$$\text{swell \%} = \left(\frac{\text{weight / bank volume}}{\text{weight / loose volume}} - 1\right) \times 100\%$$

$$\text{shrinkage \%} = \left(1 - \frac{\text{weight / bank volume}}{\text{weight / compacted volume}}\right) \times 100\%$$

$$BCM \times \left(1 + \frac{\text{swell \%}}{100}\right) \Rightarrow LCM$$

$$BCM \times \left(1 - \frac{\text{shrinkage \%}}{100}\right) \Rightarrow CCM$$

$$\text{Load factor} = \frac{\text{weight / loose unit volume}}{\text{weight / bank unit volume}}$$

$$\text{shrinkage factor} = \frac{\text{Weight / bank unit volume}}{\text{weights / compacted unit volume}}$$

$$LCM \times \text{Load factor} \Rightarrow BCM$$

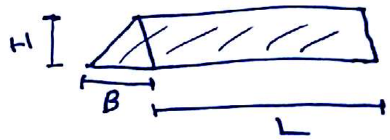
$$BCM \times \text{shrinkage factor} \Rightarrow CCM$$

* there are tables (typically) show values for load factor and shrinkage factors.

spoil Bank

$$B = \sqrt{\frac{4V}{L \times \tan R}}$$

$$H = \frac{B \times \tan R}{2}$$

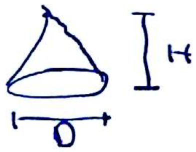


V: pile volume (m3)
R: Angle of Repose (tabulated)

spoil pile

$$D = \sqrt[3]{\frac{7.64 \times V}{\tan R}}$$

$$H = \frac{D}{2} \tan R$$



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Excavation amount estimating

1) Trench ⟹ Depth × Length × width

2) Pit ⟹ width × Length × (Average Depth)

مبنى صغير

⟹ Average depth = $\dfrac{\sum \text{corner } \cancel{\text{elevation}} \text{ depths}}{4}$

3) Large Areas ⟹ width × Length × (Average depth)

⟹ Average depth = $\dfrac{\left[1 \times \sum \text{corner depth} + 2 \times \sum \text{border depths} + 4 \times \sum \text{interior depth}\right]}{\left[1 \times \text{Number of corner} + 2 \times \text{number of border} + 4 \times \text{Number of interior}\right]}$

- depth = ground elevation − Required elevation

Backhoe

$P = C \times S \times V \times B \times E$

C: cycle/h

V: volume bucket capacity

S: swing depth factor

B: Bucket fill factor

E: Job efficiency

All of them are "Tabulated" except V.

shovel

نفس السابقة ولكن باختلاف جداول (C) & (S)

Dragline

$P = I \times S \times E$

I: Ideal dragline output (tabulated)
E: efficiency factor (tabulated)
S: swing/depth factor (tabulated based on optimum depth of cut which get also from certin table)

Clamshell

$P =$ Volume per cycle $\times$ cycles per hours $\times E$

$= \dfrac{\text{heaped volume capacity}}{\text{cycle time}} \times E$

(measured)

Rolling Resistance = 20 + 6 * penetration [kg/ton]

Grade Resistance = 10 * slope [kg/ton]

Total Resistance = Rolling Resistance + Grade Resistance [kg/ton]

Total Resistance [kg] = Total Resistance [kg/ton] * Gross weight [ton]

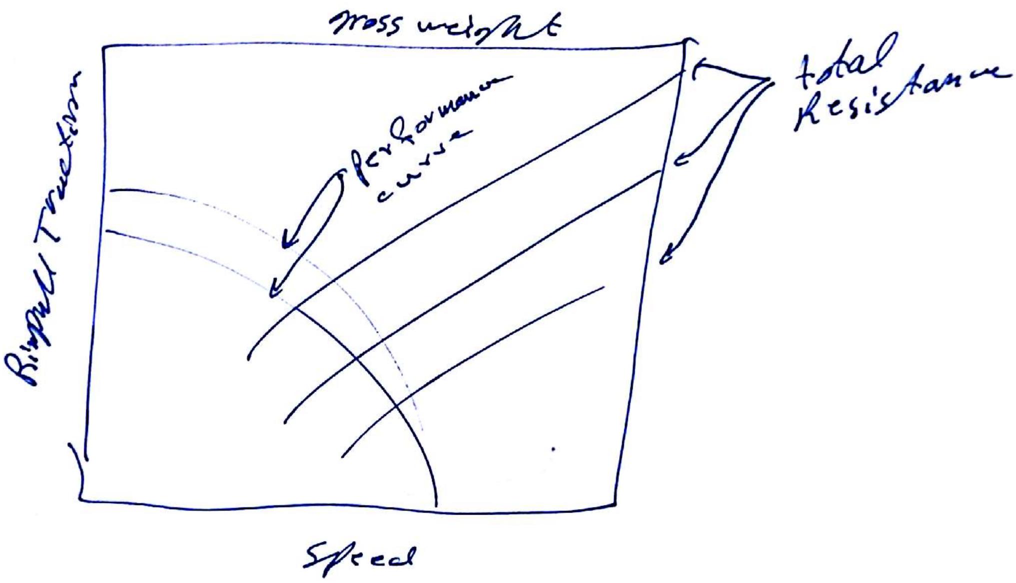
No Rolling Resistance for crawler equipments.

$$\text{Derating factor} = \frac{\text{Altitude} - 910}{102}$$

$$1 - \text{Derating factor} = 1 - \left(\frac{\text{Altitude} - 910}{102}\right)$$

$$\left(1 - \text{Derating Factor}\right) * \text{Maximum Rimpull Traction} = \text{Available Traction, Rimpull}$$

Gross weight * traction coefficient = ~~Available~~ Maximum Rimpull Traction



- خد ال Gross weight و ال total Resistance و شوف هي ال Rimpull Traction
- إقسم ال Rimpull Traction على (1 − Derating factor)
- الجواب شوف كم يقابله speed مش نفس لي ال total Resistance وال gross weight

Dozers

$$P = \frac{V}{T} * E$$

$T = \underbrace{\text{Fixed}}_{\text{from table}} + \underbrace{\text{variable}}_{\frac{\text{Distance}}{\text{speed}}} \text{ (Dozing \& Return)}$

from table (speed)

Loaders

$$P = \frac{V}{T} \times E \times B$$

(minimum distance to estimation equal 25 m)

$T = \underbrace{\text{Basic (fixed)}}_{\text{from table}} + \underbrace{\text{Variable (Travel)}}_{\text{from curve}}$

Scraper

$$P = \frac{V}{T} * E$$

$T = \left(\underbrace{\text{Fixed}}_{\text{from table}}\right) + \left(\underbrace{\text{Variable (travel)}}_{\text{from curve (empty/loaded)}} * \left[1 + \frac{\text{Derating factor}}{100}\right]\right)$

effective grad = slope + $\frac{\text{Rolling Res.}}{10}$

during pushing scraper

$$\frac{\text{cycle time of scraper}}{\text{cycle time of pusher [from table]}} = \text{No. of scraper served}$$

$$\text{No. of pusher} = \frac{\text{No. of scraper}}{\text{No. of scraper served}}$$

$$P = (\text{Production per scraper}) * (\text{No. of scraper}) * \frac{\text{No. of used pusher}}{\text{No. of pusher required [befor rounding]}}$$

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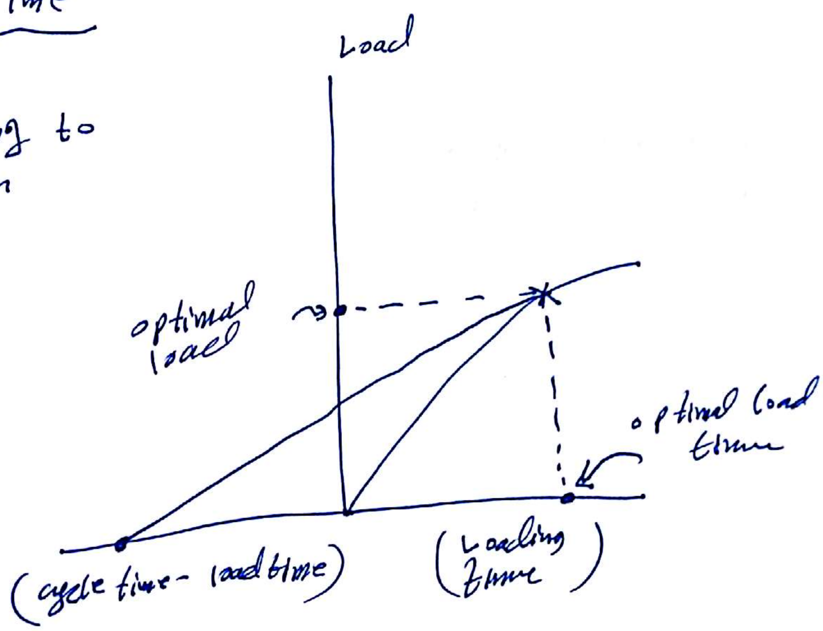
Trucks

- Truck cycle time – loading time ⇒ from table
- loading time = $\dfrac{\cancel{\text{production}} \;\; \text{مهم}}{\text{production of shovel}}$ * capacity of Truck
- Total cycle time = $\sum$ times
- No. of Required Trucks = $\dfrac{\text{total cycle time}}{\text{loading time}}$
- production = (production of excavator) * E

optimal load Time

* they are applying to get maximum productivity



Compaction

4 productivity $= \dfrac{10 \times W \times S \times L \times E}{P}$

P: Number of passes [from figure]
W: width compacted per pass (m)
S: compactor speed (Km/hr)
L: compacted layer thickness (cm)
E: Job efficiency

Grading & finishing

$$\text{Time} = \frac{1}{\text{Efficiency}} \left[\sum \frac{\text{Number of passes} \times \text{section length (Km)}}{\text{Average speed for section (Km/hr)}} \right]$$