GUARANTEEING THE LONG TERM PERFORMANCE OF PAVER PROJECTS – A PRACTICAL GUIDE TO DEVELOPING A WARRANTY

Introduction

It is estimated that 0.5 bn m^2 of pavers are installed per annum worldwide on projects varying from those comprising a few pavers on domestic patios to ones trafficked by handling equipment, highway vehicles and aircraft on projects financed by national or international agencies. Each project has two features in common: the sponsor has in mind a level of anticipated performance below which he will feel that the paver system was poor value for money; the provider will have made an assessment of the sponsor's requirements and will have provided for those requirements, usually in a commercially competitive environment. Beyond these two features, most paver projects differ in virtually every imaginable way.

The Author has, over the last 20 years, investigated many instances when the sponsor has felt that the project has performed unsatisfactorily. In some exceptional cases, a dramatic failure has occurred and there has been little doubt that the level of anticipated performance has not been attained; the resulting actions have been largely concerned with rectification which in some instances has included the elimination of pavers entirely. However, in many cases, dispute has developed between the sponsor and the provider as to what level of performance could have been reasonably anticipated - has the pavement failed or is it just getting old ? Whilst paver industries in many regions have invested heavily in the development of standards for new materials and workmanship, no-one to date has attempted to quantify the long term performance of paver projects. This paper provides a model which can be used by sponsor and provider to pre-determine a year on year level of pavement performance which can be taken as the boundary between normal wear and tear and unacceptable performance: it is felt that the term "failure" should be henceforth avoided in this context as it implies counter-productive connotations of personal incompetence.

Reasons for unsatisfactory Paver Projects

It would be tempting, but unhelpful, to list a series of technical issues which have been associated with unacceptable projects. In the author's experience technical errors in design, specification and construction could have been avoided if the following areas had been addressed prior to technical issues being developed.

(1) Sponsor and provider should be explicitly identified

Who is buying the project ? This is usually a much more complex issue than it may first appear. Only by identifying the ultimate customer can the long term performance requirements be set out numerically. For example, a local authority may be developing a bus station for a group of bus companies, all with different social and financial objectives or an airport authority may be developing an apron using aviation authority finance for the use of a handling agent representing several airlines. This

ssue can be further complicated by the appointment of a professional team whose esponsibilities may be unclear, both within the team and in relation to the sponsor and he provider.

Equally, there may be confusion as to who is the provider. For example, a design nd build contractor may have appointed a consulting engineer who may have relied ubstantially upon specialist knowledge provided by a material supplier - it is not ncommon for designers to replicate details set out in manufacturers' brochures as a neans of enhancing efficiency in design. In such a case, the material supplier is laiming expertise and may consequently become involved in a dispute.

2) Sponsor and provider should be competent to carry the project forward

Because it is possible to establish a construction related contracting or consulting rganisation with zero capital, paver projects are susceptible to difficulties resulting from he inclusion of parties unfamiliar with the aspect of the project which they have agreed o deliver. Attempts to fix the blame for unsatisfactory paver performance have usually entred on the providers. In the Authors experience, faults can often be traced back o faults made by the sponsor. These fall into the following areas:

(i) interference
(ii) insufficient financial provision
(iii) inability or unwillingness to specify requirements
(iv) bullying

It is the Author's experience that unsatisfactory paver performance can be traced o faults on both sides : a sponsor who takes a "macho" pride in having "screwed the rice right down" frequently spends more in litigation (which is rarely more than 50% ecovered) than on the project. The contractor who wins a contract at a price which annot sustain long term performance is often associated with technical unsatisfactory erformance.

3) Project should not become a research test site

Because of the rapid evaluation in mankind's understanding of pavers, many rojects include technologically innovative components. In recent years, the following nnovations have developed :

Innovation	Year and Place
Concrete pavers replace brick	1948, Rotterdam
"interlocking" shapes	1961, Germany
use for very heavy industrial loading	1970, Europe Container Terminus
mechanical laying	1980, Europe
use for aircraft pavements	1981, Luton
paver joint stabilization	1987, UK

In each of these cases, the innovation has been as a result of careful engineering consideration moving the technology forward by a small step. The result has been successful in that no harm has resulted and the whole issue of pavers has moved forward. Major failures have occurred when innovation has progressed in haste and specifiers have introduced two or more untried concepts simultaneously e.g. very fine bedding sand used in conjunction with granite pavers under severe bus traffic on fluted concrete sub-base in the US in 1988.

(4) Insufficient attention paid to long term maintenance

Nothing lasts forever and few man-made things are maintenance free. Whilst most paver projects are claimed, with sound supporting data to be low in maintenance cost, none should be left entirely unmaintained. The level of planned maintenance may comprise no more than an annual visual inspection and report but there should always be someone responsible for ensuring that the pavement remains serviceable. An example of the importance of maintenance occurred in the UK in 1992 when unmaintained pavers on a UK aircraft runway were displaced by an aircraft, causing undetected damage to the aircraft's major control surfaces. As a result, 180 passengers flew for two hours in an aircraft which could have become uncontrollable : 18 inch long holes in a tailplane is bad news at 30,000 ft.

A system to quantify pavement condition

The system presented in this section should improve the long term performance of a pavement by bringing together the sponsor and the provider to draw up an agreement which will place appropriate responsibilities on both parties throughout the life of the pavement. Central to the system is a Statement of Engineering Parameters (SEP), a document to be agreed by both parties prior to the initiation of the project. The Author has developed a Statement of Engineering Parameters for several schemes in the UK, the US, Scandinavia and the Near East, when the sponsor needed more than a non-explicit statement of confidence by the construction parties in their work. The purpose of the SEP is to permit a year on year non-subjective assessment of the present condition of the pavement. By measuring or counting the defects included in the SEP, an assessment can be made as to whether the pavement is fulfilling expectations agreed

by all parties. Should any of the parameters (defects) be exceeded, the provider is required to bring the parameter back in line with the SEP at his cost. This does not necessarily imply that any of the pavement should be brought back to original new condition, although this may be the only practical remedial treatment - for example, it may be possible to repair areas of rutting and relay the original pavers, even though some of them may be spalled. Of course, the sponsor may wish to contribute financially and bring the pavement to a higher quality than SEP requires.

The SEP is usually referred to in documents agreed by the sponsor and the supplier. Such documents may simply be an exchange of letters or may be a formal legal document. The documents may require that the provider maintains insurance throughout the design life of the pavement.

Statement of Engineering Parameters (SEP)

The SEP developed in this paper has been used as part of a legal agreement between the Author and two sponsors in the US, both public bodies responsible for city highways. It can be seen that the SEP includes for intervention during the life of the pavement. This is to be undertaken as part of a planned sequence of maintenance at the cost of the sponsor. The figures in the principal defects table will need to be adjusted according to the specific function of the project, the aspirations of the sponsor and the level of initial investment allowed by the sponsor. It should be noted that at the end of the design life, the pavement need have no residual value or may have levels of defects which render it of significant future value.

The principal benefit of the SEP system is in allowing future pavement performance to be examined against a fixed scale rather than being a subjective exercise. This should eliminate dispute and allow parties to apply their energies to keeping the pavement serviceable, rather than spending time and money arguing over responsibility. In effect, this will insure that the sponsor is provided with exactly the facility which he required and the provider will have been able to optimize his costs and pass on a benefit to the sponsor. It will have the benefit of eliminating those providers whose experience is insufficient to allow them (through their inability to secure insurance for example) to enter into a SEP agreement and will alert the sponsor to the fact that the provision of a pavement is best achieved as a partnership between the sponsor and the provider with both parties taking an agreed share in the long term performance of the pavement.

Sample Statement of Engineering Parameter

Introduction

The purpose of SEP is to define the long term performance of the pavement and to set out a program of monitoring and intervention. Providing the remedial work is undertaken to John Knapton Consulting Engineers' design and specification and providing that the work is supervised by John Knapton Consulting Engineers, the pavement will perform as set out in this document.

MONITORING PROGRAM

Three months after opening the road to traffic then at twelve month intervals thereafter, a visual inspection of the road shall be undertaken and a report shall be prepared with the following structure.

Title "Report on Condition of City Square Pavers".

Date

Name and affiliations of person responsible for inspection

The following types of defects shall be marked on a drawing:

(a) cracked or spalled pavers
(b) obviously loose pavers
(c) absence of joint sealing material
(d) rutting
(e) settlement of discrete areas of paving
(f) steps or trips between neighbouring pavers
(g) standing water
(h) steps or trips at interface between pavers and other materials
(j) horizontal movement of pavers
(k) rotation of pavers

TABLE 1 : Levels of deterioration beyond which pavement is considered to be unsatisfactory

Pavement Age : Type of defect and age of intervention (i = intervention)

	a	b	c	d	e	f	g	h	j	k
3 mths	100/i	25/i	5/i	30/i	20/i	20/i	4/i	6/i	0	0
1 year	50	10	5	20	10	10	3	4	0	2
2 "	100	20	10	30	20	15	4	5	0	4
3 "	120	30	5/i	40	30	20	5	6	1	6
4 "	140	35	4	50	40	25	6	7	2	7
5 "	160	40	8	60	50	30	7	8	3	8
6 "	180	45	12	70	60	35	7	9	4	9
7 "	200/i	50/i	15/i	80/i	70/i	40/i	8/i	10/i	5/i	10/i
8 "	50	10	5	20	10	10	3	4	0	2
9 "	100	20	10	30	20	15	4	5	0	4
10 "	120	30	15/i	40	30	20	5	6	1	6
11 "	140	35	4	50	40	25	6	7	2	7
12 "	160	40	8	60	50	30	7	8	3	8
13 "	180	45	12	70	60	35	7	9	4	9
14 "	200/i	50/i	15/i	80/i	70/i	40/i	8/i	10/i	5/i	10/i
15 "	50	10	5	20	10	10	3	4	0	2
16 "	100	20	10	30	20	15	4	5	0	4
17 "	120	30	15/i	40	30	20	5	6	1	6
18 "	140	35	4	50	40	25	6	7	2	7
19 "	160	40	8	60	50	30	7	8	3	8
20 "	180	45	12	70	60	35	7	9	4	9
21 "	200/i	50/i	15/i	80/i	70/i	40/i	8/i	10/i	5/i	10/i
22 "	50	10	5	20	10	10	3	4	0	2
23 "	100	20	10	30	20	15	4	5	0	4
24 "	120	30	15/i	40	30	20	5	6	1	6
25 "	140	35	4	50	40	25	6	7	2	7

A summary table of the following format shall be included in the report. All items in the table shall be completed, even if the value is zero.

ITEM	MEASUREMENT TYPE	UNITS
a	number of pavers	No.
b	number of pavers	No.
c	number of occurrences	No.
d	length of rutting	Ft.
e	area of settlement	Ft. 2
f	number of occurrences	No.
g	number of occurrences	No.
h	number of occurrences	No.
j	area of movement	Ft. 2
k	area of defect	Ft. 2

The report shall include notes as considered necessary by the person responsible for the inspection. It shall also include approximately twenty photographs covering the whole of the repaired area.

ANTICIPATED LEVELS OF DEFECTS AND RECOMMENDED INTERVENTION PROGRAM

Table 1 shows the highest incidence of defects which may be anticipated. It is very unlikely that each type of defect will achieve its maximum defect simultaneously. There is a possibility that one defect may exceed the stated value by 50% and a second defect may exceed the stated value by 20%. In this case, all other defects will be less than 90% of the stated value.

After three months, seven years, fourteen years, and twenty one years, intervention will take the form of undertaking local repairs. It is anticipated that defects will be confined to local areas and that wholesale repaving will not be required. In addition to the above, intervention confined to joint resealing shall be undertaken at the following ages :

three months
ten years
seventeen years
twenty four years

Joint resealing shall be undertaken only where water can enter the pavement ırface. Any areas where doubt exists shall be tested with the water box described in ɛction 13 of the Specification. If the level of water falls by less than 0.25 inches in ıree hours, the area shall be considered to be waterproof.

LTERNATIVE INTERVENTION PROGRAM

Intervention may be undertaken less frequently than specified providing none of ıe defect quantities shown in the previous table are exceeded. It is considered that fter the initial three months, it may be possible to undertake major remedial work on ten years cycle rather than the seven years cycle stated.

:ONCLUSIONS

The SEP described in this paper has been in force since 1985 and has permitted ll those parties involved in the project to assess the present condition of the pavement ı a factual numeric way. This has led to each party being able to focus attention on he condition of the pavement, rather than seeking to defend their position. As a onsequence of this, the design and construction of all of the projects to which SEP has ɔeen applied has been to a high standard. This has in turn led to an improvement in ong term performance.