**SPECIAL ARTICLE**

## GEODIMETER AND SHORT DISTANCE MEASUREMENT

by Walter W. Lorenz

During the past three years we have used the Geodimeter for a great variety of survey projects. We have found the instrument to be completely reliable, standing up to rugged conditions and consistently working to the accuracy claimed by its maker. Some of our earlier experiences were reported by A. Gibson, O. L. S., in an article published in the January 1963 issue of the "Canadian Surveyor".

The measurement of short distances with electronic distance measuring devices has always been a problem when high standards of accuracy were to be met. Traverse legs or other distances to be measured had to be of a minimum length for a certain accuracy, since the inherent error of the instrument is $\pm 2 \times 10^{-6} \times D$ where D is the measured distance. The following list indicates the error ratio for maximum instrumental error in lines of different length:

| | | |
|---|---|---|
| 500 feet | - | 1/14,750 |
| 1000 feet | - | 1/28,750 |
| 1500 feet | - | 1/41,900 |
| 1 mile | - | 1/121,750 |
| 5 miles | - | 1/308,500 |

This means, for example, that distances less than 1500 feet have to be avoided when a 1/40,000 precision is required.

During the past half year we have established a great number of horizontal control points by precise Geodimeter traverses. Even with thorough reconnaissance, terrain difficulties sometimes necessitated the introduction of courses shorter than permissible by set standards and so we decided to find a method for reducing the maximum instrumental error to some appropriate value.

We used a test range the length of which had been found by several series of measurements, using three standardized O. L. S. tapes and observing all the precautions of precise taping. Several sets of ten Geodimeter measurements each, were then taken on different days and under different atmospheric conditions and the results tabulated. The mean distance by chaining was found to be 586.486 feet, by Geodimeter 586.483 feet. The differences between mean and individual Geodimeter distances were tabulated. They indicated that the instrumental error is accidental in nature, changing sign and magnitude at random.

The probable error of any mean of 10 observations was found to range from $\pm$ 0.006 feet to $\pm$ 0.007 feet, the probable error of any single measurement from $\pm$ 0.019 feet to $\pm$ 0.023 feet. From these results we can, for any given distance, calculate the number of observations necessary to obtain a mean result meeting any certain standard of accuracy, allowing for a reasonable safety factor. Putting these results to a practical test we tabulated 142 sets of 4 measurements each. Comparing the mean distance with the mean of each set of 4 measurements, we obtained the following results:

| Deviation | No. of Sets |
|---|---|
| 0.000' to 0.005' | 71 or 50% |
| 0.006' to 0.010' | 40 or 34.5% |
| 0.011' to 0.015' | 22 or 15.5% |

The largest deviation from the mean distance occurred in 2 sets only out of the 142 sets tabulated and was as shown above, 0.015 feet. This maximum deviation was used to compute the error ratio for distances from 500 feet to 1000 feet as shown below. For comparison the third column shows the error ratio for a single measurement with maximum inherent error.

| | Error Ratio | |
|---|---|---|
| Distance | Using Maximum Deviation in Sets of Four Measurements (Practical Test) | Using Maximum Instrment Error in Single Measurement |
| 500 feet | 1/33,000 | 1/14,750 |
| 600 feet | 1/40,000 | 1/17,750 |
| 700 feet | 1/46,000 | 1/20,700 |
| 800 feet | 1/52,000 | 1/23,000 |
| 900 feet | 1/59,000 | 1/25,850 |
| 1000 feet | 1/65,000 | 1/28,750 |

We were very careful to eliminate external sources of error. Optical plummets used on both the instrument and the reflector were checked and adjusted prior to the test measurements, since inaccurate plumbing tends to be the most severe error in short distance measuring. The vertical angle was almost negligible in our case. Atmospheric conditions were observed as usual and proper corrections made. Since these corrections are relatively small and change directly with the distance, slight errors in reading temperature and pressure would be insignificant for short distance work. As another precaution we recalibrated the instrument twice before the test and used mean values for our calibration table. We also checked the instrument constant very closely.

We feel that our test has provided us with another tool for improved Geodimeter measurements and that, done properly, short distances can be measured electronically with much greater accuracy than generally thought possible.

This does not mean, however, that we will advocate the use of Geodimeter for very short distances in general. For distances under 500 feet and where the terrain is suitable, we still suggest precision chaining as the best solution. On more rugged ground we will use the Geodimeter since additional measurements take only a few minutes extra for each set, once the instrument has been set up.

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## Kitchener City Council "Finds" O.L.S. Good Business

- as reported in the Commercial News.

"Kitchener, Ont. - City Council under Mayor Keith R. Hymmen has asked City Engineer W.L. Bradley, P. Eng., to prepare a report on setting up of a surveying section. Council members feel that employing a full-time surveyor, with Ontario Land Surveyor status, would save public finds." - Underlining by the Editor.