

# Investigate on different methods of seismic design of Pipelines in underground

Ali sanaeirad, Benyamin taheri

**Abstract**— one of the most important elements of the project design of each project is considered. In the meantime satisfy the requirements of the Regulations of the utmost importance. Pipelines often for economic reasons, aesthetic, safety and environmental reasons underground dumped into landfills. In certain circumstances it may be necessary pipelines above ground is mentioned, but this case is rather unusual. Generally, oil pipelines and gas pipelines are entirely designed and executed, while water pipelines are designed for pipelines piece. Vital arterial system and equipment thereof, certain services provided in modern life, but they need to evaluate the seismic performance of modern industrial areas are clear. In this study, we tried the seismic performance of gas pipes buried in the soil with different densities to be examined finite element method and compared them.

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

## 1 INTRODUCTION

Undoubtedly one of the most important elements of the project design of each project is considered. In the meantime satisfy the requirements of the Regulations of the utmost importance. Pipelines often for economic reasons, aesthetic, safety and environmental reasons underground dumped into landfills. In certain circumstances it may be necessary pipelines above ground is mentioned, but this case is rather unusual. Generally, oil pipelines and gas pipelines are entirely designed and executed, while water pipelines are designed for pipelines piece. To develop methods to evaluate the seismic behavior of pipelines that these methods are generally divided into three groups: Approximate analysis method (Newmark and Rosenblum in 1965 and Wang 1979).

In the article it says: "Modern cities depend heavily on installation systems for their daily performance and increasing level Urbanization threat of earthquakes to more important finds of installation systems. The earthquake caused a high potential for destruction, damaging and cutting of these systems, problems caused by the earthquake, many researchers in recent years has attracted. It is known that seismic behavior of buried pipelines completely different structures on earth. "This article is an updated and comprehensive overview of the seismic response of pipelines and pipelines earthquake-resistant design is presented. President and dignity, fluid structure interaction system with various types of couplings have investigated the connection Fluid structure interaction model that has been considered in this study, by a system of hyperbolic partial differential equations are formed simultaneously with the wave axial fluid pressure waves, shear and bending the tubes inside the shell passes there, explains. Using a split operator technique,

the flux separated from the original source and sequence of equations easier by a series of homogeneous hyperbolic partial differential equations and a set of ordinary differential equations are set up in time to make up. Advanced numerical methods in time through this set of equations and using products and Stiff-consuming method can be built to implement products, analytical answers to issues relevant to the Riemann. In terms of cross-border products by formulating and solving the Riemann path analysis (non-classical) suitable for pipe ends, are properly taken into account. The proposed numerical approach to achieve numerical estimates for fluid structure interaction models of eight equations, depending on which of the two pipelines system Transit by a blow to one end of a rod is produced, used was. The numerical results obtained with experimental data available in other studies were a good match. Rourke and his colleagues studied the interaction of soil-structure began under severe loading conditions. Rourke et al in 1985 presents an overview of the books of the finite element method was used to analyze the structures or components, pressure vessels and pipelines of the theory and practical deals. This article, attach a new review of studies in this field. End of article 856 papers have been published in this field in the period 2001-2004, covers. The references are classified in the following groups: linear and nonlinear static and dynamic analysis, stress analysis and reflection, sustainability issues, temperature issues, issues of mechanical failure, problems with contact, fluid structure interaction issues, pipe production and tubes, welded components and pipelines pressure tanks, pressure vessels and pipelines, particularly for the development of finite element method, finite element software and other goodies. Kang and colleagues interaction of soil-structure for corrugated steel pipe lines that are buried deep in several sections have been reviewed. Guiqing and Tingyue will be simplified and refined to pipelines that were exposed to strong earthquakes were not discussed. The effects of soil-structure interaction, embedded pipes, padding soil, ground-water fluctuations and nonlinear material have been evaluated. Several real examples pipeline has been studied and the results were compared with various analytical methods. In

- Co-Author name is Benyamin taheri, MSc, Department of Civil Engineering, Khomein Branch, Islamic Azad University, Khomein, Iran.  
e-mail: benyamintaheri2000@gmail.com.
- Ali sanaeirad is Assistant Professor, Department of Civil Engineering, Faculty of Engineering, Arak University, Markazi Province, Iran.

this paper we have presented proposals for adjusting the formula. Alachachy and his colleagues have different effects on soil space reliability rigid pipelines reviews have been buried. In Ansys, its investigation of a discrete-continuous model for analyzing the responses buried structures static loading surface and the loading of gravity for soil the service provided. A model with two degrees of freedom indicates a structure at the top of a continuous vertical column indicates the soil. The proposed model structure interaction and soil buried by the shifting movement of rigid body structure and also the entire structure of the roof structure in the free state, have been affected, simulates. The model can be positive and negative arching display and an understanding of the effects of different variables on the type of arching and provide structural response. Soil-structure parameters in this model are: material properties and soil structure, roof openings and thickness, height and depth of the buried structures and external pressure. Buried simulate a rectangular channel with both finite element analysis model that similar results and effects of loads intersection of the problem parameters on the results led. This example shows the effect of hardness and soil arching height of the structure on top of the structure and functioning interface between the average loads on its roof. So in the early stages of the design process model can be easy to assess the effect of variables such as structural properties of the call are to be used.

## 2 BURIED PIPE MODELING SOFTWARE PLAXIS

Plaxis software for analyzing deformations and stability in geotechnical engineering projects used. Geotechnical Consultants of the important issues, a behavioral model developed to model the nonlinear, time-dependent behavior of soils is necessary depending on the intended purpose. This software is the stage of excavation and embankment loading conditions and different boundary conditions using triangular elements 6 and 15 knot the knot modeling. Was developed by the Institute CUR (Center for Civil Engineering Research and Codes) has been approved and supported. The software behavioral models Mohr-Coulomb and hardening hyperbolic model, softening models), model (Cam-Clay and softening creep model is applicable. Also, this software can make the drilling process by enabling and disable the elements in the model calculations. an example of application of this capability, layer by layer in slope stability analysis, dams and tunnels is. In the study of 15-node triangular elements are used. Due to the length of the tube is larger than its cross section, for ease strain on flat two-dimensional model is used. German also to communicate between the soil and the pipe has been used interface elements. On the other hand to enhance the accuracy of modeling elements around the smaller tube have been considered. Also for modeling the behavior of elasto-plastic tube tunnel elements are used.

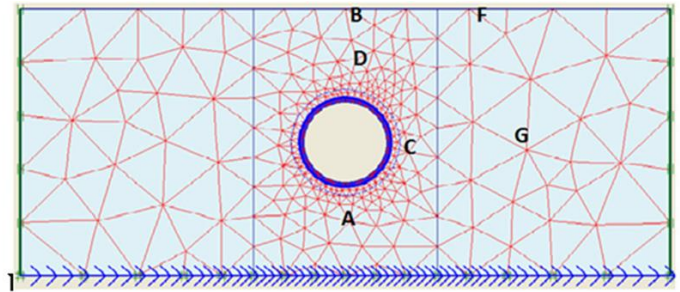


Figure 1- The finite element model of buried pipes with mesh node with Germany 15

## 3 MATERIALS USED

### 3-1 SOIL

The soil used in the study of soil below. Hardening soil model parameters are shown in the following figure.

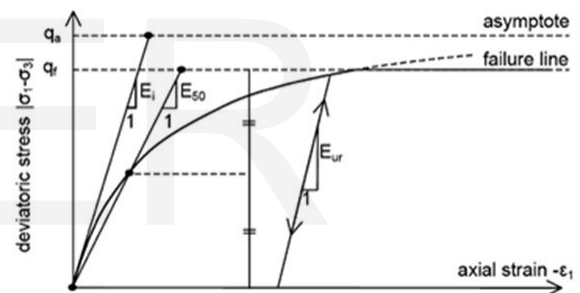


Figure 2- soil model parameters

### 3-1 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.

## 4 VERIFICATION

For validation in this study compared the results of research and modeling software Ling et al. 2003 Plaxis modeled HS (Hardening soil) is used.

Ling and his colleagues tested in 2003 using seismic modeling Santyfyvzh to have buried pipes. [29]

The amount recorded in the test interfaces at a time when the reduction factor 3.0 ( $R = 0.3$ ) was, was almost identical. Figure 4 compares the lab results are removable top tube with an error rate of less than 10 percent.

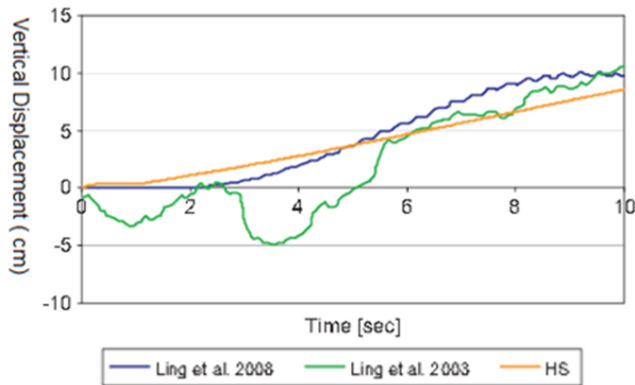


Figure 3- compares the movement of the tubes with laboratory results

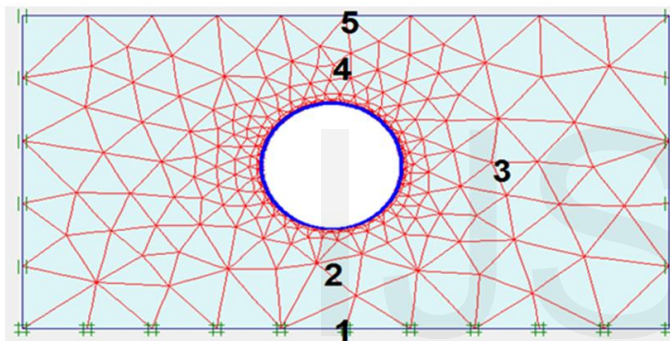


Figure 4- points examined

Impact relative density of the soil around the pipe on the pressure exerted on the tube to evaluate the effect of the relative density of the soil around the pipe pressure pipe pressure at node C is considered. As Figure (5) pressure occurs when the soil is the most densely respectively. So it can be said that the interaction between the soil and the soil around the pipe when the pipe was to be more dense. The deduction with the results obtained from the strain described in the previous section also corresponds.

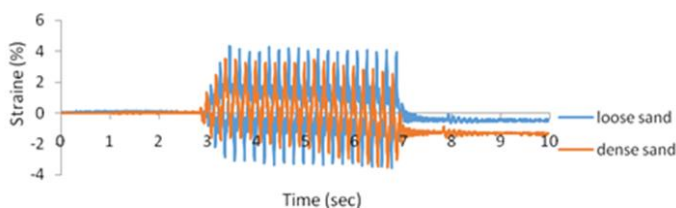


Figure 5 -compares the pressure applied to dense sand and loose tube

Two perspectives on the interaction between pipe and soil density there.

The first view: if the soil is loose around the tube, further in-

tensification occurs in soil, or in other words increase the magnification acceleration. Increase the magnification increases acceleration and thus increases the force on the tube. The second: if the soil is compacted around the pipe, causing soil compaction around the pipe between the water and the soil becomes more mobile. Increased density also increases the lateral pressure exerted on the tubing. So in this case increases the force on the tube. As a result of comparing the output of pressure and strain on the pipe both dense and loose soil can be concluded that the interaction between the soil and the soil around the pipe when the pipe is more dense. So the effect of lateral pressure on the pipe in case of impact acceleration on loose soil is the densest.

During different models with different maximum acceleration inputs, soil model, will experience different levels of shear strain. Due to nonlinearity of soil behavior, shear behavior and its interaction with the pipe in other words, the same level of strain on it. Softening the soil and reduced shear modulus with increasing strain level, the transformation that has stress-deformational figures presented here is evident. But because it would be a reduction in soil strength is the experience of the cycle load more justified. In fact, we can say that with repeated loading and unloading of a fixed maximum level of acceleration, maximum stress on the soil remained relatively constant and maximum shear strain per cycle increases, and as a result of such changes in these two parameters, reducing the hardness or modulus shear soil. Figure (6) shear modulus data for different strain levels for the three types of soil is traced. As seen in these figures, graphs relative deformation in three types of soil shear modulus with increasing strain as expected relative to the downside.

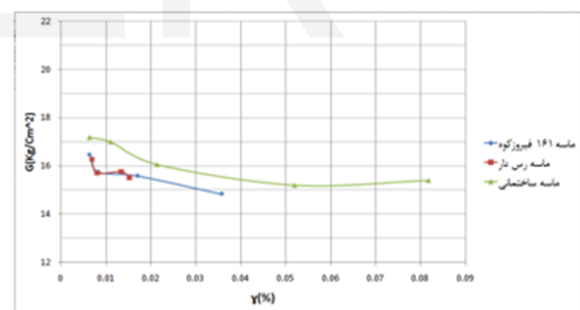


Figure 6- the shear modulus of soil types for maximum shear strain

Also according to the above figure can be seen that the modeling has been done on the construction sand, soil model, higher strain levels compared with other types of soil has experienced. Despite the decline of results in three types of soil shear modulus, shear strain levels in the model under strain levels required to reach the above graph is zero. When phase differences in the behavior and response of soil pipes unlike structural deformation due to the nature of the soil, between the load and the response, when the phase difference there. Due to the hardness of the soil is less than existing structures such as tubes where, as a result of earlier seismic loading of structures is their nonlinear behavior. Therefore, differences in hard soil and structure causing a phase shift in forces on the pipe and soil.

## 5 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, a secondary analysis as well as stress-deformation curve relative (figures hysteresis) was performed. The answer figures showed that :Study results also showed that the displacement at the soil surface subsidence and damage to the surface of the tubing buried in the sand for construction over sand and clay is then sand of Firoozkooh. Increase the maximum input acceleration vibration levels of stress and strain on the soil increases. This increase in accelerations  $g_1 / 0$ ,  $g_2 / 0$  and  $g_3 / 0$ , and for accelerations more tangible, soil deformation around and reached its maximum deformation and stresses in this frequency has not increased markedly as. Along with the increased levels of stress and strain, the internal area of the curve that represents the strain energy per cycle is damped, increased and soil behavior shows far damping. comparing results on two frequencies 5 and 3 Hz hysteresis curves can be seen that the area of the inner rings hysteresis of less than 5 Hz at a frequency of 3 Hz, which represent a broadly the attenuation in the frequency is lower. But in stress-deformation figure the slope of the curve that showed a broadly soil shear stiffness, in both frequency is almost identical. The ratio exacerbated under the pipe (compacted soil) is less than one and no more than a pipe at the top. In this study tries to evaluate the effect of soil type on the phenomenon of resonance, the resonance of the three types of soil grab  $g_4 / 0$  and 5 Hz was in check. Despite the change in aggregation and adhesion of soil, a significant change in the amount of resonance is observed.

## REFERENCES

- [1] O'Rourke, T.D., Grigoriu, M.D. and Khater, M.M. Seismic re-sponse of buried pipelines: a state of the art review, A Decade of Progress in Pressure Vessel Technology- 1985, Sundararajan, C., ed., ASME, New York, 1985, 281-322.
- [2] Chen, G. and Hao, T. (2009) Dynamic Analysis of Buried Pipeline under Earthquake Interaction. ICPTT 2009: pp. 1167-1173.
- [3] Ansys User Manual.