PAVEMENT MANAGEMENT SYSTEM IN PRACTICE

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SUMMARY

This paper presents a general description of the PMS system for the management and maintenance of block pavings of terminals and industrial sites. In fact it is only a component of a system for the management and maintenance of the total infrastructure of such sites. Taking into account the infrastructural elements present the system can be tuned to any specific site. In the mean time the system has been tested by and adopted by various companies.

1. INTRODUCTION

The last fifteen years there has been much research in the Netherlands into the structural behaviour of pavements [1-12]. This research focuses on the detection of damage to pavements and the deterioration of initial damage in the course of time. Several types of damage have been considered. On the basis of research results performance models could be developed. With these models, by performing visual inspections and considering the age of the pavement a forecast can be made as to the point of time when maintenance is due. About this subject detailed reports were presented at the Second International Conference on Concrete Block Paving in 1984, among others by working groups R1 and D3 of the SCW Study Centre for Road Construction [13, 14]. In the mean time further research has been performed, which has resulted in adapted and new knowledge [15, 16, 17]. The new knowledge covers a completely new method for pavement management and maintenance in practice. At the centre of it is the scheme of visual inspections which allows the quality of pavements to be assessed and recorded in a clear and objective way. For the conditions in the Netherlands performance models have been developed to which damage found is related and on the basis of which forecasts of residual lives can be made. In this way not only the point of time is visualized when structural repair is desired; in many cases also the type of measure to be taken is indicated.

The method has been fully automated and is called the Pavement Management System (PMS). It is mainly used for the management and maintenance of public pavements (those under the administration of Government, provincial and local authorities). Similar systems have been in use for the last few years.

Recently, Heidemij Adviesbureau B.V. h developed a new system for the managemen of terminals and industrial sites.



Figure 1: Terminal

It has been approved in actual practice. The system covers the management of the total infrastructure including pavement, sewerage, drainage, crane tracks, railway tracks, etc. Considering the scope of the conference this paper will provide a general description with an emphasis on pavements.
Data processing can be for both flexible pavements and block paving, but this description will focus on block paving.

With the new system different alternative maintenance strategies can be quickly calculated and verified and the consequences indicated. By performing the visual inspections at regular intervals, a progressive long-term planning is made for the structural maintenance of pavements which practically excludes setbacks. Calamities are prevented, which keeps the costs lower.

Therefore, this PMS is more than just a tool for those in charge of the technical aspects; it has come to be an adequate control mechanism for the management.

2. PROCEDURE

2.1 General

Production is the first priority that counts for terminals and industrial sites; all the activities are organized for speed, efficiency and saving of costs. These sites require a proper infrastructure. When considering the pavement as such, it is an absolute must to have a PMS that is geared to taking adequate measures that fall within the financial margins, and doing so at the right time to prevent any waste of money. The realization of this requires a systematic approach according to plan, for this system is a tool, no miracle, as with an improper system only inadequate results would be obtained.

The central aim of a PMS is providing a system by which the management and maintenance of pavements can be carried out in a well thought out, efficient way and based on objective criteria.

It has to be well thought out as with the system alternative maintenance strategies can be calculated and compared, both as regards quality and cost aspects. It has to be efficient as on a systematic basis (which can be in an automated way) personnel and finance are involved to prepare and realize management and maintenance. The system has to be objective as criteria are applied which are used both for the management and for the technical maintenance to determine the quality status of the pavement.

2.2 Structure

The diagram of Figure 2 shows the steps in the PMS.

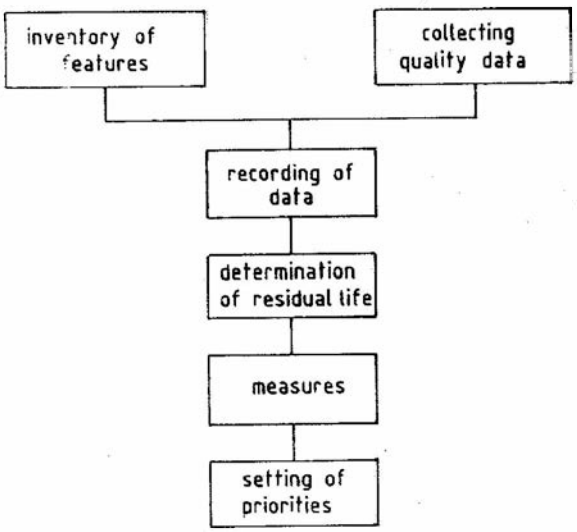


Figure 2. Diagrams of steps in PMS

The diagram of Figure 2 shows that there are a number of activity clusters which to a certain extent are interdependent. Each activity is clearly defined on the assumption that only the really essential information is collected and processed to be able to achieve a sound long-term pavement planning. It is often preferred to have a general long-term planning (for five years) and a detailed short-term planning (for one year). The following paragraphs will deal with each of the steps.

2.3 Inventory

Proper maps are a prerequisite for a PMS. As a matter of fact it shall be known what is managed and maintained. Main items are location, size, and the age of the pavement. First the total paved area is divided into maintenance sections, which in practice have physical limits and are clearly recognizable. The limits are

often determined by site dimensions, transitions to other pavement materials, major changes in cross-sections changes in pavement structures, etc. Of each section it has to be known for which purpose it is used, as damage standards and criteria have to be related to the use. By way of example: higher standards will apply to the evenness of a paved area used for stacking containers up to four tiers than to that of a floor used as a coal bunker.

This shows that the use of the site is a considerable condition when divided into sections. This practice results in that uniform damage patterns and types are found in one section. The sections are sketched in on a map. For this, digital plan drawing is practised so that in case of lay-out changes or relocations of operations a new arrangement (overlay) can be made fast. If the map allows so, the areas are measured from the map (digitalized) or otherwise determined on the spot. Figure 3 is an example of how a site can be divided into sections on the basis of the use.

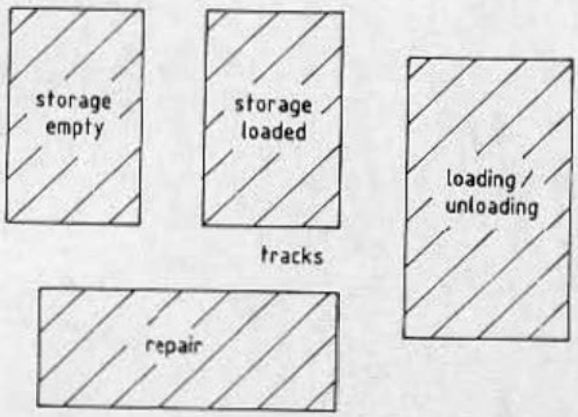


Figure 3: Sections according to use

Each of the sections or tracks can be subdivided into maintenance subsections, an example of which is shown in Figure 4. Of each of subsections a to e the basic data are recorded, which are: length, width, surface area, material used for pavement, age, use, etc. Herewith, the first step has been completed.

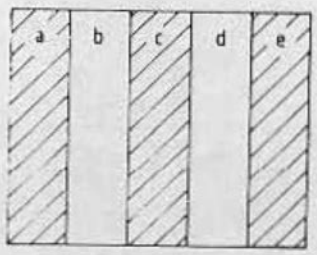


Figure 4: Subdivision into maintenance subsections.



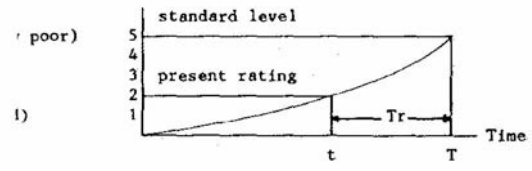
Figure 5: Subsections

2.4 Collecting quality data

After having mapped the paved areas involved each section is inspected. The quality of the pavement is assessed, initally in a visual inspection, and additional measurements can be made to determine the strength, comfort or roughness.

In visual inspections the pavement quality is expressed for several aspects, stating extent and seriousness. The clearest examples for block paving are the damage aspects of transverse unevennness and local unevenness. The quality of each type of damage is indicated with ratings ranging from 1 (good) tot 5 (very poor). The quality ratings are in accordance with the method developed by the SCW Study Centre for Road Construction, which is generally used in the Netherlands [17]. On the basis of the quality found and the age of the pavement it is forecast how the quality will deteriorate in the years to

longer to be met. Figure 6 is a diagram ving a performance model.



= residual life (time left for carrying structural measures).

ure 6: Performance model.

a better explanation the performance els for transverse unevenness and local venness in block paving are given as rices in Figures 7 and 8.

ement type: Block paving of damage: Transverse unevenness						
	Age (in years)					
Damage combination	<=3	5	8	11	15	20
-						
L1				>5		
L2, L3						
M1	o	3-7	4-8	4-9		
M2	o	2-4	2-6	3-7	3-8	4-9
M3	o	1-3	1-4	1-5	1-6	2-7
E1, E2, E3	o	0-1	0-1	0-1	0-2	0-2

lanation: B = rating of general inspection
L,M,E = slight, moderate, severe damage
1,2,3 = extent of slight, moderate and severe damage, repectively
o = table not applicable; check damage cause

gure 7: Residual life matrix for ansverse unevennes

vement type: Block paving pe of damage: Uneven surface						
	Age (in years)					
Damage combination	<=3	5	8	11	15	20
-						
L1						
L2, M1			>5			
L3	2-5	3-6	4-7	4-9		
M2	o	1-4	2-5	2-7	3-9	4-9
M3, E1	o	0-2	0-3	1-3	2-4	2-6
E2, E3	o	0-1	0-1	0-2	0-2	0-2

planation: B = rating of general inspection
L,M,E = slight, moderate, severe damage
1,2,3 = extent of slight, moderate and severe damage, repectively
o = table not applicable; check damage cause

gure 8: Residual life matrix for local evenness

2.5 Storage

As can be concluded from the previous paragraphs, many data have to be collected and recorded, depending on the extent of the paved area. There are two categories of data:

- Fixed data: these refer to the information dealt with in Paragraph 2.3. Characteristic of these is the low mutation frequency (about once every ten years). This information is collected once and can be kept up to date quite easily.
- Variable data: these are mainly the quality data dealt with in Paragraph 2.4, together with the subsequent processing, which result in the long-term planning for pavement maintenance. In principle one visual inspection is carried out every year, and all the data recorded will have to be processed. This category does have a high frequency of mutations (about once every year). In many cases this information will be collected in a given period of the year, and the results of which will have to be available by a given date. This implies that much work has to be done in a relatively short period of time.

Considering all this, automation in data storage and processing is not only a logical step but also inevitable. The major advantages of automated processing are:

- saves time and consequently reduces costs;
- reduces risk of failures;
- alternative options can be calculated quickly;
- uniform information quickly available.

2.6 Measures

The residual lives are calculated from the basic data, quality data and performance models. This means that on the basis of the present quality assessment and the history of the pavement forecasts are made for the point of time when the standard level is likely no longer to be met and when repair measures are due. The standard level depends on various factors, such as the use made of the pavement and the structure of the pavement; the level can



Figure 9: various factors

strongly differ for individual cases and has to be considered carefully. This can be reflected in the performance models. With this procedure it is well possible that for the different parts of the site with a similar damage type a different behaviour will be established, e.g. for lanes compared with storage yards.

On the basis of the residual life forecasts it is decided in what year the maintenance has to be carried out. The type of repair is found by combining the various types of damage. So, a number of uneven spots will mostly be repaired spotwise, whereas local uneveness combined with a poor transverse evenness, wide joints and a poor water run-off will lead to applying a completely new paving. Likewise, various maintenance strategies can be presented together, such as structural repairs at long intervals and with high investments, or -on a larger scale- minor maintenance at shorter intervals. The latter tends to result in average maintenance costs that are higher than of structural repair. Decisions as to the maintenance polity to be pursued will have to be made depending on what financial means are available.

For taking the decisions about repair measures, the present paper only considers the pavement quality and the standard level to be applied. Of course in practice the matter is much more complex as more conditions can affect the maintenance planning. Examples are the renewal of sewerage systems, the financial possibilities and the interference with the flows of production and goods. Fro the total coordination the optimum time t realize the maintenance is decided.

2.7 Long-term planning

The computer calculates the costs of al planned repair measures, and the result appear in conveniently arranged cost-tim charts: the long-term forecast. Thi provides an insight into the financia means required for the maintenance o pavements for a planning period of five years. If the financial planning should show peaks and valleys these can be levelled by adjusting the planning for the relevant year for certain maintenance measures, thereby visualizing the consequences of any delays. Figure 10 shows an example of such a long-term planning.

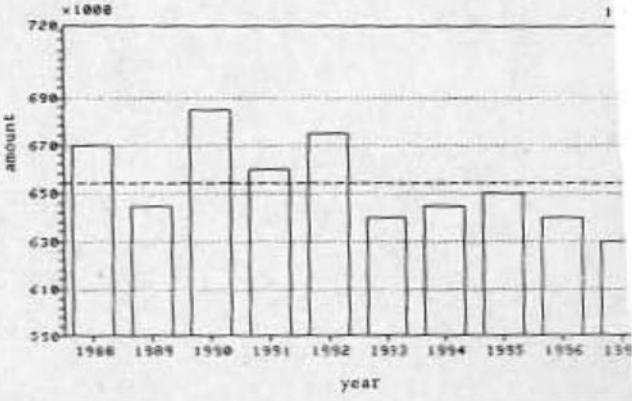


Figure 10: Long-term planning

A scheme of visual inspections at regular intervals and the processing of results will create a progressive long-term planning which is adapted every year. By way of example Paragraph 2.8 shows the planning for the first year.

2.8 Work specification

The maintenance planning for the first year is converted into a specification for the performance of the activities. For instance, for the re-paving with concrete blocks specifications are given for the shaping of the capping layer, the thickness and the shaping of the subbase, the thickness of the block paving and the requirements the sand between the blocks has to meet, as well as the types of concrete blocks to be used. This type of standard information can be drafted easily, and often only the unit prices will have to be adjusted once or twice yearly. Together with the cost estimate this will be the basis for the contractor's activities.



Figure 11: Activities

3. IN PRACTICE

This paper presents a general description of the PMS system for the management and maintenance of block pavings of terminals and industrial sites. In fact it is only a component of a system for the management and maintenance of the total infrastructure of such sites. Taking into account the infrastructural elements present the system can be tuned to any specific site. In the mean time the system has been tested by and adopted by various companies, such as:

Europe Container Terminus B.V.: ECT's Delta Terminal, situated on land reclaimed from the North Sea on the edge of the Rhine river delta, measuring approx. 80 ha.

Interforest B.V.: A forest terminal situated in Rotterdam, measuring approx. 5 ha.

Hoogovens IJmuiden: Dutch iron and steel works situated on the North Sea, measuring approx. 60 km.

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* Participation by Heidemij Adviesbureau B.V.