Core Seismic Behavior: Linear and Non-Linear Models

Jeanpierre-Gantenbein, J. Gauvain
Commissariat à l'Energie Atomique,
C.E.N. Saclay, D.E.M.T., B.P. No. 2, F-91190 Gif-sur-Yvette, France
A. Bernard, J.P. Van Dorsselaere
Commissariat à l'Energie Atomique,
C.E.N. Cadarache, D.R.N.R., B.P. No. 1, F-13115 St Paul-lez-Durance, France
A. Martelli
Comitato Nazionale per l'Energia Nucleare, Dipartimento Reattori Veloci,
Via dell'Arcoveggio 56/23, I-40100 Bologna, Italy

ABSTRACT

The usual methodology for the core seismic behaviour analysis leads to a double complementary approach : to define a core model to be included in the reactor-block seismic response analysis, simple enough but representative of basic movements (diagrid or slab) ; to define a finer core model, with basic data issued from the first model. This paper presents the history of the different models of both kinds.

The inert mass model (IMM) yielded a first rough diagrid movement.

The direct linear model (DLM), without shocks and with sodium as an added mass, let to two different ones : DLM1 with independant movements of the fuel and radial blanket subassemblies, and DLM 2 with a core combined movement.

The non-linear model (NLM) "CORALIE" uses the same basic modelization (Finite Element Beams) but accounts for shocks. It studies the response of a diameter on flats and takes into account the fluid coupling and the wrapper tube flexibility at the pad level. Damping consists of one modal part of 2 % and one part due to shocks. Finally, "CORALIE" yields the time-history of the displacements and efforts on the supports, but damping (probably greater than 2 %) and fluid-structures interaction are still to be precised. The validation experiments were performed on a RAPSODIE core mock-up on scale 1, in similitude of 1/3 as to SPX 1.

The equivalent linear model (ELM) was developed for the SPX 1 reactor-block response analysis and a specified seismic level (SB or SM). It is composed of several oscillators fixed to the diagrid and yields the same maximum displacements and efforts than the NLM.

The SPX 1 core seismic analysis with a diagrid input spectrum which corresponds to a 0,1 g ground acceleration, has been carried out with these models : some aspects of these calculations are presented here.