

## NEW HAVEN PAVEMENTS.

*By Cassius W. Kelly, Mem. Conn. Soc. C. E.*

The following statement will be, simply, an attempt to present such information in regard to the pavements of New Haven as is usually sought by visiting delegations from other cities with only a few comments.

Up to 1892 the pavements were of macadam, Telford, and stone block, mostly Belgian on sand foundations, with one short street of tar concrete, one block of asphalt blocks and some cobble stone.

With the exception of the Belgian block pavement in East Water Street and three blocks on East Street and the Chapel Street causeway, and one block of granite in Commerce Street, the stone block pavements on sand foundation, the cobble stone and the asphalt block have been replaced with other pavements.

The cost per square yard here given, for all pavements, includes all work and material except the curbing, repairs of sidewalks disturbed, and such incidental work as inspection and adjustment of sewer manholes and basins.

In 1892 the first brick pavement was laid in York Street from Chapel Street to Elm Street. It was laid in part of Syracuse brick and in part of Barrington brick and covered the space only outside the car tracks. There is a double track in this street. The trolley company, a few years later, paved between their tracks and rails with Barrington brick, which they replaced this past year with creosoted wood blocks upon laying new rails.

The brick outside the tracks were laid on a 4-inch concrete base, upon a macadam sub-base with a sand cushion  $1\frac{1}{2}$  inches in thickness. The brick were grouted with hot sand. This pavement, though badly chipped and worn, is still in use and is not yet in such condition as to excite complaint. The repairs have not been extensive. Although a central street it cannot be called a main thoroughfare and the traffic is not heavy.

The cost was \$1.96 per square yard. The following year, 1893, one block in Ashmun Street, from Gregory Street to Henry

Street, was laid with Syracuse brick on a 6-inch concrete foundation with sand cushion and hot sand grouting. This pavement cost \$2.12 per square yard, has had but slight repairs and is still in use.

In 1896 and 1897, the remaining portion of Ashmun Street, namely, from York Street to Gregory Street and from Henry Street to Munson Street, was paved with Mack wire-cut vitrified brick laid on a sand cushion and grouted with hot sand, at a cost of \$1.92 per square yard.

This pavement is still in use and has not had much repair work but is in poor condition and in need of repairs now. The travel on this street is not congested, but there is considerable very heavy traffic from three large factories that pass over it.

In 1897 a pavement of Mack wire-cut vitrified brick was laid in Wooster Street from East Street to Union Street on a 6-inch concrete foundation with sand cushion and hot sand grouting, at a cost of \$1.92 per square yard.

About nine years later a strip through the center about 12 feet wide from Chestnut Street to Olive Street was relaid with new Mack brick, and in the fall of 1911, nearly 15 years after the construction of the pavement, the entire pavement from East Street to Olive Street was taken up and replaced with a creosoted wood block pavement, as it had become too badly worn to repair.

The traffic conditions on this street were the severest of any street in the city, at least up to the time of the construction of the new pavement in East Chapel Street about three years ago, which relieved this street some.

In 1900 brick pavements of Catskill shale brick were laid in East Chapel Street from the Yale boat house to East Pearl Street, in Church Street and Whitney Avenue from Elm Street to Sagem Street, and in Commerce Street from Whiting Street to Water Street, on a concrete foundation with sand cushion and sand grouting. The cost in Chapel Street was \$1.86 per square yard, in Church Street and Whitney Avenue \$1.94, and in Commerce Street \$1.87.

East Chapel Street is a comparatively narrow street, 33 feet between curbs and has a double line of car tracks.

This pavement soon gave out over a narrow strip outside of the trolley tracks and between the rails and through the center

of Commerce Street. This portion was replaced with Syracuse brick and suit brought against the Surety Company, the brick company having failed, and the full amount of the bond, \$1,200, recovered. The Syracuse brick here are now badly worn. The pavement in Church Street and Whitney Avenue is still intact, though in need of repair.

Syracuse vitrified brick was also laid on Commerce Street between Whiting Street and Congress Avenue, under the same contract and specifications as the Catskill in the other portion of the street and at the same cost.

In the same year, 1900, Grand Avenue from Mill River to the Quinnipiac River was paved with Syracuse vitrified paving brick on a 6-inch concrete foundation with sand cushion and hot sand grouting, at a cost of \$2.29 per square yard. This pavement has had but little repairs and is in fair condition. There is a double trolley track in the street, but the street is of fair width, being about 40 feet between curbs. This was the last brick pavement laid with sand grouting.

In 1901 pavements of Syracuse vitrified brick on a 6-inch concrete foundation, 1½-inch sand cushion and grouted with a cement filler mixed in the proportion of one of sand to one of cement, were laid in Chapel Street from York Street to State Street at a cost of \$2.27 per square yard, in Crown Street from Temple Street to State Street at a cost of \$2.49½ per square yard, in George Street from Temple Street to State Street at a cost of \$2.50 per square yard, in Elm Street from York to State Street at a cost of \$2.49½ per square yard, in Temple Street from Elm Street to Congress Avenue at a cost of \$2.28 per square yard, and in Congress Avenue from George Street to Temple Street at a cost of \$2.49½ per square yard; and in 1902, the same brick under the same specification was laid in Olive Street from Water to State Street at a cost of \$2.49½ per square yard. These are central streets. The difference in prices was due to the nature of the competition.

These pavements have had but little repairs except along the rails of the trolley tracks in Chapel Street, Elm Street and Temple Street, and except in Temple Street and some parts of Elm Street, these pavement for the most part are in fair condition and some are in good condition. Portions of

Olive Street and of Temple Street show the most wear. With reasonable attention in maintenance they should last many more years, more than as many more. As the congestion increases in the central streets the team traffic moves slower, which is of advantage to the pavements.

In 1908 a pavement of Johnsonburg shale block was laid in George Street from Temple Street to College Street at a cost of \$2.95 per square yard, and in Grand Avenue between the two Mill River bridges at \$2.75 per square yard. These last two pavements were under a ten year guarantee. All other brick pavements were laid under a five year guarantee. There is a double line of trolley tracks in both these last pavements, although the pavements have been down but a short time. The indications are that the brick have good wearing qualities.

In one respect our experience has been unfortunate. The Syracuse brick used in most of our brick pavements are of the small brick size, about  $2\frac{1}{4}$  inches wide. About five years ago, the company manufacturing the brick failed and went into the hands of a receiver, and since that time we have not been able to obtain the brick for repairs and we have made use of the Barrington brick, the only available brick of a size to tooth in. But this summer that company also went into the hands of a receiver and we have not been able to get any more brick from them.

In 1896 and 1897 pavements of Sicilian rock asphalt were laid in Orange Street from Crown Street to Canner Street, 30,703 square yards; in Trumbull Street, 10,090 square yards, and in Chapel Street from York Street to the Boulevard, 24,076 square yards. The cost of the pavement in Orange Street was \$3.45 per square yard, in Trumbull Street the same, and in Chapel Street \$3.75 per square yard. This increased cost for Chapel Street was due to the increased liability for repairs under the ten year guarantee on account of the double line of trolley tracks. In Orange Street and in Trumbull Street there have been no repairs due to wear except some slight repairs in the three blocks between Crown Street and Court Street on Orange Street which are in the center of the city, and there should not be in another 15 years.

In Chapel Street, where the asphalt was carried up to the rails, the annual expense after the first five or six years has

been very great. The expense was almost entirely along the rails and mostly on the inside of the rails. The T rail is in use. In the last two or three years we have had some repairs to make in the gutters. It was the intention to pave the gutters as in the two other streets with brick and to pave also along the rails with brick, but some of the residents objected on the score of noise and secured an order requiring only asphalt. The trolley company has now placed two rows of granite blocks along the inside of each rail. The only objections ever made to this pavement were, its cost, and that it was more slippery than the artificial asphalts, but it has proved satisfactory and in the end will be as economical as any, except perhaps in the narrow portion of Chapel Street on account of the car tracks.

The rock asphalt used was a mixture of three to four parts of the natural rock from the Sicilian mine at Ragusa and one part of the rock from the German mines at Vorwohle. A thickness of two inches was laid on a 6-inch concrete foundation. A small piece of Trinidad sheet asphalt was laid in Church Street from Chapel Street to Elm Street in 1901 in accordance with the usual specifications, but it did not give satisfactory service and was replaced late in 1911 with a wood block pavement.

In 1907 a Hassam pavement was laid in Oak Street from Temple Street to Broad Street under a ten year guarantee at a cost of \$1.90 per square yard. This street has considerable travel and at times is crowded with small hucksters' teams. The pavement soon showed depressions.

In 1906 a bithulithic pavement was laid in Broadway with a broken stone foundation under a ten year guarantee at a cost of \$2.40 per square yard, and in 1907 and 1908 the same pavement was laid in State Street from Grand Avenue to Mill River on a 6-inch concrete foundation and under a ten year guarantee at \$2.75 per square yard. These two pavements have required frequent and extensive repairs and have not shown a suitable quality of durability under heavy traffic. The same pavement was used on the concrete bridges over the cut and the easterly approaches at Grand Avenue, Chapel Street, Crown Street and Fair Street and they have shown the same results. The pavements were liked by teamsters because they gave a surer foot-hold for horses than the other smooth pavements.

In 1908 a concrete pavement known as the Blome Company's Granitoid Blocked Pavement was laid in Chapel Street from a little east of the Railroad Cut to East Street, in Fair Street from Union Street to Olive Street, and in Prindle Street, under a ten year guarantee, at a cost of \$2.20 per square yard, and in 1910, the same pavement was laid in Grand Avenue from a point a little west of Olive Street to Mill River, in Commerce Street from Temple Street to Broad Street, in Dixwell Avenue from Broadway to Munson Street and in Gregson Street, under a ten year guarantee, at a cost of \$2.40 per square yard. This pavement is simply a first class Portland cement concrete pavement, and is made up of two courses. The first or bottom course is  $5\frac{1}{2}$  inches in thickness, and consists of concrete mixed in the proportion of 1 part cement, 3 parts sand, and 4 parts broken stone varying in size from  $\frac{1}{2}$  inch to  $1\frac{1}{2}$  inches. The second or top course is  $1\frac{3}{4}$  inches in thickness and follows closely the placing of the bottom course. It consists of 1 part cement and  $1\frac{1}{2}$  parts of stone screenings freed from dust. The stone runs from the finest to about  $\frac{1}{2}$  inch in size. This surface is worked smooth and marked into blocks  $4\frac{1}{2}$  inches by 9 inches, by grooves about  $\frac{1}{2}$  inch in depth.

In Fair Street, a narrow street with heavy traffic, the grooves have disappeared except on the sides of the street, after three years use. In Chapel Street, which has a double line of car tracks and is but 34 feet wide between curbs, the grooves in places, in the narrow track where the wheels travel mostly, have nearly disappeared. This is most marked on the north side, as the heaviest loads come up on that side.

The making of repairs in this pavement is a difficult problem; when a cut is made, it is necessary to keep travel off, after the repair is made, ten days, to get good results, and that requires a watchman as it is impossible otherwise to maintain a barricade. When it comes time to repair the pavement as a whole, the problem will be a difficult and expensive one.

In Prindle and Gregson Streets, which are alleys, and Commerce Street, on which traffic is not very heavy, and Dixwell Avenue, which has a double line of car tracks but is of good width, about 40 feet between curbs, the pavement is not much worn yet.

In 1908 creosoted wood block pavements were laid as follows: In Meadow Street from Congress Avenue to Water Street, in State Street from Grand Avenue to Chapel Street, in Court Street from State Street to Church Street, in Center Street from Orange Street to Temple Street, and in Church Street from Chapel Street to George Street, at \$3.25 per square yard. The blocks were 3 inches wide by 3 inches deep and were laid in a mortar bed on a concrete foundation.

In 1910 creosoted block pavements were laid in Congress Avenue from Howard Avenue to Lafayette Street at \$3.38 per square yard, and in State Street from Chapel Street to Water Street east of State Street at \$3.33 per square yard. The blocks were 3 inches wide by  $3\frac{1}{2}$  inches deep and were laid on a sand cushion. The difference in price in the two streets was due to the fact that there is a double trolley track in Congress Avenue.

In 1911, late in the season, creosoted wood block pavements replaced the brick pavement in Wooster Street from East Street to Olive Street, and the asphalt pavement outside the car tracks and the brick pavement inside the car tracks in Church Street from Chapel Street to Elm Street. In both streets the blocks were laid on a sand cushion upon the old concrete foundation. Blocks 4 inches in depth were used in Wooster Street to make up grade. Blocks three and one-half inches in depth were used in Church Street. All the wood block pavements are sand grouted, and are under a ten year guarantee from the company and the first five years are also covered by a Surety Company's bond.

All the wood blocks are of long leaf yellow pine and, with the exception of a small piece of pavement on the Edgewood Avenue Bridge, the blocks are all treated with the so-called heavy oil. In the last two lettings, alternative bids were received, based on the use of the light oil, that is oil having a minimum specific gravity of 1.03; but the lowest bids in every case were those based on the use of the heavy oil. The wood block pavements are all in good condition.

The pavement in State Street from Grand Avenue to Chapel Street was the first of the wood block pavements laid. The weather was very hot, the blocks were piled along the walk in

advance of the commencement of the work and when laid were driven back hard. Soon after, following some heavy rains, we had some trouble from buckling. The same was true of Meadow Street. In the other streets the blocks were not driven back so hard, only enough to line them up, and they did not have such exposure to the sun after being unloaded and before being laid, and we had no trouble on account of buckling, and in the case of Church Street, laid the latter part of the season, the expansion joints have not even been affected.

That is true also of those laid in 1910. The cross expansion joints were omitted from the Wooster and Church Street pavements laid late in 1911.

In 1910 a granite pavement was laid in Congress Avenue from Lafayette Street to Temple Street, and on the lower end of State Street between Water Street east of State Street and New Union Avenue on a 6-inch concrete foundation. These granite blocks are 5 inches in depth,  $3\frac{1}{2}$  to  $4\frac{1}{2}$  inches in width, dressed to lay with  $\frac{1}{2}$ -inch joints, and the head of the block was so dressed that no depression was more than  $\frac{3}{8}$  of an inch below a straight edge laid in any direction across the head parallel to the general surface of the block. The joints were grouted with a one to two cement mortar, the last application being a thicker grout than at first, and the surface was brushed over with a rubber squeegee and travel was kept off for seven days. This made a smooth, clean pavement. The cost was \$3.49 per square yard, but that was lower than the work could be done for at a profit. This should probably be nearer to \$4.00 per square yard.

In the year previous, 1909, granite was laid on some of the approaches to the Railroad Cut, where the grades were three, four and five per cent., namely, Grand Avenue, and Chapel, Crown and Fair Streets, and the joints were filled with gravel and pitch. We did not call for quite as smooth a top for the blocks. These pavements are quite satisfactory to the teamsters but are very noisy.

During 1910 and 1911 we laid some bituminous macadam pavements.

In 1910 Dwight Street from Chapel Street to Oak Street, Edgewood Avenue from Winthrop Avenue to West Park



Avenue, and Division Street from Prospect Street to Winchester Avenue were laid, using the Standard Oil macadam binder except that on a short stretch in Edgewood Avenue tarvia was used the first time over and the Standard Oil binder was used for the finish coat.

Frank Street from West Street to Barclay Street was paved with the American Tar Company's product for a binder and with a flush coat of Gulf asphalt. The mixing method was used for one block on Frank Street, but in every other case the penetration method was used.

The method of construction was as follows: first, a foundation course of No. 1 stone four inches in thickness, well rolled and filled with sand, but no surplus of sand left on top of the stone; then two inches of No. 2 stone well rolled and covered evenly with one and one-half gallons of the binder and then covered with coarse screenings freed from dust, and rolled. The surplus screenings were then brushed off and the road given a flush coat of about six-tenths of a gallon per square yard and covered with screenings freed from dust, and thoroughly rolled.

Late in 1911, Highland Street from Prospect Street to St. Ronan Street was paved with bituminous macadam, using Bermudez asphalt binder at \$1.30 per square yard; the price for two other streets to be done next year with the same binder is \$1.17 and \$1.28. The 1911 specification called for  $1\frac{1}{2}$  to  $1\frac{3}{4}$  gallons of binder the first time over.

The cost of Dwight Street, Edgewood Avenue and Division Street was less than \$1.00 per square yard. The contractors were without experience in that kind of work when they bid on those streets. Frank Street, which was let later in the season, cost \$1.19 per square yard and the bids during the past year for the same kind of work with the same binder were from \$1.15 to \$1.28 per square yard. Some contracts were let which have not yet been begun.

Late in the fall Sherman Avenue from Chapel Street to Whalley Avenue was laid with a 4-inch macadam base and 2-inch asphaltic surface, called asfalto, and Norton Street from Chapel Street to Whalley Avenue was begun with the same pavement but not finished. The cost of this pavement with a five year guarantee was \$1.40.

Our experience with the use of bituminous macadam is short but we are favorably impressed with it as a substitute for plain macadam. It is clean at all times of the year and meets those conditions of modern travel which were especially destructive of macadam. The only fear is that their maintenance will not be properly attended to; while we have a great deal of repair work on pavements, we have had comparatively little of what may properly be called maintenance. This is true, I think, of cities generally in this country.

Up to the present time the wood block pavement appears to me to be the most satisfactory in those locations where an expensive pavement is justified, though where durability is the chief concern and quiet not of especial importance the granite block pavement laid with cement joints and as described above in this statement would be the best and would be no more noisy than brick or concrete pavements.

The wood block should not be laid on a steeper grade than two per cent.

That was our reason for laying the granite on a portion of Congress Avenue and of State Street instead of continuing the wood block. I have heard it claimed that the granite pavements grouted with cement were as slippery as wood block and they may be nearly as slippery as the wood block in its most favorable condition, clean and dry, but I think not at any time as slippery as the wood block in their most unfavorable condition.

### DISCUSSION.

THE PRESIDENT: Gentlemen, you have just heard read this very valuable paper by Mr. Kelly on the New Haven pavements. It is a very valuable paper, especially to the men in our profession, because it gives prices. I guess he has described every pavement that has been laid in New Haven except the one which Jack Frost lays, and I do not think that any prices have been given for that yet. I presume you will be glad to ask Mr. Kelly some questions about his work. He has had a very long experience, and I think will be glad to answer any questions.

A MEMBER: I would like to ask Mr. Kelly a question—whether on the streets of New Haven that have been paved he

has made any comparison of the difference in wear between pavements used by horse-drawn vehicles and automobiles.

MR. KELLY: No, that has never been done. It would be pretty difficult to get at that, because most streets are used by both. As soon as a new pavement is laid the automobiles will seek that pavement if adjacent streets are unpaved. In that way a good many streets get more than their normal use from automobile traffic. For example, Ellsworth Avenue from Chapel Street to Whalley Avenue and Sherman Avenue.

A MEMBER: Would you care to say, Mr. Kelly, what you think in regard to whether the automobile traffic is in excess of the horse traffic?

MR. KELLY: No, I couldn't say about that. I know there is a great deal of auto traffic over portions of those streets, but what the proportionate use is I could not say. My observation of those pavements is that they are all about alike so far as the traffic of autos on them goes.

A MEMBER: That is, without regard to whether they are carefully laid, they wear out in about the same proportion?

MR. KELLY: Well, I wouldn't say that. Undoubtedly, the care with which they are laid has a good deal to do with the way they will stand up.

SECRETARY JACKSON: In regard to Frank Street, Mr. Kelly, wasn't the American tar product used there?

MR. KELLY: Yes.

SECRETARY JACKSON: Did that work satisfactorily?

MR. KELLY: That pavement has had more or less repairs, and it would be a little hard to tell; but it did not do quite so well as on the other streets. Whether that is due to the tar products or whether it was because of the heavier traffic I do not know. There is heavy traffic from the All-Rail Coal Company.

A MEMBER: You stated that the mixing process was used in just one block, and that all the rest was penetration work. Was the penetration work more satisfactory than the mixing?

MR. KELLY: I think the penetration is the only practical way, unless you have got a very large job and can do the mixing by machinery. We found it was going to be much more expensive to use the hand mixing process. By the penetration method a section is gone over in one direction with a dipper, and then that same area is covered in the opposite direction, so it is

completely covered, sufficient care being used to make sure that the interstices are completely filled.

MR. HILL: I would like to ask Mr. Kelly if he does not think that for heavy traffic that the wood block pavement is, all things considered, about as good a pavement as we have?

MR. KELLY: Yes, that is what I meant to indicate. The wood block is the most satisfactory, except in certain conditions when they are liable to be more slippery. We had a little difficulty with that in New Haven, but I think we have gotten along on the whole very well.

MR. HILL: You spoke of some streets having blocks three inches each way,—don't you think it is desirable to have the depth different from the width so as to avoid the mistake of setting the blocks with grain of the wood parallel with the street surface?

MR. KELLY: Yes, and we adopted such a change. We found that they had to be carefully watched. Another thing, I think blocks three inches deep are more liable to buckle than a deeper block.

MR. HILL: They are put in very rapidly, and they hardly see what they are doing sometimes. It seems to me very important to make the depth different from the width.

MR. PECK: Do I understand that in the city of New Haven no wood block pavement has been laid with a grade greater than two per cent.?

MR. KELLY: That is correct. We laid a pavement on Congress Avenue a portion of which was more than that and we substituted granite on that portion.

A MEMBER: I would like to ask if anything has been done in the way of recoating, or giving a flush coat, or painting with a coat of liquid asphalt?

MR. KELLY: No, there has not been anything here to require that, except in the original construction of the pavement, which is finished with a flush coat as described in the paper.

A MEMBER: How long have those pavements been down?

MR. KELLY: They have been down a year or two. Some have been down two years, I think.

A MEMBER: You wouldn't recommend wood block pavement on a steep grade?

MR. KELLY: No. It would be too slippery.

THE PRESIDENT: As soon as a cement pavement gets worn so that there are small depressions in it and the water gets into it, won't those go to pieces very rapidly?

MR. KELLY: Of course, any pavement as soon as it gets depressions in it ought to be repaired, because the edge of the broken down patches spreads. I do not know that the water will hasten it very much. That is the great objection to them. I was very averse to that kind of pavement, but the commissioners ordered them here. It is always quite a problem to repair such pavements, especially if there are car tracks in them.

THE PRESIDENT: Could not the grade of the street be raised and the worn concrete be top-dressed with asphalt?

MR. KELLY: The trouble is that in most of the streets there are car tracks in the pavement and it would be necessary to break up the pavement to relay the car tracks. That might be done on such streets as Fair Street or Commerce Street, where there are no car tracks.

THE PRESIDENT: There is very little wear near the gutters, and it seemed to me a street treated in that way would have body enough to hold.

MR. KELLY: Of course, if the travel was not heavy it might be treated as a concrete base and given a light dressing of sand and asphalt, but that would hardly do for our heavy traffic streets.

SECRETARY JACKSON: I would like to ask what provision is made to take care of bleeding in the building of pavements with wood blocks?

MR. KELLY: Well, that has not been as annoying to us as I should judge it has been to some others, but we have had some trouble. The only thing that was done by the city was to sprinkle with water.

MR. HILL: Do you sand the streets?

MR. KELLY: No, but that has been suggested.

MR. HILL: I would like to ask Mr. Kelly if he does not think it is a good idea to sprinkle those pavements with sand when the pavement is covered with ice?

MR. KELLY: I think that would be a good idea, but that would not apply to wood block pavements only. I have known of several horses having fallen down on the blocks on a morning and a greater number in a corresponding distance on the asphalt.

I do not think the kind of pavement makes a great deal of difference, but, of course, when the wood blocks are in an icy condition it would be better to have something on the surface to give the horses a foothold, but under ordinary conditions there is very little trouble.

MR. HILL: On the wood-block pavements, if some sharp sand could be sprinkled over them in slippery weather I think that would avoid that objection to them almost altogether.

MR. LEWIS: Do I understand, Mr. Kelly, that you have practically given up the use of brick pavements here?

MR. KELLY: Our pavement construction is now entirely in the hands of the Paving Commission. As they feel now I think they are inclined against the brick pavement. The trouble with the brick pavements is that they are noisy, and besides that, the brick are apt to vary a good deal in quality. You are apt to run up against some conditions that we have been up against here, in the failure of companies to which I have referred in the paper.

MR. KELLOGG: Could you tell us about what the average life for a brick pavement in the city of New Haven is?

MR. KELLY: One pavement that we had was made of very poor brick, and, of course, the life of that has been short, but the first pavement that we put in in York Street is still there. It has been down about nineteen years, and, now is badly worn. It will have to be taken up and renewed before long.

MR. PECK: One reason why I asked about horse-drawn traffic was because my experience is that with the same material, and with the same class of work, our pavements built under the penetration method have stayed all right under both automobile conditions and with the horse-drawn vehicles, and that where the horse-drawn traffic has been in excess of the automobile, that is, with heavy horse-drawn traffic, it is not up to more than sixty-five or seventy per cent. of the other. We have had a little trouble with the penetration method, and the mixing method I am inclined to think must be used. It depends on the care that is used to maintain the pavements. In this particular case I was a little interested because our conditions are practically the same, so far as the total amount of traffic is concerned, except that the percentage is just the reverse, with the heavy horse-drawn traffic.

MR. HILL: What is the cost of that pavement with you?

MR. PECK: With short hauls that pavement is costing about ninety cents per square yard, where the foundation is all in, or where we have had to use the foundation that we have had in some cases, but where the hauls for material, trap rock, etc., were about three miles, the cost has been about \$1.60 to \$1.70 per square yard. That included grading, etc.

MR. HILL: Don't you think for automobile traffic such as we have around here that it is about as satisfactory as anything?

MR. PECK: It can be laid cheaper, I think, than anything else, and it is about as satisfactory as anything I know of.