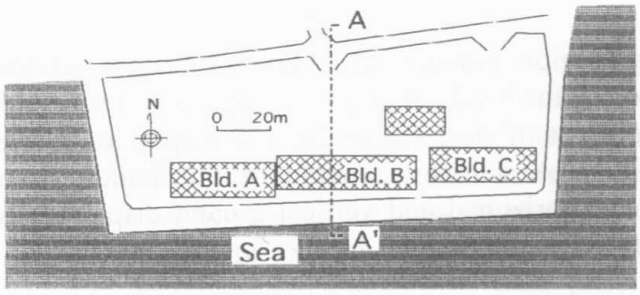

Figure 25. Plan of residential buildings in Ashiya-hama

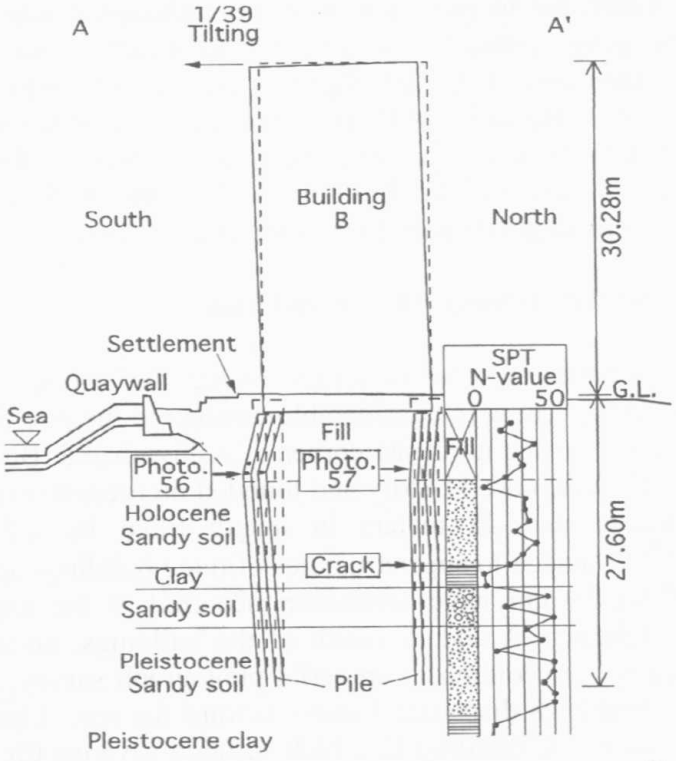

Figure 26. Cross section along A-A' in Figure 25[24]

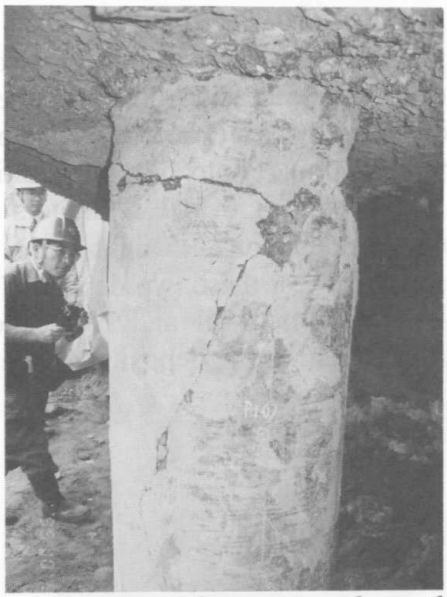

Photo 56 Failure of concrete pile on the sea side (Courtesy of Dr. H. Kiku)

Photo 57 Cracks of concrete pile of the inland side (Courtesy of Dr. H. Kiku)

(6) Nishinomiya Municipal High School

As described in 5.1, soil liquefaction was observed inland areas lying at the foot of Rokko Mountains. Nishinomiya Municipal High School is a typical example severely damaged due to the liquefaction and its induced ground displacement in this area.

The school is located on a small valley between Pleistocene terrace, 4 km from coastline. Many ground fissures occurred with sand boils in the playground. A large fissure ran with vertical gap slanted to the west, underneath a school building. Consequently, the building, supported by prestressed concrete piles 35 cm in diameter and about 8 meters in length, collapsed at eastern three columns of the ground floor and beams in the eastern third span of all of the floors, as shown Photo 58 and Figure 27. In addition, the western part of the building settled about 10 cm due to ground subsidence.

Photo 58 Collapsed school building due to lateral ground movement

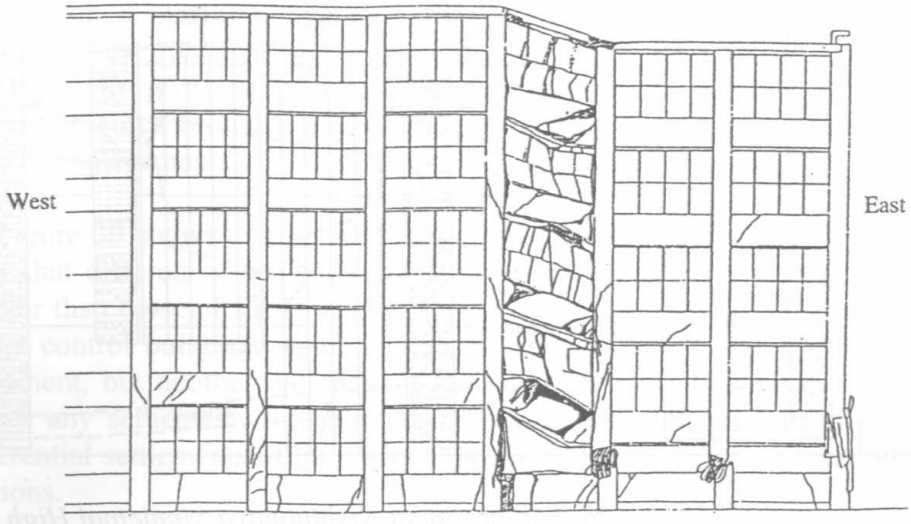

Figure 27. Schematic Figure of damaged buildings[25]

The site had been a pond filled about 30 years ago and the ground surface is gently inclined toward the south (coastline). Figure 28 shows a soil profile along a line in the east-west direction in front of the building. A fill down to depth of 2-3 meters overlies a 1-2 meters thick deposits of the pond bottom and Holocene sandy soils, which, in turn, alternate layers of Pleistocene marine clay and fluvial gravel of Osaka Group. The water table is about 3 meters deep. A survey by excavation of the upper portion of eight piles under collapsed columns revealed that a saturated loose sand layer was found at the depth of about 3 meters from the ground surface[25]. All of the piles cracked horizontally near the heads and leaned toward the southeast, namely downward. One of them was completely cracked horizontally at a depth of 3.1 meters from the ground surface. An integrity sonic test indicated that cracks also occurred at a depth of 5.7 meters from the ground surface. These depths of the cracks coincide with the interface between Holocene sand and Pleistocene silt, and that between the Pleistocene silt and gravel, respectively.

The mechanism of the damage was inferred by Nishida et al. [25] as follows: The loose fill settled first by strong vibration; at this stage, the western ground surface settled more than the eastern surface because the fill is thicker in western part. A Holocene sandy soil beneath the fill liquefied and slid westward together with overlying fill, leading to the cracks of piles. The superstructure also displaced both vertically and horizontally, resulting in the failures of the beam and the columns.

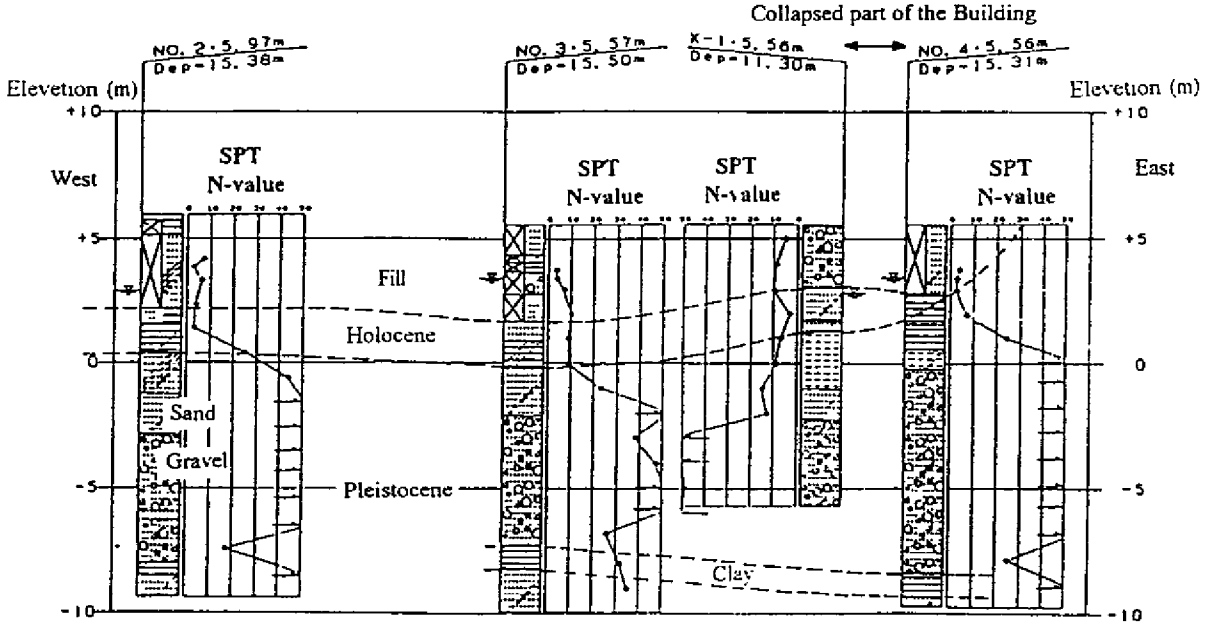

Figure 28. Soil profile at Nishinomiya Municipal High School[25]