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PROCEEDR
OPTIMISING RESOURCE USE FOR ROADSIDE INFRASTRUCTURES

A table/list of the specifications of the roadside infrastructures developed in D1.2

Deliverable D2.1

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CEDR TRANSNATIONAL RESEARCH PROGRAMME

Call 2020: Resource Efficiency and the Circular Economy

D2.1 A table/list of the specifications of the roadside infrastructures developed in D1.2

Work package / task: WP2 / task 2.2: Task 2.2: Filtering and defining the list of specifications (mechanical properties, material composition, weight of each material, estimated life-expectancy etc.) for the selected roadside infrastructures (conventional and innovative design/material solutions)

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1 Introduction

The aim of this task is to filter and define the functional and technical requirements (characteristics) of Noise and Safety barriers that must be fulfilled or satisfied as a minimum. The relevant EN standards and functional requirements have been reviewed and discussed. This was done via a workshop of CEDR PROCEEDR team members and within TRL with colleagues, to understand whether each requirement is a minimum (mandatory) or optional requirement. This information informs the development of the planned PROCEEDR Lifecycle Cost Analysis (LCA) tool.

In the table that follows this introductory text, the terminology described in *Table 1* below has been used.

Table 1: Terminology used in this document

Term used in table	Description
Mandatory	This is the minimum requirement or level of performance that must be achieved or satisfied.
Mandatory when it's the case	When this situation is relevant, or occurs, then there is a minimum requirement or level of performance that must be achieved or satisfied.
Optional	This is an optional requirement that may depend on engineering judgement and/or the sustainability requirements in the contract, or contractors' sustainability ethos.

Figure 1 illustrates the fact that noise and safety barriers need to fulfil technical and functional requirements and design before the three pillars of sustainability can be assessed and satisfied. Figure 1 summarises the sustainability of construction works according to the standardisation work of CEN/TC350. For the purposes of this project, the socio-cultural aspects of sustainability are not being considered, however they are commented on for information and in case they are relevant at a later date.

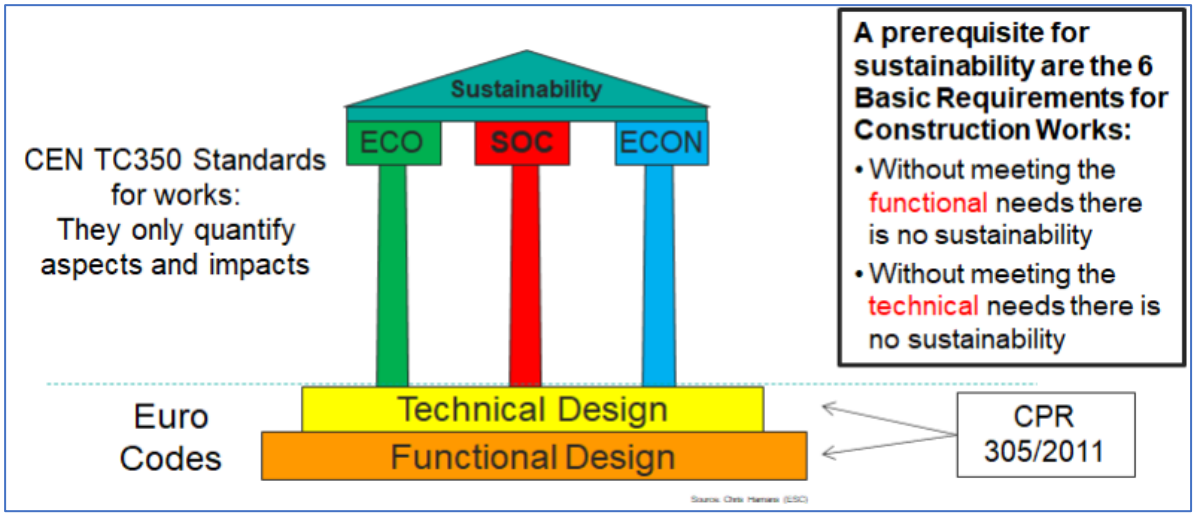

Figure 1: Sustainability of construction works according to the standardisation work of CEN/TC350 (copied from CEDR_Call-2020_Part_A_PROCEEDR Project summary document)

2 Technical and functional requirements for noise barriers and safety barriers

Table 2 gives technical and functional requirements for noise and safety barriers. It contains details of the relevant EN standards (where appropriate) with some explanatory text and any declared values for each technical and functional requirement. As has already been mentioned, it also makes an assessment as to whether each requirement is mandatory or optional (see Table 1 above for full details).

The technical and functional requirements for each type of barrier are split into the following categories:

- Noise barrier – foundation and acoustic element & supporting structure
- Safety barrier – foundation and supporting structure & safety barrier

Table 2: Technical and Functional Requirements for Noise Barriers and Safety Barriers

NOISE BARRIERS				
Characteristic	**Standard**	**Declared value**	**Comments / Notes**	**Mandatory / optional**
Foundation				
Ground investigation and testing	NA+A2:2022 to EN 1997-1:2003+A1:2013	Annex provides correlation factors (ξ) for pile foundations and anchorages in all design situations	Minimum.	Mandatory
	EN 1990:2001+A1:2005		Minimum, depending on choice of barrier. From reviewing manufacture websites, it can be seen that the type of foundation required depends on the type of barrier being installed, ground conditions and manufacturers requirements. Examples include noise barriers: • that can be set into concrete foundations or bolted down to individual concrete pads or a continuous concrete strip/pad. • that is specifically designed to eliminate the need for concrete or piled footings, requiring only a 300 – 400mm sub-base or well compacted existing ground.	Mandatory

			The UK National Highways MCHW Volume 1 Series 2500 is part of National Highways' Specification for Highway Works. It covers Special Structures. It states: Post Foundation Test - Where stated in Appendix 25/4 the Contractor shall provide test equipment and carry out loading tests on post foundations as described in Appendix 25/4. The results shall be available at least one week prior to installation of the relevant length of fence, unless otherwise stated in Appendix 25/4.	
Acoustic element & supporting structure				
Acoustic performance				
Sound Absorption & Reflection Absorption: DLα,NRD under diffuse sound field conditions Reflection: DLRI under direct sound field conditions	EN 1793-1 EN 1793-5	dB, on specified absorptive side(s) of the barrier	Minimum	Mandatory
Airborne Sound Insulation DLR under diffuse sound field conditions, DLSI,E and DLSI,P under direct sound field conditions	EN 1793-2 EN 1793-6	dB	Minimum	Mandatory
Intrinsic sound diffraction DLΔDI	EN 1793-4	dB	Optional	Optional
Non-acoustic performance				

Mechanical performance and stability Dry and wet (or reduced wet) self-weight of an acoustic element: wet, reduced wet or dry	EN 1794-1	kN/element for specified condition: wet, reduced wet or dry	Minimum	Mandatory
Resistance to loads of structural elements Maximum normal (90°) load a structural element can withstand: (wind, static load and self-weight)	EN 1794-1	kN/m along the structural element, for specified barrier heights	Minimum	Mandatory
Maximum bending moment a structural element can withstand: (dynamic load from snow clearance)	EN 1794-1	kNm at ground level	Minimum/optional	Mandatory
Resistance to loads of acoustic elements				
Maximum vertical load an element can withstand: (load from upper elements)	EN 1794-1	kN/m along the acoustic element	Minimum	Mandatory
Normal (90°) load, Fsafe or Fd50, an acoustic element can withstand with a maximum deflection of dsafe or 50 mm. When the load is Fsafe, dsafe has to be declared	EN 1794-1	kN/m2, mm	Minimum	Mandatory
Maximum deflection dmax, an acoustic element can withstand	EN 1794-1	mm	Minimum	Mandatory

under the load Fsafe ·SF or Fd50 ·SF				
Maximum normal (90°) load an acoustic element can withstand:(dynamic load from snow clearance)	EN 1794-1	kN on a 2 m x 2 m reference surface on the acoustic element	Minimum/optional	Mandatory when it is the case
Impact of stones Damage caused by controlled impacts	EN 1794-1	Succeed or fail	Minimum	Mandatory when it is the case
Safety in collision (containment level) Behaviour under impacts specified in EN 1317–2	EN 1794-1	Ranges from Low (T1) to Very high containmen t level (L4)	Only for integrated barriers	Mandatory when it is the case
General safety and environment requirements				
Danger of falling debris	EN 1794-2	Class 1 to 4	Minimum when it is a case	Mandatory when it is the case
Light Reflection: the value of reflectivity	EN 1794-2	Class 1 to 3	Minimum when it is a case	Mandatory when it is the case
Release of dangerous substances	EN 14388 EN 1794-2		Minimum	Mandatory
Environmental protection Identification of constituent materials and breakdown products	EN 1794-2	Material details	Linked to sustainability assessment, to be considered	Optional
Transparency	EN 1794-2	Static and/or dynamic	Static is linked to the social pillar of sustainability. Dynamic may be linked to safety (in case of a junction for example), where there would be a minimum mandatory requirement.	Optional or Mandatory, depending on the circumstance s

Reaction to fire				
Smoke density $D_{s,max}10_{total}$	EN 1794-3		Minimum	Mandatory
Toxic fumes: CO, HCN, HCL, NOx	EN 1794-3	µg/g	Minimum	Mandatory
Resistance to brush fire	EN 1794-3	Class 1 to 3	Minimum/optional	Mandatory when it is the case
Long term performance (durability)				
Acoustic parameters, DLα, NRD, DLR, DLRI DLSI and DLΔDI (as appropriate): working life and acoustic performance at the end of working life (when subject to specific environmental conditions)	EN 14389-1	Declared working life (years) and dB after working life	Matter of choice in sustainability approach	Optional
Non acoustic parameters (working life when subject to specific environmental conditions)	EN 14389-2	Declared working life (years)	Matter of choice in sustainability approach	Optional
Supporting structure				
Minimise gaps between supporting structure and acoustic element	EN 1794-2:2011		Minimum. Choice of material, depending on barrier type and acoustic element. Gaps to be minimised to maintain acoustic integrity. Doors shall be fitted with a self-closing mechanism and seals to prevent excessive leakage of sound through gaps. All hinges, closing mechanisms and locks shall be designed for minimum maintenance and to remain operational in	Mandatory

			adverse weather conditions.	
Other considerations (Environmental & Economic)				
Costs: associated with the product, installation, maintenance, repair, demolition; distribution of costs			Economic pillar of sustainability. Sustainability considerations and requirements should be stated in the tender documents	Optional
Security of supply: diversity of suppliers, within Europe			Matter of choice in sustainability approach. Consider material availability in the local area to minimise transport costs and availability of supply for future repair and maintenance.	Optional
Secondary/tertiary functionalities: e.g. photovoltaics			Matter of choice in sustainability approach. Recent examples include noise barriers that are self-cleaning with solar panel, and other noise barriers made of recycled materials.	Optional
Adaptability			Matter of choice in sustainability approach.	Optional
Modularity: is the construction modular?			Manufacturer dependant. Brief review of manufacturer websites show that some are modular making replacement straightforward.	Optional
Maintenance: is cleaning or other maintenance required?			The UK National Highways MCHW Volume 2 Notes for Guidance on the Specification of Highway Works Series NG 2500 for Special Structures states: In the UK, gates or gaps should be provided at about 200 m intervals to provide access for the maintenance of both the	Mandatory

			barrier and any planting behind the barrier. Where possible these access points should be located to provide access to any traffic control and communications equipment. Visual inspection undertaken to minimise cost/disruption associated with lane closures for noise measurements.	
			UK National Highways Design Manual for Roads & Bridges CS 450 Inspection of highway structures states that General inspections shall be undertaken at intervals of 24 months. A principal inspection shall be a replacement of a due general inspection.3.15 Principal inspections shall be undertaken at intervals of 72 months, unless a longer interval has been agreed by the Overseeing Organisation.	Mandatory
Repair / replacement: can it be repaired/replaced on site?			Manufacturer dependant. Brief review of manufacturer websites shows that many are manufactured off site under strict quality control. Some products can be removed and replaced in situ.	Optional
Lifetime extension options			Matter of choice in sustainability approach. Brief review of manufacturer websites indicates that many are straightforward to replace panels hence lifetime extension should be possible.	Optional
Heat islands: possibility to			Matter of choice in sustainability approach.	Optional

reduce heat island effect			Depends on the surrounding area.	
High value recycling / reuse options			Matter of choice in sustainability approach	Optional
Carbon capture capacity			Matter of choice in sustainability approach There are likely to be innovative materials available in the future to facilitate increased carbon capture	Optional

SAFETY BARRIERS				
Characteristic	**Standard**	**Declared value**	**Comments / Notes**	**Mandatory / optional**
Foundation				
Foundation details				
Foundations, anchorages and fixings shall perform according to the design of the vehicle restraint system. The vehicle restraint system's manufacturer shall provide details of the maximum forces which can be transmitted by anchorages to the foundation.	EN 1317-1: 2010		Minimum. The vehicle restraint system's manufacturer shall provide details of the maximum forces which can be transmitted by anchorages to the foundation. Such maximum forces shall be those generated at the ultimate failure of the vehicle restraint system including vehicle parapet by any conceivable impact and shall normally be greater than those that can be measured during the impact. Hence the ultimate forces which can be transmitted to the bridge deck shall be obtained by calculations or by ad-hoc tests.	Mandatory

Foundations, anchorages and fixings shall perform according to the design of the vehicle restraint system, and shall meet the design specification	EN 1317-2: 2010		Minimum. The performance of barriers including vehicle parapets may be strongly influenced by the behaviour of their foundations, anchorages and fixing. If anchorages are embedded in soil, the test item should be installed in a soil corresponding to the specifications in the design of the barrier. If the barrier is designed to be installed on a bridge or on a retaining wall, the bearing capability of the supporting surface and the strength of the anchorages should be not less than the design requirements. When testing pretensioned systems, where tension can be adjusted (for example cable barriers), the small vehicle test shall be performed with a tension corresponding to a temperature of -10 °C and the large vehicle test with a tension corresponding to a temperature of +30 °C. For the containment levels with only one test, the tension shall correspond to a temperature of 0 °C. The data for the recommended tensions/temperature shall be supplied by the manufacturer.	Mandatory

Road restraint systems can have foundation systems, the economically reasonable working life of which relates to the supporting structure.	EN 1317-5: 2007+A2: 2012 E		Minimum. The economically reasonable working life of the foundation system relates to the supporting structure. The manufacturer shall provide the following information relating to the foundations: • Procedures for installation (erection, assembly, foundations, etc.) as set out in the installation manual; • Description of the soil conditions and/or foundations suitable for the system.	Mandatory
Safety barrier performance under vehicle impact	DRAFT prEN 1317-5:2013 (will supersede EN 1317-5:2007+A2: 2012)		Minimum. Performance under vehicle impact may be influenced by the ground characteristics where the test item is installed, e.g . Soil in which the posts are driven, pavement surface, anchorages, geometry, etc. The description of the ground shall be given, according to provisions in 5.1.6 of this standard. Concerning anchorages, plinth and foundations, the manufacturer shall provide a detailed description of the test item, including information on the characteristics of the plinth material, the geometry of the plinth, the type of anchorages etc.	Mandatory

			The UK National Highways MCHW (Manual of Contract Documents for Highway Works) Volume 1 Series 400 is part of National Highways' Specification for Highway Works. It covers Road Restraint Systems (Vehicle and Pedestrian). Clause 401 paragraph 7 of that document states: The following information shall be provided by the Contractor to the Overseeing Organisation: For all proposed road restraint systems: Manufacturer's installation instructions or installation manual including foundation requirements and test methods to verify their performance. And, where contract specific Appendix 4/1 specifies requirements for loads imposed by road restraint systems on foundations or structures the nominal loads (direct forces, moments and co-existent shears) that will be transferred from the barrier or parapet to the structure or foundation shall be provided. Clause 401 paragraphs 11 & 12 state that The Contractor shall ensure that the installation instructions, or	

			installation manual as required by BS EN 1317-5, for a proposed system includes all the information necessary to install the road restraint system in the locations shown on the drawings such that the system will meet its declared performance. Installation instructions shall be appropriate to the road restraint system being installed and its location. The use of the system relative to different ground and other conditions of installation and use, including limitations (e.g. permitted temperature range), shall be defined in the installation manual. The installation manual shall also include the following information and any additional information appropriate to the system proposed and its proposed location: procedures for installation (erection, assembly, foundations, anchorages and bolt torques when relevant etc.)	
Geotechnical design and Foundations to be designed in accordance with this standard.	EN 1997-1:2004+A1: 2013		Minimum	Mandatory
Supporting Structure & Safety barrier				
Containment Level				

Safety in Collision. Behaviour under impacts. A successfully tested barrier at a given containment level should be considered as having met the containment requirements of any lower level.	EN 1317 - 2	Ranges from Low angle containment level (T1) to Very high containment level (L4). Low angle containment - T1, T2, T3 Normal containment - N1, N2 Higher containment - H1, L1, H2, L2, H3, L3 Very high containment - (H4a, H4b), (L4a, L4b)	Minimum	Mandatory
Impact Severity Level				
Impact severity assessment indices, Acceleration Severity Index (ASI) and Theoretical Head Impact Velocity (THIV) shall be carried out for cars and used to determine three impact severity classes (A, B and C).	EN 1317 - 2	A: lowest impact severity level B: medium impact severity level C: highest impact severity level	Minimum, depending on what requires protection	Mandatory

Safety Barrier Deformation				
Dynamic Deflection				
D_m: Maximum lateral dynamic displacement of any point of the traffic face of the restraint system. D_N : Normalised Dynamic Deflection shall be computed from measured data, or other test data, providing the data collection methods conform to the requirements of the standard.	EN 1317 - 2	D_m: Accuracy of measurement of 10% but not less than 0.1 m.	Minimum. Dynamic deflection (D_N), working width (W_N) and vehicle intrusion (VI_N) allow determination of the conditions for installation of each safety barrier and also to define the distances to be provided in front of obstacles to permit the system to perform satisfactorily.	Mandatory
Working Width				
W_m: Maximum lateral distance between any part of the safety barrier on the undeformed traffic side and the maximum dynamic position of any part of the barrier during impact testing to EN 1317-2. W_N: Normalised Working Width shall be computed from measured data, or other test data, providing the data collection methods conform to the requirements of the standard.	EN 1317 - 2	W_m: Accuracy of measurement of 10% but not less than 0.1 m. W_N: classes of W_N levels ranging from W1-W8.	Minimum. Dynamic deflection (D_N), working width (W_N) and vehicle intrusion (VI_N) allow determination of the conditions for installation of each safety barrier and also to define the distances to be provided in front of obstacles to permit the system to perform satisfactorily.	Mandatory
Vehicle Intrusion				

VI_m: Maximum dynamic lateral position from the undeformed traffic side of the barrier for an HGV/bus. VI_N : VI_m evaluated from high speed photographic or video recordings, and then normalised (VI_N) using measured data.	EN 1317 - 2	VI_M: Accuracy +/- 0.2m. VI_N : classes of VI_N levels ranging from VI1-9	Minimum. Dynamic deflection (D_N), working width (W_N) and vehicle intrusion (VI_N) allow determination of the conditions for installation of each safety barrier and also to define the distances to be provided in front of obstacles to permit the system to perform satisfactorily.	Mandatory
Test Vehicle Deformation				
Vehicle Cockpit Deformation Index (VCDI)				
VCDI: the index reports a standard description of the deformation of the vehicle interior and shall reflect the damage to the vehicle caused by the impact with the VRS only.	EN 1317 - 1		VCDI is not an acceptance criterion and is only determined for cars. The index designates both the location and extent of the deformation of the cockpit and consists of two alphabetic characters plus seven numeric characters: Xxabcdefg. Location of the cockpit deformation shall be indicated by the first two alphabetic characters. The value of each of the seven numeric sub-	Mandatory

			indices determined on a scale: 0 if the reduction is less than or equal to 3% 1 if the reduction is more than 3% and less or equal to 10% 2 if the reduction is more than 10 % and less or equal to 20% 3 if the reduction is more than 20% or cannot be measured due to deformation. Key a - Minimum distance between the dashboard and the top of rear seat b - Minimum distance between the roof and the floor panel c - Minimum distance between the rear seat and the motor panel. d - Minimum distance between the lower dashboard and the floor panel. e - Minimum interior width between the right and the left lower edges of the windows. f - Minimum distance between the lower edge of the right window	

			and the upper edge of left window. g - Minimum distance between the lower edge of left window and the upper edge of right window. Sub - indices a, b, c and d shall be measured on the right, on the left or on the centreline of the vehicle, whichever gives the largest deformation. Sub-indices e, f and g shall be measured at the front, in the middle or in the back of the cockpit, whichever gives the largest deformation.	
Transitions				
General conditions (length, height of profile)				
DD ENV 1317 - 4:2002 specifies requirements for the performance of terminals and transitions. It defines performance classes and acceptance criteria for impact tests. DRAFT prEN 1317-4 specifies the direction of impact, and the methods for determining the critical impact points,	DD ENV 1317 - 4:2002 (Current, work in hand) & 12/30263211 DC_DRAFT prEN 1317-4 Current, draft for	Terminals: Performance classes P1 - P4 (Table 1) Impact severity Level A,B. Transitions: Containment level: Class N1-L4 Impact severity: Level A, B C Normalised working width: class Normalised dynamic deflection:	Minimum. Ideally the same manufacturer would be used to ensure smooth transitions and continuous containment. Attention is drawn to the fact that the acceptance of a terminal or transition will require the successful completion of a series of tests.	Mandatory

for the assessment of transitions.	public comment)	metres Normalised vehicle intrusion: class The working width and vehicle intrusion of the transition is given by the highest measured values in all tests or simulations. The values for ASI and THIV are given by the highest values for these indices derived in all tests or simulations. Where Assessment method B2 or B3 is used, the design of the transition shall follow the rules in Annex A which include: In the length of the transition, the height of the profile of the longitudinal elements shall vary continuously from one barrier to the other, with no steps and with a slope not greater than 8 %. In the length of the transition the lateral position		

		of the longitudinal elements on the traffic face shall vary continuously from one barrier to the other, with no steps and with an angle to the traffic face not greater than 5°.		
Containment level				
Minimum containment level of a **transition** shall be equal to the lower containment level of the two connected VRS. If this containment level is an L level, the minimum containment class required for the transition is the corresponding H level. For example, if the lower containment level is L2 the minimum level for the transition shall be H2.	EN 1317 - 4 12/302632 11 DC DRAFT prEN 1317-4 Current, draft for public comment)		Minimum. Directly related to the Safety Barrier Containment level specified in BS EN 1317-2.	Mandatory
Threshold Level				
Provides several levels of performance for the: ▪ containment level, ▪ impact severity levels and ▪ the deformation expressed by the working width and vehicle intrusion (including normalised values).	EN 1317 - 2	The test parameters on which the acceptance criteria shall be assessed are listed in Table 6 as a function of the containment level.	Minimum	Mandatory

Resistance to snow removal				
The resistance of safety barriers to snow removal shall be assessed, if required, in accordance with Annex C which includes a classification of safety barriers for the resistance to snow removal.	EN 1317 -5:2007 + A2:2012.	Class 1 to 4, depending on the: ▪Modified material thickness of a rail in steel (mm) ▪Modified section modulus against horizontal loads (mm^2) ▪Strength against vertical loads of the connection between a post and a rail.	Minimum. EN 1317 -5:2007 + A2:2012 Annex C includes the horizontal and vertical pressure of ploughed snow against the rail and minor impacts caused by the plough in the traffic face and upper edge of the rail. A simplified evaluation method is intended for normal steel beam barriers, rope fences and monolithic pre-cast or cast-in-place concrete barriers. A test is possible for other barrier types; *Innovative barrier* types shall be evaluated in field exposure tests, or via controlled impacts by a snow plough.	Mandatory when it's the case

Durability				
Durability is the ability of a product to maintain its required performance over time, under the influence of foreseeable actions. Subject to normal maintenance, a product should enable properly designed and executed works to fulfil specified requirements for an economically reasonable working life of the product.	EN 1317 - 5: 2007 + A2: 2012.		Minimum. Manufacturers shall declare the materials and protective coatings used on the road restraint system. Road restraint systems can have foundation systems, the economically reasonable working life of which relates to the supporting structure, and this needs to be reported separately to that of the road restraint system if supplied by the VRS manufacturer. For performance under vehicle impact and resistance to snow removal, the manufacturer shall declare durability of performances according to the following: ▪ For products whose durability is ensured by a protective coating: the type of coating and the mass per square meter or the thickness of the coating applied on the product with an accuracy of 5%; ▪ For products whose durability is ensured by the type of material used: type and thickness of the material used with an accuracy of 5%.	Mandatory, manufacturer to declare
	BS 6579: Part 6: 1998		All steel components excluding reinforcing rings shall be hot dip galvanized, in accordance with BS 729, after fabrication.	
Working Life				
The working life is the period of time during which the performance of a product will be maintained at a level that enables	EN 1317 - 5: 2007 + A2 : 2012.	-	Minimum EN 1317-5:2007 +A2:2012 UK National Annex notes that the overseeing organisation should be consulted on durability requirements relating to the reasonable	Mandatory

the product to fulfil the requirements of this document (i.e. the essential characteristics of a product to meet or exceed minimum acceptable values, without incurring major costs for repair or replacement). The working life of a product depends upon its inherent durability and normal maintenance, as well as the prevailing environmental conditions. NOTE: A clear distinction should be made between the *declared* working life for a product, which underlies the assessment of durability in technical specifications, and the *actual* working life of a product in a works. The latter depends on many factors beyond the control of the producer, such as design, location of use (exposure), installation, use and maintenance. The assumed working life can thus not be interpreted as being a guarantee			working life of the road restraint systems (RRS) which may differ for different types of RRS products.	

given by the producer.				
			The UK National Highways MCHW Volume 1 Series 400 states that: safety barriers, vehicle parapets, terminals, transitions, removable barrier sections and crash cushions *shall* conform to the following. (i) All components shall be designed to achieve a serviceable life of not less than: (a) 20 years for metal safety barriers, terminals, transitions, removable barrier sections and crash cushions; (b) 50 years for concrete safety barrier systems, except for temporary safety barriers where the serviceable life shall be not less than 10 years; (c) 30 years for metal vehicle parapets and metal components of combined metal and concrete vehicle parapets; and (d) 120 years for concrete vehicle parapets and concrete components of combined metal and concrete vehicle parapets; and (ii) For metal vehicle parapets and metal components of combined metal and concrete parapets the serviceable life shall, except where stated in contract specific appendices, be obtained without the requirement for any maintenance other than that resulting from accidental damage. In addition, metal components of combined metal and concrete parapets shall be capable of replacement without damage to the concrete components.	

Non-acoustic performance				
Mechanical performance and stability				
Dry and wet (or reduced wet) self-weight of an acoustic element: wet, reduced wet or dry	EN 1794-1	kN/element for specified condition: wet, reduced wet or dry		Mandatory when it's the case
Resistance to loads of structural elements				
Maximum normal (90°) load a structural element can withstand: (wind, static load and self-weight)	EN 1794-1	kN/m along the structural element, for specified barrier heights	Minimum	Mandatory
Maximum bending moment a structural element can withstand: (dynamic load from snow clearance)	EN 1794-1	kNm at ground level	Minimum	Mandatory

Other considerations (Environmental & Economic)				
Costs: associated with the product, installation, maintenance, repair, demolition; distribution of costs			Economic pillar of sustainability. Sustainability considerations and requirements should be stated in the tender documents as it's very difficult to consider them retrospectively. Consider how often a concrete barrier has to be replaced compared to a wire barrier for example. Designer has to make this choice. Consider whether the barrier would be constructed in-situ or transported to site. Relates to Repair/replacement section.	Optional
Security of supply: diversity of suppliers, within Europe			Matter of choice in sustainability approach. Consider material availability in the local area to minimise transport costs and availability of supply for future repair and maintenance.	Optional
Secondary/tertiary functionalities: e.g. photovoltaics			Optional. There are likely to be innovative features that could be included in barriers in the near future. Recent examples include noise barriers that are self-cleaning with solar panel, and other noise barriers made of recycled materials.	Optional
Adaptability			Matter of choice in sustainability approach	Optional
Modularity: is the construction modular?	EN 1317-5: 2007 + A2: 2012		Minimum EN 1317-5 UK National Annex (NA.2.1.6) states that "The design of parapet attachment systems and anchorages should be such that removal and replacement of damaged sections of road restraint system may be readily achieved."	Mandatory (in the UK)

Maintenance: is cleaning or other maintenance required?	EN 1317 - 5: 2007 + A2: 2012.		Minimum. EN 1317-5 requires that the Installation instructions include provisions for repair, inspection, and maintenance, including indications for disassembling and reassembling or reconstruction of damaged system. Specified maintenance requirements (important for harsh environments) will affect the durability of the barrier	Mandatory
Repair / replacement: can it be repaired/replaced on site?			Optional. In the UK, repair/replacement is undertaken on site.	Optional
Lifetime extension options	EN 1317-5: 2007 + A2: 2012		Matter of choice in sustainability approach. Economic & Environment pillars of sustainability. EN 1317-5 UK National Annex (NA.2.1.6) states that "When the overseeing organization is selecting a road restraint product for any particular location account may be taken of repair and whole life maintenance characteristics whereby the contract documents may limit the material characteristics of the road restraint system." In the UK, as part of National Highways programme of upgrading all safety barriers, routine inspections are undertaken and barriers are automatically upgraded whenever repairs or replacement are required, thus extending the life of the structure.	Optional
Heat islands: possibility to			Environmental pillar of sustainability.	Optional

reduce heat island effect			Influenced by the surrounding area.	
High value recycling / reuse options	EN 1317-5: 2007 +A2: 2012		Matter of choice in sustainability approach - limited by current opportunities/markets EN 1317-5 requires the product description and installation requirements of a vehicle restraint system to include any other relevant information e.g. recycling information. No further information is provided. In the UK any damaged steel is removed, scrapped and sent for recycling; concrete barriers that are only chipped would remain in use, but when badly damaged they are scrapped with the steel and concrete being recycled.	Optional
Carbon capture capacity			Matter of choice in sustainability approach. At this time, to be attractive to manufacturers, this will need to be associated with reducing costs. There are likely to be innovative materials available in the future to facilitate increased carbon capture, but new safety testing programmes will be required to evaluate their performance.	Optional