Supplement to paper "Questions offering opportunities to elaborate on soil mechanics concepts" by Emil Mejlhede Kinslev and Marina Pantazidou, presented in Int. Conf. Advances and Innovations in Soft Soil Engineering, 24-26 August, 2026, Delft, NL.

Background to the isotache curves used to calculate consolidation and creep settlement

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The paper by Kinslev and Pantazidou (2026) discusses in Section 3.1.2 two hypotheses, A and B, for scaling consolidation and creep settlements from laboratory measurements to the field (revisited in more detail herein in Section 3.4). Hypothesis A suggests that only the time-scale of settlement accumulation is affected by the scaling from laboratory to field (same final strain, but with a slower accumulation due to the increased drainage height); hence, that the "end of primary" point (when consolidation is considered completed) is unique and that creep deformations during consolidation therefore scale with the consolidation deformations. Hypothesis B is consistent with the framework of the isotache curves (see Section 3.4), which depict a unique relationship between effective stress, void ratio (or strain) and strain rate, which results in greater accumulation of creep deformations during consolidation when the consolidation process is slower due to the scaling from laboratory to field. The main goal of this supplement is to provide detailed guidance to a non-expert reader (represented by the second author) wishing to understand the logic of

the isotache framework. To this end, it starts from graphs appearing in all introductory soil mechanics textbooks, i.e., the S-shaped curve for the settlement-log time relationship and the straight-line curve of the void ratio (e)-logσ′ relationship (for normally consolidated clays). It then builds on these curves one explanatory step at a time. For the more advanced reader, the supplement also gives pointers, in Sections 3.5 and 3.6, about the framework of isotaches as an alternative method for calculating final settlements for clays (final settlement means both consolidation settlement and secondary compression), as proposed in Section 3.1.3 of the paper.

1. Starting from a familiar test and familiar curves

1.1 The time – settlement curve

Each loading step of the oedometer test produces one time-settlement curve: settlement is plotted against the logarithm of time (and gives the familiar S-shaped curve) or the square root of time, depending on the graphical method used to determine the end of primary consolidation. However, such representations do little to help non-experts develop a sense of the order of magnitude of the time when things happen. An accompanying graph with linear axes eases the understanding of the concepts. Even less helpful (at least to the instructor), most recent textbooks use cartoon-type graphs, i.e., in this case, time-settlement graphs without numbers in the axes. From a number of textbooks consulted, a non-conceptual (hence with actual data) settlement-time curve in linear scale was found only in the classic textbook by Taylor (1948: p.219, Fig. 10.6) –reproduced herein in Figure S1–, which in combination with Fig. 10.11 from the same book shows that in a 24-hour load increment the specimen shortens by ~0.157 cm (excluding immediate compression). By the end of primary, at less than 0.5 h, the specimen shortens by ~0.122cm (78% of the settlement recorded at 24 hours). These data were doubly surprising to the non-expert second author: consolidation turns out to be complete in less than 0.5 h, i.e., very fast –in comparison to the 24-hour duration of the loading step– and more than 20% of the settlement reading at the end of the loading step, which will be used to construct the e-logσ′ curve, is due to creep!

Here it is important to realize, that this is just one example of real data and the range of behavior of all soils is naturally bigger. Considering values for the coefficient of consolidation, C_v, ranging from $4x10^{-5}$ to $4x10^{-3}$ cm^2/s (Budhu, 2011: Table 9.1, p. 245) results in 95% consolidation (T=1.129) of a standard 2 cm tall sample with double drainage (H_{dr} = 1 cm) ranging from ~5 minutes to ~7.8 hours (the calculation is made using: $t=T(H_{dr})^2/C_v$). Despite the significant variation, both values are significantly less than 24 hours.

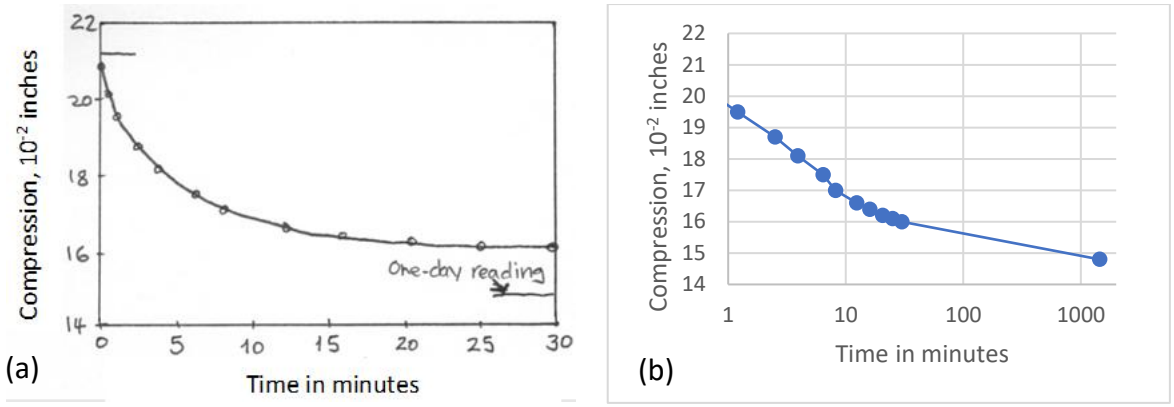


Figure S1. Time curve for a typical load increment in an oedometer test: (a) adapted from Taylor (1948: Fig. 10.6), (b) same data in logarithmic scale for time.

1.2 The effective stress – void ratio curve

The traditional e-logσ′ curve uses the final strain from each load step (Taylor, 1948; Budhu, 2011; Briaud, 2013; Powrie, 2014) rather than interpreting the individual underlying consolidation processes. This produces an incomplete graph if we do not specify how it was obtained, and in particular if we do not specify the duration of each load increment. It is a synthetic curve, in the sense that –unlike the time-settlement curve– it is not derived directly from measurements, but from interpretations of measurements obtained during each load increment of the oedometer test. So, although we typically picture a normally consolidated clay as having an e–logσ′ plot like the one depicted in Figure S2, such plots hide the influence of the time elapsed before adding a new load increment. It is likely that a 24-hour duration of the load increment was used to obtain such a plot. As we already saw from the test reported by Taylor (1948), primary consolidation may be well over at 24 hours and hence plots like the one in Figure S2 include some variable amount of creep settlement.

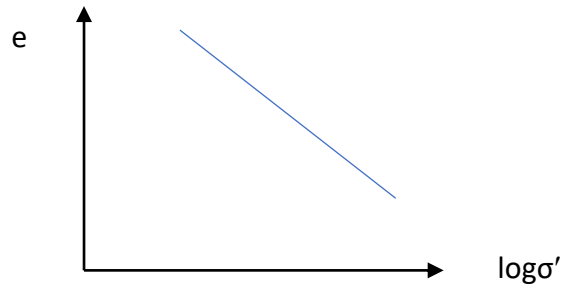


Figure S2. A typical cartoon-like e-logσ′ curve (a plot with incomplete information!). This information is obtained from an oedometer test after a few load increments, but the figure gives no inkling of them if plotted as a line without data points. Each load increment is typically allowed to act for 24 h.

The aforementioned traditional construction of the e-logσ′ curve is presented as a convenient step for the introduction of the isotache curves (see Section 3.4), as it links neatly to the perhaps more familiar isochronous curves (see Section 2.2). For a complete introduction to the construction of the e-logσ′ curve, the modern method (Terzaghi et al., 1996; Mitchell & Soga, 2005) is also presented. With the use of the final strain from each load step in the construction of the e-logσ′ curve, it was argued above that the graph depends on the load step duration. This issue is overcome by determining from each time-settlement curve the strain at the end of primary consolidation and use the corresponding void ratio in the construction of the e-logσ′ curve. This ensures that the curve is not affected by the load step duration (as long as consolidation is complete within the duration of the load step).

Despite the introduction of this modern method, the traditional method is still acknowledged by the American standards (ASTM D2435, 2025), where both methods are presented with a very short description of their respective capabilities. With the more basic textbooks only describing the traditional method and the standards acknowledging it, one may wonder whether the modern method will ever be adopted by the non-experts. At the very least, non-experts should be aware that the traditional method is more conservative, i.e., results in higher values of compression index C_c, since it combines –as already mentioned– consolidation settlement and creep settlement. Granted, such conservatism may be justified for low-compressibility clays if secondary compression is not being accounted for explicitly, as suggested by Leroueil (2017) and discussed again in Section 5.

2. Connecting familiar depictions of test results to depictions that are more faithful to reality

2.1 A richer version of the void ratio – stress curve acknowledging explicitly creep

Taylor (1948) acknowledges that there is no unique e-logσ′ curve: its position depends on the duration of the loading step. Longer loading steps will produce e-logσ′ curves translated downward but all parallel to one another: this is the idea of isochronous curves, each curve corresponding to a specific duration of the loading step. Taylor (1948) states that presumably the sample will cease compressing eventually, and adds that the time required might be many decades or centuries. Taylor (1948: p. 245, Fig. 10.14) visualizes an e-logσ′ curve that would correspond to the ultimate static case, i.e., after compression has ceased, if we could run tests with loading increments that each lasted 10 years! Taylor's (1948) Fig. 10.14 is reproduced in Figure S3 herein. Note that (i) the upper curve corresponds to a conventional test, i.e., it already includes some creep since in the "conventional test" of

Taylor, load increases every 24 hours, and (ii) in the test discussed in Figure S1, primary consolidation was over in less than 30 minutes.

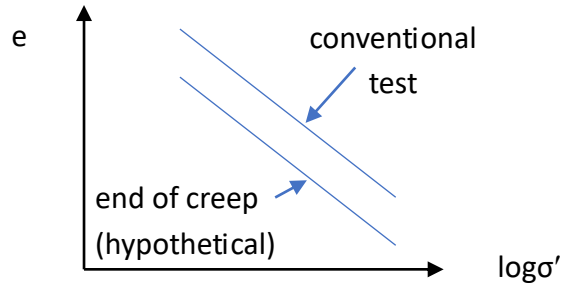


Figure S3. An e-logσ′ plot obtained from a conventional oedometer test (with a 24-hour load increment) and a hypothesized e-logσ′ plot when the speed of deformation is practically zero (adapted from Taylor, 1948: p. 245, Fig. 10.14).

2.2 Isochronous curves: a unique effective stress – void ratio (or strain) – time relationship

The effect of the duration of the load increment is demonstrated by Ladd et al. (1977), shown herein with Figure S4, which is a simplified version of their Figure 38. For longer durations of load increment, the e-logσ′ curve translates vertically downward to smaller values of void ratio, i.e., the curves are parallel to each other, provided that C_c and $C_{\alpha e}/C_c$ remain constant, where C_c is the compression index and $C_{\alpha e}$ is the secondary compression index, $C_{\alpha e} = \Delta e/\Delta \log t$. If we were to describe Figure S4 with words, we would say that, for every time interval each load increment is allowed to act, there is a unique effective stress – void ratio relationship or, equivalently, there is a unique effective stress – void ratio – time relationship. Since the curves correspond each to a specific time interval, we can call them isochronous (=same time) curves. With this understanding, we can now study a more faithful version of Figure 38 by Ladd et al. (1977), which is reproduced herein in Figure S5.

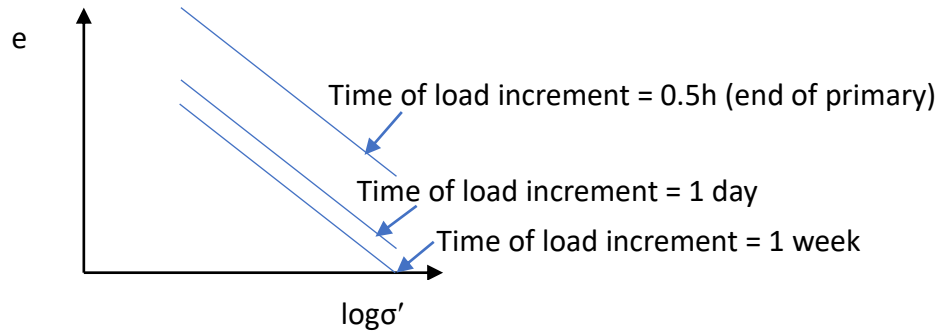


Figure S4. Three e-logσ′ curves obtained with oedometer tests performed with different duration of load increment: a simplified version of Figure 38 by Ladd et al. (1977), shown in Figure S5.

Ladd et al. (1977) use Figure S5 to demonstrate three things. First, they show that secondary compression produces a stiffening effect, by following with a dashed line a specimen first

being loaded at σ_{v0}' for 24 h. We do not know the void ratio of this specimen before loading (it was higher than e_0), but we can deduce it was left to compress beyond the end of primary consolidation, i.e., beyond the line indicated with $t=t_p=0.5$ h, for 24 h, when it reached a void ratio of e_0. Then, after these first 24 hours, the load is increased to σ_{vf}'. At the beginning, the specimen's void ratio practically remains e_0. (The compression may be approximated using the recompression index, C_r, which is much smaller than C_c, while the small stress change leads to practically zero deformation.) Primary consolidation starts again and the specimen moves along the e-logσ' curve for t = 0.5 h, as shown by the dashed line, until primary consolidation is over for the new σ_{vf}', at a void ratio equal to e_1. Such a curve has the features of an overconsolidated clay, i.e., secondary compression manifests as a yield stress, or "quasi-preconsolidation stress" in the words of Ladd et al. (1977). Second, Ladd et al. (1977) show with Figure S5 that with more time elapsed after the end of primary, the specimen moves to e-logσ' curves corresponding to larger and larger times of load increment under constant effective stress. Third, Figure S5 shows that, instead of a unique e-logσ' curve, there is a unique relationship between void ratio (e), effective stress (σ') and *time*. As we will see in Section 3.4, this behavior can be expressed in an alternative way as a unique relationship between void ratio, effective stress and *deformation rate*, which is much more convenient from a calculation point of view as it removes the need for defining time origins for the soil.

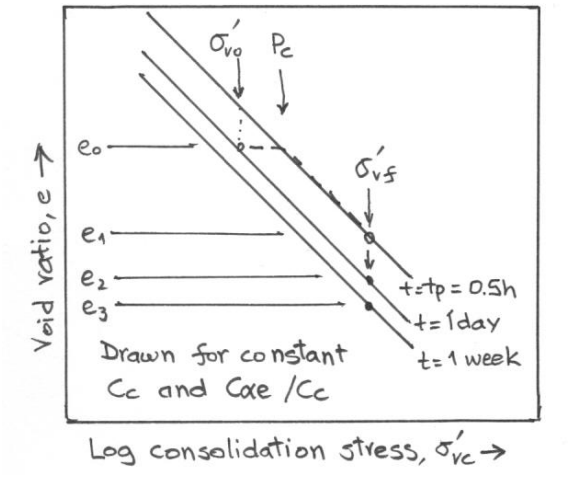


Figure S5. One-dimensional compression and the effect of secondary compression, modified by Ladd et al. (1977: Fig. 38). The dashed line follows the compression of a soil sample that has been loaded to σ'_{v0} for one day and has reached a void ratio e_0 and then it is loaded to a new load σ'_{vf}, which is allowed to act until the end of primary consolidation at 0.5 h (reaching a void ratio e_1), 1 day (reaching a void ratio e_2), or 1 week (reaching a void ratio e_3).

Because the influence of the type of test is important to understand secondary compression, we should first differentiate types of oedometer tests. Like Donald Taylor in the 1940s, most geotechnical engineers and instructors think that the "conventional" oedometer test refers a to test carried out in steps, where a) at each step we increase the load by doubling the

previous load (example in changed units: 0.025, 0.05, 0.1, 0.2, 0.4, 0.8, and 1.6 MPa) (page 214) and b) “each load is allowed to stand until compression has practically ceased”; “the use of one-day durations is very common” (Taylor 1948: p. 215).

3. Types of oedometer tests, of plotting the data and how to use these data to calculate settlements

3.1 Incremental Loading (IL) oedometer tests

The Incremental Loading (IL) test is an umbrella term for all oedometer tests in which stepwise new constant vertical total stresses are applied and the evolution of deformation/strain in the sample is monitored over time. It does not specify the size or duration of the load increment nor the size and drainage conditions of the sample. However, most commonly an IL test is a configuration where the load is doubled (or halved during unloading) in each increment and the next load step is applied after the end of primary consolidation, provided that a proper definition of the End of Primary (EOP) point is possible and the creep line can be interpreted. Ladd et al. (1977) mention that standard one-day IL oedometer tests generally include one to two cycles of secondary compression, in which case the creep line can be interpreted from such tests.

To avoid possible confusion if the reader consults various sources, we note that there is another term for the same test, the multiple-stage loading (MSL) oedometer test with reloading. A test with a load increment of 24 h would be designated as MSL24, so it is a subset of the IL tests (it could be designated as a IL24).

Finally, if the same load is added in each increment, then we have a discretized version of a Constant Rate of Loading (CRL) test ($\Delta\sigma_v/\Delta t$ = constant).

3.2 Constant Rate of Strain (CRS) oedometer tests

The incremental loading (IL) tests is not the only family of tests used to study one-dimensional compression. The constant rate of strain (CRS) test ($\Delta\varepsilon/\Delta t$ = constant) is better suited to stress the importance of time: faster tests result in less deformation at the same effective stress compared to slower tests (e.g., see Figure S6). The CRS tests require pore pressure measurements for the calculation of effective stress. Their big advantage is that they produce a continuous curve for the effective stress – strain relationship as opposed to the IL tests, which give only a point on the effective stress – strain curve for each load increment.

3.3 Other oedometer tests

For completeness, we mention that there also exists a Constant Gradient (CG) test, where the ratio of excess pore pressure to total vertical stress is controlled (it is a rarity and difficult to run).

3.4 From isochronous curves to isotache curves: a unique void ratio (or strain) – effective stress – strain rate relationship

Leroueil (2006) gives results from typical CRS tests, which are partially reproduced herein in Figure S6, showing strain as a function of effective stress in linear scale. It is clear that the soil has a better behavior at higher strain rates ("better" in the sense that the soil settles less for the same effective stress), which correspond to shorter test times.

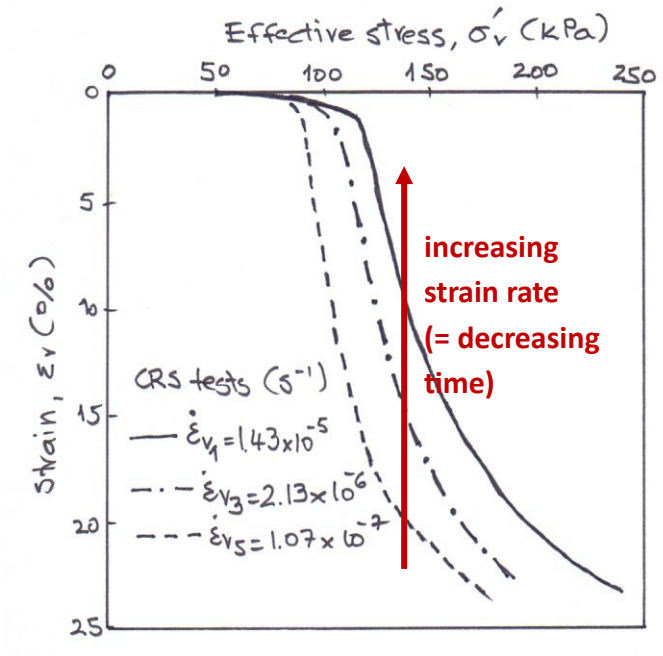


Figure S6. Results from CRS oedometer tests on Batiscan clay, modified from Leroueil (2006: Fig. 5); the original figure has six tests (run at strain rates from $\dot{\varepsilon_{v1}}$ to $\dot{\varepsilon_{v6}}$) and also shows excess pore water pressure measurements for four of the six tests.

If the strain (ε) – effective stress (σ') results in Figure S6 were plotted in ε – logσ' axes they would look like the cartoon in Figure S7. Each curve produced by one CRS test would correspond to a nearly straight line when effective stress, σ', is plotted on a logarithmic axis. These constant-rate-of-strain curves, in either set of axes, are called isotache (=same velocity) curves.

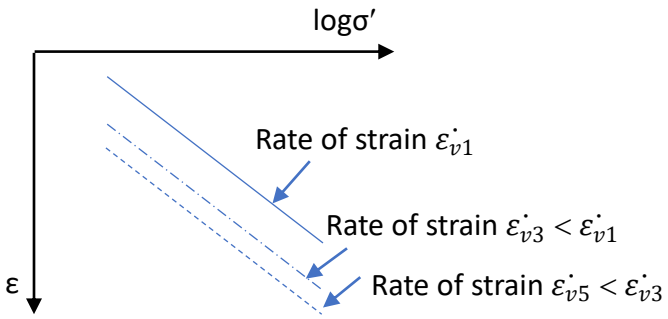


Figure S7. Conceptual constant strain rate (= isotache) curves, corresponding to the three CRS tests shown in Figure S6.

The uniqueness of the effective stress – strain – strain rate relationship is demonstrated even more impressively by Leroueil (2006: Fig. 10) with results from two tests run at alternating strain rates. These results are reproduced herein in Figure S8.

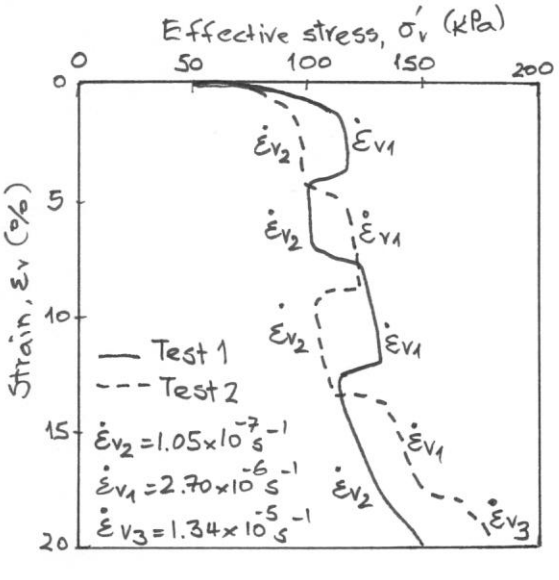


Figure S8. Two constant rate of strain (CRS) tests performed with Batiscan clay, modified from Leroueil (2006: Fig. 10). Tests 1 and 2 alternate between two strain rates $\dot{\varepsilon}_{v1}$ (higher) and $\dot{\varepsilon}_{v2}$ (lower). Test 2 also includes a final portion of the test at an even higher strain rate $\dot{\varepsilon}_{v3}$. There is clearly one curve for strain rate $\dot{\varepsilon}_{v1}$ and another for strain rate $\dot{\varepsilon}_{v2}$, to which the soil samples "return to" as the testing strain rate switches between them.

The equivalent curves in a logσ′ axis are straight lines. For a reduction of strain rate by one order of magnitude (1/10) the strain difference is expected to be constant irrespective of the value of the first strain rate. Hence, the three lines (as in Figure S9) that represent three strain rates $\dot{\varepsilon}_{v2}$= $\dot{\varepsilon}_{v1}$/10 = $\dot{\varepsilon}_{v3}$/100 will be offset to one another by a constant strain (vertical distance), which is defined by the creep index C_α (see further discussion in Section 3.5).

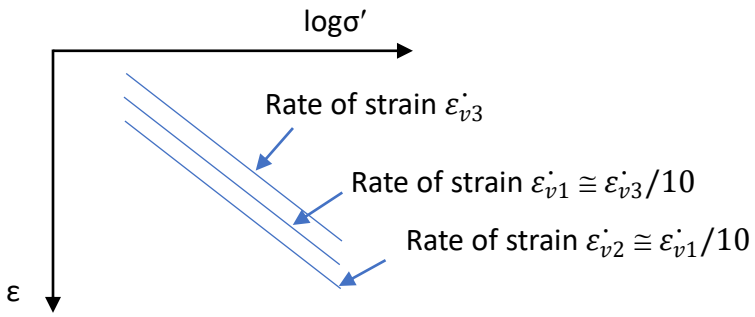


Figure S9. Conceptual depiction of the three ε-logσ′ curves corresponding to the three strain rates used in the experiments the results of which are shown in Figure S8.

We are now ready to revisit Figure 1 from the paper, reproduced herein as Figure S10, and appreciate the connection between hypothesis B and the isotache framework. Regardless of creep hypothesis, there is agreement that the creep strains (after the end of primary consolidation) may be described by a linear line in the strain (or void ratio) versus log time plot; hence, with the creep index C_α (or $C_{\alpha e}$ when defined in terms of void ratio). Differences between the two hypotheses are reiterated next.

Hypothesis A: the strain at the End of Primary (EOP) consolidation is the same for a thin sample (laboratory) and a thick sample (field).

Hypothesis B: In addition to creep being identified by the slope, C_α, the position of the line in the strain (or void ratio) versus log time plot is also unique and independent of sample thickness. Hence, both samples end up on the same line after consolidation has finished. This is a unique effective stress (the effective stress at the end of primary) – strain – time relationship or, equivalently, a unique effective stress – strain – strain rate relationship.

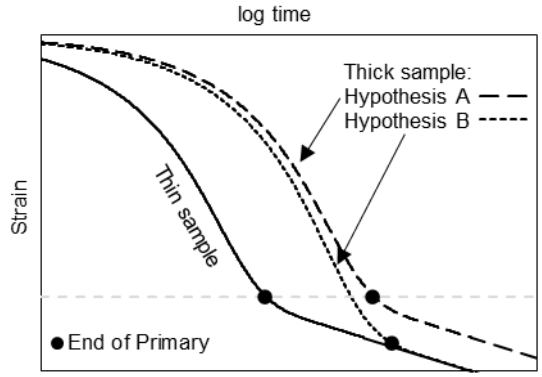


Figure S10. The origin of hypotheses A and B for extrapolating from the laboratory (thin sample) to the field (thick sample), as proposed by Ladd et al. (1977), modified from Degago et al. (2011), e.g., to also include strain of the thick sample in the entire time interval.

Leroueil (2006) contrasts conceptually the two hypotheses by distinguishing the path followed by two thick clay layers in the space of the isochronous curves, as shown in Figure S11. According to the initial version of hypothesis A, the compression of the clay layer first

moves along the recompression branch. Then, primary consolidation takes place over the virgin consolidation line, until the ultimate effective stress, $\sigma'_{vo} + \Delta\sigma_v$, is reached. After the end of primary consolidation, creep commences and the clay layer compresses further under constant effective stress. According to hypothesis B, consolidation and creep take place concurrently, so when the clay layer reaches the ultimate effective stress, the strain is higher compared to the one predicted by hypothesis A.

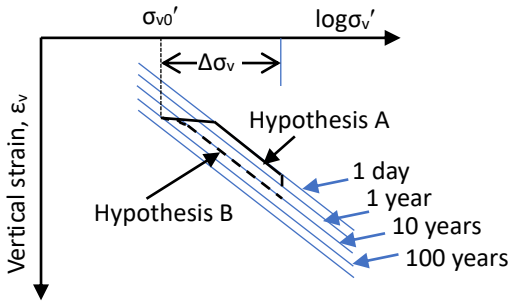


Figure S11. Predictions of hypotheses A and B contrasted in the space of the isochronous curves, modified from Leroueil (2006: Fig. 3a).

3.5 Constructing the isotache curves

The isotaches represent creep deformations and hence are only constructed when effective stress is known. This is the case either in a constant rate of strain (CRS) oedometer test, since pore pressure is measured, or in an incremental loading (IL) oedometer test, after the end of primary for each load step.

From a CRS test, the strain rate may be changed (and explicitly defined by the user) during the test to then map the change in position in the strain –or void ratio– versus effective stress plane, as shown in Figure S12 for void ratio.

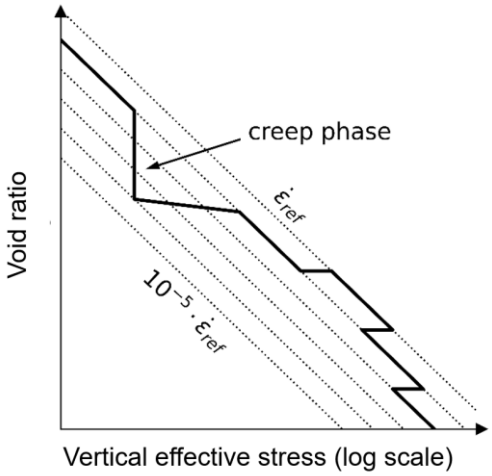


Figure S12. Conceptual behavior of a CRS test with a creep phase and three changes to the strain rate during the subsequent compression (first going from $10^{-1} \cdot \dot{\varepsilon}_{ref}$, to $\dot{\varepsilon}_{ref}$, second back to $10^{-1} \cdot \dot{\varepsilon}_{ref}$ and third to $10^{-2} \cdot \dot{\varepsilon}_{ref}$). Modified from Kinslev (2021).

From an IL test the isotaches may be constructed by mapping points of different strain ratio on each of the creep branches from each load step and connecting same strain rates. In this method for constructing isotaches lies a direct proof that the vertical spacing between them is defined by the creep index. For each load step of an IL test, the creep deformation (when consolidation is not present) is described by equation S1:

$$\varepsilon_{creep} = C_\alpha \cdot \log(t) + c \qquad \text{(S1)}$$

This forms a straight line in the strain versus logtime plot with inclination equal to C_α, the coefficient of secondary compression. Both the origin of the time axis and the value of the constant c are unimportant in the following, as we only calculate differences and derivatives. To derive the strain rate (i.e., $d\varepsilon/dt$) from this straight line, equation S1 is differentiated with respect to linear time, which results in equation S2:

$$\frac{d\varepsilon_{creep}}{dt} = \frac{C_\alpha}{t\ ln10} \qquad \text{(S2)}$$

Based on this derivative, the strain rate may be calculated for any time (once on the creep line), and since the effective stress is constant at this point (i.e., after dissipation of excess pore pressures) and the void ratio is a direct outcome of the time-curve, points for the isotaches can be drawn at each load step (where sufficient creep was allowed).

For a factor 10 change of the strain rate (hence the spacing between isotaches) the corresponding ratio of time may be calculated as:

$$\frac{\frac{d\varepsilon_{creep-1}}{dt}}{\frac{d\varepsilon_{creep-2}}{dt}} = 10 = \frac{\frac{C_\alpha}{t_1\ ln10}}{\frac{C_\alpha}{t_2\ ln10}} = \frac{t_2}{t_1} \quad \text{(S3)}$$

The strain increment between two time instances is defined by equation S1 as:

$$\varepsilon_{creep-2} - \varepsilon_{creep-1} = C_\alpha \cdot \log(t_2) + c - C_\alpha \cdot \log(t_1) - c = C_\alpha \cdot \log(\frac{t_2}{t_1}) \quad \text{(S4)}$$

Now inserting the time ratio relevant for a factor 10 change of strain rate (see equation S3) gives:

$$\varepsilon_{creep-2} - \varepsilon_{creep-1} = C_\alpha \cdot \log(10) = C_\alpha \qquad \text{(S5)}$$

Since the relationship between void ratio and strain is linear ($\varepsilon = \Delta e/(1+ e_0)$), the same argumentation may be carried through for the line as defined by void ratio:

$$e_{creep} = C_{\alpha e} \cdot \log(t) + c \qquad \text{(S6)}$$

Resulting in an equal spacing by $C_{\alpha e}$.

3.6 Calculating settlements with isotache curves

To use the isotaches for calculating the settlement in an engineering problem is by no means as simple as using hypothesis A since the creep deformations during consolidation must be

calculated in increments. Ignoring creep for a moment is useful in setting up the method for calculating settlements with the isotaches. The magnitude of the deformation will then follow the recompression index (C_r), either "indefinitely", as in e.g., Botas Freitas et al. (2011), or until a limiting compression curve, as in Yuan & Whittle (2018). The only component of time is then related to the dissipation of excess pore pressure which follows Terzaghi's theory of consolidation. This part is straightforward, but as the creep-independent (i.e., creep-free) compression moves between isotaches, a time-dependent creep compression must be added. Therefore the calculation is best performed in increments: 1) take a finite time step along the C_r branch, 2) identify the isotache reached from this step and 3) add the creep strain starting from that isotache for the time step in 1). These steps are illustrated in Figure S13.

The results of this method depend on the increment size and the method is most effectively incorporated into some computational tool, however a good approximation is definitely possible by "hand calculation".

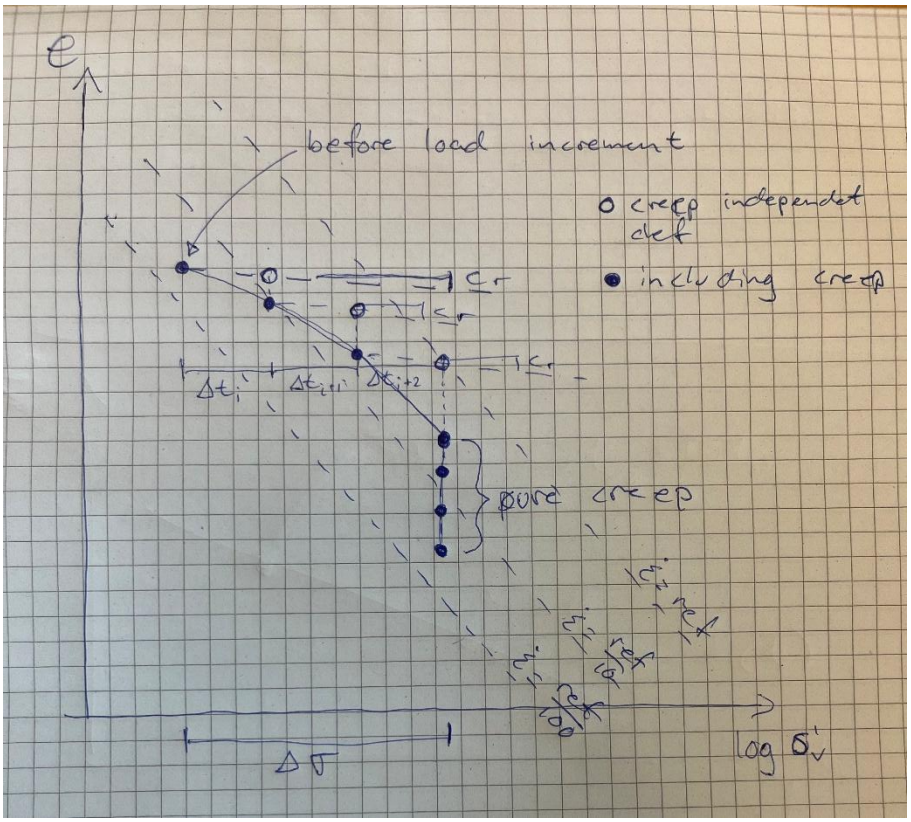


Figure S13. The relationship between void ratio and vertical effective stress during a load step of incremental loading (IL) oedometer test with indication of intersection with isotaches (the dashed lines), modified from Degago et al. (2011).

It is important to realize that the rate of pore pressure dissipation affects the path in Figure S13 since the "time spent" at each effective stress level is different and the creep portion therefore will change. For a thin sample, the consolidation is quick and not much creep will have time to accumulate, but for a thick sample, a longer time is spent at each effective

stress between the initial and the full load increment, which causes additional creep deformations.

4. Relationships between descriptions of creep phenomena in soils and in other materials

Figure S4, with results from IL tests, and Figure S9, with results from CRS tests, express the same thing: a unique relationship between effective stress, void ratio and time, expressed by isochronous curves (Figure S4) or, equivalently effective stress, strain and strain rate, expressed by isotache curves (Figure S9). Such isochronous stress (or load)-strain curves are commonly reported in the creep literature and applied to a wide range of materials, including metals (Dowling 1998) and geosynthetics (McGown et al. 2004). The idea behind the isochronous stress-strain curves is of a practical nature: we replot creep data, i.e., deformation-time data obtained for specific loads (or stresses), in the form of synthetic (i.e., not measured) load (or stress)-strain curves for a given time (e.g., see Dowling 1998: p. 714, Fig. 15.11). This concept already appeared in textbooks on creep in the 1950s; Finnie & Heller (1959) report that this method of replotting data was first suggested by McVetty (1934). The approach is equivalent to assuming that total strain is a function of stress and *time*. An equivalent assumption is that total strain is a function of stress and *strain rate*, which is the version proposed for soils by Šuklje (1957), bypassing thus the problem of determining the origin of time (t=0) in a clay deposit in the field.

5. Epilogue

A dispute in the literature regarding the scaling of settlements from laboratory measurements to the field, which may appear as a second-order issue to the uninitiated readers, offers them nevertheless an opportunity to re-evaluate the interplay between primary consolidation and creep and rethink how we interpret the results from oedometer tests. Creep forces us to consider time as a third variable together with effective stress and strain (or void ratio). This three-way effective stress – strain – time relationship can be visualized easily with a set of isochronous curves without requiring any additional knowledge other than the well-known graphs obtained from classic oedometer tests, i.e., the relationships for time-deformation and deformation-effective stress. An alternative three-way effective stress – strain – strain rate relationship can be expressed with a set of isotache curves, which can be used to calculate creep strain without having to assume that creep starts after consolidation stops. It would be useful if senior soft-soil experts provided some guidance for which practical applications creep effects are important, e.g., see Leroueil's (2017) webinar with a rule of thumb for embankments (between 53:40 and 55:18), and when it would be recommended to calculate settlements using the isotache

framework. We therefore encourage soft-soil experts with knowledge of consulting projects where the isotache framework was used to reach out to the authors.

References

ASTM International (2025). ASTM D2435/D2435M-25, Standard Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading. ASTM International, West Conshohocken, PA.

Botas Freitas, T. M., Potts, D. M. and Zdravkovic, L. (2011). A time dependent constitutive model for soils with isotach viscosity. Computers and Geotechnics 38(6):809-820.

Briaud, J.-L. (2013). Geotechnical Engineering: Unsaturated and Saturated Soils, John Wiley, Hoboken, NJ.

Budhu, M. (2011). Soil Mechanics and Foundations, 3rd edition (1st edition 2000), John Wiley, Hoboken, NJ.

Degago, S. A., Grimstad, G., Jostad, H. P., Nordal, S. and Olsson, M. (2011). Use and misuse of the isotache concept with respect to creep hypotheses A and B. Géotechnique, 61(10):897-908.

Dowling, N.E. (1998). Mechanical behavior of materials, Engineering methods for deformation, fracture and fatigue, 2nd Ed., Prentice Hall, Upper Saddle River, NJ.

Finnie, I. and Heller, W.R. (1959). Creep of engineering materials, McGraw-Hill, New York, NY.

Kinslev, E. M. (2021). Efficient performance of large infrastructure: a geomechanical approach towards sustainable design. PhD thesis at the Technical University of Denmark.

Ladd, C. C., Foott, R., Ishihara, K., Schlosser, F. and Poulos, H. G. (1977). Stress-Deformation and Strength Characteristics, State-of-the-Art Report, Proceedings of the 9th International Conference on Soil Mechanics and Foundation Engineering, Tokyo, Japan.

Leroueil, S. (2006). The isotache approach. Where are we 50 years after its development by Professor Šuklje? 2006 Prof. Šuklje's Memorial Lecture, Proc. 13th Danube Eur. Conf. Geotech. Engng., Ljubljana, 2, 55–88.

Leroueil, S. (2017). Compressibility and Consolidation of Clays: From Lab to Field Conditions. ISSMGE Webinar, April 11, https://www.issmge.org/education/recorded-webinars/compressibility-and-consolidation-of-clays-from-lab-to-field-conditions

McGown, A., Khan, A. J. and Kupec, J. (2004). The isochronous strain energy approach applied to the load–strain–time–temperature behaviour of geosynthetics, Geosynthetics International, 11(2):114-130.

McVetty, P.G. (1934). Working stresses for high temperature service, Mech. Eng., 56:149.

Mitchell, J. K. and Soga, K. (2005). Fundamentals of Soil Behavior, 3rd Ed., John Wiley & Sons, Hoboken, NJ.

Powrie, W. (2014). Soil Mechanics Concepts and Applications, 3rd Ed. (1st Ed. 1996), CRC Press, Taylor & Francis Group, Boca Raton, FL.

Šuklje, L. (1957). The analysis of the consolidation process by the isotache method, Proceedings of the 4th International Conference on Soil Mechanics and Foundation Engineering, London, United Kingdom.

Taylor, D.W. (1948). Fundamentals of Soil Mechanics. John Wiley, New York, NY.

Terzaghi, K., Peck, R. B. and Mesri, G. (1996). Soil Mechanics in Engineering Practice, 3rd Ed., John Wiley & Sons, New York, NY.

Yuan, Y. and Whittle, A. J. (2018). A novel elasto-viscoplastic formulation for compression behaviour of clays. Géotechnique 68(12):1044-1055.