THE FIELD PRACTICE OF LAYING OUT CIRCULAR CURVES FOR RAILROADS; PP. 143-214

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JOHN C. TRAUTWINE

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OF

LAYING OUT CIRCULAR CURVES

FOR

RAILROADS.

BY JOHN C. TRAUTWINE, C.E.,
OF THE UNITED STATES.

Extracted, and sold separately, from Simms's work on Levelling, being pp. 139—215.

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PREFACE.

This little volume has been prepared almost entirely with reference to the wants of young men who desire to qualify themselves for field service in an Engineer Corps. On that account the plainest language has been used to render the subject intelligible,—dispensing with mathematical brevity.

The Table of Natural Sines and Tangents to single minutes, in a form sufficiently portable for field use, will supply a want which is frequently experienced, not only in the operation of laying out curves, but on many other occasions.

One object in preparing it, was to furnish the profession with a Table that should be not only portable, but *absolutely reliable.* Those whose occupations compel them to resort to the Tables in common use, must have frequently experienced the embarrassment which attends the inaccuracies to which they are all subject. So long as a Table is known to contain a single error, the position of which is not ascertained, its employment is attended with doubt in every instance in which we are obliged to refer to it.

As Hutton's Tables of Natural Sines and Tangents are those most in use among the profession, it will be desirable to those persons who possess them, to be able to correct the following errors, which I detected in comparing them.

In Hutton's Tables, Fifth Edition, 1811.

Sine of 6° 8′, for ·1063425, read ·1068425.
Page 328, at top, for 25 Deg., read 40 Deg.
Tangent of 44° 60′, for ·1000000, read 1·000000.
Tangent of 41° 60′, for ·8994040, read ·9004040.

PREFACE.

In Dr. Gregory's corrected Edition (the 8th) of Hutton's Tables, 1838.

Sine of 49° 14′, for ·7576751, read ·7573751.

In Hassler's Tables, 1830.

Sine of 78° 24′,	read	·9795752.
Sine of 20° 60′,	,,	·3583679.
Sine of 66° 19′,	,,	·9157795.
Sine of 56° 39′,	,,	·8353279.
Sine of 55° 20′,	,,	·8224751.
Sine of 53° 4′,	,,	·7993352.
Sine of 48° 12′,	,,	·7454760.
Sine of 45° 3′,	,,	·7077236.

The discrepancies of 1 in the 7th decimal, are not considered as errors, as they are occasioned by a neglect of the value of the 8th decimal. For calculating curves, it is not necessary to use more than 4 decimals.

It is scarcely necessary to remark that, beyond 44°, the Sines, Tangents, &c., are read *upwards,* from the bottom of the page, using the corresponding column of minutes. To find the sine of an angle exceeding 90°, subtract the angle from 180°, and take out the sine of the remainder—because the sine of an angle, and that of what it wants of 180°, are the same.

J. C. T.

THE FIELD PRACTICE

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FOR

RAILROADS.

ARTICLE I.

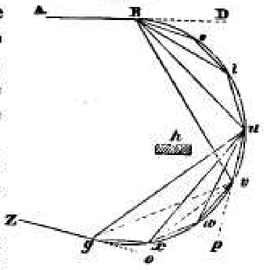
PRINCIPLES OF LAYING OUT CURVES.

METHOD I.

To lay out a Curve by means of Tangential Angles.

IF from any point B, fig. 1, in a straight line A D, we lay off any number of equal angles, as D B *s*, *s* B *t*, *t* B *u*, *u* B *v*, &c., and at the same time make the chords B *s*, *s t*, *t u*, *u v*, &c., equal to each other, then the points B, *s*, *t*, *u*, *v*, &c., will be situated in the circumference of a circle, which is tangential to the line A D at the point B.

Fig. 1.



The first of these angles, D B*s*, is called the *tangential angle*, as being that by which the curve is connected with the tangent A D; but inasmuch as the others are all equal to it, they also are called tangential angles.

If any obstacle, as *h*, should prevent our seeing from B farther than to *v*, the curve may be continued by removing the instrument to *u*, the point preceding *v*: thence sighting first on *v*, continue to lay off additional tangential angles *v u w*, *w u x*, &c., as before. Or else, moving the instrument to *v* itself instead of to *u*, sight back to *u*, and lay off first the exterior angle *p v w*, equal to *double* the tangential angle, and afterward continue the tangential angles *w v x*, *x v g*, &c., as before, to the end of the curve.

Finally, in order to pass from the end of the curve at *g*, on to a tangent *g z*, place the instrument at *g*, and sighting back to *x*, lay off the tangential angle *x g o*; then *o g* continued toward *z* will be the required tangent. (See Art. IV.)

For the tangential angles corresponding to different radii, and chords of 100 feet, see page 160.

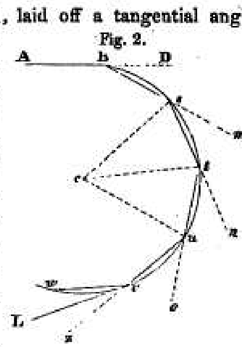
ARTICLE II.

METHOD 2.

To lay out a Curve by means of Deflection Angles.

Fig. 2. First, having, as in method 1, laid off a tangential angle D B *s*, and measured the chord B *s*, remove the instrument to the end *s* of the chord, and make the exterior angle *m s t* equal to *twice* the tangential angle, and measure the chord *s t*; and so on at the other points *t*, *u*, *v*, &c., making each of the exterior angles *n t u*, *o u v*, equal to twice the tangential angle, and all the chords equal; then will the points B, *s*, *t*, *u*, *v*, &c., be in the circumference of a circle which is tangential to the line A D at the point B, as by the first method.

Fig. 2.



But if, at any of these points, as *v*, we wish to pass off to a tangent *v* L, employ at that point the *tangential* angle *z v* L, equal to half the deflection angle *z v w*. (See Art. IV.)

These exterior angles, included between any *chord* and the extension of the preceding *chord*, are called *deflection angles*, or *angles of deflection*, or *angles of curvature*. In any given circle, the angle of deflection is always precisely double the tangential angle, supposing the chords to be equal. At page 160, we give tables of the angles corresponding to circles of different radii, embracing the limits of railroad practice; and calculated for chords 100 feet in length, that being the usual length for a measuring chain on public works.

N. B. The deflection angle of any curve is equal to the angle *t c u*, or *t c s*, &c., at the centre of the circle, subtended by one of the equal chords *t u* or *t s*. This angle at the centre, so subtended, is called the *central* angle. The tangential angle, being always half the deflection angle, is, of course, always half the central angle.

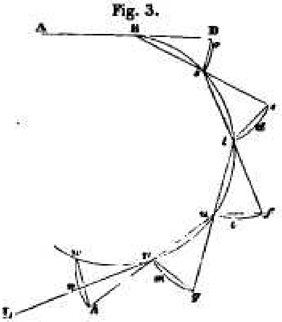
ARTICLE III.

METHOD 3.

To lay out a Curve by Eye.

The *deflection* angles, fig. 3, *e s t*, *f t u*, *g u v*, *h v w*, &c., being double, the *tangential* angle D B *s*, the *arcs e d t*, *f i u*, *g m v*, *h n w*, &c., are double the *arc* D *c s*, since the arcs of circles are proportionate to the angles which they subtend; but the *chords e t*, *f u*, *g v*, *h w*, &c., are *not* double the *chord* D *s*, since the chords of arcs are not proportionate to the arcs, or to the angles which they subtend.

Fig. 3.



The chords *e t*, *f u*, *g v*, *h w*, &c., which subtend the deflection angles, are called *deflection distances;* and the chord D *s*, which subtends the tangential angle, is called the *tangential distance*.

But although, in any given circle, the deflection distance is not *truly* twice the tangential distance, yet the difference is so trifling in large railroad curves, with chords of but 100 feet, that it may generally be neglected in curves of more than 300 feet radius.

In our tables the *precise* length of both will be found for different radii, and for chords of 100 feet.

Having these respective distances, we may frequently trace a curve on the ground by the eye only, with very tolerable accuracy, sufficient for guiding the excavations and embankments, especially on nearly level ground. Suppose, for instance, it be required to lay out in this manner a curve of 5730 feet radius.

First, find by the table, page 160, or by Art. XVI., the deflection distance *e t* or *f u*, &c., corresponding to a radius of 5730 feet for a chord of 100 feet—viz., 1·745 foot; and also the tangential distance *d s*, ·873 of a foot.

Then from the starting point B, and in line with A B, measure B D, equal 100 feet, and put a pin at D. Also from B, measure the chord B *s*, equal 100 feet; at the same time measuring with a graduated rod, from the pin D, the *tangential* distance D *s*, equal to ·873 of a foot; and place a stake at *s*. The pin at D may then be removed.

Next, make *s e* equal to 100 feet, placing a pin at *e*, precisely in line with *s* B; also from *s* measure *s t*, equal 100 feet; at the same time measuring with the rod, from the pin *e*, the *deflection* distance *e t*, equal