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PROBABILISTIC ANALYSIS OF NPP SEISMIC LOAD CONSIDERING THE LOCAL SITE EFFECTS

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Abstract: The paper presents the methodology of the seismic load modification considering the local site effects in accordance with IAEA recommendation in large-scale project "Stress Tests of NPP" [3]. The earthquake level is defined with seismological parameters of a given site and response spectrum at the free terrain level as the peak ground acceleration (PGA) corresponded to 84.1% probability of no-exceedance in 10^4 years. The previous probabilistic seismic hazard analysis (PSHA) of the NPP Bohunice site were defined for the homogenous rigid soil [7]. The 3D synthetic ground motion accelerograms $a_x(t)$, $a_y(t)$ and $a_z(t)$, compatible with a design response spectrum were generated in software COMPACEL [4-6]. The influences of the layered subsoil and level of bedrock is investigated in this paper. Two methodology was used. Firstly, the simplified model of homogenous viscoelastic layered subsoil based on continuous solution of wave-equations and Fast Fourier Transform (FFT) algorithm in software SHAKESI [5]. Secondly, 3D nonlinear model based on SFEM in software ANSYS was used to determine the design acceleration spectrum at reactor building foundation level. The probability solution was based on RSM approximation method.

Keywords: Seismic, SSI, Nuclear Power Plants, FEM, ANSYS

1. Introduction

After the accident of nuclear power plant (NPP) in Fukushima the IAEA in Vienna adopted a large-scale project "Stress Tests of NPP" [3], which defines new requirements for the verification of the safety and reliability of NPP. The methodology for calculating local design spectra is based on the following assumptions [1, 3]:

- PGA values for RLE seismicity were determined for the free field assuming the rigidity of the bed of the corresponding to the rock subsoil (for vs > 1100m/s).
- The response spectrum acceleration for SL-2 [3] were defined based on a probabilistic analysis of the site effects.
- Synthetic 3D accelerograms compatible with response spectra were generated in accordance with the requirements [3].

Based on these input data, the calculation of local design spectra, considering the real geological composition at the location of the SVP object, is carried out in the following steps:

- Calculation of the synthetic accelerograms on the base at level -100m from the free level in accordance with IAEA [3] standards.
- Calculation of the local synthetic accelerograms and the design response spectra at level of foundation from the excitation synthetic accelerations using the program SHAKESI for original and modified geological conditions.

• Calculation of the smoothed design spectra at foundation level than the median values and the statistical envelope for 84.5% probability of failure is based on previous analyses for characteristic excitation frequencies.

Table 1. Comparison of the global and local response spectrum on original subsoil.

Acceleration response spectrum for 5% damping [m/s^2]				
Horizontal accelerations				
	Base level		Free field level	
Frequency [Hz]	RLE	Local	RLE	Local
0.5	0.025	0.059	0.050	0.087
2	0.173	0.159	0.364	1.082
5	0.319	0.293	0.837	1.285
10	0.229	0.240	0.780	0.782
33	0.140	0.136	0.367	0.574

Table 2. Comparison of the global and local response spectrum on original subsoil.

Acceleration response spectrum for 5% damping [m/s^2]				
Vertical accelerations				
	Base level		Free field level	
Frequency [Hz]	RLE	Local	RLE	Local
0.5	0.015	0.043	0.050	0.086
2	0.085	0.061	0.364	1.048
5	0.199	0.167	0.837	0.815
10	0.215	0.242	0.780	0.599
33	0.103	0.096	0.367	0.531

3. Concluding Remarks

This paper presents that the consideration of the local site effects based on the experimental investigation of the subsoil properties is very important from the point of view of the safety and reliability NPP structures [3, 5].

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