Hiram, Ohio. The wet cut is 2,000 feet long and contains numerous soft spots which required surfacing from two to three times a week. During the winter, when the roadbed was frozen, it was necessary to restrict the speed of trains on this curve. This point is at the extreme outlying end of a five-mile section, and was expensive to keep up, and there was the constant fear that the section foreman might neglect to keep the track in good surface, or that some engineer

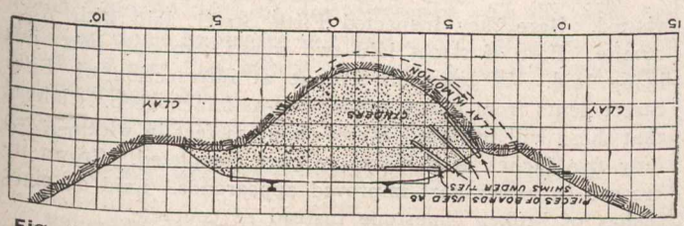

Fig. 3—Section of Track at East End of Summit Hill Cut, Norwich, O.

might disregard a slow order and cause an accident. A heavy increase in traffic also increased the difficulty of keeping a safe track, and it was decided to make a third attempt at tile drainage. Cross-section trenches were cut at the softest spots, which revealed the fact that the ballast under the original main tracks, built in 1853 (now westbound) had been depressed until there was from 44 to 48 inches under the base of rail, and that under the eastbound main built in 1887, had been depressed to a depth of from 48 to 52 inches below the base of rail. The plastic or fluid clay underlying the ballast varied in depth from 10 to 12 inches, below which it was apparently firm enough to resist lateral movement.

The track being on a 4 per cent. grade, the main tile, 8 inches in diameter, was laid at a uniform depth of 74 inches below base of rail. The cross trenches were dug every fifty feet, as narrow as possible, extreme care being taken to have the bottom of the trenches on a uniform grade line. A layer of locomotive cinders about four inches thick was carefully placed in the bottom of the trench and the drain tile laid on this, care being taken to see that the tile was at no point less than four inches from the clay sides of the trench; the entire trench on both main tile and cross drains were then filled with locomotive cinders and the ballast restored over the cross trenches. The main tile was laid from the outlet, up to the point of the first cross trench, then the cross drain was put in. When the excavation for the cross drain reached the pocket or trough under the track, it tapped a body of water, which filled the eight-inch tile two-thirds full, and required half an hour or more to drain it. This was repeated at each cross drain, the quantity of water being almost the same in every case.

After surfacing the track several times over the cross trenches, no further attention was required for thirty days, when two soft spots developed, one at a point where a cross

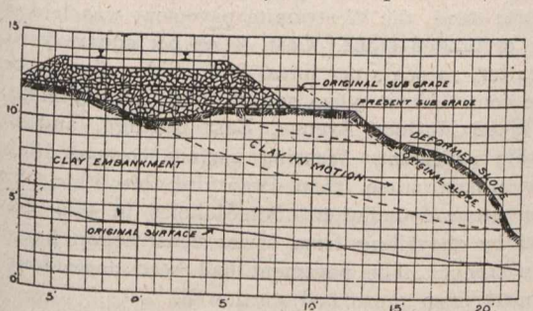

Fig. 3A—Soft Spot in Clay Embankment.

drain had been put in and another between two cross drains. The first was dug up, and it was found that the layer of cinders under the tile had been omitted, and that the tile had been laid on top of the plastic clay. This clay had been forced into the tile and completely filled it for a length of five feet, there also being sufficient horizontal movement to separate the tile 12 inches at a point under the low rail. The cross trench was deepened by removing the layer of plastic clay, the four-inch bed of cinders put in and the trench refilled. In the other case an intermediate cross trench was dug, tapping a pocket of water, which the first cross section had failed to drain; a cross drain was laid, and for the past two years no further trouble has been experienced with this cut. Since the drain tile is laid below the clay, which is saturated with water and in constant motion, and the trench of cinders intercepts all seepage water from the

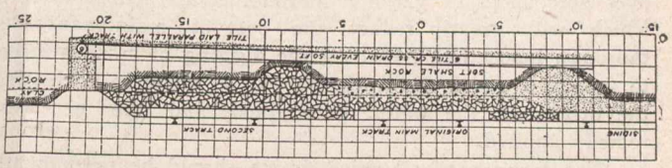

Fig. 4—Section of Tracks at Phalanx, O., Showing Original Ditches Filled and Method of Draining.

adjoining hillside, the cross drains rapidly removing all rainfall, the roadbed will soon be dried out so as to avoid all lateral movement and consequent settlement of track.

Soft spots in either Class 2, 3 or 4 can be cured by the construction of cross drains as outlined above at intervals of from 30 to 250 feet up the grade from the soft spot, constructing a drain parallel with the track where necessary to secure an outlet from the cross drains.

The maintenance of stable track over sink holes is one of the most difficult problems we have to contend with. If the ground water level can be lowered the dried-out surface of the swamp will offer a much greater resistance to the upward movement of the underlying fluid mass, and this will in turn resist the horizontal movement from under the embankment. This will reduce the penetration necessary to secure equilibrium. The saving in cost of filling will often justify the laying of a line of large drain tile miles in length, if necessary, to secure an outlet.

The elimination of soft spots is of prime importance in securing that degree of perfection in surface and line of track necessary for safety under present high speeds and heavy wheel loads. The daily amount of settlement of track at any soft spot depends on the character and degree of saturation of the material supporting the track and the intensity and frequency of the wheel load.

The character of the material being constant and the degree of saturation approximately so for days or weeks, a doubling of the traffic will about double the amount of settlement in a given time, and an abnormal increase, such as the handling of a cargo of iron ore over a branch line in twelve hours, being the equivalent of four or five days ordinary traffic, will cause four or five times the daily settlement, which might be sufficient to cause the derailment of a fast train. At one very bad soft spot careful measurements have shown a depression of one-half inch per day and corresponding movement out of line.

The large increase in modern wheel loads and traffic will develop soft spots at points which have heretofore sup-

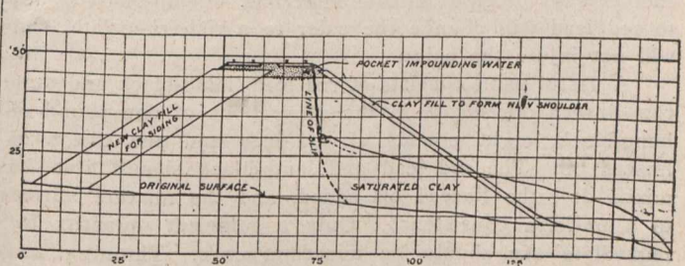

Fig. 4A—Section of Track near Bethesda, O., Showing Slip Occurring at Bottom of Sag.

ported the lighter wheel-loads and traffic. These new spots, as well as the old ones, should be thoroughly drained as promptly as possible, since each inch of settlement adds to the depth of the trench necessary to secure permanent drainage and materially increases the cost of the work. In cuts where there is seepage water on both sides, tile should be laid on both sides of the track with the necessary cross drains.