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# Damages of Stone Lanterns at Zenkoji Temple, Nagano, Caused by Northeastern Nagano Earthquake, November 22, 2014

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Stone lanterns at Zenkoji Temple, Nagano, are severely damaged by the ground shaking caused by Northeastern Nagano Earthquake, November 22 2014. Damages of the residential houses in downtown Nagano is minor compared that in Hakuba Valley, and the damages at Zenkoji appear to be the result of characteristic ground shaking in downtown Nagano.

An M 6.7 earthquake occurred at the northern portion of Itoigawa-Shizuoka Tectonic Line on November 22, 2014. Seismic shaking in the vicinity of epicenter is as severe as JMA Intensity 6-minus, which caused moderate damages of the residential houses and geomorphology damages such as movement of surface ground mass.

Nagano Zenkoji Temple is located in downtown Nagano, approximately 30 km east of the epicenter. Strong shaking by this earthquake cause a number of stone lanterns at Zenkoji to collapse but the damages in the surrounding residential area is minor. Similar damages of stone lanterns are recorded at the previous large earthquake in this epicentral area in 1714. Collapse of stone lanterns often is interpreted as the strength of shaking is as strong as JMA Intensity 5 Reported Seismic Intensities are 5-plus and 4 at JMA Nagano and 4 at K-net, respectively..

We surveyed damages at Zenkoji Temple and investigate characteristics of strong motion in downtown Nagano. Our focus is on directions of collapse of stone lanterns which would be used to study direction of strong shaking. Our field surveys took place on November 23, the next day of the earthquake, and November 30 and December 1, one week later. Previously we have surveyed stone lanterns of Zenkoji Temple in 2013 to study whether these lanterns have recorded damages by 1847 Zenkoji Earthquake, and by using this result we are able to distinguish old and new damages of these lanterns.

Our results indicate that approximately one-thirds of the stone lanterns at Zenkoji Temple fell down by the strong shaking. Damages appear to occur in the entire Zenkoji area, and it is not successful to relate these damages to local site effects within Zenkoji. Stone lantern most frequently fell down toward south. Characteristic periods of typical stone lanterns are often assumed to be 0.2 or 0.5 second, and our results imply that shaking at high frequency is particularly strong in north-south direction at Zenkoji.

Keywords: String Motion, Northern Nagano Earthquake, 2014