UTILISATION OF GEOPHYSICAL METHOD FOR SOIL BEARING CAPACITY ESTIMATION

Ao Wang, Université Rouen Normandie, UMR 6143 M2C, Rouen, France
Fayçal Rejiba, Université Rouen Normandie, UMR 6143 M2C, Rouen, France
Cécile Finco, Université Rouen Normandie, UMR 6143 M2C, Rouen, France
Luis Cavalcante Fraga, Université Rouen Normandie, UMR 6143 M2C, Rouen, France
Ayoub Saydy, Université Rouen Normandie, UMR 6143 M2C, Rouen, France, and Envisol, Rouen, France
Ludovic Bodet, Sorbonne Université, UMR 7619 METIS, Paris, France
Cyrille Fauchard, Cerema Normandie-Centre, Research Team ENDSUM, Grand-Quevilly, France

The bearing capacity of near-surface soils is an essential component in describing potential unimproved landing zones. The most straightforward measurement of soil bearing capacity can be done by a geotechnical method, the Dynamic Cone Penetrometer (DCP), at one or multiple locations on the area of interest. However, this method can only provide the soil bearing capacity at the measurement location. A bearing capacity map of a large area requires a lot of manpower and time to perform intensive measurements. Therefore, the use of geophysical methods to generate soil bearing capacity maps is a worthwhile research topic because they estimate physical properties of the soil through non-destructive and efficient measurements.

The shear-wave velocity (Vs), as a mechanical property of the soil, is most directly related to the soil bearing capacity, but the correlation between Vs and bearing capacity cannot be expressed by a single mathematical equation, since it is material or site dependent. Therefore, we try to establish the relation between them using a geostatistical framework.

A test site (30 long, 5 m width and 0.75 m depth) has been built in Cerema Normandie-Centre (Center for Studies on Risks, the Environment, Mobility and Urban Planning) with three areas with different ranges of standardized California Bearing Ratio (CBR). Surface wave method MASW (Multiple-channel Analysis of Surface Waves) and DCP measurements were performed on the centerline of the test site. 2D surface wave analysis and inversion are applied on the seismic data to extract the cross-section of Vs in the three areas.

At first stage, the raw data of DCP measurements, i.e. the penetration depth of the cone after each blow, were compared with the inverted Vs profile. A strong correlation between DCP data and Vs is observed for each area. In the second stage, a cokriging method is applied using Vs as the secondary variable and a small number of DCP data as the primary variable, to build the DCP data map of the three areas. Thanks to the important density of DCP data on the test site, this calculated DCP map can be compared with actual measurements to verify the feasibility and robustness of the use of MASW method to build soil bearing capacity maps.

Tests and verifications of this statistic-based method are required on field measurements under less controlled or even unknown conditions. Further studies are in progress where the relationships between DCP and other geophysical methods, such as EMI (Electromagnetic Induction), ERT (Electrical Resistivity Tomography) and TDR (Time Domain Reflectrometry), are currently being assessed.