Transactions of the Korean Nuclear Society Autumn Meeting
Gyeongju, Korea, October 23-25, 2013

A tsunami wave propagation analysis for the Ulchin Nuclear Power Plant considering the tsunami sources of western part of Japan

Hyun-Me Rhee [a,b*], Min-Kyu Kim [a], Dong-Hoon Sheen [b], In-Kil Choi [a]
[a]*Integrated Safety Assessment Division, Korea Atomic Energy Research Institute, 1045 Daedeok-daero, Youseong, Daejeon, 305-353*
[b]*Geology Department, Chonnam National University, 77 Yongbong-ro, Buk-gu, Gwangju, 500-757*
[*]*Corresponding author: rhhm@kaeri.re.kr*

1. Introduction

The accident which was caused by a tsunami and the Great East-Japan earthquake in 2011 occurred at the Fukushima Nuclear Power Plant (NPP) site. It is obvious that the NPP accident could be incurred by the tsunami. Therefore a Probabilistic Tsunami Hazard Analysis (PTHA) for an NPP site should be required in Korea. The PTHA methodology is developed on the PSHA (Probabilistic Seismic Hazard Analysis) method which is performed by using various tsunami sources and their weights. In this study, the fault sources of northwestern part of Japan were used to analyze as the tsunami sources. These fault sources were suggested by the Atomic Energy Society of Japan (AESJ) [1]. To perform the PTHA, the calculations of maximum and minimum wave elevations from the result of tsunami simulations are required. Thus, in this study, tsunami wave propagation analysis were performed for developing the future study of the PTHA.

2. Tsunami Fault Sources

In general, the tsunamigenic earthquakes regard as the characteristic earthquakes which the repeating and large earthquakes occurred in almost same region. The characteristic earthquake has important implication in the tsunami hazard analysis since it relates the recurrence model [2]. To analyze the wave heights which would arrived the Ulchin NPP site, the fault sources in northwestern Japan were selected. Fig. 1 shows the locations of fault sources for the tsunami simulations.

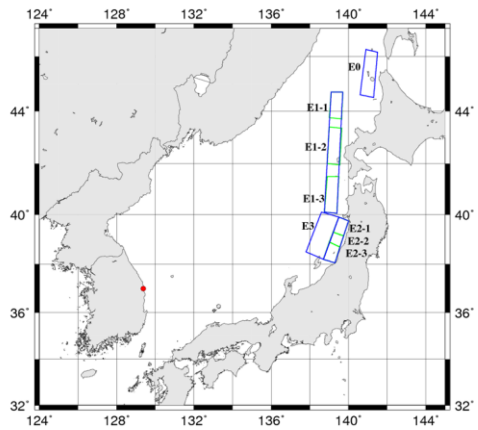

Fig. 1 The Tsunami Generation Areas

As shown in the Fig. 1 the fault source areas are coastal region off northwestern Hokkaido (E0), western Hokkaido (E1-1), southwestern Hokkaido (E1-2), western Aomori prefecture (E1-3), Akita prefecture (E2-1), Yamagata prefecture (E2-2), northern Niigata prefecture (E2-3), and northern Sado Island (E3). The magnitudes of potential earthquakes caused by the fault sources which were used in the simulations are range from 7.5 to 7.8. The fault parameters such as length, width, and dislocation had been estimated by applying the scaling law [3]. The estimated parameters are presented in table I. The lengths and the dislocations were estimated with the magnitude fluctuation of 0.2, and the widths were suggested by the dip angles (30°, 60°).

Table I: Fault Parameters for Tsunami Simulations

M_W	Length (km)	Width (km)	Dislocation (m)
7.5	50.7/71.6/101.2	30/17.3	2.1/3.0/4.2
7.7	71.6/101.2/142.9	30/17.3	3.0/4.2/5.9
7.8	85.1/120.2/169.8	30/17.3	3.5/5.0/7.1

3. Simulation Code

The TSUNAMI_ver1.1 code was used in this study for the tsunami wave propagation analysis. This code was developed by the Japan Nuclear Energy Safety Organization (JNES) [4]. For the verification of the simulation code, the simulation result was compared with the data which was suggested by the research team of Hanyang University. The suggested data shows that there is similarity with the observed data in 1983 [5, 6].

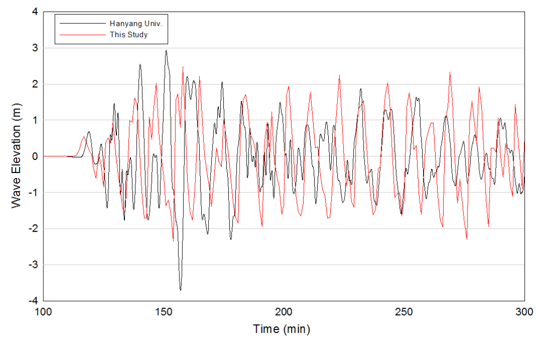

Fig. 2 The Comparison of the Time Histograms of Wave Elevation for the Verification of the Simulation Code

Fig. 2 shows the time histograms of wave elevation at a point and Fig. 3 presents the distribution of maximum wave elevation of the simulation result which was used to compare.

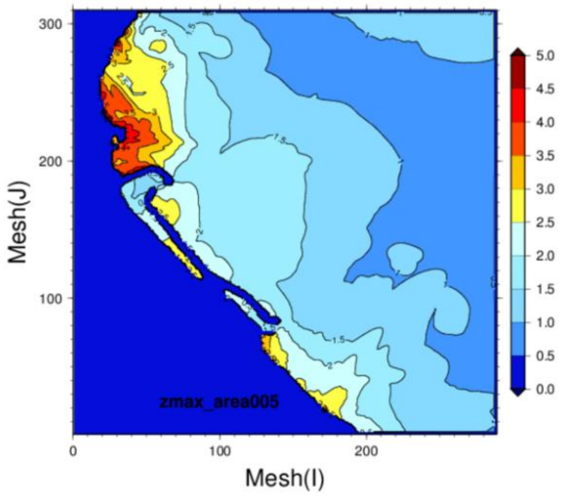

Fig. 3 The Distribution of Maximum Wave Elevation in the most smallest Near-filed Simulation Area

4. Simulation Results

The simulated results are shown in Fig. 4 by applying the fault sources in northwestern Japan. Fig. 4 displayed the time histograms of wave elevation at a point which was selected for data sampling.

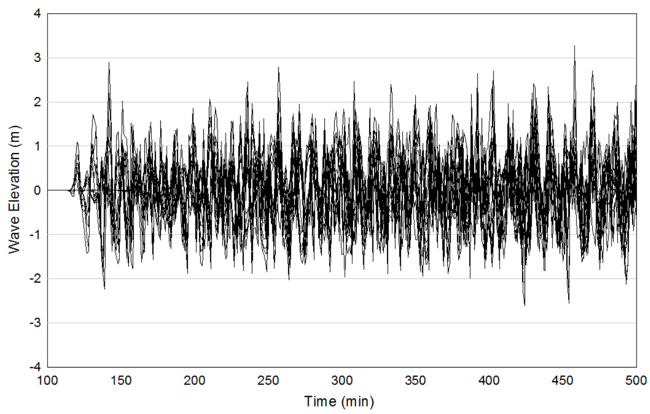

Fig. 4 The Time Histograms of Wave Elevation which were derived by Simulations

The analysis results such as the time histogram are much different according to data sampling location. It means that the result of tsunami hazard analysis could be varied according to the sampling location for wave elevation. For the reduction of sensitivity on the data sampling points, the 44 sampling points were selected by considering both the shape of breakwater and the distribution of wave height in this study. Fig. 5 illustrates the dependency on the sampling locations of the tsunami simulation results. The maximum and minimum wave elevations at sampling points were estimated from these time histograms. The maximum and minimum wave elevations would be the input parameters for PTHA. The effect of the fault sources in northwestern Japan implies the dependency on the fault direction and the potential earthquake magnitude.

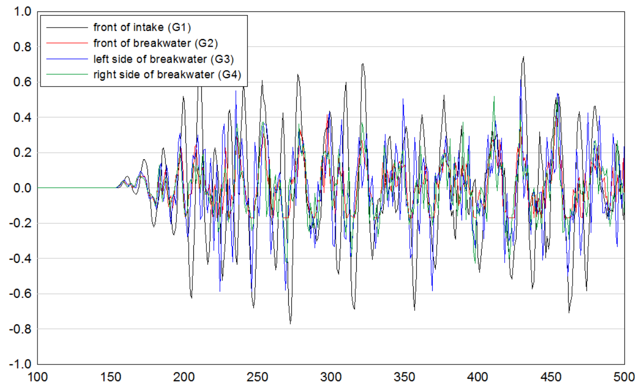

Fig. 5 The Comparison of the Time Histograms of Wave Elevation at the Groups of Sampling Points

5. Summary

The simulations of the tsunami wave propagation was performed in this study. The four groups which were composed by front of intake, front of breakwater, and left and right side of breakwater were selected as the sampling points. The time history of wave elevation at each point and the distribution of maximum wave elevation were calculated. These results could be used to the PTHA as the input parameters. The future study on the PTHA will be performed by using the mean maximum and minimum wave heights of each group.

ACKNOWLEDGEMENT

This work was supported by Nuclear Research & Development Program of the NRF grant, funded by the Korean government, MEST.

REFERENCES

[1] Atomic Energy Society of Japan, "Implementation Standard Concerning the Tsunami Probabilistic Risk Assessment of Nuclear Power Plant: 2011", AESJ-SC-RK004E:2011, NISSEI EBLO INC., Tokyo, Japan, 2013.

[2] Youngs, R.R. and Coppersmith, K.J., Implications of fault slip rates and earthquake recurrence models to probabilistic seismic hazard estimates, Bulletin of the Seismological Society of America,vol.75(4), p.939-964, 1985.

[3] Wells, D.L. and Coppersmith, K.J., New Empirical Relationships among Magnitude, Rupture Length, Rupture Width, Rupture Area, and Surface Displacement, Bulletin of the Seismological Society of America,vol.84(4), p.974-1002, 1994.

[4] Japan Nuclear Energy Safety Organization, Tsunami Simulation Code "TSUNAMI", Japan, 2008.

[5] Korea Electric Power Research Institute, "Numerical simulation of tsunamis on the coastal area of the Korea Peninsula", Daejeon, Korea, 2007.

[6] Korea Hydro Nuclear Power Co., LTD, "A Study on the Probabilistic Safety Assessment Method for Tsunami, 08SF07, Daejeon, Korea, 2010.