Structural Engineering Reconnaissance of the August 17, 1999 Earthquake: Kocaeli (Izmit), Turkey

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ABSTRACT

In late August and early September 1999, a team of structural engineers representing the Pacific Earthquake Engineering Research (PEER) Center traveled to Turkey to study damaged and undamaged buildings, bridges, industrial facilities, and lifeline infrastructure affected by the August 17, 1999, Izmit earthquake. The PEER reconnaissance team sought to improve the understanding of the *performance* of the built environment and to identify gaps in a PEER research agenda that is developing knowledge and design tools for performance-based earthquake engineering.

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The M_w 7.4 earthquake occurred on the North Anatolian fault in northwestern Turkey at 3:02 a.m. local time. The hypocenter of the earthquake was located near Izmit, 90 km east of Istanbul. Official figures placed the loss of life at approximately 17,225, with more than 44,000 injured. Approximately 77,300 homes and businesses were destroyed and 245,000 more were damaged. The total direct loss was estimated to be more than US$ 6 billion.

Chapter 1 of this report overviews the general seismicity of the area affected by the earthquake. Chapter 2 reviews briefly the practice of building seismic design and construction in the region, confirming that the construction of reinforced concrete buildings without special details for ductile response (by far the most prevalent form of construction in the epicentral region) was permitted up to the time of the earthquake. The performance of reinforced concrete frame and wall buildings is presented in some detail in Chapter 3. Chapter 4 presents information on the performance of industrial facilities including electrical substations, a petrochemical plant, and an oil refinery. The performance of these facilities during the August 17 earthquake could be considered to be representative of that of industrial facilities of a similar age (1960s and 1970s) in the United

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States and Europe. Chapter 5 summarizes and concludes with brief recommendations related to seismic design practices and performance-based earthquake engineering practice.

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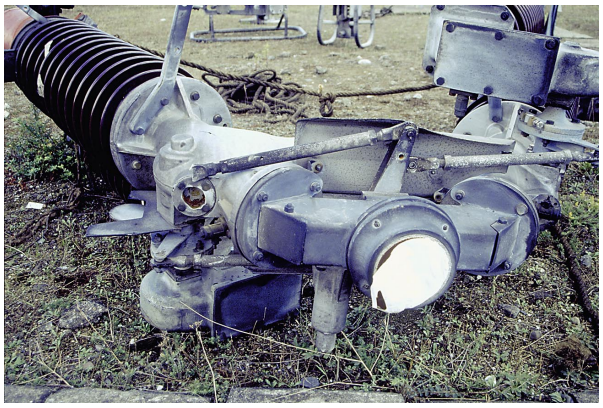

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1 Large permanent drift in weak first story of reinforced concrete building
2 Collapsed and damaged reinforced concrete apartment buildings in Degirmendere
3 Fault trace through naval station building
4 PEER reconnaissance team in front of damaged fertilizer plant tanks
5 Damaged fertilizer plant storage tanks
6 Damaged electrical substation equipment
7 Aerial view of Tüpras refinery
8 Flooding and damage resulting from sinking coastline near Gölcük
9 Soil-bearing capacity failure