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A SIMPLIFIED LEVELLING INSTRUMENT: THE A-FRAME

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Abstract

A levelling instrument has been developed which permits work in a high degree of detail without field assistance.

Detailed levelling by normal instrumental methods is a time consuming task requiring at least two operators. Faced with the problem of levelling stream cross-sections without assistance, the author has developed the A-frame.

The A-frame (Fig. 1) paces out ground distance at a constant interval. At each pace the rise or fall of the ground surface over the interval is ascertained. A single operator can level a 600-foot traverse, with a set of coordinates at every three feet of the traverse, within 40 minutes.

Description

The instrument paces distance in much the same manner as a pair of dividers paces out distance on a map. For each paced interval, the amount of elevation or depression is read from the calibrated leg. Then, by use of Table 1, ground distance is converted to horizontal distance[1]. Thus, along a given traverse, a number of closely spaced, levelled points is obtained.

The levelling device consists of an A-frame, fixed to a constant angle by means of a bracket (Fig. 1). Its rigidity maintains a constant length at the base. A length of three feet was employed, but the value may be varied to suit the user's requirements. A bar fitted with a levelling bubble is attached to one leg by a pivot which permits the bar to rotate in the vertical plane. The other leg is calibrated (Appendix) so that differences of elevation may be read off directly when the pivoted bar is brought to the horizontal position.

The A-frame permits more detailed measurements than those obtainable with the slope pantometer constructed by Pitty (1968). A prototype of the Frame, constructed from $\frac{3}{4}$-inch dowel, was calibrated to indicate height at intervals of 0.05 ft, and tested against results of dumpy levelling. On sloping ground over horizontal distances of more than one hundred feet, the horizontal equivalents determined with the A-frame nowhere differed by more than two feet from those obtained by use of the level. Total differences in elevation computed from the A-frame readings in the original trials were within 1.0 foot of those given by dumpy levelling, and most were within 0.5 foot.

Subsequent recalibration of the A-frame, to permit readings at intervals of 0.01 foot (corresponding to intervals of 12 minutes of arc) improved accuracy.

For the sake of increased rigidity which survey in such detail demands, the final model for the A-frame was constructed of aluminium tubing.

[1] Reference to the tables can be obviated by the use of a computer.

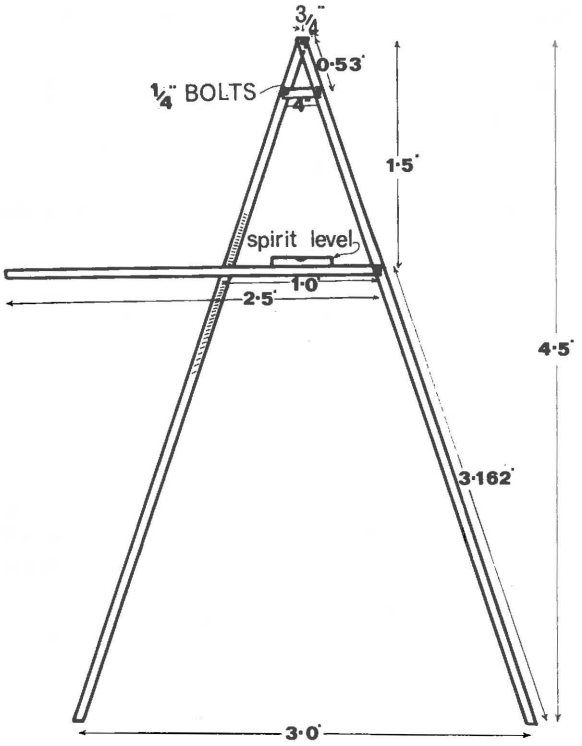

Figure 1. An A-Frame.

Limitations

With a pace of three feet, the A-frame permits observations where the difference of elevation per pace is not greater than 2.3 feet; that is, it can be used on gradients up to about 50 degrees of arc. For steeper gradients, pantometers of the kind constructed by Pitty (1968) or by R. J. Blong (pers. comm.) may be used. When the A-frame is used in water deep enough to obscure the calibrations the tape and rod method is required, the tape measuring horizontal distance and the calibrated rod the depth of water.

It is hoped that the Frame will be of use to researchers who find themselves in the field without an assistant and to those who require detailed, but not highly accurate, levelled traverses.

REFERENCE

Pitty, A. F., 1968: A Simple device for the field measurement of hillslopes. *J. Geology*, v 76, No. 6, p. 717.

APPENDIX: Calibration Equations.

$$y = \frac{4.743}{(3 \times [9/F^2 - 1]^{1/2} + 1) \times 1.5}$$

$$z = \frac{4.743}{(3 \times [9/R^2 - 1]^{1/2} - 1) \times 1.5}$$

where F = fall in feet
R = rise in feet
y = distance above zero point in feet
z = distance below zero point in feet

Table 1. Determination of True Horizontal Distance.

Elevation	Distance	Elevation	Distance
0.00	3.000	1.20	2.750
0.05	3.000	1.25	2.727
0.10	2.998	1.30	2.704
0.15	2.996	1.35	2.677
0.20	2.993	1.40	2.653
0.25	2.990	1.45	2.626
0.30	2.985	1.50	2.598
0.35	2.980	1.55	2.569
0.40	2.973	1.60	2.538
0.45	2.966	1.65	2.505
0.50	2.958	1.70	2.472
0.55	2.949	1.75	2.437
0.60	2.939	1.80	2.400
0.65	2.929	1.85	2.362
0.70	2.917	1.90	2.322
0.75	2.905	1.95	2.280
0.80	2.891	2.00	2.236
0.85	2.877	2.05	2.219
0.90	2.862	2.10	2.142
0.95	2.846	2.15	2.092
1.00	2.828	2.20	2.040
1.05	2.810	2.25	1.984
1.10	2.791	2.30	1.926
1.15	2.771	2.35	1.865