International Journal of Innovative Research in Engineering & Management (IJIREM)
ISSN: 2350-0557, Volume-9, Issue-2, April 2022
https://doi.org/10.55524/ijirem.2022.9.2.66
Article ID IJIR-2269, Pages 427-429
www.ijirem.org

Marsh funnel Test as an Alternative for Determining Liquid Limit of Soil

Henna Khurshid[1], and Brahamjeet Singh[2]

[1]M.Tech. Scholar,Department of Civil Engineering, RIMT University Mandi Gobindgarh, Punjab, India
[2]Assistant.Professor, Department of Civil Engineering, RIMT University Mandi Gobindgarh,, Punjab, India

Correspondence should be addressed to Henna Khurshid; henna786.hk@gmail.com

ABSTRACT- The liquid limit of a soil is a fundamental index property that is routinely used in engineering practice to predict the behavior of cohesive soils. The Casagrande and fall cone test methods are the standard methods used to determine liquid limit. However, these methods require significant sample preparation, are time-intensive, and are subject to a range of errors dependent on the experimenter's technique and experience. The study presented here investigates the feasibility of an alternative method for determining the liquid limit of soil. The nature of the definition of liquid limit suggests a relationship between viscosity, a mechanical fluid property, and the liquid limit. Accordingly, this study investigates the relationship between liquid limit, determined by Casagrande method, and the Marsh Funnel viscosity. The Marsh Funnel viscosity test produces an indicator of absolute viscosity by observing the time required for a fluid to flow through a calibrated funnel. Four different types of soil were prepared at a range of successively decreasing moisture contents. The liquid limit of the material was taken as the moisture content at which the Marsh Funnel viscosity approached infinity (stopped flowing). This value was then compared to the liquid limit determined using the Casagrande method in order to make preliminary conclusions regarding the suitability of using the Marsh Funnel test as an alternative method to determine liquid limit.

KEYWORDS- Marsh funnel, liquid limit,soil, Optimum Moisture Content, Shear strength.

I. INTRODUCTION

The liquid limit is one of the index properties of cohesive soils which is used extensively by geotechnical engineers[1]. It is used for the classification of fine grained soils, as well as a correlative parameter in preliminary estimation of many physical and engineering properties[2]. There are two methods at present to determine liquid limit of soils: 1) percussion method and 2) cone penetration method[3]. The percussion method (or Casagrande's falling cup method) is included in ASTM standards (ASTM Designation D4318) and is still used in much of the world[4]. Johnston and Strohm (1968), Wroth and Wood (1978), Whyte (1982), Lee and Freeman (2007), Kayabali and Tufenkci (2010), and Haigh (2012), determined many limitations and uncertainties in the Casagrande method[5]. These limitations and uncertainties included material, dimensions and weight of the cup, soil type, frequency of drops, the tendency of the halves to slide together, the migration of water in dilatant soils, and operator judgment for closure length of the groove[6-7]. In this paper a comparative study is conducted on four different types of soils, two of them being essentially Kaolinite, one Montmorillonite, and one natural soil (possibly Illite), by using the Casagrande method along with the Marsh Funnel Viscosity method[8-9].

II. MATERIALS

All soil samples, were sieved through #40 mesh prior to conducting the conventional and newly proposed methods of liquid limit tests[10]. In addition, these soils were chosen due to the differences of clay mineralogy (Kaolinite, Illite, and Montmorillonite), and their liquid limit governing mechanism.

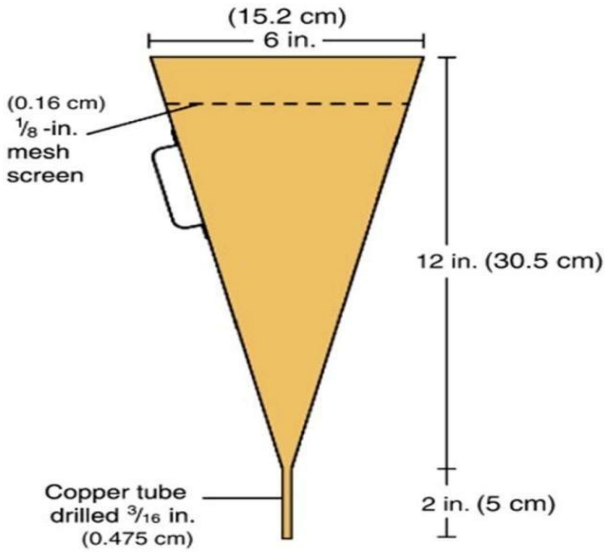

Figure 1: Marsh Funnel

Table 1. Physical properties of soil used in the present study

Soil no	soil type	LL	PL	PI	(%)	(%)	(%)
1	100% K	62	33	29	0	0	100
2	20% K,	28	18	10	40	40	20
3	10% B,	61	22	39	45	45	10
4	Natural Soil	43	20	23	80.32	6.2	12.9

III. METHODOLOGY

The apparatus used in this investigation essentially consisted of a commercially available Marsh Funnel (FIG.1) [11]. The Marsh Funnel viscosity ASTM D6910, is reported as seconds and used as an indicator of the relative consistency of fluids ASTM D6910-04 is updated in 2009 to ASTM D6910/D6910M and there is no changes in the test procedure or the funnel cone size[12]. ASTM D6910/D6910M requires that either the values stated in SI units or English units must be regarded separately as standard[13]. Because the values stated in each system may not be exact equivalents. Therefore each system shall be used independently[14]

As in the Marsh Funnel test, each soil sample of 1000 grams weight (consisting of the - #40 sieve fraction) was put into a plastic jar[15]. A sufficient amount of distilled water was added and carefully mixed with a spatula until the point where the soil mass could be slowly poured out of the jar Care was taken that the soil was not so wet as to have free water on the surface when standing[16]. The samples were allowed to stand in the capped jars for 16 to 24 hours at temperature 27o ± 2o C. Table 1 shows the Physical properties of soil used in the present study

IV. RESULTS AND DISCUSSIONS

The Marsh Funnel Viscosity versus water content, obtained in the Marsh Funnel test for four different soil types[17]. The Marsh Funnel Viscosity (MFV), of the four different soils identified in Table 2, was determined at various water contents (w). All water contents exceeded the Casagrande liquid limit of the soil[18]. Based on the slope and the curve type, the first degree of rational trend-line was assumed to be more reliable to determine proposed liquid limit (LLp). The data can be fitted quite well (regression coefficient ranges from 78% to 98%) by rational function expressed as

$$LLp = \lim_{MFV \to \infty} a.MFV+b\ MFV+c$$

Analyzing the results obtained by the Marsh Funnel method can be observed that for the tested soil, the liquid limit would be higher than that determined by Casagrande method, approximately three times [19]. Finally these observations indicate that the clay mineral type and its proportion in the clay content are responsible for marsh funnel method giving a higher value of liquid limit[20].

IV. CONCLUSIONS

The March Funnel tool is introduced as an alternative tool to determine the Atterberg limits on a more rational and quantifiable basis. The empirical equations based on the experimental data from four soil samples help determine the liquid limit with a degree of accuracy. Results from this experimental investigation done on four different soils, two of them being essentially kaolinite, one possibly illite, and one montmorillonite indicate that the liquid limit obtained by Marsh funnel are observed to be three times higher than percussion method irrespective of the clay mineral type present in the soil In this method both the viscous shear resistance and frictional shear resistance seems to work simultaneously and depending on the type of clay mineral being present in the soil, that particular mechanism dominates and becomes the controlling mechanism. Seeing the outcomes it can be suggested that the marsh funnel can be used for determining consistency limits.

REFERENCES

[1] ASTM. 2010. Standard test methods for liquid limit, plastic limit, and plasticity index of soils. ASTM standard D4318-10. American Society for Testing and Materials, West Conshohocken, PA, USA.

[2] ASTM. 2009. Standard test method for Marsh Funnel viscosity of clay construction slurries.

[3] Mechanics of the Casagrande liquid limit test. Canadian Geotechnical Journal, 49, 1015-1023.

[4] Determination of plastic and liquid limits using the reverse extrusion technique. Geotechnical Testing Journal, 33 (1), 14-22.

[5] Raina, S.S., Singla, E.S. and Batra, D.V., 2018. Comparative analysis of compressive strength and water absorption in bacterial concrete. International Journal of Engineering Development and Research, 6(3), pp.281-286.

[6] Bhatta, D.P., Singla, S. and Garg, R., 2022. Experimental investigation on the effect of Nano-silica on the silica fume-based cement composites. Materials Today: Proceedings.

[7] Singh, P., Singla, S. and Bansal, A., 2021. Evaluation of Land Use and Land Cover Transformation and Urban Dynamics Using Multi-Temporal Satellite Data. Geodetski list, 75(3), pp.257-279.

[8] Kumar, A., Singla, S., Kumar, A., Bansal, A. and Kaur, A., 2022. Efficient Prediction of Bridge Conditions Using Modified Convolutional Neural Network. Wireless Personal Communications, pp.1-15.
[9] Singh, A., Singla, S. and Garg, R., 2020, November. Performance analysis of Papercrete in presence of Rice husk ash and Fly ash. In IOP Conference Series: Materials Science and Engineering (Vol. 961, No. 1, p. 012010). IOP Publishing.
[10] Ashraf, S., Kaur, S. and Singla, S., 2022. Water Quality Assessment of Anchar Lake, Srinagar, India. Civil and Environmental Engineering Reports, 32(1), pp.88-115.
[11] Ahmad, Uzair. (2018). A Study on Effect of Polymers on the Properties of Vg-10 Grade Bitumen. International Journal for Research in Applied Science and Engineering Technology. 6. 2572-2576. 10.22214/ijraset.2018.4433.
[12] Singh, J., Singh, B. and Singla, S., Enhancement of Expensive Soil by Addition of Stone Dust and LDPE Fibre.
[13] Singh, P. and Singla, S., 2023. Estimation of Land Surface Temperature of Srinagar City, India Using Landsat 8 Data. Sustainability, Agri, Food and Environmental Research, 12(1).
[14] Irshad, U and Singla, S.,2019 "Impact of Road Conditions on Traffic Management-A Case Study of Chenab Valley." International Journal of Scientific & Technology Research 8 1179-1186.
[15] Kumar, V., Singla, S. and Garg, R., 2021. Strength and microstructure correlation of binary cement blends in presence of waste marble powder. Materials Today: Proceedings, 43, pp.857-862.
[16] Garg, R., Garg, R. and Singla, S., 2021. Experimental Investigation of Electrochemical Corrosion and Chloride Penetration of Concrete Incorporating Colloidal Nanosilica and Silica fume. Journal of Electrochemical Science and Technology, 12(4), pp.440-452.