

Geophysical Methods for Transportation Applications

Problem:

Conventional methods used for characterizing subsurface conditions that affect the stability of various transportation infrastructures are expensive, time consuming, and not fully effective. Geophysical data, when properly constrained by conventionally acquired ground-truth, can provide critical information about the physical properties of the subsurface or structure being investigated. Current state-of-the-art geophysical technology in no way eliminates the need for the use of conventional methods; however, it represents a means of expediting the investigative process, reducing overall costs, and improving reliability of the final product. Although geophysical methods are enhancement to conventional methods, geotechnical engineers do not readily use them because of lack of experience and knowledge in their applications to highway problems.

Putting it in Perspective:

Accurate and cost effective site characterization through all stages of highway construction and operation minimizes project risk and avoids/mitigates additional project costs related to unforeseen problems. Better design and construction quality, higher safety and reduction in project costs can be achieved by providing knowledge and training to the State Highway Agencies so they can apply state of the art technologies in their investigations and quality assurance.

Solution:

Applied geophysical technologies are being increasingly used by State Highway Agencies to solve transportation-related problems. The reason is relatively straightforward. Very simply, geophysical methodologies are often the quickest and most cost-effective means of investigating a geotechnical site or highway structure. This is particularly true when “time is of the essence”, when the geotechnical site is relatively large, where site conditions are highly

variable (and extrapolation between boreholes is tenuous), and when accessibility for conventional investigation methods is a problem.

Current applied geophysical technologies fall into two principle categories: surface-based methods and borehole methods. The most commonly applied surface methods are refraction and reflection seismic, electromagnetic conductivity, electrical resistivity, microgravity, magnetic, and ground penetrating radar. The most commonly applied borehole methods are cross-borehole seismic, seismic tomography, radiometric and electromagnetics.

Each one of these geophysical methods has its own characteristic applications, advantages and limitations. Some of these methods are used to generate structural/lithologic images of the subsurface between boring locations. Other tools are used to log boreholes and provide information about in-situ porosity, saturation, fluid content, permeability, fracture density, lithology, lithologic contacts, etc. Some surface-based technologies work best in areas where the ground surface is dry and sandy while others work best where the surface is moist and clayey. Some borehole-based technologies work best above the water table while others work better below the water table.

In an effort to assist State Highway Agency engineers responsible for geotechnical and/or structural investigations, the FHWA recently completed a geophysical manual entitled “*Application of Geophysical Methods to Highway Related Problems*” that describes the commonly employed geophysical methods and their principle applications related to engineering problems in the transportation industry. The manual is not intended to make engineers experts in the field of geophysics, but rather to provide them with tools that will assist them in the use of suitable geophysical and NDT techniques to evaluate problems for planning, design, construction, or remediation efforts.

Benefits:

- Provides state-of-the-art geophysical tools for planning, design, construction, repair and maintenance phases of transportation projects.
- Improve design and construction quality, increase safety, and reduce costs of transportation projects.
- Allows nondestructive investigation below the surface of the ground, pavement, bridge deck, or other transportation structures.

Additional Resources:

The manual is available on the website
www.cflhd.gov/geotechnical

For More Information, contact:

Sam Mansukhani

Phone: (708) 283-3550

Email: sam.mansukhani@fhwa.dot.gov