SLOVENSKI STANDARD
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Oprema cest - 10. del: Metode ocenjevanja in smernice za načrtovanje povezave prehodov ter zaključnic in naletnih blažilnikov trkov - Prehodi

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

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

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This draft Technical Report is submitted to CEN members for Vote. It has been drawn up by the Technical Committee CEN/TC 226.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Page

European foreword

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

This document is currently submitted to the Vote on TR.

This document will supersede ENV 1317-4:2001 in conjunction with FprCEN/TS EN 1317-7 :2023, FprCEN/TS EN 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 FprCEN/TS EN 1317-7 :2023, FprCEN/TS EN 1317-9:2023, CEN/TS 17342:2019.

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.

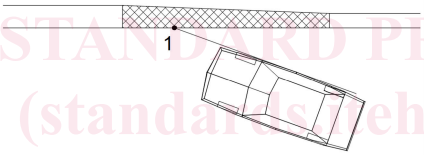
3.3
length of a transition
distance between the start and end points of the transition

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

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)

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

<table>
<tr><th rowspan="2">Assessment Method</th><th rowspan="2">Validation Category</th><th colspan="2">Full scale tests</th><th colspan="2">Virtual tests</th></tr>
<tr><th>Containment</th><th>Severity</th><th>Containment</th><th>Severity</th></tr>
<tr><td>A1</td><td>-</td><td>1</td><td>1+1[a)]</td><td>-</td><td>-</td></tr>
<tr><td>A2</td><td>-</td><td>1</td><td>2+1[a)]</td><td>-</td><td>-</td></tr>
<tr><td>B1F</td><td>Full</td><td rowspan="3">-</td><td rowspan="3">-</td><td rowspan="3">1</td><td rowspan="3">1+1[a)]</td></tr>
<tr><td>B1S</td><td>Simplified</td></tr>
<tr><td>B1N</td><td>No validation</td></tr>
<tr><td>B2F</td><td>Full</td><td rowspan="3">-</td><td rowspan="3">-</td><td rowspan="3">1</td><td rowspan="3">2+1[a)]</td></tr>
<tr><td>B2S</td><td>Simplified</td></tr>
<tr><td>B2N</td><td>No validation</td></tr>
<tr><td>B3F</td><td>Full</td><td rowspan="3">-</td><td rowspan="3">-</td><td colspan="2" rowspan="3">Scanning of the length on several impact points to find the CIP for containment and the CIP for severity</td></tr>
<tr><td>B3S</td><td>Simplified</td></tr>
<tr><td>B3N</td><td>No validation</td></tr>
<tr><td>B4</td><td>Full</td><td>1</td><td>1+1[a)]</td><td colspan="2">Scanning of the length on several impact points to find the CIP for containment and the CIP for severity</td></tr>
<tr><td>C1</td><td colspan="5">Design rules – No test</td></tr>
<tr><td>C2</td><td colspan="5">Design rules – No test</td></tr>
<tr><td colspan="6">**a)** TB32 only for L Containment Category levels</td></tr>
</table>

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

For assessment method A1, A2, B1, B2, B3 and B4 the test installation should include a length of the upstream safety barrier, the transition and a length of the downstream safety barrier. The length of the two safety barriers should be sufficient to show the performance of longer installations. The adequacy of the installed length, including transition and connected barriers but excluding any barrier end anchorages, should be evaluated from the result of the tests, i.e. with the procedure in EN 1317-2:2010, Annex B.

5.2 Assessment method A1 and B1

5.2.1 General

The minimum containment category of a transition is equal to the lower containment category, as determined by testing according to EN 1317-2:2010, of the two connected safety barriers. If this containment category is an L category, the minimum containment category required for the transition is the corresponding H category or L category. For example, if the lower containment category is L2 the minimum category for the transition should be H2 or L2.

The transition should be tested to the requirements of the selected containment category according to EN 1317-2: three tests for containment category of type “L”, two tests for containment category of type “H” and N_2, and one test for containment category of type “N1”. Test site and vehicles should be according to EN 1317-1:2010.

5.2.2 Impact direction

In general, the direction of the impacts considered in the assessment should be from the safety barrier with the lower containment category to the safety barrier with the higher containment category. If the two safety barriers have the same containment category the direction of the impacts should be from the safety barrier with the larger dynamic deflection to the one with the lower dynamic deflection. If a different impact direction is chosen, this should be justified in the test report.

The direction of the impact should be chosen to demonstrate the worst-case testing condition for the transition, according to the design of the transition.

5.2.3 Impact points

This subclause includes guidelines for the choice of the critical impact points. However, it is up to the testing laboratory to choose different critical impact points. Road Authorities and the Regulatory Authorities may choose a different position of critical impact points. If several critical impact points are identified for a transition (both for containment and severity test), it is recommended to assess additional impact points through method A or B.

NOTE Physical testing laboratories are accredited according to the EN ISO/IEC 17025 for the appropriate type of testing

The impact points should demonstrate the worst-case testing conditions of the transition, and should include any sensitive feature of the design. The reasons for the choice of the impact points should be included in the test report.

The impact point for TB11 (or TB 21 for temporary containment category) can be located at a distance of not less than 3/4 of the length of the transition downstream the start point of the transition and no more than 2 m upstream of the end of the transition (approach 1 in Figure 2).

The impact point for the containment test can be located at the midpoint of the transition but should not be more than 6 m upstream the end of the transition (approach 2 in Figure 2) with the exception of TB 32 where the impact point should not be more than 4 m upstream the end of the transition.