needs to be studied more thoroughly, and maps showing areas prone to landsliding and rockfalls should be prepared and used in the design of roads, particularly those used for commuting between important cities.

Although the collapse of freeway structures (overpasses, bridges) taught the most important lesson learned from the effects of the 1971 San Fernando (or Sylmar) EQ (Fig. 39), there is no doubt that the dramatic collapse of the Cypress St. double-deck viaduct (Fig. 33) is the first observed collapse of this particular type of freeway structure. Because this structure was designed and constructed between 1951 and 1957, when very little knowledge existed about EQ-resistant construction of this type of structure, its dramatic collapse points out clearly the need for conducting vulnerability assessments of this type of hazardous existing structure, and for immediate reliable upgrading of similar existing structures. It appears that the lessons learned from the 1971 EQ, and the reminder given by the failure of the piers in one bent of a major freeway overpass during the 1988 Whittier Narrows EQ (Fig. 30), were not taken seriously.

The collapse of the upper deck of the Bay Bridge points out that it is necessary to conduct reliable analyses of the possible relative movement between two adjacent and different structures, in the case of long multi-span bridges subjected to moderate or severe EQGMs, as well as the necessity of learning to upgrade such structures. Again, this is not a new lesson. Analysis of what happened in the 1964 Nigata EQ (Fig. 40) and in the 1985 Chile EQ (Fig. 17) clearly indicates that we forget very quickly the lessons learned in previous EQs, and do not take seriously their warnings of the urgent need to perform the assessments of the vulnerability of similar important transportation facilities in our urban areas.

38 (a) Nigata (Japan) 1964

38 (b) Oakland (U.S.) 1989

Fig. 38 SAND BOILS AT NIGATA (JAPAN) (INDUCED BY THE 1964 NIGATA EQ) AND AT THE OAKLAND INTERNATIONAL AIRPORT (INDUCED BY THE 1989 LOMA PRIETA EQ).