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ARTICLE

SETTLEMENT DETERMINATION OF SOILS BY SHEAR WAVE VELOCITY PROFILES

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ABSTRACT

Background In geotechnical engineer settlement is among the most significant aspects to in designing stable and reliable foundation. Several approaches are used to estimate settlement of soil, of which most important are Plate Load Test and "Spectral Analysis of Surface Waves method. **Methods** this test is conducted on the raw data of time series. This is converted into the frequency domain. The dispersion curves used to generate shear wave velocity profile. Spectral Analysis of Surface Waves Method (SASW) is applied to obtained Shear waves velocity. This method involves two (2) receiver attached to the ground with a power source located near to the first receiver.The shear wave velocity profile is an output of SASW method and it is applied to predict settlement of soils. **Results** Shear wave velocity profile for both sites is used as input in the simulation to predict settlement caused by the same load subjected as PLT.A good agreement is achieved between settlement measured by PLT and simulation. **Conclusion** empirical correlation between the shear-wave velocity and Spectral Analysis of Surface Waves was found. SASW method is a comparatively fresh seismic practice and has to go through continuous improvement. The method escapes the difficulties allied with traditional approaches. In our present study, the shear wave velocity has the increasing probability to estimate settlement of soil, by comparing to Conventional methods however statistically insufficient. Settlement of soils differs on behalf of changes in site/area.

KEY WORDS
Plate load test, shear-wave velocity, Spectral Analysis of Surface Waves Method

INTRODUCTION

The Settlement is there liable foundation and most important aspect designed to geoengineering. There are several types of methods are used to predict settlement and widely used is one plate Load test. The plates may vary from 760 mm to 150 mm. PLT is very useful since it can offer evidence of tough soils due to unfeasibility of sampling, however the method only trustworthy on the soil to a depth almost two times diameter of the plate [1] In late 1970's, With the arrival of spectral analysis and portable computers the outdated surface wave technique has transformed to the Spectral-Analysis-of-Surface-Waves (SASW) method. Over the last few decades, the SASW technique has fascinated many engineers and has been employed in different applications. These presentation zones include classification of foundation non-destructive estimation and description of concrete systems, evaluation of concrete structures and in situ determination of ground stiffness [10].

The shear-wave velocity (VS) is one of the most important parameters for determining dynamic soil properties and groundresponse analyses. The association among shear wave velocity and standard penetration test blow counts (SPT-N) is inspected. The main focus of the study is an association of SPT-N and shear wave velocity for various soil sorts: all soils, sand, silt and clay-type soils. The new and earlier recommended approaches showing links between uncorrected SPT-N and shear wave velocity are compared and evaluated. The uncorrected blow calculations are used for the better associations in the estimation of the shear wave. [2]

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Prediction of Ground shaking soil response requires knowledge of soil, expressed in terms of shear wave Velocity. Although it is best that this vibrant land ownership in measured quantities, which is often not economical at all locations. Shear wave correlations between Velocity and penetration resistance in this study have been assessed and compared with values based SPT received geoseismic collected from geotechnical and first-degree earthquake region of Turkey data correlations. The results obtained are incensus studies that exploded in these correlations significant amounts while not support the findings that have an important influence on the territory. The regression equation developed in this study to exhibit the best performance compared with previous projections and good equations. It is the best correlations used for situations when a hand-blow account. [3]

In the present, a method based on seismic and non- caustic were used to provide as input in numerical analysis to predict settlement.

The seismic surface wave method (MASW) is the effective method of calculating the S velocity in the field. The Dynamic Probing Heavy (DPH) test used for earth strength and its deformation properties. Correlations in the shear-wave velocity and the soil penetration resistance NDPH were estimated. Two different approaches (low vs. high strain) were compared, and the results were found to be in a good settlement when the comparative alteration between the pacesis small and smooth. Dynamic probing tests are worthy of learning a distinct point of concern in a huge field area based on preliminary seismic tests. [4]

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Continues examination for the settlement of landfill grounded on shear wave velocity and damping measurement. Seismic measurements and theoretical analysis have been linked to estimate settlement in a non-linear material. The nonlinear characteristics described in terms of strain which then called characteristic strain. Landfill immediate settlement is measured by two loaded skips tests. For the authentication of the proposed method in terms of the settlement, a finite element software or nonlinear numerical method is utilized and good agreement is achieved between observation and the proposed method. Applies the same parameter of which is shear wave velocity and damping to investigate long-term settlement on soft clay and the result compared with various settlement prediction methods as shown [Fig 1] .[5]

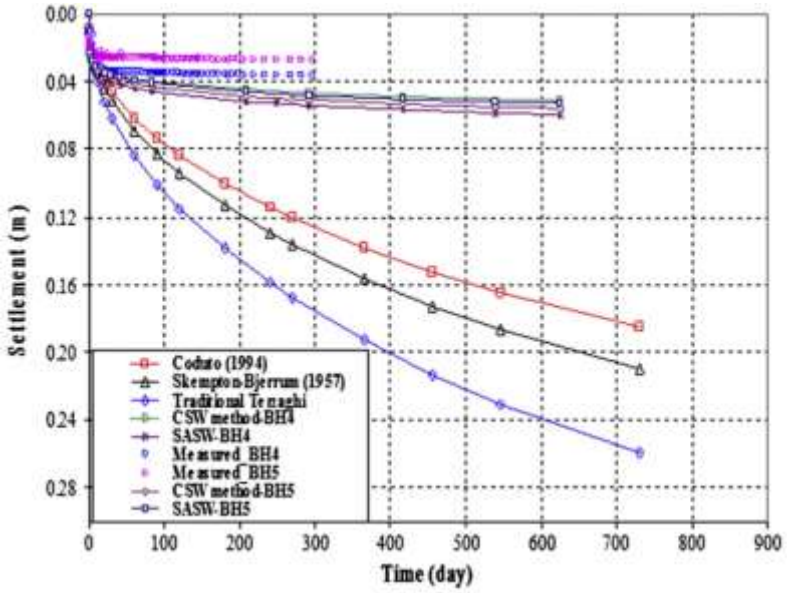

Fig. 1. Comparison of the settlement of soft clay between various prediction methods. (Mohamad Nor Omar et.al 2011).

Long term settlement of soft clay is predicted by applying a viscoelastic formula. Shear wave velocity of the seismic tests of (SASW) spectral analysis of surface wave and (CSW)continuous surface wave tests provide the elastic shear modulus (G) value. Damping at equivalent elastic strain was calculated from the hysteresis of PLT by using damping – Strain-Formula. The generalized viscoelastic formula calculates long-term settlement by applying damping and elastic settlement. Results of the viscoelastic formula are better than the observed methods. Adjustment of the settlement formula has enhanced the settlement precision to 10%.The comparison between various settlement prediction methods showed that seismic methods are the closest approximation to the actual observation of the settlement marked by Measured BH4 and BH5.[6]

METHOD

The selection of testing techniques for the measurement of dynamic soil properties requires a careful consideration and understanding of the specific problem [7]. Spectral Analysis of Surface Waves Method (SASW) is applied to obtained Shear waves velocity.This method involves two (2) receiver attached on the ground with a power source located near to the first receiver. The configuration of Spectral Analysis of Surface Waves method can be illustrated in [Fig 2].

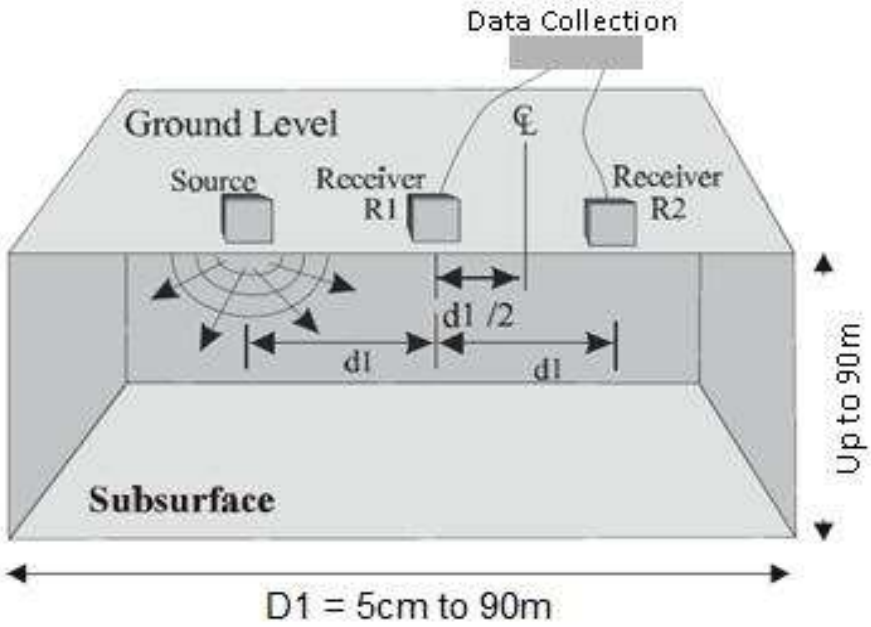

Fig.2: Illustration of SASW configuration.

This test is conducted on the raw data of time series. Which is converted into thefrequency domain. Therefore angle difference of receivers is calculated by frequency Response Phase graph. A dedicated software developed by Joh(1992) is applied to advance analysis. This full-bodied software is applied in all the process to collect raw data, performing phase covering, creating dispersion curves and turning data into shear wave velocity profile. Wrong interpretation of curve may cause to misleading dispersion curve. Finally, the dispersion curves used to generate shear wave velocity profile. The shear wave velocity profile is an output of SASW method and it is applied to predict settlement of soils.

The input is used to calculate the settlement by means of simulation. Settlement from the simulation then can be compared to conventional test such as Plate Load Test (PLT). PLT is used through additional pre. In this paper, PLTand SASW method were conducted in two different sites around, in ALABAMA,USA

RESULT AND DISCUSSION

To determine the ultimate posture capability of soil and disbursement of foundation under the loads for mud and filthy soils plate load test is done.

[Fig.3] show the both conventional PLT (Plate load test) and SASW (Spectral Analysis of Surface Waves) test conducted at site 1. [Fig. 4B] shows shear wave velocity profile obtained from SASW test. The site condition site reported to be quite saturated since the water trapped around and excavation are still not completed by the contractor. This can be seen by the shear wave velocity profile that it is lower at 0 to 0.2 meter compare to a deeper depth.

Fig.3a. Test locations of PLT and SASW method [8].

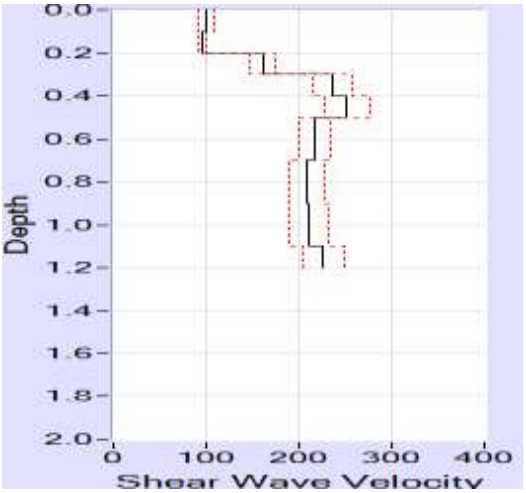

Fig.3b. Shear wave velocity profile [9].

The floor of a building under construction was selected for PLT and SASW (VSpectral Analysis of Surface Waves) test at Site 2 as in [Fig. 4a and 4b] . Since the floor is to be used for developing emergency staircase, it was compacted regularly. This can be illustrated in [Fig. 4c] where the ground has higher shear wave velocity than site 1 and is regularly stiffer along the deeper depth.

a)

b)

c)

Fig.4. VSpectral Analysis of Surface Waves].

Illustration of Comparison of Settlement from both Conventional PLT and SASW

The results show the Shear wave velocity with high likelihood to estimate the settlement of narrow groundwork by relating to conventional test even though statistically insufficient. The percentage different of settlement from both sites are 9.44 and 0.55 percent. This study can be applied to another conventional test which provides settlement as output so that it can be useful to industry.

CONCLUSION

In the present paper, we present empirical correlations between the shear-wave velocity and Spectral Analysis of Surface Waves. SASW method is a comparatively fresh seismic practice and has to go through continuous improvement during the last few decades, particularly in the inversion of the data analysis. The

method escapes the difficulties allied with traditional approaches. The non-damaging and noninvasive property of Spectral Analysis of Surface Waves method avoids sampling disturbance and unreliable sampling. In our present study, the shear wave velocity has the increasing probability to estimate settlement of soil, by comparing to Conventional methods however statistically insufficient. Settlement of soils differs on behalf of changes in site/area.

CONFLICT OF INTEREST

All the authors declare no conflict of interest with in this research.

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REFRENCES

[1] ASTM. [2003]Standard test method for bearing capacity of soil for staticload and spread footings." D 1194-94, Philadelphia.

[2] Maheswari RU, Boominathan A, Dodagoudar GR. [2010] Use of surface waves in statistical correlations of shear wave velocity and penetration resistance of Chennai soils. Geotechnical and Geological Engineering, 28(2):119-137.

[3] Hasancebi N, Ulusay R. [2007] Empirical correlations between shear wave velocity and penetration resistance for ground shaking assessments. Bulletin of Engineering Geology and the Environment, 66(2): 203-213.

[4] Strelec S., Stanko D, Gazdek M. [2016] Empirical correlation between the shear-wave velocity and the dynamic probing heavy Test; Case study Varaždin, Croatia. ACTA GEOTECHNICA SLOVENICA, 13(1): 3-15.

[5] Abbiss CP. [2001]Deformation of landfill from measurements of shear wave velocityand damping. Geotechnique 51 (6):483–492.

[6] Omar MN, Abbiss CP, Taha MR, Nayan KAM.[2011] Prediction of long-term settlement on soft clay using shear wave velocity and damping characteristics. Engineering Geology, 123(4):259-270.

[7] Ismail MA, Nayan KAM, Samsudin A R, Rafek AG. [2001]Spectral analysis of surface waves method: an initial assessment and its potential use in geology. In Geological Society of Malaysia Annual Geological Conference (pp. 185-190).

[8] Strelec S, Stanko D, Gazdek M. [2016] Empirical correlation between the shear-wave velocity and the dynamic probing heavy Test; Case study Varaždin, Croatia. ACTA GEOTECHNICA SLOVENICA, 13(1): 3-15.

[9] Martin GK, Mayne PW. [1998] Seismic flat dilatometer tests in Piedmont residual soils. Geotechnical site characterization, 2:837-843.

[10] Mattews MC, Hope VS, Clayton R.I.[1996]The geotechnical value ofground stiffness determined using seismicmethods. In Proc. J(Jh Annual Conf ofthe Eng. Group of the Geol. Soc., University ofLige, Belgium.