Interaction of soil-structure under different loading conditions for pipelines

Ali sanaeirad, Benyamin taheri

Abstract— The exact identification of the pipelines and to avoid crossing areas with liquefaction hazard Underground drainage and lowering the water level to prevent liquefaction Given the shallow cover of soil and the use of aggregate for embankment on the tube. Life line system, and its equipment's, provides essential services today, so seismic performance analysis in modern industrial area is exigent. We analyze and compare the performance analysis of gas bored pipes in various soil compactions with finite element method. We create a finite element model with three soil types and compare them. Finally, the soil with best performance is presented.

Index Terms— Pipelines, seismic analysis, earthquake, numerical modeling.

1 INTRODUCTION

With regard to the issue of the history of research in this area is divided into several subtypes, which are described below. Evaluation of Liquefaction Saturated non-cohesive soil liquefaction is the transition from solid to liquid as a result of an increase in pore water pressure and reduces soil shear strength. In order to reduce the damage you should consider the following: The exact identification of the pipelines and to avoid crossing areas with liquefaction hazard Underground drainage and lowering the water level to prevent liquefaction Given the shallow cover of soil and the use of aggregate for embankment on the tube.

In this article we read: vulnerability of lifelines in a natural phenomenon due to their wide dispersal in the environment is varied in a relatively high level. Some research has shown that after faulting, landslides rank second and third among the factors threatening pipelines buried requirements. Unlike the case of liquefaction, landslides often occur in static and seismic performance is extra stuffing. For this reason, the role of slip earthquake as the main factor is difficult. Among the three major methods for analyzing risk of slope instability due to the landslide have been developed, (corelishen statistically, quasi-static and Newmark), Newmark method provides a more reasonable results. Due to lack of sufficient data and studies on landslides occurred less local, corelishen statistical methods and the results Newmark unfortunately not possible until the time of writing this article is not ready yet. a computer program was critical acceleration with a minimum safety factor of stability. Regional gas transmission pipelines using network theory (the Taliban Sir, 1977) was the model. Then, using a model known to the public with uniform seismic faults (Derkiughlian and stigma, 1977) and the method are the effects of earthquakes on structures and decision element ideal site to site point range (MoghtaderiZadeh et al., 1981) and to support sustainable model of transverse displacement (Uruk and Nordburg, 1992), the probability of failure of the gas transmission system in the slip region (earthquakes) were estimated. The results of this study have shown that up to 0.25 g 0.2 g acceleration event for the stability of slopes in the region include gas pipelines (arteries of life) threatening. He does. The authors explain that the main concern, particularly in developed countries is increasing vulnerability of urban areas, so the emphasis is on reducing vulnerability in urban areas. One of the consequences of the earthquake soil liquefaction, which causes fractures and damage to roads, pipelines and infrastructure, is. The study included preparation of geological database and map is liquefaction. One of the most destructive phenomena and the main cause of water damage to structures and technical buildings during an earthquake, in areas that have been built on sandy soils, soil strength reduction or deterioration are due to liquefaction. Identifying vulnerable areas of the initial steps in the development planning and managing urban development. There are several methods for evaluation of soil liquefaction SWM model is used here. This study off the coast of the southeastern city of Bandar Gaz, with the aim of mapping and evaluating the potential risk of liquefaction is done. After obtaining baseline data and digital maps, SWM using parametric modeling software environment ArcGIS, overlap analysis has been done and liquefaction hazard maps have been prepared with 5 classes. Due to the sensitive nature of sediments in the northern part of the city, there is a possibility of liquefaction in the middle of the northern city of Bandar Gaz. The results of this study can be used in urban development planning, prioritization and monitoring of the implementation of building regulations in plain areas and coastal risk management and mitigation of earthquake and liquefaction is useful. Tin and steel pipes buried gas Sayadpour to assess the urban network has been affected by liquefaction. Buried pipe gas network in some urban areas could layers of loose saturated sandy soil, not buried. Such soils under seismic stimulation, with liquefaction and pipes in the network performance greatly affects the day.urban gas network of steel pipes buried under liquefaction is studied. Many researcher also studied the dynamic of buried pipes the soil in the area

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under the curve of wave propagation. What fruit seismic vulnerability of pipelines buried under the earth examined the effects of permanent deformation by finite element models the effects of pressure changes on the stress and strain caused by the lines pipes and soil surrounding the pipeline was studied and compared with each other. Aremi and Mvlsky overview of the call pipelines buried under earthquake excitation have earned. In John Eidinger study, fluid-structure interaction of water hammer (FSI) main objective is to connect coupling effects. Connect coupling effects in a variety of distinct parts such as pumps, pipes and branches were studied. The main emphasis was on the wing and pumps without limitation system for modeling was then extracted relations. Relations have been proposed as the boundary conditions for numerical modeling using finite element method for equations for equations hydraulic structures and procedure took place, was considered. The results of this study can be used by engineers to find the couplings used for connection are important or not.
Bvstas de Freitas Gomes de Rocha and fluid structure interaction numerical call Richard on pipeline systems using products (Glimm) have studied. soil-structure interaction under severe loading conditions, system performance, including earthquakes, floods, landslides, large deformation caused by tunneling or excavation deep and meetings arising out of, or severe water loss retreat minerals and fluids during oil production or mining operations, happens. Such loaded with more technology development to cope with natural hazards, human threats and building in busy urban environment, is more important. This article Rourke and his colleague's severe loading conditions were tested with reference to the earthquake. The earthquake is an example of using extreme behaviors that load in a facility in dispersed geographic area affected is. This article ground deformation caused by the earthquake effects on underground utilities below and subject to the performance of the entire water system Northridge earthquake in Los Angeles in 1994, applies. Tests carried out on a large scale for the assessment of soil-structure interaction under extreme load with reference to test the effects of sudden rupture of the city gas system, are described. Large-scale tests and develop design curves to applied forces on the pipelines during ground failure are described in this article. Makrleh analysis of pressure vessels and pipelines articles using the finite element method. The first part of their study to consider the installation of a dirt wall. In this study, we examined the strength of corrugated steel pipelines are buried. A big difference between the basic mechanical ground pressure on pipelines rigid and flexible pipelines will be distributed there. Corrugated steel pipe as flexible pipes are divided. So Soil Mechanics for corrugated steel pipe slightly rigid tubes and flexible pipes are different. Equation calculations for factors arching, reflection and maximum wall stress for corrugated steel pipe lines using the numerical data obtained for soil-structure model was formulated. This equation calculation, the current equations for assessing the validity and usability, was comparable. A shock tube model was used to analyze the deformation. Coefficients in the model tube shock absorbers using static analysis of soil-structure models were calculated. Or critical to the ultimate strength of this study as well as the equations proposed by the Iron and Steel Institute of America to deformation compared.

Chen article entitled seismic analysis simple and refined for buried pipelines has to offer. In paper of Karinski in 2007 , it is argued, the bulk of the malfunctions and failures of buried pipelines such as sewer lines, due to the heterogeneity conditions Geotechnical and soil spatial variability occurs. Soil defects include: stress, anti-tilt and joint opening leads to a violation of the restrictions serviceability. In this paper, a model has been developed that includes a description of spatial variability of soil within the geostatistical framework in which the correlation length of soil properties is the main parameter. This model is based on a mechanical description of soil-structure interaction between a set of buried pipe segments based backup and soil that has become a model adjusted. The results showed that the effects of this phenomenon depend primarily on four factors: large variety of soil, soil-structure stiffness ratio, stiffness ratio of structure-binding (relative flexibility) and soil-structure ratio. Karynskaya and his colleagues are looking for an analytical model to evaluate the static pressure on the structures were buried.

2 Buried pipe modeling software Plaxis

Acceleration applied to the model of harmonic mappings in which different models with frequency of 5 Hz = 0.4 g pga, but they took all of 5 seconds that show in figure 1.

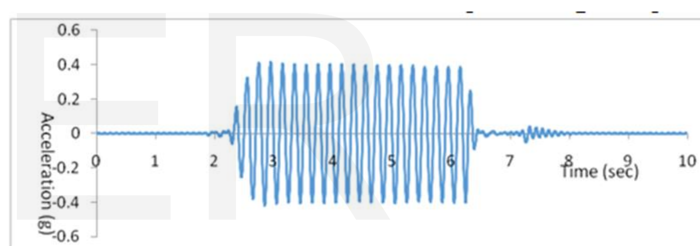

Figure 1- the mapping acceleration applied to models

2-1 Materials used

2-1-1 Soil

Based on modeling soil hardening soil model in this study, three types of soil is used for modeling. In this study, three types of soil which is an important loss as follows: 1. Standard Firoozkooh 2 sand 3. Building Supplies 15% clay

2-1-2 Pipes

made a model of the rectangle to within 2 meters and height of 1.5 meters. These dimensions have been chosen to minimize boundary effects.

3-2 Modeling Tips

3-2-1 Type of school

Since it is assumed that the Germans tunnel for linear - elastic is considered, it becomes clear just entering the modulus of elasticity. Therefore, by entering the modulus of elasticity of steel billet 106 × 2.1 is defined.

3-2-1 Standard Earthquake Boundaries

plaxis have agreed to set up a default setting standard boundary conditions for earthquake loading; this option can be selected from the Loads menu. In this case, the application automatically switches the boundaries of absorbent on the left and right vertical boundaries defined by Ux = 0 / 01m and Uy = 0 / 0m to the bottom border. Earthquakes usually is caused by horizontal movements are model specific. When the earthquake boundaries option in the menu Load Standard (Standard earth quake Soundries) is selected, the horizontal displacement component is defined by plaxis automatically.

3-3 Results

The results of this paper with plaxis software show in figure 2 and 3.

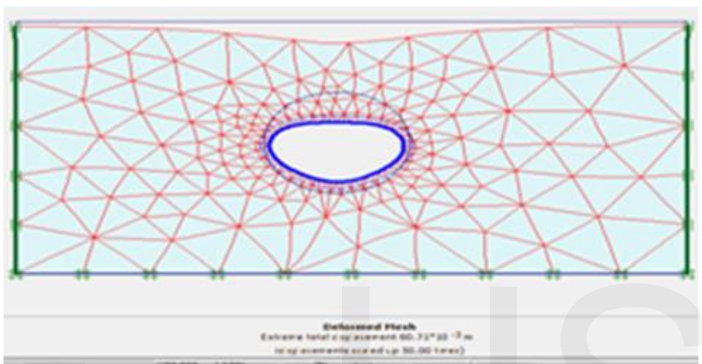

Figure 2 deformed tube model

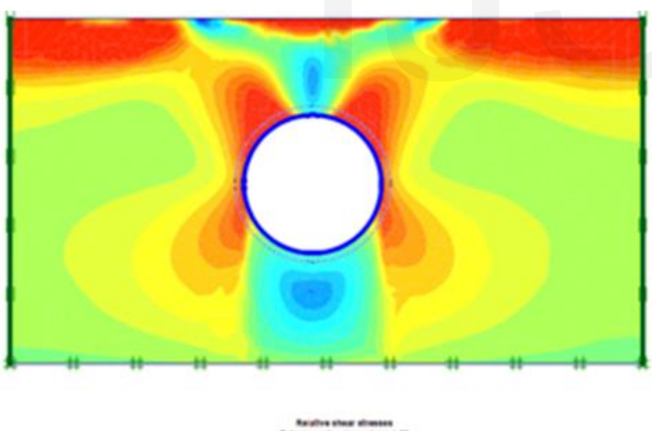

Figure 3 the stress distribution in the soil around the pipe

Impact relative density of the soil around the pipe relative deformation tube to study the effects of soil compaction on seismic behavior of two tubes is assisted modeling. This means that once the pipes under uniform stimulation of loose sand and dense sand is modeled again. The soil profile is considered loose and dense mode is as follows.

Table 1 sandy soil with different density

name	Dr (%)	e_0	B value	Φ	ψ	E (mpa)
Loose sand	40	0.737	0.98	32.5	1.9	35.8
Dense sand	70	0.439	1	38.3	44	82.7

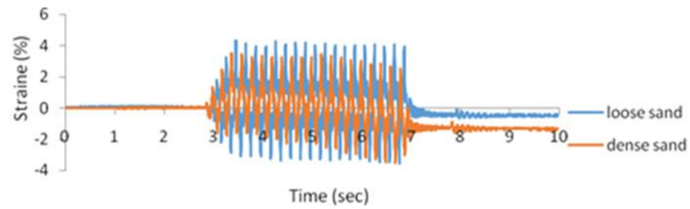

Figure 4 compare the strain on the tube in the loose sand and dense

To investigate the relative density of the soil around the tube on tube relative deformation, strain diagram node c is located on the right side and tube-shaped element (4) is shown plotted. Like that as shown in Figure (4) is placed further strain when the soil is compacted. Due to this increase can say when the soil is more compacted, accompanied by pipe and soil together is more and more interaction between the soil and the pipe is made. So is an increased force on the tube.

3-4 Influence of Soil Type on Soil Pressure on the Pipe Side

Built-in models to evaluate the effect of soil around the pipe on the pressures on the tube, on the same terms Firoozkooh 161 three types of sand, gravel and building materials were used clayey sand Firoozkooh. The soil profile is seen in Table 5. As shown in Figure (5) observed 161 Firoozkooh sand applied the most pressure on the pipe stems. The amount of pressure when the soil around the pipe, Firoozkooh sand-clay show is the lowest pressure.

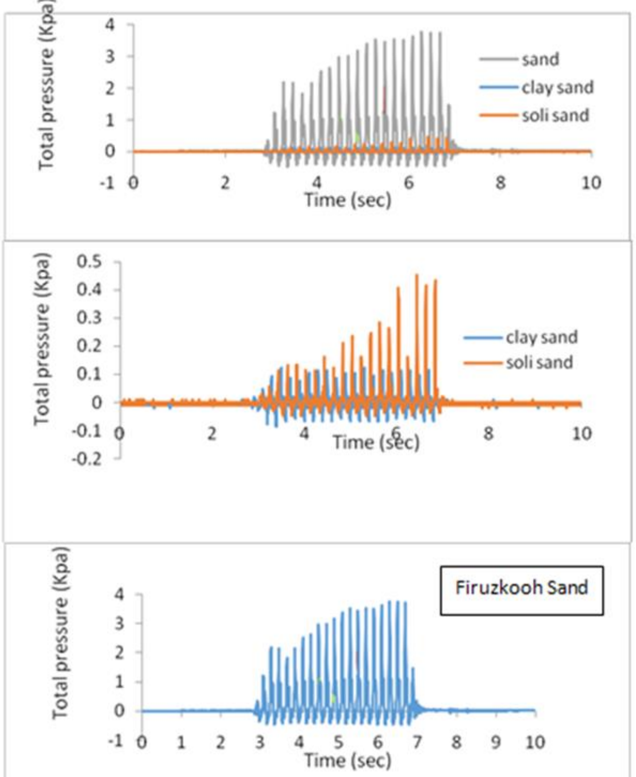

Figure 5 Comparison of pressure on the pipe buried for three types of soil

3-4-1 Impact on the soil strain on the pipe

Figure 6 are show Comparison strains under cyclic loading pipes in the building are two kinds of sandy soil and clay-bearing sands.

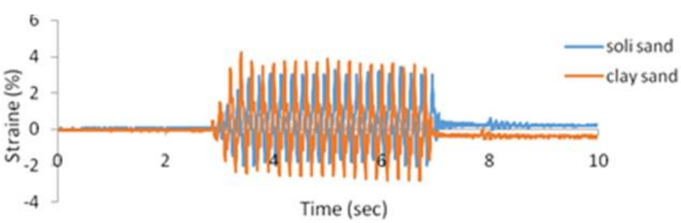

Figure 6 Comparison strains under cyclic loading pipes

3-5 Of stress-deformation curve (hysteresis curve)

In this section we review the results of the stress-deformation in different parts of the model. The stress-deformation curve in the reciprocating load that is indicative of a closed loop, hysteresis curve is called soil.

The project also reciprocating seismic loading, ie loading and unloading alternate on the model, we can use the results, plotted a curve of stress-related deformation. By calculating the relative shear stress and shear deformation between both shear stresses versus shear deformation results can be drawn. An example of such a diagram in Figure (7) is provided.

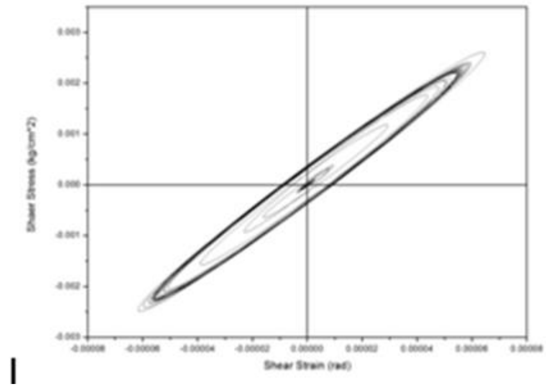

Figure 7 Example of the hysteresis curve model

3-6 Effect of soil type

As previously mentioned, to compare the behavior of soils and tubes, modeling was done on three different soil types. Firoozkooh 161 soil samples, including standard sand, gravel, clay and sand building and maintaining other parameters have been compared to. By comparing the results of the hysteresis curve in the upper part of the pipe in the three soil type, soil type influence on stress-strain curve the soil around the pipe can be clearly seen. Figure (8) the hysteresis curves of soil within the pipe trench in three different models with different soil type show.

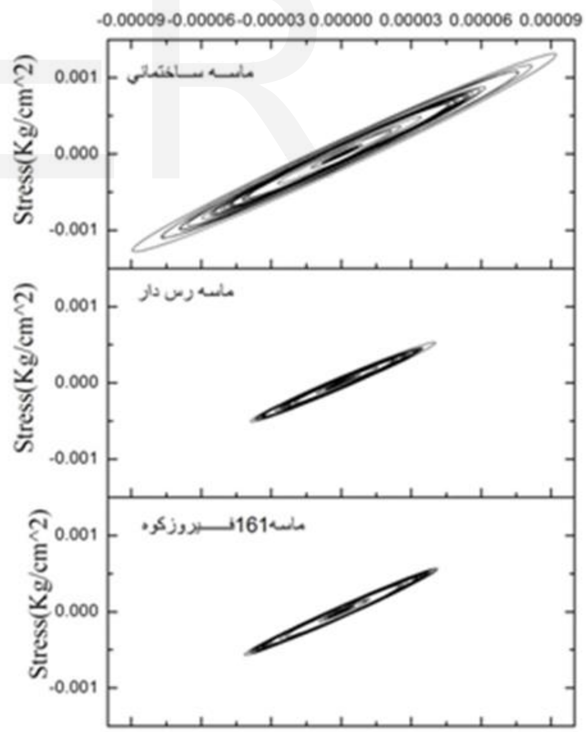

Figure 8 compares the hysteresis curve in different soil in trenches

Examines how the rapid spread samples at different depths

Intensification ratio represents the acceleration of the development process to be applied to the structure. This ratio is significantly influenced by environmental conditions (site effect) that accelerates it passes through. For example, in loose

soil, the amount of resonance compared to more dense soils. To calculate the ratio of the resonance, the maximum acceleration data anywhere considered cycle and the peak ground acceleration divided in the same cycle. The same process is repeated for lower acceleration values. Then, the ratio of resonance in different circumstances, various factors such as soil type, frequency, acceleration and other parameters on intensification of passing acceleration of the pipe is checked. Of resonance profiles at different depths of soil to obtain profiles of resonance at different levels in different parts of the acceleration and intensification ratio is calculated for each one of them. Then draw a line graph between values, gender profiles resonance is achieved. Use this chart to calculate the amount of acceleration in all levels of elevation. As shown in Figure (14) can be seen below the resonance tube (compacted soil) is less than one and no more than a pipe at the top.
of resonance profiles at different depths of soil to obtain profiles of resonance at different levels in different parts of the acceleration and intensification ratio is calculated for each one of them. Then draw a line graph between values, gender profiles resonance is achieved. Use this chart to calculate the amount of acceleration in all levels of elevation. As shown in Figure (9) can be seen below the resonance tube (compacted soil) is less than one and no more than a pipe at the top.

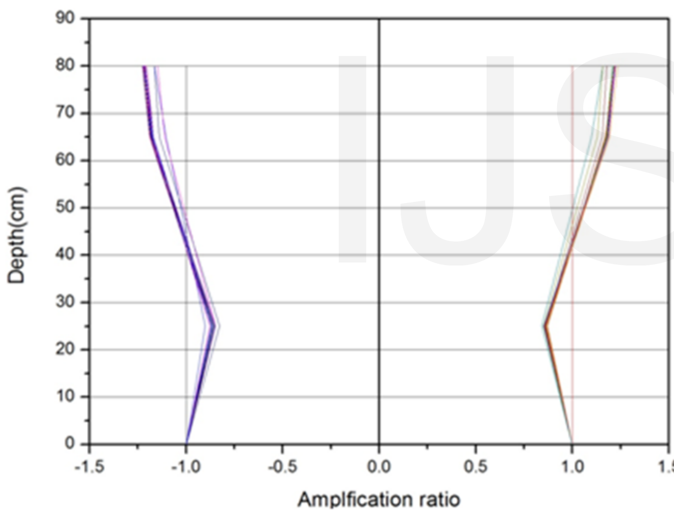

Figure 9 - Profiles of acceleration

Maximum acceleration effect on the results of resonance vibration input.
In the form of (10) and (11) tried to intensify the momentum for the base model, (2) between 0.1 g and 0.5 g compared with 5 Hz. The figure to the right shows the changes of resonance for basic acceleration 0.1 g and the left for basic acceleration 0.5 g is. It can be seen that by increasing the base input acceleration, intensification ratio increases due to the intensification of direct calculation based on input acceleration, it is justified. This increases the amount of resonance is determined acceleration at all. This process also increases closer to the soil surface are higher.

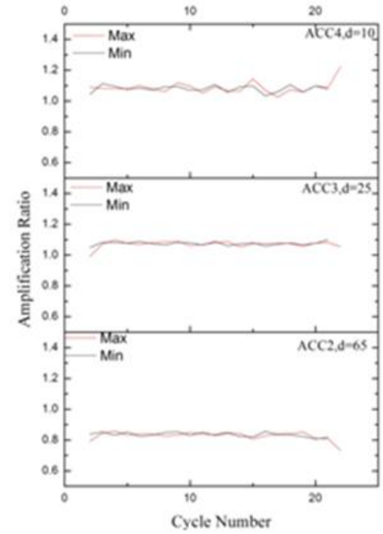

Figure 10- intensify the momentum for the base model

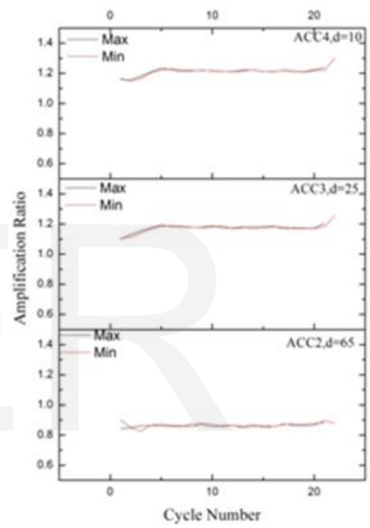

Figure 11- intensify the momentum for the base model

4 Conclusion

By examining the data, in addition to the general results of strain and pressure in different parts of the pipe, the axial force on the pipe and acceleration and meetings in different parts of the model, ¬Ay secondary analyzes as well as stress-deformation curve relative (figures hysteresis) was performed. The answer figures showed that: In examining the interaction of soil and pipe, it was observed that the relative deformations in compacted soil around the pipes are far more than loose soil pressure on the pipe also confirms this. So despite the intensification and acceleration in other words more loose soils, compacted soils density increases the pressure on the tube. Sex change was also observed that the soil around the pipe pressure tubing buried in the sand ¬Y Firoozkooh more pressure on the pipe buried in the sand ¬Y ¬Y building and the amount of sand-clay in two other soil less. in each acceleration strain and stress level has decreased in condensing mode. Compare areas strain energy due to hysteresis curves show the attenuation more broadly in the soil loose. Levels of stress and strain, the construction areas¬ more than other soil types. This type of soil than the other two types are coarser and more damping also has created. In contrast,Firoozkooh standard sand compared to building materials to more than fine-grained and less attenuation levels of stress and strain and yet is shown. With the acceleration basic input, the resonance will increase due to the intensification of direct calculation based on input acceleration, it is justified. This increases the amount of resonance is determined acceleration at all. The process is further augmenting closer to the soil surface.

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