BS EN 12767:2019
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BSI Standards Publication

Passive safety of support structures for road equipment — Requirements and test methods

bsi.

National foreword

This British Standard is the UK implementation of EN 12767:2019. It supersedes BS EN 12767:2007 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/509/10, Break-away safety.

A list of organizations represented on this committee can be obtained on request to its committee manager.

BSI, as a member of CEN, is obliged to publish EN 12767:2019 as a British Standard. However, attention is drawn to the fact that during the development of this European Standard, the UK committee voted against its approval.

BS EN 12767:2019 is a supporting standard to standards prepared under the requirements of the European Commission Mandate M/111, Circulation fixtures, given under the EU Construction Products Directive (89/106/EEC). BS EN 12767:2019 specifies performance test procedures to determine the passive safety properties of support structures such as lighting columns, sign posts, signal supports, structural elements, foundations, detachable products and any other components used to support equipment on the roadside.

BS EN 12767:2019 provides a common basis for vehicle impact testing of items of road equipment support structures to determine performance in terms of potential risk of injury to vehicle occupants when in collision with such support structures. The document does not apply to road restraint systems. BS EN 12767:2019 is a standard that sets down performance values rather than a method of manufacture. It has, in most cases, several performance classes for each property. Some of these classes have a range of values. A manufacturer can supply a product that has the lowest value and that still meets that class. Purchasers need to be aware of this when specifying their requirements. Recommended classes considered most suitable in different situations in UK practice are given in National Annex NA, which is appended at the back of this standard.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12767

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English Version

Passive safety of support structures for road equipment - Requirements and test methods

Sécurité passive des structures supports d'équipements de la route - Prescriptions et méthodes d'essai

Passive Sicherheit von Tragkonstruktionen für die Straßenausstattung - Anforderungen und Prüfverfahren

This European Standard was approved by CEN on 24 June 2019.

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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

European foreword

This document (EN 12767:2019) has been prepared by Technical Committee CEN/TC 226 “Road Equipment”, the secretariat of which is held by AFNOR.

This document shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2020, and conflicting national standards shall be withdrawn at the latest by February 2020.

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 EN 12767:2007.

The significant technical changes incorporated in this revision are:

— incorporation of the Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonized conditions for the marketing of construction products and repealing Council Directive 89/106/EEC terminology;

— introduction of a push-pull test to enable a comparison to be made between the backfills used in the test and those on-site;

— harmonization of the boundary values for occupant safety (ASI and THIV) independent of the energy absorption class;

— replacement of the occupant safety class by an alphanumeric character instead of a number to make a clear distinction with the old (EN 12767:2007) approach. Now, NE-C, LE-C and HE-C have the same occupant safety. The best occupant safety is achieved for A;

— introduction of collapse modes to classify if test items become detached or do not become detached;

— introduction of direction classes to take into account any sensitiveness to impact angle;

— improved test description, include installation manual and translation of roof deformation into a measurable value, to reduce the influence of the vehicle structure on the test results;

— introduction of an extra test at 50 km/h for cases where the test-item is not activated at low speed. An explanation of the definition of “activated” is also given;

— better rules for the determination of families (product families) based on the tested limit(s);

— introduction of a risk assessment approach, in line with the EN 1317-1:2010, for assessing changes of a version, and the use of (for example) virtual testing in this;

— possibility to declare, under certain conditions, intermediate speed classes.

Most of the comments collected from all CEN members to the previous version of this norm are implemented or solved. The definition and use of newer technologies has to be developed before introduction into the standard.

Some added changes mentioned above are expressed in a new performance classification for the product. This results in a longer description of the overall passive safety performance, but at the end, it gives a clearer indication of product performance. For example, an old performance classification like “100, HE,

3" could be translated to "100-HE-C-S-SE-MD-1". In this example, the last 4 sub-indications stands for backfill type (S), collapse mode (SE), direction class (MD) and risk of roof indentation.

Translation of older tests to this new standard is possible when sufficient information is available in the reports, photographs and videos of the tests.

The previous version of EN 12767 included test acceptance criteria – this is now, for convenience, repeated in Annex A.

When this standard is used as a supporting standard for a product standard under CPR (e.g. sign supports) relevant clauses of Annexes A, G and H are supposed to be copied inside the product standard, and the product standard refers to the rest of this standard.

When this standard is used for testing constructions with no product standard the specifying authority is supposed to refer to whole EN 12767, including Annexes A, G and H.

Annexes A, B, D, E, G, H, I, K, L, M of this document are normative, Annexes C, F, J are informative.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

The severity of accidents for the occupant(s) of a vehicle is affected (in part) by the performance of the support structures for items of road equipment under impact. Based on safety considerations, support structures can be designed to behave in controlled ways to reduce the overall risk.

Passive safety is intended to reduce the severity of injury to vehicle occupants of a car in an impact with support structures of road equipment.

This document has been developed in order to provide:

— test methods for determining impact safety performance, and

— methods to handle the data resulting from the impact tests;

— technical background about passive safety that can be used in the product standard.

The test procedure includes guidelines:

— for test item selection, test parameters, detailed test methods with different test conditions, the data to record, and requirements for reporting;

— to assess the performance within families of product (called “product families”) and for modified products (called “changed versions”).

This document considers:

— two kinds of test inputs:

  — three speed classes (50, 70 and 100);

  — three Backfill types (standard aggregates (S), special (X) and Rigid (R)).

— five kinds of test outcomes:

  — three energy absorption classes: high energy absorbing (HE), low energy absorbing (LE) and non-energy absorbing (NE);

  — five occupant safety classes (from A to E);

  — two modes of collapse for support structures (Separation mode (SE) and No separation collapse mode (NS));

  — three direction classes (single-directional (SD), bi-directional (BD) and multi-directional (MD));

  — two classes of risk of roof indentation (0 or 1).

In order to help to evaluate the risk in case of a product modification, this document introduces Virtual Testing through the definition of procedures for verification, validation, and development of numerical models.

Based on the evaluation of the performance of each tested support structure, National and Local road authorities will be able to specify the performance class of an item of road equipment support structure in terms of the likely effect on the occupants of a vehicle in impact with the structure.

1 Scope

This document specifies performance test procedures to determine the passive safety properties of support structures such as lighting columns, sign posts, signal supports, structural elements, foundations, detachable products and any other components used to support a particular item of equipment on the roadside.

This document provides a common basis for the vehicle impact testing of items of road equipment support structures.

This document does not apply to road restraint systems.

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 13285, *Unbound mixtures — Specifications*

ISO 6487, *Road vehicles — Measurement techniques in impact tests — Instrumentation*

ISO 10392, *Road vehicles — Determination of centre of gravity*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
impact test
test in which a test vehicle impacts a test item of road equipment support structure

3.2
impact angle
angle between the intended direction of traffic and the approach path of the test vehicle into the test item

3.3
vehicle impact point
initial point of impact on the test vehicle

3.4
test item impact point
initial point of impact on the test item

3.5
impact speed
v_i
measured impact speed of the impacting vehicle, measured along the test vehicle approach path at a distance no further than 6 m before the impact point

3.6
exit speed
v_e
speed of the test vehicle after the impact with the test item, measured perpendicular to the extended approach path at a point 12 m beyond the impact point

Note 1 to entry: For exit speed of non-harmful products as defined in 3.16, non-harmful support structure see 7.5, simplified test method for non-harmful support structures.

3.7
test vehicle
production models representative of current traffic in Europe used in an impact test to evaluate the performance of a test item

3.8
test item
complete system of a support structure including the road equipment to be supported and foundation (if needed)

3.9
support structure
system used to support items of road equipment

Note 1 to entry: Items of road equipment may include luminaires, traffic signs, traffic signals and utility cables or any other equipment. The system includes posts, poles, structural elements, foundations, detachable mechanisms, if used, and any other components used to support the particular item of equipment.

3.10
sign support
support structure intended to hold one or more signs

3.11
signal support
support structure intended to hold one or more signals heads

3.12
lighting column
support structure intended to hold one or more luminaires, consisting of one or more parts: a post, possibly an extension piece and, if necessary, a bracket

3.13
utility pole
support structure intended to hold power transmission, telecommunication cables or similar

3.14
cantilever support
support structure with one or more legs positioned on one side of the carriageway and a cantilever arm supporting signs, signals or other equipment mounted over traffic lanes

3.15
gantry support
support structure spanning a carriageway with one or more legs on each side of carriageway supporting signs, signals or other equipment

3.16
multi-legged support
support structures with several legs, either identical or different

Note 1 to entry: The term includes structures with legs aligned transverse to the road or along the road.

3.17
non-harmful support structure
small support structure (for example some types of bollards, self-righting signs, delineators) that causes only minor damage and a small change of speed during impact

3.18
ASI
dimensionless impact severity index calculated from the tri-axial vehicle accelerations according to the procedure given by EN 1317-1:2010, 8.1.2

3.19
THIV
velocity, expressed in km/h, at which a hypothetical "point mass" occupant impacts the surface of a hypothetical occupant compartment and calculated in accordance with the procedure given by EN 1317-1:2010, 8.1.3

3.20
ballast
mass added to a test vehicle, excluding instrumentation, to simulate cargo and/or to achieve desired test mass

3.21
total mass
mass that includes all items in the test vehicle at the beginning of the test

3.22
collapse mode
mode by which the support structure deforms under vehicle impact

3.23
anthropomorphic test device
ATD
anthropomorphic device representative of a 50th percentile adult, specifically designed to represent in form, size and mass, a vehicle occupant, and to reproduce the dynamic behaviour of an occupant in crash testing

3.24
performance class
class for one speed class, one energy absorption level, one occupant safety class, one backfill type, one collapse mode, one direction class and risk of roof indentation

3.25
product family
product series of the same type in various sizes, made from the same materials using the same design and general construction method, and having the same performance class

3.26
object length
height of the support structure

Note 1 to entry: For lighting columns, the object length is the height above ground level (h) plus half of the horizontal bracket projection (w) in case of a bracket in top of the support structure. h and w are defined by EN 40-2.

Note 2 to entry: For other support structures, the object length is the overall height of the structure including signs, signal heads and other attachments.

3.27
object mass
mass of the part of the support structure above ground level included attachments such as signs and luminaires

4 Symbols and abbreviations

ASI	Acceleration Severity Index
THIV	Theoretical Head Impact Velocity
SE	Separation collapse mode
NS	No separation collapse mode
HE	High energy absorbing category
LE	Low energy absorbing category
NE	Non energy absorbing category
S	Backfill type S, standard aggregates
X	Backfill type X, special aggregates
R	Backfill type R, rigid
SD	Single-directional
BD	Bi-directional
MD	Multi-directional
C	Circumscribed circle of supports
O	Centre of C
L	Clear opening for multi-legged supports
v	Velocity
t	Time
VT	Virtual testing
NR	No requirement
ATD	Anthropomorphic Test Device

5 General test parameters

5.1 Test site

The test site shall be generally flat and have a level, hardened surface with a gradient not exceeding 2,5 %. The area around the test item until 15 m behind shall be clear of standing water, ice or snow at the time of the test. The test site shall be of sufficient size to enable the test vehicle to be accelerated up to the required speed and controlled so that its approach to the test object is stable.

The test vehicle shall run on a levelled (no steps allowed) hardened or paved surface over the backfill volume without influencing the movement of the test item.

NOTE For the purposes of this standard, the term "paved" is used only for an installation with asphalt, brick slabs/pavers or a concrete surface.

Appropriate measures shall be taken in order to minimize dust generation from the test area and the test vehicle during the impact test so that photographic records will not be obscured.

5.2 Backfill

5.2.1 General

The manufacturer shall select the type(s) of backfill to be used in the Type Tests from those given in Table 1.

Table 1 — Backfill type

Backfill type	Name
S	Standard aggregates
X	Special
R	Rigid

The backfill at the test site shall be well known, repeatable and described thoroughly, either in the test report or as a reference to well-known and widely accepted geotechnical references or pavement properties.

Within one product family, the same backfill type shall be used for all tests.

The different backfill types are described in 5.2.2 and 5.2.3.

The backfill according to which the performance of the test item is determined is part of the performance declaration (see Annex A).

5.2.2 Backfill type S and X

Backfill type S and X identify the use of backfill material in the backfill volume.

— Backfill type S grading shall be in accordance with B.3.

— Backfill type X shall be described by a sieving curve supplied by the manufacturer and included in the test report (grading shall be in accordance with EN 13285).

The results of the push/pull test should be reported according to Annex C.

The minimum dimensions of the backfill volume, the positioning of the item in the volume and the compaction of the backfill material shall comply with B.1 and B.2. The backfill volume shall not be frozen at the time of test and shall be protected from rain before the impact test.

5.2.3 Backfill type R

Backfill type R identifies the use of a flat continuous rigid surface (such as asphalt and/or concrete) of a sufficient thickness to provide anchoring of the tested item without being displaced according to B.4.

NOTE This can be locally damaged in the impact area as a result of the impact test.

5.3 Test vehicle

5.3.1 General

The test vehicle shall be a standard passenger car and shall also meet the following specifications:

— the total mass: 900 kg ± 40 kg. Of this, the maximum allowed combined mass of ballast and instrumentation is 120 kg;

An ATD (or a driver for simplified test method) may be used; in this case the total mass includes the ATD (or driver).

— the dimensions of the test vehicle are determined according to Annex D;

— front and rear wheel track: 1,35 m ± 0,20 m;

— longitudinal centre of gravity location in distance from front axle (CGx) 0,90 m ± 0,09 m. No ATD shall be in the car when the centre of gravity is determined;

The centre of gravity shall be determined in accordance with the ISO 10392.

— lateral centre of gravity location (CGy) distance from vehicle centreline ±0,07 m;

— centre of gravity height from ground (CGz) 0,49 m ± 0,05 m;

— the vehicles to be used in the tests shall be production models representative of current traffic in Europe;

— the vehicle shall not have a sunroof;

— additional equipment on the car, which might be important for the test, shall be of a type normally delivered by the manufacturer or otherwise approved for use on the specific car type;

— a heavy car shall not be stripped of heavy standard equipment to fit into the mass restrictions of this standard;

— the tyres shall be inflated to the vehicle manufacturer's recommended pressures. The condition of the vehicle shall satisfy the requirements for the issue of a vehicle certificate of road worthiness with respect to tyres, suspension, wheel alignment and bodywork, including windows and features that are expected to affect the test result. No repairs or modifications including reinforcement shall be made that would alter the general characteristics of the vehicle or invalidate such a certification. Any repairs shall conform to the original vehicle specification as defined by the vehicle manufacturer. The vehicle shall be clean and mud deposits, which may cause dust on impact, shall be removed prior to testing. Marker points shall be placed on external surfaces of the test vehicle to aid analysis;

— the vehicle shall not be restrained by control of the steering or any other means during impact and within a distance of 12 m after the impact point (e.g. engine power, braking, anti-lock brakes, blocking or fixing);

— all fluids shall be included in the test inertial mass;

— all ballast weights shall be securely fixed to the vehicle in such a way as not to exceed the manufacturer's specifications for distribution of weight in the horizontal and vertical planes;

— ballast weights shall not be fixed in locations, which would modify the deformation of, or intrusions into, the vehicle.

The test vehicle shall satisfy the vehicle calibration test requirements of Annex E.

NOTE The use of a bogie vehicle is not accepted for determining the performance class. Nevertheless, Annex F is included in this document for technical background and stakeholders are invited to study the feasibility of replacing a real car with a bogie vehicle in the future.

5.3.2 Test vehicle instrumentation

The minimum test vehicle instrumentation and the accuracy of the measurements taken during the test shall be in accordance with EN 1317-1:2010.

Accelerometers shall be positioned as described in EN 1317-1:2010.

6 General test item parameters

6.1 General test item documentation

Before the test, the manufacturer shall supply drawings and full technical specifications for the test item. The overall tested item mass and the various component masses shall be given by the manufacturer.

Full technical specification is the material specifications and drawings necessary to uniquely identify the test item and the properties of all parts. It also includes installation and maintenance drawings and instructions necessary to ensure the initial and continuing functioning of the device to the determined safety class. Additional requirements such as foundation requirements, torque settings of brackets, sign clamps, fixing systems, anchor bolts shall be defined in the installation instructions and checked before the test.

The installation drawings shall illustrate the traffic direction. The impact safety performance of some support structures might be affected by the orientation of the impact (vehicle direction in horizontal plane). If the structure is designed to perform when hit in a particular direction, the features participating to that behaviour shall be identified.

Each drawing shall have a unique number, version number and a date, in order to uniquely identify the tested item. The drawings shall only include the tested configuration, not any untested options, sizes or variations. The test laboratory shall verify if the test item corresponds with the information in the drawings and specifications.

6.2 Test item selection

6.2.1 General

The client shall select the configuration of test items.

The item selected for testing shall be representative of actual or future production including, where present, inspection or maintenance openings or any other device which will be in use when placed on the market.

The installation of the test item at the test site shall be made in accordance with the manufacturer’s specifications as described in 6.1. Any deviation of the installation with respect to the manufacturer’s specifications shall be recorded in the test report.

In those cases where several versions of a product are based on the same construction principle, the manufacturer selects an item to be a parent member. Annex G gives explanations on how to choose the other family members.

If a modification is applied to an already tested product, Annex H gives an explanation on how to assess the risks associated with the modification, and how to evaluate the changed version.

Due to the risk of penetration of the windscreen of an impacting car, the untested reduced minimum height of the lower edge of any attachment above 2,0 kg shall not be lower than 2,0 m. For lower installations, the risk of windscreen penetration shall be evaluated.

Specific requirements for the selection of the test item are given in 6.2.2 to 6.2.7.

Multi-legged support structures are of two types: multi-legged support structures with identical legs and multi-legged support structures with non-identical legs. Identical means that these legs refer to the same drawing number.

6.2.2 Lighting column

A lighting column shall be tested with the longest and heaviest single arm bracket, and luminaire of the greatest mass related to the bracket length, for which the column is designed.

Luminaires, and cables to luminaires, shall be installed when a lighting column is tested, including typical underground cables and connection boxes and/or fuse units, if the lighting column is intended for use with such items.

Overhead cables need not be installed for the impact tests. However, if they are used at test, the overhead cables shall be installed so as to simulate the fixing on adjacent columns/posts in service.

Underground cables shall be securely fixed outside the backfill volume in such a way that the fixing does not allow movement of the cable at the fixing point during the test.

Dedicated electrical disconnections might be installed during test, and their performance can be part of additional voluntary information in a test report, however not forming basis for any pass/fail considerations of the actual support structure.

6.2.3 Sign support

A sign support shall be tested with the largest area of symmetrically mounted sign plate for which that height of support is designed. Any necessary electrical equipment, cables including underground cables and connection boxes and/or fuse units (for example for transilluminated signs) shall be installed.

6.2.4 Signal support

A signal support shall be tested with the heaviest signal head(s), together with cables including underground cables, connection boxes and/or fuse units.

Underground cables shall be securely fixed outside the backfill volume in such a way that the fixing does not allow movement of the cable at the fixing point during the test.

6.2.5 Utility pole

A utility pole shall be tested with the heaviest intended load.

Overhead cables shall be installed unless the effect of overhead cables and its fixings on the performance is known from other tests with similar utility poles.

When testing with overhead cables, at least three utility poles shall be installed and the central utility pole shall be the one impacted.

6.2.6 Multipurpose support structures

When a support type is designed to be used in more than one configuration, such as lighting columns, sign supports, traffic signal supports, etc., the result of the low speed test in one configuration may substitute the low speed test of another configuration. The result is valid for systems with a lesser mass and the same number of supports but only for supports with smaller bending moment resistance.

6.2.7 Other support structures

Other support structures shall be tested with the heaviest intended load. This includes non-harmful support structures.

Support structures, such as mailboxes, gantries, cantilever supports, emergency telephones, camera supports, weather and traffic monitoring devices supports, advertisement installations, solar panels, wind turbines or other items not specified above may also be tested in accordance with this document. In this case, the test configuration should be based (as closely as possible) on the principles described in Clauses 6 and 7 and the related sub clauses. The installation is as complete and realistic as possible.

7 Test method

7.1 General

The test shall be performed by a competent test laboratory.

For ensuring better reliability of test results the test may be performed by an accredited test laboratory according to the EN ISO/IEC 17025. The test method is described in terms of:

— impact angle;

— impact point;

— impact speed.

7.2 Impact angle

The test vehicle shall follow an approach path oriented according to the manufacturer's installation specification and with respect to the impact angle. The installation of the test item shall reproduce the installation on the road as documented by the manufacturer (see 6.1); for example the opening shall be oriented in the direction most likely to reproduce the installation on the road.

The item shall be tested with an impact angle of 20° ± 2 °. The accuracy of the measurement shall be ±0,5 °.

When required (by A.6, for bi-directional classification or other standard), an additional test shall be performed with an impact angle of 160° ± 2° (all the way around 180 ° minus 20 °) as indicated in Figure 1. This is equivalent to a vehicle leaving the road from the carriageway of the opposite side, hitting the rear of the item. The tests shall be made under identical test conditions with the exception of the test angle.

7.3 Impact point

7.3.1 General

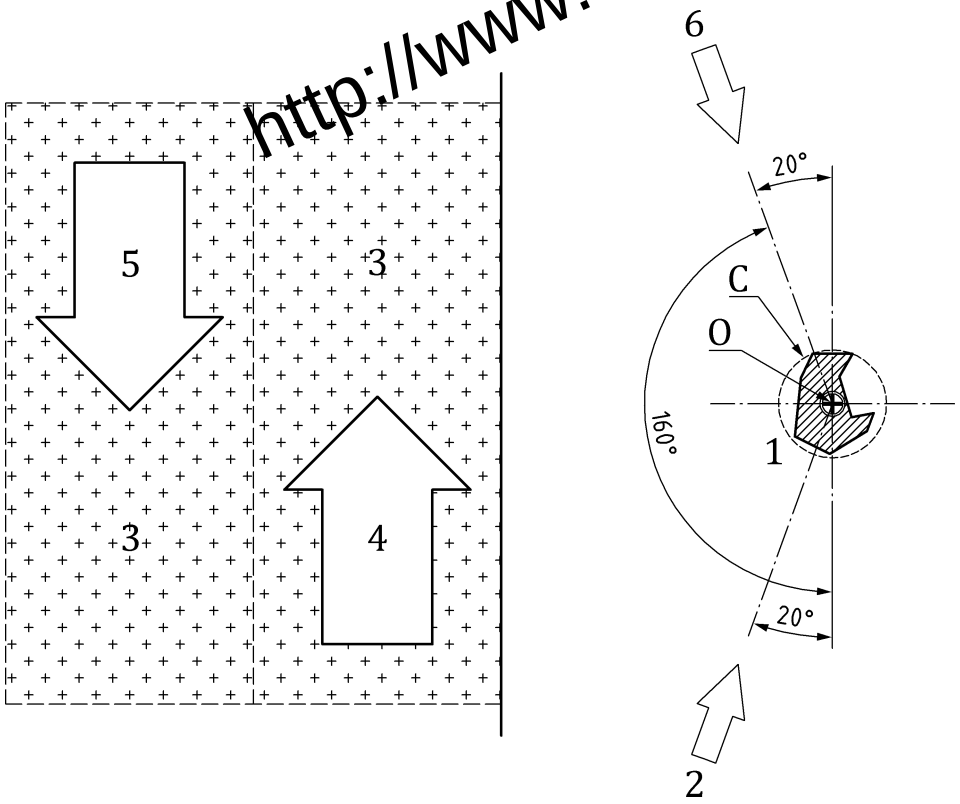
The impact point of the vehicle is the foremost point of the vehicle along the vehicle's centreline. The vehicle centreline line and the impact point of the vehicle shall be directed towards the support structure's theoretical alignment point (O), with an allowed impact alignment tolerance of ±0,1 m.

The support structure's theoretical alignment point shall be determined in accordance with 7.3.2 for single legged support structures, and 7.3.3 for multi-legged support structures.

The accuracy of the measurement of the impact alignment and the lateral movement at the exit side of the test item at the ground level shall be ±0,02 m. For rigid backfill (Type R) the accuracy of the measurement of the lateral movement at the exit side of the test item at ground level shall be ±0,005 m.

7.3.2 Theoretical alignment point for single legged support structures

For single legged support structures, the support structure theoretical alignment point (O) is the centre of the circle circumscribed around the cross section of the leg at a height of 0,3 m above ground level, in the horizontal plane, see Figure 1.



Key

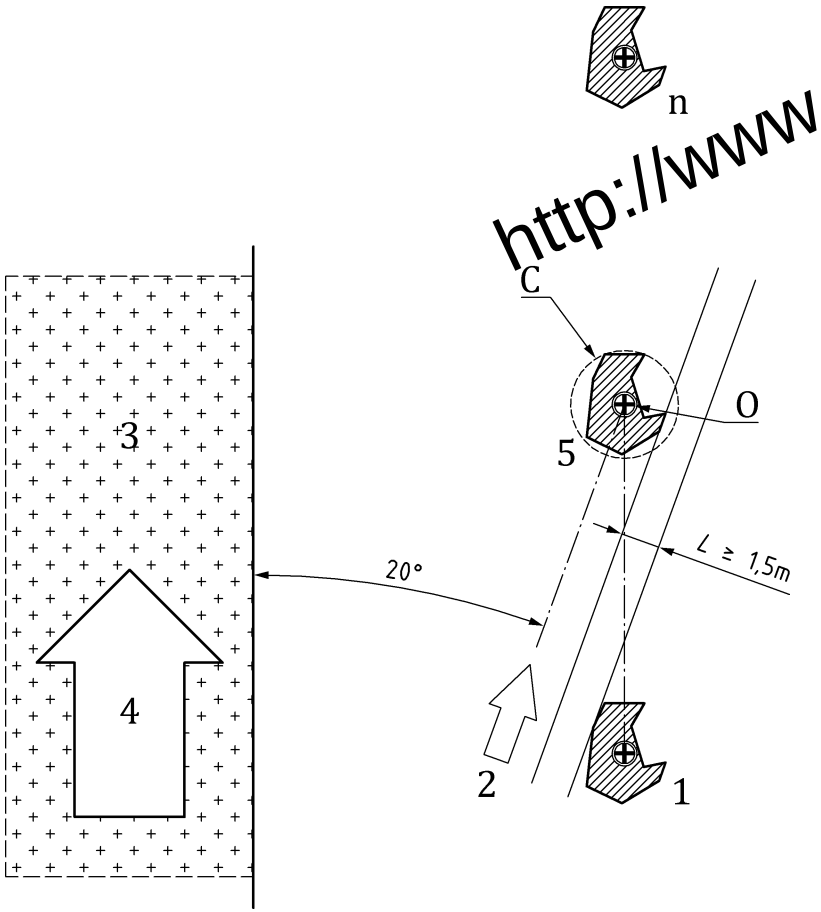
C circumscribed circle of the single support structure
O the support structure theoretical alignment point (centre of circle C)
1 leg of the single support structure
2 mandatory impact direction
3 carriageway
4 traffic flow
5 opposite traffic flow
6 impact direction opposite traffic flow (optional, see Annex A)

Figure 1 — Theoretical alignment point and impact angle of a single legged support structure

7.3.3 Theoretical alignment point for multilegged support structures

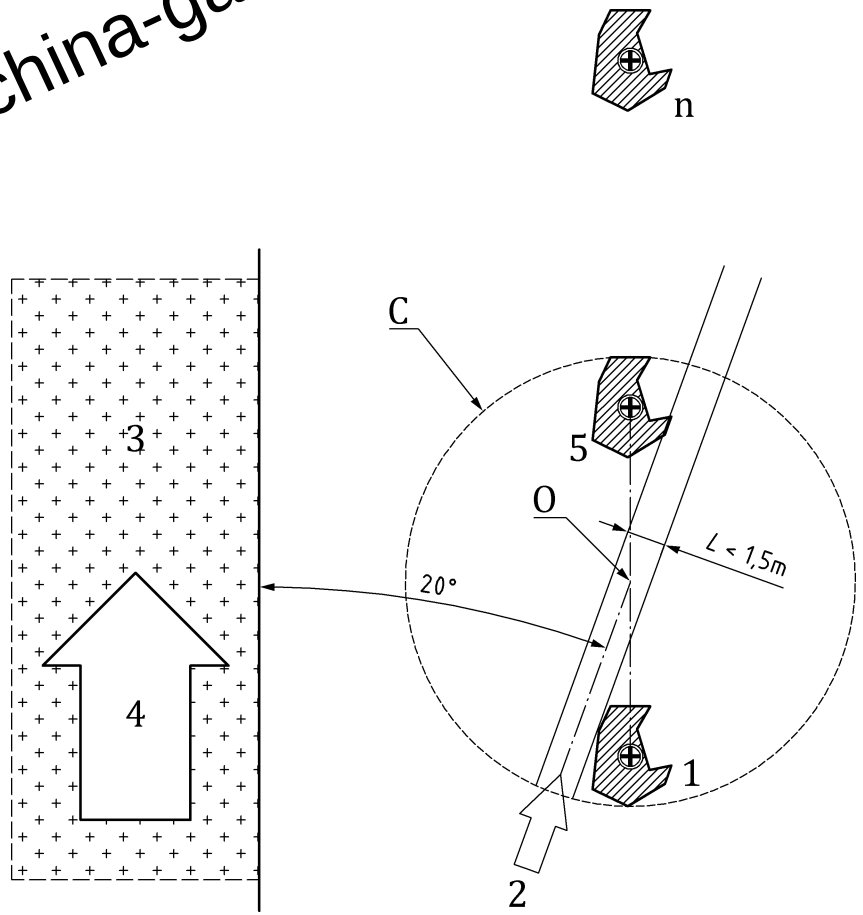
For multi-legged support structures, the projected distance at the 20 ° impact direction between two adjacent support structure legs shall be determined and reported at a height of 0,3 m above ground level in the horizontal plane. The clear opening (L) is the smallest distance as measured between the legs as indicated in Figure 2.

NOTE The clear opening is generally shorter than the distance between two adjacent legs. Normally all the legs have a constant distance between each other.



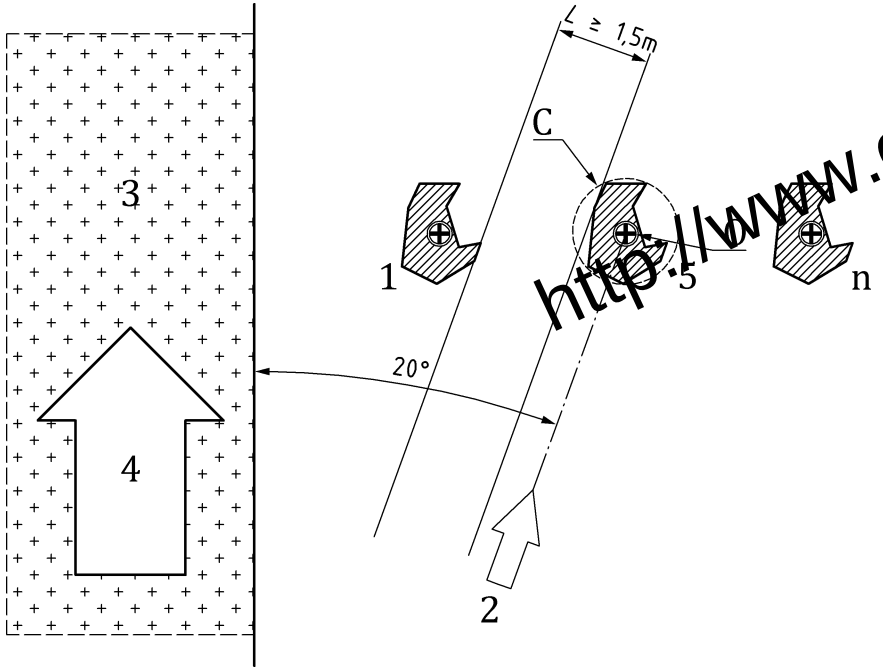
Situation with identical legs and clear opening L ≥ 1,5 m. In this case, the theoretical alignment point (O) shall be defined as for a single leg (see Figure 1), against the second leg.

a) Legs parallel to the carriageway with L ≥ 1,5 m



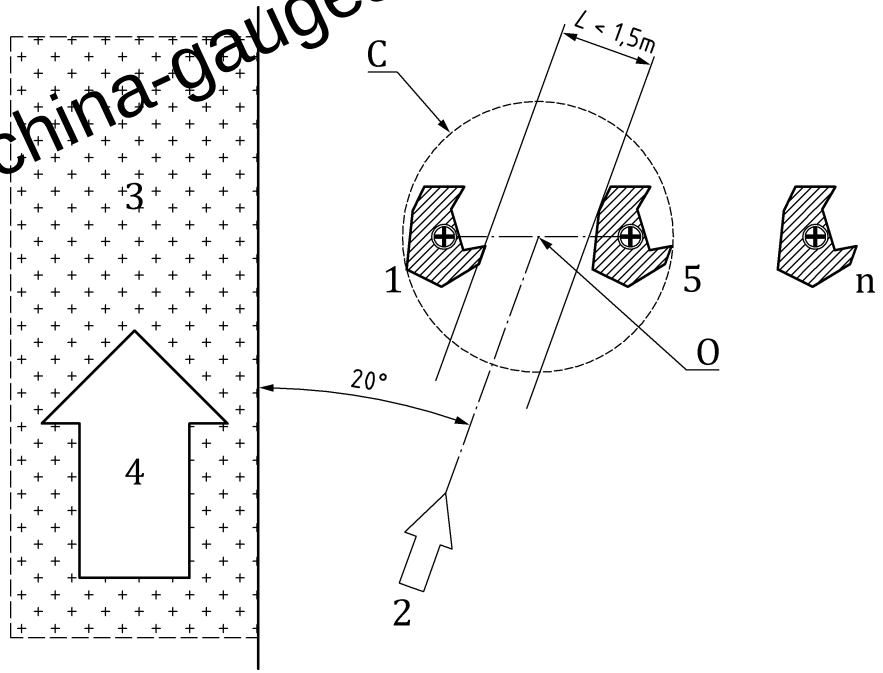
Situation with identical legs and clear opening L < 1,5 m. In this case, the theoretical alignment point (O) shall be defined between the legs.

b) Legs parallel to the carriageway with L < 1, 5 m



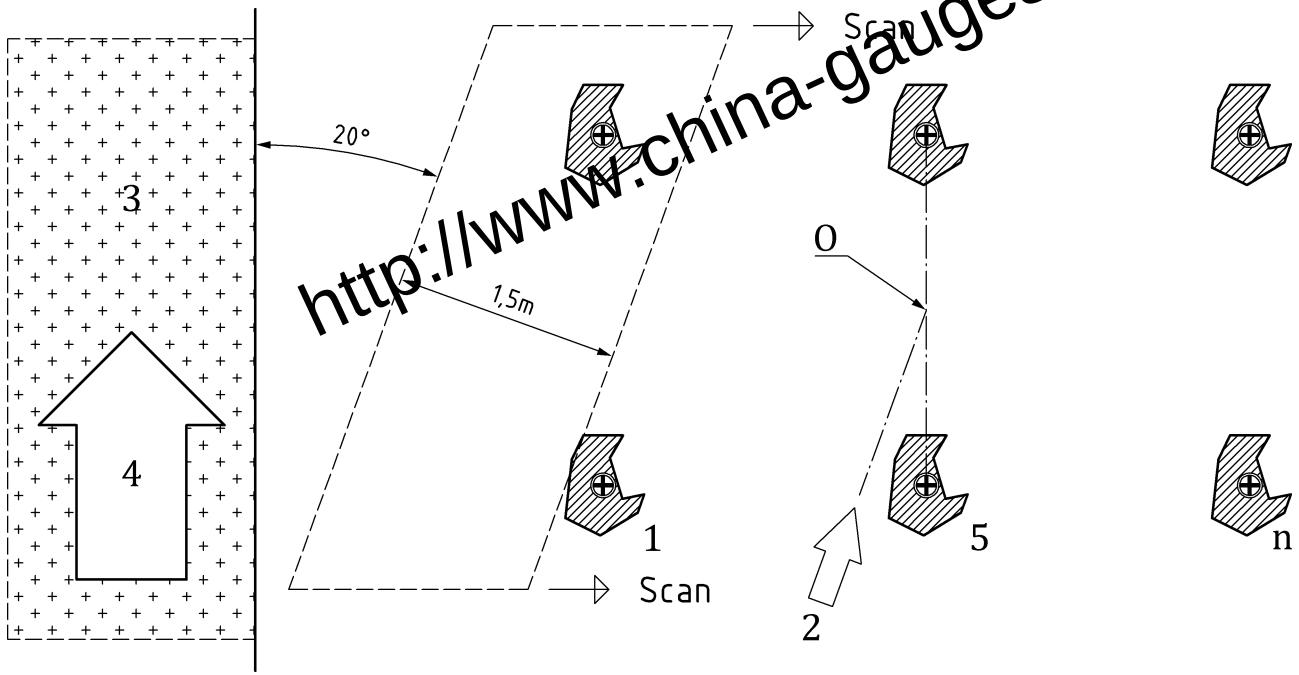
Situation with identical legs and clear opening L ≥ 1,5 m. In this case, the theoretical alignment point (O) shall be defined as for a single leg (see Figure 1), against the second leg.

c) Legs perpendicular to the carriageway with L ≥ 1,5 m



Situation with identical legs and clear opening L < 1,5 m. In this case, the theoretical alignment point (O) shall be defined between the legs.

d) Legs perpendicular to the carriageway with L < 1, 5 m



A more complex situation with a matrix of legs. In this case, the theoretical alignment point (O) shall be determined by the maximum sum of section area's caught within the 1,5 m- scanning window over all sections, as indicated. If the matrix contains more than one maximum sum of section areas, the impact shall be determined through the centre of sections within the second window. This is in line with the idea behind Figure 2c) where the second leg shall be tested.

e) Complex construction with use of scanning window

Key

C circumscribed circle of the single support structure
L clear opening
O the support structure theoretical alignment point (centre of circle C)
1 leg of the support structure closest to the carriageway
2 mandatory impact direction
3 carriageway
4 traffic flow
5 adjacent leg in the multi-legged support structure
n all other legs in the multi-legged structure, can be between 0 and endless

Figure 2 — Theoretical alignment point and impact angle of multi-legged support structures

If in case b) or d) the car goes between 2 supports without activation (see A.2) of any of the supports, an additional test shall be performed following case a) or case c).

For multi-legged support structures consisting of different support legs, at least one of the high speed tests shall be on the strongest leg. If that is not the same leg as the one identified in Figure 2 (Theoretical alignment point and impact angle of multi-legged support structures two additional tests shall be performed on the strongest leg (one high speed test and one low speed test).

7.4 Impact speed

The manufacturer shall select the speed class to which the support structure will be tested from Table 2. The speed class identifies the impact speed in the high speed test.

Table 2 — Support structure speed class

Speed class	Impact speed km/h	Impact speed tolerance km/h
50	50	±3
70	70	±5
100	100	±5

For any speed class, a low speed test shall also be carried out at 35 km/h ± 3 km/h. An additional 50 km/h test can be necessary following the provision given in A.2.

The overall accuracy of the impact speed measurement shall be within ±2 % of the target impact speed.

The test vehicle impact speed shall be measured along the test vehicle approach path, no further than 6 m before the impact point. The average impact speed shall be measured over a length of at least 1 m ahead of the impact.

7.5 Simplified test method for non-harmful support structures

The simplified test method shall be used to test support structures expected to be non-harmful according to Table A.4

The simplified test method shall be carried out as described in this standard with the following exemptions:

Clause/Subclause	
5.3	A driver can be used during the test and no vehicle instrumentation is required.
5.3.2	Shall not apply
7.4	Only the high speed test shall be carried out.
	The impact speed can be measured immediately before the impact.
8.4	The exit speeds can be measured immediately after the impact.
	Measurements of pitch and roll angle are not required.
	All the other requirements shall not apply.
8.2	The high speed film cameras and /or high speed video cameras can be replaced by normal film camera and/or video camera.
8.5	Shall not apply
8.6	The high speed film cameras and /or high speed video cameras can be replaced by normal film camera and/or video camera.
9	A simplified test report is acceptable, with just the relevant parts included.

8 Impact data measurement

8.1 General

The requested data recorded before, during and after the impact test shall be evaluated and reported accordingly. To aid the reporting of the evaluation, classes of convenience are given in Annex A.

8.2 Impact data to be recorded

The following data shall be recorded.

Pre-test data:

— mass and location of the centre of gravity of the test vehicle in the test condition including added ballast (see ISO 10392) (see 5.3);

— vehicle dimensions (see 5.3);

— interior and exterior photographs of the test vehicle;

— photographs of the test item, including photographs of the foundation and other below ground items, before installation;

— test item orientation with respect to the traffic direction (any deviations from the installation manual shall be documented) (see Clause 6 and above);

— calculated or measured object mass of the above ground part of the tested item (see 6 and above);

— marking of the point 6 m above ground level (for test-items > 6m);

— profile of vehicle roof (see 8.4);

— drawings of the test item (see Clause 6 and above);

— detailed description or drawings of the properties below if present in the test-item (if not already included in the test and foundation drawings or instruction):

  — Material/alloy type;

  — resistance to bending without using partial factor;

  — activating system (for example: slip-base, cables, break bolts, holes, etc.);

  — stiffness changes in test-item including Root-section (like for example cable entry holes, door sections, door-reinforcements, holes, steps, changes in diameter or wall thickness, connections);

  — attachments (like ground wings, bottom plates, stabilizing concrete, etc.);

— backfill type according to Table 1;

— possible push/pull test (see 5.2 and Annex C).

Test data:

— test vehicle impact speed and exit speed (see 7.4 and 8.4);

— test vehicle approach angle and impact point (see 7.2 and 7.3);

— test item impact point (see 7.3 and 8.6);

— test vehicle linear accelerations and angular rates (see 5.3.2);

— photographic records from high speed cine film cameras and/or high speed video cameras deployed in such a way as to give a complete record of the test vehicle response and test object behaviour, including deformation and deflections (see 8.6).

Post-test data:

— damage to the test item and test vehicle (see 8.3, 8.4 and 8.6);

— still photographs of the tested support structure, to aid reporting (see 8.3);

— location and mass of the test item and any significant debris (with a mass greater than 2,0 kg) according to 8.3, *Test item behaviour*;

— interior and exterior photographs of the test vehicle (see 8.4);

— collapse mode (see 8.3);

— movement of the test item at ground level (see 8.3);

— maximum displacement in the lower 2,0 m of the structure;

— roof or windshield penetration (see 8.3.3);

— vehicle behaviour (see 8.4);

— roof deformation (see 8.4).

8.3 Test item behaviour

8.3.1 General

The test item's general behaviour shall be described in the test report, with additional photographs to aid understanding. The information included shall be sufficient to determine the test item's energy absorption category and mode of collapse.

8.3.2 Collapse mode

The test item's collapse mode shall be determined as follows:

a) Separation collapse mode (SE): in this mode, the structure detaches from the ground or its foundation.

b) No separation collapse mode (NS): in this mode the support does not detach from ground or its foundation.

8.3.3 Detached elements

The final position and mass of any detached elements, with a mass greater than 2,0 kg, of the item under test shall be recorded in the test report with their weight and position. The position shall be given as a distance from the support structure's theoretical alignment point (O) and the direction related to the direction of impact.

8.3.4 Other aspects of test item behaviour

Other aspects of test item behaviour should be reported such as speed and mass. An example for determining the speed and mass of the falling support is given in Annex I.

8.4 Vehicle behaviour

The behaviour and trajectory of the vehicle shall be reported.

The exit speed of the test vehicle shall be measured perpendicular to the extended approach path at a point 12 m beyond the impact point. For a vehicle yawing, pitching or rolling, the exit speed is the speed determined by the movement of the centre of gravity of the vehicle. The measurement accuracy of the test vehicle's exit speed shall be within ±5 % of the target impact speed.

The profile of the shape of the original roof line of the test vehicle shall be made along the centre line of the vehicle prior to the impact test, using a straightedge with the lower edge shaped to the roof profile. The position of the top of the straightedge shall be recorded as a vertical distance above a fixed datum point on the lower edge of the side windows. After the impact, the roof profile shall be applied again in the same position relative to the datum, and the vertical deformation measured. The maximum vertical roof deformation shall be measured with an accuracy of ±10 mm.

Deformation shall be measured at three positions:

a) behind the windscreen;

b) in line with the rear edge of the front doors;

c) in front of the rear window.

Results shall be presented in the test report, 6 c) "Additional observations".

8.5 Impact severity indexes

Impact severity indexes shall be defined as in EN 1317-1:2010. The evaluation of vehicle occupant impact severity assessment indices ASI and THIV shall be carried for each test.

As a function of the value of the ASI and THIV indices, different occupant safety classes are defined in Table A.4.

The maximum acceptable values for the pass and fail criteria of the tests for different energy absorption categories are specified in Table A.3.

8.6 Photographic coverage

Photographic coverage shall include both the still frame photographs and the moving image videos taken before, during and after the impact test. These shall be sufficient to clearly describe the behaviour of the support structure and its installation during and after the impact, and the test vehicle's motion and trajectory before, during and after impact.

Still photographs shall be taken before and after the impact of the test vehicle with the support structure. Items not visible during the actual test, like foundations, shall be photographed before and after test.

The test shall be photographically covered by at least two high speed video cameras with a minimum speed of 200 frames per second. These cameras shall be perpendicular to the approach path of the impacting vehicle and shall together continuously cover the vehicle trajectory 6 m before, and 12 m after, the impact point. One perpendicular camera shall cover the complete support structure before and during the initial impact process.

Reference marks corresponding to the specific locations for determining the impact and exit speeds are recommended. Additional high speed cameras are recommended, particularly where the test item has a specific detachment mechanism. Overhead camera is not mandatory.

A time reference shall be incorporated for cameras which are used for determining speed. Marker points and a known scale shall be used, and the distance to the camera shall be recorded to aid video analysis.

A zero time impact marker, such as a photograph flash, is recommended for the synchronisation of images.

Normal speed cameras shall be operated at a minimum of 24 frames per second.

It is encouraged to use additional videos and still photographs to view and demonstrate any anomalies of the test that is reported or commented in other parts of this document.

NOTE A panned camera, often used in other impact test procedures, is not mandatory. The panned camera will never stay perpendicular in respect of impacting vehicle, and can thus not be used for determining any objective values. It is just an optional camera for the convenience of showing the impact sequence, if used.

9 Test report

9.1 General

For each test performed, one test report shall be provided. For example for a defined speed class, one test report shall be produced for the low speed test, and one test report shall be produced for the high speed test.

NOTE The test report for each impact speed can be in accordance with the template given in Annex J.

All collected data mentioned in 8 shall be reported.

The test item's general behaviour shall be described in the test report, with additional photographs used to aid the understanding. The information included shall be sufficient to enable the determination of the test item's energy absorbing category and mode of collapse.

9.2 Test data decimal rounding

Data related to specific requirements within this standard shall be reported in accordance with the requirements of the corresponding values in the standard. The following decimals shall be rounded off; decimals less than 5 shall be rounded downwards, and decimals 5 or greater shall be rounded upwards.

ASI shall be reported with one decimal.

EXAMPLE 1 A calculated ASI value of 1,049 is rounded downwards to 1,0 and reported in that format. A calculated ASI value of 1,05 is reported as 1,1.

THIV shall be reported without decimals.

EXAMPLE 2 A calculated THIV value of 27,49 km/h is to be reported as 27 km/h, and a determined THIV value 27,50 km/h is to be reported as 28 km/h

Angles shall be reported in degrees with one decimal and rounded off in a similar way. Mass shall be reported in kilograms, objects with mass smaller than 100 kg with one decimal, and rounded off in a similar way.

Speed shall be reported in km/h, with the accuracy of one decimal. The second decimal shall be rounded off as described above. This procedure shall be applied for both impact speed and exit speed, despite the difference in accuracy requirements.

Distances and measurements shall be reported in metres, with one decimal, except for distances within or on the test vehicle, where the position of the accelerometers and the centre of gravity shall be reported in metres with two decimals.

On manufacturer's drawings, the above decimal and precision requirements for distances or support structure dimensions shall not apply.

Annex A
(normative)

Data evaluation

A.1 Performance classes

The performance class of each tested support structure shall be expressed as a combination of speed class, energy absorption category, occupant safety class, backfill type, collapse mode, direction class given, and risk of roof indentation given by the parameters shown in Table A.1. The performance class shall be expressed in the following format: speed class-energy absorption category-occupant safety class-backfill type-collapse mode-direction class-risk of roof indentation, e.g. 100-HE-A-S-SE-MD-1, 70-LE-B-R-SE-SD-0 and 100-HE-C-X-NS-MD-1.

Table A.1 — Passive safety performance types

	Alternatives	Clause
Speed class	50, 70, 100	A.2
Energy absorption category	HE, LE or NE	A.3
Occupant safety class	A, B, C, D, E	A.4
Backfill type	S, X, R	5.2.1, Table 1
Collapse mode	SE, NS	A.5
Direction class	SD, BD, MD	A.6
Risk of roof indentation	0 or 1	A.7

The support structure shall successfully pass the test(s) described in this standard, and shall meet the general requirements given in A.2 to A.7.

The test vehicle shall not roll over (including rolling onto its side) within a 12 m radius of the impact point.

Some standard metal tubes are deemed to comply with the requirements of this standard, and their performances classes are given in Annex K.

For products tested in accordance with previous versions of this standard, Annex L provides guidelines.

Class 0 has no performance requirements and no test is required.

A.2 Evaluation of speed class

Support structures shall be classified according to speed class. Three speed classes are defined according to the selected impact speed: 100 km/h, 70 km/h and 50 km/h.

In order to receive a speed class the test item shall be tested at high speed (the class speed) and low speed (35 km/h test). If the support structure is not activated in the low speed test, an additional test at 50 km/h shall be performed in speed classes 100 km/h and 70 km/h.

Activation means that one point of the support, situated in the lower 2,0 m of the support structure, has a permanent displacement of more than 0,5 m. Rotation of the bracket or sign is not included in this movement.

If the test item is shorter than 2,0 m, displacement at the top of the support structure shall be considered.

If the test item is entirely detached from the ground, activation has been achieved.

It is possible to declare intermediate speed classes, depending on the observed collapse modes in test at high and low speed as specified in Table A.2. If an intermediate speed class is declared, all further criteria of the performance class (occupant safety class, energy absorption categories,...) from the tested speed class are also valid for the intermediate speed class.

All tests mentioned in Table A.2 are to be within the ASI and THIV values for occupant safety.

Table A.2 — Declaration of speed classes

	Impact speed used for a successful test km/h				Speed class to declare
	35	50	70	100	
Observed collapse mode	NS	NS SE			Declare speed class 50
	NS		NS		Declare speed classes 50 and 70
	NS		SE		Declare speed class 70
	NS			NS	Declare speed classes 50, 70 and 100
	NS			SE	Declare speed class 100
	SE	SE			Declare speed class 50
	SE		SE		Declare speed classes 50 and 70
	SE			SE	Declare speed classes 50, 70 and 100
	NS	NS		SE	Declare speed classes 50 and 100
	NS	SE		SE	Declare speed classes 50, 70 and 100

A.3 Evaluation of energy absorption categories

Support structures shall be classified according to the energy absorption category for the selected speed class related to the exit speed in Table A.3. The energy absorption categories are High Energy absorption (HE), Low Energy absorption (LE) and Non-Energy absorption (NE) support structures.

Table A.3 — Energy absorption categories

Speed class	50	70	100
Energy absorption category	Vehicle exit speed, v_e km/h		
HE	$v_e = 0$	$0 \le v_e \le 5$	$0 \le v_e \le 50$
LE	$0 < v_e \le 5$	$5 < v_e \le 30$	$50 < v_e \le 70$
NE	$5 < v_e \le 50$	$30 < v_e \le 70$	$70 < v_e \le 100$

If the actual impact speed is not the nominal speed, but is still within permitted tolerances given in 7.4, the measured exit speed used for the energy absorption categorization according to Table A.3 shall be adjusted to the value of adjusted exit speed by using the Formula (A.1).

$$V_{Adjusted\ Exit\ Speed} = \sqrt{V^2_{Nominal\ Impact\ Speed} - V^2_{Measured\ Impact\ Speed} + V^2_{Measured\ Exit\ Speed}} \quad \text{(A.1)}$$

For a combination of a high impact speed and low exit speed, the formula returns mathematically invalid results. When the sum under the square root is a negative number, the measured exit speed is of such low value that the adjusted exit speed goes below zero. For such cases, theoretical adjustments are not appropriate and the exit speed shall be taken as 0 km/h.

A.4 Evaluation of occupant safety class

The test item, detached elements, fragments or other debris from the test item shall not penetrate the occupant compartment. The windscreen may be fractured and the roof or other parts may be dented, but shall not be penetrated. If this requirement is not fulfilled, no occupant safety class can be declared and the test fails.

Occupant safety class shall be determined in accordance with Table A.4 on the basis of measured ASI and THIV. If class A is declared on the basis of measured exit speed it is not necessary to measure ASI and THIV values.

The ASI and THIV values of the mandatory high speed and low speed (35 km/h) tests and (where conducted) of the additional 50 km/h test, shall be taken into consideration.

Table A.4 — Impact severity indexes

Energy absorption categories	**Occupant safety class**	**Speeds**			
		Low speed test 35 km/h		**High speed test** 50 km/h, 70 km/h, 100 km/h	
		Maximum values		**Maximum values**	
		ASI	THIV km/h	ASI	THIV km/h
HE / LE / NE	E	1	27	1,4	44
HE / LE / NE	D	1	27	1,2	33
HE / LE / NE	C	1	27	1	27
HE / LE / NE	B	0,6	11	0,6	11
NE	A	No test required	No test required	No ASI and THIV measurements	

Requirements for class A are:

— car shall remain upright, and

— the difference between the measured impact speed, and

— exit speed shall not be greater than 3 km/h.

A simplified impact test presented in 7.5 may be used as an alternative test method.

A.5 Evaluation of collapse mode behaviour

Support structures shall be classified according to their collapse mode. The declared collapse mode shall be determined by the support structure behaviour in the high speed test (see 8.3.2). The following letters identify the collapse modes from which the performance of the support structure shall be declared:

— SE, Separation mode;

— NS, No Separation collapse mode.

A.6 Evaluation of the direction class

Support structures shall also be classified according to their direction class. Three direction classes are defined in Table A.5.

Table A.5 — Direction classes requirements

Direction class	Requirements
SD	Mandatory 20° impact angle test according to 7.1, as indicated by arrow 2 in Figure 1
BD	Mandatory 20° impact angle test according to 7.1, as indicated by arrow 2 in Figure 1, and one symmetry plane is perpendicular to the carriageway[a] or Mandatory 20° impact angle test according to 7.1, as indicated by arrow 2 in Figure 1 and an additional 160° impact angle as indicated by arrow 6 in Figure 1 is needed[b]
MD	Mandatory 20° impact angle test according to 7.1, as indicated by arrow 2 in Figure 1 and if more than 2 symmetries are identified[a].

[a] Any deviation from symmetry of the support structure should be evaluated.

[b] When the additional 160 ° impact angle tests are required, the high and low speed tests shall be conducted with that additional impact angle. If this test results in another performance class, the performance class shall be declared SD.

EXAMPLE 1 One or more compartment doors positioned higher than 0,5 m above the ground should not be considered as a lack of symmetry, and could be classified as Bi- or Multi-directional without any additional testing.

EXAMPLE 2 A sign fixed on one side of the support structure should not be considered as a lack of symmetry (only the support structure should be considered in the evaluation) and could be classified as Bi- or Multi-directional without any other test.

A.7 Evaluation of risk of roof indentation

The risk of roof indentation shall be evaluated according to the following test methods:

a) evaluation of roof deformation measurements in individual test according to 8.4;

b) calculation of risk in accordance with Annex I, determining the speed and mass of the falling support.

Support structures shall then be classified for the risk of roof indentation in accordance to method “a”. The highest measured value within the declared family shall be used for the classification. The following classes identify the risk of roof indentation and shall be used to declare the performance of the support structure:

Class 0: roof deformation < 102 mm

Class 1: roof deformation ≥ 102 mm

A.8 Additional information

The information on test conditions shall be available to form the installation instructions.

Additional information which shall be included includes:

— description of the foundation or underground part of the support;

— tested item configuration;

— for a sign support, the height of the sign support, the sign mass and size;

— for a lighting column, the height, the bracket length, mass of the luminaire.

A.9 Specifying passive safety

If not all properties are of interest for the specifier they can put NR (no requirement) for that property.

EXAMPLE 100-HE-C-NR means the same as the old 100,HE,3 and 100-HE-NR-S-NR-MD-NR means that occupant safety, collapse mode and risk of roof indentation are allowed to be anything.

Annex B
(normative)

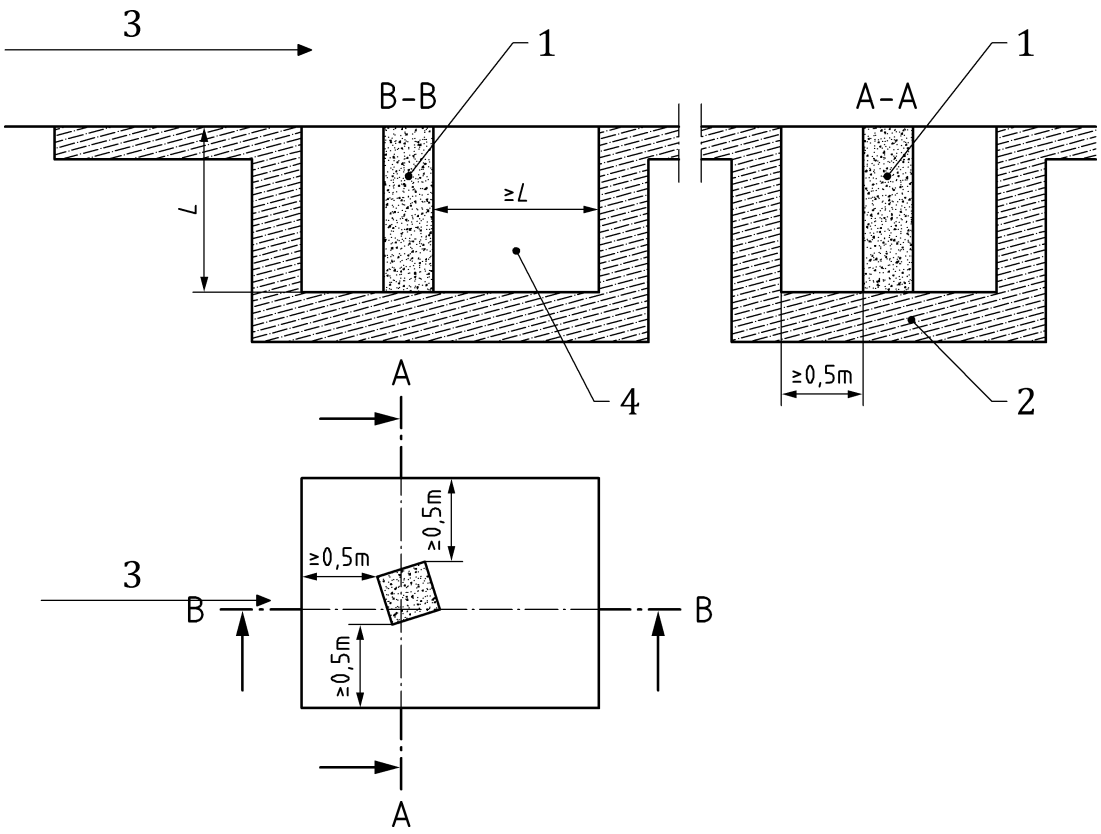
Backfill requirements

B.1 Backfill dimension and support structure positioning for S and X backfill types

The backfill dimension shall not be smaller than those indicated in Figure B.1 where the value of L is equal to the foundation depth of the test item. If a separate foundation is not used, the underground part of the support structure shall be considered to be the foundation.

The distances to be respected when positioning the support structure to be tested from the backfill's border shall not be smaller than those indicated in Figure B.1.

At the bottom depth (L), a minimum free distance of 0,5 m from any foundation's edge shall be created in any direction.



Key

1 underground part of the support structure

2 backfill's border

3 impact direction

4 backfill area

Figure B.1 — Backfill minimum dimensions for S and X backfill type

B.2 Compaction of the backfill

The backfill shall be filled as follow:

a) aggregates shall be dropped and arranged in order to make a layer with a maximum thickness of 0,3 m;

b) each layer shall then be compacted using a compactor, moving in a concentric circle starting from the outside and moving to the inside, and then back to the outside;

c) a new layer can then be created and the operation repeated until the desired level is reached.

The maximum dry density of the backfill material should be determined before using it at the test site, and the dry density should be determined during compaction work in order to facilitate control of the compaction.

The compaction method used shall be recorded.

B.3 Standard aggregates, type S

Standard aggregates shall consist of hard and durable particles of stone or gravel. No binder, such as cement, shall be used. The grain size distribution shall fulfil the requirements of the following classes defined in the EN 13285. Only the overall grading range shall be applied. For convenience, the distribution is presented in Table B.1.

— Mixture designation = 0/31,5

— Grading category = GO

— Maximum fines content category = UF7

— Minimum fines content category = LF2

— Oversize category = OC85

Table B.1 — Standard aggregates requirements

Sieve	**Mass percentage passing: EN 13285, 0/31,5** G_O (Overall grading range)	
mm	min	max
63	100	100
31,5	85 (OC_{85})	99 (OC_{85})
16	50	78
8	31	60
4	18	46
2	10	35
1	6	26
0,5	0	20

B.4 Rigid, type R

For some tests a rigid installation as described in 5.2.3 may be requested.

The installation is considered as rigid if the displacement measured at ground level after the impact test is not more than 0,01 m.

Annex C
(informative)

Push/pull test

The result of the push/pull test is valid for not more than 6 months from the date of the first push/pull tests or 20 subsequent tests, whichever is the soonest, and can be used for a backfill with aggregates with equal grading delivered at the same time as the tested one. Any change of aggregate grading and/or compaction procedure shall require a new push/pull test.

The push/pull test is carried out using an HEB 120 S355 beam (with a minimum length of 2,0 m). The beam shall be placed vertically in the backfill volume (see B.1) with one of the extremities 1 m (±0,025 m) above the level of the vehicle approach path level. When the compaction procedure is completed (see B.2) the test load (horizontal force parallel to the pavement) shall be statically applied to the beam (between 0,6 m and 1 m above ground level) in the direction of the major inertia axis of the beam and perpendicular to the traffic face.

The push/pull test ends when one of the following conditions is reached:

a) the beam deflects 0,25 m at 0,5 m height (measuring position);

b) a force equal to a momentum of 50 kNm at the ground level is achieved.

The displacement of the measuring point placed 0,5 m above ground level shall be recorded (deflection tolerance is ±5 mm). The translated force history to this point shall be plotted (the minimum applied load increment shall be 0,1 kN) against the displacement. The curve and the maximum value shall be included in the test report.

Annex D
(normative)

Vehicle data

The following vehicle dimensions shall be reported:

— width (to be measured at the maximum body width, excluding rear view mirrors);

— length (excluding tow-bar hook);

— height;

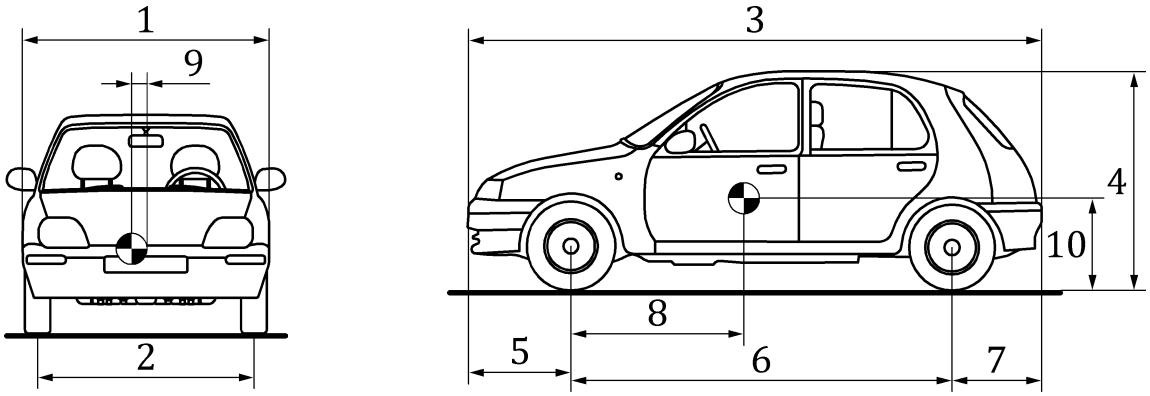
— wheel track: track width for both front and rear axles (to be measured at the centreline of the wheels);

— wheel base;

— frontal overhang;

— rear overhang (excluding tow-bar hook).

Figure D.1 illustrates these dimensions.



Key

1	width	6	wheel base
2	track width (frontal)	7	rear overhang
3	length	8	centre of mass: Longitudinal distance from front axle
4	height	9	centre of mass: Lateral distance from vehicle centre line
5	frontal overhang	10	centre of mass: Height above ground

Figure D.1 — Vehicle dimensions

The following items shall also be reported:

— ballast, mass and position;

NOTE Photograph(s) can be used to illustrate the position of ballast.

— total mass;

— centre of gravity, CGx, CGy and CGz as required by 5.3;

— vehicle kerb mass.

Annex E
(normative)

Vehicle calibration

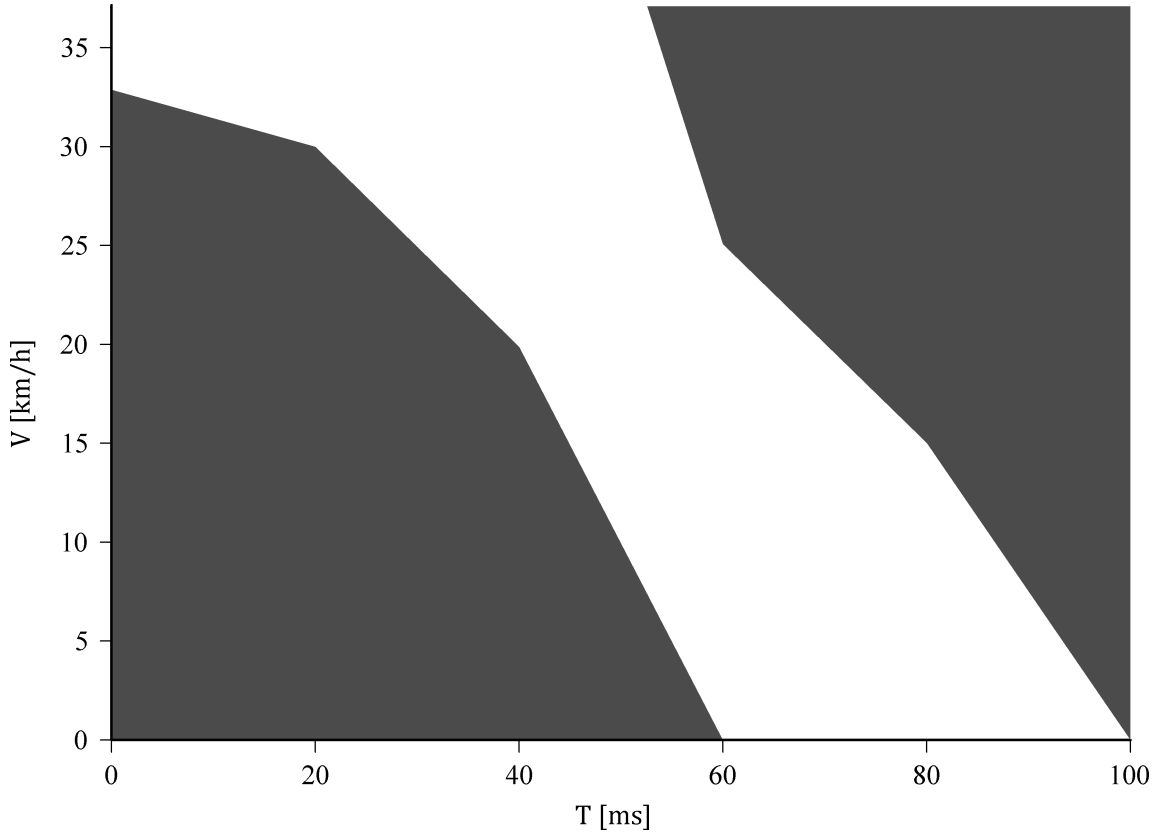
In order to ensure that the front deformation characteristics of the test vehicle are within a specified range, a calibration test shall be conducted. This calibration test shall be considered valid for cars of the same model and type produced within ±3 years from the production year of the tested vehicle.

A calibration test shall be carried out on a sample test vehicle, to confirm that the deformation characteristics of the vehicle front lie within the unshaded area of the time-velocity curve in Figure E.1 and are in accordance with Table E.1.

The calibration test shall be performed with a test vehicle impacting a vertical, rigid cylinder head-on with the vehicle centre-line aligned with the centre-line of the cylinder.

The cylinder shall have a diameter of 290 mm ± 20 mm and a height greater than the contact surface of the deformed car front, typically greater than 1 m.

At the moment of impact the lateral offset of the two centre-lines shall not exceed 100 mm. The test shall be conducted at (35 ± 2) km/h, and the rigid cylinder shall not displace statically more than 10 mm, measured at the contact surface.



Key

V velocity

T time

Figure E.1 — Vehicle calibration diagram

Table E.1 — Time/velocity requirements

Time ms	**Minimum velocity** km/h	**Maximum velocity** km/h
0	33	37
20	30	37
40	20	37
55	5	37
60	0	25
80	0	15
100	0	0

If the actual impact velocity at the calibration test is within the tolerance of ±2 km/h of the target speed, the input velocity at time 0 shall be linearly adjusted to 35 km/h, before the integration of the velocity curve is performed.

The acceleration of the car, used for this integration, shall be measured or transposed at the centre of gravity, in accordance with ISO 6487, with the channel frequency class (CFC) equal to 180 Hz.

It is permitted to shift the velocity/time curve in time to obtain the best fit.

Annex F
(informative)

Bogie vehicle

A bogie vehicle is a generic trolley, a surrogate for a production model vehicle with specified shape and frame and specified simplified kinematic properties, to replace a real car in crash testing. The deformation capabilities shall be known, validated and repeatable to be used for crash testing.

For the future development of this document it is possible that a bogie vehicle could be used as a substitute for the passenger car. The following conditions may be used as a guideline for developing and validating such a vehicle:

— the total bogie vehicle gross static mass should be 900 kg ± 40 kg and the other dimensions shall be in accordance with EN 1317-1:2010;

— the shape of the bogie vehicle should simulate the shape of a typical passenger car in this mass range especially in regard to the shape of the vehicle front and the roof and the height of the impact point;

— the requirements of the calibration test (Annex E) shall be met;

— the vehicle front, the roof and the windscreen should be adequately simulated.

Annex G
(normative)

Product families

G.1 General

When a product is manufactured in different sizes, the sizes may be grouped into product families where only some of the sizes shall be tested and the performances of other sizes can be declared on the basis of those results.

Any other change different from the one listed in Annex G shall be assessed as a changed version according to Annex H.

G.2 Product families

G.2.1 General

A parent size shall be chosen for each product family.

Within a product family all members are related to the parent member in the following way:

a) an object length lower or equal to 1,1 times the object length of the parent and higher than 2,0 m in case the penetration risk is not evaluated;

b) an object mass lower or equal to 1,1 times the object mass of the parent.

c) an equal shape of the cross section (i.e. circular, octagonal, etc.);

d) the same material/alloy properties;

e) the same design of fixing or anchoring to ground;

f) the same presence of connection or stiffness changes within the deformed part due to the initial impact. Any connection or stiffness change shall be the same or scaled down related to the parent member (i.e. door-section, reinforcements, weakened areas, weldings, bolted connections, etc.);

g) the same, smaller or no attachments above 2,0 kg in the first 2,0 m above ground level. The strength of the connections of these attachments will be equal or higher than the connection of the attachment that was present during the test;

h) the same or lower bending capacity and the same or lower shear capacity.

Evaluation of the performance within a product family is specified in G.3. If there are conflicting rules in G.2 and G.3 for specific cases then rules given in G.2 shall be considered stronger.

G.2.2 Lighting column

A successful test result of a lighting column shall also be valid for the same support structure:

— with a shorter single bracket, no greater horizontal length, and equal or lower mass;

— with a double bracket, and no greater horizontal length;

— with a post top luminaire, and no bracket.

G.2.3 Sign support

A successful test result of a sign support shall also be valid for the same support:

— with a smaller area of sign plate and no greater overall mass;

— with an asymmetric mounting sign plate and no greater overall mass or area.

G.2.4 Signal support

A successful test result of a signal support shall also be valid for the same support;

— with a lighter signal head;

— with an asymmetric mounting signal.

G.2.5 Multi-legged supports

A successful test result for a multi-legged support structure shall also be valid for multi-legged supports assembled with a different number of legs than the tested configuration. In this case the item will inherit the parent evaluation. The area and mass of the sign per leg shall not be greater than one of the tested item. If the clear opening of the tested item was larger than 1,50 m at 20 ° then the result is only valid for multi-legged supports with clear opening larger than 1,50 m.

The test result of multi-legged supports shall not be used to determine the performance classes of a single legged supports.

G.3 Evaluation of the performance within a product family

The parent member shall be tested at the speed class selected and at low speed to be able to determine a product family.

Depending on the results of the tests of the parent member, further tests shall be carried out as follows:

a) If the tested parent member complies with the NE category, no further tests are required. A product family with performance class as the tested parent member can be declared for the parent member and all smaller family members for which technical data has been provided.

b) If the tested parent member complies with the HE or LE category, further testing shall be carried out on the smallest member of the proposed product family at the high speed of the selected speed class.

   If the smallest member when tested fulfils a better or equal occupant safety class, a product family may be declared for all intermediate members of the proposed product family for which the technical data has been provided. All members of the product family shall be declared to have the same performance class as the parent member, except that for the smallest tested member the achieved better occupant safety class in the test of that member can be declared.

If the smallest member, tested at the high speed test of the selected speed class, complies with an inferior occupant safety class and/or a different energy absorption category as the parent member, the smallest member and the parent member cannot be considered as being in one product family. A product family shall not be declared.

The smallest member above means the member with the smallest height and the smallest bending resistance.

Annex H
(normative)

Changed versions

H.1 General

Any change which cannot be covered by Annex G shall be evaluated in accordance with H.2.

This Annex H may be used for the evaluation of different foundation or using different clamps in multi-legged signs than in the tested version.

All changes shall be assessed against the originally tested product.

H.2 Evaluation based on a risk analysis

H.2.1 Risk evaluation

Any proposed change shall be submitted to risk analysis.

A table including all possible risks, the corresponding evaluation method(s) and the criteria for the assessments shall be created. The table shall be used together with the test/calculation results to investigate the proposed change(s).

Once the change has been evaluated, and if the risk is assessed, the changed product inherits the classification of the original product.

H.2.2 Choice of the method

The evaluation methods are classified in accordance with Table H.1 and are available to evaluate and document the risks related to changes.

Table H.1 — Categories of evaluation methods

Category	Description
A	Engineering judgement
B1	Calculation (not including virtual testing)
B2	Static or dynamic testing (not including full scale vehicle impacts tests), possibly in combination with category A and B1
B3	Virtual vehicle impact testing, performed in accordance with Annex M, *Virtual testing – validation procedure* possibly in combination with category A, B1 or B2
C1	At least one full scale test, possibly in combination with category A, B1, B2 or B3
C2	Full scale tests

A report shall be written where the results of the risk analysis are presented and the choice of the evaluation method is justified. It shall also contain the basic results of the tests of the parent version and the results of the evaluation of the changed versions. The parent versions and the changed versions shall be described in detail.

Annex I
(normative)

Determining the speed and mass of the falling support

One high speed camera positioned perpendicularly horizontal to the support structure, at a height of 2,0 m shall be used for recording the movement of a specific point on the support structure.

The speed of the test item shall be determined by video/film tracking of a single point on the support structure during the test. This single point shall be located and marked 6 m (±0,03 m) above ground. When this point, during the vehicle impact and support structure collapse, passes through a horizontal plane situated 2,0 m above ground, the speed of the single point should be determined. For supports shorter than 6 m, the very top of the support structure shall define the point to be speed determined. It shall be clearly noted in the report that the support, and subsequently the dedicated point, is situated lower than 6 m, and the actual height of the support shall be recorded.

The vertical component of the point falling speed and mass of the test item after the vehicle impact shall be measured and recorded. This requirement shall not apply to items that stay upright during and after the test.

The object mass of the support structure above ground prior the test shall be calculated.

Annex J
(informative)

Test report

The test report may, where applicable, include the information outlined in Table J.1 preferably in the order given.

A summary sheet is recommended.

NOTE The contents of the test report is based upon the criteria of EN ISO/IEC 17025.

Drawings shall be obtained from the client. The test item shall be described in detail, together with material specifications, and installation and maintenance instructions. Also refer to the test item documentation requirements in 6.1, general test item documentation.

Additional text and photographs are recommended to describe the general result of the test and to aid the understanding of the final position of the tested support structure, trajectory and position of the car and position of major debris.

Table J.1 — Test report

Information		
1) Testing laboratory	a) Name:	
	b) Address:	
	c) Telephone number:	
	d) Facsimile number:	
	e) E-mail address:	
	f) Test site location:	
	g) Accreditation number when applicable:	
2) Report number		
3) Client	a) Name:	
	b) Address:	
	c) Telephone number:	
	d) Facsimile number:	
	e) E-mail address:	
4) Test item	a) Received date:	
	b) Tested date:	
	c) Name of test item:	
	d) Drawing, descriptions and installation instructions, enclosure No:	
	e) Foundation drawing	
5) Test procedure	a) Target data	— target impact speed, in km/h: — target impact angle, in degrees: target test item mass, in kg:

Information		
	b) Test installation	— detailed description of installation tested including its orientation: — backfill properties: — test site drawing, enclosure No: — photographs, enclosure No:
	c) Test vehicle	— model: — model year: — vehicle identification number, VIN: — test inertial mass (including ballast), in kg: — ballast, position and mass: — ATD, position, type and mass, seat belt type: — total mass (initial test mass and ATD), in kg: — dimensions of vehicle, enclosure N° (in accordance with Annex D): — position of centre of gravity: — photographs, enclosure No: NOTE In addition it is recommended to include vehicle type kerb mass in the report.
	d) Calibration test vehicle	— model: — model year: — calibration test number and test date: — calibration velocity-time curve, enclosure No:

Information			
6) Results	a) General		— test No: — date: — weather conditions including air and ground temperature at test: — impact angle, in degrees: — impact speed, in km/h: — exit speed, in km/h: — general description of test sequence: — photographs, enclosure No: location and mass of the test item and any significant debris (with a mass greater than 2,0 kg) according to 8.3; — videos

Information			
		b) General performance requirements	— Collapse mode according to A.2. — Speed class evaluation according to A.3. — Evaluation of energy absorption according to A.4. — Evaluation of risks in accordance with A.9. — Evaluation of vehicle behaviour in accordance with A.6. — Acceleration Severity Index, ASI: — Theoretical Head Impact Velocity, THIV, in km/h: — Roof deformation in accordance with A.7 and 8.4.
		c) Additional requirements for particular items	— Additional observations
		d) Additional restrictions regarding the installation:	
		e) Acceleration graphs, enclosures No:	
7)	List of enclosures	Enclosure 1 ...name.....(x pages) Enclosure 2 ...name.....(y pages)	
8)	General statements	The test results in this report relate only to the items as tested. Other impact conditions may give different results. Restrictions to the installation may be given in 6 e) of this report. This report may not be reproduced other than in full, except with the prior written permission of the issuing laboratory.	

Information		
9) Approval of report	a) Date:	
	b) Names:	
	c) Signatures:	
	d) Job titles:	

Annex K
(normative)

Deemed to comply

Standard metal tubes are often used as supports for traffic signs. Those particular types listed in Table K.1 can be regarded as complying with the classes of this standard identified in the Annex A.

Table K.1 — Single legged post supports

Description	**Material and grade**	**Tested height** (m) **Height x width of sign** (m) **Mounting height to underside** (m)	**Speed class**	**Energy absorption category**	**Occupant safety class**	**Backfill**	**Collapse Mode**	**Direction**
Circular hollow section steel posts of equal or less than 89 mm nominal diameter and 3,2 mm nominal wall thickness[a,b,c,d,e]	Steel S355J2H	3,6 1,5 × 1,15 2,1	100	NE	C	S, X and R	SE	MD

[a] Full details of the tests and conclusions are available in the report PR/SE/726/03: Passive safety tests on steel circular hollow section sign posts – TRL UK.

[b] Results are valid also for supports made of circular hollow steel or aluminium sections of the same or smaller diameter and which have a lower bending and shear capacity than tested (see Annex G).

[c] If two posts, perpendicular to the carriageway, are used for one sign:
— Where post clear opening L are less than 1,5 m, post dimensions shall not exceed 76 mm diameter and 3,2 mm wall thickness;
— Where post clear opening L are 1,5 m or greater, post dimensions shall not exceed 89 mm diameter and 3,2 mm wall thickness.
— (for definition of the clear opening L see 7.3.3)

[d] The results are not applicable to braced structures.

[e] All backfill types are deemed to comply, because the crash test was conducted in Rigid type R and any alternative will always be equal or less rigid.

Annex L
(normative)

Use of test results performed in accordance with previous versions of EN 12767

Table L.1 determines how tests performed in accordance with EN 12767:2007 and EN 12767:2000 shall be used to assess products in accordance with this standard. Tests performed before the year 2000 may be used, if the test is in accordance with EN 12767:2000.

Table L.1 — Use of old test results

Classification or level in this standard	Test in accordance with EN 12767:2007	Test in accordance with EN 12767:2000
Low speed	The low speed test specified in EN 12767:2007 is valid, but the acceptance criteria of this standard shall be used.	
Declared speed class	The high speed test specified in EN 12767:2007 is valid, but the speed class shall be declared in accordance with this standard (especially when other speed classes than test speed are declared).	
Declared energy absorption category	The high speed test specified in EN 12767:2007 is valid, but the ranges of versions shall be evaluated in accordance with this standard.	The high speed test specified in EN 12767:2000 is valid, but the exit speed shall be adjusted with the impact speed and the ranges of versions shall be evaluated in accordance with this standard.
Declared occupant safety class	The low and high speed tests specified in EN 12767:2007 are valid, but the class shall be determined and the product families shall be evaluated in accordance with this standard. ASI values of NE supports not calculated in accordance with EN 1317-1:2010 shall be either recalculated or increased with 0,1.	
Backfill type	Backfill type shall be declared but there is no need to declare the result of the pull/push test. Backfill type S shall be as defined in EN 12767:2007.	
Collapse mode	The collapse mode shall be evaluated on the basis of the videos in accordance with this standard.	
Detached elements with a mass greater than 2,0 kg	Report the location and mass of significant debris as specified in EN 12767:2007 or EN 12767:2000.	
Direction class	The direction class shall be evaluated on the basis of drawings and test results in accordance with this standard.	

Classification or level in this standard	Test in accordance with EN 12767:2007	Test in accordance with EN 12767:2000
Assessment of ranges of versions and changed versions	Assessment shall be based on this standard.	
Impact point in a multi-legged sign support	In two-legged systems either the rules of EN 12767:2007 or this standard shall be followed.	
Evaluation of risk of roof indentation	Evaluate the data if available according to A.7.	

Table L.2 gives equivalences between the old and new classes of occupant safety class.

Table L.2 — Equivalences between old and new classes

Energy class	New class	Old class	Low speed		High speed	
			Maximum value		Maximum value	
			ASI	THIV	ASI	THIV
HE / LE	C	3	1	27	1	27
	D	2	1	27	1,2	33
	E	1	1	27	1,4	44
NE	A	4	-	-	-	-
	B	3	0,6	11	0,6	11
	C	2	1	27	1	27
	D	1	1	27	1,2	33
	E	-	1	27	1,4	44

For the other properties that were not covered in the old version of the document, the results of the old test should be re-evaluated (Table L.1).

Annex M
(normative)

Virtual testing[1]

M.1 General

This annex gives provisions for:

— the use, validation, verification of virtual testing, defining procedures and acceptance criteria (see M.2);

— the requirements for the person / group performing virtual testing activities (see M.3);

— the template for report (see M.4).

Most of these provisions are described in EN 16303.

M.2 Validation procedure

M.2.1 General considerations on the modelling techniques for the vehicle

Particular attention shall be paid on the modelling of vehicle kinematics and of the components that enable it: front and rear suspensions, wheels, steering system, etc. The geometry of the vehicle shall be reproduced correctly to simulate the interaction with the support structure. The model shall include the main parts of the vehicle while other non-structural elements such as internal parts can be modelled only with regard to their inertial properties in order to reduce the computational cost.

Vehicle model shall conform to 5.3 including the calibration test requirements described in Annex E.

M.2.2 General considerations on the modelling technique for the test item

The numerical model shall include all significant parts, the connections between the parts, and appropriate boundary conditions. Particular attention shall be paid on the geometrical description of the contact areas of the modelled support structure. Proper geometry and material properties shall be used.

The virtual test shall be able to correctly describe the backfill type and behaviour. Modelling of any backfill, asphalt, concrete and similar should be documented. Simplifications as well as rigid aggregate conditions shall be justified through empirical or engineering analyses, independent of the numerical model.

M.2.3 Validation Process

M.2.3.1 General

The validation process compares the results of physical testing with the result of the corresponding virtual test. The tests shall have equal initial conditions (according to this document).

The virtual testing shall be assessed by an independent expert.

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[1] The FprEN 16303:_ will be soon submitted to Formal Vote. This FprEN 16303 will serve as basis for reviewing (editorial simplification) this Annex M in order to make reference as much as possible to EN 16303:_.

An independent expert should be a single person or a board of experts having, as a minimum, the requirements listed in Annex N Requirements for the person/group performing virtual testing activities for performing virtual testing activities

M.2.3.2 Validation requirements

M.2.3.2.1 General

To validate the model, the requirements described in the following sub clauses shall be satisfied and reported.

When general requirements in Table M.4, comparison table are not satisfied, the author of the virtual test shall explain his reasons inside the final validation report and those reasons shall be checked and agreed by the notified body.

All the tables in this chapter shall be part of the final validation report, see M.4.

M.2.3.2.2 The vehicle exit speed

The vehicle exit speed (v_e) from the physical test shall be compared with the one calculated from the virtual test ($v_e v$), and evaluated in accordance with A.3. The virtual test and the corresponding physical test shall have the same energy absorbing category.

The virtual test and the corresponding physical test are verified when the requirement in Formula (M.1) is met.

$$\left|v_e - v_e v\right| = Diff < \pm\left(0,05 \times v_i\right) \tag{M.1}$$

where

v_e is the exit speed, expressed in kilometres per hour (km/h), of the real support structure (physical test);

$v_e v$ is the exit speed, expressed in kilometres per hour (km/h), of the numerical model (virtual test);

v_i is the nominal impact speed, expressed in kilometres per hour (km/h).

The result of the physical test and the virtual test validation shall be reported as shown in Table M.1.

Table M.1 — Vehicle exit speed

Critical	Is VT in accordance with result from physical test According to Formula (M.1)?
Is the vehicle exit speed criterion satisfied?	Yes/No

M.2.3.2.3 Occupant severity indexes

The occupant severity indexes shall be evaluated in accordance with A.4. The virtual test and the corresponding physical test shall have the same occupant severity class.

The virtual test and the corresponding physical test are satisfied when the requirements in Formulae (M.2) and (M.3) for ASI and Formulae (M.4) and (M.5) for THIV are met.

$$\left|ASI - ASI_v\right| = Diff < \pm 0,1 \tag{M.2}$$

$$\left|tASI - tASI_v\right| = Diff < \pm 0,05\,s \tag{M.3}$$

$$\left|THIV - THIV_v\right| = Diff < \pm 3\,km/h \quad \text{(M.4)}$$

$$\left|time\ of\ flight - time\ of\ flight_v\right| = Diff < \pm 0,05\,s \quad \text{(M.5)}$$

The result of the physical test and the virtual test validation shall be reported as shown in Table M.2.

Table M.2 — Occupant safety indexes

Critical behaviour	Is VT in accordance with result from physical test? According to Formulae (M.2), (M.3), (M.4) and (M.5)?
Are the occupant safety class criteria satisfied?	Yes/No

M.2.3.2.4 Collapse mode

The collapse mode shall be evaluated in accordance with A.5. The virtual test and the corresponding physical test shall have the same collapse mode.

The result of the virtual test and its comparison with the physical test, shall be reported as shown in Table M.3.

Table M.3 — Collapse mode

Critical behaviour	Is VT in accordance with result from physical test?
Is the Collapse mode criterion satisfied?	Yes/No

The final shapes of the physical and virtual support structures shall be compared and reported.

M.2.3.2.5 Time history

The comparison is based on the global resultant velocity of the vehicle, in the plane motion.

The virtual test is considered validated when the vehicle velocity of the virtual test remains inside a window built around the physical velocity, until the farthest in time between the time of the maximum value of ASI and the time of flight is reached. The variation limits for the window are ±4 % of the impact velocity, and ±0,01 s in time.

When the validation is requested for a modified product, the numerical velocity time history shall remain inside the window until the vehicle has loaded the modified component(s).

M.2.3.2.6 Comparison table, general requirements

The virtual test shall be compared to the corresponding physical test. The comparison of the result of the virtual test with the result from the physical test shall be reported as shown in Table M.4.

NOTE "Yes" is to be ticked if there is agreement between the virtual test and the physical test, furthermore when a criterion is defined, "yes" means that the criterion is satisfied.

Table M.4 — Comparison table

Critical behaviour	VT result	Is VT in accordance with result from physical test?
Does the vehicle Rollover?	Yes/No	Yes/No
Does the support structure collapse?	Yes/No	Yes/No
Is there any deformation of the vehicle roof?	Yes/No	Yes/No
Is there any detached element of the tested item?	Yes/No	Yes/No
Does any part of the support structure penetrate inside the vehicle?	Yes/No	Yes/No

M.2.4 Verification Process

M.2.4.1 General

The verification process checks criteria that ensure the virtual test reliability.

M.2.4.2 Verification requirements

The evaluation in Table M.5 shall be performed at the time when the vehicle leaves the support structure, or the vehicle stops.

Table M.5 — Verification Evaluation Criteria Table

Verification Evaluation Criteria	Change (%)	Pass?
Total energy of the analysis solution (i.e. kinetic, potential, contact, etc.) shall not vary by more than 10 % from the beginning of the analysis		
Hourglass Energy of the analysis solution is less than five percent of the total initial energy at the beginning of the run.		
Hourglass Energy of the analysis solution is less than ten percent of the total internal energy at the end of the run.		
The part/material with the highest amount of hourglass energy is less than ten percent of the total internal energy of the part/material.		
Mass added to the total model is less than five percent of the total model mass at the beginning of the run.		
The part/material with the most mass added had less than 10 percent of its initial mass added.		
The moving parts/materials in the model have less than five percent of mass added to the initial moving mass of the model.		
There are no shooting nodes in the solution?		
There are no solid elements with negative volumes?		

M.3 Requirements for the person/group performing virtual testing activities

The following is the list of information to ensure the competences of an expert/organization in the domain of the virtual testing:

— have access to licensed software able to properly describe crash phenomena. This software shall as a minimum be able to handle the following requirements:

  — contact, including friction (vehicle, test item, road surface and ground);

  — large displacement, rotation, strain;

  — nonlinear constitutive laws;

  — energy absorption in vehicle, test item and foundations;

  — ability to handle buckling in vehicle and test item;

  — accelerometer definition;

  — represent vehicle trajectory;

— have knowledge and experience in physics and engineering, in order to understand and identify which physical phenomena is dominating the physical event of interest. Some relevant fields might be: mechanics, elasticity, strength of materials, fracture, nonlinear geometric effects, dynamics, vibration, optimization, plasticity and collapse load, buckling and instability, limit states, multi-physics analysis, stochastic, and non-deterministic methods, uncertainty estimation methods.

— knowledge in measuring principles, devices and techniques appropriate for virtual test model validation.

— knowledge in virtual testing modelling, in order to identify what kind of modelling hypotheses are adequate for each regulatory act.

— knowledge in mathematical methods and numerical calculations, in order to understand which numerical techniques are being used in virtual test models, and evaluate if convergence and numerical solution errors are acceptable.

— knowledge in finite element or multi-body modelling and analysis, necessary to understand how modelling hypothesis and simplifications are translated.

— knowledge in material laws and characterization methods, in order to evaluate if the right material laws are being used. Materials modelling, characterization and selection, composite structures.

— knowledge and skill in engineering analysis software (CAE), in order to know which outcomes can be obtained and be able to explore and analyse virtual test models.

The above requirements can be proven through:

— participation in similar projects;

— scientific publication;

— training classes;

— specific education in engineer of physics;

— graduated in appropriate engineering with experience in crash.

M.4 Template for report

M.4.1 General

The report for the Virtual testing contains one or more parts related to validation (one for each validated test) and one or more parts related to the evaluation of new performances (one for each virtual test).

M.4.2 Validation report general information

M.4.2.1 General

The validation and verification report shall include the following information as a minimum, in the order given below. All drawings and associated documents attached shall be clearly dated.

M.4.2.2 Validation report cover

The following is the list of information as a minimum to be included in the validation report cover:

a) name of person/group;

b) date of report;

c) name of client;

d) name of test item;

e) validation number and/or validation report number (version number if applicable);

f) test type and reference to standard;

g) number of pages including annexes;

h) official validation report language;

i) approval of report.

M.4.2.3 Person/group performing VT

The following is the list of information as a minimum to be included in the validation report cover:

a) name;

b) address;

c) telephone number;

d) internet address;

e) additional information.

M.4.2.4 Client

The following is the list of information (as a minimum) to be included, concerning entity commissioning the VT:

a) name;

b) address;

c) telephone number;

d) internet address;

e) additional information.

M.4.2.5 Test procedure

The following is the list of information, as a minimum, to be included concerning the test procedure followed by the VT:

a) test type;

b) impact speed, in kilometres per hours;

c) impact angle, in degrees;

d) total vehicle test mass, in kilograms;

e) centre of gravity location.

M.4.2.6 Software

The following is the list of information, as a minimum, to be included concerning the validation of the VT conditions:

a) type and release version of software;

b) filter used;

c) sampling rate;

d) reference to software used for pre-processing, analysis and post-processing.

M.4.2.7 Validation virtual test conditions

The following is the list of information, as a minimum, to be included concerning the validation of the VT conditions:

a) impact speed, in kilometres per hours (actual impact speed for the impact test with the same test type);

b) impact angle, in degrees (actual impact angle for the impact test with the same test type);

c) any additional information.

M.4.2.8 Test item model

The following is the list of information, as a minimum, to be included concerning the model of the test item:

a) total support structure for road equipment test mass;

b) mass of each support structure for road equipment components;

c) description of support structure for road equipment's component:

   1) for Finite Elements Models: number of nodes type and number of elements;

   2) for Multi Bodies: number of rigid bodies, degrees of freedom, deformable element formulation and contact algorithms;

d) description of material models and material properties specifications;

e) boundary conditions and constraints including ground/aggregates anchoring where applicable;

f) potential failure modes of the model;

g) possible component failure;

h) deviation from physical test item (example anchoring, aggregates condition and splices);

i) show a close-up picture (with mesh/elements) of all important functions.

EXAMPLE Bolt connections, splices and welds.

M.4.2.9 Description of test item to be modelled

All differences between the original tested item and the model shall be presented with figures and explanations.

M.4.2.10 A table that shows/reports of the following:

The following is the list of information, as a minimum, to be included concerning the geometry of the components and of the whole item:

a) side and front view of the test item model (with mesh/element);

b) relevant dimensions of the test item model;

c) drawing reference for each component;

d) material specification for each component.

M.4.2.11 Vehicle model

The following is the list of information, as a minimum, to be included concerning the model of the vehicle used:

a) model: type and release;

b) model development year;

c) origin of model;

d) validation report (report reference to vehicle model validation report), if available;

e) deviation from validated model;

EXAMPLE Added contact surfaces, modified height of vehicle and added/modified components

f) ballast, position and mass;

g) ATD model type and mass, in kilogrammes (if fitted);

h) total test mass, in kilogrammes;

i) dimensions and characteristics of vehicle;

j) position of centre of gravity;

k) description of vehicle's component;

   1) for Finite Elements Models: type and number of elements Number of nodes;

   2) for Multi Bodies: number of rigid bodies, degrees of freedom, deformable element formulation and contact algorithms;

l) material models used for different parts (rigid/deformable parts);

m) report minor modification;

n) show a picture of the vehicle model (with mesh) and point out all deviations from the validated model;

o) relevant dimensions and characteristics of vehicle model;

p) special features (extra features that may affect the results);

q) spinning wheels (Yes/No);

r) wheel axles failure (Yes/No);

s) possible penetration into the vehicle (Yes/No).

M.4.2.12 Validation criteria

Fill in the Tables M.1, M.2, M.3 and M.4 for the relevant criteria.

Fill in the Table M.5 for verification evaluation criteria.

M.4.2.13 Comment to validation activities

The following is the list of information, as a minimum, to be included concerning the comments on the validation of the numerical model:

a) description of damage to model including foundations, ground anchorages and fixings.

b) describe, comment and justify any deviation from validation requirements.

M.4.2.14 General statements

The following general statements can be included in the report:

a) the validated model in this report related only to the item tested.

b) this report may not be reproduced other than in full, except with the prior written approval of the issuing simulating institute.

M.4.2.15 Approval of report

The following is the list of information as a minimum to be included concerning the approval person/entity:

a) signature(s);

b) name(s) of authorized and responsible person(s) of virtual test institute;

c) position(s);

d) date.

M.4.2.16 Annexes

a) Reference to TT test used for the validation (number, date, performing entity) relevant data from the TT. Video records (if available) shall be presented;

b) Top and side views pictures of the crash sequences;

c) Pictures of the vehicle after impact. The pictures shall be presented with and without fringing of internal energy (with mesh);

d) Pictures of the test item after impact;

e) ASI and acceleration graphs (for both virtual test and physical test), the following shall be presented:

1) ASI as function of time;

2) X-acceleration (centre of gravity) as function of time;

3) Y-acceleration (centre of gravity) as function of time;

4) Z-acceleration (centre of gravity) as function of time.

f) Global energy balance graph shall be performed with the following energy versus time:

1) total energy;

2) internal energy;

3) kinetic energy;

4) sliding energy;

5) hourglass energy;

6) damping energy;

7) external work;

g) Drawing of test item that were used to build/validate the test item model shall be presented;

h) Animations showing the validation VT shall be enclosed.

M.4.3 New performances report

M.4.3.1 General

For each test type according to this document relevant part, one individually numbered virtual impact test report shall be produced.

The virtual impact test report shall include the following information as a minimum, in the order given below.

All drawings and associated documents shall be clearly dated.

M.4.3.2 Test procedure

The following is the list of information, as a minimum, to be included concerning the test procedure followed for the assessment of the modified version:

a) test type;

b) impact speed, in kilometres per hours;

c) impact angle in degrees;

d) total vehicle test mass, in kilogrammes;

e) centre of gravity location.

M.4.3.3 Software

The following is the list of information, as a minimum, to be included concerning the software used for the assessment of the modified version:

a) type and release version of software;

b) filter used;

c) sampling rate;

d) reference to software used for pre-processing, analysis and post-processing.

M.4.3.4 Impact virtual test conditions

The following is the list of information, as a minimum, to be included concerning the virtual test conditions for the assessment of the modified version:

a) impact speed in kilometres per hours (actual impact speed);

b) impact angle in degrees (actual impact angle).

M.4.3.5 Additional information

Relevant approved validation virtual testing report/impact test reports for the support structure shall report the following:

a) report number, date, test type and name of test item;

b) test and approval date and institute;

c) validation software type and version.

M.4.3.6 Modified component of the support structure for road equipment's model

(Values previous and after the modification shall be included).

This can include any modification influencing:

a) mass/geometry;

b) modelling of the support structure for road equipment:

   1) material / geometry /boundaries and constraints/etc.;

   2) (with mesh) of all important functions.

EXAMPLE Bolt connections, splices and welds.

A table that shows/reports of the following:

— side and front view of the test item model (with mesh);

— relevant dimensions of the model;

— drawing reference for each component;

— material specification for each component.

M.4.3.7 Vehicle model

Vehicle model shall be the same used for the validation (if not the same, information provided under O.2.11 shall be applied).

M.4.3.8 Results

The following is the list of information, as a minimum, to be included concerning the results of the assessment of the modified version:

a) length of contact in metres;

b) impact point location;

c) major parts fractured or detached (Yes/No);

d) elements of test item penetrated the passenger compartment of the vehicle (Yes/No);

e) description of damage to test item including foundations, ground anchorages and fixings;

f) ground fixing meets design levels (Yes/No/Not applicable);

g) impact speed in kilometres per hours;

h) impact angle in degrees;

i) exit speed;

j) exit angle;

k) general description of vehicle trajectory;

l) description of the damage and deformation of the test vehicle (roof deformation);

m) vehicle rolls over within test area (No/Yes);

n) acceleration severity index, ASI;

o) theoretical head impact velocity, THIV in kilometres per hours;

M.4.3.9 General statements

The report may include general statements such as: This report may not be reproduced other than in full, except with the prior written approval of the issuing simulating institute.

M.4.3.10 Approval of report

The report should include the following information concerning the person/entity which approved it:

a) signature(s);

b) name(s) of authorized and responsible person(s) of virtual testing institute;

c) position(s);

d) date.

M.4.3.11 Annexes

a) Top view pictures of the crash sequences;

b) Pictures of the vehicle after impact. The pictures shall presented with and without fringing of internal energy (with mesh);

c) Pictures of the test item after impact;

d) ASI and acceleration graphs, the following shall be presented (when specified within the EN 1317-1:2010):

   1) ASI as function of time;

   2) X-acceleration (COG) as function of time;

   3) Y-acceleration (COG) as function of time;

   4) Z-acceleration (COG) as function of time;

e) Global energy balance graph shall be performed with the following energy versus time:

   1) total energy;

   2) internal energy;

   3) kinetic energy;

   4) sliding energy;

   5) hourglass energy;

   6) damping energy;

   7) external work.

f) Drawing of modified support structure that were used to build/simulate the model shall be presented;

g) Animations showing the impact virtual test shall be enclosed.

Bibliography

[1] EN 40-1:1991, *Lighting columns — Part 1: Definitions and terms*

[2] EN 40-2:2004, *Lighting columns — Part 2: General requirements and dimensions*

[3] EN 40-3-1:2013, *Lighting columns — Part 3-1: Design and verification — Specification for characteristic loads*

[4] EN 40-3-2:2013, *Lighting columns — Part 3-2: Design and verification — Verification by testing*

[5] EN 40-3-3:2013, *Lighting columns — Part 3-3: Design and verification — Verification by calculation*

[6] EN 40-4:2005, *Lighting columns — Part 4: Requirements for reinforced and prestressed concrete lighting columns*

[7] EN 40-5:2002, *Lighting columns — Part 5: Requirements for steel lighting columns*

[8] EN 40-6:2002, *Lighting columns — Part 6: Requirements for aluminium lighting columns*

[9] EN 40-7:2002, *Lighting columns — Part 7: Requirements for fibre reinforced polymer composite lighting columns*

[10] EN 1794 (all parts), *Road traffic noise reducing devices — Non-acoustic performance*

[11] EN 12414:1999[2], *Vehicle parking control equipment — Pay and display ticket machine — Technical and functional requirements*

[12] EN 12368:2015[3], *Traffic control equipment — Signal heads*

[13] EN 12899-1:2007, *Fixed, vertical road traffic signs — Part 1: Fixed signs*

[14] EN 12899-2:2007, *Road equipment — Fixed, vertical road traffic signs — Part 2: Transilluminated traffic bollards (TTB)*

[15] EN 12899-3:2007, *Road equipment — Fixed, vertical road traffic signs — Part 3: Delineator posts and retroreflectors*

[16] EN ISO/IEC 17025:2017, *General requirements for the competence of testing and calibration laboratories*

[17] CEN/TR 16303-4:2012, *Road restraint systems — Guidelines for computational mechanics of crash testing against vehicle restraint system — Part 4: Validation Procedures*

[18] ISO 6813:1998, *Road vehicles — Collision classification — Terminology*

[19] EN 16303:2019 [4], *Road vehicles — Collision classification — Terminology*

[2] Under review

[3] Under review

[4] Under preparation. Stage at the time of publication: prEN 16303:2018.

National Annex NA
(informative)

Recommendations for passively safe support structures for road equipment

NA.1 General

BS EN 12767:2019 specifies different performance classes of passively safe support structures for road equipment to enable purchasers of such equipment in different Member States to select a performance class appropriate to the conditions in that State. The recommended support structure performance classes considered most suitable for UK practice in various road and traffic situations are given in this national annex (NA).

NOTE 1 When specifying passive safety, the standard states that for any property that is not of interest for the specifier, NR (no requirement) may be indicated.

It is the responsibility of the purchaser to specify which performance class is required or to identify NR for a particular class or classes. If either NR or no class is given, notwithstanding that the requirement to meet BS EN 12767:2019 is specified, then manufacturers can supply class 0: a support structure with no performance requirements (non-performance determined). This might not be suitable, as the products will not have been tested to determine whether they are passively safe.

The performance class designations to be used when specifying products consist of seven elements:

— impact speed;

— energy absorption category;

— occupant safety level;

— backfill type;

— collapse mechanism;

— direction of impact; and

— risk of roof indentation.

Purchasers should be aware of these designations and ensure that they specify their requirements correctly, following the recommendations of this NA.

Purchasers should familiarize themselves with the availability of products within a certain performance class before specifying, as suitable compliant products may not be available to meet the specific needs of a particular situation.

The decision to specify products that conform to performance classes from BS EN 12767:2019 in a particular situation, rather than class 0, is a matter for the road authorities.

NA.2 Selection of performance class

NA.2.1 Impact speed

Products can be classified at a particular speed or speeds dependent on the speed at which they are tested and the observed collapse mode. Table A.2 within the standard identifies the combinations of

test speed and collapse modes of successful tests that enable the relevant performance class(es) to be declared.

Recommended speed classes for different situations are incorporated in Table NA.1. Only the 100 km/h and 70 km/h classes are recommended.

NA.2.2 Energy absorption category

BS EN 12767:2019 gives information on the relative injury risks to vehicle occupants of the three energy absorption categories (outlined in A.3). Category NE supports provide a lower risk of injury to vehicle occupants than HE and LE supports and can be the most appropriate choice on non-built-up roads with insignificant volumes of non-motorized users (NMUs). Category LE and HE supports reduce the risk of secondary incidents and collisions with NMUs as the vehicle exit speed is lower, and thus can have advantages on built-up roads where there is a significant volume of NMUs.

NOTE 2 Exit speed is measured some distance after the impact point. Exit speed with LE and HE supports can still be significant, especially at high impact speeds. However, in urban areas where impact speeds will generally be lower, with HE supports the exit speed is likely to be at or close to zero at the measurement point defined in the standard.

Category NE supports are generally designed to fail and detach at the base. Lighting columns and tall signs and signals will normally fall back over the impacting vehicle, falling approximately in the original position. Smaller traffic signs may fall a short distance from the foundation, usually in the direction of travel, and may be passed over by the impacting vehicle.

NOTE 3 Some category NE supports are of the slip base type, where the column/post base is designed to slip relative to its foundation and release the column/post when the bolts holding the base plate to the foundation fail in shear. Such designs should be used with caution, as they may not operate satisfactorily where there is a difference in level between carriageway and support position, and operation can be dependent on angle of impact if different from the 20º test impact angle.

Category LE supports are generally designed to yield in front of and under the impacting vehicle before shearing or detaching towards the end of the impact event.

Category HE supports (which in practice are normally limited to longer supports) are generally designed to yield in front of and under the impacting vehicle and might sometimes wrap around the vehicle. They might straighten out again as the impact event proceeds.

Recommended energy absorption categories for traffic sign and traffic signal supports and lighting columns in different situations are incorporated in the performance class recommendations given in Table NA.1. Where multiple options are given, these are listed in order of preference for Non-built up all-purpose roads and motorways with speed limits >40mph. When selecting a performance class from the list, it might be necessary to check that suitable products that meet the specific requirements of the particular application are available and compliant with that class.

A risk assessment procedure should be used to refine the selection from the list and determine the appropriate classification for a particular situation.

Energy absorption category NE is appropriate in all situations for small non-harmful support structures (3.17, whether or not they have been tested to the standard. These can include delineators conforming to BS EN 12899-3:2007, for example:

— small sign support structures where the sign is integral with the support and the total height does not exceed 1,200 mm; and

— flexible chevron signs.

NOTE 4 Examples of small sign support structures with an integral sign are:

— posts with integral 150 mm diameter signs;

— keep left signs; and

— cycle route signs commonly used in traffic calming situations.

NOTE 5 Category NE is specified in BS 8442:2022 for self-righting bollards.

NA.2.3 Occupant safety level

For vertical traffic sign supports, traffic signal poles and lighting columns, any of the occupant safety classes B–E as specified in Table A.4 in this standard are acceptable. For this reason NR can be specified for this class.

Occupant safety class A is appropriate for small non-harmful support structures.

NA.2.4 Backfill type

— type S: standard aggregates;

— type X: special; and

— type R: rigid.

There is no evidence of any obvious safety issue with the use of passive products tested with a standard aggregate with a special or rigid foundation or socket. NR is therefore recommended for this class.

NA.2.5 Collapse mode

Two collapse modes are identified:

— SE: separation; and

— NS: no separation.

Both types of collapse may be specified on higher-speed roads. NR is therefore recommended for this class.

NA.2.6 Direction of impact

Three direction classes are identified:

— MD: multi-directional;

— BD: bi-directional; and

— SD: single-directional.

Products that perform irrespective of direction of impact are to be preferred, given the unexpected and unforeseeable nature of collisions. The recommended performance classes are therefore (in order of preference) MD, BD and SD for all situations.

NA.2.7 Risk of roof indentation

Two classes are identified:

1. 0: roof deformation less than 102 mm; and

2. 1: roof deformation equal to or greater than 102 mm.

The national annex in the previous version of this standard, BS EN 12767:2007, recommended that products that, when tested, caused a roof deformation in excess of 150 mm should be avoided. It is therefore recommended that only class 0 (roof deformation less than 102 mm) should be specified.

Table NA.1 Performance class recommendations

Situation	Location	Type of support structure		
		Lighting column	Sign or signal support	Non-harmful support structure
Non-built-up all-purpose roads and motorways with speed limits >40 mph	Generally in verges of motorways, dual carriageways and single carriageway roads	100:NE:NR:NR:NR:MD:0	100:NE:NR:NR:NR:MD:0	100:NE:A
	With significant volume of non-motorized users at the times when impact events occur	100:HE:NR:NR:NR:MD:0	100:HE:NR:NR:NR:MD:0 100:LE:NR:NR:NR:MD:0 100:NE:NR:NR:NR:MD:0	100:NE:A
	Where major risk of items falling on other carriageways below (e.g. at grade separated interchanges)	100:HE:NR:NR:NR:MD:0	100:HE:NR:NR:NR:MD:0 100:LE:NR:NR:NR:MD:0 100:NE:NR:NR:NR:MD:0	100:NE:A or 70:NE:A
Built-up roads and other roads with speed limits ≤40 mph	All locations	70:HE:NR:NR:NR:MD:0 100:HE:NR:NR:NR:MD:0 70:LE:NR:NR:NR:MD:0 100:LE:NR:NR:NR:MD:0 70:NE:NR:NR:NR:MD:0 100:NE:NR:NR:N R:MD:0	70:HE:NR:NR:NR:MD:0 100:HE:NR:NR:NR:MD:0 70:LE:NR:NR:NR:MD:0 100:LE:NR:NR:NR:MD:0 70:NE:NR:NR:NR:MD:0 100:NE:NR:NR:NR:MD:0	100:NE:A or 70:NE:A

• For roads >40mph, preference is given in the order stated from top to bottom. For roads ≤40mph, no preference is required

• Sign or signal support includes supports for items of similar weight to that of the item supported in the test, such as variable message signs and speed cameras

• Category NE can be accepted in any situation where the standard steel posts defined as 'deemed to comply' in Annex K are used

• Category MD is the most preferable in all situations, followed by category BD or category SD

NA.3 Structural requirements

This document does not give structural requirements and recommendations. The products to which BS EN 12767:2019 will commonly be applied can be found in the documents identified in Table NA.2.

Table NA.2 Structural requirements

Product	Document
Vertical traffic sign	BS EN 12899-1:2007 and its national annex
Traffic signal poles	BS EN 12368:2015(1,2)
Lighting columns	The BS EN 40 series and PD 6547:2004+A1:2009

(1) In Subclause 4.4 of BS EN 12368:2015, two possible values of temporary deflection are given, 2% and 4% of the total length of the pole, with the latter value relevant where the heads are mounted on brackets. For passively safe poles complying with a performance class from BS EN 12767:2019, 4% should be used.

(2) This standard refers to BS EN 12899-1:2007 for wind load and deflection calculations. The 4% overall deflection in BS EN 12368:2015 approximates to 5% of the length above ground level, class TDB5, as recommended in the national annex to BS EN 12899-1:2007.

NA.4 Traffic sign post spacing and sign plate recommendations

NA.4.1 Sign post spacing

Multi-leg sign supports are normally impact crash tested against one leg with a clear opening between the legs of not less than 1.5 m at the impact angle of 20°.

NOTE 6 A clear opening of 1.5 m at the impact angle approximates to a clear opening of 1.0 m between uprights.

Supports tested in this way should not be used at closer centres, as the performance is likely to be significantly different if both supports are impacted in the same impact event.

NOTE 7 If one member of a family of sign supports has been satisfactorily tested in multi-leg format, other members of the same family that have been accepted as single supports under the product family requirements of Annex G can be regarded as suitable for use in multi-leg format, subject to the requirements for sign plates and fixings.

Annex K gives details of standard metal tube sign supports deemed to comply with BS EN 12767:2019, and states that when two or more supports that are perpendicular to the carriageway are used for one sign, the clear opening between the supports must be equal to or larger than 1,500 mm at an impact angle of 20°.

Where post centres are less than 1,500 mm, post dimensions shall not exceed 76 mm diameter and 3.2 mm wall thickness.

In such a case with only two posts, the post centres should not be less than 300 mm, and with more than two posts the post centres should not be less than 750 mm. No bracing should be used between the posts, which should be connected only by the sign.

NA.4.2 Sign plate recommendations

Traffic signs are normally impact crash tested with a height above ground to sign plate of approximately 2.0 m. The standard states that lower installations may be used, but risk of windscreen penetration shall be evaluated. The risk of windscreen penetration is lower with the composite sign face substrates that are now generally used in place of solid aluminium alloy, which is considerably heavier.

Unless a complete system of support, sign plate and fixings has been tested at a lower height and is to be used complete as tested, it is recommended that the lower edge of any sign plate should not be lower than 1.8 m above ground level, and that any significant structural elements such as stiffening channels or luminaires should not be lower than 2.0 m. Nevertheless, if for sighting or other reasons a sign needs to be mounted lower than this, it is still vastly preferable for it to be mounted on passively safe supports than on rigid ones if it might be hit by a moving vehicle.

NOTE 8 For the purposes of this national annex, mounting height is normally taken as the height above ground level to the bottom edge of the sign plate at the edge nearest to the carriageway.

Sign faces should be lightweight. Some sign installations have lights or other electronic equipment attached. Any such equipment should be light in weight and deformable so as not to significantly increase the risk of personal injury on impact or to invalidate the basis of the original impact crash test.

NA.5 Foundations

Foundations protruding above ground level can be hit by impact vehicles and can be a trip hazard to pedestrians on footways and generally in urban areas. The top surface of concrete foundations on footways should not be higher than the adjacent ground level, and elsewhere should not be higher than 50 mm above ground level.

If foundations different from these used in the certified impact crash test are to be used in practice, the ground resistance to shear forces of the foundation to be used should not be less than that of the

foundations used in the test. This does not apply to class NE supports, for which the action on the foundation caused by an impact with the support is minimal.

Guidance on the design and verification of foundations for lighting columns is given in PD 6547:2004+A1:2009.

NOTE 9 Further information on the design of foundations for lighting columns and guidance on the design of foundations for traffic signs and signals are given in the Highways England publication CD 354, *Design of minor structures*.[1]

NA.6 Underground electrical cables

It is a requirement that underground cables are installed for the impact crash test and that they are fixed in the ground.

The purpose of this requirement is to ensure that the support is not tethered by the cable during the impact, preventing proper operation of the support. The requirement thus assumes that the cable is a solid connection.

In the UK, cable installations to passively safe supports must therefore still comply with all appropriate electrical regulations, standards and guidance without tethering those structures that are intended to shear or slip.

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