Road pavement cracks in Toge District, Monzen Town, Wajima City, in the January 1st, 2024, Noto Peninsula Earthquake, Japan

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Key Facts

- Hazard Type: Road pavement cracks
- Date of the disaster: January 1st, 2024
- Location of the survey (Lat. Lon., name or address): Monzen, Wajima City, Ishikawa Prefecture
- Date of the field survey (if any): March 4th and 21st, 2024
- Survey tools (if any): GPS
- Key findings: Strains produced in the ground are transmitted to road pavement, resulting in pavement cracks. The pattern of the quake-induced cracks observed in Toge District, Monzen Town of Wajima City, resembles that observed in the 2007 Noto Peninsula Earthquake.

Key Words: *pavement crack, January 1st, 2024 Noto Peninsula Earthquake,*

1. INTRODUCTION

The moment-magnitude 7.5 Noto Peninsula Earthquake on January 1st, 2024, was the largest earthquake ever to hit the Noto region since records were kept in 1885. The most brutal hit was the northern part of the peninsula exposed to the Sea of Japan. The remarkable ground uplift along the coast, spanning about 85 kilometers through Shika, Wajima, and Suzu in the northern part of the peninsula, has led to about 200 meters-wide brush of new coastline appearing[1)]. The surface moved upward as much as 4 meters at Kurosaki, Monzen Town of Wajima City. This area, including Toge, the next village to Kurosaki, was the hardest hit even in the 2007 Noto Peninsula Earthquake ($M_{JMA} = 6.9$).

Thirty-three percent of the houses in Toge were fully and partially destroyed in the 2007 Noto Peninsula Earthquake, the highest percentage among the other municipalities in the epicentral area[2)]. Given this precedent case history, the authors surveyed Toge Village to map pavement cracks and buckles on roads and compared them with those observed in the 2007 Noto Peninsula Earthquake. The idea behind this attempt was that the asphalt road pavement would fracture due to the ground surface strain beneath it.

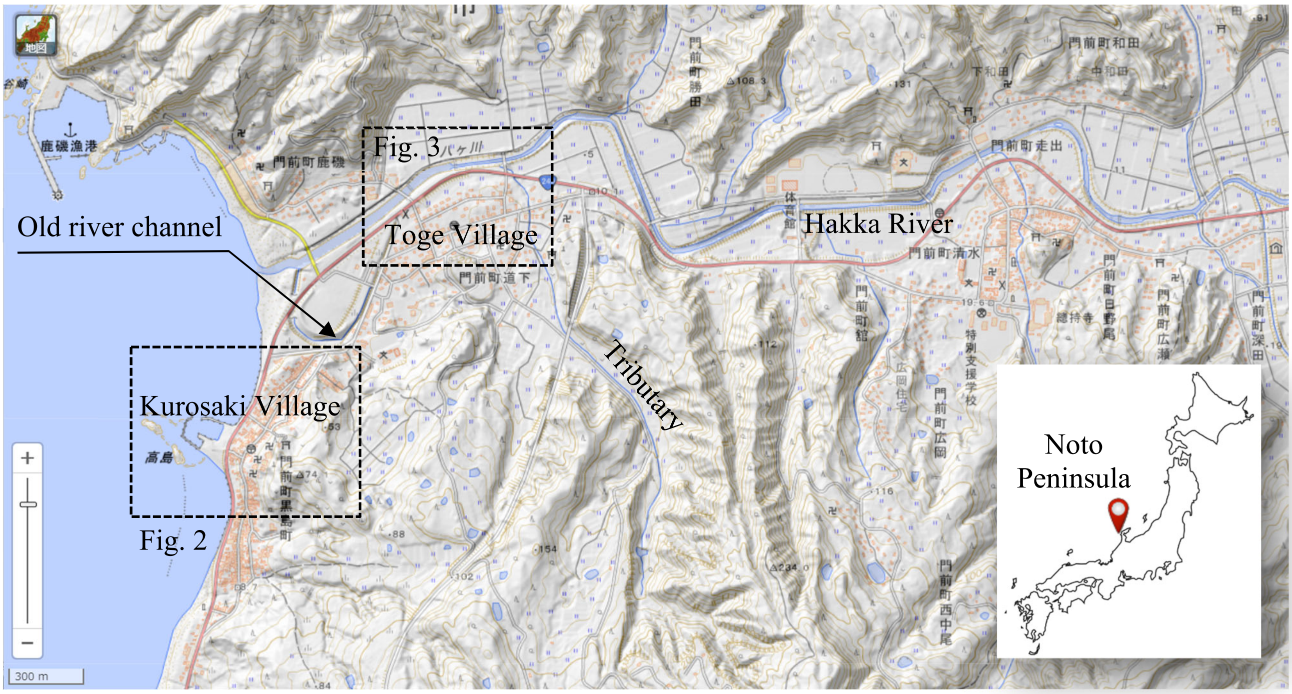

Fig. 1 Terrain of Toge Village and its vicinity (Geospatial Information Authority of Japan)

Fig. 2 Coastline of Kurosaki Village (Aerial photos from the Geospatial Information Authority of Japan): (1) before the 2024 earthquake, (2) on January 11, 2024

2. GEOLOGICAL AND GEOMORPHOLOGICAL SETTING OF TOGE VILLAGE

The Hakka River flows through a valley bottom plain from east to west and discharges into the Sea of Japan (Fig. 1). The Toge village of Monzen Town near the Hakka River mouth extends along the mainstream over an alluvial fan of a small tributary of the Hakka River. This tributary is short, only 2 km long. However, its longitudinal stream slope through the erodible hill terrain is very steep, reaching about 100 m/2000 m, thus yielding a relatively large amount of sediment runoff discharge. The 1/500,000 scale subsurface geological map “Anamizu, Togi, Tsurugiji”[3] says the erodible hill terrain is partly landslide blocks and conglomerate formation.

This amount of sediment runoff discharge has been substantial enough to develop the alluvial fan, which has long been pushing the mainstream of the Hakka River away from its original course. The current stream of the Hakka River has been improved to wind gently around the end of the alluvial fan. However, its old meandering river channel remains immediately around the periphery of the sandy alluvial fan.

As said in the Introduction, the remarkable ground uplift reaching 4 m at Kurosaki has caused a 200-m broad brush of new coastline to appear, as shown in Fig. 2.

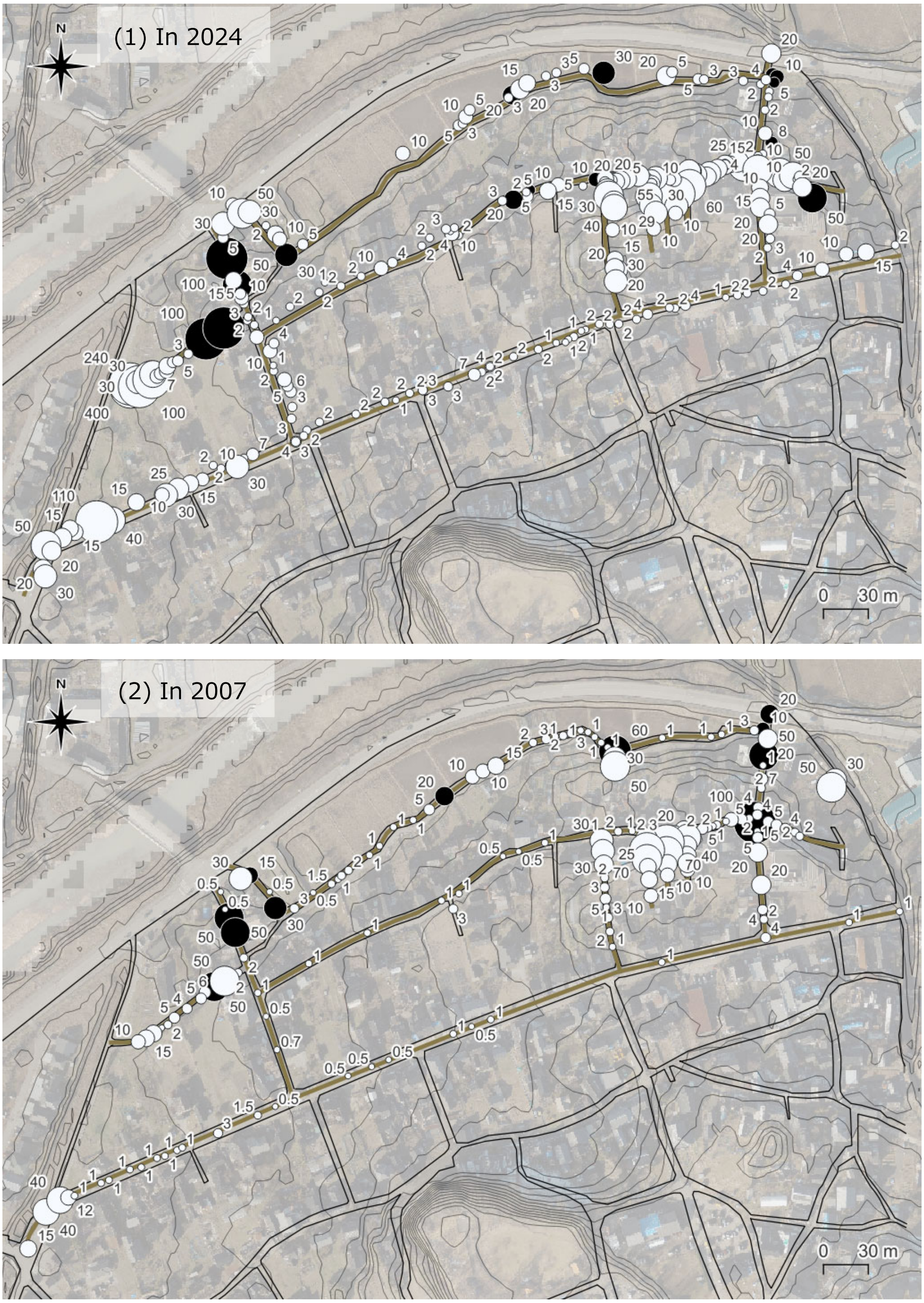

Fig. 3 Pavement fractures observed in Toge Villag in: (1) 2024, and (2) 2007: Open circles and solid circles with numbers in mm show tensile and compressional failure widths.

3. PAVEMENT CRACKS

Fig. 3(1) shows the fresh pavement crack and crush widths we observed in Toge Village on March 4th and 21st, 2024. The open and solid circles with numbers in millimeters show tensile and compressional failure widths, respectively. Though discontinuities along which one side of the pavement has moved relative to the other side exhibited various modes, not only simple tensions and compressions but also strike slips and vertical offsets, the majority are tension cracks (open circles) for the entire stretch of the examined roads. Compressional failures (solid circles) are clustered near the alluvial fan's toe parts. Fig. 3(2) shows the pavement crack and crush widths we observed 14 years ago on April 7th, 2007, immediately after the March 25th, 2007, Noto Peninsula Earthquake. The pavement fractures in 2007 are similar to those we observed in 2024 regarding their spatial distributions and relative widths, though the fractures in 2024 are more severe than those in 2007. The similarity between Figs 3(1) and 3(2) indicates that the ground deformed little by little, likewise as in past earthquakes. Since we saw sand ejecta around the toe part of the alluvial fan, re-liquefaction of the sand at similar locations may have been one of the causes of the recurring ground deformations in Toge.

4. SUMMARY

In 2007 and 2024, the Noto region was hit by upper-6-level earthquakes, which resulted in severe devastation in their overlapping epicentral areas, including Toge Village of Monzen Town in Wajima City. Road pavement fractures in Toge Village were mapped in both earthquakes and compared in this article. The similarity between the spatial distributions of the pavement fractures indicates that the ground deformed similarly to those in past earthquakes. No matter the cause, this repeatable nature of ground deformation is essential for mapping the disaster recovery strategy.

REFERENCES

1) Portal site of the 2024 Noto Peninsula Earthquake, Geospatial Information Authority of Japan, https://www.gsi.go.jp/BOUSAI/20240101_noto_earthquake.html
2) Architectural Institute of Japan: Report on the Damage Investigation of the 2007 Noto-Hanto Earthquake and the 2007 Niigataken Chuetu-oki Earthquake, Maruzen. Co., Ltd. 356p, 2010
3) 1/500,000 scale subsurface geological map "Anamizu, Togi, Tsurugiji," Ministry of Land, Infrastructure, Transport, and Tourism. https://nlftp.mlit.go.jp/kokjo/inspect/landclassification/land/5-1/prefecture17.html#prefecture17
4) Konagai, K., Ikeda, T., Takatsu, S., and Izutsu, T.: Geological and geomorphological settings and damage to civil infrastructures, Reporting Session of the damage caused by the March 25, 2007, Noto Peninsula Earthquake, Japan Society of Civil Engineers, https://www.jsce.or.jp/report/42/news3files/konagai20070329.pdf

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