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Frequency Dependency of Laboratory Measurement of Maximum Shear Wave Velocity by Bender Elements

Sara Ataii[1], Abbas Ghalandarzadeh[2], Majid Moradi[2]

[1] *M.Sc. of Geotechnical Engineering,College of Civil Engineering, University of Tehran, Tehran, Iran.*
[2] *Associate Professor, College of Civil Engineering, University of Tehran, Tehran, Iran.*

Corresponding author's Email: s.ataii@ut.ac.ir

ABSTRACT:

Maximum shear wave velocity is one of the most important dynamic parameters of soils which contributes in estimating the dynamic behaviour of soils through the maximum shear modulus. There are different methods for measuring shear wave velocity either in laboratory or in the field. One of the laboratory methods that recently has become popular due to its simplicity, is use of Bender Elements in soil samples. Contrary to its simplicity, it has several uncertainties in its data interpretation. Frequency at which the shear wave velocity is measured is one of the effective parameters that significantly affects the clearance of received wave. This article presents results from a laboratory investigation into the shear wave velocity measurement of remolded specimens of Firoozkooh sand. Specimens were subjected to 13 different levels of frequency and 11 different levels of confining pressure. Results shows that by increasing the confining pressure, the frequency at which the received wave has the best clearance, increases. It also shows that frequency dependence of soils increases by increasing the confining pressure.

Key words: Shear Wave Velocity, Frequency, Bender Element, Triaxial Apparatus.

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1- Introduction

The maximum shear modulus (Gmax) is one of the most important dynamic properties of soil which effectively contributes in evaluating the behavior of soils under dynamic loadings such as earthquake, traffic loads and machine vibrations. There are different methods of measurement either in laboratory or in the field. Laboratory methods could be divided in two groups. In the first group Gmax has been measured based on vibration such as torsional shear and resonant column (TS-RC) tests. The second group of methods has been based on wave propagation like ultrasonic method and Bender Element test. Bender Element method has first proposed by [1]. It rapidly finds its way through laboratory tests due its simplicity in use, respectively low cost, and its non-destructive operation. Bender Elements has been installed and used in different laboratory apparatus such as odeometer [2], [3], torsional shear apparatus [4], resonant column [5] , and triaxial apparatus [6]–[9]. Bender Elements are made of two piezoelectric ceramic sheets with central shim of usually ferrous nickel alloys to enhance its strength. Bender Elements operate as electromechanical transducer. When a small voltage is applied to the Bender Element, Bender Element will bend due to the polarization that has induced across its plates and thus the Bender Element will act as a transmitter element. Contrary when a Bender Element bends, a voltage is generated and so it will act as a receiver one [1], [7]. Since the strain induced in soil due to Bender Element movement is in elastic strain range of soils behaviour (less than 10-3%), based on the theory of elastic wave propagation [10], the maximum shear modulus (Gmax) can be derived from equation (1).

$$G_{max}=\rho\times V_s^2 \qquad (1)$$

Where ρ is soil density and Vs is shear wave velocity.