Acceleration of Compaction Test by Using Heat Induction on Metals That Are Electrically Electrified

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Abstract. The density of clay soil is tested in the laboratory using standard soil compaction methods or modified methods. The results of the compaction test from the two methods are in the form of a graph of the relationship between the maximum dry weight of the soil and the optimal air content of the soil. Compaction testing in the laboratory is carried out with a minimum of 5 repetitions using the addition of water for each repetition. The time required to complete soil compaction testing in the laboratory is at least two days, and requires approximately 2.5 kilograms of soil samples for 1 test. This research was conducted to shorten the time and make efficient use of soil samples to obtain soil density values using heat induction through metal. With this research, it is hoped that an alternative model for testing the density of clay soils is fast and efficient.

Keywords: Soil density, moisture content, dry weight, heat induction

1 Introduction

Soil is composed of: solids, voids and water. The volume of voids and water contained in the soil affects the strength of the soil. The fewer voids and water in the soil, the greater the strength of the soil [1]. The volume of voids and water contained in the soil can be determined by carrying out soil density testing carried out in the laboratory or direct testing in the field. The basic concept of soil density testing is to measure the change in soil weight before and after an external load is applied by impacting it with a hammer that is dropped at a certain amount and height [2]. The results of compaction tests carried out in the laboratory will produce a compaction curve in the form of a correlation between soil density and water content in the soil being tested. In practice, testing in the laboratory takes 2 to 3 days to produce a soil compaction curve. The long time to complete testing in the laboratory creates obstacles to the length of completion of compaction work in the field. Therefore, it is necessary to develop a soil compaction testing model, where the soil compaction curve is produced with a very fast testing time, one of which is by using heat induction on metal.

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Soil consists of granules, pores and water (Fig.1.) [3]. Soil density is determined by the volume of pores and water in the soil. The larger the volume of pores and water in the soil, the smaller the soil density will be [4] .

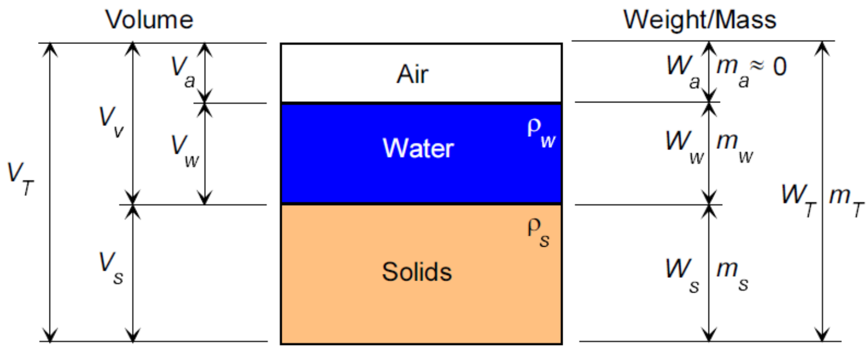

Fig. 1. Soil phase

The concept of soil density is to increase the dry volume of soil with dynamic loads so that the soil grains become closer together and reduce air voids (the pore volume decreases). The closeness of the soil grains occurs because the soil pores, which contain air and water, are reduced, while the volume of the soil grains themselves does not change [5].

Soil density is usually tested using a light compaction test (standard proctor, ASTM D689) or a heavy compaction test (modified proctor, ASTM D1557). The difference between the two compaction tests lies in the number of impacts, mold volume and weight of the hammer.

The phenomenon of soil compaction tests in the laboratory can be explained as follows: dry soil grains will increase in weight when given water graduall [6]. As water in the soil grains increases, the dry weight of the soil grains will increase. Under ideal water content conditions, maximum soil density will result (maximum γ_d). This ideal water content condition is called optimal water content (w_{opt}). The addition of water to the soil grains until they exceed the soil's ideal water content causes the soil to become soft, so that the weight of the soil grains will decrease. The phenomenon of the soil compaction test can be seen in the following image.

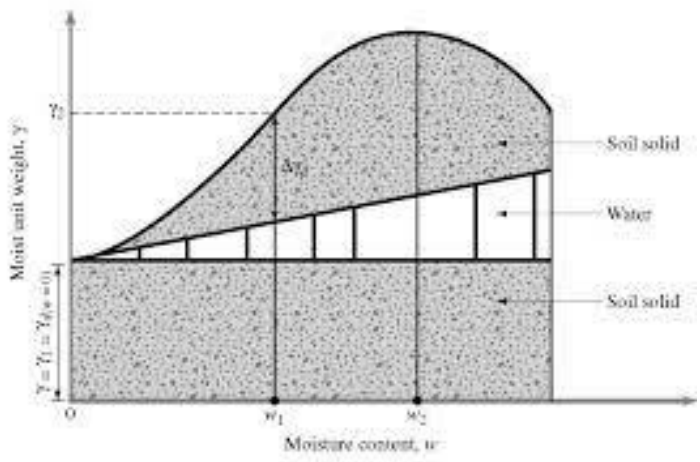

Fig. 2. Soil behavior with the addition of water

Changes in soil grain weight due to the addition of water will produce a graph of the function of dry soil density and water content (Figure 3).

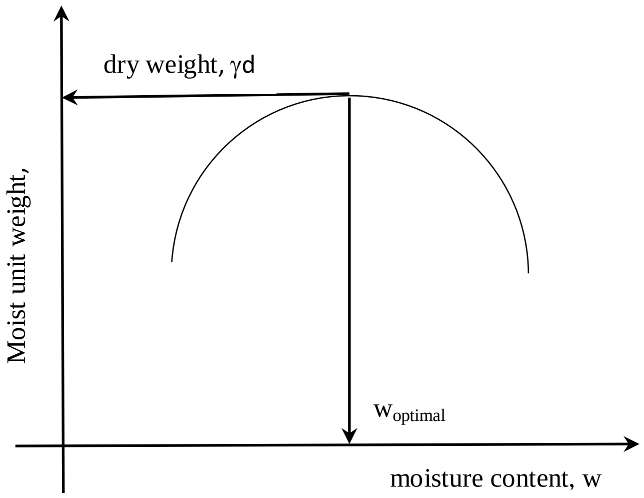

Fig. 3. Example of a soil density test graph

In the light and heavy compaction tests, the weight of the soil grains was increased using dynamic loads (2.5 kg and 4.54 kg). So this research was conducted to produce a soil compaction test model using heat from the metal induction process.

2 Research Method

The research method used is an experimental test using heat produced by metal induction which functions to evaporate the water in the soil grains, and it is hoped that the evaporation of the water will reduce the soil pores so that the weight of the soil grains will increase. Tests were carried out on several types of clay soil from the municipality of Sibolga (Central Tapanuli).

3 Results and Discussion

Test results data can be seen in the following table.

Table 1. Soil density test data using metal induction, Location: Aek Parombunan Village, South Sibolga

Descriptions	Unit	Time (hours)						
		0	1	2	3	4	5	6
Moisture content, w	%	15	11	10,8	10,8	11,1	8,2	8,0
Weight sample	gr	10	10	10	10,0	10,0	10,0	10,0
Weight wet soil + mold	gr	6090	6081	6066	6049	6036	5941	5870
Weight mold	gr	4234	4234	4234	4234	4234	4234	4234
Weight wet soil	gr	1856	1847	1832	1815	1802	1707	1636
Volume of mold	cm^3	971,6	971,6	971,6	971,6	971,6	971,6	971,6
Wet density, γ	gr/cm^3	1,91	1,90	1,89	1,87	1,85	1,76	1,68
Dry density, γd	gr/cm^3	1,661	1,713	1,702	1,686	1,669	1,624	1,559

Table 2. Soil density test data using metal induction, Location: Huta Barangan Village, North Sibolga

Descriptions	Unit	Time (hours)						
		0	1	2	3	4	5	6
Moisture content, w	%	30,65	28,57	27,50	26,76	25,00	22,06	23,29
Weight sample	gr	6,2	8,4	8,00	7,1	7,6	6,8	7,3
Weight wet soil + mold	gr	6012	5999,8	5980	5950,0	5928,5	5913,8	5894,8
Weight mold	gr	4234	4234	4234	4234	4234	4234	4234
Weight wet soil	gr	1778	1766	1746	1716	1695	1680	1661
Volume of mold	cm^3	971,6	971,6	971,6	971,6	971,6	971,6	971,6
Wet density, γ	gr/cm^3	1,83	1,82	1,80	1,77	1,74	1,73	1,71
Dry density, γd	gr/cm^3	1,401	1,414	1,409	1,393	1,395	1,416	1,387

The data from Table 1. above was then analyzed and a soil density graph was created as follows.

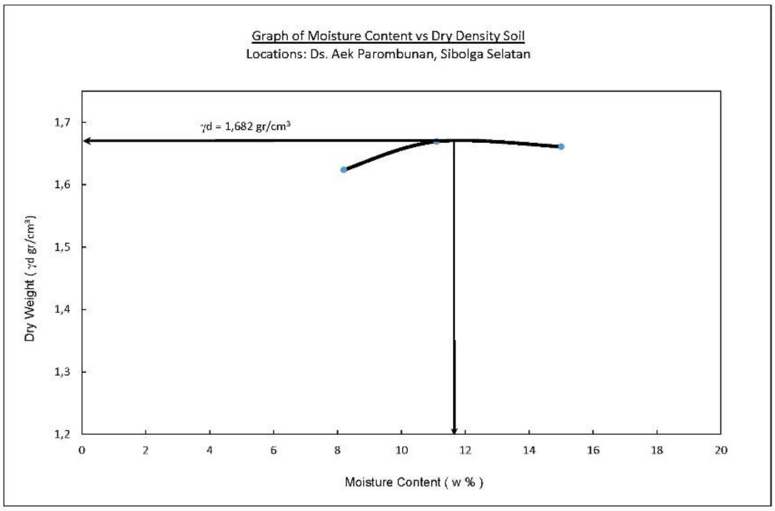

Fig. 4. Soil compaction test graph using metal heat induction

From Table 1,Table 2 and Fig. 4. it can be concluded that the soil density test using metal heat induction produces a graph of the relationship between soil dry weight and water content. This graph is similar to the soil compaction graph using dynamic loads. Regarding the actual value resulting from a soil density test using heat induction, it is necessary to carry out repeated tests with different soil samples with the results needing to be compared with conventional soil density testing.

4 Conclusion

From the results of initial tests on soil density using heat induction from metal, the results show that the soil density graph is similar to the soil density graph produced from conventional light and heavy soil density tests (ASTM D689 and ASTM D1557). To produce accurate test values, it is necessary to carry out further tests using soil samples from other locations, and the values obtained are compared with conventional density test values which are usually carried out.

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