Probabilistic External Flood Hazard Assessment at NPP Site

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1. Introduction

In recent years, the flooding risk of national major facilities has increased significantly due to heavy rainfall events. These facilities should consider and evaluate the external and internal flooding risk such as flash flood from rainfall, watershed flooding, river flooding and coastal flooding.

This study estimate the flood resulting from extreme rainfall with LIP(Local Intensive Precipitation). The impact of buildings, road, and curb at the NPP site are analyzed, and the roughness coefficient according to the landuse condition is estimated. For external flooding hazard analysis, 2D analysis is carried out by applying the analysis of the tidal levels as external boundary conditions. Based on the results of the 2D analysis, hazard curves for the inundation depth with frequency and duration are developed at specific area of NPP.

A new flood hazard curve are presented by the relationship among rainfall, flood depth and annual exceedance probability. The result of this study in expected to be a basis for the waterproof design, the flood prevention function design and the advancement of flood prevention measures.

2. Research Method

Probable Maximum Precipitation(PMP) considering the climate change scenarios of RCP4.5 and RCP8.5 are computed and compared with the probability flood by frequency analysis to estimate the LIP. In order to evaluate the external flooding risk on these structures, two dimensional hydraulic analysis is performed and the frequency hazard curve is developed using the results of flood depth and velocity. In addition, a probability distribution model was applied to hazard curve. As a result, a representative probability hazard curve was presented at NPP site.

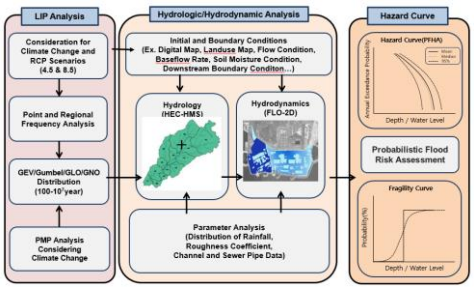

Fig. 1. Flow Chart of the Study

2.1. Detail of Topographic

The detailed topographic data for the refinement of the external flooding analysis is constructed and DEM data with high resolutions for the NPP site are generated.

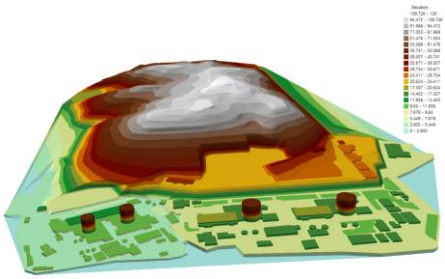

Fig. 2. TIN of NPP Site

2.2. 2D Simulation and Hazard Analysis

Based on the topographic data generated, 45 scenarios were constructed combining nine return periods from 100year to $1x10^7$ years and rainfall duration conditions from 1 hour to 3 hours.

A two-dimensional analysis comprised a grid size of 3m x 3m and total simulation time was 12 hr. (Fig. 3)

Fig. 3. Modeling of 2D Inundation Analysis

Two-dimensional analysis determined the inundation depth at each time step, and the typical results were presented as follows (Fig. 4).

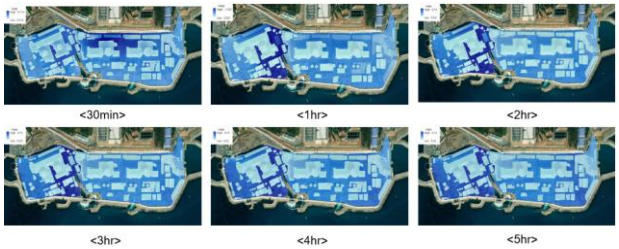

Fig. 4. Inundation Depth

(Rainfall Duration = 1hr, Return Period = 10^7y)

Fig. 5 shows the return period – flood depth relationships for the rainfall duration conditions from 1hr to 5 hours.

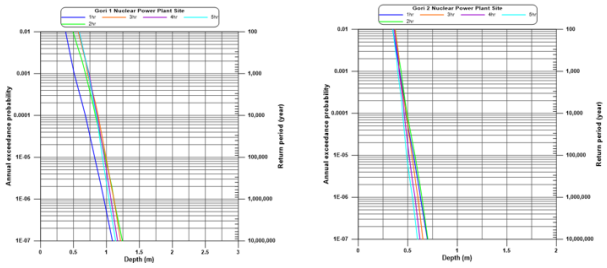

Fig. 5. Return Period – Flood Depth Relationship

2.2. Probability Flood Hazard Assessment

Two-dimensional analysis was carried out to estimate flood depths in various scenarios for the watershed, and a representative hazard curve for external flood by applying the probability distribution type for the flood watersheds.

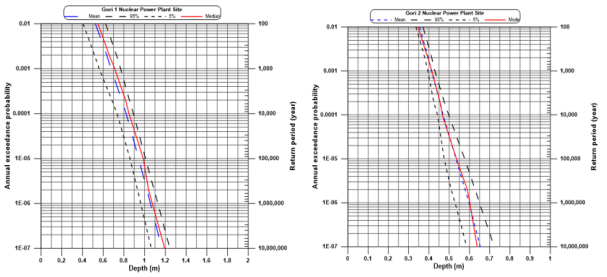

Fig. 6. Hazard Curve of NPP Site

Based on the results of the two-dimensional analysis, probability flood hazard curves for the inundation depth with the various frequency and duration conditions are developed at specific area of major facilities.

3. Conclusions

As the results of this study, the basic data for the probabilistic risk assessment of external floods that could occur at the site of the NPP from the extreme flood conditions due to river flood, watershed flood, and coastal flood were established. The probabilistic flood risk assessment method would be able to assess the risk associated with vulnerability at the site of the NPP site, and it can be used as a technical basis for comprehensive and detailed quantitative risk assessment, as well as for establishing structural/non-structural measures and for various regulation tools against severe flooding at NPP site.

4. Acknowledgments

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