

THE PROPER CONSTRUCTION OF BRICK STREET PAVEMENTS.*

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The use of vitrified brick or block for streets and roadways is an American idea, which originated about thirty years ago. It was developed from the use of brick made from the ordinary surface clays for such purposes in a few of the smaller cities of Indiana and Illinois. Shortly afterwards brick made from fire clay in the upper Ohio valley were used for a like purpose.

It will probably never be established as to who made the first vitrified brick from shale in this country. One thing is certain, that the first stiff mud brick made from a mixture of shale and common clay were produced in central Illinois. These were used for street paving purposes, and naturally followed the use of the common brick for street paving, and thus, more by accident than design, such brick were found to resist the wear of travel with greater success than the brick made from the surface clays, and thus the value of vitrified brick for paving purposes was established. In like manner it may be truthfully said that for many years following the earlier manufacture and use of paving brick progress toward betterment was, to a very great extent, merely incidental. The extended use for street paving purposes was slow. Few of the earlier manufacturers, if any, realized the development about to take place, and very few of the manufacturers had any concern of the relation their uses bore to the importance of the business. The demands for the product, however, grew continuously, regardless of the fact that so few were giving any attention whatever to their proper use as a street paving material. Finally, some few of the manufacturers began to realize that the lack of appreciation of brick streets was due to the fact that they were almost universally built without consideration either as to the physical advantages insuring durability, or in a manner making possible the greatest satisfaction to the user. The few, however, whose eyes were opened to the facts began a careful study and inquiry into the methods of construction promising to afford the greatest satisfaction possible from every standpoint. A few engineers in the central West early realized the importance of proper construction, and appreciated more than the manufacturers what the future had in store for vitrified brick. These engineers and these manufacturers, while still maintaining the value of the use of a good quality of vitrified brick for street construction, were convinced of the utter folly of depending upon that alone, and saw that other elements were equally necessary. It is not too much to say that even now the brick are too often required to bear the burden for a satisfactory street. Neither is it putting it too strong to say that the criticisms offered against brick streets are due, in nine cases out of ten, to other causes than the quality of the brick.

In the month of July of this year we had the opportunity of examining the brick streets in more than fifty cities east of the Allegheny Mountains. We were greatly surprised that in but three cities did we find the essential details of brick street construction at all complied with. Many of the details of a properly constructed brick street seem not to have found lodgment with those who are charged with their construction as being in the least degree important; they are, nevertheless, absolutely necessary for the construction of high-class brick pavements. It is, therefore, the purpose of this paper to point out the essentials which are often overlooked, ignored, or in some way or on some account neglected rather than to follow out all of the directions necessary from foundation to finish. I wish, however, to emphasize one thing, that, while a compliance with the details of construction that may be here suggested is vital in their importance to the value of the street, nevertheless, not a single suggestion here made is difficult in the least degree; neither adds greatly to the cost. If neither difficult

nor costly, why are they not complied with? Practically all of these requirements are suggested in the directions for laying brick street pavements which are promulgated by the National Paving Brick Manufacturers' Association. These directions or specifications have been adopted by practically all of the progressive engineers of this country. We wish, therefore, to give a brief answer to this question later on in this paper. The preparation of the sub-grade for brick streets does not differ essentially from that necessary in case of streets constructed with other materials. It must be drained, graded, compacted, and established in conformity with the grade of the finished street. This must be accepted as necessary by everyone. A depression here and there in the grade, a spot of loose earth, a lack of thorough compaction, or a wet condition improperly drained must, without question, be followed by conditions of the street that will bring disaster to the street as a whole. As to the quantities of the mixture that enter into the concrete foundation, so much depends on the quality of the cement to be used, the quality of the sand, gravel, stone, etc., that we will not undertake to say what proportion of cement, sand, broken stone, or gravel shall be used. Suffice it to say that the quantities must be such as will make absolutely sure the quality. There are, however, some fixed and well-known conditions in the preparation of the mixture of the concrete foundation that, in order to insure the quality of the concrete, must be observed, whether or not the concrete be machine or hand-mixed. In order that it shall be its maximum strength it must be mixed dry in the first instance, and then thoroughly mixed after the water is applied. Either in the machine or hand-mixing an intelligent supervision is worth while at all times. I have observed very often the value of the concrete reduced at least fifty per cent. by carelessness, by ignorance or indifference, by the application of too much water or by the application of too little water, by the lack of a proper proportion of some one or another of the other ingredients composing the foundation, resulting in a square yard, two square yards, or three square yards of the concrete foundation being of no more value to the street itself than a loose pile of broken stone or gravel. The manner of making the concrete foundation thus absolutely insures its failure, such concrete being so mixed that if it were in a building the building would fall of its own weight, as has happened in many instances. Such conditions obtaining in a street, while not insuring a fall, does insure a failure. This concrete as it is put in place must have a uniform surface with the grade of the finished street. Just at this point are found conditions of very great frequency which insure the failure of the street. We have said it must have a grade uniform with the grade of the finished street. The surface of it must be smooth. This cannot be accomplished by depending upon the eye; the grade stakes should be set at no greater distances apart than four to five feet. If any stone used in the concrete exceeds in size two inches in its largest dimension, it will be next to impossible to accomplish the condition desired. Sufficient water should be used in the mixture so that one man can smoothe the top with an ordinary dirt shovel—never should it be so stiff as to call into use a rammer.

It has been an interesting study from the viewpoint of both the engineers' and contractors' experience in this matter as to what a uniform and smooth surface means when applied to a concrete foundation. With some a range of grade from two to three inches furnishes a fine job. We wish to emphasize that a greater variation than one inch is utterly inexcusable in the matter of a concrete foundation for brick streets.

The sand cushion must be two inches in thickness. If less than two inches, it will not afford a sufficient relief from the vibration created by the impact of travel. If more than two inches it cannot be sufficiently compacted to afford a support to the load coming upon the brick street, and prevent cracking and crushing of the joints of the cement filler which is required in finishing the street. Thus, this cushion must be of such a thickness that will afford a relief from the impact and weight, slight though it be, yet sufficiently un-

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