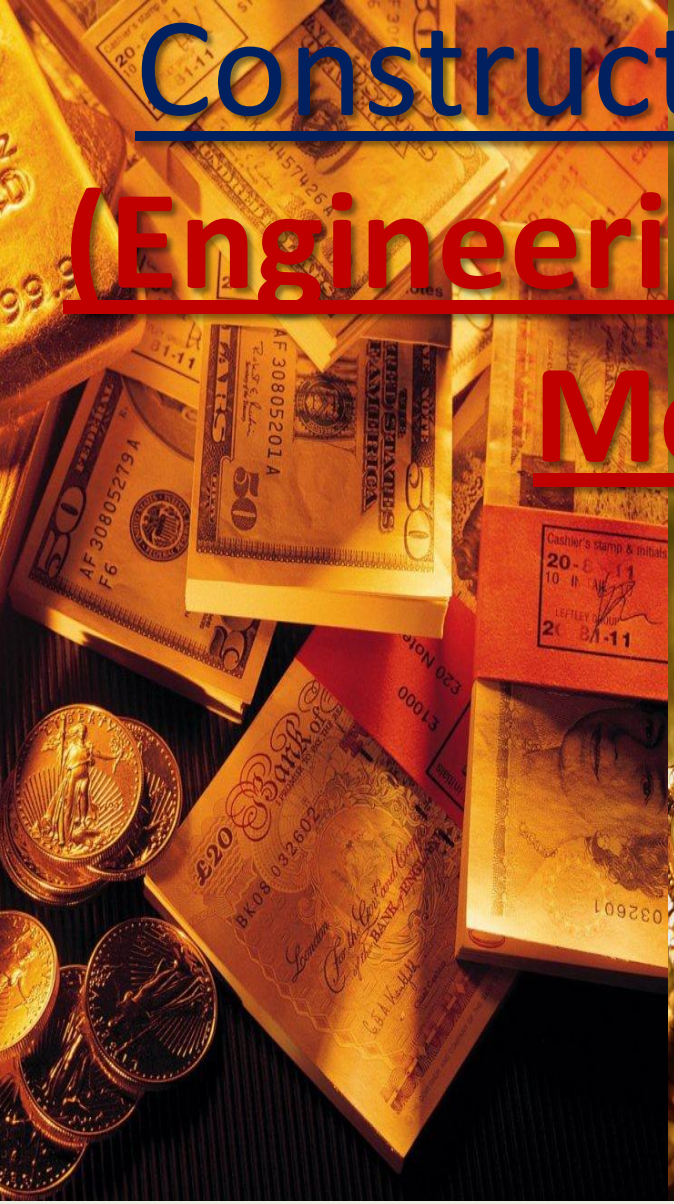
Construction Technology L 4

(Engineering Fundamentals of Moving Earth)



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General Information:

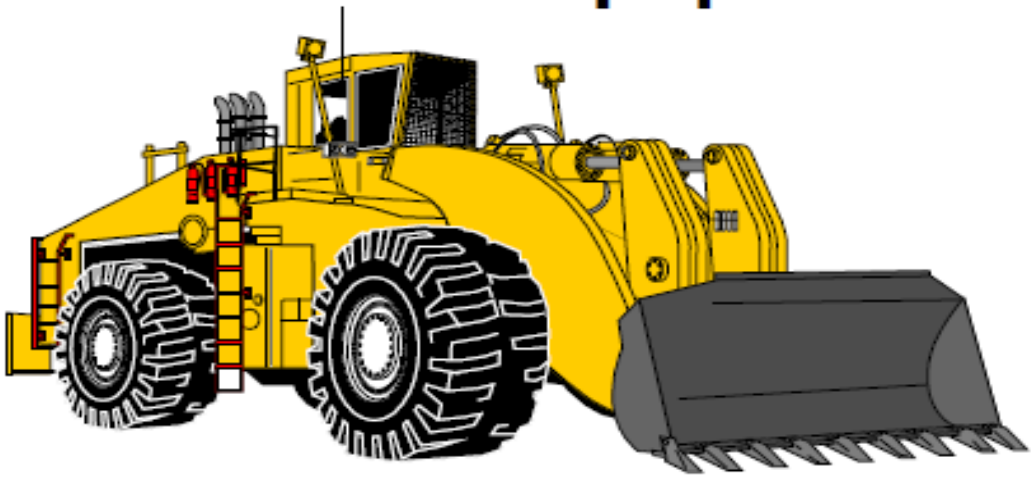
- The actual construction process of any project is really a material handling problem.
- Some materials will be used only temporarily in the support of the construction activities: reusable forms, scaffolding, shoring and some access roads.
- Materials such as water and fuel may be consumed during construction.
- Other materials will be permanently incorporated into the structure such as steel, timber, concrete, asphalt and soils.
- On heavy construction projects, the major portion of the work consists of handling and processing bulk materials.

General Information:

- **The contractor must select the proper equipment to relocate and process these materials economically.**
- **To select the proper equipment, there are two main factors to be considered: the total quantity of the material and the size of the individual pieces.**
- **The quantity of materials to be handled and the time constraint resulting from the contract or the weather conditions influence the selection of the equipment type, size and number of machines to be used. Generally the larger units of equipment have a lower unit production cost but there is a trade-off in higher mobilization and fixed cost.**
- **The loader used in the quarry to move shot rock must be able to handle the largest rock size produced.**

Use of Construction Equipment

Construction of engineered facilities requires the utilization of construction equipment.

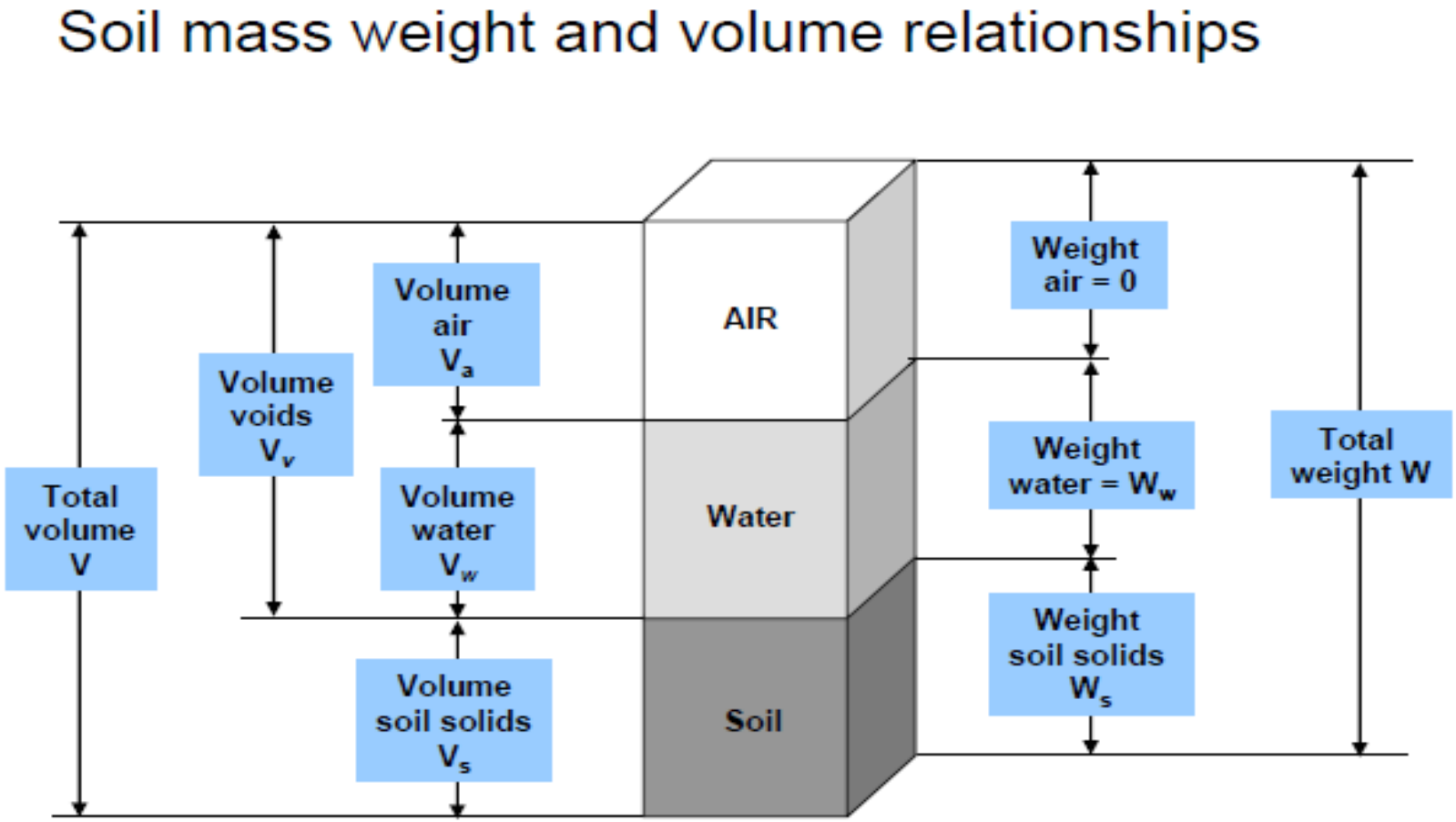


2- Material properties:

In the Contract documents, the excavation can be categorized as follows:

- **Common Excavation (ordinary earth classification that does not require the use of explosives)**
- **Rock Excavation usually requires drilling and blasting. Rock is a material that cannot be excavated by ordinary equipment. It costs more than ordinary excavation. Rock excavations involves the study of rock type, faulting, dip and strike as well as explosives characteristics.**
- **Muck Excavation (Soft organic Materials that may decay or produces subsidence in embankments).**
- **Unclassified Excavation (Materials cannot be classified as soil or rock).**
- **Studying the above items is necessary for proposing a good estimate for excavation works.**

Soil-Weight Volume Relationships:



Soil-Weight Volume Relationship

Soil mass weight and volume relationships

Unit weight (γ)	= total weight of soil/total soil volume	= W/V
Dry unit weight (γ_d)	= weight of soil solids/total soil volume	= W_s/V
Water content (ω)	= weight of water in soil/weight of soil solids	= W_w/W_s
Void ratio (e)	= volume of voids/volume of soil solids	= V_v/V_s
Porosity (n)	= volume of voids/total soil volume	= V_v/V
Specific gravity (G_s)	= weight of soil solids/volume of solids/unit weight of water	= $W_s/V_s/\gamma_w$

Total soil volume (V) = volume voids (V_v) + volume solids (V_s)

Weight of solids (W_s) = weight of soil (W)/(1+water content (ω))

or

$\gamma_d = \gamma/(1+\omega)$

Volumetric Measure:

- Material volume measure varies with material's position in the construction process. The same weight of material will occupy different volume as the material will be handled on the project.
- In general, most cohesive soils will shrink from 10 to 30% from the bank compacted state. While solid rock will swell 20 to 40% of the bank to placement in the embankment. Between the bank and loose state, the cohesive soil swell 40% and solid rock as much as 65%.
- **Bank Cubic meter:** one cubic meter of materials as it lies in the natural state (bcm).
- **Loose Cubic meter:** one cubic meter of materials after it has been disturbed by a loading process, (lcm).
- **Compacted Cubic meter:** one cubic meter of materials in the compacted state, (ccm).
- **The shrinkage factor,** is the ratio of the compacted dry weight per unit volume to the bank dry weight per unit volume.

States of soils by processing

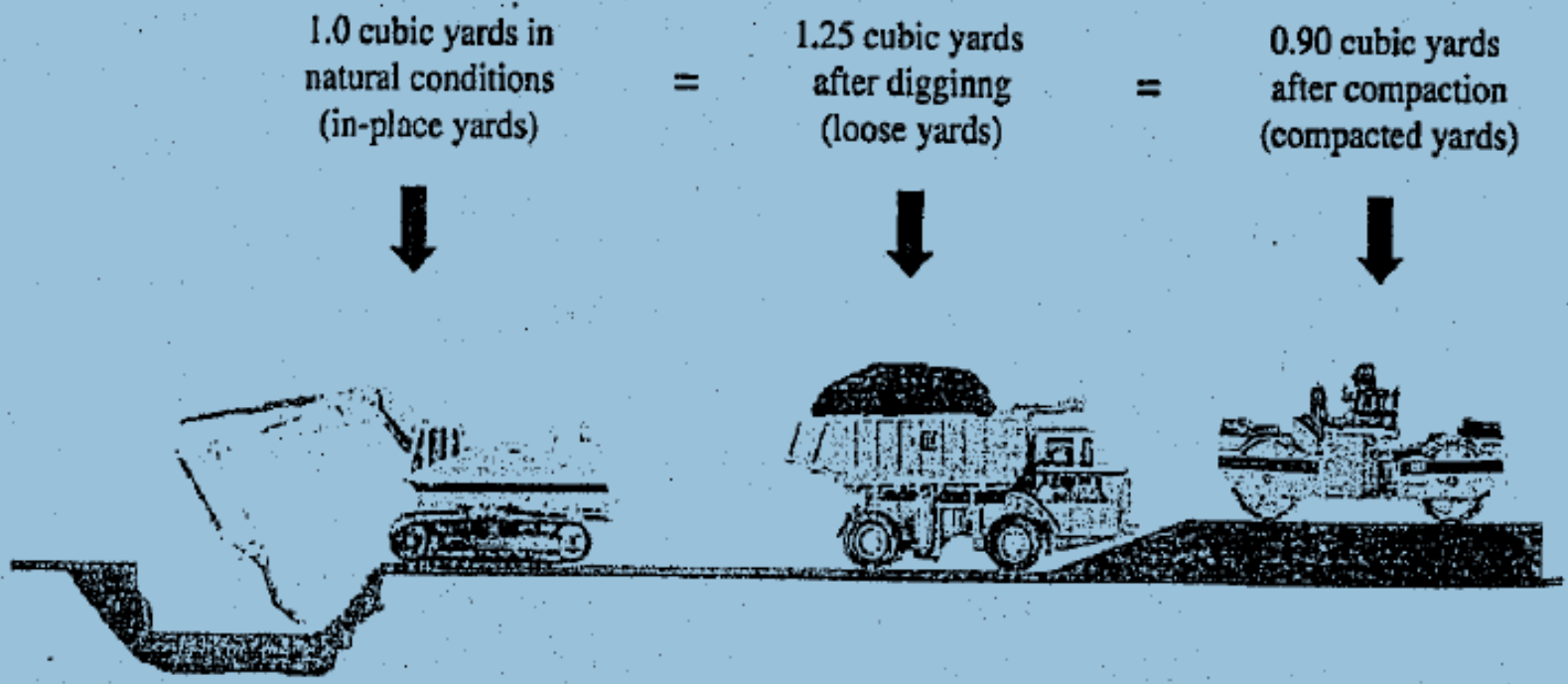


FIGURE 4.2 Material volume changes caused by processing.

Soil Properties:

- **Shrinkage Factor:** Compacted dry unit weight/bank dry unit weight
- **Shrinkage % =**
  [Compacted unit weight-bank unit weight]/Compacted unit weight x 100
- Swell factor = Loose dry unit weight/bank dry unit weight
- Swell% = (bank unit weight/loose unit weight-1) x 100

Soil Properties:

- **Example: An earth fill when compacted will occupy a net volume of 187,000 m^3. The borrow material which will be used to construct the fill is stiff clay. In its bank condition, the borrow material has a wet unit weight of 1.85 t/m^3, moisture content is 16.5% and an in place void ratio of 0.620. The fill will be constructed in layers of 30 cm each with a compacted wet unit weight of 2.10 t/m^3. degree of saturation is 37%, specific gravity is 2.65, void ratio of 0.54. If the cost of the borrow material is 7 LE/m^3, estimate the cost of the constructed fill.**

- **For the borrow Pit:**
- Void ratio (e) = 0.62
- Bulk unit weight = 1.85 t/m^3
- Water content (W/C) = 0.165
- Dry unit weight = 1.85/(1+0.165) = 1.588 t/m^3

Soil Properties:

- **For the Fill material:**
- Degree of saturation (s) = 0.37
- Bulk unit weight = 2.10 t/m^3
- Water content (W/C) S* e/G = 0.37* 0.54/2.65= 7.54%
- Dry unit weight = 2.10/(1+0.0754) = 1.953 t/m^3

Volume of the borrow material = 187,000 * 1.953/1.588 = 229,982 m^3

- **Cost of fill construction is 229,982 * 7 =1,609,874 LE**

Factors affecting the selection of Equipment type:

Travel distance:

Equipment selection is affected by the travel distance because of the time factor it introduces into the production cycle. The increased travel distance will favor the use of high speed large capacity unit.

Bearing Capacity:

A haul route must have sufficient bearing capacity to carry the imposed loads. On low bearing capacity material, this may dictate the selection of the track-type instead of wheel type running gear. The use of special low-ground-pressure machines using wide tracks or balloon tires may be necessary.

Factors affecting the selection of Equipment type:

Rolling Resistance:

- Rolling resistance is the resistance of a level surface to constant-velocity motion across it.
- This resistance varies considerably with the type and condition of the surface over which the vehicle moves.
- For vehicle which move on rubber tires the rolling resistance varies with the size of, pressure on and tread design of the tires.

Effect of Grade:

- the force-opposing movement of a vehicle up a frictionless slope is known resistance.
- The resistance increases with increasing the slope of the road.

Next lecture, Tractors and Related Equipments

THANK YOU!