



Seismic design of emergency machinery foundation for nuclear power plants

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Abstract

In nuclear power plants, diesel generator sets (gensets) are used for emergency situations, and regularly such gensets are consisted of a diesel engine, generator, and corresponding base frames mounted on elastic supports (usually spring-damper elements). Such dynamic systems should be properly designed to withstand combinations of different loadings like those originating from: earthquake, short circuit, synchronization failure as well as unbalanced diesel engine internal forces, and the analysis should be done with respect to genset static deflection due to its weight. This work outlines a procedure to evaluate the structural integrity of diesel generator base frame supports subjected to combinations of static, seismic, short circuit and synchronization fault loadings, for the needs of its installation in a Nuclear Power Plant in Ruppur, Bangladesh.

Key words: seismic load, dynamic analysis, nuclear power plant, emergency diesel genset, elastic supports

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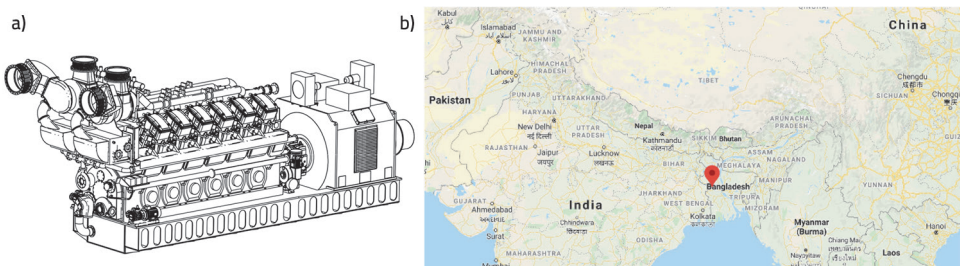


Figure 1. a) Analyzed genset; b) Geographical location of NPP Ruppur

The work is motivated by a practical engineering problem where two independent base frames belonging to diesel engine and generator, respectively, should be replaced with single common base frame supporting both devices. Detailed procedure is described in [1], while here basic idea and some specific results are shown. Fig. 2 shows the schematic presentation of dynamic system with the layout of spring damper elements.

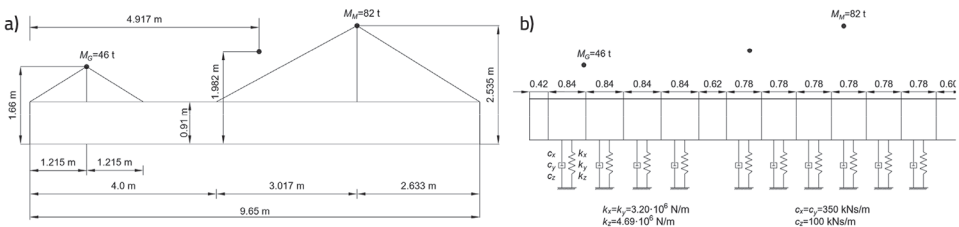


Figure 2. a) Schematic presentation of the system; b) Spring damper elements

All calculations are performed by the finite element method (FEM), by means of standard FE commercial package NASTRAN. The design earthquake for dynamic analysis is based on the earthquake in Nepal registered on April 25, 2015, with magnitude of 7.8 Mw, [2], while other loadings are obtained from the generator producer [1]. The FE model and loadings are shown in Fig. 3.

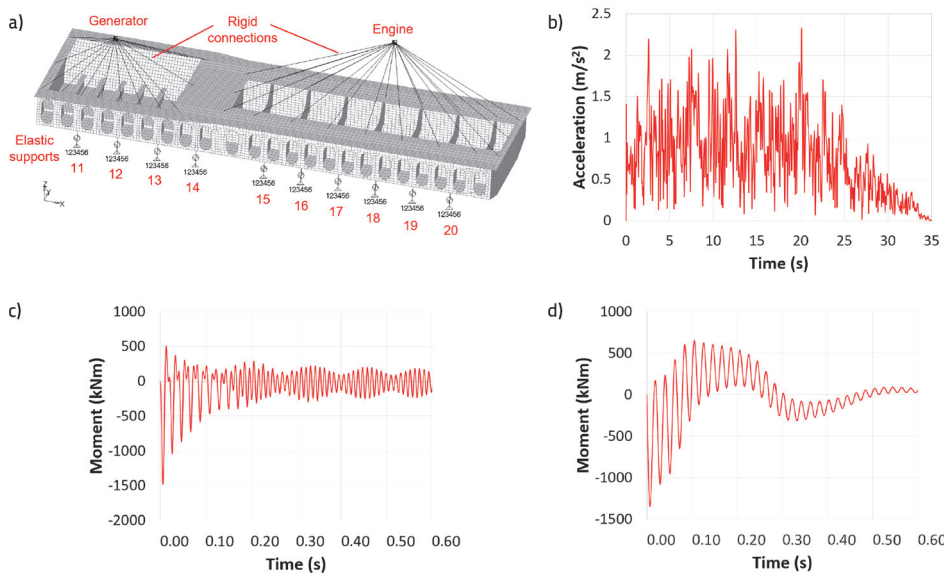


Figure 3. a) FE model; b) Total ground acceleration (design earthquake); c) 2-phase short circuit excitation moment; d) Synchronisation failure excitation moment

Strength criteria for elastic supports are given by the Russian Federal Codes and Standards in the Area of Atomic Energy Applications, [3], and based on them and calculated stresses, necessary number of springs for different load combinations is obtained, Table 1.

Table 1. Dynamical properties of model

Load combination	Gravity load	Gravity load and seismic load	Gravity load, seismic load and 2-phase short circuit	Gravity load, seismic load and synchronisation failure
Number of required supports	8	16	18	20

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References

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