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BUILDING DAMAGE IN NARITA, SAKURA AND THE TONE RIVER BASIN IN CHIBA PREFECTURE

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ABSTRACT: The 2011 Tohoku-chiho Taiheiyo-oki Earthquake that occurred on March 11 caused severe damage to buildings. In Chiba Prefecture, a Japanese Meteorological Agency (JMA) seismic intensity scale (I_{JMA}) of six-minor was recorded at Narita, Inzai-sasagami and Inzai-ohmori. Tsunami damage on the Pacific side and liquefaction damage on the Tokyo Bay side and along the Tone River of Chiba were severe. In addition to this damage, there was building damage by liquefaction. We report here on the building damage in Chiba Prefecture.

Key Words: Great East Japan earthquake, building damage, Chiba Prefecture

INTRODUCTION

The 2011 Tohoku-chiho Taiheiyo-oki Earthquake, Japan that occurred on March 11 2011, caused severe damage over a wide area of Japan including Chiba Prefecture. A Japanese Meteorological Agency (JMA) seismic intensity scale (I_{JMA}) six-minor earthquake motion was recorded at Narita and Inzai cities in Chiba Prefecture, Kanto region.

As a result of the earthquake twenty people died and two people are missing in Chiba Prefecture. There were 799 collapsed buildings, 9,810 partially collapsed buildings and more than 43,000 damaged buildings in Chiba (Chiba Prefecture).

In addition to the damage caused by earthquake movement, a tsunami affected the Pacific Ocean side and massive liquefaction occurred in the plain area along the Tone River and the Tokyo bay area.

We carried out a damage investigation of Chiba between March 22 and April 17. We surveyed mainly Abiko and Katori cities along the Tone River and Narita and Sakura cities around Inba-numa. Figure 1 shows the surveyed areas on a map of Chiba Prefecture.

Figure 1 Survey area map (Chiba Prefecture)

DAMAGE IN KATORI CITY

Katori is located along the Tone River, which was subjected to a JMA seismic intensity of scale five-upper. We surveyed the Sawara and Omigawa area in Katori between March 22 and April 17.

The major building damage in this area was caused mainly by soil failure and liquefaction.

Collapsed buildings were typically dilapidated timber houses and warehouses. Nonstructural walls of buildings fell down. The collapse of concrete block walls and roof tile damage occurred over a wide area, not only in areas subject to soil failure and liquefaction.

Sawara area

Liquefaction damage was severe on the west side of Katori city hall. Timber houses and power poles were leaning, concrete block walls had collapsed and road surfaces were deformed (Figures 2 and 3). Attached buildings were separated from main buildings by soil failure. A tank was unseated by land subsidence(Figures 4 and 5).

Revetment along the Ono River was damaged (Figure 6). The Ono River dried up by erupting sand leaving boats stranded. Many buildings along the Ono River sank.

In the important traditional building preservation area of Sawara, the roof tiles and plaster walls of traditional buildings were dislodged and collapsed (Figures 7 and 8). The government-designated excavation of the ruins of the old Ino Tadataka residence was closed and its roof was covered with blue tarpaulins (Figures 9 and 10). Mitsubishi-kan, which is a significant cultural property of Chiba, had no structural damage (Figure 11).

Figure 2 Damage of a masonry garden wall

Figure 3 Leaning power pole

Figure 4 Damage of a tank by land subsidence

Figure 5 Attached building separated from the main building

Figure 6 Damage to the revetment along Ono River

Figure 7 Timber house damage from liquefaction

Figure 8 Collapsed timber house near the Ono River Drainage Pump Station

Figure 9 Old Ino Tadataka residence

Figure 10 Important traditional building in the Sawara preservation area

Figure 11 Mitsubishi-kan (no damage)

Omigawa area

Around Omigawa station there was less liquefaction and soil failure. There were collapsed concrete block walls and fallen exterior walls. Figure 12 shows the collapsed warehouse near the Kurobe River. The warehouse collapsed because of fallen lumber.

The Shinkai-cho area of Omigawa near the Tone River was severely damaged by soil failure. A manhole and a water storage tank were uplifted by liquefaction as seen in Figure 13. Only one block of land collapsed to the west and a timber house tilted because of soil failure (Figures 14-16). Figure 17 shows a large sand eruption point in the next block. A water tank was uplifted about 30 cm by liquefaction. (Figure 18)

The two adjoining blocks responded differently. One manhole was uplifted, but the others were not damaged as shown in Figure 19.

Figure 12 Collapsed warehouse

Figure 13 Shinkai-cho area

Figure 14 Subsidence damage

Figure 15 Tilted timber house

Figure 16 Tilted timber house

Figure 17 Sand eruption point

Figure 18 Water tank uplifted by liquefaction

Figure 19 Shinkai-cho, Omigawa area

DAMAGE IN ABIKO CITY

We surveyed the Fusa and Abiko station area in Abiko on March 22. The JMA seismic intensity scale (I_{JMA}) in Abiko was five-minor. The I_{JMA} in Inzai, which is close to the Fusa area was six-minor.

The major damage around Abiko Station was fallen roof tiles. The damage in Abiko was minor excluding the damage caused by liquefaction in the Fusa area. Liquefaction was limited to the Miyako area of Fusa (Figures 20 and 21). This liquefaction area was consistent with its swamp-like origins. There were the leaning power poles and an uplifted manhole (Figures 22 and 23). Many timber buildings in the liquefaction area were tilted and had settled because of subsidence (Figures 24 and 25). The maximum total settlement was about 1 m and the tilt or inclination angle was about 1/100. A reinforced concrete structure apartment in Miyako had no structural damage but did have damage to pipes.

Figure 20 Liquefaction in Miyako

Figure 21 Sand eruption

Figure 22 Inclination of power poles


Figure 23 Uplifted manhole


Figure 24 Settling of a timber house due to liquefaction


Figure 25 Inclination of a building due to liquefaction

DAMAGE AROUND INBA-NUMA

Inba-numa is on the right bank of the Tone River. There were early reports of damage to and collapse of buildings in Narita and Sakura cities around Inba-numa. We surveyed Narita and Sakura on March 24 and April 16.

Narita city

A JMA seismic intensity scale (I_{JMA}) six-minor earthquake was recorded at JMA Narita. The level six-minor was the maximum I_{JMA} recorded in Chiba Prefecture. The JMA Narita station was set up on higher ground than the neighboring area. Figure 26 shows the JMA Narita station and Narita city hall. Damage to exterior walls was observed in a steel structure near the JR Narita station (Figure 27). No other damage was observed apart from fallen roof tiles. Damage to housing was mainly uneven settling over a limited area caused by land failure. A collapsed ceiling in a public building was also reported.

Timber buildings in the Naritasan Shinsho-ji Temple had no structural damage but many stone structures, such as a stone lantern, had fallen.

Figure 26 JMA Narita station and Narita city hall.

Figure 27 Fallen exterior walls

Figure 28 Naritasan Shinsho-ji Temple

Figure 29 Damage to a stone structure

Sakura city

A peak ground acceleration of 1,053 cm/s/s was recorded at the K-NET Sakura station (NIED). The station is set on a slope above the city hall. Figure 30 shows the K-NET Sakura station and city hall. Figure 31 shows the cityscape from Sakura city hall. The damaged roof tiles were covered in blue plastic tarpaulins. There were cracks in the stairs of a building near Keisei-Sakura station located in the low-lying area.

Damage to buildings was reported in the north of the city where the low-lying area and plateau meet. Damage to housing was mainly uneven settling. One of the area concentrated damage was in developed land in the low-lying area. The houses settled about 10 cm.

Figure 30 K-NET station and Sakura city hall on the hill.

Figure 31 Cityscape from Sakura city hall

Figure 32 Settling of a timber house

Figure 33 Damage to a column base of the stairs in Keisei-Sakura Station.

CONCLUSIONS

We conducted a preliminary damage investigation of the area along the Tone River and around Inba-numa in Chiba Prefecture.

The damage caused by earthquake movement was low. The major damage was to timber housing caused by liquefaction or soil failure. There were fallen roof tiles and exterior walls, collapsed concrete block walls and equipment damage. Old timber houses and warehouses had collapsed. The damaged buildings were mainly timber structures. Steel structure buildings and reinforced concrete structure buildings showed no or minor damage without any structural failures.

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