T H E S I S

A R E P O R T

O N T H E P A V E M E N T S

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LANSING, MICHIGAN.

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THESIS

A REPORT ON THE PAVEMENTS OF LANSING, MICH.

The object of this thesis is to report the results of an investigation of the pavement of Lansing, Michigan, and from their construction,present condition.and the amount of trafic passing over them to present some conclusions as to the relative merits of different forms of pavements and different methods of pavement construction as found in the city.

There is in all about six miles of pavement in Lansing (for actual dimensions and cost see Table I) whose total first cost is about $250,000.00. All data concerning the dimensions and cost, also a blue-print map of the city,showing the paved streets, and one showing the grade profile and a cross section of the east end of Franklin Ave. now being paved, were obtained from the records of the city engineer. We also show a copy of the specifications for this section of pavement, which is fairly representative of all.

These pavements - with the exception of the Franklin Ave. bridge, which is 3" x 8" wood blocks,- are brick, either on sand or concrete foundations, as shown in Table II. This table also shows the present condition of each section of pavement. About 85% of the total length of pavement is laid on a so called gravel foundation, but as the gravel is from 60-70% sand these foundations will be refered to hereafter as(see Table II) as sand.

T A B L E I.

Showing cost of pavements, No. yds. in each section, and date of laying.

Location of sections of pavement.	When laid	Length in ft.	Width in ft.	Number sq.yds.	Total cost.	Cost sq.yd. $	size of wearing surface of brick
Capital Ave:- Ottawa to Shiawassee	1894	1026.3	40	4862	8871.89	1.825	10"x5 1/2
Washington Ave:- Kalamazoo to Bridge	1894	1970.[illegible]	40	9750	15837.28	1.62	9"x4"
Michigan Ave:- Washington Ave to [illegible]	1895	2140.0	77.5	18427	30423.61	1.646	9"x3"
Washington Ave:- Shiawassee to Ka-zoo	1896	2656.5	79.5	24113	29239.75	1.22	9"x4"
Michigan Ave:- Capitol Ave. to Wash.	1898	678.0	66	4972	4446.04	.90	9 1/2"x3"
Franklin Ave:- Washington to Center	1898	887	50	5319.9	5005.99	1.0[illegible]5	9"x3"
Turner Street:- Franklin to Clinton	1899	605	50	3484	3[illegible]4.5[illegible]	.94	9 1/2" x3"
Washington Ave:- Shiawassee to Frank-	1899	3700	45.75	21753.6	[illegible]23;67	1.[illegible]7	9"x5"
Washington Ave:- Bridge	1902	170	36.7	693	76[illegible].00	1.[illegible]	[illegible]
Allegan St:- Grand to Capitol	1903	753	45.	6719	10854.00	1.[illegible]	[illegible]
Allegan St:- Capitol to Walnut	1903	847	30				
Capitol Ave:- Allegan to Ottawa	1904	367	50	3150	3470.00	1.10	8 1/2"x 3 1/2"
Capitol Ave:- Allegan to Ka-zoo	1905	823	36	3016	5321.00	1.764	8 1/2"x3 1/2"
Washington Ave:- River to G.T.R.R.	1905	1813	42	8875	15951.25	1.797	9"x4"
Grand St:- Mich. to Washtinaw	1905	361	45	3351	6018.[illegible]	1.75	9"x4"
Grand St:- Mich. to Washtinaw	1905	415	34				
Walnut St:- Allegan to Ottawa	1905	956	30	2153	3933.00	1.8[illegible]	9"x4"
Ottawa St:- Washington to Logan	1906	3390	33	15128	24367.60	1.610	3 1/2"x8 1/2
Franklin Ave:- Washington to Pine	1906	2078	40	9481	13152.92	1.40	8 1/2"x3 1/2"
Washtenaw Street	Being	Paved.					
Michigan Ave:- M.C.R.R. to City Limits	1906	5242.	50	2074.5	42660.00	1.26	9"x4"

We were unable to find any data at to the depth of either the sand of the concrete foundations, nor were we able to measure the same, as the pavements did not happen to be torn up while the investigation was being made. However, some idea can be obtained of the present practice by an examination of the blue-print and the specifications, already mentioned, of the Franklin Ave. pavement.

The grades of the streets are fairly uniform, the steepest grades now paved being one of 5.28% at the north end of the Washinton Ave. bridge and one of 5.05% on Franklin Ave. East, between the Lake Shore R.R. and the foot of Turner St., both of which are very reasonable grades for brick pavements.

There is very little uniformity in these pavements as regards the amount of crown, either on different portions of the same pavement or on different pavements. This lack of uniformity was determined by taking the relative elevations of the crown and gutter,(see Tables III & IV) with a leveling instrument at intervals of about half a block along each individual section of the pavement. One of the noticable features of the newer pavement is that they are nearly always given a greater crown than the old and this seems to be one of the good features, as it throws the water to the gutter more quickly. This data on crown also enabled us to form more accurately conclusions as to the manner and thoroughness of the prepmmation of the foundations. This is shown more particularly in Table IV as this table gives the actual relative elevations

TABLE II

Showing construction, and present condition of each section of pavement.

Location of pavement	Construction			Present Condition.
	Foundation	Filling	Make of Brick.	
CAPITAL AVENUE:- Ottawa street to Shiawassee street.	Concrete	Pitch	Hayden Block	Nearly perfect, one or two slight depressions, due to the breaking of foundation over pipe trenches.
Ottawa street to Allegan street.	Sand	Sand	Lane & Bolan	Bricks of inferior quality, badly chipped: several bad depressions over sewer trenches.
Allegan street to Kalamazoo street	Sand	Grout	Medal Block	Fairly good condition: bricks show some wear due to traffic.
WASHINGTON AVENUE:- Grand Trunk R.R.to Bridge	Sand	Grout	Medal Block	Rough in places due to sagging of foundation between ties on street car tracks, otherwise very good.
Bridge to Kalamazoo Street	Concrete	Pitch	Lane & Bolan	Rough nearly all the way due to settling of subgrade over water pipe trenches, also due to crushing of concrete.
Kalamazoo street to Shiawassee street	Sand	Pitch	Harris Paver	Very rough being rutted from heavy traffic also from sagging over pipe trenches, also due to wear of bricks.
Shiawassee street to Franklin avenue.	Sand	Sand	Townsend	Shows considerable wear on west side, numerous depressions due to washouts of sand, and over pipe trenches.

Table II (continued)

Location of pavement	Construction			Present Condition.
	Foundeation	Filling	Make of Brick.	
WALNUT STREET Ottawa street to Allegan street.	Sand	Tar	Medal Block	This block of pavement is very little used and being very new it is in perfect condition.
TURNER STREET Franklin Ave. to Clinton street.	Sand	Sand	Townsend	The brick here showed wear than on any other block of pavement in the city most evident along gutter,very flat.
GRAND STREET Michigan Ave to Washtinaw street	Sand	Sand	Medal Block	Pavement in good condition except that the brick showed considerable disintegration; weather.
FRANKLIN AVENUE Center street to Washington Ave.	Sand	Sand	Townsend	Numerous sags are evident where water pipes have been laid and not properly back filled.
Washington Ave. to Pine street.	Sand	Grout	Medal Block	Very good condition generally, the foundation has washed out in two small places, new.
OTTAWA STREET Washington Ave to Logan street	Sand	Grout	Medal Block	This is new pavement and is in very good condition generally, only a very few slight sags.
MICHIGAN AVENUE Washington Ave to M.C.R.R	Concrete	Tar	Harris Paver	This is in excelent condition and on the whole the best section of pavement in the city, heaviest traff
M.C.R.R. to City Limits	Sand	Sand	Medal Block	This although new is very poor was laid during rainy season and sub grade washed badly a large % of filling was also washed out before street was opened.
ALLEGAN STREET Grand street to Walnut street	Sand	Sand	Lane & Bolen	Excellent condition.

as copied from the original noted. All of the new pavements indicate a slackness of preparation of the foundation, shown by variation of as much as .27 ft. in the amount of crown on different portions of the same pavement, and also by numerous depressions, which indicate irregular setting of the foundation.

In order to compare the different pavements as to efficiency, relative to their methods of construction, it was necessary to gather some data in the comparative amounts of traffic passing over them. And as it was impossible, due to lack of time, to spend a full day on each street, a full day's traffic was taken at what was thought to be the point of maximum traffic, namely, on Washington Ave. South at the corner of Washington Ave. and Kalamazoo St., and from one to three hours traffic was taken on each of the other streets. Then to obtain an approximate idea of a days traffic on each of the other streets, we assumed that the ratio of traffic per hour on any street, to that on Washington Ave. for the same hour, was constant throughout the whole day. The traffic per day on each street was determined in the following way, (for results see Table V)

Let A = the traffic per day on Washington Ave., South.

Let a = the traffic per any hour on Washington Ave., South.

Let x = the traffic per same hour on street to be determined.

To find X = traffic per day on said street.

$\frac{a}{A}$ = percentage of whole days traffic that passes on Washington Ave. South in the hour whose traffic is represented by (a)

Then $\frac{x}{a}$ = the percentage of the amount for a given time on Wash. Ave. that passes over the other street in the same time

Therefore $X = \frac{x}{a} \cdot A$

TABLE III

Showing crown of pavement.

Location of pavement	Amount of crown	Width of street	Rise per Ft. of width.
Franklin:- Center to Wash.	.60 ft.	50 ft.	.024 ft.
Franklin:- Pine to Washington.	.43 "	40 "	.0215"
Wash.:-Franklin to Shiawassee	.3[illegible] "	45.75	.0175 "
Turner St.	.60 "	50 "	.025 "
Wash:- Shiawassee to Ka-zoo	.93 "	79.5	.0234"
Wash:- Ka-zoo to Bridge	.56 "	40 "	.028 "
Wash:- Bridge to C.T.R.R.	.60 "	42 "	.0287"
Ottawa Street	.60 "	33 "	.0364"
Capital:- Ottawa to Shiawassee	.61 "	40 "	.0364"
Capitol:- Shia. to Allegan	.57 "	50 "	.0228"
Crand Street	.67 "	45 "	.0297"
Capitol:- Allegan to Ka-zoo	.60 "	36 "	.03[illegible]"
Allegan:- Grand to Capitol	.46 "	45 "	.0205"
Allegan:- Capitol to Walnut	.47 "	30 "	.0208"
Walnut Street	.48 "	34 "	.0282"
Mich:- Capitol to Washington	.[illegible]7 "	66 "	.0178"
Mich:- Wash. to M.C.R.R.	.74 "	77.5	.0192"
Mich:- M.C.R.R. to City Limits	.57 "	50 "	.0228"

TABLE IV

Elevations from which cross-sections of pavements were determined.

Location of pavements.	Elevation of gutter.	Elevation of crown.	Amount of crown	Width of street in feet.
TURNER STREET	2.33	1.74	.59	50
Clinton street	6.53	5.87	.64	
to	8.94	8.29	.65	
Franklin Avenue.	11.91	11.32	.59	
FRANKLIN AVENUE	5.16	4.74	.91	50
Clinton Street to Washington Avenue.	5.22	4.93	.39	
FRANKLIN AVENUE	3.13	2.93	.20	40
Washington Avenue	11.51	11.22	.29	
to	8.78	8.22	.56	
Pine Street.	7.91	7.25	.66	
WASHINGTON AVENUE	9.13	8.91	.22	45.75
Franklin Avenue	7.53	7.07	.46	
to	5.41	4.87	.54	
Shiawassee Street	3.79	3.41	.38	
	6.55	6.23	.32	
WASHINGTON AVENUE	8.04	7.15	.89	79.5
Shiawassee Street to	7.12	6.12	1.00	
Kalamazoo Street.	4.47	3.56	.91	
WASHINGTON AVENUE	9.93	9.48	.45	40
Kalamazoo Street	11.51	10.80	.71	
to	8.88	8.30	.58	
Bridge.	5.23	4.72	.51	
	10.50	9.94	.56	

TABLE V

Showing the trafic per day on pavements.

Name of street and location of pavement	Total No Vehicles	Total No Tons	Tonnage to Vehicle	Percent of Maximum Tonnage.
WASH:- Mich. to Kazoo	1473	966	.65	87%
WASH:-Kazoo to Bridge	1046	735	.70	67%
WASH:-Bridge to GTRR	634	512	.80	46%
WASH.- Mich to Chia.	1404	868	.62	78%
WASH:-Frank-to Chia.	501	484	.97	44%
FRANK-Wash. to Pine.	281	266	.94	24%
FRANK-Wash. to Center	1149	947	.82	84%
TURNER STREET	854	657	.76	59%
OTTAWA ST. WEST.	326	203	.62	18%
WALNUT STREET	99	57	.57	5%
ALLEGANE Wal-to Wash	406	327	.66	29%
ALLEGAN:Wash to Grand	418	316	.75	28%
WASHTINAW STREET	354	240	.68	22%
CAPITAL AVENUE	280	135	.48	12%
GRAND STREET	550	456	.83	41%
MICH:-Wash to M.C.RR	1473	1111	.75	100%
MICH:-MCRR TO City L	635	400	.63	36%

The results regarding traffic are, of course, from the manner of obtaining them, inaccurate. No consideration was given to the variation from day to day nor from season to season, and the assumption upon which we based our method of computing traffic is not exactly true. Allowing a liberal margin for errors, however, still leaves the results, good approximations, and of much practical value in the comparison of pavements.

From a study of the data collected we draw the following conclusions:-

First; That for heavy traffic such as drayage, a brick pavement should always have a concrete foundation, with either grout of tar filler.

Second; That for a large amount of light traffic, while a concrete foundation is to be preferred, a good grade of gravel will make an effective foundation if it is prepared very carefully. On this type of pavement a tar filler should be used.

Third: That for a comparatively small amount of traffic a carefully laid foundation of gravel is sufficient and that the filler should be preferably tar, and if sand is used it should be carefully swept into the joints.

Our last and most general conclusion is that the inefficiency of a pavement can nearly always be traced to a lack of proper construction rather than to a lack of proper design.