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Consolidation Analysis by the Slope and Settlement Rate - Settlement Methods

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ABSTRACT

This paper presents results of consolidation analysis using two recently developed methods for obtaining the coefficient of consolidation (c_v) and the end-of-primary (EOP) settlement δ_p. The first method (the slope method, Al-Zoubi, 2008b) computes c_v and EOP δ_p entirely from the early stages of consolidation at $U \leq 52.6$% using the observed linear section of δ_t-$\sqrt{t}$ plot. The second method (the settlement rate - settlement method: Al-Zoubi, 2010) computes c_v and δ_p entirely from the later stages of consolidation at $U \geq 52.6$% using the observed linear section of settlement rate - settlement curve (i.e., $d\delta_t / dt$ - δ_t curve). Extensive experimental results of oedometer tests on four clayey soils show that the two methods give quite similar c_v and δ_p values that are also in good agreement with those of the Casagrande method. These results also show that the Taylor method c_v values are generally lower than those of the slope, settlement rate – settlement and Casagrande methods.

KEYWORDS: Coefficient of consolidation, End of primary settlement, Rate of settlement, Taylor, Casagrande, Preconsolidation.

INTRODUCTION

The Terzaghi one-dimensional consolidation theory is still widely used along with the results of oedometer tests in evaluating the consolidation characteristics of soils needed for predicting settlement and rate of settlement of structures founded on soils. The use of the Terzaghi theory in settlement analysis requires determination of the coefficient of consolidation c_v and end-of-primary (EOP) settlement δ_p. Depending on some similarities between the Terzaghi theoretical U - T relationship (where U is the average degree of consolidation and T is the time factor) and the experimental δ_t - t curve (where δ_t is the settlement at time t during consolidation) expressed in different forms, many techniques have been developed for obtaining c_v and EOP δ_p. The δ_t - log$t$ method (Casagrande and Fadum, 1940) computes c_v at 50% consolidation; this method requires the determination of the initial and final compressions corresponding to 0% and 100% consolidation, respectively. The δ_t - $\sqrt{t}$ method (Taylor, 1948) calculates c_v at 90% consolidation and requires the determination of the initial compression that corresponds to 0% consolidation. Based on the δ_t-log t curve, the inflection point method was also developed (Cour, 1971; Robinson, 1997; Mesri et al., 1999a). This method, which does not directly require determining the initial nor the final compressions, computes the coefficient of consolidation using the time at which an inflection point is observed in the S- shaped δ_t - log t curve; this inflection point corresponds to about 70% consolidation on the Terzaghi U - log$T$ relationship.

Each of the aforementioned existing methods determines c_v at a specified U value that varies depending on the method being used. However, other

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methods are also available that compute c_v over a range of U. The rectangular hyperbola method (Sridharan and Rao, 1981; Sridharan et al., 1987) determines c_v assuming that the T/U - T curve is linear over the range $60 \le U \le 90$ %; this method utilizes both the slope and intercept of the corresponding experimental linear segment for obtaining c_v. The velocity method (Parkin, 1978; Parkin and Lun, 1984) computes c_v by matching the initial linear section of the experimental $\log d\delta_t / dt$ - $\log t$ and theoretical $\log dU/dT$ - $\log T$ plots to obtain a scale relationship between the real time t and the dimensionless time T. It should be pointed out that other methods are also available for obtaining the coefficient of consolidation and end of primary settlement (e.g., Scott, 1961; Sivaram and Swamee, 1977; Asaoka, 1978; Robinson and Allam, 1996; Robinson, 1999; Feng and Lee 2001; Singh, 2007; Al-Zoubi, 2008b).

Generally, different values for the coefficient of consolidation and end of primary settlement have been reported by the various existing methods. For example, the c_v values obtained by the Taylor method are generally higher than those obtained by the Casagrande method (Lambe and Whitman, 1969; Hossain, 1995; Sridharan and Prakash, 1995; Robinson, 1999). The rectangular hyperbola method gives c_v values that essentially lie in between those of the Taylor and Casagrande methods (Sridharan et al., 1987). The c_v values computed by the inflection point method are quite similar to those of the Casagrande method (Mesri et al., 1999a). The velocity method gives c_v values that are close to those of the Taylor method (Parkin and Lun, 1984). These observed differences in the c_v values were attributed in the literature to either the effect of the initial compression or influence of the secondary compression or both (e.g., Parkin, 1978, 1981; Parkin and Lun, 1984; Mesri et al., 1999a; Feng and Lee, 2001) because these methods compute the coefficient of consolidation at different stages of consolidation (i.e., different U values) and therefore these methods are differently affected by the initial and secondary compressions.

However, this paper presents and compares results of consolidation analysis using two recently developed methods for obtaining c_v and EOP δ_p. The first method (the slope method, Al-Zoubi, 2008b) computes c_v and δ_p entirely from the early stages of consolidation at $U \le 52.6$ % using the initial linear section of the observed δ_t - $\sqrt{t}$ plot. The second method (the settlement rate - settlement method, Al-Zoubi, 2010) computes c_v and δ_p entirely from the later stages of consolidation at $U \ge 52.6$ % using the linear section of the observed $d\delta_t / dt$ - δ_t plot. This study shows that these two methods give quite similar c_v and δ_p values that are also in good agreement with those of the Casagrande method. This study also shows that the differences in the c_v estimates using the existing methods can be explained by the differences in the EOP δ_p estimates and might not necessarily be due to the effects of the initial and secondary compressions.

The Slope Method

The slope method is based on a fitting procedure in which the slope of the linear segment of the observed δ_t - $\sqrt{t}$ curve is fitted to the corresponding slope of the Terzaghi U - $\sqrt{T}$ relationship. According to Terzaghi (1943), the initial linear section of the theoretical U - $\sqrt{T}$ relationship may be "almost exactly" expressed for $U \ge 52.6$ % by the following equation:

$$U = M\sqrt{T} \tag{1}$$

where M is the slope of the initial linear segment of the theoretical U - $\sqrt{T}$ relationship; M is constant and equal to 1.128.

Similarly, the initial linear segment of the experimental δ_t - $\sqrt{t}$ curve may be expressed as follows:

$$\delta_t = m_1\sqrt{t} \tag{2}$$

where m is the slope of the initial linear section of the experimental δ_t - $\sqrt{t}$ curve and δ_t is the settlement at time t during consolidation and is equal to $R_t - R_o$; R_o is the dial reading corresponding to 0% consolidation and R_t is the dial reading at time t.

In the Terzaghi theory, the consolidation time t is defined in terms of time factor T, longest drainage path H_m and coefficient of consolidation c_v as follows:

$$t = \frac{T\,H_m^2}{c_v}. \tag{3}$$

On the other hand, the settlement δ_t may be expressed in terms of average degree of consolidation U and EOP δ_p by the following expression:

$$\delta_t = U\ \delta_p \tag{4}$$

where $\delta_p = R_p - R_o$; R_p is the dial reading at the EOP consolidation.

Based on Eqs. 1 to 4, the coefficient of consolidation may be given as follows

$$c_v = \frac{\pi}{4}\left(\frac{m_1}{\delta_p}\right)^2 H_m^2. \tag{5}$$

Equation 5 shows that the coefficient of consolidation can explicitly be expressed in terms of the slope m_1 and EOP δ_p independently of any specific value of U. Equation 5 also shows that c_v can be evaluated as long as the δ_t-$\sqrt{t}$ curve shows an initial linear section. This evaluation requires the initial and final compressions (i.e., R_0 and R_{100}) that correspond to 0% and 100% consolidation, respectively, for estimating the EOP δ_p.

The Initial Compression R_0 Corresponding to 0% Consolidation

The initial compression can be determined, based on sound theoretical basis as long as the initial section of the observed δ_t-$\sqrt{t}$ curve conforms to Eq. 1, by considering two settlements $\delta_1 = R_1 - R_o$ and $\delta_2 = R_2 - R_o$ corresponding to two different times t_1 and t_2 such that these two points are on the initial linear section of the observed δ_t-$\sqrt{t}$ curve; the value of R_o may be obtained from the following expression:

$$R_0 = \frac{R_2 - R_1\sqrt{t_2/t_1}}{1-\sqrt{t_2/t_1}} \tag{6}$$

where R_1 and R_2 are the dial readings at t_1 and t_2, respectively.

This is the same basis used by the Casagrande and Taylor methods. In the Casagrande method, t_2 is selected to be $4t_1$ and thus R_0 becomes equal to $2R_1 - R_2$ (i.e., $\Delta = R_0 - R_1 = R_1 - R_2$). In the Taylor method, R_0 is obtained graphically as the intercept of initial linear section of the R_t-$\sqrt{t}$ curve. Hence, the slope, Taylor and Casagrande methods are similarly affected by the factors that influence the initial linear section. However, these methods differ in the way by which the EOP δ_p is estimated as shown later.

The Final Compression R_{100} Corresponding to 100 % Consolidation

In the slope method, the EOP settlement $\delta_p(=R_{100} - R_0)$ was estimated by using the settlement $\delta_e(=R_e - R_0)$ at which the δ_t-$\sqrt{t}$ curve starts to deviate from the initial linear section. Theoretically, δ_e corresponds to U of 52.6%. However, the degree of consolidation ($U_e = \delta_e/\delta_p$) at the point where the δ_t-$\sqrt{t}$ curve starts to deviate from the initial linear section was found to range from 40% to 60% averaging at about 50% (Al-Zoubi, 2008b). Hence, the EOP settlement was estimated by the following formula:

$$\delta'_p = 2.0\ \delta_e. \tag{7}$$

The EOP settlement δ'_p values obtained from the settlement δ_e (at which the δ_t-$\sqrt{t}$ curve starts to deviate from the initial linear segment) are plotted against the EOP settlement δ_p values obtained from the Casagrande method (that gives EOP settlement that is almost identical to that defined by pore water pressure measurements as reported by Mesri et al. (1994) and Robinson (1999) for eight specimens of four clayey soils as depicted in Fig. 1. The basic properties of these soils are summarized in Table 1.

Least squares regression analysis using the 60 data points of Fig. 1 shows that coefficient of determination r^2 is 0.922 and the standard error of estimate SEE is 0.104 mm. Large r^2 values (close to 1) and low SEE values (close to zero) are indicative of a reliable estimate.

Table 1. Basic properties of the four clayey soils utilized in the present study

Soil	**Particle size**			**Compaction**		**liquid limit (%)**	**plastic limit (%)**	**specific gravity G**
	sand (%)	**silt (%)**	**clay (%)**	**optimum water content (%)**	**maximum dry density (kN/m^3)**			
Chicago Blue Clay (CBC-3)	4	64	32	14.5	17.9	29	17	2.73
Mutah Clay (Mutah-0)	15	60	25	20	15.7	44	26	2.73
Madaba Clay (Madaba-6)	14	41	45	------	------	55	25	2.78
Azraq Green Clay (AGC-3, AGC-5, AGC-6, AGC-8, AGC-13)	8	23	69	31.5	12.8	108	42	2.76

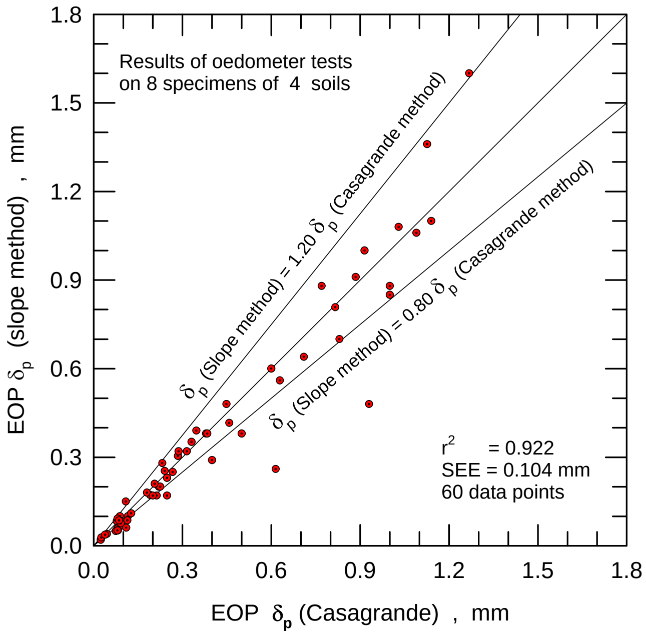

Figure 1: **EOP δ_p of the slope method as a function of EOP δ_p the Casagrande method**

The Settlement Rate - Settlement Method

In this method, the coefficient of consolidation c_v and EOP settlement δ_p can be computed entirely from the later stages of consolidation at $U \geq 52.6\,\%$, based on a curve fitting procedure in which the linear section of the experimental settlement rate-settlement ($d\delta_t / dt$ - δ_t) curve is fitted to the corresponding linear section of the Terzaghi theoretical dU / dT - U curve (Al-Zoubi, 2010).

According to Terzaghi (1943), the theoretical U - T curve may be "almost exactly" expressed, for $U > 52.6$ %, by the following expression:

$$T = -0.933 \log_{10}(1-U) - 0.085 . \quad (8)$$

Thus, the theoretical rate of consolidation may be expressed as follows:

$$\frac{dU}{dT} = C - M \; U \quad (9)$$

where C and M are the intercept and slope of the linear section of the theoretical $dU / dT - U$ relationship, respectively; both are equal to 2.468.

Equation 9 shows that, for $U \geq 52.6\,\%$, the theoretical rate of settlement (dU / dT) decreases linearly with the average degree of consolidation U (Fig. 2).

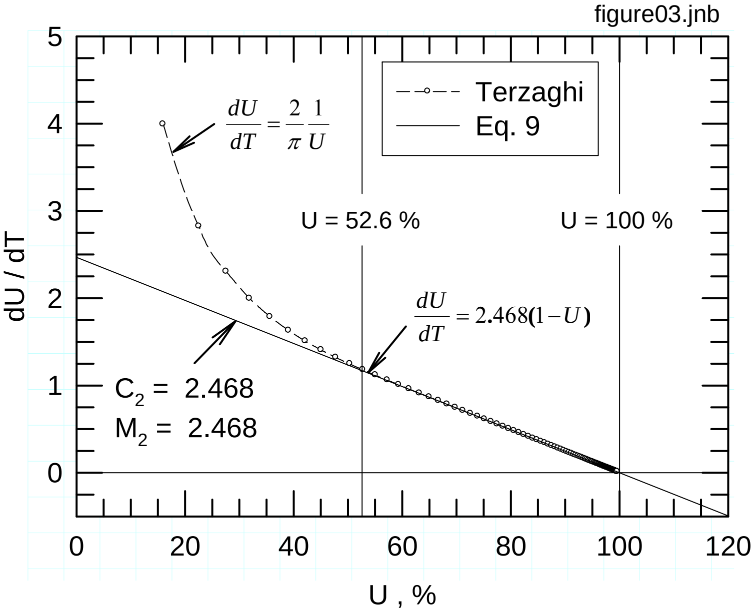

Figure 2: Terzaghi theoretical dU / dT - U relationship (Al-Zoubi, 2010)

Substituting Eqs. (3) and (4) into (9) yields:

$$\frac{d\delta_t}{dt} = \frac{2.468 c_v}{H_m^2} \left(\delta_p - \delta_t \right). \quad (10)$$

Equation 10 shows that, for $U \geq 52.6\,\%$, the observed settlement rate ($d\delta_t / dt$) decreases linearly with the settlement δ_t (Fig. 3).

According to Eq. 10, both c_v and δ_p may simultaneously be determined from the linear section of the observed $d\delta_t / dt$ - δ_t relationship that may be expressed, similar to Eq. 3, as follows:

$$\frac{d\delta_t}{dt} = c_2 - m_2 \delta_t \quad (11)$$

where c_2 and m_2 are, respectively, the intercept and slope of the linear section of the observed $d\delta_t / dt$

- δ_t curve. According to Eqs. 10 and 11, the coefficient of consolidation may be given by the following expression:

$$c_v = \frac{m_2 H_m^2}{2.468} \,. \tag{12}$$

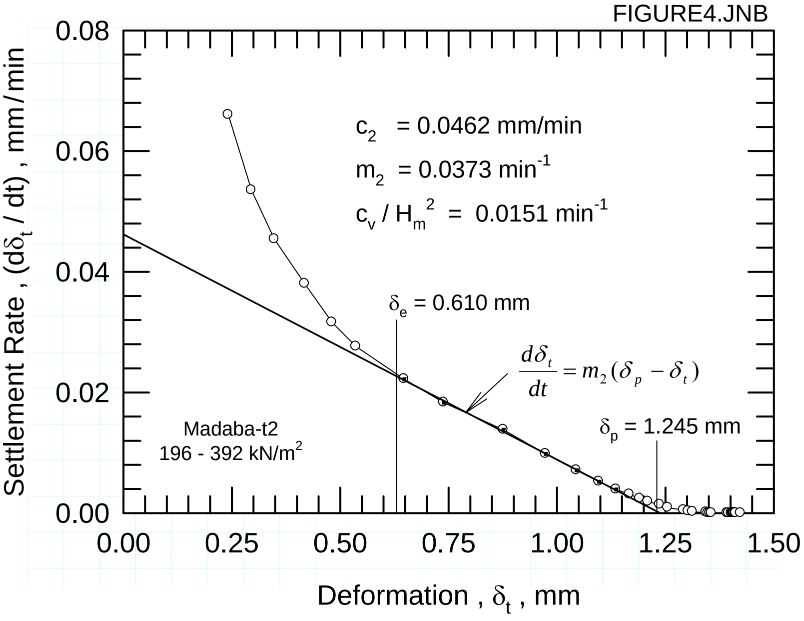

Figure 3: **A typical experimental ($d\delta_t / dt$ - δ_t) curve for Madaba Clay (Al-Zoubi, 2010)**

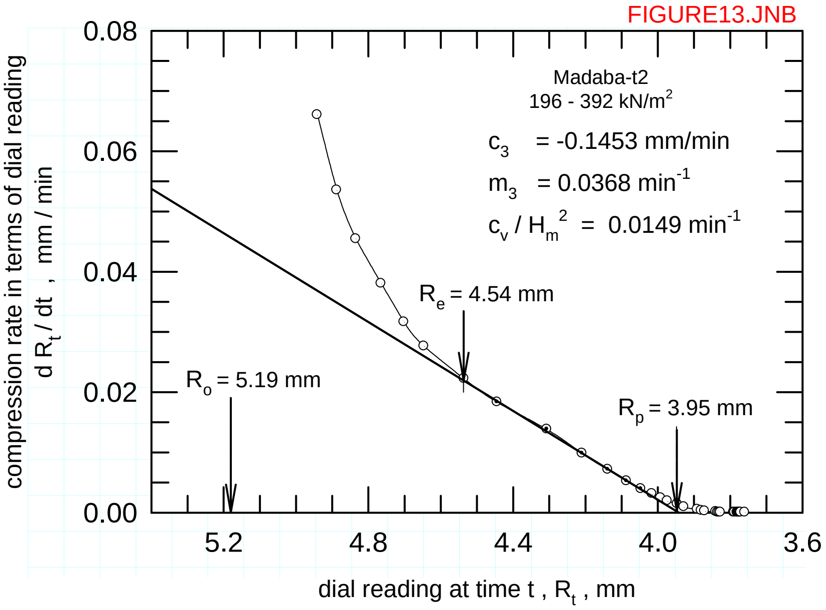

Figure 4: A typical experimental (dR_t / dt - R_t) curve for Madaba Clay (Al-Zoubi, 2010)

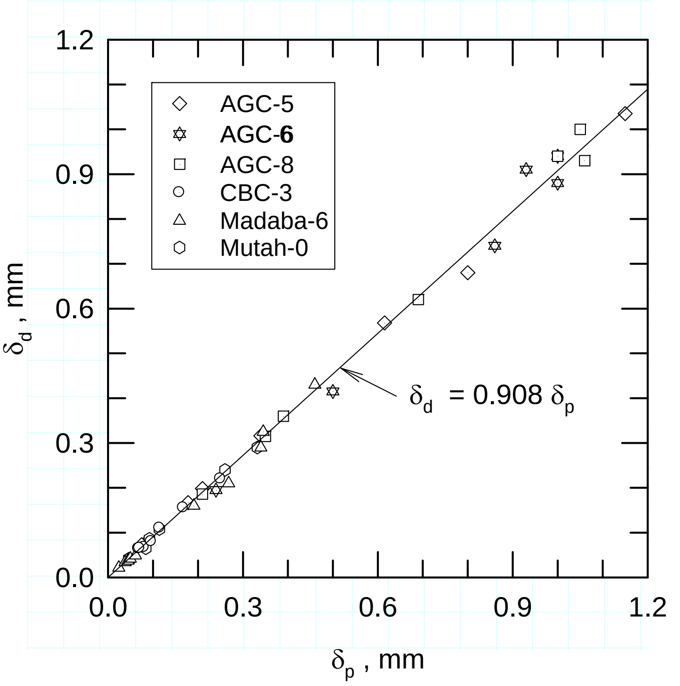

Figure 5: Settlement δ_d at which $d\delta_t / dt$ - δ_t curve deviates from linear section at advanced stages of consolidation as a function of EOP δ_p the Casagrande method

Equation 12 shows that the coefficient of consolidation is only a function of the slope m_2 of the linear section of the observed $d\delta_t / dt$ - δ_t curve. On the other hand, the EOP settlement δ_p may simultaneously be computed utilizing both the intercept and slope of the linear section of the observed $d\delta_t / dt$ - δ_t relationship as follows:

$$\delta_p = \frac{c_2}{m_2}\,. \tag{13}$$

The EOP settlement δ_p, defined by Eq. 13, represents the settlement δ_t at which the extension of the linear section of the observed $d\delta_t / dt$ - δ_t curve intersects the δ_t-axis (i.e., $d\delta_t / dt = 0$). Hence, in the SRS method, the EOP δ_p is computed by extrapolating the compression data obtained from the primary consolidation stage ($U \geq 52.6\%$) without the need to use the secondary compression range. Hence, the effect of secondary compression and load duration may be eliminated or minimized if the next load is applied at or shortly after the EOP settlement is reached that can be readily determined by the SRS method before reaching the end of test.

Equation 10 can alternatively be expressed in terms of dial gauge readings as demonstrated in Fig. 4, which also includes an alternative procedure for estimating the initial compression R_0 and the EOP settlement δ_p without using the early stage of consolidation (Al-Zoubi, 2010). Substituting $\delta_t = R_t - R_o$ and $\delta_p = R_p - R_o$ into Eq. 10 yields the following expression:

$$\frac{dR_t}{dt} = \frac{2.468 c_v}{H_m^2}\left(R_p - R_t\right) \tag{14}$$

where R_o is the corrected zero dial gauge reading, and R_t and R_p are the dial readings at time t and at EOP consolidation t_p, respectively. Equation 14 may be expressed as follows:

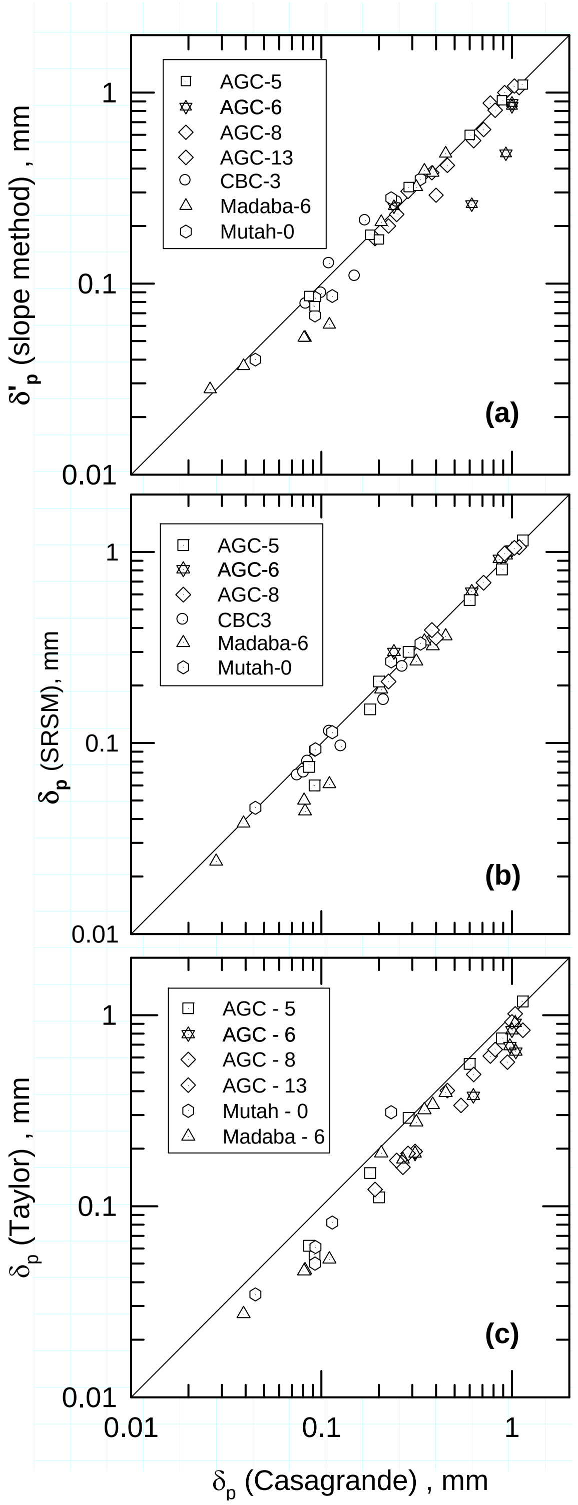

Figure 6: EOP δ_p values of the slope, SRS and Taylor methods as a function of those of the Casagrande method

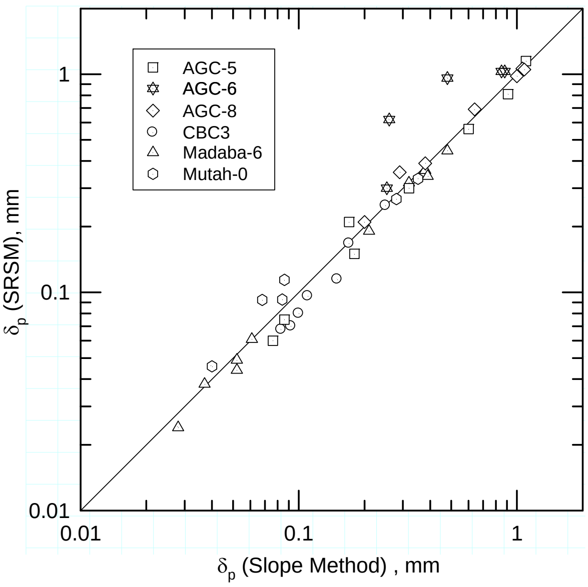

Figure 7: Comparison of the EOP δ_p values of the slope and SRS methods

$$\frac{d\,\mathrm{R}_t}{dt} = c_3 + m_3 R_t \qquad (15)$$

where c_3 and m_3 are, respectively, the intercept and slope of the linear section of the observed dR_t / dt - R_t curve (Fig. 4). According to Eqs. 14 and 15, the coefficient of consolidation and EOP compression may respectively be given in terms of c_3 and m_3 by the following expressions:

$$c_v = \frac{m_3 H_m^2}{2.468} \qquad (16)$$

$$R_p = -\frac{c_3}{m_3} \qquad (17)$$

where m_3 is equal to m_2 and c_3 is equal to $c_2 - m_2 R_0$.

The initial compression, R_o (corrected zero dial gauge reading) can be obtained using the point at which the $d\,\mathrm{R}_t / dt$ - R_t curve starts to form the linear section. The dial reading at this point is designated as R_e. Theoretically, this point corresponds to U of 52.6%. Therefore, the initial compression can be expressed as follows:

$$\mathrm{R}_0 = \mathrm{R}_\mathrm{p} - \frac{\mathrm{R}_\mathrm{p} - \mathrm{R}_\mathrm{e}}{0.474}. \qquad (18)$$

For the results of Fig. 4 (Al-Zoubi 2010), $R_p = 3.95$ and $R_e = 4.54$, therefore, using Eq. 18, $R_0 = 5.19$. This compares very well with the corresponding value ($R_0 = 5.18$) obtained by Eq. 6 developed based on the early stages of consolidation ($\mathrm{U} \le 52.6\,\%$). However, Al-Zoubi (2008b) showed that the point at which the observed δ_t - $\sqrt{t}$ curve starts to deviate from the initial linear section was 40%-60% of the Casagrande method EOP settlement δ_p. Indeed, this point is the same as that where the $d\,\mathrm{R}_t / dt$ - R_t curve starts to join the linear section at later stages of consolidation; theoretically, this point corresponds to $\mathrm{U} = 52.6\,\%$.

Hence, the c_v and δ_p values can be estimated by the SRS method without using the initial section of the compression-time curve ($\mathrm{U} \le 52.6\%$) and thus these estimates may become less affected by the factors that influence this initial section such as the initial compression.

Figure 3 shows that the rate of compression initially decreases drastically with the settlement δ_t until the $d\delta_t / dt$ - δ_t curve becomes a straight line (theoretically, starting at $U = 52.6\,\%$). However, at advanced stages of consolidation, the experimental $d\delta_t / dt$ - δ_t curve diverges from this straight line section such that the rate of compression does not come to zero at the end of primary consolidation, as is the case in the theoretical dU / dT - U relationship of Fig. 2; this may be because secondary compression at these advanced stages of primary consolidation starts to influence or dominate consolidation behavior. The point where the experimental $d\delta_t / dt$ - δ_t curve diverges from the linear section may be interpreted as the point at which the secondary compression starts to greatly influence or to dominate the compression of the soil. Figure 5, which is a plot of δ_d (settlement at the point where the $d\delta_t / dt$ - δ_t curve diverges from the linear section at advanced stages of consolidation) *versus* EOP δ_p of the SRSM, shows that secondary compression generally starts to greatly influence or to dominate the soil compression just after about 90% of the primary consolidation. Hence, the use of the linear section in the SRS method to compute the coefficient of consolidation before the curve diverges from this linear section eliminates the influence of the secondary compression on the predicted c_v values.

The SRS method requires determining the rate of settlement for obtaining the coefficient of consolidation and end of primary settlement from the later stages of consolidation $U \geq 52.6\,\%$. Computations of the settlement rate may involve computational errors that depend on the time intervals of the compression-time data recorded during the consolidation test. However, the consolidation in this stage is slow enough and thus reliable computations of the settlement rate can be obtained provided that suitable time intervals are used for this purpose; two to three additional data points to the conventional time intervals that are usually taken in conventional oedometer tests may be adequate for most soils for reliable computation of the settlement rate. Alternatively, a reliably accurate approximation for the rate of settlement may be obtained by fitting a parabola of the form $a + bt + ct^2$ to any three consecutive points $\left[(t_j, \delta_j), (t_{j+1}, \delta_{j+1}), (t_{j+2}, \delta_{j+2})\right]$ then the constants a, b and c are determined. The rate of settlement is approximated by the derivative of the fitted parabola at $\overline{t} = \left(t_j + t_{j+2}\right)/2$ by the following expression (Singh, 2001):

$$\left.\frac{d\delta_t}{dt}\right|_{\overline{t}} = \frac{\delta_{i+2} - \delta_i}{t_{i+2} - t_i}. \qquad (19)$$

Al-Zoubi (2010) showed that both procedures give almost identical results.

Comparison of the Slope, SRS, Casagrande and Taylor Methods in Terms of the EOP δ_P

The primary consolidation may be defined as the time-dependent compression resulting from the dissipation of the excess pore water pressure following the application of a loading increment. Accordingly, the primary consolidation, in the available methods that utilize only the compression - time curves in the analysis of consolidation, is arbitrarily identified because the pore water pressures are not usually measured in conventional consolidation tests. However, consolidation tests with pore water pressure measurements showed that the end of primary (EOP) settlements determined by the empirical Casagrande construction were in good agreement with those obtained when full dissipation of the excess pore water pressures was achieved (e.g., Mesri et al., 1999b; Robinson, 1999). In the present study, the slope and settlement rate-settlement methods are independently capable of evaluating the EOP δ_p as was previously illustrated by introducing Eqs. 7 and 13 for the slope and settlement rate-settlement SRS methods, respectively.

The EOP δ_p values computed by the slope, SRS and Taylor methods are plotted against the EOP δ_p values obtained by the Casagrande method in Fig. 6 utilizing results of oedometer tests conducted on four soils. The δ_p values estimated by the slope and SRS methods are quite similar to those of the Casagrande method; whereas the EOP δ_p values computed by the Taylor method are generally lower than those of the Casagrande, slope and SRS methods. The EOP δ_p values computed by the slope method are quite similar to those of the SRS method as shown in Fig. 7.

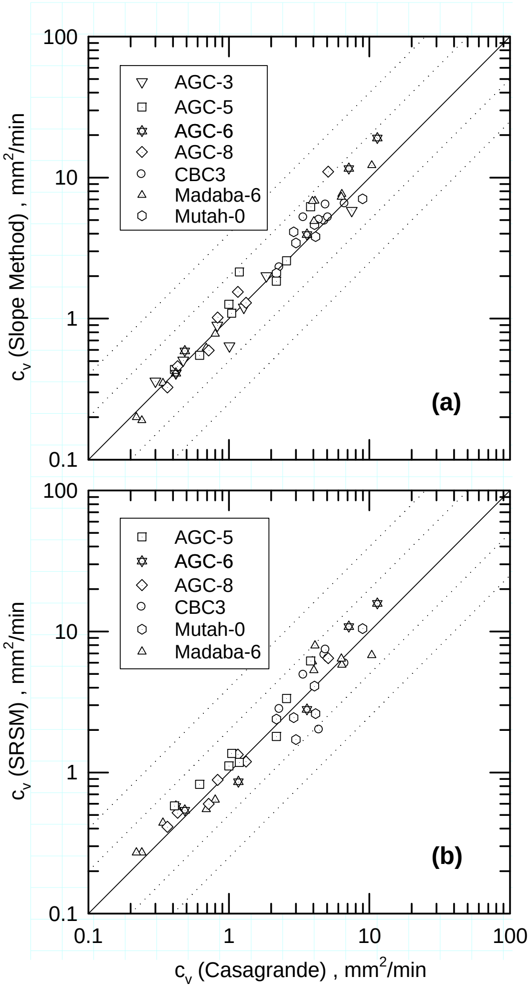

Figure 8: Comparison of c_v values of (a) the slope method and (b) the SRS method as a function of those of the Casagrande method

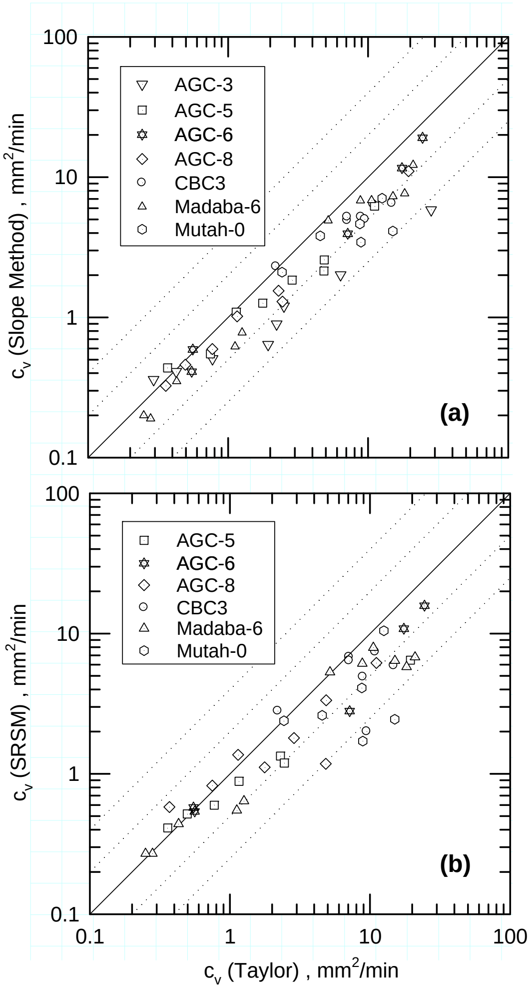

Figure 9: Comparison of c_v values of (a) the slope method and (b) the SRS method as a function of those of the Taylor method

Comparison of the Slope, SRS, Casagrande and Taylor Methods in Terms of the c_v Value

The c_v values computed by the slope and SRS methods are compared with those obtained from the Casagrande and Taylor methods utilizing results of odometer tests on four soils in Figs. 8 and 9. As can be seen from Fig. 8, the c_v values obtained by the slope and SRS methods are quite similar to those of the

Casagrande method. On the other hand, Fig. 9 shows that the c_v values of the slope and SRS methods are generally lower than those computed by the Taylor method.

Figure 10 shows a comparison between the c_v values obtained by the Taylor and Casagrande methods. The Taylor method c_v values may range from 1 to 4 times those of the slope, SRS or Casagrande method (Figs. 8 to 10). This observation is generally consistent with the reported values for the Taylor and Casagrande methods in the geotechnical engineering literature (e.g., Lambe and Whitman, 1969; Hossain, 1995; Sridharan and Prakash, 1995; Robinson, 1999).

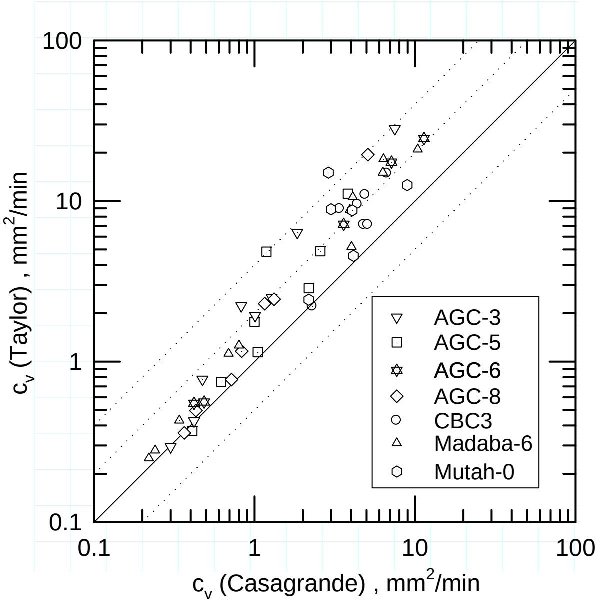

Figure 10: Comparison of c_v values computed by the Taylor and Casagrande methods

The c_v values estimated by the slope method are compared with those obtained from SRS method in Fig. 11. As can be seen, the estimated c_v values using the slope method, which calculates the c_v values from the early stages of consolidation, are quite similar to those determined by the SRS method, which calculates the c_v values from the later stages of consolidation. The similarity in the c_v values obtained using the slope, SRS and Casagrande methods presented in this study is also associated with similarity in the estimated δ_p values (demonstrated earlier in this study). In other words, the slope, SRS and Casagrande methods predict quite similar ranges for the primary consolidation that corresponds to the Terzaghi theory and these three methods also yield quite similar c_v values; this may be deduced from Eq. 5, which shows that the c_v value is primarily dependent on the EOP δ_p values for any particular pressure increment. On the other hand, the Taylor method generally results in higher values for the coefficient of consolidation as compared to the Casagrande, slope and SRS methods, mainly because this method generally predicts lower δ_p values than those of the Casagrande, slope and SRS methods.

Hence, the differences in the c_v estimates using the existing methods might not necessarily be due to the effects of the initial and secondary compressions; however, these differences in the c_v values estimated using the existing methods can be shown to be primarily due to the differences in the EOP δ_p values estimated by existing methods using different procedures (Al-Zoubi, 2008a, 2008b).

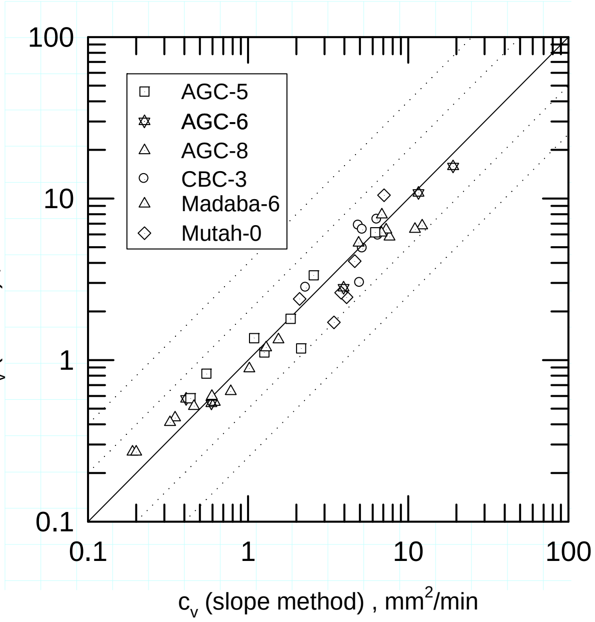

Figure 11: Comparison of the c_v values computed by the slope and SRS methods

Consequently, the similarity in the c_v estimates obtained from the slope method, which uses the early stages of consolidation, the SRS method, which uses the later stages of consolidation, and the Casagrande method, which uses both the early and later stages of consolidation including secondary compression, raises a question on the validity of the statement that the c_v estimates at the early stages of consolidation are generally different from those estimated at the later stages of consolidation that was attributed in the literature to the different degrees of influence of the initial compression and secondary compression.

SUMMARY AND CONCLUSIONS

The coefficient of consolidation c_v is commonly determined by the various existing methods utilizing fitting procedures between the experimental and theoretical compression-time relationships, plotted in different forms, at a specified average degree of consolidation or over a range of U. The various existing methods generally give different values for the coefficient of consolidation c_v as well as for end of primary (EOP) settlement δ_p.

In this study, results of consolidation analysis are compared and evaluated by using two recently developed methods for obtaining the coefficient of consolidation (c_v) and the EOP settlement δ_p. The first method (the slope method, Al-Zoubi, 2008b) computes c_v and δ_p entirely from the early stages of consolidation at $U \le 52.6\,\%$ using the linear section of the observed $\delta_t - \sqrt{t}$ plot. The second method (the settlement rate - settlement (SRS) method: Al-Zoubi, 2010) computes c_v and δ_p entirely from the later stages of consolidation at $U \ge 52.6\,\%$ using the linear section of the observed $d\delta_t / dt - \delta_t$ plot. The slope and SRS methods compute c_v and δ_p, over the respective range of U for each method, independently of any specific U value.

Extensive experimental results of oedometer tests on four clayey soils show that the two methods give quite similar c_v and δ_p values that are also in good agreement with those of the Casagrande method. These results also show that the Taylor method c_v values are generally lower than those of the slope, SRS and Casagrande method.

The slope and SRS methods are capable of independently evaluating the EOP settlement without the need to continue the test into the secondary compression stage resulting in a significant reduction in the overall testing time as compared to the Casagrande method.

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