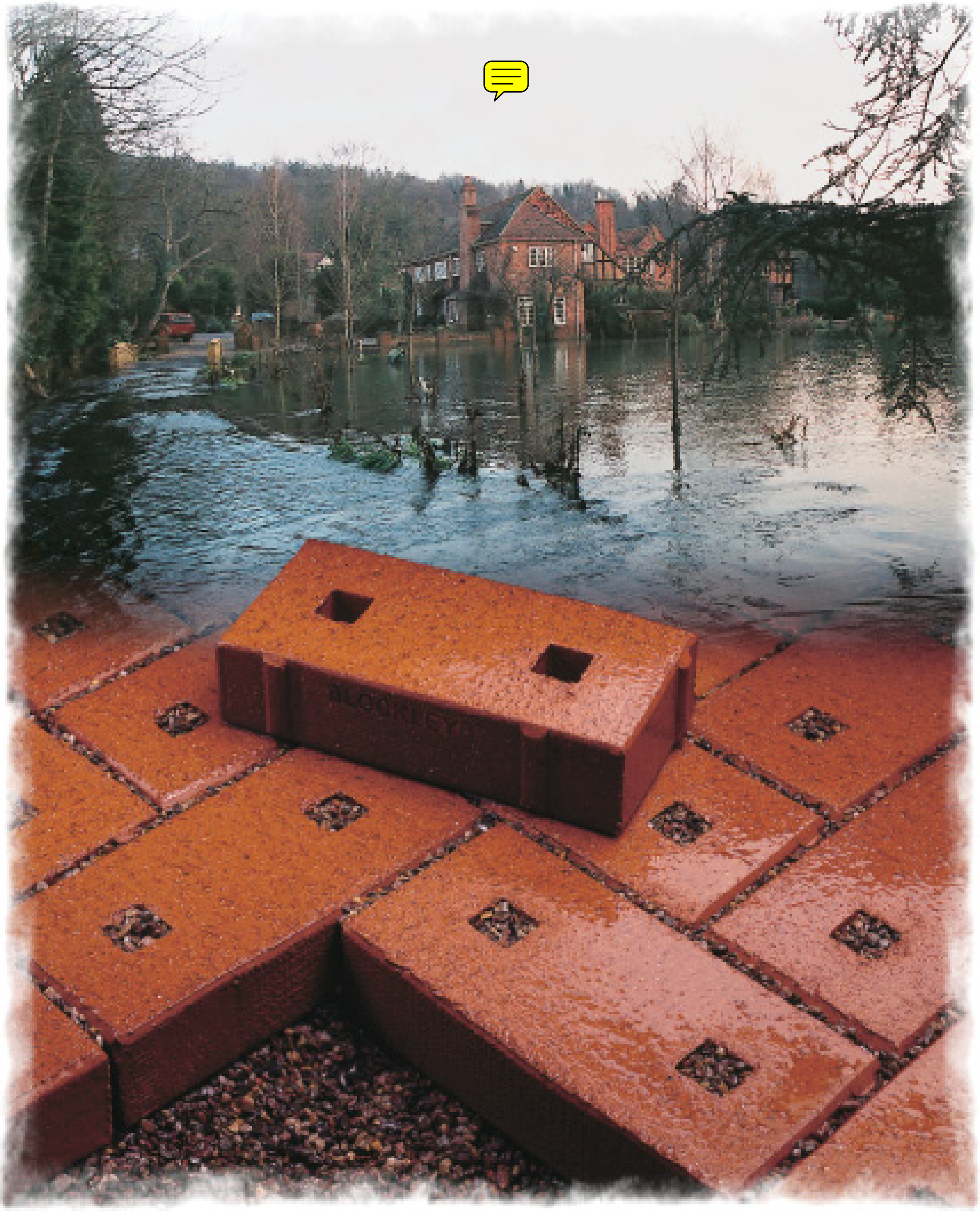
BLOCKLEYS

Permeable Paving



Background

Sustainable development presents a strategy for society to follow such that progress is in harmony with the natural world rather than in conflict with it.

Increasing pressure from planning agencies to develop 'brown field' sites in towns and cities is concentrating attention on the issues associated with sustainable rainwater disposal. Rain falling on paved areas is normally drained via gulley outlets to sewerage systems that discharge into streams and rivers. Increased run-off from the growing number of roads, paved areas and residential and industrial buildings therefore increases the risk of sewers becoming overloaded, receptive watercourses flooding and possible damage to river habitats. At the same time water table levels may become depleted.

Surface water run-off is often thought to be clean. It can, however, contain a range of contaminants including oils, organic matter, heavy metals and toxic materials. Even when highly diluted, these can adversely affect water quality.

The protection of streams and rivers from the damaging effects of flooding and pollutants can be eased by the implementation of Sustainable Drainage Systems (SuDS). These present a series of design options that permit a designer to select the best solution for a particular site. SuDS include grass swales, filter strips, retention ponds, wetlands and **permeable pavements**.

SuDS offer a number of advantages over conventional drainage systems:-

- They deal with run-off close to where rain falls
- They reduce the loading on existing sewerage systems
- They help to reduce instances of flooding
- They protect urban watercourses from accidental spillage and pollution.
- They enable new development in areas where existing sewerage systems are at or near full capacity
- They permit direct recharging of ground water resources where conditions are suitable
- They permit simpler and more cost effective drainage solutions

Permeable pavements allow 'run-off' to pass through the surface rather than running off it as would normally be the case. The pavement structure and the materials used must therefore be designed with this in mind. Depending on ground conditions, either a fully **'tanked system'** or an **'exfiltration system'** can be specified. With tanked systems water is temporarily held in a reservoir structure under the pavement formed using an impervious plastic membrane. The water is then allowed to discharge slowly through a small diameter pipe to a watercourse or an existing drainage system. Exfiltration systems are formed in a similar way to tanked systems but should only be used over a suitably pervious subgrade. The impervious plastic membrane is replaced with a woven geotextile material that allows water to pass through it into the subgrade. Subgrade soils suitable for use with exfiltration systems are assessed using a falling head permeameter. When filled to a depth of 150mm with clean water, the permeameter should empty in 20 minutes or less.

Any additional costs in constructing permeable pavements are generally more than offset by the savings made by eliminating conventional drainage networks and the simplification of surface drainage profiles.

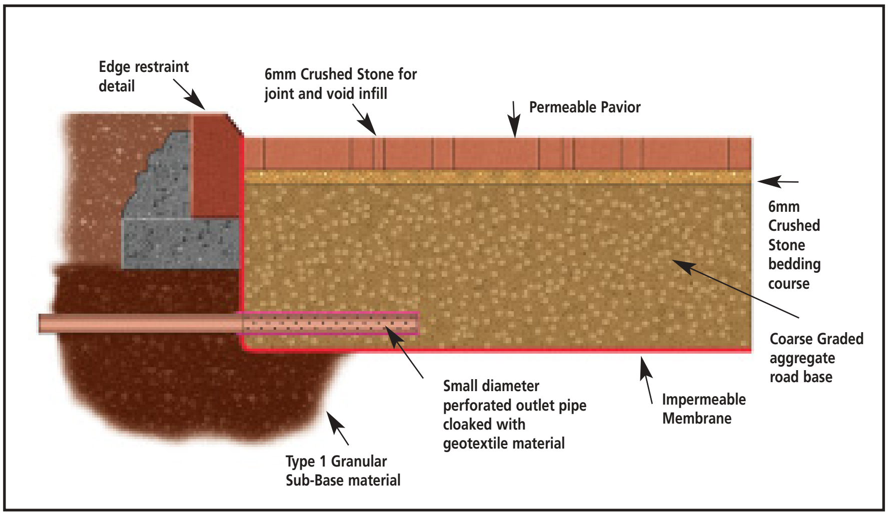


Fig 1 – Tanked Permeable Pavement System

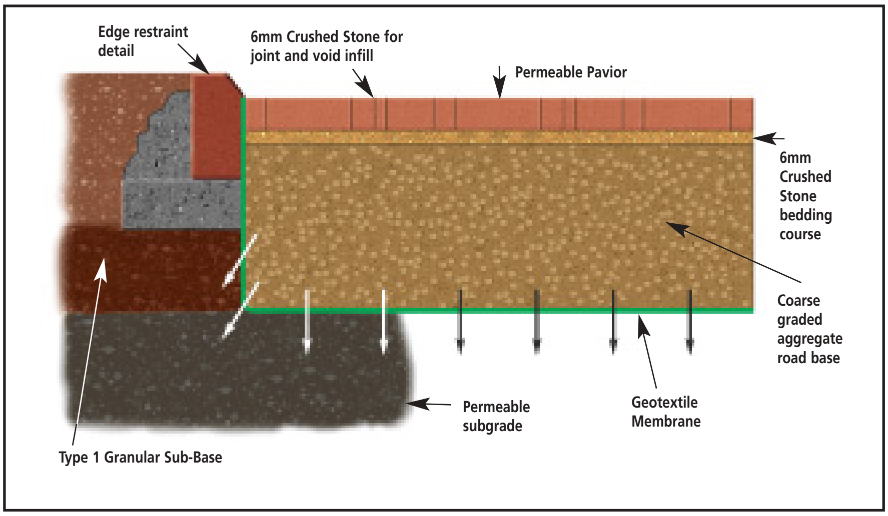


Fig 2 – Exfiltration Permeable Pavement System

Design

A typical construction for a tanked permeable pavement might be:-

Wearing Surface:-	210x105x65mm Blockleys' permeable paviors
Bedding Course:-	50mm thickness of 6mm crushed stone
Roadbase:-	Designed thickness of 20-5mm coarse graded aggregate
Impermeable Membrane:-	2000 gauge polythene
Sub-Base:-	Designed thickness of DTp Type 1 granular sub-base material to Clause 803
Capping Layer:-	Designed thickness of locally available material with a minimum California Bearing Ratio (CBR value) of 15%

***Note:-** In some circumstances the roadbase may comprise two layers of 'single size' material. The overall thickness of roadbase can be formed with a 150mm thickness of 20-5mm aggregate over a designed thickness of coarser 150 – 25mm. For heavily trafficked pavements the upper part of the roadbase may be cement stabilised.*

Design of Roadbase for Water Storage

Drainage systems are usually designed on the basis of a specific storm return period. At a specific site for a specified storm return period the rainfall depth varies throughout the country. The location of a project is therefore a critical design parameter.

Recent changes in weather patterns have led to instances of extremely high localised rainfall. For example, during a storm that passed over the UK on the 30th July 2002, storm return periods of up to once in 126 years were recorded. This is far in excess of that used as the basis for permeable pavement design. These rainfall 'peaks' (extreme events) can however generally be accommodated by the designs especially when a safety factor is used in the determination of roadbase thickness.

Permeable pavements should generally be designed on the basis of either a 6 hour or a 24 hour storm with a 5 year return period. In some circumstances, however, and depending on local design guidelines, it may be necessary to increase the return period of the design storm. Essentially this will be decided by the level of risk and the potential consequences associated with the inundation of a particular site.

The notation used to describe a storm event is MT-D where T is the return period in years and D is the storm duration.

In the UK it is conventionally assumed that the depth of water falling during an M5-60 storm event (ie a once in 5 year storm with 60 minutes duration) is 20mm. The depth of water falling on a particular location during a prescribed storm period is M5-60 x Z1 (ie 20mm x Z1). The value of Z1 is determined by selecting the nearest city to a specific site and reading off a value of 'r' from Table 1.

In Table 2 the value of Z1 can be found for a specific value of 'r' and the prescribed rainfall duration.

For example, a storm in London with a 5 year return period and duration of 24 hours (M5 – 24hours) is associated with 20mm x 2.03 = 40.6 mm of rain falling.

If the required storm return period is not 5 years, then the depth of rain falling must be multiplied by an additional factor Z2 determined from Table 3.

For example, the rainfall during a 24 hour storm with a 100 year return period will be (M5 – 24 hour) x (Z2 factor associated with 40.6mm of rainfall and 100 year return period) or 40.6 x 1.89 = 76.7mm.

If it is assumed that the roadbase material has a storage capacity in its voids of 33% and that only 60% of the voids will be saturated then the depth of roadbase required to accommodate an M100 – 24 hour storm will be (76.7 x 3) / 0.6 = 384mm.

For comparison the roadbase thickness required to accommodate an M5 - 24 hour storm event is (40.6 x 3) / 0.6 = 203mm.

Table 4 gives roadbase thicknesses to accommodate 6 hour and 24 hour rainfall for specific values of 'r' and a 5 year storm event.

In situations where run-off from adjacent impermeable surfaces; such as roofs and hard-standings, drains into areas of permeable paving, the depth of the roadbase should be increased in accordance with the equation:-

Actual Depth of Roadbase
= Designed Depth of Roadbase x **Factor M**

$$\text{Where Factor M} = \frac{\text{Total Drained Area}}{\text{Area of Permeable Paving}}$$

The increased roadbase thicknesses for 6 hour and 24 hour rainfall associated with a 5 year storm event for different values of Factor M are as shown in Table 5.

Table 1 – 'r' Value

City	r-value
Cambridge	0.45
London	0.45
Norwich	0.42
Birmingham	0.39
Bristol	0.39
Liverpool	0.39
Nottingham	0.39
Sheffield	0.39
Southampton	0.39
Belfast	0.33
Cardiff	0.33
Leeds	0.33
Manchester	0.33
Newcastle	0.33
Plymouth	0.33
Edinburgh	0.27
Aberdeen	0.24
Glasgow	0.24

***Note:-** The r-value is the ratio of the 60 minute to 2 day rainfalls with a return period of 5 years.*

Table 2 – Value of Z1

(r)	Minutes				Hours					
	5	10	5	30	1	2	4	6	10	24
0.12	0.22	0.34	0.45	0.67	1.00	1.48	2.17	2.75	3.70	6.00
0.15	0.25	0.38	0.48	0.69	1.00	1.42	2.02	2.46	3.23	4.90
0.18	0.27	0.41	0.51	0.71	1.00	1.36	1.86	2.25	2.86	4.30
0.21	0.29	0.43	0.54	0.73	1.00	1.33	1.77	2.12	2.62	3.60
0.24	0.31	0.46	0.56	0.75	1.00	1.30	1.71	2.00	2.40	3.35
0.27	0.33	0.48	0.58	0.76	1.00	1.27	1.64	1.88	2.24	3.10
0.30	0.34	0.49	0.59	0.77	1.00	1.25	1.57	1.78	2.12	2.84
0.33	0.35	0.50	0.61	0.78	1.00	1.23	1.53	1.73	2.04	2.60
0.36	0.36	0.51	0.62	0.79	1.00	1.22	1.48	1.67	1.90	2.42
0.39	0.37	0.52	0.63	0.80	1.00	1.21	1.46	1.62	1.82	2.28
0.42	0.38	0.53	0.64	0.81	1.00	1.20	1.42	1.57	1.74	2.16
0.45	0.39	0.54	0.65	0.82	1.00	1.19	1.38	1.51	1.68	2.03

Table 3 – Value of Z2

mm of rainfall	Storm Duration (Years)				
	M5	M10	M20	M50	M100
5	1.02	1.19	1.36	1.56	1.79
10	1.03	1.22	1.41	1.65	1.91
15	1.03	1.24	1.44	1.70	1.99
20	1.02	1.24	1.45	1.73	2.03
25	1.02	1.24	1.44	1.72	2.01
30	1.02	1.22	1.42	1.70	1.97
40	1.02	1.19	1.38	1.64	1.89
50	1.02	1.17	1.34	1.58	1.81
75	1.02	1.14	1.28	1.47	1.64
100	1.02	1.13	1.25	1.40	1.54
150	1.02	1.12	1.21	1.33	1.45
200	1.01	1.11	1.19	1.30	1.40

Table 4 – Roadbase Thickness (Water Storage) - 5 year storm event

Ratio of 60 minute to 2 day rainfall	Roadbase thickness to accommodate 6 hour rainfall	Roadbase thickness to accommodate 24 hour rainfall
(r)	(mm)	(mm)
0.12	275	600
0.15	250	500
0.18	225	425
0.21	225	350
0.24	200	325
0.27	200	300
0.30	175	275
0.33	175	250
0.36	175	250
0.39	175	225
0.42	150	200
0.45	150	200

Table 5 – Factored Roadbase Thicknesses - 5 year storm event

(r)	M = 1 Rainfall		M = 1.5 Rainfall		M = 2 Rainfall		M = 2.5 Rainfall		M = 3 Rainfall	
	6hr	24hr	6hr	24hr	6hr	24hr	6hr	24hr	6hr	24hr
0.12	275	600	425	900	550	1200	700	1500	825	1800
0.15	250	500	375	750	500	1000	625	1250	750	1500
0.18	225	425	350	650	450	850	575	1075	675	1275
0.21	225	350	350	525	450	700	575	875	675	1275
0.24	200	325	300	500	400	650	500	825	600	975
0.27	200	300	300	450	400	600	500	750	600	900
0.30	175	275	275	425	350	550	450	700	525	825
0.33	175	250	275	375	350	500	450	625	525	750
0.36	175	250	275	375	350	500	450	625	525	750
0.39	175	225	275	350	350	450	450	575	525	675
0.42	150	200	225	300	300	400	375	500	450	600
0.45	150	200	225	300	300	400	375	500	450	600

Design of Roadbase for Water Storage

Permeable pavements contravene the traditionally accepted principles of pavement design. These dictate that a pavement should be impermeable and that any water ingress must not weaken the components of the pavement or the underlying subgrade.

The deliberate cascading of water through a permeable pavement therefore requires a radical approach to the assessment of design loadings and the selection of construction materials.

Permeable pavements are designed on the basis of **ultimate limit state analysis** rather than serviceability limit state analysis. Traditionally loadings on highway pavements are assessed in terms of the number of 8000 kg axles (equivalent standard axles) that a pavement will be required to withstand during its design life. For permeable pavements, loading is assessed in terms of the **maximum load** that it will have to withstand.

Permeable pavement construction materials are selected on the basis of good performance when in a saturated condition. For this reason, materials with low fines contents are required. The design methodology for the materials ensures their stability, strength and durability.

The design methodology for permeable pavements follows conventional highway engineering practices and is based on laboratory and field research supported by observations of the performance of trafficked pavements.

When using an ultimate limit state design approach, loads are predicted and then multiplied by a **load safety factor** that reflects the degree of accuracy of the prediction. Material strength is measured and then adjusted by a **material safety factor** that reflects the level of consistency of the material.

Loading Assessment – For a particular design situation select a category of loading from Table 6. Multiply the **maximum axle load** by a **load partial safety factor** obtained from Table 7. Using the factored load, determine the roadbase thickness by reference to Table 8.

Roadbase Thickness

The roadbase thickness selected should be the greater of that determined for hydraulic and structural considerations.

The stability of the material used for constructing the roadbase should be assessed by reference to Table 9 and the thickness adjusted accordingly by multiplying it by the appropriate partial safety factor. Suitable roadbase materials are typically Mendip limestone, Thames Valley gravel or crushed granite.

Example of Load Category 1.

Example of Load Category 2.

Example of Load Category 3.

Example of Load Category 4.

Table 6– Load Category

Load Category	Maximum Axle Load Anticipated (kg)
Category 1 – Domestic (GVW = 2000kg)	1000
Category 2 – Light (GVW = 3500kg)	2000
Category 3 – Commercial (GVW = 7500kg)	5000
Category 4 – Heavy (GVW = 44,000kg)	11000

Note: *The category selected should relate to the highest anticipated vehicle loading – expressed as Gross Vehicle Weight (GVW) – that will use the pavement. For GVWs between those detailed above, always select the higher value.*

Table 7 – Load Partial Safety Factor

Level of Certainty of Load	Load Partial Safety Factor
Certain	1.0
Well Informed	1.2
Anecdotal	1.5

Note: *For Category 4 vehicles (Table 6) the maximum load partial safety factor is 1.1*

When roadbase thicknesses exceed 400mm resulting from, for instance, a requirement to drain impermeable areas into permeable paved areas then it may be necessary to allow the full depth of the roadbase to become saturated rather than the 60% assumed in normal design procedures.

In addition where a designed roadbase thickness exceeds 400mm, a 150mm thick layer of 20 – 5 mm aggregate (approximately 33% void ratio) may be laid above a minimum 250mm thick layer of 150 – 25 mm aggregate (approximately 40% void ratio).

Unbound granular material with a thickness of up to 225mm can be spread and compacted in one layer such that after compaction the total thickness is as specified. Where the thickness of the roadbase requires it to be constructed in two layers, the lower layer should be the thicker. The minimum compacted thickness of roadbase material should not be less than 110mm. Compaction of unbound material should be in accordance with the recommendations given in Clause 802 of the DTp Specification for Highway Works and should preferably involve the use of a twin drum vibratory roller.

The surface of any one layer of roadbase material after compaction and immediately before overlaying should be free from movement under construction plant and from ridges, loose material, pot holes, ruts or other defects. If required all loose or otherwise defective areas of a roadbase should be removed to the full thickness of a particular layer and new material laid and compacted.

In all cases, the CBR value of the roadbase material should be ≥ 30% in a dry state and when soaked.

Where a cement stabilised roadbase layer is required, the materials selected should allow the percolation of water and prevent the loss of 6mm grit from the bedding course. The cement content should be approximately 130 kg/m^3 but should also be sufficient to ensure a characteristic 28 day compressive strength of 10 N/mm^2. Aggregates used should be naturally occurring crushed rock material with an absorption value not greater than 2%. The grading should fall within the range:

Sieve Size (mm)	Percent by Mass Passing
37.5	100
20	90 - 100
14	40 - 80
10	30 - 60
5	0 - 10
2.36	0

Cement stabilised roadbases should be installed such that the upper surface of the material is within 10mm of the required level. It should be laid in accordance with the requirements of Clause 802 of the Specification for Highway Works using a suitable twin drum vibrating roller. The material should be compacted to refusal in layers not exceeding 150mm thick. Within one hour after placement and not longer than two hours after mixing, a curing compound should be applied to the surface. This should not impede the future percolation of water through the concrete. No heavy plant should be allowed onto the roadbase for at least 48 hours after its construction.

Membrane Layer

For tanked permeable pavement systems, an impermeable membrane should be included in the construction between the roadbase and the sub-base layers. This should typically be a 2000 gauge high density polyethylene (HDPE) material. Joints in the material should overlap by 300mm and should be sealed with double

sided tape. In situations where there is a danger that the water table may rise above the level of the membrane, a specialist heavy duty membrane may be required and the joints should be welded.

When an 'exfiltration' system is used, the impermeable membrane should be replaced with a woven geotextile positioned between the roadbase layer and the subgrade. Joints in the geotextile should overlap by a minimum of 300mm.

Design of the Sub-base

When constructing tanked pavements and if the subgrade soaked California Bearing Ratio (CBR value) is greater than 5%, then a sub-base formed using DTp Type 1 material is not required structurally. However a 150mm thickness should be laid as a regulating course to provide an acceptable surface on which to lay the impermeable membrane and to prevent the development of damaging localised high stresses. On poorer ground (subgrade CBR ≤ 5%) the thickness of sub-base required below the impermeable membrane should be determined as shown in Table 10.

For exfiltration pavements the use of a sub-base is not appropriate as 'well compacted' DTp Type 1 material is relatively impervious. If the CBR of the subgrade is less than 2% it is unlikely that the use of an exfiltration system will be appropriate.

Where an exfiltration system is selected and the design requires the incorporation of a sub-base layer then an additional thickness of roadbase material can be specified instead. This should be equivalent to the designed sub-base thickness and be included above the woven geotextile.

Drainage Design

Water retained in tanked permeable pavements should be discharged horizontally through a pipe positioned approximately 15 – 20mm above the base of the reservoir structure. Typically discharges from permeable pavements are restricted to 'green field' run off rates that are variously assessed at between 5 – 7 litres per sec per hectare. In the case of brownfield developments, this figure may be reduced to 2 litres per sec per hectare.

The following flow rates can be achieved with pipe outlets of various diameters:-

Pipe Diameter (mm)	Gradient	Flow Rate (l/sec)
100	1:100	6.4
75	1:100	3.5
50	1:100	1.6

The exit pipe should extend approximately 1m into the roadbase material, be multi-perforated and be completely wrapped in geotextile material.

As run-off is able to pass directly through the surface of permeable pavements, they can be constructed with perfectly flat horizontal profiles.

Wearing Surface and Bedding Course

After final compaction of the roadbase, a single size 6mm crushed stone laying course material with a grading as shown in Table 11 should be screeded over it to a depth such that after final compaction it has a thickness of 50mm ± 10 mm. It should not be compacted until the permeable paviors have been laid on it.

Permeable paviors should preferably be installed to a 45° or 90° herringbone pattern. Joint alignment should be maintained during laying operations by using string lines. Joint widths between paviors should not exceed 9mm.

Laying course material (6mm crushed stone) should be brushed over the surface to completely fill the joints and any surplus material should be removed.

A plate compactor having the following characteristics should be used for compacting the wearing surface:-

Area of vibrating plate	0.8 m^2
Frequency of vibration	60 – 90 cycles per second
Out of balance force	75 kN

A plate vibrator that achieves greater levels of compaction may be used but its acceptance must be subject to trials to ensure that no damage is caused to the paviors.

A first pass of the plate compactor should be carried out. The joints should then be topped up with 6mm crushed stone and a second pass with the plate compactor completed. This sequence of topping up the joints followed by compaction should be repeated until each point in the pavement has been subjected to four passes of the plate compactor. If necessary the joints should be finally topped up with 6mm crushed stone to ensure that they are full.

Any damaged paviors should be marked, removed and replaced as soon as possible after the completion of construction operations.

Table 8 – Roadbase Thickness (Structural)

Factored Load (kg)	Course Thickness (mm)	
	Cement Stabilised Open Graded Crushed Rock	Open Graded Crushed Rock
1400	-	150
1600	-	150
2000	-	175
2800	-	200
3200	-	250
4000	-	300
6000	-	350
8000	150 (upper)	150 (lower)
10000	200 (upper)	150 (lower)
12100	300 (upper)	150 (lower)

Note: *When a cement stabilised roadbase is required, the cement content should be approximately 130 kg/m^3 to ensure a characteristic 28 day compressive strength of at least 10 N/mm^2.*

Table 9 – Stability of Roadbase

Nature of Open – Graded Crushed Rock	Material Partial Safety Factor
As stable as D.Tp Cl. 803 Type 1 material	0.9
As stable as graded 20mm crushed rock to BS 882	1.0
As stable as rounded 20mm graded gravel to BS 882	1.3

Table 10 – Sub-Base Thickness		
Subgrade CBR Value (%)	Sub-Base Thickness (mm)	Capping Layer Thickness (mm)
> 5%	150	0
5	225	0
4	150	200
3	150	350
2	150	450
1	Subgrade improvement required	

Note: *When the sub-base thickness required exceeds 150mm, the additional thickness may be provided by capping material.*

Table 11 – 6mm Grit Laying Course Specification	
BS Sieve Size (mm)	Percentage Passing
10	100
6.3	85 - 100
3.35	0 - 35
2.36	0 - 10

Design Examples

1) A car park development in Leeds is to be constructed as a permeable pavement using Blockleys' permeable paviors as the wearing surface. The car park is in an area where the CBR of the subgrade is 4%. The maximum gross weight of vehicles using the car park will be 4600 kg based on well-informed information. A 20 – 5mm coarse graded aggregate is available locally for the roadbase which is as stable as graded crushed rock to BS 882. The permeable pavement is required to retain water falling as a result of an M5 – 24 hour storm. No adjacent impermeable areas discharge water into the permeable pavement.

Water Storage – From Table 1 determine the 'r' value for Leeds. This is **0.33**. Using this figure in Table 4 the roadbase thickness required to give sufficient water storage is **250mm**.

Structural Design – By reference to Table 6, the maximum gross vehicle weight of 4600 kg falls into **Category 3** (maximum axle loading 5000 kg). Using Table 7 and for a level of certainty of load described as **well informed**, the load partial safety factor is **1.2**. The factored design load is therefore 5000 kg x 1.2 = **6000 kg**.

In Table 8 the roadbase thickness for a design load of 6000 kg is **350mm**.

As, in this instance, the roadbase thickness derived for structural considerations is greater than that required for water storage, then the depth of roadbase selected should be **350mm**.

The material partial safety factor selected from Table 9 for an open graded crushed rock that is as stable as a graded 20mm crushed rock is 1.0. The required thickness of roadbase is therefore 350mm x 1.0 = **350mm**.

For a CBR value of 4%, Table 10 indicates that a sub-base thickness of 150mm and a capping layer thickness of 200mm should be specified. Whilst the figures in Table 10 are a useful guide, the actual capping thickness used should be determined on site such that a stable working surface is created.

The full pavement section for the car park using a 'tanked' system is therefore:

Wearing Surface	-	210x105x65mm Blockleys' Permeable Paviors
Bedding Course	-	50mm 6mm crushed stone
Roadbase	-	350mm 20 - 5mm coarse graded crushed rock
Waterproof Membrane	-	2000 gauge high density polythene sheeting
Sub-Base material	-	150mm DTp Type 1 sub-base
Capping Layer	-	200mm capping material with a minimum CBR value of 15%

2) Following a site investigation, it is found that the subgrade below the site of the car park in Leeds is sufficiently permeable to allow an 'exfiltration' system to be adopted. In this instance the use of a sub-base is not appropriate and an additional thickness of roadbase material should be used.

The total thickness of roadbase to be used is therefore:

Designed thickness	-	350mm
Additional thickness	-	350mm *(Note – This is equivalent to the thickness of the sub-base and capping layer used in the 'tanked' design)*
Total thickness	-	700mm

This thickness of roadbase can either be formed with 20 – 5 mm roadbase material or as a combination of 20-5 mm and 150 – 50mm material.

The full pavement section for the car park using an exfiltration system is therefore:

Wearing Surface	-	210x105x65mm Blockleys' Permeable Paviors
Bedding Course	-	50mm 6mm crushed stone
Roadbase (1)	-	150mm 20 – 5mm coarse graded crushed rock
Roadbase (2)	-	550mm 150 – 25mm coarse graded crushed rock
Geotextile	-	Woven geotextile

Bibliography

- British Standards Institution. BS 812 Testing Aggregates
- British Standards Institution BS 882 Specification for Aggregates from Natural Sources for Concrete
- British Standards Institution BS 13242 Aggregates for Unbound and Hydraulically Bound Materials for use in Civil Engineering Works and Road Construction
- British Standards Institution BS 7533: Part 3 Code of Practice for Laying Precast Concrete Paving Blocks and Clay Pavers for Flexible Pavements
- British Standards Institution BS EN 1344 Clay Pavers – Requirements and Test Methods

Standard Contract Documentation

Wearing Surface: Permeable clay pavior

Manufacturer: Blockleys Brick Ltd
Sommerfeld Road
Trench Lock, Telford
Shropshire TF1 5RY

Tel: 01952 251933
Fax: 01952 265377
E-mail: sales@blockleys.com
Web-site: www.blockleys.com

Work Size: 204x99x65mm

Coordinating Size: 210x105x65mm (including nibs)

Colours: Hadley Red, Hadley Red Brindle, Charcoal and Castleyard

Bond Patterns: Pedestrian Areas –
running bond
90° or 45° herringbone bond patterns.

Trafficked Areas –
90° or 45° herringbone bond patterns.

Edge Restraint: Blockleys' clay kerb profile matched to project requirements.

Bedding Course: 50mm thickness of 6mm single size crushed stone with a typical grading:-

BS Sieve Size (mm)	Percentage Passing
10	100
6.3	85-100
3.35	0-35
2.36	0-10

Roadbase: Aggregates for the roadbase should comply with BS EN 13242: 2002 – Aggregates for Unbound and Hydraulically Bound Materials for use in Civil Engineering Work and Road Construction and have a typical grading:-

20 – 5 mm Aggregate

Sieve Size (mm)	Percentage Passing
37.5	100
20	90 – 100
14	40 – 80
10	30 – 60
5	0 - 10
2.36	0

150 – 25 mm Aggregate

Sieve Size (mm)	Percentage Passing
150	100
100	45 - 75
75	12 - 50
50	0 - 10

Impermeable Membrane: (Tanked Systems) Manufactured from HDPE (high density polyethylene) they should be durable and be able to resist puncturing during placement of the roadbase material. They should be also unaffected by pollutants entering the pavement and by alkaline or acidic groundwater. Taped or welded joints should be used as appropriate to the application.

Typically a 2000 gauge material will be appropriate but advice should be obtained from the manufacturer or supplier.

Geotextile Membrane: (Exfiltration Systems) Manufactured from woven polyethylene mono-filament, the membrane should act as a filter and allow the free flow of water. It should be unaffected by pollutants entering the pavement and by alkaline or acidic ground water. In the absence of specific manufacturers' recommendations the geotextile should have the following properties:-

Mass per unit area	Greater than 100g/m^2
Tensile Strength	
Longitudinal	Greater than 25 kN/m
Transverse	Greater than 25 kN/m
Elongation at Break	
Longitudinal	Less than 25%
Transverse	Less than 25%
Opening Size	Approximately 0.45mm
Water Permeability	Greater than 0.2 m/s

Sub-base Type 1 Material as described in the Department of Transport's Specification for Highway Works Clause 803 with a typical grading:-

BS Sieve Size (mm)	Percent Passing by Mass
75	100
37.5	85 - 100
20	60 - 100
10	40 - 70
5	25 - 45
0.600	8 - 22
0.075	0 – 10

Type 1 Material can be crushed rock, slag or concrete or well-burnt non-plastic shale.

Capping Material Material with a minimum CBR of 15%. This may be rock or as-dug gravel found on or adjacent to the site or imported low cost waste or recycled material.

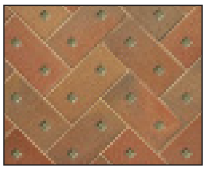
Subgrade For CBR values of ≤ 5% a subgrade improvement layer should be used. This should be formed with a combination of DTp Type 1 material and capping layer material as appropriate to a particular situation.

BS EN 1344

Table 12 – Blockleys' Permeable Paviors Technical Information	
Work Size	204 x 99 x 65mm
Co-ordinating Size (including nibs)	210 x 105 x 65mm
Texture	Wirecut
Transverse Breaking Load	T4
Liability to Efflorescence	Nil
Freeze / Thaw Resistance	FP100 Frost Resistant
Slip / Skid Resistance	U3
Abrasion Resistance	A3
Quantity per Pack	400 (4 x 100)
Coverage per Pack	8.89 sqm
Coverage per 1000	22.2 sqm
Where appropriate technical properties are assessed in accordance with the requirements of BS EN 1344: 2002	

Blockleys' permeable paviors are available in a range of four colours.

Hadley Red

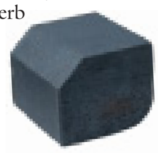


Hadley Red Brindle

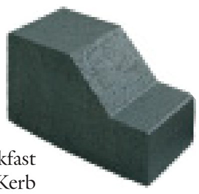
Charcoal

Castleyard

Fig 7 Kerb



Country Kerb



Buckfast Kerb

Cant Kerb

PERMANENT Non-Fade COLOUR LIFETIME GUARANTEE

A full range of chamfered paviors and clay pavior accessories is also available for use in conjunction with permeable paviors to provide a total solution for all hard landscape applications.

Information in this leaflet is provided for guidance only.
Due to the limitations of photography and printing, the colours and textures illustrated are for use as a guide only. Actual samples are available on request.
Blockleys Brick Ltd. reserves the right to amend specifications and prices at any time without prior notice, in the pursuit of continuous product development.

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