Program 7

Disaster Resistance Buildings

Proposer: Eliza ALIAS

- **Objectives: a) Introducing, exposing and describing different technologies and types of building designs that are disaster-resistant**
  b) Developing creativity and ambition among school children
- **Target: High school students**
- **Type: Illustrated short book**

Summary

This short illustrated book describes building technologies and methods to resist different kinds of natural disasters. Most of the technologies were obtained from the Disaster Reduction Hyper base. These technologies include houses with used tires, stilt and uplifted houses, the Casbah of Algiers, structural retrofitting and bamboo T-shelter.

Hopefully, this book would broaden the knowledge of school children as well as develop their creativity and ambition.

References

Disaster Reduction Hyper base,
http://drh.edm.bosai.go.jp

DRH id below:
DRH 64, DRH 16, DRH 11, DRH 18, DRH 8, DRH 17, DRH 40, DRH 41

INTRODUCTION

Disasters such as earthquakes, tsunamis , storm surges and floods are natural phenomena that sometimes could not be avoided. Thus, one way that we can do is try to resist it when it comes, for example living in disaster resistant building. This short illustrated book describes building technologies and methods in resisting different kinds of natural disasters. It aims to exposed young students especially high school students to various building design and technologies related to disasters. Whether the method of resistance is structural or non-structural, or a building recommended for post disasters, they all play significant roles during disasters. Thus, they are all presented in the book.

Most of the technologies shown are obtained from the Disaster Reduction Hyper base and could be refer in the following website http://drh.edm.bosai.go.jp/ . Information on the construction details of each building technologies are only estimation and are recommended not to be used for other purposes. More information for each technology should be refer directly to the researcher of each building technology. Information of the researchers are included in the website.

It is hope that this book would broaden the knowledge of building technologies especially in term of civil engineering and architecture among school students. It is also hope that it would generate creativity and ambition among them.

Author,
Nor Eliza Alias
Doctoral Student,
Department of Civil and Earth Resources Engineering
Kyoto University
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HOUSES WITH USED TIRES

Used tires can be built into house foundations to work as base isolators. It is also called as The "Elephant foot on tire" concept where it is based on low cost construction principles and suitable for small scale housing. In the bottom of the foundation ditches round river stones work as roller bearings. The tires slide on top in an earth quake and help also to absorb the vertical ground movements. Even though the estimation of the total cost house was not given, the cost of the technology has been mentioned to be very low and could be zero since all the materials used are from recycled items.

RESISTANCE AGAINST

EARTHQUAKE

CONSTRUCTION DETAILS (Estimated)

The construction costs of the technology is zero

Used Tires

- Waste products which do not have any particular value (Free). Great for recycling
- Allow vertical movements during earthquake

Round river stones

- Works as roller bearings. Allowing horizontal movements during earthquake

What is this?

Foundations The lowest and supporting layer of a structure . It transfers and spread the load of a building to the ground.

Base isolators A structural elements which decouple a structure from its substructure resting on a shaking ground thus protecting a building or non-building structure's integrity

Roller bearings A round element which decreases friction

Researcher : Ingemar Sävfors

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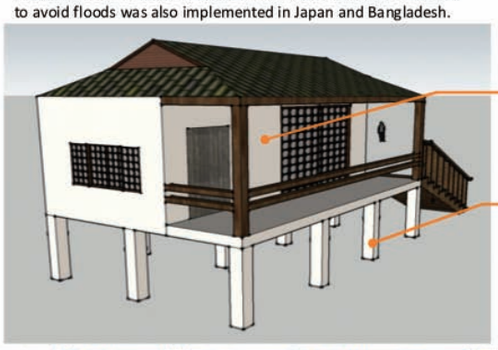
STILT AND UPLIFTED HOUSES

The mechanism of stilt house building technology is simple: raise the house to a higher level and leave spaces for flood flowing through. The stilt house building technology, an indigenous knowledge in West Hunan Province, China, has been verified by its history of more than 1,000 years. It has also been developed into new forms and applied in modern concrete buildings. Stilt houses could also be found in Malaysia (traditional wooden house) and in coastal areas in Florida, United State. Houses that were uplifted to avoid floods was also implemented in Japan and Bangladesh.



RESISTANCE AGAINST

STORM SURGE, FLASH FLOODS, FLOOD

CONSTRUCTION DETAILS (Estimated)		
CONSTRUCTION COSTS	:	600 - 2000 USD
CONSTRUCTION PERIOD	:	1-2 Months
MAN POWER	:	20 - 30 men

Material
- Traditional stilt house are made from wood however modern concrete stilt house are build now.

Stilt
- The house is raised above the ground to leave spaces for flood.

Uplifted houses

What is this?

Stilt Stilt are poles, posts or pillars used to allow a structure to stand at a distance above the ground.

Researcher : Dr. Weihua Fang,(China), Yukiko Takeuchi (Japan), Muhammad Saidur Rahman (Bangladesh)

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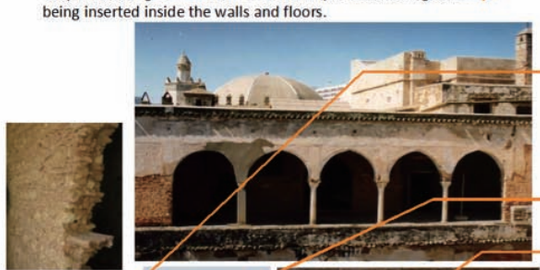
THE CASBAH OF ALGIERS

The Casbah of Algiers, which was rebuilt after the Algiers 1716 earthquake by the Ottoman, is classified as a world cultural heritage by UNESCO . These traditional earthquake-resistant building techniques have played a great role in protecting the Casbah of Algiers from earthquake which affected the site of Algiers during the last three centuries. Easy and cheap to put in place. These techniques have had the time to be tested during several destructive earthquakes which affected the site and thus proven their efficacy in reducing seismic risk. The technique includes logs of thuya being inserted inside the walls and floors.



RESISTANCE AGAINST

EARTHQUAKE

CONSTRUCTION DETAILS (Estimated)

The construction was built in the 1520's by the government during those time. Workmanship was by inhabitants living in Algeria.

Wall
- The bricks masonry walls reinforced by logs of thuya insert in all the depth of the wall .

Linked masonry walls

Floors
- The floors are constitute by a superposition of logs of thuya which are inserted in all the width of the wall, allowing movement by rolling during earthquake

What is this?

Thuya A kind of log (tree bark) used as a reinforcement for buildings for ancient buildings in Algeria.

Seismic Activities related to earthquake

Researcher : Dr. Amina Aicha Abdessemed-

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STRUCTURAL RETROFITTING

Retrofitting are applied on structural members of building. These include windows, walls, columns and roof of buildings. In Japan, retrofitting were implemented on school buildings as part of the methods to secure the safety of school children during disasters. The retrofitted school buildings also act as emergency evacuation facilities for local communities. A detail explanation on retrofitting of school buildings in Japan are described in the following website.
http://www.nier.go.jp/shisetsu/pdf/e-taishinjirei.pdf

RESISTANCE AGAINST

EARTHQUAKE, TROPICAL CYCLONES, TORNADOES, THUNDERSTORMS

CONSTRUCTION DETAILS (Estimated)	
CONSTRUCTION COSTS :	0.1 - 5million USD
CONSTRUCTION PERIOD :	3 - 8 months

Retrofitting of roof
- Bracings are installed along the entire ceiling to increase rigidity of the roof.

Retrofitting of walls
- Meshes of steel were installed to form reinforced concrete shear walls

Retrofitting of windows
- Installing steel bracings on windows or between column

What is this?

Retrofitting: Addition of new technology or features to older systems
Shear walls: In structural engineering, a shear wall is a wall composed of braced panels (also known as shear panels) to counter the effects of earthquake and wind load acting on a structure.
Steel bracings: Is a form of reinforcement and usually in an X-shaped that pushes the floor and ceiling against one another to increase the stability of a structure.

Researcher : Takayuki Nakamura

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NON-STRUCTURAL RETROFITTING

Besides building design or structural engineering method , retrofitting non-structural members of buildings could also help in reducing the impact of disasters. Examples of non-structural members in buildings are ceiling material, window and windowpane, exterior wall, lighting fixture, air conditioner and heating unit, bookshelf, storage shelves and gymnasium equipment. Detail explanation on non-structural retrofitting are described in the following website
http://www.nier.go.jp/shisetsu/pdf/e-jirei.pdf.

RESISTANCE AGAINST

EARTHQUAKE, TROPICAL CYCLONES, TORNADOES, THUNDERSTORMS

Retrofitting of bookshelves
- Bookshelves are fixed to sturdy wall, beam, or ceiling with metal brackets

Retrofitting of air conditioner

Without retrofitting
- Overturning of bookshelves by the seismic motion

What is this?

Retrofitting: Addition of new technology or features to older systems
Seismic: Activities related to earthquake

Researcher : Takayuki Nakamura

BAMBOO T-SHELTER

Bamboo T-shelter is a semi-permanent , easy construction and an inexpensive house which could be built by local people who lost their homes after a disaster. The house was design and targeted for the survivors of Jawa 2007 earthquake. It does not require special skill to build it. Sufficient strength for a permanent house can be expected. However, connecting the bamboo columns by ropes requires proper care to ensure sufficient strength of the house when it is built . This bamboo T-shelter was officially employed by the Yogyakarta local government and reported in a local newspaper .

FUNCTION

POST DISASTER RECONSTRUCTION

CONSTRUCTION DETAILS (Estimated)	
CONSTRUCTION COSTS :	Less 300 USD
CONSTRUCTION PERIOD :	2 - 3 days
MAN POWER :	1 - 2 men

Materials

- The house is made by bamboo which is easy to find in Java, Indonesia.

Technique

- Connecting the bamboo columns by ropes requires proper technique to ensure sufficient strength.

What is this?

Bamboo Bamboos are some of the fastest growing plants in the world, as some species have been recorded as growing up to 100 cm (39 in) within a 24 hour period. Bamboos are of notable economic and cultural significance in South Asia, South East Asia and East Asia, being used for building materials, and as a food source.

Researcher : Professor Atsushi Iizuka

APPENDICES

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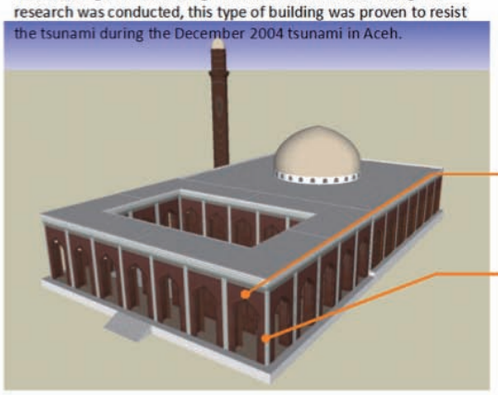
PILLARS AND ARCHES

Mosques is one example of a building that is usually designed with pillars, domes and open arches. This allowed tsunami waves to traverse the space without causing any damage to the building. The pillars also act as an energy dissipater against the hydraulic forces acting on the building from the tsunami. Even though no research was conducted, this type of building was proven to resist the tsunami during the December 2004 tsunami in Aceh.



RESISTANCE AGAINST

TSUNAMI

CONSTRUCTION DETAILS (Estimated)		
CONSTRUCTION COSTS	:	Millions USD
CONSTRUCTION PERIOD	:	1-2 Years
MAN POWER	:	20 - 100 men

Open Arches
- Allow tsunami waves to flow trough the spaces

Pillars
- Act as an energy dissi-pater against tsunami

What is this?

Pillars A column or pillar in architecture and structural engineering is a vertical structural element that transmits the weight of the structure above to other structural elements below

Arches A curved structure capable of spanning a space while supporting significant weight

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11 MARCH 2011 TSUNAMI

Pictures below are the courtesy of Negishi (negishi@bosai.go.jp) and his family. They were taken after the tsunami hits Ofunato City and Rikuzen-takata City of Iwate, Japan.

Destroyed building near coast hit by tsunami

Prefectural road No. 230 (about 100m from the coast). A fishing boat is in the house.

There were houses and stores there before March 11, 2011.

City estate. The tsunami was coming up to the 4th floor.

Japan Railway Ofunato line and residental area near Ofunato Port.

The tsunami reached up to the second floor of the building. Protrudes are seen in the second floor.