Digger Loader

Study Notes

PL 001
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 Regulations 1992
- The Electricity at Work Regulations 1989
- The Noise at Work Regulations 1989
- The Control of Substances Hazardous to Health Regulations 1988
- Road Traffic Act (UK)

& 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 Cranes BS 7121 Parts 1&2
- Safe use of Lifting Equipment
- 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

Digger Loader
4 tonnes to 10 tonnes
Rigid and Articulated
2-Wheel and 4-Wheel Drive
2-Wheel and 4-Wheel Steer

If an excavator is used for lifting operations, it should comply with the requirements of Lifting Operations and Lifting Equipment Regulations 1998 (LOLER 98) and BS 7121 Safe Use of Cranes.
MODULE ONE – INTRODUCTION

Digger loaders (180 degree type) were first built in the early 1950s. These were attachments mounted on two-wheel-drive agricultural tractors with the hydraulic pump driven from the tractor’s power take off (PTO). They were slow, clumsy machines in comparison with today’s purpose-built digger loader, often referred to as the workhorse of the industry.

Digger loaders are fitted with a front shovel or bucket forward of the front wheels and a backacter to the rear of the machine.

The operating weights of these machines range from 4 tonnes to 10 tonnes but the most commonly used machines are around 7 tonnes.

Digger loaders are often referred to as 180 degree excavators but some of the latest machines have a slew capacity of up to 360 degrees.
The main types of digger loader in use are:

- 2- or 4-wheel drive fixed position backacter 180 degree
- 2- or 4-wheel drive multi position backacter 180 degree
- Articulated 280 degree backacter
- Articulated 360 degree backacter
- 4-wheel steer 180 degree backacter

**Basic Construction**

The digger loader consists of three main parts.

- **Base machine** which consists of a chassis, generally with two large wheels to the rear and two smaller steering wheels to the front; the power unit (usually a diesel engine) and a fuel tank; an operator’s safety cab; a hydraulic pump with valves and tank.

- **Front end loader arms** are connected to the base machine with pins and hydraulic rams, and can be fitted with a variety of attachments.

- **Backhoe** consists of a frame with hydraulically-controlled stabilisers mounted across the width at the back of the base machine. Mounted on this frame there is a kingpost and slew mechanism boom, dipper and bucket or other attachment.

An articulated digger capable of 280 degrees of slew
Attachments

Front end attachments are generally a standard bucket or a four-in-one bucket. Both buckets can be fitted with forks.

Four-in-one bucket

Standard bucket

Standard bucket fitted with forks
The four-in-one bucket

There are numerous multi-purpose attachments available for the front end including concrete skips, crane hooks and road sweepers etc. 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.
**Rear end attachments** are most commonly buckets ranging in size from 225 mm to 900 mm standard profile or ditching buckets 1500 mm, 1800 mm or a tapered ditching bucket.

- **Standard profile**

Other attachments include ripper tooth, concrete breaker, post hole borer and many more.

- **Ripper tooth**
- **Ditch cleaning bucket**
- **Tapered ditching bucket**
- **Rock breaker**
- **Extending dipper**

Most models now have an extending dipper which extends and retracts hydraulically.
All the controls are operated from inside the operator's safety cab. The front end equipment is controlled by two levers in conjunction with the steering wheel, forward and reverse shuttle lever, throttle and brake.

1. Steering wheel
2. Instrument panel
3. Steering columnwitch
4. Starter switch
5. Gear lever
6. Accelerator pedal
7. Hand throttle lever
8. Parking brake lever
9. Brake pedals
10. Transmission dump pedal
11. Hazard warning lights switch
12. Forward/reverse lever
13. Instrument panel switches
14. Bonnet release
15. 2/4-wheel drive lever
16. Front bucket control lever
17. Clamshell control lever

A typical control layout
The rear end equipment is controlled by two main levers. There are two additional levers to control the stabilisers and on some models a lever to unlock the kingpost from the frame (to facilitate movement across the frame).

**WARNING**

*Do not* operate the excavator controls from outside the machine, or you could be crushed by the excavator.

On machines with + pattern control, there are two excavator control levers. The left hand lever A operates the boom and swing. The right hand lever B operates the dipper and bucket.

A  |  Boom and swing  
B  |  Dipper and bucket  
C  |  Left hand stabiliser  
D  |  Right hand stabiliser  
E  |  Hydroclamp locking device  
F  |  Extending dipper rocker pedal
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.

![Diagram of the four-stroke cycle]

1. Induction stroke
2. Compression stroke

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2 In the Compression stroke, both valves remain closed whilst the piston moves upwards; the charge of air is compressed and its temperature rises steeply. Just before the piston reaches the top of the compression stroke, fuel is injected into the top of the cylinder (combustion chamber) in a very fine spray.

3 The fuel is ignited instantly by the heat of the compressed air, and the piston is driven downwards by the rapid expansion of the burning fuel gases. This is known as the Power stroke.

4 Following the power stroke, the exhaust valve opens as the piston moves upwards, and the waste gases are expelled. This is known as the Exhaust stroke.

When the piston reaches the top of its stroke the exhaust valve closes, and this completes one cycle (four strokes).

The cycle repeats itself as long as the engine is supplied with air and fuel.

Air Induction System

An air cleaner filters the air before it enters the combustion chamber, protecting the engine from dust, water and other foreign matter.

There are two types of air cleaner in general use, the dry filter type and oilbath type. Both types are usually fitted with a pre-cleaner. The pre-cleaner comprises either a cap or bowl shaped so as to create a swirling action which causes the heavier particles of dirt to fly outwards and be deposited either within the casing of the pre-cleaner, or ejected through vents to the atmosphere.
**Turbocharger**

Some engines have a turbocharger fitted. Exhaust gases from the engine drive a turbine at very high speed. The turbine is connected to an impeller which forces air under pressure into the induction manifold. The pressurised air increases the efficiency of the engine.

The engine should be run at a high idle speed for one minute before stopping. If this procedure is not complied with, the turbocharger can continue to run for a considerable time after the engine has stopped. As the turbocharger is lubricated from the engine lubrication system, it may then suffer loss of lubrication and seize up.

**Note:** Turbocharger speeds of 65,000 rpm are common. Special precautions must be taken when stopping a turbocharged engine.
Fuel systems are designed and adapted by manufacturers to suit their particular requirements. Basically, they consist of standard components.

A supply of fuel is contained in the fuel tank. From there it is delivered via the primary fuel filter, which filters out coarse grit and foreign matter, and through the fuel lift pump to the main fuel filter which removes the finer particles. Next it goes to the injection pump which measures, pressurises and delivers the fuel to the engine's injectors by way of high pressure pipes, at the correct time. Excess fuel is delivered back to the fuel tank.

Diesel fuel is injected either into the cylinders by direct injection, or by injection into a pre-combustion chamber.

Direct injection takes place through several small atomising orifices, directly into the cylinder, where it is ignited. Multiple orifices, particularly of small size, increase the risk of clogging.

Pre-combustion designs inject through one large orifice into a pre-chamber where the fuel is atomised, and burning begins. The mixture then passes into the cylinder where complete combustion occurs.
Bleeding the fuel system

If air has entered the system, through lack of fuel, loose connections, fractured pipe etc. the engine will either stop or badly misfire. After the cause of the entry of air has been rectified, the system must be ‘bled’ as follows:

Note: This procedure should be carried out by a trained and competent person.

In-line fuel pump

1. Check adequate supply of fuel in the tank.
2. Check that the fuel cap air vent is clear.
3. Open the air bleed screws on the filters and prime by operating the lift pump until fuel flows free of air. Continue pumping whilst tightening the vent screws.
4. Carry out procedure (3) at the injection pump and restart the engine.

DPA fuel injection pump

On DPA pumps open the air bleed screws on the main filters, pump body and governor housing. Operate the priming lever and close the bleed screws in the following order: fuel filters, pump body and then governor housing. Also slacken and bleed at pump inlet union.

Note: If the engine still misfires, reopen, bleed and close each screw in turn working from the fuel tank towards engine.

Set throttle in RUN position and bleed two of the injectors using the engine starter motor. Start engine and check for misfire. If misfire persists repeat process with remaining injectors.

Always take care to observe regulations concerning avoidance of fuel spillage onto site surface causing pollution.
Fuel tank

Only clean fuel must enter the tank, through a filter in the filler. Fuel tanks may ‘sweat’ inside during the night due to condensation and, to prevent this, they should be filled at the end of each day.

Avoid topping up with fuel from the bottom of a storage drum that may be contaminated with dirt or water.

Filters

These must be cleaned at intervals recommended and, where replaceable types are employed, new elements and gaskets fitted. If the presence of dirt or water is suspected then the whole system should be cleaned.

Fuel lift pump filter

This, with the sediment bowl, if fitted, must be cleaned regularly. Care must be taken in refitting so as not to damage the filter and gasket(s).

Fuel injection pump governor

Normally lubricated from its own sump, it must be checked regularly for correct oil level. Drain and refill in accordance with the maker’s instructions. No attempt should be made to tamper with or adjust the governor.

Starting Aids

Ignition of fuel in diesel engines depends upon high temperature of the inducted and compressed air. It is sometimes necessary during cold weather to assist the ignition of the fuel. Two types of device are in general use, an excess fuel device and a glow plug device.

Excess fuel device

This allows delivery of an excess amount of fuel to the combustion chambers. It is normally operated by a control button on the fuel injector pump housing. The throttle must be open before setting the button. The device disengages automatically when the engine starts.
Glow plug device

An electric element fitted in the induction manifold (or in some cases, in each pre-combustion chamber) is operated by a control switch. When the starter is engaged, the inducted air flows over the element and is warmed to assist ignition.

Note: A variation, known as the THERMOSTART, injects fuel into the induction manifold where it is ignited by the glow plug to produce a flame to assist ignition.
Lubricating system

Without oil between the moving parts, wear through friction would be excessive and power would be lost. The heat generated would cause expansion and seizure of the parts.

Oil reaches the main and big-end bearings, camshaft bearings and rocker shaft under pressure. It bleeds out of the rocker shaft bearings and returns to the sump by gravity. The oil is heated by its contact with the moving parts, so this heat is removed by either an oil cooler fitted in the system, or by the movement of air past the surface of the sump. Foreign matter washed from the moving parts and passageways of the engine by the oil, either falls to the sump or is held in suspension by detergent oil and then removed by the filter.

The oil level in the sump should be checked before starting the engine. Remove the engine oil level dipstick, wipe clean and replace in the engine. Remove dipstick again and check the oil level against marks. If the level is low add clean oil until the correct level is obtained. Do not overfill.

Immediately after the engine is started, the oil pressure gauge should be checked for the correct pressure reading. A warning light is usually fitted to warn of low oil pressure. This warning light or gauge should be checked occasionally throughout the day for correct reading.

Any excessive oil consumption, unusual noises or vibrations should be noted and reported.

Typical lubricating system
Cooling System

Liquid cooling

The cooling system is designed to dissipate excessive heat. The engine cylinder block and head contain passages to allow circulation of the coolant (water). The system includes a radiator which provides a large cooling area and acts as a reservoir, a fan to increase the cooling air flow and a thermostat to restrict the flow of water to the radiator until correct working temperature is reached.

The coolant is circulated by a water pump and by the fact that heated water rises to the top of the radiator through convection.

Most liquid cooling systems are pressurised, using a special radiator cap, to allow higher working temperatures. Exercise extreme caution to avoid being scalded when removing the pressure cap from a hot radiator.

Air cooling

Another method of cooling is to provide each cylinder with finning over which cooling air is blown by a fan (blower). Ducting around the cylinders contains and guides the air down one side of the engine, around the cylinders, and then exhausts to atmosphere.

Maintenance of Cooling System

The system should be checked daily for:

- sufficient and correct type of coolant
- correct fan belt tension and condition
- cleanliness of air passages

During cold weather always be aware of the operating temperature of the engine of the machine. A temperature gauge or warning light is generally fitted for this purpose.
Electrical System

To start the engine of a digger loader, the crankshaft must be revolved. Diesel engines employ an electric starter motor powered from the battery to perform this function. The motor is mounted on the engine and, when the starter switch or button is engaged, the motor turns a small sliding pinion which meshes with a gear ring around the flywheel. The starter motor pinion gear disengages automatically when the engine starts.

The starter motor mounting bolts and connections require occasional checking for security.

The battery of the digger loader, (or more than one battery) is maintained in a charged condition by a dynamo or an alternator. The batteries also supply electrical current for the lights, horn, windscreen wipers etc.

Batteries

Electrolyte (the acid liquid in batteries) should be checked regularly to ensure that it covers the plates. Distilled water only should be used to top it up.

In addition to checking the level of the electrolyte the following regular checks should be made.

- Battery posts clean and free from corrosion.
- Terminals secure and clean.
- Batteries secure in their mountings.
- Filler caps in position with the air vents kept clear.

Note: Due to the presence of flammable gas given off in use, naked lights must not be allowed near batteries.

Ammeter

This is a gauge mounted on the instrument panel. It indicates the amount of charge current the batteries are receiving from the dynamo/alternator, or if a discharge (negative) situation applies. Whilst the engine is running the ammeter will normally indicate a positive charge.
Dynamo or Alternator

The purpose of the dynamo or alternator is to keep the batteries fully charged to enable all electrical circuits, including lights, and to keep them fully operational.

The mountings should be checked at regular intervals for security and, in addition, the end bearings lubricated in accordance with manufacturer’s recommendations.

No engine should be run with the batteries disconnected as this may damage the dynamo/alternator internal components.

**Note:** When a power unit is fitted with an alternator:

It is essential that the alternator is disconnected, to avoid damage to internal components, before any electric arc welding is carried out on either the machine or its attachments.

The ignition switch **must** be in the ON position when the engine is running, and OFF when the engine is **stopped**, or the batteries disconnected.

**Belt drives**

Cooling fan, dynamo, alternator, exhauister, water pump and compressor are generally driven from the engine crankshaft pulley by means of one or more belt drives.

These belts require regular attention to ensure serviceability and correct drive tension. Usually adjustment is made by moving one pulley closer to, or further away from, another pulley; or by employing a spring-loaded jockey wheel riding on the belt to limit the amount of slack

Always refer to the maker’s handbook for the correct belt adjustment.

Multi-belts must always be replaced as a complete set. If more than one belt runs on the same set of pulleys, all must be replaced in any fail.
**Power Train**

Power to travel the machine is transmitted from the engine by means of the torque converter, gearbox, differential unit and reduction gears to the wheels. Forward and reverse are obtained by using the power shuttle. A dump pedal or button is fitted to allow gear changes to be made on the move.

The engine braking effect on machines with torque convertors is reduced, so care should be taken to prevent overrun when travelling on slopes.

**Hydraulic System**

Power for the digging, loading, steering and operation of the stabilisers is provided by the hydraulic system. When the engine is running, hydraulic oil is pumped from the hydraulic tank circulated and returned via the control valves and filter. When a control valve is opened, oil under pressure is fed to the selected hydraulic ram or motor. Relief valves are included in the system to prevent excessive build-up of pressure.
Brakes

The machines are fitted with independent footbrakes which operate on the rear wheels only. They must be latched together when travelling on the public highway but can be unlatched to assist turning in confined spaces.

A hand-operated parking brake is fitted and should be applied only when the wheels are stationary, except in cases of emergency.
MODULE FIVE – STARTING UP

Checks Before Starting the Engine

Check level of:

1. engine oil
2. hydraulic oil
3. coolant
4. fuel

Check the general condition of:

1. running gear and tyres
2. hoses
3. all attachments

Starting Procedure

- All controls must be in the neutral position and all safety locks applied
- Open throttle and if necessary use cold starting aids
- Engage starter and release when engine fires
- When engine is running smoothly, throttle back to fast idle
- Check all gauges and warning lights
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 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 bonnet of the loading bucket 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.

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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.

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.

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 ¾ 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.

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.

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.
Backacter Trenching

The ensure that the sides of an excavation are vertical the machine must be levelled using the stabilisers and the front bucket.

To excavate to a uniform depth it is necessary to perform three motions simultaneously.

- The boom must be raised
- The dipper must be retracted towards the machine
- The bucket must be uncurled

Curl the full bucket up to retain the spoil.

Lift the boom until the bucket is clear of the ground, slew to the side of the trench and uncurl the bucket to deposit onto the ground or into truck hopper etc.

Slew back to the line of trench and continue digging in layers. When you are approximately 300 mm (12") deep clean the windrows from the side of the trench with the flat bottom of the bucket.

It is good practice to deposit the soil on the opposite side of the machine to the kingpost.

The excavated soil must be placed far enough away from the trench so as not to cause the sides to collapse.

To excavate a trench of uniform depth the spoil should be removed in layers not exceeding 150 mm (6’’). This prevents the soil from either side of the trench heaving up, being loosened and subsequently falling into the trench, giving unsafe edges and a wider trench than required.
To ensure that the line of a trench remains straight the string line is pulled taut along the centre line of the proposed trench and marked with spray paint. The string line is then removed. Position the kingpost of the machine directly over the line and level the machine. To check if the machine is accurately positioned, extend dipper and lower bucket teeth until they are equally spaced either side of the line. Lift the bucket clear of the ground and without slewing retract the dipper and lower the bucket to the ground again close to the machine. The bucket teeth should still be equally spaced either side of the line. If the teeth are not equally spaced it will be necessary to move the machine.

To move the machine take the weight of the machine on the bucket. By use of the slew and dipper you can move the back end of the machine to place the kingpost exactly over the line. On each subsequent pull it will make it easier to keep on line if you ensure that the front wheels are straight before moving forward. This helps keep the machine parallel to the trench.
**Loading**

To load a truck with a backacter, position the truck to the side of the machine opposite to the kingpost. Park truck far enough forward of the stabilisers to avoid slewing over the cab.

If there is any risk to the truck driver, or you are loading a truck or dumper without a protective cab, the driver should dismount and stand clear.

Load the vehicle keeping the discharge height as low as possible. Ensure the load is evenly distributed and that the truck is not overloaded.

**Manholes**

To excavate a manhole it is necessary to pull the trench half way into the proposed manhole (1)

- From position (A) excavate full length of (2)
- From position (B) excavate (3) & (4)
- From position (C) continue trench (5)
- On smaller manholes it may be necessary to move back to position (A) and clean out the excess soil before excavating at (5).
Footings

When digging footings for building foundations, it is essential that the task is tackled in the correct manner and with the correct size of bucket.

Each job will be different, but footings normally follow a regular pattern of excavation. The internal footings are dug with a small bucket and the external footings usually require a larger one.

Excavate A but stop at corner to allow dumper access to remove soil from B. When joining B and C it will be necessary to back dig. This involves pushing the soil back up trench B and picking up the loose. Continue digging but stop short of corner to allow access for digging D. When joining C and D it will be necessary to back dig as at C/B.

Wherever you start it will always be necessary to back dig twice on the footing illustrated. If you pull a trench into a trench the corners will break off as shown in this detail.
Attachment Changing

1. Place the bucket on flat level ground
2. Remove locking device from both pins
3. Remove tipping link pin
4. Remove dipper pin
5. Lift boom and dipper clear of bucket
6. Reposition dipper in jaws of required bucket
7. Lubricate dipper pin
8. Align holes in dipper and bucket
9. Insert dipper pin and attach locking device
10. Raise bucket just clear of the ground
11. The bucket can be rotated to help align crowd pin
12. Insert crowd pin and attach locking device
13. Lubricate the bucket grease points
Tipping Link Adjustment

A. Normal digging position
The position is most suitable for general excavation work. In extreme operating conditions consider the undermentioned possibilities.

B. Maximum speed position
Advantages:
- Faster digging cycle
- Greater digging reach
- Greater loading height

Disadvantages:
- Less tearout force

C. Maximum power position
Advantages:
- Greater tearout force

Disadvantages:
- Slower digging cycle
- Less digging reach
- Lower loading height

On most machines the tipping link can be adjusted to open or to close the bucket. This feature is useful if loading a high-sided truck using the back end (bucket needs to close more to retain material). It is also useful when digging to a square face (bucket needs to open out more to cut down the straight face).
Module Seven - 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 EIGHT – SAFETY

Before Operation

- Always ensure machine is serviceable and safe to use
- Carry out the daily checks
- Carry out the weekly inspection (or as required by your company scheme) required for lifting appliances and record the results
- 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
- Never climb in or out, or lean out of the rear window
- Lower all attachments to the ground whenever you leave the machine
- Lock rear end equipment for front bucket operation or road travel
- 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 NINE – TRANSPORTATION

Statutory Requirements

The Road Traffic Act (UK)

The Road Traffic Act (UK) states that the maximum speed allowed for digger 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 signaler 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:

- The back end equipment is locked up
- The independent foot brakes are locked together
- 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.
**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.

![Line of sight diagram]

**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.

![Traveller diagram]

**Offset**

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

![Offset diagram]
Sight rails

The usual type is simply an horizontal rail fixed to a stake driven vertically into the ground. The rail is at a height which will conveniently allow a person to sight over the top.

For work of longer duration, the horizontal rail may be fixed across two stakes to make a more solid fixture.

The length of the traveller to be used will be written on the back of the sight rail.

These are used for sighting a line above ground parallel with the formation level below the ground, down to which excavation is required.

500 mm x 100 mm
rail painted white
Stake
750 mm x 100 mm
x 100 mm

1.50 metre x 100 mm
rail painted black and white
Stakes
750 mm x 100 mm
x 100 mm

Profiles

These are used to control the slope of embankments or cuttings and the angle of the board denotes the slope required on the finished embankment.