ASPHALT IN RELATION TO THE HIGHWAY IMPROVEMENT PROGRAM

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Out of this conference there should come a determination to restore to asphalt a certain degree of lost dignity, a more responsible and responsive attitude toward the material itself. The time was when this highly valuable and useful resource occupied a position of its own - no matter if the dimensions of sales were small compared to the present, it has nevertheless its own particular place in the sun and the solicitous concern of the industry which produced it. Now with the sales mounting year by year, it has in large measure been forced into the position of a by-product of the mammoth petroleum industry, with the secondary attention usually accorded the smaller interest of any group.

While this may have developed quite without intention, it is not a sound attitude either from the public or the industry angle as a permanent policy. It is wholly with the thought and the appreciation of the intrinsic value of this material at its best that this analysis is brought to this conference. It is to be hoped that the important implications

and potential impacts of the asphalt group, one of the smallest upon the petroleum industry as a whole, will be self apparent and will command the attention of the responsible leaders of this industry.

The analysis of the broad relation of asphalt to highway improvement is developed under three topics, each calculated to present considerations of widely different characters but all of which support the conclusions. These are:

1. General trends affecting the use of asphalt for highway improvement.
2. The factors favorable to expansion in the use of asphalt.
3. The factors of uncertainty in engineering technique adversely affecting the use of, and the results from, asphalt.

1. General trends affecting the use of asphalt for highway improvement.

(1) Growth in numbers of motor vehicles in service

1924 about 15,000,000
1936 over 28,000,000

(2) Changes in distribution of income from highway user taxes

From 1927 to 1936, increase of total taxes collected - 90%
1927 total $560,000,000.
1936 total $1,057,000,000.

For State highways, 1927 - 73.1%
1936 - 55.2%
A loss of - 17.9% of total collections.

For local roads and streets: 1927 - 22.0%
1936 - 25 %
A net gain of - 3.1%

But in the actual amounts involved, while the income increased 90%, the amount for State highways increased only 42% and the amount for local roads and streets increased 115%.

(3) Changes in the administration of roads.

In 1930 miles under State control - 324,496
In 1936 increased to a total of 533,144 miles, or a 64.3% added responsibility in 6 years. This percentage increase of 64.3% in mileage, which has become a State responsibility, should be contrasted with the 42% increase in dollars 1927 to 1936.
In 1936, 10 States added 10,696 miles - 5 States have taken over essentially all of their public roads under State control since 1931.

(4) Changes in sources of tax income.

Along with the shift of road mileage to State responsibility has come also the shift of taxes from property to road user taxes. This fact, together with the increased items of maintenance and other expenses, accounts for the States' lack of funds for new construction and reconstruction.

(5) Diversion of road user taxes income to other than road purposes.

In 1927 - 95.1% of total receipts were made available for road purposes
In 1936 - only 80.3% - - a loss of nearly 15%.

(6) The national need for safe highways is resulting in more costly highways.

A careful study of changes in the design of highways as actually built over the past few years shows an increase in every detail, such as widths of surfacing, of shoulders, of right of way, increased sight distances, easier curves, flatter slopes, divided roadways; these and many other major and minor items, which add to the previous cost level.

Even though only a fraction of the safety problem can possibly be met by such higher cost highway designs, it is evident that very large expenditures will be made in the attempt to solve the problem in this way. The increase of motor vehicles continues after reaching an unbelievable total. The average speed of the lighter unit itself and the differential in speed, particularly on grades between the light and the heavy units, both are adding immensely to the seriousness of the difficulties confronting highway officials. This increase in speed and in numbers is rapidly relegating to the past large mileages of untreated gravel, sand-clay, and waterbound macadam types. Safety as well as economy of maintenance dictate.

2. The factors favorable to the expansion in the use of asphalt.

When asphalt was a product rather than a by-product, it was used largely in the form of asphalt cement for the higher types of pavement, such as sheet asphalt and asphalt concrete. As late as 1924 asphalt cements constituted about 70% of the total tonnage of asphalt products used in road construction, and even in 1929 about 57% of the total consumption for this purpose. In addition to the

use of asphalt in the form of cements, there was an early and consistent use in a number of States of the material for surface treatments. The great increase in its use, however, grew from other developments.

(1) The use for "oil-mix" surfaces.

While doubtless other States had been doing more or less along the same line and the Bureau of Public Roads was furthering experimental projects of like nature, the Oregon Highway Commission in 1923 began experimenting with the oil applied to the fine crushed rock and gravel surfacings that had been so extensively built in the western States. These experiments, designed to eliminate dust and to conserve the road, were so successful that during the next three years several hundred miles were built in Oregon and other western States. With experience the technique developed into standard practice and a new type of surfacing was definitely established. The effect, as reflected in the reports of the Bureau of Mines, was to jump the sales of road oils from 300,000 tons in 1927, to nearly 1,400,000 tons in 1932, and to about the same figure in 1936.

(2) The use of "cut back" asphalts and asphalt emulsions.

The petroleum products, commonly known as road oils but more accurately designated as slow-curing

liquid asphaltic road materials, were used in all the early oil-mix construction and are still being used in much of the present-day work. However, experiments begun in 1929, in which the Bureau of Public Roads and the Division of Highways of the California Department of Public Works, cooperated, demonstrated the merits of cut-back asphalts in this type of construction, and since then their use has grown enormously both in the west and also in the east where they are used extensively in surface treatments and retread surfaces. As a result the consumption of cut-backs rose from 130,000 tons in 1929 to more than 1,000,000 tons in 1936.

The great change in practice in bituminous road construction that took place from 1929 to 1936 is illustrated by the fact that during this period the total consumption of road oils and cut-back asphalt rose from about 930,000 tons to more than 2,400,000 tons and the consumption of asphalt cements declined from 57% to 31% of the total used for road purposes. Similar increase in the use of asphaltic emulsions developed during that period. Prior to 1929 the Bureau of Mines did not report the consumption of emulsions. In that year 14,800 tons of asphalt were used in emulsions produced at the refineries and in 1936 this figure had risen to 53,000 tons.

However, these figures merely illustrate the trend in the use of emulsions and not the actual quantities used, since a high percentage of the emulsions produced are manufactured elsewhere than at the refinery. Thus, the refinery production in 1936 accounted only for 12,500,000 gallons of an estimated total production of nearly 56,000,000 gallons.

Thus in addition to the bituminous surfacings using asphalt cements, since 1923 an endless variety of so-called types have been developed and used on a national scale. From the material angle the chief differentiation is in the form of the bitumens, i.e., asphaltic oil, "cut back" asphalt or asphaltic emulsion.

(3) After long years of research in soils by the Bureau of Public Roads and a number of the State Highway Departments, the new science of soil stabilization for application to road building has been developed to the point of general use. It is a fundamental requirement of all road building, of the standard pavement types, as well as of the so-called low cost types, if the maximum service is secured from the construction.

Soil stabilization at once holds the possibilities of remedying the most potent cause of failure of the low

cost types of surfacings and of extending the use of bituminous materials for the purpose, - an almost perfect potentiality that probably will not be fully developed because of the assumption that this new soil stabilization market is a certain one for this material. This is by no means true.

3. The factors of uncertainty in engineering technique adversely affecting the use of, and the results from, asphalt.

During the earlier period when the use was essentially confined to the asphalt cement form, the crude material came from a few known sources with established service records for the material as processed and used.

There was a rather general feeling of confidence in the specification requirements in common use. Through long usage these requirements had become practically standard and were generally accepted, with little question, as being adequate for the control of quality. Doubtless this confidence was justified during this period, but now it would be a mistake to view the requirements, as applied to asphalts of the present day, with any such confidence.

Rather coincident with the development of new practices in bituminous road construction came also major changes in the production of asphaltic road materials. When the use of semi-solid asphalts predominated, the crude petroleums from which they were refined not only generally came from a relatively few sources with well-established records but the methods of refining were such as would not subject the materials to excessive temperatures or pressures. The discovery of new oil fields and the development of new refining processes in which high temperatures and high pressures are utilized to increase the yield of gasoline, resulted in a chaotic status. New asphaltic materials are derived from a great variety of crude petroleums of varying characteristics. These materials are refined by numerous methods, including both those in which only moderate temperatures and pressures are utilized and the cracking processes in which the asphaltic residuals are altered more or less severely by high temperatures and high pressures. The number of combinations of variables which may affect the quality of the finished product are enormous. To these possible varieties may now be added synthetic asphalts which, if not already here, at least are promised.

Early in the period which has seen such an enormous increase in the use of liquid asphaltic materials, failures of the lower-cost and lower-type surfaces in which they were used aroused doubt as to their quality. Continued failure or inferior performance has sustained the interest. More recently it has even extended, apparently with good reason, to asphalt cements which previously had not been the object of serious suspicion. That this interest is widespread is indictaed by the replies to a questionnaire circulated late last year by the Highway Research Board. Thirty-seven States returned this questionnaire and of these, 14 reported failures of asphaltic road surfaces definitely attributed to the quality of the asphaltic material.

This interest in the quality of asphaltic road materials has resulted in much investigational work by various ogranizations and individuals. It has resulted in the adoption of new specification requirements, or the resurrection of old ones, designed to insure materials of satisfactory quality. Among others are requirements for sulphur content, fluidity factor, float-test index, susceptibility factors and ductility at low temperatures. None of these are true tests of quality. While they may exclude some poor materials they will also exclude materials known to be good. Some good materials that will not meet certain restrictive requirements may be made to do so by subjecting them to special processing. Such special manipulation may produce an asphalt meeting certain specification requirements but does not necessarily improve the product and may definitely injure it. In view of these facts the Bureau of Public Roads in general has discouraged the inclusion of discriminatory requirements in specifications for Federal-aid construction.

The Oliensis spot test is one of the tests of discriminatory character, devised for the identification of cracked or over-heated materials. For this purpose it appears to be quite satisfactory but it has never been claimed that it is a test of quality. Since, however, the finger of suspicion points most strongly at cracked

products, the Bureau has been willing to approve it in those States in which the highway officials consider such action necessary in the interest of satisfactory and durable construction, yet the purpose of the Oliensis test may be defeated, for example, by the judicious use of gilsonite.

At the moment, all of the tests and investigational work have not disclosed the fundamental knowledge necessary to develop a specification that will guarantee satisfactory quality.

In addition, there is also a lack of knowledge of how to use the materials to the best advantage. Unquestionably, much of the criticism of performance has been due, not to any lack of satisfactory quality, but rather to the improper use of materials that would have been satisfactory if their peculiarities had been recognized and taken account of. Asphalts of the same grade produced from different crudes are not necessarily alike in all their characteristics, one of the chief differences being in susceptibility to changes in temperature. One asphalt cement used in hot-mix construction may be handled satisfactorily at 325° or 350°, while another asphalt of the same penetration grade may be entirely too fluid at this temperature. Obviously, the second asphalt should be mixed at a lower temperature than the first but this difference in the required method of handling is frequently overlooked in construction practice. The unsatisfactory result is, of course,

attributed to the asphalt itself rather than to the lack of knowledge as to its proper use. Likewise, differences in the rate of hardening of cut-back asphalts of the same grade lead to similar criticisms.

The degree of heat and time of mixing in plant operations affect the quality of the finished pavement. All asphalts are altered by heating and mixing with aggregate, but some are altered more severely than others. Efforts are being made to control the alteration in the asphalt that takes place in hot-mix paving operations but much remains to be learned regarding the degree of alteration permissible and the best means for measuring it.

Specifically, what is lacking in the knowledge of asphaltic road materials? The answer might be made highly complex for it is a highly complex problem, but for the purpose of this discussion it can be greatly simplified. The primary function of asphaltic materials used in highway construction is to bind together the particles of mineral aggregate that the resulting road surface may be stable and resistant to disintegration due to traffic and weathering action. It is necessary to know how to measure the weathering characteristics of asphalt; how to determine the factors that affect the adhesion between aggregates and asphalt; how poor adhesion may be improved; how to take account of

the peculiarities of asphaltic materials from different sources that each may be used to the best advantage; and finally, how to handle asphalts during construction that they may not be damaged unduly. This rather simple statement becomes truly impressive in the light of the enormous number of variables that must be evaluated by careful research to produce the required information. And to the problems that concern the construction of adequate bituminous surfaces, there must be added all the problems that have arisen and will arise regarding the use of asphaltic materials in the stabilization of base courses and subgrades. In this field are large potentialities for future increases in consumption.

This review of the relation of asphalt to the highway improvement program is not by any stretch of the imagination submitted as all inclusive and no attempt has been made to elaborate any item in detail. It has been prepared for the purpose of bringing to the attention of the whole petroleum industry the uncertainties and blind spots in the specification technique for insuring the desired quality in asphaltic material when in place in road surfacings.

From the facts presented and their implications, the following conclusions are drawn:

Conclusions and Recommendations

1. The general trends in the fields of highway finance and highway administration are definite and serious. The available funds are falling behind the necessities and this lag will become quickly evident with the curtailment of Federal spending. In the face of the facts, the utter futility of the agitation for lower taxes on motor fuel and motor oil is self apparent. These are more likely to move upward. The only possible alternatives are to stop diversions of the income from these taxes to other than road purposes and to produce more durable surfacings for lower costs. This will require both better materials and methods.

2. The petroleum industry is dependent upon the use of adequately improved highways, including streets, for its major market. This is self-evident. The relationship and the effect of the whole series of road problems upon the industry go far beyond this point. Taxes upon the products, road maintenance, road construction, road costs, diversion of user tax income, relief of congestion, safe highways, - all these and many more have an ultimate and decided bearing in the aggregate upon the industry as a whole. Many of these items in turn are affected in a major way by the serviceability and costs of road surfacings. In these, asphaltic materials are important. Surely the intelligently selfish interest of the industry is inevitably far greater than the dimensions alone of the market for asphaltic road materials.

3. While not true perhaps of individual units of the group, the industry as a whole is not carrying a reasonable share of the load or taking a reasonably responsible attitude toward the expansion of the technical work now needed.

4. The older and newer uses of the material taken together with the known and established validity of the service of which the material is capable, make possible a constantly increasing demand.

To meet these conditions there should be a national research program developed by the Highway Research Board of the National Research Council. The Asphalt Institute is a competent agency to represent the industry in such a program, but it needs much larger support funds, - several times its present amount, - to finance an adequate participation in the research program.

With the industry taking up its responsibility in this manner, the State highway departments and the Federal Bureau of Public Roads will increase their research activities to the extent necessary to assure the success of the national research program.