



Hampshire  
County Council

## Economy, Transport and Environment Department

# Technical Guidance Note TG6-3 - Modular Pavement Design

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## 1. Policy / Approach

- 1.1. This Technical Guidance Note refers to the relevant standards for the testing, design, and construction of modular pavements to be constructed or adopted by Hampshire County Council (HCC).
- 1.2. Design Standards are used to ensure a consistent approach to modular pavement design that provide resilience and minimise the maintenance requirements of the entire pavement and its foundation during its design life. Within Hampshire these include:
- Design Manual for Roads and Bridges,
  - Manual of Contract Documents for Highway Works,
  - Specification for Highway Works,
  - British Standards,
  - HCC's Highway Construction Standard Details,
  - Notes for Guidance on the use of the HCC Series 11 Standard Detail Drawings, and
  - HCC's Technical Guidance Notes (TGs).
- 1.3. Modular pavements cover all pavements constructed from blocks or pavers made from clay, concrete or natural stone, but not flags or slabs. Where modular units are used as part of a permeable pavement, the requirements of TG6.4 – Permeable Pavements apply.
- 1.4. Where the inclusion of areas of modular paving are being considered in a highway, this shall first be discussed and agreed with the Highway Authority. The use of modular pavements should be limited but are permitted in appropriate situations within Hampshire, such as:
- Conservation Areas, heritage areas and national parks (where agreed by the Highway Authority)
  - In residential streets with design speeds  $\leq 20$ mph and very low flows such as cul-de-sacs and streets with filtered permeability (i.e. where the change in material is part of the tools-set to ensure a change in driver behaviour).

They will not be permitted on:

- Link/spine roads through residential developments
- Bus routes
- Streets / roads with design speeds greater than 20mph

Modular paving should also be avoided at junctions and speed tables due to the additional stresses created by turning movements and impact forces at these locations resulting in increased maintenance requirements with more complex traffic management/road closures.

The Highway Authority will consider the suitability for the proposed location, including the predicted traffic volumes, gradient and other factors covered below.

- 1.5. Prior to the commencement of construction, the modular pavement design and detailing shall be formally submitted for checking and approval by the Highway Authority. Should any works commence without approval, the works will be considered to be proceeding at risk and shall be removed by the initiator at their cost should the design and / or construction be determined inadequate.
- 1.6. It shall be noted that all modular pavements will incur commuted sums due to the associated increased maintenance costs. Refer to [HCC's Commuted Sum Policy](#).

## 2. Definitions & Abbreviations

<b>ATC</b>	Automatic Traffic Counter
<b>CSSM</b>	Construction Subgrade Surface Modulus
<b>CV</b>	Commercial Vehicles
<b>Departure from Standard (DfS)</b>	A non-compliance with a Mandatory Requirement of a Standard, as set out in HCC's Technical Guidance Notes or other policy/standard document cross-referred to from the Technical Guidance Notes.
<b>DMRB</b>	Design Manual for Roads and Bridges
<b>Design Organisation</b>	Any organisation, including in-house HCC resources, undertaking the design of works that affect any part of the highway network. Such works include private and public developments.
<b>DSSM</b>	Design Subgrade Surface Modulus
<b>HCC</b>	Hampshire County Council
<b>Legal Requirement</b>	A statement in a standard that is associated with the words "must" or "must not". Legal requirements cannot be departed from or relaxed.
<b>MAFI</b>	Mean Annual Frost Index
<b>Mandatory Requirement</b>	A statement in a standard with the words "shall" or "shall not"
<b>MCHW</b>	Manual of Contract Documents for Highway Works
<b>MPa</b>	MegaPascal (unit of surface modulus)
<b>MSA</b>	Million Standard Axles
<b>NH</b>	National Highways
<b>PPTV</b>	Polished Paver Test Value
<b>Relaxation</b>	A permitted variation from the Mandatory Requirement of a Standard, as set out in the Technical Guidance Notes or other policy/standard document cross-referred to from the Technical Guidance Notes.
<b>SHW</b>	Specification for Highway Works. The Specification for Highway Works is published as Volume 1 of the MCHW etc. Reference is to be made to the relevant series and clauses as applicable to the Contract.
<b>TG</b>	Technical Guidance Note - A suite of notes detailing what the adoptable standards are for HCC's Local Highway Network.

### 3. Additional Guidance

The following documents and publications are to be reviewed when preparing to design a modular pavement:

[Design Manual Roads and Bridges](#)

- CD 127 - Cross-sections and Headrooms
- CD 224 - Traffic Assessment
- CD 225 - Design for New Pavement Foundations
- CS 228 - Skidding Resistance
- CD 236 - Surface Course Materials for Construction

[Manual of Contract Documents for Highway Works - Volume 1](#)

[Manual of Contract Documents for Highway Works - Volume 2](#)

[Hampshire Highways Surfacing Options & Guidance 2016 Edition](#)

[Hampshire Highways Guidance Document for Footway & Cycleway Pavement Options](#)

BS 7533:101 - Code of Practice for the Structural Design of Pavements Using Modular Paving Units

Relevant British Standards covering the proposed materials

[Technical Guidance Notes](#)

- TG2 - Highways Cross-Sections
- TG5 – Geotechnical Investigation, Testing and Design
- TG6-1 - Pavement Foundation Design
- TG6-2 - Flexible and Rigid Pavement Design
- ITG6-4 - Permeable Paving
- TG8-1 - Drainage – General Items
- TG8-2 - Drainage – Infiltration
- TG10 - Footways / Cycleways / Shared Surfaces
- TG11 - Traffic Calming
- TG17 - Departures from Standard

[Highway Construction Standard Details](#)

[Notes for Guidance on the Highway Construction Standard Details](#)

[HCC's Commuted Sums Policy](#)

## 4. Technical Requirements

### 4.1. General

- 4.1.1. The technical requirements within this TG augment those of NH's DMRB, MCHW and relevant British Standards as specific requirements for modular pavements within Hampshire. They are to be used by all Design Organisations, both internal and external to HCC, and supersede the requirements within HCC's Companion Document to Manual for Streets (April 2010), which has been withdrawn.
- 4.1.2. The TG covers the requirements for the design of new modular pavements, as well as for the maintenance of similar existing pavements.

### 4.2. Essential Elements

- 4.2.1. The five essential elements required for modular pavement designs are:
- The nature and condition of the site through investigation,
  - The assessment of predicted traffic that the pavement will or has carried during its life,
  - The foundation on which the pavement is to be constructed,
  - The design of the modular pavement itself, and
  - The materials of which it is to be constructed.
- 4.2.2. These five elements all play a part in the design and long-term life of a road pavement. Further details on the technical requirements for each, as well as construction considerations, are provided in the following sections.

### 4.3. Investigation

- 4.3.1. Undertaking adequate investigation is vital to ensure that the subgrade strength is correctly assessed to enable a suitable foundation to be designed to support the proposed pavement. This information will assist the designer understand the ground conditions, and that of any existing pavement, to inform design decisions.
- 4.3.2. It is incumbent upon the Design Organisation to consider the condition of the existing pavement into which any new construction or maintenance works are to be tied into. If this is not undertaken, the design life or performance could be compromised.

### 4.4. Traffic Assessment

- 4.4.1. Modular pavements are generally to be restricted in their use to the entrance to Highways or low traffic streets within developments. As with all roads, the estimation of 'design traffic' (commercial vehicles / lane / day – cv/l/d), and of past and future predictions of cv/l/d for existing roads, is essential for determining the required thickness of a modular pavement. Construction traffic shall be included when establishing the cv/l/d.



#### **4.5. Foundations**

- 4.5.1. The main purpose of a pavement's foundation is to distribute the applied commercial vehicle loading at the base of the pavement through to the underlying subgrade. This is to be achieved without causing distress within the foundation or overlying layers, both during construction and the design life of the pavement. Further guidance on pavement foundation design can be found within TG6-1.

#### **4.6. Design Life**

- 4.6.1. A 40-year design period without structural maintenance is generally considered to be the most economical solution for all new carriageways, as well as for maintenance solutions. Therefore, unless a Departure from Standard has been agreed in advance, modular pavements and their foundations shall have a design life of 40-years.

## 5. Design Factors and Materials

- 5.1.1. Modular pavements are generally block paving and are commonly used on shared surface roads (Refer to 1.4). Their use may be acceptable on other roads subject to an appropriate design for increased traffic loading and the prior approval of the Highway Authority.
- 5.1.2. Concrete blocks are preferred to clay pavers, with the latter not permitted for use in carriageway or shaded situations where the growth of moss, lichen etc. can be anticipated. Clay pavers also tend to 'polish' more than concrete pavers and can be difficult to match when maintenance is required due to damaged or loss.
- 5.1.3. Modular pavements will generally only be permitted where the gradient is less than 1 in 15. Subject to approval by the Highway Authority, it may be permissible on gradients exceeding 1 in 15 if an effective form of transverse restraints can be incorporated into the design at appropriate intervals to prevent longitudinal creep.
- 5.1.4. Modular pavements, and especially the restraints, can be difficult to reinstate following utility activity. Therefore, all modular pavements are to be added to the Highway Authority's Streetworks Register as a site with '**Special Surfacing**' (Refer to [TG24 – Scheme Handover to Asset Owners](#)).
- 5.1.5. Hampshire requires that all modular pavements shall have a **2-year maintenance / guarantee period**.

### 5.2. Traffic Assessment

- 5.2.1. It is essential that details of existing traffic or predicted traffic volumes are determined; ideally as well as the number of commercial vehicles (CV) by class and categories from classified traffic counts or traffic modelling. Existing traffic data can be obtained using automatic traffic counters (ATC's), ideally by classification, or by undertaking manual or video survey classified turning counts. Where new developments are proposed, existing traffic flows from counts and proposed flows from Transport Assessments are to be combined to produce the expected traffic flows and movements for undertaking capacity assessments and the estimation of 'design traffic'.
- 5.2.2. CD 224 is to be used to determine the 'design traffic' (the commercial vehicle loading over the design period of a pavement) for new and existing roads in million standard axles (msa). Unless a Departure from Standard has been agreed, the Design Period to be used shall be 40-years, taking growth predictions into account, with a minimum design traffic loading of 0.6 msa. An allowance shall be made for the channelising of traffic at narrowings, which in accordance with BS 7533:101, requires that the design traffic should be multiplied by a factor of two.

### 5.3. Foundations

- 5.3.1. Where the subgrade is frost susceptible, the overall construction thickness should not generally be less than 450mm, irrespective of the subgrade

strength value. Where a site-specific frost index evaluation has been carried out (e-mail [climate@metoffice.gov.uk](mailto:climate@metoffice.gov.uk) quoting Mean Annual Frost Index (MAFI) – Fee payable) it may be possible to justify reducing the minimum cover to 350mm. Further information can be obtained from TRL Report RR 45 - Winter air temperatures in relation to frost damage in roads (1986).

- 5.3.2. It is essential that the subgrade strength be determined to ensure that the pavement's foundation is designed to adequately support and distribute the loading on the modular paving units. Therefore, in-situ and, where required, laboratory testing shall be undertaken to determine a Design Subgrade Surface Modulus (DSSM) to inform the foundation design. Further details of the testing requirements and frequencies are provided within [TG 6.1 - Pavement Foundation Design](#).

#### **5.4. Modular Pavement Design**

- 5.4.1. The pavement itself is the description generally given to the 'bound' materials placed above the foundation. However, in the case of modular pavements this refers to the paving units plus any bedding layer (laying course). Subbase is a foundation not a pavement material, but it is commonly specified as part of the pavement construction and specified within Appendix 7/1. If a capping layer is required, details of the material options and layer thickness are included within Appendix 6/7. Details are also specified along with the subbase, modular unit and bedding layer thicknesses within Appendix 7/1 as part of the overall 'pavement' thickness.
- 5.4.2. All pavements shall be designed in accordance BS 7533:101 using Traffic Category 7 as a minimum with a bound base and unbound surface. Typically, this will be 130mm asphalt concrete base with a 30mm laying course and 80mm thick paving blocks.
- 5.4.3. The width of the carriageway will need to consider issues of future maintenance requirements.
- 5.4.4. The presence of utilities should be considered, especially those that are shallow and potentially within or just beneath a pavement's construction. It is recommended that they are surveyed beforehand for health and safety reasons and to avoid potential strikes when any invasive investigations are to be undertaken.
- 5.4.5. Where modular paving is to be incorporated into or tied into an existing carriageway, assessing the condition of the existing pavement is essential.

#### **5.5. Surface Falls and Drainage**

- 5.5.1. The design of modular pavements shall ensure sufficient crossfall to shed surface water from the pavement surface and sufficient longitudinal fall to convey the surface water to the proposed drainage system and should be laid to the recommended gradients described in Table 36 of BS 7533-101.

- 5.5.2. Larger areas may be divided into panels to ensure the required gradients are achieved, particularly where levels are constrained such as at tie-ins with other roads or thresholds etc.
- 5.5.3. The drainage of surface water runoff from modular pavements shall be via trapped highway gullies. Where the area is a shared surface or will be used by significant numbers of pedestrians and cyclists, 450 x 450, D400 gully frames with mesh gratings that comply with BS 124 with minimum total waterway area of 975cm<sup>2</sup> shall be used instead of those required for carriageway areas. Surface channel drains and slot drains shall not be used as they are significantly more difficult to maintain.

## **5.6. Subgrade Drainage**

- 5.6.1. Subgrade drainage is considered beneficial when the water table is high, irrespective of the nature of the subgrade. Where the water table is expected to be 300mm or less from the proposed formation or sub-formation, the introduction of effective subgrade drainage can make a significant improvement on long-term subgrade surface modulus and the integrity of the pavement and shall be considered as part of the design process. Details of subgrade drainage using fin and narrow filter drains are provided within TG 6-1 - Pavement Foundation Design.

## **5.7. Management of Moisture in the Pavement Structure**

- 5.7.1. Where the base layer is impermeable or has low permeability, a drainage system should be included to prevent the accumulation of water within the laying course. This is to avoid a build-up of moisture within unbound laying courses which can result in hydraulic pressures developing during loading which can lead to failure of the pavement. A build-up of moisture within bound layers can result in frost damage or staining of natural stone paving where capillary action occurs.
- 5.7.2. The provision of 50mm diameter holes on a 2m orthogonal grid and at low points has traditionally been used to provide secondary drainage through bound base layers. The holes are to be filled with 6mm clean aggregate, with an area of geotextile separator a minimum 5 times the holes diameter placed over each to help prevent migration of the bedding sand. Weepholes within edge restraints and linear drainage systems may also be considered to allow water to escape from the laying course.

## **5.8. Materials**

- 5.8.1. Precast concrete paving blocks are the most commonly used materials within modular pavements. They shall comply with BS EN 1338 and be laid in accordance with BS 7533-101. Unless otherwise agreed by the Highway Authority, blocks shall be of standard rectangular shape 200mm x 100mm. Concrete blocks are generally constructed 60mm and 80mm thick. Only 80mm thick blocks will be considered for use within modular pavements in Hampshire.
- 5.8.2. All concrete blocks and clay pavers shall have a minimum Polished Paver Test Value (PPTV) of 55 or whatever higher value is required by the

Highway Authority. Additionally, evidence shall be submitted to demonstrate that the skidding resistance as supplied/installed is not less than the PPTV value.

- 5.8.3. High PPTVs on their own do not necessarily provide sufficient protection against skidding and therefore all modular paving materials shall have some texture to ensure resistance in wet conditions. Polished and semi-polished products shall not be accepted. If a paving product is used which has inadequate resistance to polishing, the only long-term solution will be to replace it with a more suitable product.
- 5.8.4. For concrete blocks, the maximum abrasion resistance (wide wheel abrasion) shall be  $\leq 23\text{mm}$ , or class A2 for clay pavers.
- 5.8.5. Clay pavers, where permitted, shall comply with BS EN 1344, Class T4 with frost resistance to Class FP100 and should be laid in accordance with BS 7533-101.
- 5.8.6. The colour of any proposed concrete paving blocks or clay pavers shall be clearly indicated on the construction drawings and be approved by the Highway Authority prior to the commencement of construction. For all areas to be adopted as Highway, the colour shall be agreed with the Highway Authority before fixing within the planning process either through a design brief/manual or planning condition.

## 6. Construction

### 6.1. Foundation Assessment

- 6.1.1. Immediately prior to construction commencing the Construction Subgrade Surface Modulus (CSSM) is to be determined by in-situ testing. Further details are provided within TG 6-1. In every case the lower of the DSSM or CSSM value shall be used for construction purposes. It is not permissible to reduce the foundation thickness if the CSSM is greater than the DSSM. Any change to the approved DSSM value will require approval prior to the commencement of construction.
- 6.1.2. Where the subgrade assessment indicates values of less than 30 MPa action shall be taken to effect improvement to the subgrade in line with the requirements within CD 225. Proposals for permanently improving the subgrade shall be submitted to the Highway Authority's original approver for review, with no works permitted until approval of the proposals are received. Should works continue without prior approval, this shall be deemed to be at the contractors' / developers' risk.

### 6.2. Modular Pavement Installation

- 6.2.1. The installation of all modular paving shall be undertaken in accordance with the relevant British Standard, which for concrete blocks and clay pavers is BS 7533-101, ensuring adequate drainage, foundation strength and integrity of the blocks and bedding layer. These considerations shall be reflected in both the design and construction, as failure to do so in one or both will have implications on the life expectancy of the pavement.
- 6.2.2. Modular units shall generally be laid in a 45° herringbone configuration, as this bond offers the best resistance to 'creep' caused by the action of traffic and lowest noise levels. Where any area of block paving abuts a conventional flexible construction, the first two rows of blocks adjacent to the flexible construction shall be laid in staggered stretched bond and bedded on 150mm of ST4 (Standardised prescribed concrete to Cl. 2602) and 'haunched' up on one side, with the remainder laid in a 45° herringbone configuration, unless approved otherwise.
- 6.2.3. 'Stretcher bond' or 'Running bond' pattern shall not generally be used in trafficked situations as they have insufficient stability to withstand the forces to which it will be subjected. Approval of the Highway Authority via a Departure from Standard shall be sought if anything other than a 45° herringbone configuration is proposed.
- 6.2.4. The laying course (30mm thick) and jointing sand shall comply with BS 7533:101, suitable for Traffic Category 7. Kiln dried jointing sand shall be applied and reapplied as many times as necessary until a well-bound and stable pavement is achieved. Once stable, a sealant compatible with the chosen blocks shall be applied to prevent early loss of jointing sand.
- 6.2.5. All block paved surfaces shall be sealed and will not be adopted until they have stabilised. The Design Organisation will be required to demonstrate that the chosen sealant does not compromise skid resistance in the long

term and does not reduce skid resistance to less than 45 Slip Resistance Value at the time of application.

## 7. Further Support

- 7.1. Should you have a specific query or feedback about any of the content of this Technical Guidance Note, please send an e-mail to [Technical.Guidance@hants.gov.uk](mailto:Technical.Guidance@hants.gov.uk), with the start of the e-mail title as “TG6-3 – Modular Pavement Design”.
- 7.2. Should you have a query about applying this to your particular project, please contact:
- the Design Check Engineer dealing with the specific S278 or S38 application (if you are a Developer or Developer’s Consultant)
  - the Technical Guidance Note Specialist(s) (if you are working within Hampshire County Council).
- 7.3. Associated Technical Guidance Notes:
- TG5 - Geotechnical Investigation Testing and Design
  - TG6-1 - Foundation Design
  - TG6-2 - Flexible and Rigid Pavement Design
  - TG6-4 – Technical Guidance Note – Permeable Paving
  - TG10 - Footways/Cycleways/Shared Surfaces
  - TG11 – Technical Guidance Note – Traffic Calming