Evaluation of Nuclear Gauge for Use With Coastal Calcareous and Volcanic Soils

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ABSTRACT

Wet density and nuclear gauge readings were compared to direct measurements based on weights and volumes in an effort to ascertain the accuracy of the device for use with a range of local Hawaiian soils, including volcanic and calcareous materials. This follows concerns expressed by numerous users regarding certain high moisture soils found throughout the State. Results indicate that whereas wet densities are quite accurate, moisture content readings obtained with a nuclear gauge may need to be offset at water contents above 45%. Further recommendations are presented on minimum count times, use of the gauge in the presence of very large soil particles, and the need for back-up sand cone tests.

KEY WORDS: Calcareous soils, volcanic soils, nuclear gauge

INTRODUCTION

Nuclear gauges are the most common method for measurement of in-place density and moisture content on most construction projects. They provide obvious advantages in terms of speed, accuracy, and convenience. Older methods of measurement, such as the sand cone and balloon methods, are time-consuming and involve drying soil samples in an oven for a period of as long as 24 hours before in situ density and moisture content can be determined. This is often unacceptable in projects where grading and compaction need to proceed without undue interruption. Nuclear gauges can provide density and moisture content values in as little as 15 seconds.

In Hawaii, as in most other places, the nuclear gauge is widely used by engineering and testing firms. Many projects are done on behalf of the Hawaii Department of Transportation (HIDOT). However, the HIDOT has identified a number of concerns regarding use of the nuclear gauge. These issues entail use of the gauge with certain soil types, and the need for a consistent and streamlined set of procedures to be followed by contractors in order to improve the reliability of reported results. The second concern is being addressed with the development of new guidelines for the use and calibration of individual gauges. This article focuses on the first concern, i.e. use of the gauge with certain classes of soils.

The impetus for this study was a series of issues raised by local users, which included the following (Felkel, 2008):

1. Certain fine-grained soils with high plasticity may have high hydrogen content (or high carbon, iron, boron or cadmium content) that can cause the gauge to produce false moisture content readings. In fact, 47% of surveyed users report problems of this type (Figure 1).

   
   Have you experienced problems testing with fine-grained soils?

   Yes
   47%

   No
   53%

   Figure 1. Percentage of surveyed users who have experienced problems with fine-grained soils

2. Coarse-grained soils with particles that are large in relation to the nuclear gauge sample volume may produce highly variable wet density results (Figure 2).

3. Contractors are not clear on what the differences in accuracy are of using standard 15-second, 1-minute, or 4-minute count times. In fact, a majority of them use the 15-second count time (Figure 3).