

SEISMIC VULNERABILITY ASSESSMENT OF PROCESS PIPING SUPPORTED ON PIPE-WAY IN INDUSTRIAL PLANTS

Mahmood Hosseini¹ and Omid Azizpour²

¹ Associate Professor, Structural Engineering Research Center, International Institute of Earthquake Engineering and Seismology (IIEES), Tehran, Iran, Email: hosseini@iiees.ac.ir

² Ph.D. Candidate, Graduate Program, International Institute of Earthquake Engineering and Seismology (IIEES), Tehran, Iran, Email: azizpour@iiees.ac.ir

ABSTRACT:

Many different codes, standards and guidelines are available for the structural and seismic design and assessment of industrial facilities. However, most of these codes refer the seismic considerations to building codes, which are not directly usable for industrial facilities, and should be interpreted to be used for these purposes. As it is evident, above ground process piping, supported on pipe-ways, which usually used for transmission of liquid and gas type materials in industrial facilities such petrochemical and power plants, have essential role in the functionality of such facilities. This study discusses the seismic vulnerability of the above ground process piping that commonly is used in such industrial facilities. There are three basic methods for analyzing seismic response of piping systems and related supporting structures: 1) static loading analysis, 2) response spectrum analysis and 3) time history analysis (THA). However, because of complexity of analyzing piping system and supporting structures together, separate analysis of these two systems are still widely used. As a result, the seismic loading on piping systems or support structures will be over-estimated or under-estimated, which would result in the increased stiffness or flexibility of system. This in turn can affect either the economy or the seismic safety of the designed system. To investigate the vulnerability of piping and its supporting structure as a compound system with acceptable precision the THA method has been used in this study. The considered accelerograms for THA include five different recorded earthquakes scaled to four various PGA levels. The spacing between the frames of 3-dimensional supporting structure has been supposed as 4, 6, and 8 meters to evaluate the effect of support spacing on the main responses of compound structure. Two sets of diameters and thicknesses have been considered for the piping system, made of typical construction steel St. 37, according to standard DIN 2458. The finite element method has been used to determine responses of systems in various cases, in which the pipes have been modeled by shell elements. The responses of straight segmented pipes with constant length and varying support spacing, have been calculated simultaneously under gravity loads of pipes and insulation, internal operation pressure and temperature loads, as well as seismic forces. By using the numerical results the effects of supporting structure on the response of complex system (pipes plus supporting structure) have been discussed in comparison with the piping system alone (without supporting structure).

KEYWORDS: Industrial Facilities, Process Piping, Pipe way, Segmented pipes