

Using Setts in the Public Realm

Application Notes

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1. Introduction

1.1 Context for using setts

Natural materials have been extensively used for carriageway surfaces in the past (in the form of crushed stone, wood blocks and cobbles), however over the last 60 years increasing pressure from heavy vehicle flows has led to many areas being replaced with asphalt. The simplicity of construction and inherent affordability of asphalt often outweighs the aesthetic value and durability of natural setts and slabs.

Now there is a growing emphasis on producing streetscapes which reflect the character of the buildings that surround them, with local authorities, businesses and the general public coming to value natural materials for achieving a high quality of public realm. Indeed an increasing interest in using setts within 'Better Streets' type projects has led to some very good recent examples, but also identified some common problems, which this note aims to remind you of.

There are many sources of formal guidance which this note does not attempt to summarise or supersede in any way. On this subject however this note seeks to provide a practical overview to:

- highlight key issues when designing schemes with setts, particularly in the carriageway
- help people to decide when to use setts
- identify projects that have worked well and others not so well
- offer links to more detailed guidance and resources



Exhibition Road – granite setts across the carriageway and footway achieve a unified aesthetic



Monmouth South Works – the colour of the grout can significantly impact on the overall appearance

1.2 Setts – An Overview

BS EN 1342:2001 defines a sett as a dressed block or stone greater than or equal to 50mm in depth and 50-300mm in length. Generally the length should not be greater than double the width of the unit and the thickness must be more than half the width, with the exception of certain decorative setts or those which need to fulfil a particular function such as over basements.

A huge variety of setts are available reflecting the great diversity of rock types quarried worldwide. Sedimentary rocks are generally softer and less durable than the denser igneous rock options available, but may still be suitable for certain low pressure applications. The most commonly used stone for carriageway setts in London is granite due to its strong crystalline structure, wide choice of colours and relative affordability. We will use the word "granite" to reflect common parlance rather than strict geological usage, so it will include a great variety of rocks of igneous origin. There are, however, many other options and when specifying particular products, it is most important to understand the properties of the stone that are needed to meet the requirements of a specific scheme.

Whilst most setts are granite, there are instances where limestone can and has been used in a sett size, and there are also concrete substitutes.

2. Fundamental Considerations

2.1 Why choose setts?

From a design perspective it is crucial to justify the use of setts by detailing their intended function within the context of a scheme. There are many reasons why one might choose to introduce setts:

- for the visual characteristics based on unit size, joints, colour variation, and reflectivity
- to reflect the historic character of an area
- to communicate a traffic calmed or humanised space with visually related footway and carriageway elements
- to provide a raised table to prioritise pedestrians and reduce vehicle speeds
- to improve aesthetic continuity between spaces on either side of a road
- to slow traffic speeds by causing drivers to feel they are intruders in a pedestrian space, and by increasing noise for drivers

2.2 What are the limitations?

It is important to weigh up the design intentions with the physical limitations of setts as a material choice:

- Stone in the carriageway needs to be skid-resistant and it will smooth over time as vehicles wear down the surface. Under most circumstances, it can only meet the safety requirements when the average vehicle speed is 20 mph or less.
- Setts are prone to deformation through stress, particularly where high forces are experienced when vehicles are turning. Channelising traffic also leads to more potential for fatigue and deformation. Ramps and their approaches are particularly susceptible to fatigue and higher vehicle speeds increase the impact where there is a change in verticality.
- Setts can potentially move in relation to what is next to them and if their neighbour or the restraint is not 'fixed' to an appropriate depth, they will push away and eventually lead to a cascade of failure, row by row. Where setts terminate and meet tarmac, it is important to specify a suitably robust edge detail. The sub-base for all setts and in particular median strips or flush kerbs needs to be suitably robust.
- Maintenance of the setts can be more costly and time consuming than asphalt. If laid with maximum initial strength, setts may need to be destroyed when lifted for underground maintenance.

2.3 How do I know if setts are appropriate?

Determining the extent of carriageway use is recommended to ensure that setts are appropriate for their context and can be designed for long term durability:

- Measure the type and frequency of overrunning vehicular traffic. This is measured in the number of standard axles per day; the basic indicator for designing the carriageway.
- To get a feeling for the scale, buses generally count as 2.9 standard axles each. They are particularly damaging as they tend to follow the same road line each time. 200 standard axles per day is the maximum level for using flags and 100mm deep setts. Above this 150mm setts must then be used, and for >1000 standard axles or tougher sites, 180mm deep is recommended.
- Determine anticipated vehicular speeds to ascertain the skid resistance requirements
- Consider if vehicles will be turning on the setts. Setts are especially susceptible to damage as vehicles turn because of the uneven loading across the unit, creating rifts in the sett geometry.
- Consider the likelihood of channelling as heavy vehicles on narrow carriageways can compound surface subsidence by following the same alignment each time. Avoid this if at all possible.

Identify how setts will impact on a range of users:

- Who or what will use the surface and consider what different kinds of setts are like for different users to walk or cycle on? Shared surfaces need to be sufficiently flat for pedestrians and wheelchairs.
- How will tactile navigation and safety features be incorporated? Consider the tactile and navigation features for the visually impaired and arrange these within the overall design rather than adding them after.
- Consider the noise and the effect on amenity for residents in upper floors.

Special design considerations may be required where:

- the ground is prone to subsidence. Research the ground conditions for the build (California Bearing Ratio)
- there are potential threats such as the proximity of tree roots etc.

Maintenance regimes need to accommodate particular limitations of setts:

- Consider the role of the link in the highway network and whether it can be closed for maintenance as setts need to be lifted and re-laid in panels, so the whole street may need closure.

Setts may be appropriate if these factors are satisfied and can be justified in a business case.



Problems like this arise from channelised flow and a lack of adequate substructure

Photo courtesy of Marshall's, 2012

3. General Advice on using Setts

3.1 Guidance on specifying setts

BS EN 1341 provides guidance on the breaking load for setts and details how calculations based on the number of vehicle axles anticipated over a certain time can be used to determine the building specification.

The Department for Transport's *Design Manual for Roads and Bridges* provides detailed guidance and official standards for all carriageway applications but treat it with caution with regard to sett design. BS 7533 Parts 7 and 10 are specifically relevant and also offer a standard method for laying natural stone setts where traffic levels exceed 200 or 1000 standard axles per day.

3.2 Form of the sett

Unless using reclaimed materials, there are some general rules to follow.

Setts that are cropped on all sides, mostly imported granites from Portugal, are often of relatively irregular shape and quality. They are cheaper, but only in smaller sizes (around 70/80mm or less) can they be laid to give a fairly flat walking surface. Indeed one should use the finer grained granites which split more cleanly and consider laying in arcs rather than straight lines to give more strength to the system. When laying setts unbound, the sides of the setts must be cropped (split) rather than sawn, the base should be cropped as well. This provides the best interlocking qualities with the jointing and bedding material. The straightness and accuracy of the sides is crucial to the performance of the product. Setts must not be tapered in at the bottom. If the setts are large, the top will probably need to be sawn and textured to be sufficiently flat.

When laying a bound surface in the heaviest vehicular traffic, sawn sides and base provides a better engineering result due to the way the forces within the structure react to loading. Typically joints at around 6 to 8mm are suitable (good mortar usually costs more per cubic metre than stone!). Make sure the setts are washed just before being laid to ensure there is no dust remaining so the adhesion to the mortar is optimised. In pedestrian areas and parks, the setts can have split sides and be relatively shallow whereas in major traffic zones, a size close to a cube is best, certainly with the depth not less than the width and the length as a maximum not more than twice the width.

In all cases slip resistance should be considered. In pedestrian and low vehicle use locations, any rough texture will suffice – cropped, sawn and flame-textured or sawn and bush-hammered (fine or fair-picked). This macro texture will provide the necessary slip resistance. In the street, the surface should be sawn and bush-hammered as this gives long term a better slip resistance for vehicles. Nevertheless, for the street you should check the slip resistance of the stone before specification, as even some granites can wear to a distinct polish though this is most noticeable with the fine grained black basalts. Rock types including a variety of minerals that wear differentially are generally better. There are reasons to use a sawn and flame-textured surface on the pavement as it looks better

and is easier to clean than a bush-hammered surface.

Porphyry from Italy has been used increasingly in London streetscapes. The material's formation has meant that it can come with a natural, riven, rough but quite flat surface that results from the natural separation of the layers of material in the quarry. The sides are generally split. In principle this is a great product but it is essential it is acquired from a trustworthy source. The stone has to be produced so that none of the natural layers remain unseparated or frost action will lead to eventual failure. This is not easy to see and, of course, it does not matter in frost-free Southern Italy.

Yorkstone, though long used in London in the form of paving flags was not historically seen as a sett. Locally to the quarries, it was good value for money as a sett, but relative to granite this was no longer the case when transported to London. It does not benefit much from texturing as it is a sedimentary stone and a textured surface will simply wear quicker than a sawn one until it looks just the same. The sawn surface appears good as a skid resistant material but test results do not deal with reality. Once covered with mud or algae, the stone can be very slippery indeed and does not have the texture of granite or porphyry to assist.

Purbeck limestone is the only traditional British limestone sett with the potential ability to survive frost but only some layers of stone in the quarry are suitable. A bush-hammered surface is best. There are a few small examples in London showing how this material can survive even though its wear rate would be much higher than granite.

Portland Stone has been used in some locations but has proven to be unsuccessful as a paving surface (for example in Parliament Square). Limestone setts have also been used but edge damage occurs if closely jointed (N. Terrace Trafalgar Square, Glasshouse Street and Aldwych).

3.3 Notes on Selecting Setts Types and Colours

Colour palettes may be guided by local streetscape manual specifications, especially for conservation areas. Many London boroughs have produced these documents and they are the best starting point for identifying what can be specified where. Transport for London also provides formal guidance in the *Streetscape Guidance* document.

It is important to consider nearby building materials when specifying setts and carefully design how the scheme will link to surrounding materials.

Colour is always best judged by actual samples and should not be taken solely from photographs or from the names ascribed by the supplier.

Different colours of materials often correspond to different properties at a practical level. Yellow granite for example has higher water absorption properties and lower compressive strength than grey granite (and than reddish, mid grey, green and very dark stones) and so may not be suitable for sustained heavy loading. However, this is no more than general guidance. The actual characteristics of the stone, especially compressive strength and water absorption must first be established before specifications are finalised.

Keep in mind that some blocks will become discoloured in heavy use areas like markets and so some visual variation to help mask dirt and marks may be beneficial, such as by using a mixed palette of colours. A rock type with natural variation such as porphyry may also achieve the same effect. Furthermore darker materials tend to have lower water absorption, which is an indicator of being a strong stone as well as one which will stay cleaner. Darker setts tend to be more expensive. The selection of setts and the arrangement of multiple colours will increase laying costs, and a mono-colour solution will show substitutes more.

Variations over time must also be considered when specifying products, particularly for sedimentary setts which are more prone to weathering than igneous rocks. Yorkstone is notorious for looking great on day 1, quickly accumulating dirt and looking patchy over the next few months, before settling into a more subtle and even hue years after being put down. Setts may change to varying degrees and it is good to look at precedents to see what effect will be seen in the long term.

One subtle point to note is the result of channelising. Vehicle wheels clean granite setts quite effectively but if those wheels are limited in their coverage (as sometimes in narrow traffic calming designs), some parts of the roadway will be clean while others get progressively more filthy. Overall, it may be beneficial and/or important to explain how the materials will change over time to locals/ contractors/ politicians/ colleagues.

The supplier should be able to advise on the relative benefits of different rock types and colours, and how these change in different weather conditions and over time.

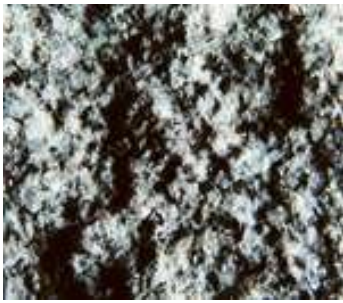
3.4 Notes on Surface Finishes

When specifying a finish it is important to consider what pressures and uses the surface will be receiving once on site. Apart from the cropped setts, the two main methods both involve first sawing the stone to obtain a flat surface then either flame-texturing (passing a hot flame across the surface, causing some crystals to leave the surface) or bush-hammering (repeatedly hitting the surface with a many-pointed hammer). Surface treatment is often referred to as fair picked or fine picked, the former being slightly rougher.

Skid resistance is the first consideration. In a street with vehicular use, either a cropped or a sawn and bush-hammered finish will be advised for this reason. Cropped surfaces are quite rough and not so comfortable to walk upon unless the setts are small in size (which they cannot be in heavy traffic). The natural surface of Italian porphyry is suitable for all applications: it is flat enough for pedestrians and rough enough for vehicular use. Rough cleft setts are also useful as a warning or deterrent.

Flame-textured surfaces of granite are more true to the inherent colour of the stone than bush-hammered surfaces. However, the yellow granites will turn pinkish when flame-textured so are mostly used bush-hammered.

In conclusion it is important to select materials not solely on their colour or finish at an aesthetic level, but to choose products based on a clear understanding of the functional demands placed on them and whether they will help you fulfil the design objectives.



Cropped



Fair picked



Bush Hammered



Flame Textured



Honed



Polished



Riven



Sawn



Chiselled



Sawn and sandblasted



Tactile - Blister



Tactile - Corduroy

Stone textures - Courtesy of CED Ltd Natural Stone

4. Construction

4.1 Methods of laying, bedding and jointing

4.1.1 Unbound Construction (*Flexible Specification*)

The traditional technique for laying setts utilises no cement at any level; stones being laid as close together as possible with grit or ash and lime brushed in to fill the joints. During early use these joints require regular infill until the setts are set within well packed joints. The resulting flexibility allows the stones to move and rub as traffic passes over, creating a tighter bond. Removal is convenient as the setts are not tightly bound and can be quickly replaced. The setts must be restrained by a strong outside edge and the sub-base needs to be strong enough to carry anticipated traffic loads.

This method is still extensively used across the Continent but is less common in British streetscapes as regular infill is required. Setts laid many years ago were relatively lightly trafficked in their early years, gradually becoming fully compacted as the traffic levels increased. It takes many years for the fill to become sufficiently compact to sustain heavy loading from vehicles. Some streets are still carrying quite heavy traffic today but rather too often some intervention connected with new or altered services underground has led to a poor standard of repair and a localised failure which rapidly cascades along the whole street. Furthermore, rigorous cleaning and maintenance regimes serve to remove the jointing material, which is what gives this form of paving its strength.

Often forgotten is how vital rainwater is to the success of unbound construction. The joints are permeable and the downward progress of water helps pack the particles together in the joints. But that rainwater must be able to continue on downwards into the bed, the sub-base and into the subsoil. Laying unbound on an impermeable structure is not a practical option.

4.1.2 Bound Construction (*Mortar Specification*)

A relatively rigid (but elastic), impermeable surface can be achieved by laying setts in mortar, with trafficked applications almost always needing specialised mortars. These offer improved tensile strength, adhesion, elasticity and other performance characteristics necessary for

withstanding high and repeated axle loads. Indeed the mortar is crucial to the durability of the surface, so it is essential to specify this just as carefully as the setts. Its impact on the aesthetics should not be forgotten: colour, finished mortar level and ensuring that the setts are not discoloured by excess mortar being the obvious aspects.

Rigid paving is generally more expensive to lay and more difficult to dig up but, when detailed appropriately, it is hard wearing. The base must be designed by an engineer who will take into account anticipated loadings, traffic levels and ground conditions, but not overdesigned as to cause unnecessary difficulty when services need attention.

Many designers have developed their own laying specifications and indeed many London borough Streetscape Manuals specify slightly differently to each other. Research is still being conducted on the performance of different mortar mixes and the comparative curing times necessary for implementation. Because of the continual vibrations from traffic, the designs for laying stone in the street are completely different to those for a building. There have been some significant successes but there have been failures too. Observing and then learning from past experience is a very good way to move forward with contemporary specifications which are endeavouring to retain all the delights of natural stone setts but with the added ability to withstand heavy usage and be able to do so for a long time. We sometime forget how frequently other types of road surfaces have to be repaired. Granite setts can last far longer if the setts and the laying method are correctly specified and the works are executed in accordance with that specification.

The basic precept should be for the total construction to be sufficiently strong not to deform but weak enough to allow interventions when necessary without causing materials to break because the mortar is too strong. As many regularly disturbed services are located in front of premises (the footway in traditional layouts), reversion to slabs in granite or limestone allows easier reinstatement in these margins, rather than wall to wall setts.

4.2 Notes on vertical shifts in the carriageway



Ramps to raised tables are particularly susceptible to compaction and a substructure needs to be detailed specifically for the ramp, to minimise the risk of collapse (above). It is also important to adhere to the regulations on maximum ramp height, length of ramp and table length wherever buses go or might go. These requirements for buses are actually good advice for all applications.

Vertical shifts in the carriageway are the most effective form of traffic calming measure and often take the form of a plateau extending across the full width of the carriageway to reduce speeds. The plateau should be long enough to accommodate a bus to improve passenger comfort.

4.3 Notes on slip and skid resistance

When considering the use of setts in the context of shared use by pedestrians and normal traffic, it is important to distinguish between 'slip resistance' and 'skid resistance'. The term 'slip resistance' applies to the likely grip available for pedestrians and 'skid resistance' refers to the grip available to normal road traffic. These two aspects are assessed differently and it is worth noting that a surface which may provide adequate slip resistance as a footway may not provide sufficient skid resistance as a road surface.

Skid resistance is primarily provided by the surface microtexture of the sett, which changes over time. A new road surface usually has a high skid resistance but this decreases as the setts are progressively polished by traffic. The polishing process tends to reach an equilibrium skid

resistance level after one to three years depending on the sett and the amount of traffic. It is possible to restore skid resistance using mechanical retexturing processes, however this may not prove cost effective in the longer term, as further treatments will be needed.

4.4 Notes on Supply

It is important to note that increased shipping costs from China in 2012 have made European suppliers relatively more affordable and it is worth investigating opportunities for sourcing materials from closer to home. Cropped setts from Portugal are generally cheaper than their Chinese equivalents but sawn and textured setts from Europe remain more expensive, although not by a vast margin.

The colour of natural stone products can vary across batches due to the inherent natural character of the quarried stone. To ensure a more consistent palette it is best to bulk order a batch with enough setts in reserve for future maintenance. Ordering the 'same' product at a later stage may result in mismatched colour tones. The use of a mix of stones has advantages in that should one or more type be unavailable in the future, its loss from the mix may well be less obvious.

Manchester uses a purchasing consortium which can help reduce costs and provide more surety of procuring quick replacements. London boroughs could benefit from this strategy if a common palette of sizes and colours were agreed.

4.5 Notes on Contractual Issues

The laying of setts is normally carried out by sub-contractors and the success or failure of a scheme is largely dependent on the standard of finish they deliver. The main contractor should be fully aware of the skills and standards required for laying natural stone and should not assume that a block-paving sub-contractor will be adequate. It is often necessary to point out to contractors that their 'best teams' will be needed for high profile schemes when laying or reinstating is needed.

The quality of workmanship is crucial for long term quality, so check that tenders are realistic and can deliver the workmanship you require.

It is important that sufficient supervision during the build is provided by the designer or project manager to encourage contractors to work towards as high a quality of finish as possible, and to ensure these standards are attained.

On a major scheme it may be prudent to arrange the laying of a sample panel to act as the reference standard in the tendering and construction processes and to have a 'deck of works'.

4.6 Communication

Streetscape construction work significantly affects the local community, particularly shopkeepers, and it is important to keep people well informed about ongoing developments. Regular engagement through consultation and communication is the best way to minimise disturbance and reduce the potential for complaints and to have a regular 'go-to-guy' when on site.

Asking people what they want in the first place may be useful, but make sure they know the pros and cons/limitations of different choices.

4.7 Maintenance

Maintaining setts can be a challenge as constant physical wear is compounded by limited maintenance budgets. Adequate construction is crucial for the long term durability of these spaces, and in turn minimises the extent of maintenance required to ensure a sustained high quality finish. In this context, note that the use of unbound systems requires more maintenance but, even so, this method (where it may be used) is cheaper over the lifetime of the street than a bound construction. Unbound construction presents a massive advantage in a street where access to underground services is very likely. Where bound surfaces are required it may be useful to be bound by mortars that are just strong enough and not over-strong to enable re-use.

A compromise has been tried in Covent Garden where the historic setts are set in 1:3 sand cement but not to the full depth of the sett. To withstand the freeze/thaw cycle and maintain the pointing for longer, a proprietary mortar has been used to point the top 25mm of the joint. This can then be disc cut when intervention is needed to break the seal before lifting the sett. It was anticipated that a strong proprietary mortar on all five side of the sett would lead to the destruction of the unit. An alternative may be a weaker mix of proprietary mortar.

In designing these structures it is important to consider at the outset how much loading is anticipated. This is the crucial determinant for specifying material and construction details. Almost intuitively, we expect stone paving surfaces to last a lifetime, indeed far longer than other materials. They do need maintenance but a little goes a long way to ensuring a lifetime of service.

5. Historic Materials and Conservation Areas

5.1 Notes on historic materials in London

A hundred and more years ago, when most of our city streets were first paved, the stones used were a commodity as concrete is today. Few paid attention to their colour, it is just good fortune that the end product is attractive. Although the production cost in different quarries could vary a little, the primary cost influence was transport. Initially by sea, the early materials came from coastal quarries, mostly in The British Isles but not exclusively so. Typically granite setts and kerbs would come from Aberdeen, Creetown and Dalbeattie in SW Scotland and also Cornwall. Inland quarries only became a realistic possibility with the advent of canals but more importantly by far, the railway. London was the hub of the railway network and direct lines existed to most parts of the country. In the nineteenth century, the railway companies were privately owned and fiercely competitive. The major companies with granite sources in their hinterland were the London and North Western (LNWR), the Great Western (GWR), the Great Northern (GNR) and Midland Railway (MR). Each of these companies sought liaison with other smaller companies to get their freight to the market. That was achieved by delivery to many small goods depots as close as possible to the destination since road haulage was very expensive indeed.

Each granite is distinctive and a geologist with the necessary knowledge can pinpoint the originating quarry with absolute certainty from the mineralogy of the material. But even without that knowledge much history can be told just by looking at the stone. In simple fashion, silver grey Cornish granites and some from Devon would have come via the GWR and tended to stay to the west side of London, the LNWR brought darker granites from North Wales, the GNR fetched setts from Leicestershire and darker granites and basalts from further North, but much changed once the MR gained access to London. Pink granites from Mountsorrel quarry abound anywhere near either its goods depots or those of the London Tilbury and Southend Railway with which it was closely linked. Unusually these often took the form of a rough 5 inch cube.

The South side of London is far more complex, with the three main companies having lines so intertwined that it is not straightforward at all. Having no granite resources of their own, theirs had to come from one of the other companies. Sett size was originally determined by the application. The oldest setts that came by sea were often very large indeed, as much as eight inches deep. Mostly they can be found along the river Thames in Docklands. As manufacturing processes became more controlled so the setts became more consistent in size and tolerance. For heavy duty applications, six inches in depth became the minimum, with lengths from a little more than the width to not much more than twice the width. The most common widths were four inches and three inches but occasionally three and a half inches is found. Aside from the five inch cubes already mentioned, just occasionally five inch wide setts can be found, mostly used as gutters along the edge of the kerbs. Because of the need to lay few rows of consistent width, setts for gutters are generally of fine quality with flat surfaces to allow good drainage. In less used side streets and most of the mews in London, four inch cubes are the norm, this being large enough to cope with the low levels of traffic and visually attractive in a small area. Very often these are pink/red in colour from the Midlands.

If a repair or extension to an existing street is required, a matching sett can sometimes be found but as there were at one time some 150 quarries in Britain winning the product, finding a perfect match can be difficult and take a long time. It just depends on the original material and what happens to be available. When reclaimed materials are required, the advice is to acquire the material in advance of letting the contract, indeed in advance of the tendering procedure. Having the materials in advance allows for knowledge of the depth of the available setts, which affects the construction detailing. If the source is determined prior to tendering, this avoids price increases arising as a result of changes in construction details.

5.2 Notes on Heritage Application

The way in which traditional materials are locally used may be important for ensuring consistency across heritage areas. Granite setts for carriageways and gutters are often constructed with subtle variations from one town to another and it is therefore important to research these differences and specify construction details accordingly.

Tumbled or hewn setts may be fitting for a heritage area as they provide a more rustic character, however these inconsistencies can make them more susceptible to rolling. The sub-base specification is therefore crucial for anticipating this movement.

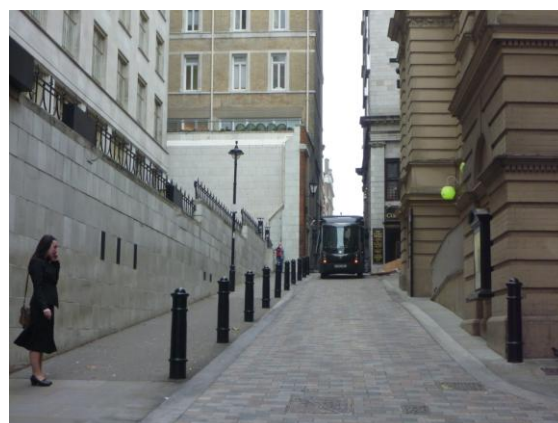
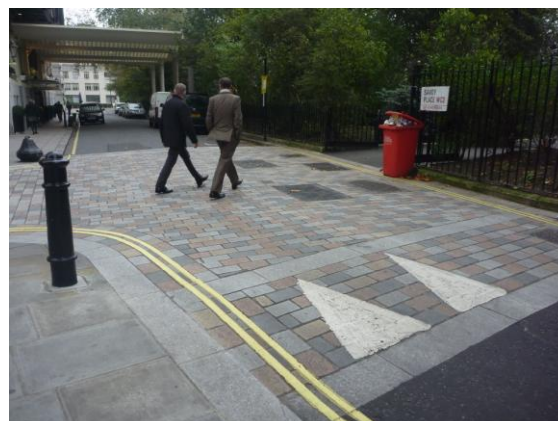
Historic setts remain on many streets across London and these should be preserved where possible and repaired as required. Pre-existing setts may also be reused in a new scheme design, but if they are to be used in a bound construction they will need to be very thoroughly cleaned beforehand.

Old setts are difficult for people with disabilities and it may be necessary to contrive 'causeways' of smoother setts to ensure equality of access for people with disabilities.

6. Precedents

6.1 Carting Lane, Westminster

implemented 2011



Carting Lane is a relatively quiet service road at the back of the Savoy. Recent improvements have sought to use setts to provide a more pedestrian friendly environment, with 150 x 250 x 180mm deep setts contained in a cordon of granite for a raised table (photo left). This is different to the Exhibition Road stainless steel angles which attempt similar containment.

Westminster notes the benefits of using mass concrete as a sub-base instead of reinforced mesh, as it is easier and less costly to repair after an intervention. For applications where the traffic is generally in a straight line, 100mm deep setts have been used in the carriageway (as in Gerrard Street), and in other places with high vehicular flows, 150mm have been used.

The justification for 150mm deep setts at the upper level of Carting Lane (photo right), was in anticipation of large servicing and delivery vehicles. As the vehicles would not be turning however, it was not deemed necessary to go to the maximum depth used in Westminster: 180mm. The granites are flame textured, contributing to improved grip.

6.2 Windrush Square, Brixton, LB Lambeth *implemented 2010*



Setts were introduced along a heavily trafficked section of Effra Road, but have recently failed, notably at the transition from asphalt to setts (*centre*) and along surface joints which align with the joints of the concrete sub-base. This suggests that even with good detailing, strong SteinTec mortar and sub-base considerations, setts may not be a good choice for high pressure applications.



Ramps on the approach to raised tables and where vehicles turn, typically receive the most wear; however in this setting the setts show no sign of failure, as the junction is subject to lower vehicular speeds and fewer standard axles per hour than on the main road.

For more information on this scheme, contact Andy Best, Head of Highways at Transport for London: AndyBest@tfl.gov.uk

6.3 Coulsdon Town Centre, LB Croydon *implemented 2010*



Although it does not strictly function as a shared surface, the paved carriageway helps to create the appearance of a central public space by visually linking the footway and road, reducing traffic speeds and providing a pedestrian oriented crossing environment. The sub-base detailing anticipated heavy vehicle turning movements and the setts in this section of the Town Centre are holding up well at the time of writing.



A notable failure of setts can however be seen along the length of the flush median strip – the result of inadequate sub-base and edge treatment detailing. Compression of the median strip created lateral forces against the tarmac resulting in a lift/drop movement across the sett; further compression eventually shattering the unit (and now replaced in patches with blacktop). The specification would be suitable had the median strip been raised, however by being flush it received regular vehicular impact, which it was not designed to withstand.

6.4 Alternatives

There are alternative ways of achieving the desired architectural effect of having a distinctive carriageway and these should be considered to balance functionality with aesthetics.

One could potentially use a manufactured concrete block paving system to provide additional strength, a resin aggregate with good skid resistance properties, or a coloured asphalt to define an area without compromising structural integrity.

In general if vehicle speeds are consistently above 20mph and axle loading is high, setts are probably not a suitable option, and asphalt may be more appropriate.



Concrete block setts used in Woolwich



'Mastertint' coloured asphalt defines an atypical junction arrangement in Coventry