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TRANSITION CURVES.

By Henry K. Wicksteed B. A. Sc., M. Can. Soc. C. E., Chief Engineer of Surveys, Mackenzie, Mann and Co. Ltd.

Mr. Wicksteed has recently written an introduction to the transition curve for a new edition of instructions to assistant and resident engineers Canadian Northern Ontario Ry., which is being got out. At our request he has kindly placed the matter at our disposal, and in transmitting it to us has written as follows:—

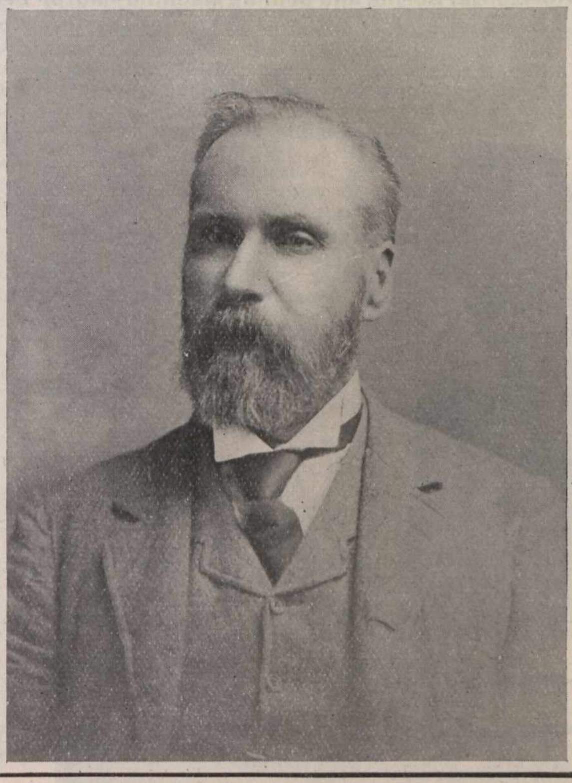
"We have tables and diagrams in our present little volume and most of the men have some idea of how to use and apply them, but in talking to them I find that not one in ten of them understands the underlying principles, the whys and the wherefores of the transition curve, and how he may work out the formulas himself, and on occasion do without the tables altogether. When one of them makes a mistake it is apt to be a very glaring and conspicuous one, and such as he would not have made if he had understood the raison d'etre of the curve, and in any case such an understanding is calculated to broaden his ideas and vastly increase his interest in his work and his efficiency.

"Mr. Howard's article in your February issue will, I think, do much to create an interest in the subject, but, even he assumes a considerable initial knowledge on the part of the reader and does not start from the beginning. I have endeavored to do so, and as we wish to make our little volume as useful as possible, I think we cannot do better than to invite your co-operation and ask through your columns for criticism and suggestions as to how we may best make the subject as clear and as simple as possible.

"It has been a hobby with me for nearly twenty years back, and I laid down then, and have since seen proved, the principle that 'the exact mathematical form of the curve used was of little consequence,' but that 'the form which would come into general use was that which could be most readily run on the ground with the least use of tables and formulæ.' That the curve which is the easiest to manipulate is also the most perfect theoretically, is a fortunate accident, but it is an accident nevertheless, and had it not happened so, we should have probably chosen some less perfect one on account of its greater simplicity.

"Just as the earlier railway engineers used the parabolic curve because the ordinates were easier to calculate than those of the circle, and they had no other method than that of ordinates to work with, when some inventive mind brought in the method of deflections, the circular curve immediately took its place, because easier to manipulate, and the parabola disappeared. Aside from the fact of its being a most useful, in fact, as we have come to believe, essential factor in railway alignment, the cubic parabola or quadratic curve is a very beautiful geometrical study in itself, and well worthy of a mathematician's attention."

In accordance with Mr. Wicksteed's suggestion, we will be pleased to receive criticisms or comments on it for publication in our columns. The paper follows:—



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The object of the transition curve is to accomplish the super-elevation of the outside rail uniformly and gradually so that the elevation shall, at any and every point, be adapted to the curvature at that point. Inasmuch as the centrifugal force which the elevation is intended to offset is inversely proportional to the radius of the curve, it follows that if the rise of the outside rail over the inner is to be uniform throughout the transition, the radius of the curvature must diminish uniformly and regularly. In other words, the curve should be one of "uniform acceleration."

If the final curve into which we transide is a 5°, for example, and we divide the transition into five equal parts, the curvature at the ends of the several divisions should be 1°, 2°, 3°, 4° and 5° respectively. This has always been admitted, but it was not until the late A. M. Wellington investigated the properties of the ideal curve that it was deemed practicable to meet these requirements exactly and a number of more or less cumbersome substitutes were in use, so cumbersome and difficult of practical application that few engineers attempted to use or even understand them, and either nothing was done at all or a mere arbitrary allowance was made by offsetting the curve inwards so as to allow room for the flattening at the ends, the form which the flattening took being dependent altogether upon the artistic sense and eye of the section foreman.

Refer to figure 1.—Let A-B be a circular curve terminating at A in the tangent F-A. C is a parallel tangent, and C-B is the transition curve, and is such that it is bisected in length by the perpendicular A-G, and A-G is in its turn bisected by it. This is somewhat obvious and scarcely needs demonstration.

Another more remarkable property, which is not obvious, but is quite susceptible of demonstration, is that the angle B.D.E., representing the total angle of the transition, is always three times B.C.E., which is the tangential angle corresponding to the point B, at which D.B. is tangential to the curve. It follows that C.B.D.= B.D.E.—B.C.D. = 3 B.C.D.—B.C.D. =2 B.C.D.

Now, assuming as in our first suppositious case, that the constant curve A-B is 5°. By hypothesis our curve is uniformly accelerating from 0° to 5° at B, and the mean curvature must be 2° 30′. If we make C.B. 150 ft., then the total deflection B.D.E. must be 3° 45′, and the tangential angle B.C.E. ⅓ of this, or 1° 15′. Double the final curvature at B. to 10°, and B.C. proportionately to 300 ft., and we get B.D.E.=15° and B.C.E. =5°, or four times what we had in the first instance. In other words, the tangential angle to any point is proportional to the square of the distance of that point from the beginning or origin of the curve.

It will be further seen that as the curve accelerates uniformly the proper transition is got, not by scheming a separate curve for each degree or pitch of central circular curve, but by cutting off a standard transition at the proper point corresponding to the degree of the central curve. If we divide this standard into a number of equal chords, and designate the chord points P, P_1, P_2, P_3, etc., the transition for a 4° curve will be the same as that for a 10°, but we shall stop it in the one case at P_4, and run an ordinary 4° circular curve from