Overview of the tangshan earthquake history essay

It is important to develop some general knowledge what causes earthquakes, in order to gain a better understanding about the Tangshan event. Earth’s crust is broken into major tectonic plates that move towards and away from each other in different directions. Debated driving forces behind this movement includes Earth’s rotation, gravity related forces and mantle dynamics. Generally, it is accepted that tectonic plates are able to move because of the relative density of oceanic lithosphere and the relative weakness of the asthenosphere.

While these plates are moving, they can collide or slide past each other creating high energy phenomena such as volcanoes and earthquakes. Specific to earthquakes, the edge of one plate is forced under another. This process is called subduction and results in intense vibrations in Earth’s crust. More specifically to Northeast China, the tectonic environment is driven by collisions between the Indian and Asian plates, and Pacific and Asian plates.

An important component of the Tangshan earthquake is the role of an extensive strike-slip fault system, known as Tancheng-Lujiang, or Tan-Lu. This system extends in a north-northeast direction for more than 3, 200 miles from the north bank of the Yangtze River in eastern China to the west across the Russian border. It is an intertwined zone of faults 5000km long and 1000km wide, neighbored by other sub-faults. These collectively played a significant part in what resulted in the Tangshan earthquake. In fact, the Tangshan earthquake sequence has been explained as the result of sequential ruptures of the Tangshan fault produced by NNE extensive faulting and associated NE-SW regional compression. The earthquake sequence then initiated at the bending region (near Tangshan City) due to continued tectonic stress that had been increasing for a long time. The relationship between the rupture geometries of the Tangshan earthquake sequence and the regional compression stresses.

The Tangshan Event

Pre-cursors

Earthquakes have occurred in the surrounding area in the past, including 22 earthquakes of magnitude 4. 75 or greater since 1485. Despite these previous activities, there were no foreshocks or clear precursory phenomenon prior to the Tangshan earthquake. However, there had been a series of abnormal signals observed in the regions of Beijing, Tianjin, Tangshan, Bohai and Zhangjiakou. Tangshan indicated that there was a consistent drop in the pumping rate (and hence groundwater levels) in the years before the event with a sharp increase in the days prior to the earthquake. Additionally, survivors interviewed following the earthquake noted that well water levels changed abruptly in the hours before the event – e. g. with rises of over a meter in at least on village in the region. There was also strange animal behavior reported, including city dwellers from the downtown area who had fish discovered that the fish were restless, jumping out of the aquarium as if wanting to escape. Unfortunately the anomalous precursory phenomena were widely scattered and inconclusive.

The main quake

The main quake struck Tangshan at 3: 42 am on July 28, 1976, and lasted approximately 23 seconds. This short lived quake was at an intensity of XI (out of XII), according to the State Seismological Bureau report, with a magnitude of 7. 5 on the Richter magnitude scale. Although the epicenter was located in the city of Tangshan, the earthquake was felt in fourteen provinces of China, and as far as Xian, in Beijing and in Tientsin.

The stress of the Tangshan quake was caused by the compression along the plate boundaries of the Indian and Asian plates, as well as the compression along the boundaries of the Pacific and Asian plates. The quake ruptured a five-mile (8 km) section of a 25-mile long fault that passes through the city Tangshan. In addition, along the west side the ground moved laterally for about five feet, in a north/northeast direction sub parallel to the major axis of the meizoseismic zone with some areas with horizontal ground displacements of up to 7 meters. On the eastern side of the rupture, the ground block tipped upward near the south end and downward at the northern end.

Although the earthquake was a shallow focal depth of 15 kilometers, it created both horizontal and vertical movement, causing the ground to rent apart by several feet, cave in to form craters, previously flat agricultural land being undulated, and soil liquefaction.

Aftershocks

Following the main earthquake, the many aftershocks also had devastating effects. There were two major aftershocks which caused additional damage to the region. On July 28, 1976 at 6: 45 pm local time an Mw 7. 0 earthquake struck, centered in Shangjialin Luanxian to the northeast of Tangshan. This caused 50 km (31 mi) rupture along the Luanxian-Laoting fault. The second major aftershock of Mw 6. 4 struck on November 15, 1976 at 9: 53 pm local time, centered south of Lutai to the southwest of Tangshan. This aftershock ruptured 20 km (12 mi) of the Jing Canal fault. In all, over 850 aftershocks occurred through the end of 1978 and were distributed throughout an area approximately 140 km (87 mi) in length and 50 km (31 mi) in width along a northeast trend, indicating the Tangshan fault as the main fault rupture.

Destruction and Casualties

The destruction of the earthquake included 242, 400 deaths; 164, 600 people severely wounded; 3, 800 people disabled; 360, 000 people suffering minor injuries; and various damages to residential areas, industrial areas, roads, railways and sewage systems. Here, the report will examine what effects the earthquake had on infrastructure and casualties.

Infrastructure

Before the 1976 earthquake, scientists did not believe Tangshan was susceptible to a large earthquake. Thus, the seismic design code for the area was zoned an intensity level of VI and the buildings in Tangshan were not built to withstand such a large earthquake. Furthermore, the city of Tangshan is located in the center of an area surrounded with major faults, where many of its structures had been built on unstable, alluvial soils. The 7. 8 earthquake that hit Tangshan was given an intensity level of XI and left hundreds of thousands of buildings destroyed.

The infrastructure damage affected many different areas. Ninety-three percent of residential buildings and 78 percent of industrial buildings were completely destroyed. Eighty percent of the water pumping stations and fourteen percent of the sewage pipes were seriously damaged. In addition, the foundations of bridges gave way, bridges collapsed, railroad lines bent, closed roads were covered with debris, highway bridges and at least two dams collapsed, all telephone and radio communications systems stopped functioning and almost all of the irrigation wells became inoperative.

The seismic waves of the earthquake spread the damage to various regions, such as Qinhuangdao and Tianjin, and a few buildings as far away as Beijing. As was the case in Tangshan city, earthquake resistance was not generally considered in the design of buildings in these other regions. Newer buildings with seismic capacity and any buildings strengthened after the 1975 Haicheng Earthquake performed much better during the Tangshan Earthquake than those designed without seismic design considerations.

Casualty

Along with infrastructure damage, there were devastating amounts of casualties. As mentioned earlier, the earthquake struck just before 4 am, when many people were asleep and unprepared. Before the earthquake, the total population of Tangshan city was approximately 1. 2 million, with 2 million within 40 km (25 mi) of the epicenter. As mentioned earlier, the official death count from the earthquake was 242, 400; however, other sources have cited the death toll to be as high as 655, 000 to 779, 000 people.

Contributing to the high number of casualties was the structure of residential buildings. Most residential structures in Tangshan and surrounding rural regions consisted of older, single-story brick or stone wall homes with only few newer multi-story brick apartment buildings built in the 1960s. Due to this structure, many buildings collapsed because of the lack of proper connections between the walls and roof, as did many reinforced concrete and masonry industrial buildings with heavy roofs, weighing as much as 400 kg (890 lbs). Finally, another contributing factor to the high death toll was the density of buildings and population in Tangshan city being extremely high. This concentration contributed to the seriousness of the loss in particular because the source of the earthquake was directly beneath the city.

Relief Response

The earthquake disaster required both short-term and long-term response. To begin, the Chinese government refused to accept international aid from the United Nations, and insisted on self reliance. This required rescue workers accompanied by appropriate equipment in order to rescue people from the collapsed buildings, as well as a pre-established plan to coordinate the effort, which was made difficult since vehicular traffic brought the few clear streets to a standstill. Also, since most of the population lost their homes due to the infrastructure destruction, there was a great need for temporary shelters. Clearing of the debris did not begin in earnest until September 1981, leaving the vast majority of the population not being able to live in permanent housing until 1985.

In addition, there was the need for long-term strategic planning. Much of this had to do with future design codes for the city. The Tangshan Earthquake led to a major update to the seismic design code, released in 1978. The study of the Tangshan Earthquake and its tectonic setting also resulted in the reclassification of hazard zonation of the Hebei province (particularly the

Tangshan region). Updates to the code included performance criteria increases with the raising of expected ground shaking intensity, introduction of a new understanding of how the liquefaction of underlying soils impacts building foundations, and the inclusion of increased vertical forces from seismic loads good building practice from the collapsed buildings in Tangshan. The earthquake also highlighted the requirement for redundancy in the provision of lifelines, accompanied by the assessment of the appropriate design standards to guarantee the minimum necessary function of roads, bridges, or utility supplies which were greatly affected by the earthquake.

The relief responses resulting from the Tangshan Earthquake created the opportunity to build and incorporate increased earthquake resistance for future seismic events. Moreover, the layout of the city was planned to reduce both the number of casualties and injured, in addition to increasing the efficacy of emergency relief and disaster rehabilitation.

The 2008 Sichuan earthquake had the same measurement on the Richter scale at 8. 0 in magnitude. It, however, occurred in a mountainous region where relief efforts were noticeably hampered by the geographical makeup of the land nearby. The Sichuan earthquake also had a much quicker and more organized response system than Tangshan, as the political, social and technological environment was different.

Discussion

Conclusion

In summary, this report has presented many important concepts to gain an understanding about the Tangshan Earthquake. It has examined the underlying driving forces, such as the Tancheng-Lujiang fault system and Tangshan fault; the various effects from the precursors, main quake, aftershocks; the destruction and casualties from the disaster, including factors that lead to an increased death toll and infrastructure damage; the relief response to the disaster and how it affected future earthquake responses; and a discussion of how amateur seismologists and professionals made predictions about the Tangshan Earthquake. Discussing these topics brings awareness on the importance of understanding natural disasters, and how a population can learn and prepare itself for future natural disasters.