SLOVENSKI STANDARD
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Železniške naprave - Novi materiali - 1.del: Smernica in metodologija potrjevanja

Railway applications - New materials - Part 1: Guideline and validation methodology

Bahnanwendungen - Neue Werkstoffe - Teil 1: Leitfaden und Validierungsmethodik

Applications ferroviaires - Nouveaux matériaux - Partie 1 : Lignes directrices et méthodologie de validation

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

This document (prEN 18128-1:2024) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

Introduction

The purpose of this document is to specify a process guideline and a methodology to support the introduction of new materials and processes to meet the minimum requirements in the railway sector in a robust, efficient and safe manner whilst supporting the confidence level and acceptability during the approval process.

This document answers to the following points:

— most existing standards for the design of railway vehicles are dedicated to standardized metallic materials and cannot be fully applied to new materials and/or processes. In fact, some of them are non-isotropic materials, multi-layer materials, strongly dependent on external environment, with different behaviour regarding fatigue, impact etc.;

— new materials and/or processes offer improved performance characteristics, e.g. reduced weight, whole life costs/reduced LCC, environmental benefits, energy efficiency, etc.

— new materials offer the opportunity for the product to be more multifunctional e.g. a structural material incorporating insulation (acoustic, thermal, electrical, etc.);

— many existing standards are written around existing materials and may not be appropriate for or limit the use of new materials;

— the acceptance and approval procedures can be prolonged and costly due to uncertainties / lack of experience with new materials.

Further parts of this standard dedicated to each specific material and processes (composite materials, additive manufacturing, new alloys etc.) will be written based on this guideline and methodology. These new parts will include methodology to define specific criteria, safety factors, tests, controls etc. associated with each material and processes.

1 Scope

This document defines a process guideline and a methodology to support the introduction of new materials and processes to meet the minimum requirements in the railway sector for all rolling stock defined in EN 17343 and onboard equipment.

This document is applicable to new materials and processes for all rolling stock and onboard equipment.

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 50125-1, *Railway applications — Environmental conditions for equipment — Part 1: rolling stock and on-board equipment*

EN 60721-3-5, *Classification of environmental conditions — Part 3: Classification of groups of environmental parameters and their severities — Section 5: Ground vehicle installations (IEC 60721-3-5)*

3 Terms and definitions

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

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

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

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

3.1
primary structural parts
parts whose main purpose is to withstand the principal loads to which the train is subjected, and that have a direct influence on the safety of people, avoiding serious harm (High Risk)

EXAMPLES Carbody, running gear, crash elements, couplers, underframe equipment, jacking and lifting features

3.2
secondary structural parts
parts which participate in the distribution of the principal loads to the main structure and supplement the safety of people, avoiding serious and moderate harm (Medium Risk)

EXAMPLES Doors, seats, interior body-mounted equipment, windscreens, windows, gangways

3.3
non-structural parts
parts of the vehicle without relevance to the structure and safety of people (Low Risk)

3.4
crash
collision between a rail vehicle and a large object

Note 1 to entry: The large object could be, for example, another rail vehicle, a road vehicle, animals or fixed infrastructure.

Note 2 to entry: Crash energy is typically measured in megajoules. See, for example EN 15227.

3.5
impact
collision between a small object and a rail vehicle, or part thereof during manufacturing, service and maintenance

Note 1 to entry: The small object could be, for example, ballast, animal, tools or debris.

Note 2 to entry: Impact includes vandalism such as kicks, screwdriver etc.

Note 3 to entry: Impact energy is typically less than kilojoule. See, for example, EN 15152.

3.6
design
all elements that define a part or an assembly of parts

EXAMPLES Geometries, thicknesses, assemblies, surface condition, color

3.7
full-scale test
test where the specimen is made using full-scale components from the vehicle being assessed

3.8
subset test
test where the specimen is made using part of the full-scale components from the vehicle being assessed

3.9
safety requirement
requirement that is needed to ensure the safety of the product

3.10
safe life
fatigue resistance concept that does not allow any failure of the component during the goal design lifetime

3.11
fail safe
resistance concept where the component, in case of failure on the main load path, is capable to do a load redistribution using an alternative load path

3.12
damage tolerant
this resistance concept assumes the unavoidable existence of defects in the materials

Note 1 to entry: Regarding this resistance concept, the component must maintain its full safety and functionality for usual operational scenarios despite of the presence of defects smaller than critical size.

4 Validation methodology

4.1 General

The overall strategy to support the introduction of new materials and processes to meet the minimum requirements in the railway sector is illustrated in Figure 1. It is a flowchart which describes the different steps to fulfil.

4.2 Concept

4.2.1 General

The first step of the validation methodology which is called “concept” is to precisely define the specifications of the part or the assembly of parts subjected to be manufactured with new materials or/and processes to identify requirements that will have to be fulfilled to validate the part.

4.2.2 Specifications

The specification of designed and manufacturing part using new material corresponds to the following points:

— trains that could be encountered. As example, category of railway vehicle. As example (L), (P), or (F) in accordance with EN 12663-1 and C-I, C-II or C-III in accordance with EN 15227;

— location of the part in the railway vehicle: interior or exterior;

— allocated volume and Interfaces with other parts in the train;

— accessibility;

— structural classification of the part: primary, secondary, or non-structural part;

— environment of the part: exposed to impacts, humidity, temperature, cleaning chemicals, electromagnetic field, electric current etc.;

— contract requirements such as lifetime, maintenance intervals, comfort, target price, weight, visual aspect, geometries…. that could be subjected to change during the project.

4.3 Requirements and prioritization

Depending on the previous specifications, a list of the different requirements (R_X) that shall be validated is established such as static, fatigue, impact, fire and smoke etc.

For each requirement, standards to fulfil shall be identified as well as potential complements asked by the contractors or necessary modifications depending on the material such as additional tests, load cases, safety factors, validation criteria etc. For some materials and processes some standards cannot be fully applied. The strategy and methods to cover the gaps are studied in the following parts.

Finally, a validation order can be established for the requirements depending on the solicitation of the part and the material behaviours. This order is mainly determined regarding the experience of the manufacturer. For example, since most of thermoplastics materials have poor fire resistance, the requirement for fire and smoke toxicity should be validated in the beginning (for example R_1 in Figure 1).

4.4 Validation of requirements R_X

In this stage, an iteration allowing the validation of all requirements is carried out on the following parameters: design of the part including assembly methods, materials and processes.

During this iteration, if one of those parameters shall be changed to allow the validation of one requirement, the previous requirements shall be validated again with the new parameters. When a solution of parameters is found allowing the validation of all requirements, the next step can be carried out.

Note: If subset or full-size tests are necessary to fully validate a requirement, they will be done in the next step of the flowchart. Otherwise, there is a risk to carry out costly tests on a design, material or process that do not allow to validate all other requirements, and which might be useless.

4.5 Test and correlation

4.5.1 General

This step aims, when it is required, to test a subset or the full-scale part and correlate results with calculation.

4.5.2 Is subset or full-scale testing required?

If the manufacturer wants to be more confident on its design, or if it is mandatory by the standards or by the contractor of the project to carry out subset or full-scale tests, they shall be done at this stage. If it is not the case the part is validated.

4.5.3 Subset or full-scale testing

In this step, a subset or a full-scale part is manufactured with the design, materials and processes determined previously and is tested as defined by standards or the contractor. This will allow to validate the hypothesis taken for the calculations such as material data, manufacturing, boundary conditions, assembly properties…. Tests will be carried out in laboratory or/and in line.

4.5.4 Is the subset or full-scale test validated?

If the subset or full-scale test is not validated according to the standard or contractor validation criteria for one or several requirements, the cause will have to be identified such as the design, the manufacturing, boundary conditions, the assembly properties or the testing conditions.

If the non-validation is due to the design of the part, materials or processes, they will have to be modified and all the validation process shall be carried out again.

4.5.5 Is fitting test results with calculation required?

If it is required by standards or by the contractor, a correlation between subset or full-size test results and numerical or analytical calculation shall be carried out at this stage. This correlation is possible if the part is pre-equipped with sensors such as deformation gauges.

If the test results do not fit with the calculation, hypothesis such as manufacturing, boundary conditions, assembly properties, testing conditions…. shall be reconsidered.

4.6 Part validated

At this stage, the part is validated regarding the overall specifications and requirements according to the project of part with new materials.