DEVELOPMENTS IN MECHANICAL LAYING TECHNIQUES IN THE NETHERLANDS

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SUMMARY

This paper contains a description of the recent developments in the area of mechanical laying techniques in the Netherlands. In the Netherlands much work is done with mechanical installation of block paving because of the soft and settling subgrade soil. Therefore the development of mechanical techniques is highly developed compared to other countries. A further description is provided in section 1 that clarifies the market in the Netherlands. When working on paver installation, time can tell that it is too heavy to continue working manually. The cost of public health and the amount of employee absences are high.

Mechanical installation is developing extensively. The mechanical way of working offers positive prospects. There is a diversity of machines and resources available for automatically paver laying. An important contribution has been provided by the pallets adequate for mechanization. Especially on the field of new paving, there are several mechanical resources available which a few are mentioned in section 2. Reinstallation has not yet been developed to the extent as new paving. But there are promising developments regarding relaying, machines which can lay the used pavers into the street. Looking to the future (section 3) there are many opportunities that can make progress in this area.

The necessity for this change is huge. To make Dutch paving branch healthy, the association VMS exerted much to achieve this. Therefore, collaboration within the whole chain of paving and stimulation of innovations are essential. This innovation seems to be coming. Soon there will be a paver laying robot in the streets of The Netherlands. The use of robot- and mechanical techniques are a development with many perspectives. Time will tell. Filling the gaps for paving is the task for the VMS and therefore for the entire industry.

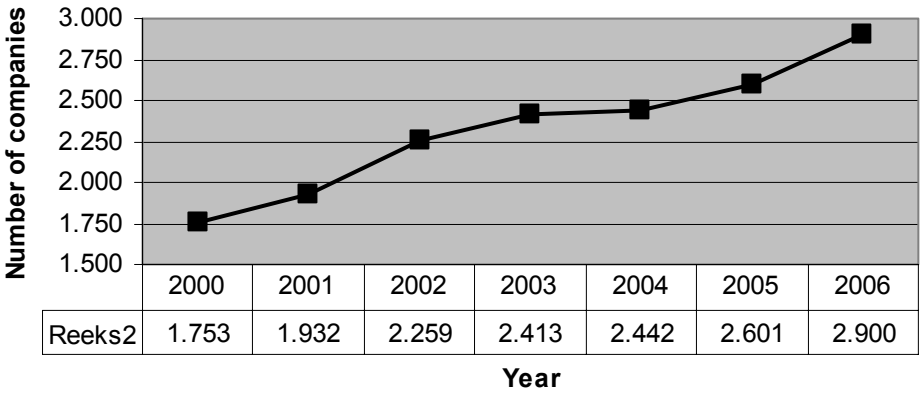
1. The current situation in the paving industry in The Netherlands

Section 1 contains a description of the current situation in the Dutch paving industry. The first paragraph contains a background description of the paving area, followed by an illustration of the working conditions of the paviour and the role of mechanical techniques in paragraph 1.2. Paragraph 1.3 goes more deeply into the mechanization rate of the Dutch paving. 1.4 explains the VMS organization. 1.5 describes the government rules regarding paving.

1.1 Background

Measured at January 2006, there are approximately ± 2,900 paving companies in the Netherlands. The number of companies which have paving activities are increasing rapidly in spite of an economic recession. The main reason is the increase of self-employed people. The amount of companies has increased with 66% between the year 2000 and 2006. Figure 1 shows the exact amount of companies by year.

Figure 1. Number of paving companies in The Netherlands



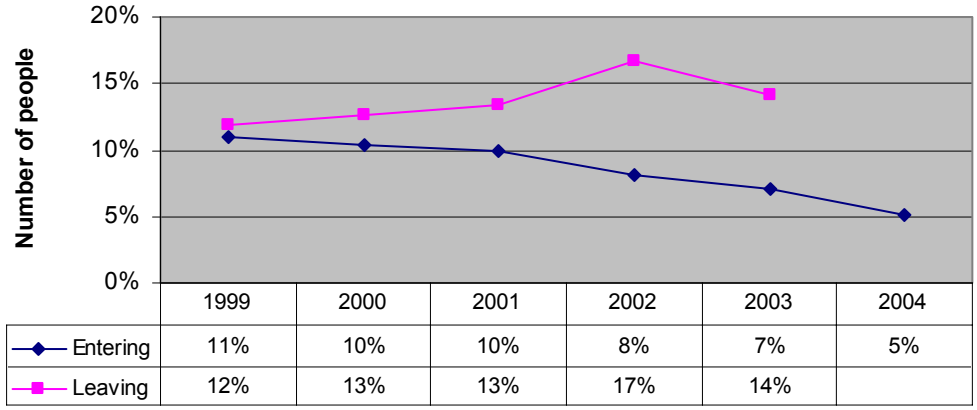
The small and medium-sized businesses character of the paving specialty is very high and it has a small business scale character. 57% of the paving companies are one-man businesses. 95% of the companies have less than 10 employees. An interesting fact is that there are no companies with more than 100 employees. 80% of the employees have an age of less than 45 years old, measured in September 2004. More than 20% of the employees are younger than 25.

1.2 Heavy working conditions and mechanization.

The working conditions of the paviour are heavy. Most of the work is done manually. Estimation on the use of mechanization in the paving specialty is around 3 to 10%. However the block paving industry in the Netherlands has made some efforts to lighten the working conditions in the past few years. However, mechanization is still too low especially when compared to other outside industries such as the automotive sector. This industry has turned their process into robotics. There are a few paviours who reach the pension able age without physical problems. This implies that the state is confronted with the costs of many years of non-productivity per average paviour. Some of the physically retired paviours find another job at the office, or as executive or in another industry.

Furthermore the amount of new paviours entering the business began declining after 1999 (see Figure 2). In 2004, the inflow has even declined in comparison with 1999 by 50%! The outflow has decreased in 2004, after a 3 year period of increasing. The inflow balance of the last 5 years is negative, hitting a bottom in the year 2002. But there is still hope for the employers, although there still is relatively more outflow than inflow. The whole construction sector is experiencing this trend. However, the outflow in the paving sector is 2 percent higher than the average outflow in the overall construction sector.

Figure 2. Number of people entering and leaving the Paving Industry in The Netherlands 1999-2004 (in % working paviours)



	1999	2000	2001	2002	2003	2004
Entering	11%	10%	10%	8%	7%	5%
Leaving	12%	13%	13%	17%	14%	

The paving sector is under heavy pressure. Illness and medical expenses are rather high. Compared to the overall construction sector, paviours are absent more often due to physical problems. 25% of the complaints are back troubles and they form the largest complaint group. The rises of several technologies including mechanization appear to have solutions for these problems.

1.3 Mechanization scale

The extent of mechanization is hard to define due to the lack of data. However, we were still able to define it by looking at the sales in paving materials. What is the percentage of mechanized bonds or pallets? This has given us an indication of mechanization within this branch. The demand from the paving companies to paving materials like bricks and paver blocks has declined by almost 25%. This is shown in Figure 3.

However, the sales of mechanized bonds have remained at the same level in the last 4 years. The extent of mechanization has increased slightly in the past few years (Figure 4). This figure reflects mechanical installation of new paver materials with a thickness of 7cm and larger. Processing old paving materials or smaller materials are excluded. Since there are hardly any mechanized processing methods, it seems like the mechanization scale in the entire sector is lower than the estimated 10%. It is estimated that relaying existing paving is done twice as much as new paving. A simple mathematical calculation shows that 2/3 of the work contains relaying. If we pass this on to the extent of mechanization, we presume that mechanization is about 3.3%.

Figure 3. Sale of paving and mechanical materials (bonds) in m2

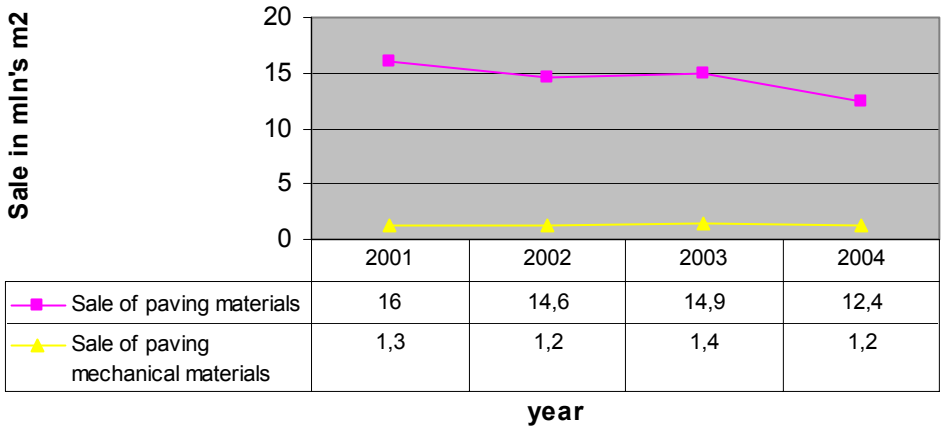
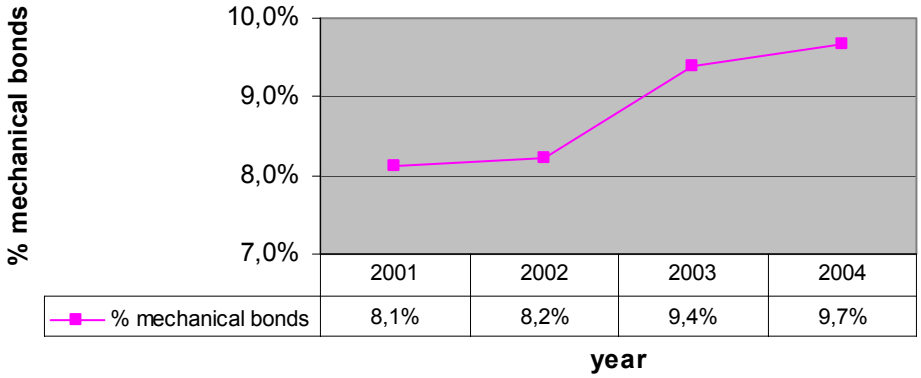


Figure 4. % mechanical materials in sale paving materials



1.4 Association VMS

Founded in 1994 the VMS association has the goal to promote mechanization of the paving process aiming on better working conditions and the well-being of the paviour, i.e., making this sector healthy. The person, the paviour, is the most important. The VMS is a chain directed organisation, meaning that they operate for all the layers and players within the paving area. The current members of the VMS are clients, local authorities, executors, contractors and suppliers of materials and road construction material.

1.5 Government rules

The reaction of the government to improve the working situation for paviours has been to tighten regulations that control the maximum allowed physical workload to which paviours may be subjected. This resulted in the handicraft approach of paving making way to a much more modern approach that ensures better labour circumstances. At the end, this process should lead to much more favourable working conditions for paviours so that more paviours reach their retirement in good health. To achieve this, lifting norms have been determined by the government. These norms limit the weights of materials that may be handled manually in relation to the frequency of handling. Effectively, materials

with a weight of more than 25 kg per person may not be layed by hand. Furthermore, it is not allowed to manually lay blocks with a weight exceeding 4 kg, nor tiles with a weight exceeding 9.5 kg.

The paving industry has focused increasingly on complying with these regulations and limitations. This has led to various technological developments in the field of mechanical laying. In recent years the have been a number of interesting developments.

2. THE MECHANICAL WAY OF PAVING

Section 2 examines the mechanization of the paving process. 2.1 describes what we must and could do in mechanization. After that, paragraph 2.2 will give a further description of the mechanization.

2.1 Mechanization: have to do and should do

The paving sector in the Netherlands has a unique position because of the soft, settling subgrade soil and the history of paving with small element paving. Therefore, development of mechanization seems to be logical. However, regarding the current extent of mechanization, this conclusion has yet no true meaning. On the other hand, we are on the edge of creating a whole new way of paving. The change is upcoming due to a new experiment by the labour expectorate who observes the ways of working. Projects from 1,500 m^2 have to be done by mechanical paving. The labour expectorate is supervising in that matter. This is a development that should cause an attitude in the paving sector that mechanization is necessary. Then the question rises: Is this possible? What are the possibilities of mechanization of paving? This will be next discussed.

2.2 A closer look at mechanization

The first paving machine was developed in 1966. Nevertheless, the use of mechanization was eventually applied in 1979. The early innovator in this development was the City of Rotterdam, one of the biggest clients and processors of paving. Mechanical installation was applied in the early 80's in Rotterdam specifically at the area around the harbour. With the use of mechanization, installation speed was higher.

40 years later, VMS has drawn up the balance sheet and is watching knowledgeably and studying which machines and resources are available. The sector has not stagnated and in there much mechanical installation knowledge has been developed. A survey study was conducted that would enable making changes. Hereafter, a short impression of several information sources follows which have been obtained during this study. The paving market can be divided in two segments: new paving and the reuse of bricks. The machinery is especially developed for new paving. There are several developments that can be named, allocated to their function in the paving process and they will be mentioned briefly.

2.2.1 The supply of paver blocks in bonds

First of all the introduction of the pallet for mechanical laying has been a step forward. By the introduction of this pallet, blocks are now delivered to paving sites in such a bond that they can directly be mechanically laid on a prepared bedding layer. Manual handling of blocks is therefore no longer required.

There are sufficient possibilities from the supplier to deliver the mechanized packages. The mechanized bonds packages can be supplied in several paving bonds for instance 90 and 45 degree

herringbone, stretcher bond, etc. Figure 5 shows the common patterns used in the mechanized packages.

Figure 5. The 90 degree herringbone delivered (left) and paved (right)

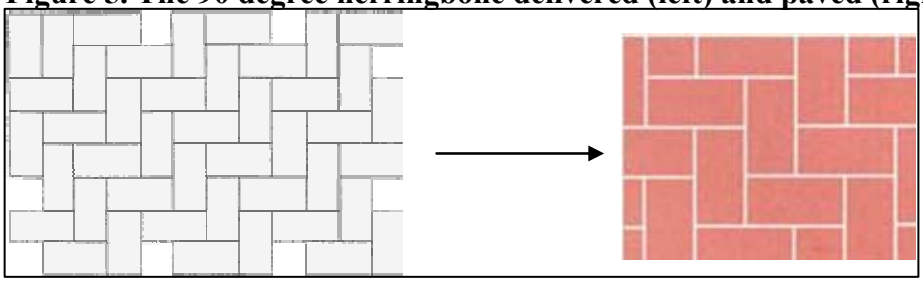


Figure 6 shows the process of mechanized paving. On this photo you can see how the package is laid by a vacuum unit.

Figure 6. Mechanized package processed with a crane and vacuum technique (source www.struykverwo.nl and www.mbi.nl)**.**



2.2.2. Laying of elements

There is a diversity of possibilities for laying the elements into the streets (bricks, stones etc.). The laying systems that are used make use of

- mechanical or hydraulic clamps or/and
- systems that make use of vacuum.

The biggest parts of these systems are pavements that are coupled to a machine. For almost every machine there is a component available. Besides that, there are specific paving machines available where the most of them are capable of laying the elements. The techniques which are used are vacuum and hydraulic techniques.

The specialised machines distinguish themselves for aiming on one or more steps in the mechanization process. These machines also depend on the mechanized paver packages. Figure 7 points out the importance of the packages. Here you can see the paving machine Optimas at work. Its primary function is to lay the pavers. In combination with other elements, this machine is able to fulfil different stages of the paving process. This machine is able to brake open a street, set the stiles, transport the pavers and sand the joints in the street.

Figure 7. The Optimas at work during The Dutch Paviorsday 2006 (source: www.machinaalstraten.nl).



The same mechanical or hydraulic clamps or vacuum systems are used to place precast edge restraints and tiles. In The Netherlands, manual handling and placing of especially the heavy precast edge restraints should hardly occur because it's banned by the government. It has to be done by machines, because it's too heavy to do manually.

The developments in the field of mechanical relaying have not been as extensive as the development in the field of laying new materials. The relaying process is more difficult, because the blocks have to be lifted out of the pavement, cleaned, placed back in the desired bond and finally relayed. However, recent developments have enabled a strong reduction of the physical workload of paviours involved in the relaying process. Such a development is 'The Bricklayer' (Figure 8). With this machine the pallet for mechanical laying is unnecessary, the machine and the paviours are making the bond.

'The Bricklayer' has been developed for working with used bricks and block pavers, but the machine is also able to work with new ones. There are three people necessary for operating this machine. The machine drives itself and is placed on the frame of the trailer. The bricks and paving stones are being placed on the machine by a crane or a shovel. After that the bricks and paving stones will be brought to the paviours. They place the elements in the desired bond. Then the grip arm places the elements on the street. This way of working requires much coordination and planning, but it will lead to better working conditions. Because of the mobility of the machine it is suitable for smaller projects.

Figure 8. The 'The Bricklayer' in action during a demonstration (source: www.vmsnet.nl).



3. THE FUTURE: FILLING THE GAPS

The final section ends with a look at the future and the introduction of the biggest innovation in the Paving Industry at this time: the streeting robot.

3.1 Looking at the future

Section 2 describes the mechanical laying techniques. However, the process of paving consists of 10 steps and each step can be analysed on the degree of mechanisation. This analysis is part of the knowledge study 'The mechanical process of paving,' which was assigned by the association VMS. The purpose of this study is to look at and learn from the past and the present and, because this is the way to look at the future. The big question is what the opportunities and threats exist for the paving industry. The technology is developing. The question is which part the mechanical way of paving will play five years or later from now. As described in section 1, the need for change in the paving industry is very high. The total costs of manual paving are far too high because of the cost of public health and the high amount of injuries, absences and dropouts. Moreover, over the last years fewer people are entering the paving industry. Therefore, the VMS is striving for a (more) healthy industry sector.

To come to a healthier sector, a complete shift is necessary: a change in attitude and behaviour of all players in the paving field. Each player and layer in the chain of paving plays a part in creating a paved street. It starts by the client or assigner, who defines the eventual requirements of the pavement. And the designer and engineer define how these requirements can be implemented into the work and thereby have a huge influence on the way of paving. However, when the paving company is involved into the first stages of the project, the final product will be of higher quality and lower costs. Logical, because the paviour knows the real demands and can directly clarify his possibilities. Cooperation between these different players will lead to the necessary change and to more innovation.

The VMS is taking steps to achieve this shift with the action plan 'On the road to more mechanical paving.' This action plan has resulted in 4 strategies:

- Creating a broad basis for mechanisation within the whole sector and politics.
- Stimulating research.
- Initiate and support innovation;

- Striving to apply mechanical techniques in the education of paviours.

To already give a little taste in how paving can look in one year, a description of the biggest innovation in the paving industry in The Netherlands follows.

3.2 The innovation in The Netherlands: robots.

On March 16, 2006, the Paving Industry was surprised by a big innovation, namely robots that assisting in paving. This revolutionary finding, named 'The Streetwise 1200' was introduced during a branch meeting. In other branches, the use of robots at the production process has become normal, but the use of robots in the paving industry is new.

Founder of this innovation is the company Robostreet. Robostreet makes use of existing, proved and successful techniques from the automotive industry. These techniques are combined and made into a fully automated paving robot. Robostreet has a patent on the machine and expects to market it early 2007.

The Streetwise 1200 is a computerized robot on caterpillar tracks and a robot arm. The robot arm automatically lays the pavements. The machine can be operated by one person. The paviour or operator manoeuvres the robot with a joystick to the starting position. After that, the operator can import all specific data into the machine: the measure of the stones, the bond, the street width, the stone type and more. The robot has a special place in the back for a pallet of stones. By GPS and the so called Vision-system the track can be paved accurate to the millimetre. During the paving process, this operator can work on the street borders. The robot performs the more heavy activities of the paving process, i.e., the transport and laying of the stones. The vehicle lays about 1200 stones an hour, or about 210 m^2 per hour. The robot can also lift the stones out of the pavement. The stones are lifted out one by one and are placed into the storage of the vehicle. This means the machine is also suitable for relaying. The robot is a big innovation, because of three unique aspects in comparison to present techniques. The robot is a:

- A fully-automated system;
- Laying the stones one-by-one instead of laying the stones a square meter at once;
- Imitating the paviour in all ways: the hands by the robot arm and the eyes by the camera vision system.

Finally, the use of robot- and mechanical techniques are a development with many perspectives. Time will tell. Filling the gaps for paving is the task for the VMS and for the entire paving sector.