

Abridgment

Settlement Rate Experience for the Use of Sand Drains in a Tidal Marsh Deposit

A. A. Seymour-Jones, Howard Needles Tammen and Bergendoff, New York

Tidal marsh deposits are found over a wide range of coastal areas in the world. Technical publications have noted the results of the use of surcharge and sand drain treatment to stabilize tidal marsh deposits. This paper supplements existing information on settlement rates in tidal marsh deposits and compares it with previously published data.

The use of surcharge treatment and conventional displacement sand drains was utilized to construct two approach roadway embankments over a tidal marsh deposit adjoining a bridge over the Maurice River at Maurice-town, New Jersey. The tidal marsh deposit generally ranges from 7.6 to 15.2 m (25 to 50 ft) in depth and consists of organic silty clay having a Unified Soil Classification System classification of OH. This soil exhibits a relatively wide variation in natural moisture content and compressibility.

The approach embankment heights for the Maurice River project ranged from 1.5 to 4.6 m (5 to 15 ft). The design height of embankment with surcharge ranged from 3.0 to 9.1 m (10 to 30 ft), twice the embankment height. The relatively large surcharge was used to eliminate most of the relatively large anticipated secondary settlement, which is typical of organic soils as well as of the primary settlement. The intent of this design was to obtain 90 percent consolidation of the underlying organic silty clay due to the weight of the embankment and surcharge during a 14-month surcharge period. To obtain this objective, displacement sand drains were used where the depth of tidal marsh deposit exceeded 7.6 m (25 ft) or where the height of embankment with surcharge exceeded 7.3 m (24 ft). The need for sand drains and the required sand drain spacing were based

on the rapid decrease in the coefficient of consolidation with the increase of the average consolidation pressure, as illustrated by the design curve in Figure 1.

The different sand drain spacing used was due to the variation in the coefficient of consolidation associated with the consolidation pressures resulting from the different fill heights and depths of tidal marsh deposit. Sand drain spacings of 3.7, 4.3, and 4.9 m (12, 14, and 16 ft) center to center on a square pattern were used as well as surcharge treatment without sand drains.

Settlement platform data were used to evaluate the field coefficient of consolidation by use of the square root of time versus settlement plot relation. Consolidation by both vertical and horizontal flow, assuming equal permeability in both directions, was used to determine the field coefficient of consolidation.

The calculated values of the coefficient of consolidation of the field data versus the average consolidation pressure are shown in Figure 1 along with the original design curve. It shows much better correlation than the laboratory data had. The field data range from 25 percent below to 50 percent above the design curve.

The effect of the sand drain spacing on the coefficient of consolidation based on the field measurements was evaluated. A plot of the coefficient of consolidation versus sand drain spacing was developed and is shown in Figure 2. Points 1 to 4 are for this project. Points 5, 6, and 7 are based on data from the files of my firm for the other projects that involved the use of surcharge and sand drains in tidal marsh soils.

Published data by others involving the use of surcharge and sand drains in tidal marsh soils were also added and are denoted by points 8 through 29. It should be noted that five of the points (4, 7, 10, 11, and 27) are for surcharge treatment without the use of sand drains. Four other points are for nondisplacement sand drains—points 14 and 24 are for augered sand drains and points 25 and 26 are for jetted sand drains.

The data in Figure 2 exhibit an appreciable variation, but indicate that the coefficient of consolidation decreases with decreasing sand drain spacing. This could be due to the increased disturbance effects caused by a closer sand drain spacing. Figure 1 shows that the consolidation pressure magnitude also affects the coefficient of consolidation, i.e., the higher the consolidation pressure, the lower the coefficient of consolidation.

To evaluate the relative effects of sand drain spacing and consolidation pressure, selected data for points on Figure 2 were replotted showing the coefficient of consolidation versus total consolidation pressure in Figure 3. Points 15, 16, and 17 show a decrease in the coefficient of consolidation with a decrease in sand drain spacing for the same total consolidation pressure as do the points 22 and 23. A comparison of points 22 and 23 with points 24 and 25, which are for the same total consolidation pressure, indicate the potential benefits to be derived from using nondisplacement sand drains. The data indicate that disturbance effects resulting in a lower coefficient of consolidation do occur with decreased sand

Figure 1. Coefficient of consolidation field data.

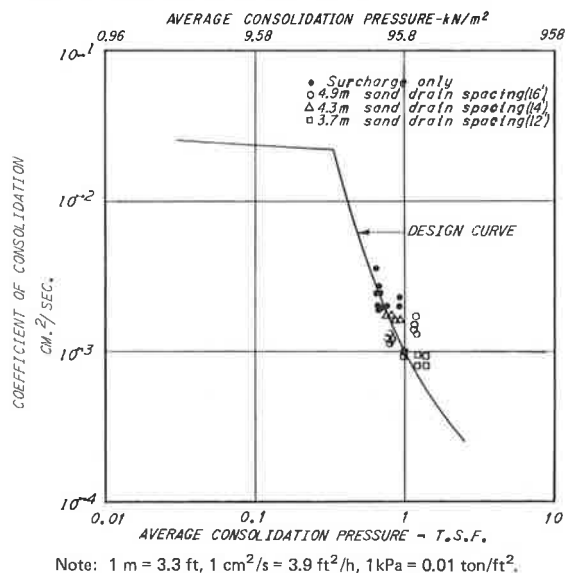
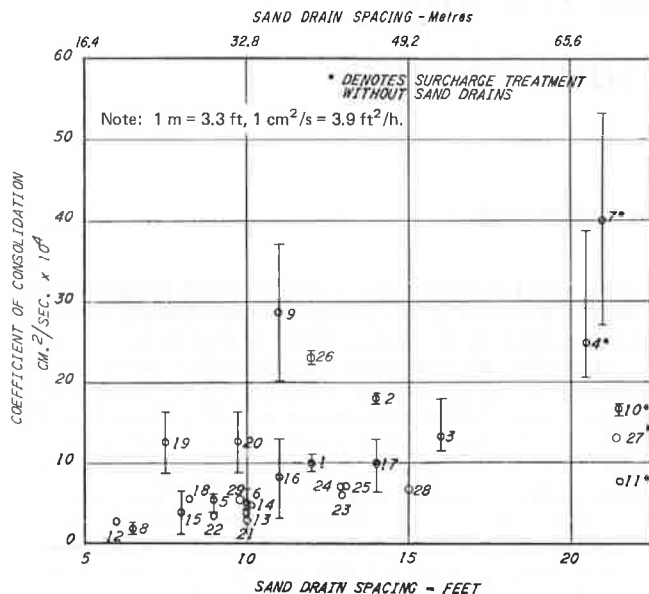


Figure 2. Relationship between coefficient of consolidation field data and sand drain spacing.



drain spacing and nondisplacement sand drains produce a lesser magnitude of disturbance than displacement sand drains.

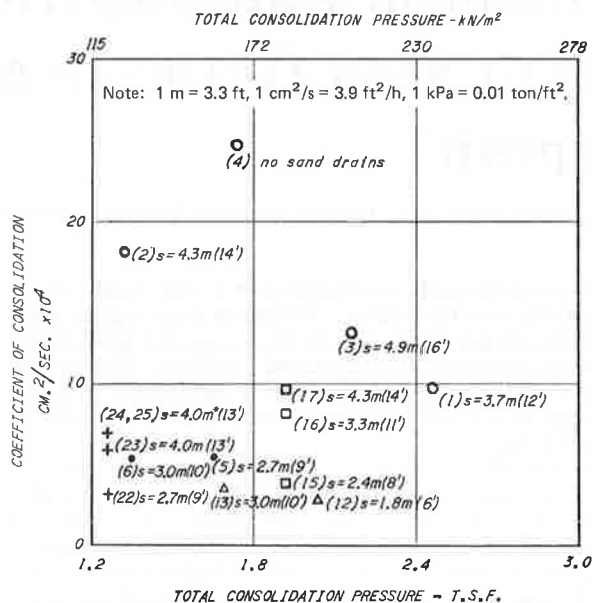
The relatively high coefficient of consolidation for point 4 with respect to points 1, 2, and 3 is probably due to the omission of sand drains for point 4 and the resulting absence of the disturbance effect due to sand drain installation.

Figures 2 and 3 show that in at least some cases the spacing used with conventional displacement sand drains does materially affect the field coefficient of consolidation and thus the field settlement rate. It is possible that for some of the other data the use of closer sand drain spacings resulted from design considerations such as lower laboratory coefficients of consolidation.

This study led to the following conclusions:

1. A review of field settlement platform data showed that the range in the settlement rate was much narrower than that indicated by the laboratory test data.
2. The field settlement data corroborated that, for the design of displacement sand drains in tidal marsh de-

Figure 3. Relationship between coefficient of consolidation field data and total consolidation pressure.



s = 4.9m denotes sand drain spacing.
* denotes auger or wash sand drains used.

posits, the average coefficient of consolidation from conventional laboratory consolidation samples should be used and that any increase in horizontal over vertical permeability should be neglected.

3. The plot of coefficient of consolidation versus sand drain spacing shows a significant trend for a large number of different tidal marsh deposits. For some of these data a closer spacing of conventional displacement sand drains showed a resulting reduction in the coefficient of consolidation as measured from field data and appears to be due to disturbance effects. These data also show that the total consolidation pressure has a marked effect on the field-measured coefficient of consolidation, as would be expected from the laboratory consolidation test data.

Publication of this paper sponsored by Committee on Embankments and Earth Slopes.

The Iowa K-Test

R. L. Handy, A. J. Lutenegeger, and
J. M. Hoover, Department of Civil
Engineering, Iowa State University,
Ames

A simple and rapid laboratory test that uses standard 9.44 cm³ (0.03 ft³) compacted soil specimens for strength comparisons is presented and discussed. The test gives discrete evaluations of undrained c , ϕ , and other strength parameters from single soil specimens. The specimens are subjected to vertical compression while confined in a split steel mold, which acts as a spring, so that spreading of the mold provides a measure of lateral stress. Thus, K , or the ratio of soil horizontal to vertical stress, may be continuously monitored and used to ob-

tain strength parameters and moduli as the test progresses. In addition, a direct measure of soil-to-steel friction as a function of normal stress is obtained. The K-test simulates an undrained, rapid field-loading situation and appears particularly applicable for transportation facilities. This paper presents representative results on several soils, discusses errors in the assumptions, and describes some potential uses of the test for design and control purposes.