

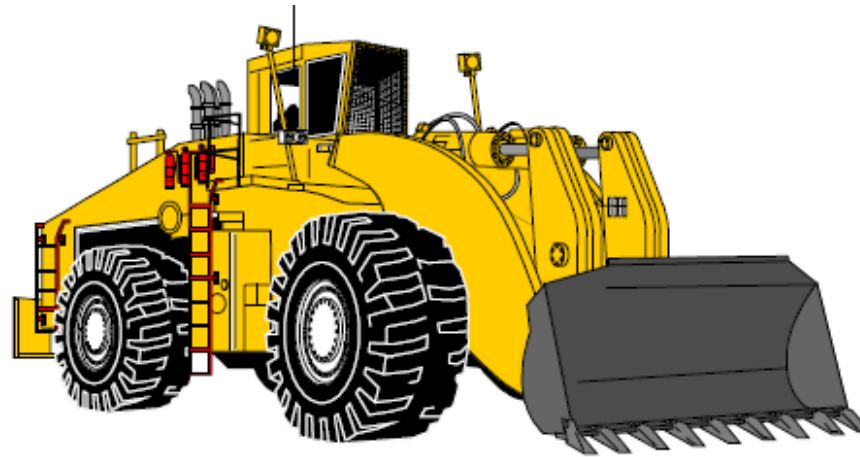


Arab Academy for Science, Technology & Maritime Transport
College of Engineering & Technology
Construction & Building Engineering

CB 524

Methods and Equipment for Construction 2

Equipment Cycle Time



Instructor: Ahmed Elyamany

Handling & Transporting Material

- Construction materials have to be **transported from** the storage yard of the material supplier **to** the job site and **from** the stockpiles on the jobsite **to** the location where the material will be permanently installed.
- This involves a **cost** that must be included in the estimate for the project.

Handling & Transporting Material

- The time required by a truck for transport of materials is divided into the following four elements:
 1. Load.
 2. Haul, **loaded**.
 3. Unload.
 4. Return, **empty**.

Cycle Time for Transporting Material

- Time for Haul-loaded and Return-empty can be determined from the speed of the vehicle and the distance traveled.
- Speed depends upon the vehicle, traffic congestion, condition of the road, and other factors.

Cycle Time for Transporting Material

- For determining time for Load and Unload production rate must be known.
- **Production rate** is defined as the number of units of work produced by a unit of equipment or a person in a specified unit of time (for example: m³/hr).

Cycle Time for Transporting Material

- The unit of time is usually **1 hr**.
- The production rate will be a **maximum** if the work is performed at the same rate during the whole hour.
- But this is **seldom** possible due to interruptions and delays.
- A machine or worker may work only for **45 min** in **1hr**
- The actual production rate (**efficiency factor**) is $45/60$ or 0.75 of the maximum production rate.

Cycle Time for Transporting Material

Example 1

- **175 tons** of sand with a density of **1.75 ton/m³** must be transported **7 km** using a **10m³** dump truck.
- **Two** laborers and **a** driver each will load the truck at a rate of **1.5 m³/hr**.
- The haul speed is **30 km/h** and return speed is **40 km/h**.
- It takes **3 min** to unload the truck.
- The cost of the truck is **\$25/hr**, the driver is **\$18/hr**, and the laborer is **\$15/hr**.
- The actual working time is **45 min** in one hr.
- **Determine the total time, total cost, and the cost/unit of transporting the sand.**

Cycle Time for Transporting Material

Example 1-Solution

1. Quantity of work:

- Volume of sand = $175/1.75 = 100$ m³

2. Cycle time:

- Load = $10/(3 \times 1.5) = 2.222$ hr.
- Haul = $7/30 = 0.233$ hr.
- Dump = $3/60 = 0.050$ hr.
- Return = $7/40 = 0.175$ hr.
- Total cycle time = $2.22+0.233+0.05+0.175 = 2.68$ hr.

Cycle Time for Transporting Material

Example 1-Solution

3. Production rate:

- Number of trips/hr. = $1/2.68 = 0.373$
- Quantity hauled/trip = $10 \text{ m}^3 \times 0.373 = 3.73 \text{ m}^3/\text{hr}$
- Production rate = $3.73 \text{ m}^3/\text{hr} \times 45/60 = 2.80 \text{ m}^3/\text{hr}$

4. Time:

- Using 1 truck and 2 laborers, time taken to transport 100 m³ of sand = $100/2.8 = 35.7 \text{ hrs.}$

Cycle Time for Transporting Material

Example 1-Solution

- **5. Cost:**
 - **Truck = 35.7 hrs x 1 x \$25 = \$892.5**
 - **Driver = 35.7 hrs x 1 x \$18 = \$642.6**
 - **Laborers = 35.7 hrs x 2 x \$15 = \$1,071**
 - **Total cost \$2,606.1**
- **6. Unit cost:**
 - **Cost/ton = \$ 2606.1 /175 = \$26**

Cycle Time for Transporting Material

Example 1-Solution

- The load time (**2.22 hr**) is significantly greater than the travel and dump time (**0.46 hr**) which indicates an imbalance between **loading** and **hauling**.
- The load time can be **reduced** by using a **tractor loader** instead of labor.

Cycle Time for Transporting Material

Example 2

- To load the truck with sand, a small tractor loader is rented at a cost of **\$50/hr**.
- The production rate of the loader is **75m³/hr**.
- The cost of transporting the loader to the site is **\$400**.
- The loader operator cost is **\$21/hr**.
- Determine the total time, cost, and cost/m³ for transporting the **175** tons of sand.

Cycle Time for Transporting Material

Example 2- Solution

1. Quantity of work:

Volume of sand = $175/1.75 = 100$ m³

2. Cycle time:

Load = $10/75 = 0.133$ hr.

Haul = $7/30 = 0.233$ hr.

Dump = $3/60 = 0.050$ hr.

Return = $7/40 = 0.175$ hr.

Total cycle time = 0.591 hr.

Cycle Time for Transporting Material

Example 2- Solution

3. Production rate:

$$\text{Number of trips/hr} = 1/0.591 = \mathbf{1.692}$$

$$\text{Quantity hauled/trip} = 10 \text{ m}^3 \times 1.691 = \mathbf{16.92 \text{ m}^3/\text{hr.}}$$

$$\text{Production rate} = 16.92 \times 45/60 = \mathbf{12.69 \text{ m}^3/\text{hr.}}$$

4. Time:

Using 1 truck and 1 loader,

$$\text{Time taken to transport 100 m}^3 \text{ of sand} = 100/12.69 = \mathbf{7.88 \text{ hrs}}$$

Cycle Time for Transporting Material

Example 2- Solution

5. Cost:

Truck = 7.88 hrs x 1 x \$25 = 197

Driver = 7.88 hrs x 1 \$18 = 141.84

Loader = 7.88 hrs x 1 x \$50 = 394

Operator 7.88 hrs x 1 x \$21 = 165.48

Total = \$898.32

Transporting loader = \$400.00

Total cost = \$1,298.32

6. Unit cost:

Cost/m³ = \$1,298.32/100 = \$12.98

Cost/ton = \$1,298.32/175 = \$7.42

Cycle Time for Transporting Material

Example 3

- Using the data in **Example 2**:
 - A. Determine the economical **number of trucks** such that the load time and transport time balance.
 - B. Also determine the **cost/unit** for transporting the material.

Cycle Time for Transporting Material

Example 3 - Solution

- The number of trucks required to balance the loader can be **calculated by** dividing the **total cycle time** by the **load time**.
- No. of trucks required = total cycle time/load time
- No. of trucks required = $0.591/0.133 = 4.44$

Cycle Time for Transporting Material

Example 3 - Solution - Alternative 1

- **Using 4 trucks:**
- There are fewer trucks than needed and hence the production rate is governed by the **truck production rate**.
- Quantity hauled by one truck = **16.92** m³/hr
- Quantity hauled by 4 trucks = $4 \times 16.92 =$ **67.68** m³/hr
- Time to transport 100 m³ of sand = $100/67.68 =$ **1.48** hrs

Cycle Time for Transporting Material

Example 3 – Solution - Alternative 1

- **Cost:**
 - **Loader = 1.48 hrs x \$ 50 = 74.00**
 - **Loader operator = 1.48 hrs x \$21 = 30.08**
 - **Trucks = 1.48 hrs x 4 x \$25 = 148.00**
 - **Truck drivers = 1.48 hrs x 4 x \$18 = 106.56**
 - **Total labor and equipment = 358.64**
 - **Transporting loader = 400.00**
 - **Total cost = \$758.64**
- **Cost/m³ = \$758.64/100 = \$7.59**

Cycle Time for Transporting Material

Example 3 – Solution - Alternative 2

- **Using 5 trucks:**
- There are more trucks than needed and hence the production rate is governed by that of the **loader**.
- Production rate of loader = **75** m³/hr
- Time required to transport 100 m³ of sand = $100/75 = 1.33$ hrs

Cycle Time for Transporting Material

Example 3 - Solution - Alternative 2

- **Cost:**
 - **Loader = 1.33 hrs x \$50 = 66.5**
 - **Loader operator = 1.33 hrs x \$ 21 = 27.93**
 - **Trucks = 1.33 hrs x 5 x \$25 = 166.25**
 - **Truck drivers = 1.33 hrs x 5 x \$18 = 119.7**
 - **Total labor and equipment= 380.38**
 - **Transporting loader = 400**
 - **Total cost = \$780.38**
- **Cost/m³ = 780.38/100 = \$7.80**

Cycle Time for Transporting Material

Example 3 - Solution

- **Alternative 1: (4 trucks)**

$$\text{Cost/m}^3 = \$7.59$$

- **Alternative 2: (4 trucks)**

$$\text{Cost/m}^3 = \$7.80$$

- **Difference = 7.80 - 7.59 = 0.21 /m³**

Choose alternative 1: (4 trucks)

Thank You