

Analysis of pulse-like waves observed in the eastern part of Fukushima Prefecture during the 2011 Tohoku earthquake

*Tomiichi Uetake¹, Kazuhito Hikima¹, Akihito Shimmura¹, Masatoshi Fujioka¹, Ryosuke Sugimoto¹

1. Tokyo Electric Power Company Holdings

1. Introduction

Strong motion records from the 2011 off the Pacific coast of Tohoku Earthquake (M9) were obtained over a wide area, and the waveform characteristics differed from region to region. In the records obtained in Fukushima Prefecture, several large pulse-like waves were observed. These pulses are considered to be generated at the strong motion generation area (SMGA) existing on the fault plane, and source models considering multiple SMGAs have been proposed [e.g. Asano and Iwata (2012), Kurahashi and Irikura (2013)]. There is also a study confirming the correspondence between pulse waves and high-frequency excitation sources on the fault plane by array analysis [Aoki et al. (2012)]. In this study, we focus on many strong motion records obtained in the eastern part of Fukushima prefecture, and examine the propagation and shape change of the pulse-like waves.

2. Records and target waves

In the eastern part of Fukushima Prefecture, many strong motion records have been obtained by K-NET, KiK-net and the seismic intensity meters. In this study, the velocity waveforms integrated from the acceleration records were used for the examination. A high-pass filter with a lower frequency limit of 0.05 Hz was applied during integration, but for records with poor signal to noise ratios in the lower frequency range, the lower limit frequency was raised to 0.1 Hz or 0.2 Hz. The figure shows the velocity waveform (EW component) of the stations along the coastline. In the velocity waveform, a plurality of pulse-like wave groups with different apparent periods are confirmed. In this study, the pulse-like wave that gave the maximum velocity at the FKSH20 was targeted.

3. Propagation characteristics of target waves

From the temporal continuity of the wave groups at adjacent observation stations, the target waves were detected along the coastline from north to south of Fukushima Prefecture. On the inland side, pulse waves can be recognized in a wide area of Abukuma Highland. The source of pulse-like waves estimated from the isochron using the JMA2001 travel-time table [Ueno et al. (2002)] was shown as the star mark (141.35 E, 37.10 N) in the figure. This position is close to the SMGA estimated by Kawabe and Kamae (2013).

4. Characteristics of target waves

Focusing on the shape of the pulse-like waves, it was a triangular shape at FKS010 and several stations close to SMGA, but a sine shape was clear at the stations a little away to the north along the coastline. The dominant frequency of the pulse wave part was about 0.5 Hz. On the south side of FKSH14 along the coast line, another wave group overlapped on the target waves. On inland side, the dominant frequency of the pulse shifted to higher frequencies and the amplitude of the pulse decreased. The largest amplitude of the target pulse wave was recorded at the station a little away from SMGA and the amplitude is different at the observation stations on the isochron. The amplitude variation of the pulse cannot be explained by a simple attenuation relation. It is considered that the site factors greatly influence the variation of wave characteristics including the amplitude.

5. Conclusions

The propagation characteristics and shape variation of pulse-like waves observed in the eastern Fukushima Prefecture during the 2011 Tohoku Earthquake were investigated. Judging from the isochron of pulse-like waves, it was propagated from the SMGA off the east coast of Fukushima Prefecture. Also, considering the spatial change of the shape and amplitude, it is considered that site characteristics have a strong influence.

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