Seismic Design of the ITER Main Tokamak Components

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In order to assess the structural performance of the ITER Main Components (i.e. Central Solenoid, Toroidal Field Coils, Poloidal Field Coils, Vacuum Vessel, Thermal Shield, Cryostat, Pedestal Ring, etc) it is important to take into account not only the mutual dynamic interaction among them during a seismic event but also their interactions with the Tokamak Buildings complex (TB).

The seismic behavior of the TB is affected by the large dimensions of the building (Length 118 m * Width 80 m * Height 75 m), the concrete basemat (thickness 3m) that has to be sufficiently rigid to support the weight of the tokamak, the presence of seismic bearing pads under the basemat, and the distribution of heavy equipment at higher levels. These factors require that the soil-structural interaction must be studied in detail, taking specific effects such as the excavation influence and the building rocking motion during seismic wave propagation into account.

The TB contains safety classified structures and it has to be designed using the seismic spectra defined for the nuclear facilities on the Cadarache site. These are based on the so called SMS spectrum (magnitude M=5.8 with an epicenter at a distance D=7.1 Km from the ITER site) and the PALEO spectrum (M=7.0 D=18.5 Km). For the analysis an envelope of these two design spectra has been used.
The study of the seismic behaviour has been carried out using different linear dynamic methodologies, such as Power Density Spectra (PDS), Spectral analyses and equivalent static analyses. Different Finite Element models of the tokamak components with different levels of refinement have been used to better investigate global results (i.e natural frequency, support loads etc) or local effects (i.e. relative displacements, stress in the components, etc.). The paper illustrates the main results of the seismic analyses and gives the seismic design input for the tokamak components in terms of support loads, accelerations and displacements.
A comparison between the results of the PDS and Spectral analysis for the case of the seismic response of the Upper Port is given, as well as suggestions on how these data should be used in the design process of the Plug.

The paper also describes the application of the seismic analyses results to the design of the vacuum vessel with the application of seismic loads as seismic accelerations in an equivalent static analysis.

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