Dredging Processes

Dr.ir. Sape A. Miedema

2. Soil Mechanics

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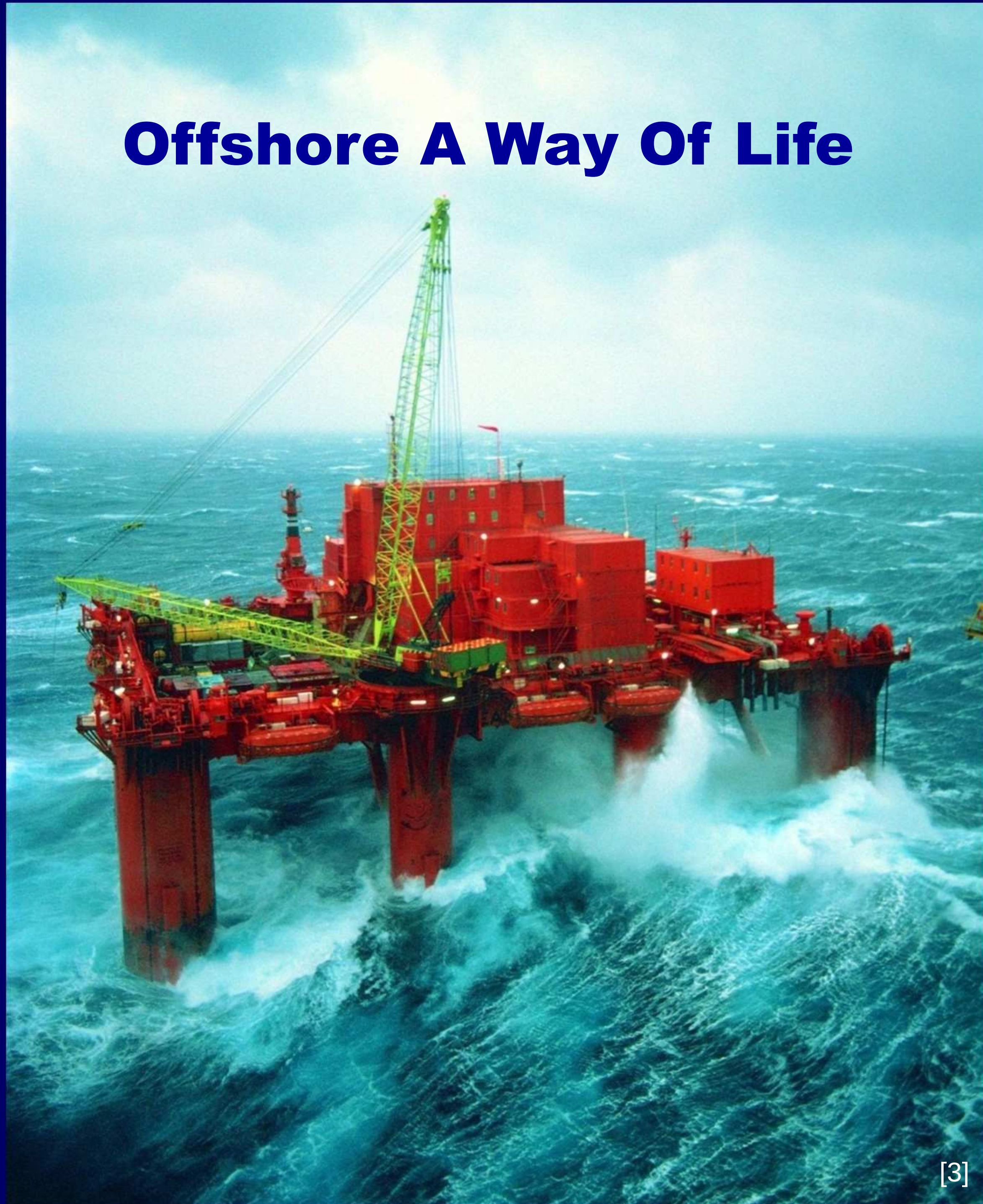
Offshore A Way Of Life



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Offshore & Dredging Engineering

Dr.ir. Sape A. Miedema
Educational Director

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Soils

Faculty of 3mE - Dredging Engineering

Soil Creation


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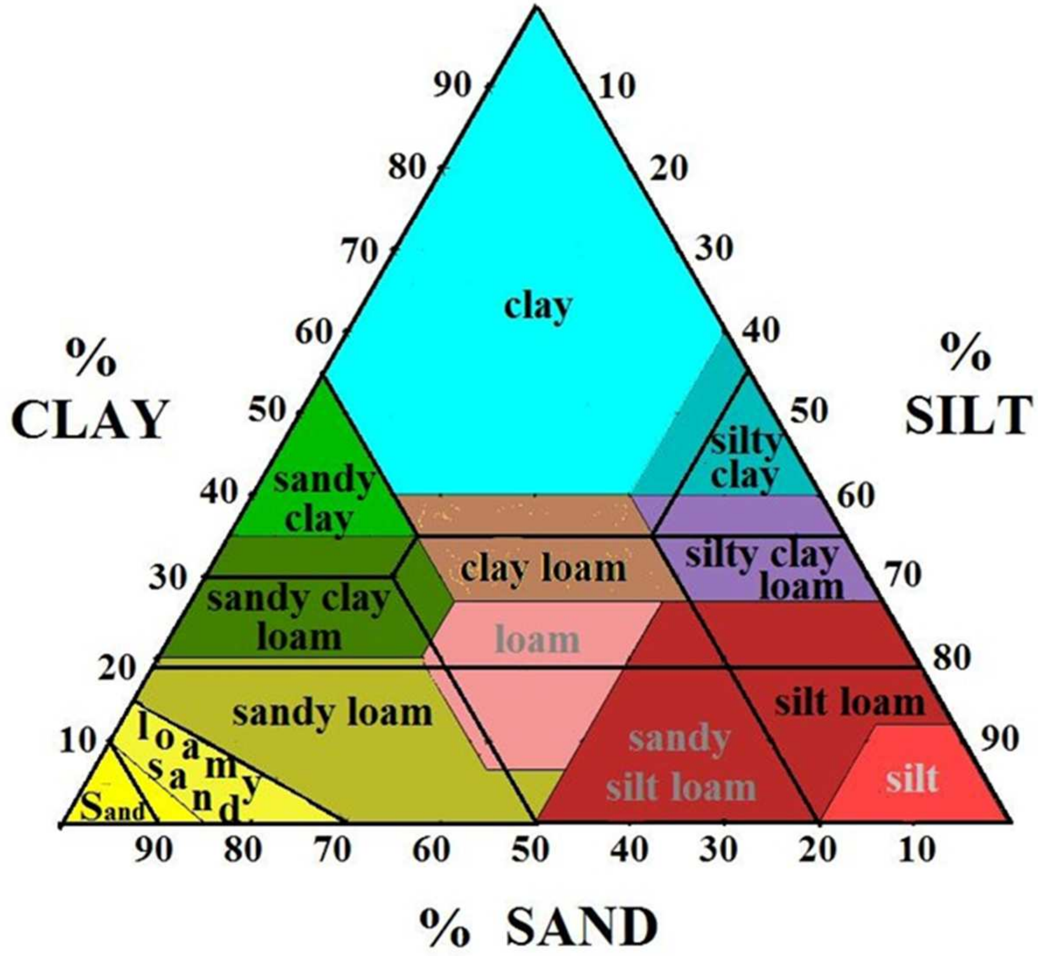
Soil Classification

A soil textural triangle showing the subtle differences between the USDA (colours) and UK- ADAS (black lines) soil classes



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Soil Classification

Name of soil separate	Diameter limits (mm) (USDA classification)
Clay	less than 0.002
Silt	0.002–0.05
Very fine sand	0.05–0.10
Fine sand	0.10–0.25
Medium sand	0.25–0.50
Coarse sand	0.50–1.00
Very coarse sand	1.00–2.00

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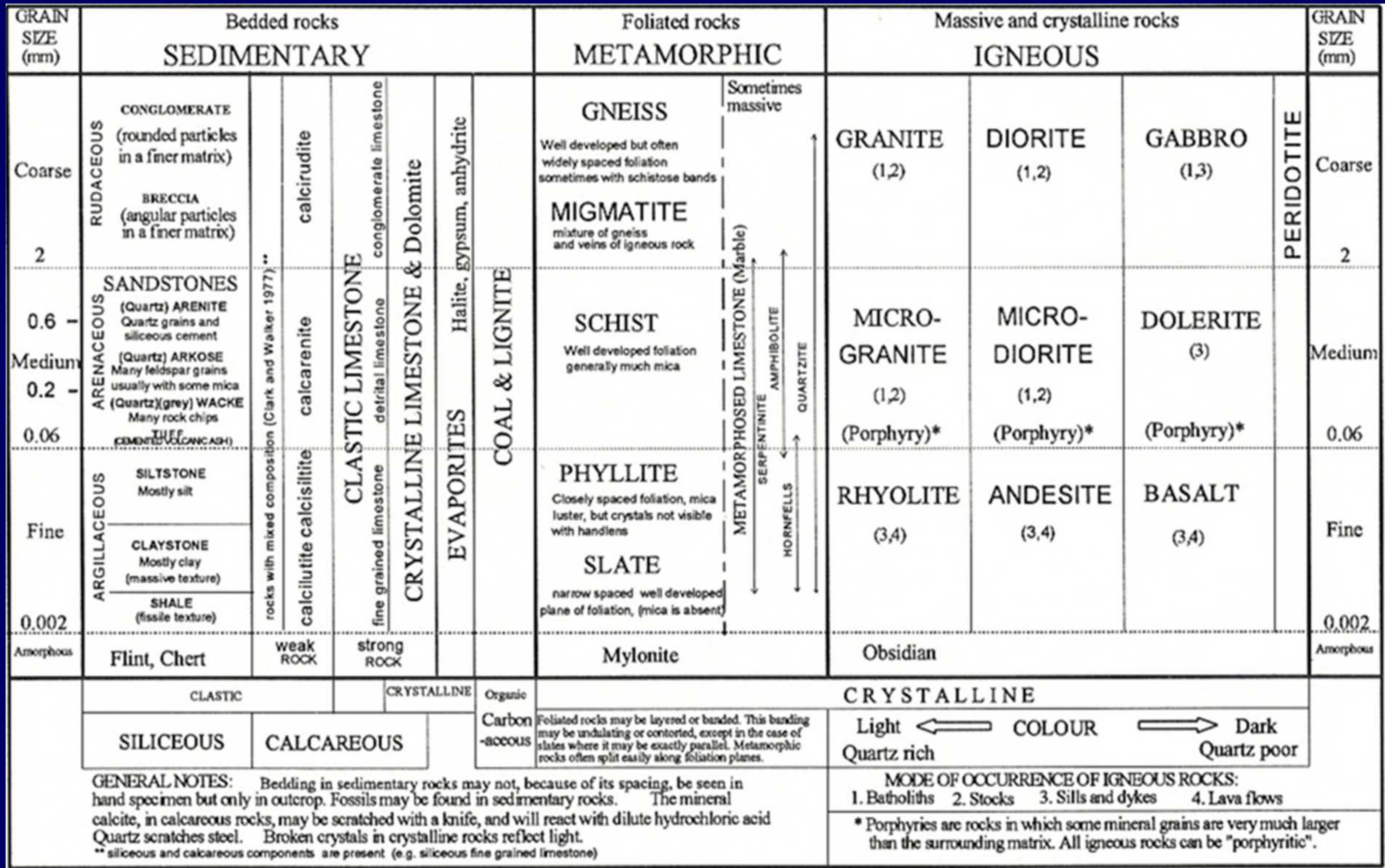
Rock Classification



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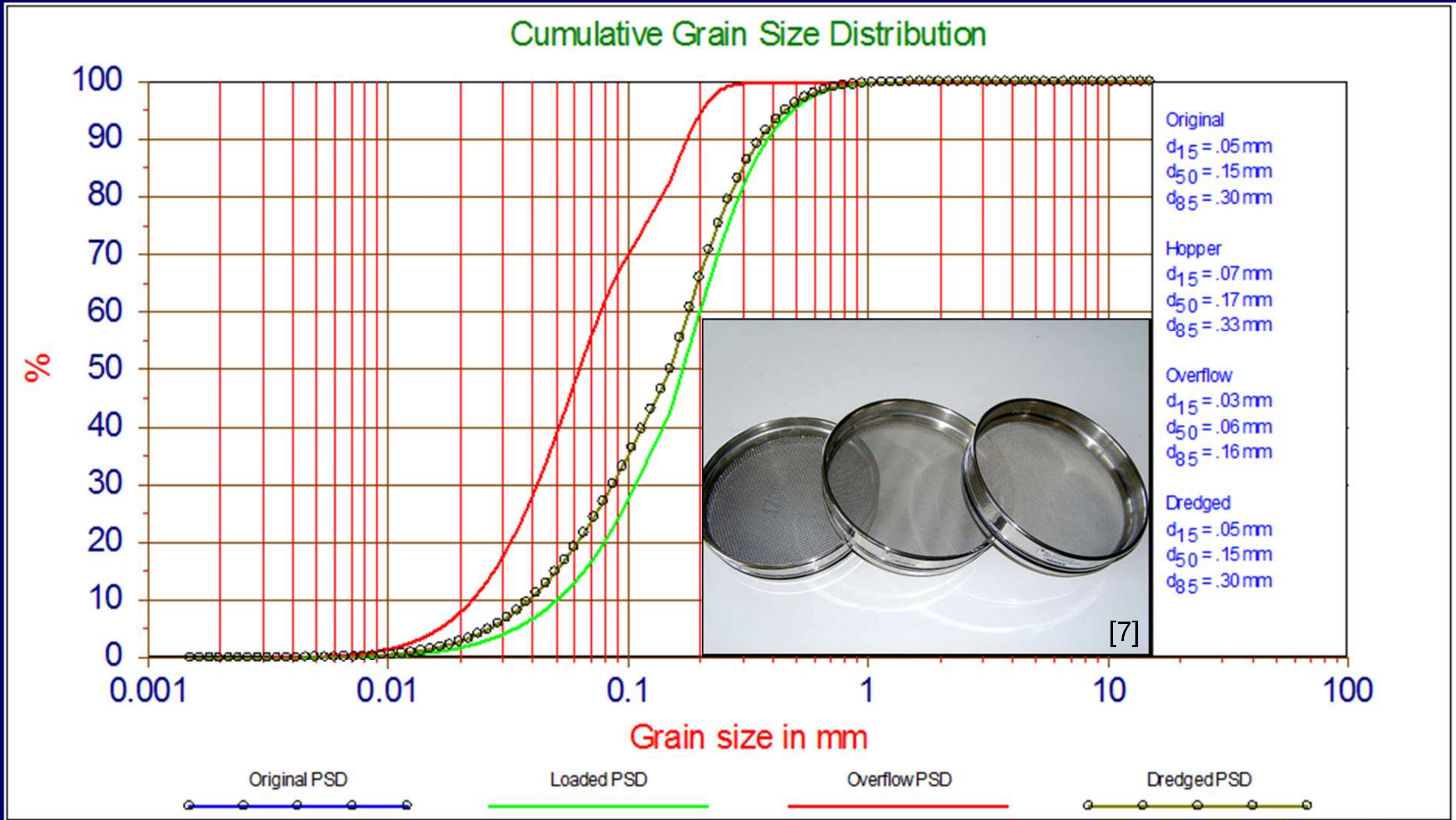
Particle Size Distribution



Trailing Suction Hopper Dredge V1.4.3, August 02, 2011, 14:58:35
Manhattan Island (C:\ProgramFiles\Trailing Suction Hopper Dredge\TSHDGLDD\Manhattan Island.Inp)
Excersise (C:\ProgramFiles\Trailing Suction Hopper Dredge\Sand\Nags Head 0.413(0.712).Inp)
Optimum production: 2493 TDS, loaded in: 30.5 min, overflow losses: 542 TDS

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Parameters

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Atterberg Limits

Plastic Limit
Liquid Limit

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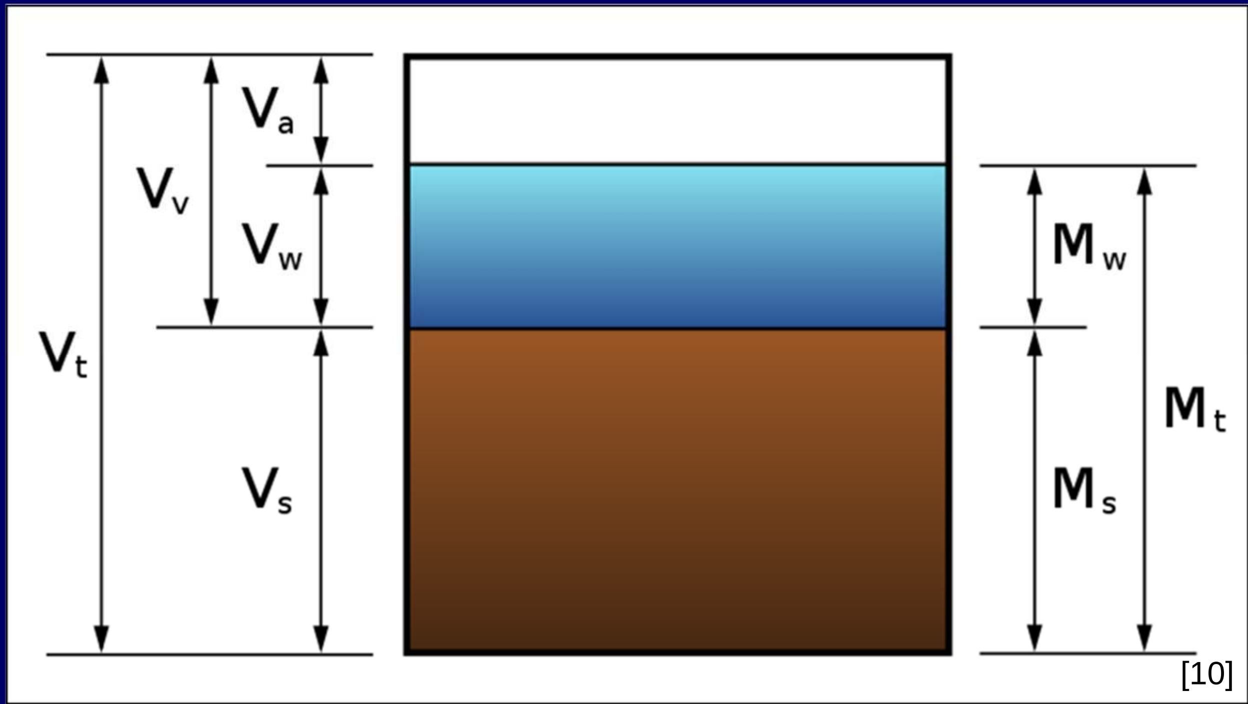
Mass Volume Relations



Density

Specific Gravity

Relative Density

Porosity – Void Ratio

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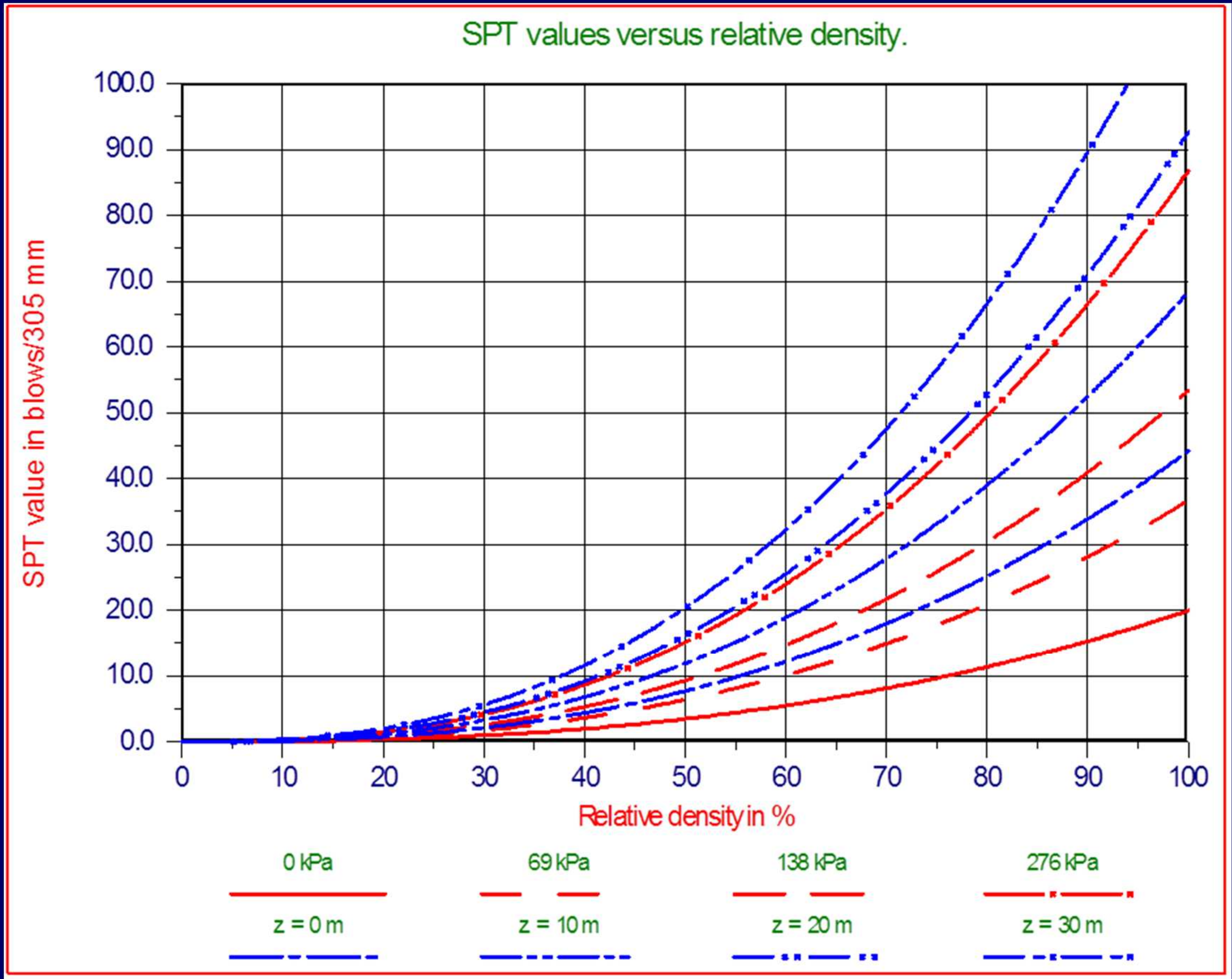
Relative Density vs SPT Value



Permeability

k (cm/s)	10^2	10^1	10^0=1	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}	10^{-10}
k (ft/day)	10^5	10,000	1,000	100	10	1	0.1	0.01	0.001	0.0001	10^{-5}	10^{-6}	10^{-7}
Relative Permeability	Pervious				Semi-Pervious				Impervious				
Aquifer	Good					Poor				None			
Unconsolidated Sand & Gravel	Well Sorted Gravel		Well Sorted Sand or Sand & Gravel			Very Fine Sand, Silt, Loess, Loam							
Unconsolidated Clay & Organic					Peat		Layered Clay			Fat / Unweathered Clay			
Consolidated Rocks	Highly Fractured Rocks				Oil Reservoir Rocks			Fresh Sandstone		Fresh Limestone, Dolomite		Fresh Granite	

Permeability	Pervious				Semi-Pervious				Impervious				
Unconsolidated Sand & Gravel	Well Sorted Gravel		Well Sorted Sand or Sand & Gravel			Very Fine Sand, Silt, Loess, Loam							
Unconsolidated Clay & Organic					Peat		Layered Clay			Unweathered Clay			
Consolidated Rocks	Highly Fractured Rocks				Oil Reservoir Rocks			Fresh Sandstone		Fresh Limestone, Dolomite		Fresh Granite	
K (cm^2)	0.001	0.0001	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}	10^{-10}	10^{-11}	10^{-12}	10^{-13}	10^{-14}	10^{-15}
K (millidarcy)	10^{+8}	10^{+7}	10^{+6}	10^{+5}	10,000	1,000	100	10	1	0.1	0.01	0.001	0.0001

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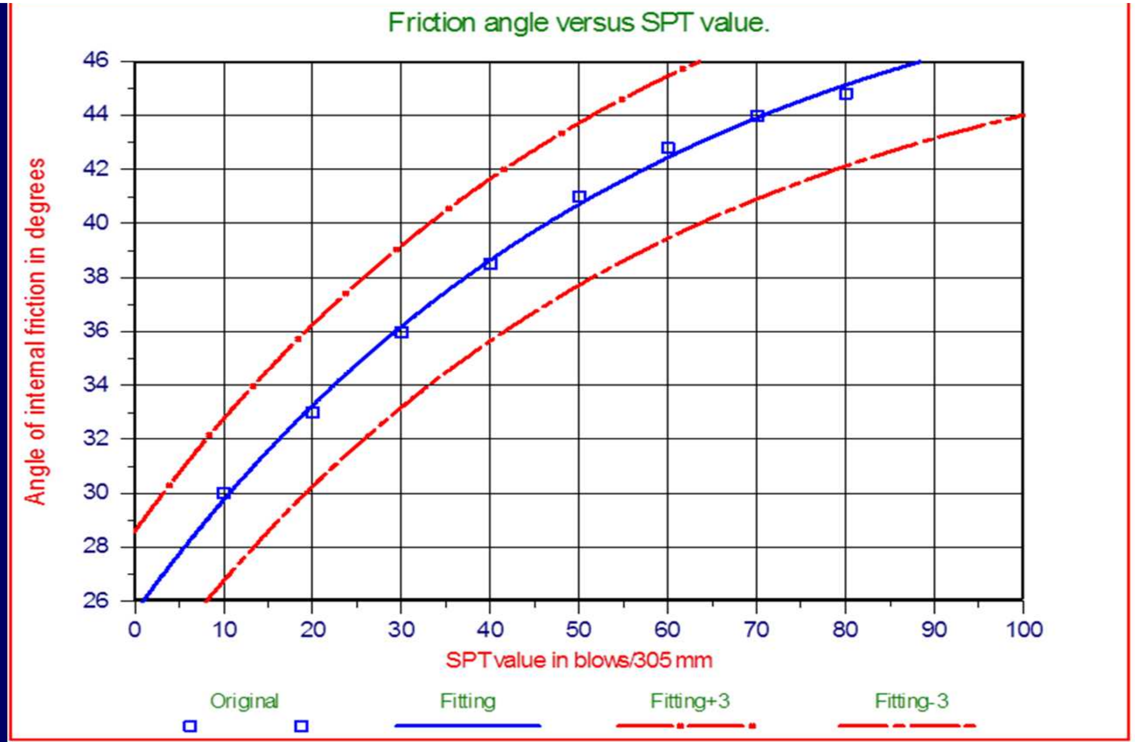
Angle of Internal Friction

SPT Penetration, N-Value (blows/ foot)	Density of Sand	φ (degrees)
<4	Very loose	<29
4 - 10	Loose	29 - 30
10 - 30	Medium	30 - 36
30 - 50	Dense	36 - 41
>50	Very dense	>41



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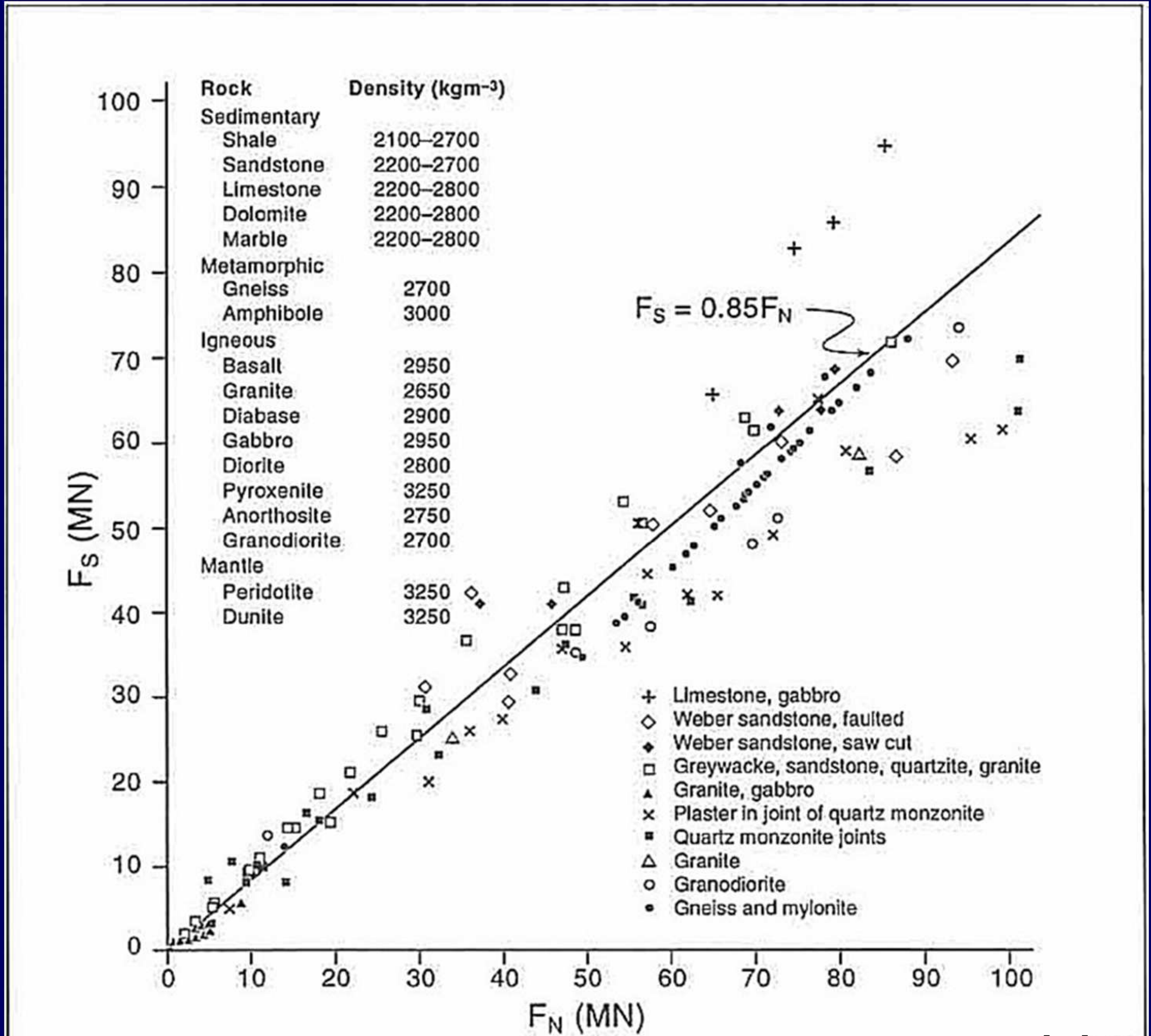
Angle of Internal Friction Rock



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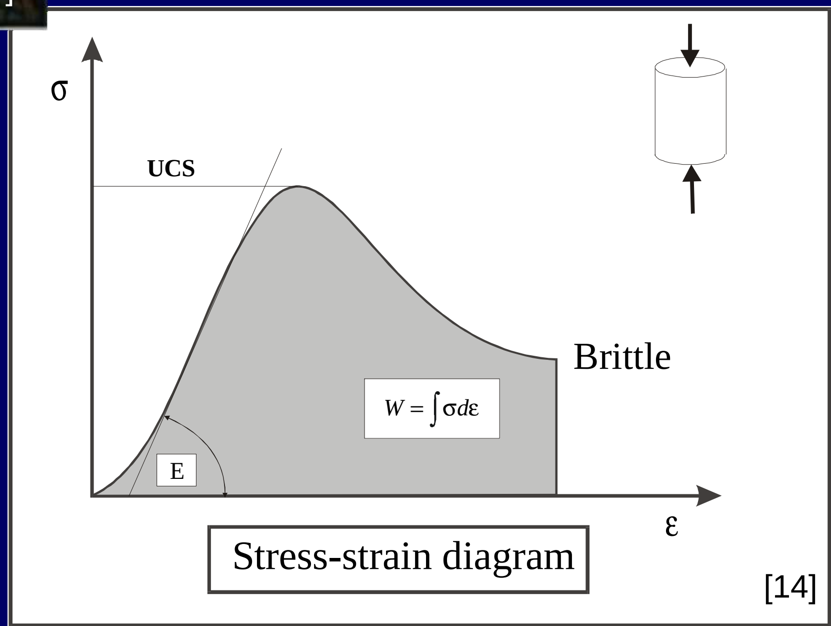
Angle of External Friction

20°	steel piles (NAVFAC)
$0.67 \cdot \varphi - 0.83 \cdot \varphi$	USACE
20°	steel (Broms)
$\frac{3}{4} \cdot \varphi$	concrete (Broms)
$\frac{2}{3} \cdot \varphi$	timber (Broms)
$0.67 \cdot \varphi$	Lindeburg
$\frac{2}{3} \cdot \varphi$	for concrete walls (Coulomb)

Cohesion/Adhesion

SPT Penetration (blows/ foot)	Estimated Consistency	U.C.S.(kPa)
<2	Very Soft	<24
2 - 4	Soft	24 - 48
4 - 8	Medium	48 - 96
8 - 15	Stiff	96 – 192
15 - 30	Very Stiff	192 – 388
>30	Hard	>388

Unconfined Compressive Stress



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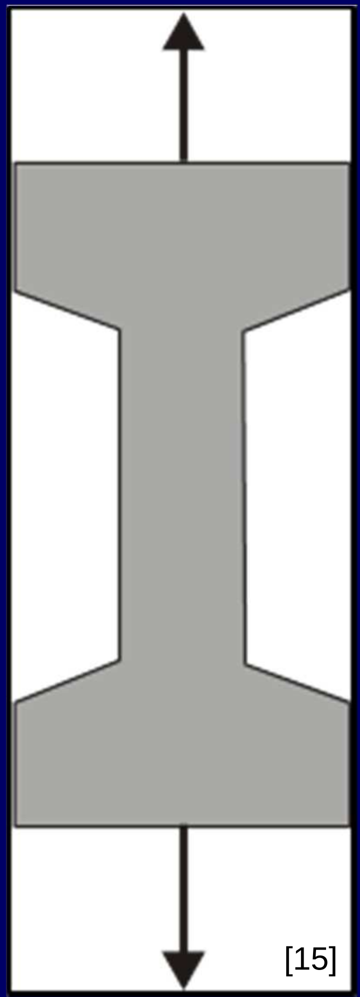
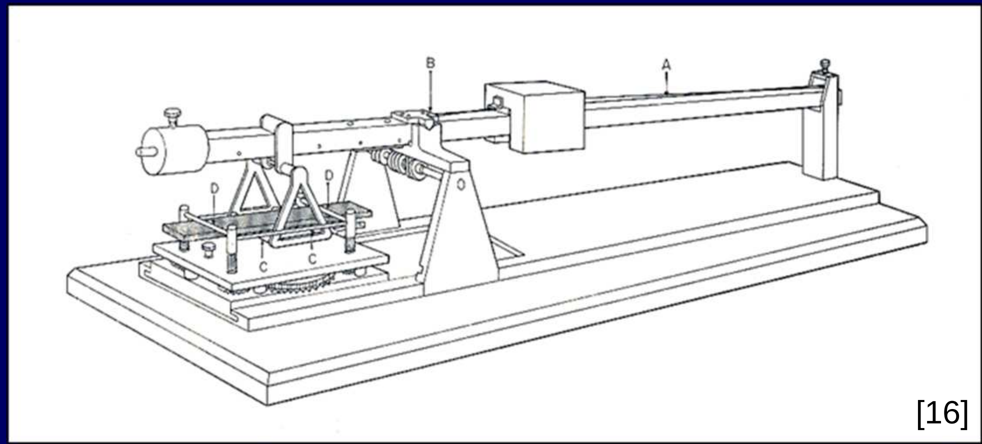
Unconfined Tensile Strength

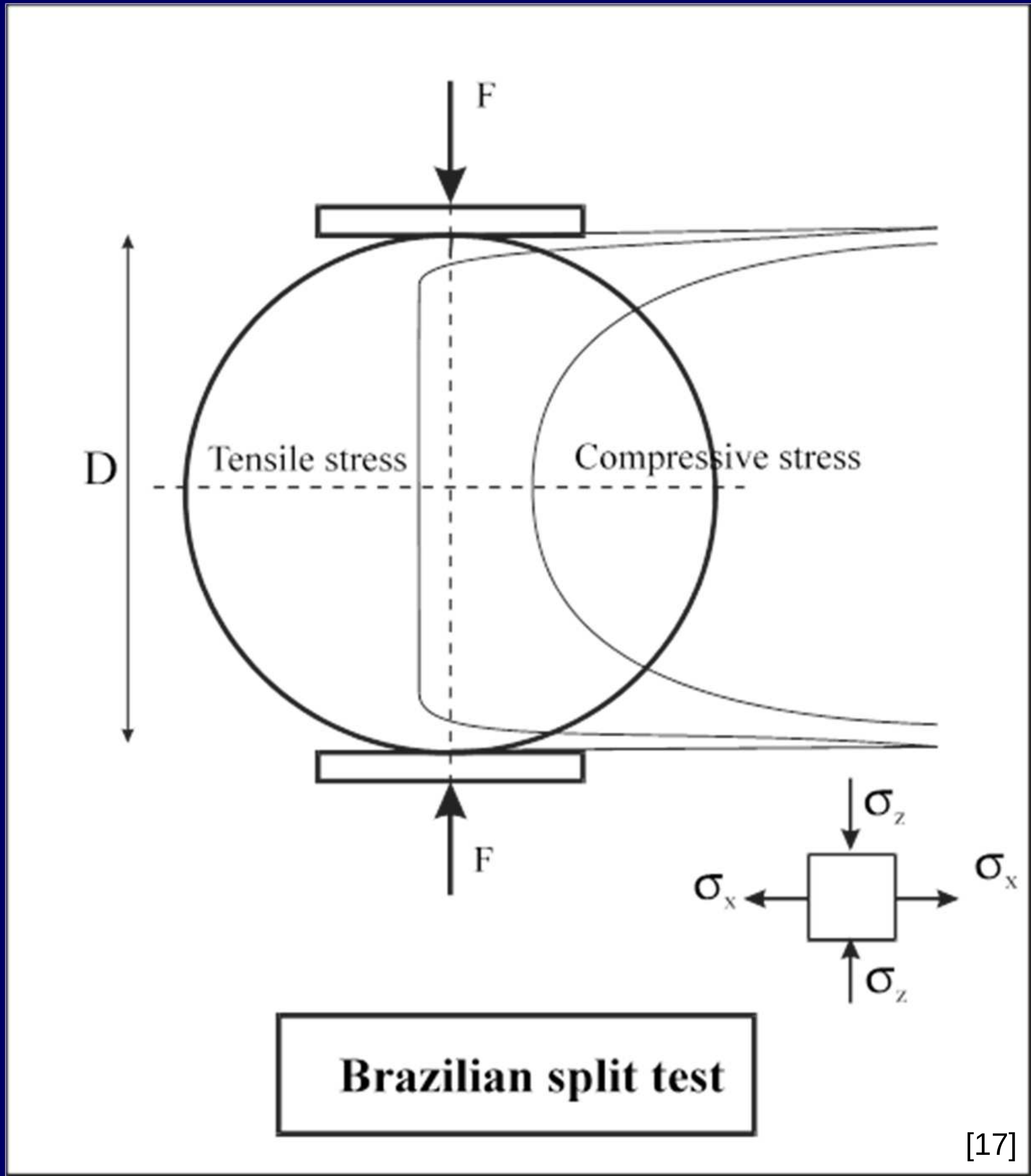


[15]

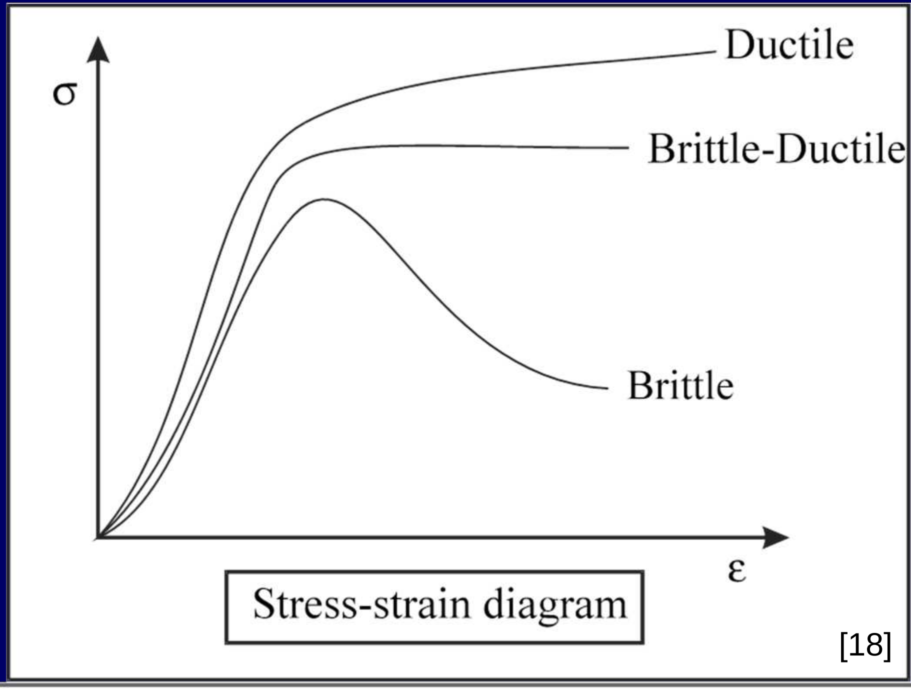


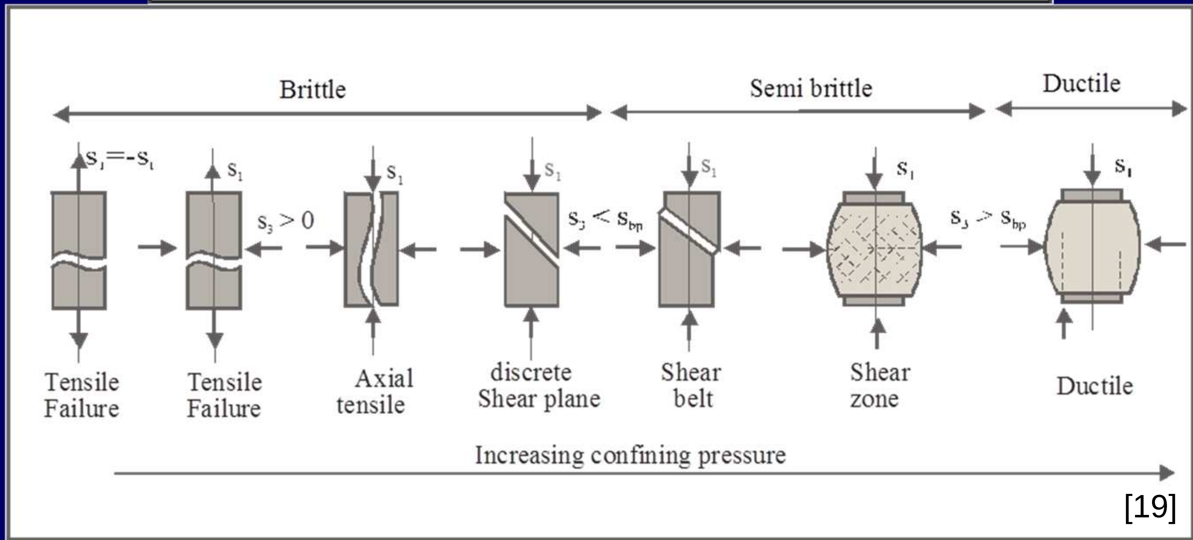
[16]

Brazilian Tensile Strength



Brittle vs Ductile





Testing

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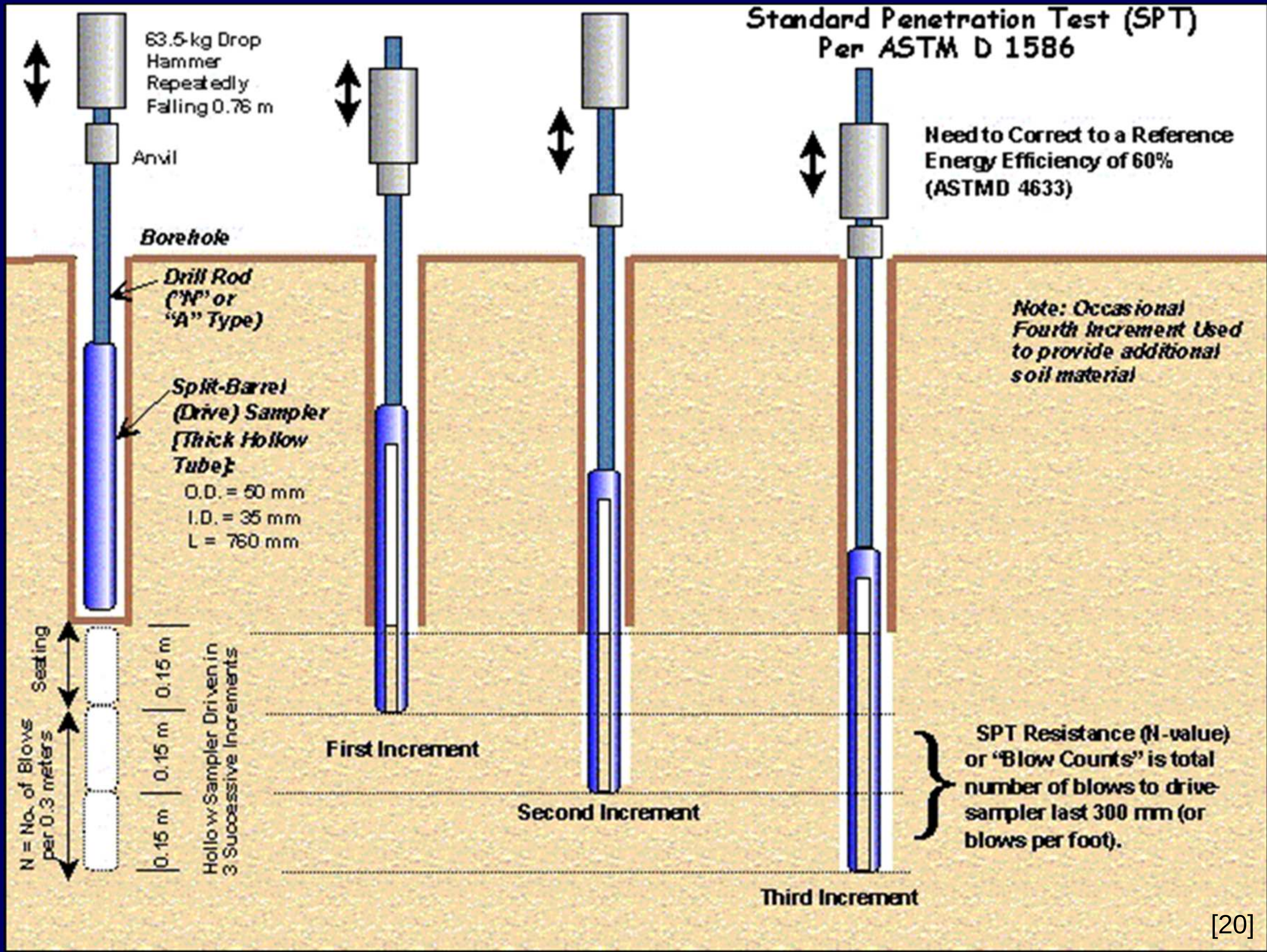
Standard Penetration Test



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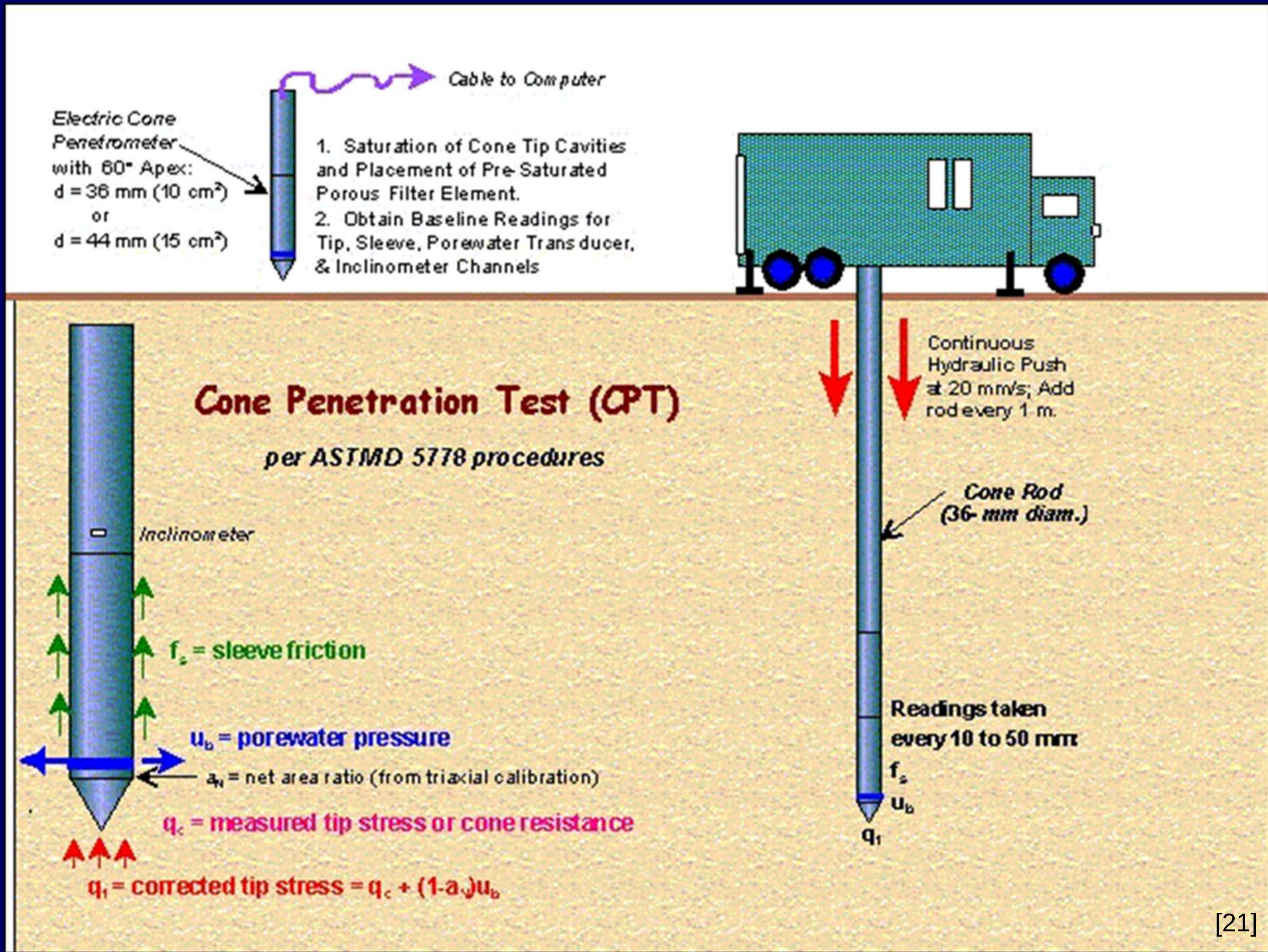
Cone Penetration Test



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Cones

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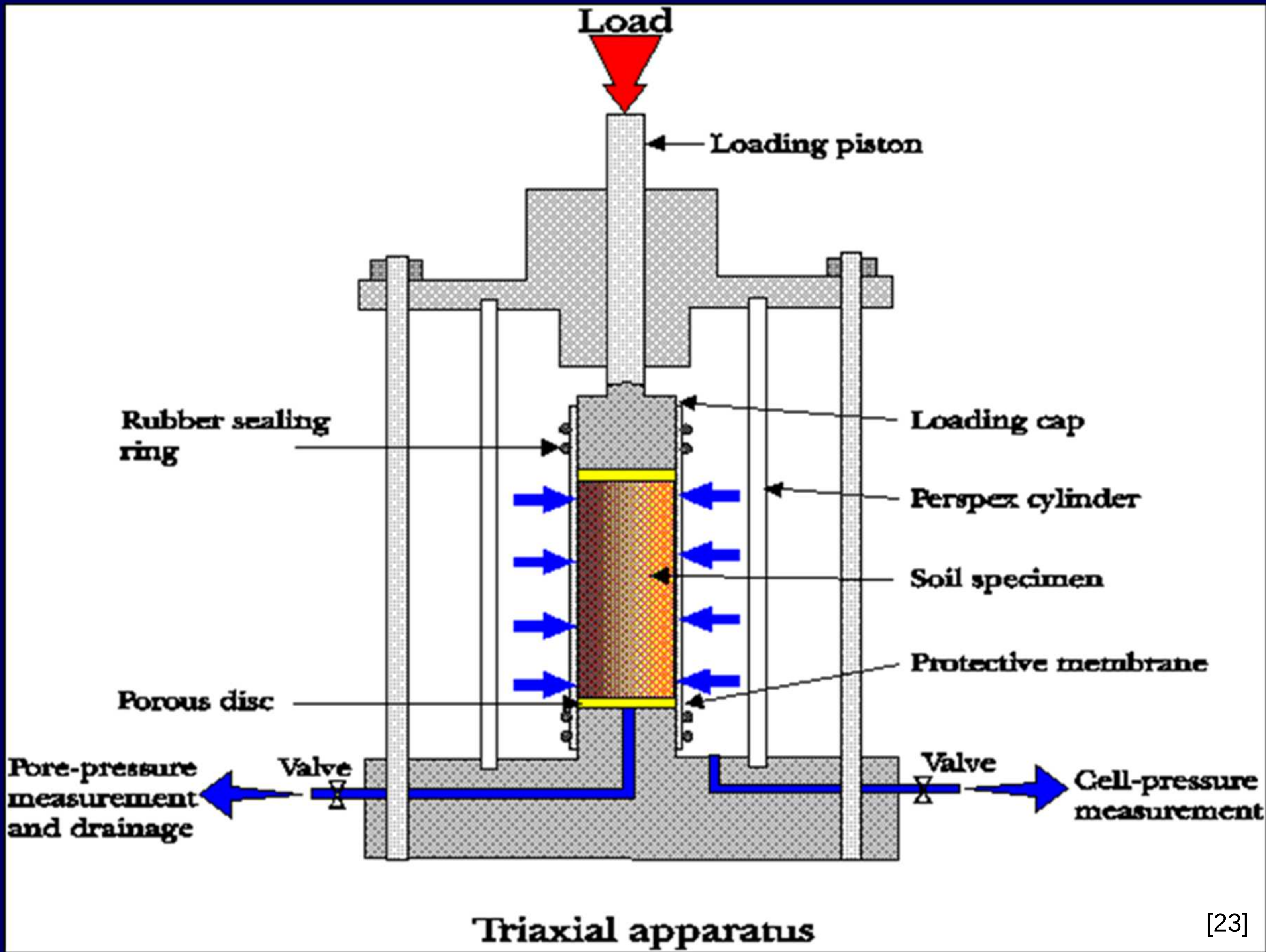
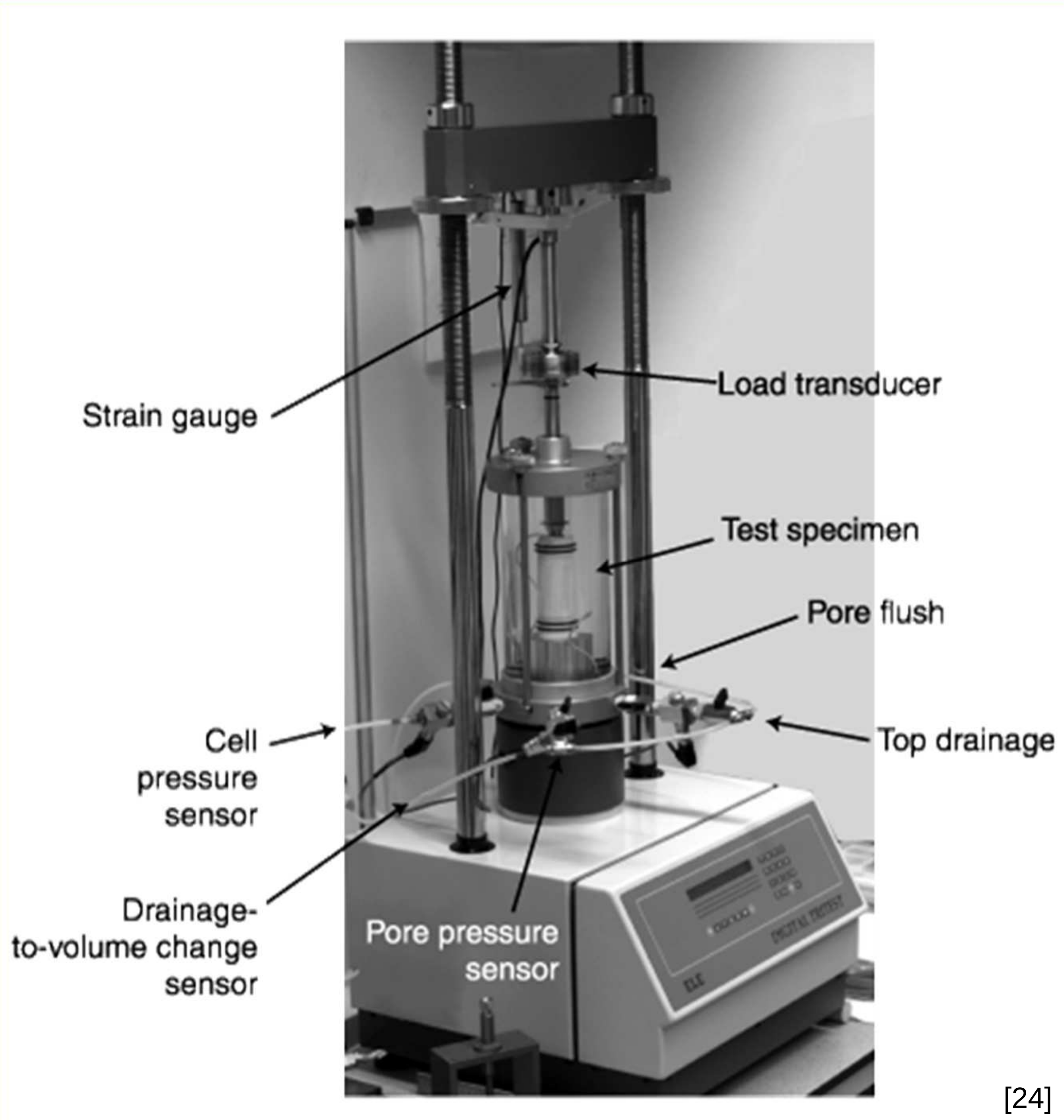
Tri-axial Test



Tri-axial Test



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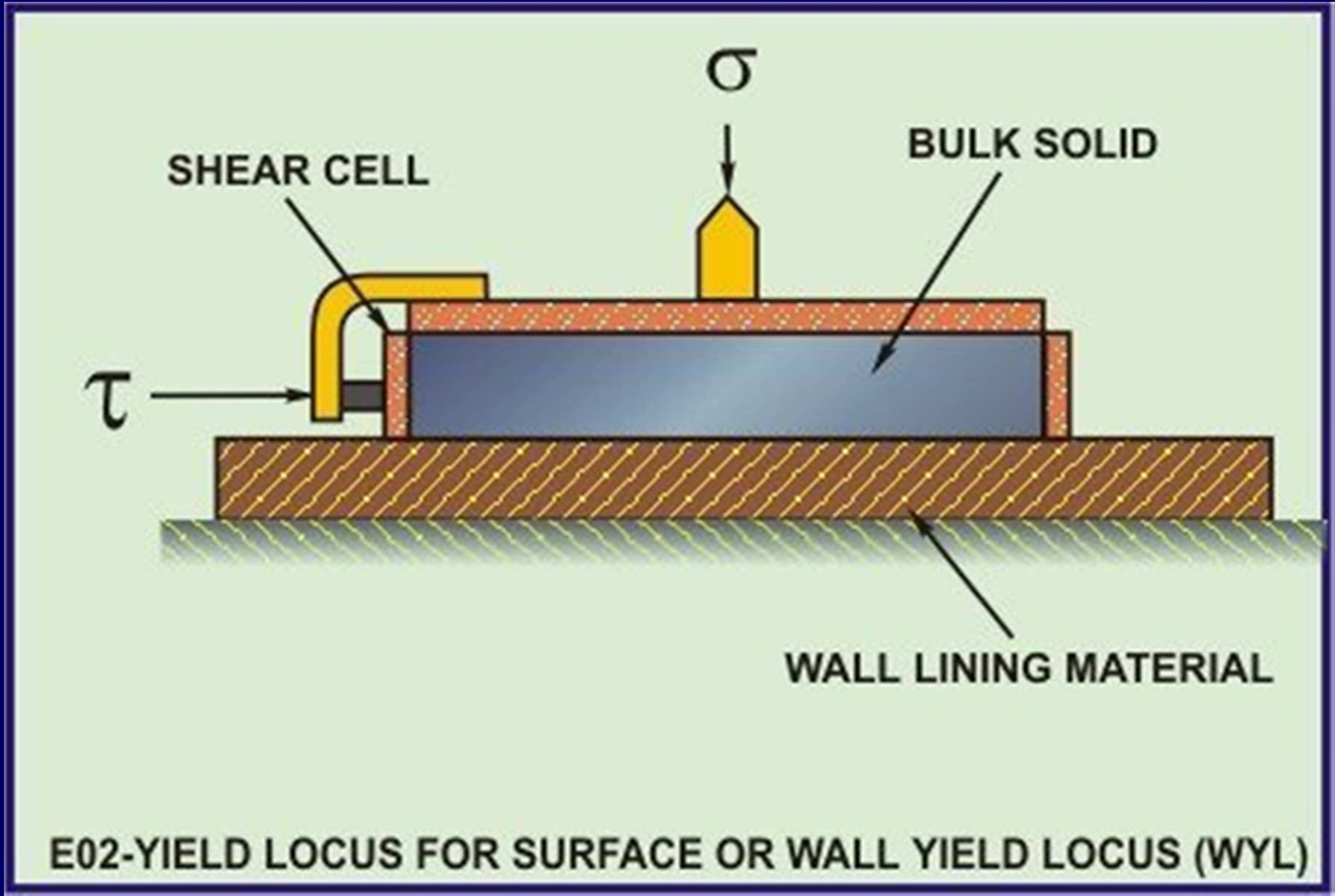
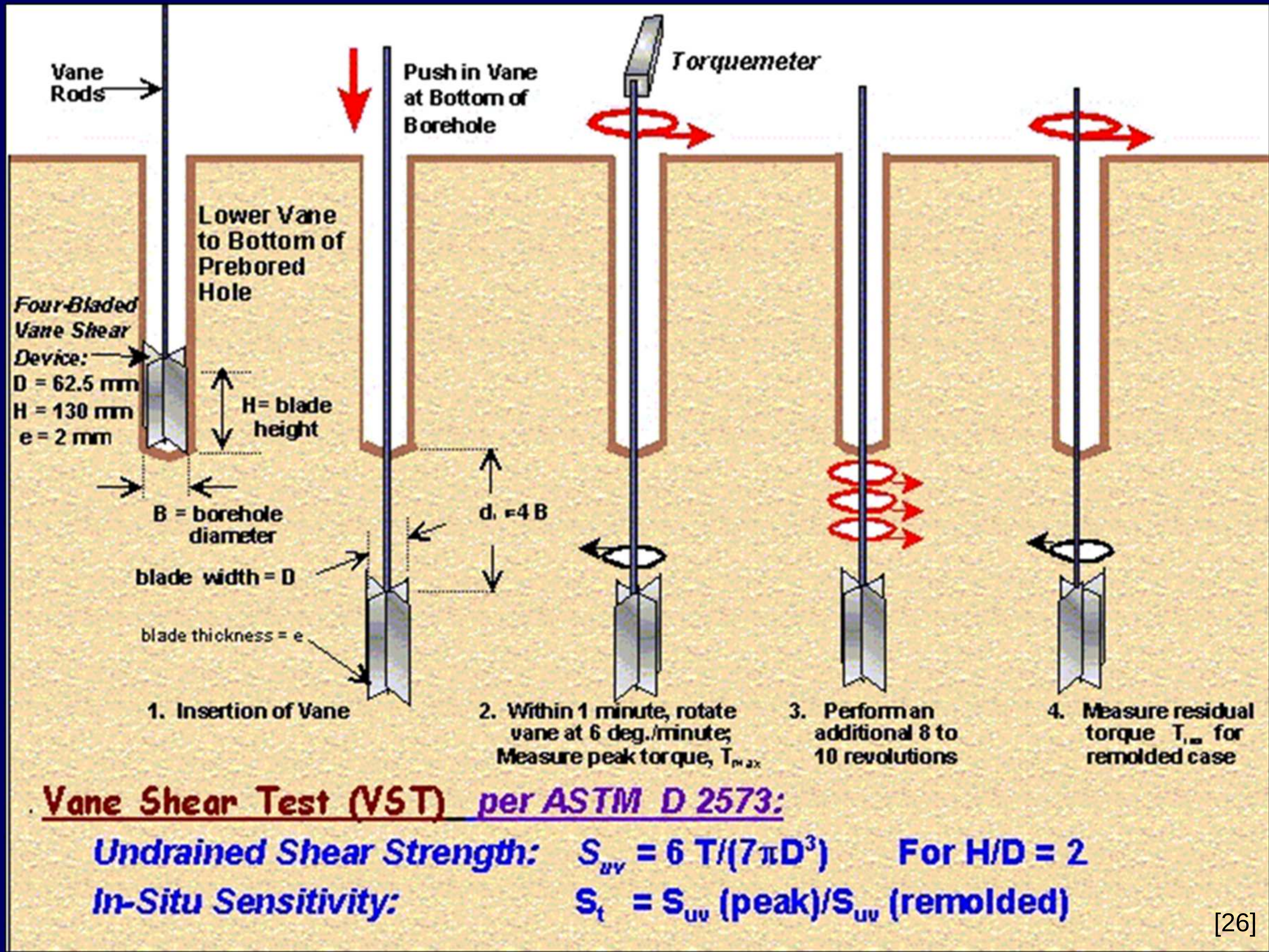
Direct Shear Test



[25]

Vane Shear Test



Questions?

Sources images

1. A model cutter head, source: Delft University of Technology.
2. Off shore platform, source: Castrol (Switzerland) AG
3. Off shore platform, source: http://www.wireropetraining.com
4. Fox Glacier, New Zealand (1986), source: Wikimedia Commons/Ot
5. Soil textural triangle, source: Creative Commons/Greenman-23
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7. Laboratory sieves; 1700 µm, 500 µm, 250 µm (from left), author: BMK/Wikipedia, source://commons.wikimedia.org/wiki/File:Laboratory_sieves_BMK.jpg
8. Liquid limit device, source: Wikimedia Commons/E smith2000
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