

# Soil Investigation

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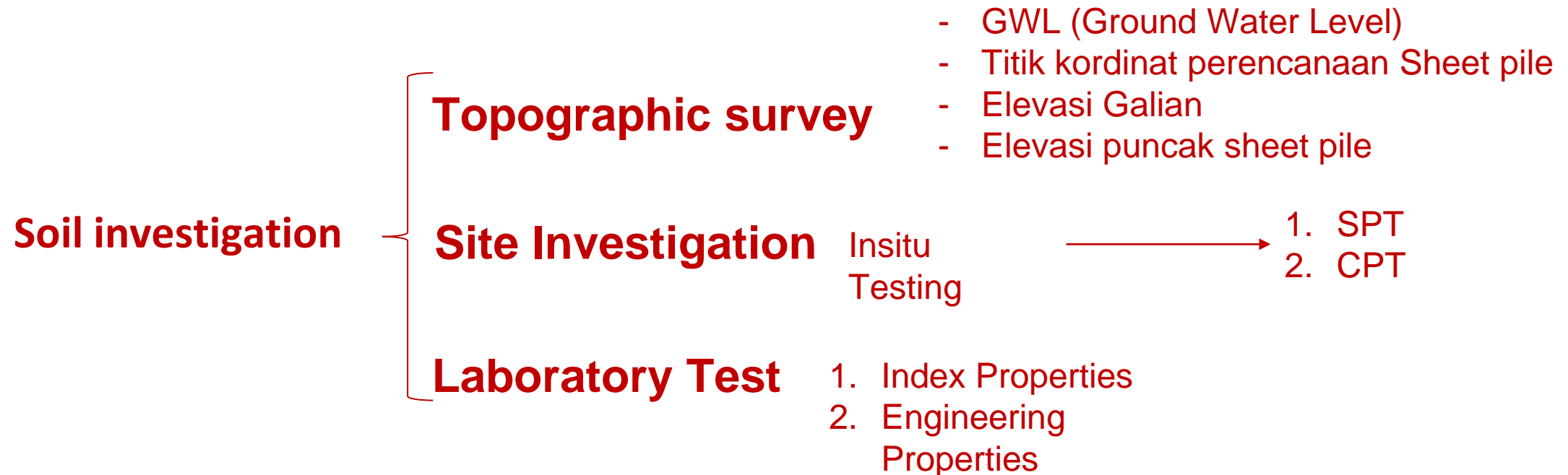


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Bandung, 2020

# Reference

Handbook of Geotechnical Investigation  
and Design Tables (Burt Look, 2007)

# Geotechnical Investigation



# Topographic survey

- GWL (Ground Water Level)
- Titik kordinat perencanaan Sheet pile
- Elevasi Galian
- Elevasi puncak sheet pile

# Site Investigation

## Insitu Test

### SPT

**SPT (Standard Penetration Test)** digunakan sebagai indikator konsistensi tanah. Berupa kepadatan relatif (Relative density) dan kekakuan (stiffness) dari tanah granular.

Noted : pengujian ini hanya untuk evaluasi kualitatif tanah, Parameter yang diperoleh adalah nilai N-spt yang biasa dikorelasikan untuk parameter *shear strength* tanah.

# Site Investigation

## Insitu Test

### SPT

#### **Keuntungan :**

- Sederhana
- Biaya murah
- Sample bisa di ambil
- Bisa di aplikasikan pada berbagai tipe tanah

#### **Kerugian :**

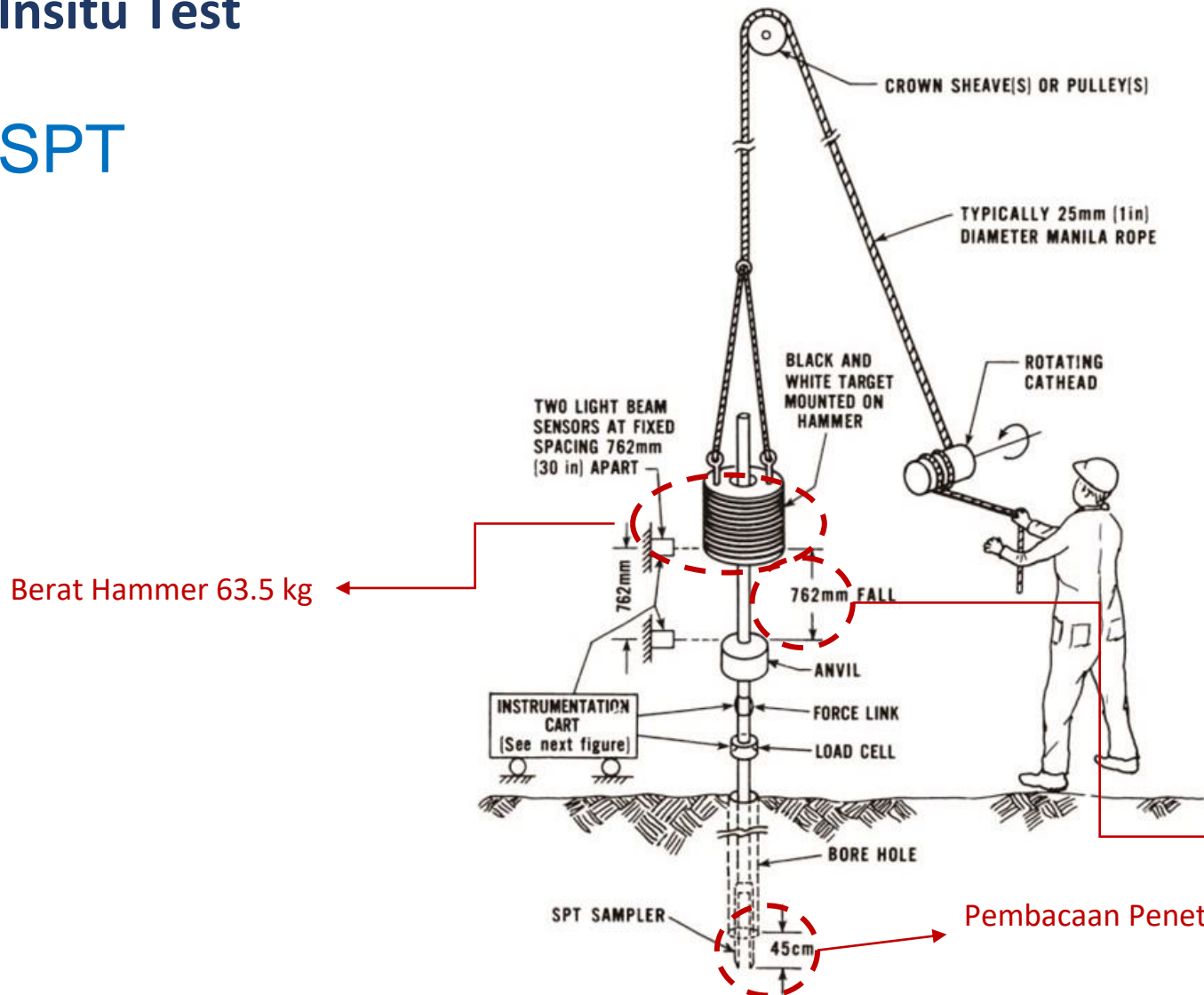
- Sample terganggu
- Parameter yang diperoleh kasar (nilai N)
- Tidak cocok diterapkan pada lempung lunak dan lanau
- Variasi nilai terlalu tinggi dan tidak tentu

# Site Investigation

## In situ Test

## SPT

The SPT is described in ASTM D-1586. Outer diameter split-spoon sampler is driven into the ground with a 140 lb (0.622 kN) drop hammer dropped 30 in. (0.77 m) repeatedly until a penetration of 18 in. is achieved. The number of blows of the hammer is recorded for each of three 6-in. (15.24 cm) intervals (totaling 18 in. or 45.72 cm). The number of blows required for advancing the sampler to the last 12 in. or 30.48 cm (second and third intervals) is defined as the SPT N-value.



# Site Investigation

## Insitu Test

### SPT

#### Consistency of Non-Cohesive Soil

Term	Nspt Value
Very loose	<4
Loose	4-10
Medium dense	10-30
Dense	30-50
Very dense	>50

Burt Look (2007)

#### Consistency of Cohesive Soil

Term	Nspt Value
Very soft	<2
Soft	2-4
Medium	4-8
Stiff	8-15
Very stiff	15-30
Hard	>30

Terezaghi & Peck (1967)



# Site Investigation

## Example

Tanggal	Kedalaman (m)		Deskripsi Tanah	Konsistensi	Warna	Ket. Pengeboran	SPT			
	Dari	Ke					N <sub>1</sub>	N <sub>2</sub>	N <sub>3</sub>	N <sub>total</sub>
	0,00	0,50	Lempung Lanau		hitam	CORING				
	0,50	1,00	Lempung Lanau		ke					
	1,00	1,50	Lempung Lanau		Abu2an					
	1,50	2,00				UDS. 1				
	2,00	2,45				SPT. 1	1/15	2/15	2/15	4/30
	2,45	3,00	Lempung Lanauan		Abu ?	CORING				
	3,00	3,50	Lempung Lanauan		ke hitam					
	3,50	4,00				UDS. 2				
	4,00	4,45	Lempung Lanauan, - -pasiran			SPT. 2.	1/15	2/15	3/15	??
	4,45	5,00	Pasir Lempung Lanauan Sisipan pasir berang		Abu ? ke hitam	CORING				

Jenis tanah berdasarkan Konsistensi ??

$$N_{spt} = 2+3 = 5 \longrightarrow \text{Medium CLAY}$$

# Site Investigation

## Insitu Test

### CPT

**CPT (Cone Penetration Test).** Metode pengujian ini mendukung data *engineering properties* tanah yang akan digunakan dalam mendesain struktur konstruksi atau fondasi. CPT menguji tanah langsung di lokasi dan tidak ada sampel tanah. Dibutuhkan pengetahuan dan pengalaman untuk meng-interpretasi hasil pengujian CPT ini. Hasil uji CPT sering di korelasikan dengan hasil pengujian laboratorium.

# Site Investigation

## Insitu Test

### CPT

#### **Keuntungan :**

- Profiling tanah cepat dan kontinu
- Data dapat diandalkan (data tidak bergantung pada operator)
- Ekonomis dan produktif
- Teori cukup kuat berdasarkan interpretasi

#### **Kekurangan :**

- Harga alat cukup mahal (untuk piezocone-CPTu dan seismic-CPTs)
- Membutuhkan kemampuan operator
- Tidak ada sampel tanah yang dapat diambil
- Penetrasi terbatas oleh tanah kerikil dan tanah tersementasi

# Laboratory Test

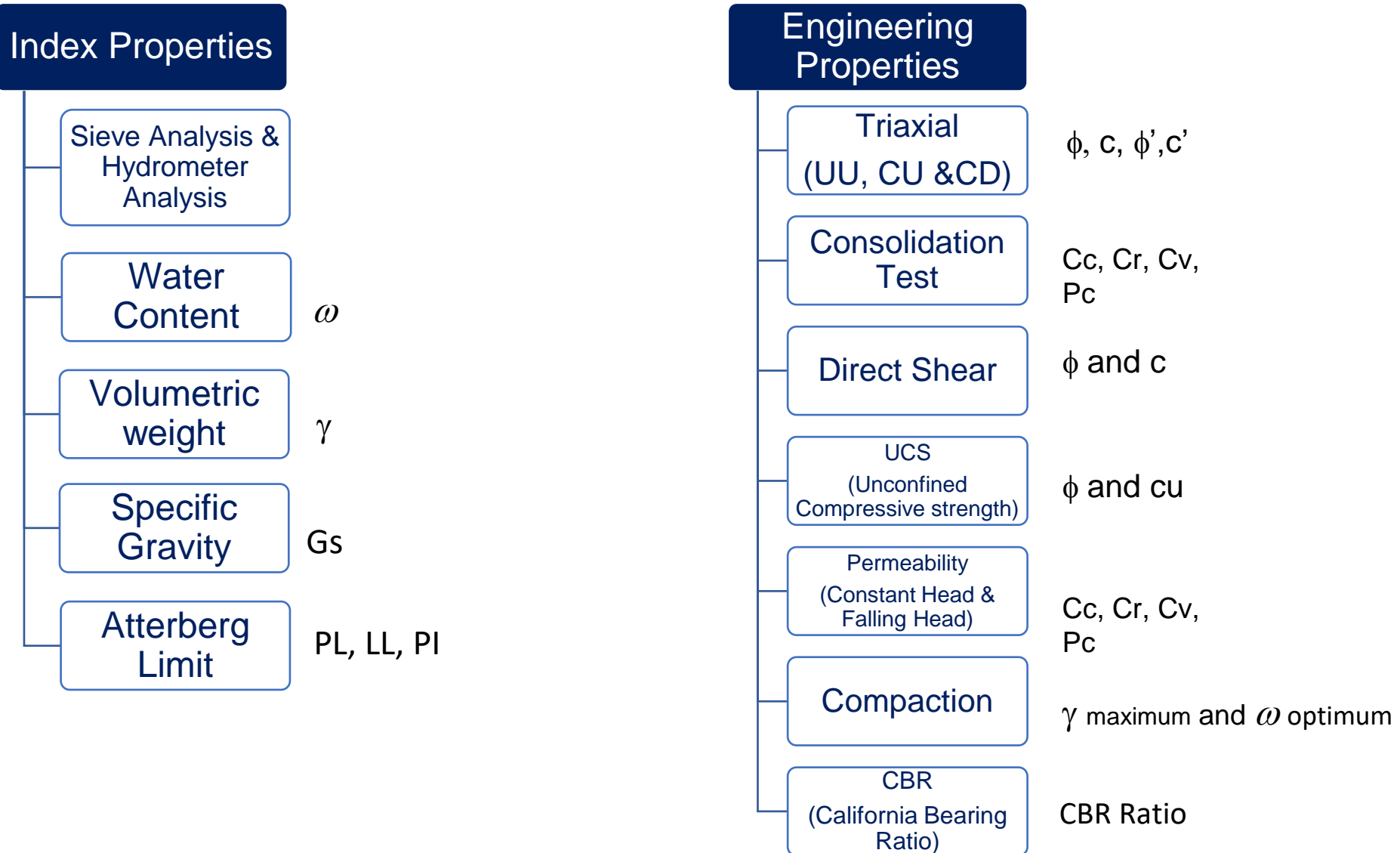
The physical properties of soils are usually determined by carrying out tests on samples of soils in a laboratory. These test can be divided into two main categories:

1. **Index Properties**, which indicate the general type of soil and the engineering category to which it belongs.
2. Tests for the assessment of **engineering properties**, such as shear strength,



Digital Triaxial PT Zifa

# Laboratory Test



# Index Properties

## Sieve Analysis & Hydrometer Analysis

Water Content

Volumetric weight

Specific Gravity (Gs)

Atterberg Limit

### Sieve Analysis

Menentukan distribusi butir (gradasi) dari suatu sampel tanah dengan menggunakan saringan ukuran paling kecil tertahan di saringan no 200 dan menentukan klasifikasi tanah (USCS) *Unified Soil Classification Sytem* sesuai hasil pemeriksaan gradasi butir tanah.



**Standar ASTM yang Berlaku**

ASTM D6913-04 (09) & ASTM D1140-14

sipilUNIKOM

### Hydrometer analysis

Pemeriksaan ini dimaksudkan untuk menentukan pembagian ukuran butir (gradasi) dari tanah yang lewat saringan no.200 atau lebih kecil dari 0.075mm.



**Standar ASTM yang Berlaku**

ASTM D7928-16

# Index Properties

## Sieve Analysis & Hydrometer Analysis

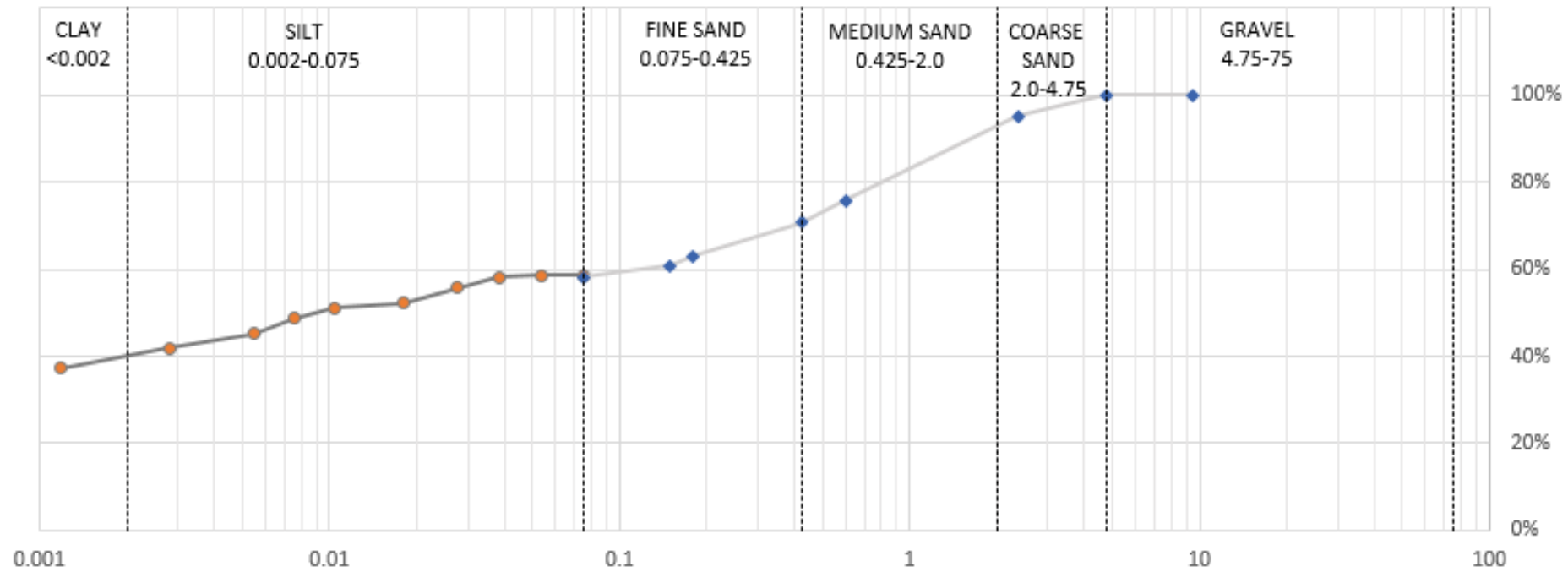
Water Content

Volumetric weight

Specific Gravity (Gs)

Atterberg Limit

## Sieve Analysis & Hidrometer





# Index Properties

Sieve Analysis &  
Hydrometer Analysis

Water Content

Volumetric weight

Specific Gravity (Gs)

Atterberg Limit

## Kadar Air

Pemeriksaan ini bertujuan untuk menentukan kadar air tanah pada sample *undisturb*. diperoleh dari rasio perbandingan berat air yang terkandung dalam pori tanah dengan berat tanah solid.

**Standar ASTM yang Berlaku : ASTM D2216-10**

## Berat Volume

Merupakan satuan berat tanah ( $\gamma$ ) sampel tanah *undisturb* yang ditentukan dari pengujian laboratorium berupa pengukuran fisik dimensi dan beratnya

**Standar ASTM yang Berlaku : ASTM D422-63**

## Specific Gravity

Merupakan rasio berat satuan tanah dengan berat satuan air. Hasil dari specific Gravity (Gs) mengindikasikan rasio tanah mendekati 2.55 -2.80 untuk semua jenis tanah. Namun pada umumnya nilai berkisar antara 2.6-2.75

**Standar ASTM yang Berlaku : ASTM D854-14**





# Index Properties

Sieve Analysis &  
Hydrometer Analysis

Water Content

Volumetric weight

Specific Gravity (Gs)

Atterberg Limit

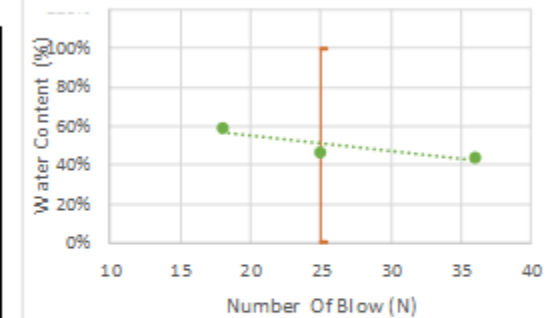
## Atterberg Limit

The Atterberg Limits consist of three separate tests: the liquid limit test, the plastic limit test, and the shrinkage limit test (ASTM D4318-10 )



Pengujian Batas Atterberg  
Atterberg Limit (ASTM D 4318-10 <sup>§1</sup>)

Trial Number		I	II	III
Container ID				
<b>Liquid Limit Test</b>				
Mass of container	Mc (gr)	10.4	10.44	11.13
Mass of moist soil + container	M1 (gr)	35.6	41.49	44.82
Mass of dry soil + container	M2 (gr)	27.88	31.6	32.27
Water content	w (%)	44.2%	46.7%	59.4%
Number of Blows	N	36	25	18
<b>Plastic Limit Test</b>				
Mass of container	Mc (gr)	3.35	3.38	3.39
Mass of moist soil + container	M1 (gr)	6.62	6.75	6.54
Mass of dry soil + container	M2 (gr)	6.28	6.25	6.19
Water content	w (%)	11.6%	17.4%	12.5%



Plastic Limit	PL	=	13.8%
Liquid Limit	LL	=	45.0%
Plasticity Index	PI	=	31.2%
Liquidity Index	LI	=	24.63%

# Engineering Properties

## Triaxial Properties

Consolidation Test

Direct Shear

UCS

(Unconfined Compressive Strength)

Permeability

(Constant head & Falling Head)

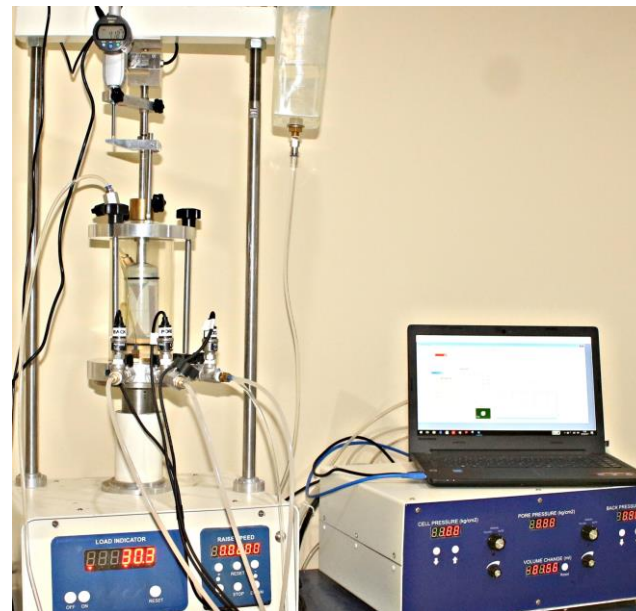
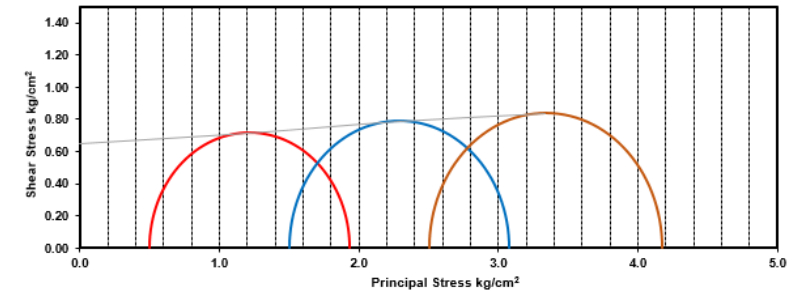
Compaction

CBR

(California Bearing Ratio)

## Triaxial Compression Test

The triaxial compression test (ASTM D2850) is used for the determination of strength parameter of soil. The two parameters acquired are cohesion ( $c$ ) and internal angle friction ( $\phi$ ).



# Engineering Properties

Triaxial Properties

Consolidation Test

Direct Shear

UCS

(Unconfined Compressive Strength)

Permeability

(Constant head & Falling Head)

Compaction

CBR

(California Bearing Ratio)

## Consolidation Test

The consolidation test is used for the determination of the consolidation characteristic of soils of low permeability. The two parameters normally acquired are:

1. The compressibility of the soil (coefficient of volume compressibility,  $C_c$ ), which is a measure of the amount by which the soil will compress when loaded and allowed to consolidate.
2. The time related parameter (coefficient of consolidation,  $C_v$ ), which indicates the rates of compression and hence the time period over which consolidation settlement will take place.



# Engineering Properties

Triaxial Properties

Consolidation Test

Direct Shear

UCS

(Unconfined Compressive Strength)

Permeability

(Constant head & Falling Head)

Compaction

CBR

(California Bearing Ratio)

## Direct Shear

The direct shear test (ASTM D3080) is used for the determination of strength parameter of soil. The two parameters acquired are cohesion ( $c$ ) and internal angle friction ( $\phi$ ).



## Unconfined Compression Test



The unconfined compression test (ASTM D2166), uses a tall, cylindrical sample of cohesive soil subjected to an axial load. This load applied quickly to maintain undrained condition. The test result are often expressed in terms of the compressive strength ( $S_u$ ).



# Engineering Properties

Triaxial Properties

Consolidation Test

Direct Shear

UCS

(Unconfined Compressive Strength)

Permeability

(Constant head & Falling Head)

Compaction

CBR

(California Bearing Ratio)

## Permeability Test

These test methods cover laboratory measurement of the hydraulic conductivity (also referred to as *coefficient of permeability*) of water-saturated porous materials with a flexible wall permeameter at temperatures between about 15 and 30°C

**ASTM : D5084-16a**



Table 8.4 Permeability based on soils classification.

Soil type	Description	USC symbol	Permeability, m/s
Gravels	Well graded	GW	$10^{-3}$ to $10^{-1}$
	Poorly graded	GP	$10^{-2}$ to $10^0$
	Silty	GM	$10^{-7}$ to $10^{-5}$
	Clayey	GC	$10^{-8}$ to $10^{-6}$
Sands	Well graded	SW	$10^{-5}$ to $10^{-3}$
	Poorly graded	SP	$10^{-4}$ to $10^{-2}$
	Silty	SM	$10^{-7}$ to $10^{-5}$
	Clayey	SC	$10^{-8}$ to $10^{-6}$
Inorganic silts	Low plasticity	ML	$10^{-9}$ to $10^{-7}$
	High plasticity	MH	$10^{-9}$ to $10^{-7}$
Inorganic clays	Low plasticity	CL	$10^{-9}$ to $10^{-7}$
	High plasticity	CH	$10^{-10}$ to $10^{-8}$
Organic	with silts/clays of low plasticity	OL	$10^{-8}$ to $10^{-6}$
	with silts/clays of high plasticity	OH	$10^{-7}$ to $10^{-5}$
Peat	Highly organic soils	Pt	$10^{-6}$ to $10^{-4}$

# Engineering Properties

Triaxial Properties

Consolidation Test

Direct Shear

UCS

(Unconfined Compressive Strength)

Permeability

(Constant head & Falling Head)

Compaction

CBR

(California Bearing Ratio)

## Compaction

Compaction tests furnish the following basic data for soils:

1. The relationship between dry density and moisture content for a given degree of compactive effort.
2. The moisture content for the most efficient compaction i.e. at which the maximum dry density is achieved under that compactive effort.

**ASTM : D1557-12**

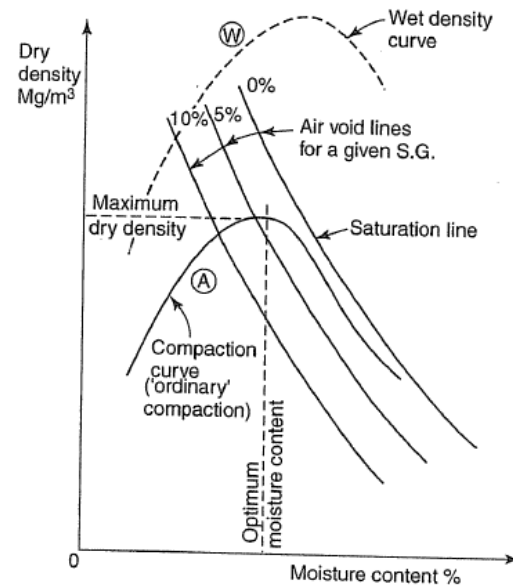


Figure 6.2 Dry density–moisture content relationship for soils



# Engineering Properties

Triaxial Properties

Consolidation Test

Direct Shear

UCS

(Unconfined Compressive Strength)

Permeability

(Constant head & Falling Head)

Compaction

**CBR**

(California Bearing Ratio)

## CBR

Tujuan uji CBR adalah untuk menilai kekuatan tanah dasar yang di kompaksi untuk digunakan dalam perancangan pengerasan.

**Astm : D1883-16**

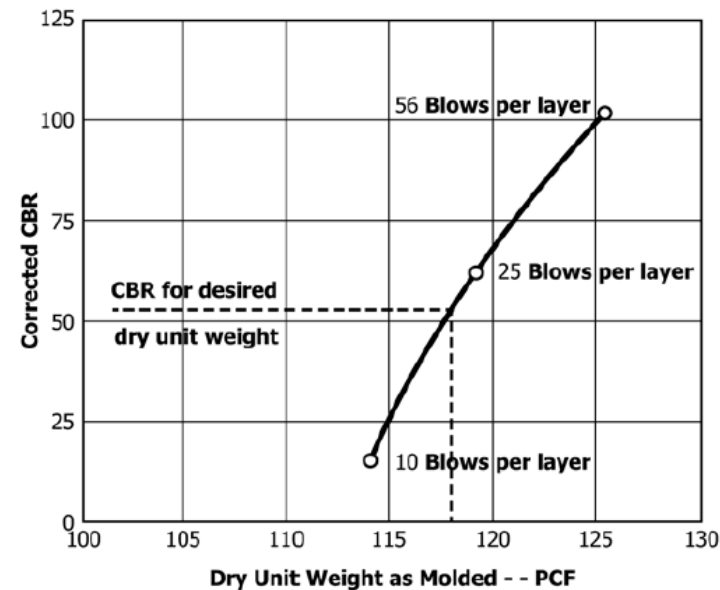


FIG. 6 Dry Unit Weight Versus CBR

