

LEASSON LEARNED AND THE $M_w = 8.8$ CHILE EARTHQUAKE

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CHILE A HISTORY OF LARGE EQ

	FECHA	MAGNITUD	OBSERVACIONES
1570	Feb. 8	8 a 8 ½	Concepción.
1575	Dic. 16	8 ½	Valdivia.
1604	Nov. 24	8 ½	Norte de Arica.
1647	May. 13	8 ½	Valparaíso
1657	Mar. 15	8	Concepción
1730	Jul. 8	8 ¾	Valparaíso
1737	Dic. 24	7 ½ a 8	Valdivia
1751	May. 25	8 ½	Concepción
1796	Mar. 30	7 ½ a 8	Copiapó
1819	Abr. 3-11	8.3	Copiapó (3 terremotos).
1822	Nov. 19	8 ½	Valparaíso
1835	Feb. 20	8 a 8 ½	Concepción.
1837	Nov. 7	8	Valdivia.
1868	Ago. 13	8 ½	Arica.
1877	May. 9	8	Iquique
1880	Ago. 15	7 ½ a 8	Illapel
1906	Ago. 16	7.9	Valparaíso.
1922	Nov. 10	8.4	Vallenar
1928	Dic. 1	8.4	Talca
1939	Ene. 24	8- 8.3	Chillán
1943	Abr. 6	8.3	Illapel
1950	Dic. 9	8.0	Calama
1960	May. 22	9.5	Sur de Chile
1966	Dic. 28	8.1	Taltal
1985	Mar. 3	7.8	Zona Central
1995	Jul. 30	8.0	Antofagasta
2001	Jun. 23	8.4	Sur Peru
2005	Jun. 13	7.8	Tarapacá
2010	Feb. 27	8.8	Centro-Sur

Total ±30 eventos = en 440 años = Aprox. 1 cada 15 años.
Lomnitz, Campos, Comte, Riddell otros



NOT ALLOWED.
Limited by code drift requirements



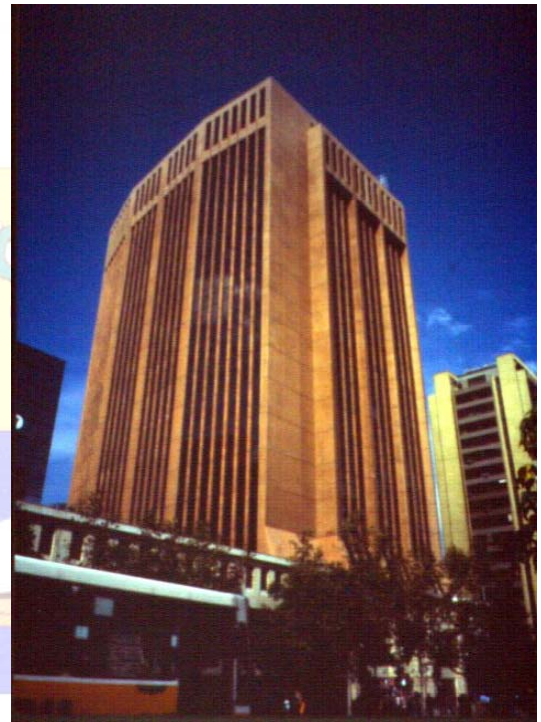
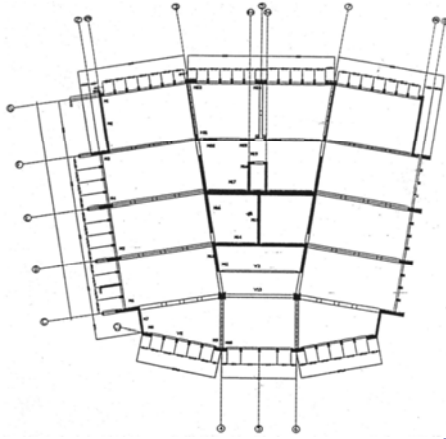
Chilean wall building extreme



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OFFICE BUILDING 1987

- Story = 21 + 3(S)
- Total H = 78 m h = 3.3 m
- Wall density = 2.3 - 4.6%/dirección
- T = 0.95 seg H/T = 82m/s

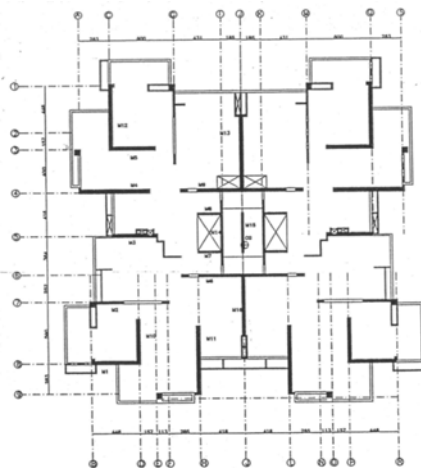


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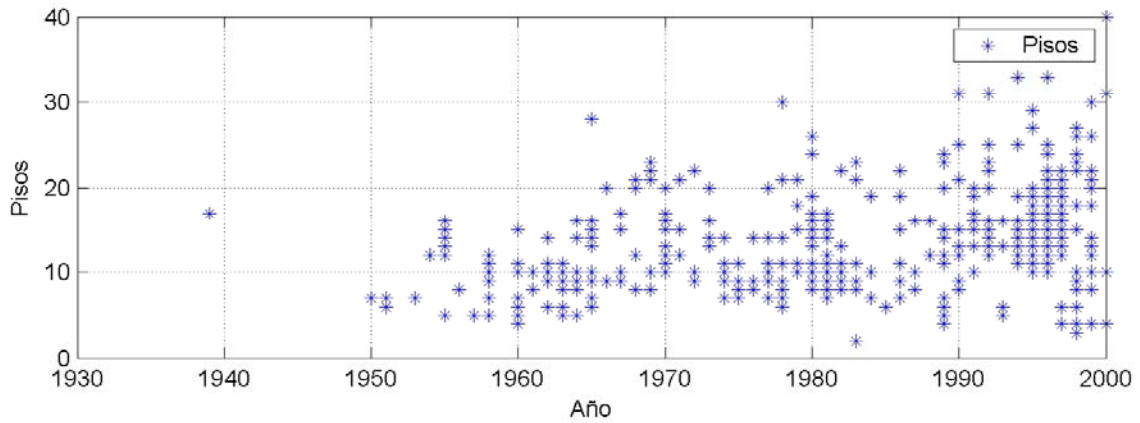
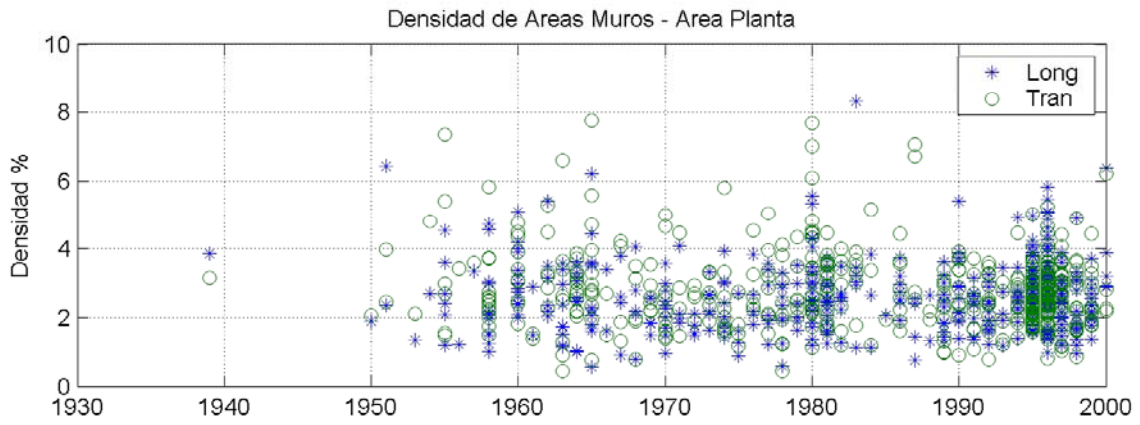


RESIDENTIAL 1996

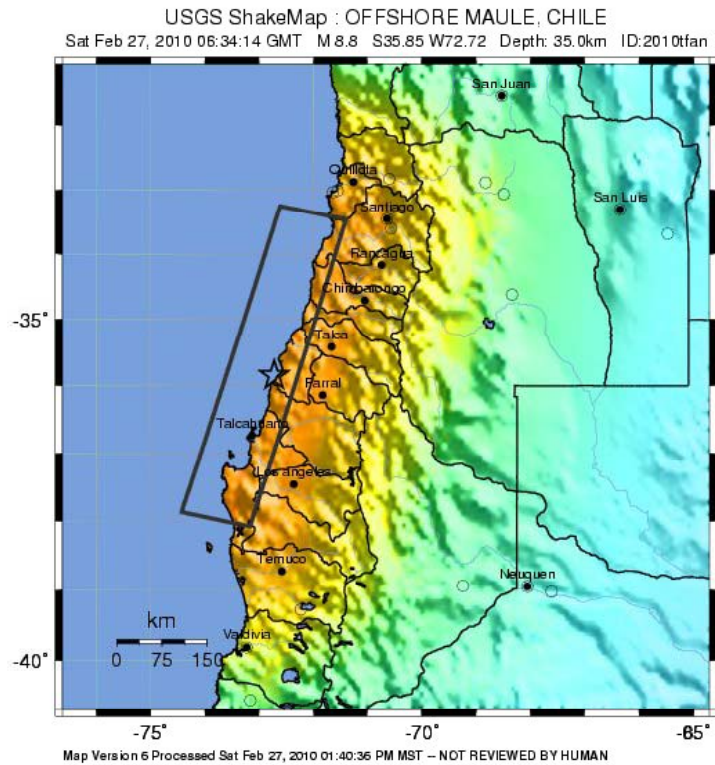
- N Storey = 24 + 3 (S)
- H = 73 m h = 2.7 m
- Wall Density d = 2% T y 1% L
- Tl = 1.0 seg
- Tr = 2.50 seg



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Moroni

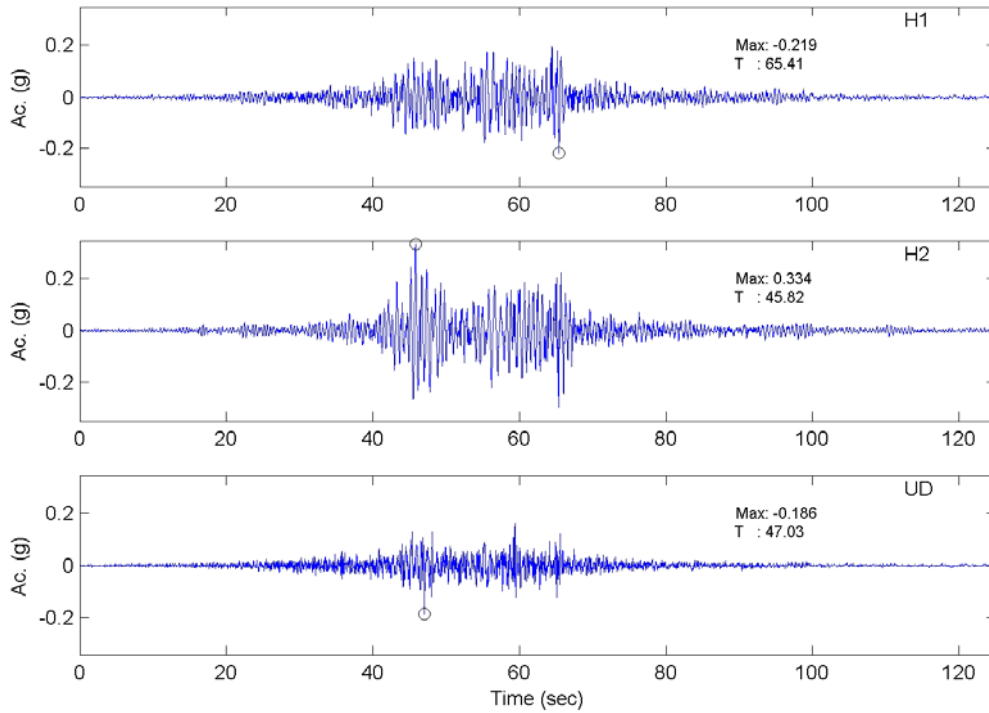


PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-18	18-31	31-60	60-118	>118
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+



MORE THAN TWO MINUTES OF SHAKING

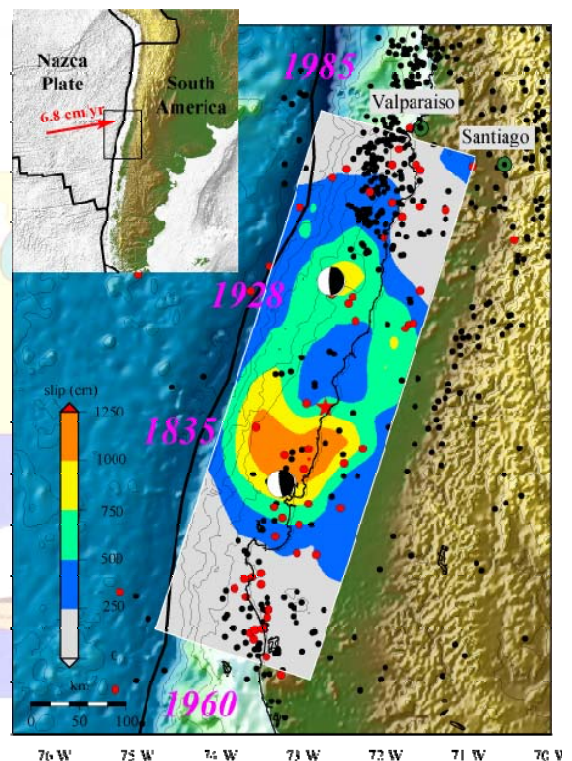
STATION: VIÑA DEL MAR - P. SOTO R. BOROSCHEK
 UNIVERSITY OF CHILE - NATIONAL STRONG GROUND MOTION NETWORK CIVIL ENG. DEPT.
 (Scale - Detrended)



ENGINEERING SEISMOLOGY

ACTION:

- Understanding ruptures, asperities and its impact on earthquake demands
 - GMPE
 - Frequency Contents
 - Duration
 - Amplitude Evolution
 - Activation of Surface Faults
 - Others
- Global and Local Deformations and Displacements
- Tsunami
- Basin and soil response
 - Vs30
 - Other Procedures for Soil Demand Characterization

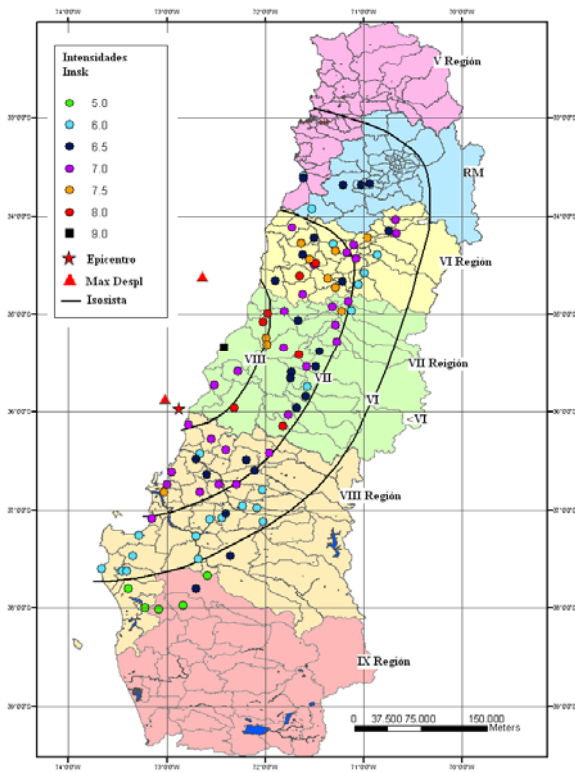


RESIDENTIAL DAMAGE



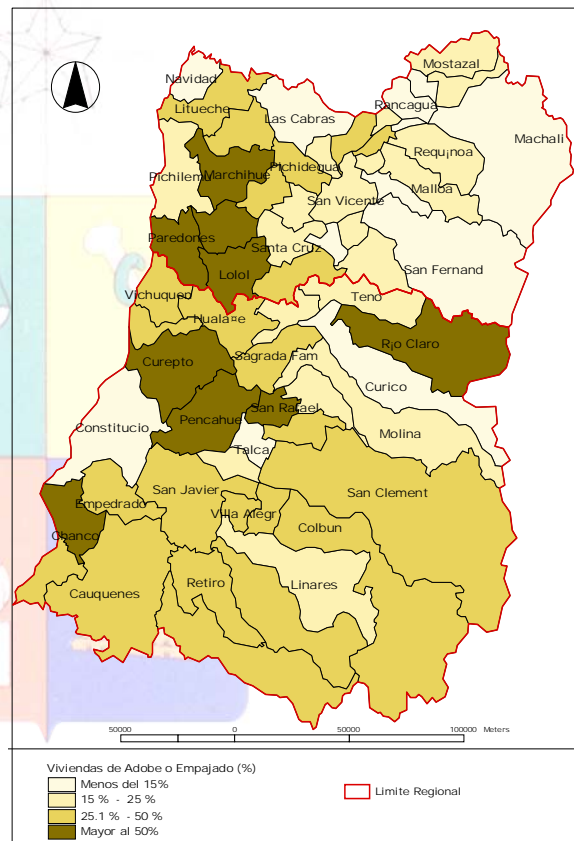
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Adobe Housing Distribution



Universidad de Chile
 M. Astroza - S. Ruiz

Stiff Soil Intensity M Astroza



Santiago



BONETT Y BLANDON

Concepción



Valparaíso



Viña del Mar

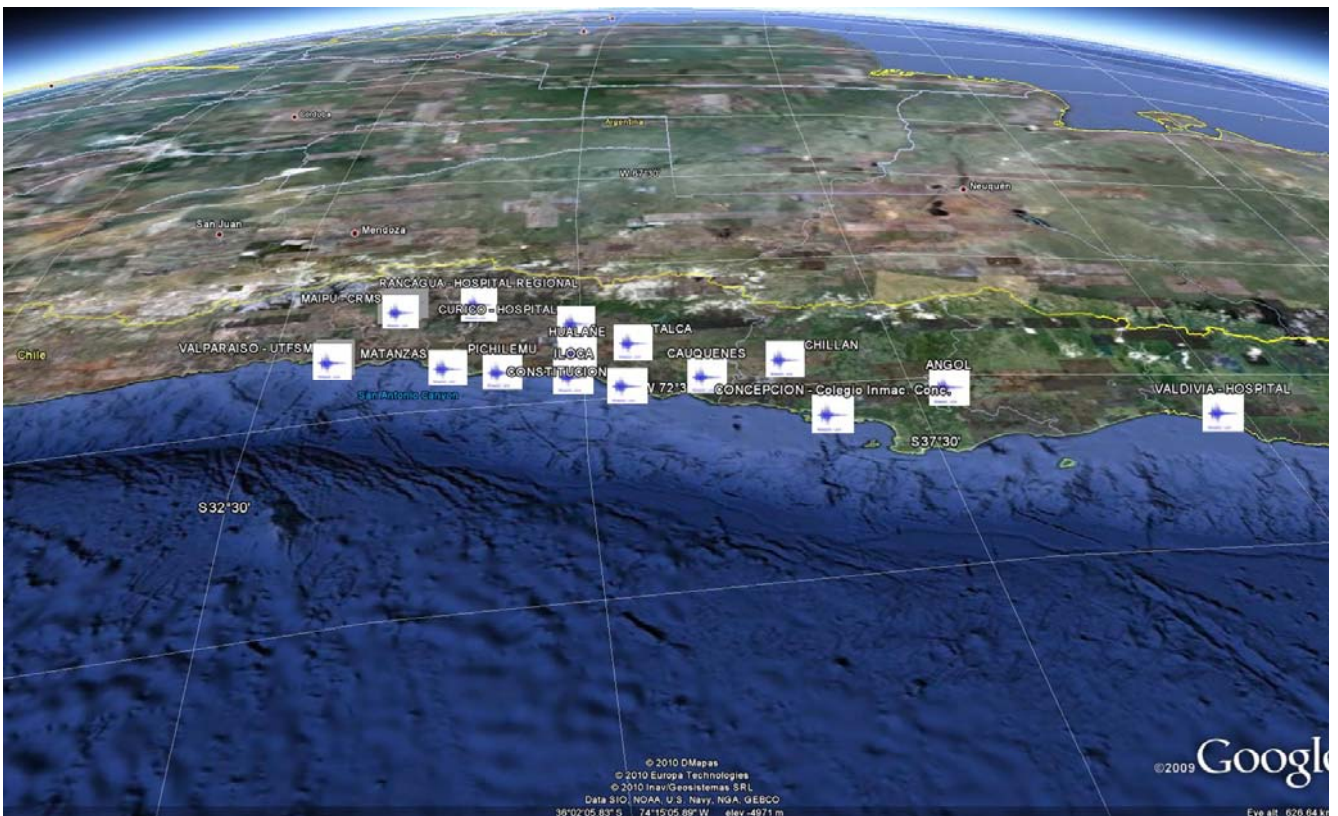
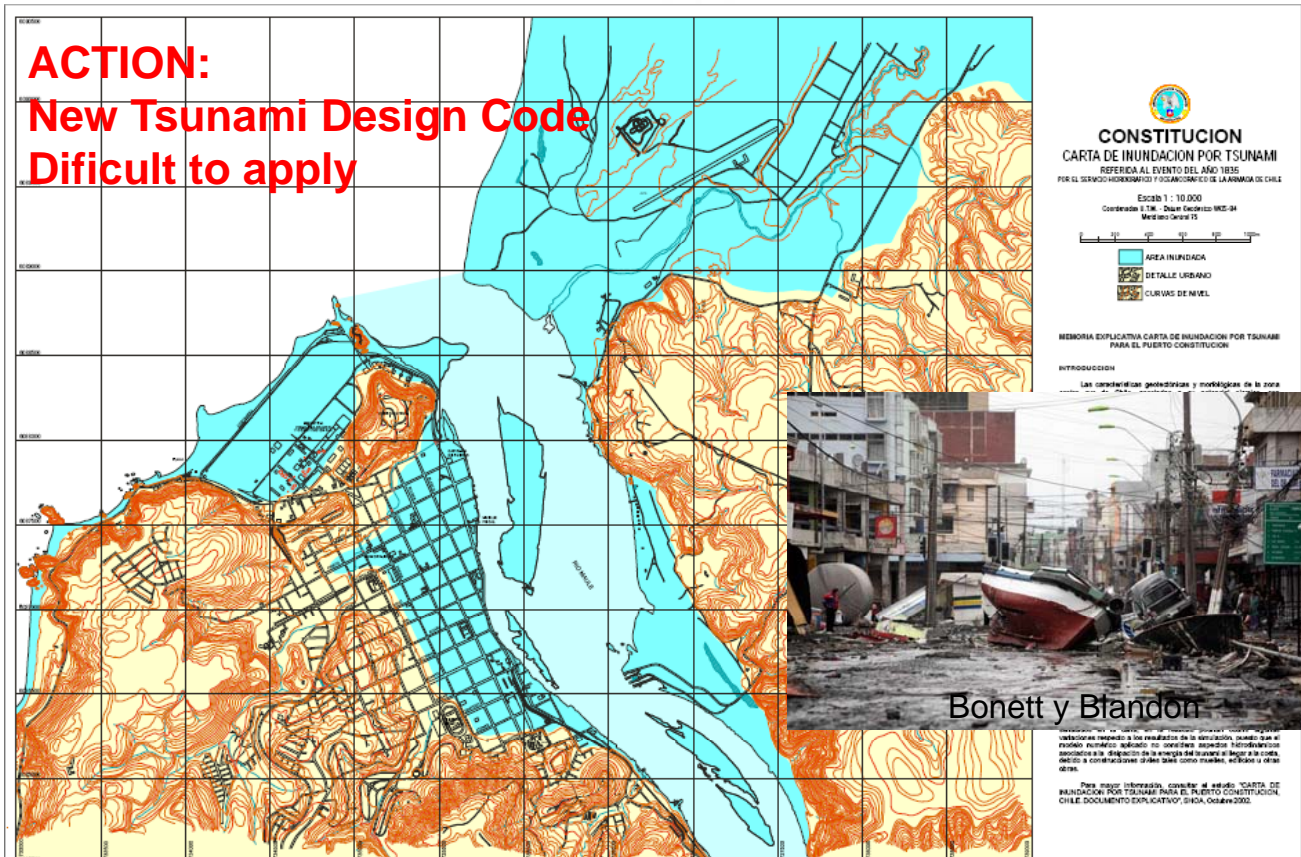


DICHATO

BEFORE

AFTER

TSUNAMI MODELING SHOA 2002



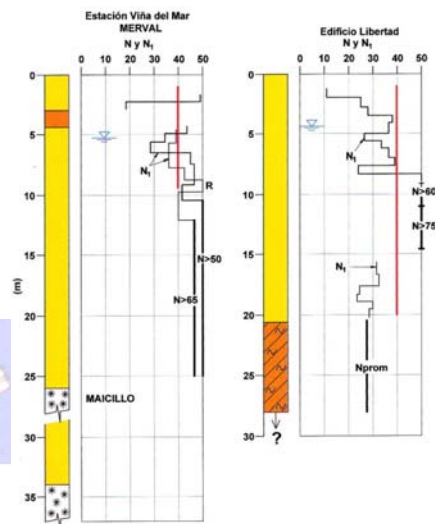
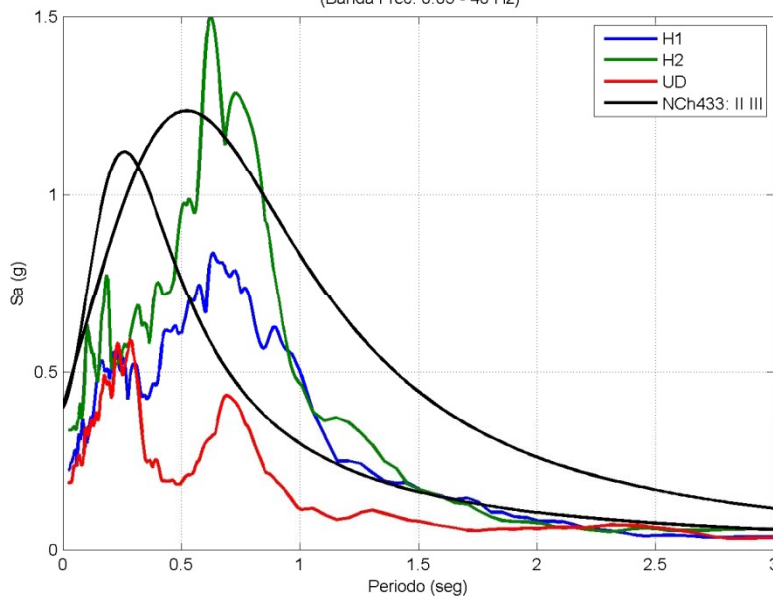
**Preliminary Process Records Maximum Acceleration
From Boroschek et al 2010 and DGF 2010.**

Station	Maximum Horizontal Acceleration (g)	Maximum Vertical Acceleration (g)
Santiago Universidad de Chile	0.17	0.14
Santiago Elevated Train Station Mirador	0.24	0.13
Santiago CRS MAIPU	0.56	0.24
Santiago Hosp. Tisne	0.30	0.28
Santiago Hosp. Sotero de Río	0.27	0.13
Santiago Cerro Calán	0.23	0.11
Santiago Campus Antumapu	0.27	0.17
El Roble Hill	0.19	0.11
Viña del Mar (Marga Marga)	0.35	0.26
Viña del Mar (Downtown)	0.33	0.19
Curico Hospital	0.47	0.20
Concepción Colegio San Pedro	0.65	0.60
Valdivia Hospital	0.14	0.05



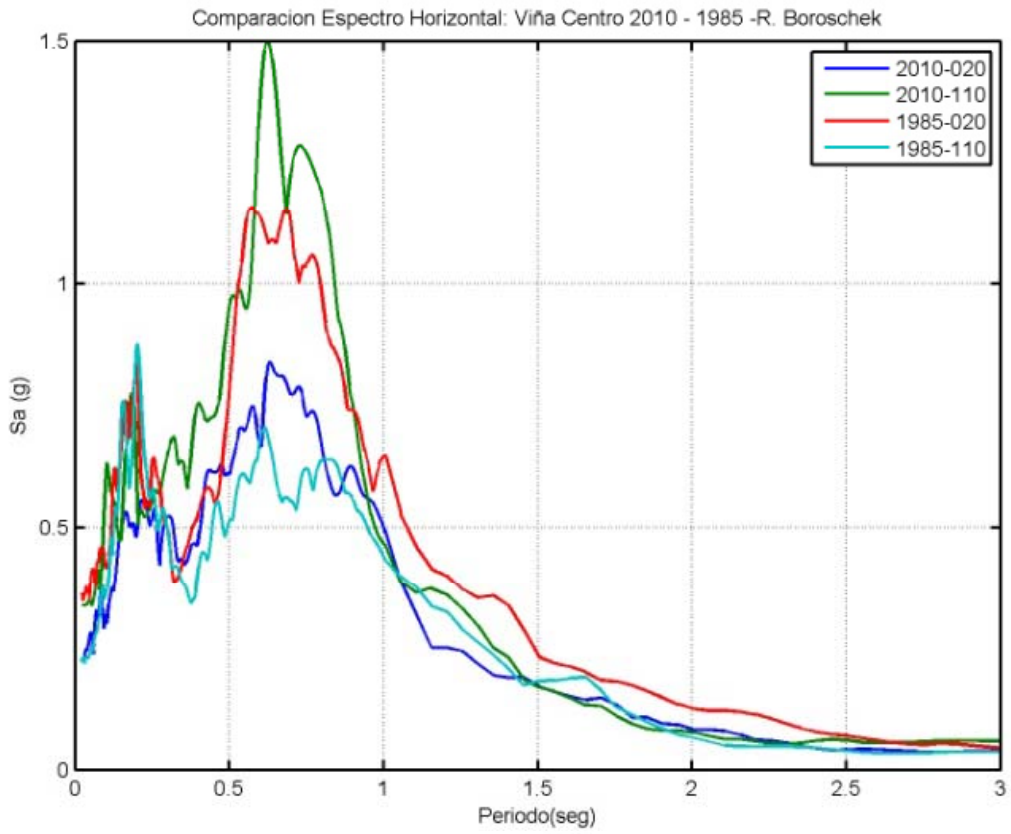
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ESPECTRO de RESPUESTA $\beta = 5\%$
RENADIC STATION: VIÑA DEL MAR - P. SOTO R. BOROSCHEK
UNIVERSITY OF CHILE - RENADIC
(Banda Frec: 0.05 - 40 Hz)

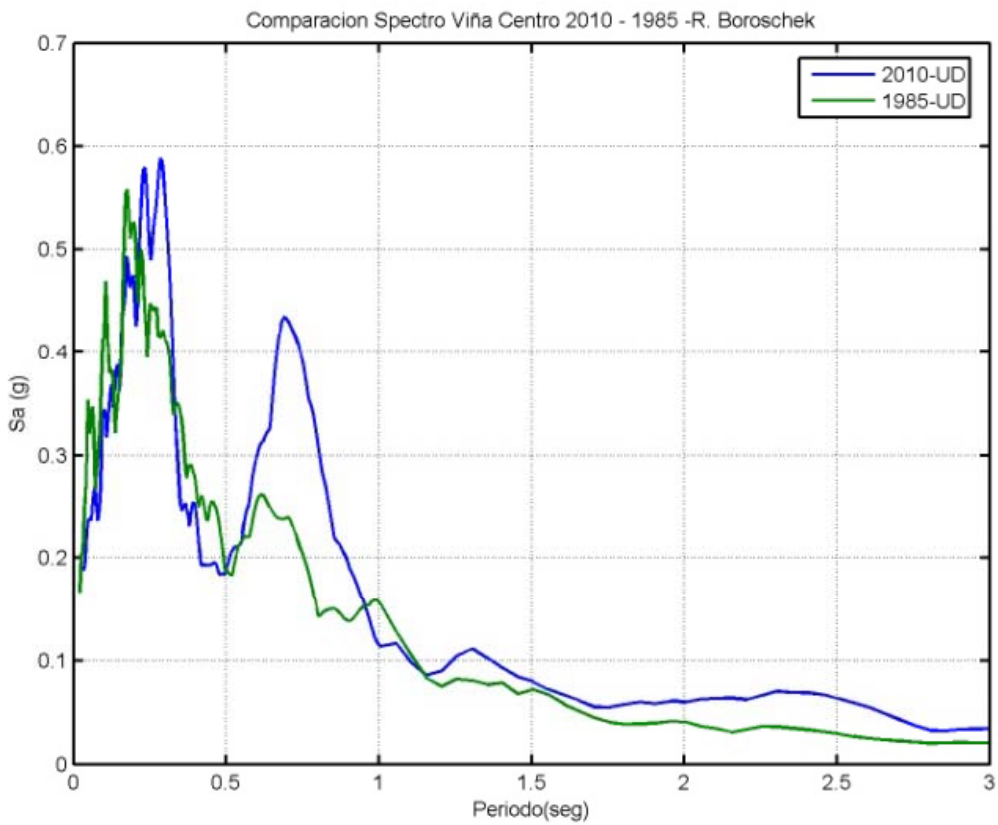


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PETRU S ORTIGOSA

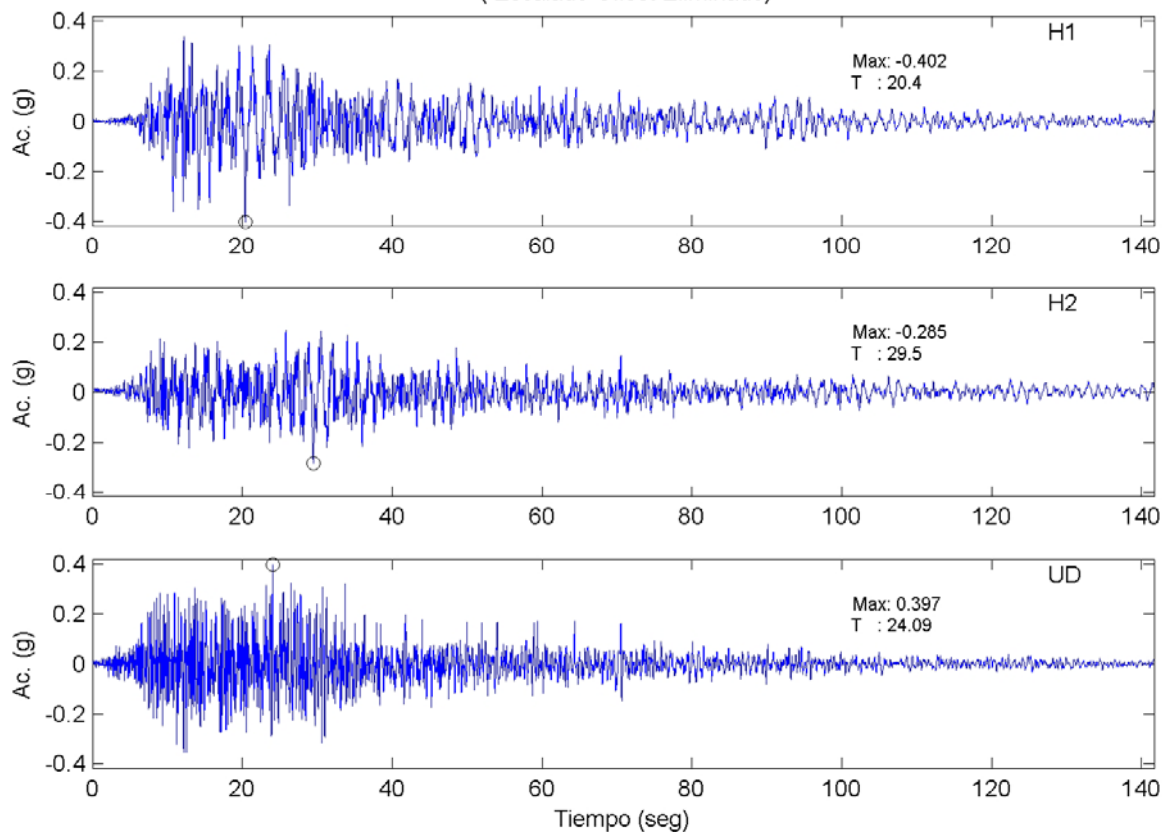


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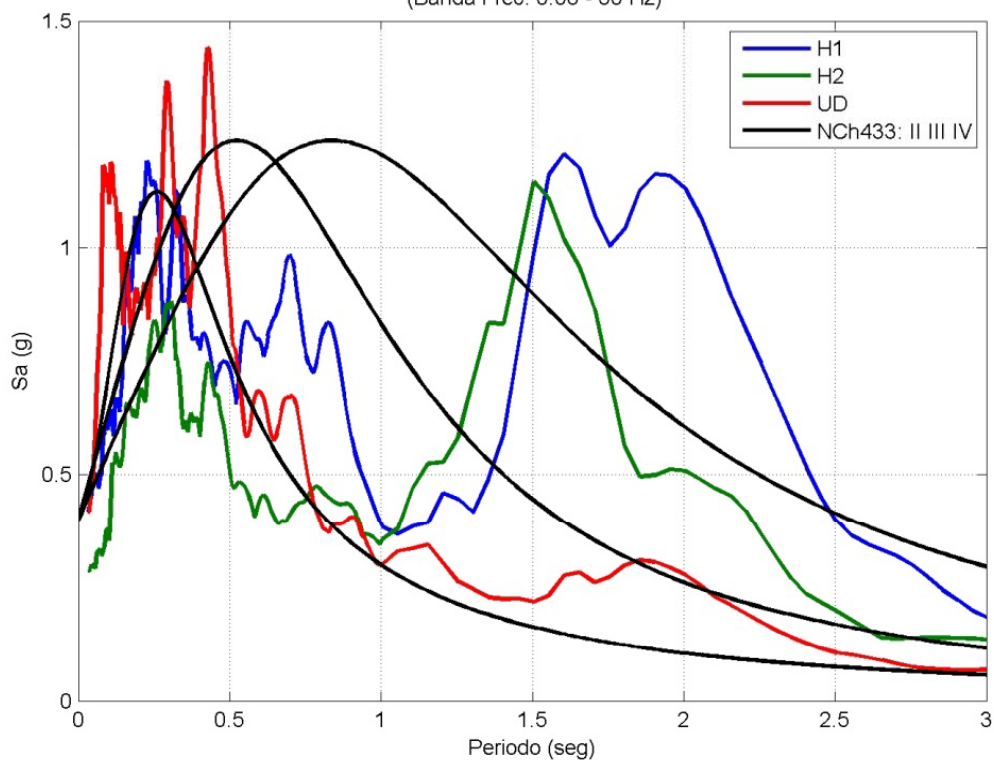


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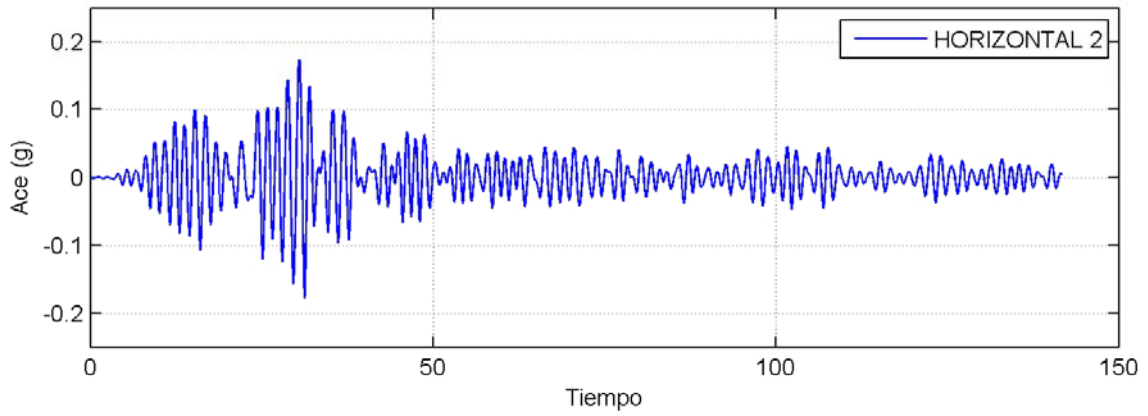
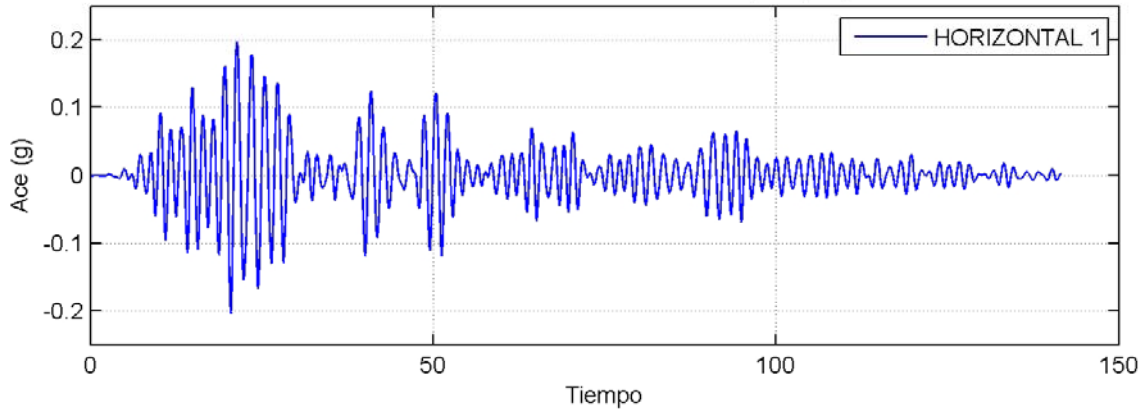
RENADIC ESTACION: CONCEPCION CENTRO PRELIMINAR/ R. BOROSCHEK
UNIVERSIDAD DE CHILE RED NACIONAL DE ACELEROGRAFOS
(Escalado Offset Eliminado)



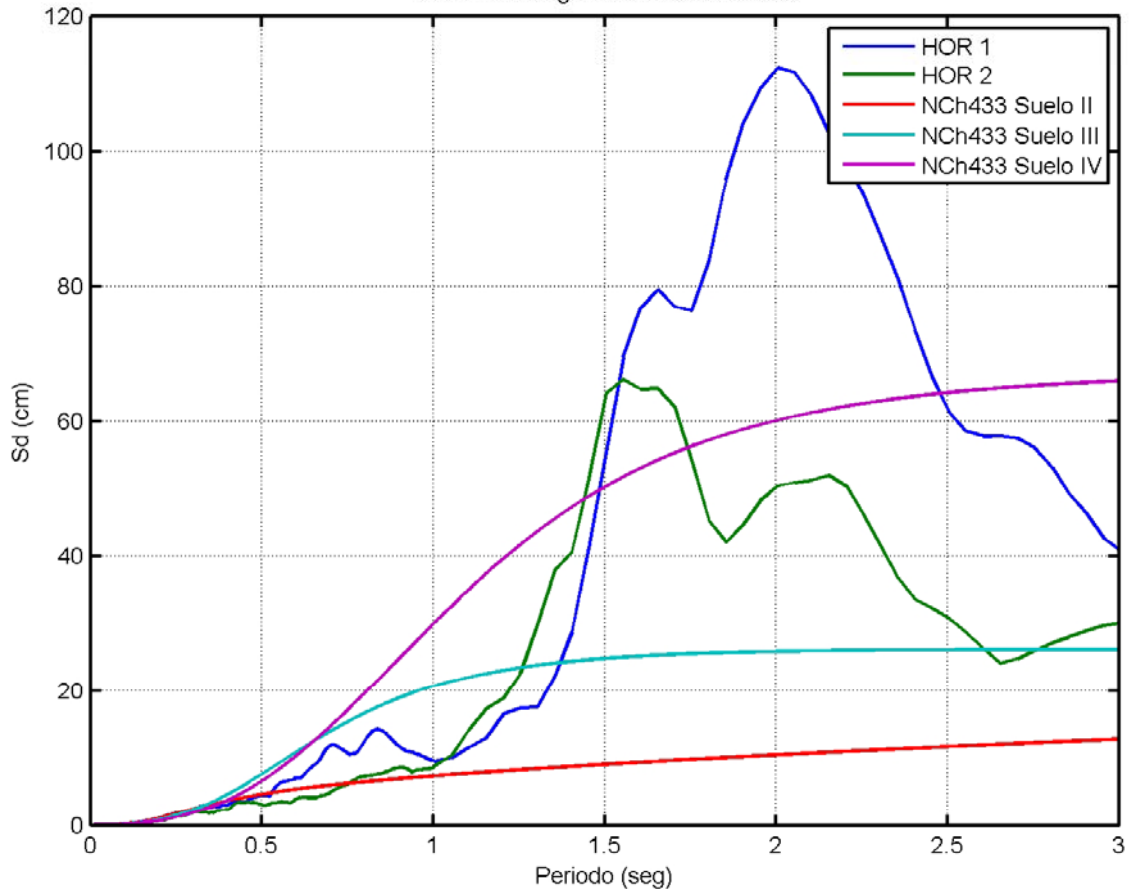
ESPECTRO de RESPUESTA $\beta = 5\%$
RENADIC ESTACION: CONCEPCION CENTRO PRELIMINAR/ R. BOROSCHEK
UNIVERSIDAD DE CHILE RED NACIONAL DE ACELEROGRAFOS
(Banda Frec: 0.08 - 30 Hz)



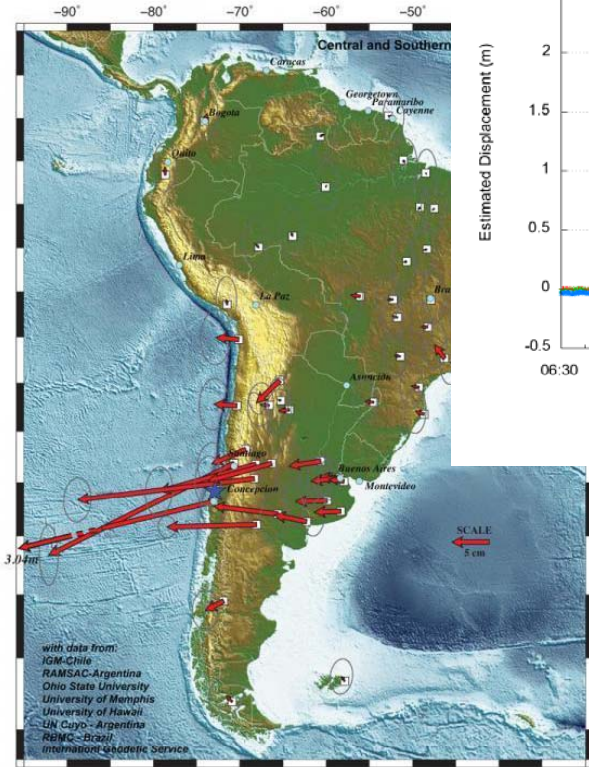
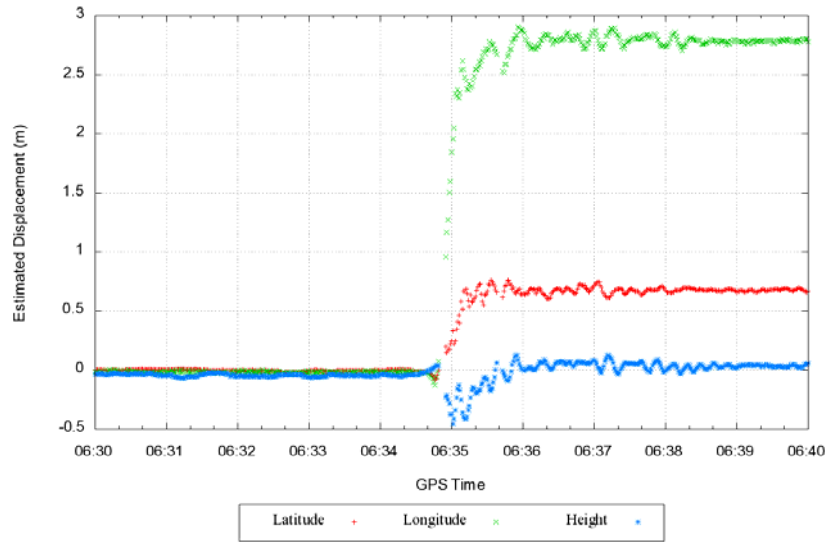
REGISTRO CONCEPCION CENTRO FILTRADO T=[1 - 3] seg R. Boroschek



ESPECTRO RESPUESTA CONCEPCION CENTRO R. Boroschek
Razon Amortiguamiento Critico: 0.05



Station CONZ, 2010/02/27 - Chile Earthquake

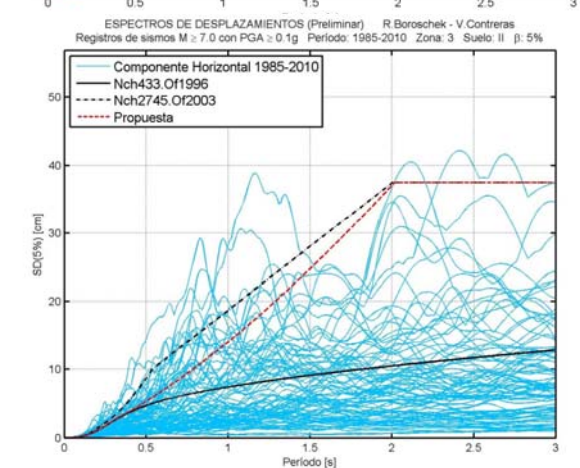
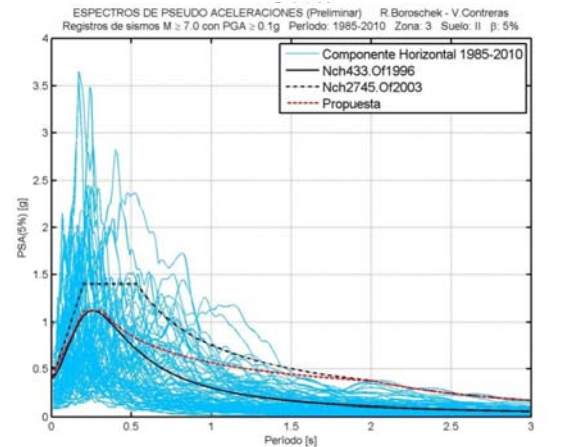
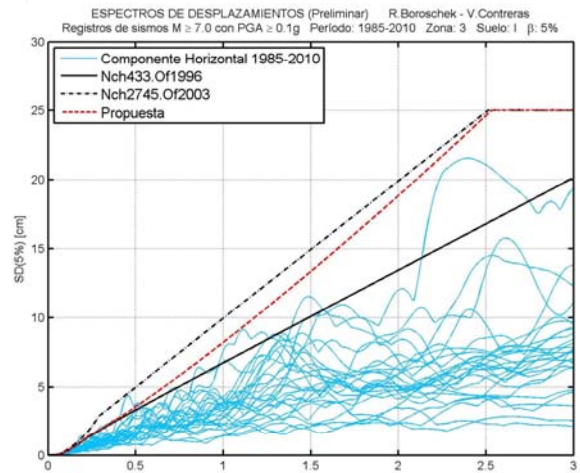
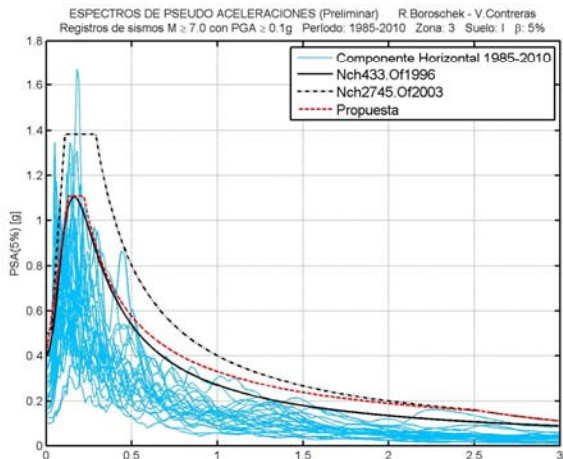


Simon Banville University of New Brunswick

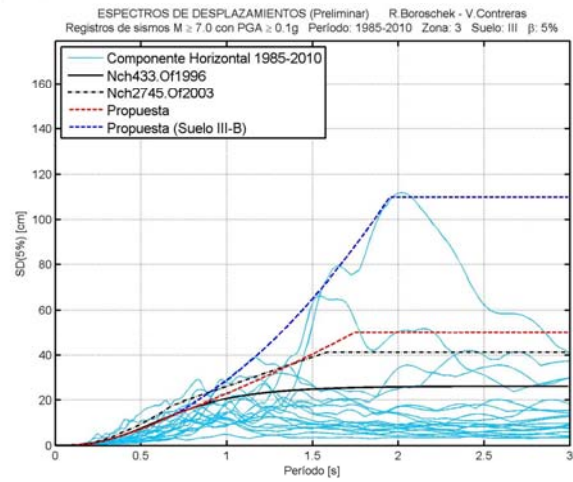
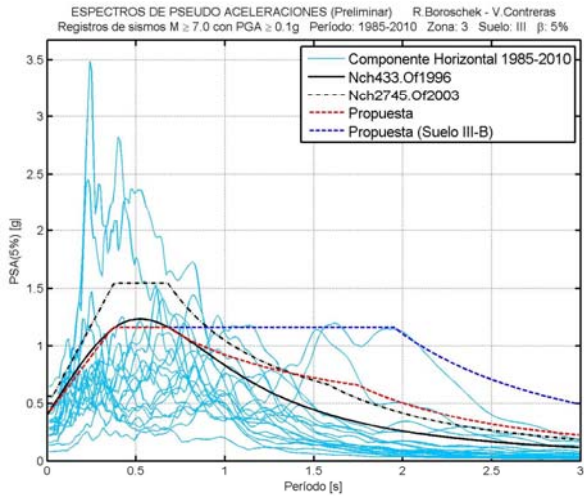
GPS DISPLACEMENTS

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NEW SPECTRUM FOR BUILDINGS

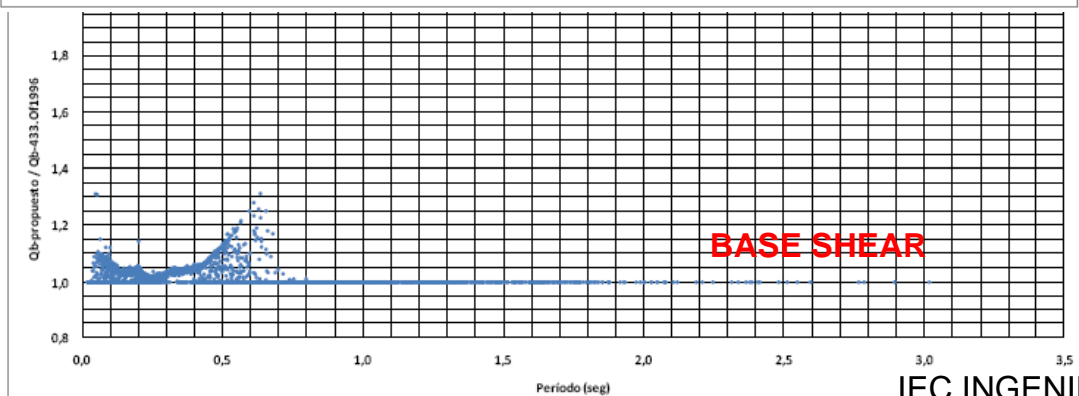
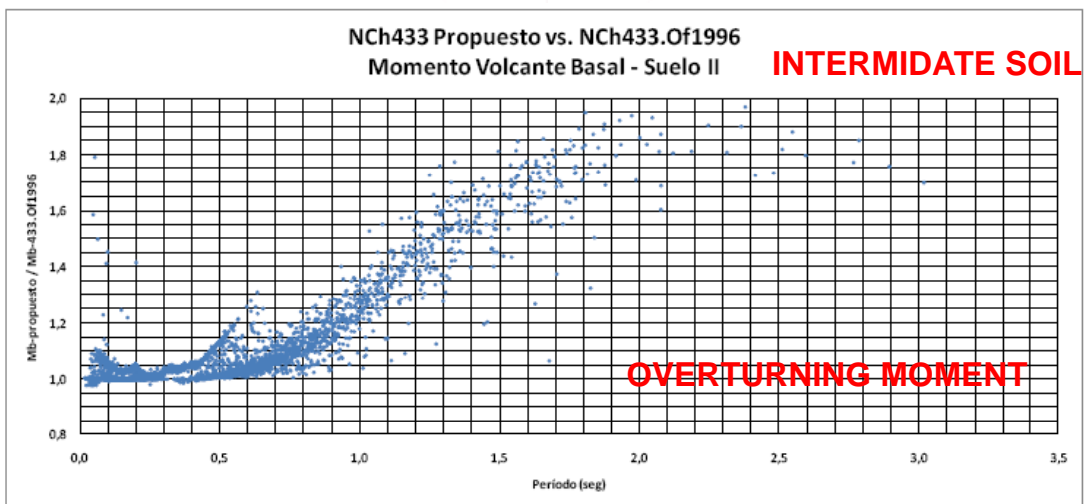


NEW SPECTRUM FOR BUILDINGS



R. Boroschek - V.
Contreras
Universidad de Chile

CALIBRATION OF PROPOSAL



VIÑA DEL MAR



R. Boroshek
le.cl

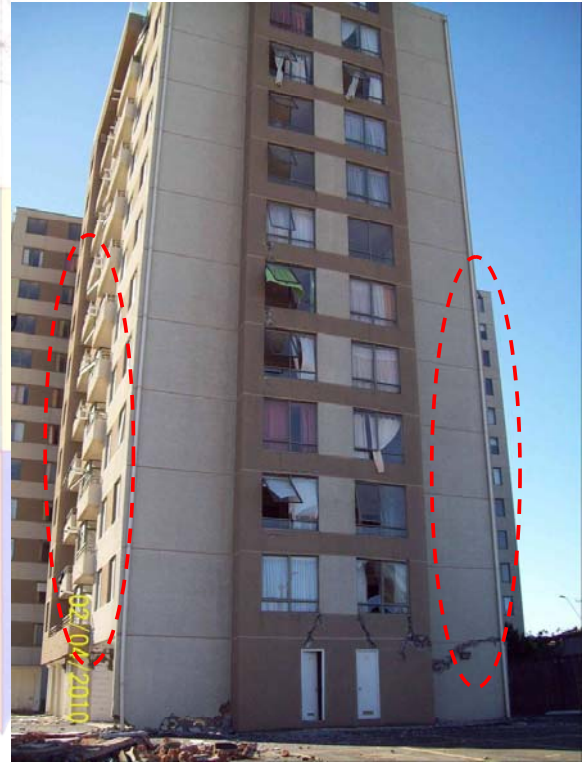
WALL DAMAGE



MEDIUM HEIGHT BUILDINGS

ACTION:

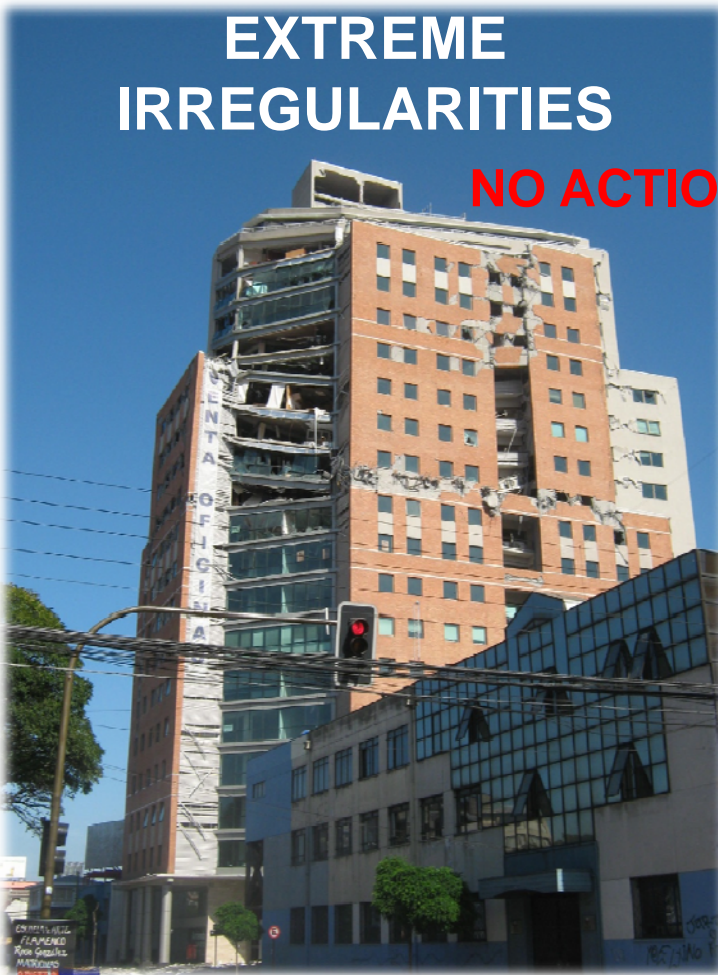
- Confinement/Detailing **MODIFY**
- Slenderness **MODIFY**
- Displacement/Cyclic Demands
- Discontinuities
- Ductility of walls **MODIFY**
- Axial load effects **MODIFY**



L. MASSONE

EXTREME IRREGULARITIES

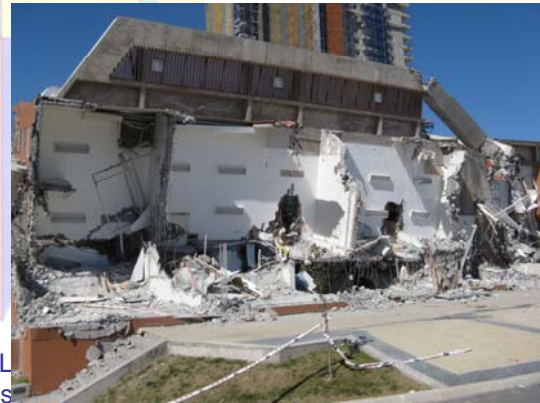
NO ACTION



BONETT Y BLANDON



ALTO RIO



CHIL
motos

SLAB WALL INTERACTION



ACTION:
Larger Displacement Demand
Strict displacement control



SLAB WALL INTERACCTION



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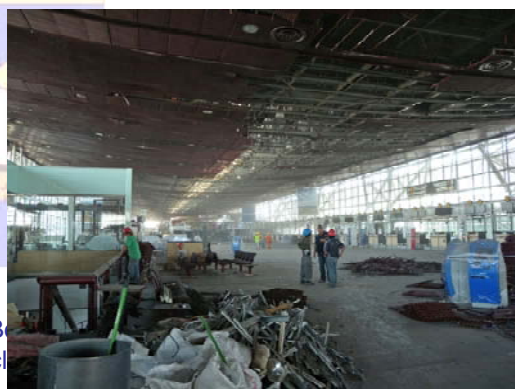
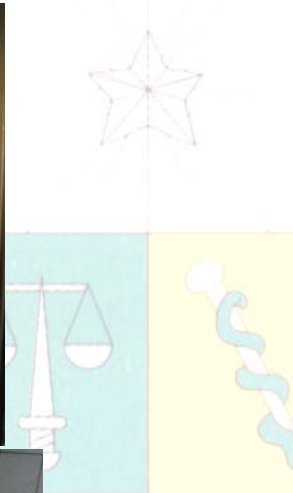
NON STRUCTURAL



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ACTION:
New Design Code

NON STRUCTURAL



BO DE CHILE - R. B
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BONETT Y BLANDON

Pre Mid-
1990s
practice

Recent
practice

Puente Perqui Lauquen
(JSCE, 2010)



Santiago (Marco Fredes, REUTERS)



ACTION:
Back to old requirements

