ICH
Instituto del Cemento y del Hormigón de Chile

Precast Concrete in Chile

Augusto Holmberg F.

a land of natural beauty

Gentileza Achisina

and modern buildings

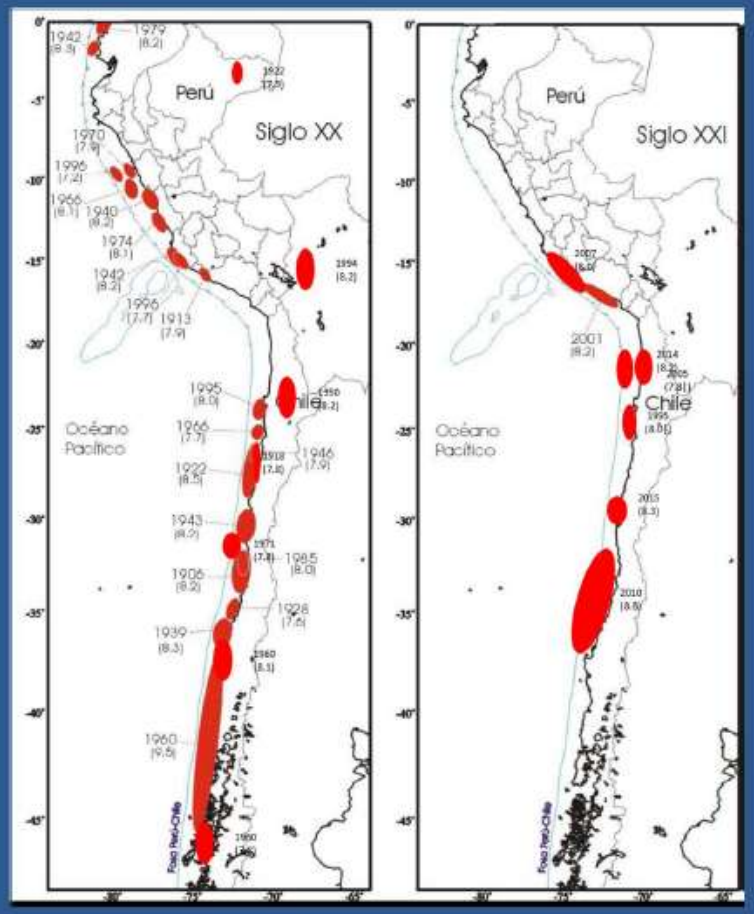
Gentileza R. lagos

a land of large earthquakes

CHILE A HISTORY OF LARGE EQ (1570 – 2015)

XX Century

XXI Century



Boroschek 2016, based on Tavera et al IGP 2007

31 EQ → 1 every 15 years

DATE	MAGNITUDE	APROX LOCATION
1570 Feb.8	8 - 8 1/2	Concepcion
1575 Dec. 16	8 1/2	Valdivia
1604 Nov.24	8 1/2	North de Arica
1647 May. 13	8 1/2	Valparaiso
1657 Mar. 15	8	Concepcion
1730 Jul. 8	8.8	Valparaiso
1737 Dec. 24	7 1/2 - 8	Valdivia
1751 May. 25	8 1/2	Concepcion
1796 Mar. 30	7 1/2 - 8	Copiapo
1819 Apr. 3-11	8.3	Copiapo (3 EQ)
1822 Nov. 19	8 1/2	Valparaiso
1835 Feb.20	8 - 8 1/2	Concepcion
1837 Nov.7	8	Valdivia
1868 Aug.13	8 1/2	Arica
1877 May.9	8	Iquique
1880 Aug. 15	7 1/2 - 8	Illapel
1906 Aug.16	7.9	Valparaiso
1922 Nov.10	8.4	Vallenar
1928 Dec. 1	8.4	Talca
1939 Jan.24	8 - 8.3	Chillan
1943 Abr. 6	8.3	Illapel
1950 Dec. 9	8	Calama
1960 May. 22	9.5	Sur de Chile
1966 Dec. 28	8.1	Taltal
1985 Mar. 3	8	Zona Central
1995 Jul. 30	8	Antofagasta
2001 Jun.23	8.4	South Peru
2005 Jun.13	7.8	Tarapaca
2010 Feb.27	8.8	Center-South
2014 Apr. 1	8.2	Iquique
2015 Sep. 16	8.3	Canela Baja

Boroschek 2016, Modificado de Lomnitz

27F Chile Earthquake

Magnitud Mw=8.8

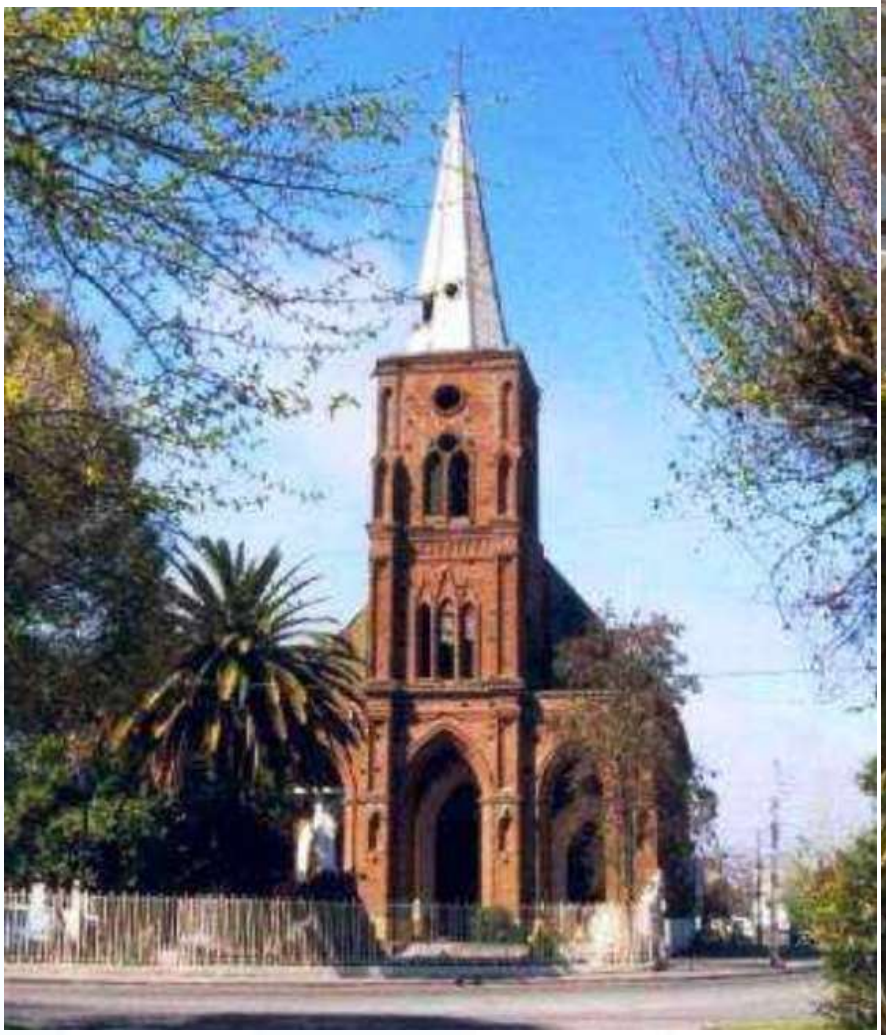
Epicenter: Cobquecura

Depth: 35 Km

Date: 27 Feb. 2010

Time: 3:35 AM

Church in Curico



Building - Concepción

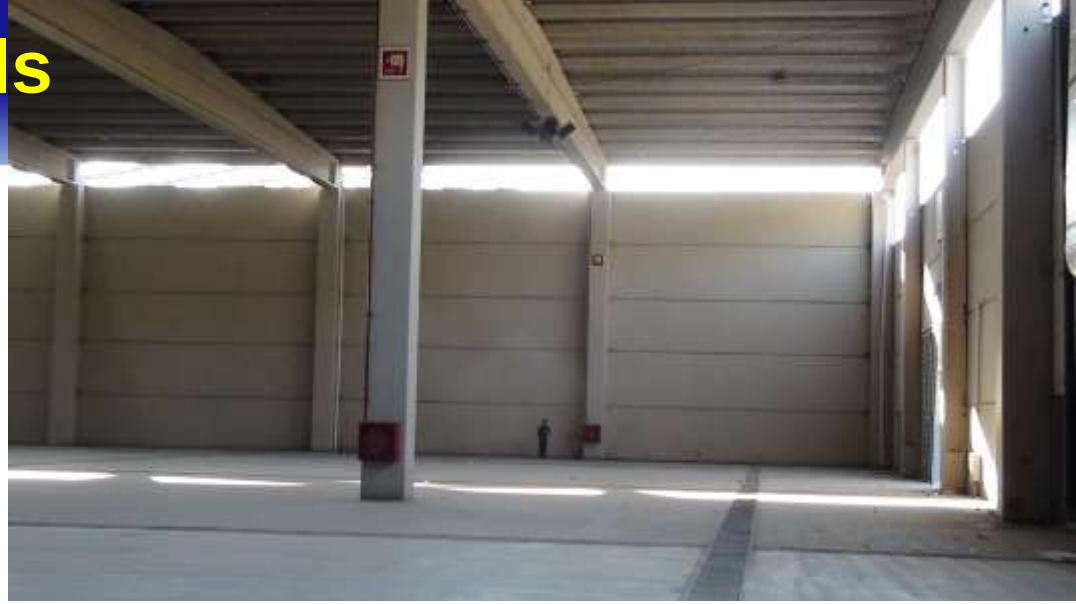
Non structural damage

Tsunami damage

Precast structures

Gentileza David Campusano

Precast cladding panels



The facts

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1.- Extensive damage in non engineered structures

Unreinforced Masonry
Adobe construction
Near 500 fatalities, most of them on adobe construction

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Very good performance with less than 2% of buildings damaged (9 stories and up)
4 buildings collapsed
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Some damage mostly related to large displacement demands (bad soils)
Cinematic compatibility issues

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4.- Tsunami was a game changer

Near 200 fatalities can be attributed to the tsunami

The most importante lesson

The most importante lesson

Life safety is paramount …

The most importante lesson

Life safety is paramount …

but is not enough

The most importante lesson

Life safety is paramount …

but is not enough any more …

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but is not enough any more …

Resilience should be the goal !!!

Earthquake performance

What is Resilience?

Resilience is the ability to recover and return to normal functioning after adversity.

Possible strategies in building seismic design:

- Avoid damage
- Allow some damage that is easily reparable
- Avoid collapse? *(LS issue not a functional issue)*

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Is it possible …?

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Is it possible …?

We believe the answer is YES

but, more important, is our responsibility

to try and make it happen.

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Let's see some projects …

Columnas with socket foundations

Jointed or rigid beam–column joint

Roof bracing diaphragm (diagonals or roof beams)

SIRVE
SEISMIC PROTECTION TECHNOLOGIES


Columnas with socket foundations
Jointed or rigid beam–column joint
Roof bracing diaphragm (diagonals or roof beams)

Distribution center

Centro de Distribución
Ripley
Gentileza Tensacon

Distribution center

Centro de Distribución
Almacenes Paris
Gentileza Tensacon

Convention center

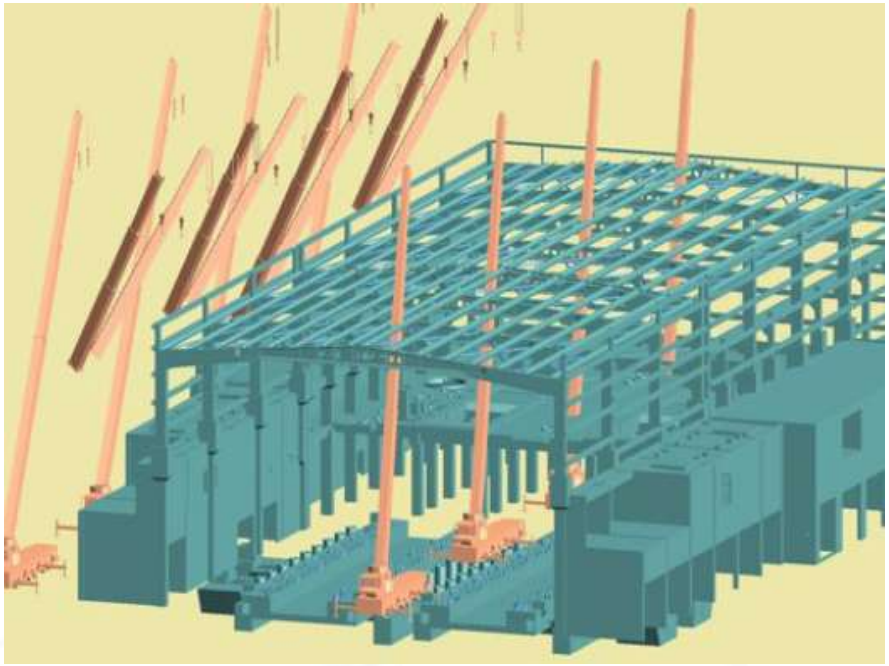
Centro de
Convenciones
Espacio Riesco
Gentileza Preansa

Convention center

Centro de Convenciones Espacio Riesco Gentileza Preansa

Cellulose factory

Precast and cast in place …



Socket foundation over cast in place structure

Planta Nueva Aldea.
Celulosa Arauco
Gentileza Preansa

Cellulose factory

Speed of construction …

Fire safety …

Planta Nueva Aldea.
Celulosa Arauco
Gentileza Preansa

Power station at Los Andes

The Place …

The Road…

Sub estación Andina
Gentileza Preansa

Power station at Los Andes

Excavation …

Erection…

Sub estación Andina
Gentileza Preansa

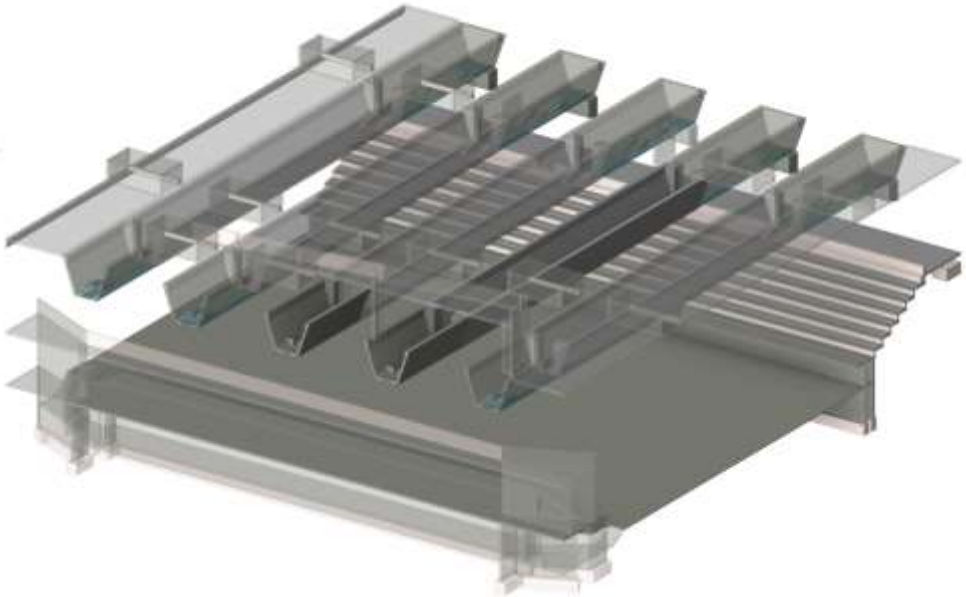
Power station at Los Andes

Erection …

Ready in 4 months (summer season)…

Sub estación Andina
Gentileza Preansa

Saint George School Gym



Gentileza
Ruiz Saavedra Ingenieros
Preansa

Saint George School Gym

Gentileza
Ruiz Saavedra Ingenieros
Preansa

Seismic isolation in buildings

Edificio Vulco
Gentileza Tensocret

Seismic isolation in buildings

Edificio Marina Paihue
Gentileza Tensocret

Seismic isolation in buildings

Edificio Marina Paihue
Gentileza Tensocret

Seismic isolation in a school

Colegio en Santiago
Gentileza Momenta

Seismic isolated school

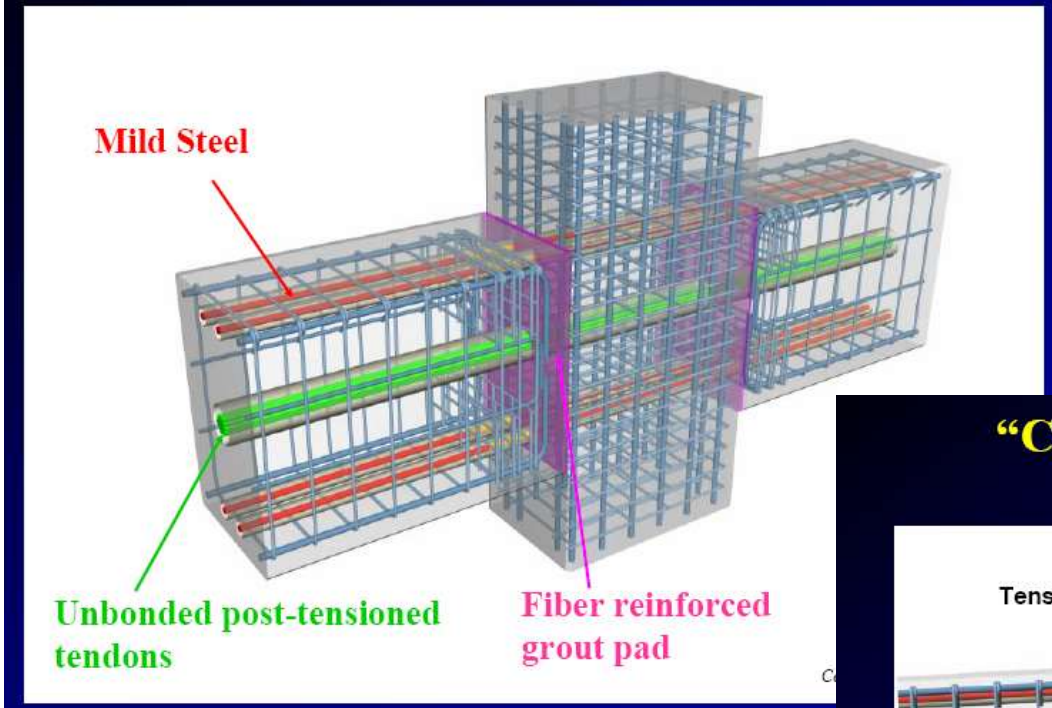
Colegio en Santiago
Gentileza Momenta

Hybrid connections building

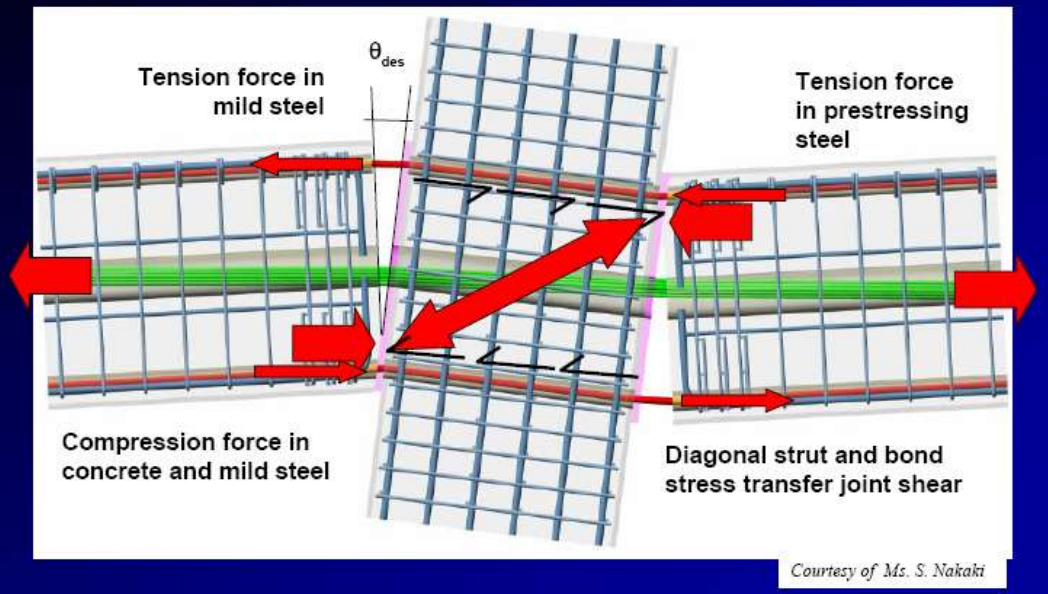
Gentileza
Patricio Bonelli

Hybrid connection

HYBRID Beam-Column connection

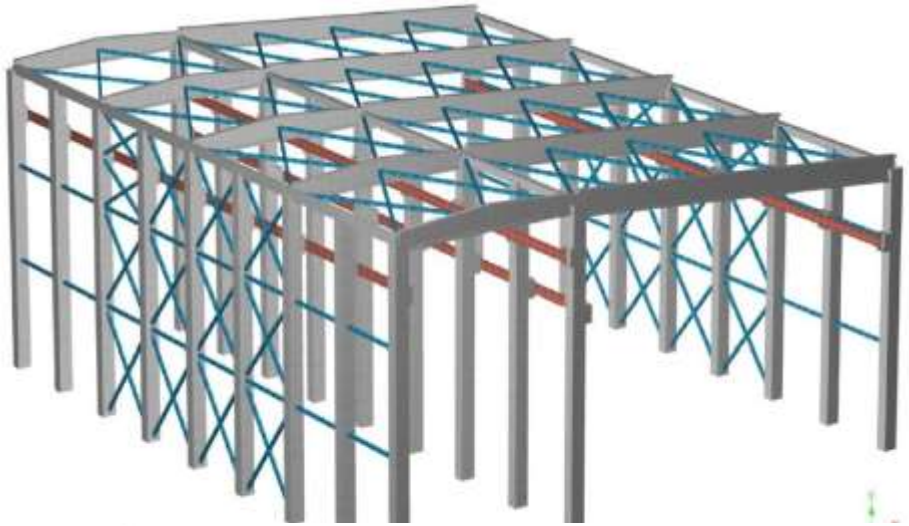


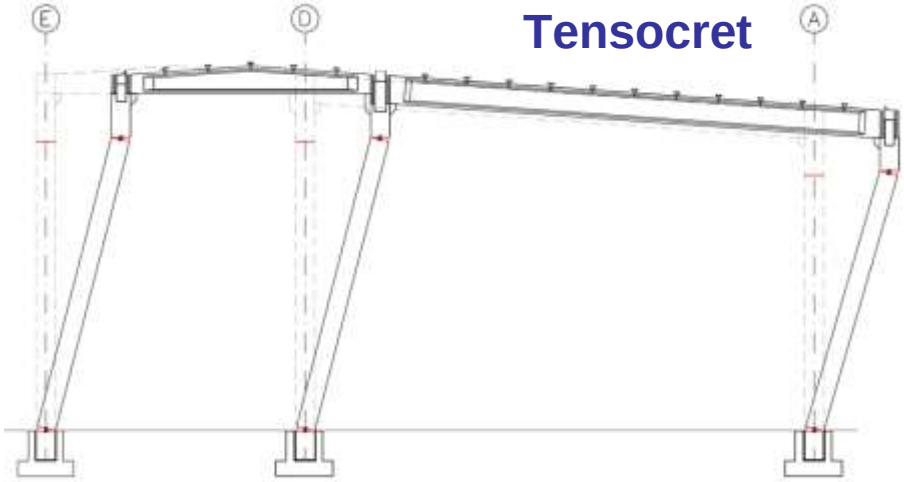
"Controlled Rocking" Mechanism



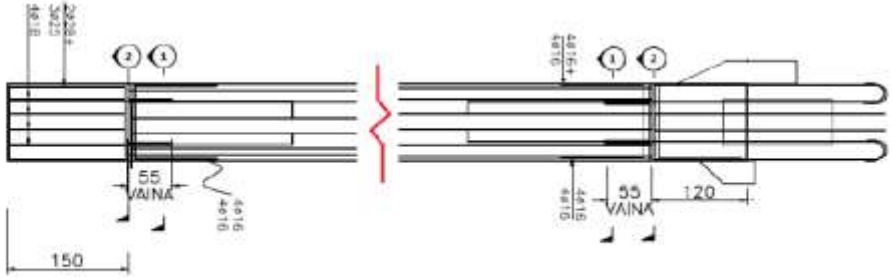
Courtesy of Ms. S. Nakaki

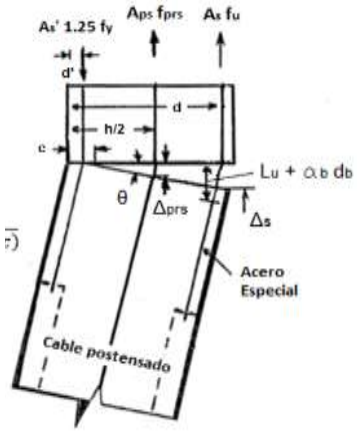
Paper factory

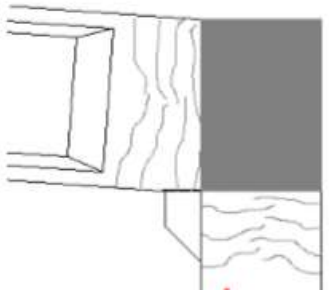


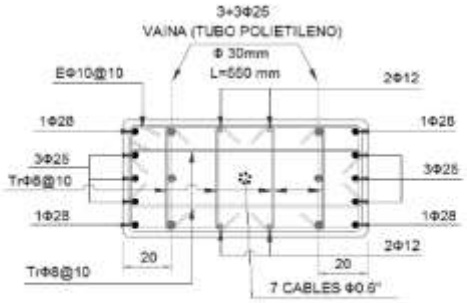


Gentileza
Patricio Bonelli
Tensocret

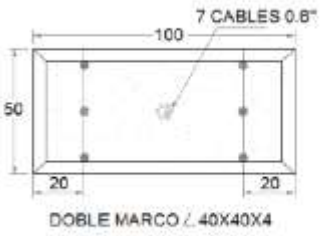








Corte 1



Corte 2

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Paper factory

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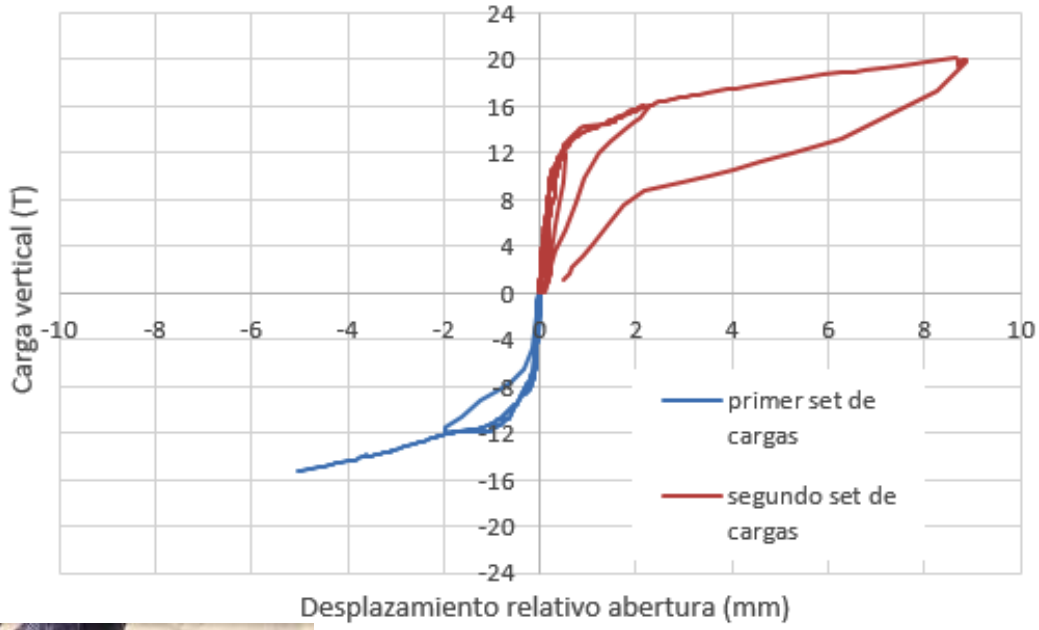

Gentileza
Patricio Bonelli
Tensocret

Final remarks

Precast concrete construction has gained popularity over the past decades in Chile. This has been especially true in industrial facilities given the benefits of this type of construction like speed of erection, low cost and fire resistance.

From 2006 Chile has a national standard for seismic design of non-building structures that includes provision for precast structures. This standard has been instrumental in the increased use of precast structures.

Final remarks

Recent 2010 earthquake (Mw 8.8) was a severe test for Chilean construction. The performance of precast structures designed under the seismic code was remarkably good, with some exceptions, mostly related to large displacements (large demands and lack of capacity), which will be addressed in the revised edition of the code.

Productivity pressures in construction are giving a new impulse to precast construction and new applications are emerging in houses, mid-rise buildings and also in heavy industrial applications and mining operations. Lack of skilled labor is expected to have a major impact on construction in the future leading to a more extensive use of precast.

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thank you …

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