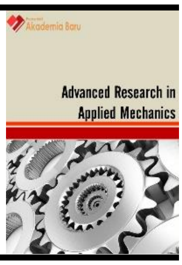
Journal of Advanced Research in Applied Mechanics

Journal homepage:
http://www.akademiabaru.com/submit/index.php/aram/index
ISSN: 2289-7895



Correlation Between the Results from Screw Driving Sounding and Mackintosh Probe Tests

Muhammad Hatta Mohd Satar[1,*], Aminaton Marto[1,2], Faizah Che Ros[1], Go Sakai[3], Masashi Shirahase[4]

1 Malaysia-Japan International Institute of Technology, Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia
2 Research Centre for Soft Soil, Universiti Tun Hussein Onn Malaysia, Johor, Malaysia
3 Japan Home Shield Corporation, Tokyo, Japan
4 Nittoseiko Co. Ltd., Kyoto, Japan

ABSTRACT

The screw driving sounding (SDS) test is a new approach for shallow foundation sites such as road, school, mosque and housing projects. SDS test not just quick, but low cost and does not need experienced person to operate. By using the Industrial Revolution 4.0 (IR 4.0) innovation through automation during testing and using the cloud technology computing to process the information collected at the site, quality data are ensured. In this study, 33 sites were tested but results from Presint 9, Putrajaya site are presented in this paper. The correlation between SDS with Mackintosh Probe Test (MPT) value was made based on the correlation between energy obtained at 250 mm penetration (E0.25) and M value for soils at the sites. Results from Presint 9 site are compared with the MPT acquired from the previous soil investigation. The coefficient of determination, R^2 = 0.4851 for Presint 9 site from the SDS test results are highly correlated with MPT test results. This discovery shows that the SDS test has great potential in soil investigation work in Malaysia with the advantage of IR 4.0 technology.

Keywords:
Screw Driving Sounding, Mackintosh Probe Test, soil investigation, Shallow Foundation, IR 4.0.

Received: 1 February 2021 **Revised: 30 March 2021** **Accepted: 15 October 2021** **Published: 18 October 2021**

1. Introduction

In Malaysia, conventional testing method such as the Mackintosh Probe test (MPT) or JKR Probe is widely implemented in the residual soils [1]. MPT is usually carried out for shallow soil investigation [2]. It is used to determine the bearing capacity of soil up to 18 m [3]. From MPT, the MPT-M value will be obtained. There are several limitations of MPT in engineering soil investigation such as is not suitable to be used in hard or gravelly soils or cobbles. This is due to its relatively low energy hammer used to drive the probe into the ground [4]. Besides that, MPT also faces disadvantages of human error due to miscalculation during conducting the test as well as the friction effect [5].

* *Corresponding author.*
E-mail address: hattasatar@gmail.com

The Screw Driving Sounding (SDS) test, is the ground investigation method which has been developed in Japan and used widely for residential house construction and to investigate soft ground usually up to 15 m depth, having the SPT-N values of between 0 and 15 (0 <N ≦ 15)[6]. It involves continuous drilling by a machine while continuously measuring the required torque, load, speed of penetration and rod friction. This process of data collection is done automatically as mention by [7]. Moreover, the screw driving sounding test is a faster, simpler procedure and low cost test compare to the standard penetration test (SPT) and other in-situ tests [8].

By analyzing the acquired data at each step, this method can estimate N value and the soil profile of the soil. It also can give an estimation of the soil profile align with the depth of machine penetration [9]. This had been proven for soils in Japan and New Zealand where SDS was able to classify soil types by the study of [10-12] for Japan soil and [13-14] for New Zealand soil.

However, it is vital to prove that SDS technique is effective as well as can provide an accurate reading regarding the soil characteristics, soil type and soil profile which previously have been identified by Standard Penetration Test (SPT) methods. In this study, the development of the correlation between properties of soils in Malaysia obtained from the MPT, with the results obtained using SDS tests

2. Materials and Methods

2.1. SDS Equipment

The SDS equipment being used in this research is the same equipment already lent to UTM through the MoA signed on 1st January 2017 with the Japan Home Sheild (JHS). The equipment is currently placed at the Malaysia-Japan International Institute of Technology, UTM Kuala Lumpur. The person in-charge of SDS equipment is Prof. Dr. Aminaton Marto assisted by Mr. Muhammad Islah Sulaiman. The SDS test equipment comprised of many parts as illustrated in Figure 1 and show clearly in the manual [15]. However, the equipment supplied to UTM sits on top of a crawler to make it easy for the equipment to be moved around to and within the test site. Figure 2 shows the photo of SDS equipment used in this research.

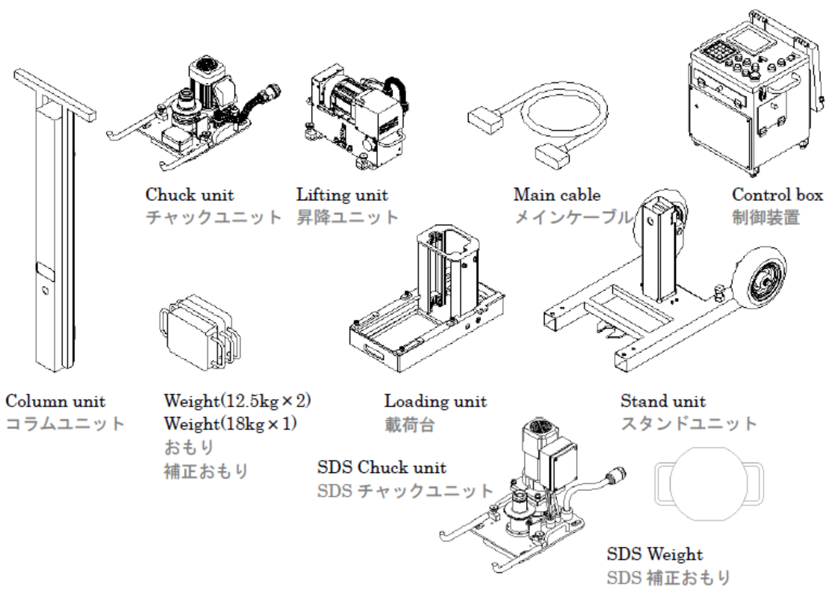


Fig. 1. Parts of Screw Driving Sounding Test Equipment [15]

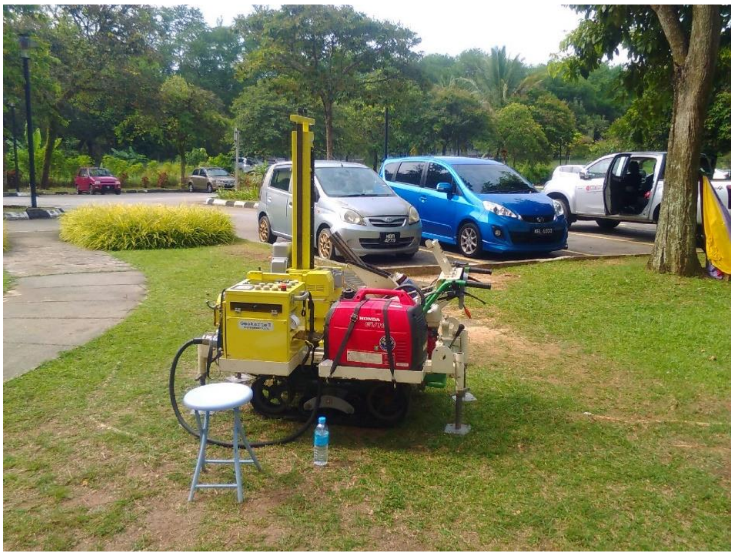


Fig. 2. Photos of SDS test equipment at Presint 9 site

2.2. Site Investigation Report

Existing site investigation (SI) methods referred to the normal conventional borehole drilling with Standard Penetration Test (SPT), and the Mackintosh Probe test (MPT) results. The conventional borehole drilling and MPT results for various sites had been obtained from the Public Works Department (JKR) (or other organisation where necessary) responsible for the chosen sites first through respective SI Reports, before SDS tests were carried out. Wherever possible, the sites were chosen based on the SI work that had been carried out within the last six months and no earthwork had been started at the site.

2.3. Screw Driving Sounding (SDS) Test

For the chosen MPT point, SDS test was also carried out at one (1) point between 0.5 to 2m from the MPT point. Upon checking with MPT results and if it is found that there is so much different with the trend, the second SDS test shall be carried out. The depth of SDS test was between 8 to 10m depth (but might extend up to 18 m) unless the machine stopped at much shallower depth as it encountered rock or boulders, or hard soils.

3. Results

3.1. Correlation between SDS and MPT test

In order to determine whether there is a good correlation between both tests, a relationship between $E_{0.25}$ and MPT-M was done. The correlation between SDS with MPT-M value was made based on the correlation between energy obtained at 250 mm penetration (E0.25) and N value for soils at the sites. It was carried out using linear regression with E0.25 obtained through three different approaches; Average 2 (A2), Average 3 (A3) and Single data (SD). The SDS approach compared MPT data at depth of 0.3m with SDS data at 0.5m depth as shown in Figure 3. For the A2, average of two subsequent 25cm depth (0.25m and 0.5m) of SDS data was used to compare with SPT value at 0.3m depth. For the A3, the SPT data was compared with average of three subsequent SDS data points: the data at 0.25m, 0.5m and 0.75m.

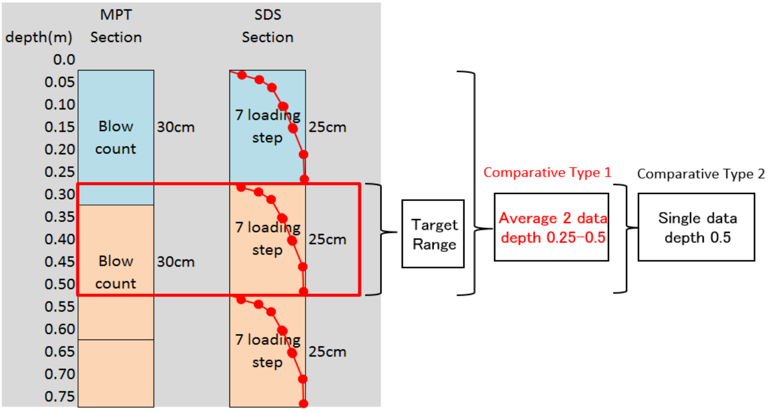


Fig. 3. Relationship between measurement position of MPT and SDS

Results from Presint 9 site in Putrajaya are compared with the MPT logs acquired from the previous soil investigation. From Figure 4, it shows the correlation between $E_{0.25}$ obtained from SDS test and MPT-N value for this particular site. The best R^2 for correlation between both tests is 0.4851 with an R value of 0.697. This shows that 69.7% of $E_{0.25}$ is dependent on MPT-M. Thus, this is considered a good correlation which is more than 50%. The equation for this correlation could be seen below:

$$E_{0.25} = 0.0057 \text{ MMPT} \tag{3.1}$$

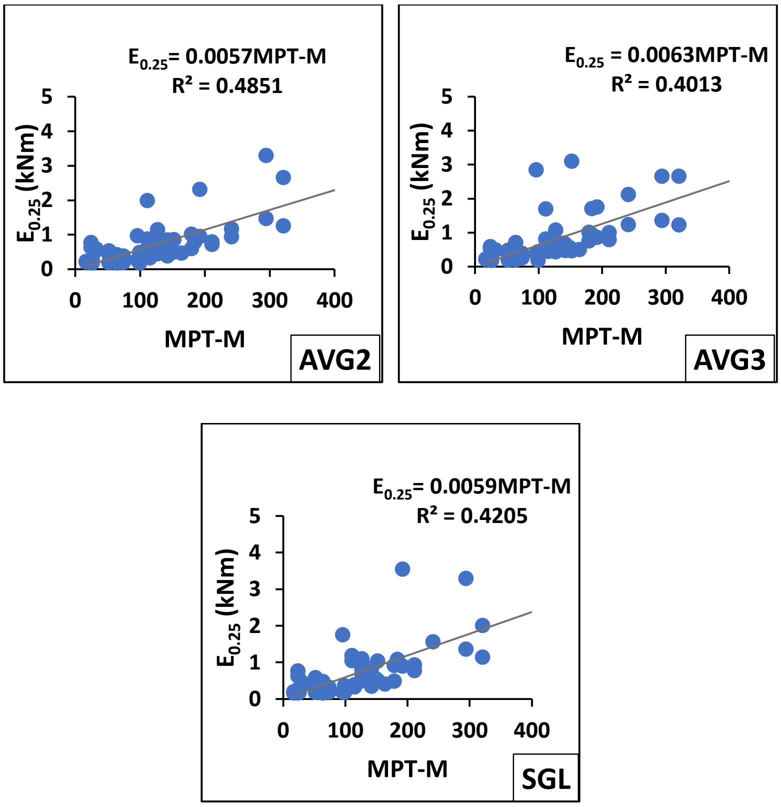


Fig. 3. Correlation for Average 2, Average 3 and Single data between E0.25 with MPT-M value for Putrajaya site

4. Conclusions

The correlation between SDS test data and the Mackintosh Probe test (MPT) data also had been established by correlating E0.25 with MPT-M or MMPT. The attempt to correlate SDS and MPT tests can be considered successful. E0.25 also correlates linearly with MPT-M.

Acknowledgement
This study had been carried out using the grant jointly given by the Japan Home Shield Corporation and Nittoseiko Co. Ltd., Kyoto, Japan through the UTSB, a wholly owned UTM company (Vot 1480). The financial assistance obtained by the corresponding author from MJIIT to support his PhD studies is also acknowledged.

References

[1] Chan, S.F. and Chin, F.K. "Engineering characteristics of the soil along the federal highway in Kuala Lumpur." Proceeding of the Third Southeast Asian Coference on Soil Engineering, Hong Kong, (1972): 41 – 45.
[2] See, G., Tan, I. and Chin, Y. "Subsurface Investigation and Interpretation of Test Results for Foundation Design in Sofr Clay." SOGISC-Seminar on Ground Improvement-Soft Clay, (August), (2000): 1–23.
[3] Islam, M. S. and Hashim, R. "Bearing capacity of stabilised tropical peat by deep mixing method. "Australian Journal of Basic and Applied Sciences, 3(2), (2009): 682–688.
[4] Fakher, A., Khodaparast, M. and Jones, C. J. F. P. "The use of the Mackintosh Probe for site investigation in soft soils." Quarterly Journal of Engineering Geology and Hydrogeology, 39(2), (2006): 189–196. http://dx.doi.org/10.1144/1470-9236-05-039
[5] Marto, A., Sakai, G., Suemasa, N. and Jamaludin, N. "An Attempt of Screw Driving Sounding Test in Malaysia" Proc. of Int. Conf. on Civil, Offshore & Environmental Engineering (ICCOEE) (2018).
[6] Nittoseiko, GeoKarte; New technology machine for SWS and SDS test. Available at: https://www.nittoseiko.co.jp/en.html
[7] Mirjafari, S.Y., Orense, R.P. and Suemasa, N. "Comparison Between CPT and SDS Data for Soil Classification." (2013) pp. 561–566.
[8] Orense, R.P., Mirjafari, Y. and Suemasa, N. "Screw driving sounding: a new test for field characterisation." Geotech. Res. 6 (1), (2019): 28–38. https://doi.org/10.1680/jgere.18.00024
[9] Chaiyaput, S., Suksawat, T. and Ayawanna, J. "Evaluation of the road failure using resistivity and screw driving sounding testing techniques: A case study in Ang Thong province, Thailand." Engineering Failure Analysis 121, 105171 (2021).
[10] Suemasa, N., Tanaka, T., Yamato, S. and Sakai, G. "Application of SDS and SD-Sampler to Survey on Embankment Improved by Floating Columns", Int. Sym. on Lowland Technology, Sept. 26-28, Hanoi, Vietnam. (2018).
[11] Tanaka, T., Suemasa, N., Ikegame, A. and Yamato, S. "Classification of Strata Using Screwdriver Sounding Test," Proc. 22nd Int. Offshore and Polar Eng. Conference, 17-22 June, Rhodes, Greece. (2012). pp. 851–856.
[12] Tanaka, T., Suemasa, N. and Tamato, S. "The Method of Soil Classification using Screw-Drive Sounding Test and Its Application", Int. Conference on Soft Ground Engineering, 3-4 December, Singapore. (2015).
[13] Mirjafari Miandeh, S.Y. "Soil Characterisation using Screw Driving Sounding (SDS) data", PhD Thesis, University of Auckland, New Zealand. (2016)
[14] Mirjafari, S.Y., Orense, R.P. and Suemasa, N. "Soil classification and liquefaction evaluation using Screw Driving Sounding," Proc. 5th Int. Conf. Geotechnical Geophysical Site Characterisation, ISC 2016, 1, no. 2001, (2016) pp. 284–286.
[15] GeoKarte III, Operation Manual, SS-301, 50/60 Hz, Version 1.03, 2010-10. (2010).