To formulate the foregoing discussion, let

e = the superelevation in feet,
g = distance in feet between centers of rail heads,
V = speed of trains in mile per hour,
v = speed of train in feet per second,
R = radius of central curve in feet,
D = degree of curve,
L = length of transition curve in feet,
l = distance in feet transition curve superelevation 1 ins., and a = inches per second a train is assumed to rise vertically on transition

$e = .06688\ g \frac{V^2}{R}$ — from the well-known formula for superelevation of the outer rail on curves.

But $\frac{L}{l} = 12e$; $\frac{1}{l} = \frac{12e}{L} = .06688 \frac{gV^2}{LR} 12$.

Assuming $g = 4.92$.

$$\frac{1}{l} = 3.94 \frac{V^2}{LR} (2) \text{ or } l = \frac{LR}{V^2} 0.254.$$

Whence, $L = 3.94 \frac{V^2}{R} - l.(3)$.

By definition, $a = \frac{v}{l}$: simplifying, $a = \frac{v}{l} = \frac{V\left(\frac{5280}{3600}\right)}{l}$; $l = 1.468 \frac{V}{a}$—(4) by (2),

$l = 0.254 \frac{LR}{V^2}$ and by (4) $l = 1.468 \frac{V}{a}$,

equating equals $0.254 \frac{LR}{V^2} = 1.468 \frac{V}{a}$.

$$L = 5.78 \left(\frac{V^3}{aR}\right) (5) \quad L = 0.00101 \left(\frac{V^3 D}{a}\right) (6).$$

Diagrams have been made showing graphically the relations of the various functions to each other. With these diagrams a comparative study may be made of the practice of some of the companies given in Bulletin 108, previously referred to, and other information gathered elsewhere, by assembling the data on a common basis.

PRODUCTION OF SPELTER.

Statistics compiled by the United States Geological Survey show that the production of spelter or metallic zinc from ore for the first six months of 1911 was 140,196 short tons, a gain of more than 5,000 tons over half the record output of 1910. Of this production, 5,135 tons was made from foreign ore. Spelter stocks were reduced from 23,232 tons to 17,788 tons. Imports remained about the same but exports were nearly double those of half the preceding year. The apparent consumption of spelter was 135,497 tons, an increase of more than 12,000 tons over the half of 1910 but about the same as in half of 1909.

TESTS OF OIL-CEMENT CONCRETE IN ROADS.

The U.S. Office of Public Roads has recently published a bulletin on Experiments in Dust Preventions and Road Preservation, which contains some figures on the subject of oil-cement concrete. The following is one of a series of tests carried on in various cities:—

The part of the street selected for this work runs from Center Street east towards Fourteenth Street, a distance of 356.1 ft. It is 19.5 ft. between gutters. The soil forming the subgrade is a coarse gravelly red clay, which after a rain becomes sticky on the surface, but remains firm below. The grade here is light and slopes toward the west. Meridian Place is subjected to light traffic consisting of delivery wagons and pleasure vehicles.

The foundation of the road was constructed in two courses, the first of which consisted of from ½-in. to 1½-in. broken stone placed to a depth of 5 ins. loose upon the prepared subgrade. After this course had been rolled until firm with a 12-ton 3-wheel roller, screenings ranging from ½-in. to dust were applied, and the surface finished as in ordinary macadam road work. This method of construction was followed by the preparation of the foundations for all of the experiments.

Common labor for this work cost $1.50 per 8-hr. day; foreman, $4; double team, $4; a 5-ton tandem roller, $8; the 3-wheel roller, $12; and a "bug" concrete mixer, $4 per day. Stone and sand cost $2.50 per cu. yd., delivered on the work. The oils and cement were donated, but their cost, including freight, is given in the cost data. The following experiments are given in the order in which they were conducted.

Experiment No. 1, Section No. 7—Fluid Residual Petroleum.

Section No. 7 is 65.8 ft. in length. A stiff mortar of 1 part cement to 2 parts sand was first prepared by hand on a mixing board, and oil to the amount of 10 per cent. by weight of the cement was then mixed with the mortar. The resulting mixture was laid over the prepared foundation to a depth of 1¼ ins. and immediately covered with broken stone similar to that used in the foundation, to a depth of 2½ ins. One side of the street was thus laid at a time and, when about 20 lin. ft. had been covered, an attempt was made to force the stone down into the mortar by rolling it with the 5-ton tandem roller. After the entire section had been rolled, it was found that the mortar had not been worked up into the voids of the stone course sufficiently. The road was, therefore, sprinkled and again rolled in the hope that a homogeneous mixture might thus be made. As this did not give the desired results, it was decided to grout the surface. A thin mortar of the same composition as that previously described was therefore prepared, poured over the surface, and "broomed" in. This last process roughened up the surface somewhat, but otherwise the section was finished off in good condition by the application of a light coat of stone screenings running from ½-in. to dust. The characteristics of the oil used in this experiment are shown in Table I.

TABLE I.—ANALYSIS OF PETROLEUM RESIDUAL OIL USED IN EXPERIMENT NO. 1—OIL-CEMENT CONCRETE.

Specific gravity 25°/25° C.	0.936
Viscosity at 50° C., Engler, 100 c. c., specific	44.1
Per cent. of loss at 163° C., 5 hrs.* (20 grams)	1.26
Per cent. of bitumen insoluble in 86° B. paraffin naphtha	1.99
Per cent. of fixed carbon	3.40

* Fluid very slightly sticky; too soft for consistency test.