

# Abaqus-based verification of the Rayleigh damping matrix in dynamic analyses for NPP civil structures

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**Abstract:** *In dynamic analysis of NPP civil structures the most suitable method proved to be the method of direct integration of equations of motion of the structure-soil system. This method takes account of geometrically nonlinear effects and dashpots with high level of attenuation. In addition, this method allows for receiving a highly effective solution for some types of NPP civil structures. However, the analysis of resultant response spectra has showed a high level of spectral accelerations at elevations of equipment arrangement. One of the main reasons of such result is in a high degree of conservatism, which provides for usage of the Rayleigh damping in material as compared with modal damping. This study describes an approach allowing to receive an improved damping matrix as a Caughey series that brings to diminishing conservatism when defining a dynamic reaction in the system. The study investigates influence of a number of the Caughey series terms to be accounted when defining the improved damping matrix. As a result, there are given also the floor response spectra for a real building considering damping in material as a Caughey series. The dynamic analysis has been implemented within Abaqus software frames.*

**Keywords:** *Concrete, Dynamics, Response Spectra, Soil-Structure Interaction, Rayleigh matrix, Caughey series*

## 1. Introduction

When carrying out dynamic analyses of NPP civil structures using Abaqus software the most suitable method proved to be the method of direct integration. This method, in contrast to the modal methods of analysis, allows for considering nonlinear effects, gives a more effective solution for some types of structural members, as well as allows for accounting dashpot elements for modeling energy outflow into soil during vibrations of a structure. Therefore, there has been developed a technique of dynamic analysis of the structure-soil system at seismic impact and aircraft crash based on the method of direct integration of equation of motion. This technique was