the houses built have a wall height of between 3.5 to 3.7 m with the distance between columns 3 m (wide wall is confined more than 9 m2). So it is necessary that a lintel beam needs to be added to the masonry wall.

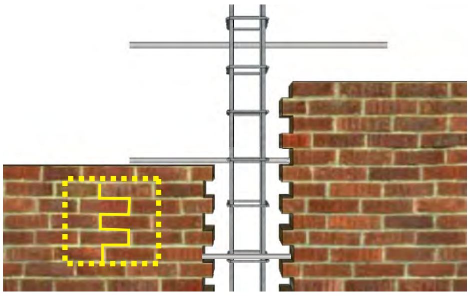
Brick Masonry Wall Making Process

①

Red bricks need to be soaked or flushed in advance to ensure that there is a perfect bonding between the red brick and the mortar. At the location where the bricks will be installed, first mark with thread to ensure the masonry is produced straight and vertical.

②





At the time of installing the bricks, press with the hand to prevent cavities. Thick mortar cover 1.5 cm. An anchor should be put in between the column and the brick masonry every six layers with using Ø10 mm steel bars. The column length should be 40 cm or more on both sides. In order that the column and the brick masonry be more unified, where the brick meets with the columns the ends of the masonry should be alternately ribbed.

③

Put the lintel beams around the building, especially at the opening of doors and windows (The area of the confined brick masonry should not be reinforced more than 9 m^2).

④

Cover the masonry using mixture ratio of cement mortar 1 cement: 4 sand, with a minimum thickness of 1.5 cm on both sides.

5. Column and Ring beam

Damage Photographs of houses Without Columns and ring beams due to earthquake

Houses without a column and ring beam can be easily damaged or even collapse if affected by the earthquake

Brick masonry wall easily collapses if not confined by concrete columns and beams

The damage occurred because the diameter of the steel bar was incorrect

Weak connections can cause masonry walls to crack resulting in collapse.

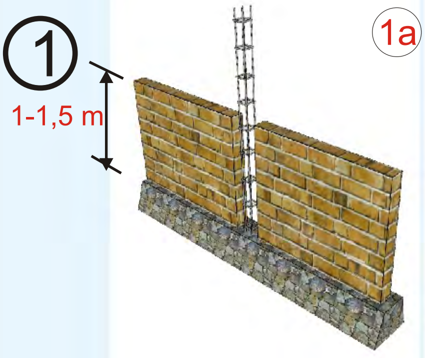
Improper steel bar connection caused the column and the ring beams to easily separate.

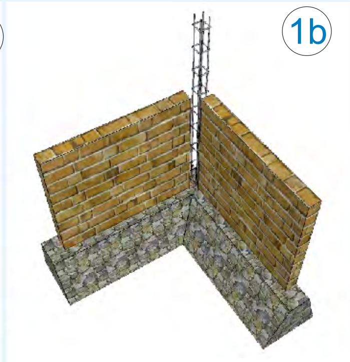
Damage to a masonry wall without a ring beam.

Source. SNS International (2010)

Procedure for Making A Column

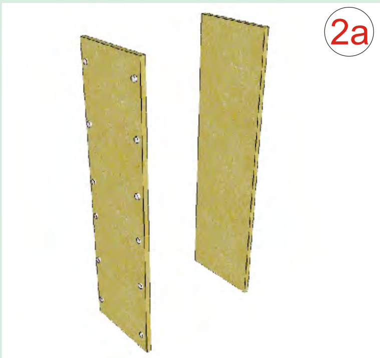
1

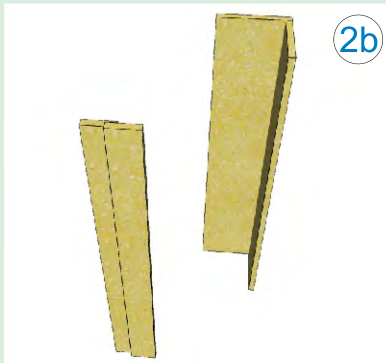




Series of reinforced steel columns that have been anchored at the foundation in established using the side buffer

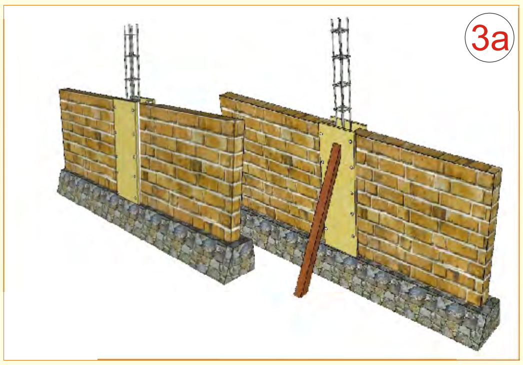
2

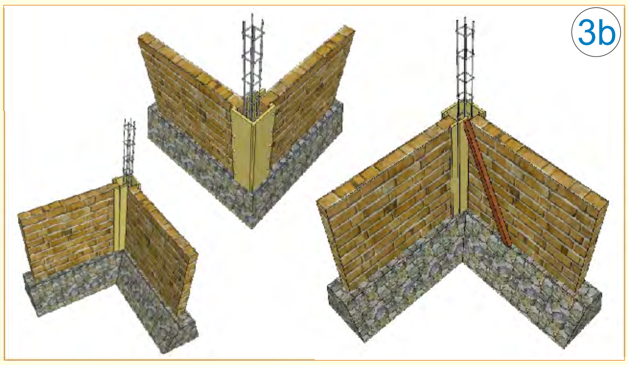




Create formwork column to the determined size. The column Size is 15 X 15 cm and the ring beam size is 12 X 15 cm.

3





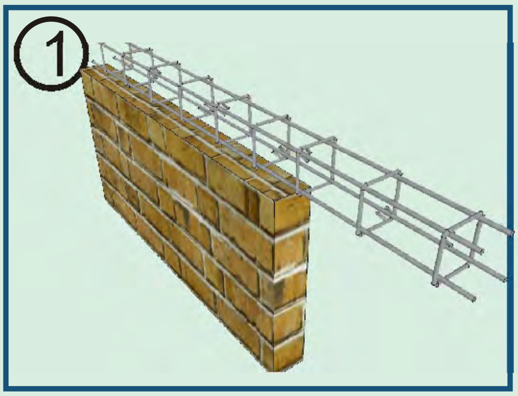
Place the formwork on both sides, then due to the fact that the thickness of the brick is less than 15 cm, to achieve the required column width additional wood battens must be fixed on both sides.

4

Step by step cast the concrete and then the concrete should be compacted by using a stick or alternatively by knocking the formwork to prevent the concrete from becoming porous. The casting of the brick column should by carried out every 1 1.5 cm of the brick stone assembly. After three days the column formwork can be removed.

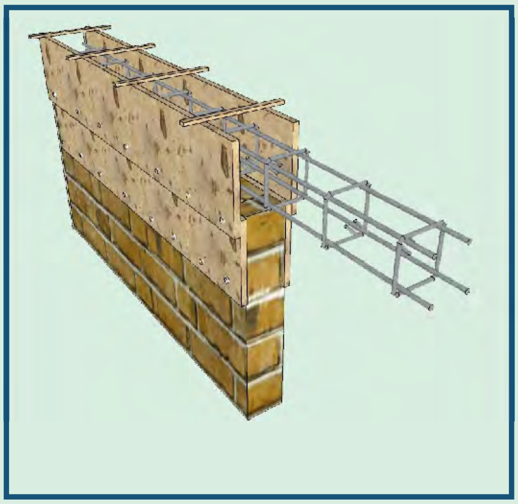
5. Column and Ring beam

The steel bar of the ring beam should be placed above the brick masonry.
The connection between the main bar must have an overlap of 40D (40 cm).



2

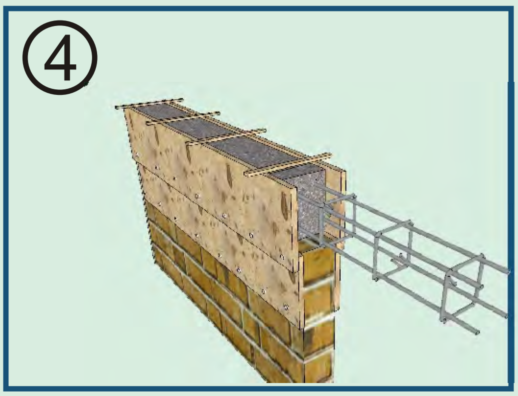
Create a wooden plank formwork with an inner width of 12 cm.



Formwork should be put on both sides of the steel bar reinforcement and tied with binding wire.

3

Close the gaps between the formwork using wetted paper cement. In order to maintain the concrete, cover with an additional 2 cm of concrete, or gravel.



Cast ring beam evenly and solidly by compacting or alternatively knocking the outside of the formwork to prevent the concrete From becoming porous.

5. Column and Ring beam

Bend the steel bar which has long edges to a length of 40 cm before being installed

Fix the part of pre bent steel bars above the masonry.

Slide the metal hoop from side to side in order to make placement easier. The main reinforcing steel connections, then bend the steel bar column in the direction of the steel bar beams.

Slide back the steel hoops to the initial position. The hoops should have a spacing of 15 cm then, finally tie with bonding wire.

Another technique, as shown on page 21 of this book:

- √ bending steel bar can also be done above the brick masonry (at the steel bar installation location by using two bending tools.
- √ With the addition of four Ø10 mm diameter steel bars which have been bent into L shapes The L shaped steel bars should be inserted to hold the connection between the ring beam and the column.

! To be remembered:
The Connection length (overlap) should be 40D (if using the main Ø10 mm diameter bar the bending length should be a minimum of 40 cm).

6. Gable

Photographs of damage to the gable without reinforced concrete gable frames due to earthquake






Source. SNS International (2010)

Gable damage occurs because masonry is not confined by reinforced concrete. This condition will greatly endanger the occupants of the house when the earthquake happens.

Process of making a gable frame

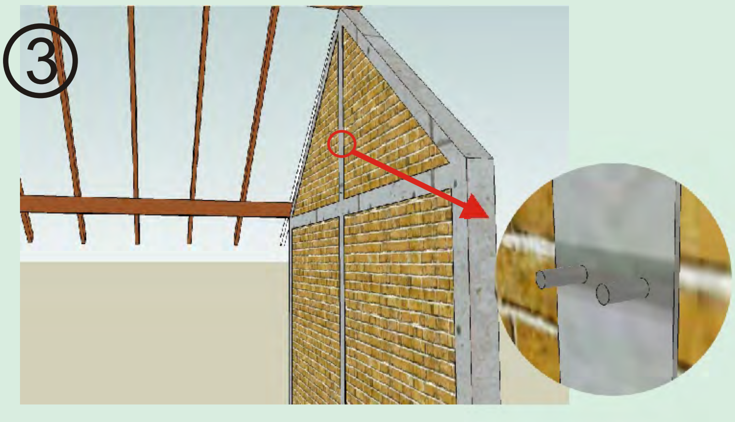
①

Firstly put the bricks on the gable, next, the main bar of the column is bent above the gable masonry, connect with gable main bar. Leaving an overlap along the connection 40 times a diameter of the main bar (40 cm).

②

Create and strengthen gable formwork using bonding wires. In order to maintain the concrete cover with a minimum depth of 1.5 cm of concrete or gravel to prevent the concrete from becoming porous. Close any gaps that exist in formwork with wet cement paper.

③



Before casting begins, if possible insert a Ø 10 mm bolt into the gable frame to install wind bracing.
Techniques can be seen on page 22 of this book.

④

Cast the concrete step by step and compact well by knocking them on the the formwork, on the connection between, gable, ring beam and column. Use the concrete with the maximum size aggregate of 2 cm (gravel). So that the concrete easily enters the reinforcement

7. Wind Bracing

Damage to the roof of brick masonry house due to earthquake

A wooden gable roof without wind bracing is easily damaged during an earthquake. A wind bracing functions as a binder between two gables / wooden gables in order that, in event of an earthquake the grids can move in the same directions (together).

Brick Masonry and reinforced concrete structures have severe damage, but the framework of the roof is still intact.

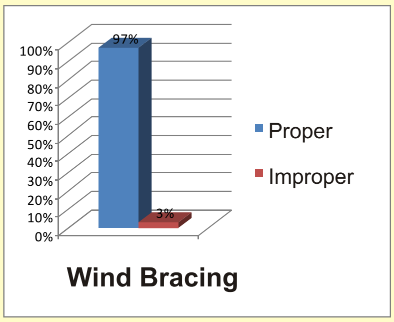
Doc. SNS International (2010)

The masonry brick Wall and structure collapsed, but the framework roof remained intact and unified.

The observation of a roof frame of a masonry brick house in Padang Pariaman after the Earthquake in West Sumatra 2009 shows the frame work of the roof is still in good condition.
The roof of the house is made from light material (zinc) and the wooden frame work of the roof was adequately connected and bonded between gable to gable and the joist.

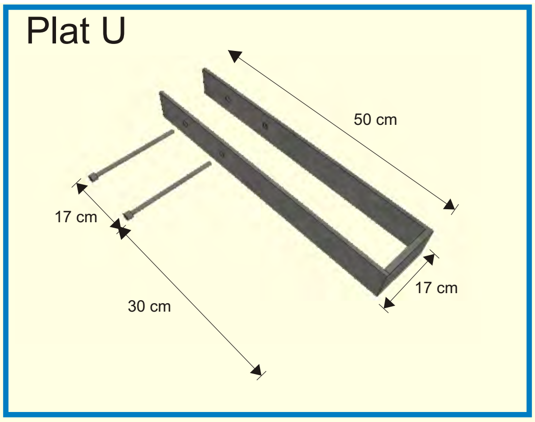
General condition of the roof in West Sumatra

From our survey results we can conclude that 90% of homes already use wind bracing.



Lightweight roofing (zinc), horizontal wind bracing installed straight or cross, the wooden joints are only nailed, and the wooden beam is put on top of the brick wall using a box system to create a diagonal (grid) structure.

Installation Process Association of Wind bracing

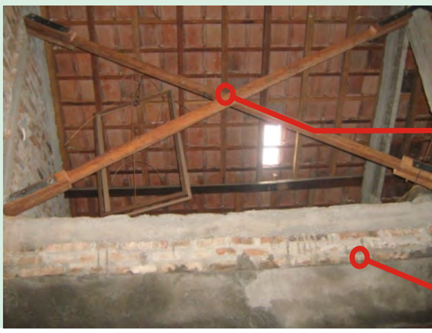


1. Cut the timber to appropriate size

2. Drill the 12 mm diameter bolt hole as pre determined layout

3. Drill the wall to insert plate - U

4. Fix the U plates and wood bracing.

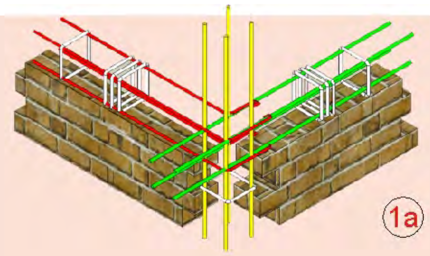


The center cross assembly mounted with bolts 12 mm or nailed

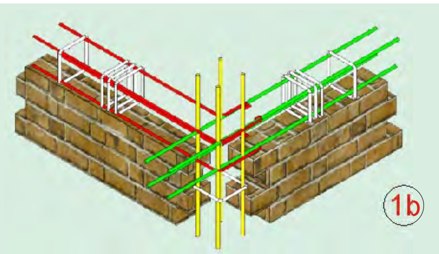
5. Wind bracing fixing is complete

MAKING PROCESS OF THE CORNER GABLE FRAME CONNECTION

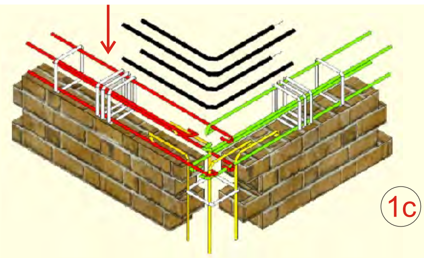
There are several ways to make a corner gable frame connection, three options have been simulated way these (a, b, c) are:



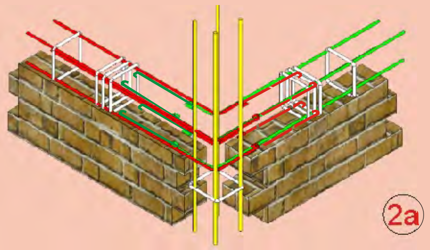
1a.The yellow steel bar or column goes straight until the top of the gables. The red steel bar of the beam is bent at 40 D, and the other steel bar of beam (green) remains straight. The hoop is bent in order to insert the 40 D steel bar in the reinforcement box.



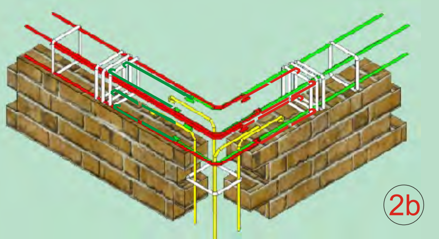
1b. The yellow steel bar for the gable beam has straight length of 40 D. The red steel bar for the gable beam is bent at 40 D, and the other steel bar (green) remains straight. The hoop is stretched to include the bent 40 D steel in the reinforcement box.



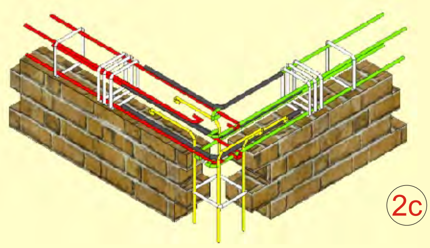
1c. The yellow steel bar for columns are bent a little and laced with the steel bars. The red steel bars are bent into the crochet origin, and the green steel bars are left straight. The hoop is stretched to put the 40 D L bend into the reinforced box.



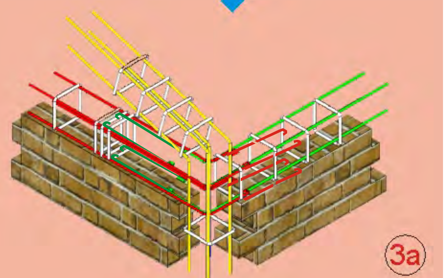
2a. All the steel bars of the beams are bent 40D



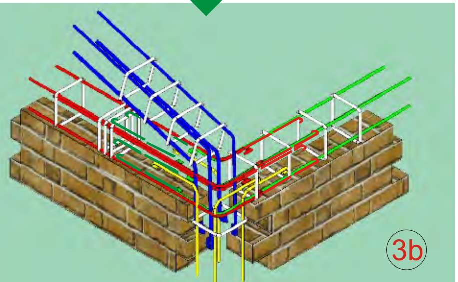
2b. All the steel bars for gable beam are bent 40 D. The yellow steel bar for column Is also bent 40 D and is also inserted Into the reinforcement box.



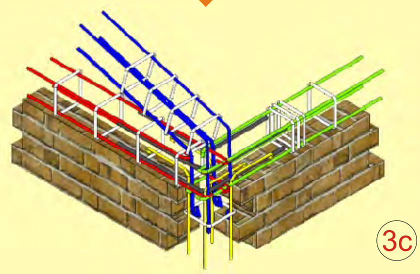
2c. Bend all the steel bars into four L-shapes with a spacing of 40 D and insert them into the reinforced box.



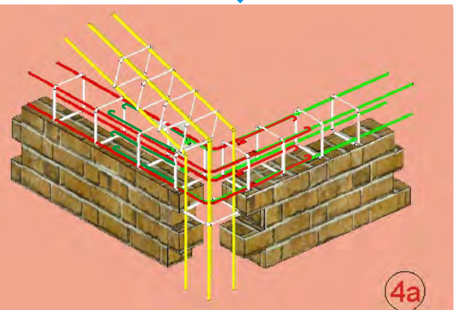
3a. The yellow steel bars for gable beam are bent to the appropriate oblique angle of the roof the hoop is returned to the normal position and is spaced every 15 cm.



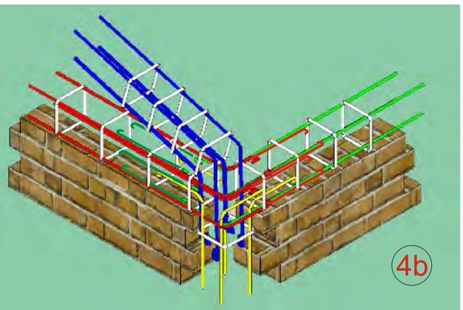
3b. The blue steel bars of gable beam are put into the reinforcement box. Hoops return to the normal position with a distance of every 15 cm.



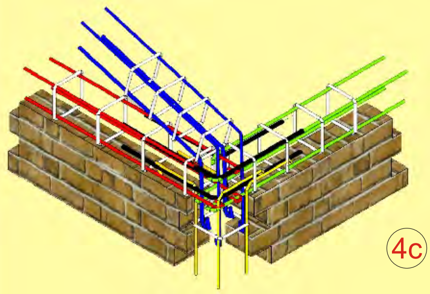
3c. The blue steel bars are planted into the yellow column and returned to the normal position they should be spaced with hoops every 15 cm.



4a. The final result the connection corner of the gable



4b. The final result the connection corner of the gable



4c. The final result the connection corner of the gable

1

COST ESTIMATION OF 1 M3 RIVERSTONE FOUNDATION WORK OF SIMPLE HOUSE
(Unit Price by 20 March 2010, location in Enam Lingkung Sub-District, Padang Pariaman District)

1 1 m^3 River stone Masonry with mortar 1 Cement : 4 Sand

Quantity	Unit	Cost Item	Unit Price	Material Cost	Labor Cost	Total Cost
3.300	sack	Portland Cement (50) kg	52,000.00	171,600.00		
0.520	m^3	Clean sand	75,000.00	39,000.00		
1.200	m^3	River stone	80,000.00	96,000.00		
0.120	PeoDay	Mason	70,000.00		8,400.00	
0.180	PeoDay	Head Mason	85,000.00		15,300.00	
3.600	PeoDay	Unskilled labour	50,000.00		180,000.00	
		Sum of material and labor (IDR)		306,600.00	203,700.00	510,300.00

2 1 m^3 Sand Backfilling Below Foundation

Quantity	Unit	Cost Item	Unit Price	Material Cost	Labor Cost	Total Cost
1.200	m^3	Backfill sand	65,000.00	78,000.00		
0.300	PeoDay	Unskilled Labour	50,000.00		15,000.00	
0.010	PeoDay	Foreman	85,000.00		850.00	
		Sum of material and labor (IDR)		78,000.00	15,850.00	93,850.00

3 1 m^3 Dig and Transport of Soil

Quantity	Unit	Cost Item	Unit Price	Material Cost	Labor Cost	Total Cost
0.980	PeoDay	Unskilled Labour	85,000.00		83,300.00	
0.025	PeoDay	Foreman	50,000.00		1,250.00	
		Sum of material and labor (IDR)		0.00	84,550.00	84,550.00

4 1 m^3 Backfilling Soil

Quantity	Unit	Cost Item	Unit Price	Material Cost	Labor Cost	Total Cost
0.380	PeoDay	Unskilled Labour	85,000.00		32,300.00	
0.055	PeoDay	Foreman	50,000.00		2,750.00	
		Sum of material and labor (IDR)		0.00	35,050.00	35,050.00

	Material Cost	Labor Cost	Total Cost
Cost Estimation per m^3 Riverstone Foundation 1 : 4 (IDR)	384,600.00	339,150.00	723,750.00

Exchange Rate US$ 1 = IDR 9,200.00

2

COST ESTIMATION FOR 1 M2 BRICK MASONRY OF SIMPLE HOUSE
(Unit Price by 20 March 2010, location in Enam Lingkung Sub-District, Padang Pariaman District)

1 1 m^2 Brick Masonry 1 Cement : 3 Sand

Quantity	Unit	Cost Item	Unit Price	Material Cost	Labor Cost	Total Cost
0.480	sack	Portland Cement (50) kg	52,000.00	24,960.00		
0.049	m^3	Clean sand	75,000.00	3,675.00		
72.000	piece	Brick	500.00	36,000.00		
0.225	PeoDay	Mason	70,000.00		15,750.00	
0.022	PeoDay	Head Mason	85,000.00		1,870.00	
0.600	PeoDay	Unskilled Labour	50,000.00		30,000.00	
		Sum of material and labor (IDR)		64,635.00	47,620.00	112,255.00

2 1 m^2 Plastering 1 Cement : 3 sand

Quantity	Unit	Cost Item	Unit Price	Material Cost	Labor Cost	Total Cost
0.170	sack	Portland Cement (50) kg	52,000.00	8,840.00		
0.026	m^3	Clean Sand	75,000.00	1,950.00		
0.200	PeoDay	Mason	70,000.00		14,000.00	
0.020	PeoDay	Head Mason	85,000.00		1,700.00	
0.400	PeoDay	Unskilled Labour	50,000.00		20,000.00	
		Sum of material and labor (IDR)		10,790.00	35,700.00	46,490.00

Exchange Rate US$ 1 = IDR 9,200.00

3

COST ESTIMATION 1 M2 ROOF

(Unit Price by 20 March 2010, location in Enam Lingkung Sub-District, Padang Pariaman District)

1 1 m^3 Wooden gable

Quantity	Unit	Cost Item	Unit Price	Material Cost	Labor Cost	Total Cost
1.100	m^3	"Kruing" timber 6/12	2,100,000.00	2,310,000.00		
15.000	kg	Steel strip (U plate)	17,000.00	255,000.00		
5.800	kg	Bolts / nails	15,000.00	87,000.00		
8.000	PeoDay	Carpenter	70,000.00		560,000.00	
2.000	PeoDay	Head Carpenter	85,000.00		170,000.00	
4.000	PeoDay	Unskilled Labour	50,000.00		200,000.00	
			Sum of material and labor (IDR)	2,652,000.00	930,000.00	3,582,000.00

2 1 m^3 wooden joist

Quantity	Unit	Cost Item	Unit Price	Material Cost	Labor Cost	Total Cost
1.100	m^3	"Kruing" timber 6/12	2,100,000.00	2,310,000.00		
3.000	kg	Bolts / nails	15,000.00	45,000.00		
5.000	PeoDay	Carpenter	70,000.00		350,000.00	
2.000	PeoDay	Head Carpenter	85,000.00		170,000.00	
2.000	PeoDay	Unskilled Labour	50,000.00		100,000.00	
			Sum of material and labor (IDR)	2,355,000.00	620,000.00	2,975,000.00

3 1 m^2 Wooden Laths "Kruing" or Similar

Quantity	Unit	Cost Item	Unit Price	Material Cost	Labor Cost	Total Cost
0.0090	m^3	"Kruing" timber rafter 5/7 cm	2,100,000.00	18,900.00		
0.0040	m^3	"Jati" timber laths 3/4 cm	5,900,000.00	23,600.00		
0.200	kg	Bolts / nails	15,000.00	3,000.00		
0.100	PeoDay	Carpenter	70,000.00		7,000.00	
0.010	PeoDay	Head Carpenter	85,000.00		850.00	
0.150	PeoDay	Unskilled Labour	50,000.00		7,500.00	
			Sum of material and labor (IDR)	45,500.00	15,350.00	60,850.00

4a 1 m^2 Zinc Roof

Quantity	Unit	Cost Item	Unit Price	Material Cost	Labor Cost	Total Cost
0.2500	sheet	Zinc roof 180	52,000.00	13,000.00		
0.100	kg	Bolts / nails	15,000.00	1,500.00		
0.080	PeoDay	Carpenter	70,000.00		5,600.00	
0.008	PeoDay	Head Carpenter	85,000.00		680.00	
0.150	PeoDay	Unskilled Labour	50,000.00		7,500.00	
			Sum of material and labor (IDR)	14,500.00	13,780.00	28,280.00

4b 1 m^2 Roof Tile

Quantity	Unit	Cost Item	Unit Price	Material Cost	Labor Cost	Total Cost
25.0000	piece	Roof tile "abadi"	1,400.00	35,000.00		
0.100	PeoDay	Carpenter	70,000.00		7,000.00	
0.010	PeoDay	Head Carpenter	85,000.00		850.00	
0.160	PeoDay	Unskilled Labour	50,000.00		8,000.00	
			Sum of material and labor (IDR)	35,000.00	15,850.00	50,850.00

5 1 m Install the top roof

Quantity	Unit	Cost Item	Unit Price	Material Cost	Labor Cost	Total Cost
3.5000	piece	Ridge tile	1,800.00	6,300.00		
0.1000	m^3	Clean sand	75,000.00	7,500.00		
0.200	sack	Portland cement	52,000.00	10,400.00		
0.250	PeoDay	Carpenter	70,000.00		17,500.00	
0.025	PeoDay	Head Carpenter	85,000.00		2,125.00	
0.600	PeoDay	Unskilled Labour	50,000.00		30,000.00	
			Sum of material and labor (IDR)	24,200.00	49,625.00	73,825.00

	Material Cost	Labor Cost	Total Cost
Cost Estimation per m2 Zinc Roof (IDR)	284,716.00	206,780.00	491,496.00
Cost Estimation per m2 of roof tiles (IDR)	305,216.00	208,850.00	514,066.00

Exchange Rate US$ 1 = IDR 9,200.00

4

COST ESTIMATION 1 M1 MAKING PLINT BEAM SIZE 15 X 20 CM
(Unit Price by 20 March 2010, location in Enam Lingkung Sub-District, Padang Pariaman District)

1 1 m1 plint beam formwork

Quantity	Unit	Cost Item	Unit Price	Material Cost	Labor Cost	Total Cost
0.00072	m3	Woodplank 2X20x200	3,000,000.00	2,160.00		
0.00051	m3	Timber 4x6x400	1,000,000.00	510.00		
0.012	kg	nails	15,750.00	189.00		
0.0015	PersonDay	Mason	80,000.00		120.00	
0.015	PersonDay	Head Mason	70,000.00		1,050.00	
0.006	PersonDay	Unskilled Labor	60,000.00		360.00	
			Sum of material and labor (IDR)	2,859.00	1,560.00	4,419.00

2 1 m1 Work / Install Steel Reinforcement

Quantity	Unit	Cost Item	Unit Price	Material Cost	Labor Cost	Total Cost
0.67	bar	Steel bar Ø10 mm x 12 m	43,000.00	28,810.00		
0.43	bar	Steel bar Ø8 mm x 12 m	36,000.00	15,480.00		
0.106	kg	Binding Wire	15,000.00	1,585.98		
0.005	PersonDay	Mason	80,000.00		394.73	
0.049	PersonDay	Head Mason	70,000.00		3,453.91	
0.049	PersonDay	Unskilled Labor	60,000.00		2,960.50	
			Sum of material and labor (IDR)	45,875.98	6,809.14	52,685.12

3 1 m1 Cast Reinforced Concrete 1:2:3

Quantity	Unit	Cost Item	Unit Price	Material Cost	Labor Cost	Total Cost
0.0246	m3	Crushed Gravel	77,777.78	1,913.33		
0.0162	m3	Sand	85,714.29	1,388.57		
0.255	sack	Cement (50 kg)	52,000.00	13,260.00		
0.003	PersonDay	Mason	80,000.00		240.00	
0.03	PersonDay	Head Mason	70,000.00		2,100.00	
0.18	PersonDay	Unskilled Labor	60,000.00		10,800.00	
			Sum of material and labor (IDR)	16,561.90	14,040.00	30,601.90
			Cost Estimation per m1	65,296.88	22,409.14	87,706.03

5

COST ESTIMATION 1 M1 MAKING COLUMN SIZE 15 X 15 CM
(Unit Price by 20 March 2010, location in Enam Lingkung Sub-District, Padang Pariaman District)

1 1 m1 Column Formwork

Quantity	Unit	Cost Item	Unit Price	Material Cost	Labor Cost	Total Cost
0.00054	m3	Woodplank 2X20x200	3,000,000.00	1,620.00		
0.000383	m3	Timber 4x6x400	1,000,000.00	382.50		
0.009	kg	nails	15,750.00	141.75		
0.001125	PersonDay	Mason	80,000.00		90.00	
0.01125	PersonDay	Head Mason	70,000.00		787.50	
0.0045	PersonDay	Unskilled Labor	60,000.00		270.00	
			Sum of material and labor (IDR)	2,144.25	1,147.50	3,291.75

2 1 m1 Work / Install Steel Reinforcement

Quantity	Unit	Cost Item	Unit Price	Material Cost	Labor Cost	Total Cost
0.67	bar	Steel bar Ø10 mm x 12 m	43,000.00	28,810.00		
0.372	bar	Steel bar Ø8 mm x 12 m	36,000.00	13,392.00		
0.102	kg	Binding Wire	15,000.00	1,523.34		
0.005	PersonDay	Mason	80,000.00		Rp 379.14	
0.047	PersonDay	Head Mason	70,000.00		Rp 3,317.50	
0.047	PersonDay	Unskilled Labor	60,000.00		Rp 2,843.57	
			Sum of material and labor (IDR)	43,725.34	6,540.21	50,265.55

3 1 m1 Cast Reinforced Concrete 1:2:3

Quantity	Unit	Cost Item	Unit Price	Material Cost	Labor Cost	Total Cost
0.01845	m3	Gravel	77,777.78	1,435.00		
0.01215	m3	Sand	85,714.29	1,041.43		
0.19125	sack	Cement (50 kg)	52,000.00	9,945.00		
0.00225	PersonDay	Mason	80,000.00		180.00	
0.0225	PersonDay	Head Mason	70,000.00		1,575.00	
0.135	PersonDay	Unskilled Labor	60,000.00		8,100.00	
			Sum of material and labor (IDR)	12,421.43	9,855.00	22,276.43
			Cost Estimation per m1	58,291.02	17,542.71	**75,833.72**

Exchange Rate US$ 1 = IDR 9,200.00

6

COST ESTIMATION 1 M1 MAKING RING BEAM SIZE 12 X 15 CM
(Unit Price by 20 March 2010, location in Enam Lingkung Sub-District, Padang Pariaman District)

1 1 m1 Ring Beam Formwork

Quantity	Unit	Cost Item	Unit Price	Material Cost	Labor Cost	Total Cost
0.00054	m3	Woodplank 2X20x200	3,000,000.00	1,620.00		
0.000383	m3	Timber 4x6x400	1,000,000.00	382.50		
0.009	kg	nails	15,750.00	141.75		
0.001125	PersonDay	Mason	80,000.00		90.00	
0.01125	PersonDay	Head Mason	70,000.00		787.50	
0.0045	PersonDay	Unskilled Labor	60,000.00		270.00	
			Sum of material and labor (IDR)	2,144.25	1,147.50	3,291.75

2 1 m1 Work / Install Steel Reinforcement

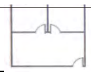
Quantity	Unit	Cost Item	Unit Price	Material Cost	Labor Cost	Total Cost
0.67	bar	Steel bar Ø10 mm x 12 m	43,000.00	28,810.00		
0.372	bar	Steel bar Ø8 mm x 12 m	36,000.00	13,392.00		
0.102	kg	Binding Wire	15,000.00	1,523.34		
0.005	PersonDay	Mason	80,000.00		379.14	
0.047	PersonDay	Head Mason	70,000.00		3,317.50	
0.047	PersonDay	Unskilled Labor	60,000.00		2,843.57	
			Sum of material and labor (IDR)	43,725.34	6,540.21	50,265.55

3 1 m1 Cast Reinforced Concrete 1:2:3

Quantity	Unit	Cost Item	Unit Price	Material Cost	Labor Cost	Total Cost
0.01845	m3	Gravel	77,777.78	1,435.00		
0.01215	m3	Sand	85,714.29	1,041.43		
0.19125	sack	Cement (50 kg)	52,000.00	9,945.00		
0.00225	PersonDay	Mason	80,000.00		180.00	
0.0225	PersonDay	Head Mason	70,000.00		1,575.00	
0.135	PersonDay	Unskilled Labor	60,000.00		8,100.00	
			Sum of material and labor (IDR)	12,421.43	9,855.00	22,276.43
			Cost Estimation per m1	58,291.02	17,542.71	**75,833.72**

Exchange Rate US$ 1 = IDR 9,200.00

COST ESTIMATION FOR SAFER HOUSE TYPE 36 (6 m X 6 m, Size 36 m 2)
(Unit Price by 20 March 2010, location in Enam Lingkung Sub-District, Padang Pariaman District)



Num	Work Type	Volume	unit	Quality (%)	Unit Price (IDR)			Total Cost (IDR)		
					Material	Labor	Total	Material	Labor	Total
1	2	3	4	5	6	7	8 = (6 + 7)	9 = (3 x 6)	10 = (3 x 7)	11 = (3 x 8)
1	Cleanup Locations	45.0	m^2	0.50	0.00	6,000.00	6,000.00	0.00	270,000.00	270,000.00
2	Measurement and "bouwplank"	36.0	m^1	0.38	3,100.00	2,600.00	5,700.00	111,600.00	93,600.00	205,200.00
3	Foundation excavation	15.2	m^3	2.38	0.00	84,550.00	84,550.00	0.00	1,285,160.00	1,285,160.00
4	Backfilling soil	5.4	m^3	0.84	0.00	84,550.00	84,550.00	0.00	456,570.00	456,570.00
5	One layer sand	1.7	m^3	0.29	78,000.00	15,850.00	93,850.00	129,480.00	26,311.00	155,791.00
6	One layer river stone without mortar	3.3	m^3	0.80	96,000.00	35,050.00	131,050.00	317,760.00	116,015.50	433,775.50
7	Stone masonry 1:4 for foundation	8.2	m^3	7.77	306,600.00	203,700.00	510,300.00	2,526,384.00	1,678,488.00	4,204,872.00
8	Reinforced Concrete Structure:			18.45						
	a. Plint beam	36.0	m^1	5.77	65,296.88	21,479.14	86,776.02	2,350,687.85	773,249.04	3,123,936.89
	b. Column	41.0	m^1	5.75	58,291.02	17,542.71	75,833.72	2,389,931.76	719,250.96	3,109,182.72
	c. Ring beam	36.0	m^1	4.71	55,377.88	15,342.21	70,720.09	1,993,603.68	552,319.56	2,545,923.24
	d. Gable beam	17.0	m^1	2.22	55,377.88	15,342.21	70,720.09	941,423.96	260,817.57	1,202,241.53
9	Roof:			13.48						
	a. Gable frame	0.5	m^3	3.58	2,652,000.00	930,000.00	3,582,000.00	1,432,080.00	502,200.00	1,934,280.00
	b. Joist	54.0	m^2	6.07	45,500.00	15,350.00	60,850.00	2,457,000.00	828,900.00	3,285,900.00
	c. Zinc roof	54.0	m^2	2.82	14,500.00	13,780.00	28,280.00	783,000.00	744,120.00	1,527,120.00
	d. Ridge roof	7.4	m^2	1.01	24,200.00	49,625.00	73,825.00	179,080.00	367,225.00	546,305.00
10	Brick masonry with mortar 1:4	99.0	m^2	20.54	64,635.00	47,620.00	112,255.00	6,398,865.00	4,714,380.00	11,113,245.00
11	Plastering with mortar 1:4 work	180.0	m^2	15.47	10,790.00	35,700.00	46,490.00	1,942,200.00	6,426,000.00	8,368,200.00
11	Doors and windows	1.8	m^3	12.18	2,652,000.00	930,000.00	3,582,000.00	4,879,680.00	1,711,200.00	6,590,880.00
12	floor with tile	36.0	m^2	6.92	68,000.00	36,000.00	104,000.00	2,448,000.00	1,296,000.00	3,744,000.00
	Sum of material and labor (IDR)			**100**				**31,280,776.25**	**22,821,806.63**	**54,102,582.89**

Exchange Rate US$ 1 = IDR 9,200.00

Masons Training Activities

In recent years, massive earthquakes have happened in the world almost every year and some of these earthquakes claimed tens of thousands of lives. Especially, these earthquakes caused tremendous damages to Asia and other areas surrounding Asia. For example, the earthquakes in Turkey (1999), India (2001), Iran (2003), Indonesia (2004, 2006, 2009), and Pakistan (2005) caused tremendous damages beyond all of your imagination.

For example, in Iran, Bam Earthquake (magnitude of 6.3) occurred on December 26, 2003 in southeast of Iran claimed more than forty thousand lives. Moreover, approximately 13 years before Bam Earthquake, Rudbar (areas along the Caspian Sea) Earthquake occurred in 1990 killed approximately twenty thousand people. Thus, during about forty years between 1962 to 2003, the people in Iran had to have experienced five times large earthquakes claimed thousands of people.

According to the research about the cause of earthquake damages in Iran by Earthquake Research Institute of Tokyo University in 1991, one of the causes of earthquake damages in Iran between 1962 to 1990 was collapse of fragile and non-engineered buildings. One of the causes of massive damages by Bam earthquake was also recognized fragile and non-engineered buildings by Building Research Institute of Japan. Thus, in Iran, the same cause in every earthquake has claimed so many lives.

In addition, Japan is one of earthquake-prone countries well-known throughout the world and the Great Hansin-Awaji Earthquake of 1995 directly hit Kobe metropolitan area and many places around Kobe and killed more than six thousand people. However, we, Japanese, have accumulated some technique, policy, and knowledge for earthquake prevention such as earthquake safer technique for construction suitable for regional characteristics in Japan based on our experiences of the Great Hansin-Awaji Earthquake and others.

We are quite sure that these accumulated technique and knowledge will be very useful for future earthquake prevention in Asia and other areas surrounding Asia, if these technique and knowledge are transferred to the areas over the social and cultural differences. Thus, we are also confident that we can mitigate some future disasters by building up disaster-prevention measures suitable for their regional characteristics.

The mission of SNS International Disaster Prevention Support Center is to support the people in Iran and other areas in Asia for building up their own culture for disaster mitigation. For carrying out the mission, we have analyzed the causes of the damages of some natural disasters such as earthquake in these areas and had some activities for disaster mitigation based on the analysis.

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