Great East Japan Earthquake Disaster

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A great earthquake, magnitude 9.0, occurred around 14:46 pm on March 11, 2011, at a 24 km-deep submarine epicenter in the sea of the Sanriku District, an area in the north-eastern part of the Main Island of Japan. This was followed immediately afterwards by raging tsunamis that completely destroyed the earthquake-stricken towns and villages. When the Earthquake struck that area, a seismic intensity of 7 was observed at Kurihara City, Miyagi Prefecture, and a level of 6 or slightly more was recorded in wide areas in Miyagi, Fukushima, Ibaragi and Tochigi Prefectures. In view of the chaos and disaster caused by the Earthquake and tsunamis along the Pacific coast, extending from the Kanto District to the north-eastern (Tohoku) part of Japan, the Earthquake was named "the 2011 off the Pacific Coast of Tohoku Earthquake" and the ruins in its aftermath "the Great East Japan Earthquake Disaster."

The amount of energy released by the Earthquake was about 1,000 times that released by the Hyogo Prefecture Southern Part Earthquake that devastated Kobe City and its surrounding areas in 1995. Figure 1 illustrates the acceleration waveforms of these two earthquakes and reveals that the seismic motion of the Earthquake with large amplitudes lasted for more than 100 seconds. The source mechanism is a reverse fault having a west northwest – east southeast pressure axis at the boundary between the landside and sinking Pacific plates. Figure 2 shows an estimated breaking process of the fault (a distribution of fault slips). Large slips were observed at three points: (1) the epicenter and its vicinity, (2) an offshore area of Iwate Prefecture and (3) the offshore region of Fukushima and Ibaragi Prefectures. Three to four focal regions that had been assumed to trigger earthquakes separately were seemingly interlocked to cause the Earthquake that was unprecedented in the past 1,000 years, with the maximum slippage reaching 23 m. The fault was about 450 km x 200 km in size.

The Earthquake, which completely destroyed the railway networks in the affected area, forced the just opened Hachinohe - Shin-Aomori section of the JR-East Tohoku Shinkansen, to totally suspend train operation. A number of narrow-gauge lines were also wrecked, with many station buildings and tracks lost or washed away on the coastal lines hit by the tsunamis. On Shinkansen lines, however, the Earthquake Early Warning System developed and implemented with support of RTRI effectively cut the power supply immediately after detecting the minor vibration at the initial stage of the earthquake and activated emergency brakes to safely stop all the trains in passenger service (except one derailed in deadhead operation near Sendai station located in an area subjected to large-scale seismic motion). As a result, no human beings were injured either on Shinkansen or on narrow-gauge lines.

After the Earthquake, RTRI immediately started the Disaster Recovery Support Task Force to support the recovery activities of the railway operators. At the request of JR-East, RTRI also surveyed the conditions of landslide areas, examined damaged facilities and derailed rolling stock and assessed the structural vibration experienced in the Earthquake. Then, it proposed recovery work to the railway operator. Thanks to the whole-hearted efforts of railway companies, the damaged railways, both the Shinkansen and the narrow-gauge networks, have steadily been restored to their normal condition, with the Tohoku Shinkansen resuming train operation along the entire route on April 29, 2011. However, it is anybody's guess when full train operations will restart along the coastal lines in the areas which were decimated and thrown into turmoil. As ever, RTRI will support the railways in their recovery work, promote analysis of the seismic incidents experienced in the Earthquake and launch activities to further improve technological measures to counter the effects of earthquakes.

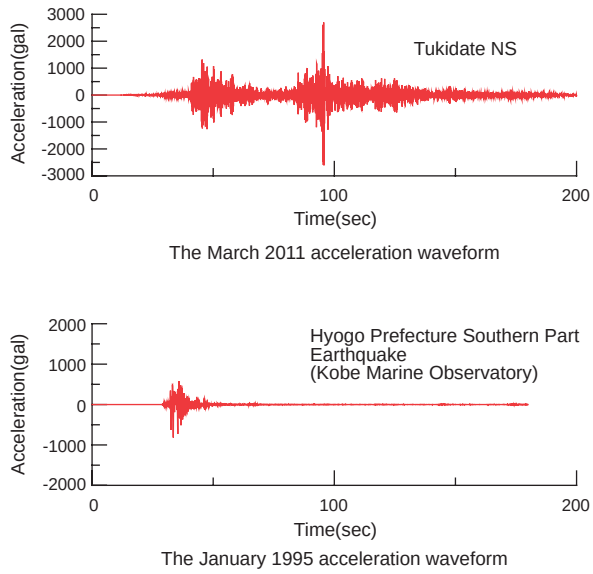

Fig.1 Comparison of seismic acceleration waveforms (source: National Research Institute for Earth Science and Disaster Prevention (NIED))

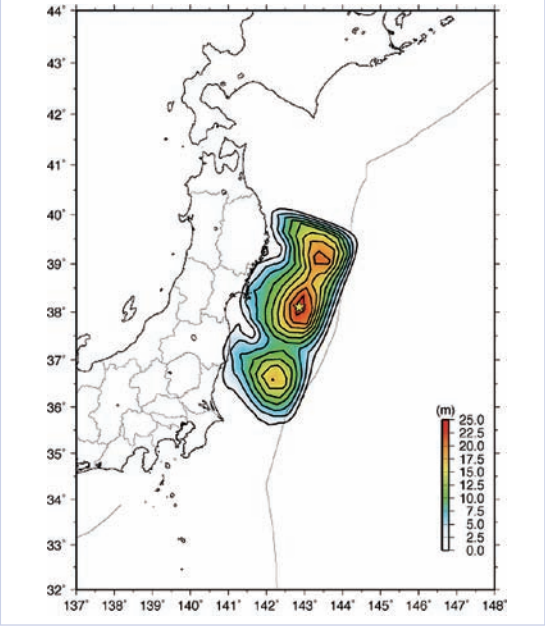

Fig.2 Distribution of fault slips (source: Dr. Yagi, Associate Professor, University of Tsukuba)