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Road restraint systems - Part 10: Assessment methods and design guidelines for transitions, terminal and crash cushion connection - transitions

Rückhaltesysteme an Straßen - Prüfmethode und Design-Richtlinien für Übergangskonstruktionen und Anbindungen von Anpralldämpfern und von Anfangs- und Endkonstruktionen an Schutzeinrichtungen

Dispositifs de retenue routiers - Méthodes d'évaluation et lignes directrices de conception pour les raccordements et les raccordements d'extrémités de file et d'atténuateur de choc

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93.080.30	Cestna oprema in pomožne naprave	Road equipment and installations

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Road restraint system - Part 10: Assessment methods and design guidelines for transitions and terminal and crashcushion connection - Transitions

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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European foreword

This document (CEN/TR 1317-10:2023) has been prepared by Technical Committee CEN/TC 226 “Road equipment”, the secretariat of which is held by AFNOR.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes ENV 1317-4:2001 in conjunction with CEN/TS 1317-7:2023, CEN/TS 1317-9:2023.

This document is read in conjunction with EN 1317-1:2010, EN 1317-2:2010, EN 1317-3:2010, EN 1317-5:2007+A2:2012, EN 16303:2020 and CEN/TS 1317-7:2023, CEN/TS 1317-9:2023, CEN/TS 17342:2019.

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CEN/TR 1317-10:2023 (E)

Introduction

In the design of roads, safety problems may arise in the connection between two different safety barriers having consistent difference in design and/or in performance. Transitions are required to provide a smooth and safe change from one safety barrier to another.

If the two safety barriers are not connected or if the connection is not strong enough to resist the forces under impact and to transfer these forces at least from the weaker to the stronger safety barrier, an impact on the connection, or its vicinity, may represent an undue risk. A similar risk can arise if the change from one safety barrier to the other is not gradual enough.

A special type of transition is the connection of two parts of the same barrier separated by a span with particular requirements that cannot be covered by a piece of the same barrier. For example, the barrier expansion joint corresponding to a bridge deck expansion joint with large movement. In this document such connections are called barrier interruptions.

The performances of transitions can be ascertained by tests, with the test methods and the acceptance criteria similar to those specified for safety barriers in EN 1317-2:2010. Due to the increasing number of different safety barrier types, which leads to a high number of barrier combinations for which transitions are needed, efforts have been made to propose simplified assessment methods for some types of transition that can be assessed more easily.

For these reasons, different Countries have established different assessment methods for transitions or, in some cases, simple design rules. Such different assessment methods and design rules cannot be considered equivalent but, if correctly applied, can allow the development of performing transitions.

Some similar problems might arise in the connection of crash cushions with barriers and in the connections of terminals with barriers different from the one connected in the terminal TT installation. As for the transitions, also these connections provide a continuous passage to and from the barrier.

A barrier-to-barrier transition should have, all along its length, at least the same containment category value as the lowest value containment level of the connected barriers (as defined in EN 1317-2:2010). On the contrary this is not required for a barrier-terminal system tested in accordance with FprCEN/TS 1317-7:2023. The terminal is always connected at the beginning (or at the end) of a barrier whose performance is measured at one third of the test installation length. The main requirement of the terminal-to-barrier connection is to carry the axial forces of barrier end anchorage and the push of the terminal. Furthermore, the surface of the connection that can come in contact with the vehicles should be continuous and smooth. Similar considerations apply to the connections of crash cushions with barriers.

For all these reasons, connections of terminals and crash cushions to barrier are not denominated transitions but terminal connection-transitions.

Due to specific local conditions on national and local road networks there might be a need to connect safety barrier(s) or cushions to other infrastructures. Road authorities can see the need to require specific connections that in part, or as a whole, can be assessed according to the principles of the methods in this document. Every connection scenario (e.g. to tunnel portal, bridge pier or a sign gantry pillar) should be analysed individually. In general, the testing and assessment methods describe herein can have a wider application than the one specified in the scope of this document.

This document is a guideline for assessment methods and design rules that are not equivalent, but are good practice for designing performing transitions and terminal connections.

This document aims to propose a set of assessment methods that might help to move closer to the harmonization of assessment methods in different countries.

1 Scope

This document defines assessment methods for transitions, considered as the linkage between safety barriers or between safety barriers and removable barrier sections.

This document also defines assessment methods for connection-transitions to terminals and crash cushions.

Road Authorities and regulatory authorities are free to determine assessment methods, values, measurements etc. and to fix the details of the requirements.

Assessment methods and design rules can also be utilized in connection with the evaluation of changed versions.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1317-1:2010, *Road restraint systems - Part 1: Terminology and general criteria for test methods*

EN 1317-2:2010, *Road restraint systems - Part 2: Performance classes, impact test acceptance criteria and test methods for safety barriers including vehicle parapets*

EN 1317-3:2010, *Road restraint systems - Part 3: Performance classes, impact test acceptance criteria and test methods for crash cushions*

3 Terms and definitions

For the purposes of this document, definitions given in EN 1317-1:2010, EN 1317-2:2010, EN 1317-3:2010 as well as the following terms and definition apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1

transition

device connecting two safety barriers of different design and/or performance assessed in accordance with this document

3.2

transition element

transition used to join two similar safety barriers

Note 1 to entry: Such transition may be a simple joint and its length may be 0.

CEN/TR 1317-10:2023 (E)**3.3****length of a transition**

distance between the start and end points of the transition

Note 1 to entry: A transition's start and end points are located where a safety barrier starts to have changes in its standard design pattern that exists over the complete length of the safety barrier. Such changes could be post distance spacing, changes in the material or in its composition, additional/other elements such as spacers, different/additional beams, height, width, etc.

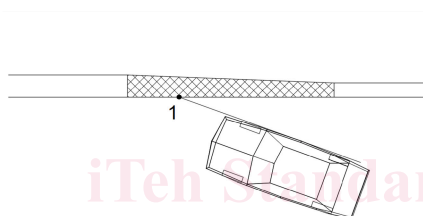
3.4**severity test**

initial type test carried out with a passenger car, which focuses on measuring the severity of the impact

Note 1 to entry: These are the tests listed in the column labelled "impact severity level ASI-THIV" in EN 1317-2:2010, Table 6.3.5

3.5**impact point**

point of intersection of a straight line parallel to the vehicle centreline, at the maximum width of the vehicle, with the traffic side of the transition, or of the safety barrier (see Figure 1)

**Key**

1 Impact point

Figure 1 — Impact point

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3.6**critical impact point****CIP**

impact point identified to reasonably represent the worst case for testing the transition

Note 1 to entry: An impact point can be critical from several points of view, e.g. containment, deflection or severity. Hence, critical impact points may be different from test to test.

3.7**containment test**

vehicle impact test providing the highest impact momentum among tests specified for the chosen containment level in accordance with EN 1317-2:2010, Table 2

Note 1 to entry: The term "containment category" used in this document has the same meaning as the term "containment level" used in EN 1317-2:2010

3.8**full scale test**

real crash test performed with a physical vehicle and a physical test item

Note 1 to entry: See also EN 1317-1:2010 and EN 1317-2:2010

3.9

virtual test or virtual testing

activities related to the use of a numerical model to reproduce a real test and/or to simulate an impact

Note 1 to entry: In accordance with EN 16303:2020

3.10

connection-transition to terminal or crash cushion

connection of a crash cushion to a barrier or of a terminal to a barrier different from the one in the TT installation

3.11

downstream

situated in the direction of the traffic on the side of the barrier

3.12

upstream

situated in the opposite direction from that of the traffic on the side of the barrier

3.13

barrier interruption

connection of two parts of the same barrier separated by a span with particular requirements

3.14

validated model

numerical model of a road restraint system that has been validated

Note 1 to entry: In accordance with EN 16303:2020.

4 Abbreviations

For the purposes of this document, the abbreviations given in EN 1317-1:2010 apply.

5 Assessment methods and design rules for transitions

5.1 General

Transitions can be assessed by full scale or virtual tests, as specified in 5.2 (assessment method A1 and B1), 5.3 (assessment method A2 and B2) and 5.4 (assessment method B3, and B4) or can be designed in accordance with appropriate design rules as specified in 5.5 (design rules C1 and C2). A barrier interruption can be assessed as a transition or as a transition element.

Assessment methods described in this document are not equivalent. It is up to the Road Authority and the Regulatory Authority to decide which method is appropriate for which use. Some methods may be excluded in some countries.

In assessment method A1 and A2 the transition is assessed by full scale tests.

In assessment method B1, B2 and B3 the transition is assessed by virtual tests. For these assessment methods one of the following validation categories for the connected safety barriers should be chosen:

- a) the numerical models of the safety barriers are validated according to EN 16303:2020 (F, full validation)

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- b) the numerical models of the safety barriers are only partially validated, i.e. validated against at least the following performances according to EN 16303:2020: ASI value or severity index class, working width value or working width class, dynamic deflection value (S, simplified validation)
- c) the numerical models of the safety barriers are NOT validated (N, no validation)

NOTE 1 Assessment method B1, B2 and B3 will be further classified as B1F, B1S or B1N, B2F, B2S or B2N and B3F, B3S or B3N.

NOTE 2 For assessment method B1, B2 and B3, one or several full-scale tests can also be required to validate the model or to improve the assessment of the transition.

In assessment method B4 the transition is assessed by full scale tests and virtual tests. The results of the full-scale tests from the two connected safety barriers and the transition are then used to validate the numerical models of the barriers and that of the transition according to EN 16303:2020. Alternatively, the full-scale test on the transition may be required after the identification of the most critical impact points identified during the scan of the transition by virtual tests to improve the assessment of the performance.

Table 1 — Summary of the Assessment Methods

Assessment Method	Validation Category	Full scale tests		Virtual tests	
		Containment	Severity	Containment	Severity
A1	-	1	1+1a)	-	-
A2	-	1	2+1a)	-	-
B1F	Full	-	-	1	1+1a)
B1S	Simplified				
B1N	No validation				
B2F	Full	-	-	1	2+1a)
B2S	Simplified				
B2N	No validation				
B3F	Full	-	-	Scanning of the length on several impact points to find the CIP for containment and the CIP for severity	
B3S	Simplified				
B3N	No validation				
B4	Full	1	1+1a)	Scanning of the length on several impact points to find the CIP for containment and the CIP for severity	
C1	Design rules – No test				
C2	Design rules – No test				
a) TB32 only for L Containment Category levels					

The numerical models should follow the requirements for numerical model of the vehicle and vehicle restraint system described within EN 16303:2020.