COOPERATIVE RESEARCH AND STANDARDIZATION OF LOW-COST ROAD IMPROVEMENT

(Federal Government Participation,
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When Mr. E. W.James, speaking before the Seventh Annual Asphalt Paving Conference at New Orleans, called attention to the need of experiments to determine how best to use light oil products in low-cost road building, he expressed the hope of the Bureau of Public Roads that the industry would find in the development of that broad field for the utilization of its products an opportunity worthy of its best efforts equal at least to that offered in the necessarily limited field of high-class pavement construction. Examination of the program of this eighth conference, suggests that the industry approved the suggestion.

The Bureau's interest in the development of methods of low-cost road construction is founded upon knowledge of the need of such methods for the improvement of literally hundreds of thousands of miles of roads on which the present traffic is of such proportions as to require a smooth, dustless, year-round surface, but not so great as to justify the necessary expenditure for a surface of high type. We have been confronted directly with this need in connection with the improvement of roads in the national forests and parks which are our special responsibility. We know that there are many miles of main roads in certain regions, particularly in the West and South, which are in need of similar improvement and we realize that the hope of satisfactory early improvement of thousands upon thousands of miles of local roads depends solely upon the prompt development of suitable low-cost surfaces.

The problem now presented by these local roads is much the same as that which thirty years ago was presented by the far more limited mileage of main roads. With the general increase in traffic density that has followed everywhere the mounting motor vehicle registration, we now find these local roads subjected to a traffic as heavy as that which years ago suggested the use of bituminous materials in the improvement of the main roads. The difference is that where 30 years ago the problem was to improve some tens of thousands of miles, that which now confronts the local authorities involves the improvement of hundreds of thousands of miles.

The Bureau's first active interest in experiments looking to the development of methods of low-cost surfacing using bituminous materials was an outgrowth of its experience with roads built in the national forests under its direct supervision. When traffic on these roads was considerably lighter than it now is we found the construction of a surface of finely crushed rock or gravel an adequate provision for year-round service. A similar type of surface had

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been adopted by a number of the Western States and a rather considerable mileage had been built when, some five or six years ago, it became apparent that traffic had already increased to a point which would demand that something be done immediately to lay the dust and reduce the heavy loss of surfacing material that was taking place.

The States of Oregon and California took the lead in the experimental use of petroleum oils by various methods to remedy the situation and when their effects had already shown some considerable promise of success, the Bureau joined with the California department in an investigation of the various methods that had been tried with a view to ascertaining what methods or combinations of methods and materials might be expected to afford the greatest measure of relief. The results of the investigation were published in 1927 in the Bureau's magazine Public Roads, and in a special bulletin of the California department.

At about the same time the Bureau was also engaged with the highway commission of South Carolina in experiments to develop the possibilities of bituminous surface treatment of topsoil roads, and the first report of these experiments, which were distinctly promising, was also published in 1927.

So much the Bureau had done when Mr. James made his recommendation to the industry at the Seventh Annual Conference in 1928. The suggestion met with immediate response and in March of the present year a joint technical committee was created to represent the industry and the Bureau in planning and carrying out a comprehensive study of all of the various methods which had by that time been developed in various parts of the country.

General Character and Limitations of The Cooperative Research.

It was agreed to limit the scope of the investigation to the study of the various newer methods of construction or treatment involving bituminous materials designed to produce a dustless surface resistant to light traffic and less expensive than standard penetration macadam. This would include the various methods of surface treatment of sand-clay, topsoil, gravel, stone and other materials, sand-asphalt mixtures and in-place mixtures of stone, gravel, sand, etc., with all types of asphaltic oils, fluid residuals, cut-backs and emulsions or heavier materials where necessary.

Four principal lines of investigation were projected:

1st. A rapid, but detailed study of the results of all the various methods developed locally in many parts of the country with a view to ascertaining definitely the merits of each, developing information which if promptly disseminated might be generally useful and practically applicable at once, and eventually leading to a knowledge of the principles involved in the newer methods from which to proceed to their further development.

2nd. To study the efficiency of the methods of applying and mixing asphalt and aggregates at present employed, to observe the operation of machinery and equipment in detail, and eventually to suggest modifications in equipment and methods which might result in physical and economic improvements of construction methods.

3rd. To analyze the asphaltic materials actually used in work done to date and all available materials which might be used with a view to the development of bituminous materials having the characteristics found to be desirable for work of the various classes, and

4th. To build and study experimental roads of various types in order to isolate the effects of variables not detectable in the broader field investigations.

In the first phase of the investigation - the broad field studies - it is proposed to make a detailed analysis of the methods, materials, cost, and service of the various types of low-cost bituminous surfaces thus far developed in various localities, both by the observation of general results obtained and by the more particular study of representative sections of each type of construction with regard to which a more or less complete history is available.

The types to be studied will include sand-clay and topsoil surface treatments in the Southeastern States; sand-asphalt surfaces in Massachusetts, North Carolina and other States; bituminous treatments of clay roads in Illinois and elsewhere; the retread method of Indiana and somewhat similar treatments of stone roads in other States; the so-called blotter treatment of gravel roads in Minnesota and adjacent States; oiled sand roads in California, Nevada, Nebraska, and elsewhere; and the mixed-in-place treatment of fine-crushed rock and gravel surfaces which has reached its highest development in the far western States.

Studies have already been made of surface treatments of sand-clay and topsoil roads in Florida and South Carolina; of oil treatments of clay roads in Illinois; and of the retread method in Indiana. The data gathered in the field by engineers of the Bureau, the Association and the respective States, are in course of analysis at the present time; and it is expected that the first reports dealing with these three types will be published very shortly. An indication of the progress that has been made and of the general character of the information obtained will be presented by Mr. Pauls later in this morning's session.

The studies of the efficiency of construction methods and equipment, which constitutes the second phase of the investigation is being conducted by the Bureau with the advice and assistance of the association. These studies are similar in their general aims and methods to studies previously made by the Bureau in the fields of grading and concrete and bituminous pavement construction; and it is hoped that they will produce information of as great value as these other studies have brought out. They have been in progress on a number of selected projects employing equipment and methods of various types for several months; but as yet it is not possible to present any definite results or conclusions.

The third phase of the investigation - that involving a study and analysis of the available bituminous materials is the particular responsibility of the industry and will doubtless be dealt with at length by Mr. Hubbard in his paper this morning.

The fourth phase, involving the construction and study of experimental roads, has also been begun and will be actively prosecuted mainly by the Bureau of Public Roads in cooperation with several of the State highway departments, but always with the active assistance and advice of representatives of the association.

Three such detailed experiments are now in progress; the first a continuation of the surface treatments of topsoil in South Carolina; the second a series of experiments in California involving the treatment of fine crushed rock and gravel surfaces with several types of bituminous materials by methods of surface treatment and mixing in place; and the third a series of experiments in the treatment of sandy soil with various asphaltic materials. The location of these experiments is the sand-hill section of Nebraska.

The Experimental Roads in South Carolina.

The South Carolina experiments have been conducted in cooperation with the State highway commission. Four experimental roads have been built in as many counties since 1925; but the first, a road in Anderson County, having served its purpose, is no longer under observation by the Bureau. A report of the experiments on this road was published in the November 1927 issue of Public Roads.

The other three projects in South Carolina are under current observation, and constitute sources of information for the cooperative investigation. These are in Spartanburg, Horry and Berkeley counties.

The Spartanburg County project is located on State Route 19, beginning at the southern city limits of Inman and extending north to the State line. There are five experimental sections aggregating 8 miles in length on each of which the topsoil surface was given a double surface treatment, the variables being the bituminous materials and the mineral covering. On all sections the priming material was applied at the rate of ¼ gallon per square yard and the second application at the rate of 1/3 gallon per square yard. On the first and fourth sections the primer was a tar of 8 to 13 specific viscosity at 40°C and the second coat hot tar, the variables being the cover material which consisted of slag and stone, both graded from ½ to 1 inch. On the second section the primer was a cut-back oil and the second application a hot asphalt of 150 to 200 penetration; the cover was ½ to 1 inch stone. The third section had a prime of cut-back oil and a second coat of hot tar with covering of stone and dolomite chats; and the fifth section a prime of tar and a second coat of hot asphalt of 150 to 200 penetration, the covering stone.

These experimental sections were built in 1925 and have since been under continuous maintenance and observation. A report of all available data up to the summer of 1927 was published in Public Roads for November of that year.

The Horry County experiments were conducted on a section of State Route 38, 20.6 miles in length, between Conway and Galivants Ferry. This project, which was a test of mixed-in-place topsoil surfaces, was constructed in 1927. There are eight experimental sections each in turn divided into sub-sections to a total of 29. Two of the sections, covering a total length of 12,700 feet, were planned to be maintained by machine. In these, four slow-curing oils

were used in the mixing process and no seal coat was applied. The four oils used on these sections were as follows:

Section 3. 5,000 feet, No. 5 road oil.
Section 4A, 2,600 feet, No. 5 road oil with pressure still tar.
Section 4B, 2,600 feet, No. 6 road oil with pressure still tar.
Section 4C, 2,500 feet, Flux oil with pressure still tar.

The remainder of the sections were designed for patrol maintenance by patching. In these, various grades of quick-drying asphalts and tars were used in the mixed base and single or double surface treatments, with cover material of sand, pea gravel, crushed stone, and treated soil. One section No. 8, had only a surface treatment. The base was not mixed. It was divided into two sub-sections on one of which the primer was 85-100 penetration asphalt cut back with naphtha and on the other tar of 8 to 13 specific viscosity. On both the seal coat was 150-200 penetration asphalt applied hot. The prime applications were in the amount of approximately a half gallon and the seal at the rate of 3/8 gallon per square yard. The cover in each case was 1½ to ½ inch stone in the amount of 60 pounds per squareyard.

On all other sections the base was mixed with bituminous material, consisting of cut backs of asphalt of 85-100, 100-120, and 150-180 penetration, and tar if 18-25 specific viscosity; and to these mixed bases were added surface treatments of various materials, the combinations being too complex to enumerate.

As previously stated these sections were built in 1927. Since that time complete records of traffic, maintenance and all pertinent information have been kept but no report has been published. The analysis of the results obtained will supply important data for consideration in the cooperative investigation.

The third of the current South Carolina experiments is located in Berkeley County. The construction was completed during the past summer. In these experiments which have been conducted on 4½ miles of State Route 46 near Moncks Corner, we have experimented with stone surfaces laid on sand-clay and marl bases, there being 2½ miles of the former and 2 miles of the latter. Except for the length of the sections the surfaces applied over the two types of base were of the same five kinds. Four of the surfaces on each type of base were mixed in place; the fifth was surface-treated.

The objects of the surface experiments were to determine the relative value of mixed-in-place and surface-treated surfaces, and to test the practicability of using variously graded mineral aggregates with cut-back asphalts in the mixed-in-place method of construction. Consequently each of the mixed-in-place sections involves a different gradation and size of mineral aggregate. The first experiment was divided into two sections in one of which the bituminous material was a 60-70 penetration asphalt cut back with 25 to 30 per cent of heavy naphtha and in the other an 85-100 penetration asphalt also cut-back with 25 to 30 per cent of heavy naphtha. In the other three mixed-in-place experiments the 85-100 penetration material was used.

1/ The surface-treated section on the marl base was treated with the same 85-100 penetration material in the amount of about a half gallon to the square yard; and the same treatment was applied to a portion of the section on sand-clay base, the remainder of the section being treated with Colas.

The California Experimental Road

The California experiments represent an effort to test under identical conditions the relative values of cut-back asphalts, emulsions, and the so-called fuel oils for surface treatment and mixed-in-place construction on fine crushed rock and gravel surfaces.

These experimental surfaces have been constructed during the past summer on a section of road about 10 miles in length near Truckee, the Bureau cooperating with the Division of Highways of the California Department of Public Works.

The section of road involved had previously been surfaced in 1927 with mixed-in-place crushed rock. The old surface had become inadequate and it was to be strengthened by addition of anew compacted depth of 3 inches of stone. Advantage was taken of this occasion to try the various bituminous materials and methods of construction.

The project includes a total of 20 experimental sections in all but two of which the mineral material is fine crushed rock, the exceptional sections being fine crushed gravel.

The bituminous treatments consisted of in-place mixtures of fuel oil, Kerosene cut backs, and emulsions; and surface treatments with fuel oil, a heavy road oil, asphalt of 150-200 penetration, and two emulsified asphalts from different sources.

The Sand-Oil Road Experiments in Nebraska.

The Nebraska experiments, which have also been constructed during the past summer are located on Federal-aid project 313-A, a stretch of road about 9½ miles in length, beginning at the town of O'Neill and running south toward Bartlett. The soil at this point is characteristic of the sandy soils which occur over a large area of the State of Nebraska.

The entire project which was constructed in cooperation with the State highway authorities, is divided into nine sections each approximately one mile in length. The work just completed consisted of the construction of a mixed sand-oil surface of 4 inches compacted depth over the entire length of the road. In this work the only variable was the bituminous material of which there were three types each applied to three sections. On sections 1, 2, and 3, the material used was road oil of 60-70 per cent asphalt of 100 penetration; on sections 4,5, and 6 an oil of 70-80 per cent asphalt of 100 penetration was used; and on sections 7,8, and 9 the material used was a soft asphalt cement cut back with a slowly volatile solvent. Each of these materials was applied at the rate of from 3 to 4 gallons per square yard.

Next summer, when the mixed surfaces have become thoroughly compacted, it is proposed to surface-treat a number of the sections as follows:

Experiments Nos. 1, 4, and 7 are to be left untreated.

Experiment No. 2 is to be given a light application of the same oil that was used in the mix and covered as needed with the sandy soil.

Experiment No. 3 is to be given a light application of a soft asphalt cement and covered as needed with the soil.

Experiment No. 5 is to be surface-treated with the same oil that was used in the mix and covered with the soil.

Experiment No. 6 will have a treatment with the soft asphalt cement and sandy soil.

Experiment No. 8 will be given the same treatment as No. 6; and

Experiment No. 9 will be treated with the same material as Nos. 6 and 8, but will be covered with gravel.

From this necessarily sketchy outline of the cooperative researches to be carried out jointly by the industry and the Bureau it will be seen that the plan contemplates:

First, a broad study of a large mileage of low-cost surfaces of the various types as constructed in all sections of the United States, with more detailed observation of certain representative sections of each type, for which the necessary historical data are available. These studies, which have been completed with respect to surface treatments of topsoil and sand-clay in the States of South Carolina and Florida, with respect to oiled clay roads in Illinois, and the retread method in Indiana, are being made by the district representatives of the Bureau and representatives of the association and several of the companies.

The second phase is the study of the efficiency of methods and equipment in use, the aim of which is eventually to suggest improvements in equipment and methods. This part of the work isbeing done by the Bureau with only incidental assistance from the association.

The third phase is the study and analysis of bituminous materials which is the special province of the association.

And finally, as a fourth phase, there are the experimental roads on which we are depending for the intensive study of materials and methods which will serve to supplement with detailed analysis the general observations made on the large mileage covered in the rapid field studies which constitute the first phase.