

IAEA PROGRAM ON HYBRID SIMULATION TESTING METHOD

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ABSTRACT

Hybrid simulation testing method is applied to assess the performance seismic isolation in nuclear power plant (NPP). The method finds out numerically the dynamic response of the isolated nuclear structure with the experimental determination of the behaviour of the real size isolators under the design seismic loads. The Extra-budgetary Program of the IAEA External Events Safety Section on hybrid simulation testing method for nuclear structure model is actively performed by IAEA Member State institutions. First specific working plan was presented in the IAEA ISSC EBP Donors meeting held on March 16-18, 2015 and allocated to working group 2.3. Problem definition of benchmark analysis, distribution of numerical model data and output excel sheet, fabrication and transfer of test bearings, hybrid simulation tests, analysis of test results, and development of IAEA technical document are main activities of the task.

The target of the benchmark is the behaviour of the isolators, not the modelling of the superstructure. Hence, it is requested that all participants use the computational models for the superstructure provided by KEPCO E&C in SAP 2000 format. The superstructure provided by KEPCO E&C is the simplified models corresponding to the Korean APR1400 nuclear island. Two seismic motions, US NRC RG1.60 design spectra and EUR 2.4.6 design spectra compatible motions, are defined for design basis earthquake (DBE) and beyond DBE ($1.67 \times \text{DBE}$). The DBE for benchmark and tests has a peak ground acceleration of 0.50 g. Three types of test bearings have been provide for the tests, that is, (1) Multi Lead-core Rubber Bearing by UNISON eTech, (2) Eradi Quake System (EQS) consisting of top plate, low plate, center friction material, MER-spring, and polytron disk by ESCO RTS, and (3) Friction Pendulum System by EPS.

Eight participants submitted numerical analysis results to the given benchmark problems, and Pacific Earthquake Engineering Research Centre (PEER) team performed hybrid simulation tests in 2016 under DBE loadings.

Numerical outputs from participants and hybrid tests results are shown in view of acceleration and displacement at some key locations of the models. Backgrounds of hybrid simulation, numerical analyses and test results, and further recommendations will be transferred to IAEA technical document.