

Credit account ballast displaced	\$0.14
Net cost per tie	\$1.15
Labor placing tie in track	.30
Cost per tie in track	\$1.45
Cost of additional ties in track.	\$464* \$928* \$1,856*
Full width of ballast base.....	164½" 324½" 644½"
Cubic yards per square inch section per mile equals 1.35	
Cubic yards ballast required...	223.39 441.07 875.23
Cost of required ballast in track, at \$1.15	\$256.90 \$507.23 \$1,006.51

To the writer it appears that the design of railroad track must be approached in the same way as the design of any mechanical parts. As a foundation it should be treated like any other foundation, and a study of its requirements, purposes, construction, and maintenance should be made. It must be designed to carry loads of certain individual magnitude, density and speed, etc., and must do this upon subgrade of given conditions. With a sufficient amount of the right kind of data, it should be possible to combine the knowledge of the loads to be imposed with that of the subgrade conditions, and prescribe the most efficient and economical track construction, which, if it cannot be immediately provided, can be approached from year to year in connection with regular track maintenance work. Subgrade conditions vary materially within short distances, but with these conditions properly charted it should be a very easy matter, in bringing the condition of the track up to a desired standard, to concentrate effort upon those sections which are farthest from that standard and which will be located from tabulated or charted data or from the frequency of service failure.

Opinions of maintenance men vary greatly upon a majority of questions relating to track and track superstructure design, and practically none of these opinions is supported by such conclusive test or experience as will make early agreement or reconciliation possible. In the maintenance-of-way department dependable data are not being collected as in the motive power department, in which department much money has been, and is continually being, profitably spent to settle questions pertaining to the design and operation of both locomotives and cars, many of which questions are of less importance than some of those relating to track construction.

The writers upon maintenance-of-way subjects will have served a useful purpose if they succeed in focusing attention upon the comparative deficiency of experimental work in this field, for as soon as this deficiency is realized then work will be inaugurated which will, in a few years, elevate the science of track construction to its proper level. The condition of our tracks is now lagging behind requirements, and we cannot consistently hope for a better state of affairs unless some move along scientific lines is soon inaugurated. In the meantime, locomotive and car designers must "mark time," so far as increased loads and speeds are concerned.

*Does not include labor cost of respacing present ties to make the insertion of additional ties possible, nor the cost of distributing the ties and ballast to point where placed in track.

While some investigations should necessarily be made under regular service, many can, nevertheless, be (and a few have been) carried out upon an experimental track of significant proportions. An experimental track was constructed a comparatively short time ago by the Prussian State Railroads at Oranienburg, Germany, and is being used to determine experimentally the best construction. Dr. H. K. Hatt, of Purdue University, who visited this installation a few years ago, reported:

"It consists of an oval track two miles in circumference over which runs a train consisting of electric locomotive and cars. At about every fifty feet two vertical rail ends were sunk in the ground on each side of the track and clips riveted onto them to serve as a reference

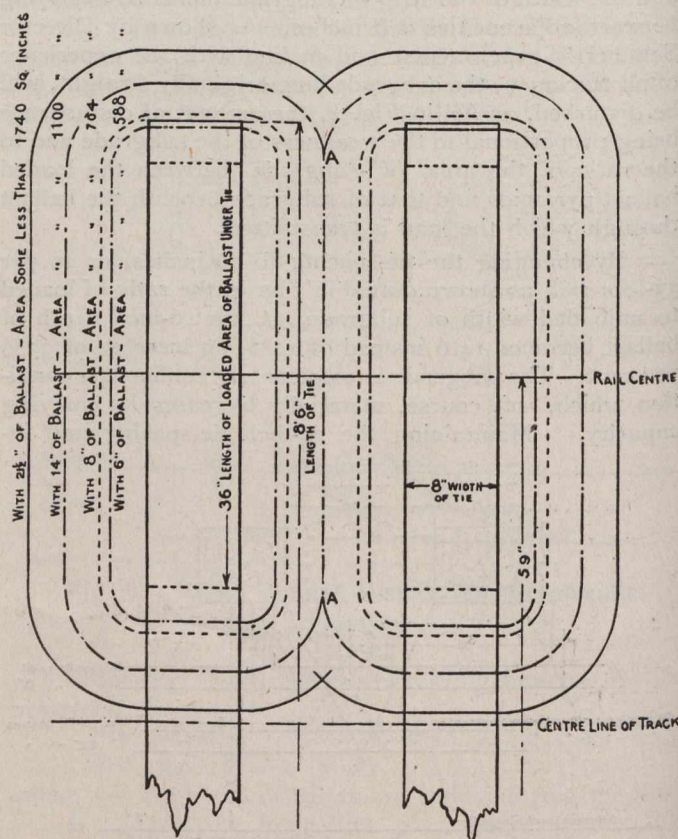


Fig. 5.—Sketch of Track Plan.

7" x 8" x 8' 6" ties spaced; 22" or 18" per 33' rail. Showing outlines and areas of loaded sections of subgrade with 6", 8", 14" and 21½" of ballast under the ties.

line, for measurement of track deformation. The service is considered as severe in one year as eight years on the main line. The cost of the roadbed and equipment is stated to have been \$40,000.

"About a year before my visit the first track had become worn out and a new track consisting mainly of steel and beech ties had been set under service.

"Some of the elements which were being experimented with at Oranienburg may be listed as follows: Prussian standard steel ties with side ribs have been down one year in different forms of ballast. The evidences of derailment of cars were visible, but the steel ties were not sprung. The modern double steel tie was used at the joints. Various forms of anchorage of rails to ties were under experimentation. These anchors are found more necessary in steel ties than in the case of wood. The