

FRAGILITY ANALYSIS OF METIS CASE STUDY



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Within the scope of WP6, models for several structures, systems, and components (SSCs) of the Ukrainian Zaporizhzhia Nuclear Power Plant (NPP) facilities were developed. These include the Reactor Building, Diesel Generator Building (DGB), Filter Containment Venting System (FCVs), Transformer, Control Monitor Cabinet (CMC), and Pump. These models were created using current finite element (FE) modelling techniques, such as the multilayer shell for shear walls modelling and fibre method for tendons and pipe section modelling, to accurately capture potential nonlinear behaviour in the OpenSees software. Additional modelling elements, such as distributed springs, were later incorporated to represent soil-structure interaction phenomena.

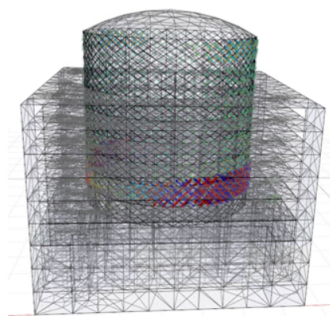
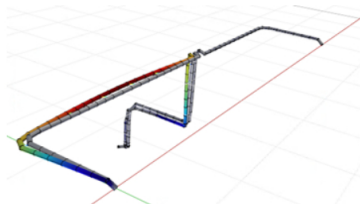




Fig. Deformation of Reactor Building at Initial Exceedance of Maximum Compressive Strength


The models were subsequently analysed using three directional ground motions inputs developed from the Metis case study (WP5), which also incorporated uncertainty propagation in site response analysis. To ensure thorough uncertainty propagation in structural responses, various uncertainties in structural properties (such as concrete and steel properties, etc.) were included.




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 Fragility Analysis of METIS case study



Fig. FirstMode Shape the Filter Containment
Venting System Model (FCVs)

To maintain consistency with previous work packages, the fragility analysis used the Cloud-regression methodology, a viable method for estimating the failure probability of NPP systems, especially when limited or no failure data is available. To assess the failure probability of components, responses at different levels of the developed structures (Reactor Building and Diesel Generator Building) were extracted for input to component fragility study. Uncertainties in component properties were also incorporated to enable comprehensive uncertainty propagation and quantification.

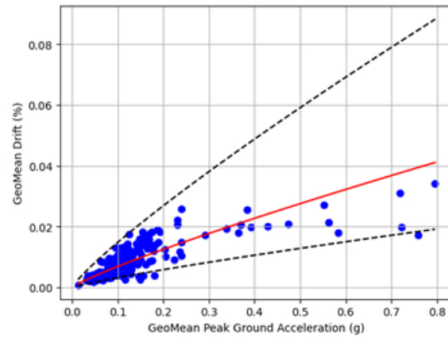


Fig. Reactor Building Response Versus Peak Ground Acceleration (PGA)

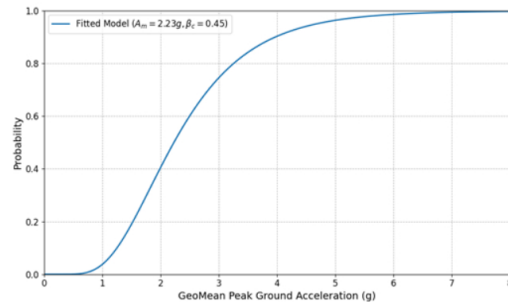


Fig. Fragility Curve of the Reactor Building Structure

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