SIMPSON GUMPERTZ & HEGER

Engineering of Structures
and Building Enclosures

Critical Systems Seismic Assessment

Luis H. Palacios, P.E.

Simpson Gumpertz & Heger Inc (SGH)

Oakland, CA

Agenda

- What is a Critical Systems Seismic Assessment?
- Key Items to Perform a Critical Systems Seismic Assessment
- Examples
- Summary

New Language in 2013 MOTEMS

3108F.7 Critical systems seismic assessment (N/E). *Fire detection and protection systems, and emergency shutdown systems shall have a seismic assessment per Section 3104F.5.3. For equipment anchorages and supports, see Section 3110F.8.*

- Added in 3 different Divisions
  - Fire Protection
  - Mechanical
  - Electrical

What is a critical systems assessment ?

3104F.5.3 Nonstructural critical systems assessment. *A seismic assessment of the survivability and continued operation during a Level 2 earthquake (see Table 31F-4-2) shall be performed for critical systems such as fire protection, emergency shutdown and electrical power systems. The assessment shall consider the adequacy and condition of anchorage, flexibility and seismically-induced interaction. For existing systems, seismic adequacy may be assessed per [4.5].*

What does this mean in English ?

- Identify what you really need to safely shut down and evacuate the terminal after “the Big One”
  - No oil spill
  - No injury to personnel
  - Don’t care whether you can operate afterwards
  - More than just equipment on the wharf

Two Parts

- Hazard Identification
  - Structured workshop
  - Terminal disciplines participate (operations, maintenance, engineering, etc.)

- Equipment / Piping / Utility Assessment
  - “CalARP” seismic assessment

Earthquake Scenario – Consider reality

- 15 seconds or more of strong shaking
- Loss of grid power
- Alarms going off
- Multiple equipment trips
- Unpredictable human response

Hazard Identification

- Identify systems and function of each system after an earthquake:
  - Fire Protection
  - ESD
  - Power
  - Instrumentation
  - Monitoring
  - Oil Transfer Systems
  - etc. etc. etc.
  - Berthing
  - Lighting
  - Communications
  - Oil Spill Response
  - Facility Access
  - Mooring

Hazard Identification

- Identify major items in each system and rate the criticality:

Equipment	Critical	Not Critical	Comments
P-185 3000 gpm electric fire pump		X	This starts first if power is available.
P-180 3000 gpm diesel driven fire pump		X	This starts second and can be manually started.
P-190 6000 gpm diesel driven fire pump	X		This is the main fire pump if no power. A check valve keeps it primed to start.
Diesel day tank	X		
P-182 / P-192 Diesel pumps for P-180 and P-190	X		

Hazard Identification

- Also identifies items on the wharf that are not critical and only need to remain in place

Mooring System	Safe mooring of vessels	Hooks	X		
		Capstans		X	Only used for line management on vessel arrival.
Berthing System	Safe berthing of vessels	Fender system		X	No oil spill risk during arrival.
Lighting	Illumination for terminal evacuation	Lighting		X	All operators carry flashlights at night.
Communications	Communications between vessel and terminal and between terminal personnel	Portable radios Ship to dock (direct communications)	X		Radios are battery powered and intrinsically safe, and provide communications between Vessel Person in Charge (VPIC) and Terminal Person in Charge (TPIC) Not susceptible to damage in the event of an earthquake.

How does this fit with other assessments ?

- Fire Protection Assessment
- Fire Hazard Assessment and Risk Analysis

No.	Category	Scenario Description	Existing Safeguards	Risk Level	Mitigations	Residual Risk
2.	Isolation of fuel source	• Break in the ship-to-shore transfer connection due to loading arm failure.	• MLAs are hydrotested annually. • Maximum allowable working pressure (MAWP) and test dates are stenciled onto MLAs and hoses. • Transfer operations begin at reduced flow rates in order to monitor for leaks. • Spill over water is mitigated by deployed spill boom.	C2	• None suggested	C2
3.	Isolation of Fuel Source	• Break in the product pipelines during vessel cargo loading / unloading from terminal tank farm due to overpressure and / or premature shutting of terminal valves.	• Pipelines are hydrotested per US Coast Guard and DOT regulations. • Motorized SIVs can close in less than 60 seconds and can be activated remotely. • Operating pressure in system is continually monitored during transfer operations.	C2	• None suggested	C2

How does this fit with other assessments ?

– HazOps (not useful for earthquake scenarios)

Guide word	Deviation	Possible causes	Consequences	Action required
MORE OF	More flow	(5)LCV fails open or LCV bypass open in error.	Settling tank overfills.	(f)Install high level alarm on LIC and check sizing of relief opposite liquid overfilling. (g)Institute locking off procedure for LCV bypass when not in use.
			Incomplete separation of water phase in tank, leading to problems on reaction section.	(h)Extend J2 pump suction line to 12" above tank base.
	More pressure	(6)Isolation valve closed in error or LCV closes, with J1 pump running.	Transfer line subjected to full pump delivery or surge pressure.	(j)Covered by (c) except when kickback blocked or isolated. Check line. FQ and flange ratings and reduce stroking speed of LCV if necessary. Install a PG upstream of LCV and an independent PG on settling tank.
		(7)Thermal expansion in an isolated valved section due to fire or strong sunlight.	Line fracture or flange leak.	(k)Install thermal expansion relief on valved section (relief discharge route to be decided later in study).
	More temperature	(8)High intermediate storage temperature.	Higher pressure in transfer line and settling tank.	(l)Check whether there is adequate warning of high temperature at intermediate storage. If not, install.

What is the “CalARP” Seismic Walkdown ?

- MOTEMS borrows from California Accidental Release Prevention Program method used for >25 years at existing facilities with hazardous materials
- Primarily visual review by experienced engineers
- Looking for vulnerabilities that have happened in earthquakes
- Not just a check for building code conformance

Shortcomings with building codes:

- Once built, nothing would ever pass new codes
- Not realistic to rebuild facilities every time the code changes
- Not meeting the building code does not mean "unsafe"
- Building codes were written for buildings by building designers

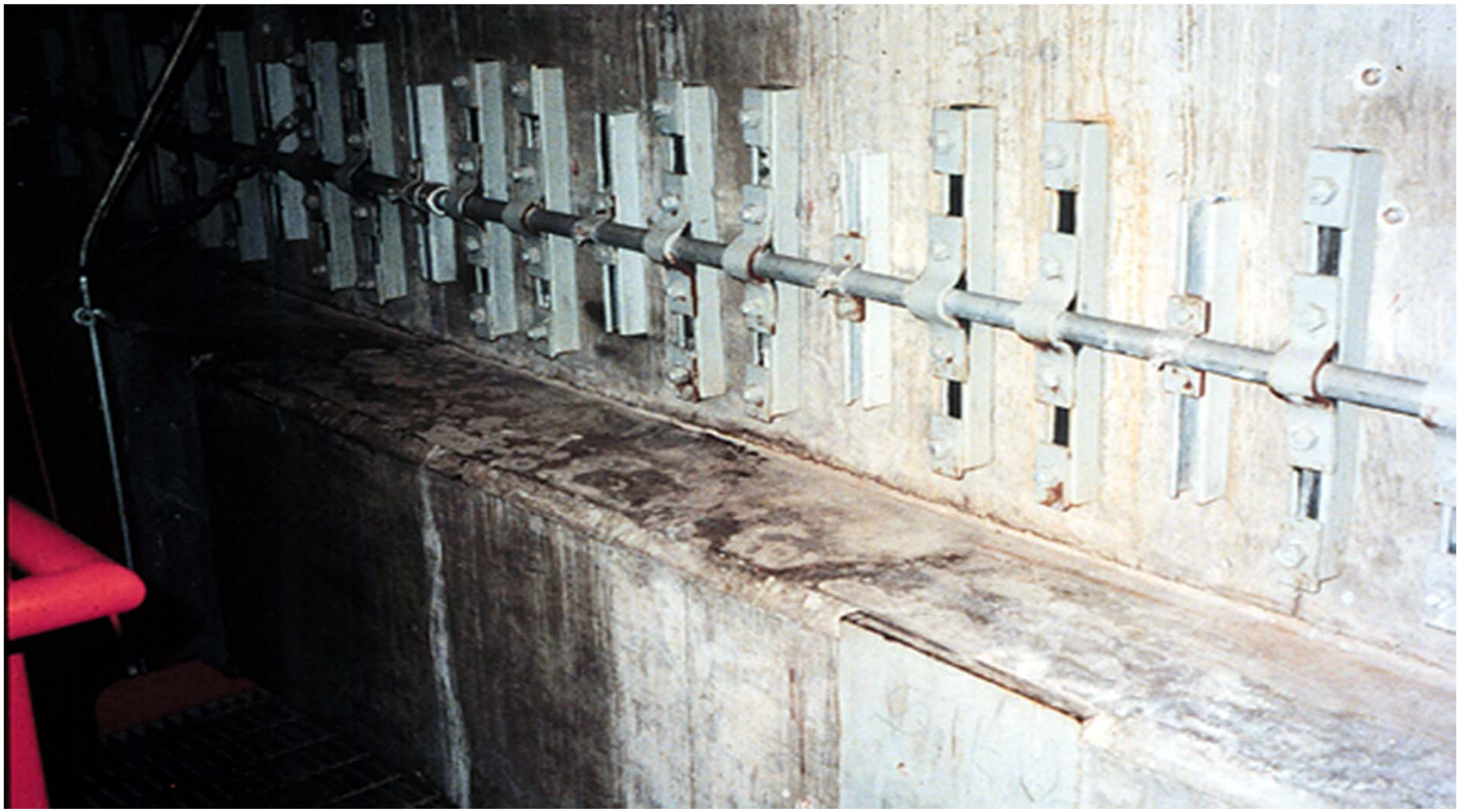
"A building code is a document that allows somebody who shouldn't be designing something the ability to design it."

-Anonymous

This assessment goes beyond building codes

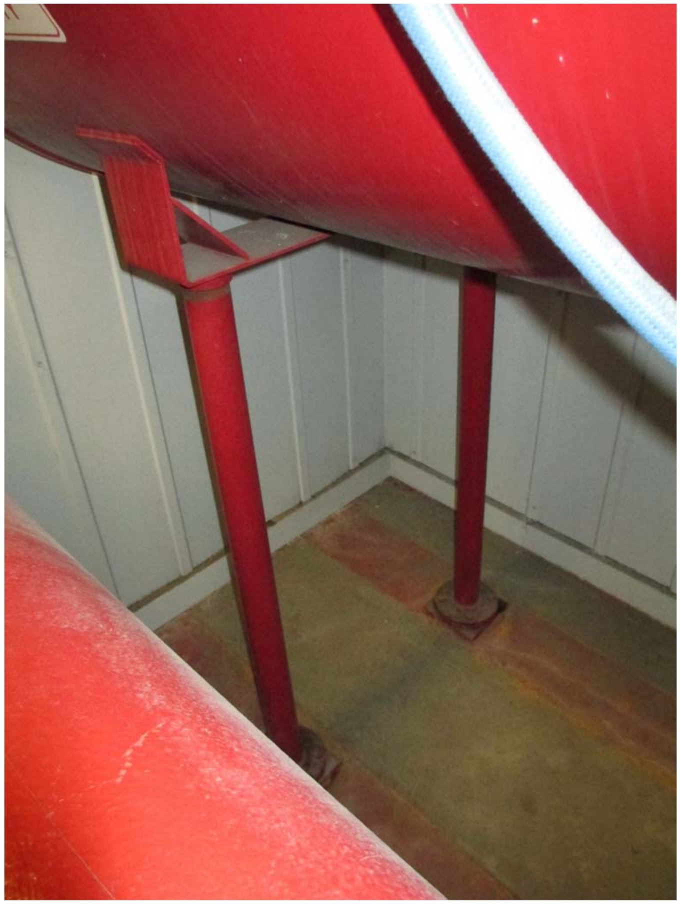
- Not purely structural
  - Whole system and its surroundings
  - Strength of anchorage
  - Flexibility of piping, etc.
  - Consequences of other things that move (“seismic interaction”)

Don’t want to end up like nuclear plants



Example: Standard Structural Concern (Diesel Day Tank)

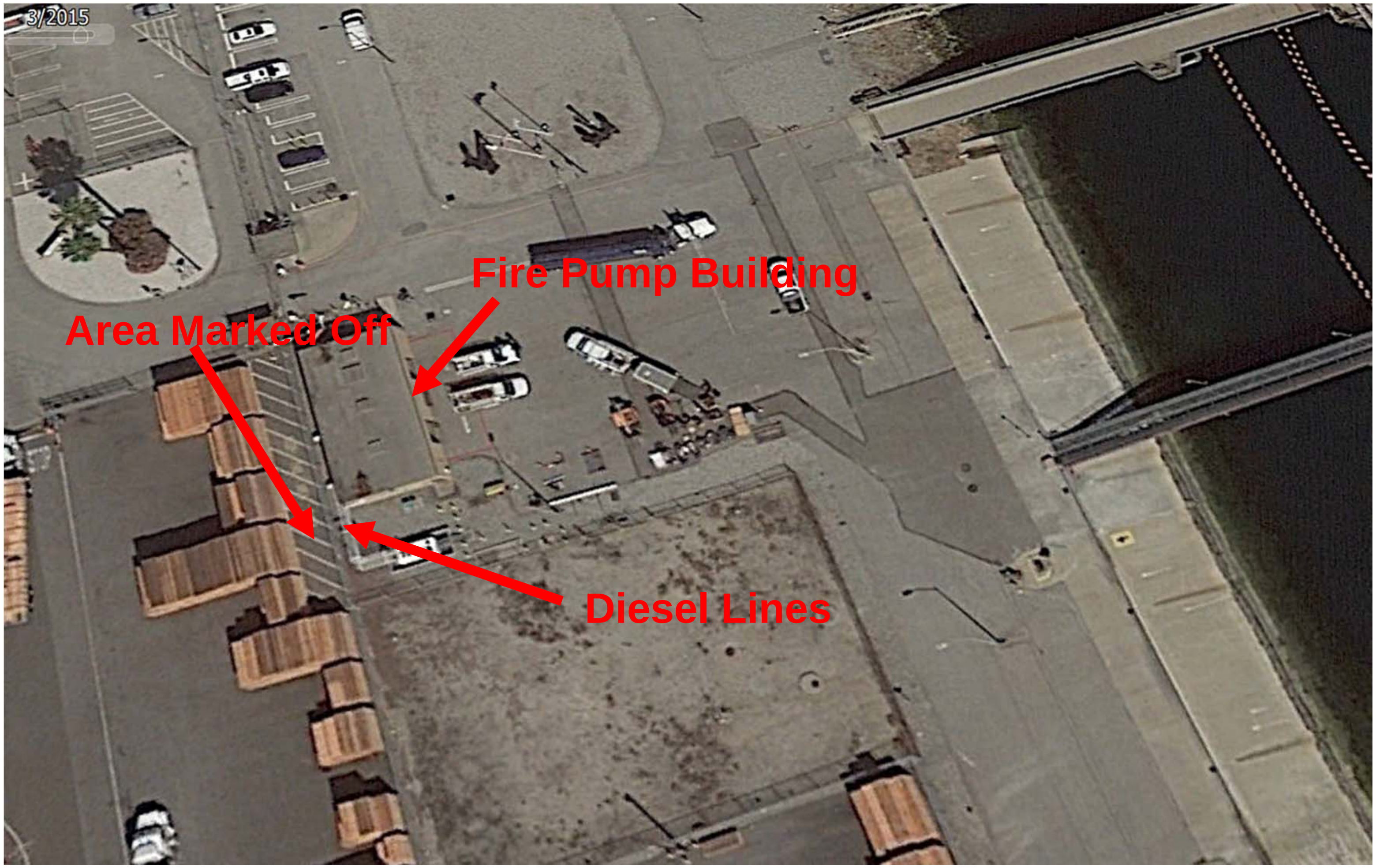
- Identified as a critical item, even though not on wharf
- Walkdown identified possible issues with strength of legs and anchorage
- Calculations and retrofit if needed



Example: “Seismic interaction” issue (diesel lines)

- Identified as a critical item, even though not on wharf
- Walkdown identified “seismic interaction” issue with neighbor’s stacked lumber piles

Mitigation not a structural fix



Example: Nonstructural system issue (Emergency access to terminal)

- Workshop identified gate access as “critical”
- Power not needed because of manual override
- Walkdown identified manual override as outside of fence

Summary

- Methodical structured process
  - Hazard workshop to identify systems and equipment
  - Walkdown by experienced engineers
- If done right, get a lot of bang for your buck
- This shouldn't happen to you !