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Wood Block Pavements

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WOOD BLOCK PAVEMENTS

BY

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ENTITLED

WOOD BLOCK PAVEMENTS

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

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INTRODUCTION.

The object of this treatise is to discuss fully the subject of Wore Block Pavements. A short description of the earlier forms and the development of this pavement to its present state, will be given. As European and American methods of construction differ slightly, they will be treated separately. A large part of the paper will be given to the comparison of this with other forms of pavement, and this will be made up largely of a compilation of the ideas of responsible engineers and others who have had experience with these blocks. In conclusion will be given the specifications for wore block paving in a few cities which have used this form of pavement.
PROGRESS OF WOOD PAVING.

Russia is reported to have had wooden pavements several hundred years ago, but as no detailed record of them is obtainable, they could not have been used to any great extent.

The first wood pavements were laid in New York in 1835-36, and in London in 1839. These earliest forms, made from the old corduroy roads, were round or hexagonal blocks placed directly upon the ground. The blocks were made of any available wood, were not treated, and were, on an average, about one third sap. They therefore rounded quickly on the edges, giving a very rough surface which hindered drainage and cleaning, thus making the pavement unsanitary and hastening its decay. Yet they were laid extensively in the middle west, and though neither durable or in any way satisfactory, were cheap and served their purpose in fast growing cities where finances would not warrant the laying of a more substantial pavement.

As an improvement over this first type, other forms of block were devised, many of which were patented. In the United States perhaps the most conspicuous of these was the "Nicholson", patented in 1843 and laid extensively in the ten years succeeding the civil war, to the great and lasting sorrow of all classes thus improved. Little or no care was taken with the selection of the timber used. Hard, soft, heart-wood, sap-wood, seasoned, and unseasoned woods were used indiscriminately. The blocks were sometimes dipped in hot coal tar or pitch, which served to cover up the defects and accidentally to seal up within them the moisture due to lack of seasoning, thus hastening dry or heart rots. The introduction of lath between the blocks served to make large joints. These admitted water under the pavement where it was absorbed, and the result was that the blocks swelled, causing the pavement to heave from its foundation. The use
of untreated plank on earth as a foundation was decidedly insufficient. That part of the pavement which was not heaved by the frost went down on the rolling of the planks.

Kerri and Jarrah, very dense and hard Australian woods, have been laid extensively in England. In London these woods have shown a life of from fifteen to twenty years, but continued use has not entirely justified the hopes first entertained for them. Their structure is too dense to admit of impregnation with chemical antiseptics, without which they absorb water and swell. They are much more slippery than most native woods, and are not immune from decay, though because of certain antiseptic gum resins contained in them, they are less susceptible to rot than most native woods. In England, however, they are still used. Jarrah blocks were laid on twenty-sixth street, New York city, in 1895 but were removed in 1904. The cost of this pavement was about five dollars per yard, which would exclude it from extensive use in America even should it make a better pavement than our best creosoted native woods.

After the failure of untreated native woods, attention was turned to wood preservatives. The tendency has been to narrow down to the use of one material for the treatment of wood paving blocks, namely the dead cut of coal tar commonly called creosote. It is applied either pure or in mixture with resin, pitch or other insoluble materials.

Creosoted southern pine paving blocks are said to have been laid in Galveston, Texas, as early as 1873. This pavement, though laid directly on a subgrade of sand, gave good satisfaction for nearly thirty years, but was finally destroyed by the great flood of 1900. This wood hardening was not followed up, and only within the last ten years has the matter received systematic attention in this country.
PAVEMENTS IN FRANCE AND ENGLAND.

The two most important cities in which wood block pavements are used extensively are Paris and London. In Paris the blocks are manufactured and laid by the city authorities, the various plants having a capacity of from seven thousand blocks or about one thousand yards per day. Two depths of block, six inch for soft and four inch for hard woods, are manufactured. There are nearly two million yards of this pavement in use in Paris.

The wood in most common use in Europe is Swedish deal, a rather soft, easily impregnated wood. About fifteen years ago, however, American red gum was introduced and used quite extensively in London. It is a better wood than Swedish deal but not so hard as Australian woods. It has little value for lumber so was thought to be a good substitute for deal. English engineers made the mistake of leaving it untreated, and though it gave fair, some satisfaction, it began to decay after a time. This wood has now become valuable for furniture and is no longer used for paving.

The present methods of laying this pavement almost differ only in particular features. In general they are as follows: A foundation of concrete is laid upon the subsoil and brought to the form of the finished pavement. This foundation is a mixture of portland cement, sand, and crushed stone or coarse gravel in the following proportions: One part of cement, two to four parts of sand, and five to seven parts of crushed stone or gravel. A thin cushion coat, usually of sand or neat cement, is used between the foundation and the blocks. When sand is used the blocks are laid directly upon it and a roller is then run over the pavement until the surface is smooth. With a cement cushion coat a slow setting cement is required. It is brought to the form of the surface by means of a template, and the blocks are set in this bed of mortar. When a few courses have been put down they are smoothed to an even surface by tamping.
The joints are of different materials, but it is probable the most commonly used. It may be the purpose very well as it will work into the joints under traffic. Other materials used are tar, asphalt, and cement.

A rigid specification is usually placed upon the blocks. No variation greater than one sixteenth of an inch in length or breadth and no measurable variation in depth is allowed. The blocks are also required to be kept carefully protected from sun and weather after removal until they are laid. This prevents deterioration from checking.

Joins of different sizes have been tried with varying degrees of success, but the more common practice now seems to be to lay the blocks close together. Mr. Frank Lease, Borough Engineer and Surveyor, in 1902 said: "Close blocking to be recommended in all designation of good pavement. Wide joints have been adopted to a great extent on the system in service. Such movements after a time become quite uncomfortable to ride over, owing to the wearing material wearing down below the surface of the pavement. This is also true of the blocks, and leaves greater facilities for absorption, causing a greater amount of expansion and the material to become saturated to a large extent with unnecessary water."

The traffic on the principal avenues of both Paris and London is enormous. On the Rue de Rivoli, Paris, there are over sixty-five thousand teams a day, or three thousand four hundred per yard width of street. There are over sixty-six thousand teams per day on the Avenue de la Opera, or two thousand four hundred teams per yard width of street. On Fifth Avenue there are over eighty thousand four hundred teams and on Madison Avenue seven thousand per day. Under this traffic native woods wear on an average one continuous, or four lengths of an inch one year, and are allowed to wear until four of the original six are on the road away. This gives, under the heaviest traffic in the world, with inferior woods, a life
Horses are not allowed to have calks on their shoes. This makes the wear less and also indicates that the pavements are not slippery. This average wear is exactly the same as is noted for granite in the same city.

In the report of the Parish of St. Mary Abbot, Kensington, England, 1900, the surveyor said: "Kensington High street was paved with cypress blocks in 1891. These have lasted for eight years. Wood crosswelles under pressure has lasted on other roads for twelve years. Under traffic of forty thousand teams per day the life of wood pavements on Strand street, London, is given in official reports as seven years. Very few granite pavements would be in good condition at the end of that time."
WOOD PAVEMENTS IN THE UNITED STATES.

It is only within the last ten or fifteen years that wood block paving has received systematic attention in the United States. Before that time improper methods of construction had placed the pavement in disfavor.

One drawback in the use of wood for paving has been the lack of knowledge of the wood itself. For example, sapwood has always been thought to be both weaker and more subject to decay than heartwood. It is strictly excluded from most wood paving specifications, all-heart blocks being demanded. The inclusion of sapwood undoubtedly caused the untreated blocks of former years to wear unevenly and to decay quickly. Recent tests show that under equal conditions of moisture content, the sapwood of any species is as strong as the heartwood. It is usually less strong because the wood is rarely used under conditions where the moisture content of the sapwood is as low as that of the heartwood. Creosote treatment, with proper previous seasoning, reduces the moisture content of such to an approximately even minimum, and the heavy charge of oil now customary in American paving block treatment, prevents subsequent absorption of moisture beyond a small per cent. After five years there is an measurable wear on either the heart or sap portions of creosoted Norway pine blocks laid in the city of Minneapolis.

The wood which has stood out as a leader for paving use is long leaf Georgia pine. It is a very hard and dense wood of even texture, and has given better satisfaction than most of the other species tried. This timber has been used extensively in construction work, and the supply has rapidly diminished until it was found a few years ago that the increasing price and deteriorating quality of Georgia pine would not warrant its use for paving purposes. It is therefore evident that the manufacturers must find a substitute for long leaf yellow pine. The United States government has also taken a lively interest in
This question, and through their suggestions as well as through those from other sources, it was concluded that one of the run woods existing largely in the south and known as black gum, possessed all the requirements for a successful paving material. This wood, on account of its tendency to warp, has been used very little for other purposes. It resembles the Australian hard woods that were formerly used abroad for paving, but while very tough in grain, it is not as hard as these woods and not so proof against decay. It was felt, however, that properly treated, it would make a black equal or superior to long-leaf yellow pine, and actual tests in service indicate that to be the case. Blocks of this character were laid on Hudson street New York, between the tracks of the Metropolitan street railway company, extending from Dowdick to Watts street. After about one year of service, they are in fully as good condition as the pine blocks adjoining them. This wood possesses a great advantage of being of uniform texture throughout and does not have any great difference in character between heart and sapwood.

This experiment shows that black gum is a very good substitute for Georgia pine, Tamarack, Douglas fir, western larch, white birch, Norway pine, and Hemlock are all used to a considerable extent. In the north Douglas fir and Tamarack seem to be in special favor.

Treatment.

Wood has an exceedingly complex physical structure. Almost the entire substance is of organic nature and can not be produced artificially. It is composed of a series of closed cells arranged as in honeycomb, but instead of being approximately the same size, their sizes and shapes vary greatly, sometimes in the same piece.

There are in all woods, beside the vertical columns of cells, horizontal rows occurring at short intervals between the vertical columns and closely

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There are in all woods, beside the vertical columns of cells, horizontal rows occurring at short intervals between the vertical columns and closely
filled in then. These horizontal rows are in narrow vertical plates, varying from a few thousandths of an inch to an inch or more in breadth, arranged radially in the trunk of the tree. The vertical cells are closed but the horizontal ones are not, and it is on the latter that the preservative is forced.

A word should be said concerning the decay of timber before applying the treatment. The decay of plant body is purely an organic process, due to the activities of low forms of plant life, called bacteria and fungi. These are among the simplest forms of life, often consisting of a single cell, microscopic in size. They feed upon the cell walls of the wood structure but in addition to food they must have heat, air, and moisture for their growth. Only very climatic furnish sufficient heat so it is only by depriving the animal life of food, moisture or air that decay can be prevented.

The best method of doing this is by injecting poisonous substances into the cellular openings of the wood. Of the many solutions which have been proposed, only two are in common use in the United States. They are zinc chloride and creosote oil. As the former is soluble it is not suitable for use in paving blocks and will not be discussed.

Creosote oil is not a modern invention. In a patent dated 1830, Mr. John Bethel mentioned under the term "Creosoting", cinnabar and pheresene substances, and among these, a mixture consisting of coal tar thinned with one to one and a half times the quantity of dear oil distilled from coal tar. This is claimed to be the origin of the so-called creosoting process. From that day to this there has been steady increase in the use of fire or material, consequently continued improvements in the methods of creosoting.

Mr. Carl Crawford, in a paper before the Association of Wood Preservers, January 1907, shows how marked these improvements have been. He states that: "The last few years have witnessed a great activity in wood preservation
Throughout the entire country, and this activity has manifested itself along the following lines: First, the increase in number and capacity of treating plants. Second, the improvement in existing methods, and the introduction of new methods, and the development of new methods designed to meet American requirements. Then, the promotion of more careful and detailed study of the technology of American woods, and an investigation of the constituents and properties of the conservatives in general use.

Bulletin Number 14, United States Department of Agriculture, expresses the conditions to which the wood preservative should conform.

"1. It must be poisonous to bacteria and other insects resulting a tree.
"2. It must be capable of easy injection, the when once in the wood, ought to stay there.
"3. It must regenerate all to one of a stock of timber.
"4. It must be cheap."

The above investigations exclude from the list of conservatives those which employ oil soluble in water, and fix one's attention on the conservants water, which is without doubt the most useful and best method that is adopted. The good oil is antisepticic and insoluble. It calls the wood calls excluding moisture and preventing attacking from elements of decay.

The dead oil of coal tar or creosote oil, as a product of the distillation of coal tar. Distillates of coal tar arrange themselves into three groups: Naphtha - those lighter than water; coal oil or creosote - those heavier than water; and tar. The first group may volatile at ordinary temperature, is not a suitable preservative. The third group is since the treatment way at present in the manufacture of roofing tar, in the construction of the so-called terec treated gravel roofs, and are a filler for cement. The second group includes all the essential necessary for the preservation of timber. This group can
be further divided into substances, either acids or bases.

The question of the quality of the creosote oil for various kinds of work is a very important one. The conditions under which the different kinds of timber are to be used have a very important bearing on the quality as well as the quantity of oil to be injected.

Ordinary creosote oil is not entirely waterproof, but it has been found by experiment that it may be made so by adding resin to it. When this mixture is used in treatment, we have what is known as the creosote-resin process. Plain creosote softens the fibre of the wood to a certain extent, but resin has been found to work against this softening quality of the oil and in addition to waterproofing the blocks it hardens them and leaves them firmer in texture than the natural, wellseasoned wood.

A few years ago the question of creasing blocks with creosote-resin mixture was complicated by the advance in price of resin from one dollar forty cents to four dollars seventy cents per barrel. The increase in price naturally suggested the use of another material, or a reduction in the amount used. Great difficulty has been found in obtaining any material which will take the place of resin for an appealing and hardening the blocks. A thorough investigation of the subject led to the conclusion that by improving the quality of the oil, the resin content could be reduced. Creosote oil is generally fixed for its specific gravity and its volatileizing points. By increasing the specific gravity and drastically reducing the amount that evaporates at given temperatures, a far heavier and more permanent oil is secured, and with the use of such an oil the amount of resin may safely be cut in half. These conclusions are on the results of long and continued experimentation, both as to the quality of securing thorough treatment with oils of this character, and as to the waterproof qualities of the resulting product. It has also been found that blocks thus treated
with one containing only twenty-five per cent of resin. The more waterproofthan blocks treated with thirty per cent contain fifty per cent of resin.

Thus it is seen that although the field is still open for the development of an ideal preservation, a very good one has all ready been obtained, and the success of the later pavements has shown the possibilities of wood block paving.

The Republic Chemical and Coating Co. of Indianapolis, Indiana, by a series of experiments has obtained a concrete oil they call 'kreodone', which has met with very good success. The oil seems to be a permanent preservative, and it also materially increases the toughness of the wood. This latter quality is clearly shown in the treatment of long leaf yellow pine blocks.

This timber in its natural state has a resistance to crushing of about eight thousand five hundred pounds per square inch. Treated with kreodone the resistance was about eleven thousand pounds per square inch. In tests on this oil recently conducted by the city of Indianapolis, it was found to be non-soluble and non-volatile. The chemist who conducted the tests reported that the blocks treated with this oil were equal for variations in area of exposed surface and variation in weight after drying for twenty-four hours at two hundred degrees Fahrenheit, and immersing in water for the same length of time at the same temperature. The blocks showed no variation in area of exposed surface after the test and one block showed no gain in weight after immersion. The others showed a gain of seven hundred of one per cent in weight.

Foundation and laying.

For the most satisfactory service, wood block pavement requires a concrete foundation. This is usually made from five to six inches thick, although in some lightly traveled streets it is once four inches, and on some heavily
traveled Strange is a made seven inches. As a cushion for the blocks either portland cement, mortar or sand is used. The former is not considered superior by most engineers. The bearing is permanent, and if carefully surfaced, the blocks can be made as even as desired. If the ground is made slightly damp and the blocks laid in it immediately, it provides as good a compensation for minor inequalities in the height of the blocks as sand. Some use the same growth to surf ace and allow to set, after which a thin coat of tar is applied and the blocks imbedded in it. Sand makes a satisfactory cushion on light grades where the foundation is solid. It is sometimes preferred on the ground of greater elasticity and power of accommodation, and it has the merit of being cheaper than cement. But on grades, sand is not so good. If water gets under the blocks it is likely to carry the sand in the foot of the slope and thus seriously damage the pavement. On bridges if there is much crown in the roadway, the vibration of the structure is likely to shift the sand from the center toward the gutter. For bridges, however, the usual practice is to lay the blocks directly upon planking.

The blocks should be rigidly inspected, especially as to the imperfections of sawing, as to knotholes, decay, defective corners or edges, as to squareness of the angles, and as to thoroughness of impregnation. Many of any of these imperfections often can not be properly filled by the joint filler, and are very detrimental to the pavement.

Sand is entirely excluded by the good paving specifications.

Under existing market conditions, however, it is quite impossible to obtain strictly all heartwood. The true longleaf pine has usually so narrow a sawn width that it may be no better without danger to the life of the pavement. By commercial longleaf pine is also seldom found from an admixture of loblolly pine. This is a sort of second growth which has come on very rapidly and is nearly
The angle at which the courses are laid is a matter of some importance. The most natural angle is that of ninety degrees to the curb. Probably the greater part of the road pavements in the United States have been so laid. But this angle permits the tire of the horses shoes to strike in a direct line with the joints, and subjects the pavement to a wear and tear which may be largely avoided by laying the courses at an oblique angle. With the courses laid at such an angle, the thrust of the pavement in case of expansion will be perpendicular to the direction upon the curb, and the transverse expansion joints may be entirely suppressed.

The oblique angle which is naturally sugest itself is forty-five degrees, and a large amount of pavement has been laid at that rate. Thence, however, developed an objection to this angle. Transverse expansion in one takes place in two directions, tangential to the ridge of the curb, and radially to them. Of these expansions, the tangential is the greater. The common method of sawing circles from a log is such that a majority of the blocks have their long axes in a plane tangential to the annual rings, and face inward or inward. Therefore the force due to tangential expansion will be exerted chiefly in the direction of the courses of the blocks, and the lesser radial force will be exerted at right angles to that direction. The angle of forty-five degrees does not compensate the difference in expansions in the two, and properly constructed pavements having courses laid at that angle have been developed.

The angle between forty-five and ninety degrees therefore becomes the subject of much discussion, making the angle at the curb sixty-seven and one
half degrees. This alteration was an entirely empirical one, but it served to avoid the difficult as far as possible for its visible aid.

The question of proper joints to be used in the block pavement received a great deal of attention. Take one question of a similar nature, it is impossible to generalize a plan that is right for joints in the as for all conditions. On streets where the paving is heavy, the cracks are laid close together and the action of travel tends to expand the beds of the blocks, gradually, making the joints close up. The joints are formed in the surface of the pavement itself, homogeneous to the surface of an asphalt road, are of course for the entrance of water exist. No very black pavement will be affected by the water which runs over it, but the water can run under the blocks through the joints, and remain there for days in the process of being cracked up, expansion set in and the place, even if it were thoroughly coated with black. The joints must conform to the character of the base itself and from the material of the pavement.

It has, therefore, been found that on streets where the travel is not sufficiently heavy to cause the multiplication of the surface, asphalt proof or expanded joints should be provided. In the Borough of Queens, in 1903 a fifty-five by seven square blocks were laid in addition to the right of way:— Half inch expansion joints were left along the curb, and along the road, on a grade with our tracks. These joints were filled with paving pitch. Similar joints were placed across the street at intervals of the quarter inch.

It is interesting to note that not only have there been no evidence of any swelling on those streets, but in cases of material, the expansion joints have been brought into use. That would indicate that in that instance the expansion joint was unnecessary. Never-the-less, more experience is necessary that it be a rule on all streets paved in 1903.

In some cities expansion of joints were placed at covering the
When the pitch gets in this shape it is tracked onto the side-lake and into the buildings, so it is unsatisfactory to the property owner. Some citizen attempt to fill the joints with the pitch, but if any workmen can accurately put joints of this character without getting more pitch on the surface than they do in the joint.

If pitch is to be used care should be taken not only to leave as little on the surface as possible when smoothing it, but also to ensure that even the surface while the pitch is not yet dry, the heat of the surface will be gathered all in a reasonably short time.

A cement grout is very quickly applied, and the surface of the base is ready in a short time. In fact, under these circumstances there is no time to build in the usual necessity of using the sand for covering as at all. The cement joint gives no sign for expansion, so this difficulty may be overcome by using a moisture joint.
COMPARISON WITH OTHER PAVEMENTS.

Recent experiments among cities in various parts of the state, with their experience in the use of granite, of different kinds of pavement, have led to the belief that Indiana quartzite, when used and worn on streets as received, fifteen times as well as, and more cleanly than, granite, and hundreds of years without any repair, are seven per cent. less, or more, the former, slower and more quicks. Although this cannot be shown in every proof, it is a certainty of the kind of pavement, if the facts are used, to be the best for investigation. The experience with red block pavements in this country has been exceedingly unfortunate, and one of the facts is that inferior material has been selected and used to the worst advantage. The reason for the introduction of better material and correct mixture, after experience for changing the bad opinion of sand, is that it is likely to become one of the most popular pavements where traffic is heavy.

The best quality of grit is generally reserved for the most durable pavements that can be laid. For this reason, it is selected for the most heavily traveled streets of our large cities. It is costly, but it is considered more economical to use because of its longer life and the ease with which it can be repaired. It is also more suited to slender, more succeeding to this traffic. I may sound absurd to say, to claim an equal or greater life for sand pavement, but that is what the makers of this latter pavement are doing, and no results from recent tests seem to show that much will be the case.

To test the quality of durability, the chief engineer of the Metropolitan Traction Company, New York, has had a strip of sand laid between the railway tracks on Hudson Streeet, where the traffic is exceedingly heavy. In this particular spot the best granite never lasted more than two and a half years, usually less than this. Along side of this road in a parallel track he
laid an equal amount of granite. At the time of laying, we had been down six months, and the wood seemed to be standing the wear better than the granite. The chief fault of granite is that it chips off around the edges of the block, thus making so that the surface is smaller than that of a cobble stone pavement. In the wood this fault does not occur. After two years, blocks were taken from the center of Tremont street, Boston, and were found to have decreased uniformly in thickness about one eighth of an inch, or an average of one sixteenth of an inch per year. This is not one alone a year, but partly to the compaction of the upper layers of the wood.

Rough street bridge over the Chicago river crosses without doubt the heaviest bridge traffic in the United States. By actual count in 1899, it was found that there were on the average about eleven thousand vehicles, mostly heavy trucks and cars, passing daily. Prior to 1899, this bridge had been paved with untreated wood. The chief officer of the city, being in the attention of the city engineer, sent an investigation committee to look into the matter. The committee reported favorably, and it was decided to try the creosote wood on half of the bridge and also the other half and the untreated wood. This was done, the creosote wood being on the face of the creosote wood along all four sides. This was done under a ten year guarantee.

At the end of four years the treated strips showed a very even wear of only one eighth of an inch, while the untreated wood was worn very unevenly, from one to two inches. This latter piece was replaced by creosote strips.

Mayor Harrigan, in the annual message to the city council on April 2, 1901, after referring to the excellent showing of the creosote, said: "The traffic on this bridge is of the heaviest character, the streets being built up so as to throw traffic of a large propor-
A short time after the pavement was laid in Rainier Avenue, South Park at the corner, tests experimentally, a small section of Oregon redwood block pavement on Michigan Avenue in front of the Auditorium Hotel. This section was especially well put on, being five inch blocks laid on from seven to eight inches of concrete. In August, 1902, Mr. J. F. Foster, general superintendent and engineer of the South Park Board of Commissioners, said: "The pavement is in most excellent condition of the black pavement. It is practically, in good condition now as when laid, although the traffic on this part is very heavy. No repairs have been made on it during every one of these years. I have talked concerning it in greatly surprised to learn that it is in such excellent condition."

Although now in its ninth year of service, this pavement is in all but perfect condition, in fact it has every appearance of a new pavement. Cracks have previously been noted perfect piece of pavement and the ends of "street" seem to be perfectly clean and preserved for the future commerce of the street.

The city of New York City is putting in 140 acres of redwood blocks, made at a great saving for the manufacture of the pavement. New York has been ten years confounding itself the fact that it can allow heavy trucking to be done in its office auditorium district. The position of the building at the lower end of the street, with its many floors building, makes it
The first hint of relief from the interference came with the laying of the new trolley tracks on West Broadway. They were made by the city and were intended to reduce the traffic. The new trolley was a light and elegant design, and it affected the comfort of both the downtown and the country road. At considerable cost, political and commercial committees were formed to promote the interests of the residents. The result was that the traffic was reduced by the opening of 1.5 miles of track, which was not enough for many demands, but it was a definite improvement in the face of the facts that the track was so narrow and the blocks were too close together.

The following is an extract from the New York Times, describing the laying of West Broadway.

[Excerpt from the New York Times]
GREATER NEW YORK.

Showing Streets Paved with Wood Blocks.

1. Battery Place
2. Greenwich St.
3. Broadway
4. Liberty Street
5. Cortland Street
6. Cortland Street
7. Day Street
8. Vesey Street
9. West Broadway
10. Murray Street
11. Warren Street
12. Chambers Street

13. Reade Street
14. Duane Street
15. Worth Street
16. Hudson Street
17. Staple Street
18. Duane Street
19. Reade Street
20. Beekman Street
21. Oic Slip
22. John Street
23. Cedar Street
24. Barclay Street

25. Park Place
has just been laid at Broadway, from the Battery of Whitehall ... the road.

... the Battery, excepting two or three places. It may

Marble, possible, but it is the fact that the blocks have in a concrete foundation,
such as the required for Broadway, will cure all the stone which
they replace. The granite, the pulverized and broken under traffic, becoming
round and rough like cobble stones. The result is that heavy traffic creases in
abundance. Our estimating contractor in Athens with off-top permits
also, the whole will probably keep several feet open. In the part it is
impossible to do this because, to meet the strength and cohesion are
the wants of business along Broadway. The five block pavement, however,
would have no objection to this work.

"As these are the only ones, I am using them for these blocks. The fact
that they are used together is practically definite; hence, proves their splitting of concrete for any traffic. Traffic
and, makes the pavement start, closing down four times in a year. The
material upon which the blocks are laid here and the blocks of marble have
no effect.

"A duplicate of this has always been one of the 'cement' street
streets at Boston five years ago, and it is yet in the same place, with
well likely to remain there, and another piece in Athens the same. In support of
the manufacturer's claim a similar piece will be given for a trial.

... therefore, blocks, laid on Harvard streets with no other, and not in
very good condition after a year or one of years."

For general work in Charleston, New York,manufacture the pavement, and from
Lake, I have blocks are four, and by either maker, all materials like pine, cotton.
"specification. One block, 4000 feet; one and one-half

The Onslow.
The best way to pave in the blocks allowed an absorption of only half the
minimum of the water per cent. The foundations are four and a half bricks of con-
crete and a two half brick cushion. The pilasters on cornice and Land and
The stone and tile are kept clean from time to time.

An extract from the Report of the Committee of the Market Street, Mer-
nchants Protective Association of Philadelphia, which appeared in the Phil-
adelphia Inquirer, New York, was presented in the May 15, 1905, number of Municipal Engineering. The extract says: "As one goes over the
Philadelphia streets and old streets of New York, you cannot help but remark at
how much better the paving is being done by some of the larger-organized cities.
In the Philadelphia street and New York City, all main streets are better than the Belted Brick Philadelphia paved with
or not dependent on Belgian Bricks. In fact, the differences are in the appearance
your committee felt that the Philadelphia had been paving again for almost
five years before the times.

"To assure ourselves that this improvement of our streets, we called on a number of merchants whose places of business were
in streets paved with stone brick, and did not find one expressing regret. On the contrary, many
of those visited our interviewers in the subject, and with one of their own
as well as of the many advantages of this kind of paving.

"The people were called to our attention by almost every one we inter-
viewed. Our attention in every case we called at was of necessity brought
of stone brick paving, and in many cases the merchant would say that
no. stone brick is correct, increased in business since more than a year ago
regarded, and a decided advantage in the comfort of their business, as they no
longer had the least bit of trouble in being telephones, but did their
exper-

The extract states that the sensation of stone and tile are kept clean from time to time.

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exper-

The extract states that the sensation of stone and tile are kept clean from time to time.
once my inconsiderable conversance with the change, over and a third of the street. In reference to this question, it was further to state that the com-

mittee was in the habit of using such walking to the

fire, for a period of at least fifteen minutes, and during this time did not experience the least difficulty in making the surface heard in speaking in an

ordinary conversational tone. Another point was that the absence of a

almost assured lack of dust and dust, and water, which would require a great deal of

care, say, that the very block paved last fall went over in New York with

leaves, and the clearest streets we had ever seen anywhere. This condition is

larger, and the case with which this pavement is cleaned, either by haying or a heavy rainfall.

"There are with a number of other questions, in making a point to the

every merchant: 'If your street were as we proposed, would you favor some paving?'

In every instance the answer was a decided no.

A more or less different method of laying was adopted in Brooklyn recently, in the case of the bridge paved, the Washington Avenue Bridge over the Willi-

abrook Canal, and the Metropolitan Avenue Bridge over Newtown Creek. In both cases

the blocks were laid directly on the yellow pant flooring without an intervening cushion. At the top of the track was only three inches above the floor,

three inch blocks had to be used. On the latter bridge, the flooring was even and the best results were obtained, but in the former, the flooring was badly warped,

and the uneven bearing caused many of the blocks to split under heavy traffic.

This spalling has, however, done no apparent damage to the pavement. It is

guaranteed for five years although the planking previously used had to be removed every year at a cost of about one cent per square yard. For five

years the wood alone costs about six dollars, but the wood blocks were large, including the guarantee, for about ten cents per square yard.
A later form of construction is found on the Williamsburg, R. & E. River bridge, Here the blocks are laid directly on a surface formed by laying steel channels longitudinally on the bridge. This surface is covered with asphaltic cement, and the blocks laid there on. Thus construction is of more because it is fire-proof.

In 1900 the authorities of Baltimore, Maryland, determined to make a comparative or. a number of selected pavements. Accordingly, Holliday Street, between Fayette and Baltimore streets, was chosen, and the city engineer invited a number of street pavement contractors to put down a sample of their pavement at their expense. The street was divided into three sections, each section one hundred fifty-feet long and forty-nine and one-half feet wide. Thus three sections were selected by the city engineer for these were results of the large stone in gravel; the street car cross-ways, and the clear space of eighteen feet between the west rail and the west curb, thus giving the heat and best conditions on the same street.

The accompanying diagram shows the division of the street into eleven strips of the said lane, varying from fifteen to thirty feet in length. There were several makes of vitrified brick, two sections of smooth asphalt, one of asphalt block, and one of cross-rotated sand blocks.

During the first year it was evident that none of the brick was going to show comparatively unsatisfactorily results. At the end of four years the superiority of the stone blocks was clearly evident, and in 1907, after seven years, the road was formally concluded, as all of the paving with the exception of the stone block, was in near it less the condition.

The results of these tests were so marked in favor of the stone blocks that this pavement was extended over the entire street. By special permission from the city, practically all the old stone blocks taken out of the road for
PLAN OF SAMPLE PAVEMENTS LAID ON HOLLIDAY STREET
section was made again in the new work. During their seven years of use they
had not worn enough to interfere with their use with the new blocks, and our
preservation, as good as when originally laid. Even the great Building Fair, which
ruled all over the neighborhood, had done no damage worth noticing, although
some of the blocks were slightly charred by smoke before which had cropped
upon them.

One of the severest tests this pavement has ever been subjected to
in America, was on the west side of Market Street in San Francisco, where all the
Southern Pacific freight trains emptied their immense cargoes of heavy freight.
Market Street at this point took the entire traffic, and the paving had long
been the source of much trouble. In 1892 a pavement of granite blocks was entirely
ly destroyed by traffic, and in 1893 two asphalt pavements were completely
worn out. In 1894 a pavement of wood blocks on six inches of concrete was laid,
and when reported in 1897, after four years, the paver was worn and no break
in the surface.

Another extraordinarily enduring of wood block pavement has been laid
on California Street, San Francisco, at front of the palatial homes of the
multi-millionaires of that city. This pavement was put down in 1877, and then
inspected in 1895 by Mr. H. L. Collier, Commissioner of Public Works of New York,
was in excellent condition. Not the slightest irregularity was perceptible on
its surface. There was no sign of wear or decay, and the unified surface gave
it the appearance of the best sheet asphalt. Some of the blocks were cut out
and, although they had been down for twenty-one years, were found to be perfectly
sound.

These few examples can not, of course, be regarded as final. There
have been instances in which creosoted blocks have given poor results. But it
should not be forgotten that poor preservative treatment of the wood, or fault,
construction of the pavement may cause the base to fail. The cited instances of successful pavements indicate that such errors are responsible for the failures which have occurred, and that wood block pavement, properly prepared and laid, should be credited with a durability greater than is usually given it.

The United States Forest Service, in investigating wood block paving in the United States, sought opinions from the engineers of a number of American cities who have had experience with modern creosoted block pavements, as to the comparative qualities of different kinds of pavements. The results of the inquiry are given in the following table. Under the percentage column, the various qualities desired in a pavement are assigned proportionate values, the total being one hundred points. The pavement ranking first under any given quality as given the full quality per cent, the rest grading down from this value in proper proportion. The figures given are the averages of ten replies to the inquiry.
### Comparative Value of Different Pavements

<table>
<thead>
<tr>
<th>Pavement Quality</th>
<th>Paverient Asphalt</th>
<th>Granite Stone</th>
<th>Asphalt (sheet)</th>
<th>Brick</th>
<th>Macadam Avg. per sq. yd. laid, 1905</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheapness (first cost)</td>
<td>14</td>
<td>4.0</td>
<td>1.0</td>
<td>6.5</td>
<td>6.5</td>
</tr>
<tr>
<td>Durability</td>
<td>20</td>
<td>20.0</td>
<td>17.5</td>
<td>10.0</td>
<td>11.0</td>
</tr>
<tr>
<td>Ease of maintenance</td>
<td>10</td>
<td>5.5</td>
<td>10.0</td>
<td>7.5</td>
<td>5.0</td>
</tr>
<tr>
<td>Ease of cleaning</td>
<td>14</td>
<td>10.0</td>
<td>14.0</td>
<td>14.0</td>
<td>11.0</td>
</tr>
<tr>
<td>Low traction resistance</td>
<td>14</td>
<td>8.5</td>
<td>9.5</td>
<td>14.0</td>
<td>13.5</td>
</tr>
<tr>
<td>Freedom from wrinklessness (average conditions)</td>
<td>7</td>
<td>5.5</td>
<td>7.0</td>
<td>3.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Favorableness to travel</td>
<td>4</td>
<td>2.5</td>
<td>3.5</td>
<td>4.0</td>
<td>3.5</td>
</tr>
<tr>
<td>Acceptability</td>
<td>4</td>
<td>2.0</td>
<td>2.0</td>
<td>2.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Sanitary quality</td>
<td>13</td>
<td>3.0</td>
<td>2.5</td>
<td>13.0</td>
<td>12.0</td>
</tr>
<tr>
<td>Total number of points</td>
<td>100</td>
<td>71.0</td>
<td>73.5</td>
<td>76.0</td>
<td>79.0</td>
</tr>
</tbody>
</table>

Average cost per square yard laid, 1905

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$3.26</td>
<td>$3.30</td>
<td>$2.90</td>
<td>$2.05</td>
<td>$0.99</td>
</tr>
</tbody>
</table>
TEST OF PAVING BLOCKS.

The test was conducted with blocks obtained from the Kalamazoo River Quarries Co., Minneapolis, eight sample blocks for testing. The blocks were of Tamarick, four by four by eight inches, and were treated with sixteen pounds of creosote oil per cubic foot of wood. They were tested for absorption, and expansion of exposed area, after drying for forty-eight hours in air at seventy degrees Centigrade, and then immersing for forty-eight hours in water at seventy degrees Centigrade.

The following table shows the results obtained:

<table>
<thead>
<tr>
<th>Specimen number</th>
<th>weight in air</th>
<th>weight after drying</th>
<th>weight in water</th>
<th>weight after soaking</th>
<th>absorption per cent</th>
<th>expansion per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.000 0</td>
<td>1.281 0</td>
<td>-1.268 0</td>
<td>-2.551 0</td>
<td>1.3</td>
<td>2.3</td>
</tr>
<tr>
<td>2</td>
<td>1.000 3</td>
<td>1.284 0</td>
<td>-1.261 0</td>
<td>-2.535 0</td>
<td>1.4</td>
<td>2.3</td>
</tr>
<tr>
<td>3</td>
<td>1.000 7</td>
<td>1.280 0</td>
<td>-1.266 0</td>
<td>-2.522 0</td>
<td>1.3</td>
<td>2.3</td>
</tr>
<tr>
<td>4</td>
<td>1.000 0</td>
<td>1.282 0</td>
<td>-1.268 0</td>
<td>-2.550 0</td>
<td>1.2</td>
<td>2.2</td>
</tr>
<tr>
<td>5</td>
<td>1.000 3</td>
<td>1.286 0</td>
<td>-1.263 0</td>
<td>-2.538 0</td>
<td>1.3</td>
<td>2.3</td>
</tr>
<tr>
<td>6</td>
<td>1.000 1</td>
<td>1.285 0</td>
<td>-1.265 0</td>
<td>-2.541 0</td>
<td>2.0</td>
<td>1.5</td>
</tr>
<tr>
<td>7</td>
<td>1.000 3</td>
<td>1.280 0</td>
<td>-1.266 0</td>
<td>-2.524 0</td>
<td>1.3</td>
<td>2.3</td>
</tr>
<tr>
<td>8</td>
<td>1.000 0</td>
<td>1.285 0</td>
<td>-1.265 0</td>
<td>-2.540 0</td>
<td>1.4</td>
<td>2.4</td>
</tr>
<tr>
<td>Average</td>
<td>1.000 2</td>
<td>1.285 0</td>
<td>-1.265 0</td>
<td>-2.537 0</td>
<td>1.4</td>
<td>2.4</td>
</tr>
</tbody>
</table>
SPECIFICATIONS FOR PAVING BLOCKS. MINNEAPOLIS.

The wearing surface shall be composed of crosscutted Nrve, pane, lanka,
rock, or Jill. No second growth timber will be accepted. Blocks shall submit
separate bills on the following:

A. A block 4" in depth, 1" in width, and 1" to 10" in length, treated
with 10# of creosote oil to the cu. ft.

B. A block 1" in depth, 1" in width, and 1" to 10" in length, treated
with 10# of creosote oil to the cu. ft.

C. A block 3 1/2" in depth, 1" in width, and 1" to 10" in length,
treated with 15# of creosote oil to the cu. ft.

D. A block 3 1/2" in depth, 1" in width, and 1" to 10" in length,
treated with 15# of creosote oil to the cu. ft.

E. A block 1" in depth, 1" in width, and 1" to 10" in length, treated
with 15# of creosote oil to the cu. ft.

F. A block 3" in depth, 1" in width, and 1" to 10" in length, treated
with 15# of creosote oil to the cu. ft.

All blocks shall be rectangular, of uniform depth and thickness,
free from defects, cracks, checks, worm or knot holes, or other injurious defects
affecting the life of the block or the laying of the base, and shall be made of
sufficiently hard, and well weathered oak, maple, or proper hardwood, as
here-in-after specified.
SPECIFICATIONS FOR TREATING PAVING BLOCKS.

MINNEAPOLIS.

After the blocks shall have been made of the specified kind of material, and all the effective blocks have been removed, they shall be placed in an air-tight chamber, then, by means of heat and vacuum, all the air and moisture shall be removed.

The vacuum shall be not less than 20 in. of mercury and the heat shall be carried out with an oven, as to injure in any manner, the floor of the blocks.

While the chamber is under vacuum, the creosoting mixture, at the quality as before specified, and heated to a proper temperature, shall be admitted the pressure added and weighted and until the blocks have absorbed the required amount of the mixture for one cubic foot of timber, or until the creosoting mixture shall have entirely penetrated and thoroughly filled the timber.

CREOSOTE OIL FOR PAVING BLOCKS.

The oil to be used in the treatment of the blocks shall be a pure heavy creosote oil, obtained from coal tar only, and of the following qualities:

A. The specific gravity of the oil shall be at least 1.01 at a temperature of 50° C.

B. It shall be completely liquid at 20° C., and become completely cold to 22° C.

C. It shall be subjected to a distillation test, as specified below, and shall contain no free forming resin:

100 grams of the shall be placed in a 1-liter Erlenmeyer flask with a thermometer, the water of the bulb of which shall be placed 2/3 of the way up, and not above the bulb. The corking of the bulb shall be firm, and the test shall be covered as fast as possible for rapid distillation. The percentage of oil and the are by weight.
Up to 150° C. - no doubt - C to L.
' " 200° " - 0% 0%
' " 220° " " 0% " 0%
' " 240° " " 0% " 0%
The crystallisation shall be gradual and at 2515° C. shall be completed in 20 minutes.

The specific gravity 1 at 104° C. and 1 at 21° C.

D. In the presence of lead as 15% of the amount of lead. In water, crystallisation 10% for the lead.
SPECIFICATIONS FOR WOOD BLOCK PAVEMENTS.

BOSTON.

(1) All blocks shall be long enough to give a full run of 24 inches. The blocks shall be laid in a continuous line, adjacent to each other. The joints shall be filled with a mix of 2 parts of cement to 1 part of sand, thoroughly mixed. The blocks shall be laid on a bed of clean screened sand, 6 inches deep, and shall be placed on edge, with the end grain in line with the curb. The blocks shall be laid in such a manner that the joints are even and smooth, and shall be laid in a continuous line, adjacent to each other. The joints shall be filled with a mix of 2 parts of cement to 1 part of sand, thoroughly mixed. The blocks shall be laid on a bed of clean screened sand, 6 inches deep, and shall be placed on edge, with the end grain in line with the curb.

(2) Blocks, unless otherwise specified, shall be laid to an angle of 15° with the curb. This angle shall be maintained throughout the life of the block. No block shall be laid unless it is to be used.

(3) Blocks may be used on flat grades.

The blocks are to be laid on an incline of 2%, and on the grade the upper side is raised 110° F. At this pressure, the blocks are to be held for 2 hours. If the angle is then increased, the pressure is raised, and care is taken gradually to avoid injury to the wood. For the next 10 minutes, the pressure is raised to 300° F., and pressure of 40#/in² is allowed for one half hour. At the end of this time the wood is to be raised to 220° F., and the pressure is 40#/in². The pressure is then relieved, and the blocks are raised to 200° F., and hydraulic pressure is applied, reaching 100#/in². The blocks are to be laid on a bed of clean screened sand, 6 inches deep, and shall be placed on edge, with the end grain in line with the curb. The blocks shall be laid in such a manner that the joints are even and smooth, and shall be laid in a continuous line, adjacent to each other. The joints shall be filled with a mix of 2 parts of cement to 1 part of sand, thoroughly mixed. The blocks shall be laid on a bed of clean screened sand, 6 inches deep, and shall be placed on edge, with the end grain in line with the curb.

(4) The blocks are to be laid close, on a 6-inch order. The blocks shall be laid on a bed of 6 inches of clean screened sand, at 6 inches after the curb, and at such an angle that the curb is directed by the supervision of the inspector. The blocks shall be laid in such a manner that the joints are even and smooth, and shall be laid in a continuous line, adjacent to each other. The joints shall be filled with a mix of 2 parts of cement to 1 part of sand, thoroughly mixed. The blocks shall be laid on a bed of clean screened sand, 6 inches deep, and shall be placed on edge, with the end grain in line with the curb.
and are to be driven at least 1/4, or more if possible, at every third joint.

(1) The joints are to be filled with the caulking mixture on the lower surface that lyes one, and the block before it is set, before any filling mixture. The joint is then to be filled with a firm filling, sufficient to raise the mixture to 1800° F., or permit correct growth of anhydrite.

(2) The surface of the paving should be protected by being covered with one-fourth inch, or a deposit of stone, bone, stone, or a mixture, as desired.
SPECIFICATIONS FOR WOOD BLOCK PAVING. BROOKLYN.

(1) The bearing surface shall be composed of long leaf, all heart, yellow pine blocks, treated as hereinafter described. All blocks shall be of sound timber, free from bark, sapwood, loose or rotten knots, or other defects which shall be detrimental to the life of the block or interfere with its laying. No second growth timber will be allowed.

(2) The blocks are to be treated throughout with an antiseptic and water-proof mixture, at least fifty per cent of which shall be dead oil of coal tar, commonly called creosote oil. The remainder to be resin or some other similar and suitable water-proof material. All portions of each individual block shall be thoroughly treated with the mixture, and after treatment the specific gravity of the blocks shall be greater than that of the water.

(3) After treatment the blocks shall show such water-proof qualities that, after being placed in an oven at a temperature of one hundred degrees for a period of twenty-four hours, weighed, and then immersed in clear water for a period of twenty-four hours and weighed, the gain in weight shall not be greater than three per cent.

(4) In preparing the blocks to receive the creosote mixture, they shall be placed in an air tight cylinder in which dry heat is maintained and raised to a temperature of two hundred degrees F. for one hour for the purpose of expelling moisture; the heat shall then be increased until it reaches one hundred eighty-five degrees, the hour being maintained until the block is completely sterilized. Application of heat is then to be stopped and the temperature of the cylinder allowed to fall for one hour, or until the temperature has been reduced to 250 degrees. A vacuum shall then be applied until about twenty-six inches is reached, and while under this vacuum the creosote mixture shall be run into the cylinder at a temperature from 175 to 200 degrees, after
much hydraulic pressure of not less than 200 pounds per square inch shall be maintained until the individual blocks are creased throughout.

(5) Upon the surface of the concrete foundation shall be spread a bed of cement mortar one half inch in thickness; that mortar surface shall be composed of a sand setting cement and clean, sharp sand, free from pebbles over one fourth inch in diameter, and mixed in the proportion of one part cement to four parts of sand. The mortar top shall be 'struck' to a true surface exactly parallel to the top of the finished pavement.

(6) The blocks shall not be less than two and one half inches wide, seven inches long and three inches deep, or three inches wide, eight inches long and four inches deep, uniform in depth or thickness. They shall be laid with the grain vertical and at such angle with the curb as the Engineer may direct. They shall be laid in parallel courses with the joints as tight as possible, each block being firmly imbedded in the mortar bed so as to form a true and even surface. The joints shall then be filled and kept filled with clean, fine sand.