CONTRIBUTION TO THE STUDY OF STRUCTURAL BEHAVIOUR OF A CONCRETE BLOCK PAVEMENT

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SUMMARY

The study is based on the hypothesis that the design of a road pavement can be considered only if pavement cohesion, that is to say, its strength to horizontal forces is secured.

For that reason, the study is separated into two parts. The first one concerns the structural behaviour of a road pavement under vertical loads. The second deals with the monolithic cohesion of a pavement and with the intervening parameters.

In the first part, the authors show that the structural behaviour of a concrete block pavement can be characterized by a «distributing effect». The distributing effect results from the spread of pressures all over the pavement. Because of the «slab effect», the paved area can be assimilated to a slab, the rigidity of which being reduced through the joints. The different tests show that the «distributing effect» and the «slab effect» are predominantly determined by the paving block thickness. It results from the second part of the study that the cohesion of the block pavement, wich must be satisfied according to any direction of the plane, can only be performed if the shape and the paving block pattern have been designed to permit the transmission of horizontal forces from the paving block to another.

This transmission performed either through the interlocking effect (case of interlocking blocks) or through the «beam effect» depends upon the folfowing conditions :

- adequate pattern to suit the paving blocks'shape
- close joints between paving blocks
- edge restraint

In practice, a certain number of recommendations for the laying of the blocks are issued from the study, which condition the cohesion of the pavement and permit as well to quantify the «distributing effect» and the «slab effect» to be taken into account for the design of concrete block paving roads.

RESUME : **CONTRIBUTION A L'ETUDE DU COMPORTEMENT STUCTUREL DES CHAUSSEES REVETUES EN PAVES BETON**

L'étude présentée est fondée sur l'hypothèse selon laquelle le dimensionnement d'une chaussée ne peut être abordé que dans le cas où la cohérence du revêtement, c'est-à-dire sa tenue vis-à-vis des efforts horizontaux, est assurée.

De ce fait, l'étude est scindée en deux parties. La première est consacrée au comportement structurel d'une chaussée sous l'action d'efforts verticaux. La seconde traite de la cohérence d'un revêtement pavé et des paramètres qui la conditionnent.

Au cours de la première partie, les auteurs montrent que le comportement structurel d'une chaussée pavée peut être caractérisé par un «effet répartiteur» et par un «effet dalle». L'effet répartiteur traduit l'épanouissement des pressions au travers du revêtement ; l'effet dalle permet de considérer la plaque pavée comme une dalle de rigidité réduite du fait de la présence des joints. Les différents essais montrent que l'effet répartiteur et l'effet dalle sont principalement conditionnés par l'épaisseur du pavé.

La seconde partie de l'étude montre que la cohérence du revêtement pavé qui doit être satisfaite suivant les différentes directions du plan ne peut être assurée que si la forme et l'appareillage des pavés permettent la transmission d'efforts horizontaux de pavés à pavés. Cette transmission qui s'effectue soit par engrènement (cas des pavés autobloquants) soit par effet poutre ne peut être obtenue que si les conditions suivantes sont remplies :

- appareillage adapté à la forme des pavés
- joints serrés entre pavés
- blocage des rives

Sur le plan pratique, cette étude a permis de dégager un certain nombre de recommandations de pose permettant d'assurer la cohérence du revêtement et de quantifier «l'effet répartiteur» et «l'effet dalle» qui peuvent de ce fait être pris en compte pour le dimensionnement des chaussées revêtues de pavés en béton.

INTRODUCTION

Although the design of block pavement is not new, did not formerly built roads prefigure them, they have been thoroughly studied for some years, as expressed oy the numerous communications pressented at the Newcastle Congress in 1980. The application of such studies is however difficult, ex abrupto, if laying conditions and requirements specific to every country or even region are not taken into account.

Therefore we tried in this study, which deals only with the mechanical behaviour of block pavements, to bring out the main factors on the structural point of view necessary to their ability to be used.

In this respect it appears from the study of the pathology of block pavements that the defects are from two origins.

The first one concerns the pathology resulting in a more or less extended hollowing by the applied load. For example :

- Rutting characterised by a paving blocks deflection along axis of the main directions of traffic. Generally speaking, we must admit that rutting phenomenon directly results form the repetition of too high pressures on a badly designed block pavement for fatigue phenomena.
- Punching : local deflection of paving blocks. It results from the action of a local high load applied on a pavement badly dimensionned for creep under static loads (industrial areas) or for fatigue (repetition of localized loads).

The second cause of pathology of block pavements corresponds to cohesion loss of the paved slab under the action of the horizontal component of the applied load. This cohesion loss appears through a sliding of the paving blocks occuring chiefly on braking or accelerating locations, as along straight line sections because of the nonalignment of the tyres. The sliding of the blocks, induced by the horizontal component of the applied load consists in a non-alignment and horizontal movements of the blocks. In severe cases, more or less localized barings may occur. In order to prevent this phenomenon, which may be severe, it is necessary to perform the best cohesion of the paved slab along any direction of the plane. The obtained results show how to ensure practically this cohesion.

A third type of pathology concerns the fracture of the paving blocks. If the production of blocks is not quality controlled, their fractures may originate from the bad quality of concrete. These fractures result from inadequate dimensionning of the blocks relatively to the traffic density or from the above mentionned pathologies which create important deleterious stresses.

In this respect, the preceding observed defects have different origins - inadequate dimensionning of the road structure relatively to the vertical component of the applied load in the first case - insufficient cohesion of the slab relatively to the horizontal component of the applied load in the second case - but there is in fact an interaction between them.

Indeed a bad dimensionning of the road structure, because it induces surface settlements, contributes to the cohesion loss of the pavement. In the same way a loss of cohesion of the paved slab induces at the level of the subbase high localised pressures and therefore slab deflections.

It is the reason why we have, in order to better distinguish the different

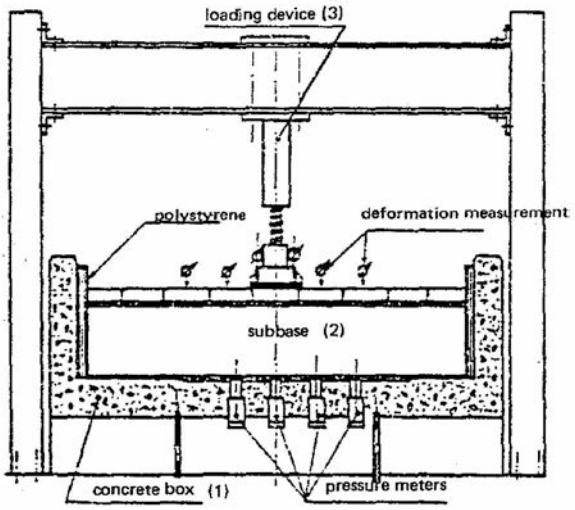
parameters which condition the behaviour of a block pavement, divided the study into two parts :

- The first one deals with the behaviour of the paved slab under the action of a repetitive vertical load. Its objective is to reveal the distributing and the slab effects arising from a block pavement, taking into account its constitution.
- The second one deals with the behaviour of the slab under the action of a horizontal load. Its objective is to reveal the main factors which contribute to the cohesion of the block pavement.

2. BEHAVIOUR OF A BLOCK PAVEMENT UNDER VERTICAL LOAD

2.1 Test procedures

Tests relative to the research into the distributing effect of the block pavements and the parameters which govern it, have been performed in laboratories on road models. Test device is shown in Figure 1.



- The box (1) is made of concrete. It contains the road subbase. Its bottom constitutes a rigid substratum. Its vertical inner sides are covered with panels of expanded polystyrene : they are able to be distorted which avoids an œdemetric behaviour of the specimen.
- The subbase (2). The various studied subbases are described in § 2.2
- The loading device (3). The loading was performed using an alternative loading jack combined with a circular steel plate (radius : 12.5 cm), the contact with the pavement is performed through a neopren disk of similar radius.

Measurements - Three types of measurements are performed :

. measurement of the transmitted pressures to the bottom of the subbase using pressure meters coinciding with the upper side of the box bottom.

. measurement of the deformation of the upper part of the pavement (in the subbase) using dial indicators (1/100 mm), located at various distances from the loading axis.

. measurement of the relative deformations, therefore of the stresses developped in the paving blocks using strain gauges.

2.2 Studied parameters

These ones characterize the subbase, others the paved slab.

Parameters concerning the subbase

Experiments were made on so-called «flexible subbase», made of coarse gravel mixture which has following characteristics :

. grading : 0 - 25

. clay content : relatively low

. sand equivalent : 57

. proctor modified test optimal water content : 11 %
maximum dry density : 2.03

Subbase composition :

- single layer subbases with reference mark G1. They are constituted by the coarse gravel mixture, strongly compacted in successive layers of 7 to 9 cm.
- dual layer subbases with reference mark G2. The lower layer (15 cm thick) is made in the same way as G1. The upper layer (20 cm thick) is made with non compacted gravel mixture (moisture content : 6.6 % - dry density comprised between 1.4 and 1.6).

Subbase thickness 25 cm - 35 cm - 45 cm

Remarks :

1. The thickness of the sand laying bed (2.5 cm) is unchanged. This laying bed is composed of a sand the characteristics of which are as follows :

. grading : 0 - 5

. sand equivalent : 93

. proctor test optimal moisture content : 13.5 %
maximum dry density : 1.75

. moisture content when settled 6.5 to 7.5 %

2. Three so-called reference tests are first conducted on subbases without pavement. Their results serve for comparison.

Parameters concerning the pavement

Geometrical shape of the blocks : 2 interlocking shapes, rectangular blocks.

Block thickness : 6 - 8 and 10 cm.

Pattern : in line, in herringbone.

The following table sums up the main properties of the studied road pavements (Table 1).

2.3 Test procedure

Different stages :

. characterizing of the materials before testing (density, moisture content)
. laying of the subbase and compaction in successive layers
. laying of the sand bed and adjustment
. placing of the blocks and sealing of the joints
. general compaction of the paved road
. setting of measuring apparatus (zero settings)
. load increase in successive stages till 3 000 daN and measurements plotting at every stage
. load cycling from 0 to 3 000 daN and measurements plotting every 100 cycles (under load and after unloading) to 3 500 cycles
. load increase in succesive stages to 6 000 daN and measurements plotting at every stage
. load cycling from 0 to 6 000 daN and measurements plotting every 100 cycles to about 1 200 cycles
. characterizing of the materials after experiment

2.4 Tests results

2.4.1 Pressure evolution at the bottom of the subbase

- Results on the reference roads without pavement :

According to the chart represented in Figure 2 showing the pressure intensity recorded on the bottom of the subbase at various distances of the loading axis :

. pressures are the highest upright the loading point and decreasing apart of this axis. Therefore they are distributed along a curved surface similar to the surface resulting from the application of Boussinesq theory.

. the pressure distribution on the bottom of the subbase tends to become unvarying with the number of loading - unloading cycles increasing. This trend particularly noticeable during the first cycles leads, according to the principle of action and reaction, to a decrease in the pressure intensity upright the loaded area and to its increase around. Resulting from the progressive action of the forces between particles

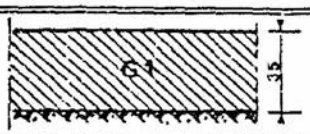
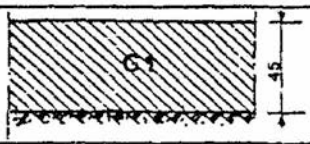
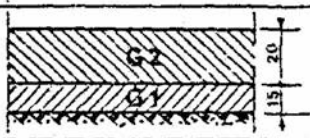
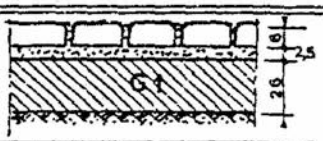
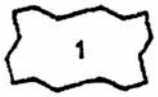
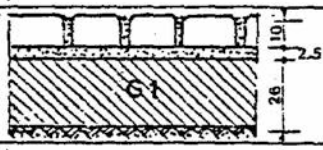
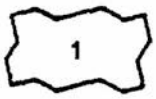
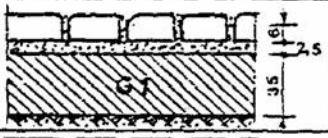
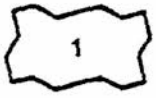
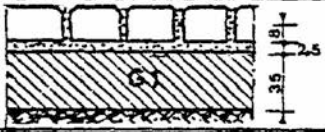
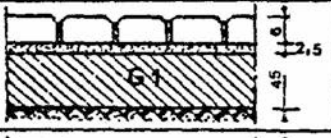
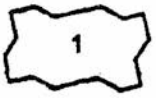
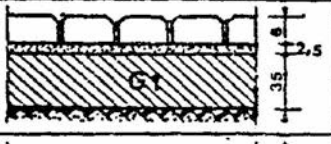
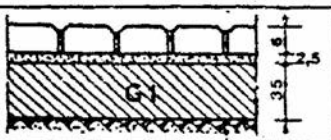
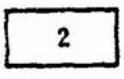
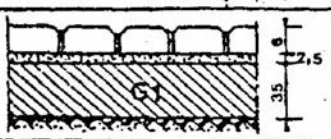
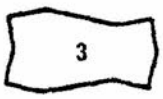
Test reference	Main parameters studied	Constitution of the subbase	Constitution of the pavement		
			Form	Thickness	Pattern
R1	Behaviour of the coarse gravel mixture				
R2	Behaviour of the coarse gravel mixture				
R3	Behaviour of the coarse gravel mixture				
P1	Block thickness Gravel thickness			6 cm	in line
P2	Block thickness Gravel thickness			10 cm	in line
P3	Block thickness Gravel thickness			6 cm	in line
P4	Block thickness Gravel thickness			8 cm	in line
P5	Block thickness Gravel thickness			6 cm	in line
P6	Block pattern			6 cm	in herring-bone
P7	Block form			6 cm	in line
P8	Block form			6 cm	in line

Tableau 1 : Studied parameters

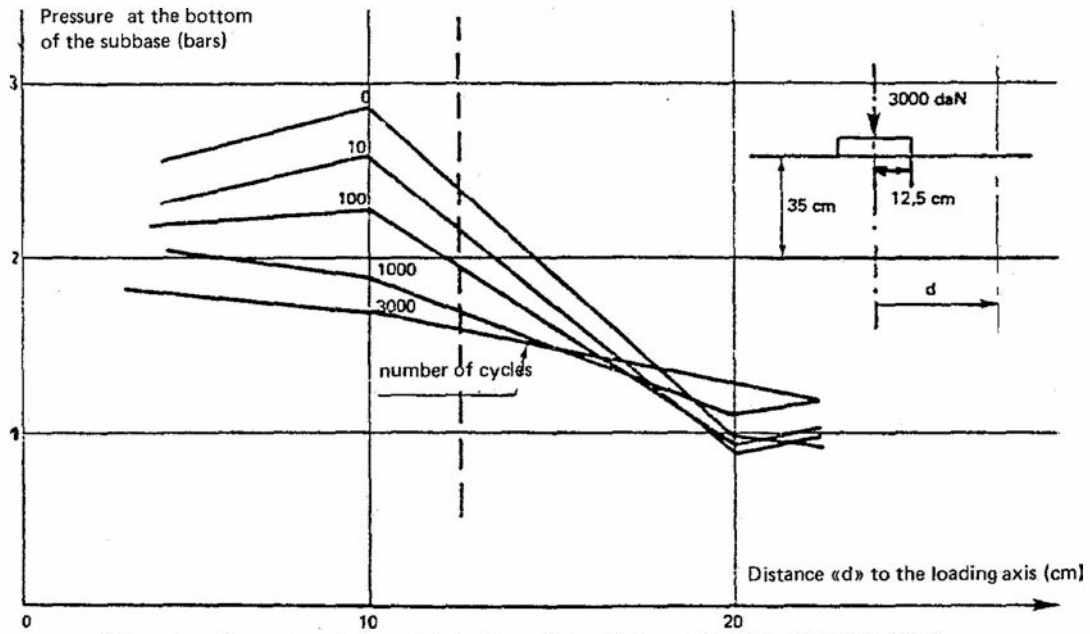


Figure 2 : Pressure evolution at the bottom of the subbase as a function of the number of cycles and of the distance to the loading axis

bound to the drawing off of water and air due to a repetitive loading, the relative uniformity of the pressures observed justifies the use of a mean pressure int the design. Moreover the various experiments show that the maximum pressure recorded on the bottom of the subbase is proportional to the applied surface pressure σo and that its intensity decreases when the subbase thickness increases.

- Results on roads with block pavement :

The experiments performed on the various types of block pavements show that their behaviour relatively to the distribution of pressures on the bottom of the subbase is similar to the behaviour observed in the reference experiments. We must point out that the intensity of the pressures ont the bottom of the subbase is much lower with block pavements : therefore this results proves that the block pavement has the ability of spreading the surface load σo.

2.4.2 Deformation curves

- Results from reference subbase

Deformation measurements performed at the top of the subbase show that the total deformation is composed of a non-permanent deformation which disappears after unloading (resilient deflection) and a permanent deformation - Figure 3. The accumulation of the residual deformation developed consecutively to loading cycles leads to a surface settlement - Figure 4 - practically in the form of rutting. The surface settlement as shown in Figure 4 is more significant during the first loading cycles. The evolution of the various surface deformations (total, resilient, permanent) plotted against the number of applied cycles is represented by the curves on Figure 5 (a) and (b).

Figures 4 and 5 show :

. A decrease of the residual deformation appearing every cycle against the number of cycles already applied, becoming negligible after the 100th cycle.

. The total deformation corresponds more to the residual one than to the resilient during the first cycles. It becomes asymptotic to the resilient deflection on and after the 100th cycle.

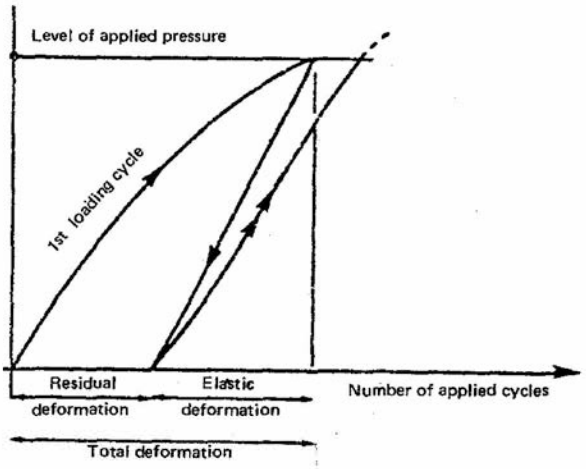


Figure 3 : Evolution of surface deformations

The variations of the resilient deflection are low. They result from the modifications in the mechanical properties of the material (evolution of its modulus of elasticity particularly).

The evolution described above relative to experiments performed with a surface pressure $\sigma 0 = 6.10$ bars (applied load : 3 000 daN) differs when the pressure is 12.20 bars. In that case it is established that the stabilization of the residual deformation is not so clear and that the evolution of the total and resilient deformations is significantly modified during the loading cycle. Thus, although the observed phenomenon is roughly the same when the pressure is 6.10 bars or 12.20 bars, a 6 000 daN load leads to successive fractures of the inner structure of the material.

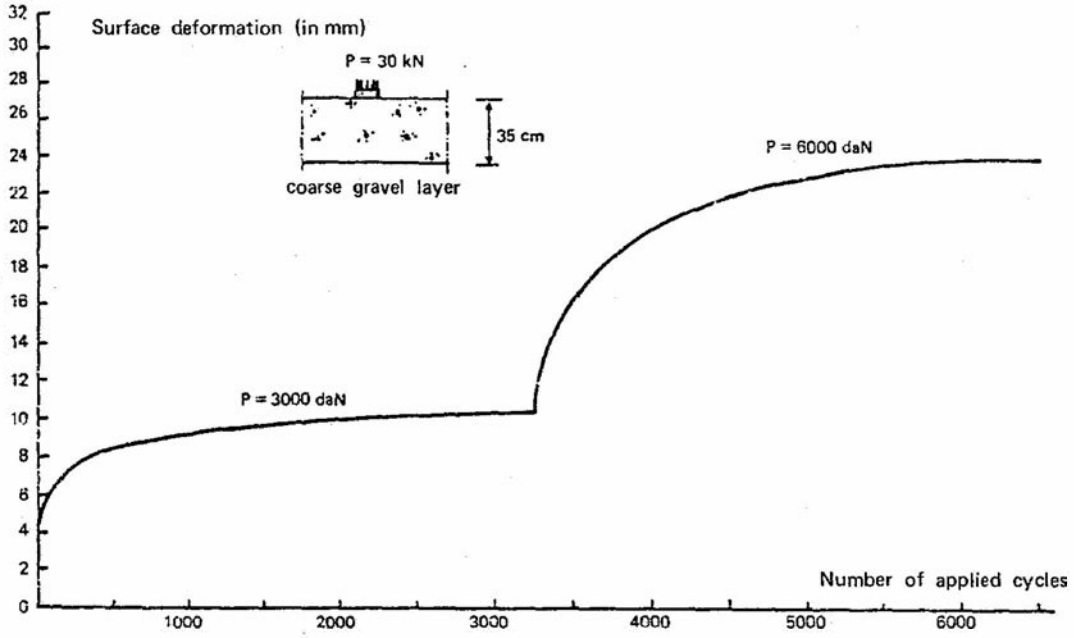


Figure 4 : Evolution of the settlement plotted against the number of applied cycles

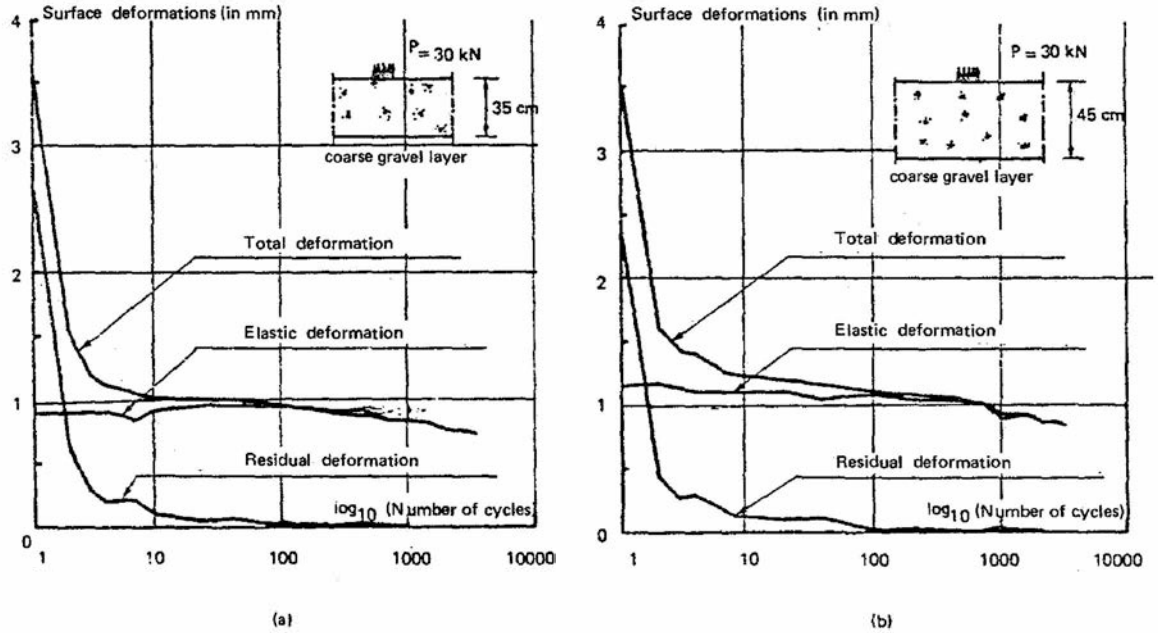


Figure 5 : Evolution of the different surface deformations plotted against the number of cycles

Considering the results of the experiments performed on the subbase Ro_3 which was compacted less than others, it is interesting to note that the resilient deflections values approximate the values recorded on compacted subbases, whereas the values of the residual deformation and of the corresponding settlement are much higher. Thus if the residual deformations are strongly influenced by the placing of the road subbase, resilient deflections depend more upon the mechanical properties of the ground (modulus of elasticity in particular) and depend principally on the arrangement of the parciles which compose the subbase material.

- Results on roads covered with a block pavement :

There is a similarity between the deformations evolution observed on subbases covered with a block pavement and the corresponding evolution on subbases without a block pavement.

. The total deformation after loading cycles, tends asymptotically after a hundred cycles towards the resilient deflection.

. The residual deformation tends to disappear after a hundred of loading cycles.

. The settlement tends to a limit.

As for the pressures, the obtained values are much lower when there is a block pavement (cf. § 2.5).

Besides, the surface deflection measurements show that the paved slab behaves identically to a slab placed on elastic bearings.

This assessment is confirmed by the observation of the fracture shape of the paved slab and by the indication of the straing gauges (fig. 6).

2.5 Interpretation of the results

The research into the behaviour of pavements as a whole shows that a block pavements reacts towards a vertical load :

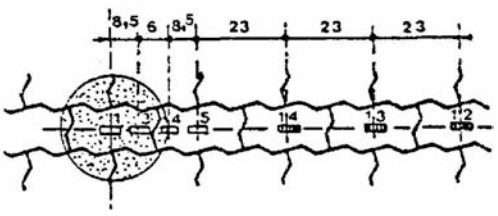
. with a distributing effect of the surface pressures that leads lo a decrease in the transmitted pressures to the subbase and a deflection decrease.

. with a slab effect. The block pavement behaves as a slab with a reduced rigidity due to the joints.

Besides, the various observations, relative to the distribution of the pressure on the bottom of the subbase and to the deformations, show that the characterisation of the distributing and the slab effects can be considered applying elastic behaviour laws, supposing permanent deformations do not interfere (for example with a general compaction of the road before it is put in service).

2.5.1 Research into the distributing effect of a block pavement

From the hypothesis of an elastics behaviour of the subbase and a rigid substratum characterizing the bearings of the studied models, table 2 shows the comparison between the deformation values recorded on the upper part of the subbase during experiments with the corresponding theoretical values issued from BURMISTER and GIROUD (I). These comparisons were established as follows : determination from the experimental deflections of the radius of an equivalent circular plate which placed at the upper level of the subbase would induce the same deflections as the experimental ones. This comparison allows the determination of the distributing coefficient value k_e, which reveals the spread all over the pavement of the applied pressure on the paved slab.



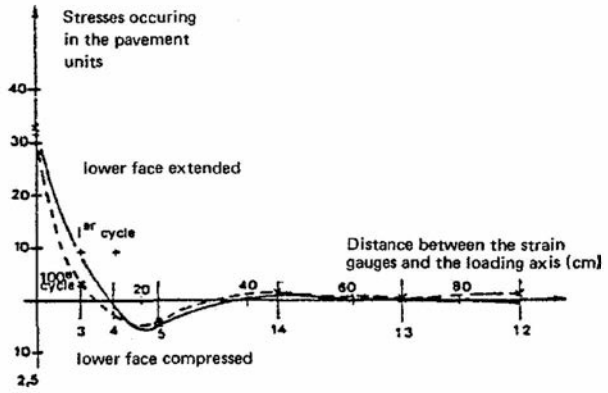


Figure 6 : Stress distribution in the paving blocks as a function of their situation with respect to the loading axis

Figure 7 illustrates : $\sigma_1 = \sigma_0 \frac{S_0}{S_1}$ (equality between action and reaction)

s_1 = surface of the equivalent plate of radius R_e

i.e. : $\sigma_1 = k_e \sigma_0$

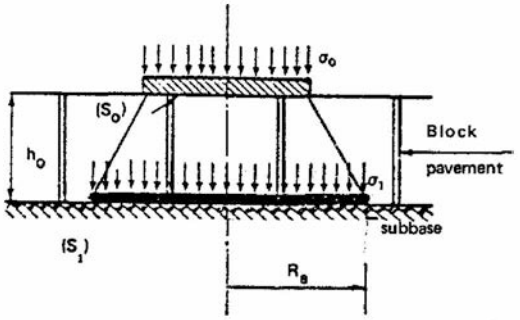


Figure 7 : Definition of the equivalent plate of radius R_e

The analysis of the results represented on table 2, indicates following particularities :

The block thickness is the parameter which has the most important role in the distributing effect of a block pavement. In the case of small surface deflections, the transmission of forces between blocks occuring mainly through friction is thus more significant when the block thickness is high. When surface deflections are higher, blocks are in contact because of the rotational interlock. Thus the paved plate behaves as a slab with a reduces rigidity due to the joints.

This process described in § 2.5.2 dealing with the rigidity of a paved plate must be taken into account however only in the case of normal deflection limits, safety and comfort criteria being required for the traffficking path.

The block's shape as well as the laying pattern are of little influence on the distributing effect.

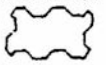
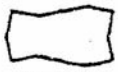
Studied parameters	Parameters kept constant	Studied parameters	Elastic deformations (mm)		Radius of the equivalent plate R_e (cm)	Distribution coeff. k_e
			experimental	calculated		
Subbase	absence of pavement	thickness of subbase 35 cm	0,804	0,819	/	1
	quality of subbase	45 cm	0,909	0,900	/	1
Pavement's thickness	form of blocks thickness of subbase : 35 cm for ho = 6 and 8 cm - 26 cm for ho = 10 cm	thickness of blocks ho = 6 cm	0,672	0,671	15,6	0,65
		ho = 8 cm	0,548	0,548	18,3	0,46
		ho = 10cm	0,274	0,274	23,0	0,30
Form of blocks	thickness of subbase : 35 cm	form of blocks 	0,672	0,671	15,6	0,65
	thickness of blocks : 6 cm		0,674	0,670	15,3	0,65
			0,684	0,689	15,2	0,65
Pattern	thickness of subbase : 35 cm thickness of blocks : 6 cm	in line	0,672	0,671	15,6	0,65
		in herring-bone	0,657	0,660	15,6	0,65

Tableau 2 : Comparison of the deformations in the upper part of the subbase with the corresponding theoretical values (GIROUD's work)

2.5.2 Research into the slab effect of a block pavement

As we saw in § 2.4.2, the slab effect occuring in a pavement is shown up by the shapes of the fracture lines (figure 8), by the profile of the surface deflections, and by the data given by the strain gauges on the blocks. This slab effect represents a second property of this type of block pavements, the characterization of which may be established using the plates theory.

Thus if the ground is supposed to behave as an elastic-plastic component it opposes to the circular loaded surface of radius «a», a proportional reaction (p) to the deflection (y), the proportionality ratio k being the modulus of reaction of the ground. According to these hypotheses, the fracture theory for the plates leads to the following formulae :

. Fracture line position (l)

$$r = a \cdot \sqrt[3]{\frac{32}{11}} \cdot \sqrt[6]{\frac{E_f \cdot l}{k\, a^4}} = a \cdot \sqrt[3]{\frac{4P}{11\, p_o\, a^2}}$$

. Value of the pressure applied on the upper side of the subbase upright the loading (or reaction of the ground at this location at the interface block-pavement subbase).

$$p_o = \frac{P}{8} \sqrt{\frac{k}{E_f\, l}} \quad \text{(bars)}$$

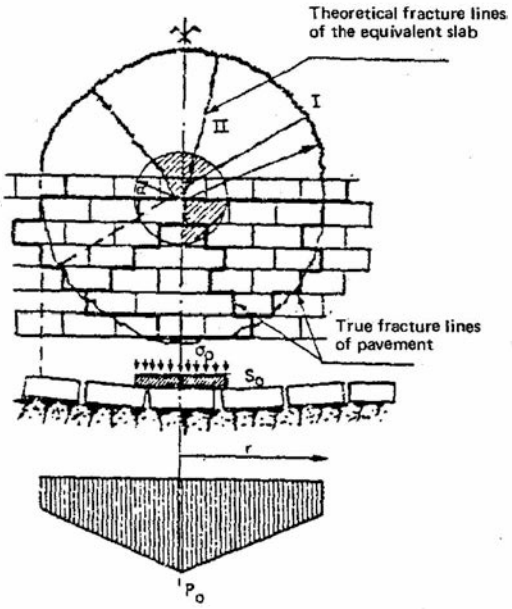


Figure 8 : General course of fracture lines of a paved slab

with :

a (cm) : the radius of the loading plate applied on the pavement.

p (daN) : applied load on the circular plate of radius a.

k (daN/cm^3) : reaction modulus of the ground.

E_f (bars) : equivalent modulus of the paved plate, the joints being taken into account.

I (cm^4) : moment of inertia per unit of the paved plate $I = 1 \cdot h_o^3$ (h_o thickness of the block - cm)

Determination of the equivalent modulus of the paved plate :

Because of the low interference of the blocks shape and the laying pattern, it seems reasonable, for the geometry of the studied blocks, to keep only one value for the equivalent modulus E_f. The values of the radius r, recorded during the experiments using various block thicknesses lead with the aid of the preceding formula to the following values (when k = 4).

Blocks thickness	r (cm)	p_0 (bars)	Mean value of E_f (bars)	p_0 (bars)
h_0 = 6 cm	≅ 30	1,86		1,98
h_0 = 8 cm	≅ 35	1,20	9 000	1,40
h_0 = 10 cm	≅ 40	0,86		0,91

Table 3

It is worth comparing the value p_0 of the pressure recorded on the interface block pavement-subbase, resulting from the application of the plates theory, with the value p'_0 of the same pressure to which leads the study of an equivalent rigid plate of radius R_e (figure 9).

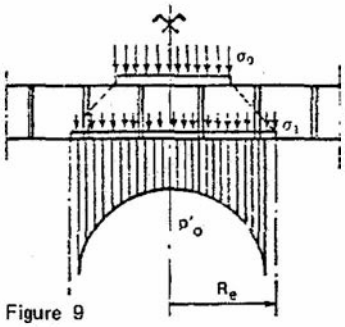


Figure 9

In this case, upright to the centre of the plate, p'_0 :

$$p'_0 = \frac{1}{2}\sigma_1 = \frac{1}{2} k_e \sigma_0$$

Therefore it must be noted that the cohesion of the various courses of the subbase conditions the slab effect ; in addition it is necessary that the pressure recorded at the ground level does not lead to the punching of the road structure, or to too high deformations. Besides, the slab effect of a paved plate is of little influence as the subbase rigidity increases. Thus for every rigid subbases, the structural role of the paved plate becomes of the lowest significance and the plate behaves only as a pavement.

3. BEHAVIOUR OF A BLOCK PAVEMENT UNDER HORIZONTAL FORCE

These experiments which were to study the various mechanisms assuring the pavement cohesion and to bring out their main factors were performed on road models as described in § 3.1.

3.1 Test procedure

The various paved plates which are described in § 3.2, are placed on a sand laying bed 2 cm thick (figure 10), which is laid on a concrete slab. These plates are submitted to a horizontal force along their axis, applied by a jack on one of their sides. The opposite side is equipped with dial

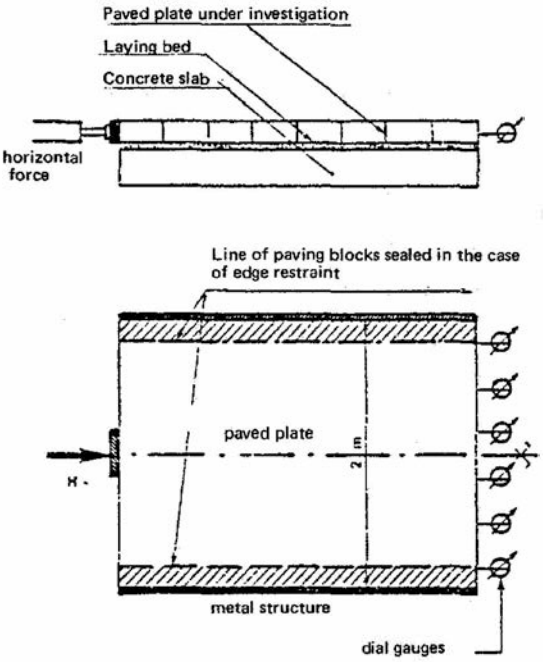


Figure 10 : Experimental arrangement for the study of the behaviour of block pavements under horizontal force

gauges ; the resulting data give information upon the cohesion value presented by the various studied plates. Both other sides were free in the case of an experimental arrangement with unrestrained edges. In the cases of an experiment device with restrained edges, the blocks placed on both edges of the plate were sealed on the structure in order to prevent them from moving.

3.2 Studied paramaters

They concern :

- the blocks shape . rectangular shape
  . interlocking shape
- the blocks pattern . blocks laid in line
  . blocks laid with broken joints
  . blocks laid in herring-bone pattern
- the direction of the horizontal force relatively to the direction of the pattern.

Table 4 lists the various experiments performed.

3.3 Behaviour of block pavements under horizontal force

A block pavement may present various types of mechanical behaviour when submitted to a horizontal force, depending on the blocks shapes, as well as on the laying pattern and on the direction of the horizontal force relatively to the laying pattern.

3.3.1 Case of a pavament performed with rectangular blocks

– The test H6, which consists in applying a horizontal force on a plate made of rectangular blocks, parallel to the continuing lines of the joints, shows that the cohesion of such a plate is near to zero whaterver the restraining of the edges. Indeed, for a relatively low value of the applied force, the line of loaded blocks moves monolithically, the friction forces which are the only ones capable of reacting on the continuous lines being too weak to perform this role.

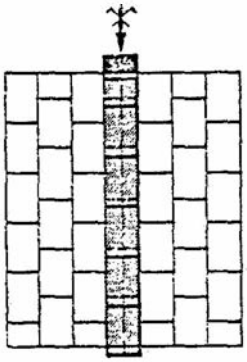


Figure 11 : Pattern of rectangular blocks loaded parallel to the continuous joint lines

– The test H7, for which the horizontal force is directed perpendicularly to the continuous lines of the joints, shows that the blocks placed on the first line perpendicular to the force are locked after taking up the clearance of the joints. When the edges are restrained, we observe a behaviour similar to that of a beam acting through friction forces on the successive lines of blocks (figure 12).

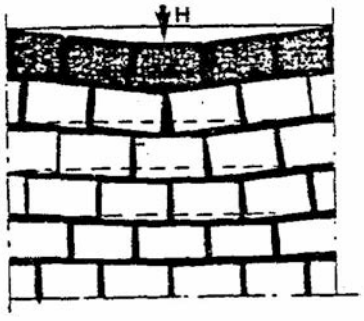


Figure 12 : Pattern of rectangular blocks loaded perpendicular to the continuous joints lines

– The test H8, with herring-bone pattern shows that the blocks contribute as a whole to the cohesion of the pavement, the blocks being successively locked by their rotation following their displacement.

3.3.2 Pavement with interlocking blocks

Coresidering the test H1, in which the horizontal force is parrallel to the continuous joint lines, we observe that the joint lines contignous to the loaded line contribute progressively to the load transfer through an interlocking effect. However this effect induces a lateral movement of the blocks, so that their action stops as soon as the clearance of the joints becomes too large (figure 13). If the lateral movement is not possible because of an edge restraint, for example plates of tests H2, H9, all the blocks of the plate contribute to the transfer of the horizontal force and the pavement cohesion is then assured.

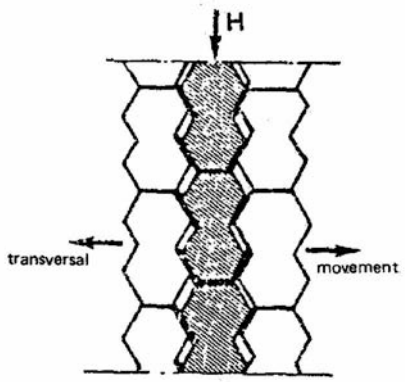


Figure 13 : Pattern of interlocking blocks loaded parallel to the continuous joint lines

When the horizontal force is perpendicular to continuous joint lines, for example test H3, H10, performed with edge restraint, we observe the same beam effect as for H7. We can notice a better contribution of the different lines of blocks due to interlocking. In the test H5, herring bone pattern the interlocking process previous by described for rectangular blocks is improved.

3.4 Test results

Though it is illusory to want to quantify the cohesion of a block pavement, the results show however that rectangular blocks in line pattern do not assure the pavement cohesion with regard to a horizontal force parallel to the continuous lines of joints. In this arrangement, a pavement made with interlocking blocks may assure a cohesion only if the joint clearance is sufficiently small, and if the edge restraint can avoid the lateral translation of the blocks submitted to the forces perpendicular to the continous joint lines. The block pavements with broken joints are all the more effective as for the cohesion of the plate that the spaces between the joints are small and the edge restraint effective. We observed the same result in the case of herring-bone pattern which is more suitable than the other ones because it does not show preferential directions with regard to the applied force.

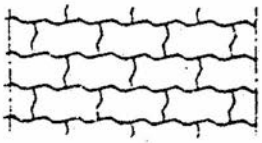
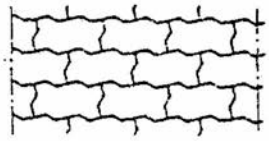
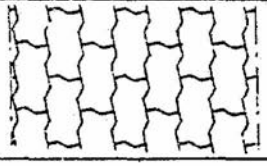
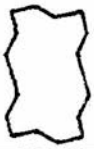
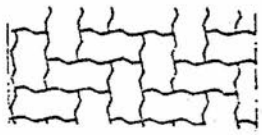
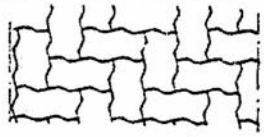
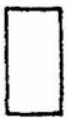
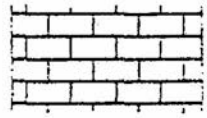
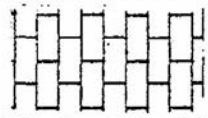
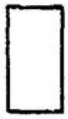
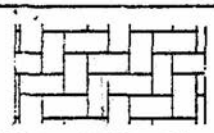
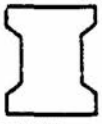
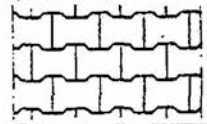
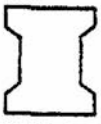
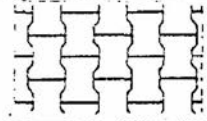
Reference of test	Edges	Form of block	Load direction	Pattern
H 1	unrestrained			
H 2	restrained			
H 3	restrained			
H 4	unrestrained			
H 5	restrained			
H 6	restrained			
H 7	restrained			
H 8	restrained			
H 9	restrained			
H 10	restrained			

Table 4

4. GENERAL CONCLUSION OF THE STUDY

This study which deals with the structural contribution of a block pavement and its cohesion with regard to the horizontal forces leads to the following conclusions :

- With regard to a vertical load, a block pavement, because it distributes the surface pressure and brings some rigidity to the subbase especially when the subbase is flexible, contributes to the overall strength of the road structure.

- The structural contribution of a block pavement can be characterized by a distributing coefficient, or by a theoretical equivalent modulus allowing to consider the block pavement as a slab with reduced rigidity because of the joints. The experiment led to quantify the distributing and the slab effects. This permits to use the existing methods of road design.

- As regards the geometrical characteristics of the paving blocks, we notice that the block's thickness is the main factor as for its structural effect, whereas the block's shape and laying pattern condition its cohesion.

- The efficient and durable cohesion of a block pavement requires however some care as for the laying, especially by keeping a small clearance in the joints and by ensuring edge restraint.

5. REFERENCES

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(II) K.W JOHANSEN - Yield - line formulae for slabs - Publication de la «Cement and Concrete Association».