

# Effect Of Air And Oven Drying Methods On Soil Plasticity

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## Abstract

Atterberg Limits were initially defined in 1911, by Albert Atterberg, a Swedish scientist. Their purposes are to classifying cohesive soils and determine engineering properties of soils. Atterberg limits include liquid limits, plastic limits, and shrinkage limits. The standard method of determination of Atterberg limits are stated in ASTM Standards. According to ASTM, all the soils tested by Atterberg limits should be oven dried, it is because drying the soils in different degree will alter their properties significantly. Some of the physical properties of soils will undergo changes that appear to be permanent. Therefore, the soil samples should be in natural or air-dried form. However, in reality, due to time constraint and other factors, many will run the tests by using soil samples that are prepared by oven drying method. They assumed there is no difference between the results of two types of drying method. However, the truth is, the properties of soil will be affected and thus give a misleading result. The objective of this study is to determine the effect of two drying methods, air-drying method and oven drying method, on the soil plasticity. Six soil samples from different cities were tested. These tests include sieve analysis, specific gravity test, hydrometer analysis, Plastic limit and liquid limit test. Conclusively, the oven drying method could not replace the air-drying method in soil preparation for both Atterberg limits tests.

**Keywords:** Plasticity, Atterberg Limits, Clay

## 1. Introduction

Almost all civil engineering structures are in contact with soil mass or rock. Soil in this case in the undisturbed natural state (in-situ or in-place condition) or artificially placed, for example, under the foundations of the structures of the soil, in general, is in-situ state whereas the back-fill behind the retaining wall is artificially placed. Similarly, soil used in the construction structures (dams, levees,

embankments for roads and railways, airfield etc.) is artificially placed. Irrespective of the fact whether soil is used as a supporting material (under foundations) or as constructional material (in earth structures) in either situations, there is an interaction between the structures and the adjacent soil; and as a result stresses develop in both causing some changes in shape and size of the structure and of adjacent soil mass.

To design stable and durable structures, an engineer must therefore, be able to visualize these changes and forecast their behavior any time. Soil being the natural product is a very complex engineering material and to understand its behavior, study of soil properties is essential. More specifically it is required for:

- Design of foundations
- Stability of slopes and cuts
- Design of earth structures (earth dams, retaining walls, sheet piles etc.)
- Design of roads and airfields

At present times, civil engineers usually depend upon Atterberg limits for the indication of soil characteristics, which is Plasticity. The Atterberg limits are liquid limit, plastic limit and shrinkage limit, and the tests to determine those limits are explained in ASTM standards. Method of drying the soil samples before the tests are carried out have been clearly stated in ASTM standards, it is because drying the soils in different degree will alter their properties significantly. Some of the physical properties of soils will undergo changes that appear to be permanent. Soil can be dried in two different ways, by air or by oven drying technique.

This study is to determine the effect of two drying methods, air drying method and oven drying method, on the soil plasticity.

## **2. Sample Selection**

In this work, our target was to test the clayey soil. So we could get the definite soil plasticity and compare the oven dried and air dried sample. Initially we obtained ten samples from ten different cities. Sites were selected keeping in mind the clay content of soil. Field test were performed on these samples in search of the clayey soil. Out of ten, six samples from cities, i.e Lahore, Sialkot, Murree, Faisalabad, Rawalpindi and Nandipur were selected. Samples varied in clay content from high to low plastic clay. Several tests were carried out to find the clay content later. Once the site was selected, sample was obtained at the depth of 1m from the surface. Samples were immediately put in zip-loc bags so that they retained their moisture until ready for the laboratory testing.

## **3. Research Methodology**

As mentioned earlier, six different samples were obtained from six different cities. Approximately, each sample weighed 5 kgs. These samples were split in two halves for oven and air-drying respectively. Oven drying procedure in ASTM D2216-71 was adopted for oven drying of the sample. Sample was put in the oven at 105° C and left overnight. For Air Drying, Soil was exposed to sunlight for whole day and moisture content was determined. This process was repeated until soil start giving constant moisture content and soil had no more moisture to be eliminated.

The main concern of this work was to find the atterberg limits. However, other tests like Specific Gravity, Sieve Analysis, Hydrometer Analysis were also carried out. Specific Gravity test helped in the confirmation of soil type whether it was clay or not. As Clay was our required material. Further, it helped later on in better analysis of the results.

Sieve and Hydrometer Analysis were carried out letter to find out the composition of the soil sample. Which further elaborated the plastic behavior of these soils as they contained clay content. In last, Atterberg limits were determined, which gave the ultimate idea of plastic behavior. Above tests were

performed on both air and oven dried samples. Results of the laboratory testing are displayed with the help of Graphs and are compared.

#### 4. Presentation and Analysis of Results

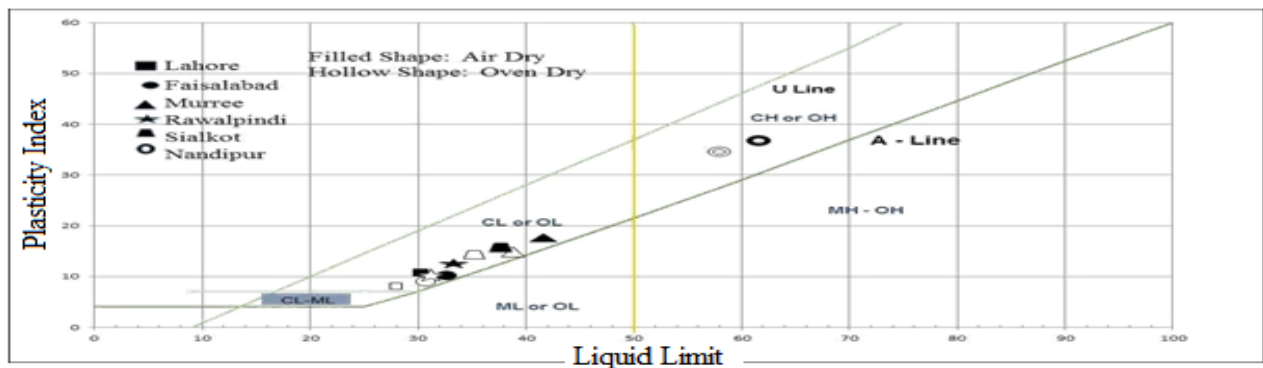
Results are displayed in tabular form as well as represented with the help of graphs. Oven dried samples are compared with air dried samples. Results of each sample are made in tabular form and corresponding graphs are also presented. Comparison graphs of air dried and oven dried samples of each sample are presented. Results of various samples are presented in the sequence of tests performed. For the better understanding and comparison of results, same graph of different samples are accumulated in one graph. Further, an effort is made to put the oven and air dried sample results collectively on same graph.

**Table 1: Atterberg's Limits**

Samples	Oven Dried				Air Dried		
	Specific Gravity	Liquid Limit (%)	Plastic Limit (%)	Pasticity Index (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
Lahore	2.66	26.5	19.36	7.14	30.1	19.44	10.66
Murree	2.72	39.7	23.12	16.58	42.5	23.82	18.97
Sialkot	2.68	35.49	21.27	14.22	36.9	21.47	15.43
Faislabad	2.68	31.1	22.01	9.09	32.2	22.1	10.1
Rawalpindi	2.72	30.8	20.83	10.07	33.5	21.4	12.1
Nandi Pur	2.78	58	23.5	34.5	61	24.36	36.64

**Table 2: Sieve and Hydrometer Analysis**

Sample	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay
Lahore	0	0	0	3%	9%	60%	28%
Muree	0	0	0	1%	8%	50%	41%
Sialkot	0	0	0	1%	6%	56%	37%
Faislabad	0	0	0	1%	9%	55%	35%
Rawalpindi	0	0	0	1%	7%	58%	34%
Nandi Pur	0	0	0	2.16%	9.84%	45%	43%



**Figure 1: Grain Size Distribution**

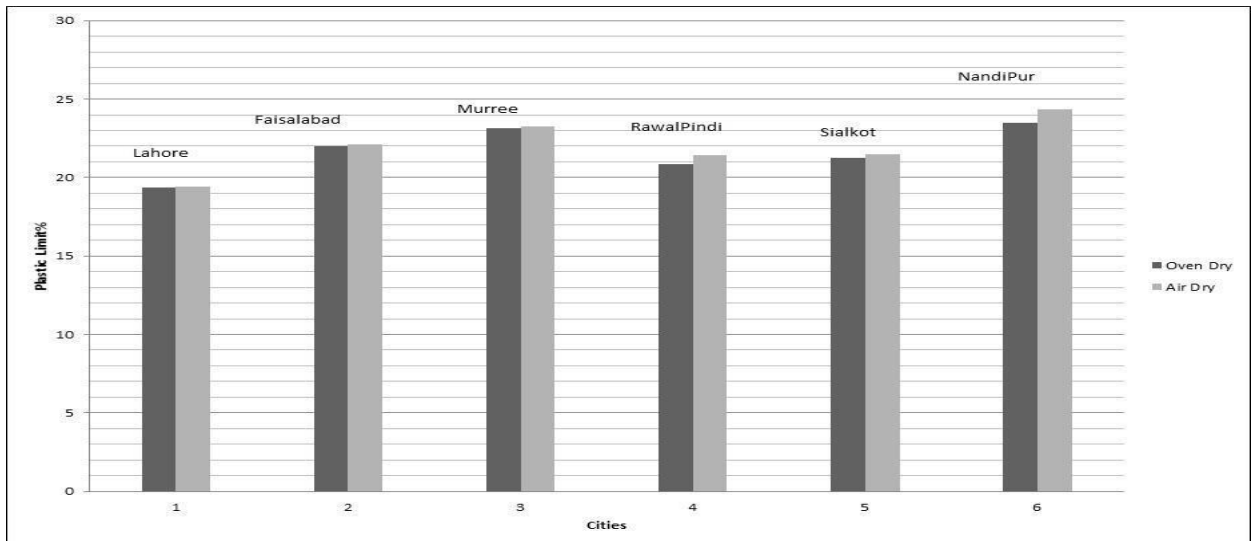


Figure 3: Plasticity Index of Selected Cities

## 5. Interpretation of Results and Conclusion

In addition to the other testings, soil samples were also classified using unified soil classification system. Soil classification is shown in Figure 3. All the sample fell into CL category except Nandipur sample which came out to be CH. The plastic limit and liquid limit tests value obtained from two drying method are different, the liquid limit of oven dried soil samples are lower than the liquid limit of air dried samples. Due to the different value of the plastic limit and liquid limit, the plasticity indexes of samples determined are different, and thus results in different subgroups in classification. Plasticity index as shown in figure 4 is more for air dried samples as compared to the oven dried sample. From the results of Atterberg limit test, it is proved that the oven drying method could not be used to replace the air drying method in preparation work of Atterberg limit tests. Oven dried sample showed decreased plasticity. The reason for that is organic matter were burnt during the overnight drying process in the oven. Moreover, minerals present in soil were largely affected by the oven burning.

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## REFERENCES

- [1] Dr. Aziz Akbar, M. Siddiqui Qureshi, "Soil Mechanics".
- [2] Whitlow, R, "Basic Soil Mechanics" 1990.
- [3] Scott, CR, "An Introduction to Soil Mechanic and Foundations"
- [4] Donald Steila, Thomas E. Pond, • "The Geography of Soils: Formation, Distribution, and Management".
- [5] Joe Boris Dixon, Sterling Barg Weed, Richard C. Dinauer, • "Minerals in Soil Environments"
- [6] D.L. Shah, A.V. Shrof, "Soil Mechanics and Geotechnical Engineering"
- [7] F.Bargaya and G. Lagacy, "Handbook of Clay Science"

- [8] Wai-Fah Chen, "Limit Analysis and Soil Plasticity" R.O. Davis, A.P.S Silvadurai, "Plasticity and Geomechanics
- [9] ASTM D2487 – 11, "Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)".
- [10] ASTM D421 - 85(2007), "Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants".
- [11] ASTM D4318 - 10e1, "Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils".
- [12] ASTM D5550 – 06, "Standard Test Method for Specific Gravity of Soil Solids by Gas Pycnometer".