

tween flush stone curbs on a six-inch broken stone base. We had learned, in a small way, from our first mistakes and placed a six-inch drainage tile beneath the centre of the roadway. But on account of the soft filler and imperfect preparation for carrying off the water, but little improvement in the result was realized. An uneven settlement of the base soon resulted in roughness.

Lorain Road, our next installation, was built sixteen feet wide, tar filled, and resting upon a crushed stone and slag base between flush curbs, with drain tile beneath each curb. Subjected to an unusually heavy traffic, the almost inevitable result of such construction must be extensive repairs, amounting almost to reconstruction.

Our next great forward step occurred when the tar filler gave way to a grout filler composed of one part sand and one part cement. This plan was followed until 1905 with success, at least in comparison with previous experiences. The cement filler alone could not cure all of the defects due to inferior drainage and frost action. Another step was therefore decided upon—the inclusion in the specifications of a requirement for a 4-inch concrete foundation which, of course, increased the price. The increased cost brought immediate opposition, resulting in a temporary return to broken stone or slag base until 1908, when concrete was again adopted as a foundation and continued up to the present time.

Since 1908 it has been the policy not merely to conform to the chief essentials of brick paving, which are: (1) properly prepared subfoundation, (2) smoothly finished concrete base, (3) compressed sand cushion, (4) laying of good brick, (5) application of the cement filler to the joints; but to attach importance to minor details of approved manner and method of construction. Doubtless we have not even yet given weight to certain details advocated by some of the more painstaking students of brick road construction in the country.

A satisfactory plan for an average rural pavement may include a paved portion anywhere from 9 to 16 feet in width, the width being controlled by the amount of traffic to which the road is subjected. A dirt or gravel macadam should occupy the balance or unpaved portion of width. Whatever dimensions are adopted, the surface drainage should be over the pavement toward a ditch on the side of the road closest to the pavement, eliminating a crown from the paved portion. The unpaved portion should be drained in the opposite direction.

Immediately you ask: "Why a dirt road?" The best answer is, "Ask the farmer," and he will tell you to ask the horse.

The engineer will save himself much trouble if he holds to such a grade line as will entail minimum depths of fill. This is not always possible and it is the larger fills that call for the most extreme care. It behooves the engineer to see that his specifications contain a clause calling for the fill to be put in layers of not more than 6-inch thickness and each layer compacted with a roller not exceeding 10 tons in weight. This clause must be enforced with rigidity.

Puddling is the one method that can be followed successfully in the treatment of old fills. The surface of the road should be broken and dirt removed from the centre to the sides. At right angles to this trench, shorter trenches should be dug at intervals of 25 feet, forming a rectangular vat. Pump water into these compartments and allow it to stand until it has leaked its way into the fill. This will disclose the weak spots and the engineer can take care of them as he thinks best.

The drainage of the graded portion of the road is of first necessity. Whatever plan is adopted, the one that will most nearly maintain the sub-structure free from moisture below the frost line is the ideal condition to be sought. This means that you must not merely drain the road bed, but adequate side ditches must be provided to carry off promptly the accumulated water. In the preparation of a sub-base the only debatable proposition is the purpose of rolling. Common practice, including the use of a very heavy roller, has been founded upon the theory of compacting the soil to as great a depth as possible. This can do no harm, but the writer believes that the chief purpose of rolling is accomplished when the weak or spouty places in the soil are revealed so that the engineer can treat them as he sees fit. For this purpose, a roller weighing from 8 to 10 tons answers every requirement.

Preceding the final preparation of the sub-base the curbs must be placed. In case of most of our rural work, curbs are placed flush with the surface of the completed pavement.

With curb set and base prepared, the next step is the placement of the concrete base, which with our roads has been 4 inches in depth. In specifying the proportions, a mixture of 1:3:5 with a permissible variation according to the size of the aggregates which will most nearly fill the voids, meets every necessity. To meet this variability, which obtains with almost every job, it is necessary to specify the size of the coarse aggregate, but not the amount, requiring only so much of the coarse aggregate to be used as shall leave the concrete most nearly free from voids. This, instead of an inflexible rule of proportions, will assure a condition of concrete whereby a smooth surface is easily attained. A smooth surface must be had, for upon that much of efficiency and durability of the wearing surface depends. It assures in the next step a requirement of equal importance, that of placing the sand cushion of uniform fill and of uniform density.

While it is possible that often too much importance is placed upon the ability of the sand cushion to afford a resiliency or absorb shock, it is unquestionably a necessity for the purpose of bringing the wearing surface of the brick to a perfect plane, by neutralizing the unevenness and lack of uniformity of the brick. No one will question but that the support of the wearing surface provided for by this sand cushion must be uniform. It is therefore necessary to compress and bring to a like density every part of this cushion. Dropping the sand cushion on to the base from dump wagons and leaving the bottom portion of the load untouched before striking off with a template is objectionable, as it renders the hand rolling difficult by having a dense pile and a loose pile to contend with, the roller spanning the looser portion. It is better to spread the sand entirely by shovels, then by rolling and striking off and re-rolling, even a third time. This brings the cushion to a condition of compactness and even density that will not only furnish an even support to the entire pavement, but will prevent the sand from flowing up into the joints of the brick when the brick surface is rolled. While it is not necessary for this cushion sand to be entirely free from soil and vegetable matter, it should be nearly so, otherwise its density cannot be maintained.

Respecting the laying of the brick, the following points are noted by Mr. McCleary as important:—

- (1) See that the lugs are turned one way.