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Effect of Diameter on Stress of Buried Pipeline under Seismic Load

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Abstract

Nowadays, pipelines have various uses; water and energy supply system, communication services and so on. Furthermore, the pipelines are affected by many type of load like earthquake. This paper has invested stress-strain on the buried pipeline in soil, under seismic load and also effect of pipe diameter on stress and displacement of pipeline. In this study, finite element models of pipeline and soil are established using the package ABAQUS. Material of pipe is steel and its diameters are 300, 700 and 1200 mm and thickness is 20 mm. pipes buried in the depth of 4 meter from ground surface. Seismic load is according to El-Centro earthquake. The results show with increasing in the diameter of pipe, average stress increased too. All stress plots showed stress on pipeline is less than yield stress of steel. So there is no plastic strain. Also with increasing the diameter of pipe, displacement has increased.

Keywords: ABAQUS, Pipeline, Seismic Load, Stress

1. INTRODUCTION

It is acknowledged that underground structures suffer less damage from earthquakes than structures on the ground surface. Earthquakes have damaged many lifeline structures. Buried gas and water pipelines are also no exceptions. The damage or disruption of buried pipelines due to earthquakes may severely affect civil lifeline structures since it may cause fires, economic losses, and disable of lifeline networks.

Subsequently, the seismic analysis and behavior of buried pipelines have been investigated by many researchers, [1]. Most of the studies mainly deal with the numerical modeling of buried pipelines, soil-pipeline interaction, and earthquake induced pipeline stress. The seismic response analysis of buried pipelines is somewhat complex since it considers the three-dimensional dynamic analysis of the soil-pipeline interaction under multipoint earthquake excitation, [2]. Therefore, a rigorous analysis is impossible. For these reasons, it is necessary to use elaborate and state-of-the-art test devices in order to estimate failure aspects of buried pipeline. However, Finite Element Methods (FEM) are also helpful for executing rigorous analysis for seismic response analysis of buried pipelines.

Investigating geotechnical problems using FEM has been widely used in this research area for many years even though there are limitations for analyzing such problems accurately. However, linear and nonlinear problems such as prediction of settlement and deformation between buried pipelines and soil is highly amenable to solution by FEM. For this reason, ABAQUS, which is used for general Finite Element Analysis (FEA), was chosen in order to estimate failure aspects of buried pipelines, [3]

In previous research simulation of buried pipeline with ABAQUS by considering the effect of earthquake, [4] and different Burying Depth, [5] is studying. The rest of this paper is to understand effect of diameter on stress of buried pipeline under seismic load by using ABAQUS.

2. SIMULATION

In this study, finite element models of the pipeline and soil are established using the package ABAQUS to carry out stress analysis of buried pipeline caused by static and seismic loads. In order to perform this analysis for a buried pipeline, it is necessary to accept three basic assumptions as below.

The welding between pipeline segments is not considered. The soil is elasto-plastic characterized by Mohr Coulomb theory and the pipeline is isotropic, elastic and perfectly plastic. Pipeline and soil are fully bonded each other and the interface between pipeline and soil is perfect without defects. According to mention of