Scraper Performance & productivity

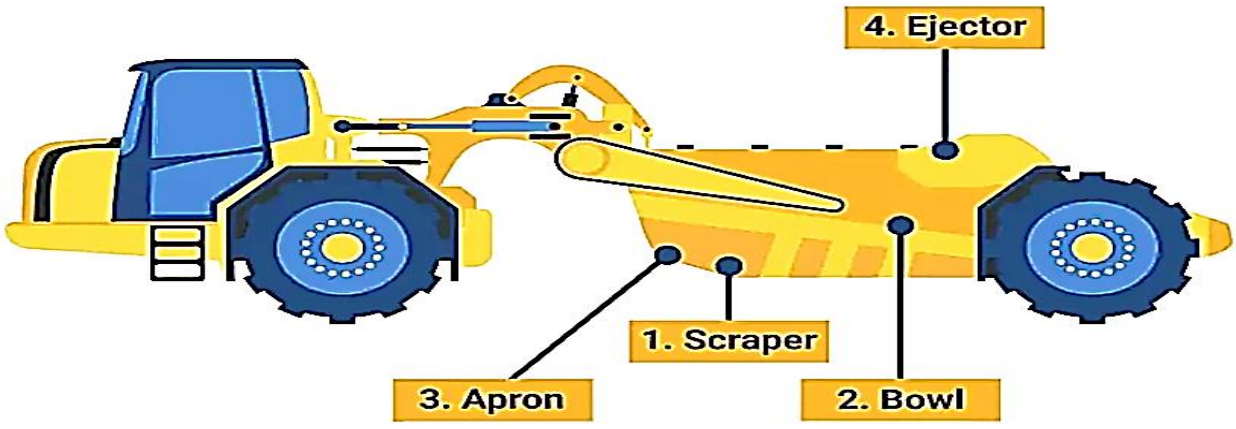
Scrapers and their description:

Scrapers, also called wheel tractor scrapers, are commonly used to scrape and level surfaces.

- These heavy-duty earthmoving machines can also haul earth and materials, such as dirt and gravel, more than just a short distance that they can move it from one job site to another.
- Scrapers offer extreme efficiency over other earthmoving vehicles when it comes to transporting materials.
- Their all-in-on productive approach can be measured by their cycle times the time it takes to load, haul, dump, and get back into position.
- A single scraper operator can move up to 72 cubic yards of material per cycle, which can cut your labor in half.

Key Parts of a Scraper:

- ***Scraper:*** The scraping blade dislodges material from the ground as the heavy machinery moves forward.
- ***Bowl:*** The bowl has a cutting edge that cuts the earth and then loads and carries it.
- ***Apron:*** This vertical blade, adjacent to the scraping blade, closes when the bowl is full, so the load is ready to be transported to a new location.
- ***Ejector:*** The ejector, at the rear of the bowl, uses hydraulics to expel loaded material.



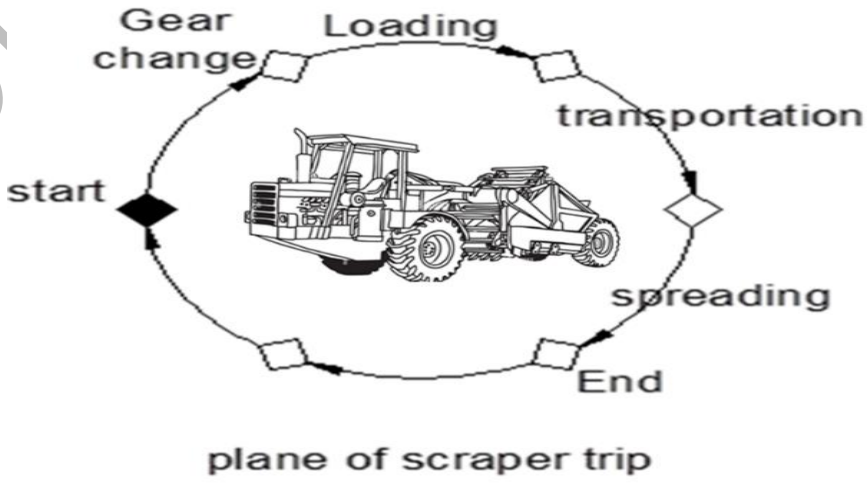
The Suitable Work to Scrapers:

- Scrapers are known for their versatility as they can be used in the construction industry, agricultural operations, or mining operations.
- There are two types of scrapers: self-propelled scrapers (motor scrapers) and towed scrapers, which require a separate piece of construction equipment to haul them.
- All types of scrapers can primarily perform tasks and projects that includes activities of:

- *Leveling*
- *Grading*
- *Excavating*
- *Road building*
- *Forestry applications*
- *Earthmoving*

Scraper Productivity Calculation:

Output (m^3/hr)
= Volume of carried materials by Scraper bowl (heaped capacity)(m^3)
× No. of Scraper trips per hour



when determining the payload (Volume) per scraper cycle, it is necessary to check both:

- *The rated weight payload.*
- *The heaped volume capacity.*
  - *The volume corresponding to the lesser of these two values will, of course, govern.*
  - *The method of estimating production is illustrated in the following application case study.*

$$\textbf{Cycle time} = \textbf{Fixed time} + \textbf{variable time}$$

$$\textbf{Fixed time} = \textbf{time for all activity except transportation and return}$$

$$\textbf{Variable time} = \textbf{transportation time} + \textbf{return time}$$

*Where: Fixed cycle time (**Table 4-7**) in this case includes:*

- *Spot time: It represents the time required for a unit to position itself in the cut and begin loading, including any waiting for a pusher.*
- *load time,*
- *maneuver and dump time.*

Table 4–7 Scraper fixed time (min)

Conditions	Spot Time: Single Pusher	Spot Time: Tandem Pusher
Favorable	0.2	0.1
Average	0.3	0.2
Unfavorable	0.5	0.5

Conditions	Load Time: Single Pusher	Tandem Pusher	Elevating Scraper	Auger	Push-Pull*
Favorable	0.5	0.4	0.8	0.7	0.7
Average	0.6	0.5	1.0	0.9	1.0
Unfavorable	1.0	0.9	1.5	1.3	1.4

Conditions	Maneuver and Dump Time: Single Engine	Twin Engine
Favorable	0.3	0.3
Average	0.7	0.6
Unfavorable	1.0	0.9

*Per pair of scrapers.

Whereas: Variable cycle time in this case includes:

- ***haul time and***
- ***return time.***

- *Haul and return times are estimated by the use of travel-time curves or by using the average-speed method with performance and retarder curves (**Figure 4-2**).*
- *It is usually necessary to break a haul route up into sections having similar total resistance values.*
- *The total travel time required to traverse all sections is found as the sum of the section travel times.*

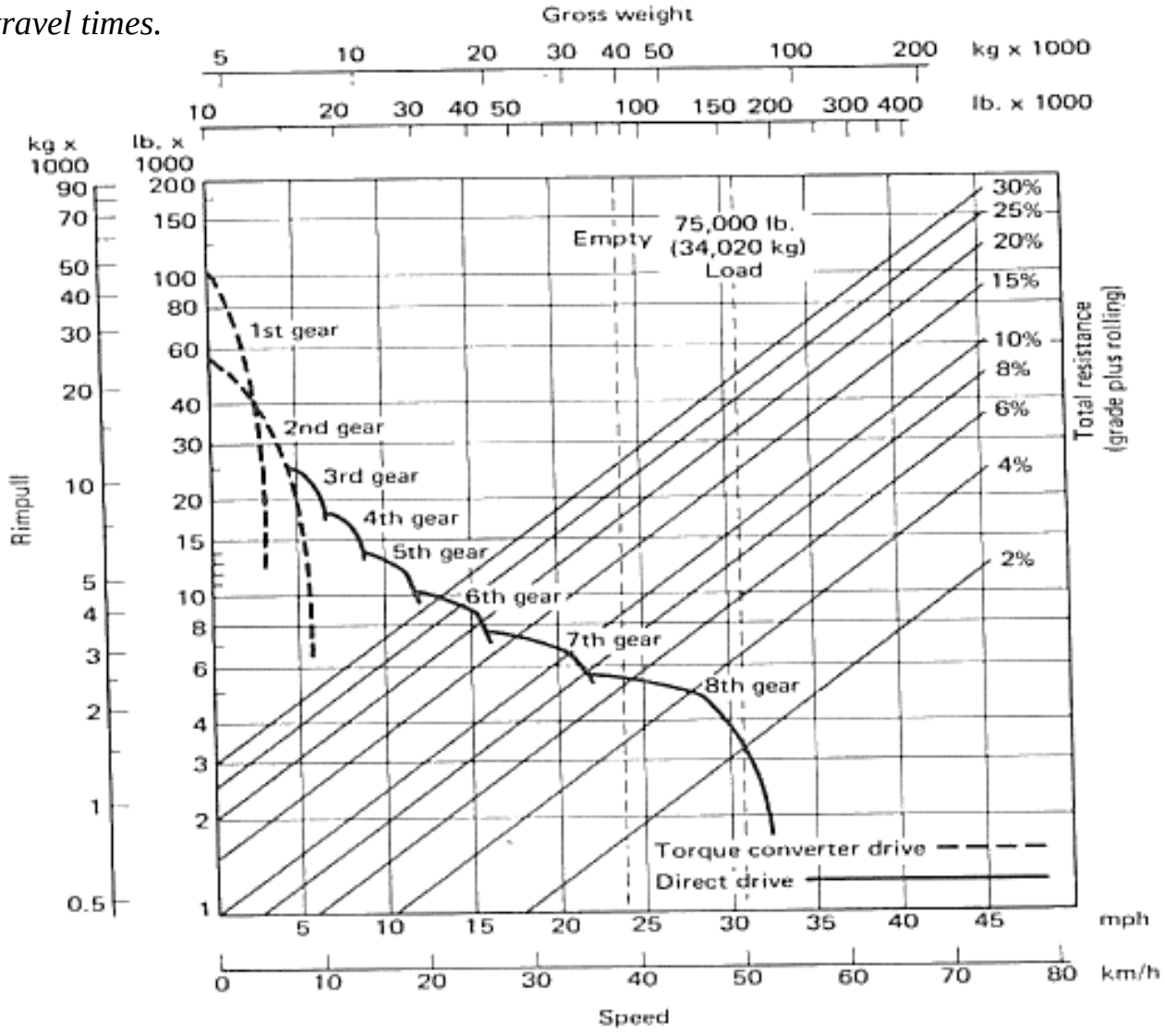


Figure 4–2 Wheel scraper performance curve. (Courtesy of Caterpillar Inc.)

Case Study No. 8-1:

Find the output of scraper used in a highway project transportation distance $= 600\ m$, scraper capacity $22\ m^3$, and transportation velocity ($19\ km/hr$), return velocity ($40\ km/hr$), fixed time $2.3\ min$, operating factor (0.83).

Solution:

$$Time\ of\ output\ trip\ =\ transportation\ time\ +\ return\ time\ +\ fixed\ time$$

$$= \frac{0.6}{\frac{19}{60}} + \frac{0.6}{\frac{40}{60}} + 2.3 = 5.1\ min.$$

$$No.\ of\ trips = \frac{60}{5.1} * 0.83 = 9.8\ trip$$

$$Output\ per\ hour = 22 * 9.8 = 215.6\ m^3/hr$$

$$Output\ per\ day = 215.6 * 8 = 1724.8\ m^3/day$$

Case Study No. 8-2:

Find the cycle time of scraper used in a highway project with transportation distance $is\ 700\ m$, scraper capacity $22\ m^3$, and transportation velocity ($17\ km/hr$), return velocity ($39\ km/hr$), operating factor (0.83). In addition, scraper has single pusher to working on unfavorable conditions.

Solution:

$$\boldsymbol{Cycle\ time\ =\ Fixed\ time\ +\ variable\ time}$$

$$\boldsymbol{Fixed\ time\ =\ time\ for\ all\ activity\ except\ transportation\ and\ return}$$

From table 4-7: spot time 0.5 min, load time 1.0min, maneuver and dump time 1.0min

$$Fixed\ time\ = 0.5 + 1.0 + 1.0 = \mathbf{2.5}\ min$$

$$\boldsymbol{Variable\ time\ =\ transportation\ time\ +\ return\ time}$$

$$\boldsymbol{Variable\ time\ = \frac{0.7}{\frac{17}{60}} + \frac{0.7}{\frac{39}{60}} = 3.55\ min}$$

$$\boldsymbol{Cycle\ time\ =\ 2.5\ +\ 3.55\ =\ 6.05\ min}$$

Case Study No. 8-3:

For a Scraper of Caterpillar (627-B), use the performance chart and the following information to:

- *The weight of the scraper (empty) is 33570 kg.*
- *The weight of the soil is 21770 kg.*
- *Rolling resistance is 20 kg/ton.*
- *Grade is 4%.*

Find the maximum speed for the scraper in the following stages:

- *Scraper is empty and moves up the grade.*
- *Scraper is loaded and moves up the grade.*

Solution:

From Caterpillar (627-B) performance chart:

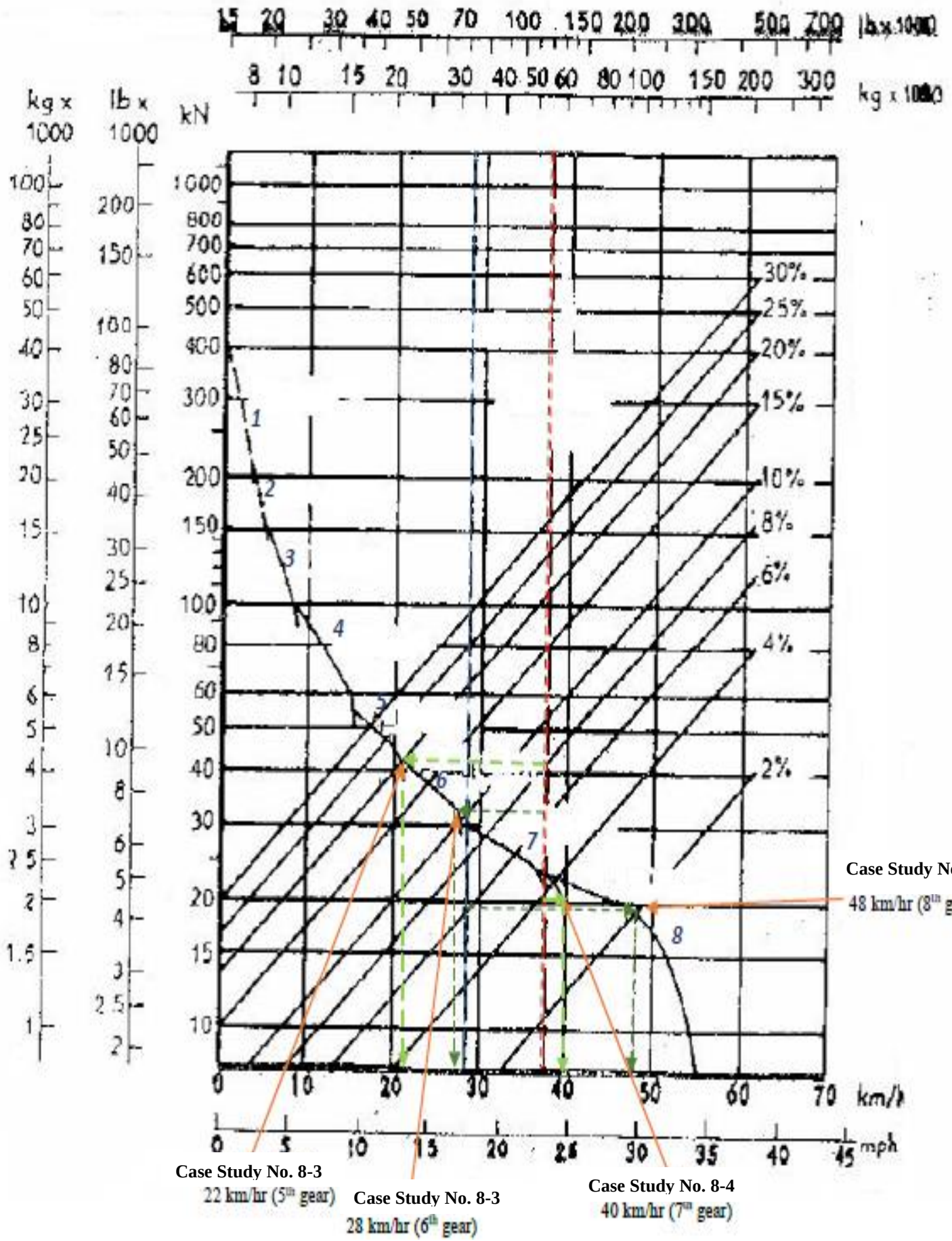
Weight of scraper (empty) = 33570 kg.

Total resistance = RR + GR = 2% + 4% = 6%.

Using performance chart → velocity = 48 km/hr (8^{th} gear).

Weight of scraper (loaded) = 33570 + 21770 = 55340 kg.

Using performance chart → velocity = 28 km/hr (6^{th} gear).


lb x 1000
kg x 1000
kN
30%
25%
20%
15%
10%
8%
6%
4%
2%
km/h
mph
Case Study No. 8-3,4
48 km/hr (8th gear)
Case Study No. 8-3
22 km/hr (5th gear)
Case Study No. 8-3
28 km/hr (6th gear)
Case Study No. 8-4
40 km/hr (7th gear)

Case Study No. 8-4:

Using the performance chart and the following information, calculate the cost of the project:

1- *Scraper capacity is 15 m^3.*

2- *Soil density (loose) is 1400 kg/m^3.*

3- *The weight of the scraper (empty) is 33570 kg.*

4- *Fixed time is 0.47 min.*

5- *Operating factor is 50 min/hr.*

6- *Swelling factor of soil is 25%.*

Scraper moves on straight road (level road) for a distance of 150 m, the rolling resistance is 40 kg/ton, then moving on a road with grade 4% for a distance of 250 m and rolling resistance of 40 kg/ton then return to the starting point empty for distance of 500 m with rolling resistance of 60 kg/ton. Find the output of the scraper per a day and if the cost of 1 m^3 of the excavation earth and transported and spread is 500 IQD/m^3, the rent of two scrapers and a bulldozer is $900*10^3$ IQD/day what is the total profit that contractor can gain per each operating day?

Solution:

From Caterpillar performance chart:

Weight of scraper (empty) = 33570 kg.

Weight of the soil = 15 X 1400 = 21000 kg.

Total weight = 54570 kg

Total resistance = RR + GR = 4% + 4% = 8%.

Using performance chart:

- Velocity of scraper (loaded) moving on the straight road for a distance of 150 m with RR = 40 kg/ton (4%) is = 40 km/hr (7^{th} gear).
- Velocity of scraper (loaded) moving up the grade road (4%) for a distance of 250 m with RR = 40 kg/ton (4%), total (RR + GR) = 8% is = 22 km/hr (5^{th} gear).

- Velocity of scraper (empty) return on the straight road for a distance of 500 m with RR = 60 kg/ton (6%) is = 48 km/hr (8^{th} gear).

Time of output trip is:

- $For\ 150\ m\ = \frac{150}{40\times\frac{1000}{60}} = 0.225\ min.$
- $For\ 250\ m\ = \frac{250}{22\times\frac{1000}{60}} = 0.682\ min.$
- $For\ 500\ m\ = \frac{500}{48\times\frac{1000}{60}} = 0.625\ min.$
- $fixed\ time = 0.47$

The time of trip = 0.225 + 0.682 + 0.625 + 0.47 = 2 min.

$$No.\ of\ trips\ for\ each\ scraper = \frac{50}{2} = 25\ trip.$$

$$Volume\ of\ soil\ (embakment) = \frac{15}{1.25} = 12\ m^3.$$

$$\therefore Output\ of\ the\ scraper = 12 \times 25 = 300\ m^3/hr$$

$$\therefore Output\ for\ two\ scrapers = 2 \times 300 = 600\ m^3/hr$$

$$Cost\ for\ work = 600 \times 500 = 300 \times 10^3\ ID/hr$$

$$cost\ for\ a\ day = 300 \times 10^3 \times 8 = 2400 \times 10^3\ IQD$$

$$Profit\ = 2400 \times 10^3 - 900 \times 10^3 = 1500 \times 10^3\ IQD$$