Zones of Compressibility in the Modified Plasticity Chart

by
S. K. Chakraborty*

Introduction

IT is a feeling of experienced research workers that properties of Atterberg limits are of somewhat empirical in nature. Strictly speaking, it is not easy to explain their true physical behaviour in heterogeneous materials like soils. Many soil experts ignore these properties and others determine their values for all silty and clayey soils which are, in turn, used on many important projects. A. Casagrande used the Atterberg limits as an aid for the identification of soils in the airfield soil classification. Plasticity index is a good measure of the degree of plasticity of soils, and a number of State Highway Departments have regulations relative to the maximum plasticity index that is to be permitted in certain types of highway fills. Definite applications of plasticity indices and liquid limits have been developed in large number of cases. The identification and classification of soils with the help of plasticity chart presented by Casagrande, is already existing. The use of the unified soil classification system by U.S.B.R., had been discussed (Wagner, 1957). Presently, under the growing importance of identification of soils with the aid of plasticity chart, the author feels that a modification of this chart has become essential to certain extent. The presented modified plasticity charts have been drawn mainly after collection of sufficient data from laboratory tests at Mesra, Ranchi and properties of most soils published in the Proceedings of International Conferences on Soil Mechanics and Foundation Engineering. The main aim of these charts is to show (*i*) zones of compressibility which are not assumed to be well defined in the existing plasticity chart, (*ii*) approximate behaviour of soils when plotted between P.I. and L.L.

Analysis of Plasticity Charts

In the given charts, there are four divisions in general, namely :

(*a*) soils of low compressibility, whose liquid limits varying from 0 to 50 percent as shown in Figure 1 (*a*) ;

(*b*) soils of medium compressibility, whose liquid limits varying from 50 to 75 percent as shown in Figure 1 (*b*) ;

(*c*) soils of high compressibility, whose liquid limits varying from 75 to 100 percent as shown in Figure 1 (*c*) ; and

(*d*) soils of very high compressibility, mostly clays, whose liquid limits varying from 100 to 750 percent as shown in Figure 1 (*d*).

*Department of Civil Engineering, Birla Institute of Technology, Mesra, Ranchi (Bihar).

This paper in the present form was received on 7 July 1972. It is open for discussion up to June 1973.

The above divisions have been done in the broader sense of the term, covering almost all types of soils present in nature.

In Figure 1 (*a*), an average Line *C* has been plotted and above the Line *C*, the zone *ABC* contains soils of slightly inorganic, silts of very low plasticity and sandy soils.

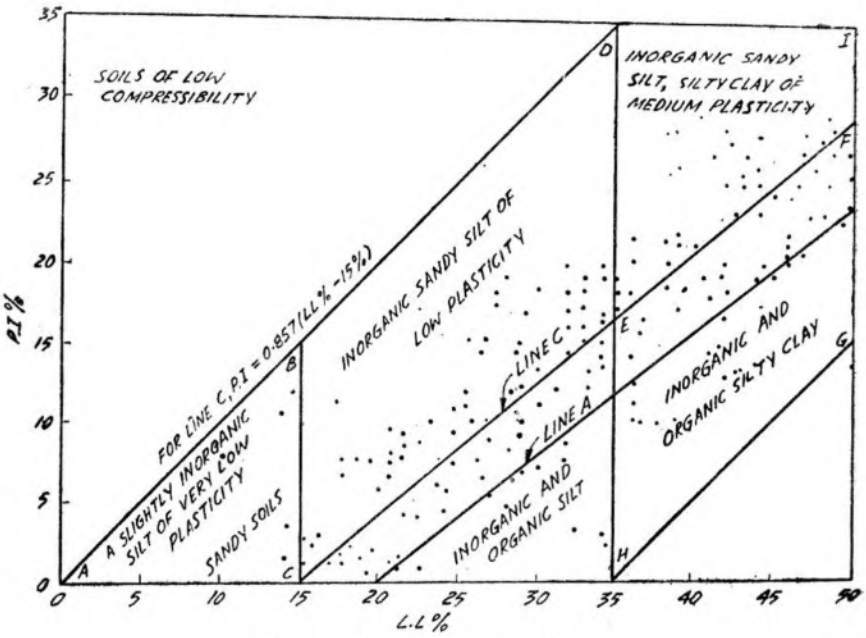

FIGURE 1(a) : Plasticity chart.

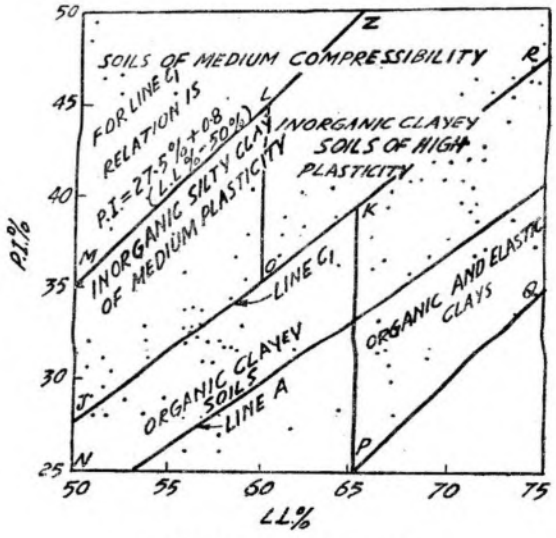

FIGURE 1(b) : Plasticity chart.

BCDE—inorganic sandy silt of low plasticity,

DEFI=inorganic sandy silt and silty clay of medium plasticity.

Above the Line *C*, soils will be strictly called soils of low compressibility. Below the Line *C*, *CEH* contains soils of low to medium compressibility and *EFGH* will contain soils of medium compressibility with P. I. varying from 15 to 28 percent. *EFGH* contains less of inorganic soils and more of organic silty clay with medium degree of expansion (Earth manual, 1960). Casagrande's Line *A* is also shown in Figure 1 (*a*) for the sake of comparison. The equation of Line *C* is P. I.=0.857 (L.L.15%).

In Figure 1 (*b*), an average Line C_1 has been plotted and above the Line C_1, the zone *MLOJ* contains soils of inorganic silty clay of medium plasticity, and soils in *MLOJ* will be strictly called soils of medium compressibility. *OLZR contains inorganic* clayey soils of high plasticity and in this zone L.L. of soils above 65 percent will contain soils of medium to high compressibility and high plasticity because of the presence of colloidal content varying from 20 to 31 percent. Below the Line C_1,the zone *JNKP* contains organic clayey soils and soils in this zone will be strictly called soils of medium to high compressibility with P. I. varying from 25 to 41 percent. *KPQR* contains organic and elastic clays,

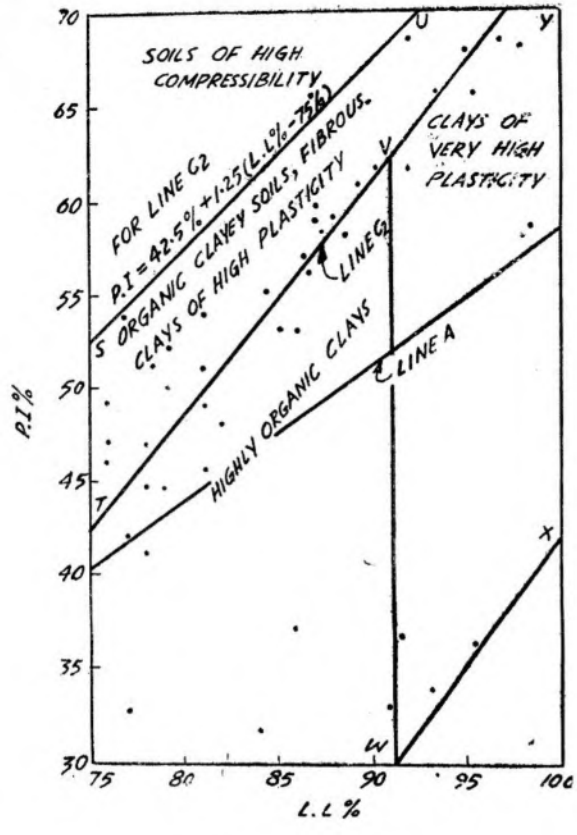

FIGURE 1(c) : Plasticity chart.

and soils in this zone will be strictly called soils of high compressibility with high degree of expansion. Casagrande's Line *A* is also shown in Figure 1 (*b*) for the sake of comparison.

In Figure 1 (*c*), an average Line C_2 has been plotted and above the Line C_2, the zone *SUYT* contains organic clayey soils, fibrous clays of high plasticity and high compressibility. Below the Line C_2, soils within *TVW* contains high organic content and soils in this zone will be called soils of high compressibility. *VWXY* contains clays of very high plasticity whose P.I. is higher than 35 percent and colloidal content higher than 28 percent with a very high degree of expansion, and soils in this zone will be strictly called soils of very high compressibility. Only few types of soils fall into this zone.

In Figure 1 (*d*), clays of very high compressibility, very high plasticity, montmorillonite, bentonites, and peat clays are plotted. Only a special type of few soils fall into this category. Swelling clays with very high degree of expansion will be strictly called highly compressible soils. Line C_3 approximately denotes soils of highly compressible nature whose L. L. are greater than 100 percent.

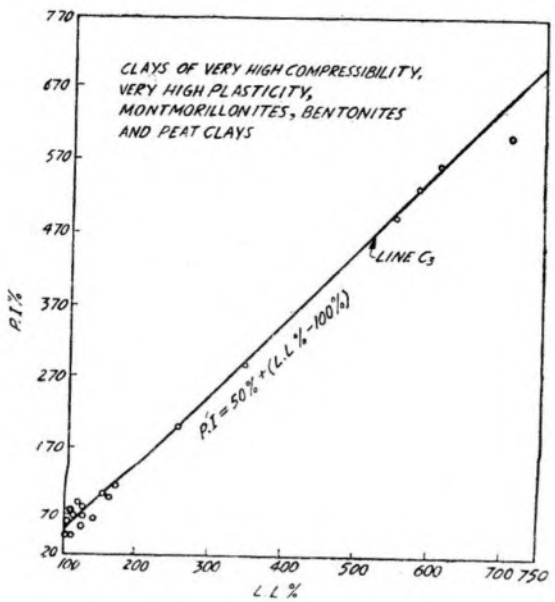

FIGURE 1(d) : Plasticity chart.

Conclusions

The presented charts will help defining soils of different degree of compressibility and approximately plotted lines for various types of soils. These charts have accommodated nearly all types of soils present in nature as falling into their definite zones of various compressibility characteristics.

Acknowledgement

The author is thankful to the authorities of Birla Institute of T echnology for due encouragement of research works carried out in the Soil Mechanics Laboratory, Mesra.

References

CASAGRANDE, A. : "Classifications and Identifications of Soils." *Proc. A.S.C.E.*, June 1947.

Earth Manual, U.S.B.R., Denver, Colorado, July 1960.

Proceedings of 2nd, 3rd, 4th, 5th and 6th International Conferences on Soil Mechanics and Foundation Engineering, All Vols. Unified Soil Classification System for Roads, Airfields, Embankments and Foundations. Military Standard, Mil-Std-619A, March 20, 1962, U.S. Deptt. of Defence, Washington 25, D.C.

WAGNER, A. A. : "The Use of the Unified Soil Classification System by B. R. *Proc.*" *4th International Conference on S.M.F.E*, Vol. I, p. 125, 1957.