

IAEA - KARISMA BENCHMARK

After the Niigataken-chuetsu-oki earthquake (NCOE), on 16 July 2007 that affected (TEPCO Kashiwazaki-Kariwa Nuclear Power Station with a magnitude of 6.6, a benchmark on the seismic behavior of NPP has been organized by IAEA, in the framework of the Working Area 2 (WA2) of the International Atomic Energy Agency – Extra Budgetary Programme (IAEA-EBO) on Seismic Safety of Existing Nuclear Power Plants.

Benchmark Objectives - The major objectives of the benchmark are:

1. understand what happened to soil and structures during the July 2007 earthquake;
2. understanding of margins: quantifying what happens both in soil and in structure when the input is increased;
3. calibration of different simulation methodologies for soil, structures and soil-structure interaction;
4. identification of main parameters influencing the response;
5. Consideration of the effect of differential movements beneath buildings;
6. Understanding of equipment behaviour for some selected equipment and approaches to margin evaluation

TASK 1: Structural Benchmark	
SUBTASK	SUB-SUBTASKS
Task 1.1 Construction and validation of the soil and structures models	1.1.1 Static and modal analysis of the fixed base model under vertical and horizontal forces
	1.1.2 Soil Column analyses
	1.1.3 Analysis of the complete model
Task 1.2 Main shock response	1.2.1 Transfer of spectra analysis
	1.2.2 Analysis of the main shock
Task 1.3 Margins assessment	
TASK 2: Equipment Benchmark	
Task 2.1 Piping System	
Task 2.2 Sloshing of the fuel pool	
Task 2.3 Atmospheric tanks buckling	

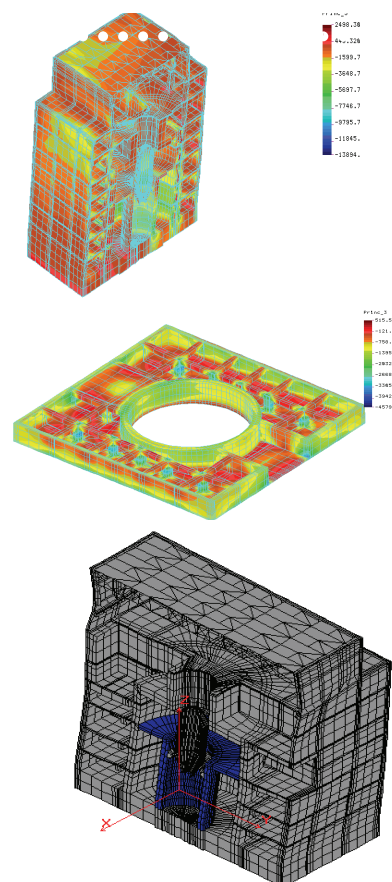
Benchmark Structure - The general project concerns two tasks: structural and equipment benchmark.

ITER-Consult joined the IAEA EBP on the "Seismic Safety of Existing NPP" in April 2009. After a preparatory activities, the analyses for the structural part of the benchmark (TASK1).have been launched in August 2009.

The first scheduled deadline March – April 2010 concerns Subtasks 1.1.1, 1.1.2. and 1.1.3

Two working teams have been established in ITER-Consult: a first group of analysts, mainly geologists and earthquake engineers is involved in soil analyses; the second group, mainly structural and mechanical engineers, has in charge the structural analyses of the building.

All data provided in the IAEA Database have been reviewed in joint meetings of the two team before starting the analyses.



To predict the detailed structural behaviour of the Unit 7 Building, a 3-D finite model has been developed. Using this model, all data requested for the benchmark have been evaluated: vertical and horizontal displacements of typical points of the structure, frequencies and modal masses.

The stick model presented in the guidance document has been developed and studied at first, to check the result of the complete model of the structure. The preliminary results obtained using the stick model have been used to identified the global weight of the building and to check the dynamic behaviour evidenced by the global finite element model.

To define a proper model of the vessel inside the global model, a specific study has been conducted, using also in this case stick and 3D models representative of the vessel alone. For the subtask concerning the soil column analysis, a layered soil column with plane-parallel strata characterized by a shear wave velocity profile up to 300 metres depth has been considered. Using this model the aftershock and main shock sequences have been reproduced, taking into account the strain dependent soil properties.

The following analyses characterize the 1st phase of Task 1 benchmark:

Task 1.1.1- Static and modal analysis of the fixed base model

- A. Static analysis of the fixed base model under vertical loads (self weight and dead loads);
- B. Static analysis of the fixed base model under horizontal forces (Uniform distribution of acceleration equal to 1 g, applied in X and Y direction, separately);
- C. Modal analysis of the fixed base model.

Task 1.1.2- Soil column analyses

- A. Soil column analyses under aftershock I;
- A. Soil column analyses under aftershock II;
- B. Soil column analyses under mainshock;

Task 1.1.3- Analysis of the complete model

- A. Modal analysis;
- A. Frequency Domain Analyses