

## Principal Research Results

# Probabilistic Considerations on Safety Factors for Seismic Stability of Foundation Grounds and Surrounding Slopes in Nuclear Power Sites

## Background

The active use of risk information as part of the safety regulations for nuclear power plants is being considered. In order to utilize such information to ensure the safety of nuclear power plants, the integration of the evaluation method for safety measures and evaluation of the failure probability of foundation grounds and surrounding slopes is needed.

## Objectives

The rationality of standard values for the seismic stability of foundation grounds and surrounding slopes (Table 1; hereinafter referred to as “standard values”) is probabilistically investigated based on existing data on nuclear power plants.

## Principal Results

### 1. Study on data of existing nuclear power plants (Fig.1)

Analysis of the suitability of correlation between the standard values used to check the safety of the sliding plane method and static analysis and the standard values used by dynamic analysis confirmed that the standard values calculated as equal to the assumed failure probability (probability below a sliding safety factor of 1.0) under dynamic analysis are almost the same as the current standard values used for the sliding plane method and static analysis.

### 2. Probabilistic examination of standard values for seismic stability and seismic importance

To examine the difference between the standard values for foundation grounds and surrounding slopes used for the sliding plane method and static analysis, the failure probabilities of foundation grounds and surrounding slopes were assumed to estimate the standard values required for deterministic checking (Fig.2). The results confirmed that when the failure probability of foundation ground is assumed to be one-tenth of the failure probability of surrounding slopes, the resulting standard values show almost the same ratio of the current standard values of 2.0 for foundation grounds and 1.5 for surrounding slopes (Fig.3). The results support the rationality of the current concept that the importance of surrounding slopes from the seismic point of view is relatively lower than that of foundation grounds.

### 3. Estimation of annual failure probability of structures which meeting to current standard values for seismic stability

Using typical models for existing foundation grounds and surrounding slopes, dynamic analysis was conducted to estimate the annual failure probability under the condition that the sliding safety factors are equal to the respective standard values (1.5 for foundation ground and 1.2 for surrounding slopes). For this analysis, the randomness of the soil properties was taken into consideration. The results show that the annual failure probability would be smaller at 10<sup>-6</sup>/year or less for foundation ground, and 10<sup>-5</sup>/year or less for surrounding slopes.

This study is part of the research work necessitated by a request made by the Federation of Electric Power Companies.

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## Reference

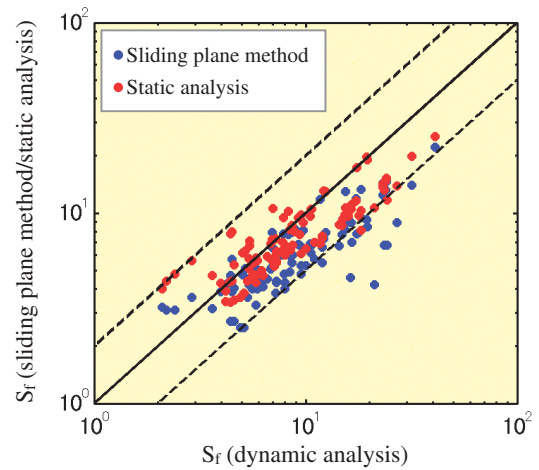
Y. Ootori, 2004, “Probabilistic Considerations on Safety Factor for Seismic Stability of Foundation Grounds and Surrounding Slopes in Nuclear Power Sites”, Technical Report N04010 (in Japanese)

**Table 1** Standard Values for Seismic Stability Currently in Use

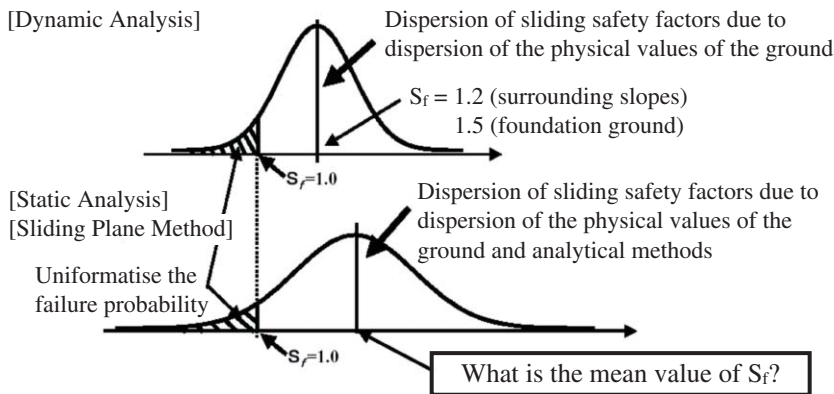
Analytical Method	Foundation Ground	Surrounding Slopes
Dynamic Analysis	1.5	1.2
Static Analysis	2.0	1.5
Sliding Plane Method	2.0	1.5

Notes

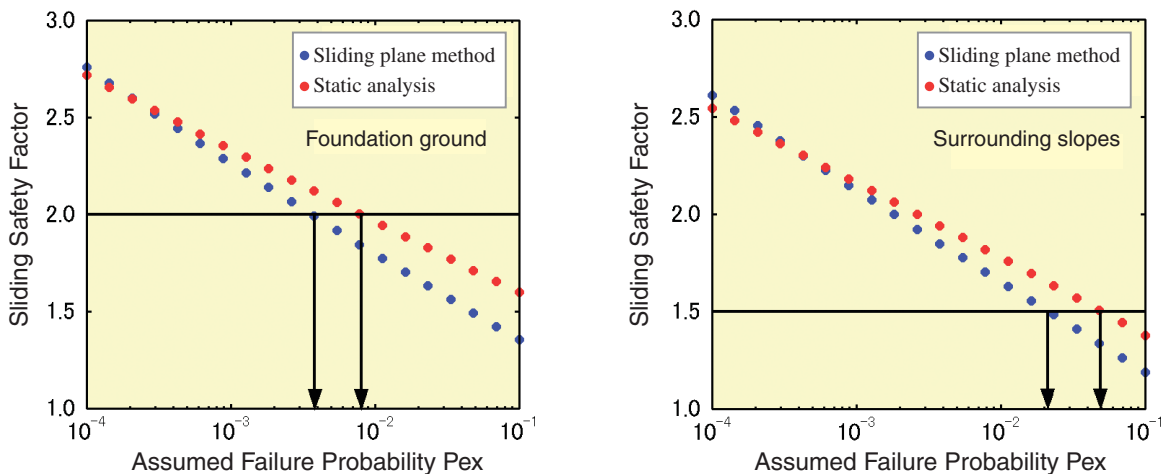
- 1) The same standard values are used for static analysis and the sliding plane method.
- 2) The standard values adopted for foundation ground are larger than those for surrounding slopes.



**Fig.1** The evaluation results on the sliding safety factors of identical structures in connection with foundation ground and surrounding slopes of existing nuclear power plants show a tendency for the values to be the largest with dynamic analysis followed by static analysis and the sliding plane method in that order.



**Fig.2** Outline of Analytical Methods



**Fig.3** Required Sliding Safety Factors

As the required sliding safety factors for the sliding plane method and static analysis little differ, it is rational for the same value to be adopted under the present standards. The estimated failure probability is smaller for foundationground than surrounding slopes.