7. フィリピンにおけるセミナー

(1)概要

① 日時:2019 年 1 月 24 日(木)9:00－15:00

② 場所:公共事業道路省 5 階多目的ホール(マニラ市)

③ 参加者:合計 71 名

参加者リスト記載者(別添参加者リスト参照) 63 名

主要機関 公共事業道路省 設計局、研究・基準局、建設局など

NHA(国家住宅庁)

ASEP(構造技術者協会)

Allied(コンクリートブロックメーカー)

Pacific Consultants(コンサルタント)

Tiger Machine(ブロック製造機械メーカー)

PHIVOLCS (火山地震研究所)

日系ゼネコンA社

JICA フィリピン事務所

JICA 長期専門家

北海道建築技術協会関係者 8 名

ミッション 7 名(石山、米澤、青野、楢府、今井、北原、滝口)

現地参加 仙木

④ 次第

(1)開会宣言、国家斉唱

(2)「安全なコンクリートホローブロック造」プロジェクトの背景、目的及び概要

北海道建築技術協会 会長:石山祐二、同会員:楢府龍雄

(3)フィリピンのブロック造の災害に対する脆弱性

北海道建築技術協会/国際協力機構:楢府龍雄

(4)フィリピンのブロック造に関する調査及び構造実験の概要

北海道建築技術協会/毛利建築設計事務所:今井弘

(5)日本の耐震構造技術の歴史と被害地震

北海道建築技術協会会長:石山祐二

(6)日本におけるコンクリートブロック構造の導入と発展

タイガーマシン製作所:北原英明

(7)北海道におけるコンクリートブロック造の活用

北海道建築技術協会/株式会社よねざわ工業:米澤稔

(8) 日本のコンクリートブロック製造プロセスの紹介（ビデオ映像）

北海道建築技術協会／㈱チヨダマシナリー：青野洋之

タイガーマシン製作所：　　　　　　仙木邦好

(9) 日比のコンクリートブロックの比較（ブロックの実物とカットサンプルの説明）

北海道建築技術協会／㈱チヨダマシナリー：青野洋之

タイガーマシン製作所：　　　　　　仙木邦好

(10) 日本のコンクリートブロック積作業の実例（ビデオ映像）

北海道建築技術協会／国際協力機構：楢府龍雄

(11) 日本とフィリピンのコンクリートブロック構造の主要な違い

北海道建築技術協会／国際協力機構：楢府龍雄

(12) 日本の耐震構造基準の概要

北海道建築技術協会　会長：石山祐二

⑤ 概要：

＜参加者について＞

・フィリピンでは、コンクリートブロックが最も広く使われている建築材料であるが（他では、レンガが広く使われている国が多いが、フィリピンではレンガはほとんど見られない）、極めて低品質で災害により酷い被害を受けている。その被害軽減のための取組には公共事業道路省（DPWH）の多くの部局の連携が必要なことから、公共事業道路省（担当窓口は設計局）では、関係する種々の部局に参加を呼びかけ、研究・基準局、建設局などからの参加が実現した。

・公共事業道路省が所管する公共建築物以外にも、幅広い分野での取り組みが必要とされることから、他の機関にも広く参加を呼び掛けた。主要な参加機関とその機関の本課題との関係は以下のとおり。

NHA（国家住宅庁）：低所得層向けの住宅供給を実施しており、その中ではコンクリートブロック造も相当のシェアで用いられている。

ASEP（構造技術者協会）：フィリピンのハイレベルの構造技術者による民間の専門家組織で、会員はブロック造（構造壁及び非構造壁）についての設計を実施。構造基準（NSCP National Structural Code of the Philippines　コンクリートブロック造を含む組積造についての章を有している）の作成を行っている。

Allied（コンクリートブロックメーカー）：マニラ首都圏の規模の主要なブロック製造メーカーの一つ。

PHIVOLCS（火山地震研究所）：フィリピン政府の科学・技術省（Department of Science and Technology）傘下の火山対策、地震対策を担当する研究機関。調査研究に加えて、その社会的な活用にも踏み出しており、JICA の SATREPS プロジェクト「フィリピン地震火山監視能力強化と防災情報の利活用推進」では、防災情報の利活用推進が主要コンポーネントの一つとされ、耐震構造技術の普及、住民の地震リスク認識の向上を実施している。

日系ゼネコンＡ社：日系のゼネラルコントラクターで、フィリピンで最も活発に事業展開を行っている企業。ビルの非構造壁の 7 割程度はブロック造とのこと。

Pacific Consultants（コンサルタント）：日本の国際協力を幅広く手掛けているコンサルタントであり、フィリピンでも多様なプロジェクトを実施している。

JICA：フィリピン事務所の中小企業支援担当者と公共事業省と防災庁に派遣されている専門家に参加いただいた。

＜発表内容、説明内容について＞

発表は、今回の取組の背景、目的、活動概要の紹介に続いて、フィリピンの問題点を理解してもらうため、「フィリピンのブロック造の災害に対する脆弱性」、「フィリピンのブロック造に関する調査及び構造実験の概要」の2つのプレゼンテーションを行った。

続いて「日本の耐震構造技術の歴史と被害地震」により、日本の耐震技術の概要を説明した。それに続いて、災害に対して優れた強靭性を示してきている日本の補強コンクリートの概要を理解してもらうため、「日本におけるコンクリートブロック構造の導入と発展」、「北海道におけるコンクリートブロック造の活用」を説明した。更に、理解を深めてもらうために、日本から持参したブロックの実物と現地で入手した低品質のものの比較、日本の各種のブロックのカットサンプルについて、説明を行った。次いで、ビデオ映像により、そうした品質の優れたブロックが製造される実際のプロセスと、日本の熟練したブロック積職人の建設作業を見てもらった。

最後に、ラップアップ的な位置づけで、「日本とフィリピンのコンクリートブロック構造の主要な違い」、「日本の耐震構造基準の概要」の説明を行い、セミナーを締めくくった。

＜まとめ＞

本セミナーの目的は、フィリピンでは品質の良くない脆弱な材料、工法と考えられている補強コンクリートブロック造が、適正な品質のブロックを用いて的確に建設されれば、災害に対して強靭であること、その実例として日本の技術の概要を理解してもらうことである。そのため、それぞれの専門家からの PPT による説明に加えて、実物のブロックによる比較、製造プロセル、建設プロセスをビデオで見てもらった。想定を超える幅広い分野の組織から多くの参加者を得ることができ、また、いずれの参加者も大変熱心に聴講いただき、コンクリートブロックが十分な強靭性を持ちうる構造であることを理解してもらうという本業務の目的を達成することができたと思われる。

なお、セミナー参加者には、公共事業道路省設計局第 4 課課長と北海道建築技術協会会長石山祐二の連名の、参加証明書が全員に交付された。

セミナー会場の様子

セミナー会場の様子

今井弘委員によるプレゼンテーション

石山祐二委員によるプレゼンテーション

北原英明委員によるプレゼンテーション

米澤稔委員によるプレゼンテーション
左は、PC 操作のサポートの今井委員

日本から持参したコンクリートブロックと各種のカットサンプルの展示

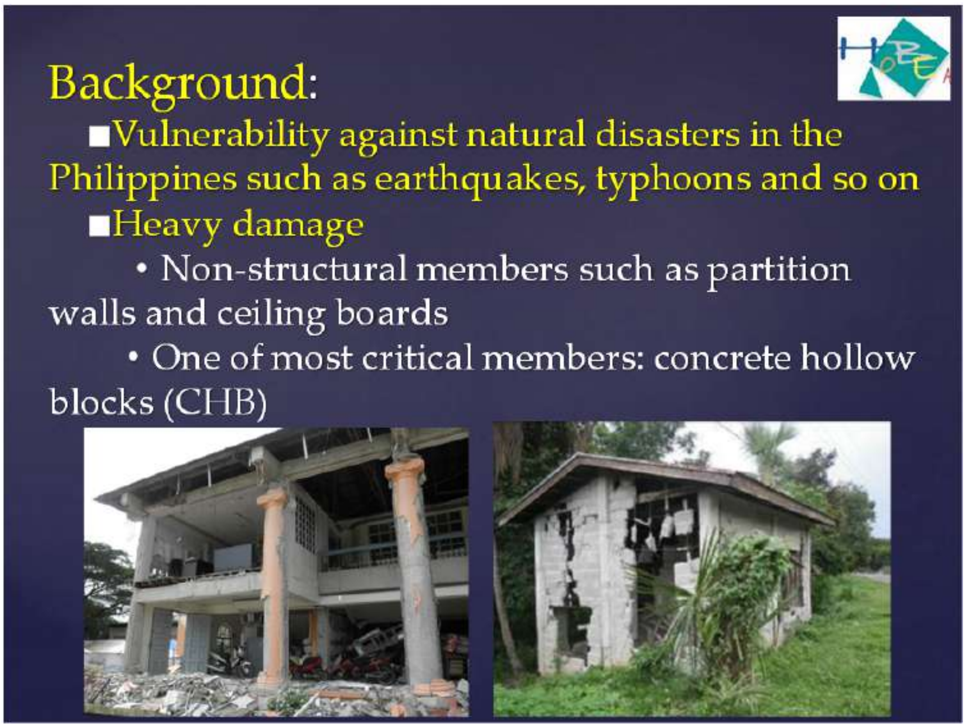
日本製のブロック（右）とフィリピンの小規模メーカーのブロック（左）
左は、手で触れただけで崩れたり、破損し破片が飛び散る。

仙木氏による説明を聞くセミナー参加者

（２）プレゼンテーションの概要

①「安全なコンクリートホローブロック造」プロジェクトの背景、目的及び概要

北海道建築技術協会　会長：石山祐二、同会員：槍府龍雄



Background:

■ Concrete hollow block structure is also widely applied in Japan

■ It shows very good performance against natural disaster similar to reinforced concrete (RC) structure

Objective:

■ To better understanding on safe concrete hollow block (CHB) structure in the Philippines by introduction of CHB technology in Japan to enhance safety of CHB structures in the Philippines

■ To create proposals for future collaboration for safer CHB in the Philippines through discussion with stakeholders in governments, engineers, private companies, NGOs and others

Major activities:

- 2019 January: Kick-off seminar in Manila
  Discussion with relevant organizations and technical surveys in the Philippines
- Fiscal year 2019/2020 (April 2019 – March 2020) (to be proposed)
  - Discussion on possible future activities with various stakeholders
  - Technical visits of CHB relating sites in Japan and discussion on future activities with leading persons from the Philippines
  - Creation of proposals on future activities and their application
  - Wrap-up seminar in the Philippines

Hokkaido Building Engineering Association (HoBEA)

Yuji Ishiyama,
President of HoBEA

Objective:

HoBEA develops building engineering, disseminates information and educate engineers in order to improve and upgrade quality, comfortability and durability of buildings in Hokkaido.

History:

1952 Hokkaido Concrete Block Association
1953 Approved by Hokkaido Pref. Government
1995 Hokkaido Masonry Building Association
2004 Hokkaido Building Engineering Association (HoBEA)
2012 Cerebrated 60 year Anniversary

Main activities:

■Five Research groups

1) Research group of masonry buildings
2) Research group of external insulation
3) Research group of building inspection
4) Research group of wood based buildings
5) Research group of environment, equipment and energy

■Various Business

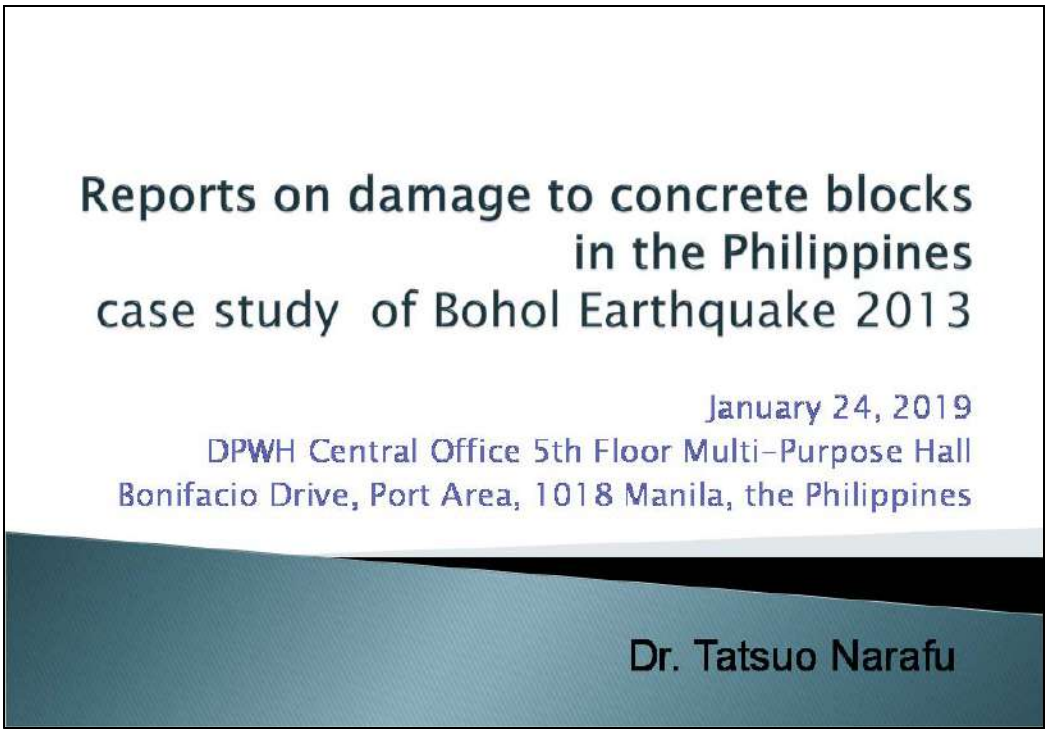
1) Entrusted research from governmental and private organizations
2) Certification of Building Insulation Specialists and Housing Inspectors
3) Training programs and seminars

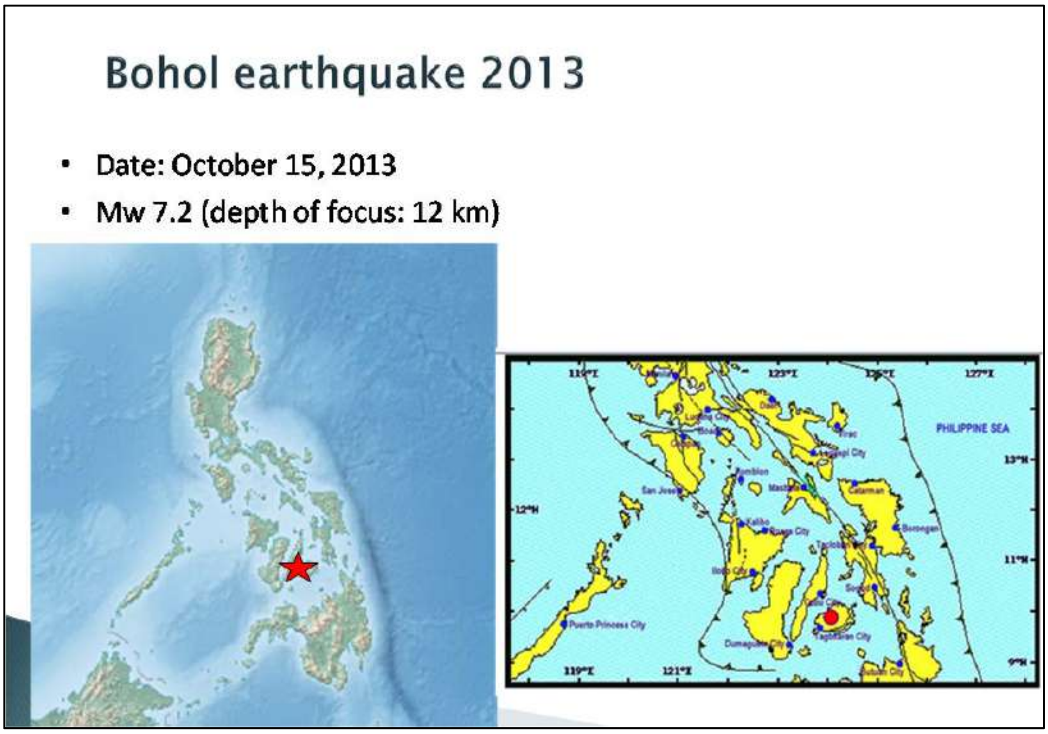
Members:

- Individual members (133)
  - Researchers of universities, research institutes, etc.
  - Engineers of governmental organizations
  - Engineers of private firms
- Corporation members (66)
  - Design firms
  - Construction companies
  - Manufacturers of materials and/or equipment

②フィリピンのブロック造の災害に対する脆弱性

北海道建築技術協会／国際協力機構：楢府龍雄





Damage

- Death: 222 people
- Missing: 8 people
- Injured: 796 people
- totally damaged houses: 13,429
- partially damaged houses: 53,683

(NDRRMC update SitRep No. 33 issued on October 31, 2013)

Example to Municipal office of Antequera

No damage in structural members
Serious damages in **non-structural walls and ceiling boards** on the second floor

Examples of to Municipal Office of Catigbian

non structural walls

-Poor/insufficient quality of concrete hollow blocks
- insufficient compaction of mortal in bonds and hollows
- improper connection of rebar

List of heavily damaged RC buildings

Huge damage to non-structural members

- Non-structural walls like shelter walls and partition walls
- Ceiling boards
- Other members such as gutter for rainwater, ornaments, etc.

Municiparity	buildings	Use	Damages			
			Structure	Non-stractural walls	Ceilings	Others
Tagbilaran	Municiparity office	x	Slight	Slight	Medium	Medium
	University Hospital	x	-	Medium	Heavy	
	School of nursing	x	-	Extreme	Heavy (most fel down)	Slight
Sagbayan	Municipal office	x	Medium	Extreme	Heavy	Extreme
	District Health care center	x	Medium (damage in beam, cracks in columns)	Medium	Heavy	
	School	x	Slight	Slight	No ceilign boards	
Catigbian	Municipal office	x	Medium (damage in columns)	Extreme	Medium	
Loon	Market building	x	Medium (failure in beams, etc.)	Extreme	Extreme	Extreme
	Hospital building 1	x	-	Heavy (most fell down)	Medium	
	Hospiral building 2	x	Slight	Extreme	Extreme	
	Hospiral building 3	x	Slight	Extreme	Extreme	Heavy
Antequera	Municipal office building 1	x	Slight	Medium	Extreme	Heavy
	Municipan builiding 2	50%	-	Medium	Medium (2nd fl)	
	Barangay office	10%	Heavy (2nd fl Tilted)	Extreme	Extreme	
	District Health care center	20%	-	Medium	Medium	

Structural members
(Columns and beams)

Municipal Government
Office of Sagbayan

- Un-continuous type of beam

Structural members
Columns and beams
Market building of Loon

- Small dimension of panels (crossing part of beams and columns)
- No hoops in the panels

Small detached house

Reinforced concrete hollow block house

- Heavy damage because of poor quality of block, insufficient compaction of mortar and poor quality and improper connection of rebar

Small detached house

Non-reinforced concrete block house

- Separation of walls at corner caused the collapse of the house, which is one of most vulnerable part of masonry structures

Summary of huge damage by Bohol EQ

・Shaking motion is far smaller than the one NSCP assumes

・heavy damage to non-structural members such as shelter walls, partition walls, ceilings, ornaments.

・Improper structural design and poor construction practice caused serious damage

・In reinforced concrete structure, damage to concrete block wall is one of the most serious ones

・Small detached houses also suffered seriously because of very vulnerable concrete block walls

・Concrete block structure is one of most urgent issues to be improved in the Philippines

Identified problems

Poor quality of concrete block manufactured by small/family industry with poor quality control

Poor ratio of cement, no curing after casting and so on

Identified problems

Poor impaction of filler mortar, not connected together well and broken into pieces

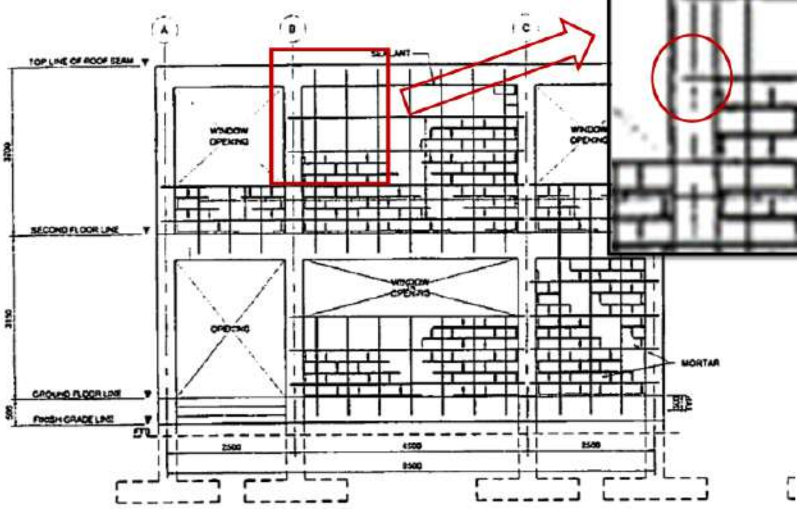
Identified problems

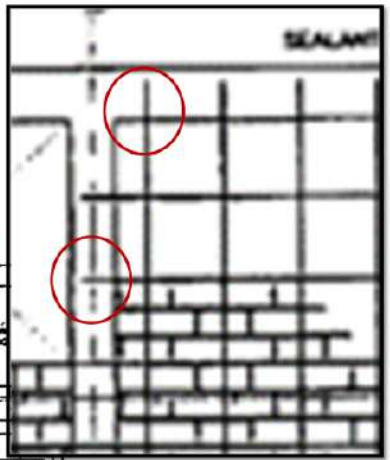
Inappropriate connection/anchor of CHB walls to structural members

(CHB in Market in Loon)

Identified problems

Design drawing of connection/anchor





Policy of Japanese government on reinforced concrete block structure

- Japanese government took a policy to develop technologies for reinforced concrete block structure and encourage to construct them as a non-flammable structure with reasonable cost
- Those housed showed good performance against disasters such as earth quake and fire
- At this moment remaining governmental rental houses of RCB:
  about 260,000 units

③フィリピンのブロック造に関する調査及び構造実験の概要

北海道建築技術協会／毛利建築設計事務所：今井弘

Full Scale Shaking Table Test

Though "FULL SCALE SHAKING TABLE TEST OF PHILIPPINE CHB MASONRY HOUSES" as comparison study, we figure out behavior during earthquake, and seismic performance of ordinary houses.

For the dissemination of Earthquake safe houses in the Philippines, we are planning to develop Simple Seismic Evaluation method and Awareness tools in the project.

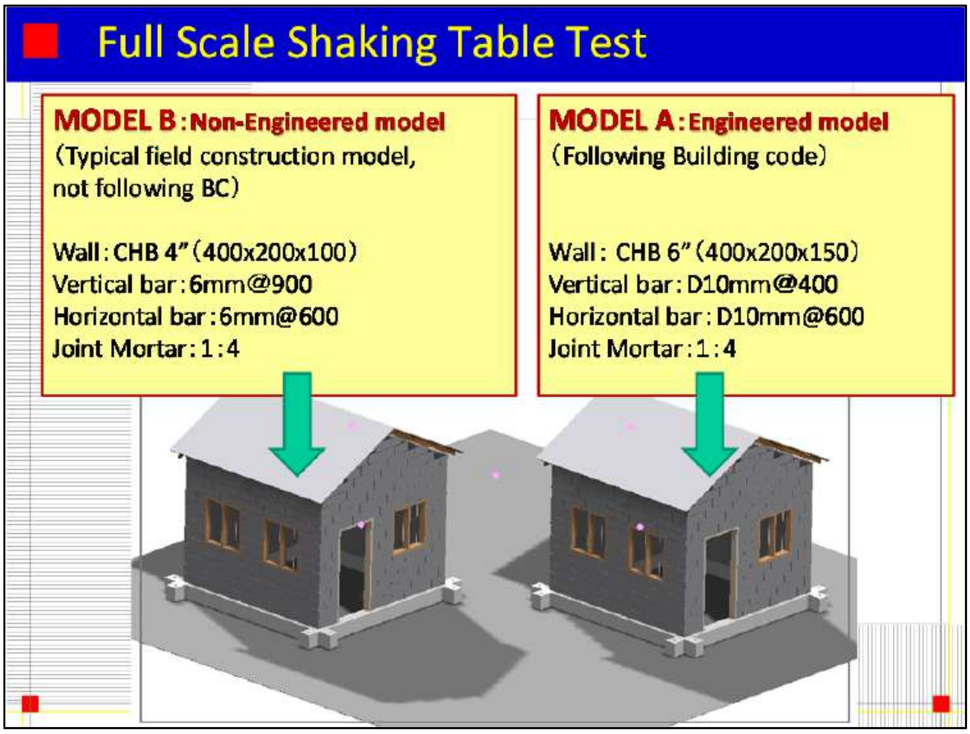
Full Scale Shaking Table Test

MODEL B : Non-Engineered model
(Typical field construction model, not following BC)

Wall : CHB 4" (400x200x100)
Vertical bar : 6mm@900
Horizontal bar : 6mm@600
Joint Mortar : 1 : 4

MODEL A : Engineered model
(Following Building code)

Wall : CHB 6" (400x200x150)
Vertical bar : D10mm@400
Horizontal bar : D10mm@600
Joint Mortar : 1 : 4


Full Scale Shaking Table Test
MODEL B : Non-Engineered model
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Wall : CHB 4" (400x200x100)
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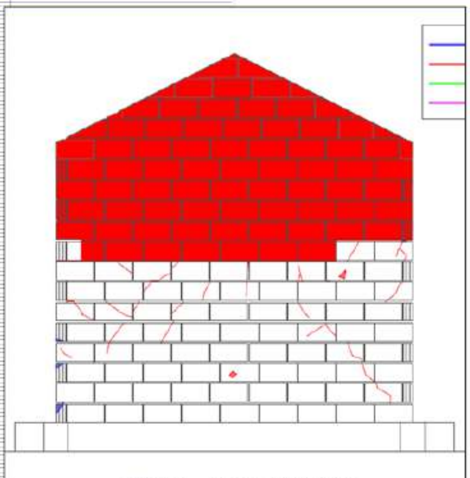
MODEL A : Engineered model
(Following Building code)
Wall : CHB 6" (400x200x150)
Vertical bar : D10mm@400
Horizontal bar : D10mm@600
Joint Mortar : 1 : 4

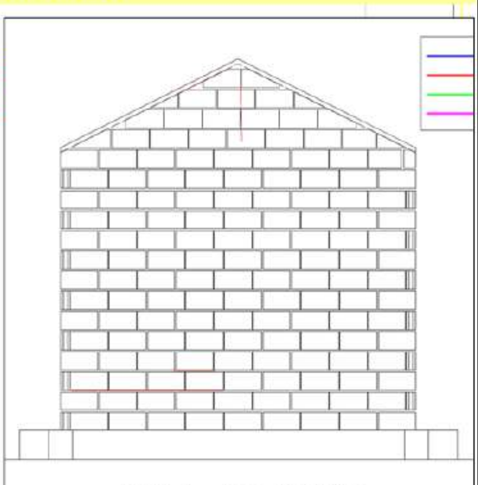

INPUT No'12 JMA Kobe 110%
Input No'12 JMA Kobe 110%
Video from inside B

INPUT No'7 Crack Drawings

West Elevation



MODEL B



MODEL A

Elemental Study of CHB

◆ Compressive strength of Full Block

Specimens		Maximum Load (kN)	Compressive Strength(N/mm^2)	Avg. of the Compressive Strength(N/mm^2)
Philippine CHB	4"	24	1.0	1.0
	6"	33	1.0	
Japanese Concrete Block	Type B-10mm	284	11.6	12.0
	Type B-15mm	423	12.9	
	Type C-10mm	476	20.6	19.7
	Type C-15mm	563	18.7	

◆ Compressive strength of Cut CHB

Specimens		Maximum Load (kN)	Compressive Strength(N/mm2)	Avg. of the Compressive Strength(N/mm2)
Philippine CHB	4"	0.6	0.9	1.5
	6"	1.1	1.7	
Japanese Concrete Block	Type B–10mm	7.6	12.8	15.9
	Type B–15mm	14.8	19.0	
	Type C–10mm	11.0	25.4	23.6
	type C–15mm	13.1	20.8	

◆ Water absorption and Air density

Specimens	Philippine CHB	Japanese Concrete Block	
		Type–B	Type–C
Water absorption rate [%]	17.6	11.5	6.6
Dry air density [g/cm^3]	1.6	1.7	2.2

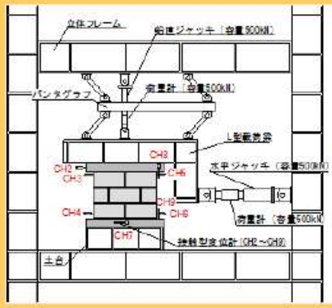
8

Shear strength CHB masonry Prism – wall unit

6 inch (150mm)		Longitudinal bar D10	Longitudinal bar D6	Longitudinal bar none
Mortar	1:4	6"-4-D10 ○ (Model A of Feb 2011)	6"-4-D6 ○	6"-4-N ○、△
Mortar	1:8	6" 8 D10 ○		
Mortar	1:4 Bad fill	6" 4N D10 ○		6" 4N-N ○、△

→ Effectiveness of Steel bar

↓ Effectiveness of mortal and proper construction



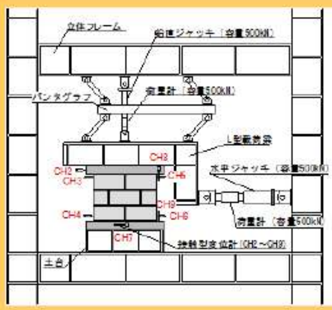
4インチ (100mm)		Longitudinal bar) D10	Longitudinal bar) D6	Longitudinal bar) none
Mortar	1:4	4"-4-D10 ○	4"-4-D6 ○	4"-4-N ○、△
Mortar	1:8			
Mortar	1:4 Bad fill		4" 4N D6 ○ (Model B of Feb 2011)	4" 4N-N ○、△

Shear strength CHB masonry Prism – wall unit

6 inch (150mm)		Longitudinal bar D10	Longitudinal bar D6	Longitudinal bar none
Mortar	1:4	6"-4-D10 ○ (Model A of Feb 2011)	6"-4-D6 ○	6"-4-N ○、△
Mortar	1:8	6" 8 D10 ○		
Mortar	1:4 Bad fill	6" 4N D10 ○		6" 4N-N ○、△

→ Effectiveness of Steel bar

↓ Effectiveness of mortal and proper construction



4インチ (100mm)		Longitudinal bar) D10	Longitudinal bar) D6	Longitudinal bar) none
Mortar	1:4	4"-4-D10 ○	4"-4-D6 ○	4"-4-N ○、△
Mortar	1:8			
Mortar	1:4 Bad fill		4" 4N D6 ○ (Model B of Feb 2011)	4" 4N-N ○、△

"How safe is my house? for CHB houses

Tool 1

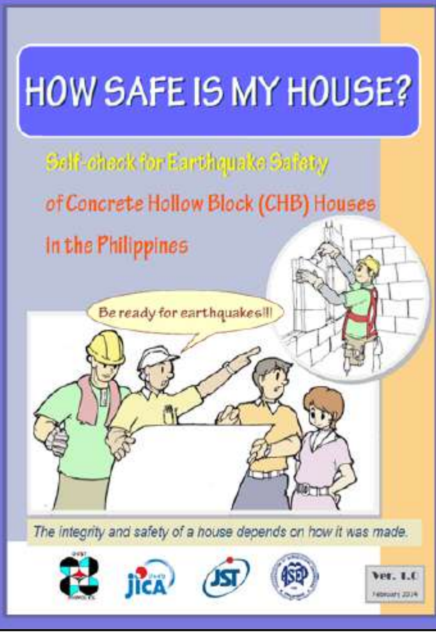
"HOW SAFE IS MY HOUSE?"
-Self Check for Earthquake Safety-

Following 12 questions concerning shape of the floor, wall openings, foundation type and condition, roof, age, etc., users

(1) can estimate the safety/vulnerability of their houses, and
(2) can understand which component of the house are important for safety.

User: House owner
Medium: Paper, Web
Target: CHB masonry structure, (1-2story building)

To understand the earthquake risk as their own problem



Development of Practical Tools for Vulnerability and Safety Evaluation houses of the Philippines

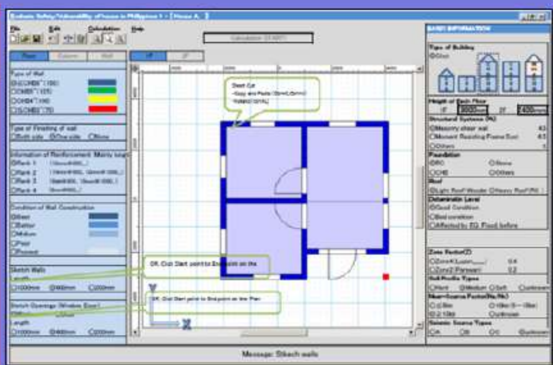
Tool 2

Software for Evaluate Safety/Vulnerability of Houses

A computer simulation was developed based on the data from the field, experimental and NSCP.
This is a visual and user-friendly interface with assistance from local engineers for:

(1) Scoring of the house status
(2) Vulnerability/safety of the house
(3) Recommendation for necessary strengthening of the house.

User: House owner with Engineer
Medium: Personal Computer
Target: CHB masonry structure, (1-2story building)



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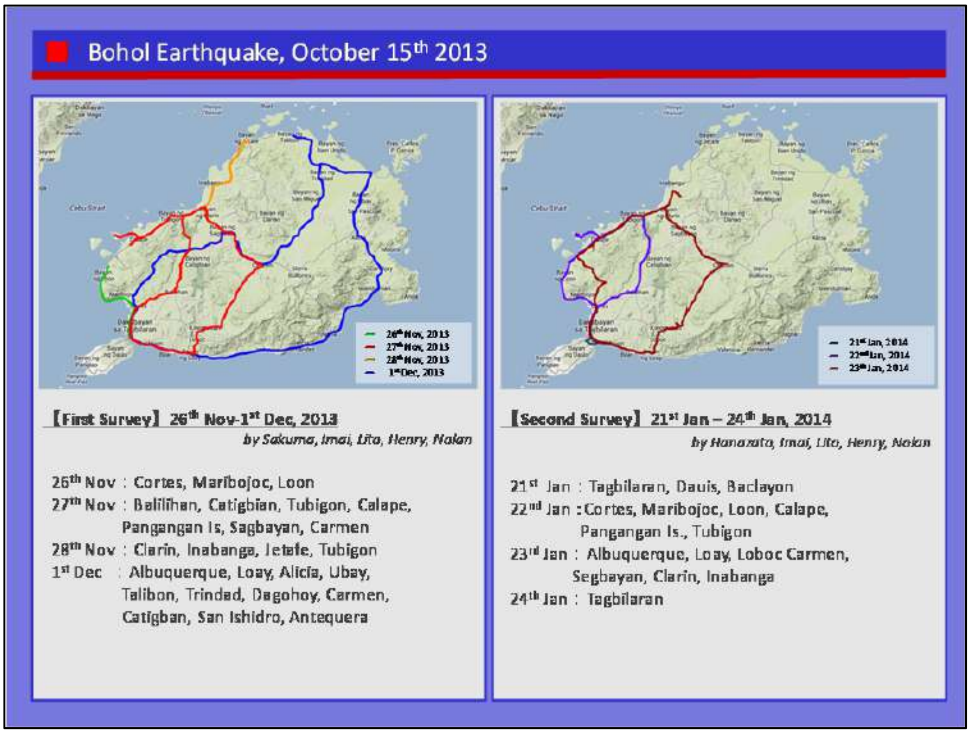
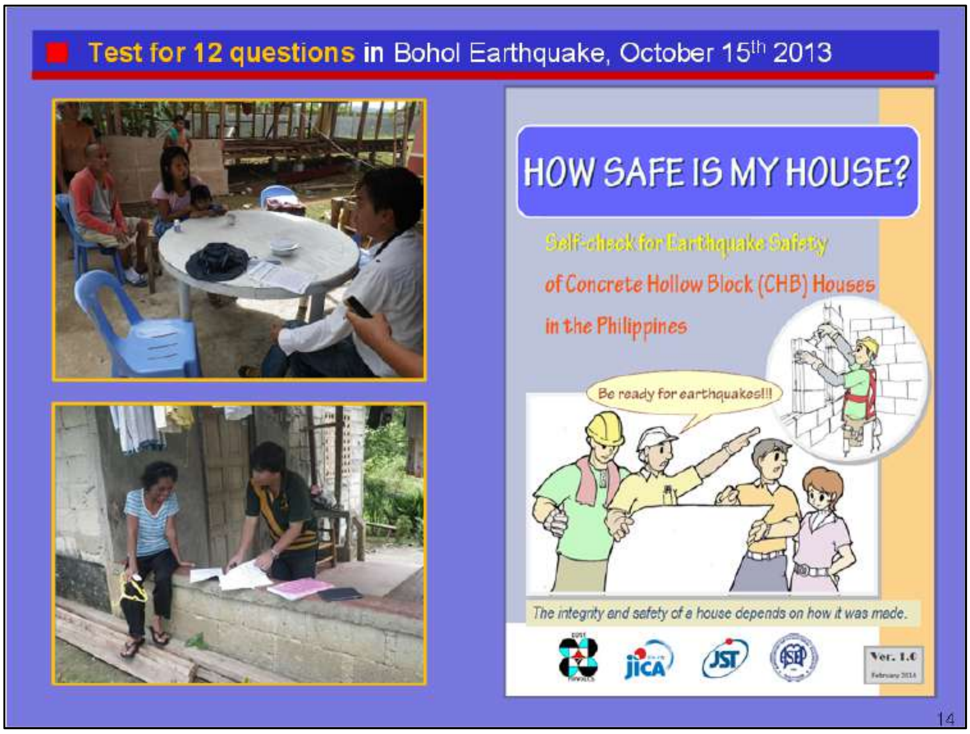

Bohol Earthquake, October 15th 2013
26th Nov, 2013
27th Nov, 2013
28th Nov, 2013
1st Dec, 2013
21st Jan, 2014
22nd Jan, 2014
23rd Jan, 2014
【First Survey】 26th Nov-1st Dec, 2013
by Sakuma, Imai, Lito, Henry, Nalan
26th Nov : Cortes, Maribojoc, Loon
27th Nov : Balilihan, Catigbian, Tubigon, Calape, Pangangan Is, Sagbayan, Carmen
28th Nov : Clarin, Inabanga, Jetafe, Tubigon
1st Dec : Albuquerque, Loay, Alicia, Ubay, Talibon, Trindad, Dagohoy, Carmen, Catigban, San Ishidro, Antequera
【Second Survey】 21st Jan – 24th Jan, 2014
by Hanazato, Imai, Lito, Henry, Nalan
21st Jan : Tagbilaran, Dauis, Baclayon
22nd Jan : Cortes, Maribojoc, Loon, Calape, Pangangan Is., Tubigon
23rd Jan : Albuquerque, Loay, Loboc Carmen, Segbayan, Clarin, Inabanga
24th Jan : Tagbilaran


Test for 12 questions in Bohol Earthquake, October 15th 2013
HOW SAFE IS MY HOUSE?
Self-check for Earthquake Safety
of Concrete Hollow Block (CHB) Houses
in the Philippines
Be ready for earthquakes!!!
The integrity and safety of a house depends on how it was made.
JICA
JST
Ver. 1.0
14


Test for 12 questions in Bohol Earthquake, October 15th 2013
Non engineered
4inch CHB
Undersized steel bar
Wide walls
Improper foundation
SCORE: [7]
Total
Evaluation and Next steps
11 - 12 points
Though this seems safe for now. Please consult experts for confirmation.
8 - 10 points
This requires strengthening, please consult experts.
0 - 7 points
This is disturbing! Please consult experts soon.
HOW SAFE IS MY HOUSE? of Concrete Hollow Block (CHB) Houses in the Philippines


Quick Quake Quality
check of your house
This earthquake disaster awareness material was prepared by the Philippine Institute of Volcanology and Seismology (PHIVOLCS) of the Department of Science and Technology (DOST) in collaboration with the Association of Structural Engineers of the Philippines (ASEP) under the Japan International Cooperation Agency (JICA) - Japan Science and Technology (JST) Project on the " Enhancement of Earthquake and Volcano Monitoring and Effective Utilization of Disaster Mitigation Information in the Philippines".

④日本の耐震構造技術の歴史と被害地震

北海道建築技術協会会長：石山祐二

History of Earthquake-Resistant Construction Technology and Related Events in Japan

Yuji Ishiyama, Dr.Eng.
President, Hokkaido Building Engineering Association
Executive Director, NewsT Research Lab.
Professor Emeritus, Hokkaido University, Japan

1880 Yokohama EQ and Seismological Society of Japan

1868 Meiji Restoration ⇨
- 230-yr isolation ended
- Overseas trade resumed
- Researchers, scientists and engineers invited to Japan

1880 Yokohama EQ (M=5.5) ⇨
- Seismological Society of Japan founded by Dr. J. Milne, Dr. J.A. Ewing and others, 1880
- Research on seismology and EQ engineering began

His tomb in Hakodate, Hokkaido, Japan

1891 Nobi EQ and Earthquake Investigation Committee

1891 Nobi EQ (M=7.9)

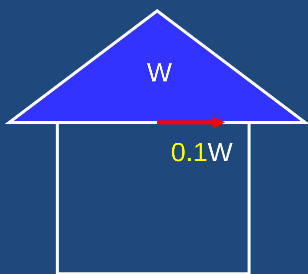
7,273 deaths

- Earthquake Investigation Committee (EIC) founded, 1892
- Research on seismology accelerated

- EIC was rechartered to the Earthquake Research Institute in 1925 which now belongs to the University of Tokyo.
- EIC made several proposals to improve EQ-resistant capacity of wooden houses and now formulates current concepts.

1923 Great Kanto EQ and Seismic Factor

- The 1923 Great Kanto EQ killed more than 100,000 people.
- In 1924, a provision that horizontal seismic factor shall be at least 0.1 was added to the Urban Building Law (UBL).
- The 1924 UBL also supplied additional provisions for
  - Wooden buildings
  - Masonry buildings
  - Steel buildings
  - RC buildings



1950 Building Standard Law after World War II

1934 Muroto Typhoon → problem with one allowable stress system became evident

1937 - UBL revised after DIN Standard of Germany introduced the concept of ordinary and extraordinary states

1943 - Wartime Temporary Standard (WTS) enforced
- Concept of short/long term loading introduced

1947 - WTS revised to Building Standard 3001

1950 - Building Standard Law replaced old regulations
- Horizontal seismic factor became 0.2

Dynamic Analyses and High-Rise Buildings

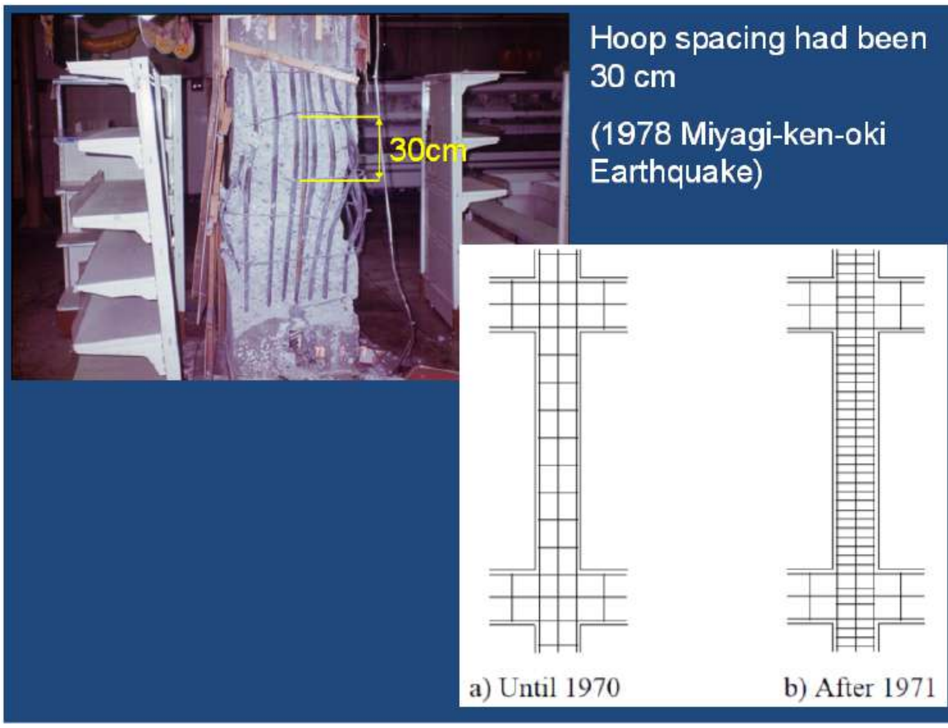
- Development of computers → analyses showed that acceleration response of buildings with longer natural period is smaller → high-rise buildings also possible in Japan
- Accumulation of EQ records and advancement of computers → dynamic analyses switched from research to practical use

  - 1963 - maximum height limit of 31m abolished
  - 1968 First high-rise in Japan

(Kasumigaseki Building, 147m)

1968 Tokachi-oki EQ and Strengthening of Shear Reinforcement

- Seismic analysis → EQ forces acting on buildings are much larger than that specified by the Building Standard Law
- Many RC buildings believed to have enough EQ-resistant capacity suffered severe damage
  - 1964 Niigata EQ (M=7.5) - 1,960 total collapse & 6,649 partial collapse
  - 1968 Tokachi-oki EQ (M=7.9) - 673 total collapse & 3,004 partial collapse
- Building Standard Law revised and shear reinforcement of RC columns strengthened
- Effectiveness of this revision proven later during the 1995 Hyogo-ken Nanbu EQ



Hoop spacing had been 30 cm

(1978 Miyagi-ken-oki Earthquake)

1981 New Seismic Design Method

1) Two EQ levels:

severe EQ motion (ultimate capacity design)

moderate EQ motion (Allowable stress design)

Structural characteristic factor to consider ductility

2) Seismic shear factor instead of seismic factor

$$V_i = C_i W_i \qquad C_i = Z R_t A_i C_0$$

3) Single formula for computing seismic forces for short and long period buildings

4) New distribution of seismic forces along the height

5) Structural balance in plan and elevation (story drift, shape factor)

1995 Great Hanshin-Awaji (Kobe) EQ and Countermeasures

- 1995 Hyogo-ken Nanbu EQ (M=7.2) → extensive damage
  - 6,460 deaths
  - 40,000 injuries
  - More than 240,000 total/partial collapse
  - More than 6,000 destroyed by fire
- Seismic evaluation and retrofitting were applied to existing buildings built before the new seismic design method
- Seismic Retrofitting Promotion Law enforced since 1995
- Damage to buildings after the new design method mainly due to soft and weak story → Revision of shape factor

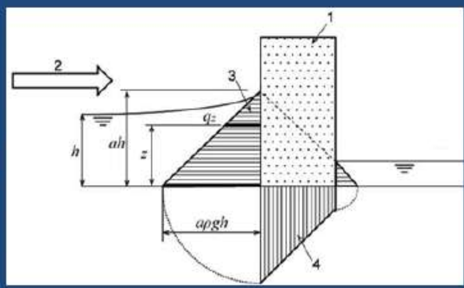
Seismic Evaluation of Existing Buildingas

- RC buildings designed to be EQ-resistant suffered unexpected damage → development of seismic evaluation:
  - 1977 - RC buildings
  - 1979 - Steel and wooden buildings
  - 1986 - SRC buildings
- Seismic evaluation was applied to many buildings in Shizuoka Prefecture and to buildings in Mexico after the 1985 Mexico EQ (M=8.1)
- Seismic Rehabilitation Promotion Law for existing buildings established after Hyogo-ken Nanbu EQ → Buildings are inspected using seismic diagnoses

2011 Great East Japan EQ

- Huge EQ (M=9.0) → huge damage
  - 16,000 deaths and 2,500 missing
  - Max tsunami run-up height 40.1m
  - More than 120,000 total collapse
- Damage to building is mainly caused by tsunami. No major revision to seismic code for buildings.
- Notification for large-scale ceilings and Notification of tsunami for buildings that should resist tsunami actions.
- Damage to nuclear power plants.

Damage caused by tsunami & Notification for tsunami actions



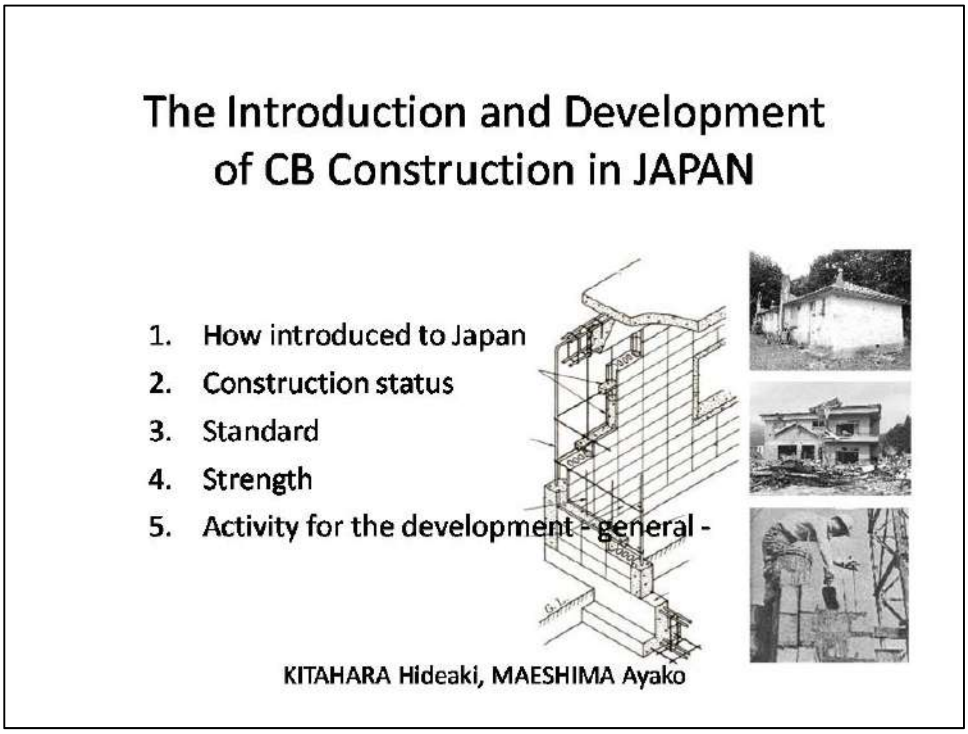
1 structure, 2 tsunami direction, 3 horizontal hydrostatic force, 4 vertical hydrostatic force (buoyancy), *a*: water depth factor, *h*: inundation depth

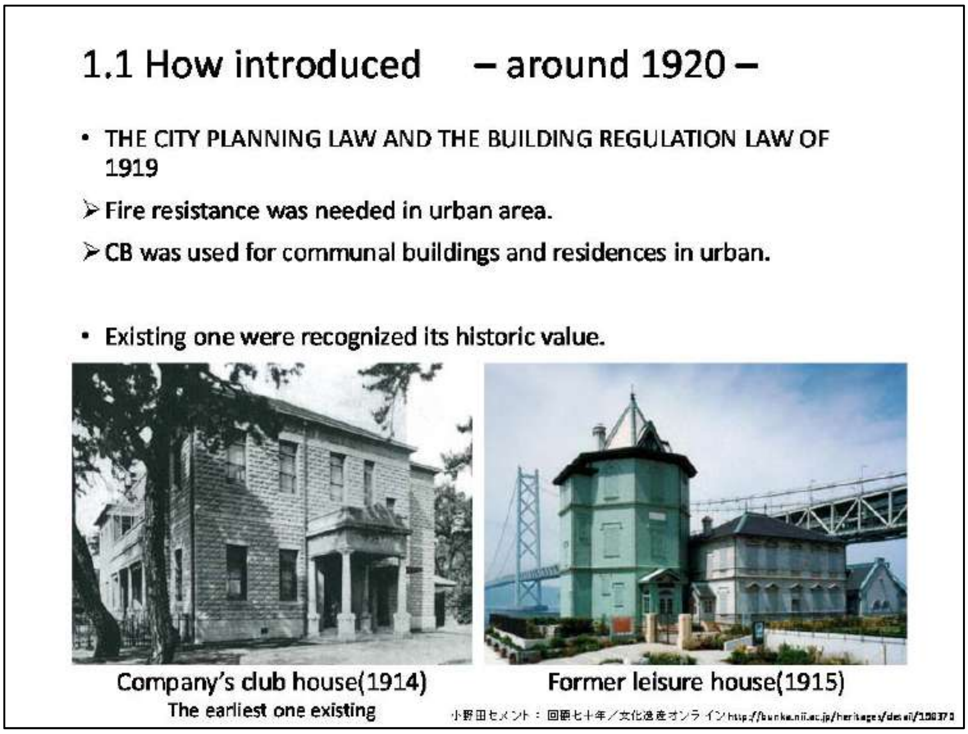
CONCLUSIONS

- Research on seismology and EQ engineering that started by the end of 19th century were developed in the 20th century.
- Further developments expected:
  - Seismology - precise EQ prediction techniques, estimation of EQ motions
  - Earthquake Engineering - seismic design, performance-based design
  - Base Isolation and Response Control Systems
- In 21st century, the fundamental objective of seismic design *(to protect human lives and minimize damage to properties)* will hopefully be accomplished.

⑤日本におけるコンクリートブロック構造の導入と発展

タイガーマシン製作所：北原英明





1.2 How introduced – after WWII –

- Timber buildings were burned down by war damage.
- By this experiment, supply shortage, national policy to save forest resources, CB was used one of easy and economical fire resistant construction for common housing.
- Standards were developed at this time.

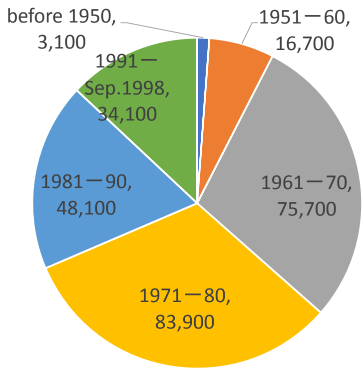
Public housing

Founded by Housing Loan Corporation

平井潔：だれにもわかるブロック建築の実際

2.1 Construction status – housing stock –

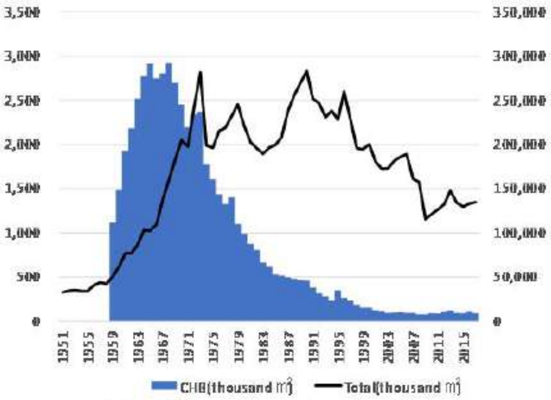
- There were about 270,000 block housings, in 1998.
- More than 60% were constructed between 1960-1980.



CB housing stock by construction year
Housing and Land Survey 1998

2.2 Construction status – new construction –

- Peak of new CB building construction was late 1960s.
- In resent years, most of new construction done in OKINAWA.
- In total, HOKKAIDO covers big part.

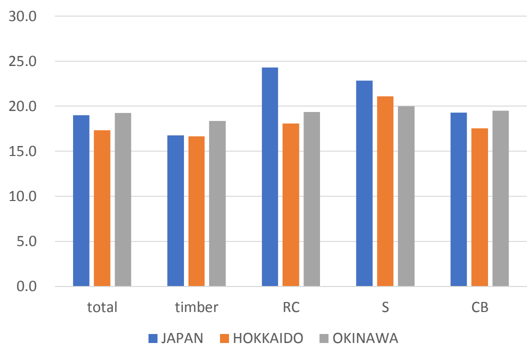


Transition of new construction

Survey of Building Construction Work Started

2.3 Construction status – cost –

- JAPAN : timber is lowest. CB is 15% higher, RC 45%, Steel 36%.
- OKINAWA : timber is higher than JAPAN average. CB is 6% higher.
- HOKKAIDO : each structure is lower than JAPAN average. Timber is same as JAPAN average. CB is 5% higher than timber.



Construction cost by structure and area(ten thousand yen/m2)

Survey of Building Construction Work Started

3.1 Standard

- Masonry unit : JIS A 5406 ⇒ next presentation

"Reinforced Concrete Block" structure system

- Structural Design : AIJ Standards for structural design of masonry structure
- Construction work: Japanese Architectural Standard Specification, JASS 7

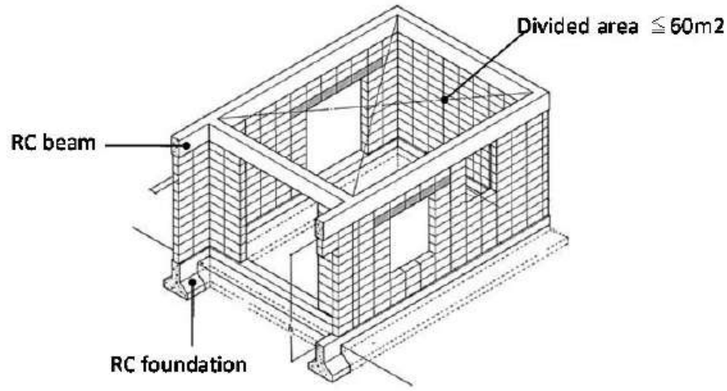

Masonry units

Structural Design

Construction work

3.2 Standard - Structural Design -

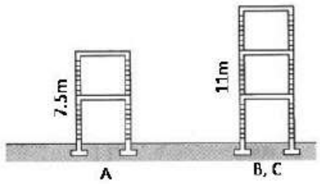
- "Reinforced Concrete Block" structure system is constructed by Reinforced concrete block wall and RC beam, slab, foundation



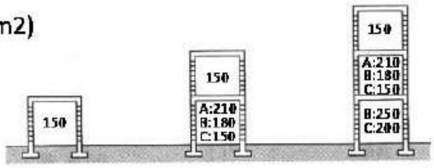
3.3 Standard - Structural Design -

- In order to block type (A<B<C, strength) followings were ruled.

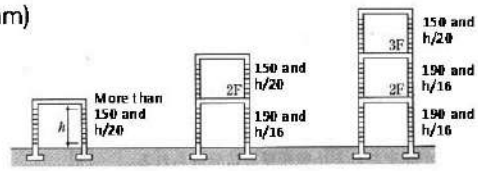
Scale



Wall quantity(mm/m2)

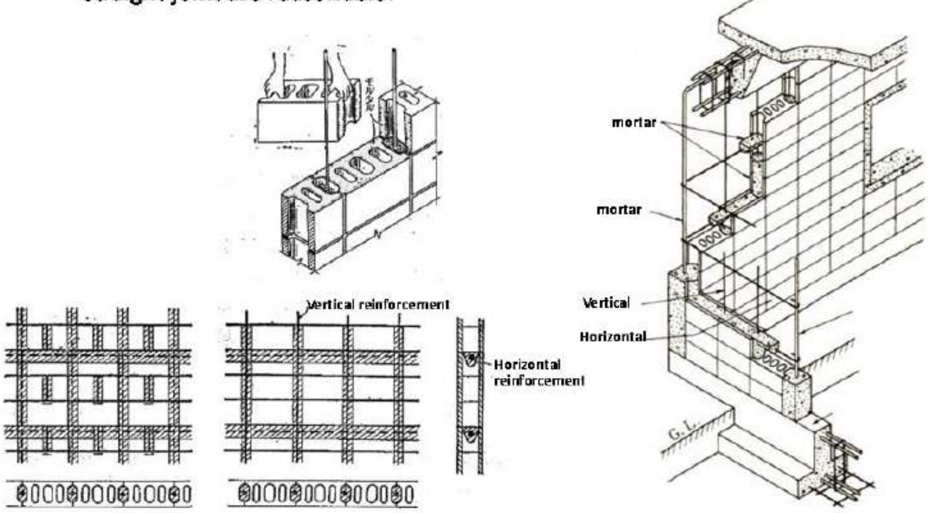


Thickness of wall(mm)



3.4 Standard - Structural Design -

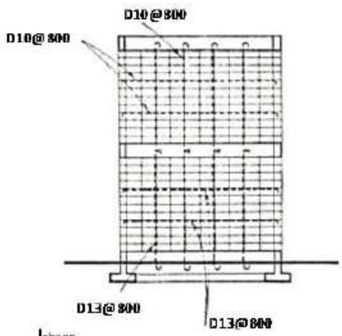
- Reinforced in a reticular pattern (vertical one should not joint in CB), straight joint are reasonable.

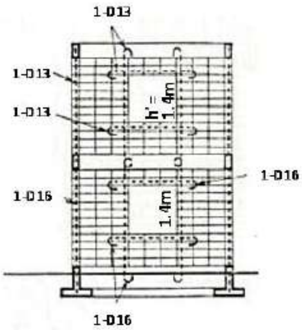


Break joint Straight joint

3.5 Standard - Structural Design -

- Bar arrangement is ruled by scale and level of the building, for shear and bending force





	shear			
	single story/top of two storied	first floor of two storied/top of three storied	2nd floor of three storied	first floor of three storied
vertical	D10@800	D10@400 D13@800	D10@400 D13@800	D13@400
horizontal	D10@800	D10@600 D13@800	D10@400 D13@600	D10@400 D13@600

		bending		
		single story/top	2nd floor from top	3rd floor from top
vertical	h'≦1.5m	1-D13	1-D16	
	1.5<h'≦2.4m	1-D13	1-D16	1-D19
	2.4m <h'	1-D13	1-D19	
horizontal		same as vertical		

4.1 Strength

Experiment (single story and two-story)

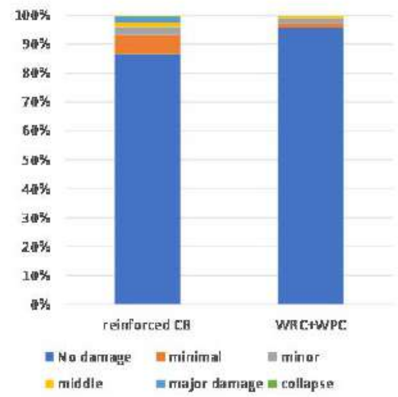
- shaking table test： base shear 0.6 - 1.2
- Static load test： base shear 0.8 - 1.0

Earthquake damage

- By the various report on the disaster, the damage of reinforced CB building were extremely little.
- Reinforced CB building under the rule, there are not serious damage on upper structure.
- In case typhoon or tsunami, the damage is smaller than timber buildings.

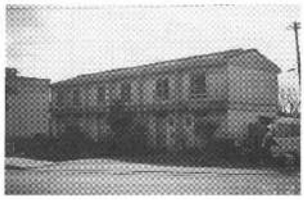
4.2 Strength – damage level –

- No damage and minimal damage were more than 90% in intensity 7 area of Great Hanshin-Awaji.
- Damage level was almost same as RC wall system buildings.



Damage ratio of reinforced CB and RC in intensity 7 area of Great Hanshin-Awaji

No damage



Major damage ,Tilted by ground movement

阪神淡路大震災調査報告

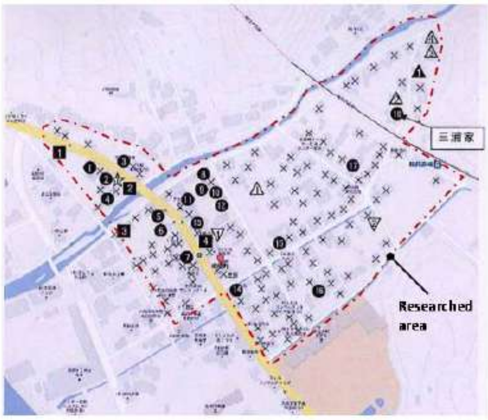
4.3 Strength – damaged case –

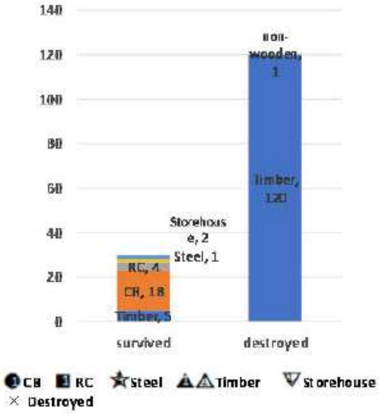
Cracks appeared on illegal reinforced CB

In tsunami area, some building collapsed by soil washed away.
However there was little damage in upper structure.

阪神淡路大震災調査報告／東日本大震災合同調査報告

4.4 Strength – tsunami area –





狭田ひろ子,三船康道：東日本大震災にみる三浦邸宅の評価

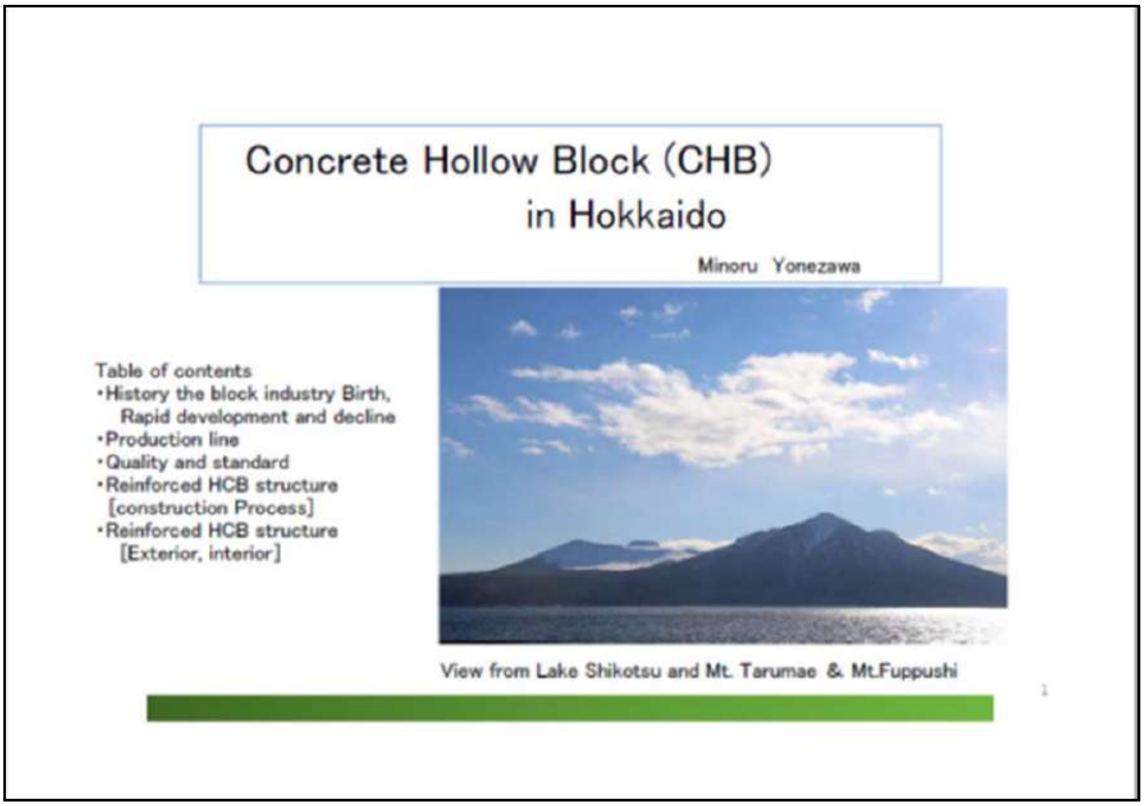
5. Activity for the development - general-

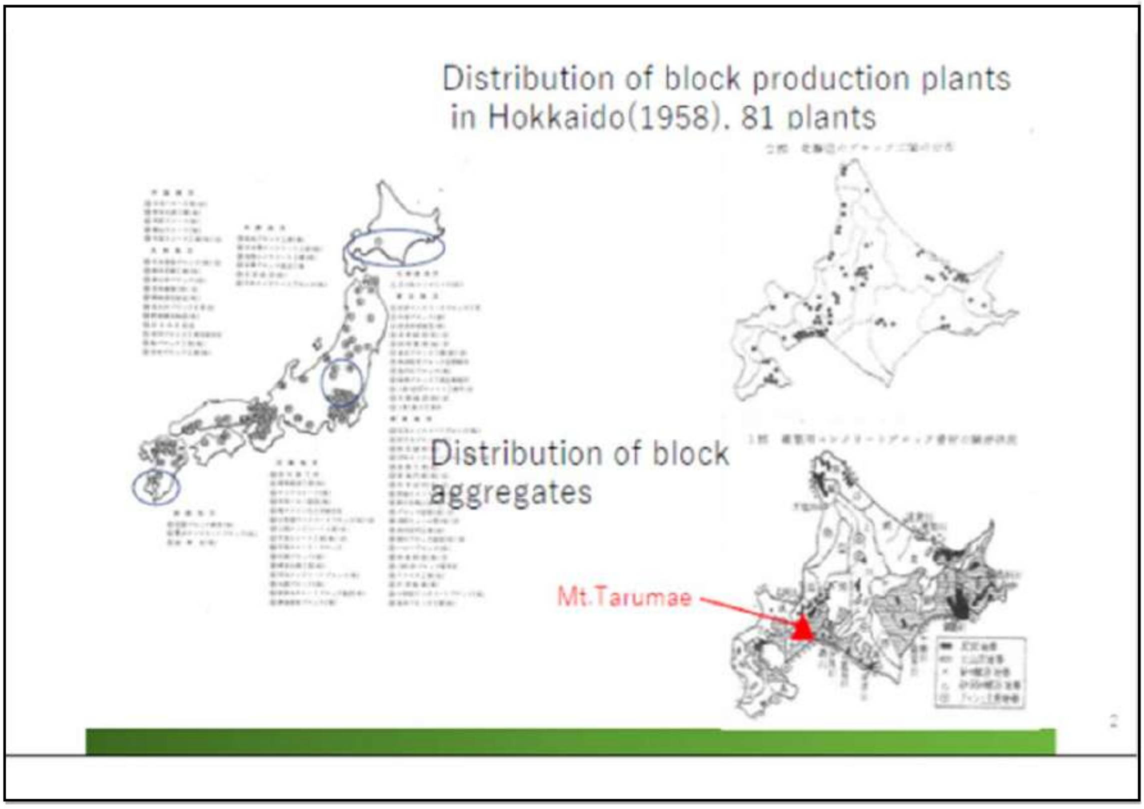
- Standards
- Housing loan
- Share now how
- Design competition
- New technology challenge and Developments

-Detail- will present tomorrow

⑥北海道におけるコンクリートブロック造の活用

北海道建築技術協会／株式会社よねざわ工業：米澤稔



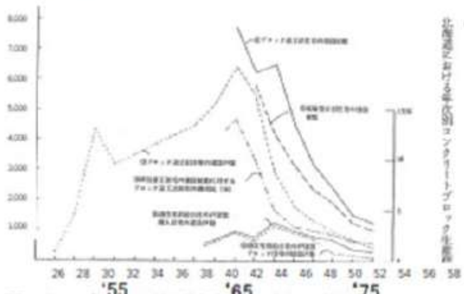


○ History of rapid development and decline from the birth of the block industry

1945年 End of World War Ⅱ
1947年 Promotion measures for block building by policy
1951年 First block-building public housing construction
1952年 "The Hokkaido Block Building Guidance Center" was established
Concrete block established as Japan Industrial Standard
Concrete block construction established as Building Standard Law
Design criteria for concrete block construction established
the Japan Society of Architectural Architects
1953年 "Law for the promotion of cold-proof housing in Hokkaido" was enacted.
1969年 Amendment of this Law
1972年 The Block Housing research Group was established
1979年 The external wall insulation method of block was built by Prof. Aratani
Hokkaido Block Building Promotion Council
(industry-academia-government collaboration) inaugurated
1980年 Construction of two model houses , external wall insulation method of block
1986年 The Masonry-forum Hokkaido has started.

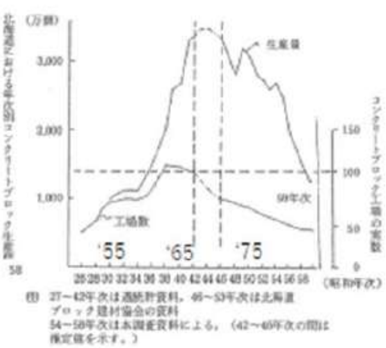
3

Number of houses built by block structure in Hokkaido



図－3 ブロック造工法住宅の建設戸数に関する年度別推移

Number of Concrete block Production and blocks produced in Hokkaido



図－4 北海道におけるコンクリートブロックの生産実績に関する年次推移

4

The birth period of the block industry in Hokkaido

The CB-built church, completed in 1951

Manual manufacturing method at the time of 1951

Hokkaido Block Building Guidance Center, established in 1952

More than 50 years of existing agricultural facilities

5

The age of rapid growth

Semi-automatic molding machine

Steam curing room around 1960 (1st floor part)

Block-building public housing development

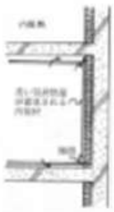
6

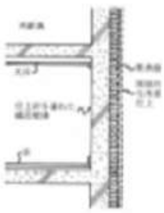
The external insulation method
-Starting in 1978～

Internal insulation

Outside insulation

Block-built model housing
The external insulation metho-1980





7

・Production line

Storage condition

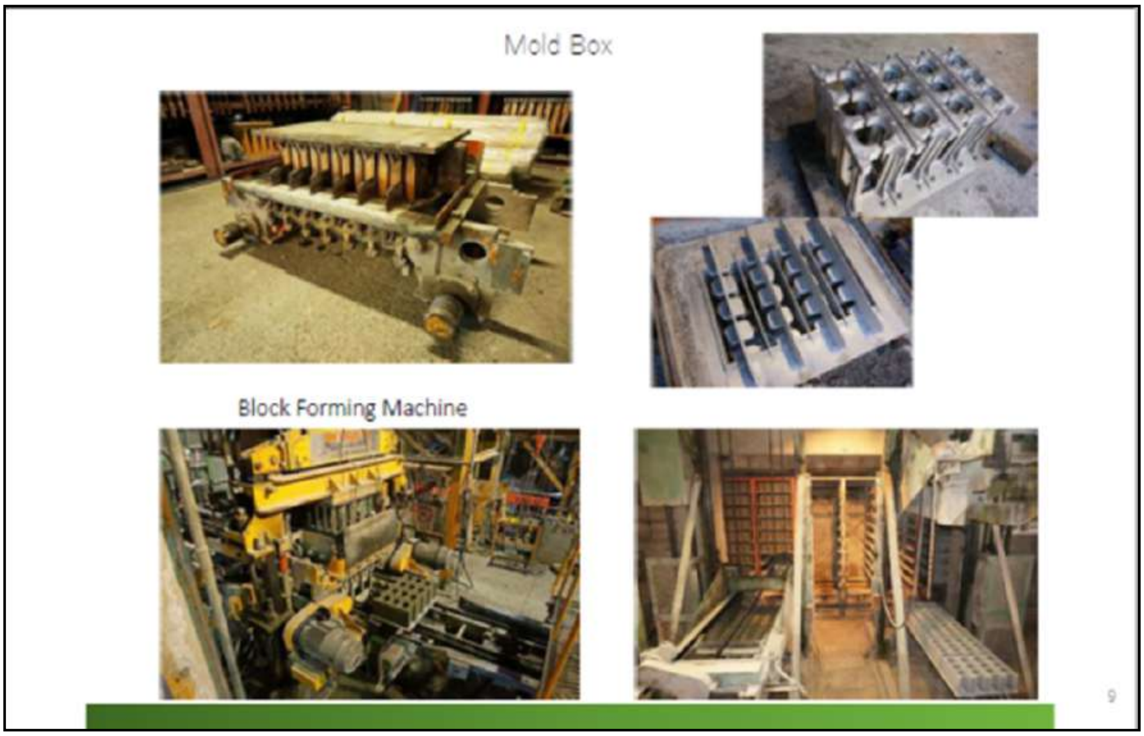
Particle size adjustment and washing equipment of volcanic gravel

Volcanic gravels with controlled particle size

Weighing equipment for raw materials

Concrete Mixers

8


Mold Box
Block Forming Machine
9


Taking out the CB from the steam curing room
Cubing equipment
Carrying out with a forklift
The outdoor product storage place
10

○Quality standards for CHB

External shape

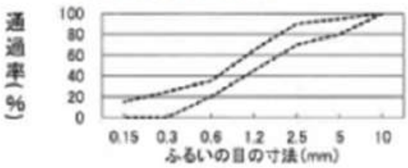
空洞ﾌﾞﾛｯｸの断面形状及び外部形状

Type			Compressive strength	Water absorption Rate
断面形状による区分	圧縮強さによる区分	圧縮強さ (1) (N/mm²)	全断面積圧縮強さ (2) (N/mm²)	質量吸水率 (%)
空洞ﾌﾞﾛｯｸ	08(A)	8以上	4以上	30以下
	12(B)	12以上	6以上	20以下
	16(C)	16以上	8以上	10以下

11

Selected volcanic gravel (natural lightweight aggregate 10mm)

Particle size Distribution



Cut samples classified by strength
· Type: A, B, C,D

Examples of standard formulation of CHB

[illegible] / 区分種類	ｾﾒﾝﾄ (kg)	火山礫 (kg)	細骨材 (kg)	水 (L)	ﾌﾗｲｱｯｼｭII (kg)	[illegible] (L)	[illegible] (L)
08(A)	230	1260	—	272	72	0.10	—
12(B)	300	1203	—	270	90	0.10	—
16(C)	296	847	655	206	50	0.10	0.20

標準配合

12

Piling work and digging the ground

Placement of rebar for foundation

Formwork for foundation

Concrete reinforcing bar arrangement

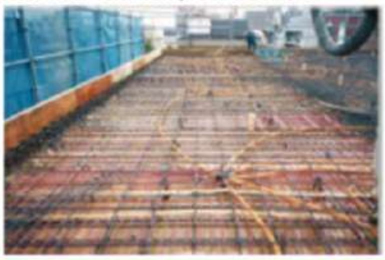
13

Loading work of blocks

Beam formwork

Leveling concrete on the second floor

Roof floor formwork, reinforcement



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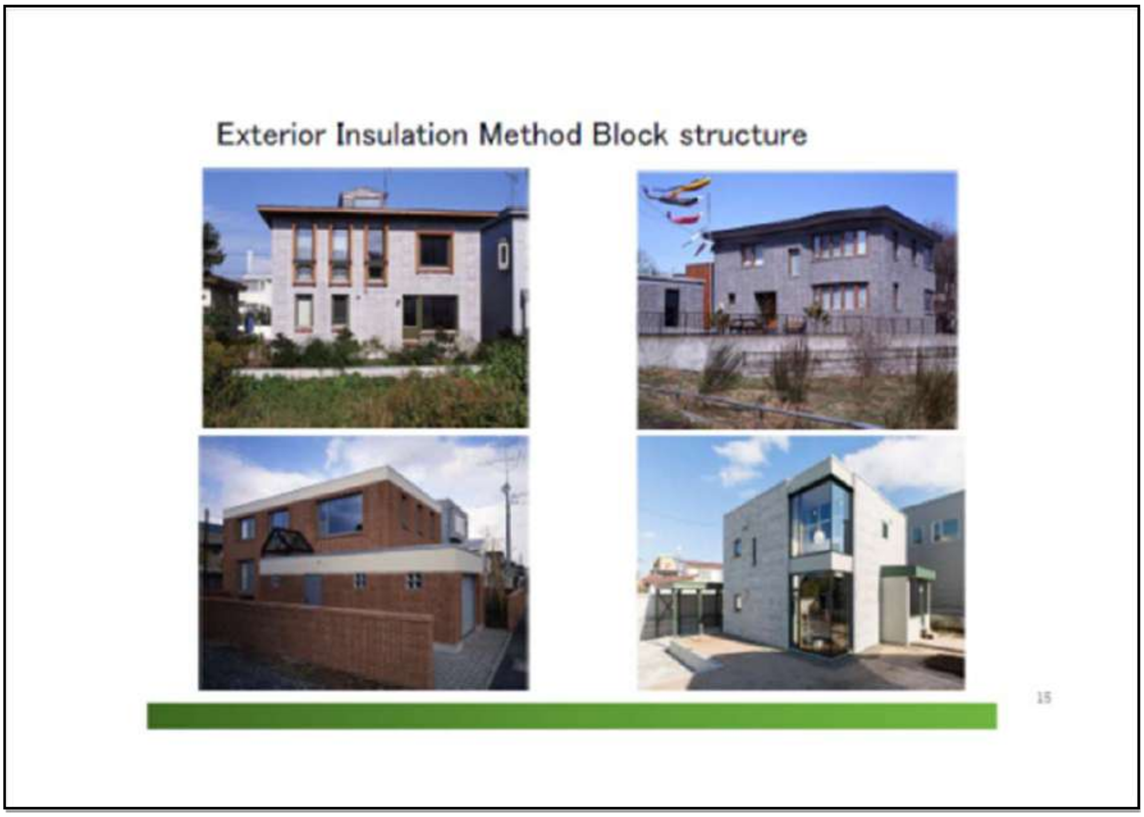
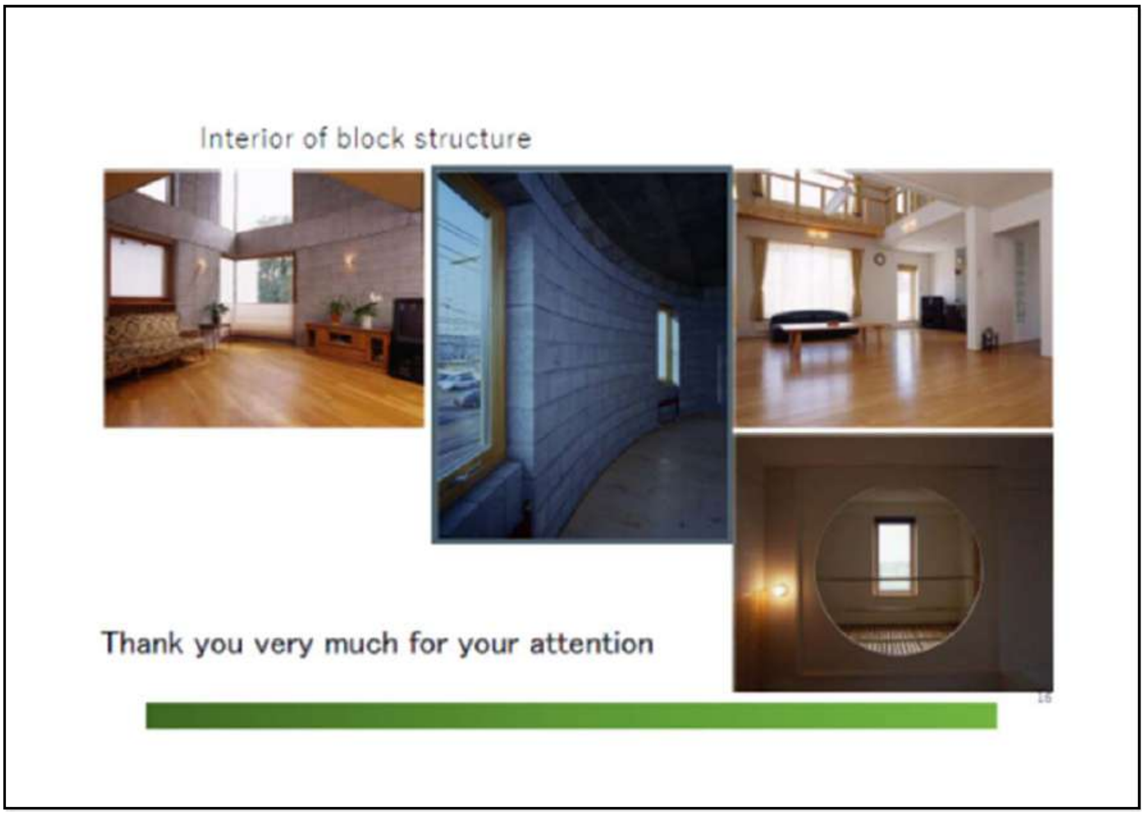

Exterior Insulation Method Block structure
15


Interior of block structure
Thank you very much for your attention

⑥コンクリートブロック施工の普及の努力　　明海大学：前島彩子

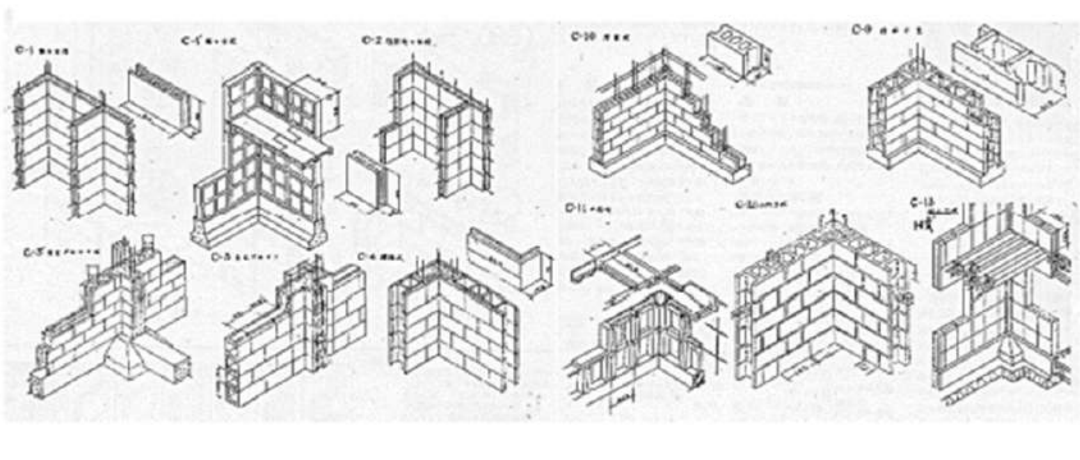
Efforts for popularization of CB construction

1. **The Change of Standards at the early period**
2. **Popularize the Standards**
3. **The Housing Loan Cooperation**
4. **Certificated worker**
5. **Optional trial**

MAESHIMA Ayako

1. The Change of Standards before standardized, after WWII

- **Around 1950, public housing agency and the Housing Loan Cooperation prepared their design.**
- **Building constructors were checked their method fitting to that design. Then various CB constructions were proposed.**



建築技術1952.6

1. The Change of Standards 1952

- First standard for structural design and masonry units was defined in 1952

It was introduced by US and
the hole was small for reinforcement

BI	BS	BM
(US type)	(follow to Japanese module)	(invented in Japan)
400×197	440×215	485×455

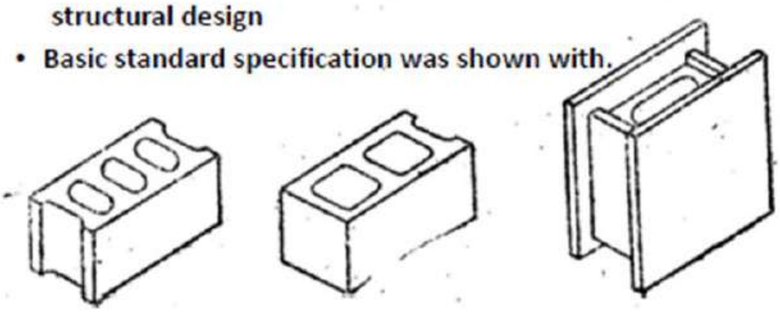
1. The Change of Standards 1952→1955

masonry units

- Minimum hollow size was defined for reinforcement.
- Shape was adjusted for joint width, and uniformed the height.
- Cement content ; cement : aggregate = 1:7→220kg/m3 more

structural design

- Basic standard specification was shown with.



	BI	BS	BM
	(US type)	(Japanese module)	(invented in Japan)
1952 ・・・	400×197	440×215	485×455
	↓	↓	↓
1955 ・・・	390×190	440×190	490×190

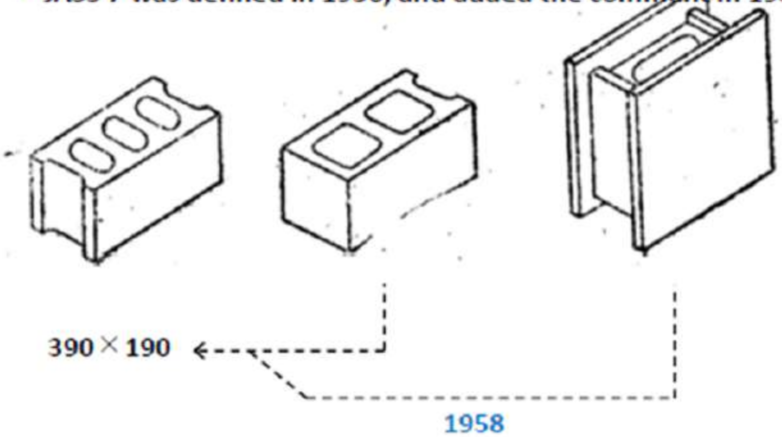
1. The Change of Standards　1955→1958

masonry units

- Shape type was reduced.
- Water-proof type was defined.

Specification

- JASS 7 was defined in 1956, and added the comment in 1959.



2. Popularize the standards

- Architectural Institute of Japan send the trainer more than ten areas in nation wide and held the workshop.
- Industry organization held the workshop for the leader of workers and following to that held for the second class architect, buck upped by government agency and local municipally.
- Prefectural institute for block construction in HOKKAIDO screened block quality, did research and guidance for both design and construction work.

Workshop for design and construction work at Hokkaido 大滝栄蔵：北海道におけるブロック建築の発展

3. The Housing Loan Cooperation

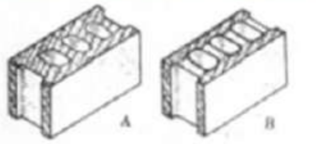
- **Loan ratio for fire-proof including simple one was higher around 1955.**
- **That accelerated the choosing of CB housing construction.**

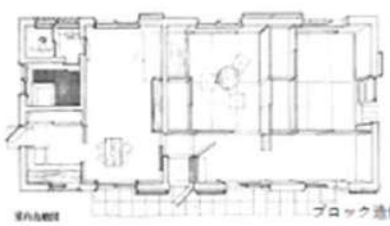
1955	Loan ratio(%)	Cost (yen) (49.5m2)	Cost ratio	Maturity period (years)	Loan limit(yen)	Loan limit ratio
Timber	80	510,000	1.0	18	400,000	1.0
Fire-prevention	80	540,000	1.1	18	430,000	1.1
Simple fire-proof	85	690,000	1.4	25	580,000	1.5
Fire-proof	85	810,000	1.6	35	680,000	1.7

ブロック造住宅設計図集

3. The Housing Loan Cooperation

- "Drawing of CB housing" was prepared by the agency.
- It contains not only drawings but also the cost comparing with timber, the point of construction work, and so on.
- It contributed to expand certain quality CB housings.





ブロック造住宅設計図集

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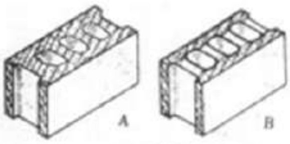
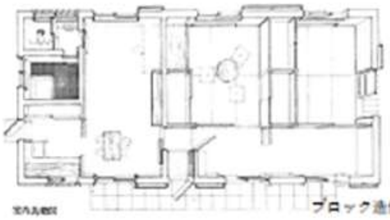




4. Certificated worker　national sector

- The skills test is a national certification program to test and certify skills of workers on certain criteria.
- This test programmed by Ministry of Health, Labor and Welfare. And it operated by Japan vocational ability development association and governor.
- Paper test(Structure, Construction method, Material, Drawings, Law, Safety and health) and skill test.
- Block construction skills is divided three levels, primary-intermediate-advanced. (First and second class started in 1964, third class 2007.
- Average number of applicant is 120 to 250 in this six years.

Skill test trial for third class

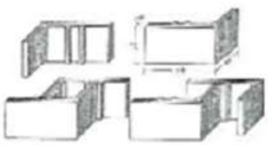
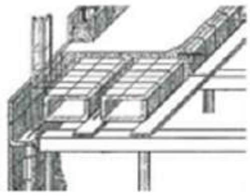
4. Certificated worker　private sector

- Concrete Block constructor is certificated by JPEX, CB contractor's association, private sector.
- Lecture and paper test

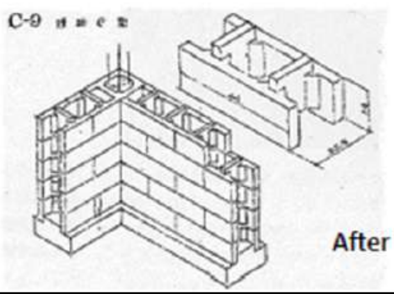
Lecture1: material, structure, construction	200 minutes
Paper test	40 minutes
Lecture2: law and planning	30 minutes
Lecture3: Drawing (practical)	130 minutes

5. Optional Trial　mold type block

- Reinforced Fully Grouted Concrete Masonry Structures using mold type had been used from early on.

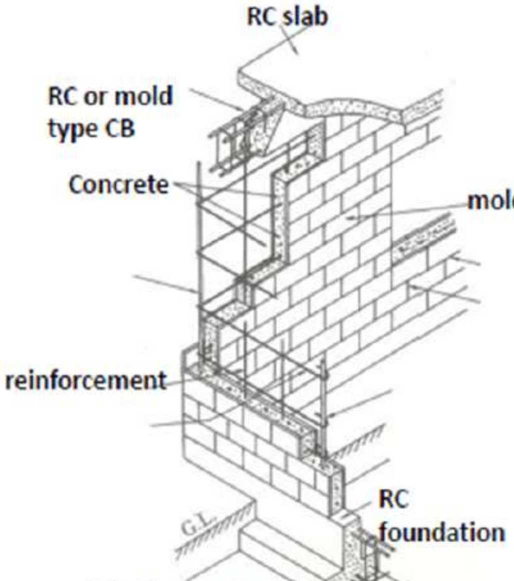
"chin block" house in 1929



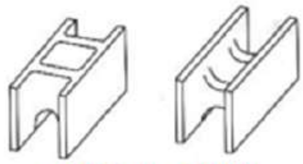
After WWII

5. Optional Trial　mold type block

- Reinforced Fully Grouted Concrete Masonry Structure can use for higher floor height or underground structures.



Structure system


Mold type CB unit


Reinforced Fully Grouted Concrete Masonry Structure by Tadao ANDO (1984, 91)

5. Optional Trial　mold type block

- Based on Reinforced Fully Grouted Concrete Masonry Structure, RM was developed by Japan and US collaborative research from 1984 to 1989.
- RM can construct five story building.


RM real scale experiment model

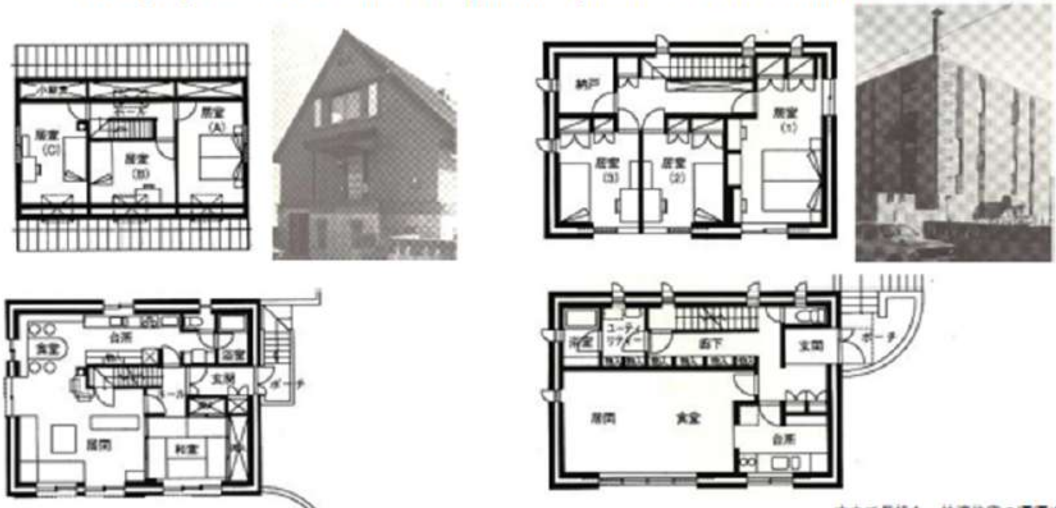
【RM from RC】
- Similarity: Structure system
- Advantage: eliminating removal of formwork, supports for formwork, outside scaffold. RC elements are protected by block.

【RM from CB】
- Similarity; Texture (but breaking joint)
- Advantage; building height, decrease the variations by workers skill level,

組積造に関する日米共同大型耐震実験研究(55)：実大5層RM構造建築物の耐震実験（その2. 試験体の製作）

5. Optional trial　external thermal insulation

- External thermal insulation for CB housing was proposed by the institutions in Hokkaido around late 1970s.
- Long life and ecology especially in hot or cold area
- The proposed two ideas were put into practice as model house.



丈夫で長持ち・快適住宅のすすめ

5. Optional trial　processed block

- Colored or textured block has been produced since around 1970s.
- Block has potential to offer variable texture.

http://www.yonezawa-k.co.jp/