Roller Operation Manual

Training Resource
1. Introduction

Incident analysis of Fulton Hogan roller incidents has shown that:

- 57% of roller incidents are caused by operator error/ lack of knowledge
- 58% of those incidents involved getting too close to the edge of the construction causing potential roll over
- 13% of incidents occurred during loading or unloading of the rollers

This learning resource is intended to provide a learner/trainee with a broad understanding of the underpinning knowledge needed to operate a roller within the Fulton Hogan organisation and up-skil operators to reduce the incidents that are occurring in the business.

The material contained in this resource may be used either as a guide when undertaking self-paced learning or as a hand-out during a formal course of instruction delivered by an approved Trainer/Facilitator within the Fulton Hogan organisation. It may also be used by an approved Registered Training Organisation (RTO) contracted with Fulton Hogan approval.
2. Machine Operation

2.1. Road Rollers

Soil-compacting equipment normally used within the earthmoving industry includes sheeps foot, pneumatic-tyred (PTR), 3 point static, double drum vibratory, and smooth-drum construction rollers. To select the most appropriate type of compaction equipment, field staff/workers must know the characteristics, capabilities, and limitations of the different types of rollers.

**Double drum vibrating pavement rollers MUST NOT be used on shoulder work or edge compaction.**

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2.2. Operating Criteria

When operating any Plant or machinery there are basic obligations that an operator must fulfil. You must:

- be licensed to operate the roller
- have been assessed as “Competent to Operate” (CTO)
- follow the company’s safe working procedures that apply at your workplace
- report any hazardous situations
- report any damage to equipment or plant to your supervisor
tell your supervisor about any maintenance or repairs that need to be carried out on the equipment you are using or any controls that aren’t labelled

ensure people are kept well away from your moving roller – people and plant do not mix

stay alert.

Careless and reckless operation of a roller is of a serious concern and may result in disciplinary action by the company.

While operating a roller, you must operate the equipment in accordance with the manufacturer’s instructions. As an operator, it is your obligation to seek instruction on any operation aspect of the machine that you may have forgotten or do not fully understand. This particularly applies to compaction work adjacent to shoulders/edges.

Fulton Hogan has an extensive list of procedures for the safe operation of mobile plant. Please do not hesitate to speak with your Supervisor/Manager if you require confirmation and clarity on any issues.

2.3. Operator Obligations

Fulton Hogan as a company places obligations on all plant operators. These obligations as a minimum when operating any machinery include:

- wearing your seatbelt at ALL times
- wearing appropriate PPE
- conducting pre-start checks
- planning the worksite and checking the equipment
- environmental obligations
- shutting down the equipment
- secure parking of machine.

2.4. Checking Attachments

Make sure any attachments are securely fitted to the machine in accordance with the relevant manufacturer’s specifications. That is with an appropriate locking device.

Attachments can be, but are not limited to:

- Drag booms
- Asphalt cutters
- Edge compactors

2.5. Lights / Electrical / Mirrors

Broken lenses and bulbs will need to be checked. Broken hazard and working lights will need to be reported and/or replaced. Reversing devices should also be checked with other items.

Mirrors are to be fitted and correctly adjusted.
2.6. Reporting

Loose nuts or bolts need to be recorded and/or reported, unless work instructions require you to carry out small repairs.
Report any of the above defects to an authorised person. An operator may also have to tag out the machine to ensure no one tries to operate it until the repairs are completed.

2.7. Mounting and Dismounting

Statistics have shown that falling is one of the major causes of personal injury.
Always use the hand holds and steps that have been provided by the manufacturer to safely mount and dismount a machine.

The correct way to climb on and off any machine is to keep three Points of Contact with the machine at all times. Both hands and one foot or both feet and one hand must be in contact with the machine. Always face the machine for safe entry or exit.

Care should be taken when conditions are wet or slippery. Ensure all steps and platforms are free from mud and scrape mud from boots before mounting the machine.
**NB:** Do not use the controls as hand holds when mounting a machine.  
**Do not jump on or off any machine, and never mount or dismount a moving machine.**

### 2.8. Cabin and Control Set Up

Before starting any machine, the cabin should be set up for the operator’s comfort and safety. This could include cleaning all windows and mirrors and also inspecting them for any damage.

The cab must be kept clear of any rubbish, tools and chains etc, otherwise the controls could be fouled up or, in the case of a roll over situation, these items will become missiles. Ensure that the floor is also clear of any grease or oil so no slips or trips can occur.

The operator must have unrestricted access to all foot and hand controls and all controls must be labelled. The cabin should be kept clean at all times.

Seat Belts must be worn and checked to see what condition they are in. If damaged, worn or deteriorated they will need to be replaced.

The seat belt clip and buckle will need to be checked for wear and tear as well.

### 2.9. Seating Position

Inspect the seat for security and its general condition; check adjustment for operation and adjust for comfort.

The operator must be able to fully depress the foot controls with their back against the seat.

You must not carry passengers on a roller unless there is an approved seat and seat belt fitted to the machine.

### 2.10. Start-up Procedure

For the correct start up and shut down procedures, look in the operator’s manual in the machine that you are operating. If you have never used the machine before then you must:

- Familiarise yourself with the machine (e.g. controls and decal information)
- Seek instruction from your supervisor if you are unclear on the operation of a specific piece of plant
- Always be seated when starting a machine. Secure the seat belt - it must be worn when operating any machinery
Check that the park brake is engaged. Make sure that the transmission control lever is in neutral position and the safety lock is on (if fitted)

Check that the throttle control or accelerator pedal is pushed past any indent that may be fitted and is in the low idle position

Turn the ignition switch to start the engine. If it fails to start within approximately 10 seconds, allow the starter to cool down and try again.

2.11. After Start Checks

Allow the engine and components to warm up to operating temperature for approximately 3 to 5 minutes before operating. During this period; operate all attachment controls, checking for correct operation. Also check for unusual noises and any vibrations. If detected, shut the machine down.

- Re-check all gauges and warning lights for correct operation. Ensure the area is clear of all personnel and equipment before moving
- Raise all lowered attachments off the ground, to a height that will be determined by the site conditions that you are working in
- Before moving off, especially before reversing, always check the direction of travel is clear of obstacles. This will include people and/or other machinery.

Rollers that are driven on public roads require registration.

2.12. Shut Down Procedures

Shutting down the machine is as critical as starting. When shutting down any machine an operator has an obligation to comply with any site safety procedures.

An operator’s obligation is to ensure that the machine is parked in a safe location and will not create a hazard.

When leaving the machine, the operator must lower all attachments to the ground and release pressure from hydraulic lines.

Ensure the machine is checked and ready for use following shut down. Once the machine has been shut down, the keys should be removed from the machine to stop any unauthorised use of the roller. In some cases, depending on the company’s work practices, the machine may need to have the cabin locked (if fitted) and refuelled.

When shutting down the machine you should:

- Neutralise the transmission
- Apply the park brake
- Place chocks under the drum to prevent roll away situations.
- Engine is stopped in accordance with manufacturer’s manual (idle engine down before turning off)
- Remove the keys
- Secure the machine against unauthorised movement
- Engage the isolator
- Complete any paper work required.
The machine should be parked on a firm level surface to ensure the machine does not roll. If this is not possible, the roller should be parked across a slope to ensure it will not slide down a wet or rain affected surface.

A machine should not be parked:
- Across access ways
- Near overhangs
- Refuelling sites
- Tidal or flood areas
- Adjacent to an excavation
- Emergency Exits

You should never park a roller near an excavation because the weight of the roller could cause the excavation to cave in, particularly if the ground is affected by rain.

Post operational checks need to be carried out to:
- Ensure that the roller is safe for the next operator to use
- Detect any structural damage
- Discover any leaks on the machine
- Ensure all systems are closed off (battery isolator).

3. Work Site Procedures

3.1. Plan Work and Check Equipment

Before commencing any days work, a prestart tailgate will need to be completed.

Points to consider in the pre-start tailgate will include:
- Site plan
- Traffic Management Plan
- Other plant movements
- Clear zones for people and plant
- Roller selection – appropriate machine for task
- Site hazards i.e. steep drop offs/soft edges
- Communication technique
- Slope/grade of the ground that you will be working on.

Always ask yourself “Do I have the skills I need to complete the task safely?” If not, STOP and ask for help.
Where a danger exists on a site; signs, barricades or fencing should be erected to warn of any dangers.

3.2. Travel Direction

Operators will need to ensure that the travel direction is clear, select the appropriate route and operate the machine at a safe speed. Be aware of:

- Recently filled trenches and sloping edges
- Other personnel and plant in or around the site
- Underground services
- Overhead power lines or cables
- Uneven, soft or sloping ground surfaces
- Hidden holes, drops and embankments
- Other obstructions that could be dangerous.

3.3. Compacting Road Edges

**Twin steel drum vibrator rollers MUST NOT be used for this task - use a construction roller.**

Identify on the site areas requiring rolling and the associated hazards. Take particular note of unstable edges, banks, drop-offs, swale drains, retaining walls and gradients greater than 3% and barricade them off.

3.4. Compaction of Fill

Do the following:

- Construct a windrow on the over constructed edge. Utilise the existing materials being compacted to form the extra width and windrow and give the roller operator a safety zone and a line to follow
- When operating within a meter of the edge; always roll in the forward direction so you have a clear vision ahead
- When rolling to within 1 meter of the edge; position yourself in the roller on the side closest to the edge (seatbelt must be worn)
- When rolling in reverse; keep 2 meters from the edge to give a larger safety zone. Use a temporary mark every 10-20 meters to give a line to follow whilst in reverse.
- When rolling downhill; always start in the lowest gear and don’t change gears at any time
- When rolling around corners; start 2 meters away from the edge and slowly move across to within a meter of the edge
- Be aware vibrators can move the roller sideways and make shoulders unstable
- Roll edges with the vibrators off
- When coming to a stop; turn vibrators off before completing the stop
- If the extreme edge needs to be rolled; use a plate compactor or similar hand operated machine. Don’t operate a wheeled or drum machine close to a drop-off.
3.5. Shoulder Construction

When constructing shoulders; over construct the pavement keeping consistent crossfall over the required edge of construction. Leave minimal windrow on outside edge to use as a line for the operator to follow, then trim shoulder off and roll with static construction roller in a forward direction.

If there is significant drop-off; the roller can be secured to the grader while rolling.

3.6. Working on Slopes and Banks

Working on sloped ground with a roller needs extra care and planning. The reason for this is the weight distribution of the roller can change and an operator could potentially tip a roller over.

- When going uphill; the centre of gravity moves downhill
- When going downhill; the centre of gravity moves downhill
- When going across a slope; the centre of gravity moves to the downhill side.

Actions to minimise risk of roll over:
1. When rolling shoulders or soft edges; always travel in a forward direction.
2. Your travel route should be directly up or down any steep slope.
3. Keep a safe distance/safe zone from edges or drop-offs when practical.
4. Operations with no defined safe zone will require a specific tailgate to be completed.
5. Before travelling on a gradient; you must select the correct gear. Select a low gear when travelling down slopes to maximise engine braking and minimise the need for brake operation. NEVER coast or freewheel down grade in neutral. If the machine has a hydrostatic gearbox; you should select the appropriate speed so you are in control of the machine at all times.
6. When commencing a run to compact a road; commence at the kerbside and not the crown or high side of the fill area.
7. Operators of a vibratory roller need to ensure they do not operate the vibrator on the first run on a slope of uncompacted materials.

If the roller starts to slide due to a bank collapsing; the operator should stop the vibrator immediately.

Idle the engine and get help if unable to drive or reverse out slowly. When operating on rough or stoney surfaces; you will need to decrease your speed to maintain safety.
4. **Type of Rollers**

Rollers are designed and used to achieve compaction of a variety of materials in the civil construction industry.

Rollers vary in shape, size and configuration:

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<td><img src="image4.png" alt="Double Drum Vibratory Image" /></td>
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A roller will effectively compact most materials by one or a combination of the following:

- the static weight of the machine
- a kneading action of a roller
- the impact and/or vibration of its wheels and/or drums.

Rollers can use a combination of these methods or just have a single application. They can be self-propelled or towed. Many rollers are articulated, but can also have rigid frames. They may have a single drum, double drum or multi tyre configuration.

This versatility allows individual rollers to be used to compact a range of different types of soils. The graph shown below will allow the selection of the most suitable roller for a given range of soil types.
4.1. Vibratory Rollers

There are two types of vibratory rollers available:

<table>
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<tr>
<th>Heavy Clay</th>
<th>Clayey Sand</th>
<th>Clayey Gravel</th>
<th>Gravel</th>
<th>Silty Sand</th>
<th>Fine Sand</th>
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Sheeps Foot

|            |            |                |        |            |          |
|            |            |                |        |            |          |

Steel Wheel

|            |            |                |        |            |          |
|            |            |                |        |            |          |

Vibrating Smooth Drum

|            |            |                |        |            |          |
|            |            |                |        |            |          |

Vibrating Sheeps Foot

|            |            |                |        |            |          |
|            |            |                |        |            |          |

Pneumatic Tyred

4.1.1. Vibration Compaction

Vibrating rollers use high speed vibration causing the particles to hit together and break up, while lower frequency has the effect of shaking the material, which allows the finer particles to gravitate to any void in the material. This causes the increase in density of a particular material. The overall rearrangement results from the dynamic forces generated by the vibrating drum hitting the ground.

All compaction results are a function of the frequency of the blows, the dynamic forces as well as the time period over which they are applied. This frequency and time relationship accounts for the slower travel speed of the vibratory roller.

**Note:**

A vibrating roller compacts material through its weight and the rolling and vibration of the roller drum.

Travel speed with these rollers is important because it determines the time that each particle is vibrated. **Generally the speed will be between 1.5 and 5 km/hr.** If the rolling speed is too slow the particles will be vibrated too much and may cause them to breakdown and change the structure of the material.

If the rolling speed is too fast then the particles will not be rearranged to fill in all the voids and the required compaction will not be achieved. The vibratory roller's effect actually...
decreases with every pass, as each pass has a larger compacted mass to move through its’ vibration cycles.

**Note:**
Remember that each pass should include a 10% overlap.

The vibratory steel drum roller is very effective with materials of larger grain size, 76-0.08mm size, provided there is less than 10% cohesive materials. The addition of tamping feet to the steel drum vibratory roller allows the roller to be used with materials up to 50% cohesive content.

Using a vibratory roller on materials that are higher than 50% cohesive content will not be as effective as non-vibrating tamping foot or sheeps foot rollers.

### 4.1.2. Amplitude of Vibration

There are some terms used with vibratory rollers such as:
- Amplitude
- Dynamic force

Amplitude is a measurement of the amount of vertical drum movement during one cycle of the vibrator. As the drum moves up and down during one cycle, the amplitude is calculated by dividing the total vertical movement by two.

\[
\text{Amplitude} = \frac{\text{Vertical Movement}}{2}
\]

Dynamic Force is the downwards force generated by the vibrating mechanism at a given frequency. The vibration induced by the vibratory roller, when working in metropolitan areas may cause irritation and/or damage to property nearby.

It is for this reason an operator must be aware of the approximate distances at which a roller may be used beside any structure on the job or adjoining the work site. As a guide, the weight of the roller is multiplied by 1.2, and then divided by the number of drums. This will give a safe working distance in metres from anything likely to be damaged by vibration.

\[
\text{Distance} = \frac{\text{Weight \times 1.2}}{\text{No. of Drums}}
\]

As an example, an 11 tonne tandem roller would be allowed to work 6.6m away.

Always place the vibrator in neutral before changing direction or stopping the machine.
4.2. Steel Wheel Rollers (Smooth Drum)

These static rollers are mainly used for finishing asphalt compaction. They give a good finish to the surface and are therefore usually used as a finishing roller.

4.3. 3 Point Rollers

These are mainly utilised to finish basecourse surfaces to the required density and tightness.

Note:
A static roller relies on its weight and the rolling of the roller drums or wheels for compaction.

4.4. Sheeps Foot Rollers

This is the oldest and most familiar compaction roller found throughout the industry and it is able to work on a large range of materials. However, it is most suited to plastic soils such as clay and silt. Its main uses are base and sub-base compaction.

If this roller is used on rock or course granular materials, the feet will tend to push the material aside and break up the lower layers of the soil rather than compact it. Worn feet will reduce its effectiveness.

A pad foot roller starts to compact the fill layer from the bottom and has high contact pressures.
To achieve compaction, the pad foot depends on:
- Contact area of the foot
4.5. Pneumatic Tyred Roller (Multi Wheel)

Multi wheel rollers are designed to carry ballast. This extra ballasted weight increases the compactive efficiency of the roller. This ballast is usually water, which is stored in compartments built into the roller body.

Sand can also be used, but is a hindrance when you need to reduce the overall weight of the machine for transportation or a site specification requirement.

Multi tyred rollers are widely used in bitumen paving and sealing work. They are also used in general road works and airfield construction as a base roller and in the finishing process.

Multi tyred rollers usually work in tandem with smooth drum rollers. In wet weather or moisture affected gravels, a multi tyred roller will allow you to continue rolling and not bring all the excess water to the surface.

Note:
A multi tyred roller compacts by kneading the material with the static weight of the machine.

5. Meeting Compaction Requirements

When selecting a particular rolling pattern to ensure effective compaction, remember to overlap previous passes to produce a seamless finish.

Optimum moisture content for the fill material is determined in a soils laboratory. The difference between it and the moisture in the field will tell whether the material must be dried or moistened.

The moisture content of a material becomes more critical as the size of the particles decrease. Small grained particles (less than 0.5mm) require more water and react noticeably to moisture changes.

Rock, gravel and sand in their pure states can be compacted either saturated or dry with little variation to the compaction rate. On the other hand, fine grained materials become plastic with addition of water and require an optimum amount of water to achieve the density required. In these fine grained silts and clays the moisture content is critical to proper compaction.
As an example, a typical clay layer with 50% cohesive material requires 8.1% to 18.5% moisture content to be workable. Below 8.1% the material is too dry and will not bond. Above 18.5% the material is too wet and becomes unstable, moving about.

The optimum moisture content is 13% and this would allow you to achieve a maximum density of 99%. This however is not generally possible and a density of 95 to 98% is generally set as being achievable. To achieve this, moisture for this sample would need to be kept between 9.7% and 15.3%.

The closer you can keep the moisture level to its optimum the easier it will be to gain or exceed the required density. To control the moisture content on site water trucks are generally used to carry and spray via hose heads and batter sprays affixed to the truck.

As coarse grained materials drain water effectively, there is generally no need to mix the material to gain the correct moisture content. However some control on moisture content should be observed.

The same cannot be said about fine grained cohesive materials. These fine grained materials act exactly the opposite to coarse grained material and in most cases the water will run off or just sit on the surface. In these soils considerable mixing is required to allow the water to penetrate into the lower areas of the fill layer. It is of an advantage if the fine grained material can be mixed prior to placement.

The methods used for mixing included disc ploughs towed by a tracked machine. There are many other mixing implements available including harrows, scarifiers and rotary hoes.

Material that is too wet can pose a larger problem than that which is too dry. This is due to the fact that it is easier and faster to add water to material than wait for the action of the sun and the wind to dry it out. There are two commonly used methods of removing excess water from a fill layer.

The easiest, but often the slowest method, is aeration. By turning the soil, air and sun will cause evaporation of the excess moisture.

Discs, harrows and even padfoot rollers can be used to expose the soil to air and sun. Another method of removing excess moisture is to mix dry soil with the wet. In this procedure alternate loads of wet and dry materials are spread and mixed together.