Pavement Maintenance

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•THE subject of maintenance has been a major item in many pavement seminars, conferences, and meetings in the past. In spite of all that has been said for it, and about it, there is still an urgent need for improvements and a substantial degree of standardization in the maintenance area.

To keep the pavements of national and state highway systems and airfields in a continuous serviceable condition at a reasonable expense, a definite plan of action must be developed and energetically followed by all concerned.

Unfortunately, the pavement maintenance problem is not simple. Many factors are involved that affect the performance and deterioration of a pavement. The extent and type of the maintenance that will be required for any particular pavement will depend on a number of conditions: the traffic system to which the pavement is subjected; climate; the structure of the pavement; the quality of construction; the frequency and extent of inspection performed, both during construction and during maintenance; engineering talent involved; maintenance practices; discipline; and money; not necessarily in that order. This sounds like a collection of words and phrases but this list of items is discussed one at a time and in a little more detail in the following.

Pavements are designed to carry traffic of various types, with safety and comfort, and with a minimum of detrimental effects to vehicles or to the pavement itself. Current evaluation of pavement performance is based on the relative ability of these pavements to serve traffic over a period of time. Although the definition of performance varies with the design engineer, performance is generally related to the quality of the "ride" of the vehicle over the road, street, or runway. Therefore, there must be a basic understanding of the traffic system utilizing the pavements, whether it is automotive vehicles or aircraft, in order to plan and provide maintenance necessary for satisfactory performance.

Considerable research is being performed to obtain or develop theories that will permit a realistic prediction of road life from the characteristics of traffic flow. The pavement serviceability-performance concept developed during the AASHO Road Test is a firm step in this direction. The Performance Index or rating that can be derived under this concept for a particular pavement could be used objectively to determine priorities for maintenance or reconstruction of that pavement; however, it does not lend itself directly to the prediction of future performance. Because serviceability is defined relative to the intended use of the pavement, the pavement profile must be kept as smooth as possible to minimize the road loading mechanics that affect road life, vehicle life and driver fatigue. Smoothness must not be maintained at the expense of slipperiness.

The traffic, itself, affects maintenance in another way; work must be accomplished during periods of low traffic density, or means of bypassing the work area must be used. In either case, safety measures of varying degrees of complexity must be taken to protect the crews and equipment engaged in the work.

Climatic conditions play an important part in the maintenance program. In spite of standardized inspection and maintenance procedures, and probably because of them, the variable effects of climate are often surprising and unpredictable. How severe these effects will be is usually determined by the quality of maintenance being performed. In the winter of 1962, in the Washington area, unusually severe temperature and icing conditions played havoc with streets and roads. Some of the damage was directly attributable to poor maintenance. Cracks in concrete as well as flexible pavements had been left unattended or haphazardly patched. Undisciplined use of snow-

clearing machinery and careless or inexperienced crews created further damage. Therefore, streets and roads that could have been restored by minor repairs often had to be replaced.

In the last decade, the weather has taken some peculiar twists. Southern states have experienced snow and frost and many northern states have had light winters. Other sections of the country, normally dry or experiencing light rainfall, have been deluged, whereas some of the "rainier" areas have been almost arid. All of this affects pavements because the usual maintenance practices in these areas were not geared to these unexpected conditions.

It is impossible to "crystal ball" freak storms or unusual weather conditions that occur only once or twice in a generation. To maintain for all possible eventualities would result in such over-maintenance that it could not be justified. However, sufficient unusual weather phenomena have occurred that justify taking certain additional precautionary measures in maintaining pavements to minimize damage from unforeseen bad weather. Keeping the pavements sealed against water infiltration, a little extra care in keeping the drainage systems open and working, keeping shoulders dressed and stable, using base and subgrade materials that are less susceptible to frost damage, and making repairs properly when they are needed often mean the difference between minor damage and costly failures.

The weather, itself, does not always create the damage. Pavements have been damaged by snow-cleaning crews or by de-icing chemicals. Snow-removal equipment has scarred surfaces sufficiently to start or accelerate spalling or surface scaling, has damaged joints and joint materials in rigid pavements, or has damaged seal coats on flexible pavements. But salt is not always bad. Maintenance engineers, in certain areas, have successfully used sodium chloride stabilization to reduce effectively the freezing and thawing effects on paving over frost-susceptible soils and subgrade materials. One of the greatest challenges to the maintenance engineer is the problem of keeping his roads, streets or runways in such condition that unusual weather, particularly weather foreign to his area, will create the least distress.

A pavement structure is designed to spread out the applied load to the extent necessary to avoid failure of the basement soil or to bridge over soils of inadequate support or localized weakness.

The retention of the structural integrity of the pavement is the direct responsibility of the maintenance engineers and the maintenance force. A properly designed and constructed pavement structure should be easy and economical to maintain, provided adequate protective measures are carried out and the traffic loads do not appreciably exceed the load criteria used in the design. Protection means joint and crack cleaning and resealing, patching spalled areas, seal-coating, keeping the drainage system operable, and other work necessary to reduce the effects of wear and tear and weather. The maintenance engineers should be familiar with the structure of all sections of paving so that the pavement can be kept in an acceptable serviceable condition at all times through normal maintenance practices.

The structure is only as good as the quality of its construction. Many excellent designs are sabotaged by poor-quality construction and many conditions influence quality. The design may be purposely altered, due to a lack of funds, and a marginal rather than an adequate pavement may result. Contractors who are not fully qualified to perform first-class paving work, or who are careless and sometimes a little dishonest, can produce low-quality pavements. In addition, honest mistakes are often made and undetected during construction. Furthermore, the quality and adequacy of supervision and inspection have their impact on the end result.

A pavement of marginal or poor quality will quickly show signs of distress. The first signs may be subtle and difficult to notice. But, maintenance engineers must be on the alert for these signs and take immediate and appropriate action to arrest or reduce the deterioration of these pavements.

Inspection is one of the most important phases of construction and subsequent maintenance. Only topnotch qualified and knowledgeable inspectors can insure pavement performance according to plans or expectations. The inspector can be, and often is, the Achilles heel of the whole pavement program. If he performs his job honestly and

effectively during construction, the pavement will be constructed as designed and will be destined for a long, useful and low maintenance life. If he follows through with the same efficiency after the pavement is in service, maintenance costs will be low and the pavement will continue to perform as expected. Only that maintenance actually required will be performed and traffic will flow with a minimum of interruption or discomfort.

Good inspectors, particularily maintenance inspectors, are in short supply. During new construction, the inspector usually has sufficient guides in specifications, drawings, and established procedures to assist him in determining whether the work is being performed satisfactorily. Even then he must have a deep sense of responsibility regarding the technical features of the specifications. When making maintenance inspections, he often has to depend largely on his experience and ability to see and recognize signs of inferior pavement performance or abnormal behavior, and from these signs, to determine the probable causes of failures or deficiencies. The timeliness, magnitude and cost of maintenance will largely depend on how expertly he performs his duties. His observations will be included in condition surveys that will be further analyzed by maintenance engineers who will decide on the work to be done and who will program it accordingly. Considerable time can be saved in the maintenance program if the inspector's reports are properly described, clear, and concise, and if his analyses are dependable.

Maintenance planning is not a job for a laborer or repairman although these trades are necessary in the program. Good engineering talent is required to back up the program and keep it working for the benefit of all concerned. The cost of salaries for professional personnel is but a drop in the bucket compared to pavement maintenance costs. A maintenance staff composed of well-qualified and experienced engineers will more than justify its existence. Men who know materials, pavement design, construction, soils, and drainage and who can quickly recognize signs of distress and know what remedial measures are necessary, can control, effectively and economically, a pavement maintenance program of considerable scope.

Once a road, street, or airfield pavement has been completed, the maintenance program begins. The maintenance practices that are carried out will determine the success or failure of the program. It is true that few programs fail, but some of them come close to it because they are wasteful and relatively ineffective. A program that encompasses a system of records or an inventory of pavement structures, regular condition surveys, and prompt remedial action when signs of distress are first noticed (provided they are noticed early), will keep pavements serviceable throughout their estimated life.

A good pavement inventory in which the road, street or runway system is subdivided into homogeneous sections for observation and evaluation is invaluable to the maintenance program. These sections can be categorized by underlying or basement soil, construction type, age, design, materials, etc., as suggested by the Canadian Good Roads Association, or in any other form that will facilitate the use of the inventory in the program. Data sheets and condition survey reports kept with the inventory provide a current status report of pavements.

Condition surveys can be made by any one or several of the many "observation" systems available. The simplest survey is made by a "walk-over" inspection of the pavement section, visually observing its condition and recording what is seen on a form or data sheet. This is tedious and time-consuming and depends on the conscientiousness and experience of the individual making the observations and the care he takes in making his notes.

Equipment that travels over the pavements at fairly good speeds, and which records the characteristics of the surface on tape by instruments, provides rapid accumulation of data that can be analyzed in the engineering office. Comparison of tapes taken over separate intervals of time gives an indication of the behavior of the pavement.

Photographic systems that take continuous strip films or successive pictures provide still another method of obtaining data on the condition of the pavement. None of the present methods of surveying pavements provides all the information necessary to plan and carry out the maintenance program. However, a combination of them does provide sufficient data, in most cases, so that the maintenance engineer can effectively study and evaluate the condition of his pavements to a major extent in his office. These

condition surveys, incidentally, can also be used to police the maintenance program because they will give an indication of the relative behavior of the pavements in the various sections of the inventory which should further indicate the quality of maintenance being performed.

The end product of the proper use of inventories and condition surveys is taking appropriate remedial action. Aggressive, continuing and appropriate action is the key to the maintenance problem. This is knowing what to do, how to do it, and then doing it. The same meticulous attention to detail must be given to the engineering of maintenance and repairs that is given to the original design. And speaking of design, all causes of deficiencies and failures must be reported to the design engineers to assist them in reducing the maintenance potential in future designs.

The methods by which maintenance can and should be accomplished are too copious to cover in this paper and no attempt has been made to do so. It would be impossible to do more than scratch the surface and even then, it would be difficult to make a choice as to what methods should be included.

The Highway Research Board, the American Society of Civil Engineers, the Asphalt Institute, the Portland Cement Association and many similar organizations have prepared and issued a considerable number of papers, articles, reports, manuals or publications outlining or recommending up-to-date methods and materials for maintaining or restoring pavements. Maintenance engineers should read, study, evaluate and utilize them in order to carry out a more aggressive maintenance program.

Discipline is nothing more than subjecting oneself to a particular code of behavior or practice, in this case, good established and progressive practices of pavement maintenance. This does not mean that one should go strictly by the book at all times. It means that one should adhere to methods and materials proved successful, but should be alert and recognize new and more effective materials, methods, tools, designs, analyses, and programing techniques. No lesser course of action should be taken than that prescribed for a particular situation, however, until careful consideration has been given to all the conditions involved.

It is so easy to prescribe design criteria, and to recommend construction, inspection, and maintenance practices, but all of this costs money. If all needed money was readily available to construct roads, streets, and runways, to hire competent inspectors and professional personnel, and to maintain these pavements in perfect condition, there would not be so many problems. Obviously, the ideal situation is to have adequate, qualified personnel; unquestionable design criteria; good and reasonable construction costs; and adequately budgeted and funded maintenance programs.

The degree of honesty, efficiency and conscientiousness, and the amount of necessary funds to reach this ideal situation are unfortunately lacking or impossible to obtain. Therefore, in order to have the best maintenance program possible, it will be necessary to:

1. Staff the maintenance division with the most competent and experienced engineering and maintenance personnel that can be obtained.
2. Prepare and keep records of all pavement structures that are as precise as possible for each maintenance district. These should include records of subgrade soils, subbase and base courses, wearing courses, drainage systems, safe load-carrying capacities, and any other information necessary to complete the data.
3. Establish a pavement condition survey program to check appropriately and record the physical condition of the pavements at regular intervals.
4. Make systematic reviews and analyses of the condition survey reports.
5. Review periodically, current maintenance methods to make sure that they are being carried out as specified or to determine whether improved methods are needed.
6. Prepare job orders or projects for preventive maintenance and to correct deficiencies revealed by the studies of condition survey and trouble reports. (Each project or job order must contain a complete description of the work to be performed.)
7. Review the job orders and projects and assemble them into suitable programs by priorities determined by the urgency of the work.
8. Develop realistic budgets to cover adequately these programs and be sure that the price of each project covers the package.

9. Schedule contracts or work to accomplish the projects under the most favorable conditions of weather and traffic and, if possible, when contract costs are most reasonable.

It is difficult to discuss the subject of pavement maintenance without repeating information that is thoroughly familiar to people who are actively engaged in this work. However, in the course of presenting this information something may be said that will provide additional food for thought or that will motivate or challenge someone to put a little more effort into improving or perfecting some phase of his maintenance program. The reason that certain items are mentioned over and over again is that some programs are still lagging and maintenance practices and methods are not keeping pace with the pavement performance demanded by present-day traffic or which are estimated to be required to meet future traffic conditions.

Satisfactory maintenance can only be obtained through constant research, aggressive action, and the combined efforts of all concerned.

Establishing a good system of surveying and recording the condition of the pavements, keeping good records, carefully analyzing the data, and then using the information obtained from the surveys properly and to the maximum extent, will provide a solid foundation for a successful pavement maintenance program.

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