Review of block paving in UK ports

by J.S. Gerrard
Development Division, Dover Harbour Board

IN 1975 the British Ports Association (BPA) engineering committee set up a working party to investigate the design, construction and performance in service of paving for container and Ro/Ro cargo handling berths.

Questionnaires concerning current paving use were sent to lhe ports shown in Table 1.

The information received included the type of paving in use, its initial and subsequent maintenance costs, details of any major defects, types of vehicles and equipment using the pavement, as well as their wheel loadings and movements.

It is of interest to note that in their replies only two ports indicated that they had used concrete block paving. These were Cardiff and Dover.

At Cardiff, the Docks Engineer specified 80 mm concrete shaped blocks on 300 mm of crushed limestone for a 600 m^2 loading bay situated outside a new transit shed. The engineer concerned reported that the main contractor for the project was most unenthusiastic in the early stage, and as a result of this a Specialist paving sub-contractor was used to lay lhe blocks. This work was carried out in September 1975 and remains in excellent working condition. Figure 1 shows a general view during construction.

At Dover a 400m^2 trial area was laid in March 1976. The area selected for the trial was situated within a heavily used Ro/Ro freight park. In Figure 2 we can sec lhe block paved area in relation to the original paving.

The freight part area had been reclaimed from the sea some 5 years earlier, and as a result of settlement of the chalk fill the original 260 mm unrcinforced concrete slab had suffered severe cracking and required replacement.

The trial was carried out in conjunction with the C&CA who gave considerable assistance with regard to design and laying methods.

The original specification agreed upon was for 80 mm blocks on 50 mm sand on 280 mm of type 2 subbasc, based on a 20 year working life. In the event the choise of sub-base material proved to be disastrous, and the trialarea collapsed within 2hours of opening io traffic.

In lhe ensuing investigation it was discovered that the moisture content within the sub-base material was excessively high, and as a result it had become unstable. Site staff confirmed that during a heavy rainstorm on the previous day they had noticed that surface water run-off from adjoining areas had been absorbed through the block joints and that the area appeared to act as a sponge.

In our earlier discussions with the C&CA it had been suggested that only 10% of surface water could initially percolate through the joints and that these would rapidly seal under traffic. It is my opinion that this figure is far too low and I would

Table 1: **Ports providing information on container and Ro/Ro Berths**

Belfast Harbour Commissioners
Port of Bristol Authority
British Transport Docks Board
Barry, Fleetwood, Garston, Grimsby & Immingham, Hull, Kings Lynn, Lowestoft, Newport, Plymouth. Southampton, and Swansea & Port Talbot
Dover Harbour Board
Dublin Port & Docks Board
Felixstowe Dock & Railway Co.
Forth Ports Authority
Ipswich Port Authority
Larne Harbour Lid.
Port of London Authority
Manchester Ship Canal Co.
Mersey Docks & Harbour Co.
Poole Harbour Commissioners
Tees & Hartlepool Port Authority
Port of Tyne Authority
Weymouth & Portland



Figure 1: Paving at Cardiff in 1976



Figure 2: Trial area at Dover in 1976.



Figure 3: Blacktop damage at Ipwich

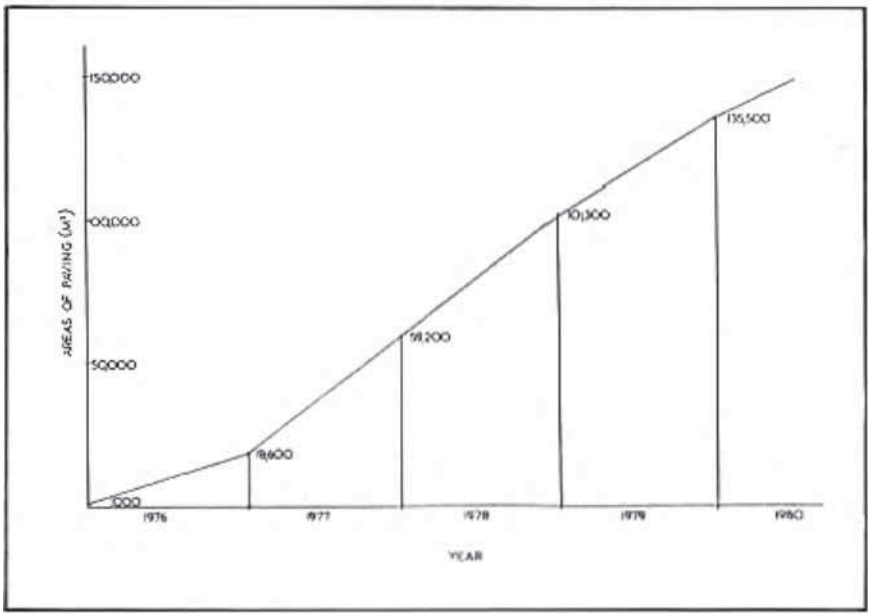


Figure 4: Growth of block paving in UK ports.

advise any engineer specifying (his type of paving to avoid using sub-base materials that are susceptible under conditions of high moisture content.

The unstable sub-base material in the trial area was subsequently removed and replaced with a 250 mm layer of lean mix concrete, and the blocks relaid. The area has now been in use for 4½ years, has had approximately 2 million freight vehicles over it. and has required no maintenance.

As is evident from the paper by H. van Leeuwen. the use of block paving in European ports had been an established practice for a number of years, and the study tour reports produced by Messrs. Knapion and Lilley in 1974/75 concerning the industrial use of block paving in Belgium, Denmark, Germany and Holland provided a sound basis for UK ports' engineers to assess this 'new' type of paving for use as an alternative to more conventional systems.

Returning to the BPA report, it became apparent from the replies received that, because many port areas are frequently subject to settlement, engineers had a preference for flexible paving.

It was also obvious that a number of ports were experiencing severe maintenance problems with conventional black top paving as a result of damage caused by jockey wheels, container corner pads and oil and hydraulic spillages. The photograph in Figure 3 illustrates this familiar problem and was taken at Ipswich.

In their final report to the BPA engineering committee, the working parly made the following comments with regard to block paving.

"Although the initial cost of laying concrete block paving is at



Figure 5: Freight parking area at Poole



Figure 6: Recent view of paving at Poole.

present higher than that for bituminous and insitu concrete pavings, it is possible that the cost may reduce in the future, and the resultant savings in maintenance costs compared with other types of pavings currently in service in ports in this country could be considerable.

"Concrete block pavings are con sidcrcd to have a significant future for use in container and Ro/Ro berths, and it is recommended that the use of this type of paving should be extended."

The survey was completed early in 1976 and at that time the total area of blockwork in UK ports was approximately 1000 square metres. From subsequent events we may say that 1976 was the base year for block paving in UK ports and is amply illustrated in Figure 4 which shows the annual growth of this type of paving.

This rapid growth started at Poole Harbour where in 1976. under the direction of the Port Engineer Mr Appleton. Poole Harbour Commissioners carried out I8000m² of block paving, for a freight parking area (Figure 5).

The area had been reclaimed from the sea some 3½ years earlier and surfaced with a 300mm layer of crushed limestone which was conveniently available from local quarries This layer was graded off to the required levels and the block paving laid directly over.

Whilst the decision to use this type of paving at Poole was based on sound knowledge gamed from its use in Europe, it was nonetheless a courageous engineering decision The burden of this type of decision is never light and the practising engineer knows only too well the attendant publicity should a failure occur.

Following 4½ years of hard wear, the paving at Poole remains in excellent condition as can be seen in the photograph in Figure 6.

The successful use of this type of paving at Poole gave suitable encouragement to other ports, and from Table 2 we can sec the substantial growth of block paving that subsequently took place in UK ports.

It emerges clearly from this table that, once a port has used block paving, it frequently specifics its use on subsequent contracts. This 1 feel is a sure sign of satisfaction on the part of the user.

Figures 7 and 8 show typical examples of block paving in some of these ports. Types of ground condition and sub-base material varied considerably as can be seen in Figure 9.

Obviously the choice of sub-base material is related to availability of local materials and financial outlay, but great care must be exercised

Table 2: Block paving within UK ports. 1976-1980

Year	Port	Use		Area (m^2)
1976	Poole	Freight Park	Ro/Ro	17600
1977	Dover	Freight Park	Ro/Ro	400
	Dover	Freight Park	Ro/Ro	20 000
	Ipswich	Freight Park	Ro/Ro	20 200
1978	Mersey	Container Terminal		1 305
	Poole	Cargo Quay		780
	Ocl. Dagenham	Container Terminal		13 400
	Poole	Cargo Quay		2 400
	Dover	Freight Park		20 000
	Shoreham	Timber Berth		4 200
1979	Poole	Cargo Quay		2 500
	Poole	Freight Park	Ro/Ro	2000
	Grimsby	Nor Cargo Terminal		8 IVO
	Grimsby	DFDS Terminal		3 300
	Grimsby	DFDS Terminal		2000
	Ipswich	Freight Park		8 100
	Dover	Freight/Car Park		10 000
1980	Dover	Freight/Car Park		17 000

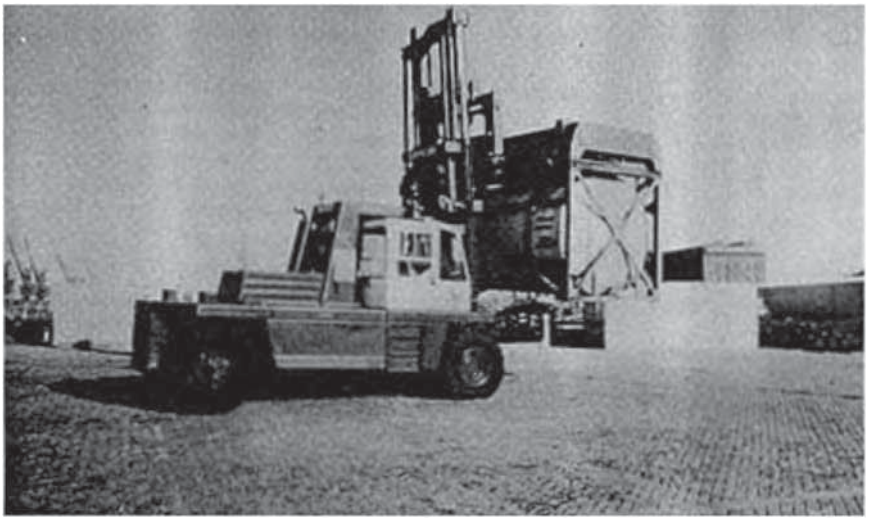


Figure 7: Paving at Immingham Docks.



Figure 8: Paving at Ipswich.

Table 3: **Block Paving: Dover 1978/79 - Cost Comparisons***

Contractor	Supply & Lay 250 mm Lean Mix (£/m²)	Supply & Lay 80 mm Blocks (£/m²)
A	4.37	6.53
B	8.03	8.60
C	6.11	8.25
D	5.56	6.79
E	4.72	8.60
F	5.07	8.00

* Prices are at 1978 levels.

when selecting this item. In conjunction with the National Coal Board (NCB), we recently laid a 5 000 m² trial area using cement stabilised minestone as a cheaper alternative to lean-mix concrete, and we are now carefully monitoring its performance. We have also recently carried out a trial in which the blocks were laid directly onto the Goodwin sand bulk fill to a new reclamation. This method is of course in line with practice in many European ports.

Many port engineers indicated that, in the early days of block paving, there was a marked disinterest by contractors in this type of paving. The high unit costs quoted were a reflection of the relatively

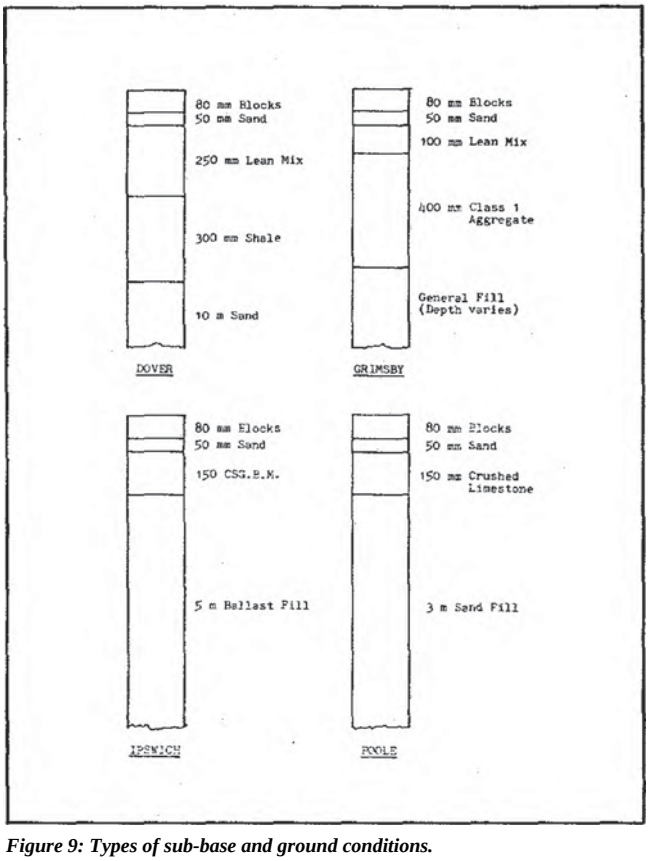


Figure 9: Types of sub-base and ground conditions.

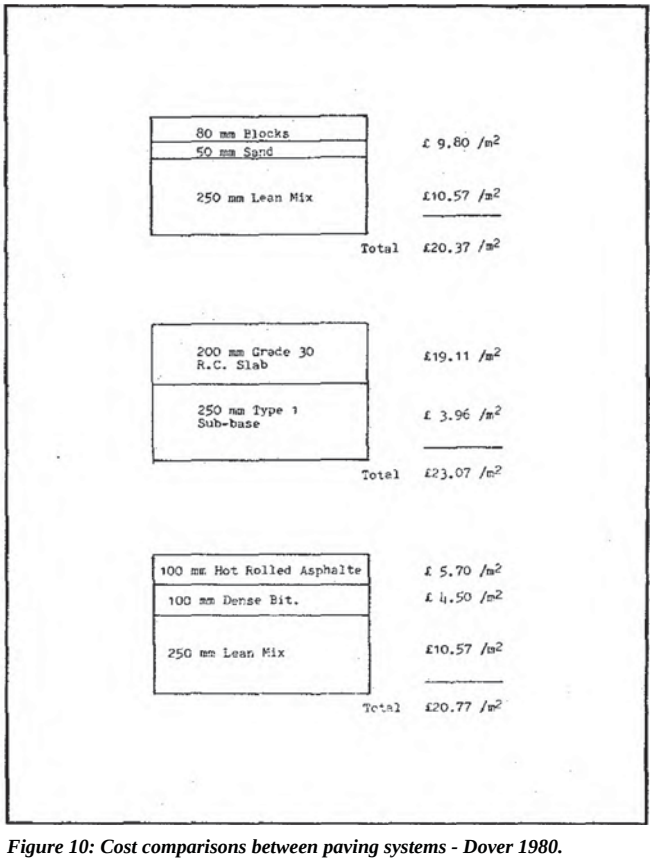
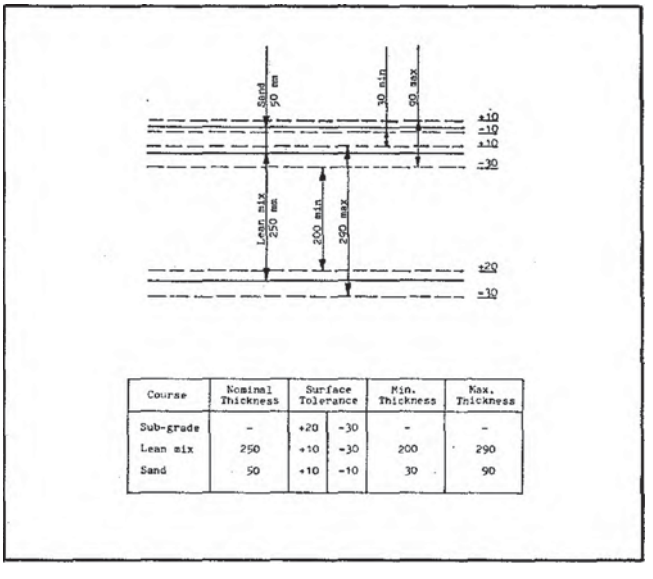


Figure 10: Cost comparisons between paving systems - Dover 1980.



Course	Nominal Thickness	Surface Tolerance		Min. Thickness	Max. Thickness
Sub-grade	-	+20	-30	-	-
Lean mix	250	+10	-30	200	290
Sand	50	+10	-10	30	90

Figure 11: Vertical tolerance variations.

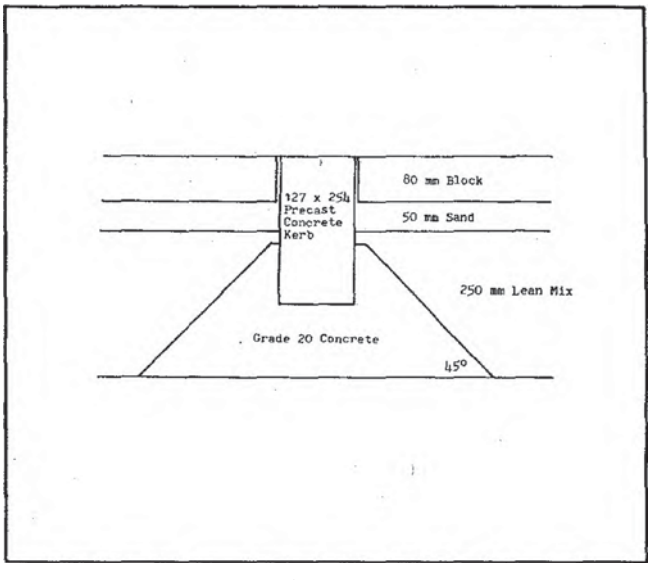


Figure 12: Cross-section through flush kerbs at Dover.

unknown laying rates and site problems associated with it.

However, with increasing usage we are seeing a much greater interest on the part of contractors and, in relative terms, costs have reduced.

Comparison of unit costs quoted by six major contractors for the supply and laying of 27000m^2 of Uniblock paving at Dover in 1978 does however reflect the variation in assessment of laying output between various contractors, and these are shown in Table 3.

There arc, of course, several specialist block-laying contractors operating within the UK, but experience at Dove r suggests that their high unit costs reflect the use of skilled labour that is not locally based.

Whilst on the subject of costs, we recently made some comparisons between different paving systems based upon quotations received during 1980, and these are illustrated in Figure 10. Obviously these prices will vary around the country, dependent upon location of constituent materials.

In my discussions with other port engineers, and from experience gained at Dover, a number of practical considerations emerge, and it may be that, in the company of such a learned as.sembly, the following practical considerations will be of interest:

1. *Laying tolerances*

The specifying engineer should ensure that there is no inherent incompatibility between the vertical tolerances stated for sub-base, sand and blocks. A failure to achieve suitable harmony could result in the situation shown in Figure II.

We have all been warned of the nasty surface effects of sand layer variations!!

2. *Flush kerbing*

When layingvery large areas of block paving it is sometimes useful to break them up into smaller bays by use of flush kerbing A typical cross section of the type used in Dover is illustrated in Figure 12, and Figure 13 shows the layout of flush kerbs in a recently completed scheme at Dover.

This system facilitates the phased handover of completed areas for operational use without risk of edge damage. In human terms it alleviates the misery of the poor blocklayer facing the seemingly endless task of laying a million or more blocks without a natural break.

It is however essential that the blocks be laid proud of the flush kerbing since they will settle at a greater rate once they arc trafficked.

3. *Manholts*

It is essential that manhole frames be

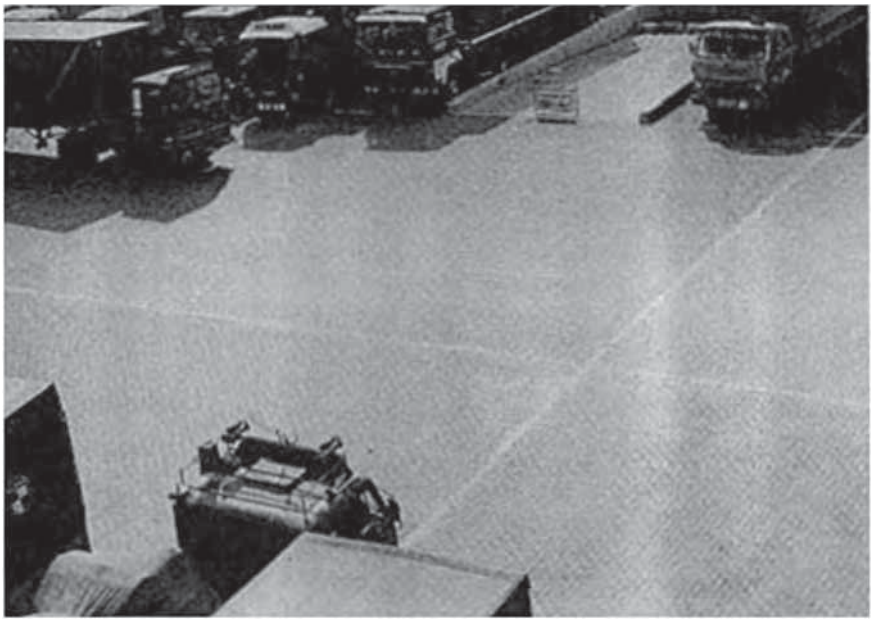


Figure 13: Layout of flush kerbs in new reclamation area - Dover.

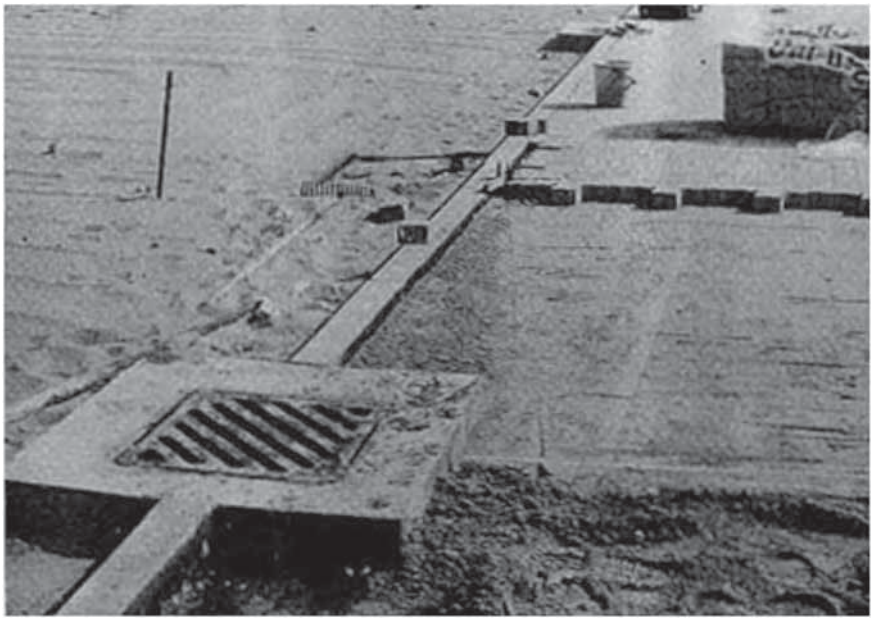


Figure 14: In situ concrete round manhole frames.



Figure 15: Vibrating roller is preferred to plate vibrators at interface.



Figure 16: Rainwater pipe discharging on to paving!

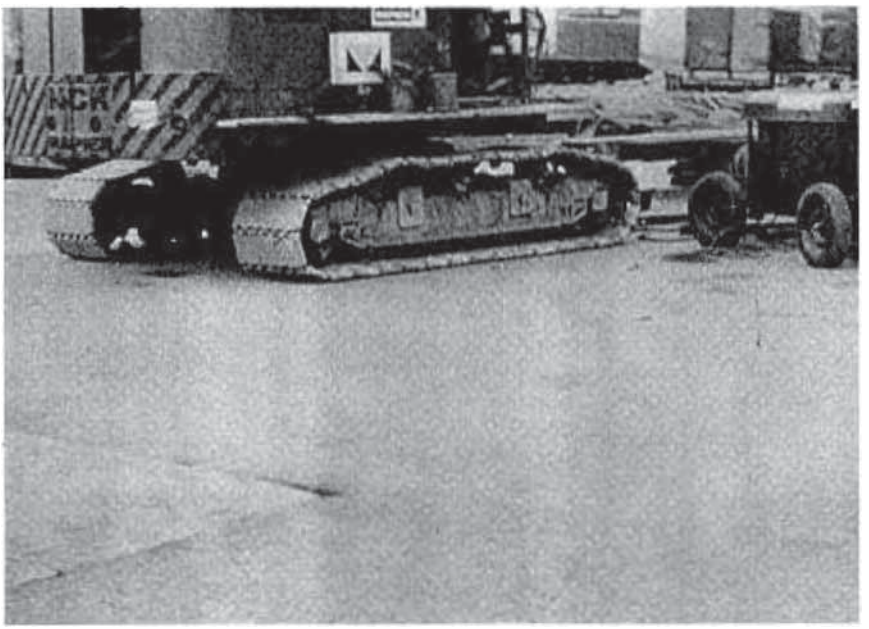


Figure 17: Heavy tracked cranes should be kept off paved areas.



Figure 18. Damaged surface caused by tracked crane.

surrounded by an insitu concrete edge strip to avoid sand loss through or under the frames (Figure 14).

4. *Laying patterns*
Operational niceties should never be allowed to force the contractor to lay more than one face at a time. Failure to apply this philosophy will result in certain disaster when the separate laying faces meet.

5. *Edge compaction*
In paved areas abutting fixed foundations such as piled structures it is advantageous to use a vibrating roller rather than a plate vibrator. The former will achieve a much more satisfactory compaction at the interface (Figure 15).

6. *Tankers*
Beware of large road tankers that have been filled with water in order to calibrate their loading capacity. There is a nasty type of official in our ports who is known to direct such vehicles onto the block paving in order to discharge their contents. The effect of 25000 gallons of water discharged vertically onto block paving via a 75 mm diameter pipe is somewhat traumatic!! A similar problem exists with regard to the discharge of rain water pipes onto such surfaces (Figure 16).

7. *Contractors' plant*
Heavy tracked cranes are totally unsuited for travel along block paved areas, and the surface must be protected. On a recent contract in Dover the contractor failed to provide adequate protection and caused severe cracking in localised areas, necessitating replacement of large numbers of blocks (Figures 17, 18).

8. *Laying method*
Where possible always lay uphill - preferably in summer.

Future use of block paving in UK ports

We at Dover are entirely satisfied with the performance of our block paving. It takes tremendous wear and tear from heavy freight vehicles, night and day, 364 days a year. We cannot afford the luxury of any down-time on our parking areas since wc will handle about 12 million passengers, 1½ million cars and 500000 freight vehicles this year.

Our view is shared by other port engineers who have specified this type of paving, and judging by the number of enquiries we have received from interested ports and consultants, it seems obvious that growth will be sustained.