USEPA BIOREACTOR WORKSHOP
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LANDFILL & WASTE GEOTECHNICAL STABILITY

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PRESENTATION OVERVIEW

- Traditional Waste Geotechnics
- Geotechnics for Bioreactor Landfills
- Final Thoughts & Recommendations

DRY TO MOIST WASTE (~1 m)

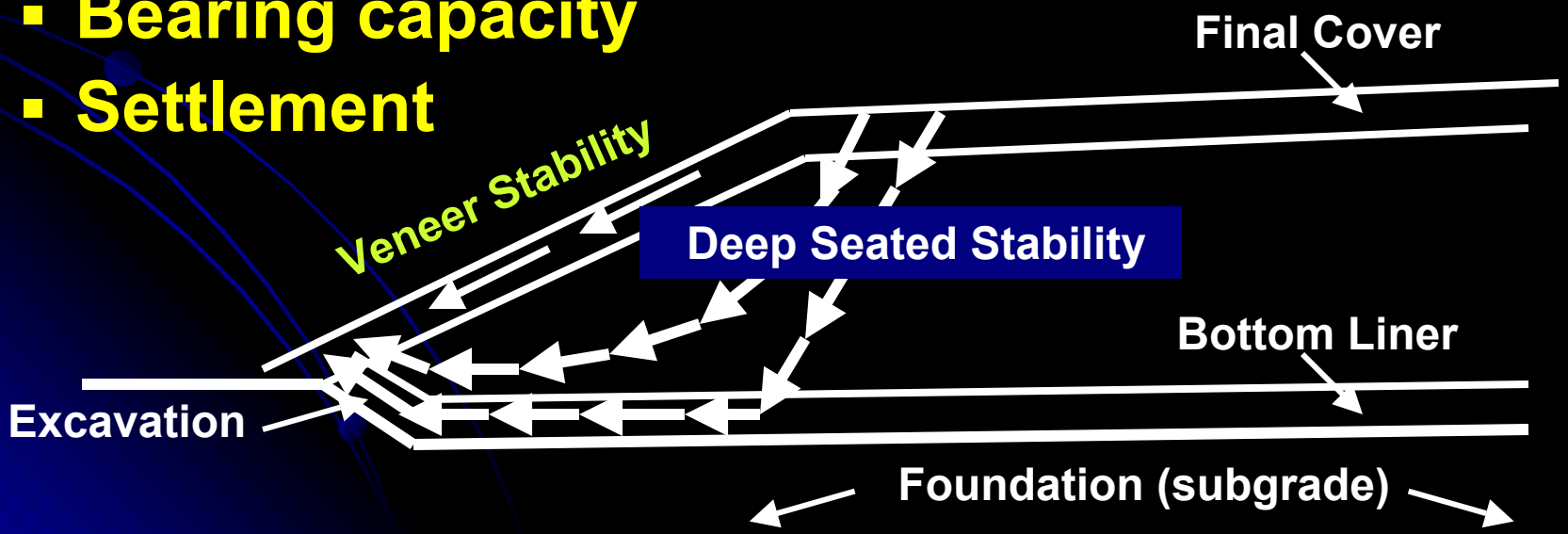
WET WASTE (~5 m)

WET TO SATURATED WASTE (NEAR LEACHATE LEVELS)

Traditional Geotechnical Approach

Principal Stability Considerations:

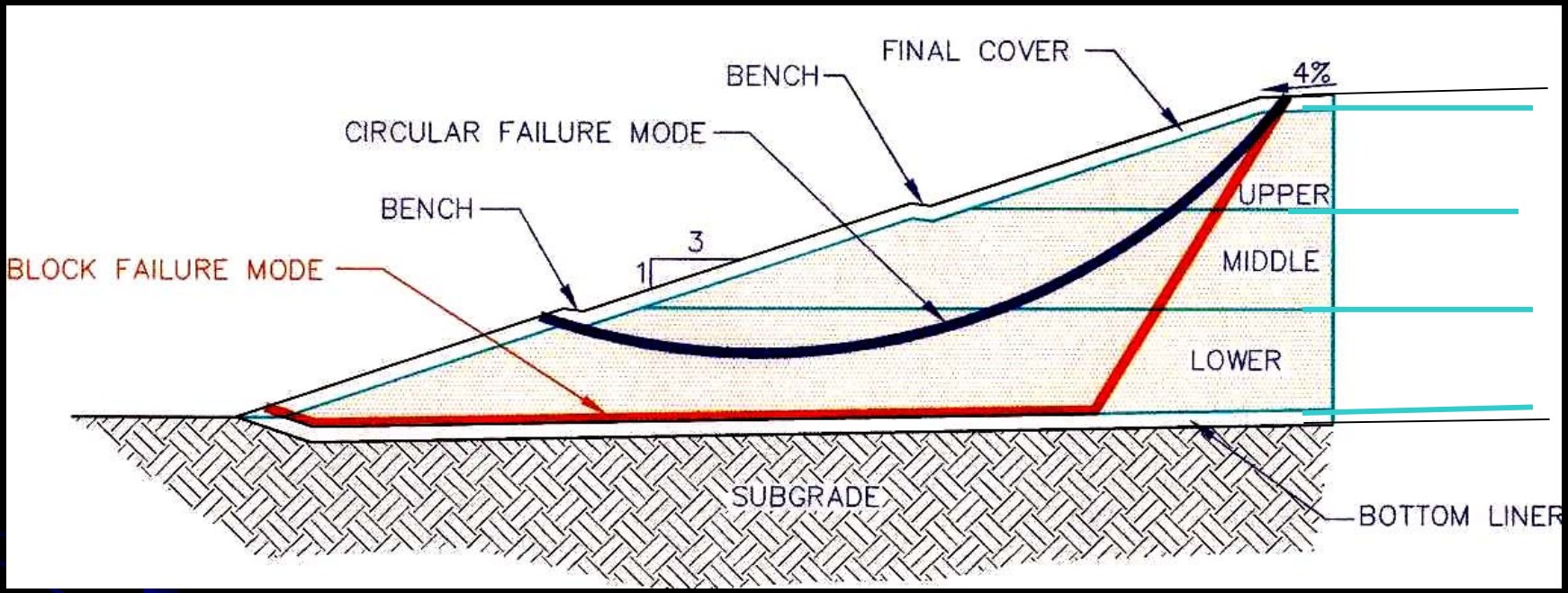
- Excavation slopes
- Interim waste slopes
- Final covered slopes
- Foundation
  - Bearing capacity
  - Settlement



Waste Geotechnics

- **Critical sideslopes**
  - Construction, operations and final
- **2-D Limit equilibrium models**
  - Spencer, Bishop, Janbu, et al
  - Minimum Factor of Safety (FS)
  - Static and pseudo-static
- **Material properties**
  - Waste: shear strength & density → waste & operation specific
  - Soil: shear strengths & density → site specific
  - Soil/Geosynthetic: interface strength → material specific

Typical Shear Surfaces



FACTORS OF SAFETY:

- FS > 1.5 for Static final (peak)
- FS > 1.3 for Static interim
- FS > 1.0 for Pseudo static (peak)
- Or, deformation analysis (e.g., Newmark's)

STABILITY MODELING:

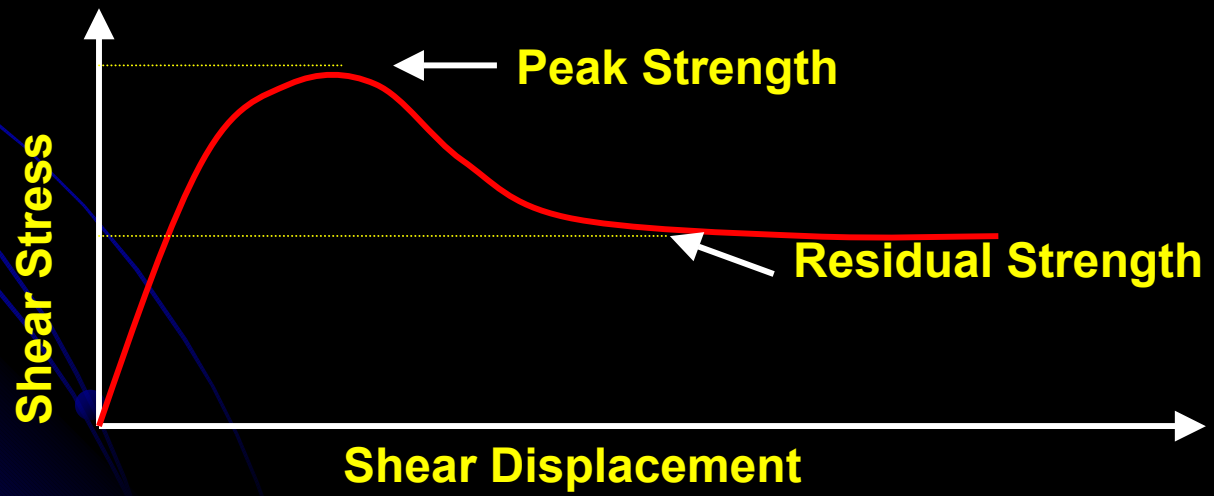
- Computer models: PCSTABL, UTEXAS3, XSTABL, and others
- Drained and Undrained conditions (pore pressures)
- Other Loadings (equipment)

A Word about FS

$$FS = \left[\frac{\text{Peak Shear Strength (or, residual)}}{\text{Shear Strength for Equilibrium}} \right]$$

$$= \frac{[C_{ult} + (N-\mu) \bullet [\tan(\emptyset_{ult})]}{[C_{equil} + (N-\mu) \bullet [\tan(\emptyset_{equil})]}$$

Ø=friction angle and C=cohesion (equivalent)
N=normal stress and μ=pore pressure
FS=1.5 means 50% more strength than required for equilibrium



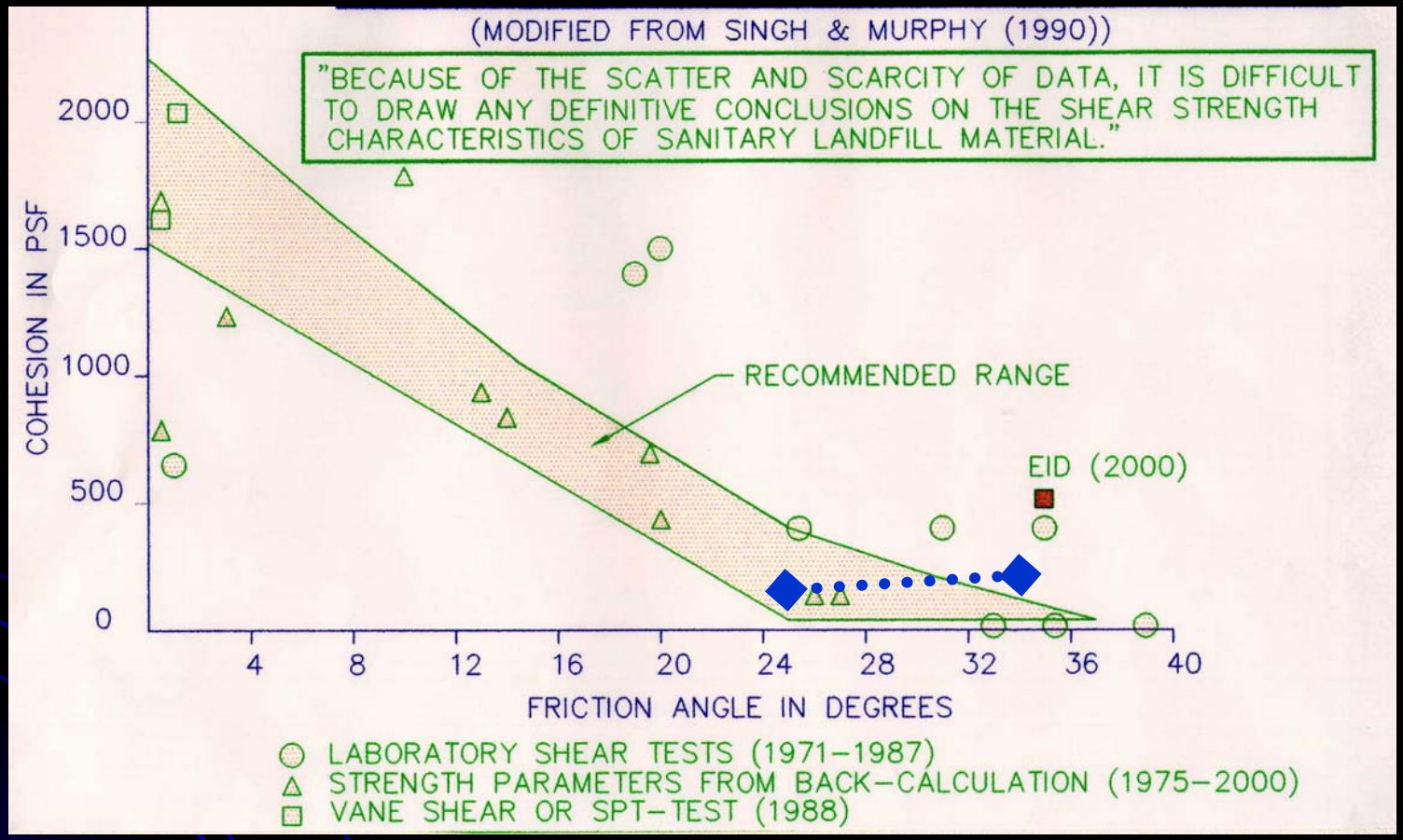
Waste Properties Ranges

- In-place (field) density: ~800 to ~1600 pcy
- Peak shear strength – *Mohr-Coulomb* behavior
  - Friction (Ø): ~20° to ~35°
  - Cohesion (C) : 0 to ~1000 psf
  - Residual strength undetermined
- Moisture content (wet weight)
  - Range: ~10% to ~60%
  - Average ~20% to 30%
  - Field Capacity (Fc): ~35% to 55%
- Permeability: ~10^{-2} to ~10^{-6} cm/sec

* All variable & function of waste type, composition, compaction, daily cover, moisture conditions, age, overburden pressure, etc

MSW Strength- Method 1

(Based on Published Lab and Field Testing)



Example:

Assume MSW peak shear strength
Ø=34° and C=200 psf
Design for FS=1.5

Equilibrium ("stability"):
Ø= atan[(tan34°)/(1.5)])= 24.2°
C= 200/1.5 =133 psf

MSW Strength – Method 2

Based on Observations

(Hiriya Landfill, Tel Aviv, 2002)

Waste Can Stand on Steep Slopes…