Publications

BULLETIN

OF THE

UNIVERSITY OF TEXAS

1915: No. 26

MAY 5 1915

Street Paving in Texas

Edited by

Edward T. Paxton

Of the Bureau of Municipal Research and Reference

MUNICIPAL RESEARCH SERIES No. 9

Published by the University six times a month and entered as second class matter at the postoffice at Austin, Texas

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The benefits of education and of useful knowledge, generally diffused through a community, are essential to the preservation of a free government.

Sam Houston.

Cultivated mind is the guardian genius of democracy. . . . It is the only dictator that freemen acknowledge and the only security that freemen desire.

Mirabeau B. Lamar.

FOREWORD

This bulletin presents a brief exposition of the importance of street paving as a municipal problem and of the magnitude of the public interest involved, and offers a modicum of information about the pavements which have been laid in Texas, and a few suggestions, in the hope that their possession may aid city engineers and city councils and commissions in the intelligent care and treatment of Texas streets.

The editor expresses his special indebtedness to Mr. L. W. Kemp, Manager of the Sales Department, Paving and Roads Division, of The Texas Company, and to Prof. E. C. H. Bantel, of the School of Civil Engineering at the University of Texas.

E. T. P.

THE STREET-PAVING PROBLEM

"Street paving in American cities has not kept pace with the other departments of municipal public work. This is principally due to the fact that the theory and practice of paving city streets has not been developed along scientific lines, and this condition is in turn largely attributable to the fact that the work has not been sufficiently under control of competent engineers. The public does not understand or appreciate that street paving is a branch of municipal work requiring for its proper conduct the knowledge and experience of able engineers. The engineer has been ignored and unappreciated, and his function has been assumed by other civic authorities. The results, painfully obvious in most of our cities, are what might be expected. . . .

"It may be confidently asserted that the first and most important step in any successful attempt at reform in American street paving practice must be the recognition that it is a branch of municipal work which requires the services of the high-class engineer, whose advice and authority must be accepted and allowed to control. With this first step taken, the others necessarily will follow automatically. . . ."*

This portrayal of conditions is blunt, and the four years that have passed since it was written may have tempered the situation somewhat; but not many moments of reflection are needed to convince one that as a portrayal of conditions it is still essentially correct. To take a single more recent instance, in the Summer of 1913 the Chamber of Commerce of Cleveland, Ohio, began an investigation of the paving conditions in that city. The report of the investigating committee says: "Communications were directed to civic organizations and to city officials in a number of the more important cities in this country, for the purpose of procuring reports and other data that might assist your committee in its work. From several of these cities valuable information was received, *but we were surprised to find how little tabulated information was obtainable upon this important subject, and how*

*Mr. Samuel Whinery, consulting engineer, of New York, in the *Engineering Record* of September 30, 1911.

*little consideration had been given to it by civic organizations and city officials in the more important cities of this country.''**

Here is a report presented scarcely more than a year ago; and a subsequent investigation of paving conditions in Akron, Ohio, brings to light a practically parallel situation.

A mile of paved street is an appreciated asset to a town or city; but it is not so imposing as a fire station, or a high school, or a storage reservoir; and as a piece of construction it does not make such a popular appeal as any kind of a structure that stands higher than a man and can be seen in three dimensions. But, with street paving costing $2.00 a square yard, the paving of a mile of street 30 feet wide represents an investment of $35,000. The net construction cost of a single mile of pavement would put up a respectable eight-room brick school building. Two miles of pavement are an investment of the same magnitude as a complete steam-electric light and power plant capable of serving a community of from 7,000 to 10,000 inhabitants. Then, with the selection of paving material left, as it often is, to lie between a plastic Council committee and a smooth-tongued contractor; with scant attention, or even scant intelligent interest, given to the matter by the people who pay for the streets or the people who use them; with inspection perfunctory during construction and often entirely lacking after the pavement is laid; is there any wonder that, under these conditions, the streets of the American city have been a sinkhole in which, constantly, dollar after dollar of taxpayers' money has found its resting place?

The first step, then, in the direction of better paved streets consists in making the people who are interested in paved streets aware of what a big, efficiency-demanding proposition street paving is.

The second step consists in making available all the information possible regarding the various kinds of pavement and paving materials, their nature, cost, and such history as they may have made for themselves in the cities where they have been laid. This material is of interest and profit not only to the citizen, but also to the city engineer. Failure and success, as applied to street paving, are relative terms. There is practically no kind of pave-

**Cleveland Pavements*, a report of the Municipal Committee of the Cleveland Chamber of Commerce, April 18, 1914.

ment whose history of service is not checkered with good records and bad, and no single kind can be recommended indiscriminately or censured indiscriminately. The performance of a pavement depends on the honesty and efficiency of its construction, the kind of care taken of it, the climate, the soil, the kind of base used, the kind of traffic to which the pavement is subjected, and the care taken of the streets, as to cleaning and repair, after the pavement is laid. The only successful way to select a street pavement is first to make note of the conditions under which it will be required to operate, and second to examine the performance of various kinds of pavement already in service under parallel conditions. The wide-awake city engineer welcomes, therefore, all the knowledge he can get of other cities' paving experiences. To be of some assistance in this direction is the purpose of the present bulletin.

The third step in securing good pavement is a step that, like the first one, each city must take for itself. Having gained a conception of the magnitude of the street-paving problem, and having informed themselves of the experiences of other cities, the third step before our citizens is to insist that their pavement is selected wisely, laid honestly, and kept in repair. They must insist that the type of pavement chosen is selected for adaptability to the climate of the city and the soil and traffic requirements of the particular street to be paved, and that the selection is not influenced by the private interests of the paving committee or the city engineer. They must insist that the city engineer is capable and disinterested and works solely for the welfare of the city; that specifications are clearly and fairly drawn; that the contractor is a responsible party; that only good quality of materials is used; that the work of construction is honestly done, and that the street, after it is laid, is regularly inspected and kept in repair. Only the insistence of the citizens of a city can accomplish these results, and where interest has been roused and information has been acquired and these results have not been accomplished, the citizens of that city can hold no one but themselves to blame.

The Bureau of Municipal Research and Reference, in the course of seeking answers to queries that had been put to it with regard to the cost of street paving, had the good fortune to gain

the consent of Mr. L. W. Kemp, of Houston, to make use of an article previously prepared by him on the history of street paving in Texas. Mr. Kemp, a former student at the University of Texas, is now Manager of the Sales Department, Paving and Roads Division, of The Texas Company. The course of his work has taken him into every town and city in Texas that has paved streets, and as a matter of personal interest he began collection of such historical data as could be obtained about the various pavements. Later, Mr. Kemp expanded his data into a paper, which he read before the civil engineering department of the University of Texas in May, 1914, and subsequently before the civil engineering department of the Agricultural and Mechanical College of Texas. When asked by the Bureau to permit the use of his paper in the present bulletin, Mr. Kemp not only gave his consent but made a complete revision of the paper, bringing it down to date.

It has already been pointed out that pavements are rarely either total failures or total successes. Due to local variations in wisdom of choice or manner of laying, the same pavement may last for years in one city and have to be plowed up at the end of nine months in another. A few general suggestions, in addition to Mr. Kemp's paper, have been included in this bulletin, but no attempt is made to criticize, favorably or unfavorably, the various pavements that have been laid in Texas, nor to list any specific instances of success or failure. To make such an attempt without at the same time presenting an analysis of the conditions in each case contributing to success or failure, would be misleading, unfair, and harmful; while, on the other hand, an analysis of that kind would go considerably beyond the limits placed on our present efforts. The purpose at hand is served when we have given an idea of average costs and told where the different pavements have been laid, or may be found in service. Each city engineer can then learn for himself, by personal inspection or direct inquiry, the record that each piece of construction has made for itself, and can judge from his findings what type of pavement is best suited to the purpose his city has at hand.

For those who wish to take further advantage of its services, however, the Bureau of Municipal Research and Reference keeps on hand considerable detailed information on street paving, in-

cluding specifications, reports of investigations, and written opinions of engineers. This material is always accessible to anyone who wishes to use it at the Bureau's office in Austin; or specific inquiries addressed to the Bureau will be answered individually, to the extent of the Bureau's resources.

STREET PAVING IN TEXAS

For the past few years my work as a representative of the firm which manufactures Texaco Asphalt has caused me to visit every town and city in Texas which has paved streets, and as a matter of information, I began two years ago to try to compile a record, or history, of paving in this State. Although such a history does not date back for more than thirty years, it has been no easy matter to record it. The files and records kept by most of the city engineers of early date—if such were kept—have long since been lost or destroyed, and I have had to get information about the work either from the old engineers themselves or from contractors who have resided in Texas for a number of years and are familiar with the work in question. Mr. F. O. Brown of Dallas, a pioneer contractor of Texas, gave me more information than anyone else. He has the distinction of having laid the first pavements in several cities (then towns) in Texas.

The question of the proper pavement to select has always been a difficult one—and is a difficult one today. Opinions differ widely on the subject. Most pavements now being advocated have merit when properly constructed and laid under conditions of climate and traffic to which they are best adapted. Some pavements prove distinct successes in one town and rank failures in another. In such event the failure is caused either by improper construction or by subjecting the pavement to a traffic condition for which it was not intended.

In this article I shall not attempt to express my opinion of the merits of the various pavements found in the State. Neither shall I mention where they have been successfully or unsuccessfully laid. I shall, in addition to an attempt to state where each was first introduced in Texas, give brief specifications for each and name the towns and cities where each may be found today. Then, if the reader is trying to solve the problem of the proper pavement to select, he will know where to go in search of information.

NICHOLSON PAVEMENT

As well as I can ascertain, the first permanent paving in Texas was done in Galveston in about 1878 or 1879, with "Nicholson" pavement, by J. W. Byrens. This pavement consisted of cypress timber sawed 4 inches wide, 6 inches deep and in lengths varying from 6 to 16 inches, laid on edge. Between each layer was placed a strip of the same timber 1 inch thick and only 4 inches deep. The 2-inch depth of open space thus left was filled with coal tar over which was thrown gravel.

In 1887, Congress avenue, from Fannin street to St. Charles

street, in Houston, was paved with the "Nicholson" pavement, by Wm. Boyd & Company, at $3.25 per square yard. This information was obtained from Mr. Matt Drennan, the present Street Commissioner of Houston, who was then a member of the Wm. Boyd firm.

BOIS D'ARC BLOCKS

Bois d'arc block pavements were introduced in Texas in 1885, in Dallas, at a cost of $1.75 per square yard. Bois d'arc timber was at that time plentiful around Dallas and in other parts of Texas. The first blocks laid were 12 inches long, but on subsequent contracts the length was reduced to 6 inches. The blocks were irregular in shape and size and were wedged with splinters of the same material. They were set on about 6 inches of gravel, which was covered with about one inch of sand. Not being of uniform size, they did not fit close together, and naturally the surface was very rough for travel. This, though a serious one, was the principle objection to them. They would seemingly last forever. The principal business street in Corsicana has been paved with them for more than 20 years and the blocks are in nearly as good a state of preservation today as they were the day they were laid. They were placed on a concrete base.

In Texas, bois d'arc blocks were laid in Dallas, Houston, San Antonio, Fort Worth, Galveston, Paris and Corsicana. The cost in Dallas at the time they were laid was $1.75 per square yard.

CREOSOTED WOOD BLOCKS

The first creosoted pine blocks used in Texas were put down on several streets in Galveston in 1885. They were 6 inches wide, from 8 to 12 inches long and 6 inches deep. No more were laid until 1909, when the City of Dallas paved Stone street, from Main to Elm, one block, with the type of blocks now in use. These are 4 inches wide, 8 inches long and of three sizes: 3, 3½ and 4 inches deep, impregnated with from 16 to 20 pounds of creosote oil to the cubic foot. They are laid on a one-inch sand cushion, and the interstices are filled with either sand or asphalt.

In Dallas, on August 3, 1914, the following prices were bid, on 18-pound treatment blocks, including 5-inch concrete base: 3-inch blocks, sand filler, $2.80 per square yard; asphalt filler, $2.88 per square yard. 3½-inch blocks, sand filler, $2.98 per square yard; asphalt filler, $3.06 per square yard. 4-inch blocks, sand filler, $3.27 per square yard; asphalt filler, $3.35 per square yard.

Texas cities where creosoted wood block pavements have been laid with sand filler are: Houston, Fort Worth, Waco, Beaumont, Austin, Paris, Amarillo, Longview, Taylor and San Angelo. Those where asphalt filler has been used are: San Antonio, Dallas, Houston and Nacogdoches.

CEDAR BLOCKS

In 1891 the principal business streets of Waco were paved with cedar blocks at a cost of $1.45 per square yard. Like bois d'arc blocks, they were irregular in size, and consequently very rough on the surface. They were removed in 1901 from most of the streets and reset in the alleys, where many of them are found today, well preserved.

VITRIFIED BRICK

Standard vitrified paving blocks, or "bricks," as they are generally called, are usually laid on edge on 1½ inches of sand cushion on 5 inches of concrete base. However, in Greenville and Waco on certain streets they have been laid flat. The depth of the sand cushion, too, is not always the same on all contracts; and the concrete base, as is the case with most other pavements, varies from 4 to 6 inches, according to the conditions under which the pavement is laid. The interstices may be filled with either sand, cement grout, pitch or asphalt.

The first brick pavements in Texas were laid in Houston on McKinney avenue and on other streets in 1892 and 1893, on gravel base. These brick were made in Garrison, Texas, and burned in an ordinary kiln, and were not, therefore, vitrified In 1899, vitrified brick were laid in South Flores street in San Antonio, and Murphy street in Dallas, and in Sixth street in Fort Worth. Standard brick pavements in Dallas, with grout filler, cost $2.19 per square yard, with asphalt filler $2.26 per square yard.

The following cities have standard brick pavements with grout filler: San Antonio, Dallas, Houston, Fort Worth, Galveston, El Paso, Austin, Waco, Beaumont, Denison, Sherman, Paris, Tyler, Temple, Amarillo, Texarkana, Greenville, Gainesville, Hillsboro, McKinney, Waxahachie, Stamford, Granger, Bowie, and Niles (North Fort Worth). Standard brick with asphalt filler has been used in Dallas, Houston, Galveston, Waco, Paris, Denison, Tyler, Texarkana, Nacogdoches, Greenville and Houston Heights.

OKLAHOMA ROCK ASPHALT*

Deposits of rock asphalt are found in several parts of Oklahoma, the largest being near Ardmore and Ada. Here sandstone is found impregnated with asphalt. It is mined and shipped

*The Bureau is informed that, when Oklahoma rock asphalt was first laid, the rock was ground and laid as found. The natural deposits varied considerably in percentage of sandstone and asphalt, however,

in boulders to the town where it is to be used, and here it is ground by machinery, heated and spread while hot, on a concrete base, to a depth of 2 inches after compression. The rock as mined runs unevenly in asphalt, containing from 4 to 8 per cent., but to this is added about 4 per cent. of refined asphalt. Oklahoma rock asphalt was first laid in Texas in 1897 in Dallas, on Main street, at $2.05 per square yard. In 1913, however, in Terrell, the price was $1.71. The pavement has been laid in Dallas, Fort Worth, Austin, Galveston, Paris, Sherman, Bonham, Terrell, Hillsboro and Mineral Wells, and recent contracts have been let in Marshall and Mount Pleasant.

UVALDE ROCK ASPHALT

Uvalde rock asphalt is found in Uvalde county, Texas. It is limestone, containing from 12 to 16 per cent. of asphalt. The Uvalde mines were first operated in about 1900, and paving was done with material from them in San Antonio, Houston, Fort Worth, Waco and Palestine. The mines were closed and not reopened until in 1913, when pavements were laid from them in Beaumont, Dallas, Houston and San Antonio, at about $2.00 per square yard on the usual 5 inches of concrete base.

SHEET ASPHALT

Sheet asphalt pavements consist of a "binder" course laid 1½ inches deep on the concrete base, and covered with a wearing surface 2 inches deep after compaction. The binder course is composed of a mixture of small stones and asphalt. The wearing surface is made of graded sand and asphalt heated separately, mechanically mixed and rolled. A batch mix for the wearing surface would run about 800 lbs. sand, 100 lbs. asphalt, and 75 lbs. stone dust or cement. The stone dust or cement is added to fill up the voids, thus making the pavement more dense.

The first sheet asphalt was laid in Dallas and Houston in 1900. Since then Houston and Fort Worth have laid more of it. In 1900, when all the asphalt was controlled by a monopoly, the pavements in Dallas cost $2.40 per square yard, but now, with competition, a recent bid of $2.05 was made in Houston.

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and the same variation appeared in the paving mixture and the resulting pavement. Of later years, contractors have adopted the policy of adding commercial asphalt to the natural mixture in proportions sufficient to insure that every batch mixed contains sufficient asphalt properly to bind the aggregate. A somewhat similar procedure seems to have been used in connection with Uvalde rock asphalt.—*Ed.*

MESQUITE BLOCKS

In 1901 the city of San Antonio paved Crockett street from Alamo plaza to Lasoya street with mesquite blocks. These blocks were smaller than the old style bois d'arc blocks, and were sawed in hexagon shape. In 1914 the city awarded contracts for paving a number of streets with rectangular mesquite blocks of the shape and size of the present day creosoted pine blocks. The city offered to supply the contractors with 3-inch blocks at $1.10 per square yard, and with 3½-inch blocks at $1.26; but it was found out that the blocks could not be obtained in sufficient quantities, and the city, therefore, withdrew its offer and the paving contracts were annulled.

BITULITHIC

Bitulithic is a patented pavement. The inventors sought to improve on sheet asphalt by substituting assorted sizes of crushed stone for sand. This, they claimed, would make the pavement more stable and would prevent it from getting too soft in the summer months. Bitulithic is composed of 2 inches of stone and asphalt mixed and applied in the same manner as in sheet asphalt. The stone ranges in size from coarse sand to fragments 1½ inches in diameter. These key together, giving the pavement "inherent stability" and reducing the voids below 21 per cent. of the aggregate. On this the patent was granted.

The first Bitulithic pavement in Texas was laid in April, 1906, in Dallas, where Swiss avenue was paved with it, from Fitzhugh to Munger. The price in Dallas is $2.20 per square yard. Since 1906 Bitulithic has been laid in Fort Worth, Houston, San Antonio, El Paso, Waco, Austin, Beaumont, Paris, Marshall, Abilene, Greenville and Corpus Christi. On some of the streets in Dallas and El Paso and on those in Marshall and Abilene it is laid on a "bituminous macadam" base.

GRANITOID

"Granitoid" is the trade name for a patented concrete pavement. The bottom course is composed of a mixture of 1 part cement, 3 parts of sand, and 4 parts of crushed stone, laid to a finished depth of 5¼ inches. Before the concrete sets it is covered with "Granitoid blocking," composed of 2 parts cement and 3 parts of crushed stone, ranging in size from 1-16 of an inch to ¼ of an inch. This surface is blocked off into rectangular blocks, and on this feature hinges the patent. The first Granitoid pavement in Texas was laid in Palestine in 1908. Since then it has been laid in Fort Worth, San Antonio, Belton and Mart. The price is about $2.15 per square yard.

ASPHALTIC CONCRETE

Asphaltic concrete specifications follow those of "Bitulithic" as closely as possible without infringing on the "Bitulithic" patents. In 1909 the Kaw Paving Company, originators of asphaltic concrete, laid a pavement in Topeka, Kansas, and were sued by the Bitulithic Company for infringing on their patents. The Kaw Paving Company won the suit in the United States District Court, District of Kansas, and since then the specifications they used have become known as the "Topeka Specifications." These specifications do not call for the use of stone over one-half inch in diameter, whereas the Bitulithic specifications provide for the use of stone as large as 1½ inches in diameter.

The first asphaltic concrete pavement in Texas was laid on Houston street in San Antonio in 1908, and a second job was put down a couple of months later in Dallas. Since then the pavement has been laid in Dallas, Houston, Fort Worth, Sherman, Denison, Greenville, Paris, Temple, Mineral Wells, Waco and McKinney.

ASPHALT MACADAM

Asphalt macadam is a pavement intended for residence streets. Its price per square yard, in Texas, ranges from 85 cents to $1.40, depending upon the cost of stone in different localities, and upon the many different specifications under which it has been laid; and these latter have differed widely as to the depth of the pavement and the quantity of asphalt to be used. Usually on top of a 5-inch macadam base a 2-inch wearing surface of broken stone, ranging in size from ¾-inch to 1½-inch, is spread, and over this is poured, in two applications, from 2 to 2½ gallons of heated asphalt to the square yard. The best results have been obtained by using 2½ gallons.

El Paso constructed the first asphalt macadam pavement in Texas in 1908. The following towns and cities have since laid it: Dallas, Houston, Fort Worth, El Paso, Marshall, Abilene, Longview, Hillsboro, Sweetwater, Wichita Falls, Mineral Wells and Highland Park (P. O. Dallas). In addition to this, asphalt macadam on a concrete base has been laid in Paris, Wichita Falls (one block), and San Angelo. In San Angelo, the price, on a 4-inch concrete base, was $1.23 per square yard.

VIBROLITHIC

The "Vibrolithic" pavement was patented by R. C. Stubbs, of Dallas, and the first street paved with it in Texas was in the Munger addition in Dallas in 1912. Mr. Stubbs' specifications call for concrete 6 inches deep, composed of 1 part cement and

5½ parts gravel. The concrete is made more dense, it is claimed, by the use of a vibrator, patented for the purpose. Before it is allowed to set the surface is covered with crushed stone ranging in size from ⅝-inch to 1 inch in diameter, and this is forced into the concrete by means of the vibrator mentioned. After the concrete has become thoroughly set it is painted with tar, over which is thrown stone screenings, thereby forming a wearing surface about ¼-inch thick. Besides in Dallas, contracts for "Vibrolithic" have been laid in Paris, Fort Worth, Greenville, San Antonio and Kaufman. The price was $1.75 per square yard in Dallas.

HASSAM

"Hassam" is another patented concrete pavement. In this the concrete is not mixed in the usual manner in a concrete mixer, but the stone is laid on the dirt foundation to a thickness of 6 inches after compaction, and then cement grout, composed of one part cement and one part sand, is poured over the surface by means of a patented distributer, while the rolling is continued until all the voids are filled and the mass thoroughly compacted. The first contract for "Hassam" in Texas was completed in Hillsboro in 1912 at $1.85 per square yard, and since then the pavement has been laid in Waco, Waxahachie and Houston.

DOLARWAY

"Dolarway" is a concrete pavement painted with a tar called "Dolarway Bitumen," in a manner similar to that used on "Vibrolithic." The mixture of the concrete is left to the city engineer of the city in which the pavement is to be laid; as is also the depth. This is not a patented pavement, but the name "Dolarway" is copyrighted, and "Dolarway Bitumen" is a brand of tar sold only by one company. The only "Dolarway" in Texas is in alleys in Waco and Austin. That in Waco was finished in November, 1912, at $1.35 per square yard.

UNPATENTED CONCRETE PAVEMENTS

Besides "Granitoid," "Hassam," "Vibrolithic" and "Dolarway," there have been a number of other concrete pavements laid in Texas, under various specifications, the prices varying as widely as those on asphalt macadam.

"Granited" concrete has been laid in Waco, Marlin and Hamlin. The price in Waco was $1.40 per square yard.

In San Antonio reinforced concrete pavements were laid in 1915 for $1.60 per square yard.

In Dallas, plain concrete pavements, 5 inches deep, composed of 1 part cement, 2 parts sand and 4 parts crushed stone, were contracted for at $1.07 per square yard.

Concrete pavements, besides those mentioned, have been laid in Houston, Galveston, Temple, Waxahachie, Yoakum and Palmer.

VERTICAL FIBER BRICK

In order to compete with other pavements in price and to overcome the greatest objection to brick pavements (that of noise) the brick interests have introduced recently a new brick which they term "vertical fiber brick." These bricks are of two sizes in depth, 3 inches and 2½ inches, and have a wearing surface of 4x8½ inches. They are intended for asphalt filler, the asphalt covering the entire surface as well as filling the interstices. Since their introduction in Texas they have almost entirely superseded the old style brick pavement. The first contract for vertical fiber brick pavement was awarded in Greenville in February, 1913. They have since been laid in Houston, Waco, Galveston, Fort Worth, Denison, Temple, Corsicana, McKinney and Sulphur Springs. Ennis has laid (1915) a vertical fiber brick pavement with asphalt filler. In McKinney the cost for 3-inch bricks on 5-inch concrete base was $1.95 per square yard.

WESTURMITE

"Westurmite," a patented pavement, is similar in composition to Bitulithic and asphaltic concrete, differing mainly in that the asphalt is not heated as in those pavements, but is dissolved by chemicals and laid cold. The first laid in Texas was completed in March, 1914, in Bryan, at $2.15. It has also been laid in Dallas and Houston.

L. W. KEMP.

SUPPLEMENTARY SUGGESTIONS

Although the choice of a type of pavement is a matter to be determined largely from local conditions, nevertheless there is a constant relation between the various types, with respect to traffic conditions, that may be stated here.

As Mr. Kemp points out in his paper, the opinions of engineers differ; but the consensus of opinion seems to be that for exceedingly heavy-traveled business streets of large cities 3½-inch or 4-inch creosoted wood blocks are to be recommended. This kind of pavement will bulge and buckle, however, if it does not receive traffic enough to keep it hammered down, and, indeed, it is rather doubtful if many streets in Texas afford this traffic. It is important in the use of wood blocks to keep the streets watered, and the blocks thus subjected to about the same amount of moisture all the time; for the result of a long, dry summer is usually to render the blocks porous, and a continuous rain following such a dry spell will cause the blocks to absorb an enormous amount of moisture in spite of their creosote treatment. It is readily seen that on but few streets is the traffic heavy enough and the watering continuous enough to keep the pavement in shape.

For less heavily traveled business streets Bitulithic, asphaltic concrete, sheet asphalt, and similar materials, seem well adapted. While these pavements probably will not stand the heavy traffic that creosoted wood blocks would bear, they seem capable of meeting the traffic requirements of nearly any Texas business street at the present time. But the tendency in the use of these materials, as in the use of creosoted wood blocks, is to overpave; that is, to put the pavement on a street on which traffic is not sufficiently heavy to keep the pavement in condition. An asphalt pavement is like a rubber band; if it is not used it soon loses its strength. Many instances are reported of asphalt streets that are badly cracked apparently because of lack of use, whereas the same pavements in the same city on more heavily traveled streets are smooth and in fair condition.

For residence streets and for business streets of small towns these paving materials gradually give way before brick, which is gaining great favor; the desirability of brick becoming greater

as the traffic on the street becomes lighter. Especially where streets are seldom cleaned, and where horses are allowed to stand hitched in one place for a long time, brick has an advantage over an asphaltic material because accumulation of dirt and manure has a tendency to rot asphalt. For some of these streets, where traffic is light and motor vehicles are not common, a well built and well kept gravel or macadam surface is still sometimes as satisfactory as any kind of more permanent pavement.

Indeed, in choosing a street surface it is worth while noting the changes in surface requirements imposed by the present preponderant use of automobiles and commercial motor vehicles. It is probably true that in Texas the horse will continue to use city pavements longer and in greater proportion than in the North and East, where cities are closer together, roads better, intercity motor traffic more feasible, and where the cities' rural neighbors make greater use of automobiles. Yet, at the present time, the heavy trucking in Texas cities, even as small as 20,000, is practically all done by motor trucks; and the use of automobiles by all classes of vehicle users is steadily increasing. The concrete results with regard to street building and surfacing are, the average business street is subjected to a heavier traffic than formerly; on all streets velocity of traffic has increased, and the principal destructive traffic force which a pavement has to stand up against is the velocity and suction of rubber tires, rather than the impact of horses' hoofs and the grinding of iron tires as heretofore; less dirt collects in the streets, and particularly less of the kind of dirt that causes pavements to rot; surfaces may now be used that were formerly rejected because they were thought too smooth to give secure footing to the heavy-burdened draft horse; and pavements, excellent in every other respect, which were formerly discriminated against on account of the excessive noise that horses made on them, may now be freely used, because it is doubtful if a motor vehicle makes more noise on any one kind of pavement than on any other.

One further point which is receiving attention in the choice of a street surface is the absorptive property of the surface with regard to artificial light. With the same number of kilowatts applied, a smooth surfaced paved street is much brighter than a muddy road, because one surface reflects light while the

other absorbs or consumes it. So, where other things are equal and two kinds of pavement have equally good records and promise to fulfill traffic and climatic requirements equally well, the choice of the kind which absorbs the least light insures a better lighted street for the same expenditure, and hence works economy for the city.

Finally, no kind of pavement, no matter how well chosen or how good the materials and workmanship, will make good unless it is laid on a firm and substantial base.

In the way of practical recommendations for the betterment of paving conditions, applicable in almost any city, there is perhaps nothing more appropriate than the extract quoted below from the report, previously referred to*, of the committee of the Cleveland Chamber of Commerce:

"Through its investigation of the subject, your committee has reached the conclusion that the present poor condition of the pavements is largely due:

"1. To the failure to properly repair and keep up pavements between and immediately adjacent to the street car tracks.

"2. To the fact that (through lack of sufficient appropriations for paving maintenance) the city has adopted the policy of repairing only those pavements that are actually dangerous, giving little or no attention to the smaller holes and broken places, which, in the interest of economy, should receive prompt attention.

"3. Funds have been wasted in the repair of pavements that should be repaved, in the effort to prolong their life far beyond the limit to which it was intended the pavement should last.

"4. The older pavements laid under obsolete specifications are unable to withstand the vibration and wear of present traffic.

"5. Demands of property owners protesting against the cost of appropriate pavements receive undue recognition from city officials, with the result that first cost takes precedence over ultimate economy.

"6. The growth of the city and changing conditions require alteration of sewers, water pipe and other underground structures, making necessary the frequent tearing up and replacement of pavements.

"7. Where pavements have been torn up, replacements have not been properly made.

"8. No traffic statistics have been kept as a basis for determining the value of the various kinds of construction.

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*See page 5.

"9. The city has never had a comprehensive paving program. Miles of new streets are laid each year, but no means are provided for keeping them in proper repair.

"A large number of pavements that were laid years ago have no concrete base. They were sufficient to bear the traffic of that day. The advent of the heavy motor truck has caused them to wear and break down rapidly. Formerly pavements in rough condition, being used only by slowly moving vehicles, were considered sufficient to meet the needs. With the fast moving vehicle and heavier truck of the present day, a smoother and more durable roadway is demanded.

"City officials of succeeding administrations have not seemed to realize the importance of keeping the city streets in proper repair. For a number of years the annual appropriations for this purpose have been entirely inadequate. As a result, the pavements have become worse from year to year, until the situation has reached a crisis demanding immediate attention. The loss to the community due to failure to properly maintain the pavements can not be determined accurately. The shortening of the life of pavements and the added maintenance cost form but a small part of the loss. To this must be added the wear and tear upon vehicles, the loss in horsepower in hauling loads over such surfaces, the added cost of street cleaning due to the uneven condition, and the injury to health due to resultant insanitary conditions.

"We are firmly of the opinion that if the true proportion of this loss were known to the community, present practices would not be tolerated, and public opinion would force city officials to give proper attention to this very important municipal function and provide ways and means for proper maintenance."

NOTE

Local street paving situations have been made the subject of report and recommendation in many cities during the past few years. Among the agencies which have undertaken local studies are the Chicago Bureau of Public Efficiency, the Cincinnati Bureau of Municipal Research, the Cleveland Chamber of Commerce, and the Municipal University of Akron, Ohio. The findings of these four agencies have been published, in each case in pamphlet form, and the pamphlets (which may probably still be obtained by addressing the several institutions and organizations) contain much of value to anyone particularly interested in city streets. The report of the Municipal University of Akron (*Akron Pavements,* by Fred E. Ayer, Municipal University,

Akron, Ohio, June, 1914) contains, in particular, a select bibliography of recent books and articles on city paving materials, compiled by the American Society of Civil Engineers.

INDEX TO PAVEMENTS LAID IN TEXAS

PUBLICATIONS OF THE BUREAU OF MUNICIPAL RESEARCH AND REFERENCE.

No. TITLE

1. *A Model Charter for Texas Cities,* Herman G. James, Feb. 10, 1914 (edition exhausted).
2. *A Model Charter for Texas Cities,* Herman G. James, March 1, 1914 (second edition).
3. *Announcement of Courses in Municipal Administration at the University of Texas,* Herman G. James, Sept. 5, 1914.
4. *Methods of Sewage Disposal for Texas Cities,* Robert M. Jameson, Oct. 1, 1914 (edition exhausted).
5. *A Model Civil Service Code for Texas Cities,* Herman G. James, Dec. 20, 1914.
6. *What Is the City Manager Plan?* Herman G. James, Feb. 20, 1915.
7. *A Student Survey of Austin, Texas,* William B. Hamilton; summarized by Herman G. James, Feb. 25, 1915.
8. *A Model Health Code for Texas Cities,* Robert M. Jameson, April 20, 1915.
9. *Street Paving in Texas,* Edited by Edward T. Paxton; principal article by L. W. Kemp, May 5, 1915.

Copies of the above bulletins may be had on application to the Bureau of Municipal Research and Reference, University of Texas.