Surveying tools keep jobs on the level

There are plenty of jobs on the farm where establishing an accurate level or straight line makes all the difference.
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Setting up a level pad for a new shed or silo, or adding a gradient to a grain storage pad to control runoff are a cinch with the right equipment. And establishing a straight fence line, or two lines at right angles is easy with a dumpy level.

While optical surveying equipment may seem old-fashioned in this age of lasers and GPS location equipment, they are still very much in use, and incredibly handy for particular applications.

Laser levelling systems, both rotary and fixed, have made levelling quicker and easier, and have the added benefit of being a one-person operation. In this month's Workshop, we will look at the use of both laser and optical systems. While this article won't teach you how to be a competent surveyor, it will show you how both systems work, and what applications they are best suited to.

Acknowledgments:
Carl Simonetti, Imex
www.imexlasers.com.au

All tools sourced from Toolmart where possible
www.toolmart.com.au

USING AN OPTICAL LEVEL

1

An optical or "dumpy" level is the traditional surveying tool. It helps to think of it as essentially a telescope with spirit level attached, fixed to a base plate graduated with 360 degrees. They are available in different levels of magnification, and the Imex LAR32 model shown here has a 32x magnification ($532 including staff and tripod). Optical levels are generally cheaper than rotary laser units, but take far more time to set up correctly. Also, the accuracy of results is dependant on correct set up.

2

The optical level attaches to a tripod with a domed top. Make sure the tripod is located on stable ground and the spikes on the legs are well pressed in. Adjust the length of the tripod legs so the scope is at a comfortable level. Attach the level to the tripod using the knob which passes through from the bottom of the domed top. Tighten when it is roughly level, when the bubble is in the centre of the level window.

3

Now use the three levelling screws under the rotary base to fine-tune the level. Note the small angled mirror above the level bubble; this is used to view the bubble from the side, without having to look directly over the unit. Rotate the unit through 360 degrees and check the bubble remains in the centre.

It is important not to rush this setup phase, as the accuracy of the job depends on how well the dumpy has been levelled. With that accomplished, everything viewed through the scope in line with the cross hairs will be on the same level plane.

Using an optical level is a two-person operation. It requires one person to hold the staff in the location where an elevation measurement is required, and another person to look through the scope and note the height. It is up to the staff holder to ensure the staff is vertical using a small level bubble positioned on the rear of the staff.

This telescopic staff is specifically designed for use with optical levels, and is known as an "E staff". Note the graduations alternate from red to black for each successive metre. The E-style graduations are designed to make it easier to view through the scope, and are grouped in 100mm blocks.

The "13" pictured indicates 1300mm from the ground or base of the staff. Each small block represents 10mm. Measurements to the millimetre are possible, but require the scope operator to interpolate between points. This means accuracy is generally plus or minus a couple of millimetres, which is adequate for most uses around the farm.

The level operator rotates the scope until the staff can be seen in the crosshairs. The small knob on the side of the base allows fine tuning of the direction.

The large knob on the side of the scope is then adjusted to bring the staff into sharp focus, after which the reading can be taken from the crosshairs.

If you are taking elevation readings across an area such as a shed pad, the location of the tripod is arbitrary, as long as it is not moved or disturbed as levels are taken, and is close enough to take accurate readings. It can actually be placed in the centre if desired. The actual height of the level above the pad is not important, as long as it is higher than the highest point of the area in question. In the case above, we have marked the elevation level on the ground (minus 365mm) with respect to the highest point measured, as we will be filling the pad until it is level. Another option here is to knock in a level peg or mark an existing peg at 365mm from the surface. A final option would be to set up string lines.

The beauty of the optical level is that it can be used to accurately set out angles or straight lines, thanks to the angle graduations on the rotary base. A common task would be to set out a line at right angles to an existing line, such as marking the locations of shed walls or squaring up a pad. Here we have placed the tripod over a corner marking peg. Note the orange plumb bob which is used to centre the tripod exactly over the peg. The dumpy is then levelled as described previously.

12

Now the unit is dialled in to the other peg which has been previously placed at the far end of our existing line. The staff is required so that the peg location can be seen through the scope.

13

Without altering the position of the level, adjust the bezel ring so the marker is at the zero degree point.

14

To set a line at 90 degrees to our datum line, rotate the head of the unit right (90 degrees) or left (270 degrees, as above). Any point in line with the crosshairs will now form a line at right angles to our datum.

15

All that remains is to have the helper adjust the position of the staff until it comes into line with the vertical line of the crosshairs. Mark this point with a peg and you now have two lines at perfect right angles to each other.

USING A ROTARY LASER LEVEL

1

The other option for levelling an area is a rotary laser level. These units, are quicker to set up than an optical level, are auto-levelling, and can be operated by one person. But they cannot be used to survey straight lines or angles as with the dumpy. The Imex 66R unit used here costs $1219 (including staff, tripod and standard receiver), and has a useable radius of up to 200m. It is accurate to 2mm over 30m, which means at 200m, accuracy drops to about 13mm, as the beam becomes slightly wider the further it travels.

2

Rotating at 600rpm, the laser diode effectively creates a level horizontal laser plane. This unit uses a red diode, but green units are also available (although generally more expensive). The wavelength of the green beam is easier for the human eye to see, so it appears brighter over a longer distance. This probably only matters if you intend to use the unit inside large areas.

3

The rotary laser uses a tripod with a flat top, and is set up in much the same manner as for the optical level. Make sure the legs are well secured, and the unit is positioned away from traffic. As opposed to the optical level, the laser unit can be positioned at a lower level, as long as it is higher than all points being surveyed.

4

Attach the level to the tripod using the bolt through the base plate. Make sure the unit is reasonably level.

5

Switch the unit on, and the laser will start to rotate. There is no requirement to manually level the unit as with the optical level, as it will self-level, provided it is reasonably level to start with. If the unit has been set up too far out of level, the rotating head will stop and a red warning light will illuminate (right). Also, the unit will shut off the laser if it has been disturbed in use. While the laser is self-levelling, this is no guarantee it will return to the same height if accidentally bumped.

With the laser unit switched on, it can now be left to operate without further attention. Laser levels are used with a receiver, as the beam is too hard to see with the naked eye in sunlight. Shown here are two receivers – a millimetre receiver (left) and standard receiver (right). The standard unit displays arrows, indicating whether it needs to be moved up or down until it lines up with the beam. The millimetre receiver displays a distance (in this case 4mm) as well as an arrow, and is a more accurate receiver. Both receivers also emit a beep which increases in frequency until it becomes a continuous sound when the unit is in line with the beam. Note the different staff, which is graduated in millimetres rather than ten-millimetre blocks.

Both receivers also have a display on the rear of the unit, so the operator can stand behind the staff with the front face of the receiver facing the laser unit (otherwise they will block the beam with their body). Note the level bubble on the sliding bracket, which is used to keep the staff perfectly vertical. Also, the reverse side of the staff has 5mm increments, which is more suited to the standard receiver.

Alternatively, the staff may be fitted with its own level bubble as shown above.

The receiver is attached to a bracket which clips over the staff, and can be slid up or down as required. The pointers indicate the point on the staff at which the measurement should be taken.

Holding the staff vertical and standing to the side or behind, slide the receiver up or down until it locks on to the laser beam

The elevation reading can then be taken, which is 920mm in this case. As long as the receiver is not bumped, the staff can be picked up and read. There is no need to hold it in position once the receiver has placed correctly.

If height variations are smaller, the staff can be used as a telescopic height rod, or "cut and fill" rod. This is ideal for re-checking work in progress, or as a final check at the end of a job. Start by placing the staff at the highest point of elevation and slide the upper telescopic section into the lower section. Attach the receiver at any arbitrary point (a whole number helps), and slide the staff in or out until the receiver is on the beam. Note the measurement at the transition between the upper and lower sections (1480mm in this case).

Now test the other locations. As these should all be lower than the starting point, it should be simply be a case of sliding the bottom section of the staff out until the receiver picks up the line. Subtract this reading from the original reading and you have the difference in height. For example, we recorded 1158mm at this point, so 1480 – 1158 = 322mm.

While good quality surveying equipment is expensive, it can often be hired, or purchased secondhand. But bear in mind the equipment is only as good as its calibration. If hiring, check the currency of calibration certificates. If a secondhand unit looks knocked around, don't expect it to be accurate.

More advanced rotary laser levels have some pretty handy features. This Imex 88G can be placed on its side to create a vertical line, making it ideal for fencing. It can also do dual gradients (slopes in two directions). Gradients are not impossible with a standard unit, but just require a bit of maths.

