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EXTENDED ABSTRACT

Comparison of Liquid Limit Obtained From Casagrande Cup Method and Cone Penetrometer for Sand and Clay Mixed Soils

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Liquid limit, Sand, Bentonite, Casagrande, Cone penetration.

1. Introduction

The behavior of the cohesive soil depends on many factors. Atterberg limits play an important role in the evaluation and classification of clays. In this paper, the relationship between the Liquid limit of the cone penetrometer methods and Casagrande cup of sand and clay mixed soils has been evaluated.

The main purpose of this study is to compare the Liquid limit values obtained from the hard-base Casagrande device with the cone penetration method and to present the relationship between the Liquid limit values obtained from the two methods in terms of the percentage of sand in the mixed soil.

2. Materials and methods

2.1. Sandy soil

The sand used in this research is type 161 sand from Firuzkoh region, which is classified as poorly graded sand (SP) based on the unified classification of soils.

2.2. Clay soil

The soil used in this research is the ground bentonite clay of Semnan city.

Liquid limit test based on Casagrande method

According to the ASTM D4318 standard, the Etterberg range of the soil was determined.

Liquid limit test based on cone penetration method

In standard BS1377, a small stainless steel cone is used.

3. Results and discussion

3.1. Comparison of liquid limit obtained from Casagrande cup method and cone penetrometer

In Fig. 1, the comparative diagram of the changes in liquid limit obtained from the cup and cone penetration devices is shown.

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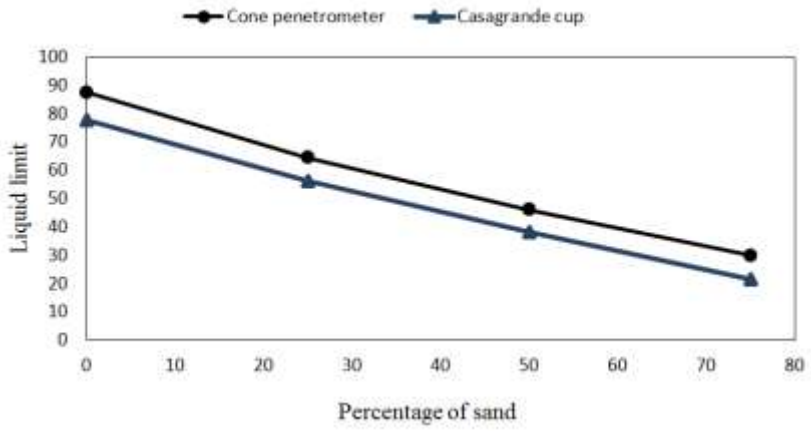

Fig. 1 Comparison chart of liquid limit to percentage of mixed soil sand in cone and cup penetration tests

The relationship between the liquid limit obtained from the experiments is as follows:

$$LL_{cone}=1.022LL_{cup}+7.58 \quad (1)$$

In this regard, LL_{cone} the liquid limit is obtained from the cone penetration device and LL_{cup} the liquid limit is obtained from the Casagrande device.

Previous studies of the index properties of clay and sand mixture indicate a linear decrease in the liquid limit with the increase in the amount of sand (Seed et al., 1964; Nagaraj and Morthy, 1987; Tan et al., 1994). In the research of Ur Rehman et al. (2020), the liquid limit obtained by the cone method was about 16% higher than that of Casagrande.

For the liquid limit of the Casagrande cup equal to 50, the value of the liquid limit resulting from the relationship in the cone method for this research is equal to 58.68. In Table 1, the liquid limit values obtained from the relationships of different researchers for the liquid limit of the Casagrande Cup equal to 50 are presented.

Table 1. Comparison of the liquid limit of the cone method of this study with previous researches for the liquid limit of 50

Reference	LL_{cone}	The difference amount
Kollaros (2016)	53.98	4.7
El-Shinawi (2017)	51.14	7.54
Prakash & Sridharan (2019)	55.95	2.73
Snyder & Vázquez (2021)	50.07	8.61

4. Conclusions

The concept of plasticity property is used in many fields of engineering and science. The main focus of this article was to investigate the psychological limit relationship between the experiment performed by the Casagrande device and cone penetration. Based on the results obtained from the present research, the following conclusions can be made about the liquid limit of mixed soil.

1) The liquid limit value obtained from the Casagrande test device for bentonite clay was 78. As the amount of sand increases, the slope and width from the origin of the moisture percentage line decreases according to the number of blows.

2) As the percentage of sand increases, the liquid limit decreases, while the relationship of the liquid limit in terms of sand percentage is linear and the coefficient of determination (R^2) is equal to 0.997.

3) The liquid limit value obtained from bentonite clay cone penetration testing device is equal to 87.As the amount of sand increases, the slope and width from the origin of the moisture percentage line decreases according to the amount of penetration.

4) The diagram of changes in liquid limit according to the percentage of sand obtained from the cone penetration device is linear and the value of the coefficient of determination is 0.999.

5) As the liquid limit of the mixed soil decreased, the difference between the results of the two test devices increased. In other words, as the plasticity property of the mixed soil increases, the difference between the liquid limit obtained by the two methods decreases.

6) For mixed soils of sand and clay with low plasticity properties, the liquid limit values of the cone penetration method are usually higher than the values of the Casagrande cup method.

Since the liquid limit is one of the important factors in the classification of soil engineering and has a great impact on soil behavior in compaction, road construction, dam construction, improvement and other soil operations, therefore, accurate determination of the plasticity properties of mixed soils is very important. Therefore, in order to gain a more detailed insight into the effect of sand on the pasty properties of clay, it is suggested to carry out other laboratory researches to determine the effect of sand and clay mixed soil granulation on the liquid limit obtained from Casagrande cup method and cone penetration.

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