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Typhoon Hazard Analysis of Kori Site using Logic Tree

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1. Introduction

Due to global warming and climate change, the intensity of tropical cyclones is increasing, which may lead to increased effects on nuclear power plants (NPPs). The US Nuclear Regulatory Commission (NRC) mandates that new NPPs should be based-design hurricane wind speeds corresponding to an annual exceedance frequency of 1E−7 [2]. Typhoon hazards are required to design new NPPs. Choun and Kim proposed a method that uses Logic Trees to analyze typhoon hazards [3]. Logic Tree and Monte Carlo Simulation (MCS) conducted a typhoon hazard analysis of the Kori site in this study. To validate the Kori site, we derived the typhoon hazard analysis of the Hanbit site and compared it with the results of a previous study.

2. Methods and Results

2.1 Methodology of Typhoon Hazard Analysis

The typhoon hazard analysis of the Kori site was derived using Logic Tree and MCS. MCS was conducted over 10,000,000 times to obtain a typhoon hazard with an annual excess probability of 1E-7. The occurrence of a typhoon is assumed to follow a Poisson distribution. After sorting the wind speed generated through the MCS, the annual wind speed frequency was estimated.

2.1.1 Wind Field Model

Wind speed can be estimated using the wind field model. The wind field model generally uses the Holland model. The Holland model calculates the gradient wind speed ($V_g(r)$) at a radius from the center of the typhoon (r), as shown in Eq.1[4].

$$V_g(r) = \sqrt{\frac{f^2r^2}{4} + \frac{B\Delta P}{\rho}\left(\frac{r_{MW}}{r}\right)^B \exp\left(-\left(\frac{r_{MW}}{r}\right)^B\right)} - \frac{fr}{2} \quad (1)$$

Where, f : Coriolis parameter
Ω: angular velocity of rotation of the earth
ρ: density of air
ΔP: difference between the ambient pressure
$r_{MW:}$ radius to the maximum wind speed
B: pressure profile parameter

2.1.2 Logic Tree

A logic tree consists of branch models and weights branch models. Logic Tree branches are composed of distributions of key parameters. The weights of the Logic Tree are set through statistical analysis of observed data. The logic tree for the Kori site is shown in Fig. 1.

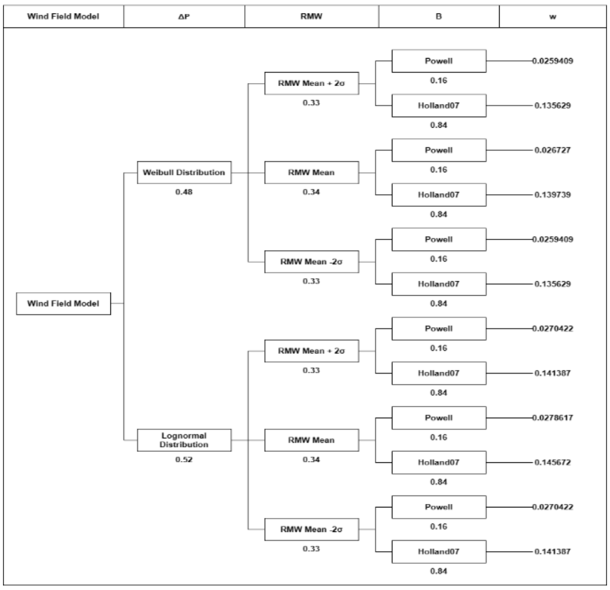

Fig. 1 Logic tree of kori site

2.2 Results of Typhoon Hazard at NPPs in Korea

A key parameter model suitable for each NPP site was selected based on the observational data. Typhoon hazards were conducted using the MCS of 12 branches of the logic tree. The typhoon hazard curve of the Hanbit site is shown in Fig. 2. The hazard curve showed the mean (μ), μ±σ, and the hazard of each logic tree branch. Table 1 compares the typhoon hazard derived from the Hanbit site with the results of previous studies [3, 6]. It was confirmed that the results derived from the Hanbit site were similar to those of previous studies. The typhoon hazard curve for the Kori site is shown in Fig. 3, and the typhoon hazard results are presented in Table II.

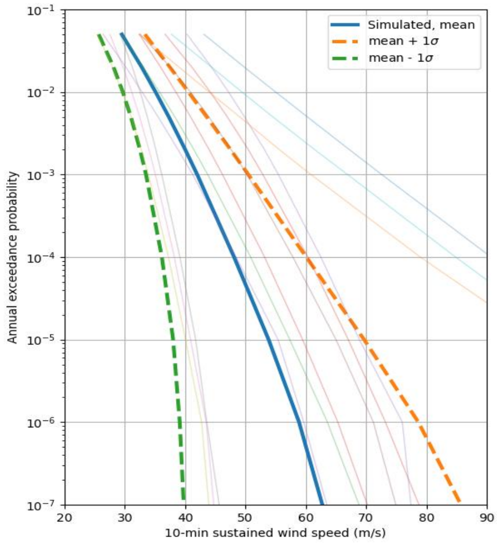

Fig. 2. Typhoon hazard curve of hanbit site

Table I. Comparison with previous studies of hanbit site[3.6]

Return period (year)	Annual exceedance probability	Simulated wind speed (m/s)	Choun and Kim (m/s)	Kang et al. (m/s)
20	5E-2	29.2	25.2	-
50	2E-2	31.4	29.0	30.1
100	1E-2	32.5	31.8	31.9
200	5E-3	34.6	34.4	33.3
500	2E-3	39.2	37.4	-
1000	1E-3	41.0	39.7	-
10000	1E-4	46.4	46.4	-
100000	1E-5	51.4	52.5	-
1000000	1E-6	55.7	57.1	-
10000000	1E-7	58.1	60.6	-

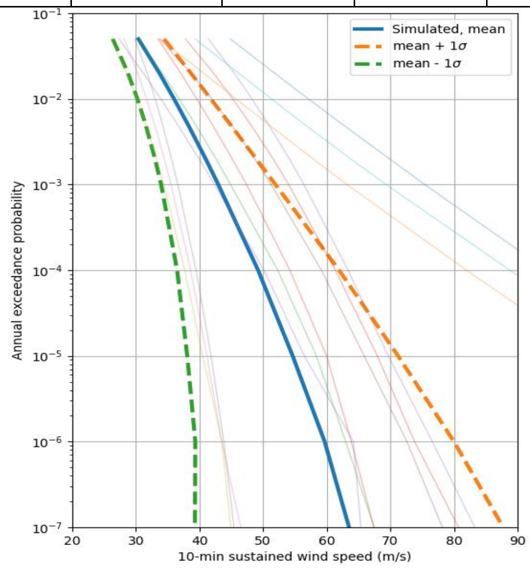

Fig. 3. Typhoon hazard curve of kori site

Table II. Comparison with previous studies of kori site[3.6]

Return period (year)	Annual exceedance probability	Simulated wind speed (m/s)
20	5E-2	30.35
50	2E-2	33.53
100	1E-2	35.75
200	5E-3	37.85
500	2E-3	40.45
1000	1E-3	42.30
10000	1E-4	47.98
100000	1E-5	53.02
1000000	1E-6	57.43
10000000	1E-7	61.98

3. Conclusions

The typhoon hazard for the Kori and Hanbit sites was derived using a Logic logic tree and MCS. A total of 12 branches of the logic tree and the typhoon hazard curves of μ and $\mu\pm\sigma$ were derived. The typhoon risk curve derived from the Hanbit site was used to compare it with previous studies on typhoon risk. The results of typhoon hazards at the Kori site were derived using the same method. The longer the return period, the higher the intensity of typhoons, and the dispersion increases.

4. Acknowledgement

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