

NONBUILDING STRUCTURES



Nonbuilding Structures

Same:

- Basic ground motion hazards
- Basic structural dynamics

Different:

- Structural characteristics
- Fault rupture
- Fluid dynamics
- Performance objectives
- Networked systems

Dams with Damage



Dam and Water Treatment Plant



Bridges



Joints at Long Spans



Elevated Roadways (1)

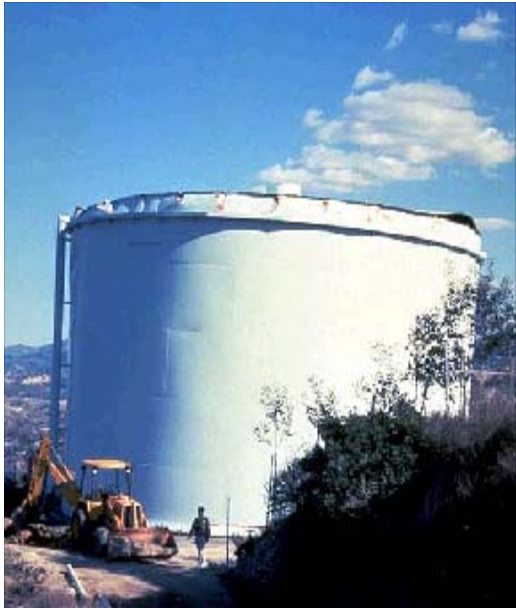


Elevated Roadways (2)

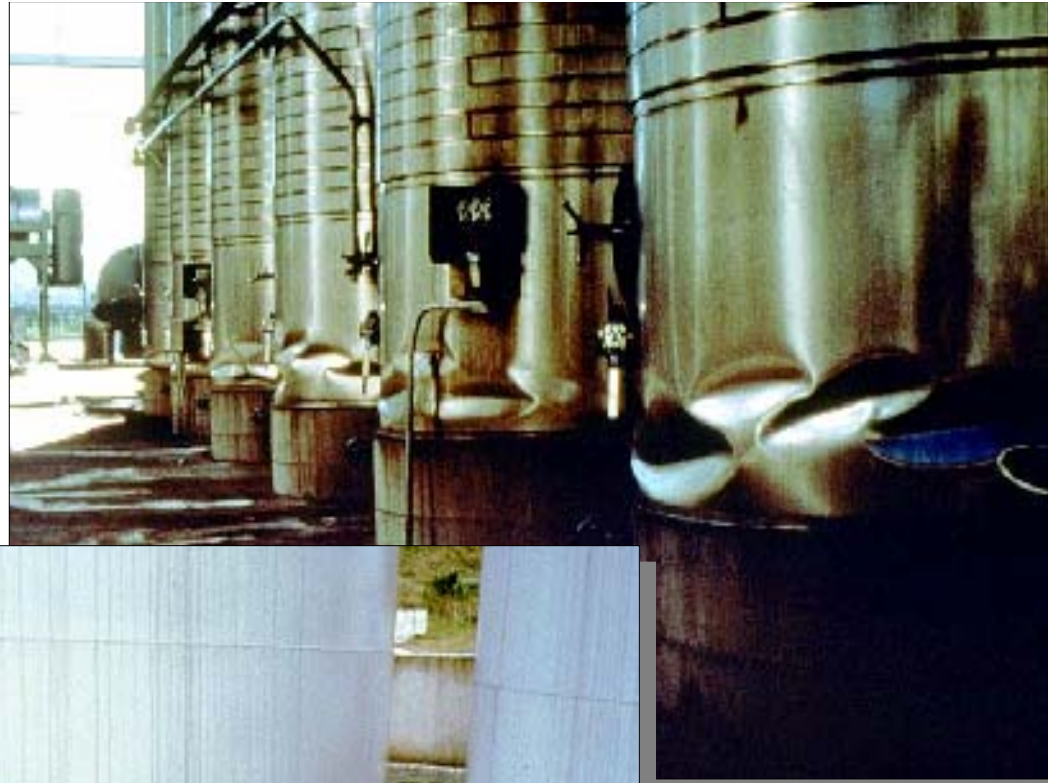


Lack of Redundancy





Tanks

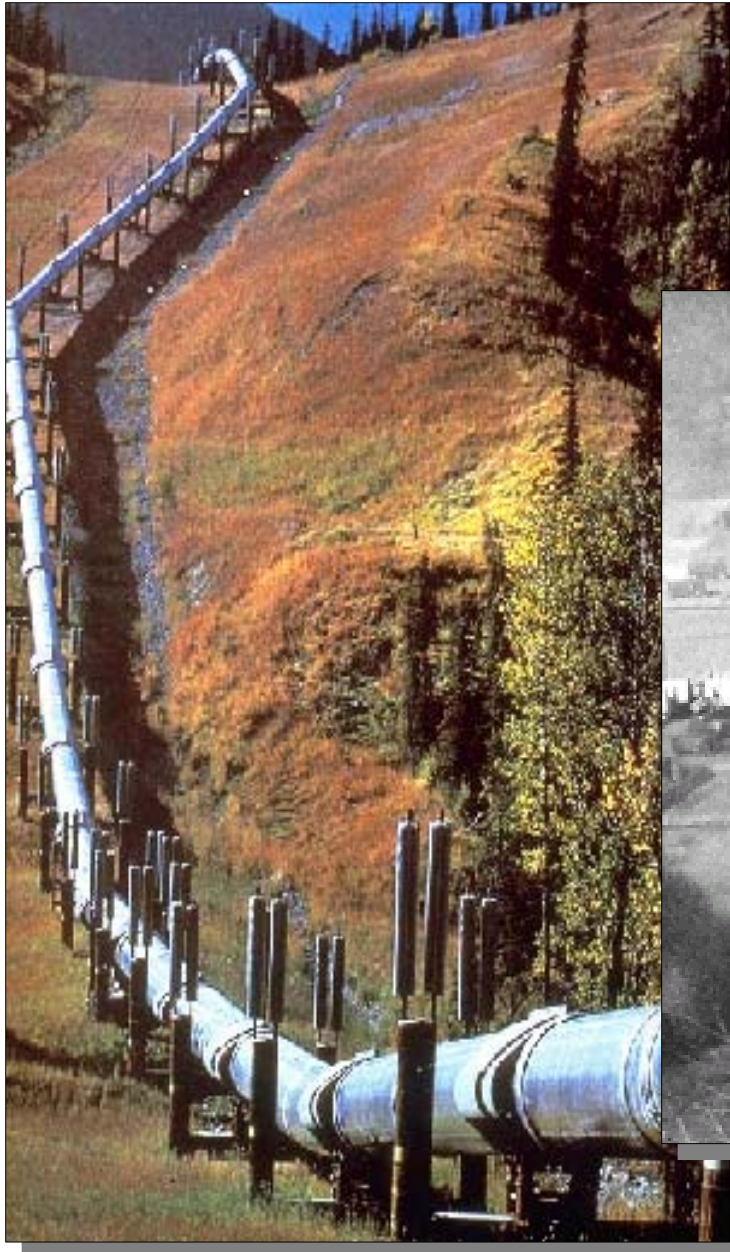


Elephant's foot buckling

Tanks & Towers

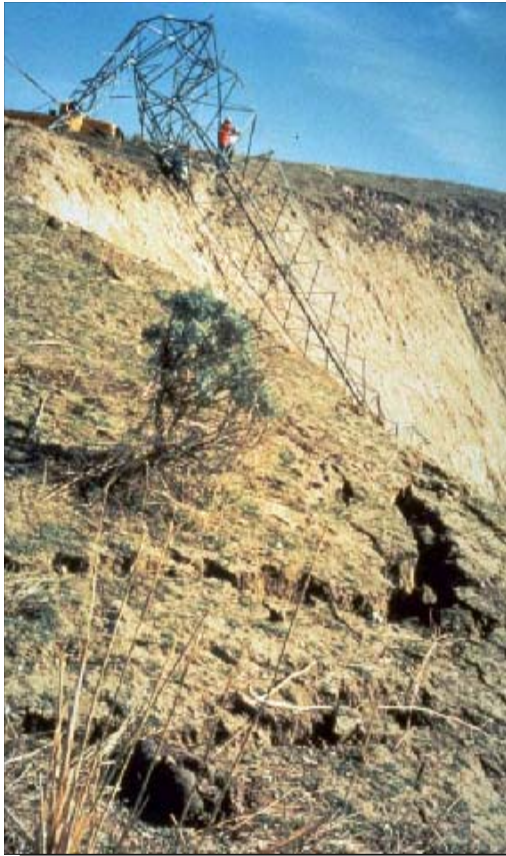


Pipelines

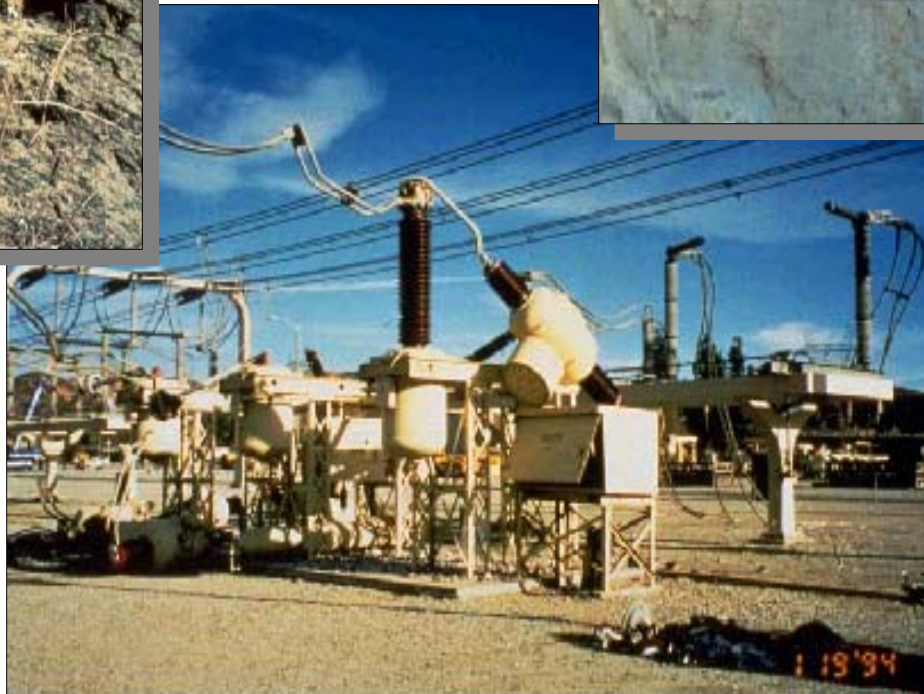


On-Grade and Buried





Electrical Towers and



Substations



Nonbuilding Structures in the *NEHRP Recommended Provisions*

SCOPE of Chapter 14:

- Self supporting structures that carry gravity loads.
- Nonbuilding structures may be supported by earth or
by other structures.

EXCLUSIONS:

- Vehicular and railroad bridges
- Nuclear power plants
- Offshore platforms
- Dams



Nonbuilding Structures

TWO CLASSIFICATIONS included in *Provisions*

1. Nonbuilding structures similar to buildings

- Dynamic response similar to buildings
- Structural systems are designed and constructed similar to buildings
- Use provisions of Chapter 14 and applicable parts of Chapter 5, 7, 8, 9,

2. Nonbuilding structures not similar to buildings

- Design and construction results in dynamic response different from buildings
- Use Chapter 14 and “approved standards” for design



Nonbuilding Structures defined similar to buildings (2000)

Examples:

- Pipe racks
- Steel storage racks
- Electric power generation facilities
- Structural towers for tanks & vessels

(Many of these have changed in the 2003 edition)



Nonbuilding Structures not similar to buildings

- Use “approved standards” for design. Loads and load distributions shall not be less than those given by NEHRP RP.

Examples:

- Earth retaining structures
- Tanks and vessels
- Telecommunication towers
- Stacks and chimneys
- Buried structures (tanks, tunnels, pipes)



Nonbuilding Structures not similar to buildings

Examples of approved design standards:

- Telecommunications structures:
 - ASCE 7, *Minimum Design Loads for Buildings and Other Structures*, 1995.
 - TIA/EIA 222F, *Structural Standards for Steel Antenna Towers and Antenna Supporting Structures*, 1996.
- Steel Stacks and Chimneys:
 - ANSI/ASME STS-1-1992, *Steel Stacks*



Nonbuilding Structures Design Requirements

- **LOADS**

- Weight, W , for calculating seismic forces includes all dead loads and all normal operating contents
- (grain, water, etc. for bins and tanks)

- **DRIFT LIMITATIONS**

- Drift limits of Section 5.2.8 do not apply - but must maintain stability. $P-\Delta$ check required.

- **FUNDAMENTAL PERIOD**

- Calculate using same methods for buildings (5.3.3)



Nonbuilding Structures Design Requirements

- **VERTICAL DISTRIBUTION OF SEISMIC FORCES**
 - Use same methods for buildings:
 - ELF or Modal Analysis
- **NONBUILDING STRUCTURES SUPPORTED BY OTHER STRUCTURES**
 - If $W_{nb} < 25\%$ of W_{tot} treat nonbuilding structure as component and design per Chapter 6
 - If $W_{nb} \geq 25\%$ of W_{tot} determine seismic forces considering effects of combined structural systems

Nonbuilding Structures Design Requirements

- **SEISMIC COEFFICIENTS AND HEIGHT LIMITS**
 - Use smaller R factor from Table 5.2.2 or Table 14.2.1.1
 - In general, height limits for nonbuilding structures are less stringent than those for buildings

Nonbuilding Structures

Design Requirements

Table 14.2.1.1: Seismic Coefficients and Height Limits

Structural System	R	Ω_0	C_d	HL	X
Steel storage racks	4	2	3½	NL	--
Elevated tanks on braced legs	3	2	2½	NL	--
Reinf conc tanks (nonsliding base)	2	2	2	NL	--
Conc silos, stacks...w/ walls to fdn	3	1 ¾	3	NL	--
Trussed towers, guyed stacks...	3	2	2 ½	NL	--
Self-supporting, not covered by other standards and not similar to bldgs	1 ¼	2	2 ½	C	--

Nonbuilding Structures Design Requirements

- **IMPORTANCE FACTOR AND SEISMIC USE GROUP**
 - Based on relative hazard of contents and function
 - Use largest value from Table 14.2.1.2 or from approved standard

Nonbuilding Structures Design Requirements

- Table 14.2.1.2: Importance Factor and SUG

Importance Factor	I=1.0	I=1.25	I=1.5
Seismic Use Group	I	II	III
Hazard	H-I	H-II	H-III
Function	F-I	F-II	F-III

H-I, H-II and H-III: Relative hazard of stored product

F-III: Communication towers, fuel storage tanks, cooling towers etc., required for the operation of SUG III buildings

F-II: Not applicable



Nonbuilding Structures

Chapter 14 Appendix

Additional design procedures and recommendations for:

- Electrical transmission, substation and distribution structures
- Buried structures
- represents current industry accepted design practice
- info not ready for inclusion in main body of chapter

