AN ANALYSIS OF THE PAVEMENTS OF OWOSSO, MICHIGAN

THESIS FOR THE DEGREE OF B. S

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An Analysis of the Pavements of Owosso, Michigan

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THESIS

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SECTION A.

A BRIEF HISTORY OF PAVING

IN GENERAL

Section A.

A BRIEF HISTORY OF PAVING IN GENERAL

Pavements have been a leading feature of civilization, and their absence is evidence of a low degree of progress. The early history of pavements is involved in obscurity. The Roman empire depended almost as much on its pavements as on its armies. Strabo says Babylon was paved 2000 B.C., and Livy relates that 170 B.C. Rome was paved from the ox market to the temple of Venus. The more important Roman roads had a paved width of 16 feet, composed of several layers of stone, mortar and cement, the upper surface being quite smooth. Portions of these pavements are still used to some extent, the Appian Way being an example. It is said that the streets of Cordovia, Spain, were both paved and lighted by 950 A.D. but most of the mediaeval streets were unpaved until the twelfth century, these being only of rude construction, cobblestone being the common material.

The Dark Ages witnessed the virtual disappearance of pavements and it was not until the king of France was sickened to the point of vomiting by the odor of mud stirred by the passing vehicles that pavements began to be laid in Paris. Paris first had pavements about 1184. The first regular pavements in London were laid in 1533. In the United States cobblestone pavements were laid as early as 1650 in both Boston and New York. But records of New York show that streets in the very heart of the city were in a condition that in these days would be most intolerable.

It was not until the 19th century that paving came to be regarded as otherwise than a luxury to be indulged in only when

the demands of traffic made it cheaper to pave the streets than to flounder through mud holes and climb over hillocks. During the second quarter of the 19th century the cities in both Europe and America began to look around for better pavements and to experiment with stone and wood blocks and in Europe with Asphalt.

Asphalt was first used in Paris in 1838 and in London in 1869, both cases rock asphalt was used. The first asphalt pavement in United States was laid in Newark, N.J. in 1870. In 1871 some asphalt was laid in New York and Philadelphia, both cases Trinadad asphalt was used. Brick was used to pave roads in Holland as early as the 17th century. The first brick pavement on a roadway in the United States was laid at Charleston, West Virginia in 1870. Since 1900 the increase in the use of brick for pavements both on city streets and county roads has been remarkable.

Wood block pavements were laid in New York in 1835 and in 1839 wood pavements were already in use in both Philadelphia and Boston. Stone block of the modern type of 3 by 9 inches, granite, with mortor joints, were laid in London in 1840. A concrete foundation was used in London, the first in that city in 1872. Prior to 1849 scarcely any pavements but cobblestone were used in New York. Granite blocks similar to those now used were introduced in New York about 1876. Concrete foundations for stone block pavements were not used regularly in New York until 1888. Large stone blocks were used in St. Louis as early as 1818.

Concrete was probably first used for a pavement surface in Inverness, Scotland, about 1865. The first concrete pavement in America was laid in Bellefontaine, Ohio, in 1884. Since 1900 concrete has been very extensively used for street pavements, and since 1910 many miles of country roads have been paved with concrete.

In America the pavements now being laid are principally asphalt, brick, stone, wood, and concrete.

Another pavement, the compacted broken stone known as macadam or Telford, has been common on streets throughout the United States. Formerly these pavements were known as water bound, fragments of stone bonded together by a natural cement of dust and moisture. But such pavements have been unable to withstand the traffic of motor trucks, etc., and many of them have either been given a bituminous surface by the application of asphalt or tar oils or have been entirely discarded as street pavements.

Foundations are to pavements what floors are to carpets. Failure to recognize the importance of good foundations has been the bane of most American, and many foreign pavements. If the foundation yields through deficient drainage or bad material and workmanship the destruction of the pavement follows.

The necessity of street paving now is no longer a subject for discussion. It is regarded as much of a requirement of settled communities as water and lighting, and without it the enormour traffic of today would be impossible. The only questions are as to which pavements are best and the problem is one for the individual engineer on the individual job. In the endeavor to secure a durable and therefore economical pavement for each particular locality with due regard to future as well as present traffic, many kinds of resistant materials have been experimented with.

SECTION B.

A HISTORY OF THE PROGRESS OF PAVING IN OWOSSO.

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A HISTORY OF THE PROGRESS OF PAVING IN OWOSSO.

In 1823 the first survey of the land in and around Owosso was made. Ten years elapsed after the original survey and yet no rude settler's cabins or stumpy fields defaced natures landscape. In 1833 the first land was bought by an individual inside the present city limits. In 1835, on July 4 the day was celebrated by cutting out roads by the settlers, following the Indian trails usually. Owosso township was organized in 1837.

In 1856 the Grand Trunk Rail Road was built from Detroit through Owosso connecting the village with the outside world. The year 1837 was an eventful one in the history of Owosso, it wittnessed the formation of the township and the completion of the mill race along which most of the inhabitance lived. In 1838 the first regular store was opened by Ebenezer Gould, the same year Daniel Gould surveyed the original plot of the village. Most of the streets were four rods wide except Washington and Main and Exchange were six rods wide. In 1859 Washington St. bridge was built costing $250 before this the river was forded. In 1858 the Ramshorn railroad between Owosso and Lansing was built with 30 miles of track, it was fancifully called the "Almighty Long and Tremendously Bad Railroad."

In 1859 the place was incorporated as a city the population being about 1000 inhabitants.

In 1898 the first pavement was laid on North Washington St. from Mason to Main St.; on South Washington St. from Main St. to Comstalk and three blocks on Exchange and one block on Main St. These

streets were all paved with Warrenite Pavement put in by the Warren Scharf Asphalt Company of New York City. In 1899 four more blocks were paved by the same company finishing out the original plan of work. It is thus interesting to note that the first pavement was of asphalt. The base of the pavement was made of crushed stone and cement mixed. These materials were mixed by hand shoveling in long wooden mixing boxes, several men getting in the box and shoveling the materials over and over. The base was made six inches in thickness. Upon this was spread hot a two and one half inch thickness of sheet asphalt thoroughly rolled. These streets were made about sixty feet wide with a brick gutter and a concrete curb. Farther out from the center of town the pavement was cut down to forty-eight feet, with sidewalks of plank others of tar, concrete or stone.

In 1904 Macadam was put in on North Washington, 5200 square yards - laid on a six inch concrete base. During the same year about four blocks on South Washington was paved with the same material to Howard Street, all of 60 feet and 48 feet respectively.

For the next five years no paving was done in town but in 1909 a large program was begun. This year saw the advent of brick pavement which has become the principal paving material used in the downtown section. During this year about 1½ miles of brick on 6 inches of concrete was laid including: 13 blocks on Oliver St. 30 feet wide with concrete curb - brick gutter, 2 blocks on North Washington to Oliver St., 4 blocks on Michigan Avenue. These pavements were all laid on a 6 inch concrete base with a sand cushion. The brick were laid from curb to curb in straight courses at right angles to the curb with lug sides all in the same direction. Whole brick

were used throughout excepting half brick for starting alternate courses, and pieces of brick for closures. Mortar filler was used throughout. Considering these pavements have been in continual use for 20 years they have stood up very well. Motor truck traffic in the modern sense of the word was then undreamed of, and it is not surprising that its severity has at present caused trouble with these pavements, for they were never planned for it.

In 1911 West Main Street was paved with the same material, brick on sand and concrete with a mortor filler. This work consisted of 10 blocks. Concrete curb and gutter was used here. This pavement is likewise in use today but is badly rutted from heavy trucks, etc.

The asphalt got pretty well worn in about 15 years and in 1914 a program of resurfacing all the asphalt and macadam pavements was begun. Brick were laid over the old pavements. Holes or depressions were filled with concrete, then a sand cushion was spread over the pavement about one inch thick and the brick laid thereon, motor filler was used throughout. In this year Main St. was thus repaved. In 1915 Exchange St. was repaved along with South Washington, both of brick over the old asphalt. These streets in places show settlement now, which is due to the asphalt breaking up underneath. This can be expected somewhat for this base is now 30 years old. More brick on concrete with sand cushion was laid on South Washington and Ball Streets along with some brick alley pavements.

Sheet asphalt was laid in 1922 over a block of old concrete pavement on East Main St. This has proved very satisfactory to date and should help solve the problem of how to recondition some of the old brick pavements in the city.

Portland cement pavements began to be extensively used beginning in 1923. These pavements were laid in cooperation with the State Highway Department on trunk lines through the city. Thus South Washington to the city limits, West Main to the city limits, East Main to the city limits, North Shiawassee to the city limits and Corunna Avenue to the city limits were all paved with standard 7 inch concrete 20 feet wide by the state and the remainder by the city together with curb and gutter of concrete. Most of these pavements were made 36 feet wide.

This summer 1929 one half mile of concrete pavement will be laid completing a small loop of paving about the down town area.

There are three bridges in the city each of which is paved with creasoted wood block, keeping the dead load down on the bridges. The maintenance is rather large on this type of paving, however.

SECTION C.

PURPOSE OF THIS THESIS.

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THE PURPOSE OF THIS THESIS.

The purpose of this thesis is to make a study of the pavements in the city of Owosso, and to investigate the relative efficiency of the types of pavements found. This includes a study of the first cost, maintenance, utility, wearing qualities, life, etc., of the various types of pavements in use in the city, together with comparisons to determine which would be the most satisfactory under average conditions.

This investigation will try to point out a program for future work along the line of improving the city streets. It is the writer's purpose to show what type of paving is the cheapest generally, and what streets need such a road surface in order to economically handle the traffic which it is subjected to. To do this the several streets needing improvement are taken up separately and analyzed as to their needs, and to the needs of the city with reference to them.

SECTION D.

SURVEY OF THE DIFFERENT PAVEMENTS.

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There are in Owosso at the present time May 1929 about 85 miles of streets, of this mileage about 7¼ miles are paved. There are four classes, as follows;

1. Cement concrete - - - - - - - -about 3.7 miles.
2. Brick on concrete foundation- - " 3.5 "
3. Sheet asphalt- - - - - - - - - " 400 feet.
4. Wood block - - - - - - - - - - " 300 feet.

There is also in Owosso about one half mile of concrete pavement under construction consisting of 2 blocks on North Park St., 3 blocks on Mason St., 2 blocks on Water St., 1 block on South Ball St., and 1 block on Comstock.

Attention is called to the map of Owosso in the pocket at the back of this volume. Upon this map will be found indicated, the location of Owosso's paved streets, with a color key to the several kinds of pavements.

A survey was made of all these pavements, as regards to their present condition, the year laid and of the costs, where such was available, together with the location of each section.

LOCATION AND CONDITION OF BRICK ON CONCRETE PAVEMENTS.

The first brick pavement laid on concrete base with sand cushion was laid in 1909 on Oliver Street from Dewey St. at the east end to First St. on the west end. This is brick laid at right angles to the curbs. The pavement is worn quite badly in places, in other places the mortor covering and filler has hardly worn off the upper surface of the brick which are firm and in good condition. In some places the brick are cracked and broken and the pavement is rough. On the whole it is in fair condition.

North Washington from Oliver to Mason was laid the same year, 1909. It is in fair condition yet, and shows wear similar to the Oliver St. pavement. It is good for perhaps 10 years more.

Michigan from Main to the Ann Arbor Railway crossing was laid in 1909. It is in a fairly good condition. A few bricks are rounded and some are broken but the pavement has held up very

well being in constant use for 20 years, along with the Oliver and

North Washington St. pavements.

In 1911 West Main from the West Main St. bridge to the Ann Arbor Railroad was paved. This pavement is very rough throughout. The edges of the brick have been rounded off badly and many places the old brick have been removed and patched with new ones. It has been said that in some places "seconds" were used unknown to the city which of course would account partly for the poor condition of the pavement.

About 3 years ago the street car tracks were removed and the space filled in with brick none too carefully by the street car company's men which roughness adds to the roughness of the street.

In 1915 Ball St. from Main to Mason was paved. This pavement is in nice condition today al though a bit sagged in a few places.

In 1916 South Washington from the S. Wash. St. bridge to Ridge was paved at a cost of $2.36 per square yard. This pavement is in very good condition. The pavement has stood up particularly well

especially around the street car tracks. There are very few cracked brick present and little or no humps or depressions in evidence. As the picture shows it makes a very nice pavement for a residential section of the city.

In 1918 North Chipmon was paved from Main to Michigan Central Railway tracks. This pavement is laid with sufficient crown for good drainage and there are very few chipped or otherwise injured brick along the route.

Comstock from Main to Park was paved in 1919, it is in very good condition and shows little wear to date.

LOCATION AND CONDITION OF BRICK ON OLD SHEET ASPHALT OR MACADAM.

Washington from Mason to the Bridge was repaved in 1915. This pavement is in excellent condition generally although there is a depression or two along the way.

Main from the Bridge to Park St. was repaved in 1915. This pavement is in good condition at present although it has very

heavy traffic. It is about 70 feet wide, and as the accompanying picture shows makes an adequate pavement for the traffic and parking of cars.

Exchange St. from Water to Park St. was repaved in 1915. This is in very good condition, having less traffic on it, not many heavy trucks. The bricks show very little wear as yet. This road surface should be good for 20 years.

LOCATION AND CONDITION OF CEMENT CONCRETE PAVEMENTS.

East Main from Saginaw to the city limits was paved in 1923, the first large concrete job. This pavement was made 36 feet wide throughout being laid in co-operation with the State Highway Department (as with several other street jobs) a high standard of work was maintained. The pavement is in very good condition, no

chipped placed found and the smooth wearing surface intact. This pavement cost $2.41 laid.

South Water from Washington to Main was laid in 1923. This pavement is in very good condition; being a part of M-47 state trunk line the work of construction was carefully done. This road shows little wear.

West Main from Ann Arbor Railroad to city limits was laid in 1924. This is part of M-21 state route. The concrete is in fine condition and should be adequate for many years.

North Shiawassee from Main to the north city limits was paved in co-operation with State aid (being part of M-47) in

1924. This pavement is in good condition although some places show wear, and a few cracks are to be seen.

In 1925 South Washington and Gute Streets from Ridge to the city limits was paved, with state aid, being part of M-47. This pavement is in good condition although as seen from the picture the smooth wearing surface has worn off in places. Most of the pavement

is only 20 feet wide which allows for no parking except on the shoulders, which is not a very desirable feature.

In 1924 Corunna Avenue from Washington to the east

city limits was paved and in 1927 the street car tracks were taken up and that 10 foot width was paved. The whole pavement is in good condition. It is a 46 foot pavement and adequate to the needs for several years. Some cracks have occurred but no settlement has taken place anywhere.

South Park from Main to Comstock was opened in 1926 and in 1927 was paved. This street is in a most excellent condition and should be satisfactory for many years.

LOCATION AND CONDITION OF SHEET ASPHALT.

There is only one block at present of sheet asphalt in the city being between Park and Saginaw Streets on Main. This is laid over old concrete pavement. The pavement was laid in 1922 and is in excellent condition at present. This means of treatment should serve to put more of the old worn out pavements in good condition.

SECTION E.

DISCUSSION IN DETAIL OF EACH OF THE TYPES OF PAVEMENT FOUND IN OWOSSO.

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1. Portland Cement Concrete.

This type of pavement is the leading kind used in the city, there being over 50% concrete pavement in service at present, with one half mile now under contract which will bring concrete up to about 55%. Added to this most of the brick pavements have a base of concrete. Concrete paving is not new, it has been in use since 1865 at least. In Scotland concrete pavement is still in service after 57 years. Michigan ranks fifth in concrete road pavement in the United States which means that the State Highway Department thinks this type is superior to any other type of road surface. This conclusion applies equally well to city pavement except for some boulevard and residential sections. There are several reasons why concrete is so popular; it costs less to drive on concrete than any other type of pavement, ~~the maintenance cost is less than for any other type of pavement,~~ the maintenance cost is less than for any other of the popular types of pavements; this was proven by the New York State Highway Department and in Kansas, Wisconsin and other states, and that between wood block, brick, asphaltic concrete, and sheet asphalt, concrete was the cheapest to patch in case openings were made in the pavement.

Owosso's concrete roads were most all laid with aid from the State Highway, although some were not. The section of pavement chosen as being typical of cement concrete construction is on North Shiawassee St. near the intersection with Elizabeth St. This pavement

was laid in 1924, at a cost of $1.69 per square yard, under contract, without the cement cost being included. This work was done in co-operation with the State, it paying for 20 feet and the city standing the expense of the remaining width together with the curb and gutter. This was of 7" standard 1:2:4 mix. This figure $1.69 plus cement does not include grading etc., only the cost of placing and finishing the concrete. As to the matter of cost, the city this Spring (1929) let a contract with a Detroit firm to pave a little over one half mile of concrete at $1.33 per square yard with a 1:2:3½ mix, and substantially the same specifications are being used as was used in 1924 on Shiawassee St. Incidentally this is a very good price, the next higher bid being $1.46 per square yard.

This pavement forms a cheap, permanent, satisfactory

pavement for all purposes. The pavement like most of the others has no particular provision made for underdrainage, except for the crown of the subgrade which amounts to 5 inches in 50 feet. This road sees much heavy traffic, being a part of M-47 state trunk line. It has been in 6 years now, and as the above picture shows,

it has not worn appreciably, no checks nor cracks being in evidence. About the only transverse marks are the 100 foot expansion joints. This pavement is in excellent condition.

Below is shown a picture of the West Main St. concrete pavement, this was laid in 1924 and at the same price, $1.69 per square yard exclusive of cement. This pavement, laid in cooperation with the State, is in good condition although it shows to some extent the effect of the heavier traffic it receives. Around the manhole shown, the concrete is beginning to ravel and break away somewhat.

This type of pavement, if designed correctly and if care is taken in laying, will stand the heaviest kind of traffic; it is also fairly easy to clean, and is a sanitary kind of pavement, being practically impervious to water. On the other hand concrete is noisy, quite slippery and requires about three weeks to set properly. Another trouble with concrete is that expansion and contraction are liable to cause ugly cracks. Quite recently though, bar mat reinforcing has been adopted extensively, which reduces these cracks materially.

2. Brick on concrete.

This method of laying a brick pavement seems to be the best one. A concrete base, of true cross section crowned the same as the brick surface, is first laid. This base in the case of the pavement shown below was 6 inches thick, of a 1:2:5 mix.

This base was allowed to set before further work was done, then 1½ inches of fine sand, shaped to the true cross section and rolled with a hard roller, was placed upon the concrete base, the brick being laid on the sand. All joints were filled with a cement mortar filler.

Concrete bases are usually most favored for new construction although other bases under different conditions are satisfactory, for instance bases of rolled courses of gravel, crushed slag or broken stone, worn concrete pavements, worn macadam pavements, and worn gravel pavements are serving. No one type of base can or should be prescribed to meet all conditions, but there is no condition that cannot be met with one

of the bases listed.

The cost of laying the North Chipman street pavement was about $2.90 per square yard complete. The cost of laying a similar pavement today, using current prices for material and labor and time date from Gillette:

Excavation for curb	per sq. yd.	0.60
Concrete curb and gutter	" " "	0.70
Base 6" concrete 1:2½:5	" " "	1.15
40 Pavers at $42.50 per M	" " "	1.80
Hauling brick	" " "	.20
Laying brick	" " "	.10
Total per sq. yd.		$4.55

This estimate does not include grading nor does it include filler or cushion, which would add to the cost somewhat. The greatest drawback to such pavements today is the heavy first cost, which becomes almost prohibitive in cities in central Michigan. A city engineer told the writer that last year the cost of the three leading types of pavements laid in his city was: concrete 7 inch, $3.08; sheet asphalt with 6 inch concrete base, $3.25 and brick on sand and 6 inch concrete base $4.25, or a difference of $1.00 per square yard between brick and asphalt and concrete still under asphalt.

Of course one thing will help repay the heavy first cost of laying brick, the high salvage value. For instance the picture shows a section of old brick on West Oliver St. This pavement was laid in 1909 twenty years ago, these brick are pretty well worn. A very large percentage of the bricks in these old

roads and streets are in good enough condition and could be relaid, if the streets were reconditioned. By following such a program a large savings could be made in the cost of repaving these streets. Brick thus have a rather high salvage value, whereas concrete has practically no salvage value whatever. The life of good paving brick is demonstrated by the old brick pavements throughout the country. An investigation of the brick in these pavements, some of which are forty years old, proves beyond a doubt that a well manufactured paving brick will render satisfactory service under heavy traffic. The unsatisfactory brick pavements are almost entirely due to four causes; poor construction; either no foundation or one that is inadequate to the traffic; poor sub-soil conditions; and to specification requirements that have proved undesirable.

3. Brick on old asphalt and macadam.

The city has about ten blocks of brick laid on a sand cushion 1½ inches thick on old asphalt and macadam whose holes etc. had been filled up and leveled off with concrete. This brick work

was laid over the original 1898 pavement which had been in service 16 years. This pavement made a satisfactory base for the brick and saved the city the extra expense of tearing out this old pavement and putting in concrete base. The brick has been in 15 years and is in excellent condition, attesting to the good judgment of the commissioners. The brick was laid in the regular way with mortar filler. This pavement should be good for 20 years if the base holds up.

4. Sheet Asphalt.

Sheet asphalt pavement in Owosso has not been used for many years except in one block of East Main St. between Park and Saginaw St. This asphalt was laid over an old concrete pavement which had been in use a number of years. Over this old concrete pavement was laid a 2 inch asphaltic binder course upon which was placed a $\frac{1}{2}$ inch wearing course of sheet asphalt. This is the usual way sheet asphalt pavements are laid, with a 6 or 7 inch concrete base, a 2 inch asphaltic binder course and a $\frac{1}{2}$ to 1 inch sheet asphalt wearing surface.

Such a pavement in Lansing last year cost $3.25 per square yard complete with curb and gutter, a 6 inch concrete base and a $2\frac{1}{2}$" asphalt and binder above. Owosso paid $1.36 for the $2\frac{1}{2}$ binder and asphalt surface alone, the curb and base being in place. This was because the city had no plant of its own, a city owned asphalt plant properly managed can save the city a large amount on its asphalt bill.

An asphalt pavement should cost a city with its own equipment about $3.25 to $3.50 per square yard. As the unit cost of Owosso's curb and the original concrete pavement are not known

now, it is impossible to compute the total cost of the work but it would doubtless run high. That is the principle drawback as far as asphalt pavement is concerned i.e. the extra cost of getting in a temporary plant to handle the asphalt work along with the fact that an asphalt pavement is more expensive than the concrete pavement.

East Main Street sheet asphalt pavement has been in use for seven years and has proven very satisfactory. It is undesirable to use sheet asphalt on streets where vehicles continually stand along the curb unless that portion of the street is paved with blocks of some kind. The slipperiness of sheet asphalt pavement is about the worst objection to it. Grades should not exceed 4 or 5 per cent usually. Sheet asphalt requires a certain amount of traffic to keep it alive, in light traffic streets the part of the pavement next to the curb becomes granular and sometimes cracks badly. Sheet asphalt also deteriorates under concentrated traffic such as may be expected on a narrow street with busy double track car line .

SECTION F.

RECOMMENDATIONS FOR A PAVING PROGRAM.

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RECOMMENDATIONS FOR A PAVING PROGRAM.

Owosso has done very little work toward the pavement improvement of her streets within the last five years, indeed only one block on South Park Street has been paved in this interval, that with 7 inch concrete, 60 feet wide. This is a poor condition when only one block from the very center of the city there is only gravel streets and bad gravel at that, most of the graveling having been done 16 years ago and little work has been done on them since, except occasional scarifying and grading.

The principal reason for the deplorable condition of Owosso's streets at present is the lack of funds. The city's overhead expenses are pretty well fixed. There are bonds to retire, interest to be met, and running expenses to be paid. The department of public improvements usually takes what is left for the maintenance of the streets. For instance this last year the department got only $15,300 for the streets and departmental expenses. Out of this small sum had to be paid the fixed expenses of the department, leaving virtually nothing for street improvement. This is why no extensive repairing or even gravelling of the streets has been undertaken.

The city from 1914 to 1928 has raised an average of a little over $7,000 a year for paving purposes. It will cost about $5,000 per mile to properly repair the rutted and almost impassable streets, of which Owosso has 80 miles.

The paving improvement of Owosso's streets naturally divides itself into three parts. The program should include (a) the resurfacing of old worn out pavements, (b) present new construction that should be undertaken now, (c) future paving needs to care for increased population and traffic.

Resurfacing.

Of Owosso's 7½ miles of pavement about 2 miles is of old brick pavement that has been laid for 20 years. This brick work is very badly worn especially on West Main St. for about ¾ mile. This stretch of pavement has had very severe usage from continual traffic from "West town" to the main part of the city and within recent years from cross-state traffic along M-21 and M-47. It is surprising how well this pavement has stood up, but today it is entirely worn out (or nearly so) and definite steps should be taken to put it in a more serviceable condition soon. This pavement has become very rough and is constantly getting worse at a rapid rate due to the heavy trucking. A glance at the picture of this pavement on a previous page shows one that the bricks are generally badly worn, with rounded edges, and many are chipped and broken under traffic, with the filler pretty well out of the joints.

This street receives the heaviest traffic of any in the city. It is very poor economy to let an old worn out street remain in place, for it costs much more for gasoline for an automobile, more for tires, and for maintenance of a car, to run it over poor roads.

There are several means of improving these old worn out brick pavements by resurfacing. The brick could be taken up and the better ones turned over and relaid, of course not 100% would be serviceable so new brick would have to be bought which alone cost $42 to $45 per thousand so either a surface of concrete or sheet asphalt would be superior probably.

If the proper mix were used, either type would be satisfactory, so it would probably resolve itself into one of economy. The sheet asphalt wearing surface could be built over the old brick, made 2½ inches thick, with binder, for about $1.25 per square yard. (Lansing did this last year on a street for $1.20.) A satisfactory concrete surface could be laid over old brick using a 1:2:3½ mix, and bar mat reinforcement, used with 4 inch concrete for about $1.18. There is little difference in price, concrete being around $0.07 cheaper, but it gives a thicker wearing surface and would stand the heavy traffic better and blends in more with the rest of the city's concrete pavement. This type of concrete surfacing can well be adopted for all the old worn pavements. It is satisfactory, for the State Highway has used it along with the Highways of California, New York, Indiana, Ohio, Texas, and Idaho for resurfacing old pavements.

Present New Construction.

The construction that should be taken up immediately includes the blocks shown cross-hatched on the map in the back of the cover. Those include Park from Main to Mason, 2 blocks of 46 ft. wide ; Mason from Park to Water 46 ft. wide to Ball, and 40 from Ball to Water; Water from Mason to Main 46 ft. wide; Com-

stock from Water to Washington, 40 ft. wide; and Ball from Main to Comstock 40 ft. wide. These streets have needed paving for a number of years, for estimations were made some ten years ago, but due to the lack of funds they were allowed to go unpaved.

These few streets each has store frontage facing them, also apartments, and are completely built up. A good pavement is absolutely essential if such stores etc., are to get trade. Another thing, gravel and dirt streets make poor parking space for cars, no one wants to get out of his car and step in mud ankle deep! A gravel street under such heavy downtown traffic simply cannot hold up. They must be scarified and graded two or three times a year, and then in a month they are a mass of ruts and hillocks to flounder over. Such streets are a very poor advertisement for any city that wants to grow.

Most of these streets are 30 ft. and 36 ft. wide, which is too narrow for cars for angle parking on both sides of the street. The city is very wisely setting the curbes back 5 ft. on each side making most of the blocks 46 ft. wide when paved. This will be a boon to farmers and other Saturday shoppers who find it very difficult indeed to find a good place to park near where they wish to shop. Such a hard surface ought to raise property values along the streets considerably.

Another great advantage for the city to consider is the great savings in maintenance costs. New York state over a ten year period (1916-25) averaged: first class concrete, maintenance $227; gravel $914, or on the same milage of road after concreted, maintenance cost was reduced about 75%. Waukesha county, Wisconsin found its maintenance costs were similiarly

reduced 66%. So the savings in maintenance alone would go a long way toward paying for the hard surface pavement.

The streets above named must absolutely be paved. The question is what kind of pavement to use for the work. As was shown previously as far as price is concerned cement concrete has the advantage. Sheet asphalt on a 6 inch concrete base costs about $3.25 per square yard, brick on sand and a 6 inch concrete base costs about $4.25 per square yard, and a 7 inch concrete pavement costs about $3.08 or $3.10 per square yard. These prices are of course estimated but are close to actual costs. Thus concrete is the most economical. The first concrete pavement in the United States was laid in 1892 and after 37 years of traffic it is still giving perfect service today. So with modern engineering, cement concrete roads should have a life as long as any other type.

There has been on file with the city, petitions for paving of Washington from Oliver to King; Williams from Washington to Shiawassee; Ridge from Washington to Michigan and Comstock from Park to Saginaw. These petitions have been on file for a year or more and some definite action should be taken soon. All of these jobs are necessary, as evidenced by the majority (60%) of the abutting property owners signatures on the petition.

Enclosed in the back pocket of this cover is a blue print of the proposed loop pavement which is being undertaken this summer.

Future Paving Program.

Owosso needs to adopt a future paving improvement program for her miles of unpaved streets. Out of some 80 miles of streets there is only about 7½ miles paved and these are almost wholly state trunk lines. There is probably not more than a mile of pavement that was not state aid road work. All of Main St. is a trunk line, all of Shiawassee St. pavement is a trunk line, about half of the length of Washington St. is trunk line, and these streets compose the major part of the city's pavements.

A five or ten year paving program that would hard surface six or seven miles of Owosso's streets should be immediately planned, for Owosso is far behind in her paving, but like the majority of cities it is difficult to get the funds to carry on an extensive program and many times the street work must suffer in order that the other departments of the city can carry on its work. The only solution to such a plan is to float a bond issue, so planned that it could be handled without increasing the city's tax rate.

Such a paving program should be built up on a thorough traffic study of Owosso's needs, for of course for a pavement to pay for itself it must be placed on the streets that get the greater traffic. For only through decreased cost of travel for the motorist throughout the years can a pavement be made to pay dividends.

The streets selected for paving should be those which are, ought to be, or are likely to develop into through traffic streets, and the "feeders." The paving should be distributed over the entire city so that those sections which are fast building up

will be provided with proper outlet. The population now is about 18,000 and by 1950 it will approximate 38,500 or about double the present population, so doubling the pavement now in would be only just. Since 1912 (17 years) the automobile registration in the United States has increased twenty-five times, and it is reasonable to suppose that in Owosso the cars owned have increased in a like proportion. But the pavement has increased from about 2 miles to 7¼ miles or about tripled. So it is altogether too obvious that many pavement improvements should be undertaken.

The street that should be first planned on for paving should be South Shiawassee from Gute to Main street. As the map shows M-47 comes into the city on South Shiawassee, turns at Gute, goes down through downtown, then out Main, then it turns out North Shiawassee again. Shiawassee street runs straight north and south, so directing all traffic down through town and out the same street causes the through traffic to go out of its way about 3200 feet. The average motor transportation cost to the road users for each thousand feet over a hard surface road is approximately $.023 for each vehicle. The cost, therefore, of one thousand vehicles per day would be $23.00 or $8395 per year. It is costing the motorists alone, then per thousand vehicles per day about ~~$8037~~ $7668.00 a year. This clearly indicates the necessity of shortening the distance, where practical, on a through-route highway. There would also be a savings of the motorist's time for it would eliminate five corners and two street car crossings. There would be 3/5 mile less maintenance cost for the city and would relieve considerable congestion in the downtown and lessen the accompanying accidents. So any such shortening

of a route like this is surely a large economic benefit to all concerned. Therefor because of the large savings, amounting to several thousand dollars annually, South Shiawassee street should be hard-surfaced soon.

A few words about the other proposed improvements to the city's streets; South Chipman street leads from the center of the west end of town directly out south to the city limits, thence to M-47 about two miles out, and then on to Morrice and other towns. It is a main artery for the south-western part of town, as the map indicates. This street serves hundreds of car owners in that district as well as much outside traffic to the rich farming land and the more distant towns. The road is in poor condition now, and because of the increasingly heavy traffic it should be included in the city's paving program. A 36 foot, 7 inch concrete pavement with curb and gutter would be quite satisfactory.

North Chipman street is the only street going north from Main street to the north western part of the city. In this section are many families and car owners that would be greatly benefited by this much needed improvement. This street leads directly to the Owosso Country Club and to the town of Henderson. This street, like most of the gravel ones, is badly in need of resurfacing. Such resurfacing and reconditioning is estimated by the city engineer to cost $5000 per mile and he cannot promise that it will hold up long either. The only satisfactory way is to plan to pave this to the city limits with 36 foot concrete.

North Washington street is not what would be termed a through street, for it ends at the city limits, but is a most desirable residential street and is practically all built up. It is

another of the streets that is about worn out, and it would surely be more economical to pave this street than to put $5000 per mile into gravel which will soon get rough and hard to ride over.

Stewart, North Dewey, King, West Oliver, and East Oliver streets along with being very nice residential streets also naturally form feeders to the main traffic streets. The main paved streets cannot serve to their best advantage unless they have paved feeders leading into them. A 36 foot concrete with curb and gutter would be satisfactory.

All of these proposed pavements are a paying proposition. "The money spent upon pavements is well invested, not only because it brings in dividends in better living conditions, from a health, comfort and convenience standpoint, but pavements pay dividends to the taxpayers in dollars and cents. So while pavements are practically a necessity they are also good dividend payers in savings in motor vehicle operating costs.

SECTION V.

CONCLUSIONS.

Section F.

CONCLUSIONS

In concluding——this study of the pavements of Owosso several facts are obvious. It is clear that several of the older pavements should be replaced soon. It is really surprising how these old pavements laid before anyone imagined designing for anything but buggies and wagons have held so well throughout the years. All of these pavements have long outlived their economic life and have paid for themselves completely.

As to the type of pavement to use in Owosso, the present accepted standard type of paving construction here, is the Portland cement concrete. It is cheaper to lay than brick on concrete, or sheet asphalt on concrete which is, of course, a big advantage other things being equal. The economic pavement is the one that will adequately serve the specific traffic, climate, social and local conditions for the least annual cost over an extended period of years representing the economic life of the pavement. Concrete pavement will adequately serve practically any type of traffic, for it is used on Woodward Avenue, Detroit which is one of the heaviest traveled streets in the country, and is giving good satisfaction. It is satisfactory enough for our climate for it is used almost entirely by the Michigan State Highway Department. As far as the least annual cost over an extended period of years is concerned, Owosso has no data on the maintenance of different types of pavement. But some other cities, states, and counties have such data. For instance Beloit, Wisconsin, has kept detailed records of the cost of pavement maintenance on some 30 miles of streets since

1919. Over the seven year period 1919 to 1925 the records of the Public Works Committee show the following. No pavements over ten years old are included.

Average cost per thousand sq. yds. per year.	
Asphalt pavement on concrete base	$2.23
Brick pavement on concrete base	$1.55
One course concrete pavement	.40

Of the openings made in the pavements of Indianapolis during 1925 for sewer, water mains or other underground structures, concrete showed the least cost of opening and replacing being $4.53, with brick and sheet asphalt $5.12 each and wood block $5.78.

Thus the maintenance cost of concrete ought to be as low as that of any other hard surface material pavement.

One of the greatest troubles with getting the best concrete road has been the lack of proper inspection, and of poor design and too liberal specifications. There are entirely too many cities where the specifications are not followed and as a consequence the construction is inferior and renders poor service. This has been the cause of failure in many pavements. The cure is simple in one sense, and can be brought about by the employment of inspectors who know their business and will enforce the specifications. The difficulty is, that in many cities politicians limit the engineering to control everything but the supervision of the construction. Their control over the construction is through unqualified inspectors who are forced upon them. This fact is the cause of a great loss of money to a city, for unless the inspector is trained and real observing some contractors men will be found leaving out a bag of

cement in the mix here and there, or will put in too much aggregate, or will run the batch too wet and put it through the mixer too quickly, or will make the slab too thin, or any number of other costly things to the city. It is almost impossible to get around these troubles by specifications etc., the only way is to have enough thoroughly competent inspectors on the job.

Previously, many pavements were not carefully enough designed,and as a result poor and insufficient slab thickness was constructed,with a result that the pavement had too short a life.

As a conclusion we can say that concrete pavements are among the most variable as to correct quantities and conditions. But by the measurement of all ingredience, in their proper proportions with actual weighing apparatus; have the ingredience thoroughly mixed and for a full minute in a drum rotating between 14 and 20 revolutions per minute. Then the inspector must see that the proper grades have been established and properly leveled and smoothed down to receive the concrete. He should see to it that the subgrade is sprinkled before the concrete is placed. He should not allow too "wet" a mix to go through,and he should see to it that a smooth surface is made. If such precautions are followed (along with many others), and the pavement has been properly designed with reference to width and thickness, etc., a long life, economical first class pavement will result. However if poor inspection is provided, there is apt to places where unsatisfactory work has been done, and this result applies to all pavement work.

The loss to the city and the motorist by continued use of poor gravel roads is very real. The public cannot by any stretch of the imagination be conceived to have more than a remote concep-

tion of the economic loss that results from improper highway design or construction. This loss is unquestionably enormous but it is made up of millions of small items that are concealed in those every day expenses of vehicle operation or road maintenance that are taken as a matter of course.

The development of pavement systems has reached the stage where some clearly defined method of ascertaining the influence of the various types of roadway surfaces upon transportation costs is needed. It often happens that types of roadways are constructed, or old roads continued in service, that require maintenance expenditures in excess of the service value of the roadway surface and therefore place an undue burden on the maintenance funds.

The Bates Experimental Road near Springfield, Illinois, was the scene of extensive tests during 1922. These tests were run by the United States Bureau of Public Roads. This experimental road consisted of 63 sections of pavement which included all the well known types. Over these a fleet of army trucks made 23,200 round trips, at first with bare chassis and then with gradually increasing loads until a gross weight of ten tons had been reached. Only thirteen sections successfully carried all the loads imposed upon them. Of these, ten sections were of concrete. The other three were, one of brick and two of asphalt, both laid on foundations six inches or more in thickness, of the same kind of concrete used in the successful all-concrete sections. Such tests show quite conclusively that concrete will stand heavy traffic as well,if not better than other types.

During 1924 the Minnesota State Highway Commission kept

accurate accounts of the total cost for that year of a paved road under fairly heavy traffic and of a gravel road with less than half that traffic. Their costs below show that the gravel surface was an expensive luxury:

	Paved Highway	Gravel Highway
Depreciation	$220.00	$60.00
Interest on Investment	1,296.00	296.00
Maintenance or Upkeep	162.00	2,745.00
Total Annual Cost per Mile	$1,678.00	$ 3,101.00

This shows an annual cost of a good paved highway of about 55% of that of a gravel highway. These figures and facts could just as well apply to Owosso's unpaved streets, and surely this is a good argument for beginning a paving program, and yearly adding paved streets for the city's welfare. It costs less to drive on pavement, for the motorist, than on gravel or dirt roads, and as the writer pointed out previously such savings run into large amounts of money in a year's time. The White Company of Cleveland run tests over various highways near Cleveland with equal loaded trucks, the average mileage obtained per gallon of gasoline consumed on the various types of road surface is summerized in the following table:

Concrete	11.78	miles per gallon.
Good brick	11.44	" " "
Fair brick	9.88	" " "
Fair bituminous macadam	9.48	" " "
Good gravel	9.39	" " "
Fair gravel	7.19	" " "
Earth	5.78	" " "

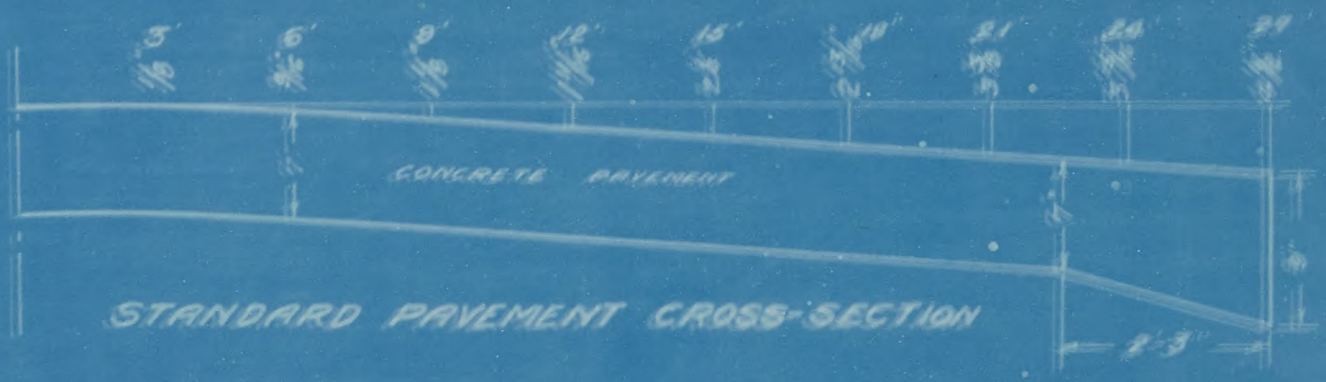
These figures along with others given in this report show very plainly that a paved roadway where traffic is at all heavy is necessary economically for the city, as well as for the motor user. The average motorist saves about 1.8 cents per mile by driving over a paved street rather than over a gravel one, and a similar savings is made by the truck driver.

CONCRETE PAVEMENT

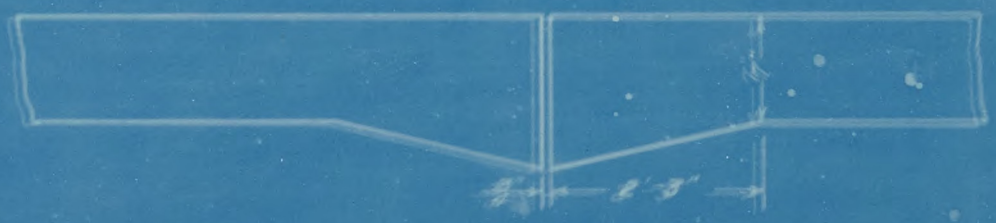
OWOSSO MICHIGAN

1929

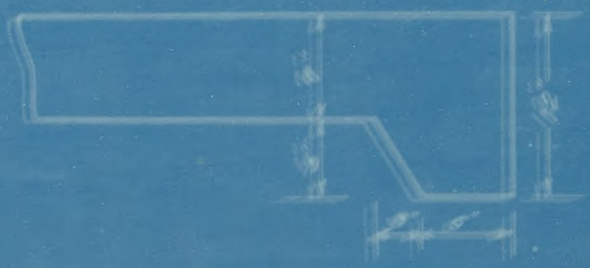
STANDARD CROWN PROFILE



STANDARD PAVEMENT CROSS-SECTION



STD. EXPANSION JOINT



STANDARD HEADER