THE RE-USE OF CONCRETE PAVING BLOCKS, MECHANICAL LAYING IN ROTTERDAM

C.W.A. Geense
Rotterdam Public Works, The Netherlands

Summary

The total public area of the municipality of Rotterdam has approx. 2,500 hectares of of pavement. 25 % is asphalted. 75 % is surfaced with small elements.

After a period of rapid growth, the mechanical laying of new paved roads in Rotterdam is beginning to stagnate. There are various reasons for this, but one of the most important is the changing nature of roadworks, i.e. a trend away from the construction of new roads towards the maintenance and repair of existing roads.

An important advantage of concrete paving blocks is that they are ready-to-use modules for non-destructive recycling: i.e. they can be re-used without having to be reduced to rubble first.

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ing. C.W.A. Geense
Rotterdam Public Works
Road Constructing Department
P.O. Box 6633
3002 AP Rotterdam
The Netherlands

Telephone (+31) 104894310
Telefax (+31) 104897004

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1. Summary

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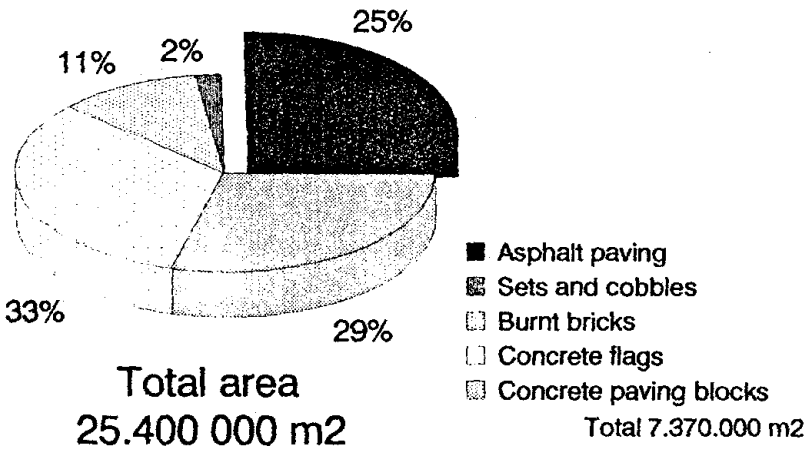
The plan of approach drawn up in 1991 has turned out to be feasible. The detection problems have been solved and the various technologies are still being tested to find the best combination, but there have been other unexpected developments which also offeres new perspectives.

2. The position of small elements in Rotterdam

The total public area for which the municipality of Rotterdam is responsible, including the port area, has approx. 2,500 hectares of surfaced areas.



You will note that only 25% of this area is asphalted, so that 75% is surfaced with small elements.

3. The paving branche in the Netherlands

A comparison of the annual turnover of the asphalting branche and the paving branche in the Netherlands reveals important differences:

Turnover asphalt branche	NLG 700,000,000
	NOK 2,713,000,000
	ECU 323,000,000
Turnover paving branche	NLG 1,500,000,000
	NOK 5,814,000,000
	ECU 692,200,000

In this connection it is important to bear in mind that the necessary materials and equipment form the most important component of the asphalting turnover, but that labour accounts for 70-80% of the paving turnover. This labour is supplied by 15,500 registered paviours and foremen.
Of these:

3,000 are employed by government (municipalities)
12,500 are employed by 900 private companies.

180,000 units of product are paved or re-paved every year, at a ratio of:
20% new paving to 80% re-paving.

4. Working conditions

A paviour handles 20 to 30 tonnes of concrete blocks per day, but extremes of 40 tonnes have been recorded. A paviour must also handle heavy gulleys and kerbs, which is why a paviour's work is considered one of the heaviest forms of labour in the Netherlands.
Some figures to illustrate this:

40% is under 25 year
25% is between 35 and 55 year
there are barely any paviours over 55 year
absenteeism on account of illness is 15% (compared with 10% in the construction branche)
60% of the absenteeism and incapacity is due to back injuries,

absenteeism costs	NLG 10,000
	NOK 38,800
	ECU 4,600

per employee per year.
Which means that 1.5 men are required to achieve 1 year production.

5. The EC General Directive on Safety, Health and Welfare on Construction sites

The implementation of this European directive as of 1 January 1994 has entailed that the legislation on working conditions which is applicable in the Netherlands has been

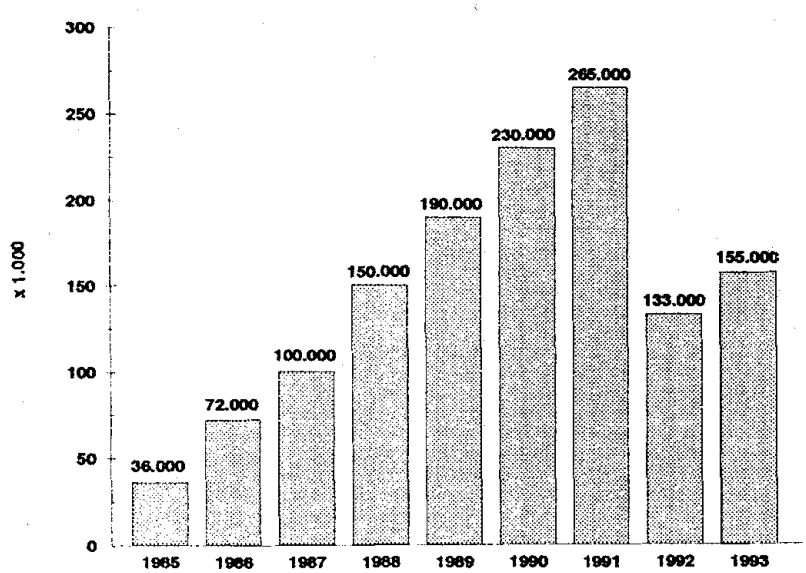
ghtened up. Futhermore two new legislations have been added:
to cut absenteeism on account of illness, and
to reduce the number of people on incapacitation benefits

hese new legislations mean that employers are being forced to assume responsibility for rger risks than previously, and in the long run this will be reflected in the price per unit f product.
he branche is increasingly calling on the principals (i.e. local governments) to cooperate ctively in further improving of the working conditions, e.g. by including specific ovisions prescribing the use of mechanical equipment for kerbs and gulleys or even echanical paving in contracts. It is clear that the government is being allocated a greater sponsibility for ensuring better working conditions by:
promoting designs which are conductive to better working conditions
appointing coordinators to monitor working conditions
drawing up health and safety plans

Mechanization in Rotterdam

he Rotterdam Public Works department has been a pioneer in respect of mechanical aving since 1982, and this was partly due to its emphasis on active policies in respect of orking conditions of its own employees. An another important reason was the enormous ze of the total area for which it is responsible: 1 to 1.5 million m^2 of public area is aved or re-paved in Rotterdam every year.
ecause of its greater speed, mechanical paving has the advantage that the inconvenience r residents and users can be reduced to a minimum. The development of mechanical aving in Rotterdam can be illustrated as follows:

Mechanical paving in Rotterdam in m^2



The decrease between 1991 and 1992 is quite dramatic, almost 50%, although it should be pointed out that there has been a slight recovery in 1993 - by 17% to 155,000 m². This decline has been caused on the one hand by a cut in the total production in Rotterdam (i.e. from 1.5 to 1 million m²) as a result of the stagnation on the housing market, the tendency to postpone infrastructural investments and general cost-cutting measures.
On the other hand this decline is also caused by a shift of emphasis within the nature of the roadworks, away from the construction of new roads in favour of the maintenance and repair of existing roads (which entails more re-paving).

7. The trend away from paving towards re-paving

For Rotterdam, this trend can be illustrated as follows:

Year	Percentage of new paving	Percentage of re-paving
< 1991	50%	50%
1992-1993	40%	60%
1996 >	20%	80%

At a national level, this ratio already is 20 to 80.

This movement away from new paving to re-paving can be explained as follows.
The Netherlands have a centuries-old tradition of the use of small elements. Because of their favourable characteristics, concrete paving blocks became popular in the early 60s, a period of great economic growth. At that time roads were designed according to empirical principles and on the basis of current traffic levels.

But traffic levels have increased greatly since then, both in terms of intensity and in terms of axle loads. A axle load of 115 KN is permitted in law, but in practice, extreme figures such as 200 KN are regularly measured.
The underground infrastructure (i.e. cables and pipelines) is also being utilized more intensively, which means that roads must be dug up before the capacity of this underground infrastructure can be adapted. An example is the expansion of the data networks using glass fibre cables.
In practice this means that roads need to be dug up or repaired more often to ensure that they come up to present and future standards. One of the ways of doing this is constructing a new road on a rubble foundation.

8. Rubble foundation

Forced by circumstances, Rotterdam Public Works had to look for ways of using excess rubble after the bombardment of the city in World War II. Initially this rubble was used as foundation for asphalt roads, but in the early 70s, it also started being used under small elements.
Because of stricter environmental standards and the increasing scarcity of natural resources, and because re-use is becoming an increasingly important objective in itself,

Public Works aims to optimalize every kind of re-use. This is why concrete granulate is now also being used to make new concrete products where possible and is even being used as additive to asphalted roads.

A first logical conclusion could be to use the old concrete paving blocks to make new blocks, but concrete paving blocks can however be re-used at a much higher level.

9. The re-use of concrete paving blocks

It is possible to distinguish between various degrees of re-use and the considerations for doing so:

	CONSIDERATIONS
1. Re-use on the same project	Re-laying costs
2. Re-use on another project	Transportation and storage costs
3. Re-use by breaking down to concrete granulate for new blocks	Total transportation, storage and energy costs
4. Re-use by breaking down to rubble foundation	Total transportation, storage and energy costs
5. Sale to private householders for domestic purposes (gardens, drives etc.)	Relatively low market value
6. Waste	Environmental and waste charges

It is necessary to examine the price of new materials in the light of all these considerations, and it is also necessary to examine transportation more closely because not only the distance but also time factors (the volume of traffic, tailbacks etc.) can affect the costs. Another factor which is more difficult to quantify but which should certainly be borne in mind in this respect is that it is becoming increasingly important to reduce transportation for environmental reasons.

It will be clear from the above that small elements have the additional advantage that paving blocks are ready-to-use modules for non-destructive recycling: they can be re-used without having to be reduced to rubble first. Re-use cuts the waste stream, means less use of natural resources and less need for transportation.

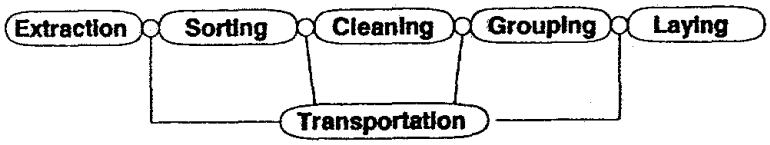
10. The necessity for mechanical re-paving

At present, roads are only re-paved by hand, as mechanical re-paving is still in an experimental stage. Mechanical re-paving has become necessary as a result of:

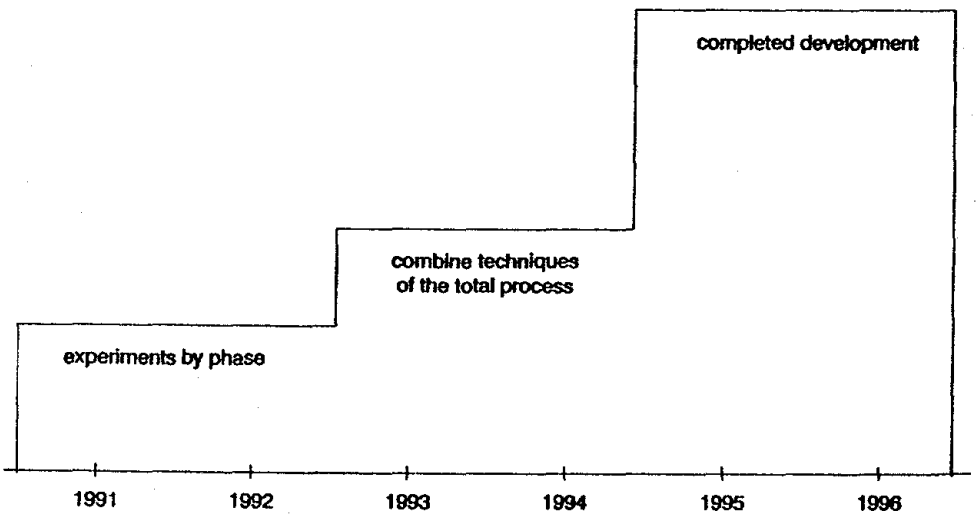
- Working conditions
  The problem of absenteeism on account of illness, disability and more stringent legislation
- Labour potential
  As a result of the difficulty of attracting skilled paviours in the number required and with the required qualities
- Greater speed
  Less inconvenience for users and residents

11. Plan of approach

The total mechanical re-paving process consists of the following consecutive phases:



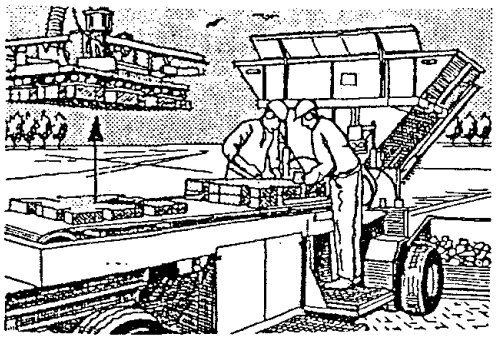
The various phases can be improved and developed separately and in various ways. The transportation phase can be modified and adapted to fit in with the other phases in various ways. There is good technology for the final phase - laying - vacuum methods and clamp systems. Because there is a close relationship between the logistics of the total process and the working methods used in the various individual phases, the plan of approach has opted for a step-by-step development of these phases. This means that improvements can be made with only limited investments and that a total process can be developed using state-of-the-art technology in every phase. In first instance, it has been decided to end the process with one of the existing laying methods so that the other phases can be brought into line with that. At a later stage, the laying can again be adapted to the preceding phases, if this should appear to be necessary.

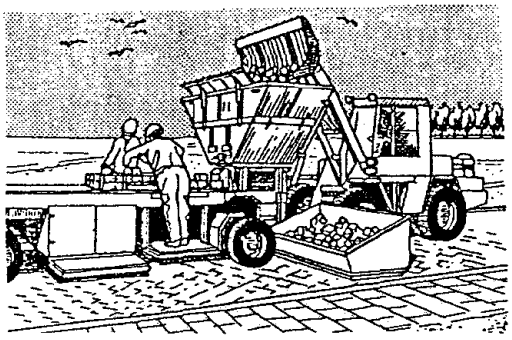


is likely that another two years of development will be necessary to bring mechanical
-paving up to the same level as mechanical paving.
he first experimental trials were conducted in 1989.
'Brainstorm project' for the re-use of paving blocks has been set up in collaboration
ith a specialized innovative centre for inventions called 'ID-NL'.

2. The status quo in the development of mechanical re-paving

described the results of the first experiments in the proceedings of the Fourth
ternational Conference on Concrete Block Paving in Auckland in February 1992.
t present two versions of the mobile installation described in the 4th experiment are in
peration.

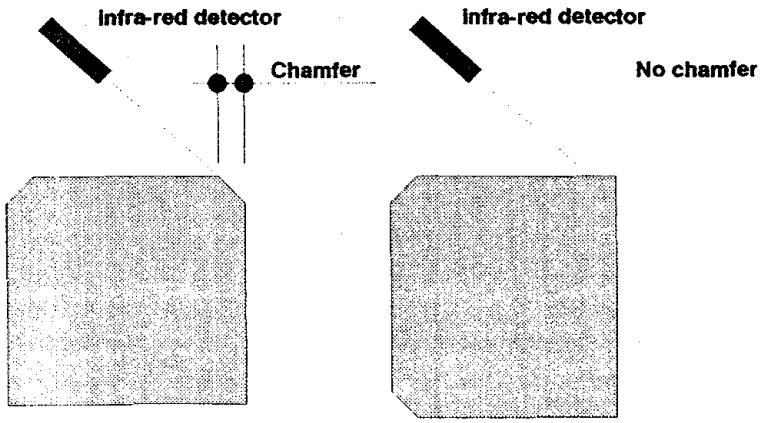




theory, the mechanical re-paving process can be completely automated using existing
chnology. This has been demonstrated using different trial projects. After the
scontinuation of two projects for financial reasons, three projects are now being tested
establish which is the most effective.

is expected that at least one of these projects will be fully operational before the end of
994, which means that the original plan of approach drawn up in 1991 has turned out to
feasible.

he biggest problem to be overcome was the detection of the blocks, firstly to be able to
rt them and secondly to be able to group them.
he chamfer is the key for this, and attempts are being made to detect this chamfer using
echanical, ultrasound, optical and infrared sensors. Until now, infrared sensors have
hieved the best results.



These sensors mean it is possible to opt for a certain percentage of damaged surface which can be selected as desired. One of the drawbacks is that the blocks have to be completely clean, while one of the advantages is that the quality standards for re-use can be defined as one of the selection criteria.

13. A comparison of the costs

At present, new concrete paving blocks are supplied on site on pallets for a price which varies between:

NLG 16.00	and	NLG 20.00	per m².
NOK 62.00	and	NOK 77.50	
ECU 7.35	and	ECU 9.20	

Costings have indicated that re-used blocks can be supplied grouped on pallets on the same site where they are extracted for a sum which varies between:

NLG 7.00	and	NLG 12.50	per m²
NOK 27.00	and	NOK 48.50	
ECU 3.25	and	ECU 5.80	

including extraction, sorting and cleaning.

14. Half blocks on the street

A working party is conducting a study under this title to determine which savings can be achieved in construction costs if half blocks are used in block-packages when paving mechanically. It is also examining whether elbow bonds with or without half blocks have any significant advantages.
In order to study this, trials are being conducted in four test sections in the Rotterdam port area and, as a result of traffic diversions for another large-scale project, these trial areas have had to cope with heavy traffic on a long-term basis. Various traffic flow and deformation studies have been conducted.
The first results of this study indicate that it is possible to make considerable savings in terms of logistics, labour and therefore construction costs.

15. Recent developments

In the Spring of 1994 there was a first demonstration in Rotterdam of a paving machine based on a totally new concept. This computer-operated machine ensures that blocks from a traditional 'straight package' can be laid in a herringbone bond, layer by layer, across the entire width of a 3 up to 6 m wide road, from mitre to mitre, without using infiller blocks.
Only two people are needed for the operation of this machine, and its present production is 60 to 70 m² per hour!!!
This machine therefore opens new perspectives for mechanical re-paving.
The same manufacturer demonstrated a new grading device, a simple profiling method based on the principle of the 'slip-form paver' used on concrete roads.
This device, which is formed by elements of 100, 50 or 25 cm width, can profile sand very quickly and accurately.

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ing. C.W.A. Geense
Rotterdam Public Works
Road Constructing Department
P.O. Box 6633
3002 AP Rotterdam
The Netherlands

Telephone (+31) 104894310
Telefax (+31) 104897004