

The Canadian Engineer

A weekly paper for engineers and engineering-contractors

HIGHWAYS AND HIGHWAY SURVEYING

FURTHER POINTS ESSENTIAL TO A SCIENTIFIC APPLICATION OF SURVEYING PRACTICE TO HIGHWAY WORK—SUGGESTIONS PERTAINING TO LEVELLING

By DANIEL J. HAUER

Consulting Engineer and Construction Economist

[Note—This article on levelling in connection with highway surveying follows directly the subject matter of another which appeared in February 19th issue under a similar heading. The plotting and some other features of highway surveying will be dealt with in a later article.—Editor.]

The Work of Levelling.—The taking of levels over the surveyed area is of great importance and should be done with care and judgment. If possible, a bench mark established above tide water should be obtained to start the levels. This can frequently be done from some railroad company or government survey. If this is not possible, and the surveys start near tidewater, a gauge should be put on the beach, and mean tide or mean low water obtained. The value of this is evident. On extensive surveys all sections of the work can be checked if the levels are on the same datum line. These levels can also be used for any work, and it is always of value to have them based on tide water. However, if it is not possible to get such an elevation to start the levels, an assumed elevation can be used, taking care that it is large enough to prevent any minus elevations.

With a bench mark to start from, the first work to do is to run a set of benches over a part of the surveyed line. This is one difference between highway surveying and railroad surveys. On highways the line of the survey is known, while on railroads it is not. Thus benches can be run ahead of the transit party. With a set of benches run, they can be checked as the line levels are taken, thus the levels are checked as they are taken. It is customary to run the levels as the benches are established, afterwards checking the benches. By this method, if errors are discovered, either a long line of levels must be run over or else two elevations from a bench mark must be used, one in each direction from the error, which is a great inconvenience and may lead to other mistakes.

If the benches are run first and then checked the levels can be kept right, it seldom being necessary to run over more than 1,000 ft. By all means, no matter how they are run, have the levels and bench marks checked. This is the only proper method and will save much confusion later, as well as time and money.

Levels should check within a few hundredths between benches and within a tenth for a mile. If they do not, they should be re-run until they do. Bench marks should be established about every 500 ft., making about 10 per mile. In very level country they can be farther apart, but even then not more than 1,000 ft. It is very

little trouble to make benches, and to have them close together means the saving of much work on locations and construction. They should always be established near cross roads and bridges. If the bridge is high there should be one at the road level and one near the stream, so that work can be done from one set up on any part of the structure. If the bridge is a long one, a bench should be on each side, and these should be checked within one hundredth of a foot.

Bench marks can be made on the knots of trees. These are most permanent and can be used for some years. Door steps and curb stones in towns and villages can likewise be used. When trees or stones are not convenient, heavy spikes can be driven into telephone or telegraph poles along the road. Any heavy spike will do if it is driven securely, leaving only enough of the head projecting to the bear level rod. A railroad spike gives the best bench mark of this kind.

Many poles have to be removed to allow of road improvements, so it is often necessary to transfer bench marks from one pole to another. Other expeditious ways of making bench marks will suggest themselves. If the work is extensive enough and the cost will warrant it, permanent stone or concrete monuments can be set for some of the bench marks. These should have a copper tack or plate set in them, and if of concrete the elevation should be cast in the concrete.

If possible, all bench marks should have their elevations marked on them. A description of each should be entered in the note book with its location described in reference to the transit line. A list of bench marks, their elevations and description should be entered in the back of each level note book for quick reference.

In taking levels, each station should be taken on the transit line and at each break in the ground. When the transit line is not the same as the centre line of the road the centre must also be taken. These two elevations are most important. In addition to them the elevation on the sides of the roads should be taken. If the ground dips or rises much beyond the sides of the roads, enough elevations should be taken to show the character of the ground to about the limit of the right-of-way of the road. From such notes it is possible to plot cross-sections of the road.

It is evident that with the large number of levels to be taken and with checking the bench marks, the work of levelling on highway surveys goes much slower than the work of running the transit line. Thus every help