

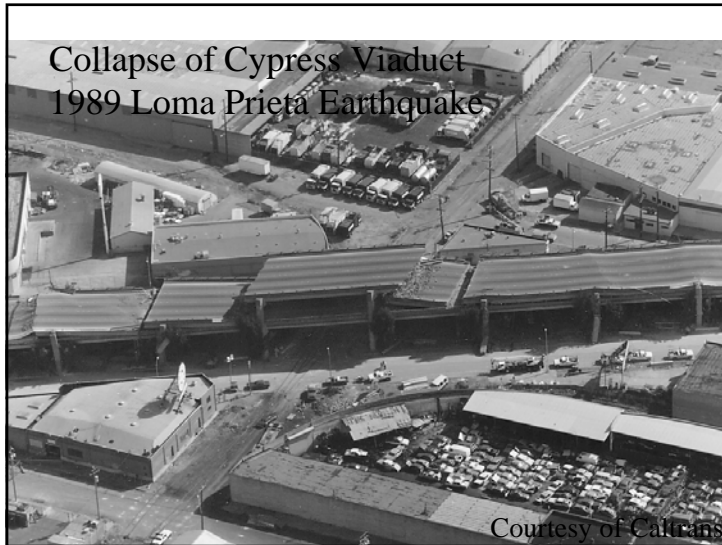
2.3 Seismic Damage of Bridges in USA

Collapse of 5/14 South Connector
Overcrossing



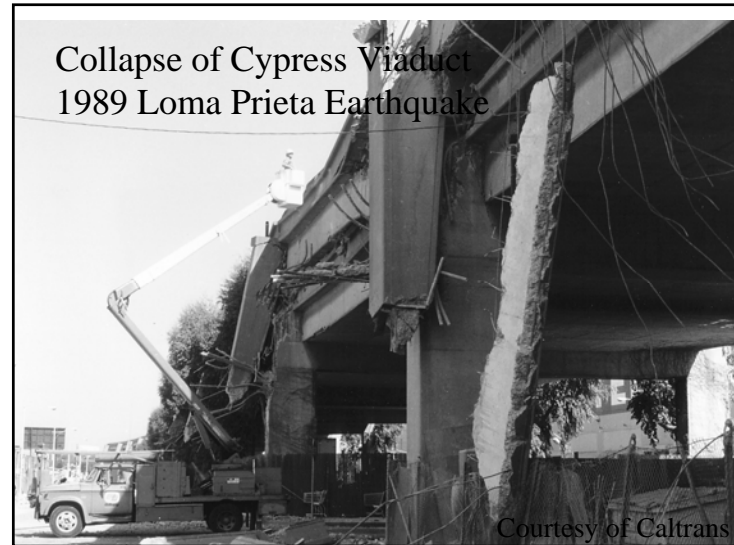
1971 San Fernando, USA, Earthquake

Collapse of Cypress Viaduct
1989 Loma Prieta Earthquake



Courtesy of Caltrans

Collapse of Cypress Viaduct
1989 Loma Prieta Earthquake



Courtesy of Caltrans



Pounding of Decks at Intermediate Hinge



History of Seismic Design of Bridges in USA

- 1776 Independence
- 1830-1840 Gold Rush
- 1850 California became a part of US territory
- 1906 San Francisco Earthquake
- 1933 Long Beach Earthquake
- Field Act (0.1 Seismic coefficient for school buildings, and 0.02-0.05 seismic coefficient or other structures) & Riley Act
- 1936 Construction of San Francisco Oakland Bay Bridge
- 1957 Construction of Cypress Viaduct
- 1961 First Stipulation for Seismic Effects in AASHTO
- 1961 First Stipulation for Seismic Effect in California Department of Transportation

History of Seismic Design of Bridges in USA (continued)

- 1971 San Fernando Earthquake
Damage of bridges during 11 earthquakes with magnitude of 5.4-7.7 between 1933 and 1971 was only \$100,000
- 1973 New Caltrans Seismic Design
(Incorporated into AASHTO in 1975)
- 1981 New FHWA Seismic Design Code
- 1989 Loma Prieta EQ
- 1994 Northridge EQ

History of Seismic Design of Bridges in Japan

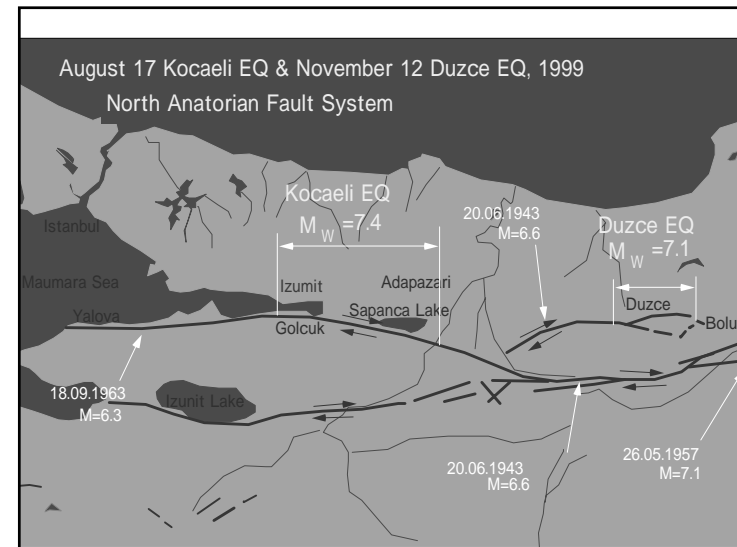
- 1923 Kanto EQ
- 1925 First Design Code for Bridges including Seismic Effects
- 1964 Design Specifications (2 pages)
 $kh=0.2$, $kv=0.1$
- 1971 First Independent Seismic Design Specifications (30 pages)
Unseating prevention devices, Evaluation for liquefaction potential
- 1980 Design Specifications (50 pages)
Updated Evaluation for Liquefaction

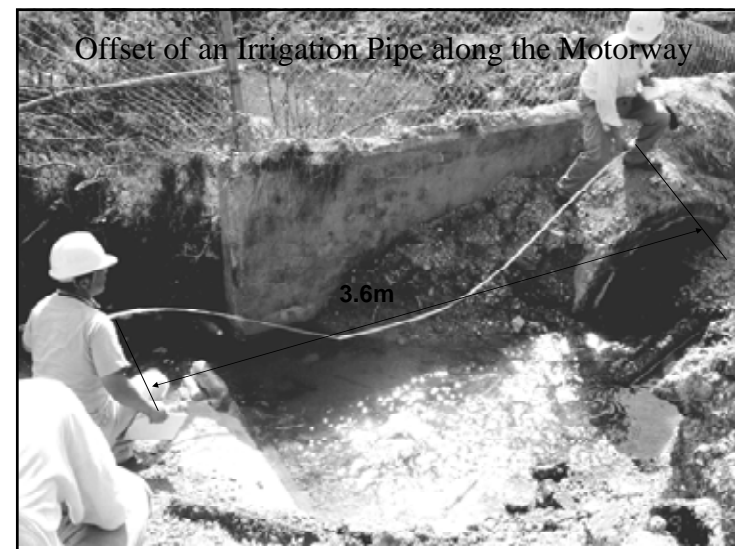
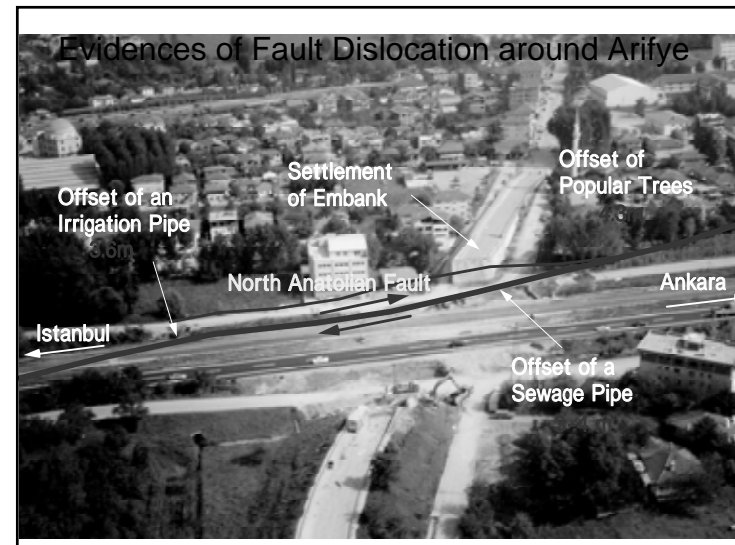
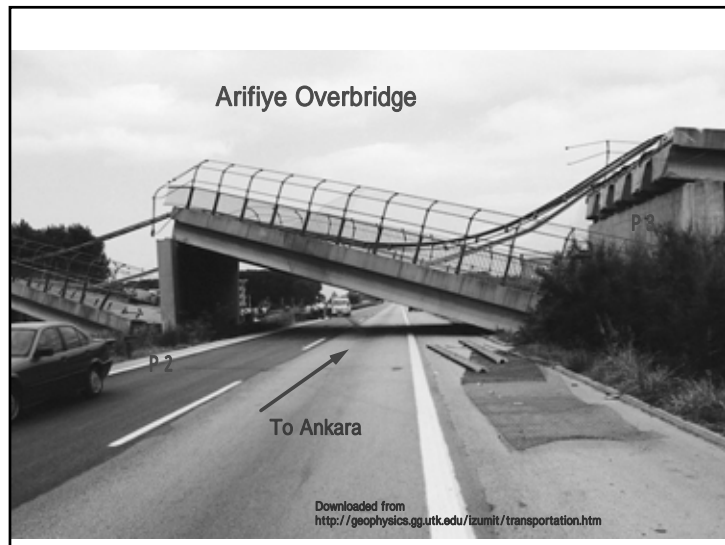
History of Seismic Design of Bridges in Japan (continued)

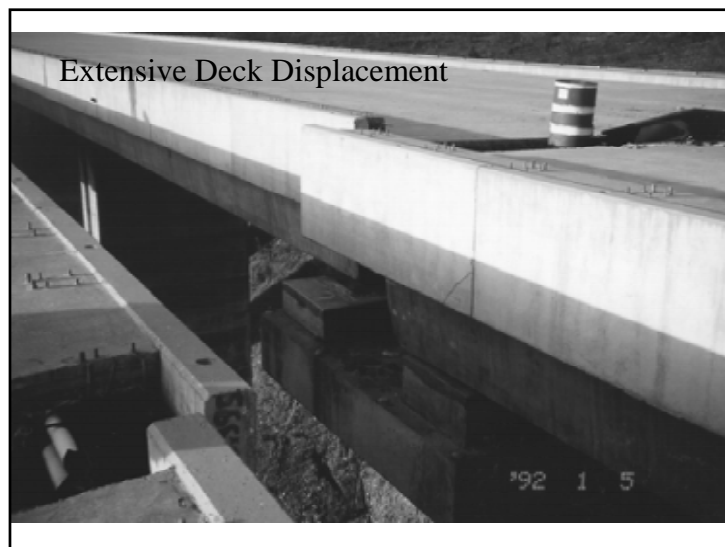
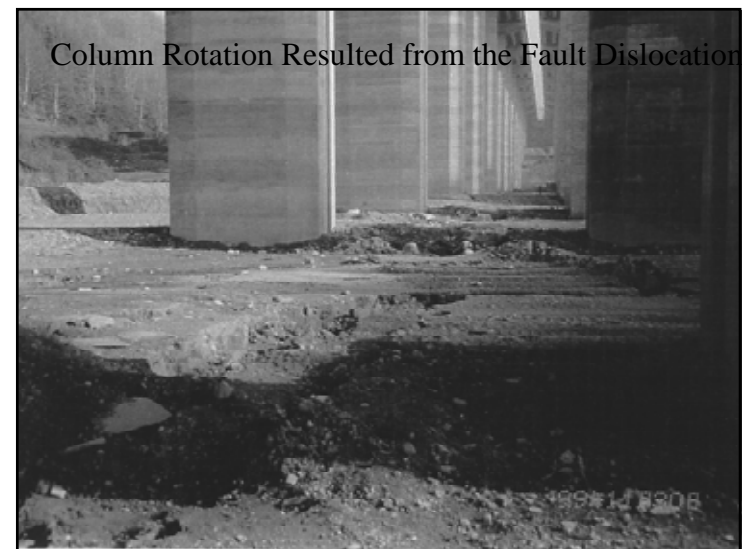
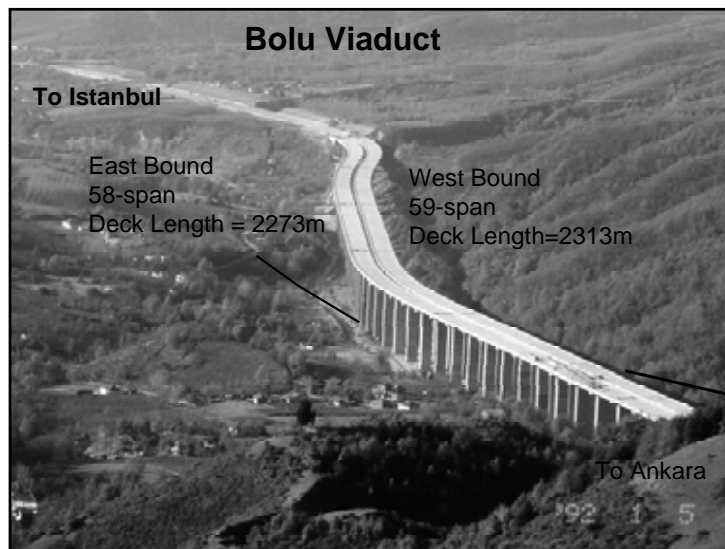
- 1990 Design Specifications (100 pages)
Check for Ductility, Lateral Force for Multi-span
Bridges, Standard Ground Motions for Dynamic
Analysis
- 1995 Kobe EQ
- 1996 Design Specifications (200 pages)
Ductility Design, Near-Field Ground Motions
- 2002 Design Specifications (240 pages)

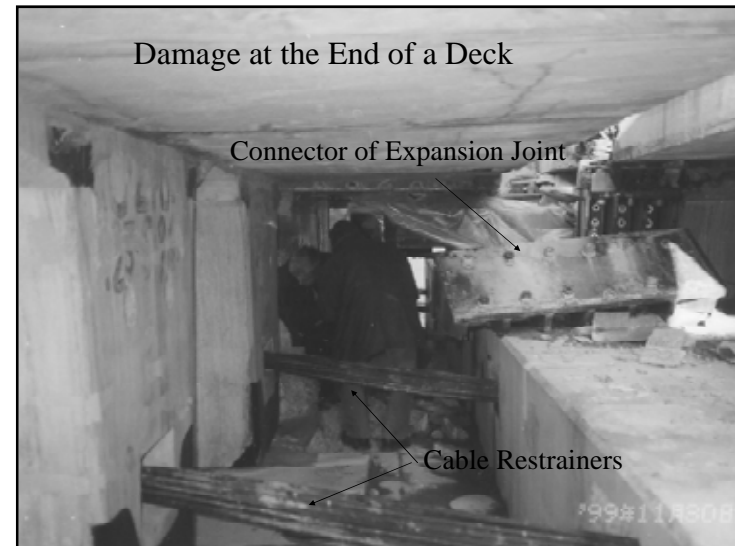
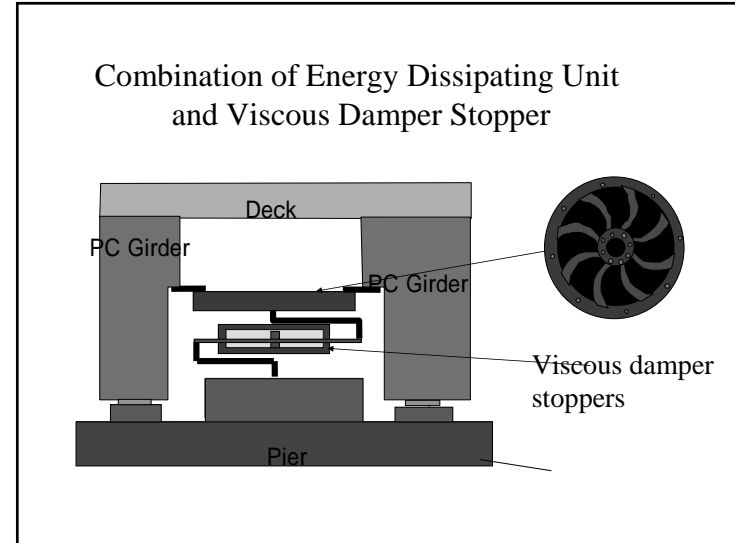
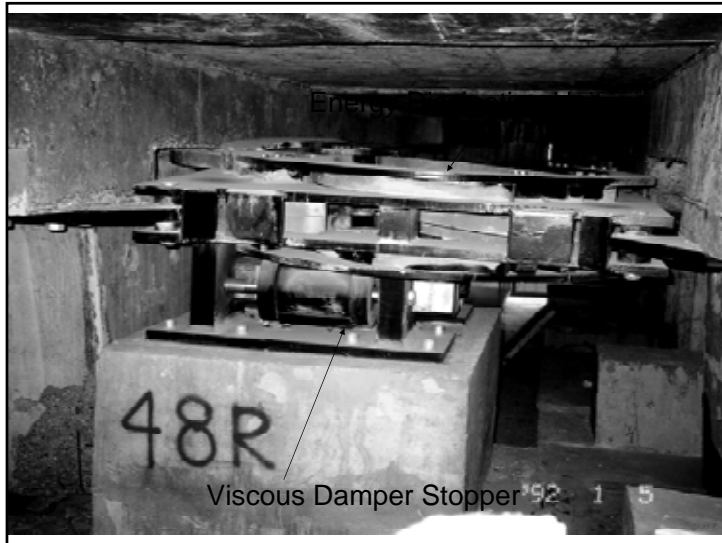
2.4 Damage of Bridges Due to Fault Displacement

2.4.1 1999 Kocaeli & Duzce, Turkey, EQs







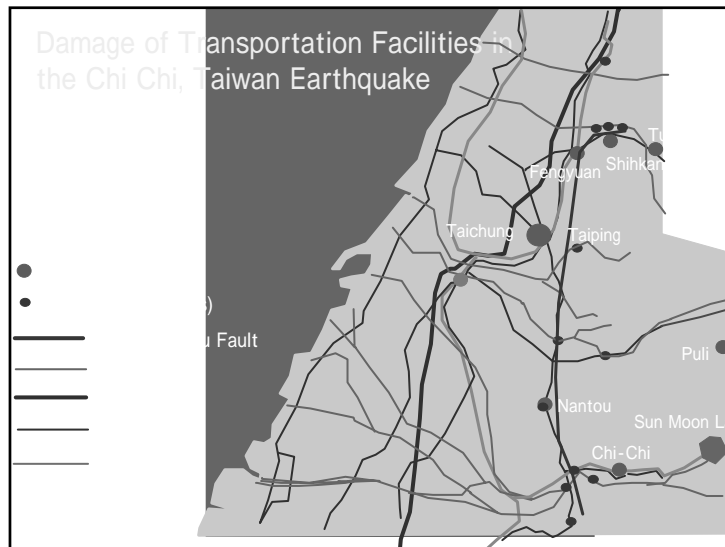


Pile Foundation
Damaged by
Fault Displacement



2.4.2 1999 Chi Chi, Taiwan, EQ

Damage of Transportation Facilities in
the Chi Chi, Taiwan Earthquake



Bei-Fong Bridge

