

## Field Soil Undrained Strength ( $S_u$ ) Estimator

Using the Torvane, Pocket Penetrometer, and your hand for estimating strength

POC: Dr. Rick Olsen, HQ USACE CW E&C

Richard.s.Olsen@usace.army.mil --- version v6c --- 13+1012

Note: 1 tsf  $\approx$  1 kgf/cm<sup>2</sup>  $\approx$  2000 psf  $\approx$  100 KPa  $\approx$  0.1 MPA  $\approx$  10 N/cm<sup>2</sup>  $\approx$  1 atm (use psf for  $S_u$  in USA)

### Torvane usage (TorV or TV) For estimated clay undrained strength ( $S_u$ )

Select vane size so failure occurs at more than 30% but less than about 60% of full rotation,  
Apply a strong pressure to the Torvane (but don't overly push the probe to fail the soil in bearing),  
Carefully turn the handle to cause failure in about 10 seconds.

#### TorV has three vane sizes:

*The maximum strengths below reflect rotations equal to full 360° rotation or 100% rotation*

**Normal Vane** (to stiff clay),  $S_u = 0$  to 2000 psf

**Large Vane attachment** (to very soft clay),  $S_u = 0$  to 400 psf

**Small Vane attachment** (to very stiff clay),  $S_u = 0$  to 5000 psf

**In the field show "TorV" then state the vane size, and record rotation as a percent (%)**

Record TV strength as a percent of full rotation (i.e. 360 degrees=100%)

e.g., "TorV LargeV 65%"  $\rightarrow$  in the office calculate  $S_u = 260$  psf

Try to perform at least 4 measurements and then bag the sample (for  $w_n$ )

e.g., "TorV NormV (45, 36, 42, 39)% bagged"

Always perform remolded tests, after 2 full rotations, e.g., "TorV LargeV REM=13%"

### Pocket Penetrometer usage (PPen or PP) -- remember TorV is always better than PPen

The PPen estimated strength is in terms of "Compression Strength" ( $C_s$ ), therefore

Undrained Strength is equal to half of the compression strength; ( $S_u$ )<sub>TXUU</sub> =  $\frac{1}{2} * C_s$

#### PPen has two footing sizes:

*The maximum strengths shown below are at maximum scale of the Pocket Pen, i.e. index = 4.5*

**Normal Footing** (for very stiff),  $C_s = 0$  to 9000 psf ( $S_u = 4500$  psf)

**Large Footing added** (for soft clays),  $C_s = 0$  to 585 psf ( $S_u = 292$  psf)

**In the field show "PPen" (state if using large footing), and record PP as an index (i = 0 to 4.5)**

e.g., "PPen LargeF i=4"  $\rightarrow$  in the office calculate  $S_u = 260$  psf {remember the  $\frac{1}{2}$  factor}

### Estimating Field Clay Strengths using your hand

Very Soft  $S_u \approx 250$  psf

Penetrate with **Fist** several inches is **Easy**.

(Use large vane for TorV or large footing for PPen)

Soft  $S_u \approx 500$  psf

Penetrate with **Thumb** several inches is **Easy**.

(use normal vane for TorV or large footing for PPen)

Medium Stiff  $S_u \approx 500$ -1000 psf

Penetrate with **Thumb** several inches with **moderate** effort.

(use normal vane for TorV or normal footing for PPen)

Stiff  $S_u \approx 1000$ -2000 psf

**Indented** with **Thumb** with **great effort**.

(use small to normal vane for TorV or normal footing for PPen)

Very Stiff  $S_u \approx 2000$ -4000 psf

**Indented** with thumb **Nail** is **Easy**.

(use small vane for TorV or normal footing for PPen)

Hard  $S_u > 4000$  psf

**Indented** with thumb **Nail** with **difficulty**.

(use small vane for TorV or normal footing for PPen)

**Show field estimates as simple words**, e.g. "thumb inches easy"  $\rightarrow$  in the office state  $S_u \approx 500$  psf