Learning from Earthquakes

The March 2, 1997, Ardebil Earthquake in Northwest Iran

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In the afternoon (16:27 local time) of March 2nd, 1997, a relatively strong earthquake of magnitude 5.5 on the Richter scale shook a large area in the Ardebil province in the northwest of Iran. This earthquake had several hundred aftershocks, the strongest of which had a magnitude of 5.2 on the Richter scale. As a result of the earthquake, 965 people died and more than 2,600 people were injured. From the observed damage, an intensity of VII+ on the Modified Mercalli scale was assigned to the area close to the epicenter (i.e. 10 kilometer radius).

The epicenter was located at the piedmonts of Mount Sabalan with latitude and longitude of 37.9 and 47.9 degrees respectively. This mountain, with a height of 4,800 meters, is composed of rigid volcanic rocks of quaternary period. The area is generally affected by the deformation caused by intercontinental northeast-southwest plate collisions. Topographical contour lines follow the same general trend. Most of the faults in the area are a combination of strike-slip faulting and thrusts.

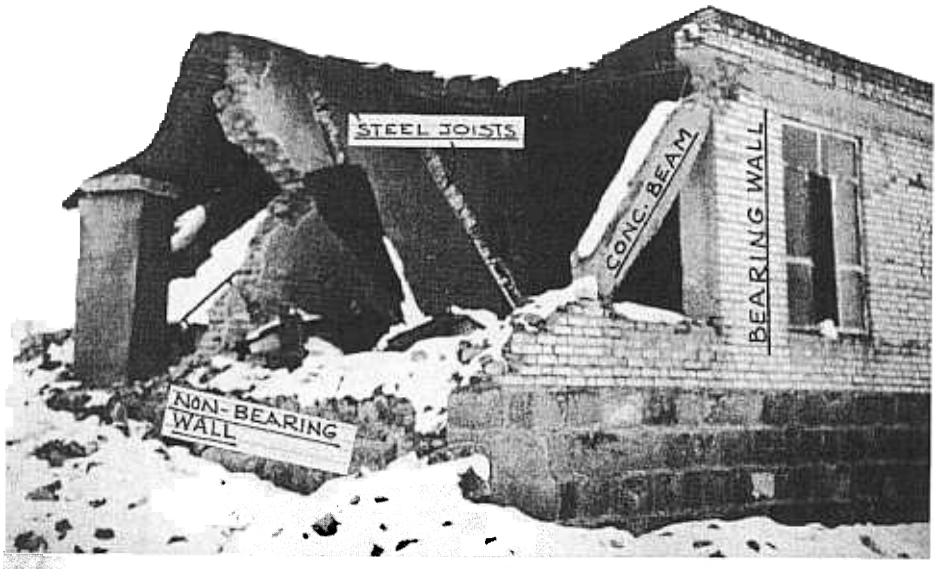
Tectonically the whole northwest region of Iran is considered to be a very seismologically active area. This is due to a northeasterly movement of the rigid Arabian plate of 3 centimeters per year that has been the main factor behind the general topographical trends in the northwestern part of Iran, eastern Turkey, and some of the central Asian countries.

Most of the slope instabilities and sliding occurred along steep slopes, road banks, and unprotected river banks within a radius of about ten kilometers from the earthquake source. Liquefaction was not a big problem in this earthquake because the depth and extent of liquefiable soil layers, which are limited to river valleys, are negligible. A major landslide with an approximate radius of 50 meters occurred just outside the town of Astara, which is about 40 kilometers east of the epicenter. This landslide caused a major blockage of the main road to the city of Ardebil.

In general, the non-engineered adobe houses (the majority of the houses in the affected area) suffered the heaviest damage. Other buildings in the area included homes, stables, schools, medical centers and government offices. Those that were at least semi-engineered or were made of bricks with a cement mortar behaved relatively well and maintained their integrity. Almost all of the death toll was due to the collapse of the adobe homes.

In addition to the adobe homes, another type of common structural system in the area requires relatively more expensive building materials: structural steel joists and bricks. In this type of construction, masonry bearing walls support the ends of steel joists that are laid parallel to each other, at an approximate spacing of one meter, filled with arching masonry to form a roofing system. It was observed in many instances that these roofing systems lacked the necessary resistance against earthquake motion and collapse, especially at the region where they meet the non-bearing walls parallel to the joists.

None of the engineered structural systems that were built out of steel or concrete experienced any noticeable (exterior) damage from this earthquake. Also, there was no report on any damage to any of the lifeline facilities, nor was any observed by the reconnaissance team.



Collapse of a non-bearing wall caused the collapse of part of a roof.