SPECIFICATION & INSTALLATION GUIDANCE

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Kilsaran
ideas taking shape

Specification and Design Guidance

The extensive range of paving products available from Kilsaran will provide a full range of solutions for any project whether commercial, civic, industrial or a residential scheme.

This section will give some basic specification and design guidance for project appraisal purposes

Paving Unit Advice

Generally **Concrete Flag Paving** (large element) paving units are used for pedestrian, civic, amenity and street footpath construction and are not suitable for vehicular trafficking unless a suitable sub base design has been prepared and guidance to this effect has been given on the individual product page.

Concrete Block paving is suitable for a wide range of schemes from light pedestrian areas, domestic driveways, to commercial and HGV trafficked areas, utility areas and adapted roadways. Block paving can be adapted for a full and versatile range of visual and functional uses.

Product Standards and Specifications

The full range of Kilsaran products are manufactured to fully meet all requirements of all current British and European Standards.

To ensure the best application and performance of all products it is the responsibility of the client to ensure that during the design and installation process the relevant complimentary standards for design, installation, construction and maintenance are followed.

Product Type	Manufacturing Standards	Site Specific Design Standards	Installation/ Construction Standards
Paving Blocks	BS EN 1338:2003	BS 7533 Part 1 or 2	BS 7533-3
Paving Flags	BS EN 1339:2003	BS 7533 Part 8 or 12	BS 7533-4
Permeable Paving	BS EN 1338:2003	BS 7533-13	BS 7533-13
Kerbing	BS EN 1340	BS 7533-6	BS 7533-6
Tactile Paving	BS 7997, DD CEN/TS 15209:2008	DETR Tactile Paving Guidance Document	BS 7533-4

Block Paving Design & Specification Guidance

The below information is provided as a guideline for appraisal purposes only on the basics of block pavement design and considerations. In all cases the user is advised to review this guidance against the detailed requirements of the BS 7533 suite of standards which provide in-depth detail on design, installation, construction and maintenance of concrete block pavements

BS / EN Standard	Title
BS EN 1338:2003	Concrete paving blocks — Requirements and test methods
BS 7533-1	Guide for the structural design of heavy duty pavements constructed of clay pavers or precast concrete paving blocks
BS 7533-2	Guide for the structural design of lightly trafficked pavements constructed of clay pavers or precast concrete paving blocks
BS 7533-3	Code of practice for laying precast concrete paving blocks and clay pavers for flexible pavements
BS 7533-11	Code of practice for the opening, maintenance and reinstatement of pavements of concrete, clay and natural stone

Principles of Concrete Block Pavements

The principle on which concrete block pavements operate is that it is a flexible construction technique. For this is reason no cement based materials are permitted for use as a sub base layer and especially in the laying course material. The pavement must maintain its flexible construction to perform effectively.

This flexible nature of the pavement construction allows concrete block pavements to carry from very light to extremely high loadings from trucks and commercial vehicles to aircraft and handling and stacking machinery. This is not always possible with in situ concrete or bituminous macadam surfaces which may suffer pavement fatigue under the same loading stresses.

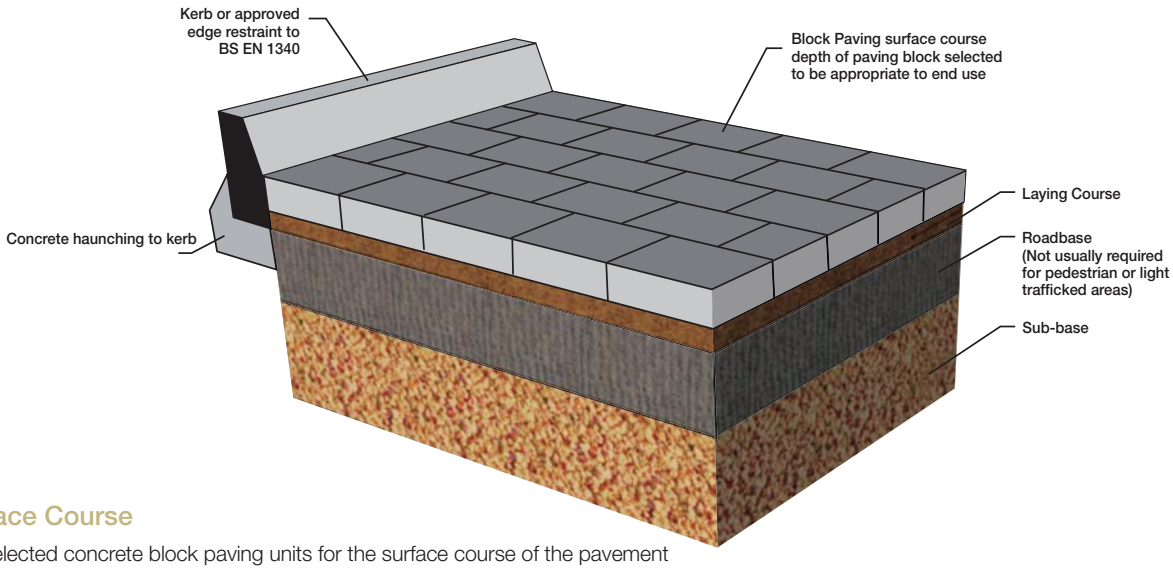
The individual concrete paving blocks are ‘locked’ together in their laying pattern and as one block is loaded it spreads its load to its neighbouring block and the load is spread outwards in a radial pattern, effectively dissipating the load over a larger area.

Since there is no bound surface and paving blocks are relying on their neighbouring block to provide frictional interlock to hold them in place, it is an essential part of the block pavement design that there is a rigid edge restraint on all sides of the pavement, this can consist of an appropriate kerb haunched in concrete, an existing structure or a rigidly fixed perimeter course. It is also essential that during construction all joints are fully filled with the correct grade of jointing sand and the joints are inspected and topped up as required immediately after construction and for the future life of the pavement. The jointing material assists with the interlock of the pavement, and improperly filled joints is likely result in deterioration of the surfacing layer and the sub base layers underneath.

Block Paving Design & Specification Guidance

Concrete block pavements typically consist of either three or four layers of construction as detailed in the cross section below:

Typical Cross Section of Concrete Block Pavement



Surface Course

The selected concrete block paving units for the surface course of the pavement

Laying Course

The layer of material on which the block paving units are bedded. It is essential that this material complies with the requirements of BS 7533-3 tables D.1, D.2 and D.3 and is appropriate to the end use of the pavement. It is not permitted to add cement or lime to the laying course material to act as a binder. Note that for more heavily trafficked sites the nominal depth of the laying course material is reduced and the allowable fines content is also reduced to minimise the potential for settlement and deterioration in use.

Roadbase

The material placed above the sub-base and beneath the laying course layers. A roadbase layer will typically only be required in pavements that will be required to accommodate medium to heavier duty commercial traffic loadings, or where the subgrade (ground conditions) are poor and require improvement for the desired traffic loadings. The roadbase layer will act as a 'stiffening layer' in the pavement construction and may be a cement bound granular material (CBM) or a bituminous macadam material. Note that conventional lean mix concrete or mass concrete is not suitable for use in block pavements that are to receive vehicular traffic.

Sub-base

All concrete block pavements will require a sub-base layer. This is usually a high quality granular all in aggregate material which is installed and compacted in layers. Normally this material will be a 'Type I' material in accordance with clause 803 of the Department for Transport Specification for Highway Works or clause 804 type B in accordance with the National Roads Authority Specification for Road Works. The use of lower quality fill materials and recycled rubble fill should be avoided unless the material has been independently tested to demonstrate it meets or exceeds the requirements of the specified sub-base material above.

Paving Block Thicknesses

Most of the Kilsaran range of block paving is available in a variety of thicknesses to suit different end use requirements. While the depth of paving block selected must be appropriate to the end use, the maximum loading capacity that a constructed pavement can withstand will also be heavily dependent on the pavement build up and construction being appropriate to that end use.

Table 1 - Pavement Type / End Use	Minimum thickness of Block Paving (mm)
Domestic & pedestrian footpaths	40mm
Domestic driveways (light traffic) & pedestrian footpaths	50mm
Normal duty trafficked areas, car parking, retail, public areas with lower volume commercial traffic	60mm
Service roads in retail, commercial and civic public areas. Adapted public roadways and commercially and heavier trafficked areas	80mm

Note details in this table are intended as a quick reference guide only. For more detailed description of loading categories and trafficking types please review table 2 below and BS 7533 part 1 or 2.

Site Assessment for Design Purposes

Stage 1 – Establishing bearing capacity of the existing sub-grade

For pavement design purposes it is necessary to know the strength or bearing capacity of the underlying sub grade (soil / clay). A simple site test method known as the CBR test (California Bearing Ratio) is used to determine subgrade bearing capacity. This is a simple test where a plunger of standard size and mass is forced into the sub-grade and the force at which the plunger stops at is recorded.

The CBR value is calculated from this. Typical values are in the range of 3-5% for normal clay sub-grades. Wet, poorly drained and made up ground will have lower values. The lower the value, the more sub base / pavement build-up will be required as per **table 2**.

CBR Testing being carried out on site

On most schemes the pavement designer will already have site CBR values to hand as this testing would have been carried out at site investigation stage prior to designing other buildings or structures on site. The Structural Engineer would have required this for the foundation design of the building and you are likely to find CBR values in this report. Note the lowest average CBR values will be taken for the site.

For smaller schemes and residential schemes where it is not economically feasible to carry out site investigation and CBR testing, BS 7533-2 provides guidance in table 1 on likely CBR values for different physical ground conditions determined on site. An experienced paving and groundwork's contractor is likely to be able to advise on the basis of a site visit.

Stage 2 - Commercial Traffic Assessment

When the site appropriate CBR value for the site has been determined at stage 1, it will be necessary to decide on the appropriate traffic category for the pavement and select a loading category as detailed in the table below. It is essential at this design stage that all commercial traffic including occasional service vehicles and emergency vehicle access is taken into account within the design process. Pavements which have not been designed to accommodate HGV traffic should never receive service vehicles or emergency vehicles. It is also necessary to factor in increasing traffic volumes over the design life of the pavement. The BS 7533 design standards provide further guidance in this area.

Stage 3 – Pavement Construction Thickness

When details from stage (1) CBR assessment and stage (2) traffic assessment have been ascertained it is possible to determine the required thicknesses of block paving, laying course and sub base that are likely to be required for the scheme. Table 2 below is based on Table 4 of BS 7533-2 which gives guidance on construction thickness of block pavements. Note very heavily trafficked sites will have to be designed separately to the requirements of BS 7533-1.

Table 2 - Pavement Construction Thickness

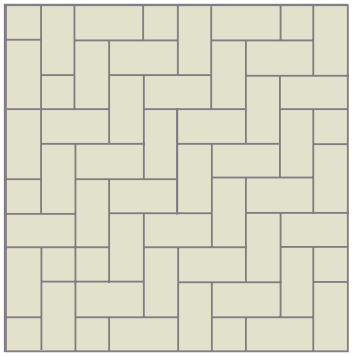
Loading or end use Description	BS 7533-2 Loading Category	Maximum commercial vehicle movements per day	Minimum compacted sub base thickness (mm)					Nominal compacted thickness (mm)		Minimum Paving Block thickness (mm)
			Design CBR							
			≤2%	3%	4%	5%	≥6%	Roadbase	Laying Course	
Commercially trafficked pavements, roadways, heavily trafficked commercial areas, adopted major roadways and streets, freight depots, container and shipping terminals, rail depots etc	Category I	For commercially heavy trafficked pavements the design guidance in this table and BS 7533-2 is not appropriate and a more detailed site specific design will be required to be carried out in accordance with the requirements of BS 7533-1 with the assistance of an appropriate Consulting Engineer with detailed experience of Pavement Design.								
Adopted minor roadways and access roads, delivery roads within business areas and shopping facilities, cul de sac's, petrol station forecourts, pedestrianised areas subject to heavy vehicle movements, footways regularly overridden by vehicles and car parks receiving heavy traffic regularly	Category II	≥ 5 For commercial vehicle movements above 10 per day consult BS 7533-1 and seek specialist design guidance	400	350	250	150	150	125	30	80 in more heavily trafficked areas 60 in medium traffic
Pedestrianised and car trafficked areas receiving only occasional heavy traffic (1 commercial vehicle per week max)	Category IIIa	Less than 1	350	300	225	150	150	0	50	50
Car parks receiving no heavy traffic, footways receiving no vehicle traffic	Category IIIb	Zero	300	250	175	100	100	0	50	50
Private drives, patios and hard landscaping areas which never receive commercial traffic	Category IV	Zero	200	150	125	100	75	0	50	40 (no traffic) 50 with light traffic

Construction

All materials used and installation and construction methodology should fully comply with the requirements of BS 7533-3. Maintenance and re-instatement work where required should also meet the requirements of this standard and BS 7533-11.

Block Paving Laying Patterns

The laying pattern has a significant impact on the long term stability of the paved surface and its load bearing abilities. Block paving schemes which have been designed to accommodate heavier traffic loads and commercial and service vehicles are normally completed in herringbone pattern (either 45 or 90 degree) as this has been time proven to be the most effective laying pattern for dissipating heavy loads and resisting spread from continual turning movements. Patterns such as stretcher bond will also be effective for medium traffic loading while patterns such as parquet or stack bond will not be suitable for vehicular trafficking.

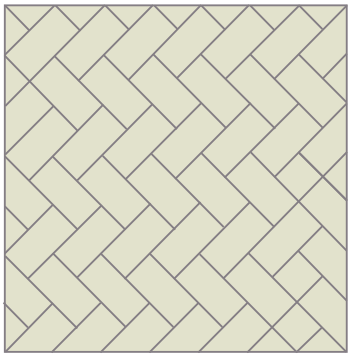


90 Degree Herringbone

Suitable for all loading categories up to and including heavier duty commercially trafficked pavements

Products which can be laid in this pattern:

- Slane 200 x 100mm
- Mellifont Large size only (240 x 160mm)
- Lismore Large size only (240 x 160mm)
- Newgrange Large size only (240 x 160mm)

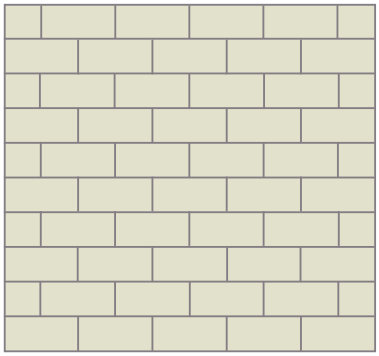


45 Degree Herringbone

Suitable for all loading categories up to and including heavier duty commercially trafficked pavements

Products which can be laid in this pattern:

- Slane 200 x 100mm
- Mellifont Large size only (240 x 160mm)
- Lismore Large size only (240 x 160mm)
- Newgrange Large size only (240 x 160mm)

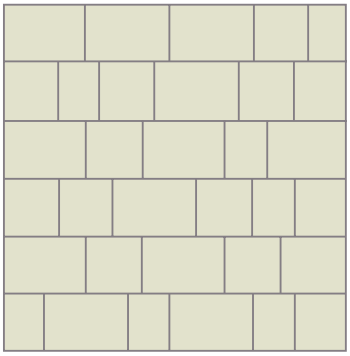


Stretcher Bond

Suitable for all loading categories up to medium traffic commercial pavements having once to twice weekly goods vehicle traffic. Should be laid with longitudinal joints at 90 degrees to the direction of traffic

Products which can be laid in this pattern:

- Slane 200x100mm
- Mellifont Large size only (240x160mm)
- Lismore Large size only (240x160mm)
- Newgrange Large size only (240x160mm)
- Boyne

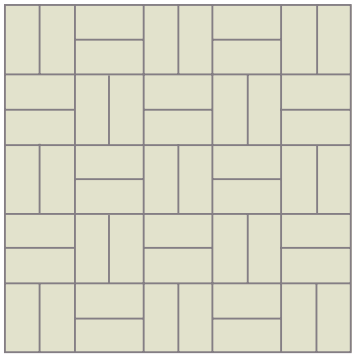


Random Stretcher Bond

Suitable for all loading categories up to medium traffic commercial pavements having once to twice weekly goods vehicle traffic. Should be laid with longitudinal joints at 90 degrees to the direction of traffic

Products which can be laid in this pattern:

- Mellifont 3 size mix
- Lismore 3 size mix
- Newgrange 3 size mix

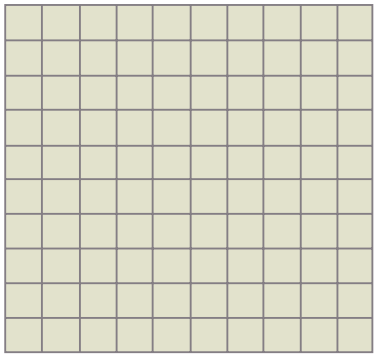


Parquet or Basket-weave

Generally suitable for pedestrian areas only. Not recommended for areas which are to receive vehicular traffic

Products which can be laid in this pattern:

- Slane 200x100mm



Stack Bond

Generally suitable for pedestrian areas only. Not recommended for areas which are to receive vehicular traffic

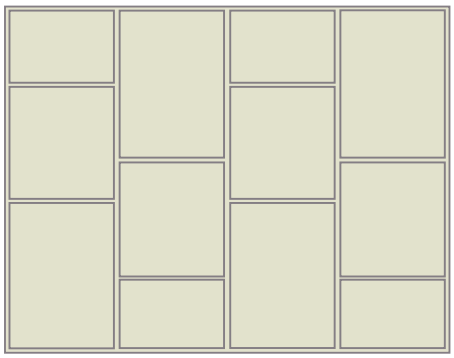
Products which can be laid in this pattern:

- Slane 100x100 size
- Mellifont Medium size only (160x160mm)
- Lismore Medium size only (160x160mm)
- Newgrange Medium size only (160x160mm)

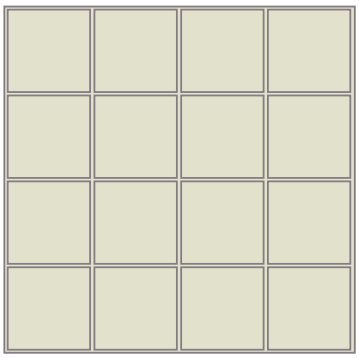
Flag Paving
Flag Paving Laying Patterns

Flag paving is generally not laid in the same style of laying pattern as block paving as many traditional unit sizes in flag paving are square in shape and commonly either a stack bond or variations on a stretcher bond is adapted on many schemes

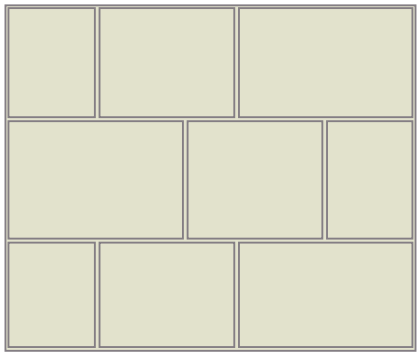
As flag paving is generally not used for vehicular trafficking the laying pattern will not have the same impact on the long term structural stability of the paved surface as it does for block paved surfaces. It should be noted however that often for public schemes and local authority utility schemes that transverse bond laying patterns are often favoured where the longitudinal joint is at 90 degrees to the direction of pedestrian traffic



Transverse Stretcher Bond



Stack Bond



Longitudinal Stretcher bond

Flag Paving Design & Specification Guidance

The below information is provided as a guideline for appraisal purposes only on the basics of flag pavement design and considerations. In all cases the user is advised to review this guidance against the detailed requirements of the BS 7533 suite of standards which provide in-depth detail on design, installation, construction and maintenance of concrete flag pavements

BS / EN Standard	Title
BS EN 1339:2003	Concrete paving blocks — Requirements and test methods
BS 7533-1	Code of practice for the construction of pavements of precast concrete flags or natural stone slabs
BS 7533-2	Guide for the structural design of lightly trafficked pavements constructed of clay pavers or precast concrete paving blocks
BS 7533-3	Guide to the structural design of trafficked pavements constructed on a bound base using concrete paving flags and natural stone slabs
BS 7533-11	Code of practice for the opening, maintenance and reinstatement of pavements of concrete, clay and natural stone

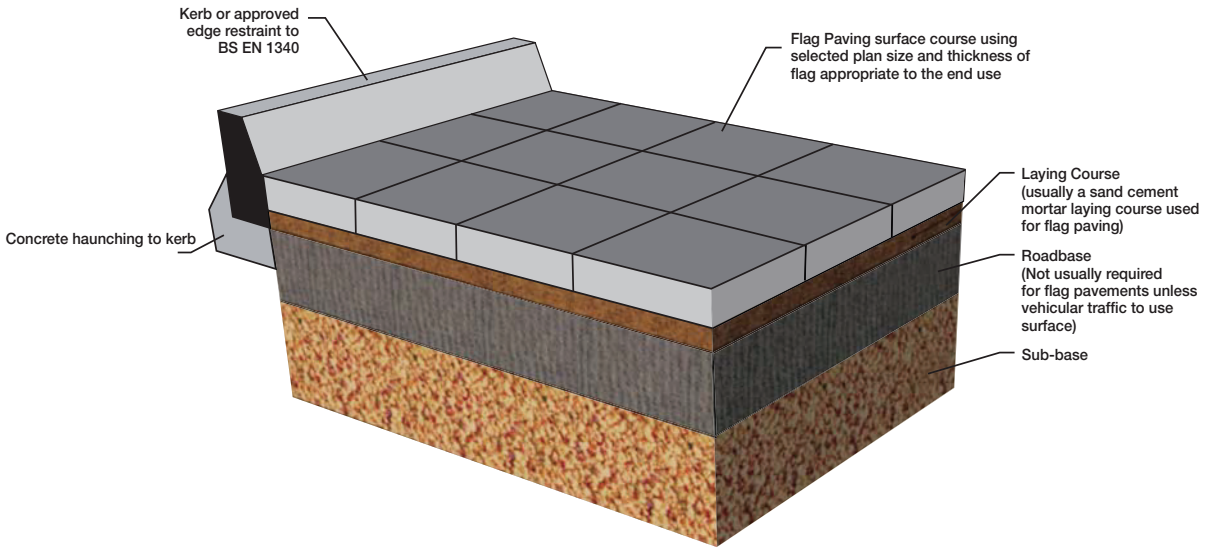
Principles of Concrete Flag Pavements

Flag pavements are generally constructed for pedestrian use or occasionally for emergency or service vehicle access. Since flag paving is not frequently designed and installed to be trafficked, often it will be installed as a rigid bedding construction and so unlike block paving will not be flexible in construction and accommodate vehicle traffic. Experience has shown however that rigidly constructed flag pavements are a long term low maintenance solution and often adapted by local authorities for streetworks and repairs.

Like block paving, it is advised for flag pavements that there is a rigid edge restraint on all sides of the pavement, this can consist of an appropriate kerb haunched in concrete, an existing structure or a rigidly fixed perimeter course. It is also essential that during construction all joints are fully filled with the correct grade of jointing sand and the joints are inspected and topped up as required immediately after construction and for the future life of the pavement. The jointing material in flag pavements prevent water ingress into the pavement layers and potential deterioration of the sub base layers underneath.

Concrete block pavements typically consist of either three or four layers of construction as detailed in the cross section below:

Typical Cross Section of Concrete Flag Pavement



Surface Course

The selected concrete flag paving units for the surface course of the pavement

Flag Paving Design & Specification Guidance

Laying Course

The layer of material on which the block paving units are bedded. It is essential that this material complies with the requirements of BS 7533-3 tables D.1, D.2 and D.3 and is appropriate to the end use of the pavement. It is not permitted to add cement or lime to the laying course material to act as a binder. Note that for more heavily trafficked sites the nominal depth of the laying course material is reduced and the allowable fines content is also reduced to minimise the potential for settlement and deterioration in use.

Sand laying course should comply with the requirements of BS 7533-4 section 5.4.6.2 and table 5. Where a sand laying course is adapted it is not permitted to add cement or lime to the laying course material to act as a binder. For bound construction a cement based mortar complying with the requirements of section 5.4.4.2 of BS 7533-4 should be used. Note that normally the finished / compacted depth of laying course material for flag construction should be 25mm for both sand and mortar based laying course materials. Concrete flag paving laid on a bound cement based laying course (mortar bed) should have 4-6mm joints filled with a cement based mortar class M6 to BS EN 998-2.

Roadbase (Not usually required)

The material placed above the sub-base and beneath the laying course layers. A roadbase layer will typically only be required in flag pavements that will be required to accommodate vehicular traffic loadings or where emergency vehicle access must be allowed for, or where the subgrade (ground conditions) are poor and require improvement for the desired traffic loadings. The roadbase layer will act as a 'stiffening layer' in the pavement construction and may be a cement bound granular material (CBM) or a bituminous macadam material

Sub-base

All concrete flag pavements will require a sub-base layer. This is usually a high quality granular all in aggregate material which is installed and compacted in layers. Normally this material will be a 'Type I' material in accordance with clause 803 of the Department for Transport Specification for Highway Works or clause 804 type B in accordance with the National Roads Authority Specification for Road Works. The use of lower quality fill materials and recycled rubble fill should be avoided unless the material has been independently tested to demonstrate it meets or exceeds the requirements of the specified sub-base material above.

Paving Flag Thicknesses

Most of the Kilsaran range of flag paving is available in a variety of thicknesses to suit different end use requirements. Most of the paving flag range is supplied in 50mm depth as standard. While the depth of paving flag selected must be appropriate to the end use, the maximum loading capacity that a constructed pavement can withstand will be substantially more dependent on the pavement build up and construction being appropriate to that end use than the paving flag unit itself.

Flags have been traditionally specified for many years in the common British Standard sizes detailed in BS 7263-1 and the national annex of BS EN 1339:2003

BS Size Flag Designation	Work Size (mm)	Thickness (mm)	Class 3 Flags	
			Characteristic Breaking Load	Minimum Individual Breaking Load
B50	600 x 600	50	9.1	7.3
B63	600 x 600	63	14.4	11.6
E70	400 x 400	70	18.4	14.7
F40	400 x 400	40	9.5	7.6
F5	400 x 400	50	9.5	7.6
F63	400 x 400	63	16.1	12.9
F80	400 x 400	80	16.1	12.9

Information contained in this table is based on BS EN 1339:2003 NA.2 and BS 7263-1:2001 and how these standards best apply to the relevant Kilsaran concrete paving flag products

Pavement Type / End Use	Minimum Thickness and Flag Type
No vehicle traffic at any time, patios, paths and pedestrian only areas	All unit sizes, 40mm in domestic and 50mm in public areas
Very occasional use by cars and cleaning equipment	All unit sizes in 50mm depth or greater with appropriately robust sub base design
Pavements with light vehicular (car only) crossings	All unit sizes in minimum 63mm depth with appropriately robust sub base design
Pavements with light vehicular (car only) traffic or where emergency vehicle access may be required	F80 minimum with appropriately robust sub base design

Information contained in this table is based on guidance within the National Annex of BS EN 1339:2003 and is interpreted as it best applies to the relevant Kilsaran concrete paving flag products

Site Assessment for Design Purposes

Similar to block paving structural design, for commercial flag paving schemes the ground conditions (drainage and CBR values) and current and predicted traffic volumes (only for trafficked flag pavements) need to be determined to select the most suitable paving flag unit size and depth and also to allow a suitable sub base design to be carried out.

Unlike block paving structural design, the depth of sub base and roadbase (when required) construction is determined using graphs for the paving flag unit stress limit and separately for sub base material stress limit. These graphs are detailed in section 6.4 of BS 7533-8 and the higher value obtained from the two graph interpretations should be used.

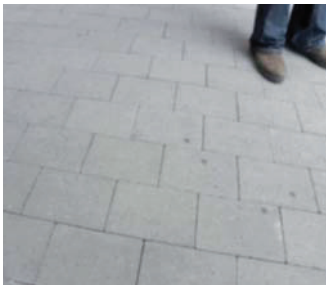
For flag paving schemes where no vehicular traffic is to use the surface a simplified approach is often used where the sub base depth will be in the region of 100-150mm and an experienced paving / groundworks contractor will be able to advise at appraisal stage if this should be sufficient.

Construction

All materials used and installation and construction methodology should fully comply with the requirements of BS 7533-4. Maintenance and re-instatement work where required should also meet the requirements of this standard and BS 7533-11.

Kilsaran strongly advise that all paving works should be carried out by an experienced paving contractor. It is a specialist skill and the integrity and durability of the completed paving is highly dependent on expert skill, care and attention during construction and installation.

Joint Width
Selection of the Appropriate Paving Unit



Narrow Joints
≤1mm

Standard Joint
1.5-2mm

Wide Joint
4-8mm

Most types of block and flag paving will have an integrated spacer nib which is part of the side profile of the unit when manufactured. Spacer nibs are designed to give an even distance between each unit and allow for even and consistent straight lines when laying paving. The spacer nib in conjunction with the chamfer detail it provides an even joint profile and protects the units from damage during laying and trafficking when in use.

Each product in this brochure is classified in terms of joint profile as shown above and consideration should be given to the most appropriate joint profile for the scheme

- ✓ Narrow joints should be selected for areas where low joint maintenance is desired, eg indoor areas and shopping trolley areas. Products with narrow joints will usually have no integral spacer nib and no chamfer and must be laid with care and attention to strict surface regularity tolerances. Re-jointing may never be required during normal design life. This type of joint profile will not be suitable for anything above lightly trafficked areas due to potential chipping of edges of units.

- ✓ Standard Joint products is the most commonly used type of paving suitable for all locations, traffic categories and schemes, especially commercial projects where maintenance will be lower. Jointing will require inspection every 6-12 months normally and re joint possibly every 5-10 years in normal use.

- ✓ Most types of flag paving is supplied with a standard joint profile, eg Classic Flags, Newgrange and Shelbourne Flag ranges.

- ✓ Wide joints will require more maintenance to maintain joints topped up. Products with wide joints are generally used where an olden look and feel of cobble type paving is desired. Normally traditional kiln dried jointing sand is not suited to wide joints as experience has shown that wind and rain naturally removes the sand along with routine washing and cleaning of the area. Usually wide joint paving will require a polymeric (self hardening) jointing sand compound such as Kilsaran PermaJoint 200.

Joint Maintenance

All joint profile units will require routine inspection and maintenance where required both after initial installation and on an ongoing basis. It is essential for all types of block and flag paving that joints are maintained full in all areas for the lifetime of the pavement. The frictional interlock of block paving depends on joints being full at all times and this also prevents water entering the laying course and sub base layers and causing more serious damage.

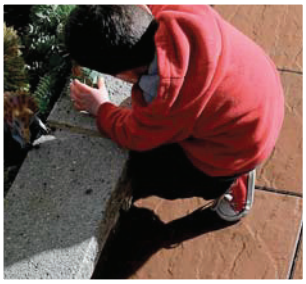
Newly jointed areas or areas which have had jointing material recently replaced will need to be inspected shortly after jointing and topped up as some initial settlement of jointing materials will inevitably occur. After pressure washing or cleaning paving it is likely that joints will also require topping up.

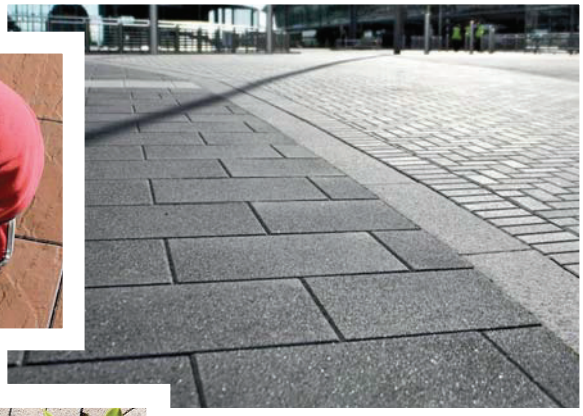
Colour Selection

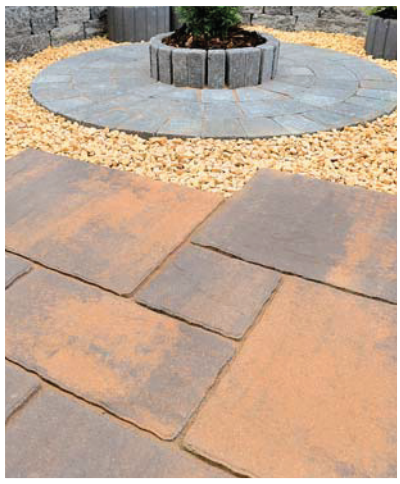
It should be noted that brighter colours, such as silver, buff, red etc along with textured finishes will require additional routine cleaning to maintain the colour and finish of the paved surface. Natural and charcoal colours lend themselves more to commercial projects where it is desired to have reduced cleaning and maintenance routines. Silver and buff colours can be susceptible to discolouration if weed killer, chemical treatments or rust inadvertently come into contact with the surface.

During installation great care must be taken especially with brighter / lighter colours not to get dirt, laying course materials or soil on the surface of paving. The correct colour of jointing material must also be selected for the paving unit. See jointing section of this guide.

All Kilsaran paving products are produced to the highest quality standards however it must be accepted by the customer that all paving products are subject to slight variations in colour tone and shade due to minor variations in naturally occurring raw materials and manufacturing. The full and accurate quantity required for a project must be advised in advance to Kilsaran to include an allowance for any waste or extra material that may be required to allow us to supply from one production batch. On site it is essential to lay from three to six packs working alternately through each pack and layer to achieve an even blend on site. This is especially important for blended colour products.







Slip/Skid Guidelines

The current product standards for block paving and flag paving are BS EN 1338 / 1339 respectively. Section 5.3.5 of both standards deals with slip/skid resistance states that 'Concrete paving blocks have satisfactory slip/skid resistance provided that their whole upper surface has not been ground and/or polished to produce a very smooth surface'. Essentially this means there is not a current clearly defined standard for what is deemed 'slip resistant' or not.

For guidance purposes on previous standard specification for slip / skid values, the table below from the now superceded BS product standards below illustrates the previous BS standard guidance in this area. A minimum guidance value of 35 in pedestrian areas and 45 in vehicular trafficked areas is advised.

All Kilsaran paving products have their specific slip/skid test value quoted in the product technical & performance data section on each product page. This is quoted as the wet tested USRV (unpolished slip resistance value) rating for the product. Most products with a standard finish will have a minimum value of 60 or greater with the exception of products with a ground finish which will have a typical value in the range of 50 – 55.

If a specific slip skid value is required for a project, this should can be discussed with a member of the Kilsaran technical team.

Slip / Skid Pendulum Testing Apparatus

Table below based on BS 6717: 2001 (Table 5) and BS 7263-1:2001 (Table 9)

Class	Mean Slip/Skid Resistance Value C Scale Units
S1	No performance determined
S2	≥ 35
S3	≥ 45
S4	Manufacturer's declared value

NOTE For special applications, e.g. approaches to traffic lights, a higher value may be appropriate Paving blocks of class S2 are suitable for use in pedestrian areas and paving blocks of class S3 are suitable for use in vehicular areas.

NOTE For special applications, e.g. approaches to traffic lights, a higher value may be appropriate