AN EXPERIMENTAL STUDY OF THE PRACTIBILITY OF BLOTTER TYPE ROADS

THESIS FOR THE DEGREE OF B. S.

Edward C. Brewster

1932

Roads

AN EXPERIMENTAL STUDY OF THE PRACTIBILITY OF BLOTTER TYPE ROADS

A Thesis Submitted to

The Faculty of

MICHIGAN STATE COLLEGE

of

AGRICULTURE AND APPLIED SCIENCE

by

EDWARD C. BREWSTER

Candidate for the Degree

of

Bachelor of Science

June 1932

THESIS

PREFACE

Of the many different kinds of low cost roads recently developed, perhaps the most recent is the so-called "Blotter Type". It is so recent that it is not yet widely known; and also there has been little experimental work done on it.

So it has been the author's intention in this thesis work to study the essential element of this recently developed road in the laboratory, and to make an enough of a cost analysis to determine whether or not it has a practical value.

The author wishes to express his appreciate to Mr. Rothgary, Mr. Finney, and the Michigan State Highway Department for the information and assistance they have given him.

E. C. B.

CONTENTS

INTRODUCTION

The Lincoln Oil Refining Company of Ohio has lately brought out a development in low-cost road construction that has given rise to considerable controversy and forecasting. This development is the "Blotter Type Road", and is designed with the view in mind of providing a suitable type of road for sandy country where gravel and crushed rock are costly.

Up to the point of the wearing surface itself, the construction of this road is no different than that of any other. However, when the flat earth grade has been established, the method begins to depart from the older ways. When the grade is ready for its wearing course, the center is trenched out by bladed for the whole width of the wearing course to a depth of between five and eight inches. This earth that has been bladed out is deposited on the shoulder to thoroughly air-dry. The trench bottom is then rolled and given a treatment of Bitummion Oil or tar. This surface is then allowed to thoroughly set and the earth that was bladed out on the shoulders is again bladed back into its original position, making sure that it is thoroughly dry when this is done. When it is in place, it is compacted by again rolling, and the road is given its surface treatment. This may be one of several kinds. It may be a heavy asphaltic binder that tends to form a hard surface, or it may be a asphetic oil treatment that tends to hold the road in place, or it may even be a sheet asphalt top.

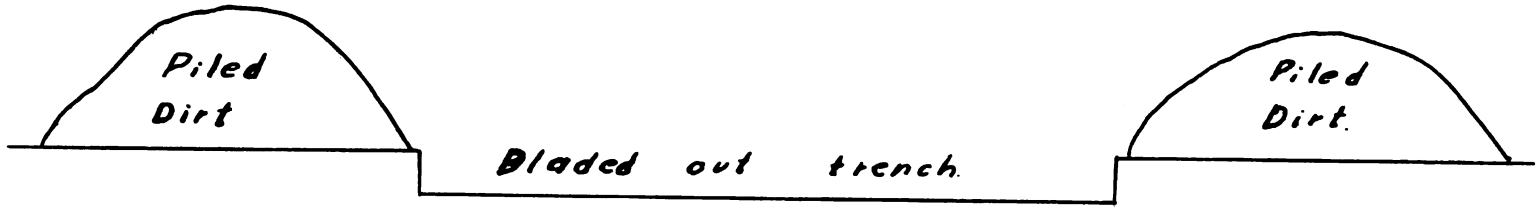
The type used by the Lincoln Oil Refining Company is a heavy asphatic oil applied hot and after application has a powered asphalt spread on it to take up excess oil and form a hard asphaltic surface. It is said to be very satisfactory in the limited number of cases where it has been so used.

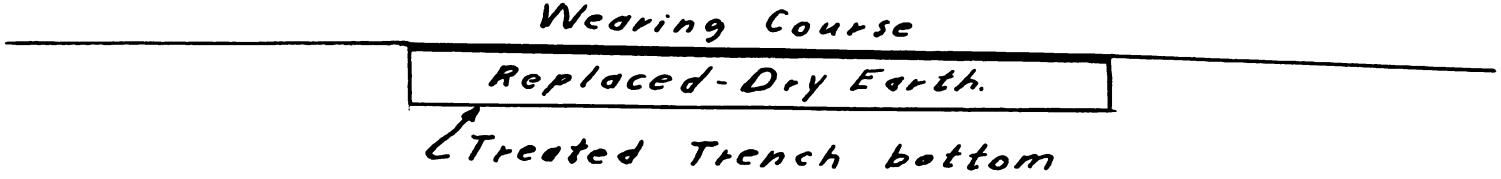
But whatever surface is used, it must be water tight, as also must be the initial treatment on the trenched out sub-grade.

For it is this keeping the earth replaced in the trench, called the mat, dry that is the essential feature of this type road. This mat is kept dry so that its wearing power will not be diminished, and thus distribute any load placed upon the road surface over enough of an area on the sub-grade so that the load per unit area on the sub-grade is low enough not to cause a failure of the sub-grade.

This type of road would be especially practical in a sandy country where crushed stone or gravel is hard to get, and so the cost of building up a section that will properly distribute the load on the sub-grade is high, and where there is so much capillary moisture in the sub-grade is sufficient to destroy the bearing power of the sand.

The weak point in the design and theory is, does this first application of Oil upon the trenched out sub-grade keep the capillary water from wetting the mat above it, and if it does, how much oil is needed?





ROAD CROSS - SECTION

EXPERIMENTAL WORK

It is the investigation of the effectiveness, and necessary qualities, of this first application that this work is concerned with.

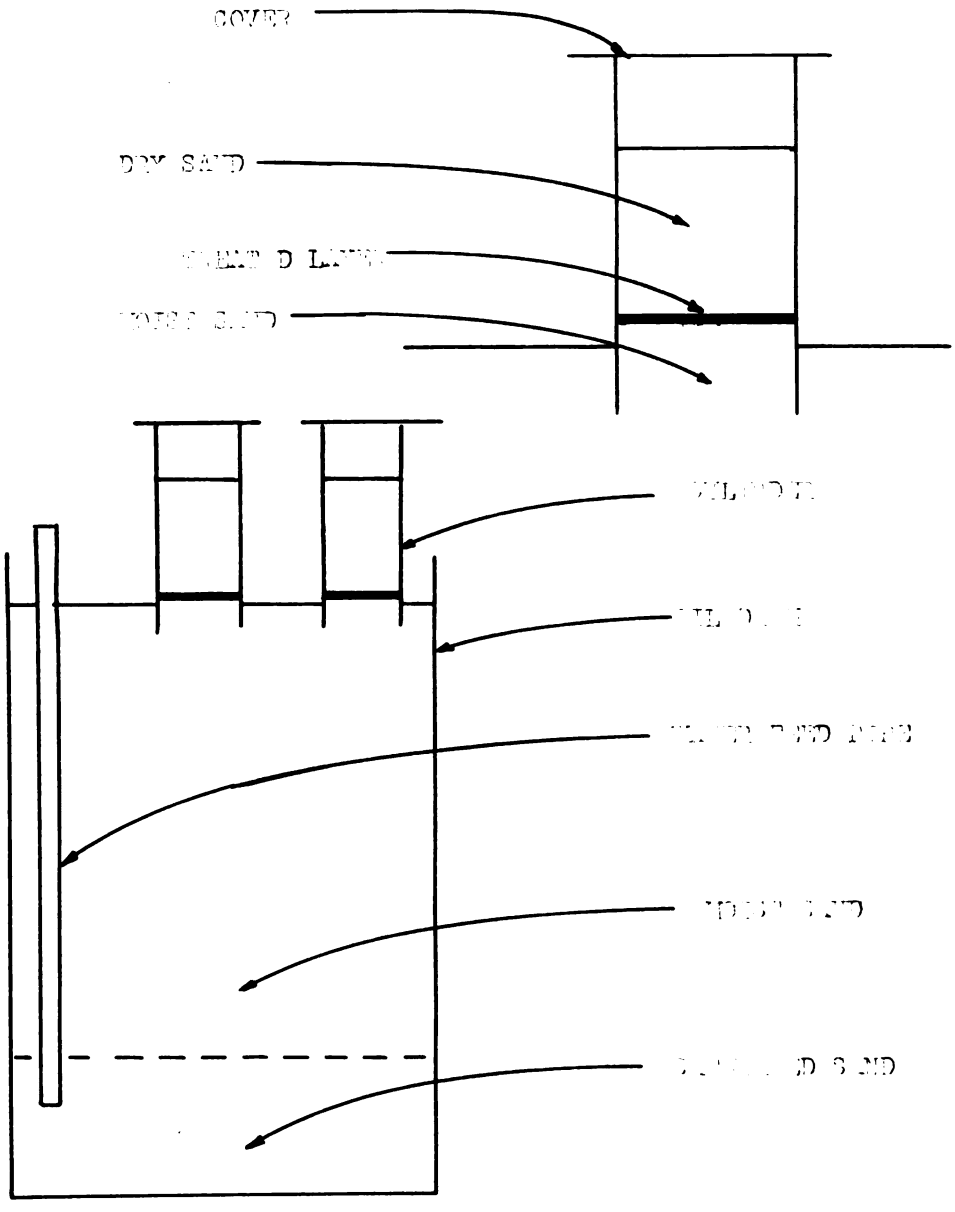
The apparatus used was of the author's own design, and every attempt was made to have it represent typical field applications instead of ideal laboratory conditions.

A large oil drum was set on end and filled with sand of a nature similar to that found in sandy country. In filling this drum, the bottum pot was first filled and then enough water put in so that there was an inch or so free water on the surface, then a 2" pipe was set in this sand. This pipe was long enough to project above the surface of the sand when the drum was completely filled with sand. This pipe was used to feed water to the lower portion of the drum. The sand used to fill the drum the rest of the way was kept moist, but did not contain any free water.

Then upon the top of the sand in the drum were set, vertically, 6" cylinders, 10" long. These cylinders were set into the sand a little ways, about 2 or 3 inches, and then upon the sand surface inside was applied the oil or tar treatment. Then above this treated surface the cylinder was nearly filled with thoroughly dried sand. The cylinder was then capped and allowed to stand for six days.

After the six days were up, the cylinder was removed, and the percentage of capillary moisture both above and below the oil layer was found. This percentage was found by first weighing the sand just as it came out of the cylinder, and then thoroughly drying it, and again weighing it. The numerical percentage was found by dividing the weight lost during the drying, by the dry weight of the sand.

Tests were run on six different types of oils and tar--they were:



1. Standard Road Oil No. 6.
   Mfgs.
   Standard Oil Co. (Ind.).

2. Tarmac
   Mfgs.
   American Tar Products.

3. Linco
   Mfgs.
   Lincoln Oil Refining Co. of Ohio.

4. Tarvia "Protectar".
   Mfgs.
   Barrett Co.

5. Refined Water-Gas-Tar.
   Mfgs.
   American Tar Products.

6. Non-Asphaltic Road Oil
   Mfgs.
   Standard Oil Co. (Ind.)

The quantities of each brand was varied from 0.25 gal. to 1.50 gal. per square yard of surface in 0.25 gal. steps.

Tests were also made on the cylinder with no treated layer for correlation purposes, and two of the standard sub-grade tests recorded by the Bureau of Public Roads in investigating sub-grade soil were made on the sand in the drum. These two tests were the capillary moisture test, and the moisture equivalent test; field method.

TEST DATA

CORRELATION TEST

Trial	Bottom of Cylinder	Middle of Cylinder
1.	4.90%	3.40%
2.	5.05%	3.56%
3.	4.88%	3.44%
4.	4.93%	3.48%
Average	4.94%	3.47%

With the exception of the non-asphaltic Road Oil, all the brands tested, quantities above 1 gal. per square yard gave no indication of allowing capillary water to pass, so they will be left out of the following tabulations.

1. STANDARD ROAD OIL NO. 6

Gallons per sq. yd.	% of Moisture above treatment	% of Moisture below treatment
0.25	2.50	5.03
0.50	0.45	5.00
0.75	0.00	4.89
1.00	0.00	5.11

2. TARMAC

Gallons per sq. yds.	% of Moisture Above Treatment	% of Moisture Below Treatment
0.25	0.65	4.72
0.50	0.20	4.80
0.75	0.00	4.77
1.00	0.00	4.78

3. Linco

Gallons per sq. yd.	% of Moisture Above Treatment	% of Moisture Below Treatment
0.25	0.15	5.12
0.50	0.03	5.16
0.75	0.00	5.07
1.00	0.00	5.10

4. TARVIA "PROTECTAR"

Gallons per sq. yd.	% of Moisture Above Treatment	% of Moisture Below Treatment
0.25	0.20	4.93
0.50	0.01	4.95
0.75	0.00	4.87
1.00	0.00	4.96

5. REFINED WATER-GAS-TAR

Gallons per sq. yd.	% of Moisture Above Treatment	% of Moisture Below Treatment
0.25	1.93	4.81
0.50	0.67	4.78
0.75	0.21	4.87
1.00	0.00	4.82

6. NON-ASPHALTIS ROAD OIL

Gallons per sq. yd.	% of Moisture Above Treatment	% of Moisture Below Treatment
0.25	3.41	5.13
0.50	2.11	4.97
0.75	0.97	4.95
1.00	0.63	5.07
1.25	0.20	4.98
1.50	0.11	5.12

The results of the Bureau's of Public Roads Standard capillary moisture tests gave 18.03% moisture.

The Standard Moisture Equivalent test gave as result 17.30%.

One variation from probable actual field methods that might effect results of the test was the manner of applying the treatment in the cylinder.

In the field, this treatment would probably be spread on the surface attempts were made to so apply it in the cylinders, but considerably difficulty was encountered in getting an even coat, especially with the smaller quantities that the oil or tar was first mixed with a small quantity of sand and this mixture spread in the cylinder. After it was spread, it was packed down with hot irons.

This method more closely resembles a premixed treatment spread and rolled into place on the sub-grade. However, the author believes that this variation was justifible because of the more even applications it gave, and would not seriously alter the results.

COST SUMMARY

No matter how effective this type of road is in holding up under traffic in the conditions it is designed for, if its cost is too high, it has no place in the road building business. It should not cost a bit more than any other type of road that will hold up under the same traffic in the same conditions.

Because of this fact, a cost study of this type road should be made along with experimental work on it. The following work presents an initial study into this phase.

The various unit costs were obtained from [illegible] sources.

The cost of the various brands of treatment oil or tar were taken from actual bids upon work received by the Michigan State Highway Department in recent years. This amount includes spraying on the surface, based on cost per gallon.

The blading costs were taken from the opinion of various men engaged in construction and maintenance work, and from Ingham County [illegible] figures.

The cost of the wearing course was based on the experimental work done by the Lincoln Refining Company.

These costs were as follows, for oils and tars:

Standard Road Oil No. 6	$0.0580 gal.
Tarmac	0.0640 "
Linco	0.1000 "
Tarvia	0.1000 "
Water-Gas-Tar	0.0875 "

It might be well to state at this point that the tests on the non-asphaltic road oil indicated that this oil has no use in this type of work, and so no costs were figured for construction based on its use. It is meant as a dust layer only, and not as a water-proof binder.

The cost of blading the dirt out of the trench was estimated as being $0.030 per square yard.

The cost of replacing this dirt after the treatment was given the sub-grade, and rolling it down was estimated as being about $0.045 per square yard.

The cost of the wearing surface was figured as being about $0.180 per square yard. This was arrived at through the experience of the Lincoln Refining Company's work. They used 1.50 gallons of oil per square yard at a cost of about $0.100 a gallon, and powered asphalt of about one pound per square yard, at a cost of $0.005 a pound. The blading and rolling were estimated to bring the total up to $0.180 per square yard.

It might prove possible in cases of heavy traffic to use a sheet asphalt top. This would not require gravel in its construction, and would probably stand much heavier traffic loads. The cost of this kind of surface is about $0.900 per square yard in place.

Other cost figures, besides some supplementary over to the above work were taken out of Engineering News

No other attempt is made here to include maintenance cost in this summary as too little is known about the life of this kind of road, or what rate it depreciates. It is even probable that it would present some new maintenance problem that will be peculiar to this type alone, so just initial construction costs of the wearing surface itself are made, based on the quantity of treatment that the tests indicate as best for each brand.

UNIT COST. Oil-Treated Wearing Course

1. Standard Road Oil — 0.75 gallon used

Item	cost sq. yd.
Initial Trench Blading	$0.0300
Treatment	0.0435
Second Blading & Rolling	0.0450
Surface	0.1800
Total	0.2985

2. Tarmac -- 0.75 gallon used.

Item	cost sq. yd.
Initial Trench Blading	$0.0300
Treatment	0.0480
Second Blading & Rolling	0.0450
Surface	0.1800
Total	0.3030

3. Linco -- 0.75 gallon used.

Item	cost sq. yd.
Initial Trench Blading	$0.0300
Treatment	0.0750
Second Blading & Rolling	0.0450
Surface	0.1800
Total	0.3300

4. Tarvia -- 0.75 gallon used.

Item	cost sq. yd.
Initial Trench Blading	$0.0300
Treatment	0.0750
Second Blading & Rolling	0.0450
Surface	0.1800
Total	0.3300

5. Refined Water-Gas-Tar -- 1.00 gallon used.

Item	cost sq. yd.
Initial Trench Blading	$0.0300
Treatment	0.0875
Second Blading & Rolling	0.0450
Surface	0.1800
Total	0.3425

The cost per mile of 20' surface of this type is for each brand:

1.	Standard Road Oil No. 6	$3,502.00
2.	Tarmac	3,554.80
3.	Linco	3,871.56
4.	Tarvia	3,871.56
5.	Water-Gas-Tar	4,018.21

Using a sheet asphalt wearing surface built of the oil processed type, the following figures were obtained for a road 20' wide.

Type	Unit Cost	Mile Cost
1. Standard Road Oil No. 3	$1.01[illegible]	$11,[illegible]
2. Tarvac	1.[illegible]	1[illegible], 1.[illegible]
3. Linco	1.[illegible]	1,[illegible].00
4. Tarvia	1.0[illegible]	12,[illegible].00
5. Water-Gas Tar	1.[illegible]	12,[illegible].75

For the roads that carry the same traffic load as the "Blotter Type" is designed for, the cost is about $7,200.00 per mile where gravel is moderate in cost. This applies to Ingham County where gravel runs around $1.10 per cubic yd.

This makes the cost of "Blotter Type" road excessive for those localities wheregravel is easily obtainable, but where it is not, this type is cheaper than ones using gravel or stone in their construction. In sandy country gravel costs upwards of a $1.00 a cu. yd. This brings the cost of the local type road up to about $4,800.00 a mile in these sandy localities. This is appreciable above the cost of the "Blotter Type".

CONCLUSION

The results of the test tended to show that the heavier the oil or tar is and the greater its ability to bind together the sand particles, the better it controlled capillary water. Also, they showed that it might be possible to use less oil or tar per cubic yard, than has been done so far in this type of road work.

The tests gave a fairly constant percentage of capillary moisture in the sand below the treatment, and so it is not out of line to compare the different brands against each other.

Although the condition of the tests were not as severe as would probably exist in actual field condition, the tests indicate that the capillary water can be completely kept out of the mat above the first treatment at not an excessive cost.

The cost figures, while not accurate or complete enough to base a final opinion on, show that in its locality this type of road gives promise of economic justification. However, with a sheet asphalt wearing surface, as has been suggested could be used with this method of construction, the cost is high. High enough to make it a competitor with a concrete road.,

But the Blotter Type Road evidently deserves considerable serious study for it is possible that it has a place in the road building program of the country.

ROOM USE ONLY