FIELD TEST ON CONCRETE BLOCK PAVEMENTS: INVESTIGATION OF LOAD DISTRIBUTION CAPACITY

MATTIAS WAPPLING, M.Sc., PH.D. STUDENT, DEPT. OF STRUCTURAL ENGINEERING, ROYAL INSTITUTE OF TECHNOLOGY (KTH)
SE-100 44 Stockholm, Sweden
TEL: + 46 8 790 7946 FAX: + 46 8 21 69 49
E-Mail: mattias.waeppling@struct.kth.se
JOHAN SILFWERBRAND, PROFESSOR, DEPT. OF STRUCTURAL ENGINEERING, ROYAL INSTITUTE OF TECHNOLOGY

ABSTRACT

During 1997, a survey of Swedish concrete block pavements was carried out. A series of FWD tests were performed and clear indications of differences in load carrying capacity due to differences in edge restraint were recorded. During the autumn of 1998, a test pavement was constructed. The objective of the test pavement is to examine the load distribution and how it varies dependent on the choice of edge restraint, their anchorage and curvature of the pavement. Also the influence of various bound base-layers will be studied.

The deflection is measured at various depths of the pavement foundation. A total of 60 sensors are measuring both static and dynamic deflections in the base and sub-grade. The permanent rutting is also monitored.

1 INTRODUCTION

Concrete block pavements have good load carrying capacity and load distribution ability. The concrete block pavement is durable, insensitive to settlements, and easy to repair, bright and aesthetically attractive. It has therefore frequently been used in urban environments. In Sweden, however, concrete block pavements have been less frequent than in other comparable European countries. There are, however, signs indicating an increased amount of concrete block pavements among new Swedish roads.

Swedish as well as international experiences show that modern concrete block pavements perform satisfactorily. The analytical base for design is, however, limited. Consequently, improved design methods based on increased knowledge of the structural behaviour of concrete block pavements constructed according to current practice are important.

LI Background

During 1997, a survey of Swedish concrete block pavements was carried out. A series of Falling Weight Deflectometer (FWD) tests were performed and clear indications of differences in load carrying capacity due to differences in edge restraint were recorded. To further increase the understanding of the structural behaviour of concert block pavements, especially concentrating on how edge restraints contribute to the load carrying capacity, a

test pavement was constructed during the autumn of 1998. The objective of the tests is to examine the load distribution and how it varies dependent on the choice of edge restraint, their anchorage and curvature of the pavement. Also the influence of various bound sub-base-layers will be studied.

2 TEST PAVEMENT

2.1 Specification

The test pavement is located at the entrance of a precast-concrete factory and is thus subject to heavy traffic from transports to and from the plant (see Figure 1). The factory is located in Uppsala, 80 km north of Stockholm. The subgrade consists of clay. The test pavement spans a length of 70 m with two driving lanes (each 3,5 m wide), so totalling 490 m^2. The concrete blocks, simply called pavers, were chosen rectangular for simplicity and were lain in a herringbone pattern. The pavement is divided into five equally long sections with varying base layers and varying curvature of the surface. By using the symmetry of a road-section, different anchorage of the edge restraint is tested. In total, nine different cases are studied.

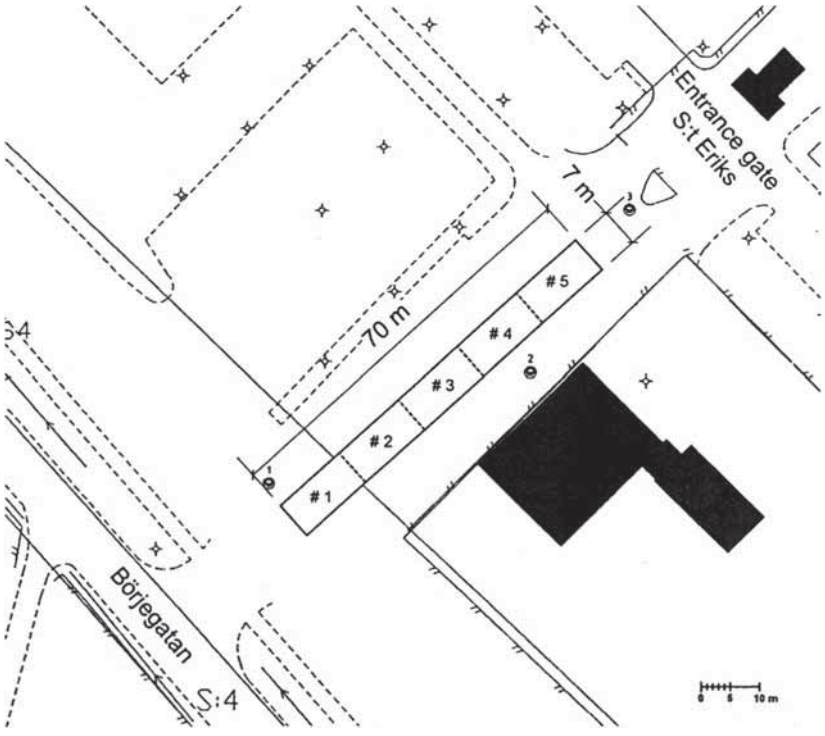

Figure 1: The test pavement is located at the entrance of a precast-concrete factory (S:t Eriks). All traffic to and from the plant is directed in such a way that all transports passes over the test pavement.

2.2 Test variables

The pavement primarily consists of four layers. A sub-base that is equal for the entire pavement, a base layer that either is comprised of a stabilised material in combination with gravel (as in Figure 2, below) or just simply gravel and finally the pavers set in a laying

course. The superstructure totals 700 mm in all sections. As is stated above (in section 2.1), each driving lane is studied separately. The anchorage of the edge restraint varies on either side of the section, one side is set in a lean mix concrete and the other side only set in gravel. One section is lacking edged restraints completely. Finally, the pavement has two different curvatures: 2.5 %, which is the normal case, and 5 %. The test variables can be summarised as follows:

- Edge restraint
  - Set in lean concrete (normal anchorage).
  - Set in gravel (weak anchorage).
  - No edge restraints at all.
- Curvature
  - Normal curvature, 2.5 %.
  - High curvature, 5 %.
- Base layer
  - Asphalt stabilised gravel on granular sub-base.
  - Cement stabilised gravel (lean mix concrete) on granular sub-base.
  - Only unbound gravel in base layers.

Table 1: Characteristics for the different test sections.

	Section 1	Section 2	Section 3	Section 4	Section 5
Anchorage	Weak/ Normal	Weak/ Normal	Weak/ Normal	Weak/ Normal	No edge restraints
Curvature	5%	5%	2.5 %	2.5 %	2.5 %
Base layer	Unbound crushed gravel	Cement stabilised gravel	Asphalt stabilised gravel	Unbound crushed gravel	Unbound crushed gravel

2.3 Testing

During the construction phase of the pavement, FWD tests where made on each base layer for input data on elastic properties for future use in analytical models. Furthermore, to ensure that the unbound layers were evenly compacted, especially during the installation of the deflection sensors, measurements with a Nuclear Density Meter were carried out. Samples of some of the materials used in the construction were also taken.

The deflection is measured at various depths (see Figure 2 and Photo 1) of the pavement foundation. A total of 60 sensors are measuring both static and dynamic deflections in the base layers and the sub-grade. The sensors are assembled on fixed distances on a steel bar, in such a way that after the installation the sensors can move vertically with negligible restraint. Each section has four steel bars, two in each driving lane, positioned where the most likely wheel track will occur.

The permanent rutting is also monitored using a laser. Measuring a profile between fixed points on the pavement. Complementary FWD measurements are also conducted.

Traffic and traffic loads are monitored minutely.

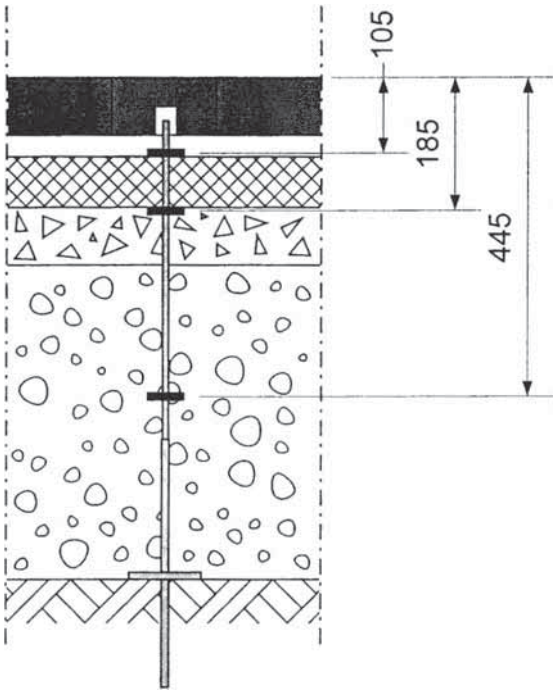

Figure 2: Detail of a test section with stabilised base layer and sensor assembly.

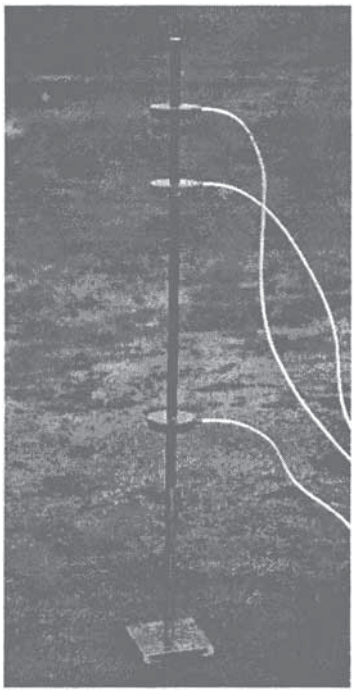

Photo 1: Three sensors is assembled on a steel bar. The distance from the sensors to the terrace is the same for all 20 units.

3 RESULTS AND DISCUSSION

In the writing moment the evaluation of one year of measurements is being done. The results from which will be published in a licentiate thesis [1] this spring (the spring 2000). Therefore, more test result will be available to present at the conference in Tokyo, September 2000. The profile measurements that have been done so far is presented at the end of this paper. The pavement is still very "young" and the rutting is relative small but already can interesting conclusion be drawn from these (see section 5 below).

Follow up measurements will be done after the published thesis. It is the long time deformation of a road that is of decisive importance to its performance. Consequently, a long series of measurements is desirable.

4 PROFILE MEASUREMENTS

So far four series of profile measurements have been done. They are presented in Figure 3 to Figure 7 below. The normal anchorage, i.e., edge restraints anchored in concrete, is on the left of the profile for section #1 to #4. Section #5 is without edge restraints altogether.

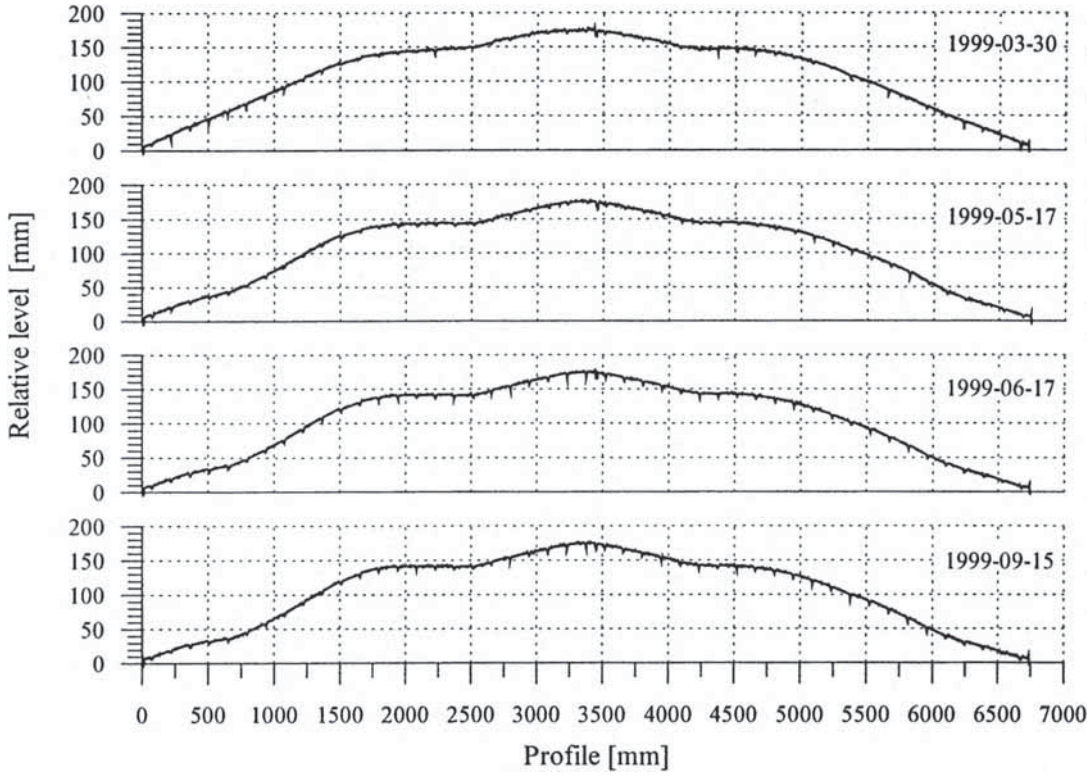

Figure 3: Profile for test section # 1. Normal / weak anchorage, 5 % curvature, unbound crushed gravel in base layer.

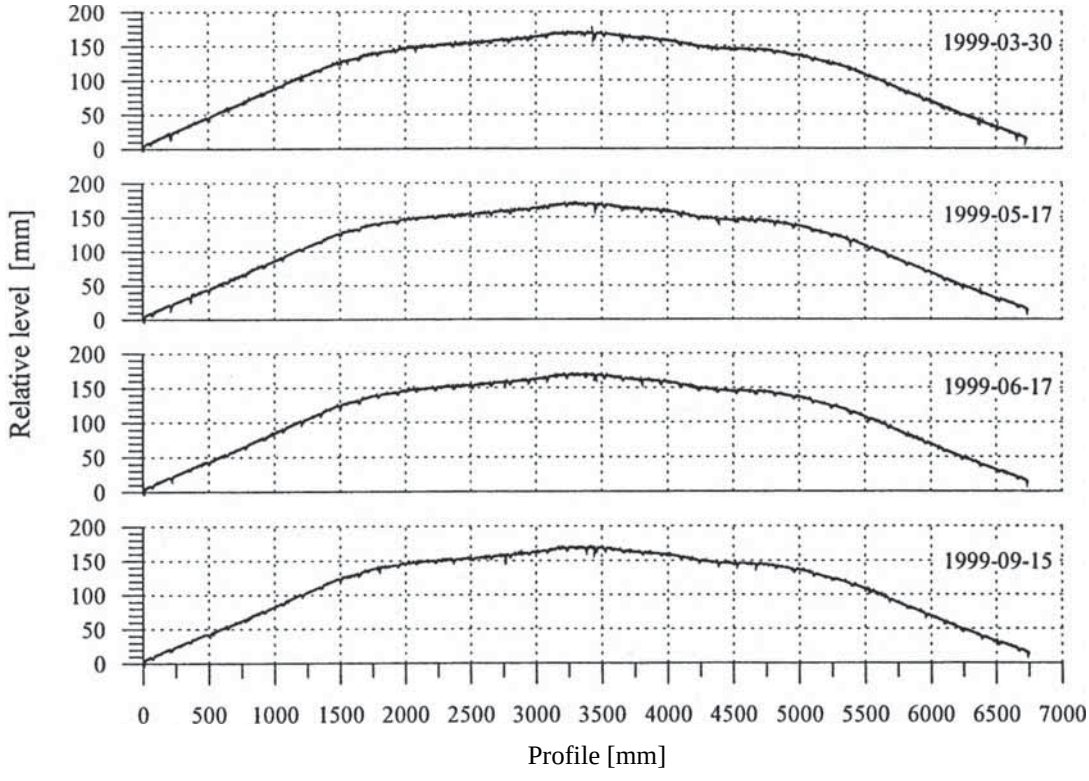

Figure 4: Profile for test section # 2. Normal / weak anchorage, 5 % curvature, cement stabilised gravel in base layer.

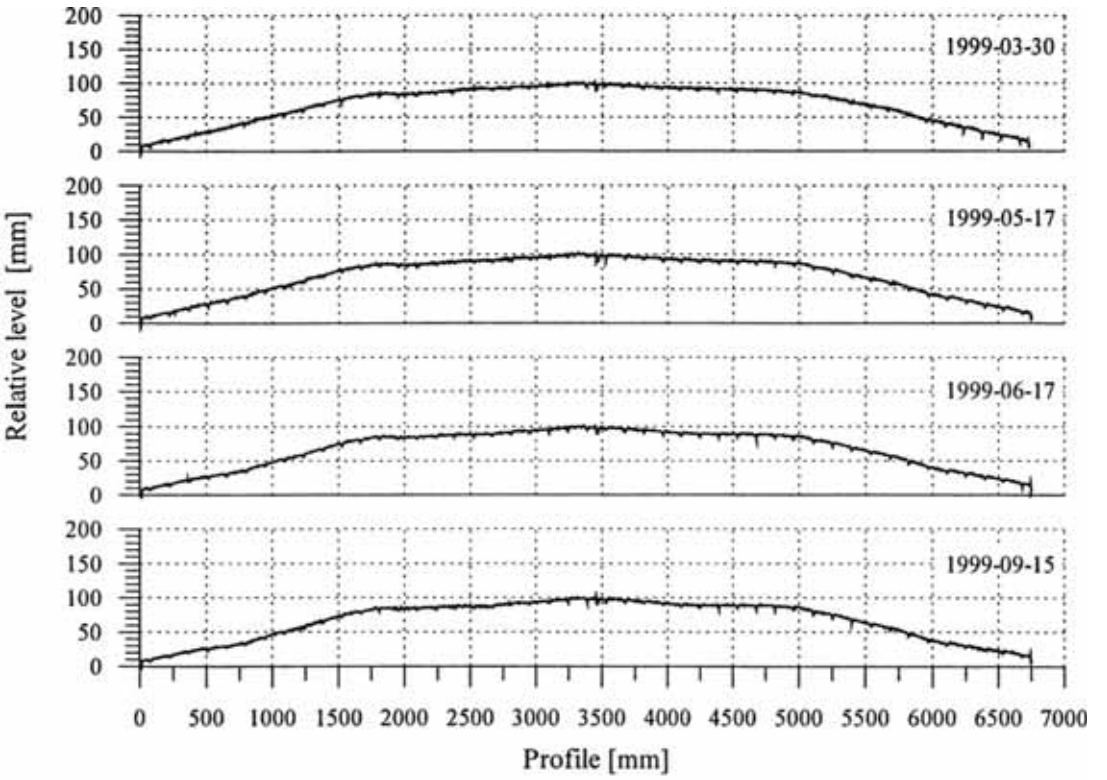

Figure 5: Profile for test section # 3. Normal / weak anchorage, 2.5 % curvature, asphalt stabilised gravel in base layer.

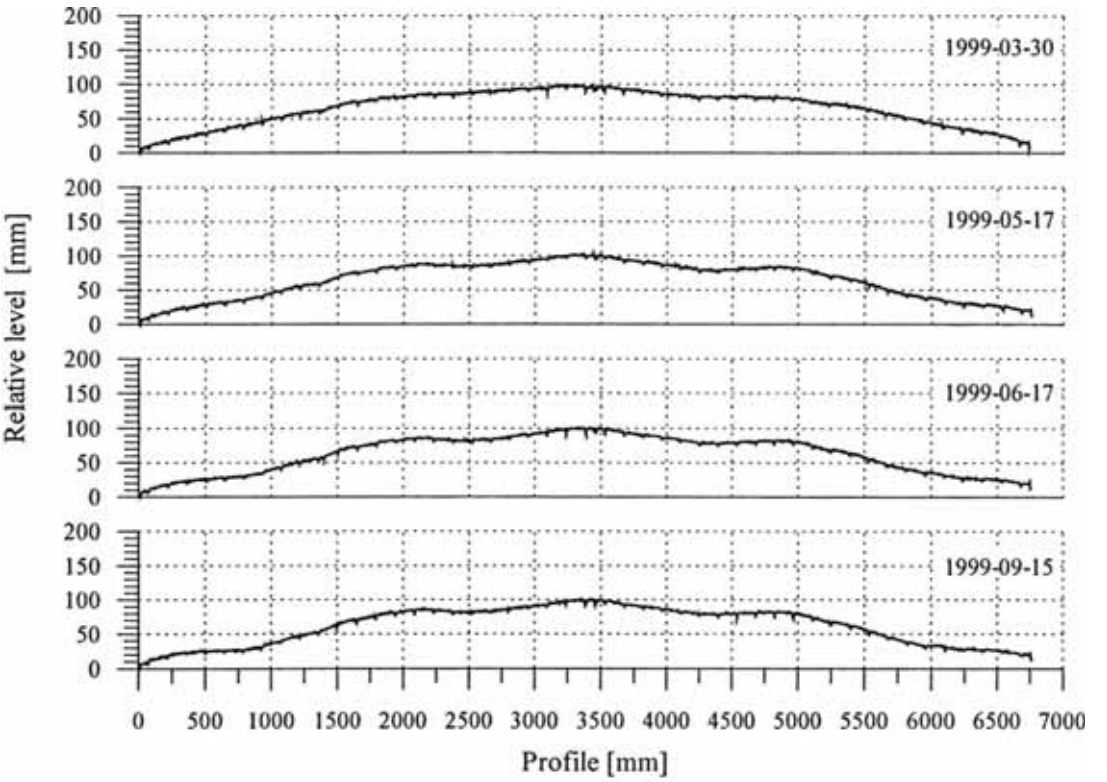

Figure 6: Profile for test section # 4. Normal / weak anchorage, 2.5 % curvature, unbound crushed gravel in base layer.

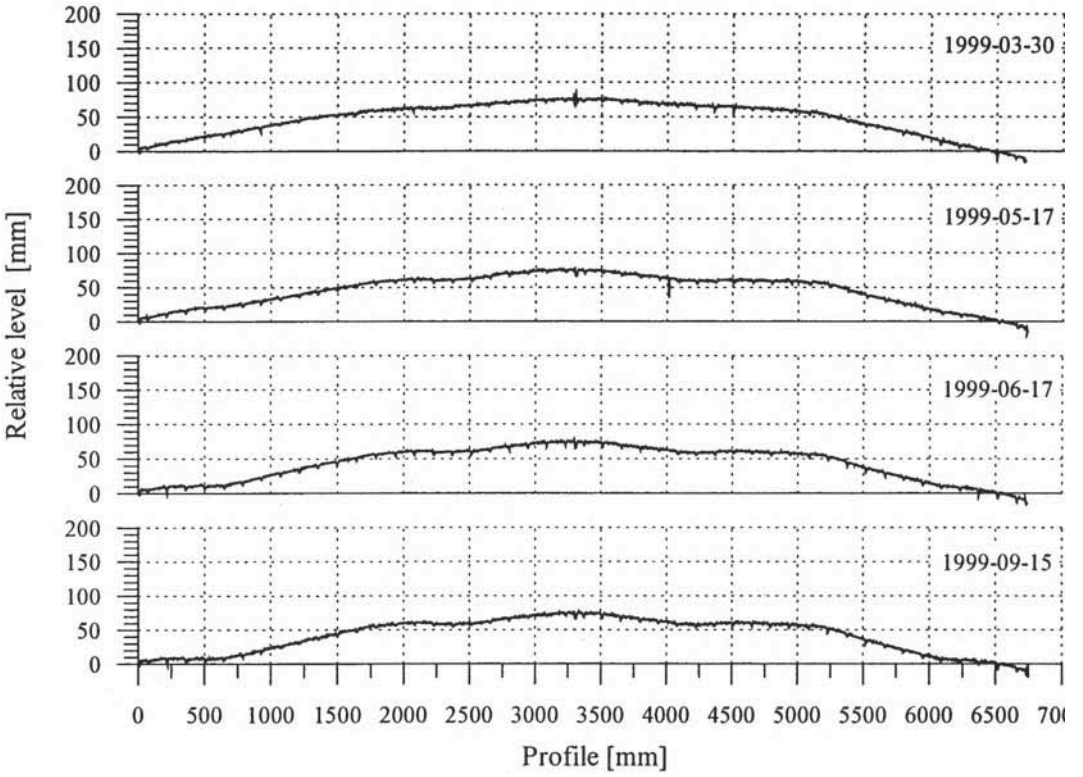

Figure 7: Profile for test section # 5. No edge restraints, 2.5 % curvature, unbound crushed gravel in base layer.

5 CONCLUDING REMARKS

Based on the performance of Swedish field tests on concrete block pavements, the following conclusions can be drawn:

(1) All test sections perform well after two winters and 12 months of trafficking.

(2) A significant rutting was observed after two months of trafficking, but the increase ceases successively.

(3) The rutting is most evident on test sections without stabilised base layer.

(4) Edge restraints anchored in concrete seem to limit the rutting on sections without stabilised base layer.

(5) Measurements on vertical deflections, FWD, and joint width, due to space limitations not showed in this paper, support the conclusions above.

REFERENCE

1. Wappling, M., (2000). Structural Behaviour of Concrete Block Pavements - Field Tests and Survey of Swedish Concrete Block Paving (preliminary title). Licentiate Thesis, Department of Structural Engineering, Royal Institute of Technology, Stockholm, Sweden.