

ELECTROTAPE FOR SURVEYING LAND DEVELOPMENTS (*)

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Introduction and Background

Over the past 5 years, electronic distance-measuring instruments have been perfected to an extent that engineers have been able to obtain accurate and economic measurements of lines varying from 1 to 30 miles. Several articles have appeared in recent literature. Little has been written, however, on short-line applications for line lengths from 600 to 2 600 feet. One such application is the preliminary survey work necessary for land analysis and planning of residential developments.

Ruskin Fisher and Associates have found that the Electrotape, manufactured by Cubic Corporation, San Diego, California, is an instrument well-suited for such short-line applications. The Electrotape is well-designed for the accuracy specifications, with extensive savings over conventional chain traverse methods, both for long-line and short-line applications. The employment by Fisher and Associates of the Electrotape for second-order surveys has saved countless man-hours over the standard methods of surveying and traverse work. It has been used effectively for flood control areas and for the ground control of mapping large areas such as Government and industrial development sites, as well as for small-area survey requirements of private land developers.

Short-Line Applications

This type of survey work is performed to establish coordinated positions on aerially visible ground points over a large or small area. The specific area may be contemplated for future development but accurate locations of ownership lines and ground terrain are required for the study of road patterns, natural surface drainage, and other pertinent features that will effect the final development. This basic information is obtained by

(*) *L.H.B. Note.* — This article may assist hydrographers when choosing a method for the determination of coastal topography in regions where maps are deficient.

field surveying. Use of the Electrotape results in a considerable savings in man-hours and thus on the total cost for the preliminary study.

Current short-line field methods of Fisher and Associates consist of the establishment of ground control survey points for the purpose of aerial mapping, together with a complete section subdivision of the boundaries of land that are to be considered for residential or recreational land development. Equipment consists of two Electrotape units, with self-contained two-way FM radio, internal batteries, two tripods, two psychrometers, and two altimeters, as well as a two-man crew (observer and recorder) assigned to each unit. In order effectively to utilize the capabilities of the crews, one vehicle and a lightweight two-way radio are included because communication by mobile radio has been shown to expedite crew movements. A second-order theodolite is used to observe horizontal angles after distance measurements are recorded by Electrotape units. In remote and sometimes isolated areas, an overnight battery charger is included for recharging the self-contained batteries which provide the power for each Electrotape.

Critical Choice of Control Points

The initial planning in this survey work must be well laid out in advance in order to choose the correct combined horizontal and vertical control points for aerial mapping and section control. Poor choice can result in excessive man-hours and unnecessary complications.

In this initial planning phase, one engineer spends approximately one day in the field doing reconnaissance, such as recovery of section subdivision corners and determination of the most suitable survey route for the Electrotape between the recovered corners. These points and lines are used for the coordinated boundaries of the land area and also for the horizontal control points of the aerial mapping. If this preliminary field investigation does not establish a suitable route between the corners, an alternate route is planned with eccentric points. These eccentric points are placed in such a manner that minimum time is required by the field crew in locating the true subdivision corner from the eccentric positions. The eccentric positions are used, however, for controlling the over-all boundary traverse and mapping of the land area. Duplication of field work is eliminated by these planning steps. For example, if points for mapping a given area are set at random, then re-surveying over the same area a second time for recovery of section subdivision corners would be necessary.

Electrotape Operation

When the initial survey plan is laid out, two Electrotape units are sent to the project. Each unit occupies a predesignated control point and records distances between these points. The shortest distances are 600 feet more or less, with a maximum of 2 600 feet. Each surveyed course takes less than 1 hour including setting up each unit, and taking the

readings to obtain distances in both directions, and dismantling and moving on to another point. In two 8-hour days, this four-man Electrotape crew can cover up to 10 miles of measured courses with an accuracy of over 1 part in 20 000, as compared to 10 days required by typical survey crews.

After completing this operation, one of the crews runs a three-wire level circuit through each of the control points or through supplementary points if required. At the same time, the other crew measures the horizontal angles from one control point to another. The horizontal angles and levels are carried throughout the entire traverse net. At the end of the field work, all information is reduced, calculated, and then adjusted in the office.

Survey Information

This operation results in the horizontal coordinates on each traverse control point together with vertical control over the entire area. This information is then used to control the final maps from aerial photos plotted on a scale from 1 inch = 50 feet to 1 inch = 400 feet. Another result is a contour of 2-foot or 5-foot interval, depending on the basic needs of the preliminary design and study.

At the time the preliminary planning is completed and approved, the final layouts are designed and calculated for establishment of ownership lines and grading plans. This information is calculated into the over-all control network that has been established in the field by the Electrotape units. This survey net (called the primary survey control net) is used for all future survey work such as clearing and grading of road right-of-ways, construction of all utilities and final placement of intermediate property corners in the entire development.

Comparison with Conventional Methods

The use of Electrotape has resulted in savings up to 66 % in man-hours over the conventional survey party using chain and traverse methods. This is a direct saving to the land developer, because of the minimal time required to measure long and short courses over rough terrain, as well as eliminating the need to measure down ravines or up steep inclines to get from one control point to another.

The field procedure described here would take basically 10 days to measure and record 10 miles of control traverse when using a conventional four-man survey party (Party Chief, Instrument Man, Head Chainman, and a Rear Chainman). This does not include the vertical control that is required for such projects.

A comparison of Electrotape with conventional techniques produced the following interesting time-savings data :

<i>Item</i>	<i>Electrotape Traverse</i>	<i>Chain Traverse</i>
Accuracy	1 part in 20 000+	1 part in 8 000+
Time required for horizontal control traverse (10 miles) ..	2 days	10 days
Vertical control	1 day	1 day
Total man-hours for completed survey control	94 man-hours	302 man-hours
Job cost compared to conventional methods	35 to 40 %	100 %

Conclusions

Continuous employment of the Electrotape will allow total amortization of the Electrotape cost within approximately 5 months. This should be of considerable interest to those firms where seasonal considerations control the ability and output of conventional survey techniques. The Electrotape has proven to be effective in all climatic conditions and is less affected by extremes of weather than are conventional traverse methods.

It is the opinion of Fisher and Associates that the Electrotape is an invaluable instrument for the surveyor. It can be employed either on extensive control surveys covering vast areas, or on local control and mapping projects, where it is more efficient than conventional methods.