BITUMINOUS MATERIALS FOR SURFACE TREATMENT

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For twenty years or more the use of bituminous materials in the surface treatment of highways has had an important place in the work of State, county and city highway departments as a means of improving the condition and serviceability of roads, the traffic upon which did not warrant the construction of the more costly types of surfacing Excepting the use of oil for many years on earth roads in certain central States, and the wide use of the lighter materials as dust palliatives, most attention in surface treatment has been given to the treatment of macadam roads, and in more recent years to the treatment of the better types of gravel surfaces Long experience with macadam roads has developed general knowledge of conditions essential for the greatest degree of success, and has demonstrated the value of a wide range of bituminous materials, both as to character and consistency, for macadam surface treatment To a less degree, this is also true as applied to gravel roads

In the last two or three years there has been a rapid development of interest in surface treatment of lower type surfaces as a possible means of extending the utility of the enormous mileage of such roads under rapidly increasing traffic, and of preserving the capital invested in their construction This is shown by treatment of macadam, gravel, top-soil and sand-clay in such widely scattered States as North Carolina, South Carolina, Tennessee, Michigan, Wisconsin, Minnesota, Maine and Wyoming, oiling of the finer earth types in Illinois, Iowa, and other Central States, and surface treatment of fine crushed rock or gravel surfacing in Oregon, California and Idaho

BITUMINOUS MATERIALS

Bituminous materials economically available for surface treatment in the different sections of the United States vary considerably, both as to range in type and character of material and to some extent as to range of consistency. This fact is due to the nature of crude petroleums handled by refineries in the several sections, to variations in their refining practices, and with tars, to the different methods of gas and coke production, as well as to the varying state of development in use for road purposes of such tar as is produced

In the Eastern and Central States, the use of tar products for surface treatment is well developed and a wide range of products is available, including those derived from gas-house, coke-oven, and

water-gas tars, of practically any desired consistency In States west of the Rocky Mountains, however, tar has been little used in road construction or maintenance Much of the tar produced is oil-tar, and only recently has the use of this material been attempted During the past season considerable oil-tar has been applied on gravel and crushed rock roads in the State of Oregon

Petroleum products, however, have been used for surface treatment in all sections of the country, and may be said to be generally available In the Eastern States they may be obtained in grades ranging from very fluid oils of non-asphaltic character, eminently suitable for use as dust palliatives, to soft asphalts, and include slow-curing and rapid-curing road oils, heavy oils for hot application, and cut-back asphalt products, adapted to a variety of road types and conditions

In the Central States also a broad range of petroleum products may be utilized, although road oils of the most highly asphaltic or rapidly curing character are not so readily available

Bituminous materials for surface treatment in the Pacific States are essentially derived from asphaltic petroleum The greatest development has been in the use of hot application materials, producing a heavy mat treatment, but recently a great deal of attention has been focused on the use of lighter materials, particularly in the State of Oregon, where beginning about three years ago noteworthy success has been obtained in treatment of gravel and crushed road roads

TYPE OF ROAD AND OBJECT OF TREATMENT

In studying bituminous materials for surface treatment, the problem of most suitable bituminous material can never be considered separately from the character of the non-bituminous material of the road surface In fact, the success or failure of the treatment is more dependent on what the road to be treated consists of and its adequacy in thickness and design to carry the traffic than on the selection of the tar or oil to be used Thus the road may be of graded earth, and the material to be treated very fine material containing a large percentage of clay, or toward the other extreme, it may be a substantial waterbound macadam presenting no unusual difficulties in treatment

The purpose of the application of oil or tar also limits the selection of bituminous materials These may be applied merely for the purpose of minimizing a dust nuisance without affecting the methods of maintenance, altering methods of maintenance, and in effect changing the type of road surfacing, they may be used for the purpose of binding the existing road material or with added sand, gravel or rock, developing a substantial mat over the road

The treatment of waterbound macadam or crushed stone roads is well understood as to methods and the behavior of different bituminous materials Of more concern at the present time is the surface treatment of gravel and lower type roads as a phase in the development of intermediate type roads, along these lines the correlation of existing information and promotion of research would be of great value

Without attempting to summarize the practice of the various States, it may be sufficient at this time to call attention to some outstanding developments in State highway work, and to indicate what researches are under way, or completed, involving tars and oils as surface treatment materials In this connection references to a number of published papers are appended to this report

The treatment of earth roads has been extensively studied in Illinois, with experiments on six roads from 1923 to 1925 A variety of oils were used as produced by different refining processes As applied to specific soils in Illinois, Mr F L Sperry (2)[1] concludes that "binding properties and adhesiveness are secondary in importance to the ability of the oil to resist emulsification and retain its life in contact with the soil This may not hold true in extremely dry climates Reduced pressure tar is a satisfactory oil for earth roads Cut-back or mat-forming oils which develop their asphalt content by the evaporation of their lighter constituents after their application are not well suited for earth roads Non-volatile and homogeneous oils penetrate better and are more evenly and uniformly absorbed by the soil than blended products Blended oils tend to separate or fractionate when applied" It should be observed that in earth road treatments as typified by the Illinois roads, the object sought is the formation of a waterproof dustless surface for all-season traffic, not primarily the prevention of dust, and that this is obtained through absorption of oil by the earthy material itself

North Carolina and South Carolina have developed an extensive use of carpet treatments of top-soil and sand-clay surfaces In North Carolina the first treatment is of tar and sand, which, after receiving traffic for a few days, is covered with an application of rapidly curing cut-back asphalt, also covered with sand

A sand-asphalt type of surface results, which has a first cost of approximately $2,500 per mile, and is estimated to average about $650 per mile over a period of ten years, or less than the cost of maintenance of the untreated road Several hundred miles have been so treated

[1] Numbers refer to list of references on page 254

South Carolina has treated a large mileage of top-soil roads, beginning in an experimental way, by somewhat similar methods A priming application of thin tar is made, but both tar and heavy oil have been used for the second application and crushed granite is the usual cover material (5)

In cooperation with the U S Bureau of Public Roads, the State highway department is also conducting a series of experiments in surface treatment of top-soil This includes a number of sections treated in a manner similar to the more extensively used methods outlined above, and also a number of experimental sections with cold applications of oil or tar, and others where a mixture of bituminous material and soil in place was accomplished All these sections are in acceptable condition after nearly 18 months' service.

Minnesota in 1924 started applying bituminous materials to gravel roads in an experimental way The work has been continued under careful supervision with a wide variety of products and an intensive study of bituminous materials, soils, and gravel is contemplated this winter Typical gravel roads of Minnesota that have been treated in most cases have not been surfaced with a thick course of gravel, and the character of existing subsoil, frequently very plastic clay, is expected to have a very important bearing on the results of treatment In some cases oil has been applied to the soil before placing the gravel in an attempt to find its value as a means of conserving the limited supply of gravel The problem of surface treatment in this State is a very pressing one

Wisconsin also is studying gravel road treatment, the first work covering tar treatments only (6) Here the method of mixing tar and gravel by blading and harrowing has been extensively used. Along the same line, there has been some use of a similar method in Pennsylvania where a tar-rock mixture is developed under traffic with frequent blading Some time, of course, is required to secure a finished surface, which in most cases resembles bituminous macadam Similar work has been done in Tennessee This State began in 1925 to experiment with different grades of oil and tar, as well as with methods of surface treatment for sand-clay, gravel and macadam roads

Oregon in the past three years has had noteworthy success in the treatment of fine crushed rock and gravel surfacing, and several hundred miles have been thus improved in sections of the State having low rainfall A California residual petroleum, marketed as fuel oil, is purchased for this purpose, using specifications which are still considered incomplete Heavier oils and oil-tar products have also been used to some extent in an experimental way A

typical Oregon fine-crushed rock or gravel road is constructed in two courses, each 4 inches thick, loose measurement Material for the base course has a maximum size of 1½ inches, and for the top course ¾ inch The material is bonded under traffic, frequently with the addition of filler and binder In treating such a surface, particular attention is given to the preparation of a well-bonded, smooth-riding road, and thorough cleaning before oiling, and absorption of the oil by the bonded road to a maximum degree is obtained One-half gallon per square yard will be absorbed to a depth of about 1¼ inches

The success which the State highway department of Oregon has had in surface treatment has attracted a great deal of attention and comment in the Western States It should be emphasized that this success is undoubtedly due, in a large measure, to the foresight and painstaking attention to details of the work which maintenance engineers of the department have given their oiling work

Other Western States have taken up surface treatment as a promising means of increasing the service of gravel and crushed rock roads California has this season treated at least 300 to 400 miles In some of the more arid regions where it is difficult to secure a properly compacted and cemented road surface, oil has been used as a mixture with the loose material, and it is reported that very encouraging results have been obtained

The development of an economical road surface intermediate between crushed rock and gravel and pavement types is a matter of extreme importance to all the Western States, and a study of this problem has been undertaken cooperatively by the State Highway Commission of California and the U S Bureau of Public Roads. This involves, of course, consideration of methods, materials, and field of bituminous surface treatment, as a phase in such a study having major importance and promise In view of the rapidly developing surface treatment programs of Western States, it is expected to coordinate and make available all related information on this subject as applied to those States, in season to be of service during the coming year

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SUBGRADE MATERIALS AND TESTS

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The subject of subgrades and subgrade materials for highway work has been given intensive study for the past several years The relative object of all investigators is to try to develop methods of tests applicable to the laboratory, or proferably to the field, for the identification of subgrade soils, from the standpoint of determining their suitability for the efficient support of the surface

Progress has been made in the determination of the suitability of certain soils for this proper support For instance, it has been checked by numerous investigators that the clay content is one of the governing features of subgrade soils which effect their stability. Some laboratory tests for the identification of these soils have been developed, and one field test has been developed within the past several years known as the moisture equivalent determination, and has been applied to some extent

METHODS OF REMEDYING POOR SUBGRADE CONDITIONS

One of the original methods for improving poor subgrade conditions was to endeavor to stabilize clay soils by admixtures of finer materials, such as Portland cement, hydrated lime, etc The theory of a sand-clay surfacing also has been followed to some extent The later reports on subgrade investigations seem to indicate that the finely ground materials, such as hydrated lime, Portland cement, etc , are not as efficient for this purpose as the coarser granular materials such as sand, stone, screenings, etc [1]

The Proceedings of the Fourth Annual Meeting of the Highway Research Board, page 66, tabulates digest of subgrade needs, suggested by the contact men in the various State highway departments:

[1] "The Present Status of Subgrade Studies," Public Roads, Volume 6, No 7, September, 1925, page 160