

ASPHALT OIL TREATED HIGHWAYS.

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Many thousands of miles of gravel or similarly surfaced roads in the Rocky Mountain territory can no longer be satisfactorily maintained as such for the traffic which they must now carry. The so-called high-type or rigid pavement is beyond the financial resources of the States in this vast domain, except for a very limited mileage on highways carrying heavily concentrated traffic such as found in the Denver area. While this condition has been developing gradually it was not entirely unforeseen by highway executives who realized some two or three years ago that there was an imperative need for an intermediate type that would provide a smooth, dustless surface, not subject to rapid wear and attendant losses of material, and most important perhaps would decelerate the rapidly mounting costs of maintenance.

There have been constructed in the Western States in the past ten years a great many miles of highway surfaced with gravel, crushed gravel or rock, shale and selected material. These have been built to uniformly high standards of alignment, grade and drainage. This type under good maintenance provides an all-weather road that is highly satisfactory as long as the amount of traffic does not pass the point where it is no longer possible to hold a smooth surface under the arid conditions that exist in this region. A daily traffic in excess of about 800 per day will result in a very unsatisfactory surface which may be raveled and loose, rough from pot holes, or corrugated. Such a condition cannot be solved by any known methods of maintenance or equipment even at greatly increased costs. Of even greater concern is the loss of surfacing material. This loss has been found by actual measurement to be

as great as one inch in depth per year which is equivalent to 484 tons per mile per year. Crushed gravel surfacing in Wyoming averages \$4,400.00 per mile first cost for a 6" depth, with a maximum as high as \$9,000.00 per mile where a long haul is involved. The annual replacement of this lost material will therefore cost from \$500.00 to as high as \$1800.00 per mile per year. The original surfacing of many Wyoming projects has exhausted all available materials in the vicinity of the project and resurfacing can only be accomplished at a very much higher figure.

This is the situation, growing more acute each day with the rapidly increasing traffic, that has been confronting Highway Officials, already faced with insistent demands for completion of their highway systems and having only limited funds with which to work. It was natural that the engineering and research departments should turn to some form of treatment that would conserve the surfaces already in place and render them more serviceable.

Asphaltic oil has been used for many years in the treatment of macadam, gravel and selected material or top soil surfaces. In California may be found many miles of bituminous treated roads which have rendered satisfactory service for moderate amounts of traffic and that are still in good condition. In the scramble which started about ten years ago to build the so-called "permanent" type the need for the intermediate type or bituminous treated surface was to a large extent lost sight of and it has been only within the past two or three years that this has again been receiving the attention that it deserves. That it has been developing rapidly may be judged from the fact that during this season all of the eleven Western States have been carrying on oiling programs varying from a few miles to 350 miles each and interest is extending

to South Dakota and Nebraska to the East of us.

The Wyoming Highway Department began the experimental treatment of short sections of gravel roads in 1924 using local refined oils which were recommended as suitable. The oil was applied largely as a surface treatment and very little surface mixing was performed as compared with present day methods, the idea being to leave a "mud" of fine material on top for maintenance. This method was copied from Wisconsin where good results had been obtained using coal tar as the binder. The resultant surface was quite satisfactory for a few months when disintegration would develop and the surface soon become very rough from pot holes. Re-oiling with the same oil had the same result.

A more detailed investigation of the oil furnished was then made and the conclusion reached that it was not suitable due to the wax content and that only a pure asphaltic base oil would meet the requirements thus excluding cut-backs where surface mix methods are employed.

A specification for road oil was then written for the 1927 and subsequent requirements which is as follows:

SPECIFICATION A

OIL ASPHALT shall be a natural asphaltic base crude or residue therefrom and shall have a specific viscosity (Engler) at 122° F. of not less than 25 nor more than 45.

WATER AND SEDIMENT. Water and sediment combined shall not contain more than 2%.

ASPHALTIC CONTENT: The oil shall contain not less than 60 % nor more than 75% of asphaltic residue, having a penetration of 30° at 77° F.

WAX CONTENT: Shall not be more than two percent (2%) by weight.

**SOLUBILITY IN CARBON DISULFIDE:** Shall not be less than ninety nine (99%) per cent.

**TEST METHODS:** All tests of road oils shall be made in accordance with U. S. Department of Agriculture Bulletin No. 1216, with the amendments and revisions thereof.

**ASPHALT CONTENT:** Asphalt content shall be determined by open evaporation using the A.S.T.M. Tentative method D. 243-26 F. the open cup vapor bath method, or the Brown Evaporator.

Using oil furnished under this specification from the Casper refinery of the Midwest refining Company, 15.4 miles of the Casper-Salt Creek Highway was treated in 1927. Some raveling developed during the following winter, apparently due largely to insufficient oil consequently this project was re-worked the past season and 0.5 gal. per sq. yd. added so that this has now had 1.5 gal. of oil per sq. yd.

Other projects in Natrona, Washon, Carbon and Albany Counties have been treated the past season so that Wyoming now has 57 miles of asphalt oil treated roads.

The character of road suitable for treatment and methods used in the application of the oil and subsequent operations merit a brief description although perhaps not comprehended in the title of this paper.

Success in oil treatment is dependent on adequate sub-base, and uniformly graded aggregate in the surface materials that are to be treated. The treated asphalt mat being deficient in supporting strength must depend upon a well compacted base course which should generally be not less than 5" in thickness and 18' in width. Usually favorable sub-grade and drainage

conditions may allow a lesser thickness but on clay or gumbo soil the possibility of a softened sub-base makes shoulder breaks a danger to be avoided. Grading of the aggregate to be treated should be of the greatest possible uniformity with 45-50% passing the 10 mesh and 5-10% passing the 200 mesh. The proper percentage of 200 mesh material is highly important for without it a dense quick-setting surface will not be obtained and the result will be a surface tending to ravel. Old gravel surfaced projects will nearly always be found deficient in the proper amount of fines due to wind and erosion under traffic, and this deficiency must be supplied before completing the application of oil and mixing.

A compacted thickness of 3" is generally considered desirable in the completed mat. On old roads that are compacted scarifying will be required to a depth of 3". This material is then moved into a windrow in the center of the road with a blade grader and observation made to determine that the quantity is uniform; an experienced man will perform this operation very rapidly. In the case of new or resurfacing projects the top course material can be dumped in the center or at one side shoulder and worked into a uniform windrow with a blade grader. This center windrow is then flattened out with the same blade outfit and is ready to receive the oil applied through a pressure distributor preferably of 1000 to 1200 gallons capacity. The oil should be applied at a temperature of 120° -150° F., at the rate of 0.5 gallons per square yard. Following the distributor is a tractor and disc harrow which operates continuously until all the oil is applied. The oil is applied in three applications of 0.15 gallons each or the exact amount that has been determined to be necessary for the aggregate being treated. Following the application of all the oil the material is again

bladed into one windrow and then mixed or processed by blading back and forth across the road until every particle is coated with oil and the entire mass is a uniform color when it is ready to lay down and receive traffic. For the mixing or processing either two or three units are the most economical depending on local conditions, these units may be either one-man 10' blades with #20 Caterpillar for power or 10' blades pulled with #30 Caterpillars, all should be alike, however, in any one crew. For the final laying down a 10' or 12' blade with sufficient power is most satisfactory. After the material is laid down traffic should be turned over it and then maintained for a few days with a blade or multiple blade until it has taken its final shape and set. The result is the smoothest riding surface that can be built.

Laboratory control of oil, aggregate and mat are essential. The only sure control for the mix is the stain test which is dependable in competent hands and once the proper mix has been established. However, a stain test which is applicable in one locality taking into consideration the climate, etc., may or may not be applicable in another. There has been careful field control of Wyoming's 1928 work with detailed records as to aggregate, and oil and samples of the finished mix were taken at numerous places so that all possible conditions have been recorded.

There is considerable difference between crushed rock such as limestone, crushed gravel and screened gravel in ease of processing, ability to set up quickly and maintain compaction thereafter. Limestone is difficult to process, sets very quickly, and has excellent stability. Crushed gravel is medium in processing, set and stability. Screened gravel is easy to process, has a slow set and fair to poor stability. Absence of material above the  $\frac{1}{2}$  inch makes for longer time of set and poorer stability.

Detail description and cost data on three typical projects treated this season are given in the following:

Federal Aid Project 186-A, Rawlins-Farco, length 5,874 miles. Crushed limestone 1" maximum base course 4" thick 20' wide placed in 1927 well compacted at time top course material placed in June 1928. Top course  $\frac{3}{4}$ " maximum crushed limestone 2" thick 20' wide, cost per square yd. \$0.1436.

Federal Aid Project 168-B, beginning at point 11 miles west of Casper and extending west towards Natrona a distance of 11,398 miles. Screened pit run gravel aggregate, 3" by 18' base course placed in 1927 and 3" by 18' top course for oiling place in Spring 1928, cost per sq. yd. \$ 0. 1229.

Project 37-A, Torrington-Lingle, length 9,119 miles, originally constructed in 1921 with pit run gravel surface 6" by 18' having  $2\frac{1}{2}$ " maximum. Over one-half of surfacing worn out so that resurfacing necessary. Sufficient crushed gravel with 1" maximum for new top course 3" 18' was placed in windrow along shoulder before treatment, cost per sq. yd. \$0.1714.

Future maintenance costs are not definitely known but probably will not exceed \$200.00 per mile and are estimated by several States at \$150. to \$175 per mile.

A recent development in the use of asphalt road oil calls for "plant mix" instead of "road mix" as above described. Plant mix is adapted to those projects which are scheduled for treatment immediately following placing of aggregate on the road either now or as a resurfacing operation. It appears that plant mix will result in a more uniform product, less interference from unfavorable weather and will cause less interruption to traffic. Plant mix is also more susceptible to successful handling by contract due to the relatively simple control and the elimination of many of the indefinite factors which enter into a road mix job. Comparative

costs of road and plant mix are available to only a limited extent but indicate no appreciable difference.

It seems entirely possible that future general development of these two methods will see road mix method applied by State forces to those projects already completed and which can be treated to advantage without the addition of any large amount of new aggregate, while the plant mix method will be adopted to all new work and handled by contract.

It is believed that asphaltic oil treatment of gravel and crushed rock surfaces throughout the Rocky Mountain region is justified and may be expected to proceed as rapidly as funds are available. Oregon has 1200 miles treated with 700 miles additional needing treatment, and Washington has treated 800 miles in the past two years. Wyoming has 1500 miles needing treatment. It is altogether probable that the 10 States in this region have at least 20,000 miles of highways which should be treated and which will require an average of 16,000 gallons of oil per mile. This potential program can be speeded-up through lower prices on oil, equitable freight rates, and a spirit of co-operation on the part of the producing companies.

The Wyoming Highway Department has pioneered in this work in this territory at considerable expense and without co-operation on the part of those who would seem to have a direct interest through the development of a market for black oil. Neighboring States have looked upon Wyoming's asphaltic oil with suspicion and would not use it preferring the California oil of known characteristics. In order to prove conclusively the merits or demerits of Wyoming oils as compared with California oils the Wyoming Commission called for bids on its estimated requirements for the 1928 season. At certain specific points of delivery the California oil was the cheapest when compared with a bid price of 4 cents per gallon at Casper. It was thus decided to purchase sufficient California oil so that one carload could be used on each



project under identical conditions with two different Wyoming oils. This has been done and the results by next summer should be easily discernible

It was never contemplated by anyone connected with the Highway Department that California oil would be used exclusively on Wyoming roads although criticism of the Department in that form has been made. The primary object was to demonstrate the merit of Wyoming oil and thus open up an immense market in the surrounding States.

It should be generally understood that the term "black oil" as applied to the product of various fields does not indicate that it is satisfactory to use in road surface treatment and in no case referring to Wyoming oils is such product suitable to use as a crude. There are three grades of crudes, paraffine, intermediate and asphaltic. Only those crudes should be used in the manufacture of road oil in which the paraffine content is very low, probably not exceeding 2.5% in the residue. Suitable road oil is a refined product made from crudes that meet certain specifications.

In conclusion the writer desires to stress the importance of recognizing the limitations of asphaltic oil treatment, it is not a solution of every problem connected with highways but if adopted where the conditions seem to warrant after study of the governing factors it will undoubtedly furnish a surface of low cost, intermediate type which will afford the motorist real pleasure and at a real saving in his cost of motor vehicle operation.