VOLUME 4 GEOTECHNICS AND DRAINAGE
SECTION 2 DRAINAGE

PART 4

HA 79/97

EDGE OF PAVEMENT DETAILS FOR POROUS ASPHALT SURFACE COURSES

SUMMARY

This Advice Note extends the guidance in HA 39 Edge of Pavement Details (DMRB 4.2) to the particular requirements for porous asphalt (PA) surface courses and provides advice on how the requirements can be incorporated into standard edge of pavement details.

INSTRUCTIONS FOR USE

1. Insert HA 79/97 into Volume 4, Section 2 after Part 3.

2. Archive this sheet as appropriate.

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THE HIGHWAYS AGENCY

THE SCOTTISH OFFICE DEVELOPMENT DEPARTMENT

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THE DEPARTMENT OF THE ENVIRONMENT FOR NORTHERN IRELAND

Edge of Pavement Details for Porous Asphalt Surface Courses

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Contents

1. INTRODUCTION

Scope

1.1 The Highway Construction Details (HCD - MCHW 3) are intended for use on all contracts for an Overseeing Organisation. The 'B' Series of HCD (MCHW 3) depict pavement edge details dealing with drainage aspects of highway verges and central reserves. HA 39 Edge of Pavement Details (DMRB 4.2) provides background and guidance, together with additional information required by the 'B' Series of HCD in the contract documentation, on edge of pavement details for traditional surface course materials.

1.2 This document extends the guidance in HA 39 (DMRB 4.2) to the particular requirements for porous asphalt (PA) surface courses, together with how those requirements can be incorporated into standard edge of pavement details. The guidance is based on a set of such details, developed from the drawings in the 'B' Series of HCD (MCHW 3) for the particular requirements of porous asphalt, which are given in Annex A. This annex will remain extant only until such time as the necessary details and advice are subsumed into HCD (MCHW 3).

1.3 The fundamental difficulty with the edge drainage detail for PA is that the most efficient method of water removal from the PA requires an open, free face at the edge of the carriageway. This typically 50 mm step, if formed vertically, may have undesirable safety implications for some road users. This document draws attention to this problem and solutions are described for different situations.

1.4 As with HA 39 (DMRB 4.2), this document augments the advice given in TA 57 Roadside Features (DMRB 6.3) but does not cover Road Geometry, Pavement Design, Signing, Lighting and Road Layout Aspects. General guidance on the use of porous asphalt as the surface course is given HD 27 Pavement Construction Methods (DMRB 7.2.4) and safety aspects of the juxtaposition of surface water channels and safety fences are considered in HA 37 Hydraulic Design of Road Edge Surface Water Channels (DMRB 4.2).

Limitations on Advice

1.5 There is limited experience of porous asphalt in the United Kingdom. Therefore, some of the advice is not as well proven as that for many other areas, and it may be superseded with further experience. The limitations in experience are reflected in some of the guidance. Nevertheless, the guidance given is based on the best advice available with current knowledge.

1.6 Some of the edge details in this document have been used in practice either in trials or, more recently, in larger contracts. Some systems, for example those proposed for bridges, have had only very limited and recent use and, therefore, long term performance is still to be determined. Some new systems, based on the application of sound drainage principles which avoid many of the problems encountered with edge drainage of PA, are also included.

1.7 With increasing use of PA, experience of the various systems described should enable long term assessments to be made, together with proposals for consequential improvements. Alternative systems may be developed in the future, and advice on the suitability of their use should be sought from the Overseeing Organisation.

Definitions

1.8 The definitions and descriptions given in HA 39 (DMRB 4.2) and Clause 517 of the Specification for Highway Works (MCHW 1) are used and apply in this document.

Implementation

1.9 This Advice Note should be used forthwith for all relevant schemes currently in preparation, provided that in the opinion of the Overseeing Organisation, this would not result in significant additional expense or delay. Design Organisations should confirm its application with the Overseeing Organisation.

2. PRINCIPLES

Basic Principles

2.1 The system employed at the edge of the carriageway should both provide safe conditions for road users and ensure that dry conditions are maintained within non-porous pavement layers and that the porous asphalt surface course is drained. Also, the road foundations, associated earthworks and structures must not be adversely affected by surface water run-off.

2.2 The main principles to be considered in the edge of pavement details for PA are:

a) Drainage: providing free drainage for the full thickness of the PA to enable the water emerging from the edge to flow away quickly;

b) Safety: having regard to the safety of all road users by minimising potential hazards introduced by the special requirements for PA, with particular reference to two-wheeled road users; and

c) Maintenance: providing the means to minimise the ingress and build up of detritus in the drainage system, and providing a practical means for its removal.

There is no single edge drainage system that is suitable for all situations and it is necessary to achieve a balance between some of these conflicting requirements.

Factors to be Considered

2.3 The edge drainage system appropriate for a site where the PA is to be laid depends on:

- category of road;
- gradient;
- embankment or cutting;
- urban, rural or industrial environment; and
- overbridge, underbridge or tunnel.

2.4 The following categories of edges to a PA surface course will need to be considered:

- upper carriageway edges; and
- lower carriageway edges.

In addition, the details around manholes and at the following joints between surface courses may also require attention:

- longitudinal joints with materials other than porous asphalt;
- transverse joints with materials other than porous asphalt; and
- bridge expansion joints.

2.5 With the number of possible combinations of the foregoing factors, there may be more than one possible practical solution to a particular situation. The choice should depend on the economics and expected durability of the alternative solutions in conjunction with the principles set out in paragraph 2.2.

Drainage of Carriageways

2.6 Removal of water is vital if the PA is to be an effective drainage layer. The crossfall of the impervious surface underlying the PA should be a minimum of 2.5 per cent (calculated in accordance with TD 9 Highway Link Design (DMRB 6.1) for the appropriate radii curves) to ensure storm water will reach the carriageway edges quickly and easily. The exception to this is at reverses of crossfall where a minimum longitudinal gradient of 1 in 200 should be achieved so that water does not accumulate in the flat spot. Maximum effect is obtained when the edge of the surfacing is free draining, with unobstructed discharge of water along its whole length, allowing water to freely enter the drainage system, so preventing localised backing up within the layer.

Drainage of Bridge Decks

2.7 Although there is little UK experience of the use of PA on bridges, similar principles will apply, together with the need to consider the effect of flexibility of the bridge structure and, in particular, the need to avoid water penetration into the structure. On bridge decks, the drainage system should be designed to permit an adequate water flow through and from the PA, including taking account of the expansion joints. Some suggestions are given in Chapter 5 for draining PA which continues over bridges, but detailed advice should be sought from the Overseeing Organisation.

Safety

2.8 In addition to its primary benefit of noise reduction, the use of PA is intended to enhance safety for road users during rainfall by removing water from the surface and hence reducing spray and glare. However, the use of free edges and channels can also present a danger, particularly to two-wheeled road users. Advice on the use of different types of kerbs and edgings is given in TA 57 Roadside features (DMRB 6.3).

Maintenance

2.9 Advice on maintenance of PA is given in HD 27 Pavement Construction Methods (DMRB 7.2.4), in particular that drainage channels require cleaning at least annually. Advice on maintenance procedures, including certain drainage features, is also given in the Trunk Road Maintenance Manual : Routine and Winter Maintenance Code (England and Wales).

2.10 In principle, cleaning of PA can be carried out to restore some of the hydraulic conductivity lost through the accumulation of detritus. However, whilst techniques are continually improving, to date the systems tested have not proved fully effective (TRL Project Report 108).

3. DESIGN PHILOSOPHY

Surface Drainage

3.1 The drainage characteristics of PA are different from those of a conventional surfacing, as described in HD 27 Pavement Construction Methods (DMRB 7.2.4).

3.2 During rainfall, unlike in traditional surfaces, there may be a considerable time lag before water emerges from the edge of PA and a limited amount of rainfall can be absorbed and retained within the layer. Hence, the edge run-off of a PA surface may be slightly higher in certain instances than the corresponding edge run-off from a traditional surface. Nevertheless, the total quantity of water drained from the surfacing will always be slightly less than the total rainfall over a period due to storm water retained in the surfacing, subsequently lost through evaporation.

3.3 As PA ages, the hydraulic conductivity reduces due to the deposition of detritus, particularly along hard shoulders on motorways (especially in the normal situation when these are on the lower side of the carriageway). Thus, the PA gradually becomes less permeable and so the edge drainage system should be designed to allow for water run-off from the top surface of the PA as well as the bottom of the layer. Water run-off from the top of the PA can also occur when the rainfall rate is heavy and prolonged such that the PA becomes saturated.

Upper Carriageway Edges

3.4 Significant amounts of storm water will not normally emerge from PA along the upper carriageway edge. Consequently, a seal or kerb along that edge is desirable where there is a risk of detritus being washed into the PA.

3.5 Where a kerb is installed on the upper carriageway edge, PA should be laid up to the kerb. This detail can also be used on structures.

3.6 Where a kerb is not installed on the upper carriageway edge, the edge of the PA should be such that the level of soil or other loose material adjoining the edge should not be higher than the top of the base course. However, where the PA has to abut an impermeable material at the same level, hot-applied binder should be painted on the edge of the PA in order to seal the pores against ingress of fines (Annex A, Drawing No. Sk6, Type Sk6A).

Lower Carriageway Edges

3.7 The design of the edge details for the lower edge of a PA carriageway requires the utmost care and attention. Standard details are described in Chapter 4.

3.8 PA should not be laid against a kerb or verge which is impermeable at the lower carriageway edge. If the carriageway edge becomes impermeable with time (which can occur with topsoil in very wet conditions), a section (Figure 3.1) will accumulate water from which detritus will settle, clogging the material. The section will be approximately 2 m wide for 50 mm thick PA laid at a gradient of 2.5 per cent. If surface drainage is adequate, water will be able to flow over the clogged area, but will cause surface run-off over part of the carriageway. If the edge drainage is inadequate, this may lead to water remaining on the surface causing stagnation. The extent of the water on the surface can be greater if the kerb is proud of the top surface of the PA.

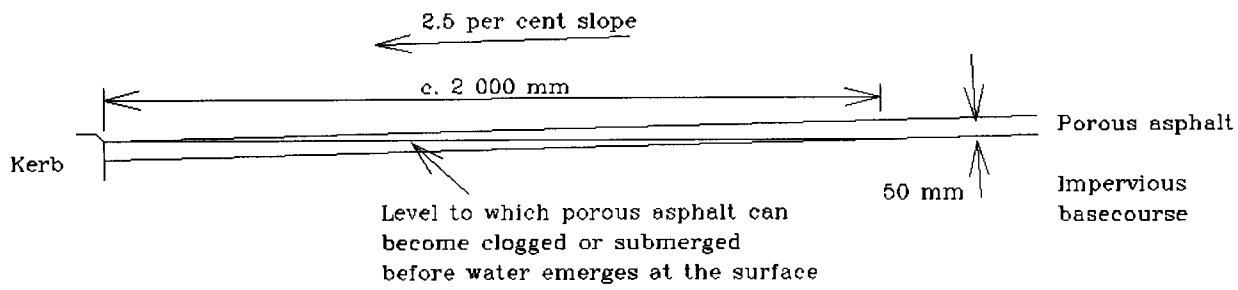

Figure 3.1 Clogging Effect on an Impermeable Kerb

Joints

3.9 Advice on joints in PA is given in HD 27 (DMRB 7.2.4).

3.10 Where PA is laid on a substantially level site, it may abut an impermeable surfacing transversely without special consideration of additional detail.

3.11 Where PA is laid on a longitudinal gradient, storm water will migrate in the direction of greatest resultant gradient. If the lower end of the PA abuts a dense surfacing transversely, water may emerge at the joint and cause a localised splash problem. In this situation, the lane ends of the PA should be staggered in the direction of the maximum gradient, as shown in Figure 3.2. The stagger at each longitudinal joint between lengths laid by different paving machines should be the width of PA being laid by one paver times the gradient divided by the crossfall.

3.12 If the gradient of the carriageway exceeds that of the crossfall, then staggering the lane ends may be insufficient to stop the splash problem and the PA should be continued to where the carriageway crossfall exceeds its gradient.

3.13 Longitudinal joints between PA and an impermeable surfacing are permitted, provided the crossfall is from the impermeable surfacing onto the PA. PA should not be used where the road crossfall is from the PA to an impermeable surfacing because of the splash problem and because of the long-term retention of water in the PA.

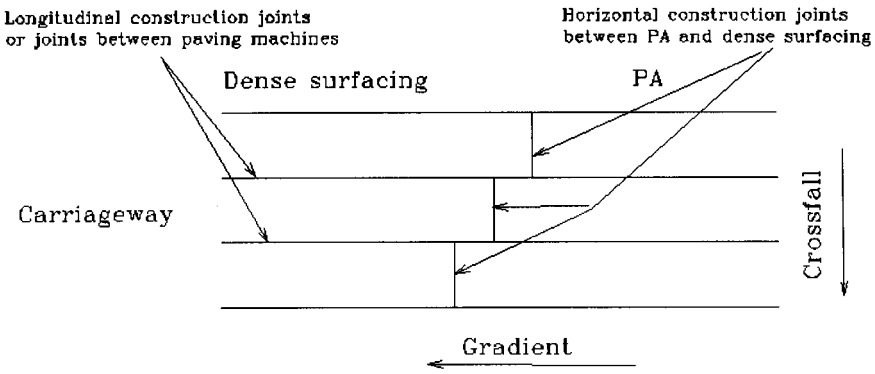

Figure 3.2 Plan showing Staggered Lane Ends for PA

4. BASIC DESIGNS

4.1 Six basic designs for draining PA have been identified and are listed below:

(i) Combined Drainage and Kerb Systems (Annex A - Drawing No. Sk5)
(ii) Linear Drainage Channel Systems (Annex A - Drawing No. Sk5)
(iii) Extended PA over a Combined Filter Drain (Annex A - Drawing Nos. Sk1, Sk2 and Sk7)
(iv) Free Edge with a Kerbed Channel (Annex A - Drawing Nos. Sk3 and Sk4)
(v) Free Edge with a Surface Water Channel (Annex A - Drawing No. Sk3 and Sk4)
(vi) Free Edge with Over-the-Edge Drainage (Annex A - Drawing No. Sk6)

Combined Drainage and Kerb Systems

4.2 Where positive drainage is required for kerbed carriageways surfaced with PA, a combined drainage and kerb system is normally employed. These systems are specified in Clause 516 of the Specification for Highway Works (MCHW 1) and are shown in Annex A, Drawing No. Sk5, Type Sk5B. When used with PA rather than conventional surfacing, the kerbs should be laid with the bottom of the side inlets flush with, or slightly below, the top of the basecourse and the PA may be locally shaped at each inlet around a simple former. A disadvantage of this system is that the open area acting as an inlet is often only about 10 per cent of the PA's cross-section at the kerb, which will reduce the rate of drainage and could lead to a build up of detritus in the PA between the inlets so that the PA to basecourse interface remains wet for long periods. An advantage of the system is that, even when the PA becomes fully blocked or the rainfall is so heavy that water runs on the surface of the road, the inlets will take the water away as if the road had a conventional impermeable surfacing.

4.3 A combined drainage and kerb system specifically designed for PA includes a single slot with the vertical face of the PA on one side and the kerbed face on the other (Annex A, Drawing No. Sk5, Type Sk5D). The upper part of the slot will need to be formed when laying the PA.

4.4 Types Sk5B and Sk5D on Annex A, Drawing Sk5 may be provided as pre-cast units. Type Sk5D may also be slipformed, whereas this process may not be appropriate for Type Sk5B.

Linear Drainage Channel Systems

4.5 These systems are permitted under Clause 517 (MCHW 1) and NG517 of the Notes for Guidance (MCHW 2). Linear drainage channels employed with PA will have certain differences from those used with conventional surfacing but must still comply with the general requirements of Clause 517. Two types of channel are detailed within the specification, with the top surface having either a grating or a longitudinal slot for water entry. Two strength classes are recognised in the specification: Class C which may be installed in locations protected from direct traffic loading, and Class D which are designed to withstand loadings of all types of vehicles that are permitted on the highway. As with other drainage features, the Design Organisation should ensure that they are not located within the running surface of the carriageway. Advice on this may be obtained from the Overseeing Organisation.

4.6 When channels with gratings are installed in locations where they may experience occasional vehicle overrun, they must be of the integral type meeting the Class D strength requirements as described in Clause 517. When employed adjacent to PA surfacing, such channels will need to have inlets on the side adjacent to the PA. The open area should contain as great a proportion of those sides as is practicable, with the side inlets extending to the level of the bottom of the PA. The open area provided in the side of the channel will be a balance between maximising the openings for best drainage and meeting the strength requirements of Clause 517. This system is shown in Annex A, Drawing No. Sk5, Type Sk5A.

4.7 Channels with a continuous or intermittent inlet slot on the top surface are also permitted under Clause 517. In this case, the system may be installed such that water from the PA drains through this slot without the need for additional side entry openings, although the design should only be used in conjunction with kerbs or vertical concrete barriers to prevent water emerging from the PA overshooting the slot. Again, where these channels may be subject to occasional vehicle overrun, they must meet the Class D strength requirements. One option is shown in Annex A, Drawing No. Sk5, Type Sk5C where the unit is constructed with one side of the top surface adjacent to the slot 50 mm lower than the other resulting in a flush surface when the

PA is laid. A variation of this design is shown in Annex A, Drawing No. Sk5, Type Sk5D where the unit is cast with an integral kerb on one side (see also paragraph 4.3).

4.8 Should linear drainage be required where water might enter from both sides of the channel, for example on motorway nosings, then modified versions of Types Sk5A or Sk5C may be employed permitting water entry from both sides.

4.9 Types Sk5A, Sk5C and Sk5D shown on Annex A, Drawing Sk5 may be provided as pre-cast units. Types Sk5C and Sk5D may also be slipformed, whereas this process may not be appropriate for Type Sk5A.

Extended PA over Verge or Central Reserve with Water Feeding into a Filter Drain

4.10 HA 39 Edge of Pavement Details (DMRB 4.2) gives guidance on the use of combined filter drains for conventional surfacing materials. This Part considers modifications to the top layer of these filter drains (depicted in HCD B1, B5 and B15) for use with PA surface courses and gives specific advice on the modified details. Notwithstanding the specific advice contained herein, the general advice for combined filter drains given in HA 39 (DMRB 4.2) shall apply.

4.11 HA 39 considers the problem of stone scatter with conventional filter drains. If not less than the top 100 mm of the type B filter drain material is bound together with bitumen, the risk of stone scatter and vehicles getting bogged in loose material can be minimised without excessively reducing the surface permeability. This technique is shown in Annex A, Drawings Nos. Sk1, Sk2 and Sk7 where bitumen-bound aggregate extends from the edge of the carriageway over the filter drain. Advice on the specification for bitumen bonded aggregate topping should be sought from the Overseeing Organisation.

Free Edge with a Kerbed Channel

4.12 An edge channel can be formed by stopping PA with a free edge not less than 300 mm from a kerb (Annex A, Drawing No. Sk3, Types Sk3D and Drawing No. Sk4, Type Sk4D). Such channels will have a generally similar capacity to the flow within a standard gutter formed by a kerb and road crossfall. The channels should transport the water to a gullypot, catchpit or similar and thence via pipes to an outfall.

4.13 Where a free edge is provided, consideration should be given to the safety of the road user. Safety aspects of channel slopes are considered in HA 37 Hydraulic Design of Road Edge Surface Water Channels (DMRB 4.2). To minimise fretting and spalling along the free edges of PA, and to allow easier egress of any errant wheels that may enter the channel, the edge of the PA may be formed to give a 45 degree slope by compacting against a bevelled support. The chamfer should not be formed by differential compaction or by 'moving' the material during compaction.

Free Edge with Surface Water Channel

4.14 Where a surface water channel to Clause 510 (MCHW 1) is employed for surface water drainage, the PA may be terminated to a similar profile described in paragraph 4.13. The edge of the PA should be at least 300 mm from the junction between the channel and the basecourse. This layout is shown in Annex A, Drawing No. Sk3, Types Sk3A to Sk3C and Drawing No. Sk4, Type Sk4A to SkC. When calculating channel dimensions, the depth of the channel (y_3) must not exceed 150 mm (HA 37 in DMRB 4.2), of which the PA will form the top 50 mm.

Free Edge with Over-the-Edge Drainage

4.15 Over-the-edge drainage should be used only where the soil in the verge is sufficiently permeable, and the geometry and sub-soil is such that damage is not done to the road pavement, foundation or earthworks. Advice on suitable situations for over-the-edge drainage is given in HA 39 (DMRB 4.2).

4.16 Where a free edge is provided, the edge of the PA should be formed as described in paragraph 4.13 and as shown in Annex A, Drawing No. Sk6, Type Sk6B.

Application and Limitations on Use of Basic Designs for Trunk Roads and Motorways

4.17 The use of a free edge is the most efficient means of drainage and is generally the cheapest option. However, the Design Organisation must ensure that this detail would not constitute an unacceptable hazard to the road user in each situation where it is to be proposed because, with PA, the verge cannot be made up to near the height of the pavement surface as is the case with impervious surfaces.

4.18 A free edge with over-the-edge drainage can be used on roads without kerbs where the edges are not obstructed by vegetation, soil or other matter (so allowing free drainage to an open ditch or other drainage system) and the location of the free edge does not create a hazard for road users, especially two-wheeled road users.

4.19 While the use of a free edge with either a kerbed channel or a surface water channel is generally comparable with existing accepted features such as kerbs and surface water channels, the Design Organisation must ensure that it would not constitute an unacceptable hazard to road users.

4.20 Free edges with either over-the-edge drainage or a kerbed channel or a surface water channel are not likely to be suitable for use on roads frequented by pedestrians or pedal cyclists because of possible safety hazards; motorways and certain trunk dual carriageways have limited pedestrian and, for motorways, pedal cycle access. The absence of road lighting on roads with some pedestrians and/or pedal cyclists present will exacerbate the need to use a different solution. External kerbed channels and surface water channel which involve a step down where the PA finishes should not be used immediately adjacent to the edge of the carriageway without a hardstrip or hardshoulder other than alongside the central reserve.

4.21 The use of extended PA over a combined filter drain is generally appropriate for rural trunk roads where there is space to install the filter drains and where the bitumen bound topping is not likely to be used as part of the pavement.

4.22 Combined drainage and kerb systems and linear drainage systems could be applied on most trunk roads, but would be uneconomic where alternative designs can be used. Therefore, they are most applicable for urban trunk roads where pedestrians are present, on bridges or where there are other constraints on the selection of the drainage system.

Non-Standard Details

4.23 Details other than the standard details can be used provided it can be shown that, in developing the alternative drawings, the basic principles have been addressed and a similar design philosophy adopted. In particular, there may be circumstances for which none of the standard details are fully applicable, and modifications will need to be made. Advice should be sought from the Overseeing Organisation in these circumstances.

5. ADDENDUM FOR BRIDGE DECKS

5.1 An open channel adjacent to a kerb can be used on a bridge with a concrete deck, subject to the same constraints as for a carriageway (paragraphs 4.12 to 4.13). Where this is not possible, a linear drain (paragraphs 4.5 to 4.9) may be used. However, it may be desirable to use other types of proprietary drainage units. The units should have side provision to drain from both the edge and surface of the PA and should have a high proportion of open area.

5.2 A combined drainage and kerb system which can be used is shown in Figure 5.1. This type of system is seated in the impermeable layer below the PA and extends above it. This detail may also be used in situations other than bridge decks if it may be justified economically.

5.3 Where bridge expansion joints are encountered for joint movements up to 20 mm, a buried asphaltic plug expansion joint, flush with bridge deck, should be used so that the PA can be laid smoothly over the joint and not cause any obstruction to the flow of water through the surface course. For larger joint movements, an alternative appropriate expansion joint should be used with provision for suitable drainage from the PA.

5.4 Where a drainage channel, linear drain or equivalent system crosses an expansion joint, a flexible piped system should be installed across the joint. The plug joint should be extended to cover the piped units.

5.5 There is lack of experience concerning the performance of PA on steel decked bridges, which tend to be more flexible than concrete decks. Hence, HD 27 (DMRB 7.2.4) recommends that PA is not used on steel or steel composite bridges. Nevertheless, if PA is to be used on such bridges, the general principles remain the same. Special attention may need to be paid to ensure the integrity of the tack-coat under the PA and also in relation to drainage channels.

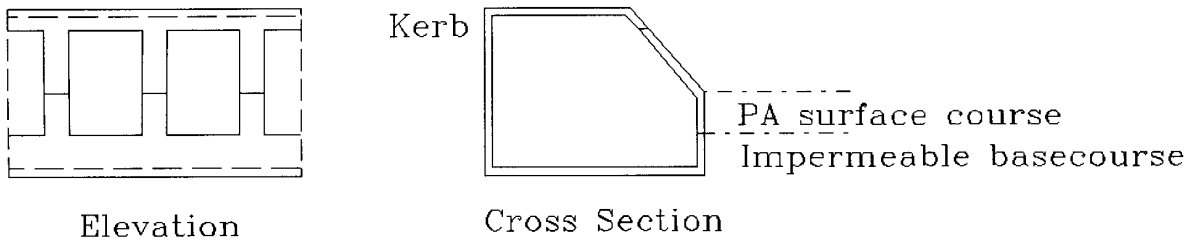

Figure 5.1 Proposed Combined Drainage and Kerb System

6. REFERENCES

1. Design Manual for Roads and Bridges (DMRB): Stationery Office Ltd

TA 57 Roadside Features (DMRB 6.3)
HA 37 Hydraulic Design of Road Edge Surface Water Channels (DMRB 4.2)
HA 39 Edge of Pavement Details (DMRB 4.2)
TD 9 Highway Link Design (DMRB 6.1.1)
HD 27 Pavement Construction Methods (DMRB 7.2.4)

2. Manual of Contract Documents for Highway Works (MCHW): Stationery Office ltd

Specification for Highway Works (MCHW 1)
Notes for Guidance on the Specification for Highway Works (MCHW 2)
Highway Construction Details (MCH 3)

3. Trunk Road Maintenance Manual: HA

Routine and Winter Maintenance Code (TRMM Vol 2)

4. TRL Report: TRL (to be published)

Report PR 108 by J C Nicholls. Review of UK Porous Asphalt Trials

7. ENQUIRIES

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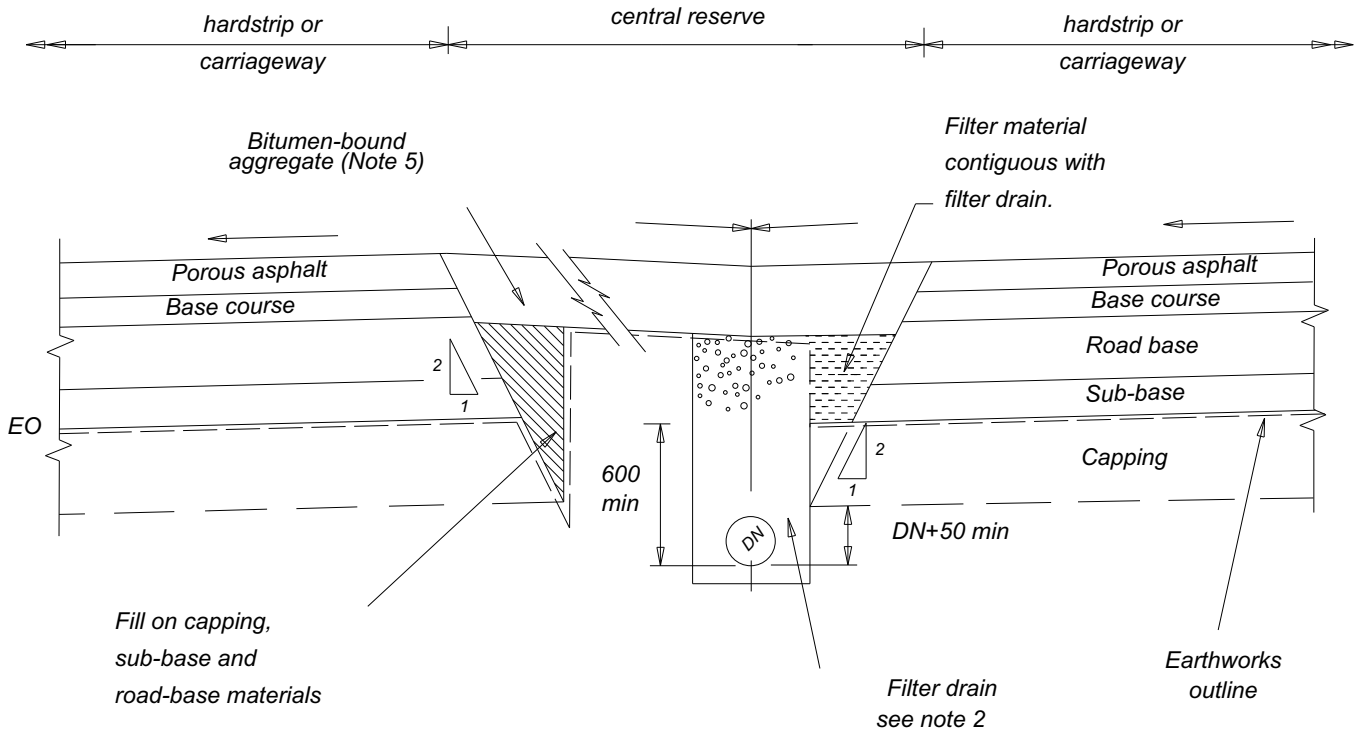
All technical enquiries or comments on this document should be sent in writing as appropriate to the above.

ANNEX A

EDGE DETAILS DRAWINGS

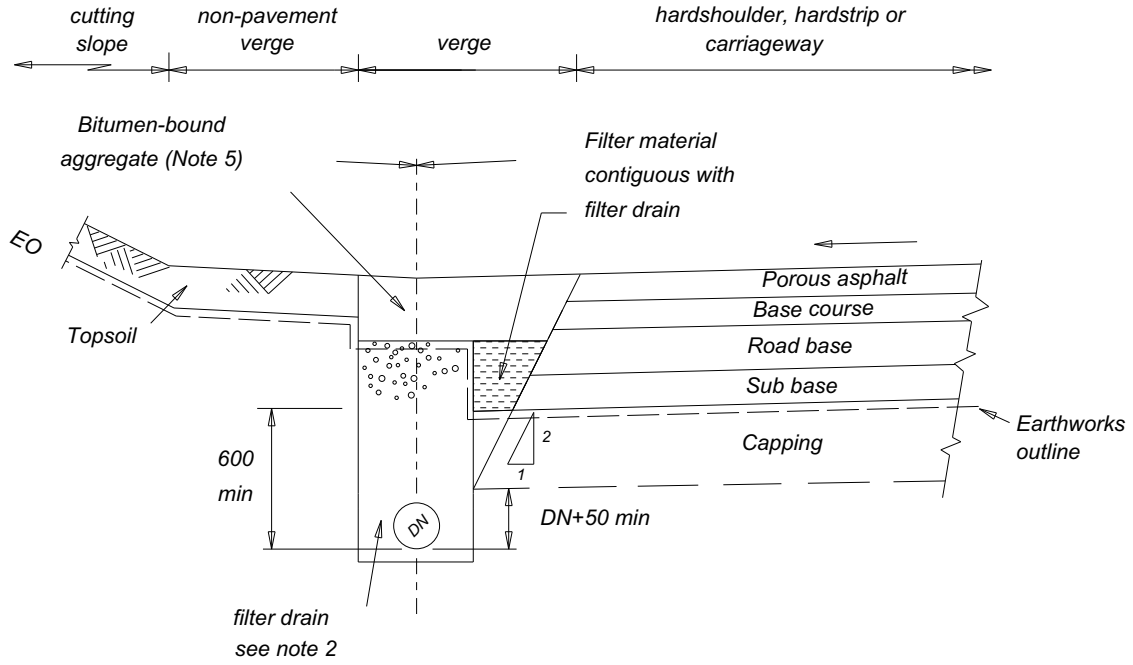
Drawing No.	Description
Sk1	Central Reserve - Combined Surface Water and Ground Water Filter Drains (Flexible Carriageway and Flexible Composite Carriageway)
Sk2	Cuttings - Combined Surface Water and Ground Water Filter Drains (Flexible Carriageway and Flexible Composite Carriageway)
Sk3	Central Reserve - External Kerbed Channel or Surface Water Channel Type Sk3A - Standard Concrete Channel (channel base formed within sub-base layer) Type Sk3B - Standard Concrete Channel (channel base formed on the sub-base layer) Type Sk3C - Standard Concrete Channel (channel base formed on first road base layer) Type Sk3D - Kerbed Channel
Sk4	Cutting - External Kerbed Channel or Surface Water Channel Type Sk4A - Standard Concrete Channel in Verge (channel base formed within sub-base layer) Type Sk4B - Standard Concrete Channel in Verge (channel base formed on the sub-base layer) Type Sk4C - Standard Concrete Channel in Verge (channel base formed on first road base layer) Type Sk4D - Kerbed Channel in Verge
Sk5	Cutting, Embankment or Central Reserve - Combined Drainage and Kerb and/or Linear Drainage Channel Systems Type Sk5A - Linear Drainage Channel with Top Grating and Additional Side Entry Openings Type Sk5B - Combined Drainage and Kerb System Type Sk5C - Linear Slot Drainage Channel for use in Conjunction with Vertical Concrete Barrier Type Sk5D - Combined Linear Slot Drainage Channel and Kerb System
Sk6	Embankment - Verge and Carriageway Drainage over Embankment Slopes (Flexible Carriageway and Flexible Composite Carriageway) Type Sk6A - Drainage away from Verge Type Sk6B - Drainage towards Verge
Sk7	Cutting and Central Reserve - Combined Surface Water and Ground Water Filter Drains Type Sk7A Type Sk7B Type Sk7C Type Sk7D



TYPE Sk1 - CENTRAL RESERVE
(FLEXIBLE CARRIAGEWAY & FLEXIBLE COMPOSITE CARRIAGEWAY)

NOTES:

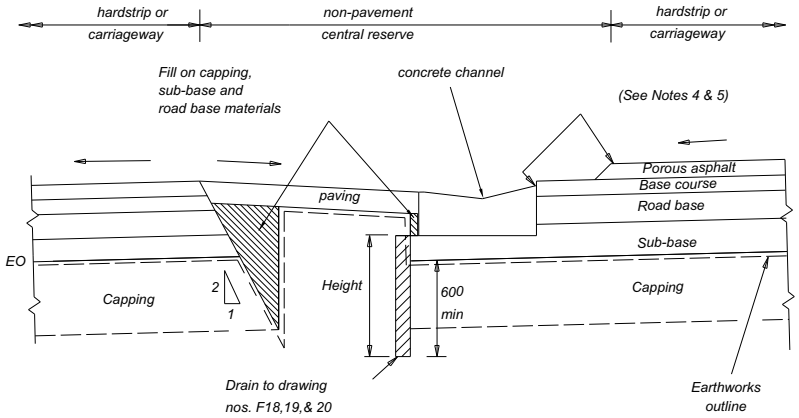
1. *ALL DIMENSIONS ARE IN MILLIMETRES.*
2. *Alternative treatments to top of filter drains are shown on Drawing No. Sk7. Type Sk7A is shown on this drawing.*
3. *'DN' represents nominal diameter of the pipe.*
4. *Pipes shall be laid to the levels shown on the drawings and schedules.*
5. *Advice on the specification for bitumen-bonded aggregate topping should be sought from the Overseeing Organisation.*



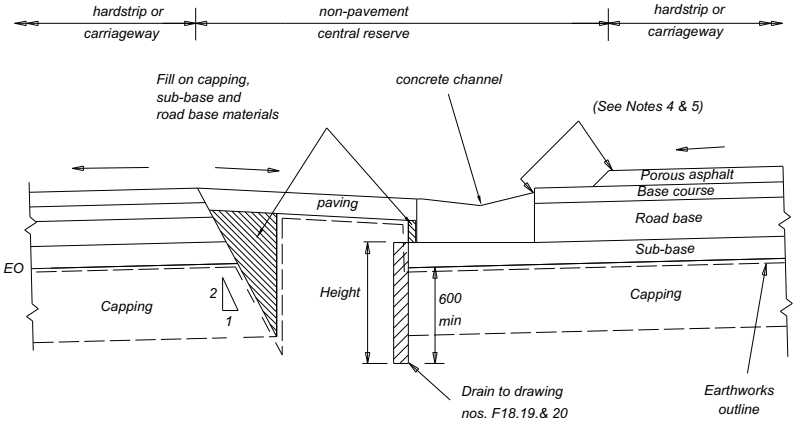
TYPE Sk2 - CUTTINGS
(FLEXIBLE CARRIAGEWAY & FLEXIBLE COMPOSITE CARRIAGEWAY)

NOTES:

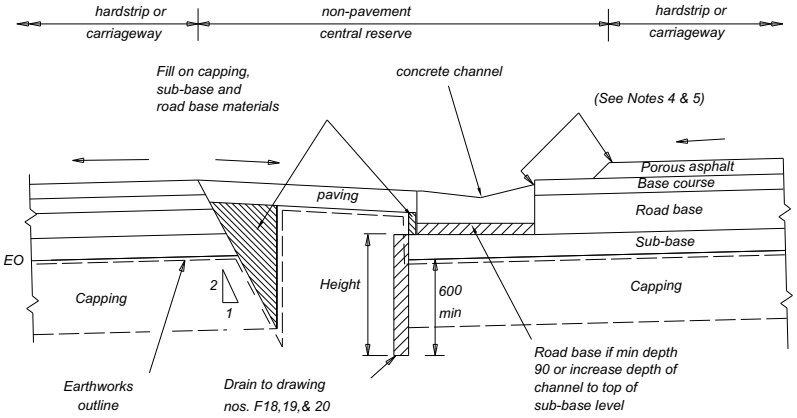
1. *ALL DIMENSIONS ARE IN MILLIMETRES.*
2. *Alternative treatments to top of filter drains are shown on Drawing No. Sk7. Type Sk7A is shown on this drawing.*
3. *'DN' represents nominal diameter of the pipe.*
4. *Pipes shall be laid to the levels shown on the drawings and schedules.*
5. *Advice on the specification for bitumen-bonded aggregate topping should be sought from the Overseeing Organisation.*



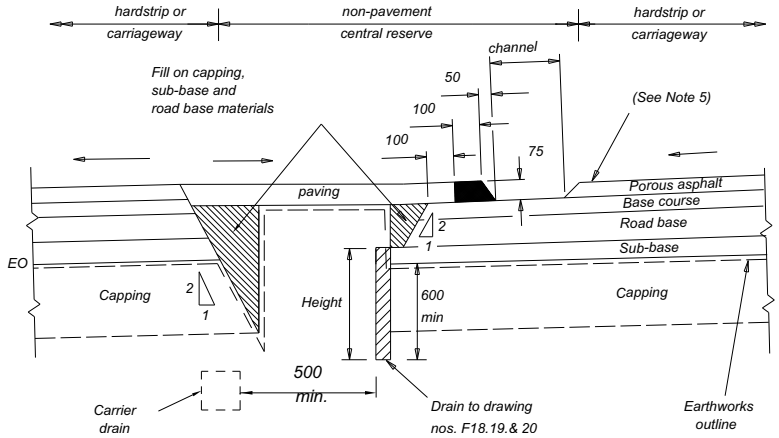
TYPE Sk3A - STANDARD CONCRETE CHANNEL
(CHANNEL BASE FORMED WITHIN SUB-BASE LAYER)



TYPE Sk3B - STANDARD CONCRETE CHANNEL
(CHANNEL BASE FORMED ON THE SUB-BASE LAYER)



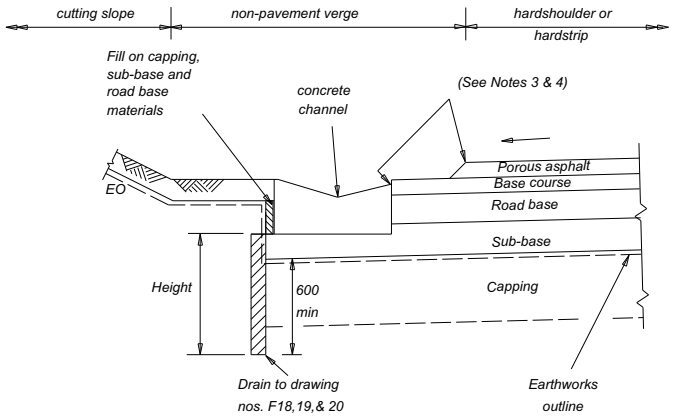
TYPE Sk3C - STANDARD CONCRETE CHANNEL
(CHANNEL BASE FORMED ON FIRST ROAD BASE LAYER)



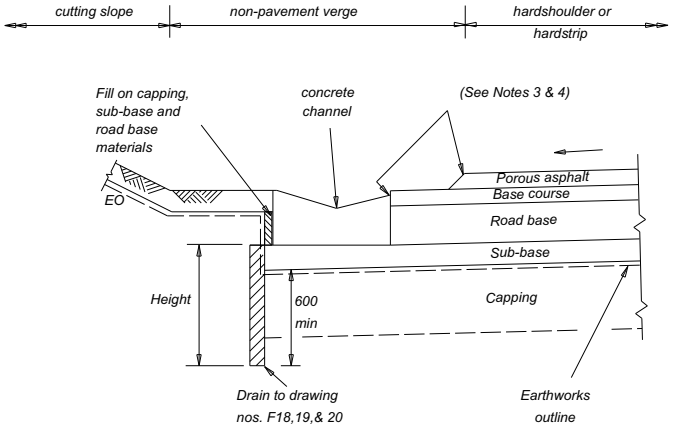
TYPE Sk3D - KERBED CHANNEL

NOTES:

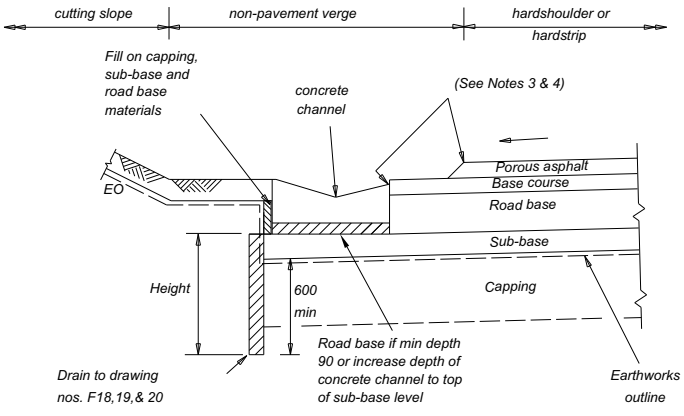
1. *ALL DIMENSIONS ARE IN MILLIMETRES.*
2. *For details of concrete channel, see Drawing No. B14 of HCD (MCHW 3).*
3. *Paving in the central reserve shall be as described in Appendix 5/3.*
4. *Notwithstanding other tolerances in the Specification, the finished level of the concrete channel shall not be higher, nor more than 10mm lower, than the top of the basecourse.*
5. *The free edge of the porous asphalt to be formed as described in paragraph 4.13.*



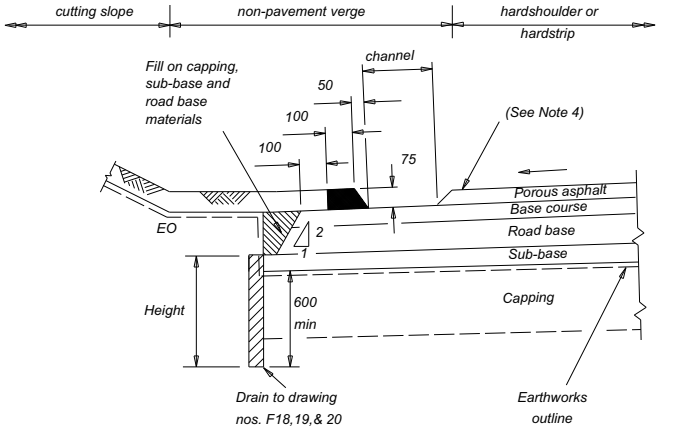
TYPE Sk4A - STANDARD CONCRETE CHANNEL IN VERGE (CHANNEL BASE FORMED WITHIN SUB-BASE LAYER)



TYPE Sk4B - STANDARD CONCRETE CHANNEL IN VERGE (CHANNEL BASE FORMED ON THE SUB-BASE LAYER)



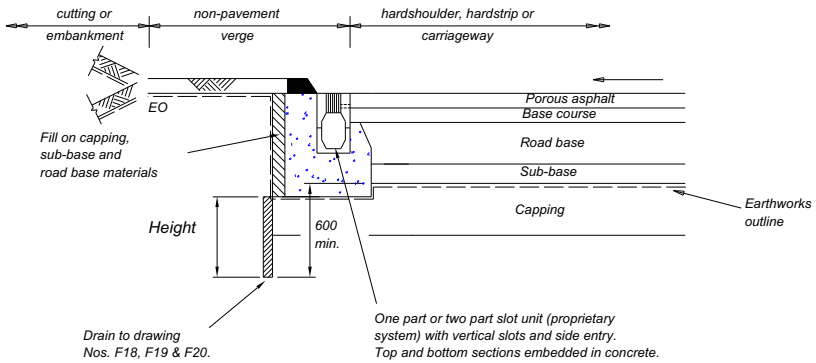
TYPE Sk4C - STANDARD CONCRETE CHANNEL IN VERGE (CHANNEL BASE FORMED ON FIRST ROAD BASE LAYER)



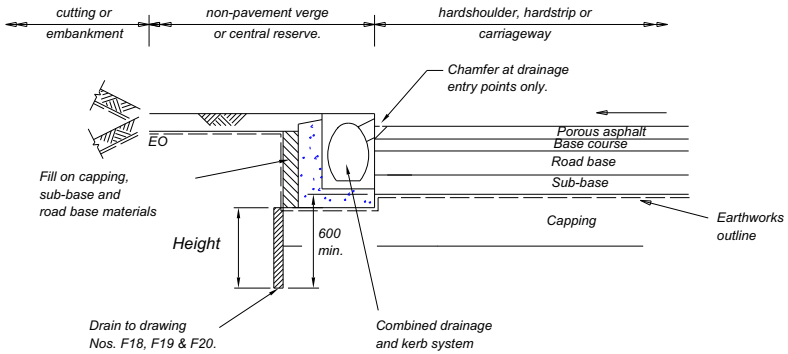
TYPE Sk4D - KERBED CHANNEL IN VERGE

NOTES:

1. *ALL DIMENSIONS ARE IN MILLIMETRES.*
2. *Paving in the central reserve shall be as described in Appendix 5/3.*
3. *Notwithstanding other tolerances in the Specification, the finished level of the concrete channel shall not be higher, nor more than 10mm lower, than the top of the basecourse.*
4. *The free edge of the porous asphalt to be formed as described in paragraph 4.13.*



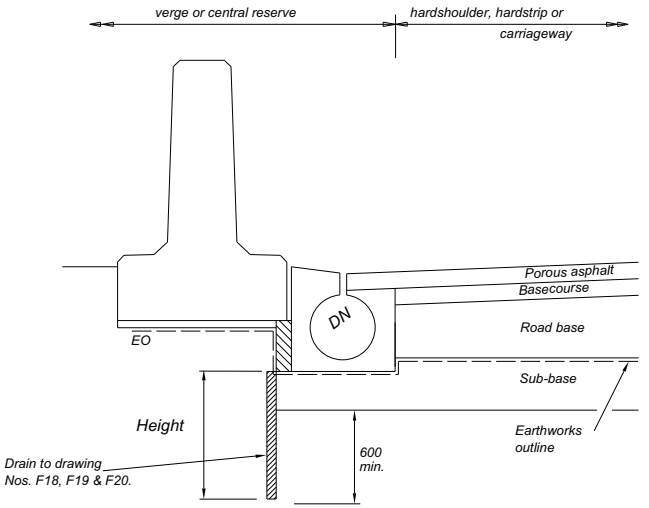
TYPE Sk5A - LINEAR DRAINAGE CHANNEL WITH TOP GRATING AND ADDITIONAL SIDE ENTRY OPENINGS



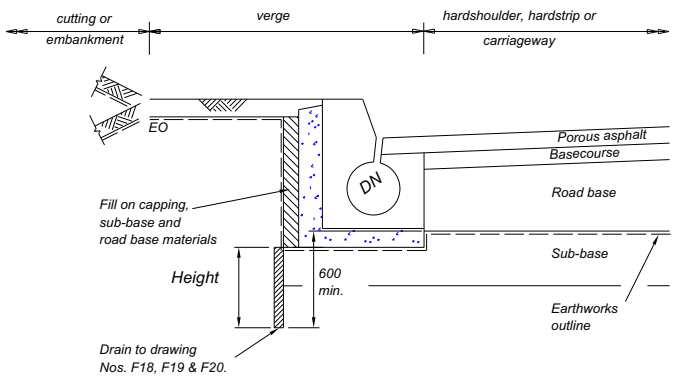
TYPE Sk5B - COMBINED DRAINAGE AND KERB SYSTEM

NOTES:

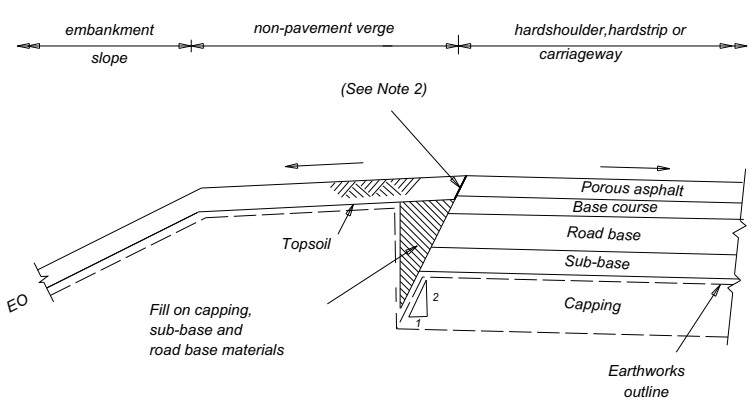
1. *ALL DIMENSIONS ARE IN MILLIMETRES.*
2. *Carrier drains shall be as detailed on the drawings and schedules.*
3. *'DN' represents nominal diameter of the pipe.*



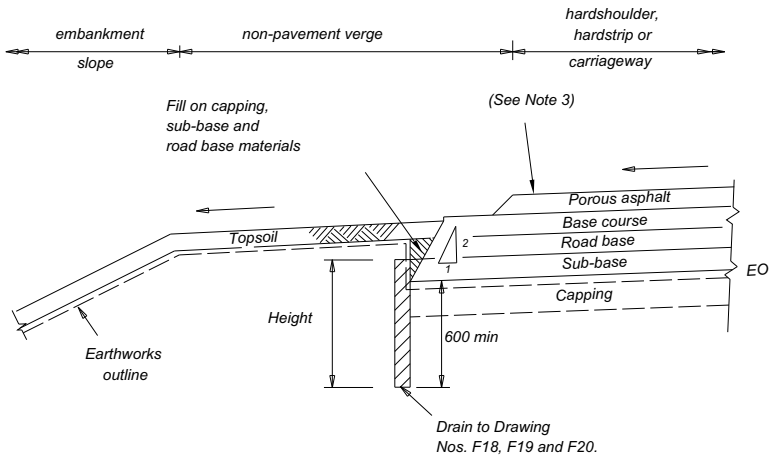
TYPE Sk5C - LINEAR SLOT DRAINAGE CHANNEL FOR USE IN CONJUNCTION WITH VERTICAL CONCRETE BARRIER



TYPE Sk5D - COMBINED LINEAR SLOT DRAINAGE CHANNEL AND KERB SYSTEM



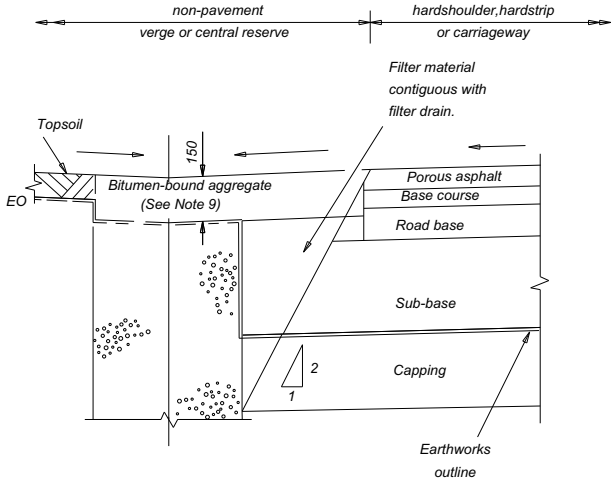
TYPE Sk6A - DRAINAGE AWAY FROM VERGE
(FLEXIBLE CARRIAGEWAY & FLEXIBLE COMPOSITE CARRIAGEWAY)



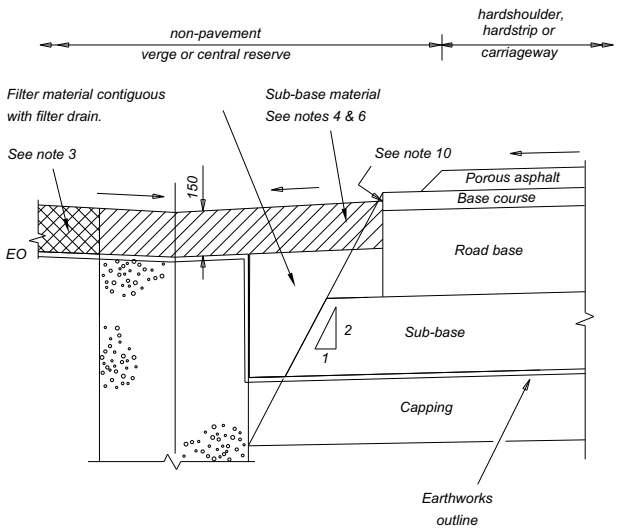
TYPE Sk6B - DRAINAGE TOWARDS VERGE
(FLEXIBLE CARRIAGEWAY & FLEXIBLE COMPOSITE CARRIAGEWAY)

NOTES:

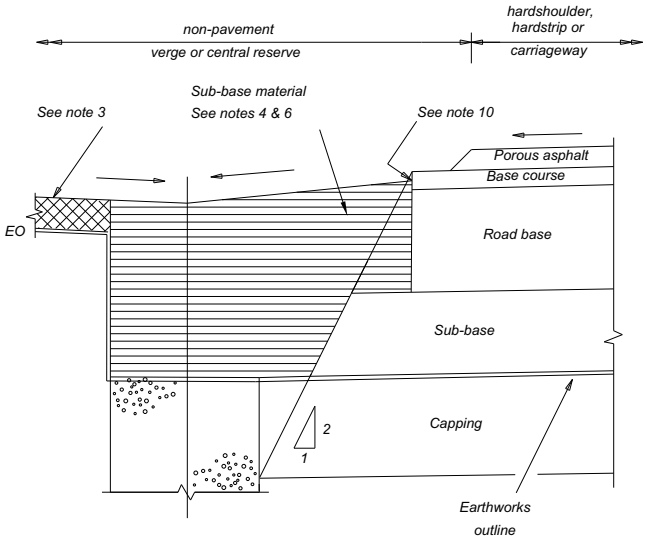
1. *ALL DIMENSIONS ARE IN MILLIMETRES.*
2. *Hot-applied binder to be painted on the edge of the PA before topsoil is laid alongside at upper carriageway edges in order to seal the pores.*
3. *The free edge of the porous asphalt to be formed as described in paragraph 4.13.*



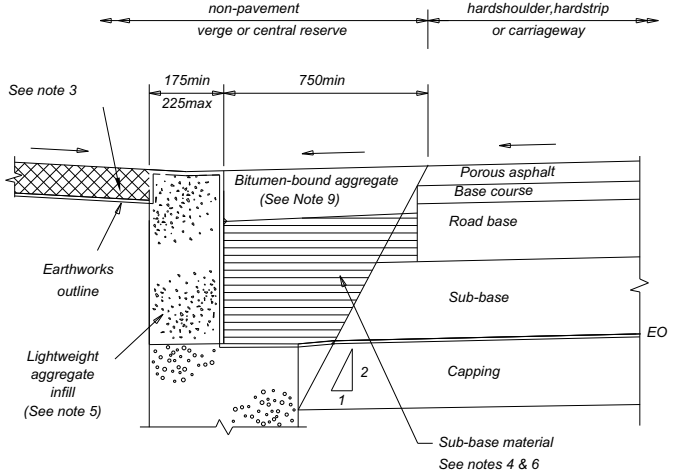
TYPE Sk7A



TYPE Sk7C



TYPE Sk7B



TYPE Sk7D

NOTES

1. *ALL DIMENSIONS ARE IN MILLIMETRES.*
2. *The drawing shows alternative treatments to top of drains shown on Drawings Sk1 & Sk2 and is applicable to flexible carriageways and flexible composite carriageway options. Sub-base and topsoil materials should be taken to the edge of pavement layer as appropriate.*
3. *Material in this layer may be topsoil or sub-base material and the depth and type shall be as described in Appendix 5/1.*
4. *Sub-base material shall be unbound material as specified in Clause 801 of S.H.W.*
5. *Material in this infill shall be lightweight aggregate as described in Appendix 5/1.*
6. *Where described in Appendix 5/1 a geotextile membrane shall be provided between the type B filter material and overlaying layers for drain types B, C & D.*
7. *For dimensions of filter drain relative to pavement layer see Drawings Sk1 & Sk2.*
8. *Detail of lower section of filter drain shall be as types G, H or I in Drawing F2 or as described in Appendix 5/1.*
9. *Advice on the specification for bitumen-bonded aggregate topping should be sought from the Overseeing Organisation.*
10. *Notwithstanding other tolerances in the Specification, the finished level of material adjacent to the pavement when sub-base is used as topping shall be 25mm below the top of basecourse.*