THE HUMAN ASPECTS OF CONCRETE BLOCK PAVING

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SUMMARY

This paper traces the history of block paving in the Netherlands and, amongst others, the appearance of paving with concrete paving blocks. Besides manual paving and the methods and means used (blockpaving with a street hammer and ordening of the elements), a description is given of the developments of mechanical paving. The latter also as a result of the negative influence of the working conditions (such as the working posture, the weight to be handled and the climate) upon the paviour's health.
The Dutch quality standards of block paving require a thorough and proper training of the paviour. In the Netherlands, such training is given in the form of modules. The content of each module will be presented together with the manner in which theoretical and practical training take shape in the Netherlands.

1. INTRODUCTION

In this paper the following points will be discussed:
- The history of blockpaving in the Netherlands;
- The hand methods of paving;
- The paving conditions;
- The use of materials and tools;
- Mechanical paving;
- The need of good-innovated-training.

2. THE HISTORY OF BLOCKPAVING IN THE NETHERLANDS

The Netherlands has a long history concerning open pavements. Generally an open pavement consists of a number of elements (stones, bricks), which are put next to each other, creating a gap. This gap is called a joint. In ancient times already, roads were paved with boulders and erratic blocks. This changed however in 1176, when in Middelburg, as a result of a committed crime a man was sentenced by the government to lay "40 Zeeuwse roeden tichelbestrating" (40 Zeeuwse rods of tile paving). This meant that the man had to walk from Middelburg to the river Schelde, cut tablets of clay, spread these to dry and then bake them in a field oven. After baking the tiles he had to carry them to Middelburg and lay them in front of the Town Hall, being watched by the bailiff.
This was the initiation of the paving brick, which is still used in the Netherlands to pave roads. The Netherlands is very suitable to fabricate the (burnt) paving brick, as the raw material river clay, was and still is readily available in the forelands of the rivers "Rijn", "Maas" and "Waal". River forelands are strips of land which during winter time are flooded as a result of the increased water level. The clay particles, which are available in the water, settle down on the forelands. In the earlier days the clay was first digged off and then manually shaped to rectangular elements, dried and baked in a field oven. Of course the dimensional accuracy of the bricks fabricated in this way was not very stable. Today the production process to fabricate (burnt) paving bricks has been mechanized and automatized considerably.
Thanks to these improved production methods the dimensional stability of the (burnt) paving brick is much

better now.
This history explains the feet, that in the Netherlands mainly rectangular stones are used, without any profile at the sides.
Due to various reasons the use of (burnt) paving bricks is reduced after the second World War.
After this war, pavement material was sparingly available. After the fifties the post-war reconstruction of the Netherlands involved construction of many roads. The brick industry could not meet the demand. This was a reason to look for an adequate alternative, which was the concrete paving block, developed at that time.
The shape of the concrete paving block was based on the rectangular shape of the (burnt) paving brick (brick size).
The concrete block, which was new in the Netherlands, very quickly swept a part of the Dutch market In new built cities, such as Lelystad and Almere, and in the industrial areas and port areas, such as the Europe Container Terminal yard at Rotterdam, concrete paving blocks were, and still are used.
Apart from that also for special projects, such as for example the Rhinebridge yard at Arnhem, concrete paving blocks are used. This project, initiated with black and white concrete blocks, symbolizes the disappeared harbour at that location.
The breakthrough of the concrete block on the Dutch market is also caused by its dimensional stability. This dimensional stability of a concrete block is better than the dimensional stability of a (burnt) paving brick.

3. THE HAND METHODS OF PAVING

In the Netherlands up to the middle of 1980 blockpaving was almost carried out by hand only. For manual blockpaving in Holland three working postures can be distinguished, being:
- the kneeling working posture;
- the sitting working posture;
- the standing working posture.

These working postures will be briefly discussed in section 4.1.

For manual blockpaving two methods will be discussed here:
1. element application using a street hammer;
2. ordering of the elements.

3.1 Element application using a street hammer.

In the Netherlands almost all blockpaving, carried out by means of a street hammer, is laid on a sand bed. If a street hammer is used, the paviour is located in the sand bed. In that case the sand bed is roughly finished below the profile and compacted by means of a vibrating roller or vibrating plate. After that the paviour lays the "hoogtestenen" (benchmarks, placed perpendicular to the road axis) and "naaldstenen" (benchmarks, placed parallel to the road axis) and finishes the sand bed at the correct level, together with his assistant. The "hoogtestenen" en "naaldstenen" are benchmarks to indicate the correct elevation of the blockpaving to be applied. The paviour then equalizes the sand bed surface by means of the street hammer and lays the block against a previously placed element. He then knocks the block down with the street hammer to the correct level. Knocking the block into the sand bed, the paviour must make sure that the bottom of the block is resting on the sand bed at all points. This means that below the block there may be no cavities in the sand.
On top of that the paviour shall pave the block leveled (below one line) into the sand bed. Since the paviour sometimes hits the block near the edge, there is a good chance the block is slightly sloping. Then we say the block is not settled well. The block also shall meet the direction of blocks laid before. With this

method the sand bed below the applied blocks does not have to be finished accurately. He therefore levels it with the street hammer.

3.2 Ordering of the elements.

Ordering of the elements means laying the elements on an accurately finished sand bed profile. During manual ordering of the elements the paviour is sitting, standing or kneeling on the elements ordered before.
That means, he does not use a hammer during the ordering of the blocks. The sand being accurately finished under profile, will prevent the occurrence of cavities below the block.
Since the ordering paviour does not knock the block into the sand bed by hammer, it normally will rest leveled on the bed.
The methods mentioned above are used for paving bricks as well as for paving blocks.

4. THE PAVING CONDITIONS

During paving, either by hammer or without, the posture and the weight to be handled determine the loads, which the body is exposed to. Besides, as far as muscular complaints are concerned the climate is also of influence.

4.1 Posture during work

As mentioned before in Holland the paviour, paving by hand, either with a hammer or without, performs his job, kneeling, sitting or standing. In areas, where in the past mainly heavy flag stone had to be handled, ihe standing posture was commonly used.
Working this way, certain parts of the body are overloaded and due to this, many paviours have physical complaints at a relatively early age.
During the kneeling posture most of the paviours get knee complaints. The sitting posture causes stomach complaints and the standing posture usually leads to back complaints. On top of that all working postures mentioned before are a source of complaints as far as the wrist and shoulder joints are concerned.

4.2 The weight to be handled

If a right-handed paviour is laying concrete paving blocks (block size, 80 mm thick), he carries a street hammer of approx. 2.5 kgs in his right hand. With the hammer he knocks approximately four times on each block and lifts the hammer about 150 mm at each knock. He then picks up the block with his left hand. The weight of a block is about 4 kgs.
The daily production of a paviour is about 80 sqm, in which case the number of blocks is 44 per sqm. This means that a paviour moves about 14,000 kgs with his left hand and lifts about 35,000 kgs to a height of about 150 mm every day.
This gives an idea of the load, which is working on the body during manual paving, either with or without a hammer, apart from the physical load as a result of the working posture.

On top of that other elements, which are required for road construction, such as concrete kerbstones (edging), special stones for drive ways etc. and catch basins bring in (too) much weight, literally as well as figuratively.

4.3 The climate

The climate in the Netherlands causes many muscular complaints for those who are actually involved in road construction.

5. THE USE OF MATERIALS AND TOOLS

The present traffic, putting continuously higher demands to the construction of roads, the size of materials to be applied is increasing simultaneously. An important disadvantage is the fact that the weight of materials to be applied is also increasing. It causes problems during the material handling. On the long term the load of those materials, influencing the human body, may well cause considerable damage and human sorrow. In the Netherlands the use of these materials is disputed during some time already.
Taking the development of the present traffic into account, however, a decrease in weight of the materials to be used is not likely on a short term.
The Dutch "ARBOUW"-Committee is occupied with the research and information concerning the improvement of the working conditions of the individual road construction worker. On top of that, this Committee develops and stimulates the development of resources which lead to more human activities.
Thanks to the work of this Committee the people concerned in the Netherlands do realize that the application of mechanical equipment has to be stimulated. In this matter the Committee mainly supports the developments as far as mechanical ordering of paving blocks is concerned.

6. MECHANICAL PAVING

Apart from other problems, by the middle of 1980, the designers of Europe Container Terminal industrial yard at Rotterdam were facing the following problems: a subsoil, being sensitive as far as settlement is concerned, a relatively large surface to be paved and concentrated loads on the pavement (by parked containers). Consequently blockpaving with concrete paving blocks was chosen. The concrete paving blocks had to be laid on a sand and cement stabilisation base.

This choice was made since concrete paving blocks were readily available on short term and in the required quantities, and also because concrete paving blocks meet higher requirements as far as dimensional stability is concerned.
Besides in Holland concrete paving blocks are considerably cheaper than (burnt) paving bricks and also available in higher quantities. Taking the size of the area into account (50 ha) and the period of time in which the blockpaving had to be constructed, a mechanical ordering machine was developed. This machine consists of a hydraulic excavator equiped with a blocks clamp.
Apart from all the thinking for the development of this excavator, together with the supplier of concrete paving blocks a new method had to be found to pack the concrete blocks, to be used by the ordering machine.

Although during construction a lot of experience had to be gained, the dimensional stability of concrete paving blocks has considerably contributed to the fact, that from the very beginning the paving of this area did meet the requirements of blockpaving.
As for manual ordering of concrete paving blocks, the accurate "on level" preparation of the sand bed for mechanical ordering is a must as well. Taking the pavement requirements of todays traffic into account, the pavement structure of a new road or the reconstruction of an existing road preferably consists of the following parts:

1. the subgrade;
2. the (sub-)base;
3. the street layer (bedding sand layer);
4. the block layer.

Since the bedding sand layer for mechanical ordering shall be accurately leveled, the (sub-)base profile shall meet certain requirements as well. Big deviations in this profile require extra attention and as the case may be, an alternative finishing.

As a result of the social changes mentioned before and due to the need to construct roads in an economically representative manner, mechanical ordering of concrete paving blocks in the Netherlands experiences a boom.
Although not fitting within the objectives of this conference, it is reported that at the moment in Holland tests are carried out with mechanical ordering of paving bricks. The first results are encouraging.

7. THE NEED OF GOOD-INNOVATED-TRAINING

The "Stichting Beroepsopleidingen Weg- en Waterbouw" (Institute for Vocational Training in Civil Engineering) takes care of a number of civil trainings. One of these training is the Paviour Training. The Paviour Training is developed in the thirties by a number of big cities in the Netherlands. In 1940 this training has been taken over and standardized by the Institute for Vocational Training in Civil Engineering and at the end the successful trainee receives a nationally recognized certificate. In this way a class training for young people was started. For elder people a correspondence course was initiated, in co-operation with an institute for correspondence courses. Elder employees had to meet practical experience requirements.

This initiation of nationally standardized courses has been the basis for the present skill of the Dutch paviour.

To adapt to the modified conditions the Institute for Vocational Training in Civil Engineering has established a modified course. This course pays ample attention to recent developments as far as mechanically ordering is concerned. The training is composed of a practical and theoretical part.

7.1 Theoretical training

To attend the theoretical part the trainee is visiting school one day a week.
This theoretical training consists of the following modules:
1. Assistant paviour and Edging;
2. Road paving;
3. Profiles and block patterns.

A short summary of each module and of the way the trainee is instructed (in practice) is presented.

7.1.1 Assistant paviour/Edging

This module involves the most frequent basics. In theoretical issues actual situations are discussed, using detailed drawings. The advantage of this method is the near approach of actual conditions. In a theoretical issue he becomes familiar with a number of aspects, such as:
- safe and healthy working conditions;
- determination of direction and level of edgings;
- properties and characteristics of materials used by him;

- ergonomically well considered handling of tools and equipment;
- correct site distribution of required material;
- required working measures to meet environmental standards;

7.1.2 Road paving

In this module the involved definitions for the assembly and construction of the road body, which the trainee needs, are discussed. Besides, the module deals with the various paving structures. This module also includes a number of theoretical issues, with detailed drawings, involving a number of actual aspects again.

7.1.3 Profiles and patterns

This module deals with cross profiles, which are commonly used in road construction in the Netherlands. Using the means mentioned before the trainee is made familiar with the differences among these cross profiles. He also learns how to calculate these profiles and how they must be plotted:

a. stretcher bond;
b. "keper" bond (herringbone bond - blocks 45° to road axis);
c. "elleboog" bond (herringbone bond - blocks parallel and perpendicular to road axis);
d. basket weave;
e. diagonally paved stretcher bond.

He also learns how to make blockpavements in a quality-wise representative manner, taking the various properties and characteristics of materials into account.

This module spends much attention to the importance of the finishing of blockpaving which includes the final sand spray on the blockpaving, brushing the sand into the gaps to fill the joints and vibrating the blockpaving.

7.2 Practical training

For practical training purposes a task book has been developed for each module, to provide the training with the desired structure.

The trainee practises under normal working conditions. On top of that the trainee gets an additional practical training during periods that no work can be carried out, due to bad climatological conditions in Holland. This additional practical training is given in a covered and heated room. The trainee then practises the basic skills he needs. With this kind of exercise the trainee develops the degree of mastership he needs for his work in a relatively short period of time.

7.3 Examination

Each module, the theoretical part as well as the practical part, ends with a final test. After successfully passing the test, the trainee receives a certificate. After having obtained all certificates involved, the trainee can exchange these for a nationally recognized diploma.

After having passed this training the trainee has a choice out of several follow-up courses. The Institute for Vocational Training in Civil Engineering keeps track of the developments on mechanical ordering of elements and the courses will be updated wherever necessary.

It is strongly believed that such a training is not required in the Netherlands only. This training is important for every country, which by means of blockpaving aims for an infrastructure, allowing fast and safe transport of people, raw material and goods. Hie implementation of the plans for the desired infrastructure requires qualified, thoroughly trained people. In our stand, Holland - and especially our Institute - will be pleased to render additional information about the contents and types of our educations.