A Method of Determining Swell Potential of An Expansive Clay

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ABRIDGMENT

•THE SUBGRADE volume change occurring when highway pavements are placed in cut sections is of particular concern in this study. This condition appears to be ideal for swell of subgrade soil since overburden removel reduces the confining pressure in the subgrade while the relatively light pavement structure provides an impermeable ground cover which induces an accumulation of water under the pavement. Such an accumulation probably results from both the interference of normal moisture evaporation and the ingress of surface water made possible by the excavation. This combination of pressure release and moisture increase causes an effective stress decrease in the soil and can cause pavement heave which may be of the order of several inches. When this heave is accompanied by differential movements, the structure will crack.

This study is concerned with the use of the one-dimensional consolidometer test as a method for determining the swell characteristics of an expansive subgrade soil and for predicting its swell potential. Although the method devised is applicable to any expansive soil, it was specifically applied to a stiff, fissured clay shale which serves as subgrade for Interstate 70 northwest of Limon, Colorado. Since completion of this part of Interstate 70 in 1959, the expansive characteristics of this subgrade soil, which is a part of the Laramie formation of eastern Colorado, have resulted in considerable heaving and faulting of the concrete pavement. This distress has been confined to cut sections and pavement heave in these sections has been as great as 1.0 ft in the five years since construction.

It was necessary to design new sampling equipment to obtain satisfactory consolidometer-test samples in this hard, fissured material. The sampler designed contains a series of liners, which enable the test specimens to remain confined in linear rings from time of field sampling until the consolidometer test is completed in the laboratory. Each individual liner ring has the same height as the diametrically enlarged consolidometer ring into which it is fitted. Complete lateral confinement is thus maintained on the specimens during all phases of the sampling and testing procedure; this prevents stress relief accompanied by premature expansion during transfer of the sample into the consolidometer.

A relatively rapid method of determining the expansion characteristics of a soil was developed in which the sample is loaded and unloaded in single increments. This method provides reliable information both for identification and volume change prediction of high volume change soils. The swell curve obtained in this consolidometer test procedure yields not only the swell index as an indicator of swell potential, but is utilized, together with the soil stress changes resulting from overburden removal in construction of the cut, to estimate the portion of surface heave likely to result from this weight removal. The portion of total heave resulting from moisture increase due to pavement cover and/or excavation is obtained in a similar swell test in which the soil is given free access to water while under full overburden pressure. These two laboratory volume changes resulting from pressure release and soil moisture increase are used

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to estimate total surface heave. Such estimation enables the engineer to consider the implications of this movement on the proposed structure, and possibly may provide insight concerning the best means of preventing such movement.

The validity of this method of surface heave prediction can only be established with certainty by comparing a predicted quantity of heave with actual pavement heave at a site where heave prediction is made before highway construction. Such verification has not yet been attempted, since no new Colorado highways on swelling soils are at the proper stage of construction. However, an excellent field check was obtained at the site on Interstate 70 by sampling the highly expansive clay shale below existing pavement level at a point outside the cut slope but close enough to the cut so that soil with the same characteristics was dealt with. The potential heave of the soil lying below cut grade as determined by this method was about 0.6 ft, a value very close to the average measured heave of 0.65 ft which the pavement had undergone at that point in the five years since construction.

By means of this method it is possible to estimate the potential heave of increments of soil at any sampling depth. As expected, it was shown in this study that layers of soil immediately beneath the pavement contribute more to heave of the pavement than increments at greater depth. Of the 0.6 ft total potential heave estimated for this site, about 0.24 ft of swell was shown by the consolidometer test method to have derived from the uppermost 10 ft below cut grade; the second 10 ft of soil contributed about 0.13 ft of swell; the third 10 ft contributed about 0.09 ft of swell, etc.