Priority Assessment

M.S. SNAITH and J.C. BURROW

ABSTRACT

In road maintenance remedial work should be ordered into an action list based on need; the most pressing items receive the highest priority. Some form of costing of each item is required to assist the engineer in selecting the cut-off point in the priority list. Therefore costing is also mentioned in the paper. In the past engineering judgment has correctly played an important role in setting priorities. The advent of the maintenance management system, however, requires that engineering judgment be delineated in a series of rational decisions that may be implemented by the system. Unfortunately there is more to priority assessment than merely placing the worst condition measured at the top of a priority action list. This paper attempts to define the parameters to be considered and to draw attention to areas frequently neglected when formulating priority determination schemes.

Considerable data on the long-term physical and geometric characteristics of a road and its current condition are required before remedial works can be selected. In the extreme every piece of road requires some repair work. The engineer has to decide what works are required and in what order they should be done. The diagnosis and selection of each particular item of maintenance is beyond the scope of this paper although it is closely allied. Ideally the engineer would be able to select all sections of road that require some treatment and have those treatments carried out instantaneously. Unfortunately the world is not ideal and usually the available money is insufficient. The engineer must therefore arrange the works into a priority order and this paper seeks to demonstrate how this may be done.

UNSEEN PRIORITY ORDERING

To concentrate resources on those sections that need maintenance, an engineer or a maintenance management system will disregard any road section that does not have an observed fault. This action automatically places certain road sections at the lowest level of priority. Conversely the conscientious road engineer will correct immediately those faults he knows will lead to rapid and progressive failure, for example, blocked drains or potholes (1). Such maintenance will be arranged for on observation or as rapidly after observation as possible. It could be argued that this action places these items at the top priority level. Finally some roads are clearly in a condition where accepted maintenance treatments are insufficient and complete reconstruction is required. Such road sections fall outside the scope of the normal priority ordering of maintenance works. However these items are shown in Figure 1 to draw attention to them.

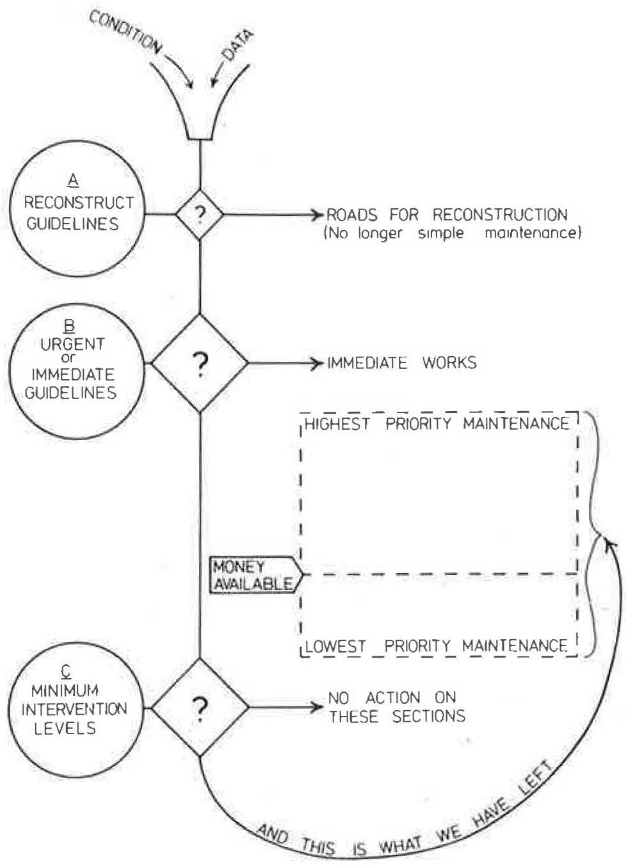

FIGURE 1 Priority rating: the full picture?

BLANKET PRIORITY RATING OR INDIVIDUAL ITEM RATING

Blanket. The American rating system of present serviceability index (PSI) combines items ranging from extent of cracking to the unevenness of the riding surface (2). Figure 2 shows the rating system with various patterns of serviceability for a pavement with age (3). There is unfortunately still considerable discussion as to whether these patterns are representative of real roads, although some computational models for predicting condition appear to rely on these trends of behavior (4). Using this approach a simple rating system would be to calculate the overall PSI of every road section and place them in ascending order of PSI; the result would be a priority list.

Individual. A different approach to priority rating is to study each individual defect measured (e.g., rutting, cracking, edge deterioration, surface stone loss, surface transient deflection). In this technique every item is assessed. The selected remedial works to correct the individual item is then allocated a place in the priority ordering as a function of the seriousness.

Clearly it is necessary to consider every defect in a substandard section of road, but it would ap-

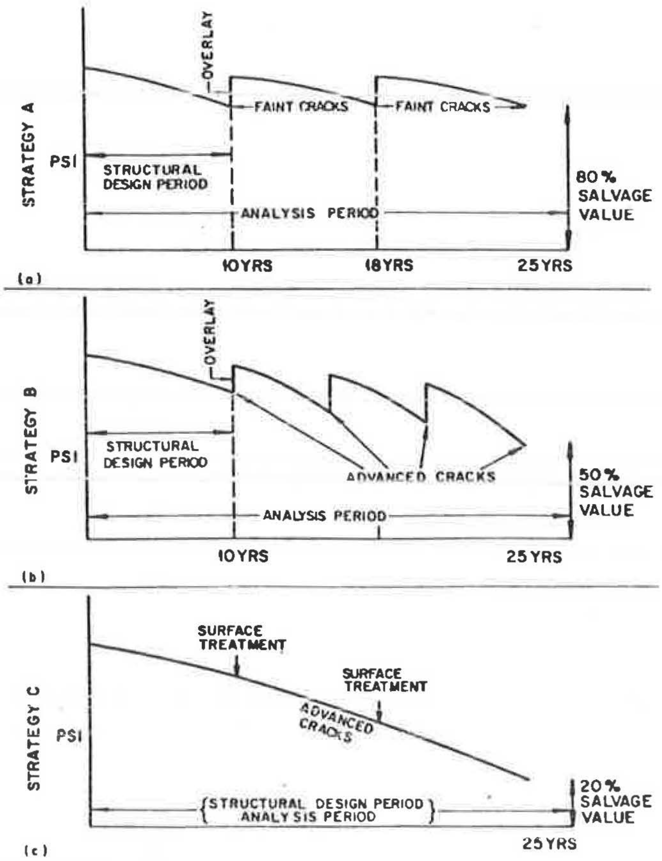

FIGURE 2 A selection of rehabilitation strategies.

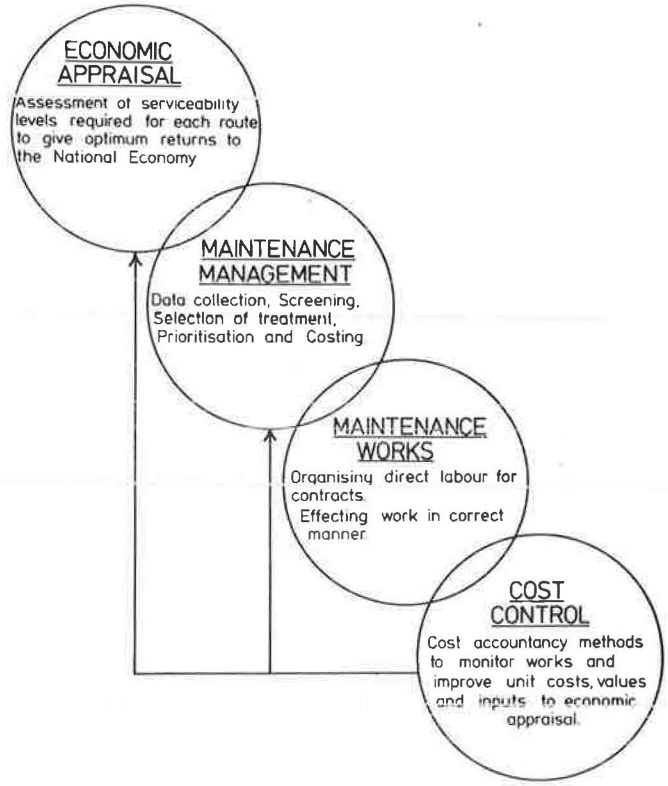

FIGURE 3 Various interrelating aspects of road maintenance.

pear unreasonable to allow a section of road with a large number of minor faults a higher priority position than a road section with one extremely serious defect. Consequently it is felt that the latter approach is to be preferred.

USER COMFORT VERSUS STRUCTURAL INTEGRITY

Should priority be given to roads that give an uncomfortable ride or to roads that are in danger of becoming structurally unsound? It is possible to have a very bumpy road that is perfectly sound or conversely a smooth road that will collapse completely during the next wet season. It may be argued that this is a political decision, and indeed it may end up as such. The ideal way, however, of resolving this problem is by using a highway cost model to calculate the costs of construction, maintenance, and vehicle operation over the life of the pavement.

Such programs are widely used overseas and provide the engineer with the tool to assess the overall cost to the national economy of a particular maintenance strategy (5,6). A cost model can be used to determine the optimum level of serviceability at the lowest total cost. Whatever level of user comfort or structural integrity is required to keep the road at this level of serviceability is then correct (Figure 3). This appears to be a simple task but of course it is not. For example, the techniques based on transient deflections that predict structural integrity will not necessarily result in roads of a specified riding quality. It would seem therefore that any priority rating method must reflect both user comfort and structural integrity if it is to be acceptable.

DATA REQUIRED

Obviously data on road conditions are required before remedial works can be selected. Also the worst sections should be given the highest priority. The problem is that the worst sections, with respect to condition, are not necessarily the most important to the national economy.

Consider a main road with a spur of 500 m to the entrance of a leisure complex: the spur road has not been constructed particularly well because it was not expected to carry heavy traffic. Assume that it has deteriorated at a faster rate than the main road and is showing evidence of severe distress whereas the main road has minor cracking and rutting. Which section should receive the highest priority--the main road with minor defects and high traffic levels or the spur road with major defects and minor traffic? The economy of the country is more dependent on the main road. Consequently it is clear that any rating system must be able to weight economic importance against extent and type of defect observed in a pavement.

A second problem is road construction type. Consider a flexible pavement with 10 mm ruts and a concrete road with the same. The former would scarcely demand a high priority. The latter would indicate that the rigid surfacing had ceased to behave as designed and would require rapid replacement. Consequently it should be placed high in the priority order.

The location of a portion of the road is another factor to be considered. For example, it has been recognized that different sites have different requirements for sideways force coefficient (7). If a value of 0.50 were obtained for a relatively safe site no action would be required. A value of 0.50 at a busy road junction, however, should result in rapid remedial treatment. Thus any priority rating system should take account of the location of the section of road under scrutiny.

PRIORITY SECTION LENGTH

Certain measurements that assess road condition are made at discrete points (e.g., deflection) whereas others are made over a sizable length of roadway (e.g., riding quality). If these measurements are to be considered together all data must be associated with the same minimum length of road--say 50 m. However it is probably not practicable to work on such short lengths of road. Consequently when pavement section lengths are selected for priority ordering consideration should be given to the plant facilities and supervision available. In a similar vein, when the priority list has been produced it should be reanalyzed to produce priority bands so that work in a particular region, of a particular type, can be carried out conveniently at the same time thereby reducing costs.

COSTING

There probably will not be sufficient resources to fund all remedial works required. To make use of the priority listing it will be necessary to cost the remedial works and produce a running total with the priority list. An example of this is shown in Figure 4. This requires that remedial works be selected by the maintenance system, which implies that the maintenance system will use each individual item of defect data rather than an amalgam of data as would be expected from the blanket approach discussed above. Each treatment will require a unit cost, and it should be remembered that a provision should be made for different unit costs in different parts of a country.

The costs produced by this process will be somewhat crude and it would be dangerous to rely on them too heavily. To refine such costings, and indeed monitor cost trends for various remedial works in various parts of the country, it would be advisable to add a full cost accounting system. The economic aspects of road maintenance are shown in Figure 3.

PRIORITY SELECTION METHOD

If the above arguments are accepted, any method employed in priority ordering will have to be able to take account of the following:

1. User comfort and structural integrity,
2. Defective items observed should be considered individually,
3. The economic importance of the route,
4. The construction type of the pavement, and
5. Each stretch of road should be of a practical length for remedial works.

In order to demonstrate how these items may be combined into a form suitable for computer manipulation the example of the algorithm employed in System BSM, a management system for developing countries (8) is given.

DRV = PD * N' (DW * bfA + TW * bfB)

where

PD = percentage deterioration,
DW = defect weighting in percent,
TW = traffic weighting in percent, and
N' = actual length or area divided by the average length or area.

The defect rating value (DRV) is calculated both for every defect observed and every measurement taken that is indicative of a critical state (e.g., an excessive deflection). The DRV is calculated as a function of the extent or magnitude of the defect or measurement (normalized with respect to the average length or area of all the subsections, N'), the seriousness of the defect, and the economic importance of the route as judged by traffic level. Various balancing factors (bfA and bfB) are included that allow the algorithm to be tuned to the specific requirements of each country. These balancing factors could be used, for example, to increase the importance of traffic as opposed to the defect type in producing the DRV.

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ORDER NO 01  PROV 1  DIST 1  TRAFF GROUP 2  F'WAY GROUP  0   TREATMENT HISTORY
SURVEY INFORMATION (10/81)   NO. BRIDGES 0  NO. CULVERTS 0
C'WAY 200m x 06.7m Sealed Surf Neat Gravel Base CBR<10
LEFT  FOOTWAY 0.0m             LEFT  SHLDR 1.8m Gravel
RIGHT FOOTWAY 0.0m             RIGHT SHLDR 1.8m Gravel

CRITICAL DEFNs   PRESENT    PREVIOUS  | SUGGESTED T'MENTS  QTY     RATE     $
                                      |
 Minor C'way    25% 10/81             | Thin Overlay      1340     2.50  3350
 Right Rutt's   60% 10/81             | Patch R Wh Tracks  120       10  1200
                                      |

PSI =  3.52   PVA=  8440  PVB=  11457  RUNNING TOTAL $  12450   TOTAL $   4550
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LEFT  FOOTWAY 0.0m             LEFT  SHLDR 1.8m Gravel
RIGHT FOOTWAY 0.0m             RIGHT SHLDR 1.8m Gravel

CRITICAL DEFNs   PRESENT    PREVIOUS  | SUGGESTED T'MENTS  QTY     RATE     $
                                      |
 Left Rutt's    60% 10/81             | Patch L Wh Tracks  120       10  1200
 Right Shldr    50% 10/81             | Repair R Shldr     180     1.00   180
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FIGURE 4 System BSM priority listing showing cost running total.

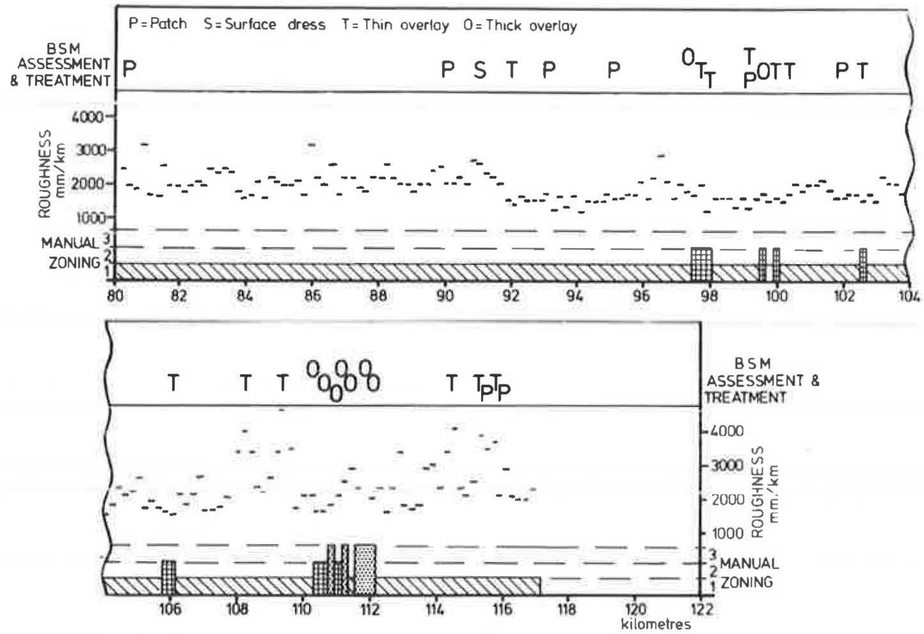

FIGURE 5 Results of manual analysis, roughness survey, and system BSM analysis.

DRV calculations may be made for a number of defects measured in a particular subsection of road. The number used to define the overall importance of the particular subsection in the queue for remedial works in the network is the highest DRV in the particular subsection under scrutiny. This DRV is known as the priority rating value (PVA). Essentially the subsections may be arranged into an order of suggested works, with costings attached. If a subsection has the highest priority rating value in the network, it will be classed as having the highest priority for remedial works. A portion of such a listing is shown in Figure 4, which shows two subsections in descending order of priority for works.

Finally an example is shown in Figure 5 where the algorithm is used on a trial section of the route network in Botswana alongside the more normal methods of simple visual assessment for structural integrity and roughness measurement. The latter serves as an indication of the level of serviceability. In this case, traffic and construction types for each subsection were determined by separate surveys [details of these surveys are published elsewhere (9)]. On the sample shown in Figure 5 there is a high degree of correlation between those sections where the algorithm assigned a high priority and those sections with either a low structural assessment or a low level of serviceability. This demonstrates that the algorithm is providing what a priority assessment procedure should; that is, the ability to keep the road network in an adequate structural condition while taking into account total transport costs (if these are taken as a function of the roughness value).

CONCLUDING REMARKS

A number of methods of priority rating are available. However, it is suggested that the method outlined in this paper is both logical and simple. Furthermore it has been used with considerable success in recent comparative trials in Botswana with more generally accepted manual methods (9).

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Priority Decisions in Risk Management for Local Governments

DANIEL S. TURNER and RICHARD P. KRAMER

ABSTRACT

Traffic-accident related liability suits against local governments have reached epidemic proportions in some parts of the nation. In spite of the obvious risk of liability and financial loss, many jurisdictions have been slow to take action. Cities and counties need to take positive actions to promote safety and minimize risk. Guidance is given for forming a Risk Management System (RMS) to fit local conditions. A literature review, summarized by topic, is included to allow rapid review by engineers, administrators, and elected officials. Information has been provided to help local governments take positive steps to make risk management an accepted component of day-to-day operations. An effective RMS begins with knowledgeable, committed leaders who exercise discretionary authority. A RMS is a planned program based on a strong accident reduction program and employees who are conscientious about carrying it out. It uses a priority technique to systematically eliminate trouble spots while making maximum use of available funding.

The following scenario was taken from a recent southeastern newspaper. Names and dates have been omitted because of the potential for legal proceedings against the city.

> ZZZ police said today a malfunctioning traffic signal was a "possible contributing factor" that left a woman dead and another woman in very critical condition. Officer XXX said he checked the traffic signal and at the time of the accident, the light facing the victim's lane was burned out. In addition, the sun screen over the green signal facing her was missing, causing the "green light to appear to be illuminated", XXX said.
>
> Of the light, XXX stated, "At that time of day the sun was setting in the west and was shining directly on the light. It could appear green." He added that the light was repaired around noon on the day after the accident.

Witnesses are prepared to testify that the signal malfunctioned frequently. If the city had reason to know of the defective signal and should have repaired it, they will probably pay substantial damages to the victims or victims' estates.

This is not an isolated case. The number of law suits related to traffic accidents is staggering, and it is still growing. Since the early 1970s many states have lost their immunity by either court mandate or legislative action (1) as shown by Figure 1. The trend toward increasing numbers of lawsuits (2) is illustrated in Figure 2. By 1980 the number of suits and claims reached almost 2,100 in California, Louisiana had well over 500, and almost all states were wondering how to curtail the problem.

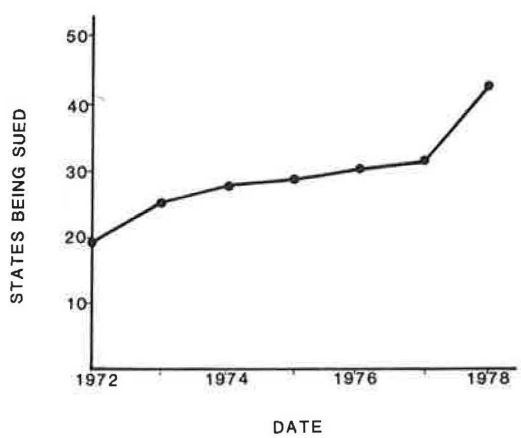

FIGURE 1 **Status of soverign immunity among the States (1).**