Design Manual for Roads and Bridges

Drainage
Design

CD 525
Design of combined surface and sub-surface drains and management of stone scatter

(formerly HD 217/18)

Revision 1

Summary
This document sets out requirements and provides recommendations on the design of new combined surface and sub-surface drains (also called French drains), and the treatment of existing combined surface and sub-surface drains where used as a road drainage system.

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.

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Release notes

Version	Date	Details of amendments
1	Mar 2020	Revision 1 (March 2020) Update to references only. Revision 0 (February 2020) CD 525 replaces HD 217/18. This 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This document supersedes HD 217/18, which is withdrawn.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

This document sets out requirements and provides recommendations on the design of new combined surface and sub-surface drains (also called French drains), and the treatment of existing combined surface and sub-surface drains where used as a road drainage system.

The purpose of combined surface and sub-surface drains is to remove water from the road surface and unbound sub-surface pavement layers to prevent groundwater entering the pavement foundation, as well as contributing to attenuation and filtration of surface water runoff.

Combined surface and sub-surface drains are most effective when located at the nearside carriageway edge or in the central reserve. However, vehicles may accidentally run over these drains and dislodge the filter medium, resulting in stone scatter on the carriageway. This can present a hazard to road users and vehicles and such hazard should be assessed and mitigated.

Additionally, where rounded filter medium has been used in drains, heavy vehicles can become stranded as the filter medium is displaced by the wheels allowing the vehicle to sink.

Assumptions made in the preparation of this document

The assumptions made in GG 101 [Ref 7.N] apply to this document.

Mutual Recognition

Where there is a requirement 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 7.N].

Abbreviations

Abbreviations

Abbreviation	Definition
HGV	Heavy Goods Vehicle
MCHW	Manual of Contract Documents for Highways Works

Terms and definitions

Terms

Term	Definition
Bitumen bound shredded tyre material	Treatment consisting of size-reduced rubber fraction of used tyres, bitumen based binder, filler and additives. NOTE: Also known as 'tyre-derived rubber materials' WRAP Tyres [Ref 6.I].
Combined surface and sub-surface drain	System of drainage that comprises a perforated, porous or open jointed carrier pipe, bedded in granular material, in a trench that is then backfilled with a granular filter material of Type A, B or C as defined in MCHW Series 500 [Ref 9.N].
Fin drain	A planar geocomposite arrangement designed to remove sub-surface moisture from beneath the pavement. NOTE: This can solely comprise a core surrounded by textile or incorporate a pipe within the geotextile wrap.
French drain	Alternative name for combined surface and sub-surface drain.
Groundwater	All water which is below the surface of the ground in the saturation zone (below the water table) and in direct contact with the ground or subsoil, see 2000/60/EC [Ref 2.I].
Surface water	Inland waters (except groundwater), transitional waters and coastal waters, see 2000/60/EC [Ref 2.I].

1. Scope

Aspects covered

1.1 The methods and design requirements in this document shall be applied where the design of new combined surface and sub-surface drains is undertaken.

1.2 The methods and design requirements in this document shall be applied to the surface treatment of existing combined surface and sub-surface drains:

1) where surface treatments are installed, or stabilisation is undertaken during major maintenance works; or
2) as a retro-fit for areas where the maintenance authority has identified stone scatter as a safety issue.

1.3 Stone scatter from combined surface and sub-surface drains shall be mitigated at all locations.

Implementation

1.4 This document shall be implemented forthwith on all schemes involving new construction, improvement and maintenance on the Overseeing Organisations' motorway and all-purpose trunk roads according to the implementation requirements of GG 101 [Ref 7.N].

Use of GG 101

1.5 The requirements contained in GG 101 [Ref 7.N] shall be followed in respect of activities covered by this document.

Health and safety

1.6 Safety risk mitigation measures shall follow the ERIC hierarchy - eliminate, reduce, isolate and control for each identified safety risk.

2. Design of combined surface and sub-surface drains

Design criteria

2.1 Carrier pipes for a combined surface and sub-surface drain shall be designed in accordance with the criteria stated in CG 501 [Ref 2.N] and the standard drainage details in CD 524 [Ref 3.N] and MCHW HCD Drawings [Ref 8.N].

2.1.1 Combined surface and sub-surface drains may be used in the following locations where groundwater levels have the potential to become high enough to interfere with the operation of a surface water drainage system or there is limited verge width, as detailed in CG 501 [Ref 2.N]:

1) along the edge of cuttings;
2) within the central reserve.

NOTE 1 Combined surface and sub-surface drains have the capacity to facilitate the lowering of groundwater levels.

NOTE 2 The risk of surcharge within combined surface and sub-surface drains can be reduced by increasing the pipe diameter to the next available diameter thereby reducing the depth of flow in the pipe.

2.2 Where a geotextile is to be used within a combined surface and sub-surface drain, the pore size of the geotextile shall be specified in accordance with BS EN 13252 [Ref 4.N] and the criteria used for fin drains as given in MCHW Series NG500 [Ref 10.N].

NOTE Geotextile with small pore sizes can become clogged with fine particles and hence render the drain unserviceable and also hinder the temporary removal of the filter material during on-site cleaning.

2.3 Where recycled coarse aggregate or recycled concrete aggregate is to be used as filter media it shall be specified in accordance with the requirements of MCHW Series 500 [Ref 9.N].

2.4 When designing combined surface and sub-surface drains in areas where protected species are known or suspected to exist, the nature conservation requirements stated in LD 118 [Ref 1.N] shall be complied with.

Composite designs

2.5 Where a composite design incorporating a grassed channel is used, the grassed surface channel shall be designed in accordance with criteria stated in CD 521 [Ref 6.N].

NOTE 1 A composite design drains sub-surface flows and low surface water flows through a combined surface and sub-surface drain, while higher surface water flows are directed to grated inlets via a grassed channel.

NOTE 2 The provision of a composite design can form an aesthetic, economic method of flow attenuation and surface water runoff treatment and reduce the need for additional stabilisation where stone scatter is an issue.

NOTE 3 Grassed surface water channels are an alternative to the use of slip formed concrete channels and offer environmental benefits as described in CD 521 [Ref 6.N].

3. Managing risk of stone scatter and vehicle stranding

Scenarios for use

3.1 Stone scatter from combined surface and sub-surface drains shall be mitigated at all locations.

3.2 Surface treatment or stabilisation of proposed combined surface and sub-surface drains shall be included in the design for the following locations where the risk of stone scatter occurring is greatest.

1) slip roads joining the main carriageway;
2) drains located in the central reserve at the pavement edge in front of the safety barrier;
3) drains located on a bend, the curve of which falls below the desirable minimum radii as detailed in CD 109 [Ref 5.N];
4) where the hard shoulder is designed to be used as a running lane;
5) where maintenance authority has identified stone scatter as a safety or injury issue issue to road users or maintenance staff;
6) carriageways with no hard shoulder where the drain could be trafficked by maintenance vehicles;
7) drains adjacent to lay-bys, service areas or grade separated junctions of two or more primary routes, where drivers of goods vehicles pull off from the paved surface.

3.3 The existence and position of other locations with an increased risk of stone scatter shall be determined as part of the design.

NOTE *The operational history of a road is a potential resource from which to establish locations of increased risk of stone scatter.*

3.4 Surface treatment or stabilisation of existing combined surface and sub-surface drains shall be included in the design for the locations listed in this section.

Geo-synthetic grids

3.5 Where a geo-synthetic grid is used for surface stabilisation the design shall require it to be manufactured from high density polyethylene or polypropylene which has an ultimate tensile strength in each direction of 30 kNm or greater and a minimum aperture of 40 mm.

3.5.1 Where a geo-synthetic grid is used for surface stabilisation the design should have a minimum overlap at joints in the geo-synthetic grid reinforcement not to be less than 300 mm.

NOTE 1 *Geo-synthetic grid installed in the filter material of a combined surface and sub-surface drain locks the aggregate particles together increasing the stability of the surface and reducing the risk of the wheels of fully loaded heavy goods vehicles (HGVs) sinking into the drain and the vehicles becoming stranded.*

NOTE 2 *Geo-synthetic grid installed in the filter material of a combined surface and sub-surface drain reduces the risks of stone scatter.*

NOTE 3 *Performance of geo-synthetic grids is not improved by turning the geo-synthetic grid upwards at the drain edges.*

Bitumen bound shredded tyres

3.6 Bitumen bound shredded tyre material shall only be used as a treatment to improve the stability of combined surface and sub-surface drains, thus reducing the risk of stone scatter.

NOTE 1 *The instability of conventional stone filled combined surface and sub-surface drains (experienced when vehicles over-run) can be overcome by use of a bitumen bound shredded tyre surface treatment.*

NOTE 2 *Bitumen bound shredded tyre material is able to withstand the effects of vehicles braking or sliding on it with little loss of tyre material.*

3.6.1 The design of works to treat or stabilise existing combined surface and sub-surface drains should include the removal of any soil strips located between the drain and the carriageway edge to the same depth as the filter material and replacement with bitumen bound shredded tyre material.

NOTE 1 *Soil strips support vegetation growth that can eventually restrict surface water flows to the drain, see CIRIA C753 [Ref 5.I].*

NOTE 2 *Removal of the adjacent soil strip prevents it from breaking away from the trench side during construction and contaminating the filter material or causing fractures to form in the paved surface.*

3.6.2 Where the binder-course and roadbase extends beyond the surface course at the pavement edge the edge of the pavement should be saw-cut to roadbase depth in order to increase the thickness of bitumen bound shredded tyre material immediately adjacent to the pavement construction.

NOTE *A greater thickness of bitumen bound shredded tyre material forms a stronger surfacing layer and reduces the risk of scatter of shredded tyre material.*

3.7 The shredded tyre material shall comply with Type B grading as specified in MCHW Series 500 [Ref 9.N].

3.8 In accordance with CD 524 [Ref 3.N], the surface of the bitumen bound shredded tyre material shall be dished as a means of diverting high flows to outlet gratings.

3.8.1 The slope of any channel where bitumen bound shredded tyre materials are used should not be steeper than 1 in 5.

3.8.2 The design of the scheme may include a crossfall over the surface of the bitumen bound shredded tyre material.

NOTE *Surface water can naturally flow along the crossfall towards the rear of the drain, reducing the risk of ponding and clogging of the bitumen bound shredded tyre material along the edge of the pavement.*

3.8.3 The bitumen bound shredded tyre material should be confined to the drain surface at a thickness of between 150 mm and 200 mm.

3.9 Total immersion of the bitumen bound shredded tyre material shall be avoided in order to prevent any risk of contamination to ground or surface waters, see TRL RR1422 [Ref 4.I].

3.10 The design of bitumen bound shredded tyre material shall prevent any piece of the surface material entering the drainage system through any gratings or other openings.

NOTE *Bitumen bound shredded tyre material used next to grated catchpits can result in detached pieces of the tyre material entering the drainage system.*

3.11 A design using bitumen bound shredded tyre material shall not pose a risk to pedestrians and cyclists.

3.12 The shredded tyre material shall not have exposed steel protruding from the chips.

NOTE *Tyres from HGVs or earth moving vehicles contain less steel than tyres from cars.*

3.12.1 Tyres from either HGVs or earth moving vehicles should be used in preference to car tyres.

NOTE 1 *Tyres from either HGVs or earth moving vehicles have thick tyre walls that better meet the grading requirements for drainage filter media as specified in MCHW Series 500 [Ref 9.N].*

NOTE 2 *Tyres from HGVs or earth moving vehicles have better permeability characteristics than car tyres when bonded.*

NOTE 3 *The risk of fire posed by the use of bitumen bound shredded tyres is low as detailed in FRS Report TCR195/98 [Ref 3.I].*

3.13 The bitumen binder and inert inorganic filler for the bitumen bound shredded tyre surface treatment shall be specified in the design.

NOTE 1 *Polymer-modified binders are permitted.*

NOTE 2 *BS EN 12591 [Ref 1.I] provides further information on the design and specification of bituminous binders.*

3.13.1 The design of the bitumen bound shredded tyre surface treatment may include the application of coloured emulsion to the finished surface to differentiate between the carriageway and the drain surfaces.

Other bitumen bound aggregate

3.14 Where designs of new combined surface and sub-surface drains include bitumen bound aggregate (excluding shredded tyres) the aggregate shall be specified in accordance with Type B grading in MCHW Series 500 [Ref 9.N].

NOTE Other types of aggregate potentially suitable for use bound in bitumen include but are not limited to crushed concrete, glass, granular blast furnace slag and other sources of plastic and rubber products.

3.15 Where designs of new combined surface and sub-surface drains include bitumen bound aggregate it shall be placed only within the top 200 mm of the drain.

3.15.1 Design of surface treatment for existing combined surface and sub-surface drains may include bitumen bound aggregate within the top 200 mm but only following prior removal of existing material.

Other surfacing

3.16 Where a combined surface and sub-surface drain is capped with type 1 sub-base material it shall be designed in accordance with standard details given in MCHW HCD Drawings [Ref 8.N] and CD 524 [Ref 3.N].

NOTE 1 Type 1 material provides a firm surface and reduces the risk of stone scatter caused by vehicle over-run.

NOTE 2 Type 1 sub-base material has a low permeability and is unlikely to facilitate the ingress of surface run-off.

4. 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	Highways England. LD 118, 'Biodiversity design'
Ref 2.N	Highways England. CG 501, 'Design of highway drainage systems'
Ref 3.N	Highways England. CD 524, 'Edge of pavement details'
Ref 4.N	BSI. BS EN 13252, 'Geotextiles and geotextile-related products. Characteristics required for use in drainage systems '
Ref 5.N	Highways England. CD 109, 'Highway link design'
Ref 6.N	Highways England. CD 521, 'Hydraulic design of road edge surface water channels and outlets'
Ref 7.N	Highways England. GG 101, 'Introduction to the Design Manual for Roads and Bridges'
Ref 8.N	Highways England. MCHW HCD Drawings, 'Manual of Contract Documents for Highway Works Volume 3: Highway Construction Details'
Ref 9.N	Highways England. MCHW Series 500, 'Manual of Contract Documents for Highway Works, Volume 1 Specification for Highway Works. Series 500 Drainage and service ducts.'
Ref 10.N	Highways England. MCHW Series NG500, 'Manual of Contract Documents for Highway Works, Volume 2 Notes for Guidance on the Specification for Highway Works. - Drainage and Service Ducts'

5. Informative references

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

Ref 1.I	BSI. BS EN 12591, 'Bitumen and bituminous binders. Specifications for paving grade bitumens.'
Ref 2.I	2000/60/EC, 'Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy'
Ref 3.I	Fire Research Station. Marshall, N.R. FRS Report TCR195/98, 'Fire Performance of Recycled Tyres used as Drainage Material for Highways'
Ref 4.I	Transport Research Laboratory. Ahmed, I., and Lovell, C.W. TRL RR1422, 'Rubber Soils as Lightweight Geo-materials'
Ref 5.I	Construction Industry Research and Information Association. London. Woods-Ballard,B., Wilson,S., Udale Clark,H., Illman,S., Scott,T., Ashley,R., Kellagher,R. CIRIA C753, 'The SuDS Manual'
Ref 6.I	Environment Agency, WRAP. WRAP Tyres, 'Tyre-derived rubber materials: end of waste criteria for the production and use of tyre-derived rubber materials'

Notification

This document was notified in draft to the European Commission in accordance with Technical Standards and Regulations Directive 2015/1535/EU.