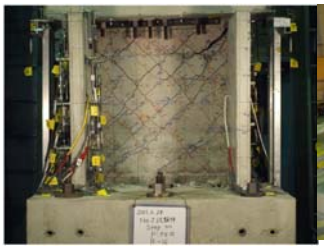
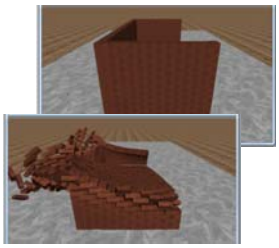
G3: Seismic Resistance of Buildings








GL: T. Saito (BRI), C. Zavala (UNI)

Project Flow-chart

Research Topic (Organization)	Period (2010-2014)					
	2009 (10 Months)	2010	2011	2012	2013	2014 (12Months)
G1: Seismic Motion & Geotechnical 【Chiba, Tokyo Tech, BRI, NIED, CISMID, IGP】 1) Source Modeling and Seismic Motion 2) Site Response & Microzonatio 3) Slope Failure Assessment	Source Modeling		Simulation of Strong Motion			
	EQ and MT Measurement			Microzonation		
	Field Survey		Seismic Response		Hazard Map	
G2: Tsunami 【Tohoku, BRI, Tsukuba, TEPSCO DHN, CISMID】 1) Tsunami Propagation and Impacts 2) Tsunami Hazard Mapping 3) Tsunami Damage Mitigation Technology	Tsunami Simulation		Inundation and Impact			
	Data Collection		Damage Assessment Method		Tsunami Damage Analysis	
	Historical Tsunami Data			Tsunami Damage Mitigation technology		
G3: Buildings【BRI, Nagoya, Yokohama National, Akita Pref., CISMID】 1) Seismic Tests Database 2) Diagnosis and Retrofit 3) Retrofit of Historical Buildings	Literature Survey, Tests			Database Development		
	Diagnosis Method		Retrofit Technology, Validation Tests		Guideline	
	Survey, Risk Assessment			Retrofit Technology		Guideline
G4: Damage Assessment 【Tokyo Tech, Chiba, AIST, Tsukuba, CISMID】 1) Geo-spatial Database 2) Damage Detection using Remote Sensing 3) Damage Assessment for Scenario EQ	Data Collection	Geospatial Data		Database Development		
	Data Collection	Methodology		Damage Detection		
		Damage Assessment Method		Assessment, Risk Map		
G5: Disaster Mitigation Plan and Project Management 【Chiba, Tohoku, BRI, Tokyo Tech, Ritsumeikan, INDECI, CISMID】 1) Project Management 2) Disaster Mitigation Planning	Project Officer, Project Management, Public Announcement					
	WS▼	WS▼	WS▼	WS▼	WS▼	
	Workshop Organization			Mitigation Planning	Dissemination, Education	

Group 3 Building (Equipment)

Structural testing

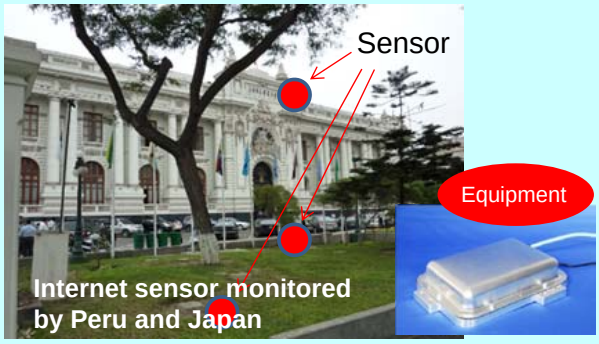
Material testing

Renewal of old CISMID machine

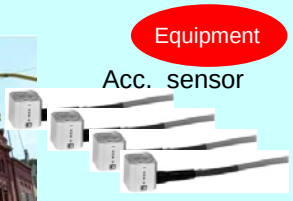
50ton Universal

300ton Compression

Building monitoring

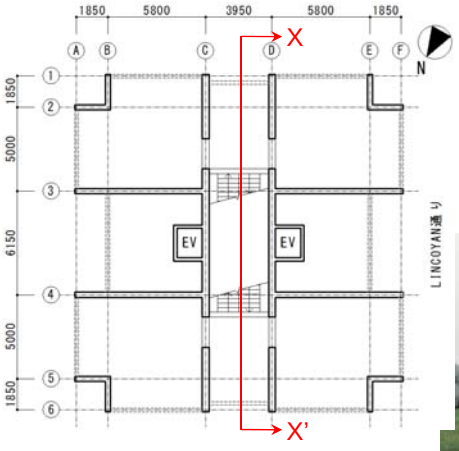


Dynamic behavior monitoring & test



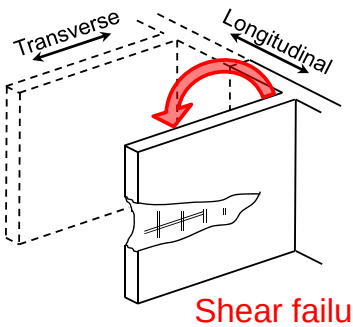
Motivation of structural test (1)

17-story building



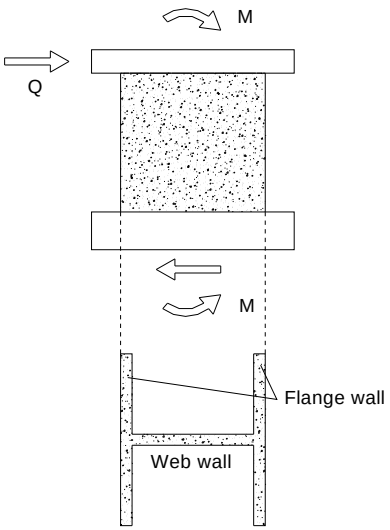
2010 Chile Earthquake

Japan-Peru-Chile joint investigation team



Wall structure suffered flexural failure.

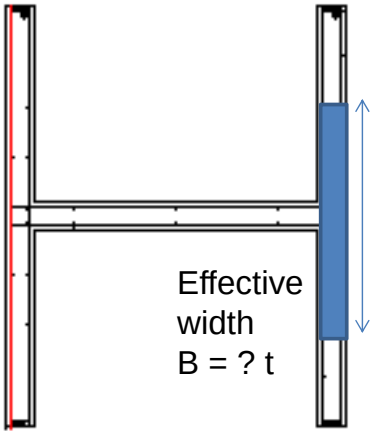
Shear failure of wall … studied well
Flexural failure of wall … need more study



Japan
Yokohama Univ.

Double reinforcement
→ confinement effect

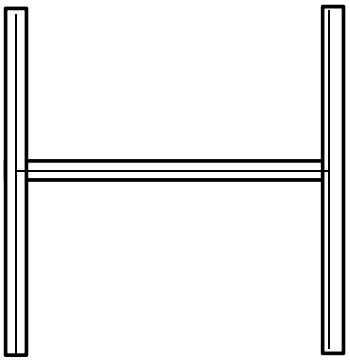
Contribution of
transverse wall



Peru
CISMID

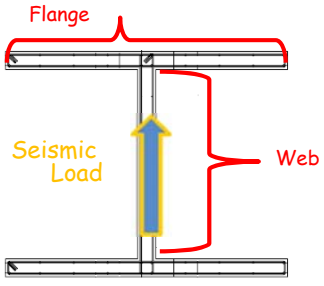
Single wire mesh reinforcement
→ no confinement effect

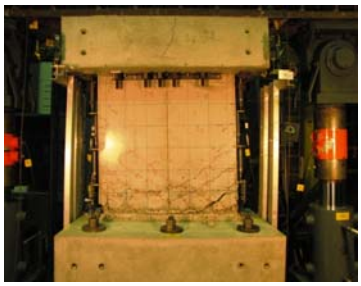
Contribution of
transverse wall



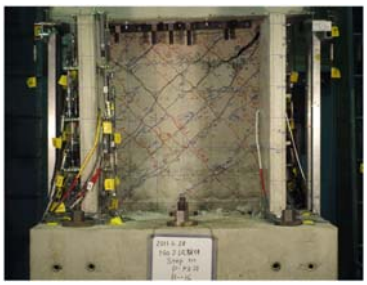
Progress Report
Seismic Test Database(1)

Structural Test in National Yokohama University (2010-2011)

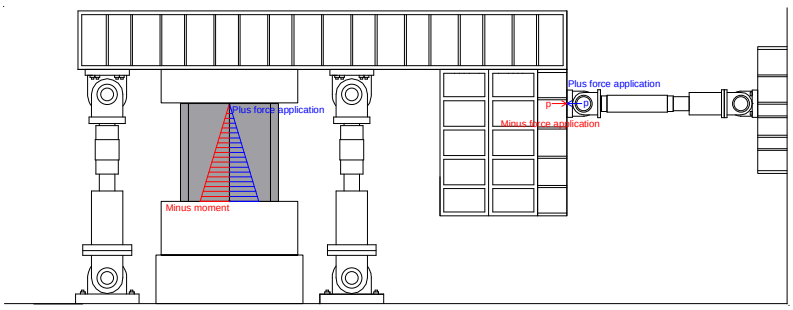




Specimen without Flange

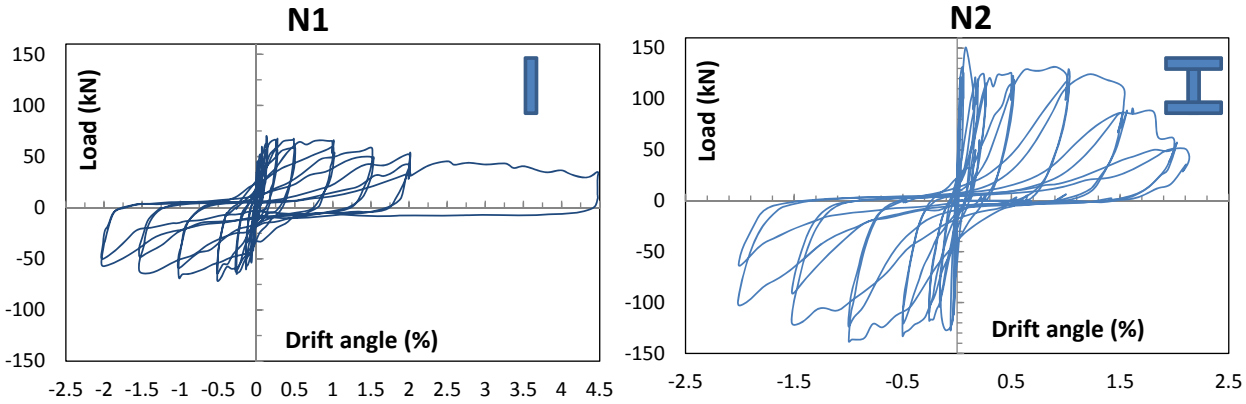


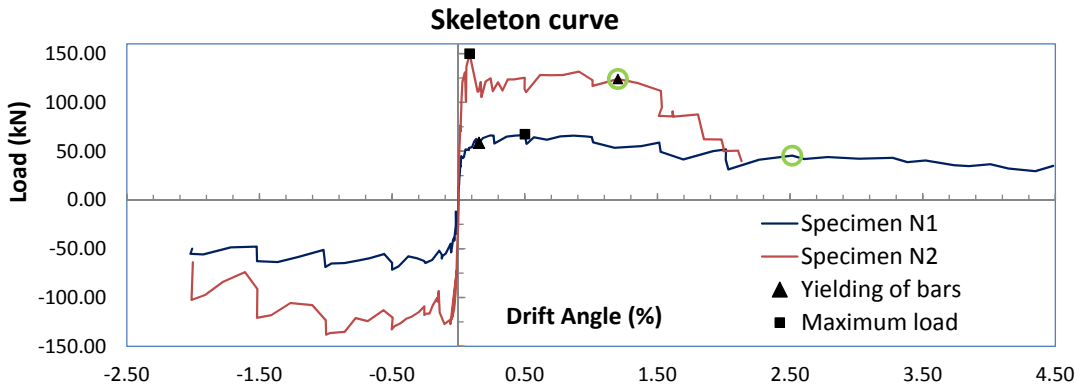
Specimen with Flange



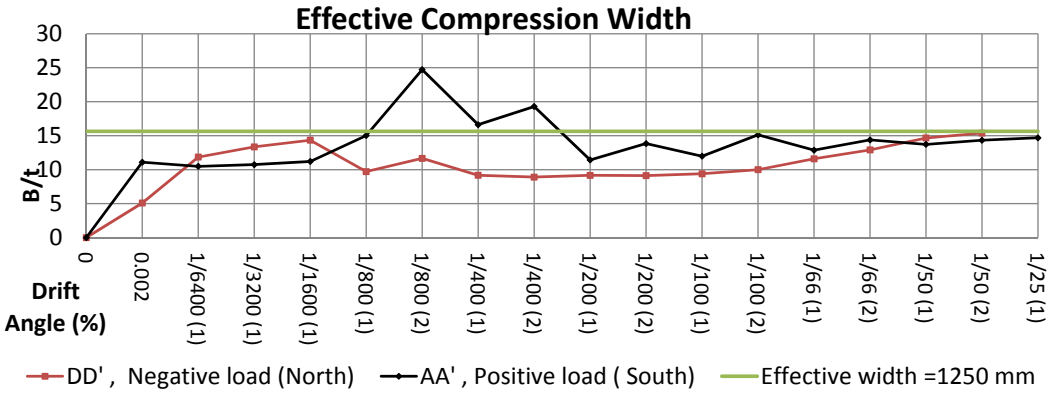
- Ciclic load
- 1/3 Scale
- Displacement control

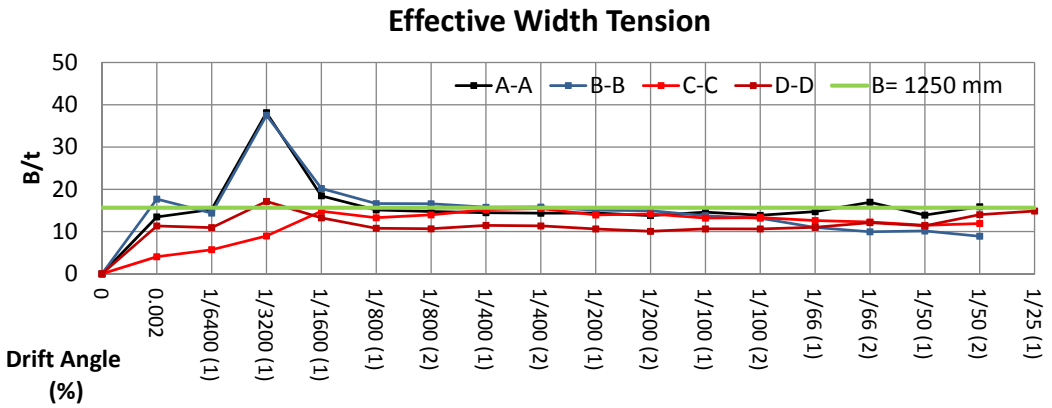
LOAD VS DRIFT ANGLE CURVE





Effective Width calculation result





Motivation of structural test (2)

OUT-OF-PLANE FAILURE

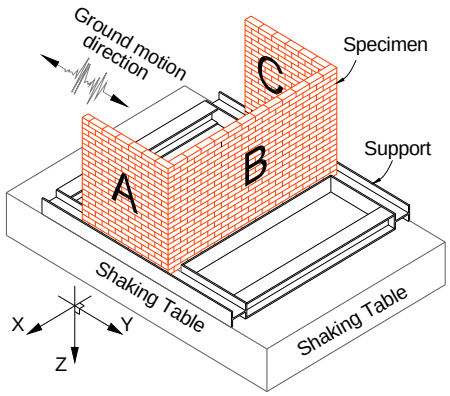
Puente Piedra – Lima - Perú

San Juan de Lurigancho – Lima - Perú

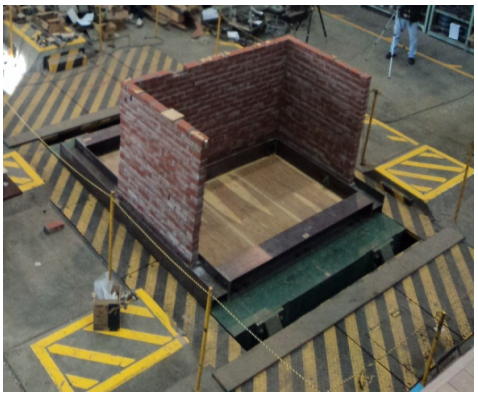
Arequipa Earthquake – Peru (2001)

Long Beach Earthquake – Souther California (1933)

Progress Report
Seismic Test Database(2)



Test Setup



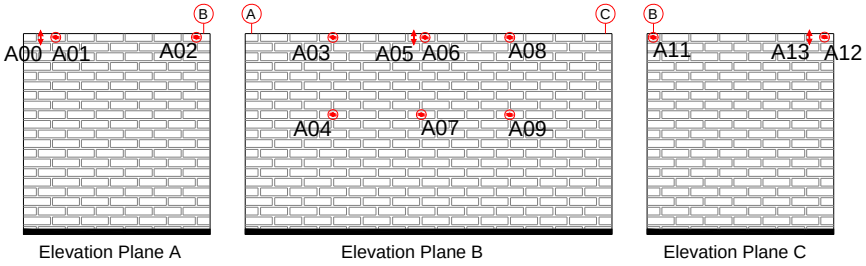
Specimen on the shaking table

Test	Type	Frequency (hz)	Amplitude (mm)
1	sweep wave	0.8 - 20	0.5
2	sweep wave	0.8 - 20	0.5
3	sweep wave	0.8 - 20	0.5
4	random wave	5 - 20	0.5
5	random wave	5 - 20	10
6	random wave	12 - 20	5
7	random wave	12 - 20	5
8	random wave	12 - 20	10
9	random wave	12 - 20	15
10	random wave	10 - 15	5

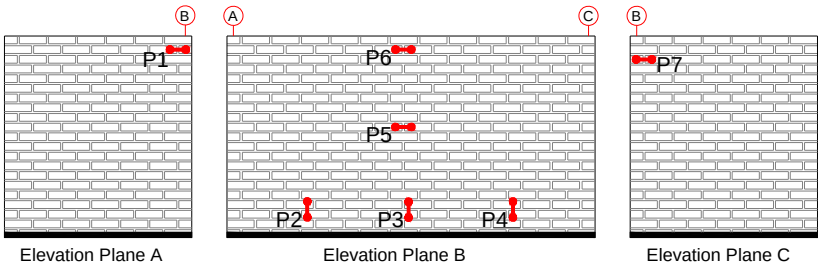
Test	Type	Frequency (hz)	Amplitude (mm)
11	random wave	10 - 15	10
12	random wave	10 - 15	15
13	sweep wave	0.8 - 20	0.5
14	random wave	5 - 15	10
15	random wave	5 - 15	20
16	random wave	5 - 10	20
17	random wave	5 - 10	30
18	random wave	5 - 10	40
19	random wave	5 - 10	50
20	random wave	3 - 8	70

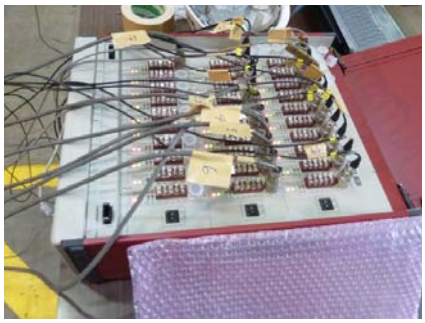
INSTRUMENTATION FOR THE TEST

Positions of accelerometers

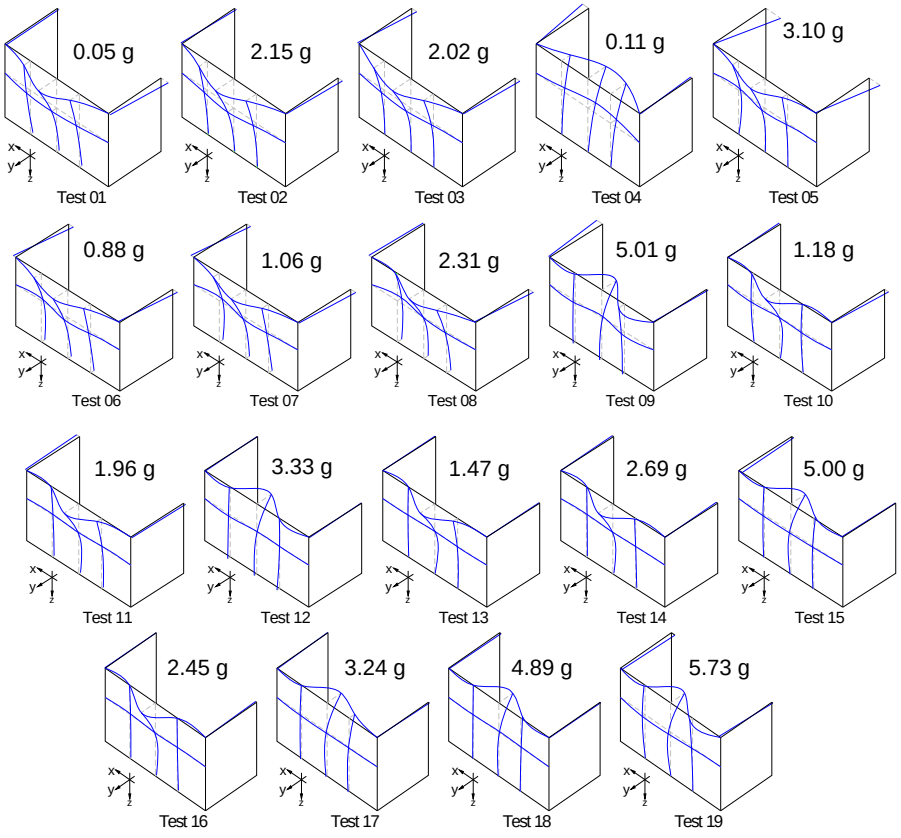


Positions of pi gauges

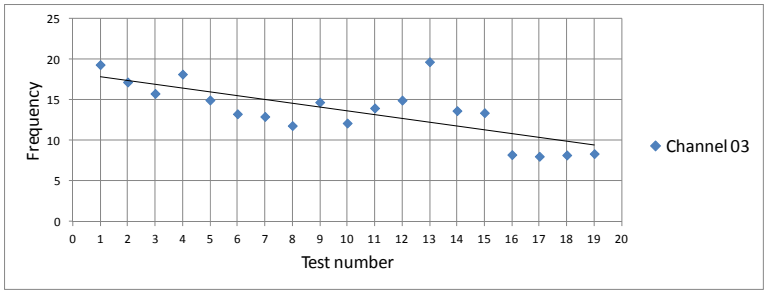


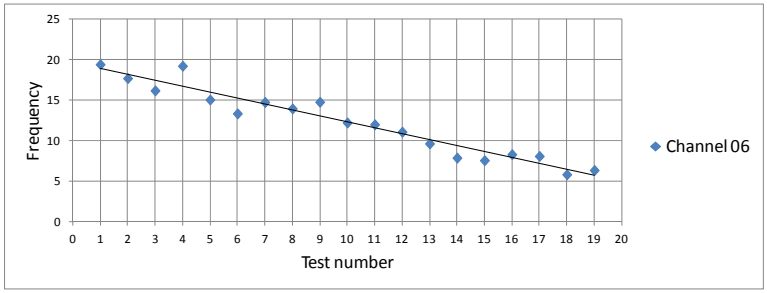


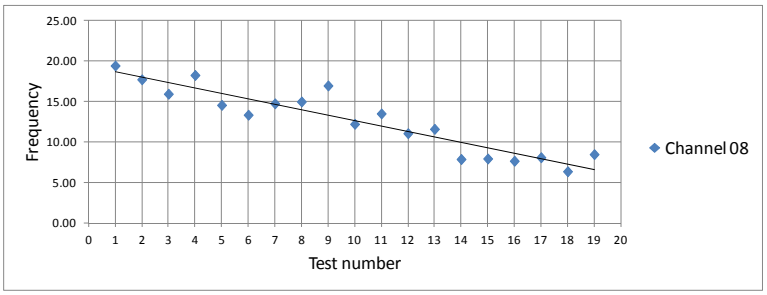
MAXIMUM ACCELERATION RECORDED

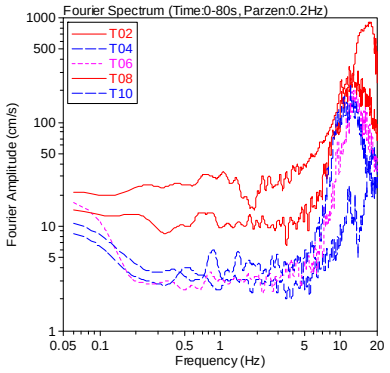


VARIATION OF THE NATURAL FREQUENCY

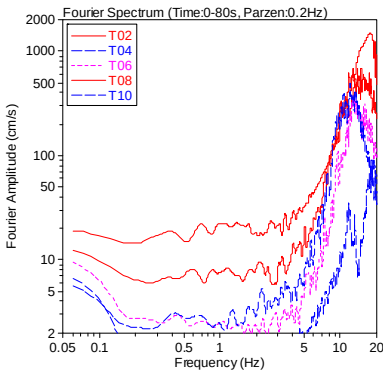






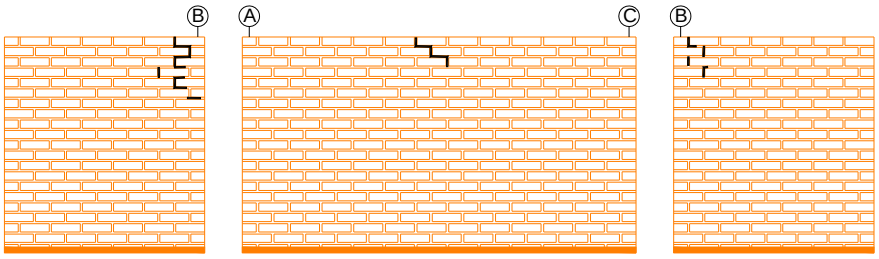


Channel 03



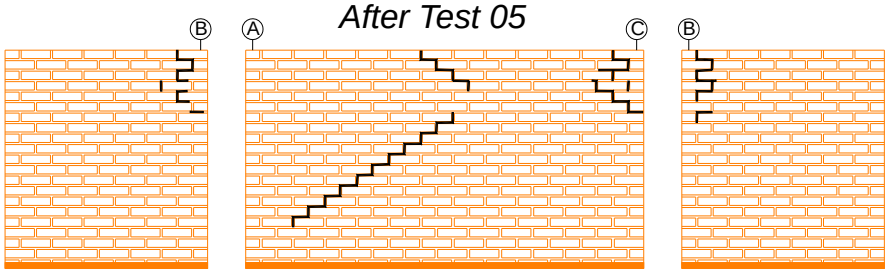
Channel 06

CRACK PATTERNS (1)



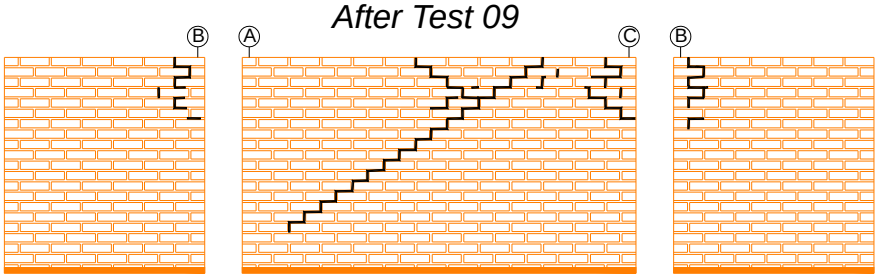
After Test 05

After Test 09



After Test 09

After Test 09



Elevation Plane A

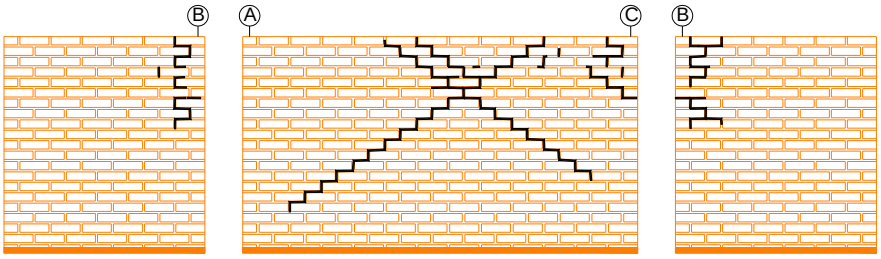
Elevation Plane B

Elevation Plane C

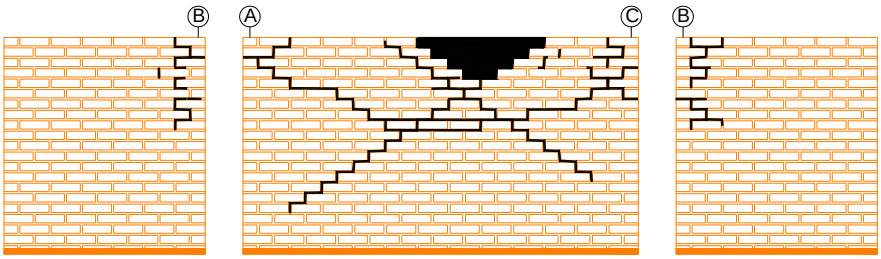
After Test 13

After Test 13

CRACK PATTERNS (2)



After Test 19

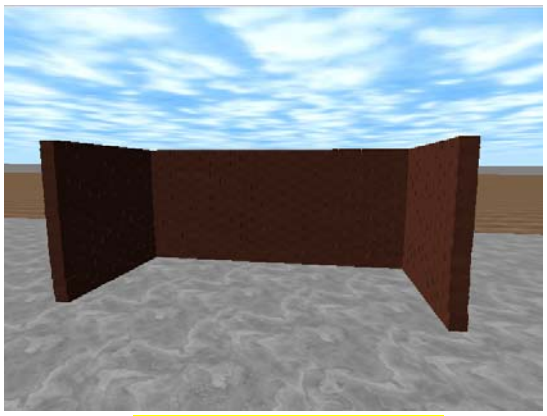


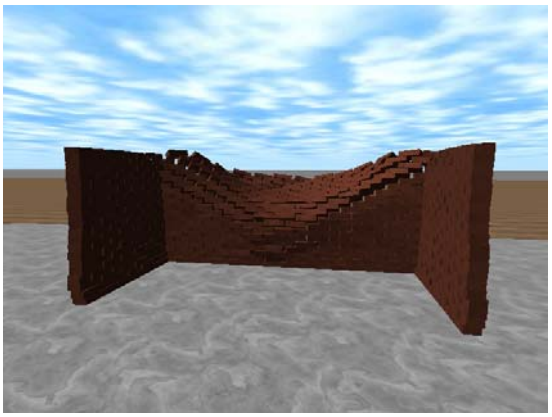
After Test 20

After Test 19

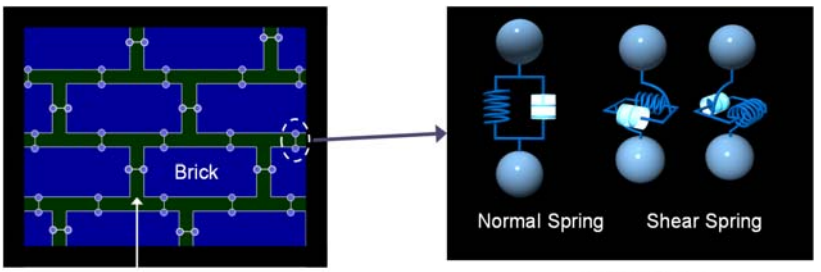
Progress Report

Simulation of collapse behavior of masonry structure





STERA_Briq



Discrete element model for brick

Progress Report
Diagnosis and Retrofit(1)

Literature Survey and Database of Seismic Diagnosis Method (Building Research Institute)

Review of Experimental Data
Resistance mechanism, failure mode, ultimate strength, ultimate displacement
Proposal: restoring force characteristics model
Proposal: equations to determine restoring force characteristics models

Review of Analytical Data
Analytical methods, analytical model
Proposal: restoring force characteristics model

Review of Design Codes
Analytical methods, target performance, acceptance criteria
design equations

Data Source
Domestic: Technical papers (AIJ, JCI etc.)
International: Existing design codes, technical papers (EERI, ACI, ASCE, etc.)

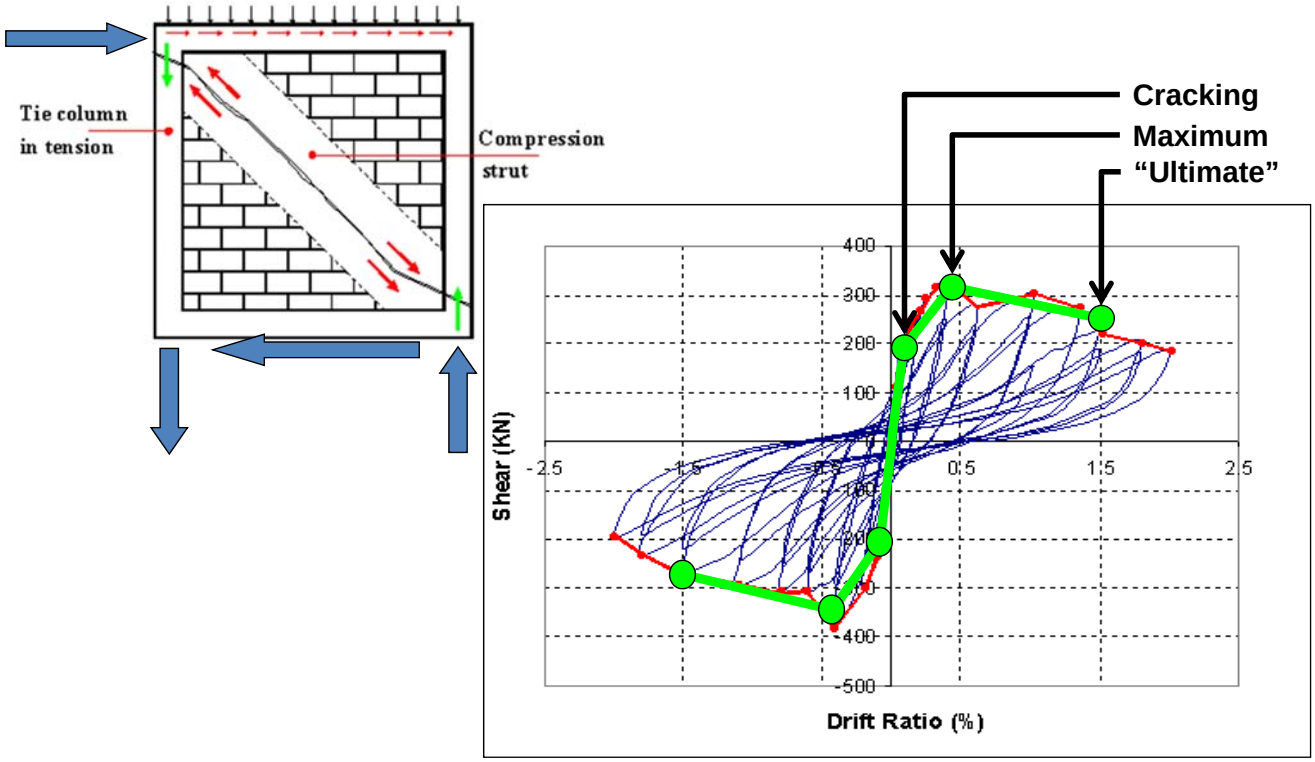
Collection of Data of Masonry Structure

(as of March 13, 2012)

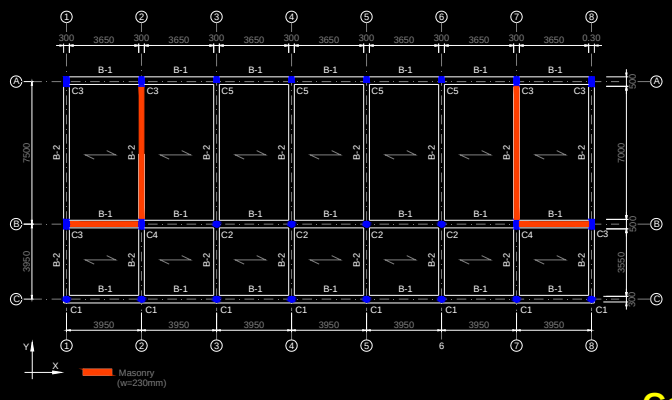
Reference	Total Number of Papers	Empirical Study	Others	Remarks
Architectural Institute of Japan (AIJ)	367	241	57:material 69: others	1979 - 2010
Japan Concrete Institute (JCI)	20	12	8: material, analysis, others	2003 - 2008
World Conference on Earthquake Engineering (WCEE)	243	89	154: design, analysis, others	1980(7WCEE) - 2008(14WCEE)
Earthquake Spectra (Earthquake Engineering Research Institute: EERI)	158	12	146: design, analysis, others	1984 - 2011

Masonry : Unreinforced Masonry, Reinforced Masonry and Confined Masonry

In-plane shear response



Progress Report
Diagnosis and Retrofit(2)



ELEVATION: Axis "B"

Seismic vulnerability assessment of Peruvian buildings using Japanese method (Is index)

Capacity

$I_S = 0.500$

$I_S = 0.300$

$I_S = 0.250$

> Demand ?

Is0 = 0.6 (Japan, RC)

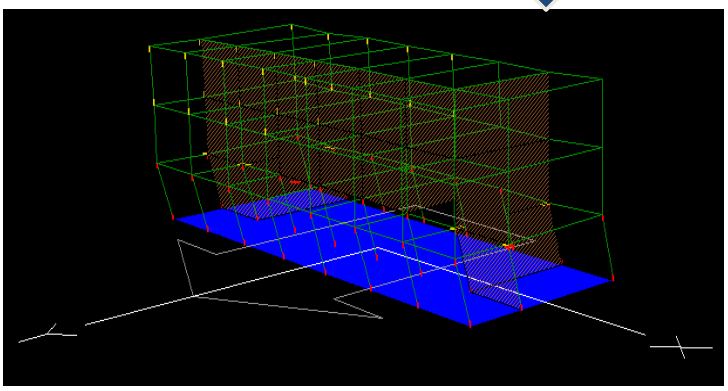
Is0 = 0.4 (Peru, RC)
= ? (Peru, Masonry)

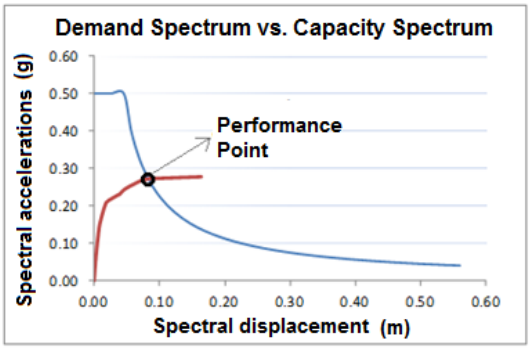
EXAMPLE: Framed Structure of RC - Usage: Education (Engineering Faculty FIC-UNI)

Progress Report

Simulation of dynamic performance of a building

STERA_3D





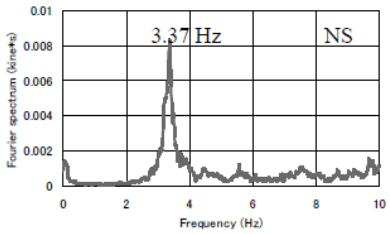
Progress Report

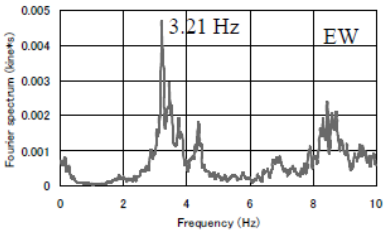
Retrofit of Historical Buildings

Vibration Characteristics of Traditional Adobe-Quincha Buildings (Akita Prefectural University, BRI and CISMID)

Comercio Hotel

Micro-tremor measurement





Dominant frequency

Human Resources Development

Lecture in CISMID

G3 meeting in CISMID

Lecture in TACNA

Short term training in BRI

Field survey of historical buildings in LIMA