CHAPTER 5

Conclusions and Recommendations

5.1 Conclusions and Recommendations

The development of this method was born from the need to find a way of measuring the density of the substratum using a non-invasive approach. It is believed that the new approach discussed in this thesis can meet this requirement. The method utilizes data in three dimensions; which include vertical pressure waves (P-waves) and horizontal shear waves (S-waves).

Comparison with the laboratory data was favourable. This method was successful in the field and poses some merit. Single layer scenarios where the method can be applied are only encountered in very few cases. Examples of single layer cases are man-made structures, such as road embankments and gravity dam walls. Tests in multi-layer situations, particularly with the weathered profile were also successful. In most cases, the weathered layer is a multi-layered medium.

The accuracy of the proposed method depends largely on the quality of instrumentation, processing accuracy (determining the damping factor (b) of the seismic traces) and of the subsurface. Given that the rocks and soil are strongly, but less than critically damped (Thorne & Wallace 1995) it is evident that the calculated volume depends largely on the damping factor. Various approaches for determining this factor have to be investigated on good-quality data and the processing software (Fourie and Cole, 2004). The coupling of the base plate with the subsurface is not yet perfected. This could lead to a lower determination of the excited mass and volume, and subsequently the density.

As with most other geophysical methods (such as the D.C. electrical resistivity and electromagnetic methods (Griffiths *et al*., 1969, Telford, 1986, Kearey et.al, 1991), it will be impossible to do absolute accurate interpretations without any verification.

The method will yield a good first-order approximation, and if test pits or boreholes are available to verify the interpreted results, the savings may be considerable.

From the experience gained, it is evident that this method works relatively fast. It is possible to perform approximately 10 soundings in one day, depending on accessibility and the terrain. A major negative factor at this stage is that the equipment is still very heavy, which makes it difficult to manipulate. A redesign of the equipment will be necessary to increase the ease of handling and mobility of the equipment. One solution may be to permanently mount the equipment on a specialised vehicle.

Currently, data processing such as the digital signal processing and filtering, are done by means of dedicated in-house developed software in Visual Basic (Fourie and Cole, 2004). This software unifies all the necessary processes and routines to process the data and the display options into one package.

One important addition towards the software can be done. For Q-values that stay more or less constant, a technique was developed by Kjartansson (1979) whereby the Q-factor can be established by means of a relationship between the frequencies of the successive layers and the small movement elasticity modulii of the successive layers. This relationship is given below:

$$\left(\frac{1}{Q}\right) \approx \frac{\Pi}{\log\left(\frac{\omega}{\omega_0}\right)}\left(\frac{1}{2}\frac{k_1 - k_0}{k_0}\right) \qquad 5.1$$

The main application from this relationship would be that the Q-values that is needed to calculate the layer thicknesses can already be determined during the mass determination phase. This will save a tremendous amount of time during the processing of the data.

Finally, the main advantages of this method should be emphasized:

- The method is non-invasive/non-destructive.
- The method will be cost effective, by limiting the number of test pits, and large diameter exploration holes.
- Laboratory costs will be reduced.
- The method is fast, and the production rate is relatively high.

Recommendations are that:

- Setup should be mounted on a specialized vehicle for easier operation.
- More weight increments to a larger total mass of 1000Kg should be utilized in order to obtain the small movement modulus more accurately.
- Improvement on the software should be done and the Kjartansson method of Q-factor development should be incorporated into the software.
- Method should be tested for the influence of discontinuities in the soil.

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