



Lessons learned from the 12 May 2008 Wenchuan earthquake: Impact on industry

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The earthquake that shook Wenchuan County in China's Sichuan Province on 12 May 2008 was a major event with a moment magnitude of $MW = 7.9$ and a depth of only 19 km. It caused a fault rupture of 270 km length and affected a total area of about 500,000 km². With the intensity reaching XI in the region near the epicentre and peak ground acceleration values as high as 0.63g the earthquake killed almost 70,000 people, injured over 374,000 and rendered 5,000,000 homeless. Over 18,000 are still listed as missing. Prior to the earthquake the area was considered a region of moderate seismicity with a design intensity of 7.

Sichuan Province is home to a significant proportion of Chinese chemical and nuclear industry and consequently has a very strong economy. The direct economic loss due to the earthquake amounts to over 1.1 billion Euros. In addition to economic damage there is also concern about earthquake-triggered damage to and destruction of industrial facilities housing or processing hazardous substances and the potential consequences of their release to man or the environment. In order to understand how well the chemical industry fared in the earthquake-affected areas a reconnaissance field trip was organised from 15-21 November, 2008, which included visits to industry in Deyang, Shifang, Mianzhu, Mianyang, Anxian and Dujiangyan. In total we collected information on earthquake effects at 18 industrial facilities.

Lessons learned from this reconnaissance field trip confirm the devastating consequences that natural disasters can have on industrial facilities. In addition to casualties and environmental harm the economic losses due to damage, prolonged shut-down periods and business interruption are often ruinous and may result in lay-off of workers. In the case of the visited facilities the shut-down time was up to 6 months. Two facilities were damaged beyond repair and have resulted in significant ammonia, sulphuric acid and other releases that in addition to polluting a river also necessitated the evacuation of 6,000 residents. The main cause of worker death and injury was the collapse of warehouses, office and manufacturing buildings. This concerned mostly concrete structures with insufficient confinement or poor reinforcement that could not withstand the earthquake loads. The falling debris resulted in equipment damage and loss, as well as pipe severing and crushing in buildings housing machinery. This was brought about either by direct debris impact or by support failure inside buildings. Pipes were also severed, bent or crushed outside of structures when connected tanks were displaced or buildings collapsed, although in many cases anchoring proved to be effective in avoiding displacement. Pipe support concrete columns in the open generally performed well. In some sites soil-liquefaction induced damage was evident, highlighting the need to consider potential site effects when selecting the location for a facility.