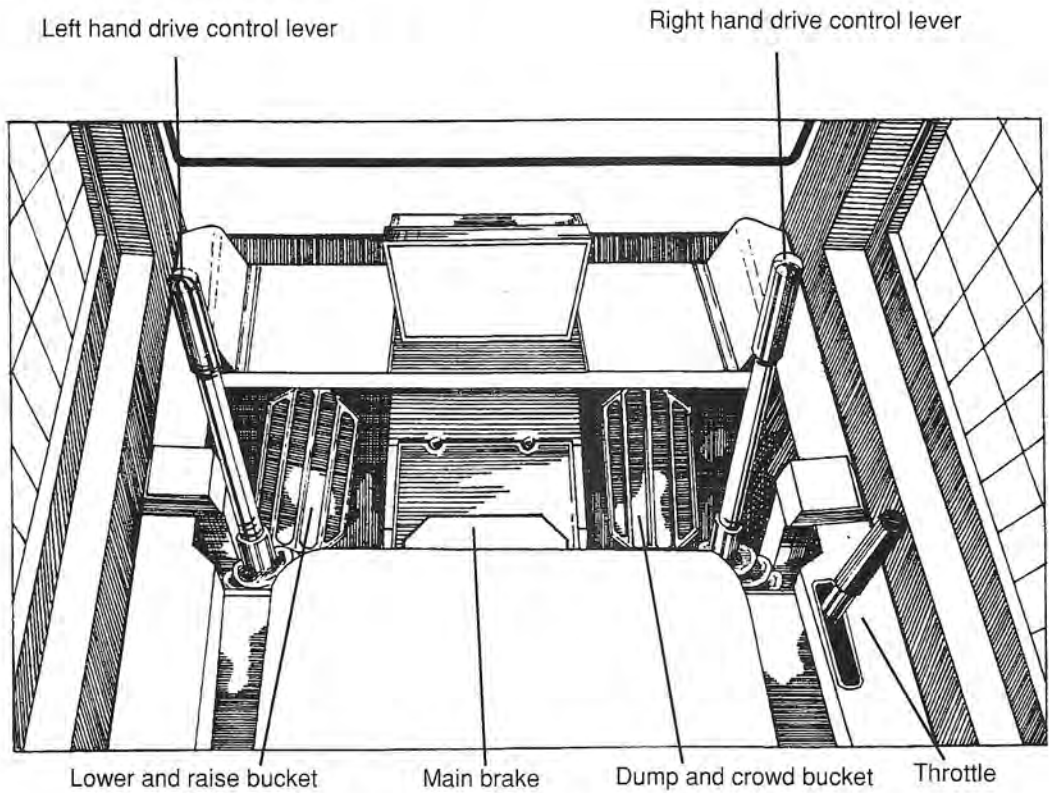


## Controls

The controls vary from manufacturer to manufacturer.

The most common configuration is;



**Skid steer loader controls**

# MODULE THREE – POWER UNIT SYSTEMS

## The Power Unit

### How does a diesel engine work?

The fuel used in modern high speed diesel engines, usually gas oil, is a liquid, which does not vaporise at ordinary temperatures. It is injected into the cylinders of the engine in a very fine spray.

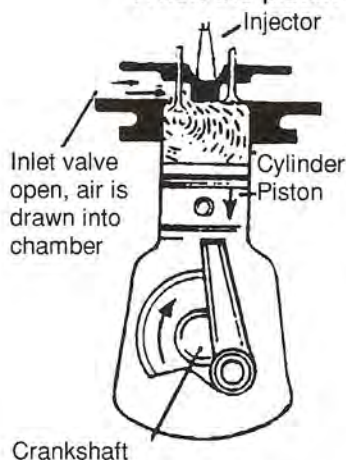
The air necessary for combustion is drawn into the combustion chamber and then compressed by the piston to a high pressure. The compression heats the air sufficiently to ignite the fuel spray spontaneously when the injection takes place.

This process is the characteristic feature of the diesel engine, or as it is otherwise called, the compression ignition engine.

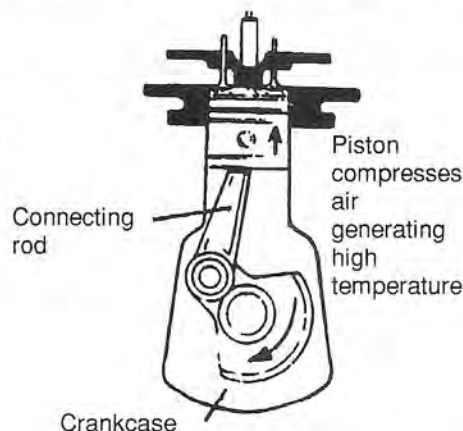
### Four-stroke cycle

It is quite simple mechanically. If we consider only the four-stroke engine (a complete movement of the piston, up OR down, is known as a stroke) the working cycle is as follows:

- 1 The piston moves down in the cylinder as the inlet valve opens, and a charge of clean air is drawn in. This is known as the **Induction stroke**. When the piston reaches the bottom of its travel, the inlet valve closes.



1 – Induction stroke



2 – Compression stroke

## MODULE SIX – OPERATING TECHNIQUES

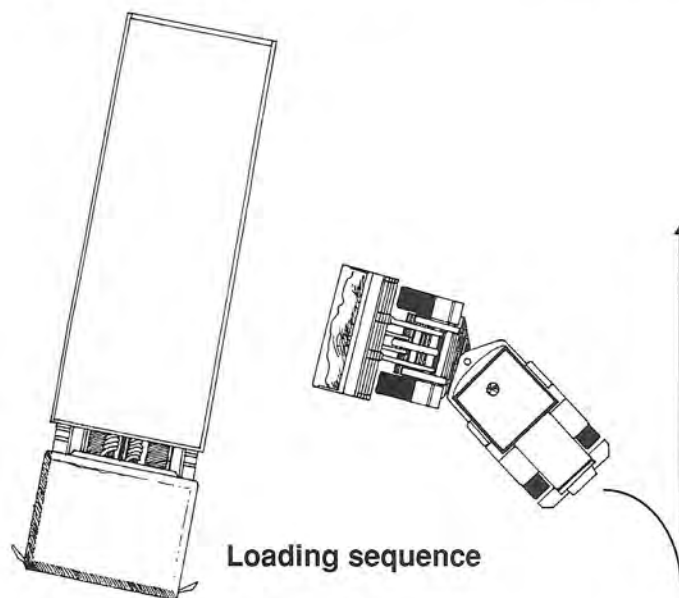
### Loading Sequence

- ⇒ Lower front bucket to the ground with the bottom parallel to the surface.
- ⇒ Avoid too much down pressure as this will tend to lift the front wheels off the ground.
- ⇒ When resistance is felt, raise the bucket slightly and crowd whilst still moving forward.
- ⇒ Reverse machine keeping the bucket low for stability.
- ⇒ Line up with the vehicle to be loaded, raising the bucket as you travel forwards.
- ⇒ When the bucket is at the correct height; stop with the front wheels of the machine just clear of the truck and dump the material.
- ⇒ Back the machine away, lowering and resetting the bucket to the dig position.

Take care when loading trucks that you do not hit the truck with either the wheels of the loader or with the bucket itself.

Always ensure that the truck is evenly loaded and not over the rated capacity.

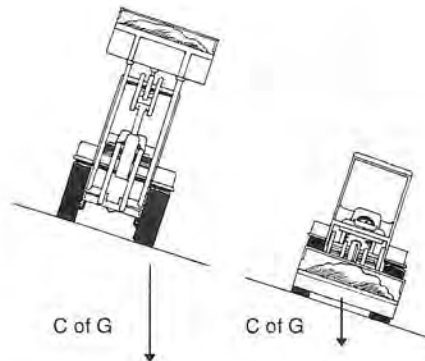
The siting of the truck is most important if output is not to be lost. The truck should be between 30 and 60 degrees to the heap and the loader should work in a 'Y', keeping manoeuvring to a minimum.





### Carrying material

When carrying material keep the loaded bucket close to the ground. This lowers the centre of gravity and increases stability. Drive at a speed which is consistent with the site conditions.



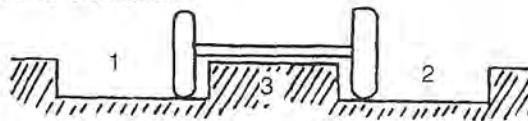
Carrying material

### Stripping

Stripping requires a technique similar to loading but the bucket is tilted forward to penetrate into the ground. When sufficient depth is reached, or resistance is felt, roll the bucket back slightly keeping it flat and level. When the bucket is full crowd it back and carry the load to the discharge point.

To maintain an even cut when site stripping cut '1' then '2' then '3' repeating '2' and '3' over the whole area.

At '3' leave room for the wheels.

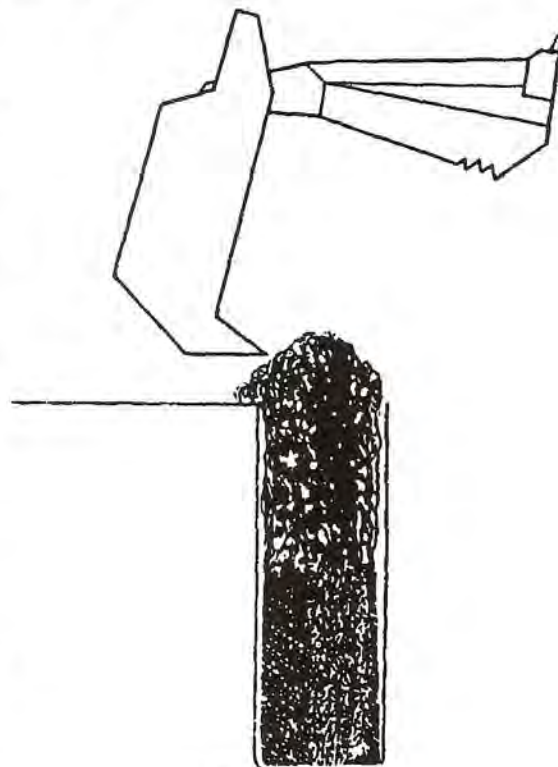


Stripping

### Backfilling excavations

Position the machine at 90 degrees to trench, set bucket flat and level and lower to the ground, drive forward and push spoil towards the trench. Just before reaching the edge of the trench raise bucket slightly (approx. 50 mm) then fully open clamshell depositing spoil back into trench. On subsequent passes position machine so as to only take  $\frac{3}{4}$  bucket width at a time. This prevents soil running around the bucket and forming a windrow which requires you to go back and clear up.

When all the spoil is back in the trench run the wheels over the length of the trench line to achieve partial compaction. Grade off area to surrounding levels using scraper position.



Backfilling

If using a standard bucket the technique is the same except that instead of opening the clamshell it will be necessary to lift the bucket high enough to dump the material into the trench.

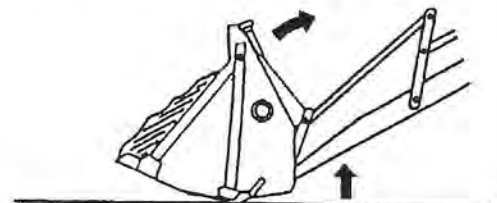
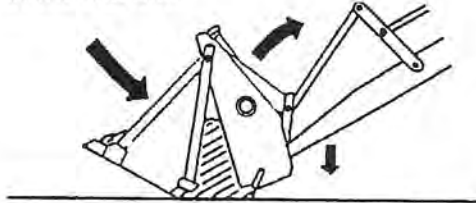
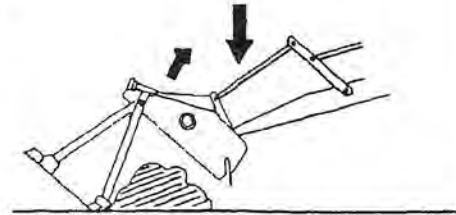
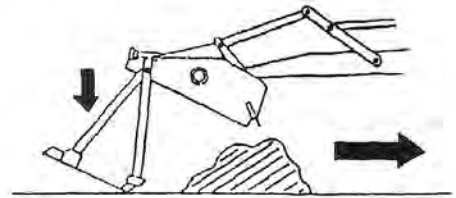
### Grabbing material with the clamshell

To pick up the last bucket load from a stockpile etc.

Fully open the clamshell and tilt forward until the back of the clam is on the ground behind the material.

Drag the clam back until material is heaped then tilt bucket back and lower to the ground, placing the control lever in 'float'.

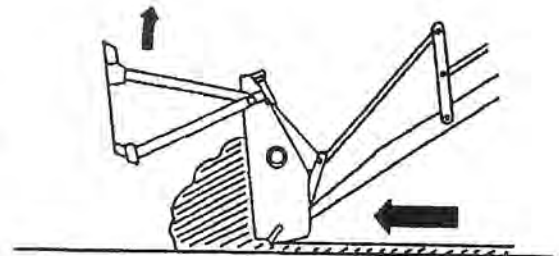
By closing the clamshell and tilting the bucket back simultaneously, the back and front of the bucket remain in contact with the ground and the material is retained in the bucket.



Clamshell operation

### Spreading material

With the four-in-one bucket full of material lower the bucket and tilt it forward until level, at the required depth of spread. Fully open the clamshell and use the dozer blade to spread the material.



Spreading

### Excavations

When excavating an area below ground level start at one side. Lower and level the shovel on the ground, select a low gear and drive the machine forward, slightly tip the shovel forward to penetrate the ground and adjust the shovel to the required depth of dig and maintain a level cut. When the shovel is full crowd back the shovel to retain the spoil and reverse the machine back up the cut and carry the spoil to the dump area.

Make the second cut starting slightly forward of the preceding cut.

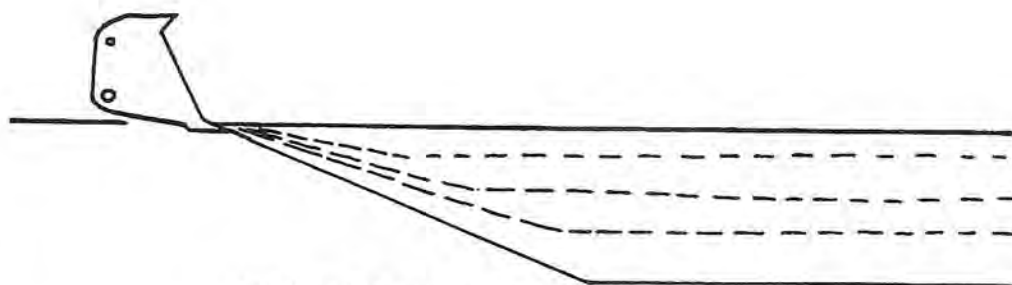
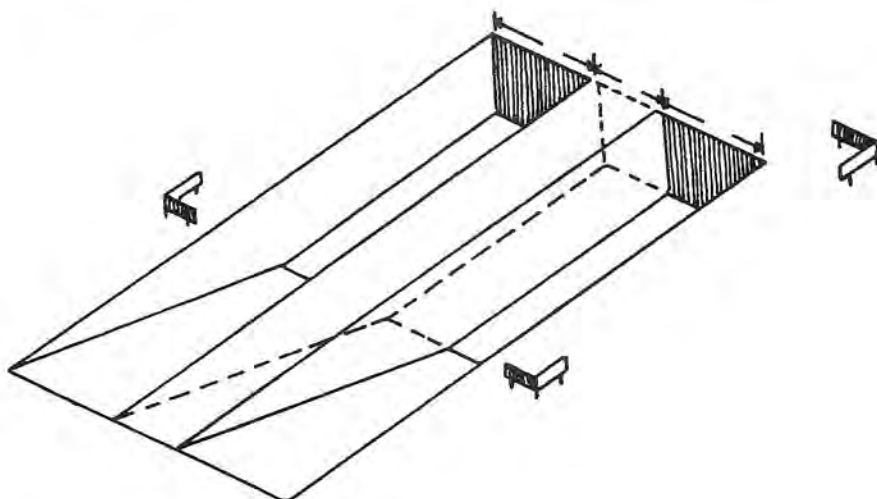
Make subsequent cuts to deepen the excavation and form a ramp. When travelling down the ramp keep the shovel level and in slight contact with the

ground, this will shape the ramp and prevent any material that becomes dislodged from falling under one track, thereby causing lack of level.

Proceed to excavate opposite side of area as above.

By excavating the two sides first, it ensures alignment of the sides with the setting out and will produce vertical walls.

In a large excavation where a vehicle is travelling into the excavation to carry material out the ramp should not exceed 20 degrees. The operator should carry out periodic maintenance of the ramp to clear up spilt material and fill any ruts that may have been caused.



**Method of excavating and forming a ramp**

## **Scarifying**

Scarifying means loosening the surface of blacktop or other paving material.

Ensure that the teeth are not too deep, or the sub grade may be torn out and mixed with the surface material.

When the material is hard and well consolidated, remove some of the teeth to ensure that those remaining are well able to give the penetration required.

Ensure that the remaining teeth are spread out evenly, to prevent undue strain on the frame.

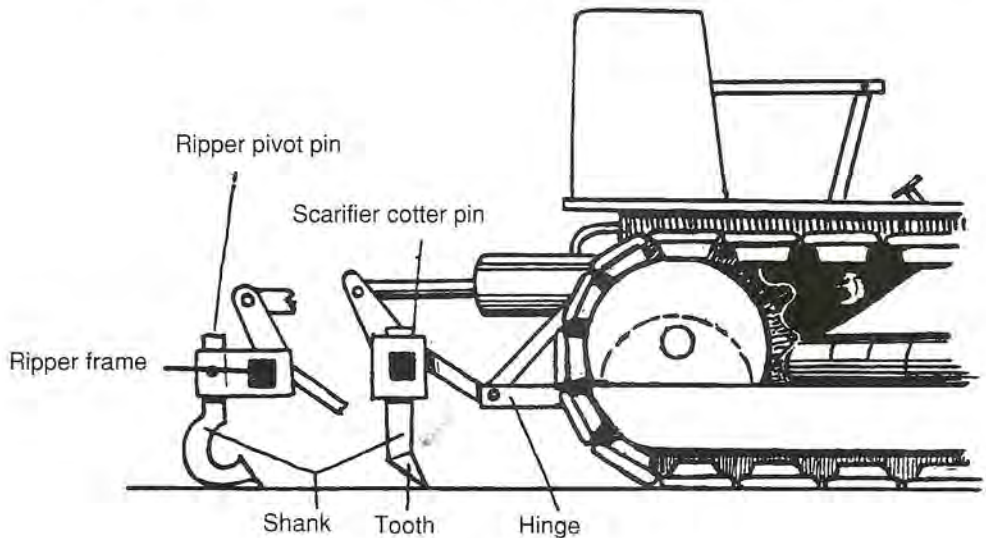
## Ripping

Whilst the ripper teeth are in the ground make straight cuts only.

Do not attempt to turn the machine with the ripper in the ground, as this could damage the ripper mounting.

At the end of the run lift the ripper clear of the ground, turn the machine and align it for the next ripping pass and lower the teeth on the move to the required depth.

If the ground is frozen hard, rip only relatively small areas at a time. This will prevent the ground refreezing before the machines can get to work on it.



**Scarifier and ripper attachments**



# MODULE SIX – MAINTENANCE

## Maintenance Programme

All machines are expensive. If users are to obtain a profitable return on plant investment, it is essential that the machine is maintained fully and economically.

An efficient maintenance programme makes use of all available resources. These include the operator, the site mechanic, depot mechanic and various workshop facilities.

The object will be to:

- ⇒ maintain maximum output from the machines
- ⇒ obtain maximum working life between overhauls
- ⇒ as far as possible prevent breakdowns on site

Generally, maintenance can be divided into two categories:

- ⇒ planned
- ⇒ preventative

An effective maintenance programme should be a combination of the two.

### Planned maintenance

This is an overall plan designed to ensure that the machines are fully maintained with the minimum number of staff. Aim for an even work load on the maintenance department.

The plan should take into consideration:

- ⇒ company policy
- ⇒ length of time the machine will be retained
- ⇒ type of machine
- ⇒ type of work for which it will be used
- ⇒ expected hours the machine will work by day, week, month etc.



Previous experience, and knowledge obtained from records or other sources or different machine characteristics, can assist greatly in the formulation of such a plan. Regular technical inspections are necessary to allow amendments to the plan as needs arise, also to ensure that operator maintenance is being carried out efficiently. The reports from these should indicate:

- ⇒ the location of the plant
- ⇒ the lubrication and cleanliness state of the machine
- ⇒ the mechanical state of the machine. Show repairs that require immediate action; repairs that should be effected in the very near future; and those that can safely be carried forward to a more convenient date
- ⇒ the total machine hours

Records of field servicing, adjustments and running repairs will assist in amending and updating the overall maintenance plan. The plan must be sufficiently flexible to allow for unforeseen circumstances, such as machine damaged in transit etc.

### **Preventative maintenance**

This is a series of checks and inspections performed at regular intervals. They are designed to extend the working life of the machine, and prevent premature and unexpected failure of components.

The inspection will be of the whole machine to assess general wear and condition of parts, and allow ordering of any replacements. It will also allow the arrangement of machine time so that repairs or replacements can be effected with the least interruption to the work schedule.

The operator's contribution to preventative maintenance is of prime importance. It is essential that adequate time and facilities are given. Supplies of materials (oils, greases etc.) should be always to hand, with suitable provision for storing them.

All maintenance should be carried out in accordance with the machine manufacturer's schedule or as dictated by company policy.

# MODULE SEVEN- SAFETY

## Before Operation

- Always ensure machine is serviceable and safe to use
- Carry out the daily checks
- Carry out weekly inspections as per company schedule
- Always face the machine and use the hand and foot holds provided when climbing on or off. **Never jump**
- Check the location of underground services and overhead lines
- Clean all windows, mirrors, lights
- Check the function of brakes, steering and all controls
- Lock cab doors open or keep them shut. Never let them swing loose

## During Operation

- Always wear a seat belt if fitted
- Periodically check the instruments and gauges
- Never carry passengers
- Be aware of persons entering the working area of the machine
- Keep cab clean and free of loose items
- Lower all attachments to the ground whenever you leave the machine
- Use all safety devices fitted
- Travel at speeds consistent with site conditions
- Never remove guards with engine running
- Always look to the rear before reversing

## After Operation

- Always park on firm, level ground in a safe location
- Lower all equipment to the ground and (when engine has stopped) release pressures
- Apply handbrake and all safety locks
- Stop the engine, remove key and lock the doors

# MODULE EIGHT – TRANSPORTATION

## Statutory Requirements

### The Road Traffic Act (UK)

The Road Traffic Act (UK) states that the maximum speed allowed for loaders on the public highway is 12 mph. Where vehicles have to be driven on the public highway the requirements of the Road Traffic Act apply and an appropriate licence is essential.

In certain cases the minimum age for drivers is 21 years (Motor Vehicles (Driving Licences) Regs 1995). Vehicle should be registered and taxed in accordance with the Road Traffic Act.

## Transportation of Plant

### Loading and unloading

Accidents when plant is being loaded or unloaded to and from a transporter are all too common. They are usually the result of too little thought being given to the task.

Before loading or unloading check:

- that the transporter is capable of taking the weight of the machine to be loaded and is in a safe condition
- that the ground is capable of taking the weight of transporter plus load (e.g. transporter wheels will not sink and cause instability)
- that there are no overhead obstructions, e.g. live power lines
- that the transporter is parked in a straight line and its brakes are engaged
- that signals are taken from one person; normally the transporter driver
- that the machine is lined up with the ramps correctly and that the drive on to the ramps is carried out with caution
- that the weight of the machine is transferred smoothly from ramps on to transporter (eased over the point of balance)
- that the position of the plant on the transporter is to the driver's satisfaction (they know the axle loadings)
- that when machine is correctly positioned the brakes are applied; attachments lowered; gears disengaged and the machine secured



**Note:**

On some semi-low-loaders, jacks should be lowered to support the platform during loading. If jacks are not fitted, other forms of packing such as wooden sleepers or blocks should be used.

If loading or unloading must be carried out on a public highway, or near a public footpath, ensure suitable precautions are taken to protect the public, e.g. use of signaller to control traffic, use of traffic cones.

If the machine is travelled on the public highway ensure that all requirements of the road traffic act are complied with and that:

⇒ Nothing is carried in the front bucket other than ancillary equipment

Slow-moving vehicles are required to have an amber flashing beacon if travelling at less than 25 mph on dual carriageways.

If a slow-moving vehicle has a queue of traffic behind it, it is required to pull over if a suitable side road, lay-by etc. can be found, so as to allow vehicles to pass.

# MODULE NINE – ADDITIONAL TECHNIQUES

## Site Level Pegs and Markers

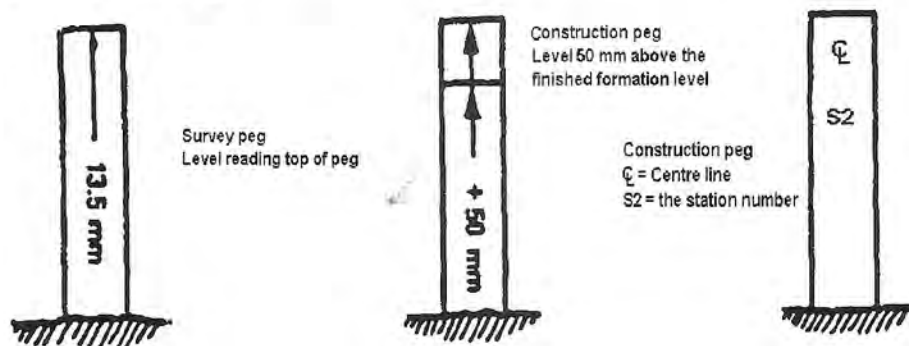
Whenever construction work of any kind is to be carried out, a site survey will be undertaken and all earthworks clearly marked out.

Various forms of markers are used to denote levels and centre or guide lines. They assist the site engineer in keeping control of all earthmoving operations in the construction, and it is essential that plant operators recognise and know their use.

### Site pegs

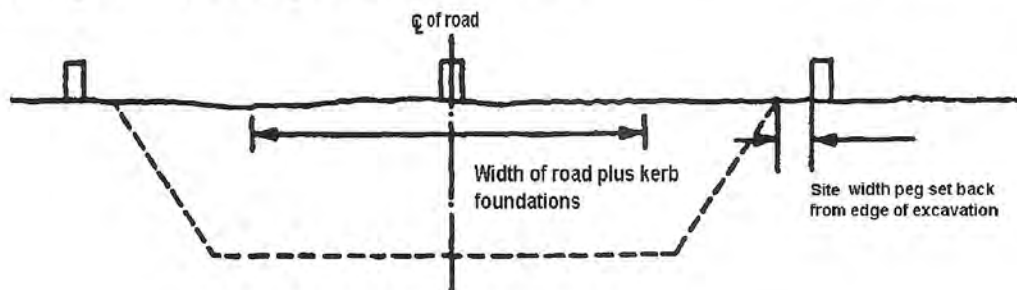
These are wooden stakes 500 to 750 mm in length, of 50 mm square section. The tops are often painted white to make them stand out on the site.

The significance of every peg used on a construction site will be clearly marked on the face of the peg.



### Side-width pegs

These are normally offset to prevent being knocked out of position by plant etc. working close to the edge of the excavations.

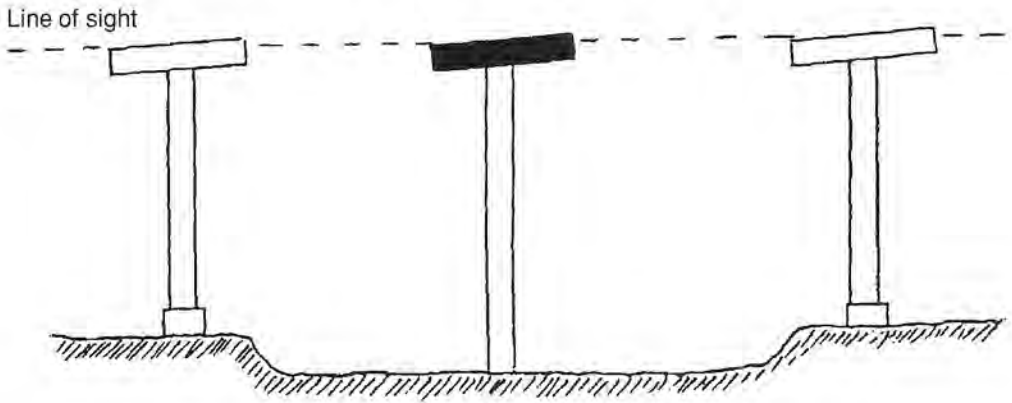


## Boning rods

Made up in wood in the shape of a letter T – three to a set, two white and one black.

The black boning rod is referred to as the traveller, and can be shorter or longer than the two white rods.

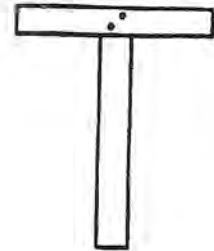
A set of boning rods is used for sighting and levelling above fixed datum points.



## Travellers

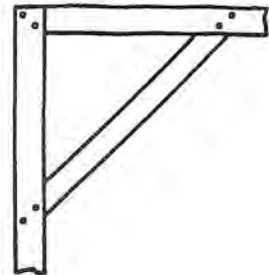
These are used between the sight rails for checking the depth of excavations.

The traveller is T-shaped. Its length is determined by the vertical distance between the top of the sight rail and the level of the finished excavation.



## Offset

On some types of work it is necessary to offset the sight rails and in such cases a 'gibbet' type of traveller is used.





**Loading Shovel**

**Study Notes**

**PL 011**

**CITB**  
DIRECT  
TRAINING

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# LOADING SHOVELS

## Regulations Applicable

- ⇒ Health and Safety at Work Act 1974
- ⇒ The Management of Health and Safety at Work Act 1992
- ⇒ Provision and Use of Work Equipment Regulations 1998
- ⇒ Lifting Operations and Lifting Equipment Regulations 1998
- ⇒ Supply of Machinery (Safety) Regulations 1992
- ⇒ The Electricity at Work Regulations 1989
- ⇒ The Noise at Work Regulations 1989
- ⇒ The Control of Substances Hazardous to Health Regulations 1989
- ⇒ Road Traffic Act (UK)
- ⇒ The Construction (Health, Safety and Welfare) Regulations 1996

## & Guidance notes

- ⇒ Control of Noise Order 1984
- ⇒ Electricity on Construction Sites GS 24
- ⇒ Avoiding Danger from Buried Cables GS 23
- ⇒ Avoidance of Danger from Overhead Cables GS 6
- ⇒ Safe use of Work Equipment L22
- ⇒ Codes of Practice for Excavations and Backfilling BS 8000 BS Part 1 1989

Further guidance on these regulations is given in the plant operator Safety Awareness training manual CSN 074, which accompanies this manual.

## Category of Plant

Loading Shovel (wheeled) rigid and articulated  
Loading Shovel (tracked)  
Loading Shovel (skid steer)

# MODULE ONE – INTRODUCTION

## Wheeled Loading Shovels

Today's purpose built wheeled loading shovels have derived from the agricultural tractor fitted with a small front shovel, hydraulically driven from the PTO (power take off).

Modern wheeled loading shovels basically fall into two categories

Rigid and Articulated



**Articulated wheeled Loading Shovel**



## Tracked Loading Shovel

The tracked loading shovel is derived from the early crawler tractor that was used in agriculture. The addition of the loader arms, shovel and a simple hydraulic system produced the early tracked loading shovel.

Today's machines are purpose designed and built with state of the art technology.



**Tracked Loading Shovel**

## Skid Steer Loading Shovel

Skid Steer machines are purpose built machines that have been developed to operate in confined spaces.

They can be described as a mix of wheeled and tracked loaders in that they have the advantage of speed and the ability to travel on blacktop, concrete etc. without damaging the surface like a wheeled loader and have the manoeuvrability of a tracked machine.



**Skid Steer Loader**



# MODULE TWO –TYPES OF MACHINE

## Rigid and Articulated Wheeled Loading Shovels

### Basic construction

The rigid machines have a rectangular chassis with an axle mounted at front and rear, they may be 2 or 4 wheel steer & 2 or 4 wheel drive

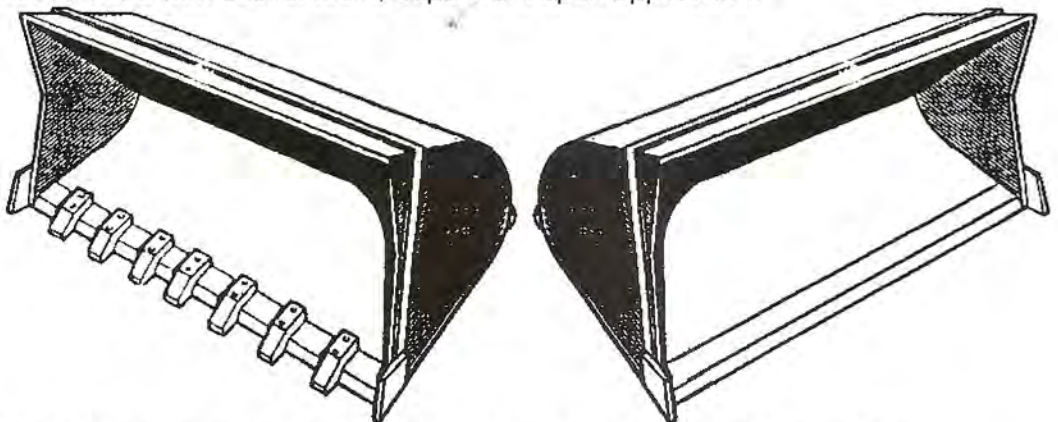
The articulated machines consist of two chassis joined at a central pivot point, each with a fixed axle.

The power unit and counterweight will be housed in the rear unit with the front end equipment, generally a shovel, mounted on the front unit. The cab may be mounted on the front or the rear dependent on the manufacturer.

Care should be taken if operating a loading shovel with the cab and controls mounted on the opposite unit to that normally operated, as the effect on the steering will seem unusual at first.

### Attachments

Loading shovels will normally be fitted with a standard shovel that may or may not be fitted with bucket teeth, dependent upon application.



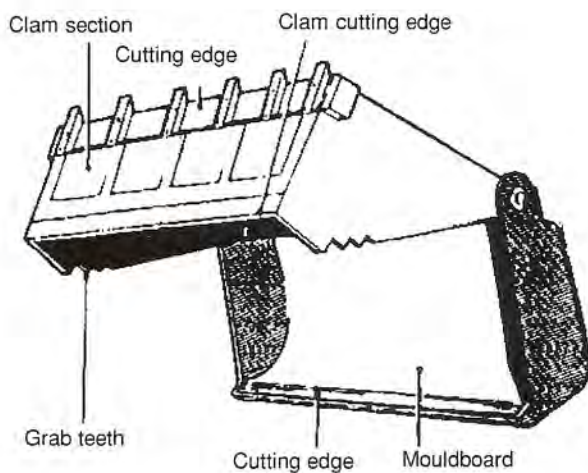
The principal uses of a loading shovel fitted with a standard shovel are;

- ⇒ Loading from stockpiles
- ⇒ Digging and loading in-place material
- ⇒ Re-handling
- ⇒ Loading and carrying (short distances)



Other equipment that may be fitted;

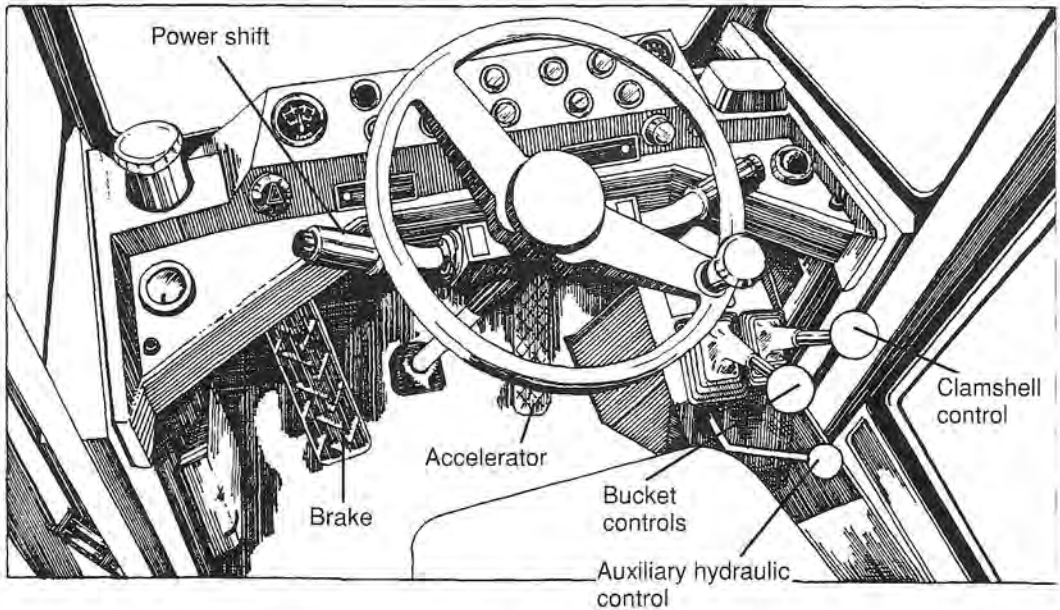
- Fork Lift Attachment
- Log Clamps
- Side Tipping Buckets
- 4 in 1 Bucket



**4 in one bucket**

## Controls

The controls for the wheeled loading shovel fall into two categories, those with a conventional steering wheel and those fitted with joystick steering

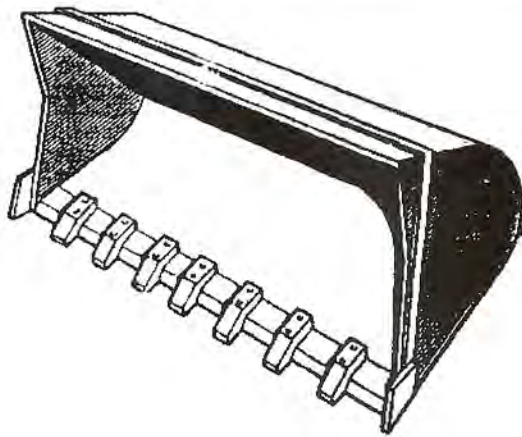


### Wheeled loader cab and controls

Conventional steering wheel fitted to Rigid and Articulated Loading Shovels  
Joystick steering only fitted to Articulated Loading Shovels

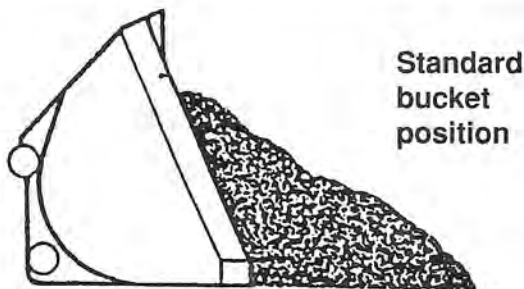
## Attachments

The tracked loading shovel will generally be fitted with a standard or a 4 in 1 shovel

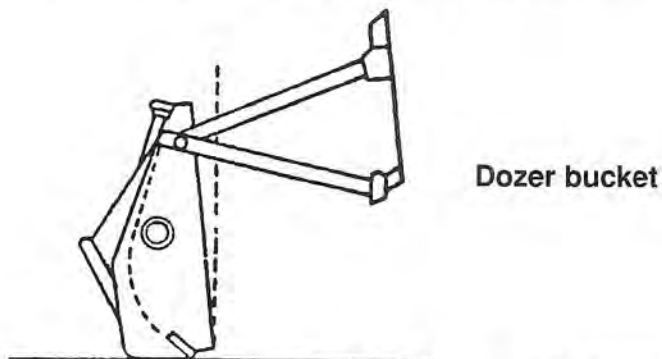


## The four-in-one bucket

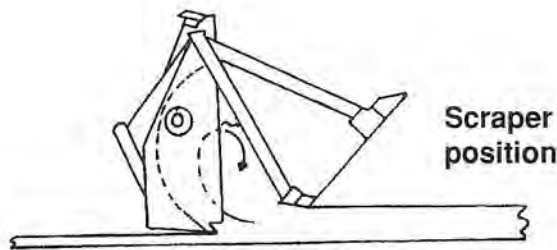
The four-in-one bucket is so called because it can be used in four main positions.



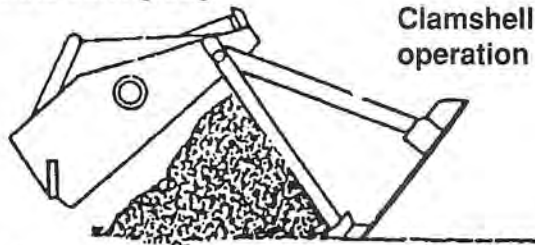
- 1 With the clamshell closed it is used as a standard bucket.



- 2 With the clamshell fully open the back edge of the bucket is used as a dozer blade.



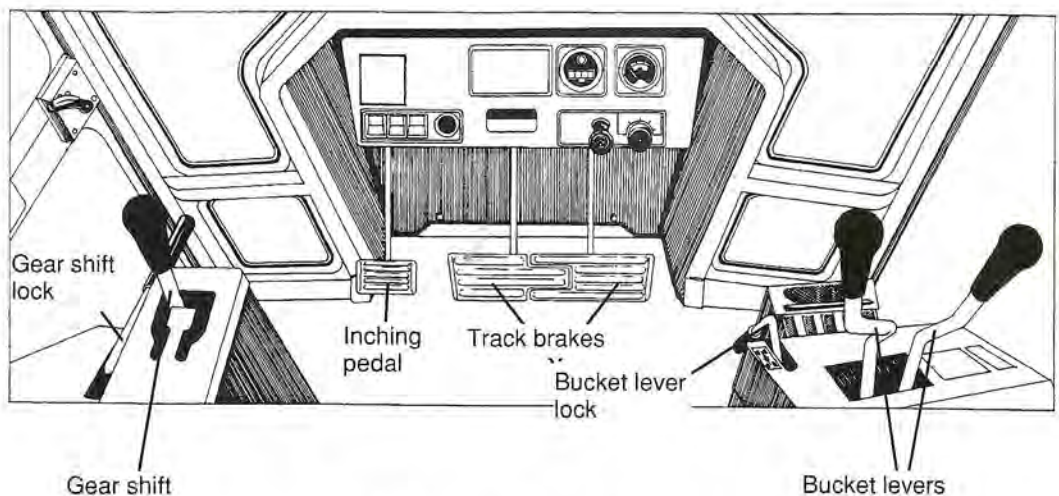
- 3 With the clamshell partially opened the bucket is used in the scraper position. Here the clamshell acts as a depth gauge and the rear of the bucket as the cutting edge.



- 4 With the clamshell fully open and on the ground and the rear of the bucket on the ground simultaneously close the clamshell and tilt the bucket back to grab the materials.

The tracked loading shovels may also be fitted with scarifiers or ripper teeth.

### Controls



### Tracked loader controls

The controls illustrated above are only a guide as different manufacturers have different layouts of the controls.

Loading shovels steer by stopping or slowing one track and allowing the other to drive. The degree to which one track is stopped determines how sharp the turn will be.

Some of the more modern tracked loading shovels steer with positive drive to both tracks, and turns are made by slowing or speeding one track.

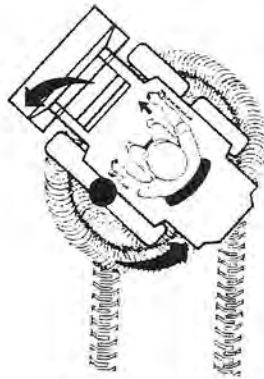


# Skid Steer

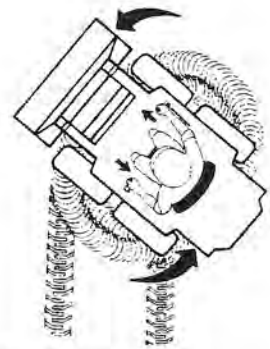
## Basic construction

The skid steer loading shovel consists of two sets of wheels, not joined transversely by an axle as in conventional machines, but joined longitudinally.

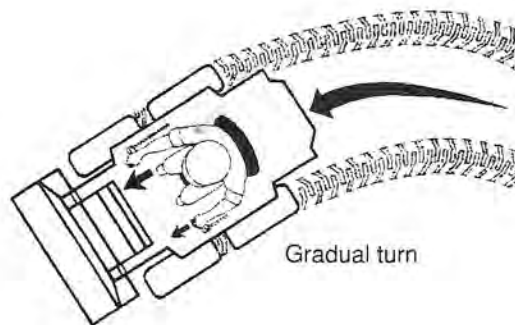
The drive to the right set of wheels is independent from the drive to the left set of wheels, so allowing the speed and direction of each set of wheels to be controlled independently.



Pivot turn



Counter-rotation turn



Gradual turn

## Attachments

The attachments that can be mounted on a skid steer loading shovel are numerous, the following are some of the most popular.

- Backacter
- Road Brush
- Post Hole Borer
- Fork Lift
- Log Clamps
- 4 in 1 bucket