THIRD SESSION

FRIDAY, DECEMBER 4, 1925, AT 10:00 A. M.

E J MEHREN, Presiding
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Chairman Mehren The first paper on this morning's program is the report of the Committee on Maintenance

REPORT OF COMMITTEE ON MAINTENANCE

Chairman, W H ROOT
Iowa State Highway Commission, Ames, Iowa

For the 1925 season the Committee on Maintenance undertook the study of seven different maintenance problems. Each of these problems was assigned to a committee member who carried on the work through the season and submitted a sub-committee report in October The sub-committee reports were then discussed and revised by the whole committee and the committee report formulated The subjects studied together with the sub-committee assignments follow·

A. Dust Prevention and Surface Treatment of Gravel and Macadam Roads—G C Dillman, Michigan State Highway Department
B. Crack Fillers for Concrete Pavements—J T Donaghey, Wisconsin State Highway Department
C Snow Removal and Snow Removal Equipment—H K Bishop, U. S Bureau of Public Roads.
D Guide, Caution, and Danger Signs—W H Root, Iowa State Highway Department.
E Standardized Maintenance Accounting—W A Van Duzer, Pennsylvania State Highway Department.
F The Relation Between the Age of a Pavement and Its Annual Cost—W A McLean, Consulting Engineer, Toronto, Canada
G. Coverings for Poorly Constructed and Disintegrating Concrete Roads—A H. Hinkle, Indiana State Highway Department.

A DUST PREVENTION AND SURFACE TREATMENT OF GRAVEL AND MACADAM ROADS

GRAVEL ROADS

Light asphaltic oil as a dust pallative is used to a very limited extent in a few States, applications varying from one-eighth to one-half gallon per square yard per treatment and effective from six weeks to one season The most desirable surface is such that it can be maintained with a blade although a few States maintain a mat

A large number of States are using calcium chloride as a dust palliative, a few of them only in an experimental way Usual application is by means of mechanical spreader and single treatments vary from one-half pound to one and one-half pounds The period of effectiveness is one season with two to three applications

Very little information on relative effectiveness of calcium chloride and light asphaltic oil treatments Season's application of calcium chloride varies from $250 to $300 per mile as against $300 to $500 per mile for light asphaltic oil

No recent development in the way of new methods of application or in equipment in the past two years, however it is evident that the general tendency for both calcium chloride and light asphaltic oil treatments is toward smaller amounts per application and applying more often

Effectiveness of light oil treatment is not carried over from one year to the next to any appreciable extent There is, however, an accumulative effectiveness in calcium chloride applications especially so after a road has been treated for two or three years To avoid excess softening of the surface calcium chloride should not ordinarily be used atfer September 1st

The practice of surface-treating gravel roads with bituminous materials is usually with the idea of forming a mat surface General plan for treatment is to scarify surface, if necessary, blade the surface to smooth it, add new gravel where necessary, compact under traffic which is preferable, or by rolling, apply bituminous material with pressure distributor at rate of one-quarter gallon for first application and from one-quarter to one-third gallon for second application and blade the surface to proper condition

Both cold and hot bituminous treatments for gravel surfaces are common and alternating appears to be practical. The tendency in use of cover material is toward stone chips, pea gravel, or slag The finer sands are not held in much favor There is no great trouble in holding a treated surface in reasonably smooth condition for one year The practice, however, is to treat each year for two or three years and it appears entirely possible to work to a ratio of two treatments in three years to three treatments in four years

The opinion is quite general that the minimum traffic in which light asphaltic oil or calcium chloride treatment is justified ranges from 300 to 500 vehicles per 24 hours, and the minimum traffic justifying a bituminous or mat-forming surface treatment ranges from 500 to 800 vehicles per 24 hours

There is a wide range in annual cost per square yard for bituminous-treated gravel surfaces The first treatment usually runs from 12 to 20 cents per square yard and the annual maintenance, including following

treatments generally runs from 6 to 12 cents per square yard of surface treated

MACADAM

Many States use both hot and cold treatments with good results Some States are not alternating hot and cold treatments while others have had very good results with that method

Cover material is usually rolled into the treatment although a few States do not think it necessary The standard method of application is to patch the surface, reshape where necessary, sweep with some mechanical or power device and apply the bituminous material, then apply bitumen with pressure distributor and place cover material

The most recent and practical developments in special equipment for this type of work are the blower with large opening and flat nozzle, two drags lashed side by side for smoothing up and distributing cover material and the automatic chip spreader

There are a number of things that stand in the way of successful treatments and the following suggestions are made

1 Men handling the work should have good working knowledge of the methods and materials
2 Sufficient funds should be provided properly to do the work
3 A uniform cross section should be secured and after consolidation and curing of 30 to 60 days, properly cleaned
4 Standard specification bituminous materials should be used
5 A good quality of cover material free from dirt and dust should be used and spread uniformly in sufficient amounts Stone of as large a size as 1 inch may be used.
6 Initial treatment should be of light tar uniformly applied in two applications totaling 0 5 to 0 6 gallon per square yard On heavy traffic roads skid chipping of 10 to 15 pounds per square yard should then be applied
7 Second treatment may be either a low viscosity tar or asphalt, followed by an application of the chips
8 Third treatment may be either cold asphalt, cold tar, or hot asphalt, followed by 20 to 25 pounds chips for cold treatment and 35 to 40 pounds chips with hot.
9 Treating alternate sides of road is recommended to take care of traffic
10 Good follow-up maintenance after treating should be provided

B CRACK FILLERS FOR CONCRETE PAVEMENTS

After tabulating the reports from the various States, it is plain to see that there is some variation of opinion as regards the proper fillers to use Even where the States are in the same latitude engineers differ

as to the type of filler and the specifications governing their use Quite a number of the States use asphalt in its various forms exclusively, while others use tar Some require penetration as low as 35 while others require penetration up to 250 Most of the States use sand, either coarse or fine, as a covering material A few experiments have been tried with sawdust, pea gravel, and stone chips The practice is quite uniform in the matter of cleaning the cracks, namely sweeping or brushing them out The State of Michigan has employed steam jet and air compressor and has found them quite satisfactory It is claimed that the old dead material can be removed from the cracks down to a depth of an inch and a half or so In filling the cracks with bitumen, most States allow a variation of an inch on either side of the crack for excess material In filling cracks one-fourth inch wide or less most of the States pour the clear bitumen in the cracks and then place the covering on the top In filling larger cracks some of the States use a mastic of bitumen and sand, pea gravel, or stone chips

In the majority of cases where patented crack fillers have been used they have been found to be unsatisfactory, claiming that they become brittle in cold weather and disintegrate The patented fillers have been found to be quite expensive and the results obtained were not sufficiently better to warrant the extra expense

Quite a number of the States are experimenting with different materials Illinois is carrying on a series of tests using both tars and asphalts. Connecticut has five experiments with the tar base and five experiments with an asphalt base now in progress Michigan is experimenting with mixture of tar and asphalt California is experimenting with mixtures of asphalt and ground corn stalks, and also asphalt and sawdust These materials, of course, being placed in the wider cracks and expansion joints These tests have not been carried far enough for definite conclusions to be drawn

C SNOW REMOVAL AND SNOW REMOVAL EQUIPMENT

The principal research work on snow removal during the past year has been carried on by the U S Bureau of Public Roads and the Michigan State Highway Department The work by the Bureau of Public Roads will be published soon and will be available for distribution The Michigan investigation, which was made by V R Burton, of the State Highway Department, will probably be published this winter

The increased demands of traffic for continuous service during the entire year have lent special interest to the subject of snow removal and snow removal equipment While the removal of snow from the public highways is of recent origin, it is annually receiving more and more attention from the State highway departments and the local authorities

The U S Bureau of Public Roads during the past two or three years

has been making a study of snow removal problems and snow removal equipment. A special report has recently been compiled by the Bureau covering the snow removal work done during the winter of 1924 and 1925. Information has been collected by questionnaires through the State highway departments and in some instances through the local authorities and considerable information has been compiled on snow removal. The following information has been summarized from this report.

There are over 36 States which experience snowfall to a considerable extent rendering numerous sections of their important highways impassable to motor traffic in the winter season during periods of time increasing from a few days or a few weeks in some localities to several months in others.

From available data collected from the States under discussion during the past three years, it is recorded that approximately $760,000 was expended for snow removal during the winter season of 1922 and 1923; approximately $960,000 during the winter season of 1923 and 1924, and approximately $1,380,000 during the winter season of 1924 and 1925. As each season shows a material increase in expenditures over the last, the statement may be ventured that snow removal and control is gaining in popularity.

The methods followed and equipment used in the removal and control of snow are many and varied. They range from a strong-armed squad with the trusty shovel to the use of the powerfully built, lateral type

Figure 1—Road which has been cleared of snow

rotary plow which, when operated in connection with a caterpillar tractor, finds no drifts too deep for removal (Figure 1)

With snowfall averaging from 20 seasonal inches for States in some sections of the United States within the snow area to 392 seasonal inches for States in other sections, it is apparent that any class of this equipment may be considered suitable for use in one location or another over the 36 States The Weather Bureau has furnished the information that the minimum and maximum annual snowfall recorded from a period of years for different sections of the State of California show an average of 1 inch in some localities and an average of 783 inches in others Using this State as an example, it is apparent that suitable equipment for adequate snow removal could range from the lighter type to the most powerful and effective plant available Just which type of plow, used in connection with truck or tractor, is best suited for work in depths of snow, is a much mooted question For convenience of discussion, adequate snow removal equipment as generally in use lately may be segregated in the following classes

1 Straight blade plows attached to trucks
2 V-shaped plows attached to trucks
3 V-shaped plows attached to tractors
4 The rotary type of snow agitator

Of course, it is a fact that straight-blade plows are at times mounted on tractors and also that the blades of both the straight type and V-shaped plow vary materially in length and height of blade along with strength of construction, but with these facts in consideration and others, an effort has been made to learn which class of equipment is best suited for different depths and conditions of snow proposed for removal

1 STRAIGHT BLADE PLOWS ATTACHED TO TRUCKS

This form of equipment (Figure 2) is quite common and can be used very economically where the snowfall is light Usually the blade is mounted in front of the truck, although at times it is mounted underneath This is particularly true where the work of snow removal is undertaken shortly after the beginning of the snowfall and continues throughout the storm The ordinary outfit can usually remove twice the depth of recently fallen snow than it can handle after the snow has become drifted, wet, or heavy Many States believe that the straight blade plows are best used in connection with single trucks but in some instances where the snow is rather deep and there is no more powerful equipment available, it is believed necessary to employ the trucks in tandem

Figure 2—Pair of straight blade plows in action

Figure 3—V-shaped plow on a truck

2 V-SHAPED PLOWS ATTACHED TO TRUCKS

V-shaped plows are manufactured for truck use and are used mounted on trucks to some considerable extent (Figure 3) Quite a number of the States that use straight-blade plows on trucks and V-shaped plows on tractors do not use the V-shaped plow in connection with trucks The idea appears to be that in view of the fact that the V-shaped plow is a heavier tool, adaptable to heavier snowfall, that the tractor, with its increased power, should be used for its mount Some of the States that do use this type of plow mounted on trucks report them capable of work in relation to depths of snow about equal to the straight blade with a truck, while others claim them capable of removing snow of slightly increased depth and compactness, while still others report that compacted snow as deep as 5 feet can be removed with this outfit

3 V-SHAPED PLOWS ATTACHED TO TRACTORS

Through localities with considerable snowfall and organizations perfected for snow fighting, it has been reported by all concerned that the V-shaped plow mounted on a tractor is a highly desirable unit of equipment for snow removal (Figure 4) This unit is recommended by numerous State highway officials as efficient for snow removal from a depth of 12 inches, or less if compacted, to 4 or 5 feet of fairly loose snow Of course, it must be taken into consideration that the V-plow is manufactured in various depths of blade and strength of construction This model of plow ranges in type from using timber for its material with steel reinforcements, assembled by State and county maintenance shops, hauled by from two to six head of horses, to steel constructed plows, supplied by the trade, with depth of blade increasing from probably 8 inches to 3 feet or more, and of many and variable designs The plows of this class as supplied by the trade are usually designed for truck or tractor mounts but are generally found more efficient for work with tractors This class of equipment reaches its highest efficiency in localities of frequent snowfall of from 1 to 3 feet of depth and with organizations equipped with a number of suitable tractors

4 THE ROTARY TYPE OF SNOW AGITATOR

This type of snow removal equipment (Figure 5) must necessarily be confined, due to economic reasons, to well-organized snow removal units and to localities with considerable seasonal snowfall It is used or proposed for use in a number of the mountainous States for clearing the mountain passes and in other States for extraordinarily heavy snowfall and for cutting through deep drifts over long cuts with no lateral space to push the snow as would be necessary in the ordinary V-plow This rotary plow with lateral fan arrangement has been used by some few of the States at least during the past winter with successful results

Figure 4—V-shaped plow on a tractor

Figure 5—Rotary plow throwing snow both ways

The States reporting this type of snow agitator are Washington, Nebraska, Wisconsin, and Michigan In the last mentioned State, 16 county owned rotary plows were in use during the past winter and 5 State owned plows The State Highway Commissioner informs us that the State and county experience with this type of plow was in general quite satisfactory

With respect to the various depths of snow for which the foregoing outfits are suitable, we might summarize the information furnished by the State highway departments and others to the U. S Bureau of Public Roads as follows

The straight blade type of plow mounted on a truck is capable of removing snow from 6 inches in depth compacted to 12 inches in depth on a level and from 15 to 18 inches for short drifts

The V-plow mounted on a truck can move from the minimum depth to probably 15 inches of light snow on a level and from 18 to 24 or 30 inches through short drifts

A V-plow mounted on a tractor, especially the caterpillar type, can handle wet, heavy, compacted snow from 12 inches deep to 3 feet, and can buck drifted but not too heavy snow up to 4 feet and at times to greater depth

The lateral type rotary plow can agitate and clear snow from 2 feet to 9 feet Of course these depths are liable to change with the condition of the snow to be removed and the local equipment available, as well as the topography of the country and are offered for the consideration of those making a study of the subject

The width of passage cleared in snow removal activities varies from a width sufficient to accommodate one-way traffic with occasional turnouts to 24 feet and in some instances to the full width of the shoulders of 36 feet or more In cases where the push plows are employed the first storm of the season should be cleared to a generous width of passage in order that there may be lateral space to hold the snow pushed to one side or the other from subsequent storms

The average cost of snow removal per mile is a very indefinite figure It varies so widely between one State and another and even between counties in the same State that little information can be given on the subject The cost of snow removal varies with the density of the snow, depth and length of drifts, and width of travelled way provided One mid-western State with considerable snow to contend with, reports that 2,580 miles of road was maintained for wheeled traffic during the winter of 1924 and 1925 at an average seasonal cost of $22 52 per mile The average width to which the snow was removed on this system of highways was probably 24 feet and the average seasonal snowfall was 46 inches This average cost per mile was considered by the State as remarkably low as compared with the average cost per mile of $59 12

for the winter of 1923 and 1924, and was attributed partly to the fact that a great many units of new modern equipment were placed in operation last winter which decreased the amount of hand shoveling that had been necessary

A north-eastern State with considerable snow cleared 406 miles of road last winter at an average seasonal cost of $44.00 per mile The width cleared averaged 24 feet

One of the north-central States reports 400 miles of road cleared at a seasonal average cost of $44.96 per mile In this area the snowfall ranged from 53 to 70 inches deep and the width of roadway cleared was 24 feet where possible

In order to illustrate the variable cost of snow removal, the following is quoted from an eastern State

"The number of miles in the 1924–25 program was 816, the total cost of snow work was $223,117, and the average cost was $273 per mile, but the average cost does not have much significance as the cost on the minimum section was $8 70 per mile and on the maximum section $2,033 Snow is removed to a uniform width of 20 feet except in a very few instances where it is removed up to 30 feet"

With snow falling in the absence of wind there is nothing to do but call out the snow fighting units with their equipment and go to work, but with snow that falls with accompanying high wind, which is often the case, or followed by wind storms before the snow has become settled, ways and means can be provided beforehand to prevent more or less serious drifting conditions This is done by the different States in various ways By placing snow fences, either permanent or temporary, on the windward side of the highway to be protected, by removing road fences from the lee side of a highway that has been acting as wind breaks and causing resultant snow drifting conditions, by planting and training hedges at positions of vantage, and other methods of prevention. Some of these methods consist of studied locations of new roads during preliminary surveys with drifting conditions in mind, elevating the grade of improvement projects above the surrounding country where possible and necessary, or, at times by the design of flatter side slopes.

Both the heavier design and more or less permanent in place types o so-called railroad snow fence and the lighter or more portable type of fence—picket and wire on driven posts, are used by a number of the States for snow drifting prevention The railroad type is not recommended very highly when considered in comparison with the lighter type The States that have used the heavier type wholly have nothing in particular to say against it, but those using both types much prefer the lighter type In comparison, the objection to the railroad type appears to be that it is more expensive to build, difficult to handle, not easily installed and dismantled during an emergency, and can not as a rule be erected across fields under cultivation

The light type of fence, wooden slats woven together with galvanized wire cable, used in connection with driven iron or wooden posts, is recommended very highly by all concerned Some of its desirable features appear to be It is considerably cheaper and much easier to install and dismantle, it is considered by some more efficient than the railroad type and is expected to gradually replace its use, it is believed by others actually to last longer, it can be placed in open fields late in the fall and removed in the spring, and in this manner be no detriment to the agricultural use of the field One State had over 90 miles of the light fence in use during the winter 1924–25 and approximately 40 miles additional contemplated for its use this winter This State reports that the average price of this snow fence was 7 84 cents per linear foot The posts on the average 31 8 cents each The average spacing of the posts was 12 2 feet The cost of erection was 1 4 cents per foot The cost of removing the fence and storing it in the spring was 1 4 cents per foot Assuming a life of five years for the fence, and we have some which has been in service longer than that, this makes a net yearly cost of 4 9 cents per foot

Fences of one type or another used for prevention of snow blockades on rural highways are considered highly desirable and economical by most of the States reporting In some instances they are reported as being very effective in preventing drifts and tend to make an extensive snow patrol system more or less unnecessary In other cases it is reported that snow fences properly erected and located pay for their first cost several times over in one snow season

Considerable thought has been given to the planting of hedges for the avoidance of snow drifting along rural roads Observation and study of numerous natural conditions that cause snow drifting and other natural conditions that prevent it prove that hedges properly located would be useful to prevent drifting, although it might not be practicable to make the effort to grow them Drifting is often caused by tall weeds grown but not cut along the road or in the adjacent field In many cases the removal of low lying brush from the lee side of the road and in the adjacent fields will counteract drift forming tendencies Drifting of snow on many of the highways in a State situated in the corn growing belt is prevented due to the custom of permitting the corn fodder to stand through the winter The standing stalks collect the snow before it reaches the highway Elimination of snow drifting conditions is often accomplished by studied locations or relocations of new roads or roads proposed for improvement A number of the States take the snow problems into consideration in selecting new locations for construction work and consequently experience fewer blockades on recently constructed roads than on those earlier located and built The locations of roads are influenced by efforts to keep away from northern slopes

and topographical conditions that cause snow drifts In some States all locations are made with the elimination of snow troubles one of the governing features

D GUIDE, CAUTION AND DANGER SIGNS

The agitation for a standardized system of guide and warning signs is beginning to bear fruit Last year we made mention of the fact that the American Association of State Highway Officials had requested the Secretary of Agriculture to appoint a committee of U S. Bureau of Public Roads and State highway representatives to formulate a plan of numbers and uniform signs for a system of highways of interstate character

On March 2, 1925, the Secretary appointed a committee of 24, with Thomas H MacDonald, Chief of the U S Bureau of Public Roads, as

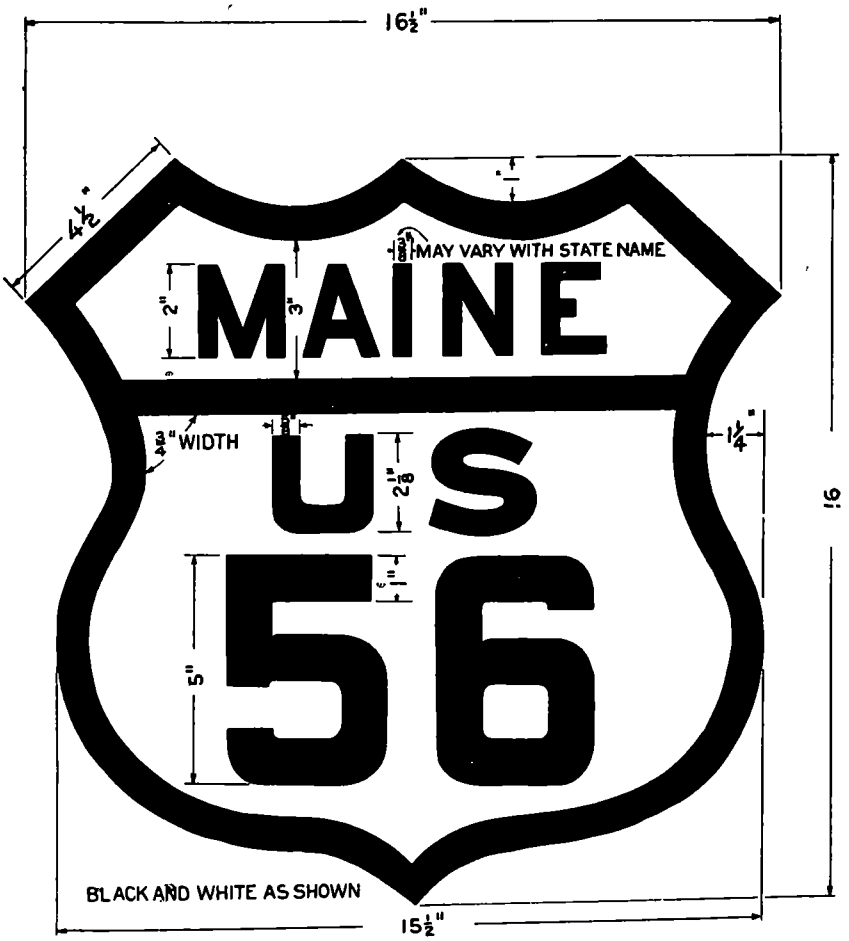

Figure 6—U S. Highway Marker

its chairman The committee adopted a policy of close cooperation with the States and, after numerous group meetings with State representatives, they prepared a complete report which was submitted to the Secretary of Agriculture and approved by him November 18, 1925 The report then came before the annual meeting of the American Association of State Highway Officials at Detroit on November 19, 1925, and was accepted by the convention The report will now be sent to the several States for a letter ballot

The report was accompanied by a map on which was shown the interstate highway system selected by the joint board The committee recommended that these roads be known as U S Highways All of the routes were designated by numbers and it is planned to mark them with a distinctive marker, which is a 15-inch shield with black letters on a white background (Figure 6) A complete set of warning signs in which the caution is indicated by both shape and color was adopted These signs have black lettering on a yellow background Directional signs are standardized both as to size and lettering and are to be black on white The Bureau of Public Roads is to act as a clearing-house for additional needed signs A strong recommendation is made to the states that they adopt the standard warning signs for their State roads as well as for the U S Highways The U S shield, however, is not to be used except on U S Highways The committee report would also provide for including the cost of signs as a part of Federal aid estimates on roads constructed or to be constructed

The American Association of State Highway Officials is intrusted with the task of designing a suitable interstate boundary marker

The adoption of this committee report by the American Association of State Highway Officials is certainly a long step forward. It is anticipated that by this time next year many States will have completed the marking of the U S highway system

E. STANDARDIZED MAINTENANCE ACCOUNTING

The committee is glad to report that the standard system of maintenance accounting recommended by the American Association of State Highway Officials and reported in last year's report of the Maintenance Committee, is gaining favor among the States and that the States are quite generally adopting maintenance systems of accounts which will enable them to make reports conforming to this standard A questionnaire to the States was answered by 21 States The replies indicate that 8 States have adopted the American Association standard, 3 use a modified system, 3 favor this system but have not yet adopted it, and 6 are using systems of their own

The suggestion is made that the maintenance accounting should cover quantities of work performed and unit costs as well as purposes, totals

and places of expenditures and further that the accounting should serve a number of useful purposes, as follows

First, to furnish summarized detail data of general maintenance, surface treatment, and resurfacing of the various roads of the State highway system for record and for study of operation costs

Second, to show annual and cumulative costs of maintenance other than additions and betterments in such way that different types can be readily compared as to economy

Third, to make a running record of the building up or developing of the various roads of the State highway system, taking into account additions and betterments, and depreciations as well as construction costs

Fourth, to provide "comparable costs" for comparison of efficiency in the divisions or districts and of the individual foremen and caretakers (patrolmen)

F. RELATION BETWEEN AGE OF PAVEMENT AND ITS ANNUAL MAINTENANCE COST

Extensive correspondence and inquiry has been carried on during the year, with the view of determining the amount of material available for a study of this question, and the best methods and channels through which it might be approached, and research encouraged

Information derived from various forms of pavement in city service is no doubt instructive Data extending over a considerable period is available in some degree with respect to city streets But it has been found, with respect to pavements in the open country, on State highway or other heavy traffic systems, that reliable statistics can rarely be obtained for a sufficient period to justify definite conclusions.

The most illuminative research which has come to the attention of the committee during the past year, is an analysis of maintenance costs of asphalt pavements at Columbus, Ohio, by R H Simpson, Chief Engineer, Division of Engineering and Construction, in the Department of Public Service of that city

Costs kept since 1888, over a period of 37 years, have been averaged, analyzed and charted Streets are divided into those of heavy and of light traffic, the distinction broadly being that "all pavements in business sections, in railway terminal districts, and all thoroughfares have been considered as heavy traffic pavements, and all others as light traffic" From this analysis, the following deductions are indicated

1 That repair costs increase somewhat uniformly with the age of the pavement
2 That a very small outlay is required during the first 5 year period

3 That there is a "critical period" in the history of each pavement, usually from the tenth to the thirteenth year, when heavy repair costs are required, following which there is lower maintenance cost for a few years

4 That heavy traffic pavements have a period of heavy maintenance at approximately 10 or 12 year cycles

The results of a study of maintenance costs on the city pavements of Columbus, Ohio, while valuable and suggestive, are not definitely applicable to modern conditions on highways of through traffic, and such studies involving old-time conditions of construction and traffic may be decidedly misleading, more especially in regard to the comparative merits of different paving materials

After consideration, the committee has reached the following conclusions

Marked improvements have been made recently in the use of certain road materials, and in the design of pavements

Maintenance data to be fully informative should extend over a period of not less than 20 years

Deductions from long term data, at the present time, must necessarily pertain to pavement design of an inferior type, and therefore would be misleading with respect to modern uses of paving materials

In the earlier periods of highway construction, records were seldom kept in such detail as to be of service in the present investigation, segregating slab maintenance from the cost of shoulders, drainage, culvert repair, snow removal, and items of improvement

Traffic conditions have changed markedly, and maintenance costs ten or fifteen years ago, do not reflect the conditions which now exist

Traffic records concurrent with cost data for any extended period are incomplete

Maintenance costs, to be reasonably informative, should be on a ton-yard basis

Inquiry by the committee indicated that records of a fully acceptable type, such as will not be misleading with respect to the comparative merits of paving materials, are practically non-existent

G COVERINGS FOR POORLY CONSTRUCTED AND DISINTEGRATING CONCRETE ROADS

A very important question to solve in road economics is how to treat a poor concrete road that is disintergating This question will become more important each year because of the large mileage of this type of road surface that has been built in past years and the large mileage that is being built each year Many miles of the concrete road constructed in previous years are not up to present standards of construction and hence, will soon need a resurfacing with something

While many of the defects in a fairly well constructed concrete road are being successfully repaired with new concrete wherein patches of the old concrete are cut away and replaced with concrete, it will be desirable in time completely to resurface the concrete road

While there are quite a few isolated cases here and there over the country where concrete roads have been resurfaced by one thing or another, there has been but little systematic study of this work with a view to learning what is the most economical surface to place on such roads The question as to whether the minimum thickness of a resurfacing with concrete should be three, four, or five inches and the question of whether it should be reinforced, how the joints should be constructed, etc , are matters which must be learned from careful observation over a period of years

Perhaps the best that can be done with such a subject at this time for research purposes is to enumerate the various pieces of construction work wherein an old concrete road has been resurfaced Then by observing these various kinds of resurfacing from time to time, sooner or later, some valuable conclusions can be drawn

The following are some of the pieces of work which will admit of study in this regard

Indiana, near South Bend, on the Lincoln Highway —This past year part of the Lincoln Highway just west of South Bend, Indiana, was resurfaced with six different types of construction, each 500 feet in length The old concrete road was built about 1917, 18 feet wide, 9 inches thick in the center and 7 inches on the sides It had disintegrated under traffic to a point where it was almost beyond patching As a matter of experiment, St Joseph County resurfaced the six stretches of 500 feet each of the following types

1	Asphalt emulsion mix, 1 inch deep, cost	$1,150
2	Natural rock asphalt, 1½ inches deep, cost	1,400
3	Asphaltic concrete, 2 inches deep, cost	1,430
4	Sheet asphalt, 1½-inch binder course, 1½-inch top, cost	1,570
5.	Bituminous macadam (asphalt), 3 inches deep, cost	1,100
6.	Concrete 5 inches deep (steel fabric reinforcement 35 pounds per 100 square feet, placed 2½ inches beneath surface), cost	2,150
	Total cost	8,800

Indiana, near Indianapolis, State Road 37.—This past year 1,000 feet of State Road 37, northeast of Indianapolis, beginning with Thirty-eighth Street, was resurfaced with 2 inches of emulsified asphalt. The old concrete road was built in 1917, 20 feet wide, 6 inches thick at edges

and 8 inches in the center Under the heavy freight traffic it was breaking down in many places which required quite extensive patching It was attempted to learn if the resurfacing would stop further breaking of the old concrete which now becomes a base for the new emulsified asphalt

Ohio, Ashtabula County, State Road 151, Section E, just west of Andover —The old concrete road was built in 1912 of plain concrete 6 inches thick, 16 feet wide, and 1 22 miles long. It was resurfaced in 1921 with a 3 inch brick top

Ohio, Geauga County, State Road 15, Section G, just west of Scottland.— The old concrete road was built in 1915, 6 inches deep to a width of 14 feet and a length of 1 52 miles In 1921 it was widened with concrete to a width of 16 feet, and resurfaced with 4 inch brick surface with tarmastic filler. Surface is now in fair condition.

Ohio, Huron County, State Road 290, Section G–2, west of East Townshend —The old concrete road was built in 1914, 6 inches thick and 14 feet wide and 0 85 mile long, of plain concrete In 1924 it was widened to 20 feet with concrete and resurfaced with a 4-inch brick top with asphalt filler Present condition good.

Ohio, Huron County, State Road 290, Section G–1, length 1 75 miles.— The old concrete constructed is the same as G–2 above. It was widened in 1922 with concrete 18 feet, and resurfaced with brick 3½ inches thick with asphalt filler and 12-inch concrete curb built on either side. The present condition is good.

Ohio, Licking County, State Road 47, Section F, 3.92 miles long, just east of Granville —The old road was built in 1914 of plain concrete 5 inches thick on the sides and 7 inches in the center In 1925 it was widened to 20 feet with concrete and resurfaced with reinforced concrete 5 inches thick in center and 5½ inches on the sides.

Ohio, Lorain County, State Road 3, 5 62 miles, Section J, west of Oakpoint —The old road was built in 1915 of plain concrete, thickness, 6 to 7½ inches. It was not so badly broken but narrow and dangerous for the heavy traffic, hence it was widened in 1923 to 18 feet with concrete and resurfaced with bituminous concrete hot mix top. The surface is now wavy and shows some cracks over the old pavement

Ohio, Muskingum County, State Road 344, Section E, 1.07 miles long, north of Dresden —The old road was built in 1912 of plain concrete 6 inches thick It was badly broken and disintegrated, when in 1921 it was resurfaced with 4 inches of concrete, part of it plain and part of it reinforced with wire mesh The surface at present is cracked quite badly.

Ohio, Trumbull County, State Road 150, Section G, 2 86 miles long — The old concrete road was built in 1915 of plain concrete 6 inches thick and to a width of 10 feet. It was badly broken and disintegrated and

was widened in 1924 to 16 feet with concrete and resurfaced with rock asphalt Present condition good

Ohio, Huron County, State Road 290, Section N, 1.32 miles long —The old road was built of plain concrete 6 inches thick and 12 feet wide In 1915 it was widened to 16 feet with waterbound macadam strips along each side In 1919 it was resurfaced with brick to a 16 foot width using asphalt filler. In 1922 a 24 inch wide concrete gutter was built on each side, making a total width of pavement of 20 feet The present condition of the surface is good over the old concrete but poor over the macadam portion.

California —The California State Highway Commission has resurfaced many miles of old concrete roads with a new concrete top Perhaps far more extensive work of this kind has been done in this State than in any other State and no doubt it will furnish much valuable information in future years as to the details of design necessary in resurfacing old concrete roads.

Wisconsin, Milwaukee County, built the Janesville Road in 1912 In 1914 2,000 feet of this road were resurfaced with brick, and in 1917 another 2,000 feet were resurfaced with a 3 to 4 inch thickness of concrete, reinforced with 27 pound mesh reinforcement with a 1–1½–2½ mix

A detailed description of each particular job mentioned above can be had usually by writing to the county or State authority in which the work is located.

DESCRIPTION OF ROUGHOMETER

A device has been developed in District 7 of the Bureau of Public Roads for measuring roughness of paved roads A complete description of this machine will be published by the Bureau soon A brief outline of the roughometer by District Engineer Voshell follows

"The roughometer is an apparatus for measuring the relative movement between the front axle and the frame of a moving automobile It consists essentially of a rack and pinion, the rack being fastened to the front axle of the automobile and the axle of the pinion to the frame of the automobile The pinion is equipped with a ball bearing clutch so that it moves freely in one direction on its axle but is prevented entirely from moving in the opposite direction, with the result that when the rack is moved up and down, the axle of the pinion moves in one direction only. The movement of the axle of the pinion is transmitted to the dash of the automobile by an ordinary speedometer cable and through a bevel gear to a veeder counter The various parts of the apparatus are so designed that a 1 inch movement of the rack registers as one unit on the counter We have designated the total-plus move-

ment of the rack when the automobile is driven 1 mile over a pavement as the 'roughness factor' of the pavement

"In order that the roughness factors of various sections of pavement may be comparable, it is necessary that the car be driven at the same speed on all sections and that the tires have the same degree of inflation As a matter of convenience we have adopted 30 miles as our standard speed and 60 pounds as standard tire inflation Experiment shows that the roughness factor will be increased about 8 per cent when the car is driven at 35 miles per hour over that when it is driven at 30 miles per hour, and decreased about 15 per cent when it is driven at 25 miles per hour

"About three years ago the State Highway Department of Illinois began its campaign of securing smoother pavements, and the records indicate that it has succeeded Following are the average roughness factors for those sections of pavement tested, arranged by year constructed

1920	166
1921	134
1922	123
1923	100
1924	95
1925	81

"The roughness factors obtained for various sections of pavement in Indiana and Michigan show these States to have made marked progress in the last three years and they are now building pavements with an average roughness factor of less than 100

"It is difficult to describe the riding qualities of pavements having different roughness factors My experience, however, is that pavements having roughness factors of less than 100 will give no unpleasant vibration or lurching of an automobile traveling at 35 to 40 miles per hour, that pavements having roughness factors between 100 and 150 will cause some unpleasant vibration, but no susceptible lurching of the car, while pavements having roughness factors of more than 150 will cause considerable unpleasant vibration and at times a disagreeable lurching of the car"

COMMITTEE RECOMMENDATIONS

The committee would recommend the following disposition of the maintenance problems now under consideration

1 Dust prevention and surface treatment of gravel and macadam roads

We feel that the general practice in this type of work has become so standardized that no further research work is needed, at least for a few

years, so we would recommend that the topic be dropped for next year

2 Crack fillers for concrete pavements.

The committee would recommend that this topic be continued for study, with the special end in view of determining, first, whether it is at all necessary to fill the average small crack, and, second, if it is found necessary to fill these cracks whether the bitumen should be allowed to overflow the crack or whether it should be confined entirely to the crack

3 Snow removal and snow removal equipment

Conditions vary so greatly between the States in the snow belt that the committee feels that research work should be carried on by practically every State Inasmuch as this topic is demanding more and more attention, we would recommend that it be continued for further study

4 Guide, Caution, and Danger Signs

The committee feels that the work of standardization of these signs has been taken care of in a satisfactory manner, and, with a strong recommendation to the various States to put this system in operation as quickly as possible, the committee would recommend that the subject be dropped the coming year

5 Standardized Maintenance Accounting

The committee recommends that the standard system of accounting as adopted by the American Association of State Highway Officials be put in operation by all of the States at as early a time as possible We feel that the research work has been completed on this subject but would suggest that the Bureau of Public Roads submit to the various States the standard system as adopted with a request that the States so keep their maintenance costs on Federal aid projects that the maintenance of these projects can be reported in accordance with the standard system

6 The Relation Between Age of Pavement and Its Annual Maintenance Cost

On account of the various factors entering into this problem and the lack of satisfactory data, the Committee would recommend that this topic be dropped from the list of research problems until such time as cost and traffic records of a uniform character are obtainable for a sufficient period accurately to reflect true cost data

7 Coverings for Poorly Constructed and Disintegrating Concrete Roads

The committee has listed a number of resurfaced roads which should be studied from year to year We would recommend that this topic be continued for study