Design Manual for Roads and Bridges

Pavement
Design

CD 239
Footway and cycleway pavement design

(formerly HD 39/16)

Revision 0

Summary
This document sets out the requirements for new footway and cycleway pavement construction. It covers footways constructed from common materials that are subject to pedestrian and/or cycle traffic and some overrun by vehicular traffic.

Application by Overseeing Organisations
Any specific requirements for Overseeing Organisations alternative or supplementary to those given in this document are given in National Application Annexes to this document.

Feedback and Enquiries
Users of this document are encouraged to raise any enquiries and/or provide feedback on the content and usage of this document to the dedicated Highways England team. The email address for all enquiries and feedback is: Standards_Enquiries@highwaysengland.co.uk

This is a controlled document.

Contents

Release notes

Version	Date	Details of amendments
0	May 2019	CD 239 replaces HD 39/16. The full document has been re-written to make it compliant with the new Highways England drafting rules.

Foreword

Publishing information

This document is published by Highways England.

This document supersedes HD 39/16, which is withdrawn.

Contractual and legal considerations

This document forms part of the works specification. It does not purport to include all the necessary provisions of a contract. Users are responsible for applying all appropriate documents applicable to their contract.

Introduction

Background

Research has been carried out at the Transport Research Laboratory (TRL) to identify the causes of failure in footways (see TRL 134 [Ref 1.I]) and thus to recommend suitable designs to improve the surface condition of footways over their design life. Vehicle overrun and works by statutory undertakers have been identified as the most common causes of failure in footways. Growth of vegetation, natural ageing of bituminous material, and poor design and construction have also been identified as significant causes of deterioration.

Assumptions made in the preparation of the document

The assumptions made in GG 101 [Ref 15.N] apply to this document.

Mutual Recognition

Where there is a requirement in this document for compliance with any part of a "British Standard" or other technical specification, that requirement may be met by compliance with the Mutual Recognition clause in GG 101 [Ref 15.N].

Abbreviations

Abbreviations

Abbreviation	Definition
AC	Asphalt Concrete
CBGM	Cement Bound Granular Material
CBR	California Bearing Ratio
CRBM	Cold Recycled Bound Materials
cv/d	Commercial vehicles per day
HGV	Heavy Goods Vehicle
HRA	Hot Rolled Asphalt
MAFI	Mean Annual Frost Index
msa	Million standard axles
NG	Notes for Guidance
PSV	Polished Stone Value
SHW	Specification for Highways Works
USRV	Unpolished Skid Resistance Value

Terms and definitions

Terms

Term	Definition
Formation level	Top of prepared subgrade, including any capping layer or subgrade improvement, on which pavement construction is founded; that is, on which subbase is placed.
Pedestrianised area	Paved area for pedestrian and cyclist usage, rather than vehicular traffic, but generally subject to significant regular trafficking by delivery and maintenance vehicles.
Residential area	Urban or suburban environment with residential dwellings; these will generally have vehicular access to the carriageway across any adjacent footway or cycleway.
Statutory Undertaker	Utility body that has statutory right of access to buried services.

1. Scope

Aspects covered

1.1 This document presents requirements that shall be used for the design of the pavement construction for new footways and cycleways surfaced with asphalt, concrete block or clay pavers, natural stone slabs or setts, pre-cast concrete flags or in-situ concrete and subject to pedestrian and/or cycle traffic and some overrun by vehicular traffic.

NOTE *This document does not address the maintenance of existing footways or cycleways.*

Implementation

1.2 This document shall be implemented forthwith on all schemes involving new construction, improvement or maintenance on the Overseeing Organisations' motorway and all-purpose trunk roads according to the implementation requirements of GG 101 [Ref 15.N].

Use of GG 101

1.3 The requirements contained in GG 101 [Ref 15.N] shall be followed in respect of activities covered by this document.

2. General design requirements

Geometry

2.1 The geometrical design of footways and cycleways shall be in accordance with TA 90 [Ref 27.N].

NOTE 1 *In Scotland, additional advice on geometric design can be found in Cycling by Design [Ref 3.I] and Roads for All (2013) [Ref 12.I].*

NOTE 2 *In Wales, additional advice on geometric design can be found in Design Guidance: Active Travel (Wales) Act (2013) [Ref 5.I].*

NOTE 3 *Coloured surfacing can be used to emphasise the presence of a footway or cycleway.*

Drainage

2.2 The design of drainage systems for footways and cycleways shall be in accordance with:

1) HD 33 [Ref 10.N];
2) HD 49 [Ref 14.N].

2.3 Water shall not pool against kerbs, structures or other highways assets.

Statutory undertakers

2.4 Risk of disruption due to access for maintenance or repair to services shall be minimised.

2.4.1 Where possible, services should be placed in the verge rather than under the footway or cycleway.

3. Structural design of footway and cycleway pavements

Pavement foundation

3.1 The design life of foundations for footway and cycleway pavements shall be 40 years.

3.2 The subgrade for footway or cycleway construction shall be assessed in terms of its California Bearing Ratio (CBR).

3.3 In-situ testing to support the determination of design CBR shall be in accordance with IAN 73 [Ref 11.N].

3.4 The design CBR shall represent equilibrium subgrade condition.

3.5 Where the CBR of the subgrade is less than 2.5% it shall be improved in accordance with the options presented in IAN 73 [Ref 11.N].

3.6 Where the mean annual frost index (MAFI) for the location is ≥ 50 all material within 450mm of the surface shall be non-frost-susceptible.

3.7 Frost susceptibility shall be determined in accordance with Clause 801 of Series 800 of the SHW [Ref 20.N].

3.7.1 Further information on the development and calculation of the MAFI may be obtained from Report RR45 [Ref 13.I].

3.7.2 Information to support determination of the MAFI for sites in the United Kingdom may be obtained from the Met Office.

3.8 Where the MAFI for the location is < 50 all material within 350mm of the surface shall be non-frost-susceptible.

3.9 Where the existing material does not meet the requirements for non-frost susceptibility it shall be stabilised in accordance with the options presented in IAN 73 [Ref 11.N].

Pavement loading

3.10 The loading for the footway or cycleway shall be categorised as follows:

1) pedestrian/cycle-only;
2) light-vehicle; or
3) heavy-vehicle.

Pedestrian/cycle-only

3.11 The pedestrian/cycle-only category shall be used where the footway/cycleway is physically separated from the carriageway.

3.12 The footway/cycleway shall be considered to be physically separated from the carriageway where:

1) there is a barrier or other permanent obstruction (e.g. bollards) such that vehicular traffic cannot mount the footway/cycleway; or
2) there is a verge of width 3m or greater.

3.13 The pedestrian/cycle-only category shall be used where the footway/cycleway is not physically separated from the carriageway but where there can be no use or overrun by vehicles, including cleaning or maintenance vehicles.

Light-vehicle

3.14 The light-vehicle category shall be used:

1) where occasional overrun by HGVs is likely (i.e. as might occur two or three times in a year by delivery vehicles); or

2) where cumulative vehicular traffic loading over the design life is less than 0.5msa.

3.15 Light-vehicle overrun shall be assumed:

1) at domestic crossings, that is access to private driveways; or,
2) where occasional access by delivery vehicles is likely; or,
3) for footways/cycleways that are not physically separated from the carriageway and are adjacent to roads through residential areas.

Heavy-vehicle

3.16 The heavy-vehicle category shall be used:

1) where significant overrun by HGV is likely (i.e. allowing for one vehicle per working day over the design life time); or,
2) where cumulative vehicular traffic loading over the design life is between 0.5 and 12msa.

3.17 Heavy-vehicle overrun shall be assumed:

1) for footways/cycleways that are adjacent to, but not physically separated from the carriageway in areas where deliveries take place;
2) for footways/cycleways where there is uncertainty about the frequency of HGV overrun.

Pavement construction options and thickness design

3.18 The pavement construction options and design thicknesses corresponding to the pavement loading categories shall be selected from the tables presented below.

Table 3.18a Pedestrian-only footways and cycle-only cycleways

<table>
<tr><th rowspan="2">Layer</th><th colspan="4">Surface options</th></tr>
<tr><td>Asphalt</td><td colspan="2">Pavers/setts</td><td>Flags/slabs</td><td>Concrete</td></tr>
<tr><td rowspan="2">Surfacing</td><td rowspan="2">20 mm surface course
50 mm binder course</td><td>≥ 50 mm clay pavers</td><td>≥ 60 mm concrete blocks</td><td>≥ 50 mm</td><td rowspan="2">150 mm unreinforced</td></tr>
<tr><td colspan="2">30 mm laying course</td><td>25 mm laying course</td></tr>
<tr><td>Subbase</td><td colspan="4">100 mm</td></tr>
<tr><td>Subgrade</td><td colspan="4">≥ 2.5% CBR</td></tr>
</table>

Table 3.18b Light-vehicle footways and cycleways

Layer	Surface options					
	Asphalt	Pavers/setts		Flags/slabs		Concrete
Surfacing	20 mm surface course 50 mm binder course	≥ 50 mm clay pavers	≥ 60 mm concrete blocks	300 mm x 300 mm x 60 mm or 400 mm x 400 mm x 65mm or 450 mm x 450 mm x 70mm		150 mm unreinforced
		30 mm laying course		25 mm laying course		
Base	-	70 mm dense AC or CBGM A C5/6 (or stronger)				-
Subbase	225 mm	200 mm	150 mm	200 mm	150 mm	100 mm
Subgrade	≥ 2.5% CBR	2.5% ≥ CBR ≤ 5%	CBR > 5%	2.5% ≥ CBR ≤ 5%	CBR > 5%	≥ 2.5% CBR

Table 3.18c Heavy-vehicle footways/cycleways

Layer	Surface options				
	Asphalt		Pavers / setts or flags / slabs		Concrete
Surfacing	25 mm surface course		As Table 3.17b		200 mm unreinforced
Base	90 mm dense AC		90 mm dense AC	100 mm CBGM A C 5/6 (or stronger)	-
Subbase	320 mm	210 mm	165 mm	150 mm	150 mm
Subgrade	2.5% ≥ CBR ≤ 4%	CBR > 4 %	2.5% ≥ CBR ≤ 5%	CBR > 5%	≥ 2.5% CBR

NOTE *Larger flag/slab sizes are restricted because they can be difficult to lay, requiring mechanical handling, and can be damaged by vehicle overrun.*

Edge restraints

3.19 Continuous restraint where footway and cycleway construction abuts an adjoining carriageway shall be provided by the installation of kerbs.

3.20 The kerbs shall be placed on 150 mm concrete bedding over 100 mm subbase.

3.21 Elsewhere, unless the footway or cycleway abuts an existing building, wall or kerb, continuous restraint shall be provided by the installation of edgings.

3.22 The edgings shall be placed on 100 mm concrete bedding over 100 mm subbase.

4. Materials

4.1 Materials for footway and cycleway construction shall be selected from the options presented in Tables 4.1a to 4.1j.

Table 4.1a Permitted construction materials for footways and cycleways: subbase

Permitted material option	Specification	Guidance
Type 1	Series 800 of the SHW [Ref 6.I] Clause 803, Series 1100 of the SHW [Ref 19.N]	Series NG 800 [Ref 10.I]
Type 3	Series 800 of the SHW [Ref 6.I] Clause 805, Series 1100 of the SHW [Ref 19.N]	Series NG 800 [Ref 10.I]
CBGM A	Series 800 of the SHW [Ref 6.I] Clause 821, Series 1100 of the SHW [Ref 19.N]	Series NG 800 [Ref 10.I]
CBGM B	Series 800 of the SHW [Ref 6.I] Clause 822, Series 1100 of the SHW [Ref 19.N]	Series NG 800 [Ref 10.I]
CBGM C	Series 800 of the SHW [Ref 6.I] Clause 823, Series 1100 of the SHW [Ref 19.N]	Series NG 800 [Ref 10.I]

Table 4.1b Permitted construction materials for footways and cycleways: capping layer

Permitted material option	Specification	Guidance
Capping	Series 600 of the SHW [Ref 17.N] Clauses 613, 614	Series NG 600 [Ref 9.I]
Frost protection layer	Series 800 of the SHW [Ref 6.I] Clause 801	Series NG 800 [Ref 10.I]

Table 4.1c Permitted construction materials for footways and cycleways: asphalt surface course

Permitted material option	Specification	Guidance
6 mm dense asphalt concrete surface course	Series 900 of the SHW [Ref 21.N] Clause 909: AC 6 dense surf 70/100 AC 6 dense surf 100/150	Series NG 900 [Ref 11.I]
10mm close graded asphalt concrete surface course	Series 900 of the SHW [Ref 21.N] Clause 912: AC 10 close surf 70/100 AC 10 close surface 100/150	Series NG 900 [Ref 11.I]
15/10 hot rolled asphalt (without coated chippings)	Series 900 of the SHW [Ref 21.N] Clause 910: HRA 15/10 F surf 40/60	Series NG 900 [Ref 11.I]

Table 4.1d Permitted construction materials for footways and cycleways: asphalt binder course/base

Permitted material option	Specification	Guidance
20mm dense base/binder course	Series 900 of the SHW [Ref 21.N] Clause 906: AC 20 dense bin 40/60 Clause 948 CRBM AC 32 dense base 40/60	Series NG 900 [Ref 11.I] PD 6691:2015+A1:2016 [Ref 4.I]

Table 4.1e Permitted construction materials for footways and cycleways: concrete

Permitted material option	Specification	Guidance
In-situ unreinforced concrete	Series 1000 of the SHW [Ref 18.N] Clause 1001: C32/40 URC	Series NG 1000 [Ref 7.I]
Bedding to kerbs/edgings C 6/8 or ST1	Series 1100 of the SHW [Ref 19.N] Clause 1101, BS 8500 Part 2 [Ref 9.N]	Series NG 1100 [Ref 8.I]
Backing to kerbs/edgings C 6/8 or ST1	Series 1100 of the SHW [Ref 19.N] Clause 1101, BS 8500 Part 2 [Ref 9.N]	Series NG 1100 [Ref 8.I]

Table 4.1f Permitted construction materials for footways and cycleways: pavers/setts

Permitted material option	Specification	Guidance
Clay	Series 1100 of the SHW [Ref 19.N] Clause 1108, BS EN 1344 [Ref 4.N]	[Ref 2.I].
Concrete blocks	Series 1100 of the SHW [Ref 19.N] Clause 1108, BS EN 1338 [Ref 7.N]	
Natural stone setts	BS EN 1342 [Ref 25.N]	

Table 4.1g Permitted construction materials for footways and cycleways: flags

Permitted material option	Specification	Guidance
Pre-cast concrete	MCHW1 Clause 1104, BS EN 1339 [Ref 8.N]	[Ref 2.I]
Natural stone slabs	MCHW1 Clause 1104, BS EN 1341 [Ref 26.N]	[Ref 2.I]

Table 4.1h Permitted construction materials for footways and cycleways: kerbs and edgings

Permitted material option	Specification	Guidance
Pre-cast concrete kerbs	Series 1100 of the SHW [Ref 19.N] Clause 1101, BS EN 1340 [Ref 6.N]	Series NG 1100 [Ref 8.I]
Free standing in-situ concrete kerbs	Series 1100 of the SHW [Ref 19.N] Clause 1103, BS 5931: 1980 [Ref 5.N]	Series NG 1100 [Ref 8.I]
In-situ asphalt kerbs	Series 1100 of the SHW [Ref 19.N] MCHW1 Clause 1102, BS 5931: 1980 [Ref 5.N]	Series NG 1100 [Ref 8.I]
Polymer kerbs	Not currently included in MCHW	
Pre-cast concrete edgings	Series 1100 of the SHW [Ref 19.N] Clause 1101, BS EN 1340 [Ref 6.N]	Series NG 1100 [Ref 8.I]

Table 4.1i Permitted construction materials for footways and cycleways: laying course and jointing material

Permitted material option	Specification	Guidance
Laying course - unbound	Series 1100 of the SHW [Ref 19.N] Clause 1104 BS EN 12620 [Ref 2.N] BS 7533-3 [Ref 23.N]	'Asset Management Guidance for Footways and Cycle Routes: Pavement Design and Maintenance', UK Roads Liaison Group (UKRLG), 2018. [Ref 2.I]
Laying course - bound	BS 7533-4 [Ref 24.N]	[Ref 2.I] - as above
Jointing material - unbound	Series 1100 of the SHW [Ref 19.N] Clause 1104 BS EN 12620 [Ref 2.N] BS 7533-3 [Ref 23.N]	[Ref 2.I] - as above
Jointing material - bound	BS 7533-4 [Ref 24.N]	[Ref 2.I] - as above

Table 4.1j Permitted construction materials for footways and cycleways: linear drainage channels

Permitted material option	Specification	Guidance
Linear drainage channel	Series 500 of the SHW [Ref 16.N] Clause 517 BS EN 1433 [Ref 12.N]	

4.2 Asphalt surfacing shall be used for cycleways.

4.2.1 Where the combined design thickness of asphalt surface course and base/binder course ≤70 mm, and to meet the minimum layer thickness vs nominal size requirements of BS 594987 [Ref 3.N], a single layer of 20 mm dense binder course may be used.

4.3 Coarse aggregate in asphalt surface course, and in binder course where it is used as the running surface, shall be of polished stone value category PSV_{50} in accordance with BS EN 13043 [Ref 1.N].

4.4 The PSV requirement shall not apply to chippings applied in small quantities for decorative purposes.

4.5 Natural stone flags or setts shall have a minimum unpolished skid resistance value (USRV) of 35 determined in accordance with BS EN 14231 [Ref 22.N] in wet conditions.

4.5.1 Natural stone flags or setts are not recommended for new footways, primarily for reasons of high maintenance requirements, but may be used for aesthetic reasons when indicated by environmental design considerations.

4.6 Provision of tactile paving shall be in accordance with Guidance on the use of Tactile Paving [Ref 13.N].

5. Normative References

The following documents, in whole or in part, are normative references for this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Ref 1.N	BSI. BS EN 13043, 'Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas'
Ref 2.N	BSI. BS EN 12620, 'Aggregates for concrete'
Ref 3.N	BSI. BS 594987, 'Asphalt for roads and other paved areas. Specification for transport, laying, compaction and product type testing protocols'
Ref 4.N	BSI. BS EN 1344, 'Clay pavers. Requirements and test methods'
Ref 5.N	BSI. BS 5931: 1980, 'Code of practice for machine laid in-situ edge details for paved areas'
Ref 6.N	BSI. BS EN 1340, 'Concrete kerb units. Requirements and test methods.'
Ref 7.N	BSI. BS EN 1338, 'Concrete paving blocks. Requirements and test methods.'
Ref 8.N	BSI. BS EN 1339, 'Concrete paving flags. Requirements and test methods.'
Ref 9.N	BSI. BS 8500 Part 2, 'Concrete. Complementary British Standard to BS EN 206. Specification for constituent materials and concrete.'
Ref 10.N	Highways England. HD 33, 'Design of Highway Drainage Systems'
Ref 11.N	Highways England. IAN 73, 'Design of Pavement Foundations'
Ref 12.N	BSI. BS EN 1433, 'Drainage channels for vehicular and pedestrian areas - Classification, design and testing requirements, marking and evaluation of conformity (AMD 16109) (AMD Corrigendum 16739)'
Ref 13.N	DETR. 'Guidance on the use of Tactile Paving'
Ref 14.N	Highways England. HD 49, 'Highway Drainage Design Principal Requirements'
Ref 15.N	Highways England. GG 101, 'Introduction to the Design Manual for Roads and Bridges'
Ref 16.N	Highways England. Series 500 of the SHW, 'Manual of Contract Documents for Highway Works, Volume 1 Specification for Highway Works. Series 500 Drainage and service ducts.'
Ref 17.N	Highways England. Series 600 of the SHW, 'Manual of Contract Documents for Highway Works, Volume 1 Specification for Highway Works. Series 600 Earthworks'
Ref 18.N	Highways England. Series 1000 of the SHW, 'Manual of Contract Documents for Highway Works. Volume 1 - Specification for Highway Works. Series 1000 Road Pavements – Concrete Materials'
Ref 19.N	Highways England. Series 1100 of the SHW, 'Manual of Contract Documents for Highway Works. Volume 1 Specification for Highway Works. Series 1100 Kerbs, Footways and Paved Areas.'
Ref 20.N	Highways England. Series 800 of the SHW, 'Manual of Contract Documents For Highway Works. Volume 1 Specification for Highway Works. Series 800 Road Pavements — Unbound, Cement and Other Hydraulically Bound Mixtures'
Ref 21.N	Highways England. Series 900 of the SHW, 'Manual of Contract Documents for Highway Works. Volume 1 Specification for Highway Works. Series 900 Road Pavements – Bituminous Bound Materials.'

Ref 22.N	BSI. BS EN 14231, 'Natural stone test methods. Determination of the slip resistance by means of the pendulum tester.'
Ref 23.N	BSI. BS 7533-3, 'Pavements constructed with clay, natural stone or concrete pavers. Part 3: Code of practice for laying precast concrete paving blocks and clay pavers for flexible pavements.'
Ref 24.N	BSI. BS 7533-4, 'Pavements constructed with clay, natural stone or concrete pavers. Part 4: Code of practice for the construction of pavements of precast concrete flags or natural stone slabs.'
Ref 25.N	BSI. BS EN 1342, 'Setts of natural stone for external paving. Requirements and test methods.'
Ref 26.N	BSI. BS EN 1341, 'Slabs of natural stone for external paving. Requirements and test methods.'
Ref 27.N	Highways England. TA 90, 'The Geometric Design of Pedestrian, Cycle and Equestrian Routes'

6. Informative References

The following documents are informative references for this document and provide supporting information.

Ref 1.I	TRL. Burtwell M.H.. TRL 134, 'A study of footway maintenance'
Ref 2.I	UK Roads Liaison Group. 'Asset Management Guidance for Footways and Cycle Routes: Pavement Design and Maintenance'
Ref 3.I	Transport Scotland. 'Cycling by Design'
Ref 4.I	BSI. PD 6691:2015+A1:2016, 'Guidance on the use of BS EN 13108, Bituminous mixtures. Material specifications'
Ref 5.I	Welsh Government. 'In Wales, additional advice on geometric design can be found in Design Guidance: Active Travel (Wales) Act'
Ref 6.I	Highways England. Series 800 of the SHW, 'Manual of Contract Documents For Highway Works. Volume 1 Specification for Highway Works. Series 800 Road Pavements — Unbound, Cement and Other Hydraulically Bound Mixtures'
Ref 7.I	Highways England. Series NG 1000, 'Manual of Contract Documents for Highway Works. Volume 2 - Notes for Guidance on the Specification for Highway Works. Series NG 1000 Road Pavements – Concrete Materials.'
Ref 8.I	Highways England. Series NG 1100, 'Manual of Contract Documents for Highway Works. Volume 2 - Notes for Guidance on the Specification for Highway Works. Series NG 1100 Kerbs, Footways and Paved Areas.'
Ref 9.I	Highways England. Series NG 600, 'Manual of Contract Documents for Highway Works. Volume 2 - Notes for Guidance on the Specification for Highway Works. Series NG 600 Earthworks.'
Ref 10.I	Highways England. Series NG 800, 'Manual of Contract Documents for Highway Works. Volume 2 - Notes for Guidance on the Specification for Highway Works. Series NG 800 Road Pavements – Unbound, Cement and Other Hydraulically Bound Mixtures'
Ref 11.I	Highways England. Series NG 900, 'Manual of Contract Documents for Highway Works. Volume 2 - Notes for Guidance on the Specification for Highway Works. Series NG 900 Road Pavements – Bituminous Bound Materials.'
Ref 12.I	Scottish Government. Transport Scotland. Roads for All (2013), 'Roads for All: Transport Scotland'
Ref 13.I	TRL Ltd. Report RR45, 'Winter air temperatures in relation to frost damage in roads'