A MAINTENANCE-OF-WAY DEPARTMENT RAILROAD TESTING PLANT.*

By B. B. Milner.

SOME time ago the writer was asked to assist a maintenance-of-way engineer in the investigation of a problem which involved a study of track design and the stresses imposed upon its various members. Consultation with several men of recognized experience and authority, as well as an investigation of all experimental work performed in this connection, and a search through the literature of the subject, revealed the fact that dependable data upon which to base definite conclusions upon various points raised were lacking.

The same revelation was made by Mr. O. E. Selby, bridge engineer of the Cleveland, Cincinnati, Chicago & St. Louis Railway, in a paper, entitled "A Study of the Stresses Existing in Track Superstructure and Rational Design Based Thereon," which was published in Bulletin No. 80, American Railway Engineering and Maintenance-of-Way Association, October, 1906. This paper elaborated upon the statement that "railroad track has grown in strength as heavier loads have made increased strength necessary, but such growth has been entirely along empirical lines, and not one single detail of track superstructure bears marks of engineering design."

Mr. Selby, after careful consideration of such factors as rail loading and stress therein, tie bending, bearing of tie upon the ballast, depth of ballast and its bearing upon the subgrade, developed the track design shown in Fig. 1. The sizes on the drawing are for 60,000-pound axle loads. The principal sizes for 50,000-pound loads, using various weights of rail, are given in Table I.

Table I.

Rail	80 pounds	90 pounds	100 pounds	Rail with Sec. Mod. 20
Axle load	50,000	50,000	50,000	60,000
Size of ties	7"x 8"x 8½'	7"x 8"x 8½'	7"x 8"x 8½'	7"x 9"x 8½'
Spacing of ties	16½"	18"	20"	20"
No. of ties 33-foot rail	24	22	20	20
Depth of ballast	14" stone	16" stone	18" stone	12" stone, 12" gravel
Width of roadbed	21'	21'	22'	24'

From this table it is at once seen that the number of ties per 33-foot rail, as well as the depth of ballast, is much greater than that found in standard track to-day, and, since the figures in the table are the result of a careful consideration of the strength of the materials involved,

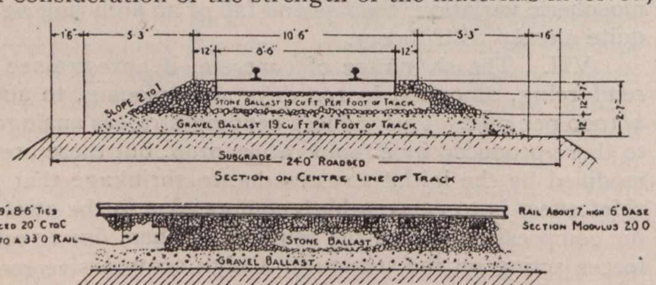

Fig. 1.—Track Superstructure for 60,000 lb. Axle Loads.

it is not surprising that the question of strengthening our present standard tracks is becoming such a live one, especially with our heavier trunk lines.

*Abstract from paper as presented to the Franklin Institute and published in the Journal of the Institute for August, 1913.

The depth of ballast, computed by Mr. Selby, was obtained from formulæ for the thickness of ballast necessary to produce equal distribution of axle loads on the surface of subgrade beneath the ballast, for which Mr. Thomas H. Johnson, consulting engineer of the Pennsylvania Lines West of Pittsburgh, was responsible. Mr. Johnson deduced these formulæ after studying a report, made by Railroad Director Schubert, of Berlin, in 1899, of observations extending over a period of over three years, on the action of ties actually in track. This report was translated and published by Mr. W. C. Cushing, chief engineer, maintenance-of-way, Pennsylvania Lines, and appeared in Bulletin No. 76 of the American Engineering and Maintenance-of-way Association, June, 1906.

In Mr. Johnson's formulæ the two following premises are made:—

1. "That the width of distribution of the load is equal, for stone ballast, to the width of the tie plus the depth of the ballast, and, for gravel ballast, to the width of the tie plus half the depth of the ballast."

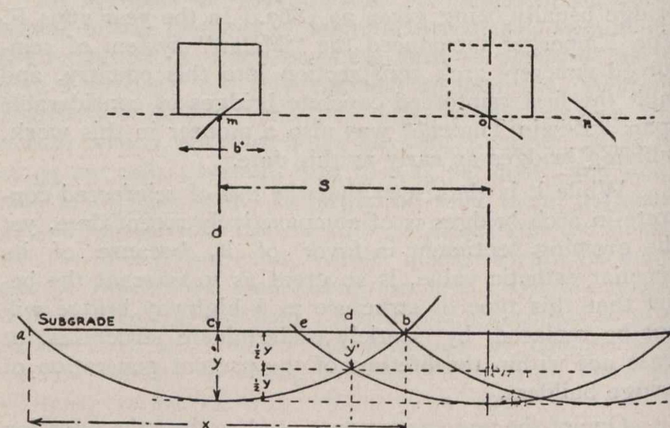

Fig. 2.—Width of Load Distribution Graphically Expressed.

From Fig. 2 this premise may algebraically be expressed thus:—

For gravel, $x = b' + \frac{1}{2} d'$ ....(1)

For stone, $x = b' + d'$ ....(2)

where x is the width of ballast pyramid carrying the load.

2. "That the intensities of pressure within that width are proportional to ordinates to an arc of a circle whose radius and chord are equal to the width of distribution of the load."

The deduction of the formulæ is as follows:—

If the circular arcs be considered as approximate parabolas, the intensities of pressure may be assumed to be proportional to the ordinates of the curves. The area of the parabolic segment $= \frac{2}{3}xy$, hence the mean ordinate $= \frac{2}{3}y$, or the mean pressure $= \frac{2}{3}$ the maximum.

The pressure at b is o, hence, to obtain an approximately uniform distribution of pressure over the surface of the subgrade, the tie-spacing S must be such that the curves overlap and have a common ordinate y' equal to $\frac{1}{2}y$. This will obtain when $db = \frac{1}{4}$ cb; $eb = \frac{1}{4}$ ab or $mo = \frac{3}{4}$ mn.

Hence, the tie-spacing $S = \frac{3}{4}x$.

Therefore, from (1), for gravel, $S = \frac{3}{4} (b' + \frac{1}{2} d')$ and from (2), for stone $S = \frac{3}{4} (b' + d')$ from which the required ballast depths d' are obtained by transposition:

For gravel, $d' = 8/3 (S - \frac{3}{4} b')$

For stone, $d' = 4/3 (S - \frac{3}{4} b')$

both of which give values of d' much greater than exist in practice.