The Canadian Engineer

VOL. V.—No. 4. TORONTO AND MONTREAL, AUGUST, 1897. PRICE, 10 CENTS $1.00 PER YEAR.

The Canadian Engineer.

ISSUED MONTHLY IN THE INTERESTS OF THE

CIVIL, MECHANICAL, ELECTRICAL, LOCOMOTIVE, STATIONARY MARINE AND SANITARY ENGINEER; THE MANUFACTURER, THE CONTRACTOR AND THE MERCHANT IN THE METAL TRADES.

SUBSCRIPTION—Canada and the United States, $1.00 per year; Great Britain and foreign, 6s. Advertising rates on application.

OFFICES—62 Church Street, Toronto; and Fraser Building, Montreal.

BIGGAR, SAMUEL & CO., Publishers,

E. B. BIGGAR Address—Fraser Building,

R. R. SAMUEL MONTREAL, QUE.

Toronto Telephone, 1392. Montreal Telephone, 2589.

All business correspondence should be addressed to our Montreal office. Editorial matter, cuts, electros and drawings should be addressed to the Toronto Office, and should be sent whenever possible, by mail, not by express. The publishers do not undertake to pay duty on cuts from abroad. Changes of advertisements should be in our hands not later than the 1st of each month to ensure insertion.

CONTENTS OF THIS NUMBER:

For THE CANADIAN ENGINEER.

RAILWAY ENGINEERING.*

BY CECIL B. SMITH, MA. E., MEM. CAN. SOC. C. E., ASSISTANT PROF. OF CIVIL ENGINEERING IN M'GILL UNIVERSITY.

CHAPTER II.

TRAIN RESISTANCES AND THEIR COST.

ART. 6.—TRAIN RESISTANCES.—(*Continued*).

(C.) CURVE RESISTANCES.

In America a curve is designated by the number of degrees which a hundred foot chord subtends at the centre of the circle, thus a 1° curve subtends 1°, etc. The radius of a 1° curve=5730 feet, and the radius of a

$D°$ curve is (approx.) $= \frac{5730}{D}$ feet.

The centrifugal force of a train passing around a curve at v feet per second $= C = \frac{Wv^2}{gr}$ .... (6)

If we change v into V (miles per hour) and r into D (degree of curve) we will get $C = \frac{W}{32.2} \times \frac{V^2(1.467)^2}{1} \times \frac{D}{5730} = \frac{WV^2D}{85666}$ .... (7)

Now, in order to counterbalance this force, the outer rails, on curves, are elevated sufficiently above the inner ones (super-elevation) to make the resultant of gravity and centrifugal force to pass midway between the rails and at right angles to the track, and the floor of the car will then be parallel to the track (see Fig. 3). It is evident from the figure that by similar triangles

$$\frac{\text{Super-elevation}}{\text{Gauge}} = \frac{\text{Centrifugal Force}}{\text{Weight}} \text{ or}$$

$$\text{Elevation} = E = G \times \frac{C}{W} = \frac{59V^2D}{85666} \quad \{\text{from (7)}\} \text{ .... (8)}$$

by which it will be seen that the required elevation varies directly with the degree of curve and with the square of the velocity.

For a 1° curve, $E = \frac{59}{85666} V^2 = .00069\ V^2$ .... (9)

TABLE VII.

TABLE OF SUPER-ELEVATION OF OUTER RAIL, PER DEGREE, FOR DIFFERENT VELOCITIES.

V (miles per hour) ...	5	10	15	20	25	30	35	40	45	50	60	70	80	90	100
E (inches) ...	.02	.07	.15	.28	.43	.62	.84	1.10	1.40	1.72	2.48	3.36	4.40	5.60	6.90

It is evident, however, that only at that particular speed for which the outer rail is elevated will the car body be normal to the track. At slower speeds, the inner springs will compress and outer ones extend somewhat, while for higher speeds the reverse will be the case. The custom, on general traffic roads, is to elevate for medium passenger speeds of say 30 miles per hour, which is slightly over one-half inch per degree, while on high speed passenger tracks of roads having only light curves, particularly, elevations of as much as one inch per degree are common.

It may be assumed that a safe maximum riding speed will exist when the car body becomes level. Wellington's assumption is that the weight of a passenger-car will compress its springs six inches, and that the distance of the centre of gravity of the car body above the springs is equal to the distance of the springs apart giving equal turning couples. The total centrifugal force necessary for this action will be approximated.

$$C = \frac{WV_1^2D}{85666} = \left(\frac{E}{6} \times \frac{W}{2}\right) + \left(\frac{WV^2D}{85666}\right) = \frac{59V^2DW}{12 \times 85666} + \frac{WV^2D}{85666}$$

or, eliminating, $V_1^2 = \left(\frac{59}{12} + 1\right) V^2 = \frac{71}{12} V^2$

$\therefore V_1 = 2.43 V$ .... (10).

(where V_1 = speed to bring car body level.)

(V = speed for which track is elevated.)

This speed is, evidently, independent of the curvature.

The speed at which trains, running on tracks properly elevated, will overturn, is very high, and not of sufficient interest to calculate, and will depend on the amount of compression possible in the springs before the car body comes down on the buffers, and upon the amount of elevation per degree of curve given to the track.

Those roads which have sharp curves will always run at moderate speeds around them; the sharper the curve the less the speed. This fact and practical ballasting difficulties have limited the total super-elevation to about six or eight inches, which corresponds to a curve of 8° to 12°, depending on the speeds expected, on curves of greater sharpness the lessened speeds will require less elevation per degree.

The position which a short rigid truck assumes in passing around a curve is as in Fig. 4; the front outer wheel flange against the rail head, and the rear wheels radial to the curve and midway between the rails, unless

*This series of papers will be issued in book form as soon as they have appeared in THE CANADIAN ENGINEER.