Design Manual for Roads and Bridges

Drainage
Design

CD 528
Vortex separators for use with road drainage systems

(formerly HD 220/18)

Revision 0

Summary
This document provides the requirements and advice for including vortex separators within road drainage systems.

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
0	Feb 2020	CD 528 replaces HD 220/18. 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This document supersedes HD 220/17, which is withdrawn.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

The principle operation of the vortex separator is to use tangential flow into the chamber to induce rotational motion in the fluid where a combination of gravity and boundary layer effects separate solids from the liquid.

The hydraulic design ensures that the action of the circulating flow exerts a much greater tangential force on the solids than the friction resulting from the centrifugal force generated by the rotating flow. Differential velocities and the low energy of the vortex allow the denser sediment and grit material to settle in the chamber while oil and floatables are retained in circulating flow on the surface. The hydraulic characteristic of the core shape ensures the settled sediments are retained within the base of the device irrespective of the velocities of the flow through the device.

Assumptions in the preparation of this document

The assumptions made in GG 101 [Ref 4.N] apply to this document.

A vortex separator is assumed to have no minimum flow velocity at which it operates.

Vortex separators are assumed to operate at all velocities of flow; even below the design limit.

Terms and definitions

Terms

Term	Definition
Hydrodynamic vortex grit separator	Referred to as a vortex separator they are proprietary products designed to remove sediments in suspension and floatable debris in the flow of highway surface runoff.

1. Scope

Aspects covered

1.1 The requirements in this document shall be used to identify the locations, the principal function, operation and maintenance of the vortex separator device.

NOTE *Vortex separators are proprietary products. This document contains no requirements for the hydraulic design of the vortex separator device.*

Implementation

1.2 This document shall be implemented forthwith on all schemes involving the use of vortex separators on the Overseeing Organisation's motorway and all-purpose trunk roads according to the implementation requirements of GG 101 [Ref 4.N].

Use of GG 101

1.3 The requirements contained in GG 101 [Ref 4.N] shall be followed in respect of activities covered by this document.

Health and safety

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

2. Design requirements

Hydraulic inflow and outflow design

2.1 Where the drainage system design in accordance with CG 501 [Ref 1.N] utilises a vortex separator, the system's pipe design shall be compatible with the requirements of a (or range of) vortex separator(s).

2.2 Where the drainage system design includes a vortex separator, the design shall assume that the inflow to the vortex separator is via a central core or an external annulus.

2.3 Where the inlet pipe to the vortex separator is submerged it shall maintain a positive hydraulic gradient.

2.3.1 The inlet pipe into the vortex separator may be required to be submerged, in accordance with manufacturer's instructions.

2.4 Where a submerged inlet pipe is required, the outlet pipe from the vortex separator shall have a lower invert level than the inlet pipe's upstream invert level.

2.5 Contributing pipelines shall be connected to a chamber upstream of the vortex separator.

2.5.1 The upstream chamber should be a manhole rather than a catchpit to minimise turbulence and maintain stable flow conditions in the inlet pipe to the vortex separator.

2.6 Only one inlet pipe and one outlet pipe shall be connected to the vortex separator.

2.7 The drainage system design shall minimise turbulence and maintain stable flow conditions in the pipe upstream of the vortex separator.

2.7.1 A vortex separator should be designed within the drainage system to remove sediment and debris as close to the source as possible.

2.7.2 Some vortex separators may include an upstream meshed basket to aid in the removal of coarse debris.

NOTE *Locating vortex separators immediately upstream of the point of discharge does not give the greatest hydraulic benefit to the drainage system.*

2.8 The location and design of the vortex separator shall include geotechnical design aspects, including ground stability and flotation calculations.

Designing for maintenance

2.9 In designing for maintenance, access to the central core and annulus shall be provided via a rectangular opening in a vortex separator's cover slab.

2.10 Locating vortex separators remotely from the outfall shall be beneficial where the outfall or topography precludes access for maintenance.

Information to be provided to Overseeing Organisation

2.11 On completion of the drainage system design, a record of the following information on vortex separators shall be provided:

1) maximum and minimum discharge rates into the vortex separator;
2) the calculation of sediment load in accordance with CD 523 [Ref 2.N]; and
3) the routine maintenance period.

2.12 The treatment capacity of the vortex separator shall be calculated by the manufacture.

2.12.1 The calculation of treatment capacity may be based on the calculation of sediment load in accordance with CD 523 [Ref 2.N] and the routine maintenance period.

2.13 The treatment capacity of the vortex separator shall be used to determine the peak flow capacity limit.

NOTE *The treatment capacity of the vortex separator is not the hydraulic capacity.*

3. Operation and maintenance

General

3.1 The design shall facilitate safe access to the vortex separator for operational and maintenance staff and vehicles.

3.1.1 The vortex separator should be positioned to be clear of the carriageway and to facilitate safe access and manoeuvring, minimising the requirement for traffic management.

3.1.2 Access for maintenance vehicles, especially larger vehicles such as a vacuum tanker, may require construction of an adjacent hard-standing designed to withstand the expected loadings.

3.1.3 On roads with all lane running or without a hard shoulder, closing lanes and even minimal traffic management is potentially not achievable and other access solutions should be sought.

3.2 The drainage system design shall allow space to maintain the vortex separator including inspections, emptying retained sediment and cleaning in accordance with manufacturer's requirements.

3.2.1 A vortex separator may be used to retain surface water when there is an emergency spillage which could cause a pollution incident.

3.3 In designing for maintenance, the location of the vortex separator and vehicle access and egress routes shall not interfere with other roadside features.

Vortex separator asset data

3.4 Vortex separators shall be recorded, on all new and existing drainage systems, as a point asset in the Overseeing Organisation's asset management system.

3.4.1 Where the vortex separator forms part of a continuous asset it should be connected as a point asset at each end, with one point defined as upstream and the other as downstream.

Commissioning

3.5 The commissioning phase of the vortex separator shall evidence that the vortex separator is operating with the level of removal of sediments and debris as designed, whilst maximising maintenance intervals.

3.5.1 The commissioning phase of the vortex separator may increase or decrease the maintenance intervals (i.e. emptying) specified at the design stage due to site conditions.

3.6 A record of the vortex separator's requirements for operation, inspection, emptying and cleaning as a result of the design and commissioning phase shall be provided.

4. Safety issues

General

4.1 The design of vortex separators shall include lockable covers that can be locked when not being accessed for maintenance purposes.

Placard

4.2 The vortex separator's cover shall be marked 'VORTEX SEPARATOR' with a permanent tamper proof marking.

4.3 The vortex separator access hatch shall have a prohibition sign (P001) that complies with BS EN ISO 7010 [Ref 3.N] and H&S (SSS) Regs 1996 [Ref 5.N] permanently affixed.

4.3.1 Warning text notices should include:

1) warning confined space;
2) no unauthorised entry; and,
3) keep locked.

4.4 A permanent warning sign fixed in a prominent visible location on the vortex separator's chamber opening shall warn against accessing the chamber.

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	Highways England. CG 501, 'Design of highway drainage systems'
Ref 2.N	Highways England. CD 523, 'Determination of pipe roughness and assessment of sediment deposition to aid pipeline design'
Ref 3.N	BSI. ISO PH/8/1. BS EN ISO 7010, 'Graphical symbols. Safety colours and safety signs. Registered safety signs'
Ref 4.N	Highways England. GG 101, 'Introduction to the Design Manual for Roads and Bridges'
Ref 5.N	HSE. H&S (SSS) Regs 1996, 'Safety signs and signals. The Health and Safety (Safety Signs and Signals) Regulations 1996'

6. Informative references

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

Ref 1.I	Highways England. LA 113, 'Road drainage and the water environment'
Ref 2.I	Highways England. CD 527, 'Sumpless gullies'

Appendix A. Generic details

A1 Drainage design philosophy

Following the introduction of CD 527 [Ref 2.I] the drainage philosophy is to reduce maintenance where practical and improve the quality of surface water runoff discharging from the carriageway. The elimination of the gully sump may lead to an improvement in water quality. However, this can potentially increase the amount of sediment entering the drainage system. CD 523 [Ref 2.N] provides guidance on the design of the pipeline to transport sediment and the assessment of the volumes of sediment that a road might generate. There is scope to further reduce maintenance activity by reducing the number or frequency of catchpits and instead trap sediment at more centralised locations, remote from the carriageway.

At remote locations sediment can be removed without recourse to major traffic management associated with lane closures. The vortex separator with its comparatively small footprint would enable these aims to be achieved. To further this, the Highways Agency (now Highways England) undertook a full scale trial by installing a vortex separator during M25 widening works. An 18 month long trial monitored the volume of sediment retained and the contaminants present in both the sediment and the water. The trial has indicated that, when properly maintained, vortex separators offer an effective additional treatment option in any treatment train approach, for example when used in conjunction with isolating devices and other propriety devices. This is particularly important when the quality of runoff discharging from a highway requires significant improvement before entering to a receiving water body.

A2 Vortex separators operation

Some versions of the vortex separator contain internal filters to remove more of the suspended solids in the runoff, including smaller sized particles. Alternatively filters can be installed in a chamber immediately downstream of the vortex separator. Filters can be manufactured to remove soluble pollutants such as toxic metals, as well as suspended solids. The inclusion of a filter offers a higher level of environment protection, but at the expense of a reduced hydraulic capacity of the vortex separator, as filters are more effective when treating significantly lower flows than vortex separator capacity.

Applications where low flows from sub-annual rainfall events pass through both the vortex separator and an additional chamber containing a filter, may be the ideal system where the receiving water environment is vulnerable. Although a bifurcation arrangement, with a downstream filter chamber which can be bypassed, would allow the higher flows from the less frequent rainfall events to be treated by the vortex separator only and then bypass the filter chamber.

Where the design process has identified a risk of polluted discharge entering the environment, the requirements of LA 113 [Ref 1.I] in undertaking a Highways Agency Water Risk Assessment Tool assessment should be followed and an appropriate remediation measure proposed.