BUILDING CONSTRUCTION PRACTICES

TYPES OF EARTHWORK EQUIPMENT

TRACTORS, MOTOR GRADERS, SCRAPERS, FRONT END WADERS, EARTH MOVERS

PRESENTED BY-

NABEEL FAROOQUI
NAVDEEP SINGH
MUNISH RANA
NEHA PANDIT

PRESENTED TO-

PROF. YUVRAJ SINGH

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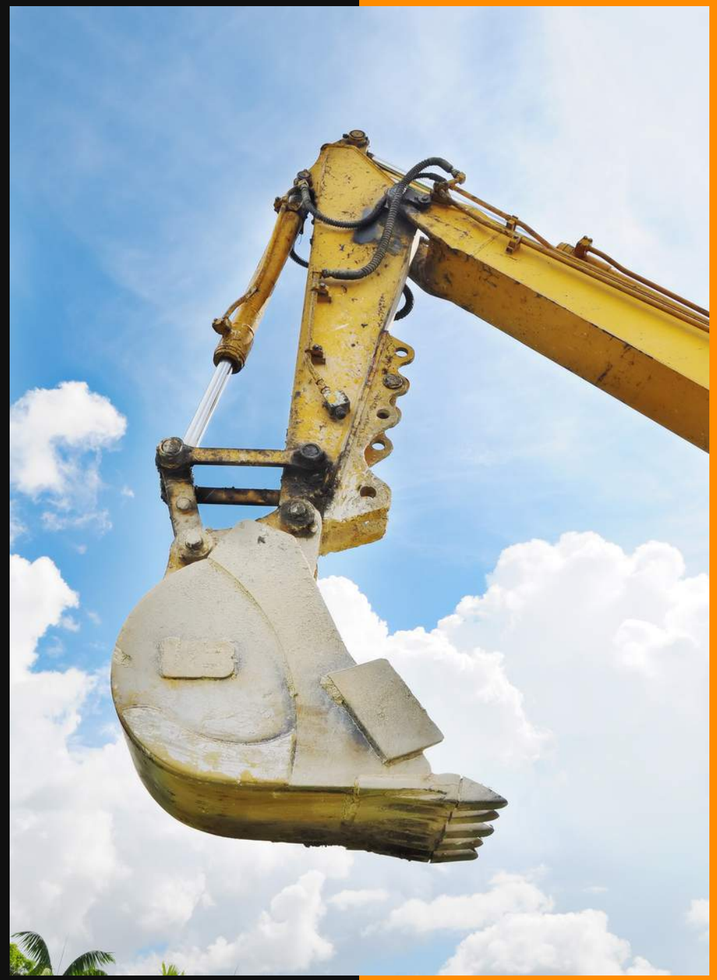


EARTH MOVERS

Excavators

Motor Graders

Bulldozers

EARTH MOVING

- to level the ground
- for grading of the ground
- stripping of the soil
- for deep excavation (to make foundation)
- for excavating trenches (for piping etc.)

EARTH MOVING OPERATIONS:-

- excavating
- loading
- hauling
- placing
- compacting
- grading, and
- finishing

BULLDOZER

tractor unit attached with earthmoving blade

Can be used for different types of applications in a construction project site.

Up to approximately 100 m EHD

depends upon -

- size of dozers
- type of material to be pushed

USES -

- clearing vegetation and trees (land clearing)
- opening up roads through mountain
- as a supporting equipment (assisting scrapers)
- spreading earth fill
- back filling trenches
- maintaining haul roads

Rome K/G clearing blades used for land clearing.

Earthmoving blades not to be used.

Only the cutting edge is replaced as it is bolted to the blades.
The cutting edge wears out so it is frequently changed.

Can also be used as a ripper!

Front end - earth moving blade
rear end - ripper

1. **to loosen the earth and then using earth moving blade and push the earth.**
2. **for ripping the rocks, an alternate to drilling and blasting method.**

Rippability of rocks must be checked before, weather the rocks are rippable or not.

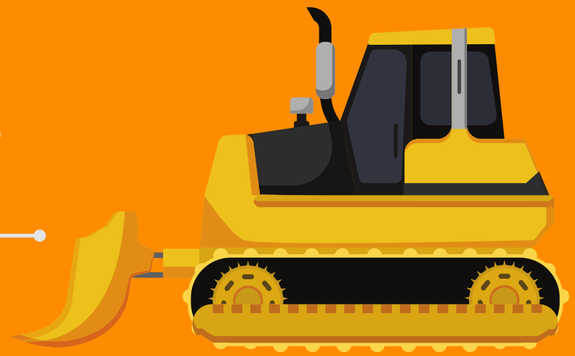
Can also be used for stripping - removal of the top layer of the soil.

TYPES OF BULLDOZERS

wheel mounted bulldozers

1. more mobility
   mobilization easier to the project site
   can be operated on paved roads or highways
   without damaging the surface.
2. less tractive effort

track mounted bulldozers



1. less mobility
   will probably damage paved roads surface.
   Suitable for use in -
   a) Clayey or muddy or rocky terrains
   b) Ripping roads and cutting trees
   c) Steepy terrains
2. more tractive effort (broader contact area)

BLADE ADJUSTMENTS

movement of the blade depends upon the connection between -
tractor and the bulldozer blade

There are three types of ways in which the blades can be operated based on their movement with respect to the axes.

Note that for any type of blade, only two movements are possible consecutively.

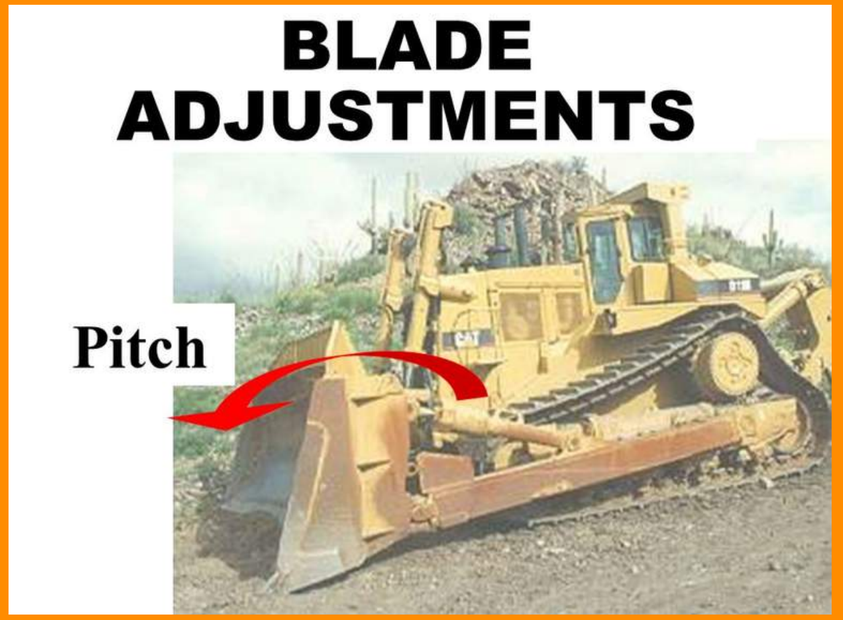
PITCHING

TILTING

ANGLING

PITCHING -

1. Top end may move forward or backward.
2. Rotation of the blade about the X-axis.
3. By changing the angle of penetration, we can alter the depth of penetration on our will.
4. The extent of pitch depends upon the manufacturer



TILTING -

1. Change in the angle of penetration of the blade.
2. Movement in the vertical plane.
3. Difference in elevation of two ends of the blade.
4. The extent of pitch depends upon the manufacturer
5. Used when the soil is hard.

Significance of Tilting - For hard soils and huge terrains, more concentration of power is needed. When one end of the blade is raised, the other end is now only in contact with the earth, so concentration of power will be more in that limited portion of the blade.

ANGLING -

1. Only possible when there is C frame connection between the tractor and the blade. Because for simple connections the blade is perpendicular to the direction of motion.
2. Rotation is about the Y-axis.

Significance of Angling -

- For sidehill cutting
- working on one side of the road (in narrow constraints)
- for piping, backfilling the trench

BLADE PERFORMANCE -

Indicators of blade performance -

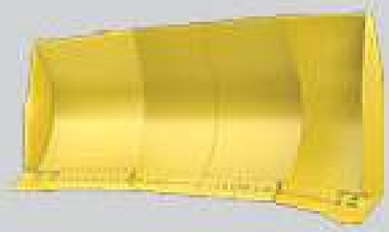
- Horsepower per m of cutting edge -- Cutting Ratio
  measure of the blade's ability to penetrate hard soil.
  smaller dimension ∝ more horsepower concentration ∝ more cutting ratio

- Horsepower per loose cubic m of the material retained in front of the blade -- Load Ratio
  ability to push the load once the blade is loaded.
  Load Ratio ∝ speed at which the soil will be pushed.

DIFFERENT BLADES -

S-BLADE

The straight blade has no side wings, making it the shortest of dozer blade types. Designed for shaping, stripping, and fine grading surfaces, the lack of wings reduces the blades ability to lift or carry material as it will fall off the edges during prolonged pushes.



U-BLADE

The U-Blade is designed to move big loads across long distances. The large wings and curved shape cradle loose materials like coal or soil and keep the load contained as it's transported across the ground.

S-U-BLADE

The S-U-Blade has smaller wings then the full U-blade and less curve like an S-Blade making it the middle ground in dozer blades – less capacity, but increased strength.

PAT-BLADE

With multiple hydraulic cylinders allowing the dozer blade to tilt and angle in nearly every direction the PAT-blade is a versatile blade that allows an operator to shape and finish ground to exacting specifications and to move material with precision.

CUSHION BLADE

If another machine like a scraper or a track-type tractor needs to be pushed, the cushion blade is specifically designed for that task with reinforced areas and specially designed systems to absorb shock.

MOTOR GRADERS

- Graders also called as motor graders
- used in construction especially for the construction of roads. It is mainly used to -

1. level the soil surface
2. to remove snow or dirt from the roads
3. to flatten the surface of soil before laying asphalt layer
4. to remove unnecessary soil layer from the ground etc.

- Contains a horizontal blade in between front and rear wheels and this blade is lowered in to the ground while working.

SPEED:
✓ LIGHT DUTY - 6-10 KM/HR.
✓ HEAVY DUTY - 2-3 KM/HR.
✓ NORMAL DUTY - 4-6 KM/HR.

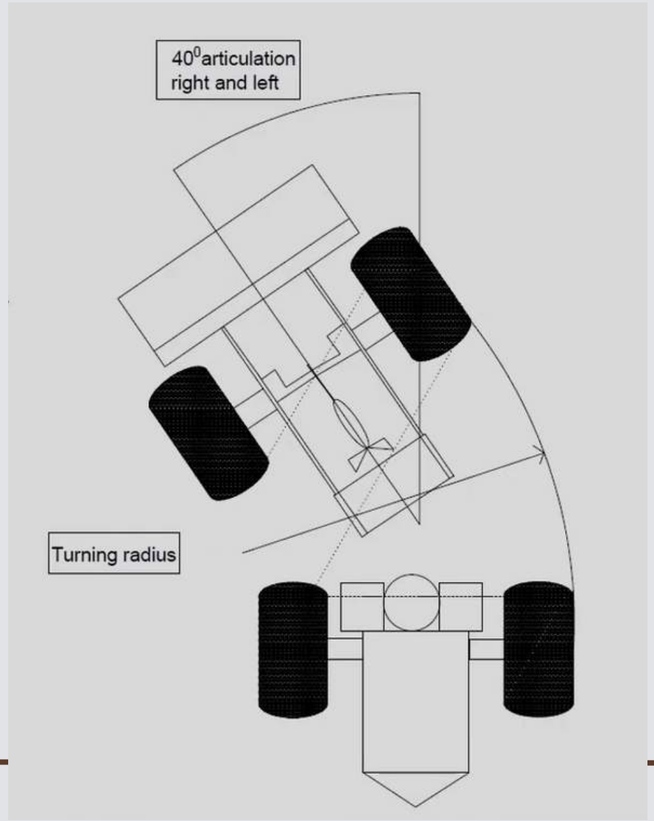
- **THE FRONT OF THE GRADER FRAME IS SUPPORTED ON A PAIR OF FRONT WHEELS & REAR ON TANDEM WHEELS.**
- **THE CURVED BLADE IS SUPPORTED ON THE CIRCLE AND BE**
- **TURNED THROUGH 360 DEGREES.**
- **THE BLADE HAS REPLACEABLE EDGES.**
- **CUTTING DEPTH - 2-4 CM.**

TYPES OF GRADERS

Motor graders are classified depending on the arrangement of their frame. There are two types of categories graders can fall under: Rigid frame motor grader and Articulated frame motor grader.

The rigid frame motor grader has only one axle. Axle is unable to turn left or right about a point.

An articulated grader is a vehicle that has a permanent or semi-permanent pivot joint in its construction, allowing the vehicle to turn more sharply.



TRACTORS

1. Various different kinds of blades for scraping, excavation, and rippers ultimately going to be mounted to the tractors.

2. **VERSATILE** machine

3. Converts engine energy to tractive energy

4. Used as a mount for many accessories - front-end shovels, bulldozers, etc.

5. Used for -

- clearing
- excavating
- hauling
- conveying

Factors effecting selection

1. **Size -** capacity of the job makes a big difference, is it heavy or light?

2. **Purpose -** What is the purpose of the job? Weather it is pulling, conveying, hauling, excavating.

3. **Type of footing on which it will travel -** if the surface is even or uneven.

4. **Smoothness and firmness of the soil**

5. **Slope and length of the level road**

Gradability of Tractor - maximum slope (in %) upto which a wheel type of crawler mounted tractor may move at a uniform speed.

Features of Two-Wheel Tractor -

- Tractive Force
- Maneuverability
- Rolling Resistance less

Features of a Four-Wheel Tractor-

- Better steering properties
- Less tendency to bump over rough roads
- speed
- can work as independent as well

SCRAPERS

- **capable of excavating, hauling & dumping material over medium to long haul distances.**
- **used for long haul distances (upto 1000 m)**
- **commonly used in road projects**
- **VERSATILE machine**
- **good in loading and hauling both**

- **As the loaders and excavators are good at loading and their efficiency cannot be compared with scrapers, likewise we cannot compare the efficiency of a truck with that of scrapers in case of hauling.**

- **EHD -**

1. dozer/loader - up to 100 m
2. scraper - up to 100-1000 m
3. truck - > 1000 m

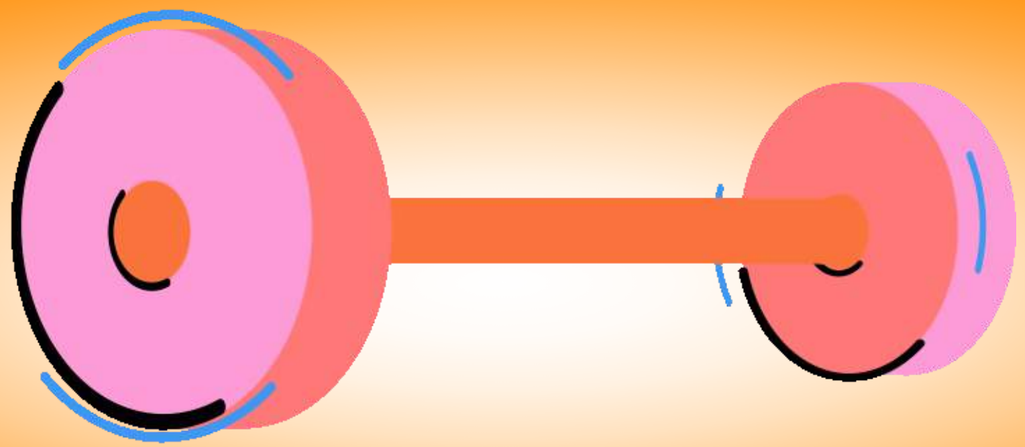
SCRAPER TYPES -

(based on if it needs assistance form other machines during loading operation)

1. Pusher Loaded -

- Single powered axle
- Tandem powered axle

2. Self Loaded



BULL DOZER + SCRAPER

(C-blade)

- bulldozer is attached only when we are cutting or using loading operation.
- the scraper can haul itself after the loading operation.
- We use crawler-mounted bulldozers to increase the loading power of the scraper, as the scrapers are wheel mounted only.

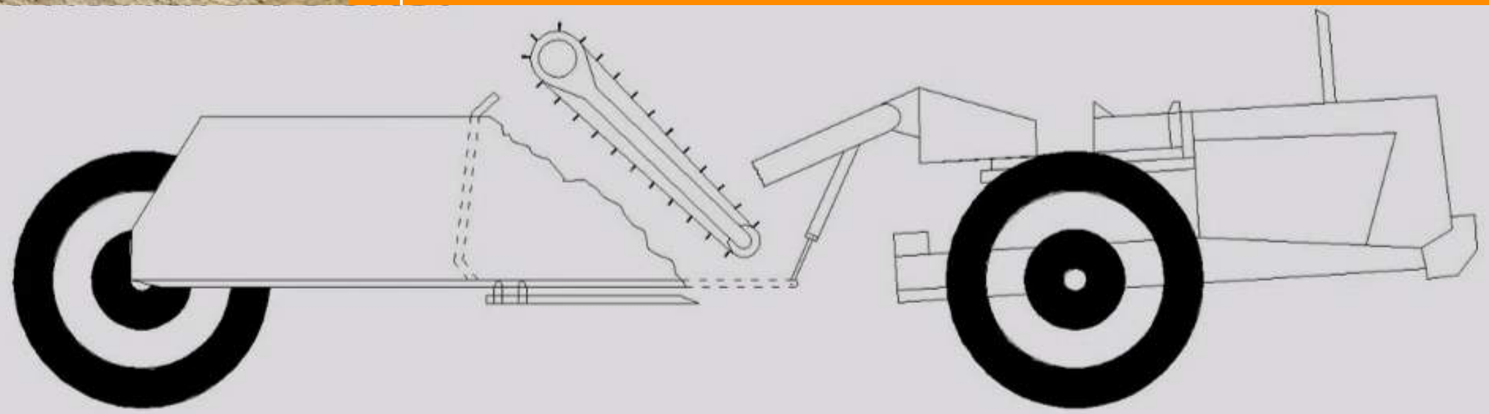
May not be the case that all the axles are powered, to transfer the power to the wheel.

Powered Axle - axle which serves to transmit the power to wheels.
Dead Axle - axle that carries a wheel without the power to drive it.
(suspension and steering component)

Single Powered - both axles are not powered.

- Tandem Powered - both axles are powered.
- have twin engine arrangements for extra power to overcome resistance.
- machines are operated in tough conditions where Rolling Resistance is high and Frade Resistance is high, for ex - muddy, rocky, and hardened clayey terrains. So its economical for tough underfoot conditions.
- cost 25% more than single powered axle.

- Heavier and costlier than conventional scrapers.
- Don't need any assistance/pusher
- Self-weight is a disadvantage
- Economic for only short haul distances
- Cannot handle rough terrains containing rocks, bigger-sized rocks can easily jam in the chain elevator assembly.



Modified after Harris et al (1994)

FRONT END WADERS

Tractor provided with front-end bucket.
Basically an excavator, good at excavating above ground level.

EHD - 200 m (wheel mounted)
100 m (crawler)

Lifts material --> Carries it --> Dumps into haulers, which is not possible in bulldozers and scrapers

seen in -
asphalt batching plants
RMC factories (aggregate crushing plants)

TYPES OF LOADERS

BASED ON -

1. Capabilities of Buckets -

<1 m^3 - 15 m^3

2. Mounting

- Crawler mounted tractor
- Wheel mounted tractor

3. Frame

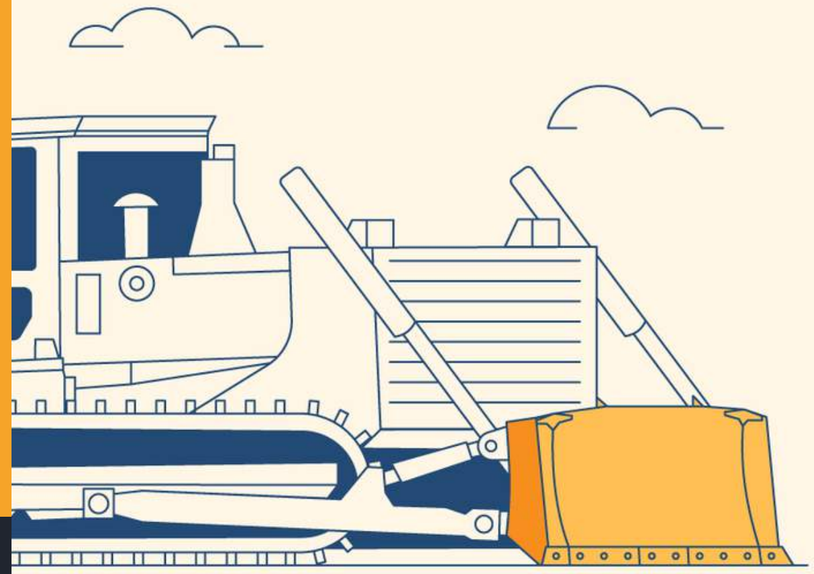
- Rigid frame
- Articulated frame

Wheeler Loader	Track Loader
Less expensive	Highly expensive
Less maintainance	maintenance high
Much faster	Slower in speed
Replacement cost of tyres high	More reliable performance
--	Good traction Can overcome tough terrains

TYPES OF BLADES USED -

S-BLADE

Shortest blade with no side wings



Location

Back, bottom corners of the blade

Ideal Tasks

Stripping, ditching

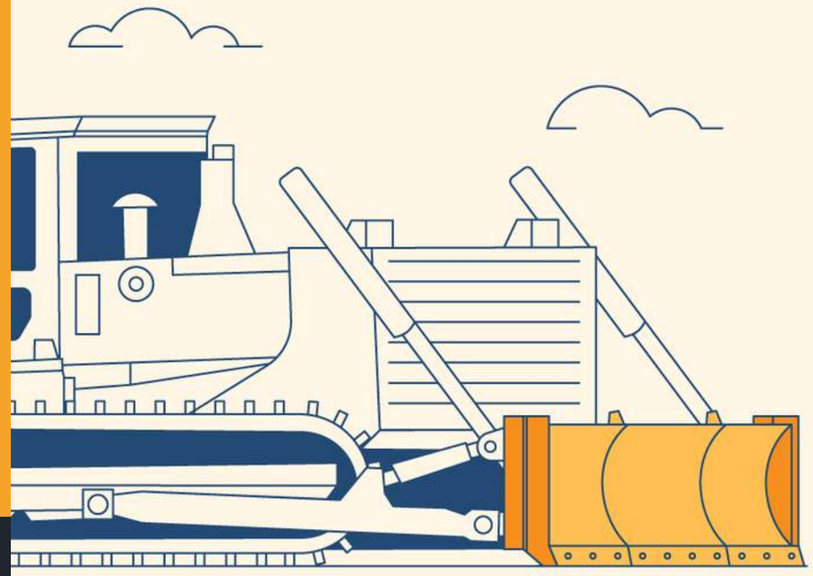
Best used for

Fine-grained and medium to hard material

TYPES OF BLADES USED -

U-BLADE

Curved shape with large side wings



Location

Back, bottom corners of the blade

Ideal Tasks

Pushing, materials handling

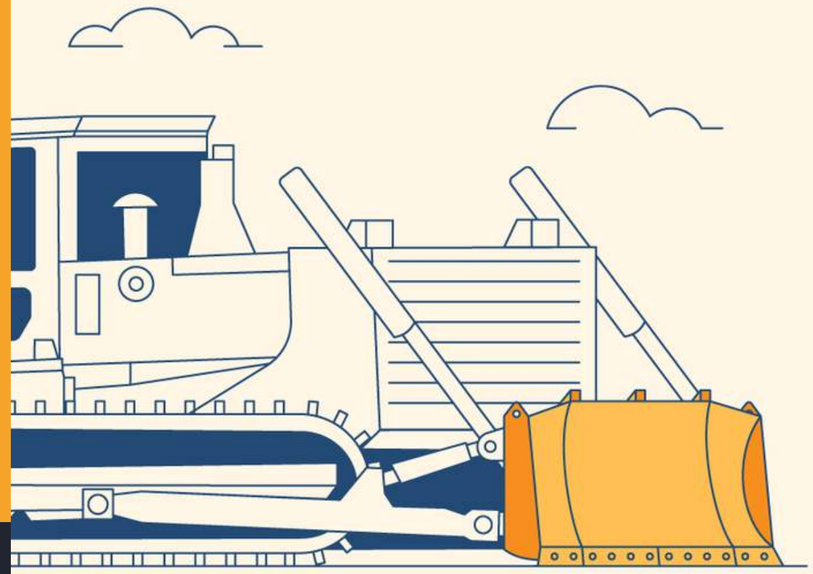
Best used for

Soft to medium soil

TYPES OF BLADES USED -

S-U-BLADE

Narrow, slightly curved shape with side wings



Location

Back, bottom corners of the blade

Ideal Tasks

Backfilling, crowning

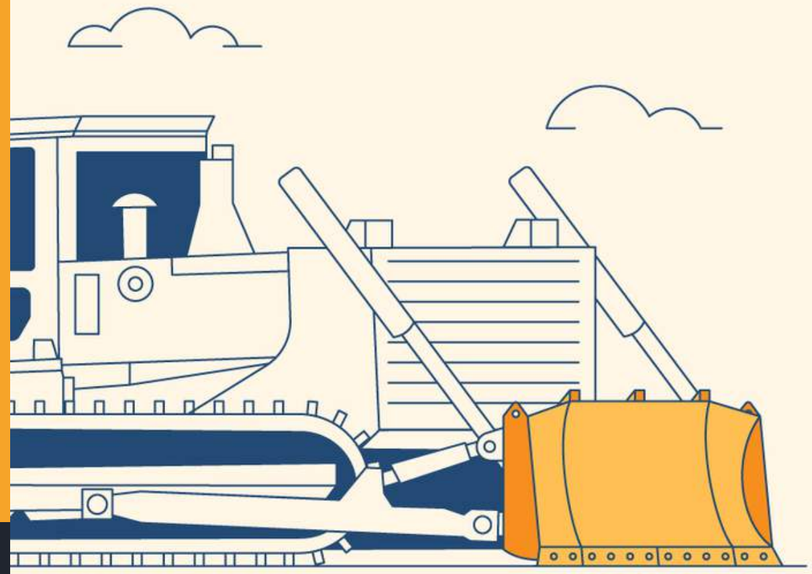
Best used for

Soft to medium soil

TYPES OF BLADES USED -

S-U-BLADE

Narrow, slightly curved shape with side wings



Location

Back, bottom corners of the blade

Ideal Tasks

Backfilling, crowning

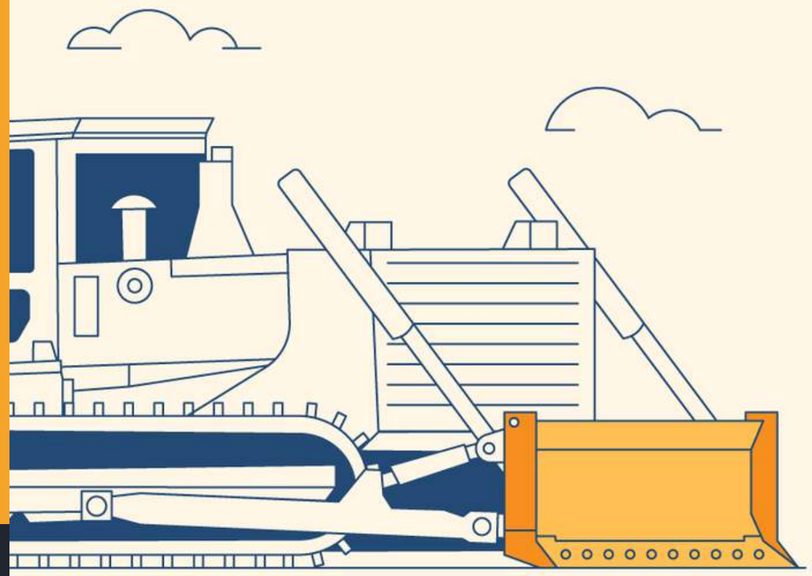
Best used for

Soft to medium soil

TYPES OF BLADES USED -

ANGLE BLADE

Two-way blade with angled motion



Location

Center panel

Ideal Tasks

Shaping, stumping

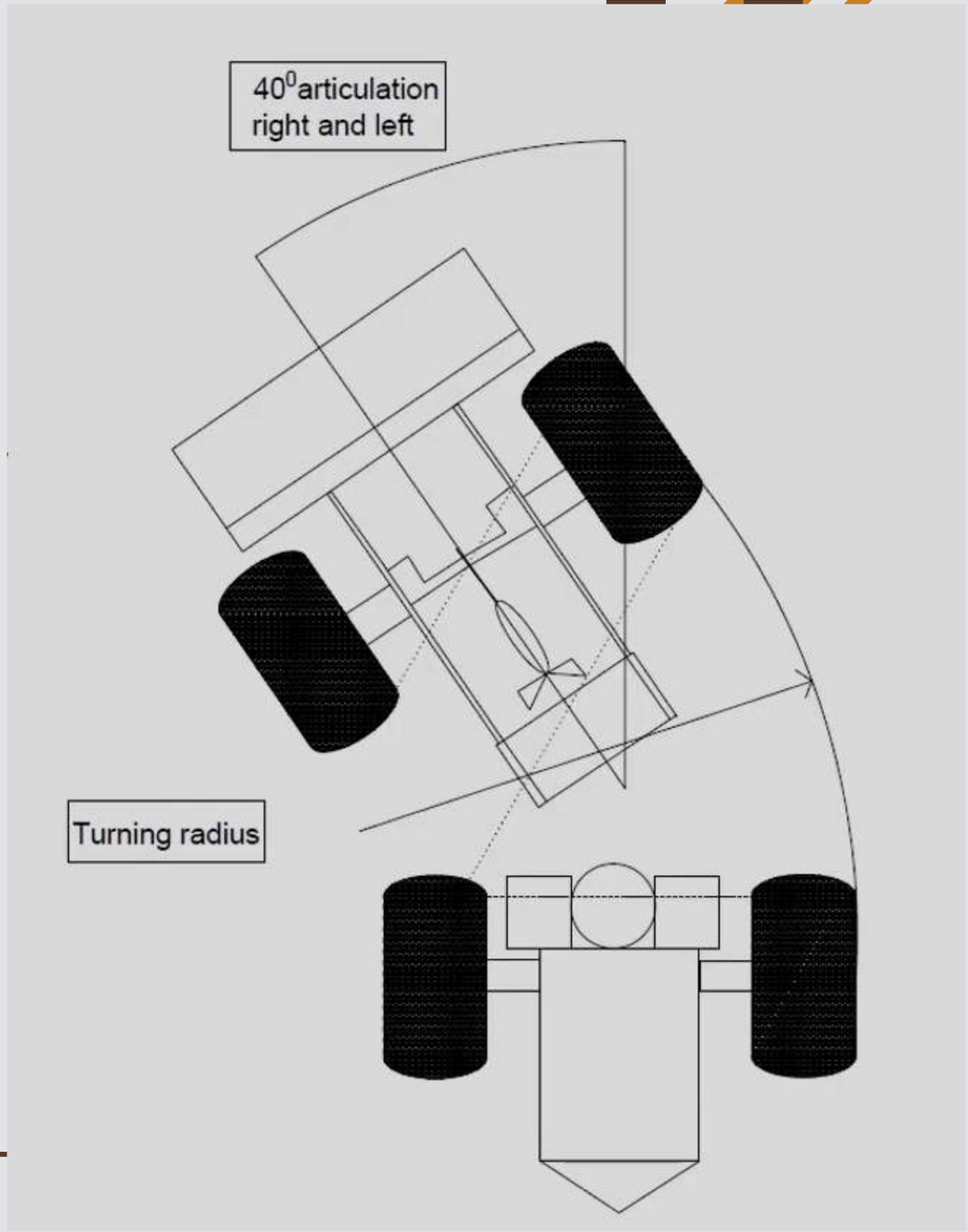
Best used for

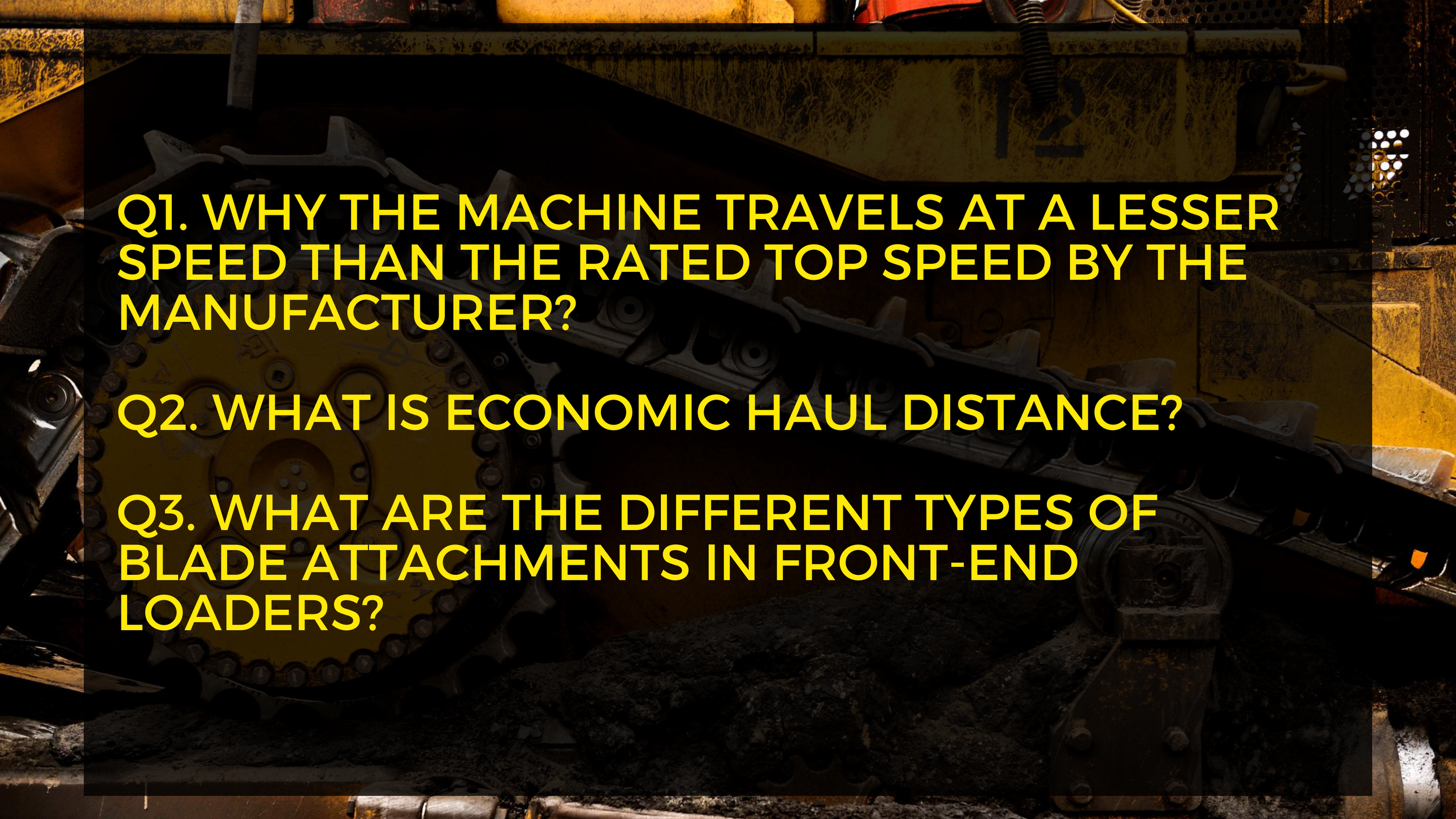
Soft to medium hard soil, snow and gravel

Articulated Wheel Loader

pivot joint between the front axle & rear axle.

- the machine is hinged between the front axle and the rear axle.
- the joint will provide greater maneuverability (turning up to 40 degrees)
- convenient in confined areas and narrow spaces like one side of the road.





Q1. WHY THE MACHINE TRAVELS AT A LESSER SPEED THAN THE RATED TOP SPEED BY THE MANUFACTURER?

Q2. WHAT IS ECONOMIC HAUL DISTANCE?

Q3. WHAT ARE THE DIFFERENT TYPES OF BLADE ATTACHMENTS IN FRONT-END LOADERS?

THANK YOU!

ANY QUESTIONS?