Characterizing Backfills around Water Pipelines Using Field Methods

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ABSTRACT

The unit weight of the backfill around the flexible pipe is an important quality control measurement and to ensure the support for the pipelines. Field tests were undertaken at different locations to determine the in-situ unit weight of backfill around 30 inches in diameter water pipelines. The field methods included Shelby tube sampling, direct push method and nuclear gage method. Repeatability of the test methods was also investigated. Using the direct push method the spatial variation of unit weight and moisture content of backfill material around the pipes were determined. Results from the in-situ tests were compared to the unit weight specified in the design based on laboratory compaction test.

INTRODUCTION

Placing the backfill around the flexible pipe to specified density is an important to ensure the support for the pipe. There is very limited information in the literature to determine the spatial variation of densities and moisture contents of backfill material around pipes. In this field study, Direct push method was used to determine the properties of the backfill around a water pipeline. The study included a calibration phase in addition to testing backfill materials around pipes along a residential neighborhood in Houston, Texas. The work included sampling over 100 ft. of soils and using direct push at 25 locations.

OBJECTIVE

The objective of this study was to verify the performance of the Direct Push method with Direct Sampling.

TESTING PROCEDURES AND DATA COLLECTION

The DP readings were taken at every 0.1 ft and hence each bore hole had at least 150 data points on density and another 150 point on moisture content. Over 4000 feet of backfill was surveyed and the DP work was done in four segments. Total of 68 bore holes were tested along the pipeline with additional 20 repeated tests. Nuclear Gage (NG) tests and laboratory standard compaction tests were also performed to determine the density and moisture content.

RESULTS AND DISCUSSIONS

(I) FIELD SAMPLING

In order to directly measure the dry and wet densities (γ_d, γ) and moisture content (w(z)) of soils, Shelby tube samples were obtained from eight locations. Four samples were obtained from backfilled locations and four from undisturbed ground locations. Total samples obtained from the 8 locations amounted to over 100 ft. Of the eight boreholes, four were within the backfill region and the other four were placed in the undisturbed ground.

Based on the testing it can be concluded that greater variation in the densities and moisture contents were measured in the backfills as compared to undisturbed ground and the properties have been quantified.

(II) DIRECT PUSH METHOD

The direct push (DP) method was used to determine the in-situ density and moisture content. The direct push method measured the wet density and moisture content at an interval of 0.1 ft. along a bore hole. A total of 25 direct push test results were collected. Eight of the direct push test results were analyzed. The direct push method was sensitive to the variation in the wet density and moisture content in the backfill and undisturbed ground. The results must be verified using field samples.

(III) FIELD SAMPLING VERSUS DIRECT PUSH METHOD

The results from the two methods are compared. The analyses were separated into undisturbed ground locations and pipe backfill area. Based on the analyses, in the undisturbed ground, the wet density results from the field sampling was comparable to the direct push method. The wet density showed a difference of -12.53 to 8.67 pcf. The moisture content from direct sampling results were always lower than the direct push method. The moisture content showed a difference of -21.23 to -9.87%. The dry density from field sampling results was always higher than the direct push method. The variation of the dry density was from 0.0 to 22.83 pcf. In the pipe backfill, the wet density from field sampling had mixed results compared to the direct push method. The difference in mean wet density varied from -22.22 to 30.54 pcf. The moisture Content from direct sampling results was always lower than the direct push method. The difference in mean moisture content varied from -23.01 to -16.4%. The dry density from direct sampling was almost always higher than the direct push method. The difference in the mean dry density varied from -2.94 to 29.08 pcf.

(IV) NUCLEAR GAGE AND OTHER METHODS

In the previous study, two correlations between the nuclear gage and direct push were investigated and the data were analyzed for three linear relationships as follows:

(a) Dry Density $[\gamma_d\ (x, y, z)]_{NG} = \alpha_D\ [\gamma_d\ (x,y,z)]_{DP}$ (1)

(b) Wet Density $[\gamma\ (x, y, z)]_{NG} = \alpha\ [\gamma\ (x,y,z)]_{DP}$ (2)

(c) Moisture Content $[W\ (x, y, z)]_{NG} = \alpha_M\ [W\ (x,y,z)]_{DP}$ (3)

Based on the analyses the α parameters determined for the mean values of dry density, wet density and moisture content were 1.021, 1.012 and 1.051 respectively. Very limited data was available from the nuclear gage tests at the test locations. Base on very limited data, the backfill dry and wet densities were lower than the surrounding undisturbed soils. The moisture content had greater variation in the backfill soil compared to the surrounding undisturbed soil.

CONCLUSIONS AND RECOMMENDATIONS

Based on the field sampling (over 100 ft) and direct push method (500 ft), the following can be concluded on the densities and moisture contents measured in Houston, Texas.

(1) Direct Sampling Method: Based on the testing it can be concluded that greater variation in the densities and moisture contents were measured in the backfills as compared to undisturbed ground and the properties have been quantified.

(2) Direct Push versus Field Sampling: In the undisturbed ground, the wet density results from the field sampling were comparable to the direct push method. In the pipe backfill, the wet density from field sampling had mixed results compared to the direct push method.

REFERENCE

Paul W. Mayne and Roman Hryciw (2000), Innovation and Applications in Geotechnical Site Characterization, ASCE, Geotechnical Special Publication No. 97, Denver, Colorado.