APPLICATION OF MECHANICAL PAVING AND REPAVING IN ROTTERDAM

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SUMMARY

"In the repaving activity, the mechanical regrouping of blocks to be reused is the missing link for complete mechanization".
My colleague and predecessor, Mr. S.J.A. Vievermans, concluded his presentation to the C.B.P. conference in Rome 1988 with this statement. In making this conclusion he put the cat among the pigeons in respect of the obstacles to mechanical repaving at that time. There were no techniques for mechanical repaving and ideas came no further than the drawing-board. The main obstacle was the huge investment required to execute these ideas. It was also likely that any prototype would quickly be outdated.
Interest in mechanical repaving has remained, however, due to two factors:
- the increasing mechanization of paving by Rotterdam Public Works (1988: 15%, 1990: 25%);
- the proportion of repaving within the total paving work (50-60%).

The situation in Rotterdam furthermore necessitated mechanical repaving for a number of other reasons:
- because of its poor soil conditions and intensive underground infrastructure, roads in Rotterdam have to be repaved more frequently;
- it has become increasingly difficult to recruit and train skilled paviours;
- the strict regulations with regard to improving working conditions;
- mechanical paving can only be carried out with new blocks.

Like with the big breakthrough for mechanical paving in the Netherlands (Delta Container Terminal, Rotterdam 1983), the development of mechanical repaving also requires the cooperation of the many parties involved. The provisional result is that experimental projects have been set up.
In this paper we will reconsider our view on the necessity of mechanical paving in general, and of mechanical repaving in particular.

1. INTRODUCTION

The present method of laying blocks by hand, which is most frequently used, has barely changed since Roman times (the Via Appia, 312 BC). The Industrial Revolution, which mechanized and automated almost every type of manual labour, would completely appear to have bypassed paving.
After a number of half-hearted attempts in the past, it was not until 1983 upon the construction of the Delta Container Terminal (approx. 80 hectares) that mechanical paving really broke through in the Netherlands.

The Rotterdam Public Works department has been a pioneer in respect of mechanical paving since 1982, and this was partly due to its emphasis on active policies in respect of working conditions. Another reason for the significance of mechanical paving is the enormous size of the total area for which the department is responsible, which includes developed urban areas and the large industrial and harbour areas, all with an extensive infrastructure. [1]

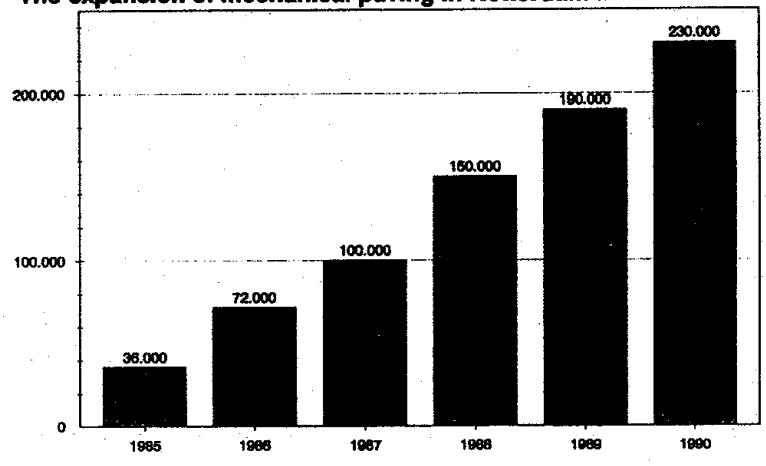
Table 1
Area and pavement type of Rotterdam 1991

Pavement type	Urban area	Industrial and harbour areas	Total	
	ha	ha	ha	%
Asphalt paving	460	180	640	25
Setts and cobbles	31	20	51	2
Burnt bricks	284	–	284	11
Concrete flags	785	43	828	33
Concrete paving blocks	660	77	737	29
Total	2.220	320	2.540	100

1 ha = 10.000 m²

In the early days, paving machines were mostly used for large projects, but innovation, especially in the field of logistics, means that it has now become feasible to use machines on much smaller projects (from 300 m^2), including in urban areas.
About 1½ million square metres of surface area are paved or repaved in and around Rotterdam every year, of which approximately two-thirds is done by the Road Constructing department.
The proportion done by mechanical paving methods has increased steadily in the past five years.

Table 2
The expansion of mechanical paving in Rotterdam in m²



An important advantage of mechanical paving is that the inconvenience for the users and residents is restricted to a minimum as a result of the speed with which the work can be carried out.
There is a huge resistance to mechanical paving methods amongst paviours. This resistance is based, among other things, on emotional grounds. The paviours see the introduction of machines as a threat to their trade. Most paving contractors in the Netherlands are small companies which are unable to make the investments necessary for mechanization. Some also believe that mechanical paving is only feasible for incidental large-scale projects. The present situation is similar to the resistance and the difficulties encountered upon the introduction of mechanization in almost all trades.
The importance of the further implementation of mechanical paving and the development of mechanical repaving methods in particular shall be discussed below. The following is a brief account of the preliminary results of some experimental projects intended to introduce mechanical repaving.

2. PRESENT DEVELOPMENTS AND OPTIONS

2.1 General

Relatively speaking, a large number of renovation projects are due to be carried out in various residential areas, harbour and industrial areas in Rotterdam in the near future. These renovation projects mean that repaving will play a larger role within the total package. At present the ratio of repaving to new paving is 1 : 1, but prognoses indicate that this ratio will rise to 2 : 1.

Concrete paving blocks have been popular since the sixties because of their favourable characteristics. The present quality of the surface to be renovated is therefore such that these concrete paving blocks can largely be reused.

2.2 Options

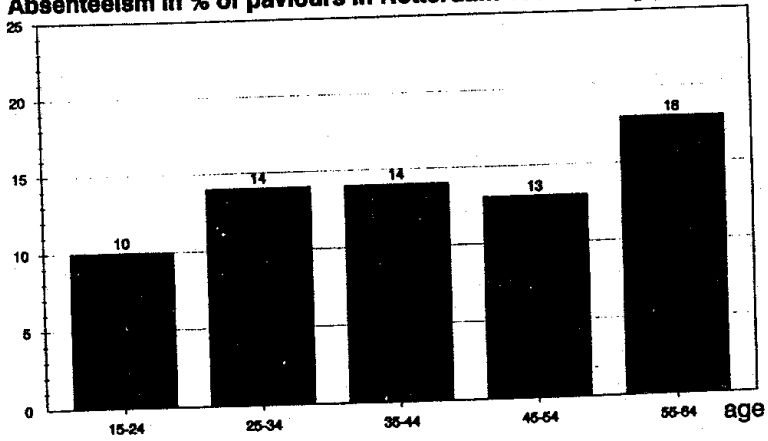
Up till now, mechanical paving has been possible only with new blocks. Because of this, it will be necessary to select one of the following alternatives in the near future (5 to 10 years):

a. the existing concrete paving blocks must be repaved by hand;
b. the existing concrete paving blocks must be sold and new blocks must be purchased for mechanical paving;
c. the existing concrete paving blocks must be broken up and used for foundations or as concrete granulate for making new blocks;
d. mechanical repaving must be developed so that existing paving materials can be reused on site.

We have chosen for the last option for the following reasons:

- **Costs**
  * The sale of used concrete paving blocks brings in very little, unlike used setts and cobbles and burnt bricks.
  * Saving on the purchase of new materials.
- **Working conditions**
  * The standards set for working conditions are becoming ever stricter.
  * Absenteeism due to illness and the percentage of paviours who become incapacitated as a result of back, knee and wrist injuries is very high (of these, back injuries account for 58%, knee injuries for 25% and wrist injuries for 17%). [2]

Table 3
Absenteeism in % of paviours in Rotterdam 1987-1988 [2]



- **Workforce**
  * It is becoming increasingly difficult to find skilled paviours or to attract people who want to be trained as paviour.
- **Applicability**
  * The repaving method is also suited for burnt bricks.
- **Environmental aspects**
  * A concrete paving block is a ready-made module for non-destructive recycling. (It can be reused without first being reduced to rubble.)
  * This reuse means that debris can be restricted and that energy can be conserved.

3. OBSTACLES TO MECHANICAL REPAVING

Until 1990 there was practically no scope for mechanical repaving, whereby the mechanical sorting and regrouping of used materials was a special obstacle.
Improvements came no further than the drawing-board because many ideas would have required huge investments.
It was furthermore feared that a prototype would become rapidly outdated.
Unlike the paving of a new container terminal, which was a vast but uniform project, most repaving work concerns a number of small-scale projects using existing material.
The older concrete blocks vary more in size, and this could be a problem for mechanical processing.
Paviours already object to mechanical paving methods, and they see mechanical repaving as the final blow for their skill.

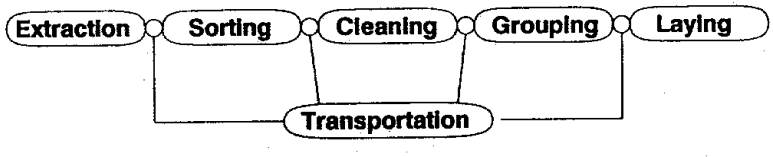
4. PLAN OF APPROACH

4.1 Removing obstacles

In order to remove the resistance and obstacles described above, it is essential for the various parties concerned such as the principals, contractors, machine manufacturers and concrete block manufacturers to cooperate with each other. Most repaving projects are small-scale projects which are widely-distributed geographically. In order to ensure continuity for the development of machine repaving and to get a return on the high investments, it is necessary for a number of principals (that is, public works departments) to cooperate.
This national basis will in the first place have to be formed by the principals who recognise the importance of mechanical repaving, specifically the municipalities of Amsterdam, The Hague, Zaanstad and Rotterdam.

4.2 Improving technology

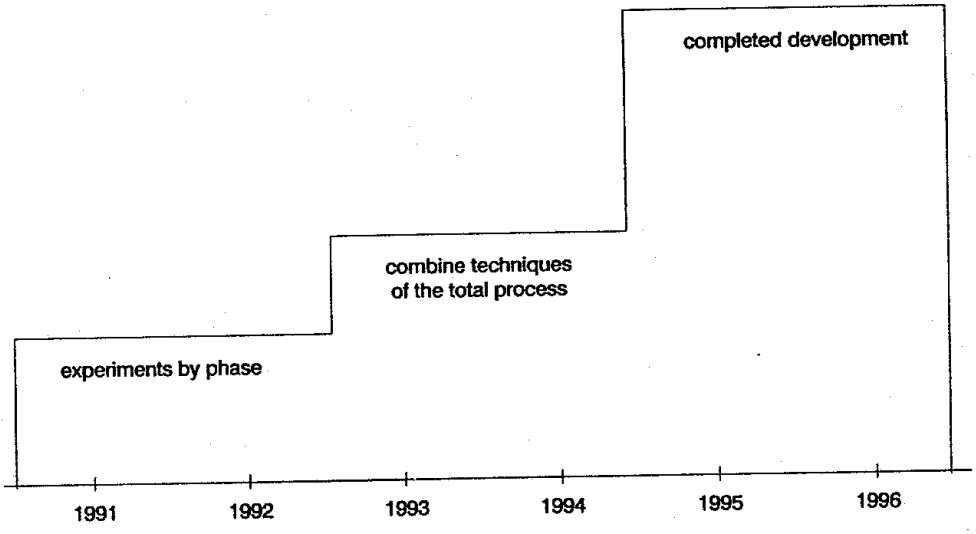
The complete mechanical repaving process consists of the following phases:



The various phases can be developed separately and improved in various places and in various ways, but the transportation phase can be fitted into and modified according to the other phases.
For the final laying phase good techniques are available: the vacuum method (Schaeff) and the clamp method (Delta S).[1]

Because there is a close link between the logistics of the entire process and the working methods used in the individual phases, it was decided to opt for a plan of approach whereby these phases were developed step by step. In this way it will be possible to make improvements with limited investments, and to develop a process which makes use of state-of-the-art technology per phase.
At present the existing vacuum method is the last phase and the other phases have been geared to this laying method. If it should appear to be necessary, the laying can be modified according to the previous phases at a later stage.

The first experiments were started at the end of 1990, in conjunction with a contractor called Ouwejan. Other contractors had expressed an interest, but on the whole, most had more reservations.
It is likely that a period of five years will be necessary to develop mechanical repaving to the present level of mechanical paving.



The expectation is that after 1996 a method will have been developed which will have advantages similar to mechanical paving such as:
- lower costs
- better working conditions
- smaller workforce needed (restricted number of skilled people necessary)
- less inconvenience because of time-saving working methods

Repaving has a number of additional specifically environmental aspects such as:
- less use of natural materials
- less waste

4.3 Consequences for the paviours trade

The introduction of mechanical paving and repaving methods has had consequences for the paviour's trade in that the traditional paviour will now be restricted to more small-scale jobs. As the potential group of paviours has reduced considerably in the Netherlands, this is unlikely to lead to problems with unemployment. The new generation of paviours will be confronted more than the old generation with organisation, logistics, tolerances and the operation of machines etc.

5. THE EXPERIMENTS

As stated above, the first experiments were started at the end of 1990. The experiments which were carried out up to the writing of this paper (May 1991) will be described in brief hereafter.
More up-to-date results will be presented at the conference.

5.1 1st experiment

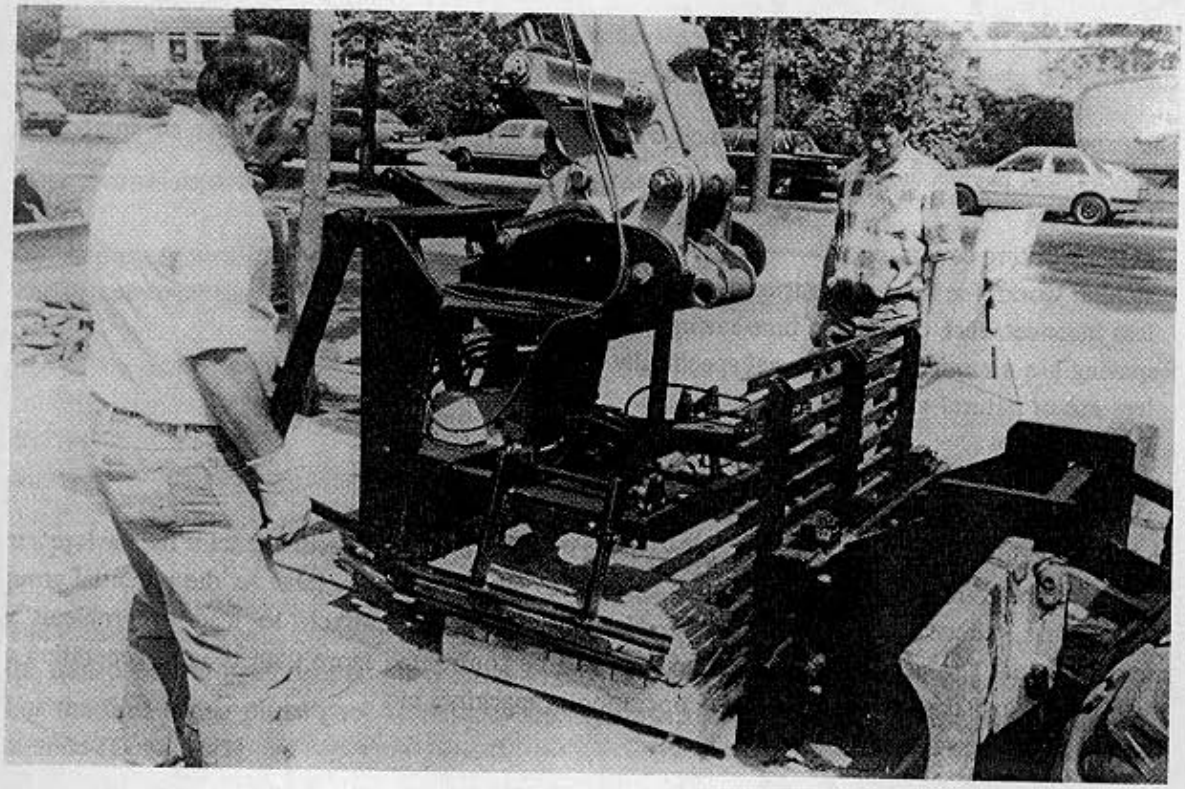
It would be ideal if blocks could be picked up from the street paving bond and all, be arranged on pallets and be transported for relaying.
A first experiment by extracting blocks and flags from existing paving with a vacuum machine was conducted.

Results
This method cannot cope with concrete paving blocks, although flags are suitable. This method is therefore being developed further.
One problem is that dirt and weeds are not removed from between the joints of the flags.

5.2 2nd experiment

After the first experiment a machine with which the blocks and flags could be scooped up into the bond was developed.
The joints between the blocks and flags were cleaned by means of vibration, but this turned out to be only partially effective. That is why it was subsequently decided to improve the cleaning of the joints by means of air pressure, and by water pressure at a later stage.

Results
These methods turned out to be less satisfactory than was hoped for. The blocks and flags were still not clean enough and the working speed was too low.



5.3 3rd experiment

In the third experiment, the blocks were transported to a work area in bulk where they were sorted and grouped on pallets by hand. Later the blocks, which had been pre-grouped on the pallets, were transported to the job and mechanically relaid using the vacuum method.

Results

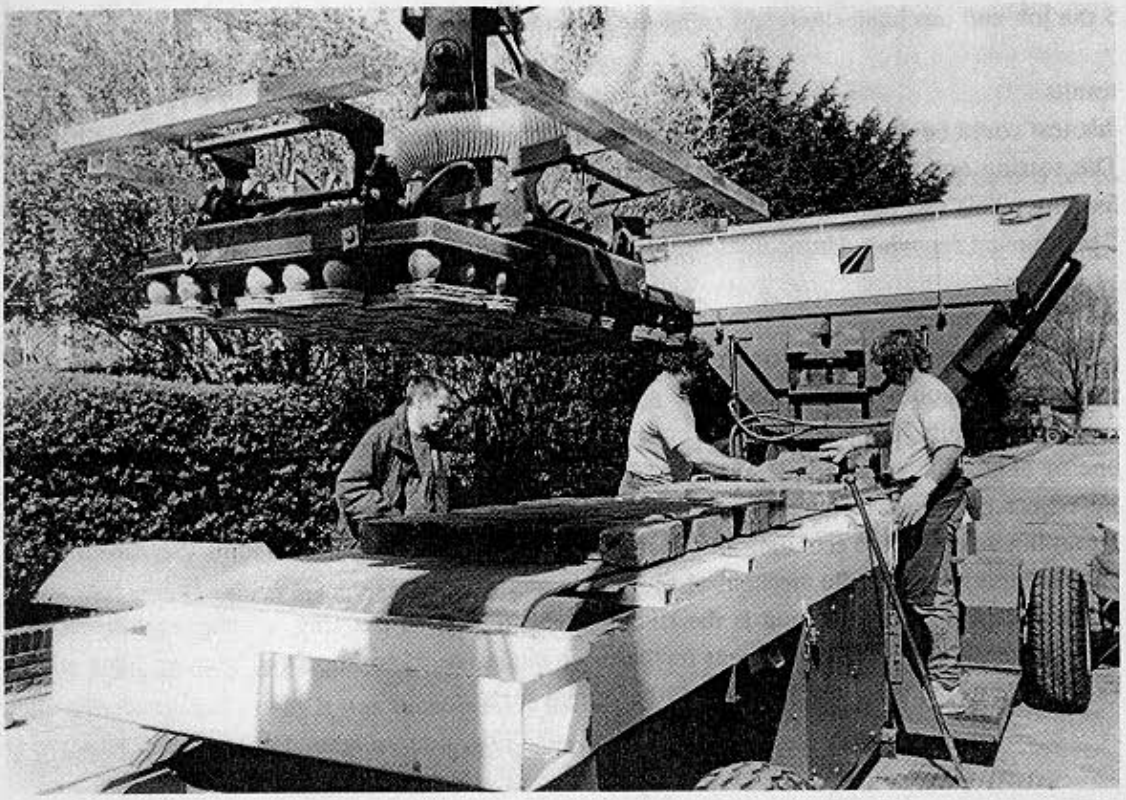
This test could be described as a success from the point of view of improved working conditions. (The sorting and regrouping was done at raised-table level, so that there was no need for continual stooping.) This test established that it is possible to achieve relatively high-quality paving work by means of mechanical repaving. Unfortunately this method is too expensive to be competitive.

5.4 4th experiment

The 4th experiment continued on from the 3rd and comprised a method whereby the sorting and grouping was done on a mobile installation on the site, immediately before the laying. The transportation was done in advance in bulk. In first instance we built a simple machine whereby the sorting and regrouping was still done by hand. This mobile unit was coupled to a vacuum laying machine.

The object of this experiment was first to establish whether the logistics of this mobile sorting and regrouping method were economically feasible. After that, it will be possible to further develop the sorting and regrouping into a fully mechanical processing method.

A critical aspect of this method is the timing of the transport, cleaning, sorting, regrouping and laying phases in terms. This 4th experiment furthermore made use of an improved vacuum plate with which it was possible to lift used blocks with a rather rough surface.



Results

The most important result of this test is that the first prototype was able to give a good end-product using used materials with a rough surface, even if there was question of relatively large differences in size.
It has become apparent that this method is economically feasible.

N.B.

An important side-effect of these experiments is that there is increased interest in mechanical repaving all over the country. Principals and contractors who were initially sceptical have been encouraged to participate in the essential development of mechanical repaving methods.

6. NEW FACTS IN ROTTERDAM (AFTER ROME 1988)

Aside from the development of mechanical repaving, other activities within the framework of the mechanization of roadworks have continued to be developed.
Some examples are:

- 75% of all concrete kerbs (total of 100,000 m^1 per annum) are placed mechanically;
- in 1989 a start was made with the mechanical laying of concrete flags (1990 production: 50,000 m^2);
- a new type of concrete paving block was introduced (211 x 211 x 60 mm) which is suitable for pavements (cycle paths and footways) which are occasionally used by heavy goods vehicles.

7. FINAL WORD

Paving work in Rotterdam has been increasingly mechanized since 1982, accounting for more than 25% by 1991. In order to continue this growth, it is essential that mechanical repaving also continues to develop. What has been done till now is no more than a first step.
In the near future robots will carry out work which is at present still done by hand. This will be a large improvement. Additionally, trials are presently being conducted with a computer-controlled, experimental high-tech machine which can group and lay concrete paving blocks.
The first experiments for mechanical repaving are promising.

8. REFERENCES

1 Vievermans, S.J.A.
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2 Andriesse, I.
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