Construction Technology L 5
(Tractors & Related Equipment)

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Tractors Use:

- ✓ **Tractors are self-contained units that are designed to provide tractive power for drawbar works.**
- ✓ **Tractors have many uses as construction equipment. While their primary purpose may be to pull or push loads, they are also used as mounts for many types of accessories, such as front-end shovels, bulldozers and others.**
- ✓ **For the tractors to be used for drawbar work, they should have a low center of gravity. This is a perquisite for good machines.**
- ✓ **The larger the difference between the line of force transmission from the machines and the line of resisting force, the less effective utilization of the of the developed power.**
- ✓ **Typical project applications are land clearing, Bulldozing, Ripping and towing other pieces of construction equipment.**

Selection of Tractors:

Types of Tractors:

In selecting a tractor several factors should be considered such as:

- ✓ The size required for a given job.
- ✓ The kind of job for which it will be used.
- ✓ The type of footing over which it will operate.
- ✓ The firmness of the haul road.
- ✓ The smoothness of the haul road.
- ✓ The slope of the haul road.
- ✓ The length of the haul road.
- ✓ Finally, the type of work it will do after this job is completed.

Types/Performance Characteristics of Tractors:

- **There are two main types of tractors which are:**

1. **Crawler type which is used to increase floatation and the movement over a non-paved surface. However the speed is very low.**

2. **Wheel Type which is used on paved surfaces and it has a greater speed compared with the crawler type tractors.**

Types/Performance Characteristics of Tractors:

Crawler Type Bulldozers

Types/Performance Characteristics of Tractors:

Wheel Type Bulldozers

Comparison between Crawler type and Wheel type tractors is shown on the following table.

No.	Wheel Type Tractors	Crawler type Tractors
1	Good on firm soils or concrete and abrasive soils which have no sharp-edged pieces.	Can work on variety of soils including sharp edged pieces.
2	Best for leveled and downhill work	Can work almost any terrain
3	Wet weather, causing soft and slick surfaces that will stop operation.	Can work on soft ground and over mud-slick surfaces
4	Good for long travel distance as they have high speed 8 to 20 mph.	Good for short travel distance as they have low speed 5-7 mph.
5	Can only handle moderate blade loads.	Can push large blade loads.

2- Crawler Type Tractors:

- ✓ Crawler tractors are usually rated by size or weight and power.
- ✓ The weight is important on many projects because the maximum tractive effort that a unit can provide is limited to the product of weight times the coefficient of traction for the unit and the particular road surface, regardless of the power supplied by the engine.
- ✓ The equivalent drawbar pull which a crawler tractor must provide, is **the algebraic sum of the pull required by the towed load, the effect of grade on tractor and the effect of increased or decreased rolling resistance on the tractor**.

$$\textit{Equivalent Drawbar Pull} = \left(\textit{Pull Required by Towed Load} \pm \textit{Effect of Grade} \pm \textit{Difference in Drawbar Pull due to Rolling Resistance} \right) \quad \ldots\ldots (4\text{-}1)$$

2- Wheel Type Tractors:

- ✓ The wheel-type tractors are either two-wheel or four-wheel. One of the primary advantages of a wheel tractor compared with a crawler tractor is the higher speed that may exceed (50 km/hr.).
- ✓ However, in order to attain a higher speed a wheel tractor must sacrifice pulling effort.
- ✓ Also, because of lower coefficient of traction between rubber tires and soil surfaces, the wheel tractor may slip its wheels before developing its rated pulling effort.
- ✓ As the speed is increased through the selection of higher gear, the rim pull will be decreased in approximately the same proportion.
- ✓ Thus, for a given unit whose engine is operated at a rated power, the product of the speed times the rim pull will remain approximately constant.

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2- Wheel Type Tractors:

The net drawbar pull of a wheel tractor is the **smaller value** obtained by either:

1. Deducting from the available rim pull the pull required to overcome the rolling resistance when it's traveling on a level haul surface.

$$\begin{matrix}\textit{Net Drawbar Pull}\\ \textit{of a wheel tractor}\end{matrix} = \begin{matrix}\textit{Available}\\ \textit{Rim Pull}\end{matrix} - \begin{matrix}\textit{Pull Required}\\ \textit{to overcome the}\\ \textit{Rolling Resistance}\end{matrix} \qquad \ldots\ldots (4\text{-}2)$$

2. Deducting from the product of the coefficient of traction and the gross weight on the pulling wheels the pull required to overcome the rolling resistance when it's traveling on a level haul surface.

$$\begin{matrix}\textit{Net Drawbar Pull}\\ \textit{of a wheel tractor}\end{matrix} = \left(W_{ton} \times \textit{Coefficient of Traction}\right) - \begin{matrix}\textit{Pull Required}\\ \textit{to overcome the}\\ \textit{Rolling Resistance}\end{matrix} \qquad \ldots\ldots (4\text{-}3)$$

Grade-ability:

Grade-ability: It is defined as ***the maximum slope (expressed as a percent) that a crawler or wheel-type tractor (or related equipment) may move up at a uniform speed***.

The gradability of a crawler tractor is determined by subtracting from the available drawbar pull the total pull required to overcome the rolling resistance of the unit and any load that it will pull.

$$\begin{pmatrix} Drawbar\ Pull\ to \\ Overcome\ \ Grade \end{pmatrix} = W_{tons} \times \ 10 \times \ \ Gradability\ (\%) \qquad \ldots\ldots (4\text{-}4)$$

$$Gradability = \frac{\begin{pmatrix} Drawbar\ Pull\ to \\ Overcome\ \ Grade \end{pmatrix}}{W_{tons} \times 10} \qquad \ldots\ldots (4\text{-}5)$$

2- Bulldozers:

- A bulldozer is a tractor unit which has a blade attached to its front. The blade is used to push, shear, cut and roll material a head of the tractor.
- The bulldozers is an effective and versatile earth remover equipment.
- Bulldozers are used as both support and production machines on many construction projects. They can be used from the start to the finish of the construction activity.
- Bulldozers are mounted with blades which are perpendicular to the direction of travel, while angle-dozers are mounted with blades set an angle with the direction of the travel.
- The first one push the earth forward while the latter push the earth at a side in accordance with the blade angle.

2- Types of Bulldozers:

- ✓ There are two main types of Bulldozers which are Bulldozers and Angledozers. Also there are two main types Crawler type Bulldozes and Wheel mounted Bulldozers.

4.3.2. Comparison between Bulldozers and Angledozers:

Bulldozers	Angledozers
1. Bulldozers are mounted with blades perpendicular to the direction of travel.	1. Angledozers are mounted with blades set at an angle with the direction of travel.
2. Bulldozers push the earth forward.	2. Angledozers push the earth forward and to one side.

* The size of a bulldozer is indicated by the length and height of the blade.

Bulldozers:

Advantages of Crawler-Type Bulldozers:

- Ability to deliver greater tractive effort, especially if operating on soft footing, such as loose or muddy soil.
- Ability to travel over muddy surfaces.
- Ability to travel over rough surfaces, which may reduce the cost of maintenance.
- Ability to operate in rocky formations, where rubber tires might be damaged.
- Greater use on construction jobs.

Advantages of Wheel-Mounted Bulldozers:

- ✓ Higher travel speed on the job or from one job to another.
- ✓ Elimination of hauling equipment to transport the bulldozer to a job.
- ✓ Greater output.
- ✓ Less operator fatigue.
- ✓ Ability to travel on paved highways without damaging the surface.

Angle Dozers:

Bulldozers:

Uses of Bulldozers:

1. Stripping:

- Bulldozers are good machines for stripping which is the removal of a thin layer of material. In most project, this term is used for the removal of the top soils.
- Stripping should be conducted in such a manner that push/haul distance are minimized.
- Bulldozers are economical machines for haul distances of less than 300 ft.
- Bulldozers can be very effective support machines for long haul stripping situations when used to create piles of materials that will be picked up by scrapers.

2- Crawler Type Tractors:

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Uses of Bulldozers:

2. Pioneering and Side hill Cuts:

- It is very difficult to develop the initial working table for excavations made on steep ground.
- The Bulldozers are used to make ramps that enables machines to move up the mountain.
- However, it is very difficult for a machine to move up on one shot. It has to rest and therefore it is very important to establish a horizontal terrain for rest.
- With the above conditions the machines can reach up the terrain and carry out the required work.

Uses of Bulldozers:

3. Ditching:

- A bulldozer can be used to accomplish ditching, but this is only practical for rough ditch section.
- Small shallow ditches are usually cut with motor graders. While large deep ditches are usually cut with excavators. In dry state, cut may be made with scrapers.
- If the dozer is used to cut rough ditches, the machines pushes the material out of the cut by working perpendicular to the line of the ditch.

4. Backfilling:

- A dozer can be efficiently used to backfill a ditch or pushing the material against structure.
- A dozer equipped with angle blade can drift the backfilling material into the ditch or pipe trench.

Uses of Bulldozers:

3. Blade to Blade Dozing:

- It is a technique used to increase the production of a bulldozers. The technique is sometimes referred to as side by side dozing.
- As the name implies: two machines are maneuver so that their blades are right next to each other during the pushing phase of the production cycle.
- This reduces the side slippage of each machines by 50%.
- When the machines operate simultaneously, delay to the cycle occurs. Such delay in combination with the achieved slippage limits the total increase in the production rate by 15 to 25%.

Blade to Blade Dozing

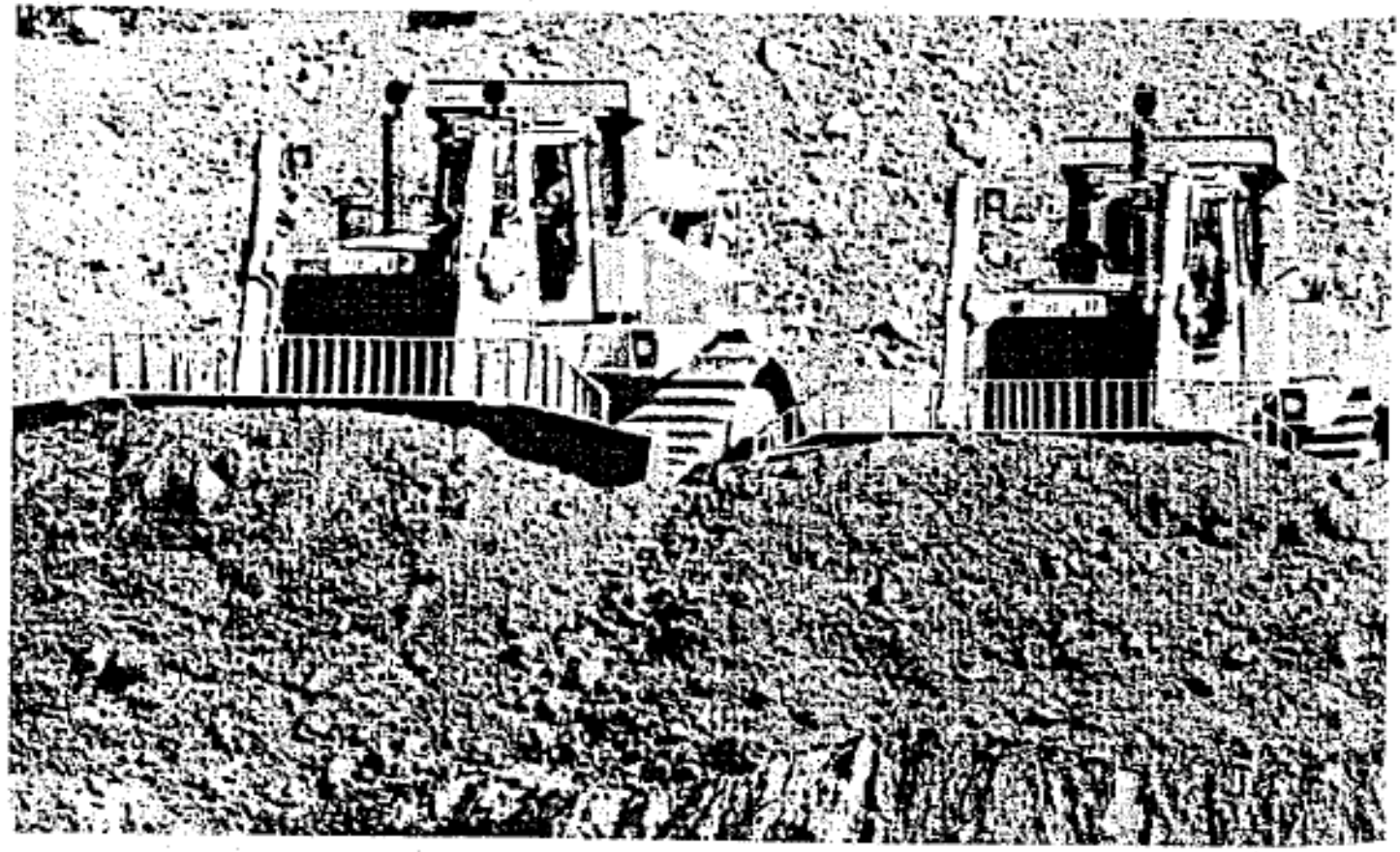

FIGURE 7.10 Blade-to-blade dozing used to increase production by minimizing spillage.

Bulldozers Production Estimates:

The amount of material the Bulldozer moves is dependent on the quantity that will remain in front of the blade during the push. The factors that control dozer production rates are:

1. **Blade type**
2. **Type and condition of material**
3. **Cycle time**

Blade Type: straight blades roll material in front of the blade. Universal and semi universal blades control side spillage by holding the materials within the blades. Because the U and SU blades force the material to move to the material to the center, there is a greater degree of material volumetric swell. With the U and SU blades quantity of loose material will be greater than that of the S blades.

Bulldozers Production Estimates:

Type and condition of Material:

- The type and condition of material being handled affect the shape of the pushed mass in front of the blades.
- Cohesive material (clays) will boil and heap.
- Materials that exhibit a slippery quality or those that have mica content will ride over the ground and swell out.
- Cohesion-less material (sands) are known as dead material that do not exhibit heap or swell properties.

Cycle Time:

- The sum of the time required to push a load, back-track and maneuver into position to push again represents one dozer production cycle.

Bulldozers Production Estimates:

Blade Load:

- The load that the blade will carry and can be estimated by several methods:

1. Manufacturer's blade rating,
2. Previous experience (similar material, equipment and work condition).
3. Field measurements.

- Manufacturer's blade rating,

- $V_s = 0.80WH^2$
- $Vu = Vs + ZH(W-Z) \tan Xo$
- Where:

V_s = capacity of straight or angle blade in Icy
Vu = Capacity of the universal blade, in Icy
W = Blade width in yd
H= effective Blade height in yd
Z = wing length measured parallel to blade width, in yd
X= wing angle

- Student to study the formulas as per 1, 2 & 3.

Next lecture, Introduction to Contracts

THANK YOU!