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ANALYZING EFFECTS OF SOIL PARAMETERS ON BURIED PIPE BEHAVIOR AND DECIDING GOVERNING PARAMETER USING STATISTICAL APPROACH**

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ABSTRACT

One of the most common and practical difficulties a pipeline engineer faces at the initial stage of the project is the lack of Soil survey data. Hence, various soil parameters like soil type, density, friction angle, cohesive pressure, depth of cover, pipe coating etc. are needed to be assumed. The critical designs like anchor block requirement, pipe route changes, support loads which involve a huge cost are required to be 'Issued for Construction' based on assumed data. This paper briefly illustrates and compares the results obtained from the two most common buried pipe stress analysis methods viz. 'American Lifeline Alliance- Appendix B'(1)and 'Stress Analysis Methods for Underground Pipelines' (2) and shows their effects graphically on the various Stress Analysis results like pipe movement, end force, active length (virtual anchor length) and bending stress generated in the buried pipeline. Further, this paper comes up with an unique application of ANOVA, a Statistical method, to find out the most significant soil parameter affecting the said results. The paper explains this method with a solved example. These results are useful for a pipeline engineer to determine the governing soil parameter in the design and thus provide a useful tool to make optimum assumptions in absence of soil data so as to minimize the changes in future design and helps saving the cost of the project due to rework.

INTRODUCTION

Pipeline is the most preferred mode of transportation of liquid or gaseous hydrocarbons between the source and the destination. Pipelines are preferred to be routed buried compared to above ground due to safety reasons and construction cost. This feature itself makes it different than the above ground pipe. Even though the temperature of the pipeline is not high (~ 60 to 120 ºC), its long run can create larger expansion. Various soil parameters (like soil type, density, friction angle, cohesive pressure) and factors associated with pipe (like depth of cover, type of pipe coating) affect the buried line behavior. Ironically, most of the pipelines have to be engineered at the initial stage of the project by assuming these parameters. The design needs to be updated or changed as the site data is progressively obtained. An engineer should be aware of the effect of a particular soil parameter on the specific result. However, the soil stiffness equations are little complex to understand and often reluctance is shown to understand them.

A table presenting typical pipeline properties is given below.

Table 1: Various Soil Properties (4)

No.	Name	γ	Φ	c	μ
Unit	…	kg/m^3	^{0}	kPa	…
1	Gravel	1800	35	1000	0.58
2	Sand	1700	35	100	0.5
3	Silt	2100	34	75	0.5
4	Clay	1900	20	15	0.33

NOMENCLATURE

c : Cohesion kPa