Soil Investigation and Infrastructure Planning for Sustainable Land Use: A Comparison of Shear Wave Velocity Determination Methods

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Introduction

Shear wave velocity (V_s) is a key parameter for characterising the dynamic properties of soils and supports reliable infrastructure planning. V_s profiles are commonly obtained by the Seismic Cone Penetration Test (SCPT) and Multichannel Analysis of Surface Waves (MASW), but differences in their principles and spatial scales may affect the results (Park et al., 1999; Foti et al., 2014).

Aim: to compare SCPT and MASW results and their practical applicability for geotechnical investigations.

Methods

Seismic Cone Penetration Test (SCPT)

- 16 sites; Geotech seismic probe, Pagani TG 63-150
- V_s measured every 1.0 m (two geophones, horizontal hammer source)
- Processing: SeismicLog, 25-150 Hz band-pass filter

Multichannel Analysis of Surface Waves (MASW)

- 16 sites; Geode-24 system, winMASW software
- 96 m survey line, 4 m geophone spacing
- Joint inversion of Rayleigh and Love wave dispersion
- Effective investigation depth ≈ 30 m

Data Processing and Comparison

- SCPT and MASW V_s compared for corresponding geological layers (mean SCPT value per layer)
- Difference calculated relative to the mean V_s of each layer
- Agreement threshold: 15%

Discussion

10 / 29

paired comparisons with deviation > 15%

Deviations were mainly related to data-processing quality, soil heterogeneity and differences in measurement scale.

Local geological conditions strongly affect V_s, so representative data for Baltic sediments are needed.

References

Foti, S., Lai, C.G., Rix, G.J., Strobbia, C. (2014). Surface wave methods for near-surface site characterization. *CRC Press*. ISBN 9780415678766

Park, C.B., Miller, R.D., Xia, J. (1999). Multichannel analysis of surface waves. *Geophysics*, 64(3), 800–808. https://doi.org/10.1190/1.1444590

Results

- SCPT investigation depth at most sites: 5-10 m
- Points 4, 5, 7 and 9 reached the greatest depths and were analysed in detail

Point 8: anomalously low SCPT V_s beneath a peat layer - data quality assessment and geological interpretation are essential.

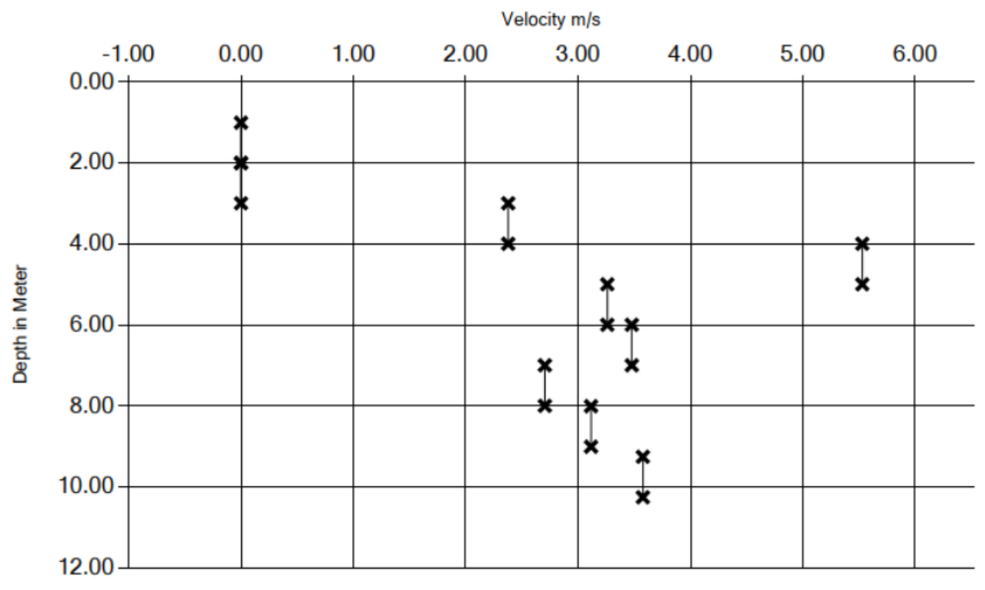


Figure 1. *SCPT shear wave velocity profile, survey point 8*

Point 9: SCPT V_s changes follow the geological profile; MASW gave high-quality Rayleigh and Love wave records and a consistent inversion model.

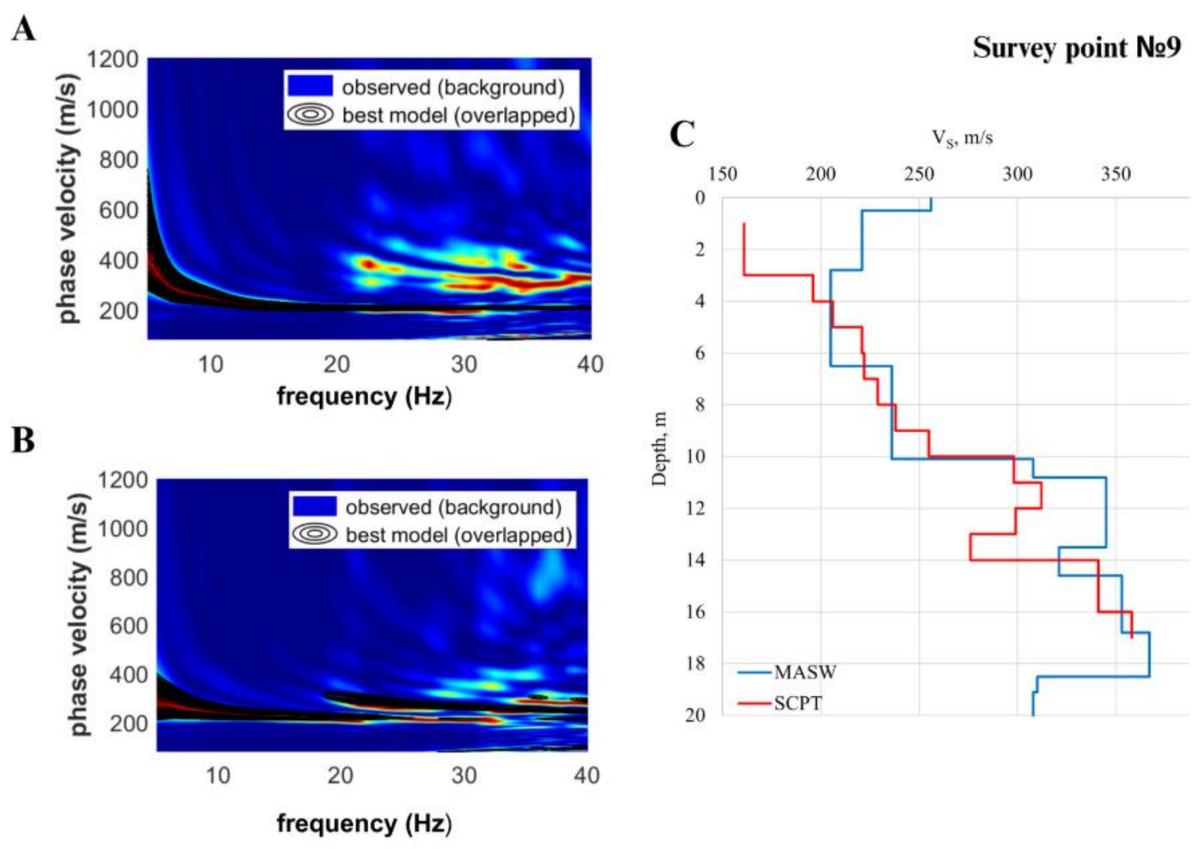


Figure 2. *Survey point 9: A) Rayleigh and B) Love wave phase velocity spectra; C) MASW inversion model and SCPT V_s profile*

Conclusions

- SCPT gives high-resolution vertical profiles (typically 5-10 m); MASW is faster and reaches ~30 m.
- The methods are complementary; combining them with geological data improves soil characterisation.
- Characteristic V_s ranges were established for glacial and glaciolacustrine deposits in the study area.
- Appropriate method selection supports efficient infrastructure planning and sustainable land use.