(Paper No. 2958.)

“A Super-Elevation Tape and its Uses.”

By JOSEPH HAYWOOD WATSON BUCK, M. Inst. C.E.

In a Paper by Mr. J. Price, a formula is given for finding the length in feet of a chord, the offset from the centre of which to the rail of a railway curve gives the cant required whatever the radius may be, the length of the chord depending on the speed of the train.¹

This formula is $\frac{V}{2}\sqrt{G}$, V being the velocity in feet per second, and G the gauge. If M is the velocity in miles per hour, the formula becomes $0.73 M \sqrt{G}$. If the ordinary gauge of 4 feet $8\frac{1}{2}$ inches between the rails be considered 5 feet between the centres of the rails of the curve, $\sqrt{G} = 2.236$ and the formula becomes $1.64 M$; and a tape can be made, marked with figures representing the miles per hour alone, the reverse side being marked with similar divisions of one half the length, for convenience in finding the centre of the chord in each case.

It occurred to the Author that such a tape might be utilized, independently of the radius, in setting out a curve of adjustment between a curve and a straight line, so as to cause the super-elevation of the outer rail, by means of a regular gradient, to disappear at the junction of the curve with the straight, as shown in *Fig. 1*, indicating the construction of such a curve by means of offsets with sufficient accuracy for practical purposes. The dimensions are given in terms of the super-elevation tape and the cant, denoted respectively by S and C . Reverse curves which have been set out or laid in, without a “piece of straight” between them, may next be examined, taking first curves of equal radius, namely, which give equal cants upon the application of the super-elevation tape, as shown in *Fig. 2*. The position of a straight line corresponding to that shown in *Fig. 1* is first found by means of two offsets, each equal to four times the cant, at a distance equal to the length of the

¹ Minutes of Proceedings Inst. C.E., vol. xxxii. p. 193.

super-elevation tape from the point of junction of the two curves, giving the first "shift" corresponding to the original curve in

Fig. 1.

Fig. 1. A further "shift" is now required, equal to the cant, as shown in Fig. 1, and the setting out then proceeds as before, Fig. 2.

Next, curves of unequal radii, namely, which give unequal

Fig. 2.

cants upon the application of the super-elevation tape, as shown in Fig. 3, can be solved without reference to the radius of either of the curves. A straight line twice the length of the super-

Fig. 3.

elevation tape is required as before; and the position of this is fixed by the first "shifts," the amounts of which are obtained in the following manner:—The sum of the first "shifts" is equal to

the sum of the two offsets Y and y , the value of each of which must first be ascertained. Let S equal as before the length of the super-elevation tape, and C and c respectively equal the cant of the sharper and flatter curves. By similar triangles, the portions X and x of the total length of $2S$ are respectively proportional to the radii of the flatter and sharper curves; but the cants being inversely in the same proportion, $2S \times \frac{C}{C+c} = X$, and $2S \times \frac{c}{C+c} = x$, either of which being given, the other can be obtained by subtracting it from $2S$.

Fig. 4.

Now in *Fig. 4*, which shows the relation of the three known quantities, c , X , and S , to the unknown quantity Y , $\frac{\frac{1}{4}S^2}{c} = \frac{X^2}{Y}$, whence $Y = 4c \times \frac{X^2}{S^2}$. Similarly, $\frac{\frac{1}{4}S^2}{C} = \frac{x^2}{y}$, and $y = 4C \times \frac{x^2}{S^2}$.

The first "shift" for each curve is then obtained as follows, *Fig. 3*:—Let F be the "shift" for the sharper curve, and f for the flatter. The "shift" in each case being proportional to the cant, and this being also respectively the inverse ratio of the offsets Y and y , each being proportional to the radius of its own curve, $F = Y$, and $f = y$.

The Paper is illustrated by diagrams, from which the *Figs.* in the text have been prepared.