

## **Appendix 7**

# **MANUAL OF MONITORING CONSTRUCTION FOR SAFER HOUSING**



# MANUAL OF WATCHING OVER CONSTRUCTION OF SAFER HOUSING



SEPTEMBER 2008  
JAPAN INTERNATIONAL COOPERATION AGENCY





Picture of the constructive process of safer housing



Picture of the constructive process of the foundation and the tie beam



Picture of the constructive process of the cane roof

# TO READERS OF THIS BOOK

Big Earthquake was occurred in Ica region on August of 2007 and revealed vulnerability of houses against earthquake. Housing reconstruction needs safer housing against earthquake. Japan International Cooperation Agency (hereinafter referred to as “JICA”) has conducted the Study on Housing Reconstruction with Seismic-resistant Houses in the Republic of Perú (hereinafter referred to as “the Study”) in response to a request of the Government of the Republic of Perú (hereinafter referred to as “the Government of Perú”).

An idea of safer housing is come from concepts of minimum requirements, which illustrate the essence of structural aspects of housing in design, construction and inspection. JICA Study Team has prepared the minimum requirements of safer housing. The minimum requirements are guided by key requirements established in Sub-Project on Housing Administration Capacity Enhancement to improve the vulnerability of Housing for Central Jawa and DIY Earthquake Reconstruction Program Indonesia which was conducted by JICA.

Based on the minimum requirements, i) prototype drawings for safer housing, ii) manual of watching over construction of safer housing and iii) manual of simple inspection for construction of safer housing were prepared by the Study. Those materials play an important role in facilitating safer housing reconstruction of affected families. Majority of the affected families cannot prepare the necessary drawings for building permit due to a lack of budget. The prototype drawings can be adopted as the necessary drawings. The manual of watching over construction of safer housing can be applicable for house owner to check whether or not house construction is appropriate. Taking user-friendly manual into consideration the manual was prepared for the one who has no construction knowledge to understand appropriate construction methods easily. The manual of simple inspection for safer housing can assist in developing capability of municipal inspectors for safer housing construction. Those two manuals help to complement a lack of municipality inspectors.

Existing building permit itself needs speedup and simplification due to lots of applicants who reconstruct their houses without delay. For that reason JICA Study Team has proposed to introduce the prototype drawings and the above-mentioned manuals into the existing building permit system.

District municipality will have a drawing bank for building permit by making use of the prototype drawings. The drawing bank benefits building permit applicants because the prototype drawings show affordable construction costs and are automatically approved in a process of building permit. Construction of safer housing will be disseminated through activities based on the said manuals. In other words,

the house construction will be watched over carefully by house owner and inspected exactly by municipality inspector.

As the above-mentioned background, this book a manual of watching over construction of safer housing was prepared by The JICA Study Team. The readers of this book are ordinary people who reconstruct their houses.

In this way, we hope that this book can contribute in the reconstruction of safer houses in the Ica Region.

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# ACKNOWLEDGEMENTS

This book was prepared by JICA Study Team, thanks to the united efforts of Ministry of Housing, Construction and Sanitation (hereinafter referred to as “MVCS”) which is implemented the Study jointly.

Dr. QF Rómulo Triveño Pinto, President of Ica Region, has made district municipalities in Ica Region a request of cooperation with JICA Study Team as smooth implementation of the Study.

Mayors of the target district municipalities, where a pilot project of the Study is implemented, provide officials and place for on-the-job training of the Study to deal with needs from many people to reconstruct their houses. The mayors are; Mr. Lucio Juárez Ochoa of Pueblo Nuevo in Chincha province, Mr. Marino Ucharima of Independencia in Pisco province and Dr. Ruben A. Velásquez Serna of La Tinguiña in Ica province.

Dr. Carlos Alberto Zavala Toledo, a director of CISMID (Japan Peru Center for Earthquake Engineering and disaster mitigation) and an associate professor of FIC/UNI (Faculty of Civil Engineering in National University of Engineering), has become a technical advisor of the pilot project of the Study to have given many practical and professional advices to JICA Study Team. He authorized the minimum requirements in respect of civil engineering and approved this book as very practical, effect and complementary systems to the existing building permit.

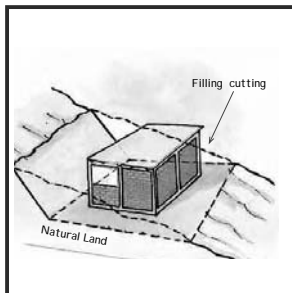
Lastly, I highly appreciate efforts of some other persons concerned with the Study.

Eng. Kobayashi Ichiro  
Team Leader, JICA Study Team

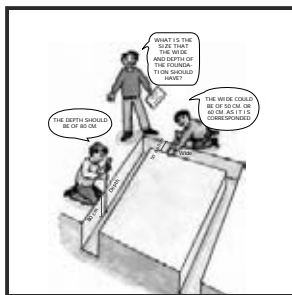


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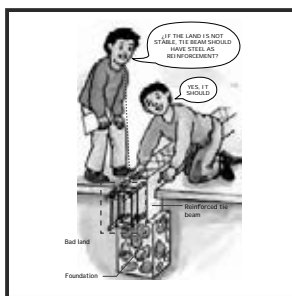
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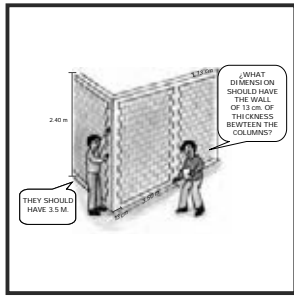
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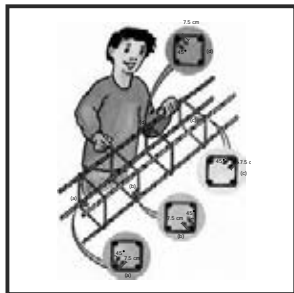


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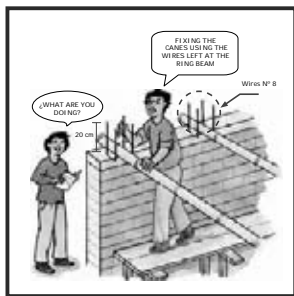
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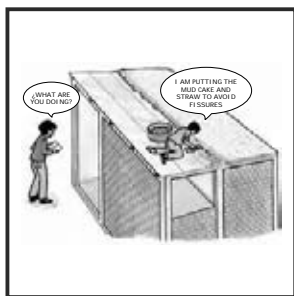
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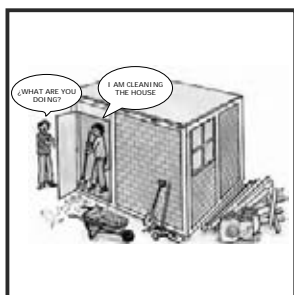
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# CHAPTER 1: General Aspects of the Manual

The Chapter 1 includes general aspects of the manual, such as objectives, manual contents, scopes, problems and limitations; and benefits and results of the manual.

## 1.1. BACKGROUND OF THE MANUAL ELABORATION

The backgrounds for the elaboration of this manual are the following:

- The majority of the families have a reduced economy and they can not contract an architect or engineer to prepare the drawings of their houses.
- For that reason at the construction period they have not the supervision of an expert.
- The majority of the housing owners can not identify the mistakes at the constructive process, because they have not the knowledge of that process.

## 1.2. MANUAL OBJECTIVES

This manual is an instrument used for the owners to inspect the construction of their housing and reduce the problems occurred in the constructive phase. This manual will help them to verify that the construction is performing according to the minimum requirements for a safer house.

## 1.3. CONTENTS OF THIS MANUAL

The manual has the minimum requirements of safer housing; these minimum requirements are showed by a Poster. This manual has also the important steps followed during the constructive stages of a housing using illustrations and pictures.

## 1.4. SCOPES OF THIS MANUAL

This manual is for the owners who usually ignore the constructive process of housing. This manual shows in a simple and graphic way the phase or moment when the owners have to pay more attention in order to have a safer housing.

## 1.5. BENEFITS OF THE USE OF THIS MANUAL

This manual will reduce the mistakes that will occur during the constructive phases because they are based at the minimum requirements and also the owner can watch the construction of their own housing.

## 1.6. REGISTRY OF THE WATCHING

At the inferior central part of each page it is possible to record if the process of watching was made during the described construction phase.

## CHAPTER 2: Minimum requirements for safer housing

The following items describes the more important aspects of the structural design, construction and inspection of a confined masonry house. The chapter has:

### 1. Quality of the materials

#### 1.1. Concrete

- a) Mixture design for reinforced tie beam is one (1) portion of Portland cement, two (2) portions of clean coarse sand, four (4) portions of crushed stone (the size is less than 1/2") and one (1) portion of clean and drinkable water. Mixture design for non reinforced tie beam is one (1) portion of Portland cement, eight (8) portions of hormigon, two and half (2.5) portions of medium stones (the size is maximum 4") and one and quarter (1.25) portions of clean and drinkable water.

Mixture design for confined columns, ring beams and light slab is one (1) portion of Portland cement, two (2) portions of clean coarse sand, three (3) portions of clean crushed stone (the size is less than 1/2") and one (1) portion of clean and drinkable water.

In case of salty soil for foundation, vinyl sheet is used to prevent salt damage of concrete.

- b) Materials are well mixed where the aggregate is not visible and poured to form work immediately.  
c) Form work is hard and no bleeding.  
d) Any gaps and void is avoided by using a stick to compact concrete when it is pouring.

#### 1.2. Mortar

Mixture design is one (1) portion of Portland cement and four (4) portions of clean coarse sand.

#### 1.3. Foundation

Mixture design for foundation is one (1) portion of Portland cement, ten (10) portions of hormigon, one and half (1.5) portions of clean and drinkable water and three (3) portions of

large stones (the size is maximum 10")  
Hormigon is composed of gravel and coarse sand directly obtained from quarry place

#### **1.4. Wood**

Wood is hard, dry, dense fiber, well cured, no crack and straight.

#### **1.5. Brick**

Brick is burned and orange color without white pale shadow. Brick is also dust free, without cracks or bending.

#### **1.6. Water**

Water is clean and drinkable.

### **2. Structural Section of Main Members**

Wall of confined masonry house is enclosed firmly with reinforced concrete tie beam, reinforced concrete column and reinforced concrete ring beam on a stable foundation with enough strength. Every vertical part of wall corner is firmly connected, forming confined elements.

#### **2.1. Foundation**

Foundation width and height is 60 cm or more. In case of the foundation without loads from small beams of roofing, the width of foundation can be 50 cm. Foundation depth is no less than 80 cm.

#### **2.2. Sections of reinforced concrete member**

- a) Tie beam width is 13 cm or 24 cm according to the width of the wall. The minimum height is 50 cm. Tie beam is reinforced with four (4) steel bars of 3/8" diameter, with stirrups of 1/4" diameter at 20 cm intervals. If the soil is mainly composed of slime and/or sand, the tie beam is needed to be reinforced.
- b) Maximum wall area framed with tie beam, column and ring beam is 12.0 m<sup>2</sup>. The maximum height of the wall is 2.4 m.
- c) Column has a minimum section of 13 cm wide and 15 cm high, and four (4) steel bars of 3/8" diameter are placed with hoops of 1/4" diameter. Five (5) hoops are placed from the connection point with tie beam. First hoop is placed at 5 cm from the connection point. The other four (4) hoops above the first hoop are placed at 10 cm interval. Another five (5) hoops are placed from the point with ring



beam as the same case from the connection of tie beam. At the rest space of column hoops are placed at 25 cm interval.

Additionally, two (2) stirrups are placed in joint of column and ring beam at 10 cm interval. Three (3) stirrups are also placed in joint of column and tie beam at 15 cm interval.

- d) Minimum dimension of ring beam is 13 cm wide and 20 cm high, and four (4) steel bars of 3/8" diameter are placed with stirrups of 1/4" diameter. Five (5) stirrups are placed from the connection point with column. First stirrup is placed at 5 cm from the connection point. The other four (4) stirrups beside the first stirrup are placed at 10 cm interval. Another five (5) stirrups are placed from the connection point with the other column as the same case from the connection of the other above mentioned column. At the rest space of ring beam space stirrups are placed at 25 cm interval.
- e) Minimum covering depth of concrete is 2 cm for walls with finish and 3 cm for walls without finish. In case of foundation, covering depth is 7.5 cm.
- f) Minimum length of structural wall is 1.2 m.

### 2.3. Maximum span

Maximum span of columns is 5.0 m in case of 24 cm wide wall. It is 3.5 m in case of 13 cm wide wall.

## 3. Connection of Structural Members

### 3.1. Anchor of column to tie beam and ring beam

Four (4) steel bars of column anchor to the foundation. The steel bars bend 90° at 7.5 cm from the bottom of foundation. The bended steel bars are prolonged 25 cm. In case of reinforced tie beam, the steel bars of column and tie beam must be carefully tied by steel wires to ensure an adequate connection between these structural elements. In case of good soil, concrete without reinforcement is used.

In the same way, four (4) steel bars of column anchor to reinforced ring beam. The steel bars bend 90° at 2 cm from the top of ring beam. The bended steel bars are prolonged 25 cm measured from the column surface.

### **3.2. Connection of wall and column**

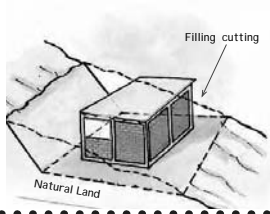
There are two connection methods. One is that joint between wall and columns is geared and the length of the salient part of brick does not exceed 5 cm. The other is that two (2) steel bars of 1/4" diameter anchor at every four (4) layers of wall bricks at least 40 cm inside masonry and 12.5 cm inside column with vertical turning of 90° at 10 cm.

### **3.3. Overlapping of reinforcements**

Steel bars of reinforced concrete overlap at least at 40 cm.

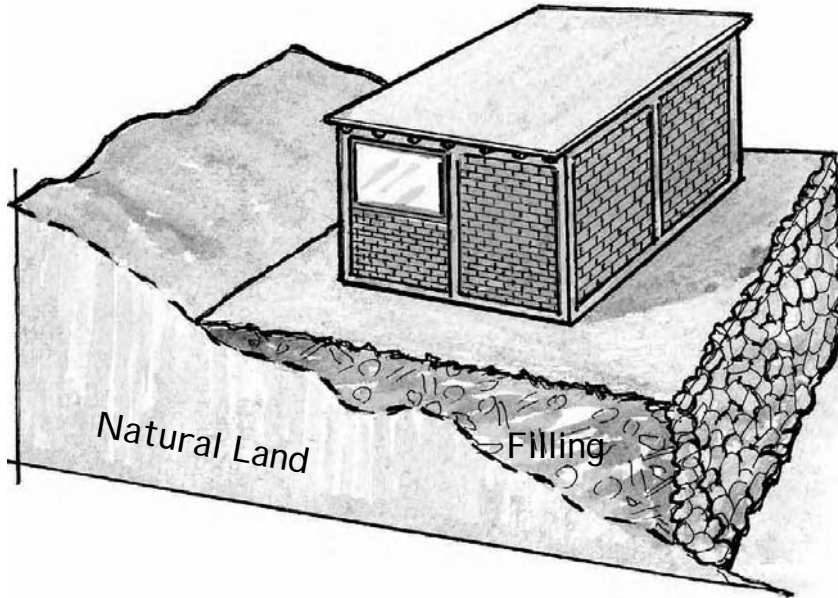
### **3.4. Wall joint mortar thickness**

Thickness of joint mortar for wall is from 1.0 to 1.5 cm. .

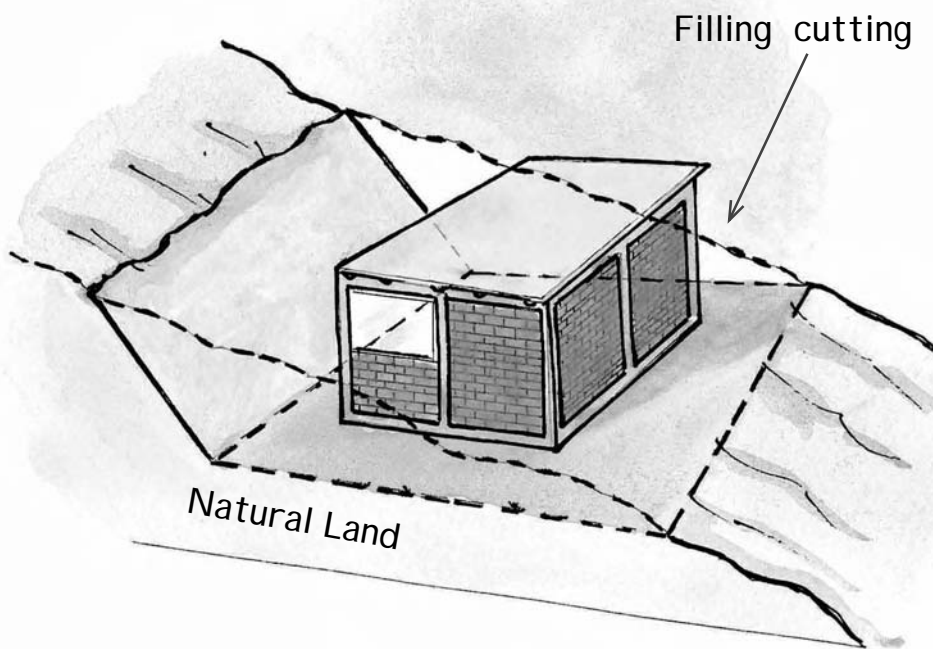


### 3.1 PRELIMINARY WORKS

3.1.1. ¿IN WHICH LAND DO YOU HAVE TO ESTABLISH YOUR HOUSING?



It is not recommended to built a house in a filling land

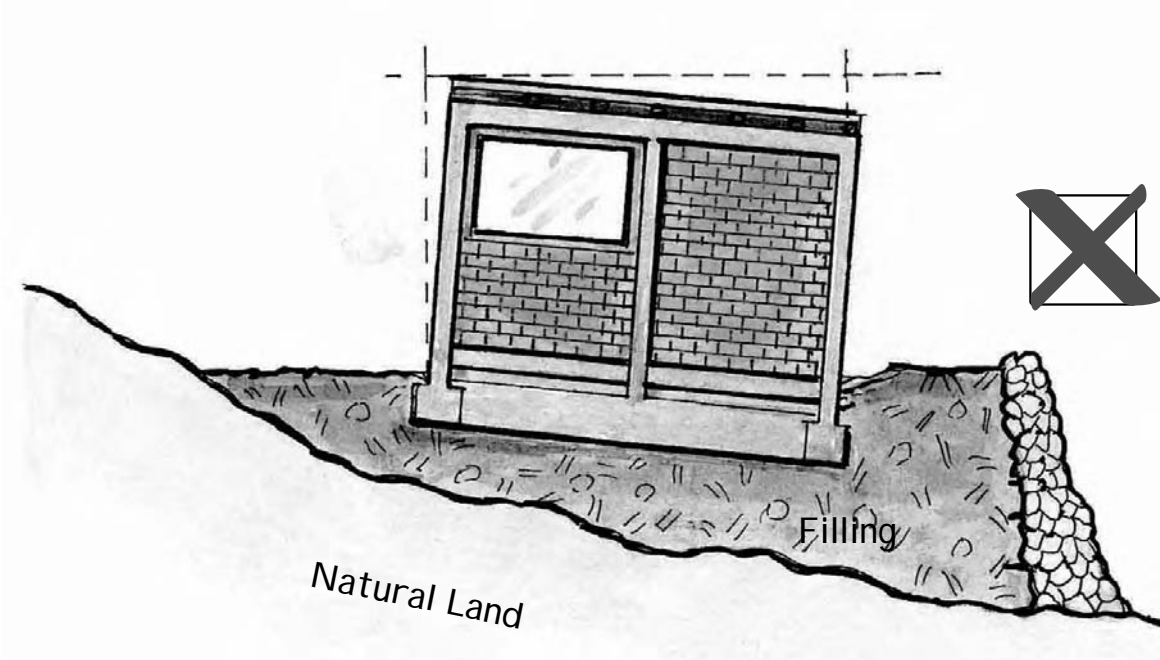


The house must be founded in a plain and stable land

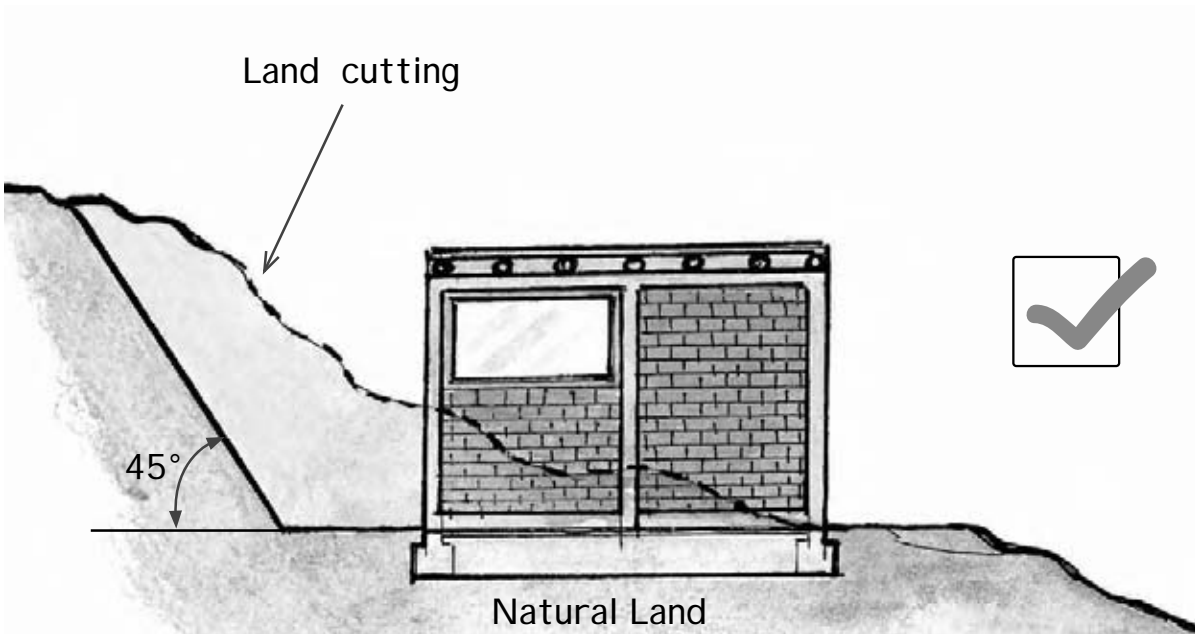
¿What is the watching result?

GOOD	BAD
------	-----

# AVOID FILLED LAND



It is not recommended to built in a filled land



If the house is founded in a stable land, it will not suffer setting and will be more stable

¿What is the watching result?

GOOD	BAD
------	-----

3-A7-17

### 3.1.2. ¿HOW SHOULD BE MY LAND BEFORE TO BUILD?



¿What is the watching result?

GOOD	BAD
------	-----



## CLEANING AND LAYING OUT OF THE LAND



It is not recommended a dirty land as it is showed in the picture



This picture shows a cut and leveled land

### 3.1.3. ¿WHAT KIND OF MATERIAL DO I HAVE TO USE?

IT IS NOT RECOMMENDED TO USE MATERIALS OF POOR QUALITY AND BAD FINISHING



¡NO!

YOU HAVE TO USE MATERIALS OF GOOD QUALITY AND FINISHING

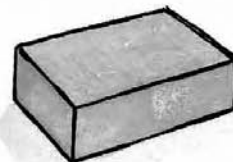


¡YES!



WITH STAINS, CRACKS, HIT

BRICK

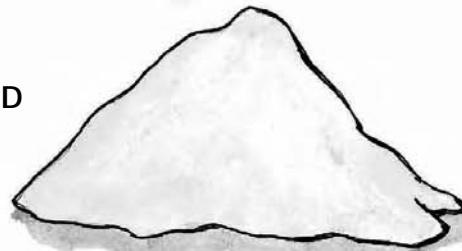


EQUAL COLOR, UNIFORM, SAME SIZE

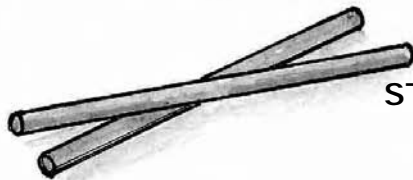


DIRTY WITH GARBAGE

SAND

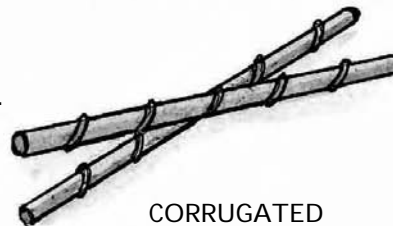


CLEAN, UNIFORM COLOR



PLAIN

STEEL



CORRUGATED



See minimum requirements at the section 1.5 of the Poster

¿What is the watching result?

GOOD	BAD
------	-----

## EXAMPLES OF APPROPRIATE MATERIALS



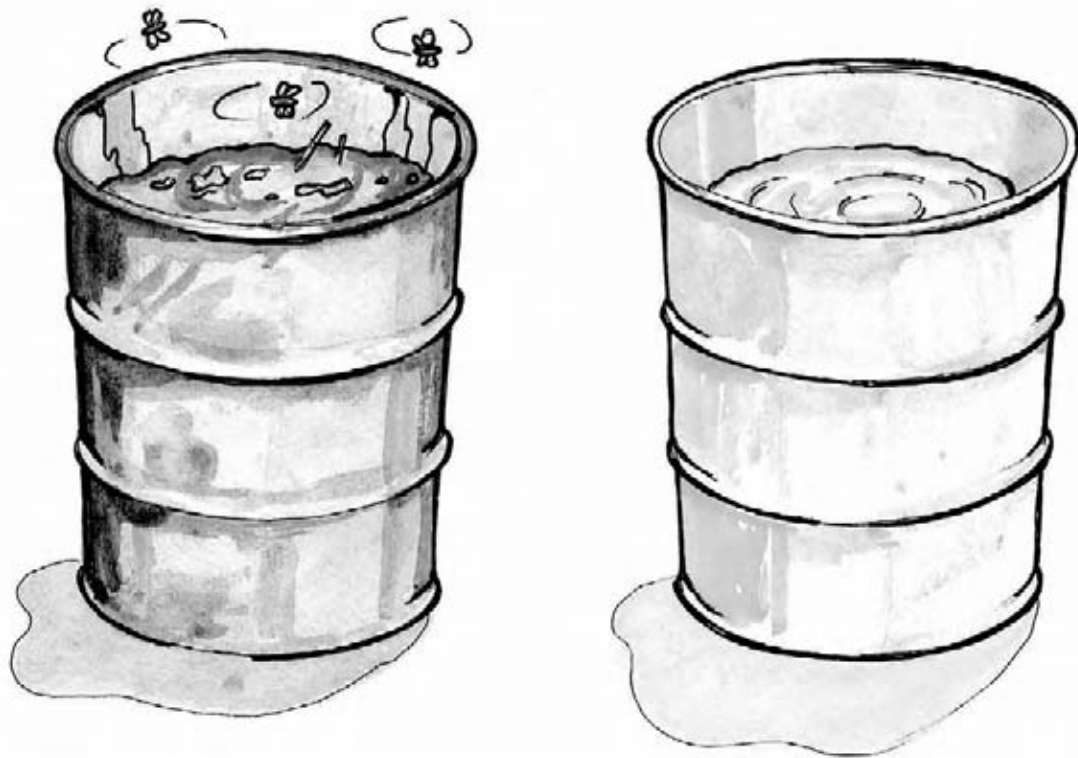
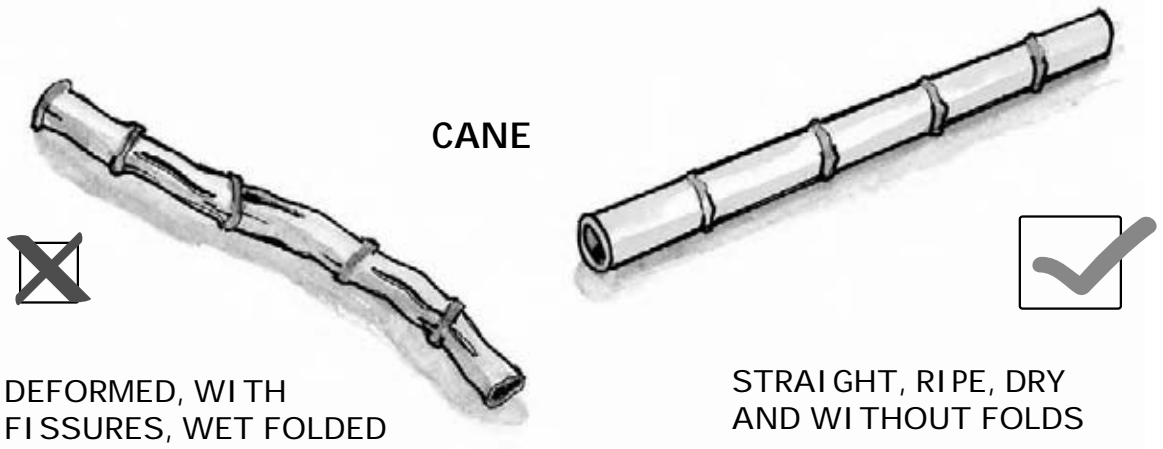
This picture shows a good quality and clean land



Clean crushed stone



## SELECTION OF THE MATERIALS



**¡NO!**

**¡YES!**

See minimum requirements at the section 1.5 of the Poster

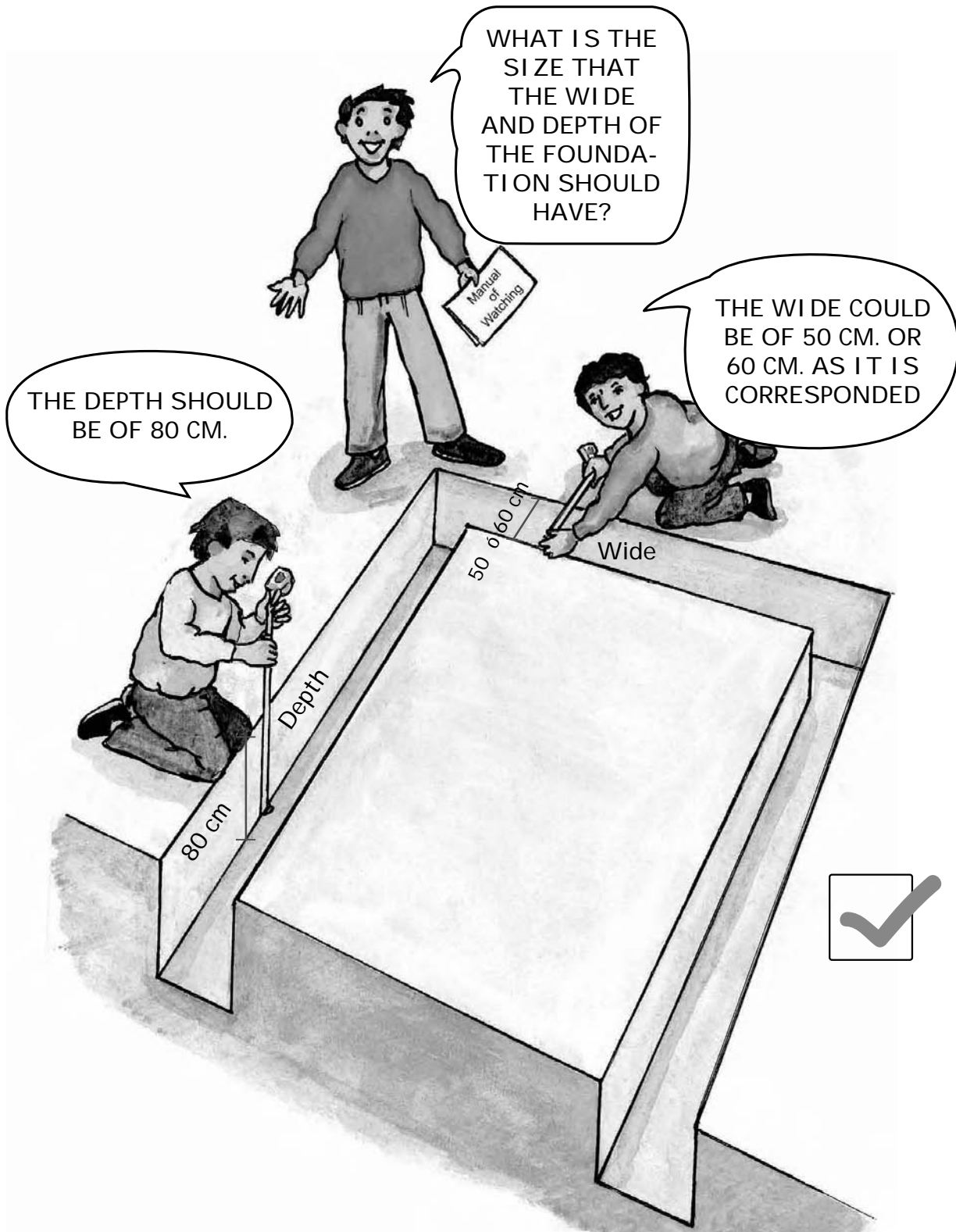
¿What is the watching result?

GOOD	BAD
------	-----





## 3.2 EXCAVATION WORKS



See minimum requirements at the section 2.1 of the Poster

¿What is the watching result?

GOOD	BAD
------	-----

3-A7-23



## EXCAVATION OF THE FOUNDATIONS



Once you make the line of your foundation you should to verify the wide and height of it



The foundation should be straight as it is shown