

ECONOMICS OF RESURFACING DISINTEGRATED PAVEMENTS

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In making a detailed study of the economics of the resurfacing of disintegrated pavements, many factors are involved, each demanding careful consideration in order that a complete understanding may be had, not only of the economics of the operation itself, but also of the economic justification of the operation or program.

In justifying resurfacing work, one of the first factors to be considered is the need for the work itself. Let us first investigate the justification of need for resurfacing of concrete pavements, plain or reinforced. The first item to support the need is probably the age of the pavement. In considering the age of the pavement such items as slab design, present condition of the concrete itself, and width of the existing pavement will demand study and answer as to whether or not the slab design is heavy enough to withstand the traffic loads that the pavement is asked to carry; whether or not the slab is showing disintegration or failure to the extent that it is no longer possible to maintain it satisfactorily with the funds available for maintenance and, whether or not the width of the existing pavement is ample to safely accommodate the traffic load it is now asked to carry. With respect to traffic density and unit weights that many pavements are now carrying, it is probably universally true that these density and weight demands far exceed any anticipation of these items that may have been estimated at the time the pavement was designed and constructed.

Further items of study demanding consideration is the alignment and grade of the existing pavement. These items will

no doubt vary as extensively as the terrain over which any highway department has constructed or will be asked to construct highways. Line and grade are highly important however to the ultimate success of resurfacing work, because after the work is done a better riding highway will result which will promote an increase in the speed of traffic, thereby requiring a line and grade of such nature as to insure a satisfactory degree of safety to an accelerated traffic flow.

The study items reviewed also apply to pavement types other than concrete that may be considered for resurfacing. Other common types considered may be macadam or brick pavements. In addition to making the same studies for these pavements as for concrete, such items as existing cross section in the case of early macadam pavements, and supporting base in the case of brick pavements, will call for consideration and determination in order to ascertain if the resurfacing is economically feasible.

Another factor having a direct bearing on whether or not resurfacing is economically sound is the magnitude of needed reconstruction and whether or not available funds for reconstruction are ample to meet that need. In many cases it is highly probable that the need for reconstruction in cost will far exceed the possibilities in so far as available funds for reconstruction are concerned. The problem is then usually partially solved by deciding to extend the life of existing pavements and in some cases no doubt to the point where maintenance costs become prohibitive. In many cases the problem of spreading reconstruction opera-

tions over an extended period can be solved by supplementing with and substituting resurfacing on projects that by their location, use and physical status will warrant a resurfacing operation.

So far this discussion has considered only the generalities dealing with establishing the need for resurfacing. Assuming that the need for resurfacing has been justified, we will next consider some items of preparation and operation that require study in order to expedite a more economical resurfacing program.

Let us assume that the resurfacing program has been made of individual projects that are being considered for resurfacing because they either cannot be reconstructed because of financial or physical impossibility, or are structurally sound to the point that reconstruction cannot be warranted but the specific highway in question is unsatisfactory by virtue of its width, lack of curve elevation or other conditions that do require some modernization to adequately meet traffic demands. The questions to be answered than are, in the first case, how long must reconstruction be deferred? How much base correction will be required to carry the pavement for that length of time? Will the job require plans? How thick must the resurfacing course be to successfully carry the pavement for the required length of time? In the latter type of pavement being considered for resurfacing, where the existing highway can be salvaged and modernized by widening, curve elevation, etc., the question of how much refinement can be justified must be answered in addition to consideration being given to the foregoing items, all having a direct bearing on the economic justification for resurfacing.

After the resurfacing program has been established, there are many items of detail operation that must be investigated and worked out. These include such items as specifications for the resurfacing material, the types of resurfacing material needed, whether it may be a mixed in place material or a plant mix material, shall the material be a cold mix type material or a hot mix type material; the type of

aggregates available that can be utilized in the production of bituminous concrete; the plants available that can produce bituminous concrete; the proximity of the plants to the site of the work, keeping the length of haul to a minimum, thereby effecting the economy; the types of material the available plants are able to produce; the possibility and feasibility of the use of portable plants. All of these items bear an important relationship to the resultant overall cost of resurfacing projects and programs.

The above factors were given consideration in the State of Pennsylvania and a study was made of our highway system in an effort to determine its needs in order to keep it currently modern. The following are some of the facts and figures with which we were and are confronted.

The Pennsylvania State Highway System consists of 40,893 miles of road, which mileage includes 6,667 miles of concrete pavement, 24,742 miles of bituminous pavement and 2,058 miles of miscellaneous improved types (brick, block, bituminous concrete).

1,818 miles of the concrete pavement and 3,282 miles of the bituminous pavement are more than 25 years old. In 1941 the Department of Highways estimated that modernization of its highway system would require an expenditure of 550 million dollars within a period of 5 years, or an average of 110 million dollars per year. During the period of 1942 to 1945 inclusive, very little new construction was undertaken, with the result that this program was set back. Another modernization estimate was made in 1946, and, due to disintegration from heavy war traffic, it was then estimated the process of modernization would cost 850 million dollars if this were to be completed in a five year period, or an average of 170 million dollars per year.

We have compiled some costs comparing the costs of reconstructing two-lane highways on approximately the existing road bed with a minimum of grading quantities and using the existing structures, where possible. In comparison to these figures we have also compiled cost for resurfacing

that was done during the same period. In 1946 we reconstructed 110 miles of road at a total cost of \$6,074,710, or an average of \$55,225 per mile. During the same period 256 miles of road were widened and resurfaced, or resurfaced without widening, at a total cost of \$7,776,470, or an average of \$30,377 per mile.

In 1947 it was decided that this program of resurfacing or rehabilitation should be expanded and in that year 162 miles of reconstruction work was completed at a total cost of \$8,974,400, or an average of \$55,400 per mile, and 286 miles of resurfacing, or widening and resurfacing were completed at a total cost of \$11,088,400, or an average of \$38,771 per mile.

The funds available to the Department of Highways to date will permit a construction program of approximately 100 million dollars per year, but beginning with 1949 approximately 65 million dollars per year will be available. It is necessary, therefore, that the funds available for construction be used to provide modern express highways in those locations where large volumes of traffic must be handled, and the Department must resort to the rehabilitation of other roads on the State Highway System in order to provide for the increased traffic on them.

Resurfacing or widening, where necessary, permits us to salvage the existing pavement and use it as a base course, and with the addition of a new wearing surface, the life of the pavement can be extended for at least ten years. This life may be extended further. The first resurfacing job of any size in Pennsylvania was completed in 1933. Amiesite was used on this project. This surface has been surface treated three times, to date, and is still giving good service. Some of our outstanding salvage and resurfacing jobs are as follows:

In 1943 we had a section of road in Schuylkill County (Route 140) where the concrete pavement which was placed in 1925 had failed to the extent that we were unable to maintain it. In desperation we arranged for resurfacing the existing pavement with 2 in. of bituminous

concrete. This work was done by contract. The project was 5.79 miles in length and the total cost was \$151,498, or an average of \$26,165 per mile. The average daily traffic on this road is 2,380 automobiles and 420 trucks, or a total of 2800 vehicles. This pavement is subject to heavy coal hauling and today is in good condition. The pavement maintenance on this particular section of road has been a minimum. Up to the present, the failures have not exceeded 300 square yards of the 61,000 square yards of resurfacing done.

The William Penn Highway (Routes 285 and 285 Sp) between Harrisburg and Allentown took a terrific beating during the war. Certain sections of this road east of Hamburg were recommended for resurfacing in 1947. An inspection of this road in May 1947 indicated that resurfacing could be delayed for at least one year, in hopes that the reconstruction of this particular section of road could be undertaken. However, we found that reconstruction would be delayed for several years, and an inspection in July revealed that the concrete slabs had been so badly broken in the 3 months' interval that it would be impossible to maintain this pavement for the heavy truck traffic involved during the coming winter. It was therefore decided immediately to subseal this pavement, replace the disintegrated concrete and resurface with 3 in. of hot bituminous concrete. This work was started in August and completed in November. This pavement has been in service more than a year and no failures are visible. The total cost of this work is \$26,670 per mile. It is estimated that this pavement will now carry traffic satisfactorily for 8 to 10 years, during which time reconstruction or relocation will be undertaken. When the road is reconstructed on relocation the old road will still be in satisfactory condition to return the local authorities for maintenance. In 1948 on the same general section of the William Penn Highway carrying heavy traffic between Harrisburg and New York City, more resurfacing was constructed on sections that were deferred in 1947. This work consisted of 9.28 miles and was constructed at a total

cost of \$287,865, or an average of \$31,020 per mile. It is interesting to note that these costs are approximately \$5,000 per mile higher than the work done in the same vicinity the preceding year. This increase in cost was due primarily to the additional amount of concrete patching that was made necessary due to the work being deferred and a possible slight increase in cost of materials over the preceding year. As brought out above, it is estimated that this pavement will now carry traffic satisfactorily from 8 to 10 years.

On Traffic Route 6 between Coudersport and Galeton, we had a section of concrete pavement that was constructed in 1921, 1922 and 1923. This pavement started to show signs of failure in 1936 and 9.4 miles were resurfaced with 2 in. of amiesite type bituminous concrete. This pavement was maintained by concrete patching for several years and in 1948 it had reached the point where it was practically impossible to maintain it for traffic. It was decided at that time that we would resurface the entire section, 18.11 miles in length, with hot bituminous concrete. On the sections previously resurfaced a new 1 in. surface was placed; on the remaining sections a 3 in. bituminous surface was placed. This work was done by contract. The total cost was \$257,827, or an average of \$14,240 per mile. This entire project was completed in three months' time and this pavement is now in such condition that it will successfully carry traffic for at least 10 years. The present traffic on this road averages 1,123 vehicles per day. With this volume of traffic it is doubtful if reconstruction will be required within the next 10 or 15 years.

On Traffic Route 22 in Washington County, which is the William Penn Highway, in a section west of Pittsburgh from 1944 to 1947, 12.71 miles were resurfaced at a total cost of \$169,849, or an average of \$13,363 per mile. The unit cost will indicate that negligible grading quantities were required, with practically no work necessary on structures. This route carried extremely heavy traffic during the war, such traffic being made up of heavy loads of steel being transported

from the steel mills around Pittsburgh to Steubenville, Ohio, and other points for further processing. The sections that were completed in 1944 have now been subject to traffic over 4 years and show no signs of distress or deterioration. The material that was used was a hot mix type bituminous concrete.

On L.R. 93, T.R. 62, in Forest and Warren Counties, from a period 1944 to 1947, 24.04 miles were resurfaced at a total cost of \$889,285, or an average cost of \$36,992 per mile. This pavement had originally been constructed in 1928 and was made up of 16 ft. and 18 ft. widths with a comparatively light design. The resurfacing consisted of widening to 20 ft., elevating the curves, extending the drainage structures where necessary and providing adequate width berms. The resultant pavement is one that, barring an unforeseen up-surge in traffic demands, should give indefinite service. Although some slight failure, due to pumping joints, motivated the resurfacing, this project serves as a splendid example to illustrate the value of salvaging the existing pavement wherever possible.

On L.R. 142 in Montgomery and Chester Counties, which is better identified as being the Lincoln Highway, leading west from Philadelphia, 20.85 miles of pavement were resurfaced at a total cost of \$874,862, or an average cost of \$41,960 per mile. For the most part, this section of pavement is 3-lane, which is reflected in the unit cost. Needless to say, this highway carries very heavy traffic and observation discloses that the sections resurfaced early are giving very satisfactory results.

On L.R. 212, T.R. 6 in Tioga County we experienced extensive break-ups over the past winter, which necessitated something being done during the present working season. With Department Forces we have completed this year on this section of highway 8.94 miles of resurfacing at a total cost of \$299,979, or an average cost of \$33,555 per mile. In this resurfacing operation it was necessary to provide a 6 in. aggregate base course over approximately 3½ miles of the existing

pavement in order to provide needed additional strength, the cost of which operation is reflected in the somewhat higher than usual unit cost for ordinary resurfacing operations. This section of highway carries approximately 1,200 vehicles per day and with the treatment given to it is expected to render satisfactory service for many years to come.

The demands for highway improvements in Pennsylvania have reached the point where our finances will not permit reconstruction as rapidly as traffic demands. Consequently, it is necessary for us to consider rehabilitation rather than reconstruction, particularly in view of the fact that rehabilitation can be undertaken at approximately one-half to one-third the cost of reconstruction. The rehabilitation work that we have completed indicates that this is a sound policy and we intend to expand this program.

Our program consists of four types of work: (1) Resurfacing the existing pavement, which consists of repairing the existing base course (concrete or macadam) and placing a new wearing surface; (2) placing additional depth of base on the existing pavement and placing a new surface; (3) widening and repairing the existing pavement and placing a new surface and (4) subsealing and repairing the existing pavement and placing a new sur-

face thereon.

This program has been accepted with favor by the traveling public and the comments received indicate that motorists are more interested in a smoother riding surface than in expensive corrections of profile and alignment. Our rehabilitation program has also enabled us to keep our maintenance costs within reasonable limits, because in most instances those pavements that were in such condition that they had to be resurfaced had deteriorated to the point where maintenance costs were almost prohibitive. It is our opinion that with the rapid increase in traffic volume and the demand for super-highways in urban areas, and on main state highways, the only way that the integrity of the State Highway System can be preserved is by the reclamation or salvaging of highways carrying comparatively smaller volumes of traffic. It is doubted if our highway system will ever reach the point where we can say that it is adequate for traffic at all times; however, we are limited in funds and also the facilities--labor, equipment and materials--required to carry out reconstruction programs that will keep our highway systems 100 percent modern. Consequently the maximum salvaging of our present pavements by resurfacing appears to be the only method whereby we can continue the satisfactory use of our highway transportation system.