Site specific spectral amplification in Sendai during the 2011 Off Pacific Coast Tohoku Earthquake

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1. Introduction

Ground motion characteristics in Sendai during the 2011 Off Pacific Coast Tohoku Earthquake show strong site effect due to geological condition. Site specific spectral amplification and ground motion non-stationarity have influence to structural damage. In this study, different geological conditions in local sites are selected and investigated the spectral amplification characteristics of ground motion for each site. Observed strong motion data are used from sites of EEWS and Strong motion network of DCRC[1)] to evaluate for real-time ground motion prediction for earthquake early warning system (Fig.1). Based on investigation result, each target site is classified for specific frequency ranges which cause the significant spectral amplification.

2. Site specific spectral amplification

Spectral amplification characteristcs of ground motion during the 2011 Off Pacific Coast Tohoku Earthquake are investigated together with past earthquakes occurred in Miyagiken-Oki area.

Firstly, the Oshika site from EEWS is a considered as a front site to warning for Sendai city, recently under evaluation for ground motion prediction development. The available times are estimated between the front site and target sites using data set of previuos Miyagiken Oki earthquakes, mainly foreshocks, main shock and aftershock of the earthquake 11 March 2011. M9.0 (Fig.2). In case of 2011 (M9.0) earthquake, the travel time difference is 26 – 28 sec for P wave at front site and S wave target sites, 12- 15 sec for S waves between sites. Fig.3 shows the spectral transfer function between Oshika site locating outcrop at Oshika peninsula along Pacific Caost and other sites in Sendai.

Secondly, inside city as a reference point for seismic design of building, the Sumitomo site is selected at engineering bedrock and spectral charactreistics are investigated. The site is located on dilluvial terrace area in center of Sendai city and local site consists tertiary rock. Aobayama site is located in hilly zone to the west from Sumitomo which consisting neo tertiary deposit. Local site effect gives spectral amplification around 1 sec, it is amplified 2 times comparing to Sumitomo during severe shaking of ground in both cases of earthquakes 2011 (M9.0) and 1978 (M7.4) (Fig.4). Spectral amplification in this range caused the heavy damage to buildings with 8-9 stories. One of example is a 9 story building which has long-term structural health monitoring system and it is investigated[2)]. Oroshimachi and Nagamachi sites are located in allivial deposit area to the east and south from Sumitomo respectively(Fig.5). Spectral amplification is observed about 0.6 sec period in Oroshimachi area. Amplification characteristics in nagamchi site show 4 times larger in 1 sec period and 3 times larger in 3 sec, comparing to Sumitomo site. Especially Nagamachi site stands for the effect of the deep undersground geological structure[3)].

3. Concluding remarks

In this study, the site effect on spectral amplification is investigated based on the strong motion records in Sendai City. The site specific spectral amplification should be taken into account to predict accurate real-time ground motion. Front site waveform data are expected to be also used to enhance its accuracy.

References

1) Susumu Ohno and Masato Motosaka, Strong-motion characteristics in Sendai during the 2011 Off Pacific Coast Tohoku Earthquake and its aftershocks, Japan Geoscience Union Meeting, 2011

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2. Yamagata University

2) Tsoggerel Tsamba and Masato Motosaka, Investigation of dynamic behavior of a damaged 9-story building during the 2011 Off Pacific Coast Tohoku Earthquake, Annual Meeting, Architectural Institute of Japan, 2011
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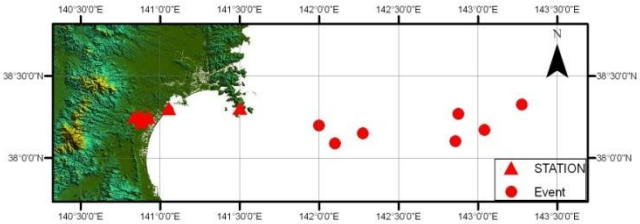

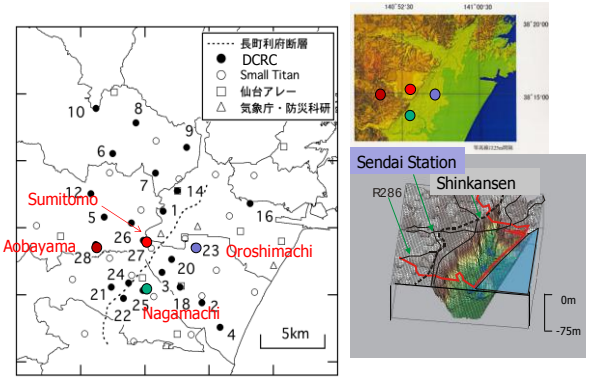

Fig.1 Epicenters of earthquakes and sites (left), and strong motion networks and Sendai geological map (right)

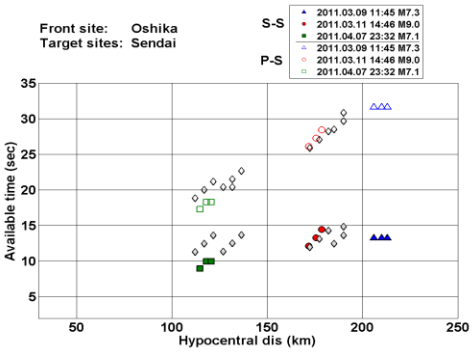

Fig.2 Available time for the investigated earthquakes

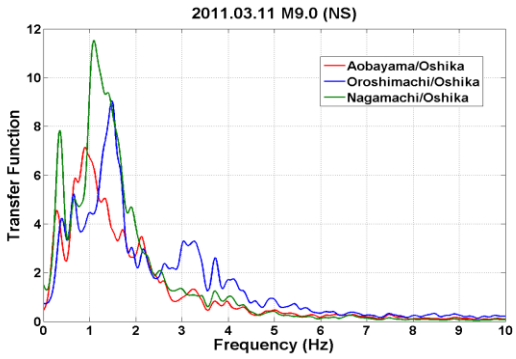

Fig.3 Transfer functions at 3 target sites

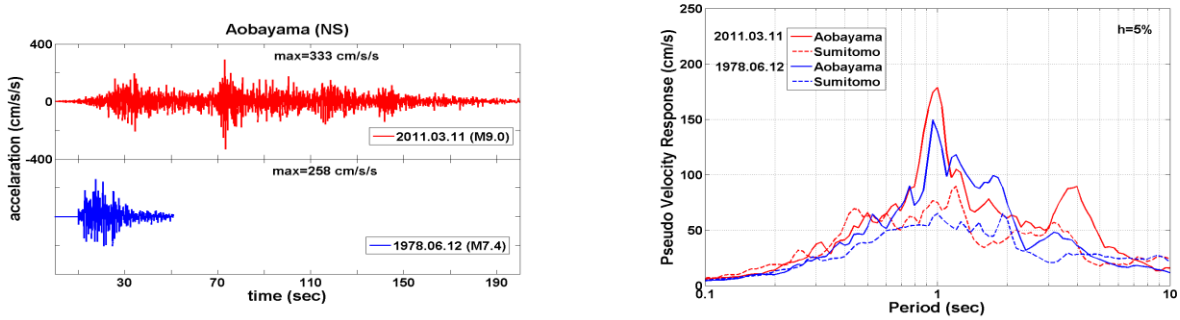

Fig.4 Time histories and spectra at Aobayama site on hilly zone for 2011 and 1978 earthquakes

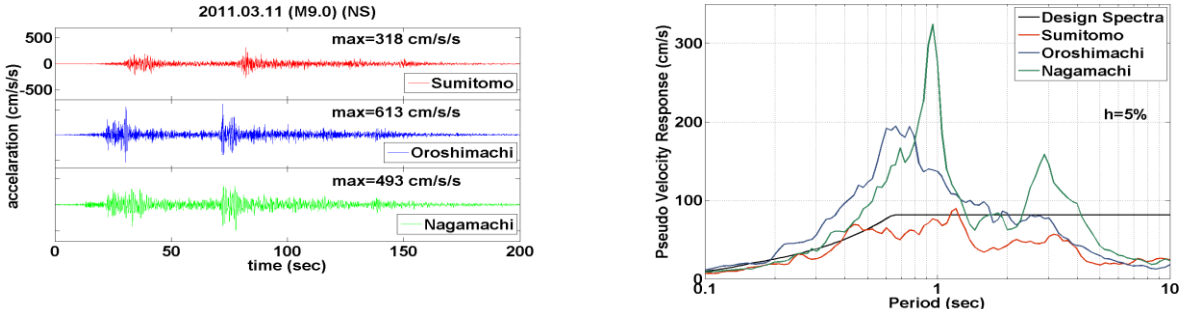

Fig.5 Time histories and spectra at Oroshimachi site on alluvial deposit and at Nagamachi site with effect of deep underground structure