

EFFICIENCY OF BITUMINOUS SURFACES AND PAVEMENTS UNDER MOTOR TRUCK TRAFFIC*

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THE title of this paper covers a subject upon which a great deal of thought has been spent by progressive highway engineers as applied to pre-war traffic conditions and its progressive normal development. Many engineers had, at least in their own minds, classified the various types of pavements with relation to their efficiency under ordinary variations in traffic encountered on county, state and municipal highways and their ideas were fairly well fixed on the subject as evidenced by more or less consistent practice in their choice of types when reconstruction or new construction became necessary. Just where the dividing line should be drawn, so far as traffic is concerned, between different types of pavements has always been a matter of individual opinion, but in general with increases in volume and weight of traffic the increasing efficiency of the bituminous types has been rated as follows:—

- 1 Bituminous surfaces.
- 2 Bituminous macadam.
- 3 Bituminous concrete.
- 4 Sheet asphalt and asphalt block.

Suddenly and with little opportunity for anticipation, a very large mileage of our important state highways and many of our local county and municipal pavements were subjected to a tremendous increase in traffic. This increase was not only in volume, which would have presented a comparatively simple problem to solve, but in the weight and load carrying capacity of the individual vehicle. This, coupled with an unusually severe winter and immediately followed by war restrictions upon the use of many road materials, labor shortage, excessive costs, and loss of members of highway engineering organizations, created a situation during the year 1918 which was abnormally serious and complicated. With comparatively few exceptions, new construction ceased and maintenance was so handicapped as to become inadequate.

Foundations or Subgrades Failed

Hundreds of miles of roads failed under the heavy motor truck traffic within a comparatively few weeks or months. Roads with bituminous surfaces, bituminous macadam roads and bituminous concrete roads all failed alike, together with other types used in state and county work. These failures were not only sudden but complete and almost over night an excellent surface might become impassable. Such rapid and complete failures in municipal pavements were of less common occurrence and as sheet asphalt and asphalt block have always been largely confined to municipal work, failures of these types have not been noted to the same extent as the other types mentioned.

In the haste and confusion of war activities little opportunity has existed for a systematic and comprehensive study of the problem suddenly thrust upon highway engineers. Reports from all parts of the country have, however, established one outstanding fact which has a most important bearing upon any consideration of the efficiency of bituminous surfaces and bituminous pavements. A very large proportion of the failures have been characterized by an almost simultaneous destruction of the entire road structure, and not merely the disintegration of the wearing course or pavement proper. No type of pavement will be efficient unless provided with a foundation which will hold up the pavement until it is worn out. When, therefore, the entire structure fails suddenly, inadequate subgrade or foundation conditions are primarily responsible and but little basis exists for placing an efficiency valuation upon the wearing course.

Inevitably coupled with subgrade and drainage conditions, foundation failures occurring as previously described

may be due to one of two causes, lack of thickness, or inability of the foundation structure to sustain the loads without appreciable internal movement. So far as bituminous surfaces or bituminous pavements are concerned, remedy of the first cause does not affect the general type of construction. If, however, present heavy motor truck traffic is to continue and possibly increase in weight as well as volume the second cause may have a direct bearing upon possible modifications in design and in the ultimate determination of the efficiency of certain classes of bituminous work. Most subgrades have a much lower carrying capacity in the spring than at other periods of the year. As there is practically no slab effect produced by the structure of a broken stone or gravel foundation, a load applied to any overlying bituminous surface is transmitted quite directly to the subgrade. In other words, the intensity of load under its point of application is relatively high throughout the foundation thickness.

Slab Foundation Necessary

Under heavy motor truck traffic the intensity of load transmitted through a two inch thickness of dense bituminous concrete to the foundation may be so great as to cause an internal movement sufficient to produce disintegration of the pavement. This is particularly true when the subgrade is of a soft or clayey nature and appears to be quite possible irrespective of any economical thickness of broken stone or gravel foundation which may be used. In general, the experience on heavily travelled city streets has demonstrated the necessity of a slab foundation for any wearing course and there appears to be no reason why such experience should not serve as a guide for new construction of bituminous pavements on state and county highways subjected to modern heavy truck traffic. On these highways the traffic has certainly been as severe as on many city business streets, so far as weight of unit loads is concerned, and more severe when the high speed often attained by such traffic is considered.

With respect to existing gravel and macadam roads, whether or not they have been previously surface treated with bituminous material, it would seem far safer at the present time to attempt to preserve such roads under heavy motor truck traffic by means of surface treatment with bituminous materials rather than to utilize them as foundations for the construction of new bituminous macadam or bituminous concrete pavements. In other words, for the time being such treatments may prove more efficient than the use of a higher type of pavement placed upon the existing road although it is clearly recognized that, under heavy motor truck traffic, the bituminous pavements are more efficient providing the foundation is adequate to support the loads.

Gravel Roads and Frost

Under the same conditions of traffic bituminous surfaces are most efficient in localities where frost action is either absent or not severe. Such treatments used in connection with gravel roads adjacent to army cantonments in the far south have given reasonable satisfaction even under heavy motor truck traffic. North of the frost line and particularly in connection with the treatment of clayey gravel roads which become soft during the spring months, bituminous surfaces are apt to completely disappear. If, however, the gravel road is maintained by dragging and at the end of the thawing out period is reshaped, thoroughly compacted and again treated with bituminous material, it may be kept in a reasonably satisfactory condition. Under very heavy motor truck traffic, however, maintenance costs may be extremely high so that if a continuation of such traffic is to be expected the construction of a new road may be necessary. Thus, during a period of 120 days on a clay gravel road leading from Alexandria to Camp Humphreys, Virginia, which was subjected to an average daily traffic of some 230 heavy motor trucks, the cost for maintenance amounted to approximately \$10,000 per mile. Because of this enormous expense the construction of a new type of road became necessary.

In connection with this road it is of interest to note that prior to its maintenance as a gravel road, it had served as

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