SUBSURFACE IDENTIFICATION USING ACTIVE MASW SURVEY: RESOLUTION OF DISPERSION IMAGE

A Thesis

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Jumrik Taipodia

Department of Civil Engineering

Indian Institute of Technology Guwahati

Guwahati – 781039, India

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ABSTRACT

'Multichannel Analysis of Surface Waves (MASW)' is a non-destructive field seismic survey method used for the identification of soil stratification. The three primary steps of MASW survey comprise field data acquisition, dispersion analysis and inversion analysis. During data acquisition, the vibration signatures generated by active or passive sources are recorded by a series of geophone receivers arranged in a predefined array. In the dispersion analysis, the collected wavefield are further processed to obtain the unimodal or multimodal dispersion trends represented by the frequency-phase velocity relationships. The dispersion curve is further processed through the inversion analysis to obtain the shear wave velocity profile of the substrata in 1-D, 2-D or 3-D formats. The resolution of dispersion image plays a crucial role in governing the accuracy and reliability of the outcome. Resolution gets affected by several parameters related to data acquisition and data pre-processing. Further, a good resolution dispersion image aids in unambiguous identification of the dispersion curve which is the prime requirement for the inversion analysis. Incorrect identification of the dispersion curve will lead to erroneous subsurface stratification.

Based on the active MASW survey conducted on soil sites of varying stiffness characteristics, the thesis reports the influence of the data acquisition and pre-processing parameters to obtain a good resolution dispersion image. In this regard, raw wavefield signatures, generated by a 10 kg sledgehammer or 40 kg Propelled Energy Generator (PEG), were collected using a linear array of 12-or-24 numbers of 4.5 Hz geophones. Various receiver layouts and field configurations were considered, and wavefields were collected using various sampling frequencies and sampling lengths. The collected data were pre-processed by various filtering and muting techniques. Based on the obtained results, recommendations have been provided about the choices of the data acquisition and data pre-processing parameters to achieve good resolution dispersion images. An exact representation of the dispersion curve is imperative to the accuracy of the shear wave velocity profile obtained from the data analysis. The quality of the dispersion trend is guided by the signal-to-noise (SNR) ratio. Conventional approach of manual extraction of dispersion curve from a dispersion image often leads to discrepancies owing to the erroneous selection of dispersion points leading to a low SNR ratio, thus leading to inaccurate subsoil stratification. Moreover, the manual extraction is subjective to the user discretion, leading to non-repeatability of the obtained outcome. This thesis reports the development of an image-processing based automated dispersion curve extraction strategy which can identify the exact occurrence of the local peak energies as the dispersion modes and overcomes the limitations of manual extraction technique. The extracted dispersion curve is subsequently subjected to inversion analysis, and the effects of various inversion parameters on the shear wave profiling have also been reported. The guidelines developed have been further used in a case study of Active MASW survey conducted along Jia Bharali river bed (a tributary of River Brahmaputra) for the proposed construction work of a 1.2 km long bridge along the new 4-lane road from Dolabari to Jamuguri connecting NH-37A with NH-52 in Tezpur, Assam. From the field study, the subsoil stratification along the proposed bridge alignment was determined which revealed top erodible riverbed sediment layer, thick soft soil layer with intermittent and perched boulder deposits, followed by deep seated bedrocks. Such findings would help in the planning and design of the foundations of the bridge piers.

Keywords: Active MASW survey; Data acquisition and preprocessing; Resolution; Dispersion image; Dispersion curve; Automated extraction; Inversion analysis; Shear wave velocity profile