UNIT 3

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Trucks and Hauling Equipment :

→ In transporting excavated material, processed aggregates and construction materials and for moving other pieces of construction equipment.

→ Trucks serve one purpose, they are hauling units that, because of their high travel speeds, provide relatively low hauling costs.

→ the use of trucks as the primary hauling unit provides a high degree of flexibility.

→ Most trucks can be operated over any haul road for which the surface is sufficiently firm and smooth, on which the grades are not excessively steep.

→ Some units are designated as off-highway trucks because their size and weight are greater than that permitted on public highways.

→ Off-highway trucks are used for hauling material in quarries and on large projects involving the movement of substantial amounts of earth and rock.

→ On such projects, the size and costs of these large trucks are easily justified because of the increased production capability they provide.

→ Trucks can be classified by many factors, including

1. the method of dumping the load - rear dump, bottom dump, side dump.
2. the type of frame - rigid frame (or) articulated
3. the size and type of engine - gasoline, diesel, butane (or) propane
4. the kind of drive - two-wheel, four-wheel, (or) six wheel.
5. the number of wheels and axles, and the arrangement of driving wheels
6. the class of material hauled - earth, rock, coal (or) ore
7. the capacity - gravimetric (tons) (or) volumetric (cubic yards)

→ If trucks are to be purchased for general material hauling, the purchaser should select units adaptable to the multipurposes for which they will be employed.

→ On the other hand, if trucks are to be used on a given project for a single purpose, they should be selected specifically to fit the requirements of the project.

Rigid Dump trucks:

→ In the Rigid dump trucks (RDT), there is one immensely strong main frame on which are mounted both axles, the body and the cab.

→ the main frame assures long life of equipment

Articulated dump trucks:

→ In the articulated dump trucks (ADT), rear frame and front frame are connected by articulated coupling.

→ ADTs have the following distinct advantages over RDTs for the construction and earth moving industries

(a) Low turning radius

(b) Higher tractive effect

(c) Better operator comfort

(D) Faster cycle time

Rear dump trucks:

→ Rear dump trucks are heavy duty trucks with a strongly built body which is hinged at the back and is fitted with a hydraulic pump on the underside to lift the front of the body and tilt it backwards into a dumping position.

→ They can haul free-flowing material such as earth, sand, gravel, blasted rocks, ore, shale, coal etc.

Rear Dump trucks are used when:

(a) the material to be hauled is large rock and the maximum flexibility is required for hauling a variety of materials under variable job conditions

(b) Maximum gradability and rapid spotting in restricted area is required.

(c) the hauling unit is subjected to severe loading impact when under a large shovel & dragline.

(d) Dumping is restricted in hoppers or fill.

→ In cold climate countries, the body is designed to prevent material from freeting.

→ Exhaust gases from the engine are carried through ducts which heat the body of the truck and it helps considerably when hauling wet, adhesive and sticky materials.

Bottom Dump trucks:

→ In Bottom Dump Trucks, the body always remains in position and the discharge of material takes place through the bottom by the opening of two longitudinal gates.

Bottom Dump trucks are used when:

(a) the material to be hauled is easy flowing like sand, gravel, dry earth etc

(b) the load is to be spread in layers as on fill of a dam.

(c) the material is discharged while the unit is moving and the rapid and controlled rate of discharge gives these units a time advantage over rear dump trucks.

(d) Because of limited openings these donot find application when the material is of big size or it is wet and sticky.

(e) Long adverse grades should not exceed 5% for the best performance.

Dump trucks:

→ Side dump trucks have the body hinged on both sides such that they can dump the material in a long narrow length or one one & both sides of a road.

→ the dump trucks are built with a strong chassis to withstand rough road conditions at construction sites the dumper can handle both free flowing material and the rock

Capacities of trucks and hauling equipment:

→ There are at least three methods of rating the capacities of trucks and wagons:

1. Gravimetric - the load it will carry, expressed as a weight
2. struck volume - the volumetric amount it will carry, if the load is water level in the body.
3. Heaped volume - the volumetric amount it will carry, if the load is heaped on a 2:1 slope above the body.

→ the gravimetric rating is usually expressed in pounds & kilograms and the latter two rating in cubic yards (a) cubic meters.

→ the struck capacity of a truck is the volume of material that it will haul when it is filled level to the top of the body sides.

→ the heaped capacity is the volume of material that it will haul when the load is heaped above the sides.

→ the standard for rated heaped capacity uses an assumed 2:1 slope

→ the actual heaped capacity will vary with the material that is being hauled.

→ Wet earth or sandy clay can be hauled with a slope of about 1:1, while dry sand or gravel may not permit a slope greater than about 3:1

→ To determine the heaped capacity of a unit, it is necessary to know the struck capacity, the length and width of the body, and the slope at which the material will remain stable while the unit is moving.

→ Smooth haul roads will permit a larger heaped capacity than the rough haul rods.

→ the truck's weight capacity may limit the volumetric load a unit can carry

→ this happens when hauling a material having high unit weight such as iron (or) even wet sand.

→ However, when the unit weight of the materials is such that the safe load is not exceeded, a unit can be filled to its heaped capacity.

→ Always checks to ensure that the volumetric load doesnot cause a condition where the load weight exceeds the gravimetric capacity of the truck.

5. Truck size Affects productivity:

→ the productivity of a truck depends on the size of its load and the number of trips it can make in a unit of time.

→ the no. of trips completed per hour is a function of cycle time.

→ Truck cycle time has four components.

① load time ② haul time
③ dump time ④ return time

→ Examining a match between truck body size and excavator bucket size yields the size of the load and load time

→ the haul and return cycle times will depend of the weight of the truck, the horsepower of the engine, the haul and return distances and return ~~Cycle times will depend on~~ distances, and the condition of the roads traversed.

→ Dump time is a function of the type of equipment and conditions in the dump area.

→ when an excavator is used to load material into trucks, the size of the truck cargo body introduces several factors, which affect the production rate and the cost of handling the material.

Small trucks - Advantages.

1. More flexibility, which may be an advantage in restricted work sites
2. Higher speed, can achieve higher haul and return speeds.
3. production, little impact if one truck breaks down
4. Balance of fleet, easy to match no. of trucks to excavator production

Small trucks - Disadvantages:

1. Number, more trucks increases operational dangers in the pit, along the haul road and the dump.
2. More drivers required, more needed for a given output
3. Loading impediment, small target for excavator bucket
4. positioning time, total spotting time greater because of the number required.

Large trucks - Advantages:

1. Number, fewer needed for a given output
2. Drivers required, fewer needed for a given output
3. Loading advantage, larger target for the excavator bucket.
4. positioning time, frequency of spotting trucks is reduced.

3 rge trucks – Disadvantages:

1. cost of truck time at loading greater, especially with small excavators.
2. Loads heavier, possible damage to the haul roads thus increasing the cost for maintenance of the haul road.
3. Balance of fleet, difficult to match number of trucks to excavator production.
4. Size, may not be permitted to haul on highways.

CALCULATING TRUCK PRODUCTION:

→ the most important consideration when matching excavators and trucks is finding equipment having compatible capacities.

→ Matched capacities yield maximum loading efficiency.

→ the following is a format that can be used to calculate truck production

① Number of Bucket loads:

→ the first important step in analyzing truck production is to determine the number of excavator bucket loads it takes to load the truck.

$$\text{Balanced number of bucket loads} = \frac{\text{Truck capacity (lcy)}}{\text{Bucket capacity (lcy)}}$$

(2) Load Time and Truck load volume:

→ the actual number of bucket loads placed on the truck must be an integer number.

→ It is possible to not completely fill the bucket (light load) to match the bucket volume to the truck volume, but that practice is usually inefficient as it result in wasted loading time.

→ if one less bucket load is placed on the truck, the loading time will be reduced. but the load on the truck is also reduced.

→ Sometimes job conditions will dictate that a lesser number of bucket loads be placed on the truck i.e, the load size is adjusted if haul roads are in poor condition & if the trucks must traverse steep grades.

→ The truck load volume in such cases will equal the bucket volume multiplied by the no. of bucket loads.

Next Lower integer: For the case where the number of bucket loads is rounded down to an integer lower than the balance number of loads are reduced because of job conditions.

Load time = Number of bucket loads × Bucket cycle time

Truck load (volumetric) = Number of bucket loads × Bucket Volume
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Higher integer: If the division of truck cargo body volume by the bucket volume is rounded to the next integer and that higher number of bucket loads is placed on the truck, excess material will spill off the truck

→ In such case, the loading duration equals the bucket cycle time multiplied by the number of bucket swings.

→ But the volume of the load on the truck equals the truck capacity, not the number of bucket swings multiplied by the bucket volume.

Load time = Number of bucket loads x Bucket cycle time

Truck load (volumetric) = Truck Volumetric capacity.

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Gravimetric check:

→ Always check the load weight against the gravimetric capacity of the truck.

Truck load (gravimetric) = Volumetric load (cy) x Unit weight (loose vol. lb/cy)

Truck load (gravimetric) < Rated gravimetric payload.

③ Haul time

→ Hauling should be at the highest safe speed and in the proper gear.

→ To increase efficiency, use one-way traffic patterns.

fpm = feet per minute
mph = miles per hour

$$\text{Haul time} = \frac{\text{Haul distance (ft)}}{88 \text{ fpm/mph} \times \text{Haul speed (mph)}}$$

→ Based on the gross weight of the truck with load, and considering the rolling and grade resistance from the loading area to dump point, haul travel speeds can be estimated using the truck manufacturer's performance chart.

→ The truck's performance chart should be used to determine the maximum speed for each section of haul road having a significant difference in grade or rolling resistance

④ Return time :

→ Based on the empty vehicle weight and the rolling and grade resistance from the dump point to the loading area, return travel speeds can be estimated using the truck manufacturers performance chart.

$$\text{Return time (min)} = \frac{\text{Return distance (ft)}}{88 \text{ fpm/mph} \times \text{Haul speed (mph)}}$$

⑤ Dump time :

→ Dump time will depend on the type of hauling unit and congestion in the dump area.

→ Consider that the dumping area is usually crowded with support equipment.

dozers are spreading the dumped material, and multiple pieces of compaction equipment may be working in the area.

→ Rear dumps must be spotted before dumping
→ This usually means that the truck must come to a complete stop and then backup some distance
→ total dumping time in such cases can exceed 2 min.
→ Bottom dumps will customarily dump while moving.
→ After dumping, the truck normally turns and returns to the loading area.
→ Under favorable conditions, a rear dump can dump and turn in 0.7 min but an average unfavorable time is about 1.5 min.
→ Bottom-dumps can dump in 0.3 min under favorable conditions, but they too may average 1.5 min when conditions are unfavorable.
→ Always try to visualize the conditions in the dump area when estimating dump time

(6) Truck cycle time:

→ the cycle time of a truck is the sum of the load time, the haul time, the dump time, and return time

$$\text{Truck cycle time} = \underset{\text{time}}{\text{Load}} + \underset{\text{time}}{\text{Haul}} + \underset{\text{time}}{\text{Dump}} + \underset{\text{time}}{\text{Return}}$$

(7) Number of trucks required:

→ the no. of trucks required to keep the loading equipment working at capacity is

$$\text{Balanced no. of trucks} = \frac{\text{Truck cycle time (min)}}{\text{Excavator cycle time (min)}}$$

production:

→ the number of trucks must be an integer number

Integer lower than Balance number:

→ if an integer number of trucks lower than the result in above equation is choosen, then the trucks will control production.

$$\text{production (cy/hr)} = \text{Truck load (cy)} \times \text{No. of trucks} \times \frac{60 \text{ min}}{\text{Truck cycle time (min)}} \quad \text{— (A)}$$

Integer Greater than Balance number:

→ When an integer number of trucks greater than the result in above equation is selected production is controlled by the loading equipment

$$\text{production (cy/hr)} = \text{Truck load (cy)} \times \frac{60 \text{ min}}{\text{Excavator cycle time (min)}} \quad \text{— (B)}$$

→ As a rule, it is better to never keep the loading equipment waiting.

→ If there is not a sufficient number of haul trucks, there will be a loss in production.

→ Truck bunching (or) queuing will reduce production 10 to 20% even when there is a perfect match between excavator capacity and the no. of trucks.

→ If there are extra haul units, the queuing effect is reduced.

→ Therefore, it is usually best to have more trucks that is with above equation roundup to the next integer.

⑧ Efficiency:

→ the production calculated with either equation (A) & equation (B) is based on a 60-min working hour.

→ that production should be adjusted by an efficiency factor

→ Longer hauling distances usually result in better driver efficiency.

→ Driver efficiency increased as haul distance increases out to about 8000 ft, after which efficiency remain constant.

→ Other critical elements affecting efficiency are bunching equipment condition.

$$\text{Adjusted production} = \text{production} \times \frac{\text{Working time (min/hr)}}{60 \text{ min}}.$$

Types of compaction equipment:

→ Applying energy to a soil by one & more of the following methods will cause compaction.

1. Impact - sharp blow
2. pressure - static weight
3. Vibration - shaking
4. kneading - Manipulation (or) rearranging.