PAVIOUR: AN UNHEALTHY TRADE ?

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SUMMARY

Statistics show relatively high rates of absenteeism and disability among paviours. Lumbar injuries are the main reason, followed by complaints of the knees and the wrists.
So the question arises: Is paving overstraining?
This question is not new. Although paviours form a relatively small group in the Dutch construction branch (3 to 4% of all employees), the attention for their working conditions has been bigger than for any other trade in construction.
Since 1957 several research projects have been carried out. Unfortunately none of these gives an answer to the above mentioned question; neither were the causes of the health-impairment pointed.
In 1981 this problem again became of current interest. Questions about the reported high rate of absenteeism were posed to the Minister of Labour and Social Affairs by a member of parliament.
At that time, the Foundation for Occupational Health Care in the Construction Industry (BGBouw) had already started a research program. This consisted of the following phases:

I - an inquiry under paviours and their employers in order to map out the problems.
II - an analysis of working postures and a medical judgement of these.
III - an inventory of materials and tools and of the state of mechanisation
IV - an analysis of the cases of early retirement (number, age, reasons).

At this moment, the first three phases have been finished; however, the results show that relatively minor changes in the working conditions could result in major improvements for the health and well-being of paviours.

1. PAVEMENT AND PAVIOURS IN THE NETHERLANDS

As implicated in the name the Netherlands (which means lowlands), most of its soil is a few meters above or below the sea level. Combined with a relatively wet climate, the land used to be soggy during many months of the year. This initiated a very early need for good roads; hence our history in road construction goes back a few thousand years.
Originally the covering of swamp-roads consisted of tree-trunks and wooden blocks. Other roads were paved with rubble stones, later with hewed cobbles and yet later with burnt clay bricks; in the fifties of this century the concrete paving blocks were introduced.

At the moment 33% of the total metalled area in the Netherlands is paved with concrete blocks and 23% with concrete paving-slabs (flags) (most 30 x 30 cm, but also up to 60 x 60 cm). The annual use of new bricks/blocks is 15 x 10^6 m^2 (1980), of which 92% are concrete ones. New paving flags amount 12 x 10^6 m^2 per year and new kerbs 12 x 10^6 m.

The population of paviours and hodmen in 1980 was as follows:

	in private companies		in municipal service		total	
paviours	7.500	60%	appr. 2.000	53%	9.500	58%
hodmen	5.000	40%	appr. 1.800	47%	6.800	42%
total	12.500	100%	3.800	100%	16.300	100%

Table 1: Number of paviours in the Netherlands.

Paving requires a rather high level of education. Many of the above numbered paviours have followed an apprenticeship of 4 years, during which they received both theoretical education and practical training. Usually the hodman is less educated; his task is to assist the paviour and to provide him with materials. However, the bounds between these two trades are not straight and job-rotation between these two is not uncommon.

Most paviours are relatively young, as can be concluded from the following age-distribution:

age	paviours	construction tradesmen
20	19.9 %	9.1 %
20 - 24	24.7 %	16.7 %
25 - 29	15.9 %	16.3 %
30 - 34	15.7 %	16.2 %
35 - 44	14.0 %	22.5 %
45 - 54	5.5 %	13.0 %
55 - 65	4.4 %	6.0 %
65	0.0 %	0.2 %

Table 2: The age distribution of paviours compared to that of other construction workers.

Only 10% of the paviours is older than 44 years while in the other construction trades this is almost 20%. Apparently many paviours retire between their 35th and 44th year of age. At the moment we have no objective opinion of the reasons for this retirement, but the analysis of this is now in progress.

2. BGBOUW

In the Netherlands the construction industry is the branch that shows the highest rate of absenteeism. The resulting expenses and social consequences made, that in 1972 employers and empoyees in this branch together decided to found a national organization for occupational health care: BGBouw.
The execution of the medical care is delegated by contract to 42 independant occupational health centres, that cover the whole country. Each construction worker is free to take the advantages of this care, that consists of a medical entrance examination, periodic examinations from the age of 35, consultings on request and absenteeism-attendance.
Besides, the occupational physicians and nurses visit the construction sites to advice on special problems in the field of ergonomics and industrial hygiene.

Research projects on the specific problems of a trade or on certain health hazard, are carried out by, or by order of the Central Bureau of BGBouw. The aim of these studies is to inventory the occupational health hazards in order to give recommendations for the improvement of working conditions.

3. INVENTORY OF POTENTIAL HEALTH HAZARDS

The aim of this first stage of research was to get a thorough view on all relevant aspects of the working conditions.
A working group was set up to make this inventory. Members were: occupational physicians, an employer and an employee, an expert of the community of Amsterdam, the director of the Paviours Training Institute and two of the staff of the Central Bureau of BGBouw.

Primarily literature was studied and interviews were held with experts in the field of paving. We soon found out, that these sources did not provide sufficient reliable information. So it was decided to held a questionnaire among employees and standardised interviews with employers.
For the questionnaire a random sample was taken out of the paviours who are in service of both private companies and communities. The total sample numbered 1.111 and to those people the questionnaire, supplemented with a letter in which the goals of the inventory were described, was mailed in june 1982.
After six weeks the reactions amounted 499 (44.3%), of which 461 were usable. Excluded were those respondents who said not to be paviours, those who had been unemployed or ill for more than a year, and those who had answered less than half of the questions or who gave so called humorous answers.

The data have been processed at the Computer Centre of the University of Leiden. Frequency-distributions as well as two- and three-dimensional crossings were made.

The 34 questions were classified in seven items:

- working postures
- work-organisation
- materials and tools
- clothing
- environmental conditions
- health aspects
- safety

Below the most relevant findings are described per item; but first the characteristics of the sample of paviours is given in short. Compared to the age-distribution that was given in table 2, the groups under 25, and over 55 are a little too small. Most of the respondents have much experience in paving: 67.5% work in this trade for more than 10 years; only 13% have been a paviour for less than 5 years. The distribution over the two groups of employers (private versus community) is sufficiently according to the actual situation to be able to distinguish effects between those.
One third of the respondents have completed the 4 years apprenticeship; of those who are in service with communities this percentage is far much higher (61%).

Working postures

Three different working postures can be discriminated (fig. 1): the kneeled posture, the stooped posture and sitted on a stool.

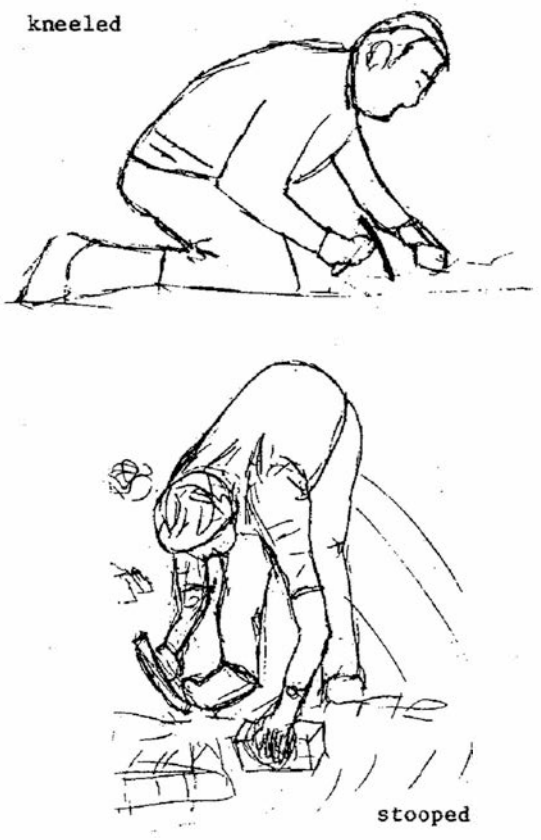


Fig. 1. The three typical working postures of paviours.



sitted on stool

The choice out of these seems to be only impulsed by the region where one has learned the trade. No one else than the paviours of the community of Amsterdam works sitted; in the Rotterdam region all paviours work in the stooped position, which working method can also be found by some of the paviours in the southern part of the country. Everywhere else paviours are working in a kneeled posture.

More than half of the respondents (54%) works only as a paviour, while the rest rotates jobs more or less with the hodman; in this group there are relatively many younger paviours. This method seems to be growing; from the occupational health view the alternation of different tasks is a favourable development.

Organizational aspects

In the Netherlands we have two methods for the laying of bricks: the traditional craft method resp. the "laying down" method. In the first, each brick/block is laid seperately in a not prepared sub-base of sand and then hammered in to the required level. With the second method blocks are laid down on a compacted sand sub base. 85% of the Dutch paviours are always applying the traditional craft method.
The placing of gullies for the discharge of rain forms part of the task of 56% of the respondents.
Half of the paviours have the opinion that the work-pace is too high. This has become worse during the last few years.
Although the question of usual production rates gave answers of a wide range, a mean of appr. 80 m^2 per working day seems to be reasonable for new works with concrete blocks.

Materials and tools

The results of these questions will be presented in paragraph 5, together with the results of that part of the research program.

Clothing

Most of the paviours wear clothes according to their own choice. Usually this consist of trousers, shirt and sweater. Over-alls and other kinds of occupational clothing are not very often worn. However, 44% of the respondents say to be interested in a special suit for paviours, provided that this is supple, strong, warm, easily washable, and waterproof.
A disadvantage of the trousers-shirt combination is that in the bended posture, that is applied by all paviours, the lumbar part of the body becomes naked and this will cool down easily. This plays a role in the cause of lumbar injuries.
Only a little less than half of the respondents are usually wearing a long undershirt, which can prevent the mentioned negative effect. In this group relatively many persons have back complaints, which can be explained by: "one takes no good care until the complaints have already occured."

Environmental aspects

The answers to these questions show that rain, humidity, cold, noise and exhaust gases are frequently a nuisance for paviours.

Health aspects

The results of this part of the inquiry are also based on answers to questions only. The most important one was:
"Did you ever have an illness or complaints that -in your opinion- had been caused by your work as a paviour? If so, which were the complaints?"
Almost 80% of the persons answers yes to this question. The scores were as follows:

shoulder or neck	5.8%
back	58.5%
arm, elbow	4.2%
wrist	16.8%
knee	24.7%
miscellanious	11.9%

Table 3. The most mentioned health complaints/illnesses

The back-, knee- and wrist-complaints are positively correlated with age, but even stronger correlated with the length of the period during which one worked as a paviour. So, there is a significant work-effect on these complaints.

There is no difference in the prevalence of back-complaints over the three typical working postures. This point will be discussed further in par. 4.
Wrist complaints are found twice as much by the stooped workers; knee-complaints occur mainly by kneeled-working paviours.
The alternation of paving and working as a hodman, seems to have a positive effect when considering the prevention of back-complaints. This may be effected by different loads on groups of muscles.
Paviours that usually do not place kerbs show half as many back-complaints as those who are used to work with these!
The concrete paving slabs of medium seize (40x60 to 60x60 cm) show the same effect.

Safety

18% Of the questioned paviours say to have had an accident in their work. Although the question is not formulated to give detailed results, this percentage is quite low in relation to other trades in the construction industry.
Foot injuries, caused by faling objects and hand injuries due to contusion or inaccurate strikes are the most mentioned causes of accidents.
Only 2 paviours (out of 469) reported accidents with traffic (apart from travelling to and from the work).

Conclusions on the basis of the inquiry

The high percentage of paviours that responded to the questionnaire and the quality of the answers that were given, show a keen interest in the working conditions of this trade. It was remarkable, that the opinions of employers and employees are very much the same.
As causes for the job-related health hazards, paviours and their employers point particularly to the heavy materials and the tools. For the future some of them expect that mechanisation will bring much progress in working conditions.

4. WORKING POSTURES

As is stated in the summary, since 1957 several reports have been published about the work and working conditions of paviours. Most of these deal more or less with the matter of the work- ing postures.
As a first step in this part of our reserach program, we made an analysis of these publications. We concluded that comparisons of the advantages and the disadvantages of the three typical postures have been made a few times, but there were always reasons to decide that no conclusions might be drawn.
So we decided to take up this question.
Firstly we commissioned the "Stichting Arbeids- technisch Onderzoek Bouwnijverheid" (Foundation for Work Analysis Studies in the Construction Industry) to make time and motion studies of paviours, extended with a description of the applied movements and postures. These formed the basis for a medical assessment of the pos- tures. This assessment took place in three phases; two two-headed teams (an occupational physician and a physical therapist, resp. an orthopaedic surgeon and an ergotherapist) made reports, irrespective of each other. They both had a different approach; the first group concentrated itself on the effects of a specific posture or movement on parts of joints, while the second group paid more attention to the posture on the whole and the coherence of the loads in the different joints.
These two reports were compared and summarized by one of the top-experts in physical load in the Netherlands.

Results of the postural assessment

Several findings of this study consist with the results of the inquiry. However, before drawing any conclusion, one has to consider that up to now only little is known about the long term effects on the human body (or joints) of rather unilateral movements, which are not overstrain- ing on short term.
The following conclusions have to be viewed in this light:

- Although none of the three postures that paviours apply are ideal, it is uncertain, that the big number of lumbar injuries of paviours are caused predominantly by the placing of bricks.
- According to the present insights, none of the three postures is unacceptable in view of the potential health impairment.
- None of the three postures is more favourable than the others.
- Backcomplaints seem to be mainly caused by the handling of heavy materials. These are especially the kerbs, and the gullies, that have to be placed with bad working postures. For the handling of these a (mechanical) solution has to be found.

5.MATERIALS AND TOOLS

In the third phase, the working group made a study of the materials and tools used by paviours.

Permissable loads

On the basis of our inquiry, of many publications and of our medical assesment, can be concluded, that paviours have the opinion that the heavy load of many materials is the biggest problem in their work. So it is understandable, that paviours would like an official limit to be issued for the weight of loads that have to be handled manually.

Before going into the matter of the paving materials, it is necessary to give our view on permissable loads. It should be stated first, that the succesfull introduction of such permissable loads for paving materials will only solve a part of the problem. About 60% of the paving work in the Netherlands consist of repavement of the present material. So only on the longer term we may expect a positive effect of the devellopment of less heavy materials.
A second consideration is the chance that such a limit will give succesful results. It remains to be seen if it is econmically and technically possible, to lower the weight of a large number of materials.
The third point are the limit values themselves. A study-group of BGBouw has considered this point and concluded that the scientific knowledge about the relation between external load and the risk of getting lumbar injuries (or complaints) is yet unsufficient to draw up a definite set of permissable loads. However,

to attain at least some progress, we established tentative directives, which can be adjusted when scientific progress gives reason to do so. These directives consist of a table in which is discriminated on the basis of sex, age and lifting frequency. Besides, the study-group decided that the working conditions in the construction industry differ so widely, that these have to be considered. So in the table for each combination of sex, age or frequency two values are given: one for ideal conditions and one for aggravating conditions. The conditions are assessed on the basis of the qualities of the floor, the load, the climate, the task and the lifting stretch.
It can be imagined, that the application of these directives in a specific situation, demands some knowledge and skill in the field of ergonomics. Just look at the situation of the handling of a wheel-barrow loaded with sand on a pavement, compared with paving of concrete paving slabs of 60 x 60 cm. This example will illustrate that many different values for permissable loads are required. Consequently, in this paper no concrete limit values are given.

Materials

There is a wide choice of paving materials. The quality demands on which these are designed are mainly of economical, technical and aesthetical kind. The qualities in the sense of easy to handle seem to be of minor importance. In this paragraph this aspect is especially worked out.

When we consider the assortment of paving materials on this item, it can be split up in the following groups:

- small elements (bricks and blocks)
- concrete paving slabs (flags) (30x30 cm)
- concrete paving slabs medium seize (40x60 to 60x60 cm)
- kerbs
- gullies
- various materials

Small elements

Although there are relatively little complaints about the bricks and the blocks, there are some seizes that give problems. The blocks with a height of 9 resp. 10 cm are considered to be too heavy. Some paviours have difficulties with the grip of the blocks of 22 x 11 cm; they are too wide. Besides, there were some complaints about the roughness or the sharpness of this material.
The hammers that are applied to pave these with, hardly give any problem.

Small concrete paving slabs (flags)

(30 x 30 x 4,5 to 8 cm)
There are only a few remarks that the slabs with a height of 8 cm are too heavy.

Medium seize concrete paving slabs

These slabs are finished as an decorating flag (gravelled surface) or with a conventional concrete surface. The application of these slabs seems to be growing, especially for pedestrial areas. The placing of these slabs is done by hand, sometimes with a simple tool (fig. 2). The mean production is 80 m^2 per day.
There are very many complaints about the weight and the dimensions of these slabs.

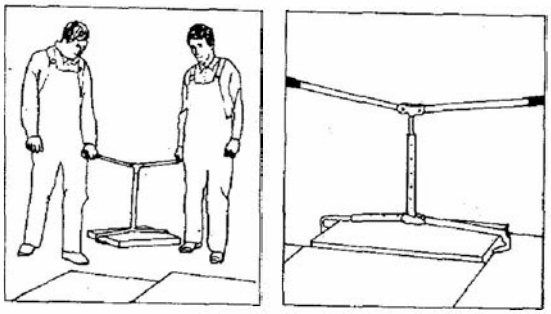


Fig. 2. A hand-tool for the laying of medium seize concrete paving slabs.

Kerbs

In this group there are several materials, like the kerbs, the taper kerbs, the dropped kerbs, edgings, etc. (fig. 3).

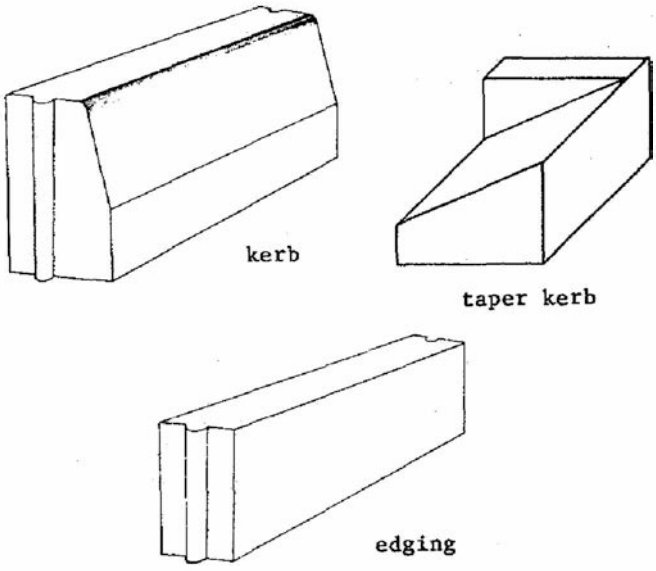


Fig. 3. Different kinds of kerbs.

The weight of kerbs goes up to 115 kg; the taped kerbs weigh even up to 145 kg. Per working day 60-80 m of kerbs are placed. Our inquiry showed that 64% of the paviours have objections to the materials of this group; they are considered to be too large, too long and too heavy. These objections are supported by the finding that half as many of the paviours that do not handle kerbs, have back-complaints, compared to those who are used to place them.

The lifting-grip with which the kerbs are placed (fig. 4) is not adequate: the tips wear out too quick, which can result in a falling kerb with all possible results as jammed toes, etc.

Gullies

Gullies are placed in pavements to drain the rain. The paviour places them, adjusts them on the right height and connects them to the sewage.
These concrete gullies are often placed by hand; they are difficult to handle and in connection to this there are quite some complaints about their weight.

Various materials and tools

This group consists of many different materials, like those shown in fig. 5. Many of these are hard to handle and very heavy. Working with these is incidential. For some of these adequate tools have been developed.
Relatively few of the tools that paviours use, give problems. The knee-protectors however, are often not good enough. As many paviours suffer from knee-complaints, good knee-protectors are very important.



Fig. 4. Paviours handling a kerb with a lifting grip.

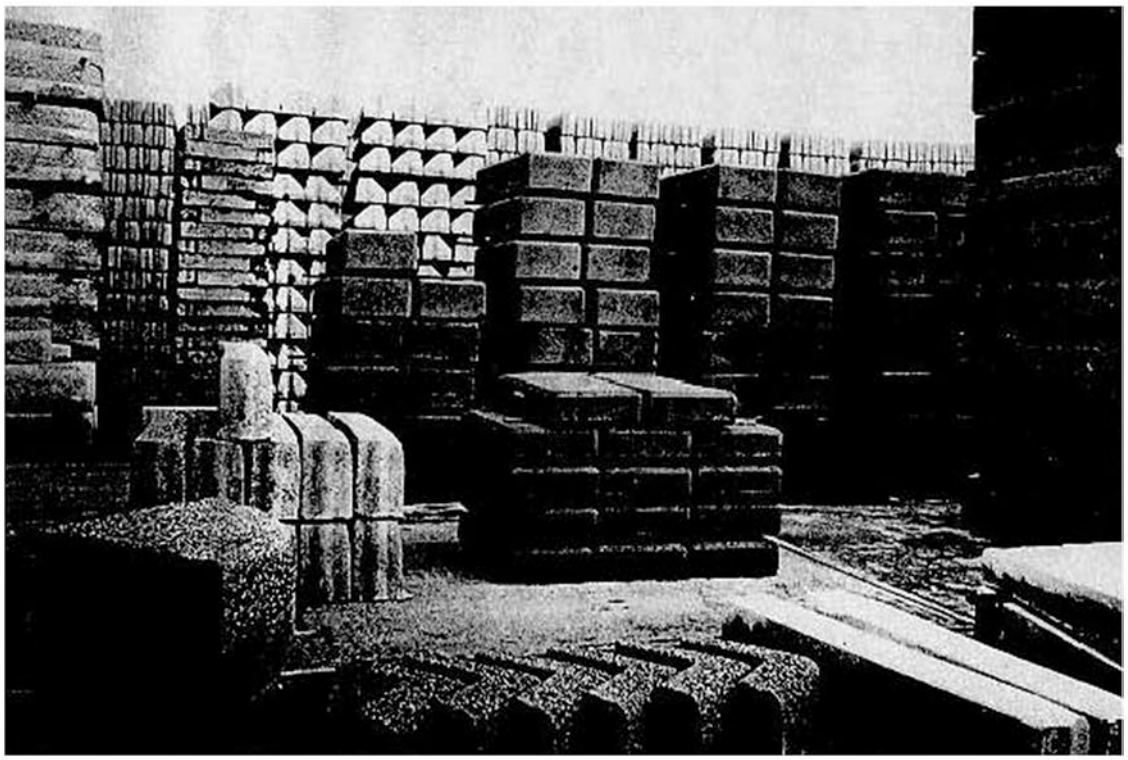


Fig. 5. Various materials in storage.

Mechanisation

Since dozens of years efforts have been made to mechanise paving. In short, the state of the art will be described for each of the material-groups.

Block laying

For this two ways of mechanisation can be discriminated: mechanised handwork, resp. full mechanisation. Since some years there is attention for a block handling device that is developed in Germany. This device has twoo wheels (figs. 6 and 7) and a package of bricks can be taken from the pallet in bond. Next the paviour moves the device to the intended place where the blocks can be placed into position. So there is no handwork between the production and the placing of the blocks. At the moment this device is in use at some sites. The most efficient use seems to be on large areas without disturbances of the paving-pattern. The price of the device is about Dfl. 4,000.

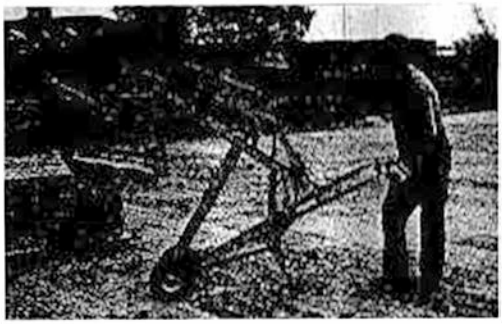




Fig. 6 and 7. Block laying device.

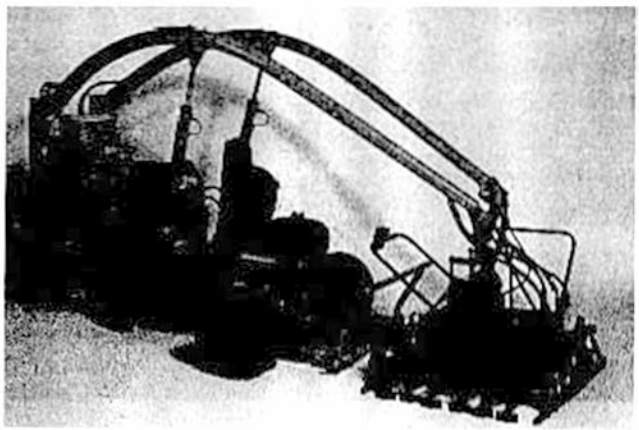


Fig. 8. An example of a block laying machine.

For full-mechanised paving some machines are available (fig. 8).
In principle there is much resemblance with the formentioned device. The difference is that the paviour sits on the selfpropelled machine. The initial expenses are in the order of Dfl. 50,000.=

The effective production of the two types of mechanisation is roughly the same; but with the hand device three men are needed, while with the selfpropelled machine two men are sufficient.

The placing of concrete paving slabs

For the placing of the small size concrete paving slabs no mechanical aids are needed. For the large ones a device on wheels is designed and tested (fig. 9). This is operated by one man. The slab is picked up in vertical position from a package consisting of 15 - 22 slabs. Next the paviour moves to the intended place over the area that is already paved. By lifting the device a little, the slab turns over, after which it can be positioned. A valve in the hydraulic system can be operated by a lever, after which the slab is released. This device amounts to appr. Dfl. 7,000.=.

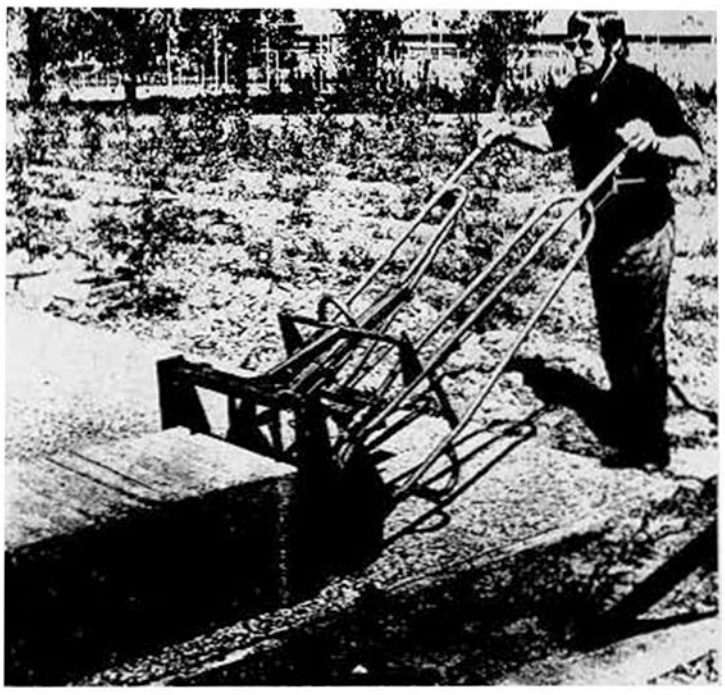


Fig. 9. Device for the laying of medium seized concrete paving slabs.

The placing of kerbs and gullies

As far as we found mechanisation of this work has never been praticed. In a German journal an advertisement for a simple device on wheels was inserted; however the dealer did not react on a request for further information.

Sometimes a tripod hoisting windlass is used to place gullies. The problem remains that the gullie has to be placed nearby the windlass, which will often be handwork. Besides, the productivity of this method is not very high.
Another possibility is to place these elements with a small-wheel loader, which is sometimes on the site to transport sand, blocks, etc. But also this method often includes much physical effort.

For the development of a mechanical aid for the placing of these materials, three lines could be followed:

1. a self-propelled machine, that is specialized for the placing of kerbs and eventually gullies;
2. a self-propelled multi-purpose machine, that can be provided with various accessories and tools, for transporting, leveling, earth moving, etc. and also for the placing of kerbs;
3. a simple device on wheels as is described in the text about the medium seized paving slabs.

One can expect that type 2 will give the highest chance of succes.

Conclusions concerning materials and tools

Concrete paving blocks with a height of 9 or 10 cm or with a width of 11 cm should not be placed in handwork.
The medium seized concrete paving slabs shall be placed with a mechanical aid. The existing device is adequate; in small works the handtool (as shown in fig. 2) can be an acceptable alternative.
The development and introduction of a proper tool or device for the placing of kerbs, edgings and gullies should have highest priority.

Even when this problem is solved, the lifting grip will incidentally be used for the placing of kerbs. That tool has to be redesigned so that the kerb cannot slip out of the grip and that the paviour can lift with acceptable postures.

The weight of many paving materials should be decresed, or increased to a level that paviours will automatically look away from handwork.

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