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Laboratory comparison of determining density and moisture by nondestructive and destructive nuclear methods ASTM2216 and ASTM1556c

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Abstract: This study aims at determining soil density and moisture through laboratory comparison of nondestructive method of nuclear gauge density and destructive method ASTM2216 and ASTM1556c in basic levels and under levels of different pilots in road making projects and oil refineries. Obtained results are show through graphs. The results reveal that density and moisture in the two aforementioned methods in application places (road making projects) are different according due to unevenness of grading and nonattainment laboratory condition. Mostly, nuclear gauge density shows a more density and moisture than destructive method ASTM2216 and ASTM1556c.the nuclear test speed is relatively more than the destructive method.

Key words: ASTM2216 and ASTM1556c; Nuclear gauge density

1. Introduction

In most of building operations such as constructing soil dams, roadbed, levees, ant etc., in which soil is used as the basic material, soil layers compaction must be in a form with the least porosity and the maximum dry density. And for most of materials, the rate of moisture is one of the characteristics that are used in determining relationship between soil behavior and its outstanding characteristics. The moisture rate of a material is used in determining the description of the relationship between climate and solid materials per a specific volume. We study the determination of the rate of soil moisture in test ASTM2216.

Since the soil resistance is directly related to particles degree of density and therefore to weight per unit or density, density measurement is regularly and continually necessary in order to act by adding density with different methods when necessary. The aim of density is to improve soil engineering properties through obtaining benefits such as reducing permeability, increasing soil shear strength, and improving soil sloe stability, improving the bearing capacity of soil substrates, controlling change of undesirable volume such as inflation due to solidification, swelling and shrinkage due to humidity change, and etc. (Newel et al., 2011). Testing method of determining special weight and soil density by using ASTEM1556 method is used to measure compacted soil density while constructing levees and it can be used as a criterion for soil compaction in terms of density or compaction rate. This test is usually used for unsaturated soils or is not used in places where water penetrates in density hole. The test is not accurate in changing soils and or soils that change their volume due to walking near the hole during the test. Thus, it is necessary to use the precise and quick methods to test the density and moisture in the place in order to act quickly while necessary. The nuclear gauge density is the quickest method in the world now that it uses two radiations to measure the materials density and moisture (Yong, 2009). The interplay between radiation and materials is different but most of mechanisms are against both radiations. Both methods are indirect in way that in fact another quantity of material is measured. Then, moisture and density are calculated from this quantity. The difference between the measured quantity and moisture is called chemical error density or chemical combination error. The measured density is obtained through Gama radiation which is a kind of electromagnetic radiation. Its frequency is radio frequency of TV signal and it has invisible rays (Zabko, 2010). The materials become ionized in exposing with Gama radiation. In the higher frequencies, it is usual to analyze the Photon quantum effects and mass inertia, and also the desired moisture content is measured by neutron radiation that neutron is consists of particles without electric load. These particles are very energetic due to absorption of Gama ray.

Being time consuming, the current methods of soil compaction measuring decrease the rate of embankment. By using these methods, there will only be the possibility of soil compaction measuring in the limited places. In the condition with the emergency of the test result, the high rate, in the places with high amount of moisture and the impossibility of shifting method of density testing to other methods, one can measure the wet density

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(WD), dry density (DD) and moisture percentage by using the nuclear nondestructive method. However, it is essential to investigate the use of this test in a study and to compare it with current methods such as ASTM2216 andASTM1556.

2. Methods and Materials

2.1. Introducing soil layer

According to the comparison between soil density and moisture in the two aforementioned methods, the sol with nice grading is required in doing the test, and the grading changes in these layers should be limited and defined in way that the basis and substratum layers have a better condition than other soil layers in terms of grading. This was the main reason for our choice in doing the test in these two layers over the other current soil layers.

Measuring the determination of density and moisture rate by using nondestructive nuclear method:

The method of determining density and soil moisture rate by using nuclear density gauge: it is done through radiation of Gama ray to determine soil density and to determine moisture through radiation of Neutron ray that is particle without load. These particles are very energetic as a result of Gama ray absorption. Alpha particles are emitted by nucleus of n atom, and Neutron is automatically formed rarely. The overall method of this device is as this way that at first the device sensor is put in the total thickness of soil layer and then the numbers of dry density and soil moisture rate is read directly. The Gama waves are sent to the soil through the device sensor and the required information are received and saved in the device. The required numbers are read directly from the device.

Measurement of density determination and moisture rate by using ASTM1556 and ASTM2216 methods**:**

Hole-making based on ASTM1556 and in various places in this test is used to determine soil density or to measure special weight by using sandy cone. This method is used in soils in which the big particle materials (stone) with diameter more than 1.5 inch (38mm) are rare. It is used to measure special weight of natural soils only if hollow spaces of soil or cavities in the soil are so small that sand does not fall in it. To determine soil measurement rate through ASTM2216 method, the test sample was dried in a kiln with 110° C temperature. The moisture rate is calculate by considering water mass and sample dried mass.

2.2. The devices calibration

In order to obtain precise results, one should calibrate the devices before doing the tests. In doing so, possible error minimized, therefore, the calibration of the nuclear devices is done based on ASTMD3017 and ASTMD2922 methods. To calibrate the Sand-Bottle method, one should put the density sand into the Sand-Bottle device for three times and measure cone and can bottom that the sand density is obtained. We calibrate the moisture cans and scales by common laboratory methods and also calibrate oven device in the various temperature. Then, we design the calibration graph.

2.3. Choosing the points to be tested

The laboratory comparison of chosen places has been made in rood-making projects (surrounding roads projects of Tombak Kangan site) and refinery of Phase2 (EPC2 Unit) in the basis and substratum layers in the different pilots and the results have been plotted in charts.

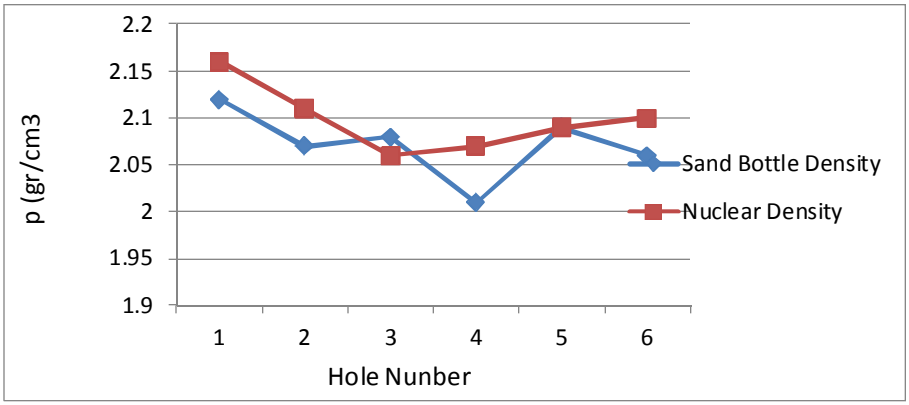

Fig. 1: The comparison of substratum density - test place: part 1 of Kangan bypass

The Figure analyses: it shows the comparison of density by using two nuclear methods and ASTM1556 in part 1 Kanghan bypass site. The results reveal that in the point ASTM1563, the density is more than the nuclear method for various reasons, and in the point the densities are the same. Laboratory error, rate of materials big particles, unsuitable grading of the materials in the various layers of soil can be various possible reasons for differences in these points.

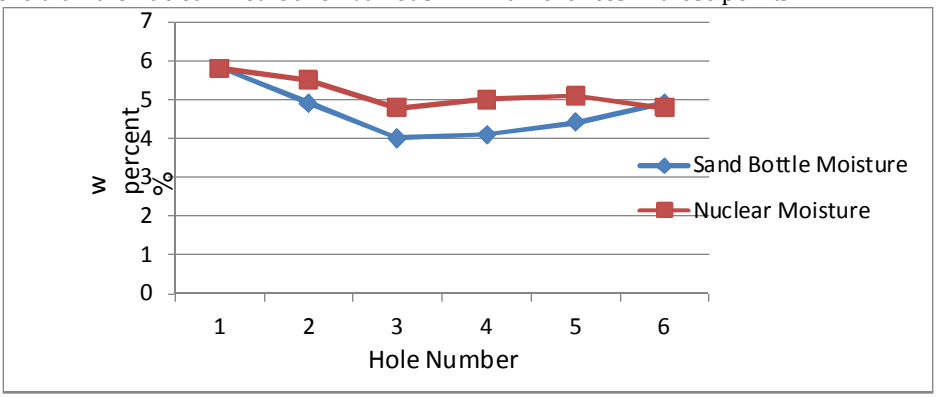

Fig. 2: The comparison of substratum materials moisture - test place: part 1 of Kangan bypass

The Figure analyses: it shows the comparison of moisture by using two nuclear methods and ASTM1556 in part 1 Kanghan bypass site. The results are the same in the poin1 and in the point 6 the results for the nuclear method are a little more. One can say that laboratory error, rate of materials big particles, unsuitable grading of the materials in the various layers of soil are various possible reasons for differences in these points.

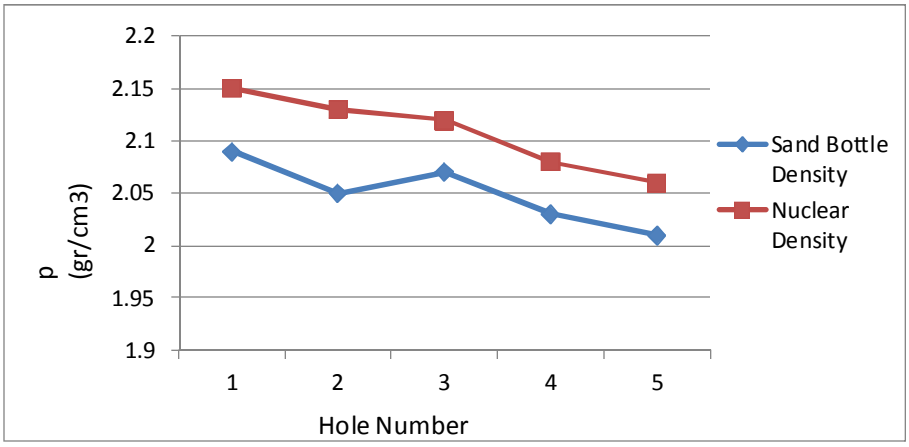

Fig. 3: The comparison of substratum density – test place: Phase 12- EPC2

The Figure analyses: it shows the comparison of substratum density by using two nuclear methods and ASTM1556 in Phase 12 site (EPC2 Unit). The results reveal a good likeness for the nuclear methods with ASTM1556 method.

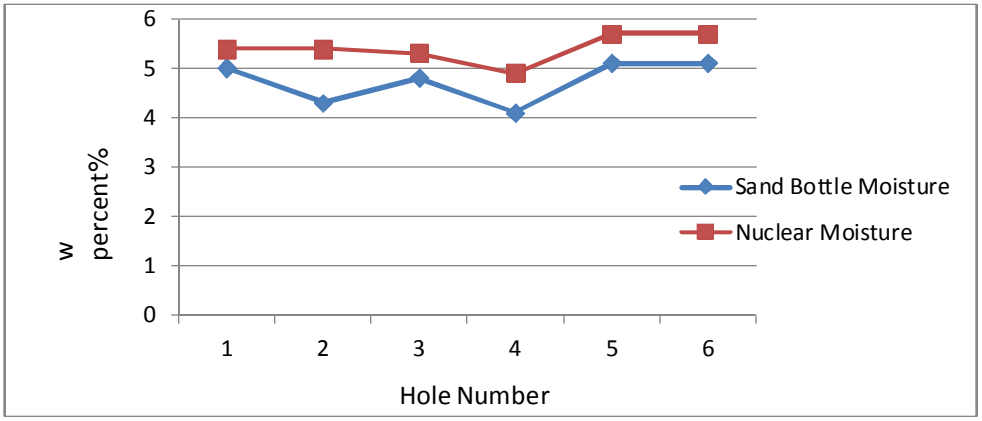

Fig. 4: The comparison of substratum moisture – test place: Phase 12- EPC2

The Figure analyses: it shows the comparison of moisture by using two nuclear methods and ASTM1556 in Phase 12 site (EPC2 Unit). The results reveal a good likeness for the nuclear methods with ASTM1556 method.

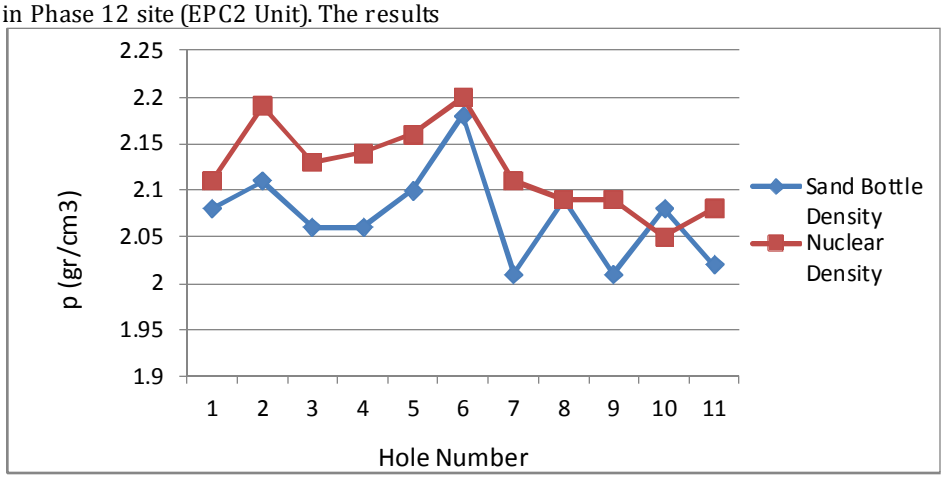

Fig. 5: The comparison of basis density - test place: part 1 of Kangan bypass

The Figure analyses: it shows the comparison of density by using two nuclear methods and ASTM1556 in part 1 Kanghan bypass site. The results reveal that in poin10, ASTM1556 are more than nuclear method and in the point 8 they are the same. One can say that laboratory error, rate of materials big particles, unsuitable grading of the materials in the various layers of soil are various possible reasons for differences in these points.

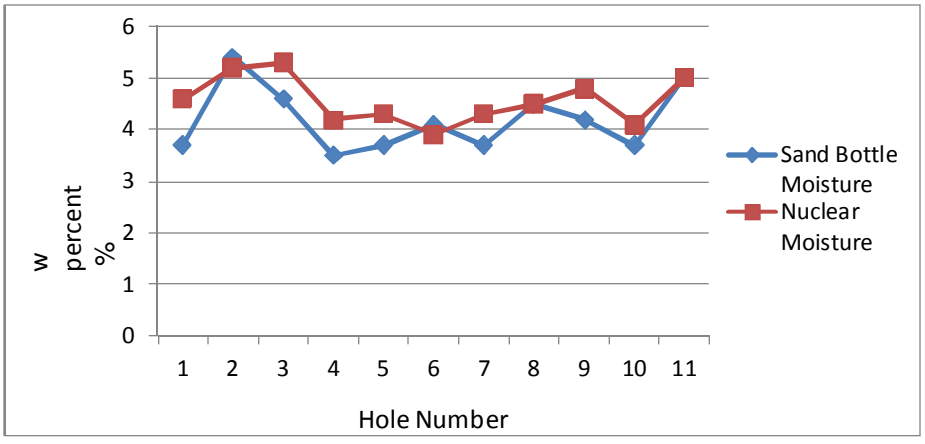

Fig.6: The comparison of basis moisture - test place: part 1 of Kangan bypass

The Figure analyses: it shows the comparison of moisture by using two nuclear methods and ASTM2216 in part 1 Kanghan bypass site. The results are the same at points 7and 11, and in points 6and 2 the nuclear method is a little more. In the points 11 and 8, they are the same. One can say that

laboratory error, rate of materials big particles, unsuitable grading of the materials in the various layers of soil are various possible reasons for differences in these points.

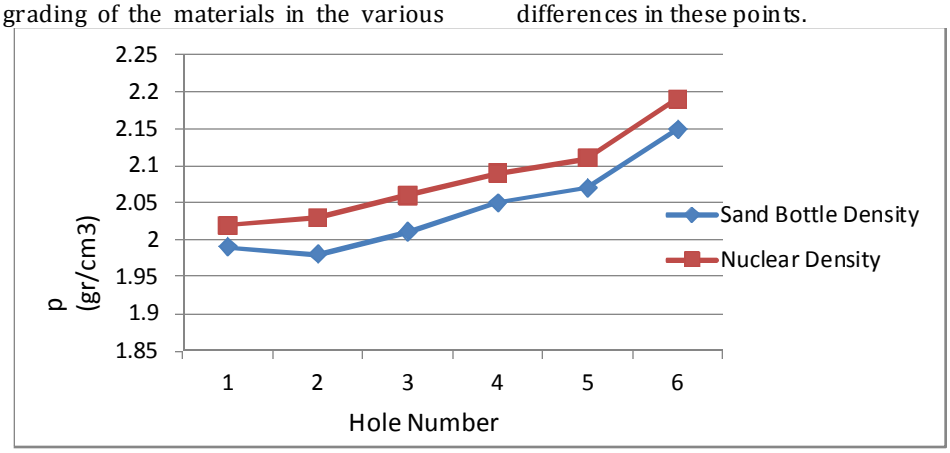

Fig. 7: The comparison of basis density – test place: Phase 12- EPC2

The Figure analyses: it shows the comparison of basis density by using two nuclear methods and ASTM1556 in Phase 12 site (EPC2 Unit). The results reveal a good likeness for the nuclear methods with ASTM1556 method.

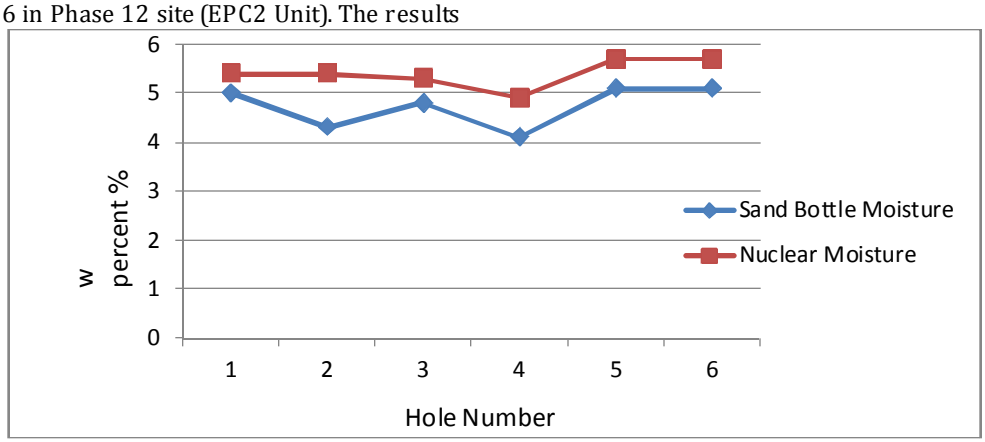

Fig. 8: The comparison of basis moisture – test place: Phase 12- EPC2

The Figure analyses: it shows the comparison of moisture by using two nuclear methods and ASTM2216 in Phase 12 site (EPC2 Unit). The results reveal a good likeness for the nuclear methods with ASTM2216 method.

3. Conclusion

In this study, the determination of density and the moisture rate by using laboratory comparison of nondestructive nuclear density gauge method and destructive methods ASTM1556 & ASTM2216 in the basis and substratum layers in various pilots in road making projects located in surrounding roads of Tombak, KAngan site and Kangan oil refinery was investigated. The result reveals concordance between two destructive and nuclear methods in terms of moisture and density. Thus, according to the high rate of nuclear method, it is superior to the other two methods.

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