GUIDE TO THE CONSTRUCTION, USE AND OPERATION OF A HOME-MADE LEVEL

EXTENSION GUIDE No........

SOIL AND WATER CONSERVATIONS SERIES
Introduction

There are a number of field activities that require the determination of levels of various points in the field. Where accurate and wide ranging levels are required, then instruments that can read graduated staff accurately will be required. Various types of engineering levels and theodolites with telescopic lenses have been developed for such purposes. These instruments are, however, pretty sophisticated and expensive. They are thus, virtually out of reach of most ordinary field workers. So, there is the need to have simple instruments that can be used on the field particularly in setting up simple soil conservation structures on farm lands. The home-made level is one such instrument that has a wide application in the lay-out of contour lines for contour farming, contour strip cropping, terracing and the construction of storm drains. It can also be used in the construction of short ridges of irrigation channels in a small irrigation field. In addition, there can be many other applications of it in works that require the determination of relative levels of points within small areas of land.

The home-made level can be constructed easily by virtually any good carpenter. A roadside welder will also be required, while the only thing that needs to be bought in the market is carpenter’s level and a bearing.
Fig. 1: Diagram showing the component parts of a home-made level.

Construction of the Level

The level can be constructed using the following materials:

- 3.43m (10 ft) length of a 2” x 2” (5cm x 5cm) wood
- 30.48cm (1 ft) x 30.48cm (1 ft) x 2.5cm (1 in) plank
- 111.76m (44”) length of 2.5cm x 5cm (1” x 2”) wood
- 20.3cm (8”) length of 5.0cm x 2.5cm (2” x 1”) wood
- 6 bolts and nuts 10.16cm (4”) long 6mm (1/4”) diameter
- 4 bolts and nuts 5cm (2”) long 6mm (1/4”) diameter
- 20.32cm x 5cm (8" x 2") piece of sheet-metal (to be marked sheet metal A).
- 5cm (2"") diameter bearing with a centre hole of 1.9cm (3/4") diameter.
- 4.4cm (1 3/4") length of 1.9cm (3/4") pipe.
- 2 pieces of 10.16cm (4") x 3.2cm (1 1/4") sheets-metals (to be marked B1 and B2).
- 2 pieces of 1.3cm (1/2") x 30.48cm (1 ft) sheet-metals (to be marked sheet metals C1 and C2).
- 2 pieces of 3.8cm x 1.9cm (1 1/2" x 3/4") metal bars (to be marked D1 and D2).
- 3.2cm x 30.48cm (1 1/4" x 1 ft) sheet-metal (to be marked sheet-metal E).
- 10 washers 2.5cm (1") outer diameter and 6mm (1/4") inner diameter.

With the above materials available, the construction can now begin component by component as follows:
Construction of the Level head

Fig. 2: Diagram showing the component parts of the head of the home-made level.

The construction of the level head (see figure 2) is mainly metal work and the steps are as follows:

i. Pick the metal piece of 20.3 cm x 5 cm (8" x 2") i.e. metal A.
- Mark two lines across the width about 1.3 cm (1/2") from each end of the longer side of the metal and label them X1 and X2.
- Mark another line across the metal right at the middle of the longer side (i.e. 10.2 cm (4") from either of the two ends).
- Drill a 6mm (1/4"") or diameter hole at the middle of each of the lines at the two ends of the metal (i.e. lines X1 and X2).
- Weld the 5cm (2"") diameter bearing at the middle of the metal such that the line marked at the middle will run across its diameters.
- Make a hole in the two pieces of metals 3.8cm x 1.9cm (1 1/2"x 3/4"") i.e. D1 and D2, about 1.3cm (1/2"") from one end of the longer side.
- Weld these two pieces of the bearing at the middle of it as well as to the edge of the metal piece on which the bearing itself is welded. This should be so welded such that the holes made will be sticking out above the bearing.
- Weld the 1.9cm (3/4"") pipe to the middle of the metal piece E, 3.2cm x 20.48cm (1 1/4" x 1 ft).
- Weld the two metal pieces 1.3cm x 30.48cm (1/2" x 1 ft) i.e. C1 and C2 along their edges each on the long side of the metal piece E mentioned above i.e. the piece 3.2cm x 30.48cm (11/4" x 1 ft) on the reverse face of where the metal pipe was welded. If done well, it will look like a channel.
- Pick the two metal pieces 10.16cm x 3.2cm (4" x 1 1/4"") i.e. B1 and B2 drill a hole on each exactly 1.3cm (1/2"") from one end along the longer side of it. Accuracy is very essential in this case. The other ends of these metal pieces are welded on to the edge of the metal piece E across its width each on one of its two ends with hole sticking out well above it.
- Two thin wires one vertical through the centre of the hole and
the other horizontal passing through the same centre are sold-
dered on to one of two pieces (i.e. either B1 or B2 to form a
cross-hair. This then, becomes the reading hole.

- The metal pipe is inserted into the bearing, while the carpenter’s
level is slotted into the channel made using the metal pieces.
The head of the level is now complete.

**The Construction of the Level support**

The level support (see figure 1) is made up of two pieces of
wood. One piece of 1.2m (4ft) length is cut out of the 3.48m (10 ft)
length of the 5cm x 5cm (2” x 2”’) wood. The other piece is the 20.3cm
(8’’) length of 5cm x 2.5cm (2” x 1’’) wood. Two holes are drilled on
this small piece of wood which is of the same size as the metal piece
(metal A) on which a bearing was welded, while constructing the level
head.

A groove is made in the middle of one of the faces of this small
piece of wood such that the 1.2m (4ft) long 5cm x 5cm (2”x 2’’) wood
can lock in so as to form a T, the two are nailed together to ensure that
the longer one does not snap out of the groove. Two holes are then
drilled on the support. One is 15.2cm (6’’) from the lower end of the T,
while the second hole is 35.6cm (1 ft 2’’) from the lower end of the T.
The level support is now complete.

**The Construction of the Level base**

The level base (see figure 1) consists of a piece of square plank,
two support helpers, base liners and leveling bolts. The procedure for
the base construction is as follows:

- Pick the 30.48cm x 30.48cm (1 ft x 1 ft) piece of plant (P) and mark out four lines each parallel to and 5cm (2") from the side of the planks.

- At the intersections of the lines holes are drilled of 6mm (1/4") diameter.

- The 10.16cm (4") long bolts of 6mm (1/4") diameter is passed through the holes and the nuts screwed on the other side with washers on both sides of the plank.

- 4 pieces of 2.5cm x 2.5cm (1" x 1") wood (referred to as L1 to L4) of 28cm (11") length is fixed parallel to the sides of the planks on the edges of the washers and on the side where the bolts are projecting out. They form a square around the four washers.

- The support helpers are two 0.91m (3 ft) long 5cm x 5cm (2" x 2") wood (H1 and H2) on which a slot is made. The slot is cut 6mm (1/4") wide and 61cm (2 ft) long and is 22.9cm (9") from one end of the wood. These two support helpers are fixed on the base plank (P) in the middle of it such that the support can slide between them. The lowest end of the slot is about 6.4cm (2 1/2") above the base plank. As a matter of fact, before they are fixed, they should be assembled together with the level support. This is done by passing one 10.16cm (4") long bolt through each of the two holes in the level support such that it comes out through the slots on the support helpers. A small groove is made for the head of the bolt to seat, such that it will not pro-
trude out. The level support will thus, be in between the two helpers. It must be emphasised here, that each of the helpers is held to the support by a bolt. No one bolt hold the three together. The nuts that tie the bolts are on the outside of the slot on the helpers. Washers are used on the side where the nuts are tied. Small rods are welded on to the nuts to make an ear for them such that they can be tied or loosened without using a spanner. With this assembly, the precise position where the helpers should be fixed on the base plank can be marked. The plank is laid level on the ground. The helpers and support are held vertical in the middle of the plank. The positions of the helpers are marked. A small groove is made on the plank at those positions such that the two helpers can slot in. They need not be fixed together with a nail as long as they have been firmly slotted in to the groove.

Assembling the level

At this point, the level has been partially assembled. What remains is the fixing of the level head on to the level support. This is done by simply mounting the metal piece A on the wood piece (1) at the top of the level support. Two 5cm (2") bolts are passed through holes on both the metal and the wood pieces and tied together.

The home-made level has been constructed (see figure 1). What remains is the graduated staff from which reading is to be taken. It also needs to be constructed.
Materials Required for Constructing the Graduated Staff

Fig. 3: Graduated Staff components

The following are required for the construction: (See figure 3):
5cm x 5cm (2" x 2") wood in 4 different lengths. One 205.7cm (6.89 ft) long, another 15.24cm (6") long and two others each 22.9cm (9") long.

30.48cm x 30.48cm (1 ft x 1 ft) square piece of plywood.

2 bolts and nuts, 10.16cm (4") long and 6mm (1/4") diameter.

Construction of the Staff

The following procedure is followed for the construction (See fig. 3):

The 205.7cm (6.89 ft) is graduated with a pencil and straight edge after planing at least one side of it and painting it white.

It will look better if all the sides are planed. The graduation is made by drawing straight lines across one of the faces of the wood such that the lines are perpendicular to the edges of the wood and parallel to one another at intervals of 1cm (0.4") between lines. The intervals are painted halfway alternately with black paint for the first 10.16cm (4") and then with the red paint for the next 10.16cm (4"). The staff will look like what is in the figure. The readings that will be taken from the staff is, therefore, in metric.

The 30.48cm x 30.48cm (1 ft x 1 ft) piece of plywood is taken and two lines are drawn on it diagonally. The interaction of the two lines is at the centre of the piece. That point is used as the centre and circle of 15.24cm (6") radius is drawn, by means of a compass or a string with a pencil tied to it. The circle drawn is used to curve out a disc of 30.48cm (1 ft) diameter. A small
hole of 5cm (2") diameter is drilled right at the centre. Two perpendicular lines through the centre of the disc are drawn on one face to create 4 sectors. Two opposite ones are painted white, while the other two are painted red.

This disc is then laid on the ground with the painted face down. The graduated staff is laid on it such that the graduated face is looking down and is laid with the middle of it parallel to one of the lines drawn on the other face of the disc.

The two pieces of wood 22.9cm (9") long are laid on the disc one on each side of the graduated staff. They should be so positioned that the graduated staff can slide in between them. The position of the two pieces of wood is then marked clearly.

The third piece of wood 15.24cm (6") long is placed in the middle and across the two pieces of the wood and the graduated staff. A marking is made of the point through which a hole can be drilled, so that the wooden disc, and the three pieces of wood can all be held together by means of two bolts and nuts. The graduated staff will be sliding between them. When the nuts are tightened it stops sliding.

The two 22.9cm (9") wood pieces are nailed to the disc at the positions marked for them earlier.
Operation of the Home-made Level

Fig. 4: Diagram showing the various labeled components of the home-made level.

The home-made level can be used to take point levels within short distances from where it is positioned (see figure 4). The procedure for operating it, is as follows:

- The level is set up at point not more than 10cm (33 ft) to 15.24m (50 ft) away from the points where levels are to be taken.
- It should be leveled using the carpenters level and the bolts at the base. If the ground is not too hard a small press with the
foot can push the bolts into the ground. Each bolt is pressed down as necessary until the head of the instrument is level in all directions. You are now ready to take readings.

- The graduated staff is held vertically at the point where the level is required, with the graduated face of the staff directed at the level.
- The person taking the reading then turns the level around such that he can sight the staff through the two holes at the top of the level with his eyes at the viewing hole.
- The reading is taken using the cross hairs at the reading hole. Once the vertical hair shows that the graduated staff is vertical, the horizontal hair should be used to take the reading.

Applications of the Home-Made Level

The home-made level can be used not only in small leveling work such as in the construction of small irrigation channels and basins, but it also comes in handy in the lay-out of contour lines on the farm for the purpose of contour farming, strip cropping and terracing of farm lands.