

Florida Department of Transportation Research

Geophysical Testing of Rock and Its Relationship to Physical Properties

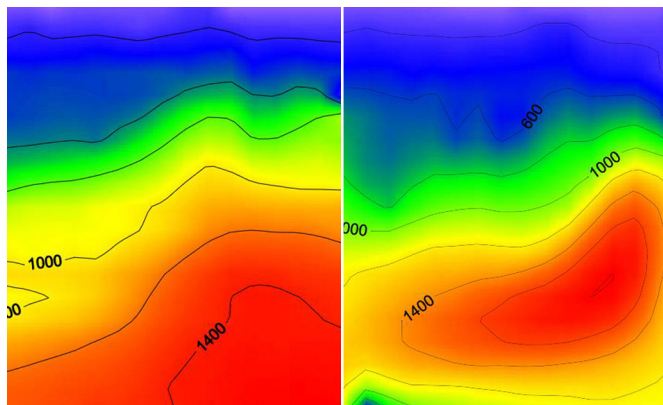
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Designing deep foundations requires understanding their mechanical properties and load-bearing capacity, derived from knowledge of a site's geology and geophysical characteristics. One approach to this is seismic techniques, which measure wave velocity in ground layers and produce arrival time data, which is inverted mathematically to reconstruct a site's underground cross-section. Of particular interest is determining the variability of the geological characteristics in rock formations in the critical load-bearing layers used for construction of drilled shafts.

University of Florida and University of North Florida researchers sought to extend FDOT's site characterization abilities by improving data collection and inversion methods, as well to establish relationships between the resulting parameters obtained from geophysical testing with those associated with the design and construction of drilled shafts normally used by geotechnical engineers. They compared seismic data from surface detectors with combined data, taken by detectors on the surface and in boreholes, to optimize a testing configuration to obtain high-quality test results and properties within the critical rock socket portion of the drilled shaft. Physical testing at three north Florida sites was preceded by computer simulation studies. Data from all studies were inverted by a method called simulated annealing.

Simulated sites included typical Florida features, such as low-velocity layers and voids between higher velocity layers, which surface data and traditional inversion may not detect. Using simulation, researchers examined the effectiveness and uncertainties of their methods and compared reconstructions using surface data or combined data.

The physical sites are well characterized, with features like the computer simulations. Researchers compared surface and combined data and found both on simulated and



Profiles of a Ft. McCoy site show that combined data (right) produced more detail than surface data alone (left). The section is 15 m wide and 18 m deep.

physical sites that combined data better mapped subterranean structures. Also, the studied methods characterize geophysical properties as well as or better than those derived from more conventional procedures.

The researchers' methods have advantages because Florida sites often vary significantly over short distances, and small samples may not give adequate information. The computer methods used in the study take more time than other methods, but produce equal or better results and uncertainty information useful in evaluating reconstructed profiles.

Results from non-invasive methods were consistent with invasive techniques, such as cone penetrometry or standard penetration tests. Combined data characterized the presence, location, general shape, and true velocity of embedded low-velocity zones. This is especially important near the rock socket portion of a drilled shaft, because the nature and variability of this material will determine the axial capacity properties of the rock to be used for the design and construction of drilled shafts. The methods of this study are a valuable addition to FDOT's site characterization tools and a useful adjunct to traditional site testing techniques.