THE EFECTS OF EARTHQUAKE STRONG MOTION ON PERFORMANCE OF BURIED GAS PIPELINES

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Keywords: Wave Propagation, Buried Gas Pipeline

Pipelines are often referred as "lifelines" and this demonstrates that pipelines play an important role in human's life. Due to huge length and wide geographical distribution of pipelines, they are subjected to more seismic hazards. Seismic wave propagations affect the operation of buried pipelines which influence safety of these systems during and after earthquakes.

Earthquake time-history analyses have been performed for a buried gas pipeline of API - Grade B&X-52, which is popularly used in IRAN. For this purpose, various parameters such as the type of buried gas pipeline, end-restraint conditions, soil characteristics, single and multiple earthquake input ground motions, and burial depths are selected. A comparative study has been performed to obtain the response characteristics of strains in a buried pipeline section, axial relative displacement, and transverse relative displacement. The capacity evaluation of the pipeline with respect to the response characteristics has been performed in comparison with the allowable strain and displacement capacity in axial and transverse directions, as suggested by the Guidelines for the Seismic Design of Buried Gas Pipelines.

The interaction between soil and pipe has been evaluated by using nonlinear springs as suggested by American Lifeline Alliance which can consider slipping between pipe and soil. In the present study, the numerical simulation of the response of buried pipelines to seismic wave propagation is estimated and guidelines for the safe design of gas pipelines in the field of seismic hazard in strong motion is presented.

PLAXIS, a nonlinear and dynamic analysis program, is used for the analytical modeling and earthquake response analysis of a buried pipeline. It has been developed for 2D and 3D nonlinear analyses of steel, reinforced concrete, and composite structures by considering both the material inelasticity and geometric nonlinearity. In addition, a variety of cross-sections are also available. The cross-sections can be divided into a user-defined number of monitoring points for the accurate estimation of the cross-section behavior, static time history, and dynamic time history facilities.

Nonlinear time-history analyses have been performed for the analytical models, while the analytical response under multiple ground motions is evaluated. The results were compared with the results of seismic safety evaluation of a continuous pipeline in Indian Institute of Technology Kanpur.

In that test, a continuous buried pipeline is designed to carry natural gas at a pressure (P) of 7.5 MPa. The installation temperature and operating temperature of the pipeline are 30°C and 60°C respectively. The pipe is of API X-52 grade with 0.6 m diameter (D) and 0.0064 m wall thickness (t). The pipeline carried out is buried at 1.2 m of soil cover. the results are shown in Table 1.

Table 1. Compering the results of IITK with this study

Summary of results	Maximum strain in pipe in tension	Maximum strain in pipe in compression	Allowable strain in pipe in tension	Allowable strain in pipe in compression	SAFE/ UNSAFE
IITK RESULT	0.0011	-----	0.03	0.00373	SAFE
RESULT IN THIS STUDY	0.0015	0.001	0.03	0.00373	SAFE

The results are in good agreement with the regulations of IITK

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