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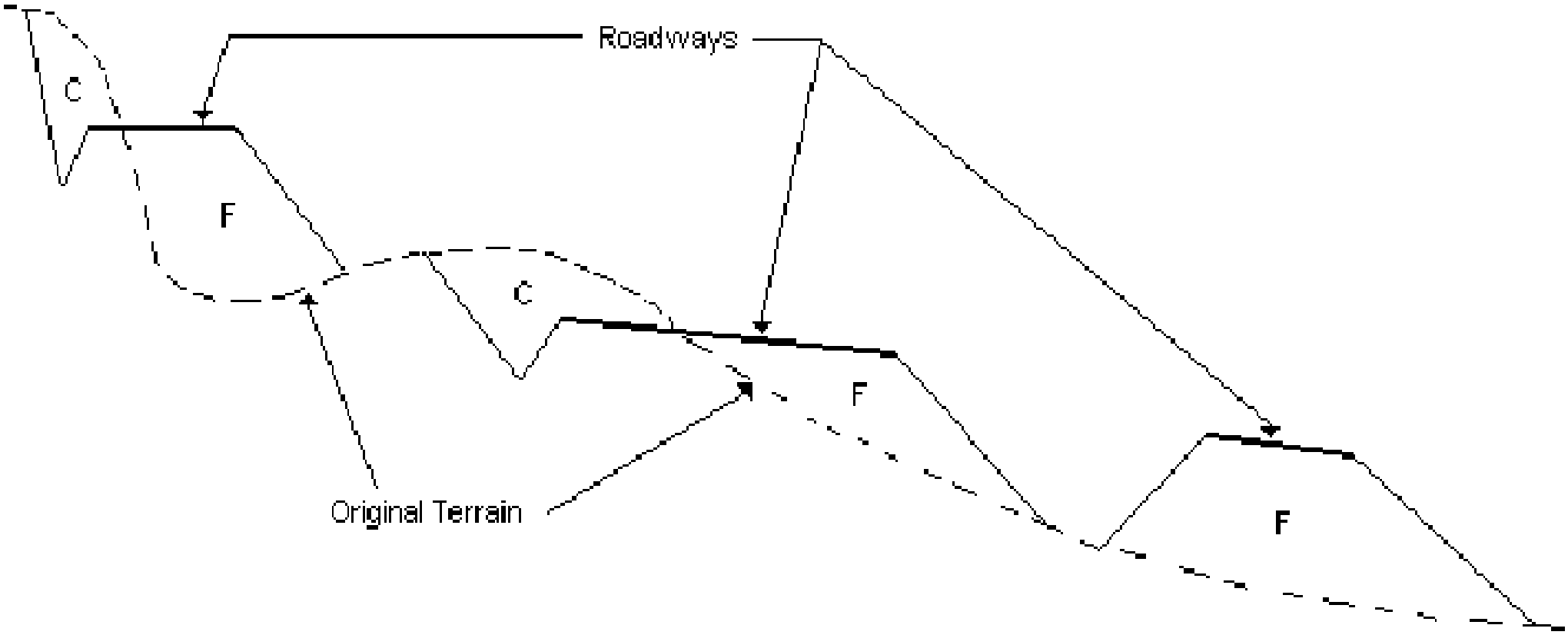
ENCE 361 Soil Mechanics

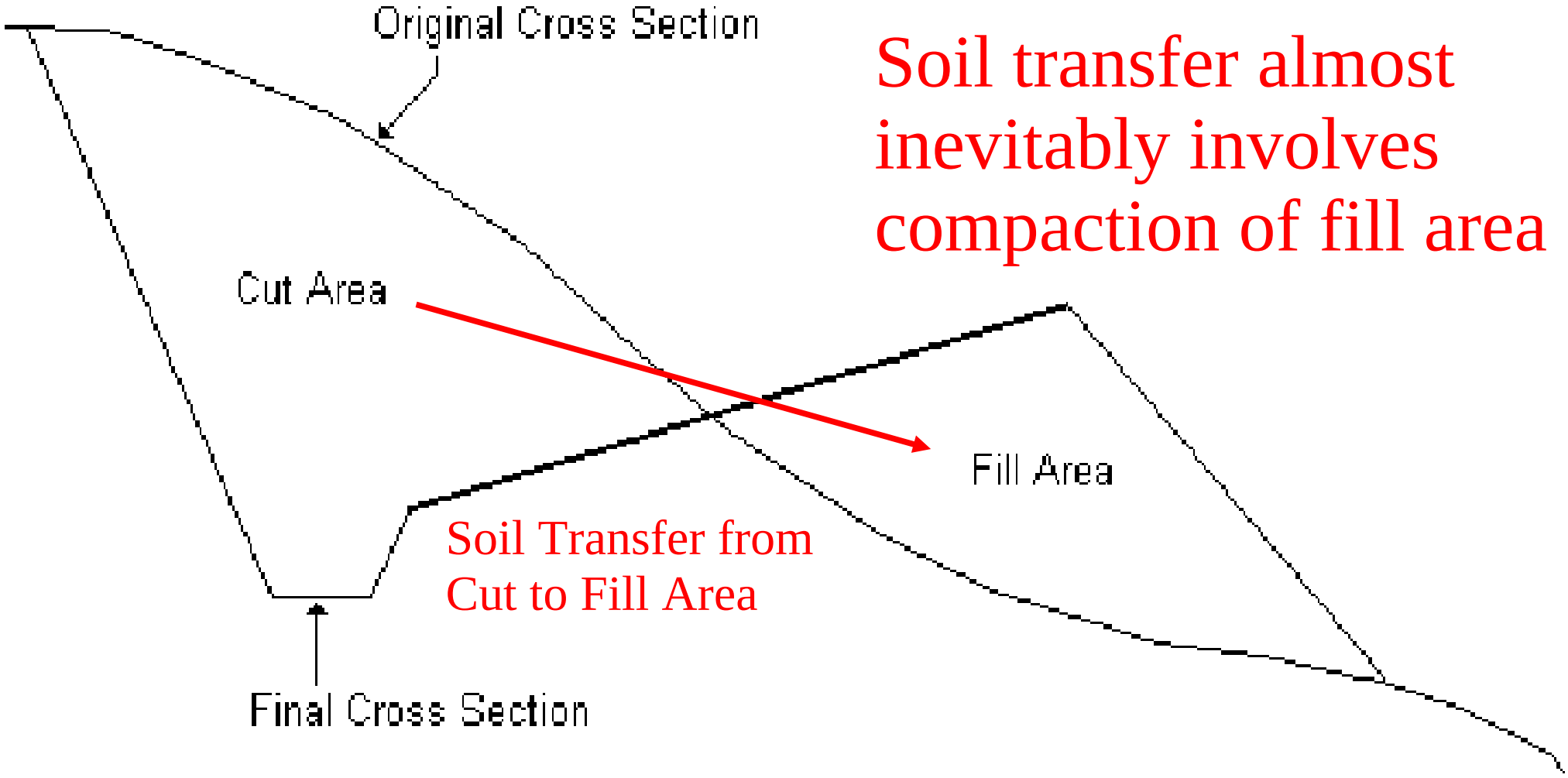
Compaction of Soil: Earthwork Quantity Calculations

Fill and Grade Work

"Let every valley be lifted up, and every mountain and hill be made low; and let the rough ground become a plain, and the rugged terrain a broad valley; Then the glory of the LORD will be revealed, and all flesh will see {it} together; for the mouth of the LORD has spoken." (Isa 40:4-5 NAS)

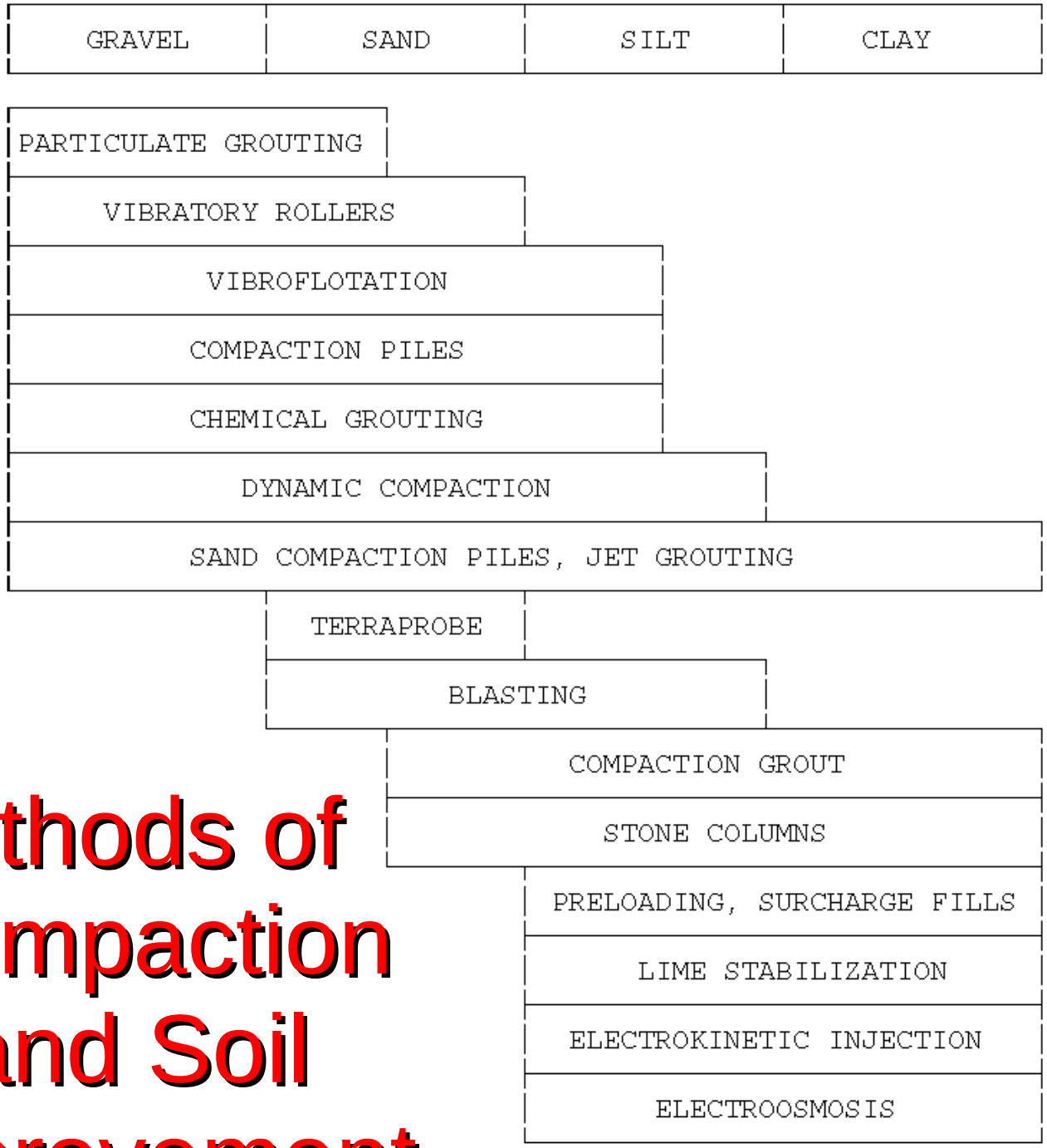


Cut and Fill



Soil transfer almost inevitably involves compaction of fill area

Methods of Compaction and Soil Improvement



Earthwork Quantity Example

- Cut area
  - Result of soil sampling in cut area
    - Twelve undisturbed soil samples taken
    - Average dry unit weight of soil = 108 pcf
    - Average water content = 9.1%
  - Result of compaction tests on relative bulk sample
    - Maximum dry unit weight @ 100% compaction = 124 pcf
    - Water content at maximum dry unit weight = 12.8%
  - Specifications call for at least 90% compaction
    - Will use 92% compaction for calculation

Earthwork Quantity Example

- Grading plan
  - 12,000 cu. yd. Of Cut
  - 11,500 cu. yd. Of Fill
- Find
  - Shrinkage factor
  - Required volume of soils to either add or substract from fill requirement to “make the cut”
  - Compute weight of import or export in tons
  - Compute the additional water (over what comes from the cut) to bring the fill to the optimum moisture content

Earthwork Quantity Example

- What are we moving from one place to another?
  - Soil
  - Water
- Need to compute the following quantities first
  - Dry and wet unit weight of cut and fill
  - Soil weight in the cut specifications
  - Soil weight in the fill specifications

Earthwork Quantity Example

- Dry and Wet Unit Weight
  - Cut
    - Dry = γ_1 = 108 pcf (given)
    - Wet = γ_3 = 108 (1+.091) = 117.83 pcf
  - Fill
    - Dry = γ_4 = (124 pcf)C_r = (124)(0.92) = 114.08 pcf
    - Wet = γ_2 = 114.08 (1+.128) = 128.68 pcf

Earthwork Quantity Example

- Compute Soil Weights from Dry Unit Weights
  - Cut
    - $W_{sc} = V_{sc}\gamma_1 = (12{,}000)(27)(108) = 34{,}992{,}000$ lbs. = 17,496 tons
  - Fill
    - $W_{sf} = V_{sf}\gamma_1 = (11{,}500)(27)(114.08) = 35{,}421{,}840$ lbs. = 17,711 tons
  - Amount of additional soil needed from cut to make fill specification = 17,711 – 17,496 = 215 tons
  - Volume of soil based on cut dry unit weight = (429,840 lbs)/108 = 3980 ft^3 = 147.41 yd^3

Earthwork Quantity Example

- Compute total weight of cut moved (with water)
  - $W_{\text{additional total}}$ = (3980 ft^3)(117.83 pcf) = 468963.4 lbs = 234.5 tons
- Compute total water from original cut specificaiton
  - $W_{wc} = w_c W_{sc}$ = (0.091)(34,992,000 lbs.) = 3,184,272 lbs. = 1592.14 ton

Earthwork Quantity Example

- Compute total water from original fill specification
  - $W_{wc} = w_c W_{sc}$ = (0.128)(35,421,840 lbs.) = 4,533,996 lbs. = 2267 tons
- Compute total water needed
  - ΔW = 2267 – 1592.14 = 674.86 tons
- Compute water from additional cut material
  - W_{add} = (215)(0.091) = 19.56 tons

Earthwork Quantity Example

- Compute weight of water that must be added directly to fill
  - W_{direct} = 674.86 tons - 19.56 tons = 655.3 tons
- Compute volume of water in gallons
  - V_{direct} = (1728)(2000)(655.3)/((231)(62.4) = 157,116 gal.

Shrinkage Factor

- Shrinkage Factor

$$SF = \frac{\Delta V}{V} = \left(\frac{\gamma_{d_f}}{\gamma_{d_c}} - 1\right) \times 100 \ percent$$

- SF = (114.08/108 -1) x 100 = 5.63%

Questions