Chapter 3

Winches

In this chapter you will find out:

- ✓ The different winch types and how they work.
- ✓ That traction aid is not winch-assist.
- ✓ Your machine skills could impact winch tensions.

This chapter is about the winch. Not about how they are anchored or repositioned which is discussed in Chapter 5.

What is a winch?

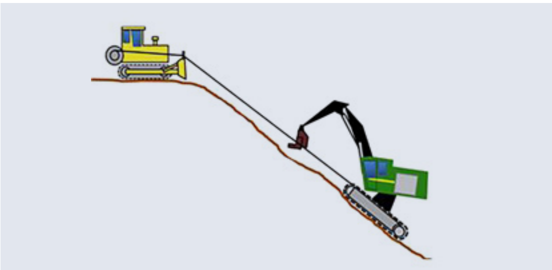
A winch is a powered geared drum that spools the wire rope. Winch systems can have different mechanisms for managing tension and power that aim to provide constant tension. The operator adjusts the winch settings. For example, some have the wire rope tensioned through constant hydraulic pressure or band brakes applied to the drum.

Some drums pivot under load, which acts as a shock absorber within the rigging system.

There are two options for the winch location:

- On the anchor machine.
- On the steep slope harvesting or extraction machine.

Winch Anchor Machines



The winch(es) are mounted and powered by a mobile anchor. The winch anchor machine is typically a modified excavator or a bulldozer. The complexity and cost of fitting a winch to the anchor machine make them purpose-built machines. The harvesting or extraction is done by a second machine working on the slope.

Anchors can range from small units that deliver a pulling power of 5 tonnes up to larger systems more common in New Zealand that deliver pulling of 18-23 tonnes.

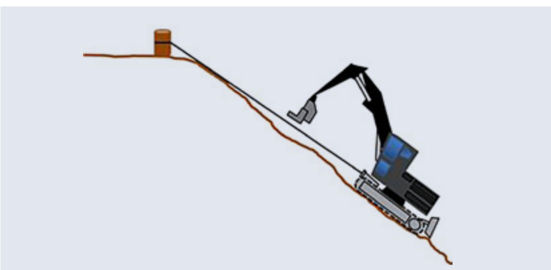
The advantage of the system is the:

- Winch anchor machine is mobile and can assist with a line shift.
- Two machines can easily disconnect so either machine can do other work or work with a different machine, e.g. the steep slope harvesting machine can shift between winch-assist and other operations.
- Winch anchor machine can still operate as a dozer and or a digger.

These are a few examples of commercial models available, top left: Eco-Forst T-WINCH 30.2. Top right: T Max. Below left: Electrical and Machinery Services (EMS) Tractionline and below right: DC Equipment's Falcon winch-assist.

Winch on the steep slope harvesting machine

The second option is the winch mounted on the steep slope harvesting (SSH) machine. They can either be integrated into the chassis or have a winch mounted onto the machine. It is a one-machine winch-assist system when anchored to stumps or deadmen, although it can also be supported by a second anchor machine that does not have the winch on it.



The advantages of the integrated systems:

- It is a one-machine system.
- The rope doesn't move along the ground because the rope is spooled on the SSH machine.
- Flexibility in the anchor type, e.g. a stump, deadman, or mobile anchor.

The only New Zealand made winch integrated SSH machine is the ClimbMax. In Europe, most have the winch mounted on the SSH.

Left: ClimbMax Steep Slope Harvester. Right: HERZOG ALPINE Synchrowinch.

Single and double rope (two-line) systems

Winch-assist can be single or double rope systems. There are advantages and disadvantages in both systems, and the choice comes down to the merits contractors can see for their operations.

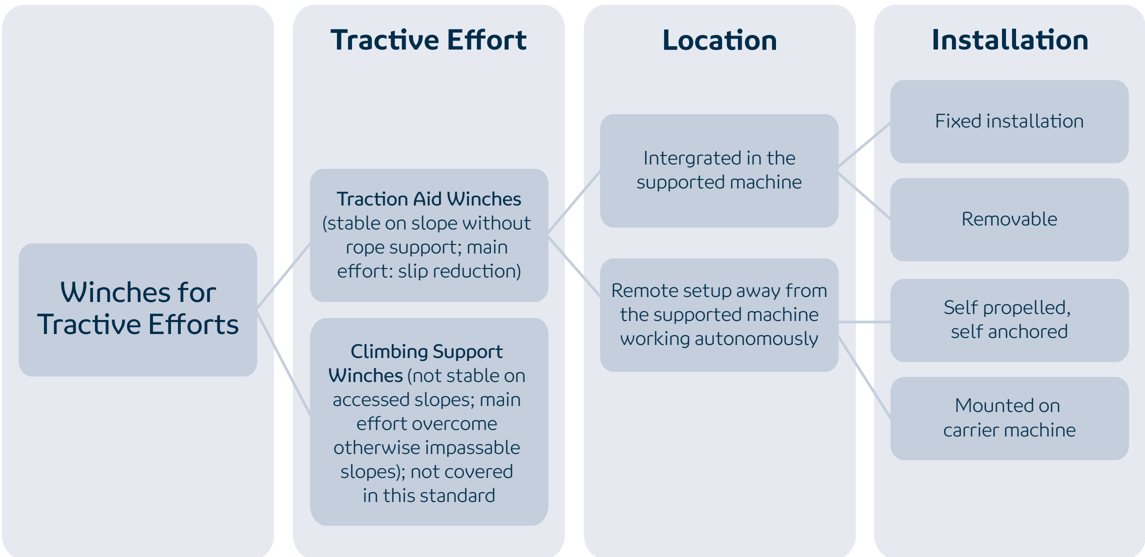
Examples of double rope systems. Left: EMS Tractionline. Right: The Remote Operated Bulldozer ROB.

The difference between 'traction-aid' and 'climbing support winches'

The ISO standard 19472-2:2021(E) Machinery for Forestry; Winches – Part 2: Traction aid winches was published in January 2022. The ISO standard distinguishes traction aid winches and climbing support winches, as seen in the diagram below. Traction aid is where the rope is added to reduce machine slip, but the supported machine is both stable and still able to move on the slope without support from the rope.

This is different from how many operators use winch-assist in New Zealand. Winch-assist is often used to help access terrain that would otherwise be impassable. The term 'climbing support' has been coined by the standards review committee to differentiate between the ISO 19472 traction aid systems that have been designed, manufactured, and employed in the northern hemisphere with those manufactured in New Zealand.

The standard is significant because of the implications around differences in the Safe Working Load (SWL). The ACOP requirement is for a winch-assisted operation's rigging to be tensioned up to at least 1/3rd of the ropes rated breaking strength. The ISO standard allows for wire rope to be operated at a tension up to 1/2 the rope's minimum breaking strength, recognising it is only for traction aid.



Good winch features

The following are good features for winches used in assisted operations.

- A winch specific emergency stop procedure.
- A pre-set maximum line pull that does not exceed the safe working load of the wire rope (33% of breaking limit).
- A winch auto-stop mechanism designed if the anchor machine loses power or when the drums' minimum wire rope length is reached.
- A winch braking system can hold the steep slope harvesting machine if power, traction, or stability are lost.
- Chartered Professional Engineer or manufacturer certified winch attachment points and tow hitches.
- Systems that in 'real time' monitors, records and relays to the steep slope harvesting machine cable tension and winch rope details like rope off and remaining on the drum.
- The manufacturer's service schedule for the winch and its ancillaries' parts.

Winch tension monitoring systems

Cable-assist machines should have a tension monitoring system. Wire rope has a Safe Working Load (SWL), and without a monitor, the tension in the rope cannot be managed. The operator needs to set the tension and view the current tension setting.

Like in cable logging, tension is difficult to measure directly as a load cell cannot easily be put into the rigging system, so monitors indirectly measure tension. Three examples are:

1. Putting a small deflection ('bight') in the rope using three sheaves and measuring the pressure on one of the sheaves.
2. Measuring the hydraulic pressure in the winch drum.
3. Using a sheave in the rigging system, where the rope passes through a known change in direction.

All three require careful calibration to reflect the tension in the rope accurately. Torque varies with the diameter of the winch drum. For example, when using hydraulic drum pressure, 'the effective diameter', or the number of wraps on the drum, must be calibrated correctly.

A three sheave deflection winch tension monitor system.

Many factors affect winch tensions

Winch-assisted operations are complex, and the forces involved are relatively large. The operator sets the desired tension. A good operating practice is to use the lowest possible winch setting required for the job. This creates the least amount of stress and risk in the system.

Increased loading known as shock loading, can be common when using winch-assist.

A frequent cause of shock loading is lag in the system's response time to machine movement. While shock loading cannot be avoided entirely, understanding it helps to avoid overloading. The example winch-assist tension graphs below show some limitations in managing tensions.

1. **Moving the machine causes most 'shocks' and not from felling or shovelling**

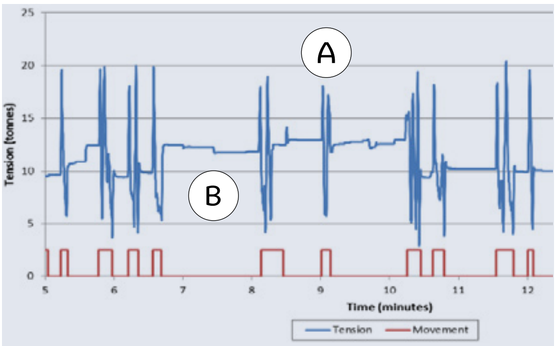


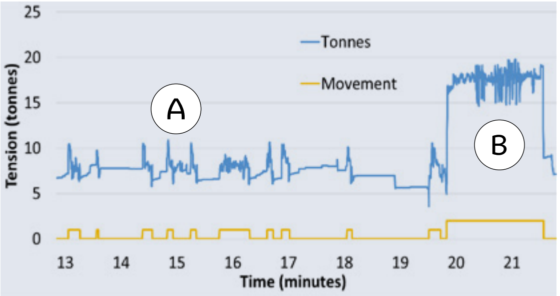
Figure 1

A Spikes are from the machine moving
B Flat sections are the machine felling

Tracked machines, especially when moving downhill, can generate a large pulling force combined with traction and gravity! There is often a small lag between when the machine is pulling the rope, and when the winch can adjust its tension. This shows up on the tension charts as a spike with tensions going both up and down.

Also shown on Figure 1 is when the machine was moving (orange line). This confirms that nearly all sudden spikes are from machine movements, not from the felling or shovelling activity.

2. The tension depends on the operator setting



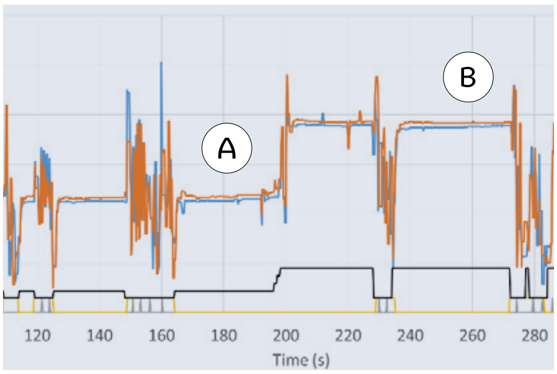
A Machine working downhill
B Machine heading up the slope

Figure 2

Operators can choose from tension settings as low as a few tonnes, all the way up to the safe working load (SWL).

Figure 2 shows the operator choosing a tension of about 6-7 tonnes while working downhill, and then at the 20-minute mark, increasing the setting to 18 tonnes to help the machine go back up the hill. This change in setting is much larger than the smaller shock loads.

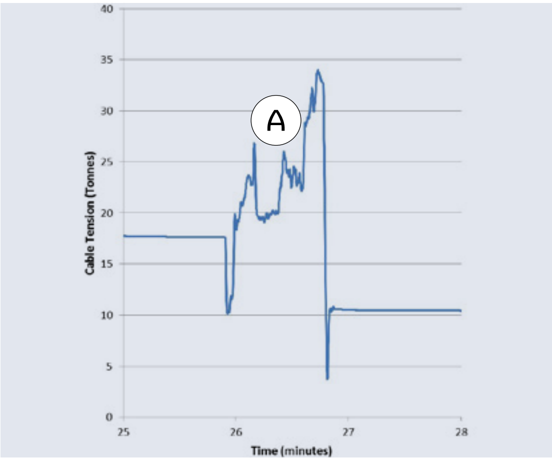
Figure 3 chart shows the operator of a two rope system (blue and orange lines) changing their setting from about 4.5 tonnes up to 8 tonnes. For example, this might be required as the slope gets steeper or the soil conditions become wetter. The chart shows that dual-wire systems share the load evenly.



A Initial tension
B Operator increased winch tension

Figure 3

3. Extreme winch tensions do arise from operator errors



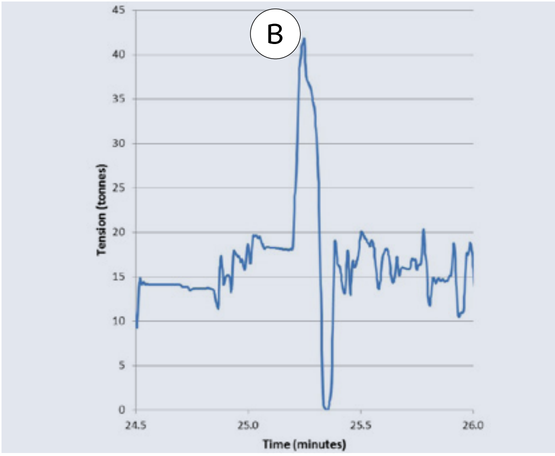


Figure 4 and Figure 5

A Machine 'stuck' behind an obstacle

B Operator had brake on and drove down the hill

Figures 4 and 5 show that operator decisions can potentially lead to serious risk. Left: The steep slope harvesting machine was stuck behind an obstacle, so the operator put the tension up to its highest setting then used the boom to generate an extra force to solve the problem. The graph spiked to 34 tonne, which is well over the SWL.

Right: The operator still had the system on a manual feed setting and began to move the machine downhill. When the winch is either off or in a manual setting, the winch won't adjust to an increase (or decrease) in rope tension. The graph shows over 40 tonnes on the rope when both gravity and the steep slope harvesting machine's traction were pulling on the winch.

4. Redirects (rub trees or stumps)

Redirects add friction and result in the rope tension being different above and below the redirect. For example, if a winch applies a rope tension, the pulling power of the rope reduces after going around the redirect. See the section 'How redirects change rope tension' on page 61.

Shock loading results in higher tensions than the operator setting.

Guidelines when working with winches

- Record winch operating hours for operational machinery and rigging. servicing and replacement schedules.
- Before operating, make sure all safety systems are operating.
- Don't override safety controls.
- Use a constant tension system. Never allow slack to develop in the line.
- Use a mechanism or system to prevent accidental operation of the assisted machine when the winch is in manual mode.