DRAINAGE OF SOFT SPOTS IN OLD ROADBED.*

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Soft spots may be divided into five classes, according to their origin, as enumerated below:—

(1) Small irregularities of surface of subgrade, where character of soil is such that it will hold water.

(2) Building new shoulder of clay, cementing furnace slag or other impervious material, impounding surface water, which will follow the grade until it meets some obstruction, as a bridge abutment or culvert arch or a low point in sag of grade line.

(3) The settlement of new track in wet cuts or on new clay fills during the soft thawing weather following the first winter's use, forming a trough in the subgrade, along which the seepage water from wet cuts and the rainfall which penetrates the ballast will run until meeting an obstruction.

(4) The construction of new second track or siding by filling the old ditch with porous material, leaving a pocket to collect and retain surface water, which will soften up the roadbed on both sides.

(5) "Sink holes" occurring where an embankment has been built across a swamp and settlement occurs without lateral deformation of the embankment.

Class (1)—A small irregularity of surface of subgrade will permit the formation of a pool of water a few feet in diameter and an inch or two in depth during a rain shower, visible in the subgrade before ballast is applied, but lost to sight and memory when track is laid and ballasted. If the soil is of such consistency that it will not readily absorb this water and the ballast protecting it from the direct rays of the sun and preventing evaporation, it will lie in the pool a long time, softening up a few inches of the subgrade, which, under the pressure of traffic will move laterally, causing a settlement of the ballast and track and increasing the depth and capacity of the pool.

The section foreman surfaces the track, and a few days or weeks, depending on the amount of water available and time required to soften up enough of the subgrade to permit lateral movement, the process is repeated. When the ballast between the ties has been used up the supervisor is appealed to, and, locomotive ashes being the most highly recommended material for use in soft spots, he orders a liberal supply, and these are used in future to surface the track.

The plastic clay forced from under the track by the pressure of traffic has by this time begun to heave up the bottom of the ditch and obstruct the surface drainage. This is dug up and trucked out or thrown up on the bank and the bottom of the ditch reduced to its original grade line. Should this soft spot or several similar ones occur in a cut and the maintenance of line and surface become burdensome, relief will be sought in drain tile. The size of tile is often determined by the number of failures of small tile with which the division engineer is acquainted, and is usually made 6 or 8 inches; the depth, after consulting various authorities, is fixed at 2½ feet below the bottom of the tie, and, if possible, the service of a farmer, skilled in the art, is secured to lay the tile. No effort is made to connect the pool of water under the track with the drain tile, it being assumed that the water will penetrate the intervening clay. If the spot is of long standing under heavy traffic the bottom of the pool has been forced down to a greater depth than the tile and the clay in which the tile is laid is soft enough to move horizontally and vertically under the pressure of the clay forced from under the track. In the course of a few weeks or months, according to season and traffic, there has been sufficient movement at the softest points to separate the joints of the tile and allow the plastic clay to be forced into the tile, completely closing it. The vertical movement of the clay will eventually raise the tile until it is brought to the level of the bottom of the surface ditch, and another failure of tile drainage will be recorded and the tile will be relaid, covering it with cinder, stone or straw to prevent the clay entering the pipe. This tile will remain open longer than its predecessor, but the movement of the clay will, in time, destroy the line and grade and render it useless also.

Class (2)—The building of a new shoulder on a fill almost invariably produces a soft spot at the lowest point of the sag in grade line of the original subgrade, causing a large wart or protuberance to form on the side of the embankment. The low point, or sag, in grade line usually occurs near the lowest point of the original surface where the ground is possibly swampy, the soft spot is attributed to the failure of the original surface to support the roadbed, although it may have performed this function without failure for years.

To improve the grade and remove part of the sag, ballast is laid on deeper in the sag, and after several reballastings the slope of ballast has reached the top edge of the original embankment, and the top of ballast slope begins at the end of the tie, and it is impossible to apply more ballast; hence the necessity for building a new shoulder. This is done by throwing up the soil from borrow pits along the embankment if this is not too high, or by cleaning out or deepening the cut, depositing the clay on the side of the embankment and ballast and forming the new shoulder a few inches below the bottom of the tie. Rainfall and seepage water from wet cuts will penetrate the ballast to the original subgrade, and, finding no lateral outlet, will follow the subgrade to the lowest point and there stand until it softens up the embankment sufficiently ot cause a lateral movement under traffic, or possibly to cause a part or even the whole embankment to be reduced to the consistency of mush, when it will slough out, dropping vertically from the ends of the ties and spreading out over the adjoining surface. If the quantity of water is small and the material of the embankment tenacious the settlement and lateral movement will be slower and the result will be a bulge or protuberance on the side of the embankment. Should there be a bridge or open culvert to obstruct the flow of water on the subgrade, the masonry will be constantly saturated and the disintegrating action of frost will be greatly augmented. If the fill behind the abutment is of clay, the hydrostatic pressure under traffic will cause the abutment to bulge out, requiring the rebuilding of the masonry, the cause being usually attributed to poor foundation.

If the opening is covered by an arch the masonry will be subject to disintegration due to the action of the frost

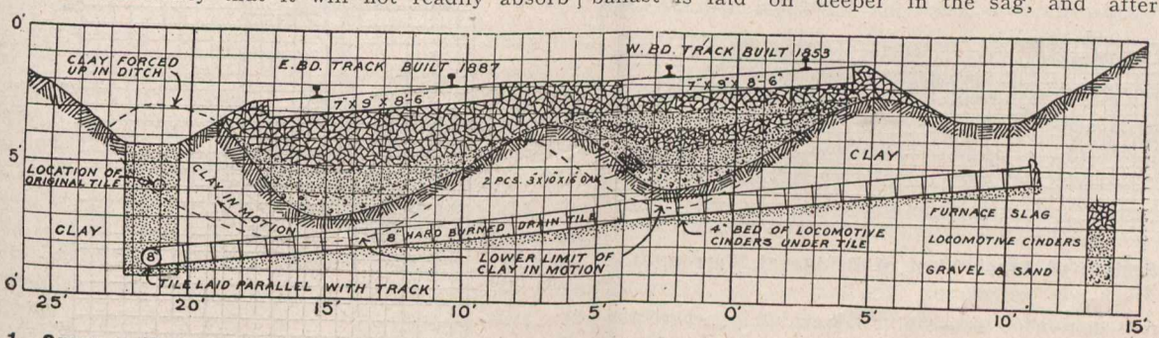

Fig. 1—Cross-section of Tracks at Hiram, O., Showing Distortion of Sub-Grade and Method of Drainage.

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