

Relationship Between Soil Compaction and Engineering Properties from Study of Soil Composition.

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ABSTRACT

The formation of Soil material Studies in my last publication of September 2022 has a relatively with Relationship between Soil Composition and Engineering Properties in the study and formation of Soil. This brings INDEX Properties of the Group of soils with similarities of Engineering properties. Therefore, when discussing about Soil Composition, we also discussed the mineralogy which strongly effect the size and sharps of Particles in soil. For cohesive soils, the knowledge of composition is always helpful in predicting and expressing unusual or adverse behaves, e-g·Hallowysite→Very low d_d . (radioactive) . Montepoliak → highly expensive. SEE BRAGER/DAZE ·illite→Quick clay(Ref to previous Publication) However, Composition praise Cannot predict the engineering factors, Such as: variation, Composition agents, the usual mineral presents and effect of pore fluid composition.

Keyword: Engineering properties, soil Composition, Index properties

INTRODUCTION.

The formation of soil in it relation to other components is all about the engineering properties from mineral sources. Mineral material brings about the element that help in the formation of soil particle depending on the geographical region. Factor of Elements as stated includes the following; Granular Soils, Cohesive Soil with empirical correlation, Relative State, Over view of USCS, Details of USCS like remarks. collectively, all were referred to as majors for soil material composition.

Objective

Is to relatively conduct a simple tests in order to determine: 1st The SOIL TYPE, 2nd It's RELATIVE STATE. Then can expect similar engineering properties, e.g, Coef. of permeability, comprehensibility strength.

Is to present a simplified approach and distinguish between GRANULAR reverse COHESIVE soils

METHODOLOGY

3.1 Granular Soils

1) Soil Type: Use particle size distribution ASTM D422*As was applied in the south East Enugu Nigeria Road Project

a) Smallest Size (Related to k) D_{10} 0 % Fines (%-No.200 sieve=75 μ m)

b) Gradation (Related to Δe range) Coef.of Uniformity, C_u $C_u = D_{60}/D_{10} > 5 \pm 1$ = well graded,

< 2 uniform (DAS, 2004).

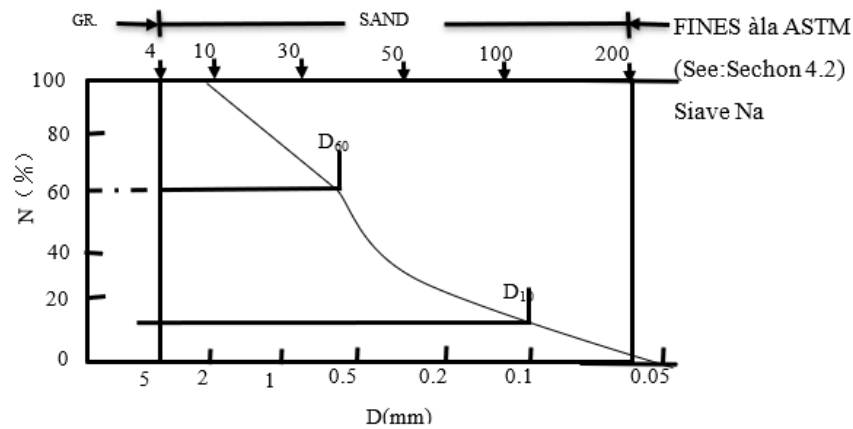


Fig. 3.1. Graph of Relativity

3.2 Relative state: Use Relative Density, D_r

$$D_r = \frac{Q_{\max} - Q}{Q_{\max} - Q_{\min}}$$

- $Q_{\min}$ (max. density) via ASTM D4253 (vibration in mold with sin change load).
- $Q_{\max}$ (min. density) via ASTM D4254 (pour through funnel into mold).
- $D_r > 70\%$ is "dense"; $D_r \leq 30\%$ is "loose" (worry about liquifaction during earthquake).

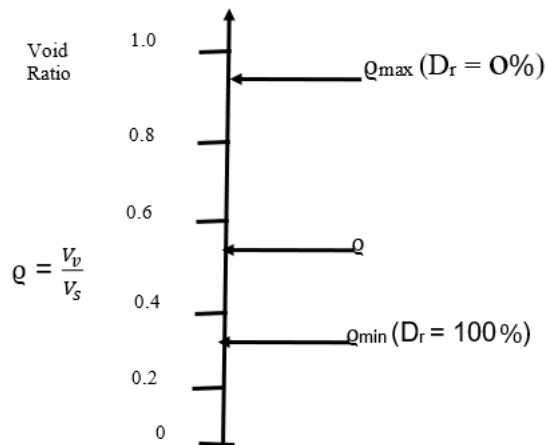


Fig. 3.2 Relative Density Steps.

3.3 Empirical correlation for Granular Soils

- $k(\text{cm/sec}) = [D_{10}(\text{mm})]^2$ very good for loose, fairly uniform sands
- See sheet C for estimation of insect density and drained function angle(Φ^1)

Table 3.1 Showing Granular Soil Result

Sieve No	4	8	10	16	20	30	40	50	60	100	140	200
Dia.(mm)	4.75	2.36	2.00	1.18	0.85	0.60	0.425	0.30	0.25	0.15	0.106	0.075

3.4 Cohesive Soils

- 1) Soil Type: Use Alterberg Limits (ASTM D4318).

Tests run on remolded soil passing #40 sieve.

NOTE: Best to start with soil at W_N because air/oven drying can reduce W_L & I_p of soils containing organic matter, smectite, al & Fe oxide, etc

- W_L corresponds to low undrained shear strength $s_u = 20\text{g/cm}^2 = 40\text{psf} \approx 2\text{kPa}$ * (like butter at room temperature)
- W_p when soil loses ability to deform plastically (crumbling of 3.2mm = 1/8 in dia thread of soil)
- W_s = computed w for $S=100\%$ an oven drying curve of saturated soil
- $I_p = PI = W_L - W_p$ is Δw (3.1)

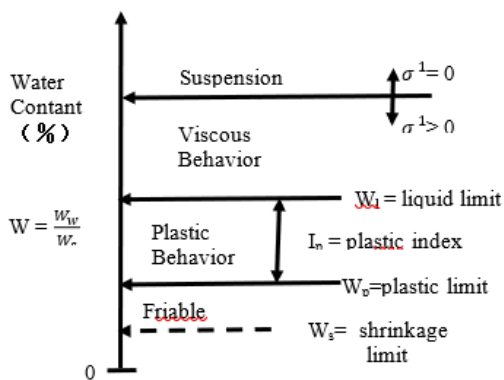
- range over which soil exhibits plastic behavior

- $I_L = LI = \text{liquidity Index}$ (3.2)

- $(W_N - W_p)/(W_L - W_p = I_p)$ $\{I_L > 1.5 \rightarrow \text{high sensitivity},$

$$S_t = \frac{S_{\alpha}(U)}{S_{\alpha}(R)} \approx 100 \pm 50 \} \quad (3.3)$$

- $\text{Activity} = \frac{I_p (\%)}{\% - 2\mu\text{m (clay fraction)}}$ (3.4)



F1g. 3·2a Plasticity and Liquid Index Profile (ASTM D4318)

Above A- Line = Inorganic clays

- High oven dried strength.
- Very low k · Tough at W_p

Below A-Line = Silts & Organic Soils

- Very friable as $w \rightarrow w_p$
- Lower oven dried strength

Casagrande's Plasticity Chart

- (1) Marine illite clay (BBC)
- (2) Deltaic Smectite clays (gulf marine)
- (3) Arctic silts (alaska)
- (4) Mudflat deposits (N. E. Coastline)

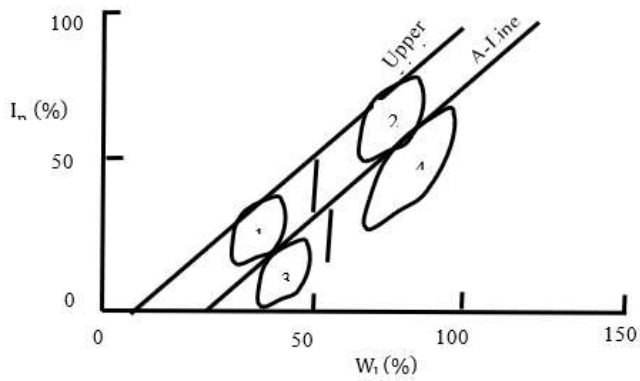


Fig. 3.2b: Casagrande's Plasticity Chart

1akm = 1kgf/cm² = 2000psf = 1TSF = 10 TSM $\approx$ 100 kPa = 1 bar 100KN/m²

3.4 Relative State

Use Stress History (current σ_{vc}^1 plus σ_p^1 or OCR)

- Ulustrete via 1-D consolidation test starting with soil slung

Note: $\sigma^1 \equiv \bar{\sigma} = \sigma - \mu$
 μ = effective stress

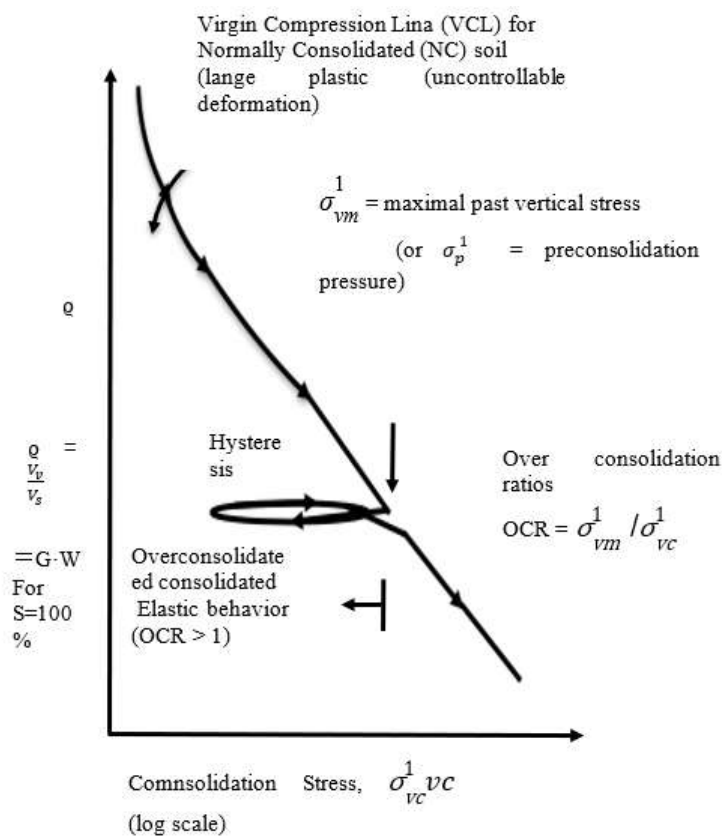


Fig. 3.1 Relative State Chat.

3.5 Empirical correlation for cohesive soils

- Coefficient of consolidation, C_v : See sheet D₁ (excellent correlation)
- Virgin Compression index, $C_c = - \frac{dq}{d \log \sigma_{vc}^1}$ = slope of VCL, $C_c = 0.009 (w_1 - 10\%)$ (Tengaghi & Peekk 1967)
- Remolded unchained shear strength [at w_1 , $S_u = 1.6 \text{ kPa} = 33 \text{ psf}$], $S_u (\text{kPa}) = 1 / (I_2 - 0.21)^2$ [Leroueil et al. 1983, CGJ'20(4)]
- SHANSEP equation for design of homogeneous sedimentary cohesive soils, $S_u = \sigma_{vo}^1 = S(\text{OCR})^m$ (Also see Aue Sheet DI), $S_u = \sigma_{vo}^1 = S(\text{OCR})^m$, CL & CH clays, $S = 0.22 \pm 0.03 \text{ SD}$, (Also see Aue Sheet DI), Soil below A-limit, $S = 0.25 \pm 0.05 \text{ SD}$, $m = 0.8 \pm 0.1$ (Ladd 1991)
- Drained shear strength (values of $C^1 \Phi^1$) See Sheet D2

3.6 Unified Soil Classification System (USCS)

Overview of USCS (ASTM D 2487)

= Sieve size **% fines** = % passing #200 (75 μm)

4.0 Material Modification

TABLE 4.1: Modifier

	Six Main Soil Types	<5% Fines Gradation	Between Dual	>12% Fines Plasticity
<50% Passing #200	<div style="display: flex; align-items: center;"> <div style="font-size: 3em; margin-right: 10px;">}</div> <div> <p>W = Well graded</p> <p>p = Poorly graded</p> <p>G = Gravel</p> <p>— #4</p> <p>S = Sand</p> </div> </div>	W = Well graded	Use Both, Eg., SW-SM	M = silty C = Clayey

	M = Silt	Below A-Line	
>50% Passing	C = clay	On/Above A-Line	Plasticity Chart
	O = Organic	$\frac{LL_{dried}}{LL_{not\ dried}} < 0.75$	L = Low (LL < 50)
#200	Pt = Peot	Mostly organic matter	H = High (LL > 50)

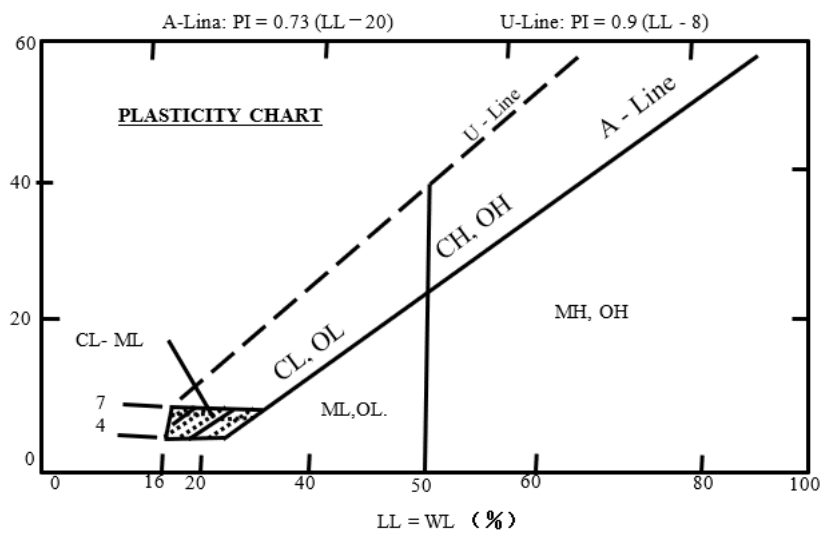


Fig: 4·1 Details of USCS

See sheet E

4.2 Ramarks & Examples

1) Coarse Grainid (granular)

- Well va Poorly graded
- $C_u = D_{60} / D_{10} > 4$ or 6 requires a wide range in particular sizes,
- $1 \leq C_c = \frac{D_{30}}{D_{60} \cdot D_{10}} \leq 3$ present gap grading,
- C_c =Coef. Of curvature
- <5% Fines, e.g, GW, GP=7
- Well, Poorly graded Gravel
- >12% Fines, e.g, SM,SC=Silty,Clayey Sand.
- $5 \leq \% \text{ Fines} \leq 12\% \rightarrow$ Dual classification for both gradation and plasticity GW - GM=Will graded Gravel with silt e.g, SP - SC = Poorly graded Sand with clay

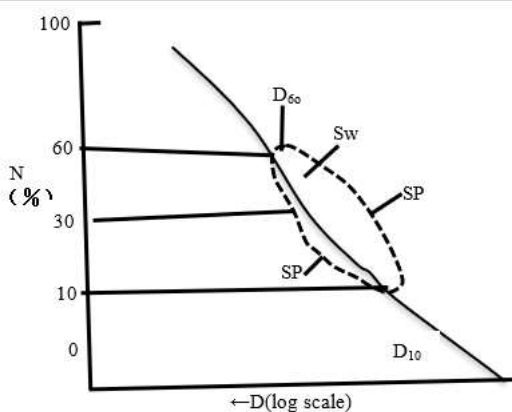


Fig: 4·2

2) Fine Grained (Cohesive)

On a above A-Line

- CL, CH = lean, fat Clay
- OL, OH = organic clay (CCL → lean, fat organic clay).

Below A-line

- ML, MH = silt, elastic Silt (CCL → lean, plastic silt)
- OL, OH = organic silt (CCL → lean, plastic organic silt).

For Both

- If > 30% + #200; add "sandy" or "gravelly" below the name e.g. Sandy, lean Clay
- If 15 - 29% + #200; add "with sand" or "with gravel" after the name e.g. lean Silt with gravel

CONCLUSION/ SUMMARY

In conclusion, this soil classification of index Properties is to simplify and demonstrate the relationship of these group soils that are relatively similar to Engineering properties when experience both in Nigeria and other Western world countries. However, when looking at the state of granular soil, the cohesive soil of ATTERSEG LIMITS – ASTM D4318, the Casagrande measuring charts and the relative state which shows the history of 1-D consolidations using unified soil classification system, its shown that all of these properties and testing, demonstrates that the Engineering contributions sums up the effect and contributions to the soil strength in general.

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