M 8.8 CHILE EARTHQUAKE PORT DAMAGE ASSESSMENT

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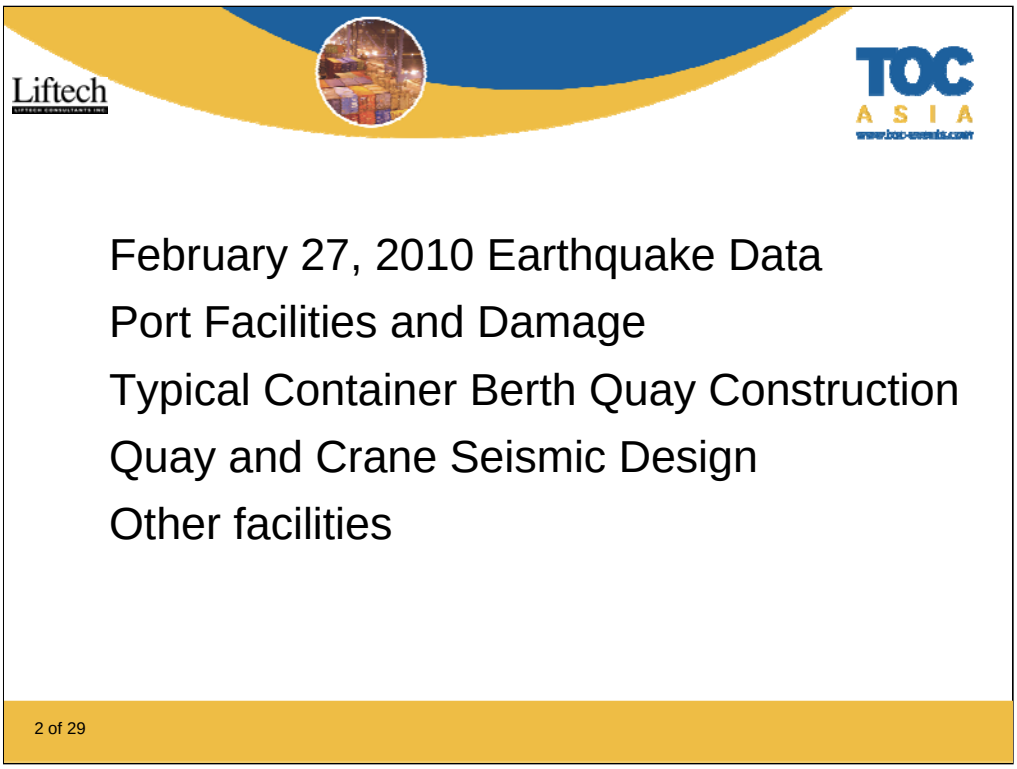
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ASIA
February 27, 2010 Earthquake Data
Port Facilities and Damage
Typical Container Berth Quay Construction
Quay and Crane Seismic Design
Other facilities
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Earthquake and Terminal Locations

Source: USGS

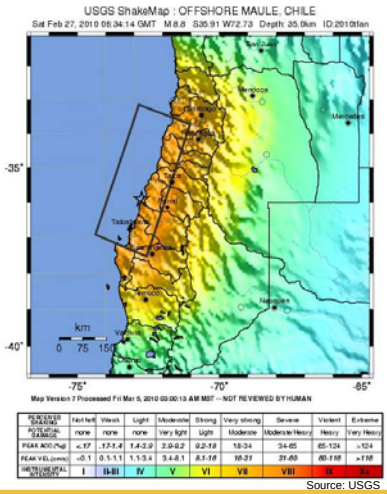
Source: BBC

Basic Earthquake Information

Saturday, Feb. 27, 2010

Magnitude: Mw8.8
6th largest recorded

Location:
Offshore of Maule, Chile
Focus 35 km deep



Source: USGS

Peak Ground Accelerations

Source: USGS

	Valparaiso	0.15g – 0.20 g
	San Antonio	0.15g – 0.20 g
⊙	Epicenter	0.30g
	Concepcion	0.25g

San Antonio Port

Source: Wikipedia

9 Berths - 7 operating as of March 5
6 Gantry cranes

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STI - San Antonio

3 Berths - 6 gantry cranes
2 Gantry cranes damaged
(not from earthquake)

Source: Google Earth

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STI
Crane Damage

Photo Courtesy of MIT

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STI
Gantry Trucks Derailed

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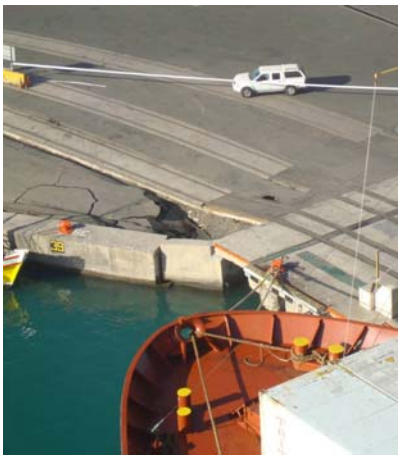
STI
Yard Cargo Damage

STI
Quay & Yard Damage



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STI
Quay & Yard Damage

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Quay & Yard Damage

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Puerto Panul Public Terminal

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San Vicente Terminal

3 Berths - none operating

Photo Courtesy of MIT/Berger ABAM

Quay Damage

San Vicente Terminal - Yard



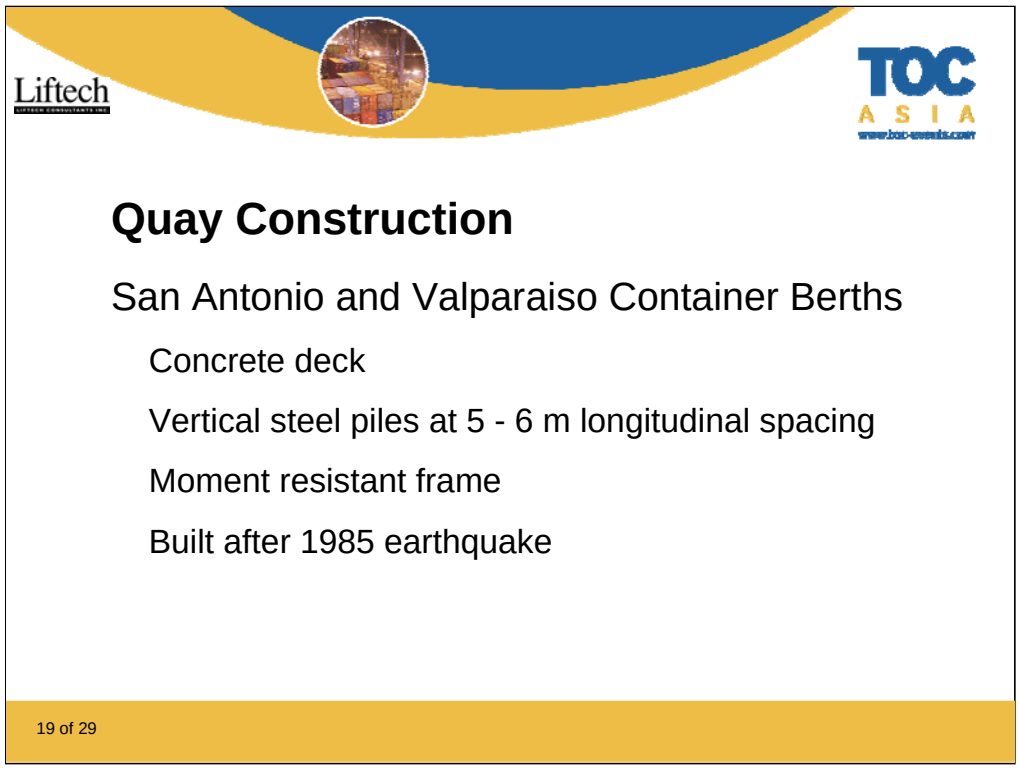
Photos Courtesy of Berger/ABAM

Separation – up to 22 cm wide, 2.3 m deep

TPSV - Valparaíso

8 berths - 6 operating
5 gantry cranes - no damage

Source: Google Earth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Quay Construction
San Antonio and Valparaiso Container Berths
Concrete deck
Vertical steel piles at 5 - 6 m longitudinal spacing
Moment resistant frame
Built after 1985 earthquake
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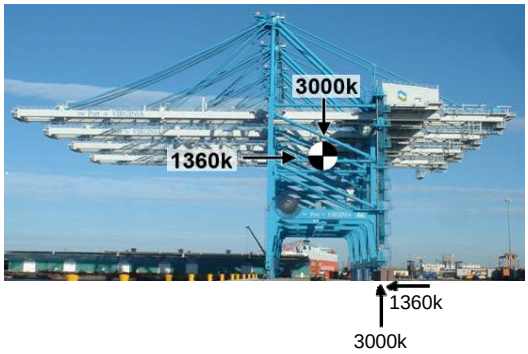
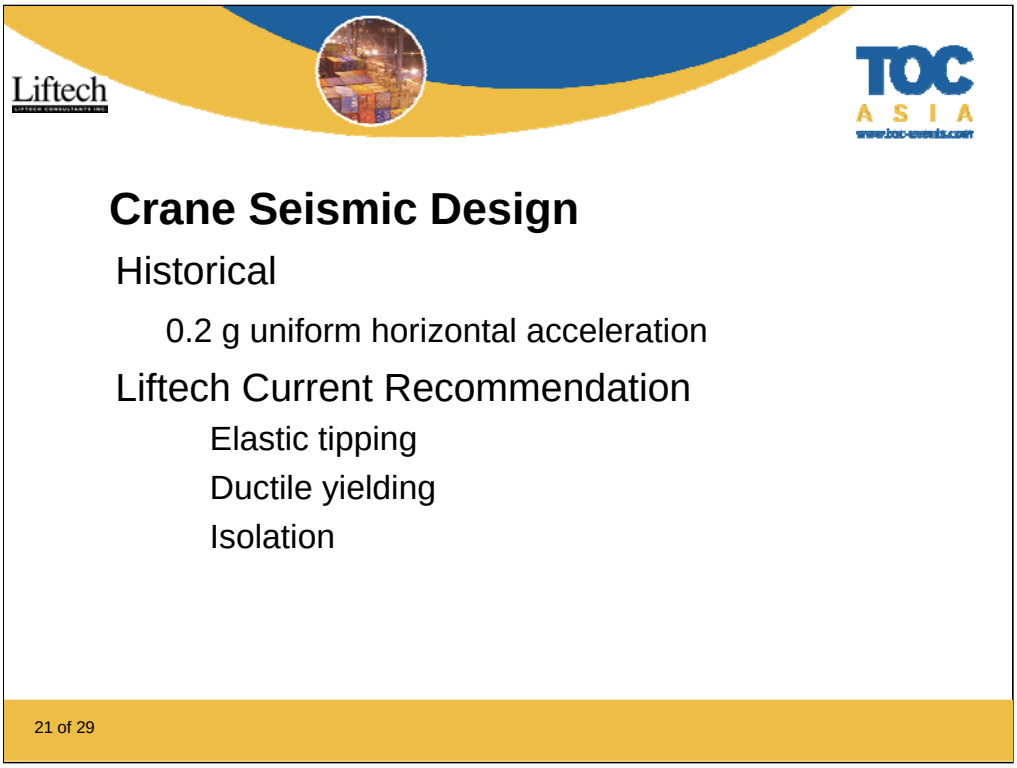
Crane Seismic Design

50’ Gage



100’ Gage or Larger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Crane Seismic Design
Historical
0.2 g uniform horizontal acceleration
Liftech Current Recommendation
Elastic tipping
Ductile yielding
Isolation
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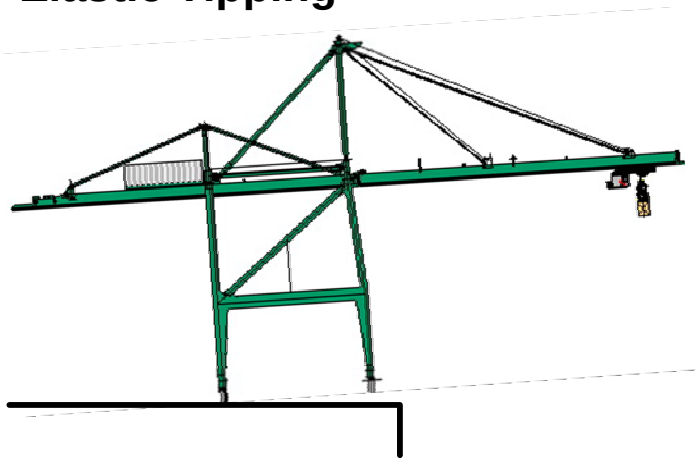
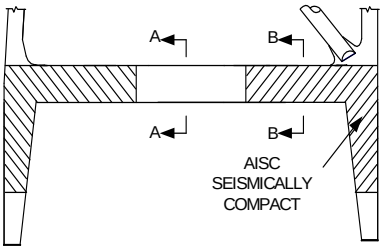
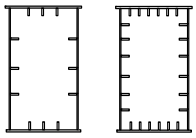
Elastic Tipping

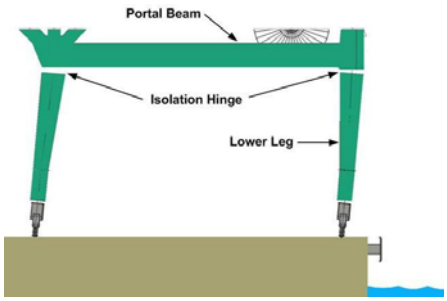


Ductile Yielding





Seismic Isolation



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MHI Design

ZPMC Model

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Santiago Airport

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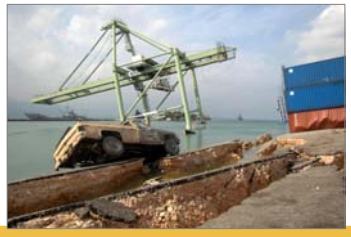
Kobe 1995 Magnitude 6.9 - PGA = 0.5 g

Source: Liftech

Haiti 2010 Magnitude 7.0 - PGA = 0.25g



Source: Flikr

Summary- Major Ports

- Large magnitude earthquake
- Quay structures performed well
- Yard settlement at some terminals
- Gantry crane damage
  - Minor from earthquake
  - Significant collateral to two cranes

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