SLOVENSKI STANDARD
kSIST FprEN 17019:2016

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Tehtanje cestnih vozil v gibanju

Weigh-in-Motion of Road Vehicles

Wägung von Fahrzeugen während dem Fahrt

Pesage en marche des véhicules routiers

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17.100	Merjenje sile, teže in tlaka	Measurement of force, weight and pressure
43.180	Diagnostična, vzdrževalna in preskusna oprema	Diagnostic, maintenance and test equipment

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Wägung von Fahrzeugen während der Fahrt - Anforderungen

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

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Contents

Page

European foreword

This document (FprEN 17019:2016) has been prepared by Technical Committee CEN/SS F05 “Measuring Instruments”, the secretariat of which is held by CCMC.

This document is currently submitted to the Formal Vote.

This European Standard has been prepared by the FiWi (FEHRL institutes WIM initiative) working group and is based on the European Specification on WIM of Road Vehicles (COST323, 1999) published in 1999 by the COST323 Management Committee. The statistical background may be found in (Jacob, 2002) and the technical references in (Jacob et al., 2002).

This standard was prepared to deal with aspects related to:

— scope, normative references, terminology and symbols (Clauses 1 to 3);

— site selection, operating conditions and environmental requirements (Clauses 4 and 5);

— accuracy classification (Clause 6);

— system calibration and testing (Clauses 7 to 11);

The informative Annexes A, B, C, D and E provide respectively:

— comparison with the OIML R134-1 international recommendation;

— standard test plans and simplified acceptance procedures;

— guidelines for system calibration;

— guidelines for data and test result presentation, and computer tools for accuracy assessment;

— comments and explanations of the main clauses.

Introduction

This standard comprises comprehensive and detailed requirements based on a scientific and technical background developed in the COST323 action (Jacob, O'Brien and Jehaes, 2002). The procedure for assessing the accuracy of a WIM system is flexible and general. It may use almost any test plan, depending on the context and means available. The whole standard is based on a statistical approach of the accuracy assessment, with tolerances which are the boundaries of confidence intervals, and a level of confidence, reflecting the probability that an individual measure lays in the specified tolerances or in the confidence interval. This level of confidence can be specified by the users, depending on the application.

However, several users and WIM manufacturers expressed the need to have a simplified procedure for common tests and applications, easier to implement and to understand. Therefore a simplified procedure adapted to standard test plans and with a fixed level of confidence of 95 % was developed. Wherever possible, the detailed clauses of this standard were simplified to allow common users to easily assess a WIM system accuracy.

When a simplified approach is available, the section concerned is duplicated as follows:

— Section title – Detailed procedure,

— Section title – Simplified procedure,

and they are numbered with consecutive numbers at the same level.

The clauses of the simplified procedure may be applied instead of those of the detailed procedure, if respecting the conditions of application.

The simplified procedure mainly applies for the check of the accuracy of a WIM system (Clause 10). The condition is to fix the confidence level at 95 %. The acceptance test can be done using approximate analytical formula (Annex B, B.3.1) or one of the four standard test plans proposed (Annex B, B.1)and charts (Annex B, B.2).

More in details:

— Clauses 1 to 5, 7 to 9 and 11 are common to the detailed and simplified procedures;

— in Clause 6 (Accuracy classes tolerances) the simplified procedure only deals with fixed accuracy classes referred by a letter and a number (e.g. B(10)) as stated in 6.2, while the detailed procedure also includes interpolated classes (6.1 and 6.3.4);

— the detailed procedure to check the accuracy by testing is given in 10.1, 10.3, 10.5 and 10.7, while the simplified procedure is described in 10.2, 10.4, 10.6 and 10.8, using the standard test plans given in the Annex B.

1 Scope

1.1 This standard specifies the requirements for installation, calibration, performance and accuracy assessment, and test methods for Weigh-in-Motion (WIM) systems, that are used to determine gross weights, axle and group-of-axle loads for road vehicles when they are weighed in motion.

1.2 This standard applies to:

1.2.1 WIM systems installed on road infrastructure (including bridges), but not to the WIM systems installed on-board of vehicles;

1.2.2 High speed WIM (HS-WIM) systems, i.e. systems installed in one or more traffic lane(s) of a road, and operated automatically under normal traffic conditions, and to low speed WIM (LS-WIM) systems, i.e. systems installed in a controlled weighing area, and operated under controlled conditions;

1.2.3 WIM systems using either scales which are able to weigh standard masses statically, or other sensors which may measure the loads indirectly;

1.2.4 on-site full WIM system performance assessment and model (type) approval, but excludes laboratory (product) tests or tests on parts of systems (e.g. sensors only).

1.6 The scope of this standard covers all WIM applications, except trade.

NOTE For load enforcement of road vehicles, this standard or the OIML (International Organization for Legal Metrology) international recommendation R 134-1 and 134-2 (OIML, 2004 and 2006) applies, depending on the national requirements and legislation.

1.7 WIM systems used for trade are dealt with in the OIML recommendations R134-1 and R134-2 (OIML, 2006 and 2004). These OIML recommendations apply to WIM systems installed in controlled weighing areas, on a specified apron and where the vehicle speed is controlled. They mainly apply to WIM systems composed of scales, which are capable of weighing standard masses statically. The OIML recommendations are limited to the highest accuracy classes (0,2 to 10), with tolerances for 100 % of the measurements.

This standard applies to any WIM system, which may be installed either in a controlled weighing area, or on a road open to traffic. These systems may use road sensors and bridge WIM.

This standard covers type approval testing, initial and in service testing.

This standard specifies the required performance and ability of WIM systems in general, but does not aim to standardize products.

2 Normative references

The following referenced documents are indispensable for the application 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.

ISO 3534-1:2006, *Statistics — Vocabulary and symbols — Part 1: General statistical terms and terms used in probability*

ISO 3534-2:2007, *Statistics — Vocabulary and symbols — Part 2: Applied statistics*

ISO/IEC Guide 99:2007, *International vocabulary of metrology — Basic and general concepts and associated terms (VIM)*

3 Terms, definitions, symbols and abbreviations

For the purposes of this document, the terms and definitions given in the Glossary of WIM terms of the COST 323 final report (Jacob et al., 2002), in ISO 3534-1 and ISO 3534-2, in ISO/IEC Guide 99:2007 and the following apply.

3.1 Terms and definitions taken from the Vocabulary of International Metrology

3.1.0
quantity
property of a phenomenon, body, or substance, to which a magnitude can be assigned

3.1.1
measurement
process of experimentally obtaining information about the magnitude of a quantity

3.1.2
measurand
quantity intended to be measured

3.1.3
measurement method/procedure
generic description of a logical sequence of operations used in a measurement / detailed description of a measurement according to one or more measurement principles and to a given measurement method

3.1.4
measurement result
information about the magnitude of a quantity, obtained experimentally

3.1.5
measurement uncertainty
parameter that characterizes the dispersion of the quantity values that are being attributed to a measurand, based on the information used

3.1.6
standard (measurement) uncertainty
measurement uncertainty expressed as a standard deviation

3.1.7
calibration
(a) operation establishing the relation between quantity values provided by measurement standards (French “étalon”) and the corresponding indications of a measuring system, carried out under specified conditions and including evaluation of measurement uncertainty; or

(b) operation that establishes the relation, obtained by reference to one or more measurement standards (French “étalon”), that exists under specified conditions, between the indication of a measuring system and the measurement result that would be obtained using the measuring system

3.1.8
(metrological) traceability
property of a measurement result relating the result to a stated metrological reference through an unbroken chain of calibrations of a measuring system or comparisons, each contributing to the stated measurement uncertainty

3.1.9
verification
confirmation through examination of a given item and provision of objective evidence that it fulfils specified requirements

3.1.10
influence quantity
quantity which, in a direct measurement, is not the quantity being measured, but whose change affects the relation between the indication of the measuring system and the measurement result

3.1.11
Correction
modification applied to a quantity value obtained from measurement, to compensate for a systematic effect

3.1.12
(measurement) precision
closeness of agreement between quantity values obtained by replicate measurements of a quantity, under specified conditions

3.1.13
measuring instrument
device or combination of devices designed for measurement of quantities

3.1.14
measuring transducer
device that provides at its output a quantity having a determined relation to the quantity at its input

3.1.15
measuring system
set of measuring instruments and other devices or substances assembled and adapted to the measurement of quantities of specified kinds within specified intervals of values

3.1.16
sensor
element of a measuring system that is directly affected by the phenomenon, body, or substance carrying the quantity to be measured

3.1.17
detector
device or substance that indicates the presence of a phenomenon, body, or substance when a threshold value of an associated quantity is exceeded

3.1.18
adjustment
set of operations carried out on a measuring system in order that it provide prescribed indications corresponding to given values of the quantity to be measured

3.1.19
measuring interval
set of values of the quantities of the same kind that can be measured by a given measuring system, with specified measurement uncertainty under defined conditions

3.1.20
steady state condition
operating condition of a measuring system in which the possible variation with time of the quantity being measured is such that a calibration of the measuring system carried out with a measurand constant with time remains valid

3.1.21
rated operating condition
condition that shall be fulfilled during measurement in order that a measuring system perform as designed

3.1.22
limiting condition
extreme condition that a measuring system is required to withstand without damage, and without degradation of specified metrological characteristics when it is subsequently operated under its rated operating conditions

3.1.23
reference condition
condition of use prescribed for evaluating the performance of a measuring system or for comparison of measurement results

3.1.24
resolution
smallest change, in the value of a quantity being measured by a measuring system, that causes a perceptible change in the corresponding indication

3.1.25
stability
ability of a measuring system to maintain its metrological characteristics constant with time

3.1.26
drift
change in the indication of a measuring system, generally slow and continuous, related neither to a change in the quantity being measured nor to a change of an influence quantity

3.1.27
instrumental uncertainty
component of measurement uncertainty attributed to a measuring instrument and determined by its calibration

3.1.28
accuracy class
class of measuring instruments that meet stated metrological requirements which are intended to keep instrumental uncertainty within specified limits under specified operating conditions; or

class of measuring instruments that meet stated metrological requirements which are intended to keep errors (3.1.32) within specified limits under specified operating conditions

3.1.29
true value (of a quantity)
quantity value consistent with the definition of a quantity. Also an accepted reference to which a measurement (result) is compared to assess an error

3.1.30
accuracy of a measurement
closeness of agreement between a quantity value obtained by measurement and the true value of the measurand

Accuracy of a measuring system:

ability of a measuring system to provide a quantity value close to the true value of a measurand

3.1.31
trueness
closeness of agreement between the average that would ensue from an infinite number of quantity values obtained under specified measurement conditions and the true value of the measurand

3.1.32
error
difference of quantity value obtained by measurement and true value of the measurand

3.1.33
random error
difference of quantity value obtained by measurement and average that would ensue from an infinite number of replicated measurements of the same measurand carried out under repeatability conditions

3.1.34
systematic error
difference of average that would ensue from an infinite number of replicated measurements of the same measurand carried out under repeatability conditions and true value of the measurand

3.1.35
maximum permissible error
one of the two extreme values of the error permitted by specifications or regulations for a given measuring system

3.1.36
intrinsic error (of a measuring system)
error of indication when determined under reference conditions

3.1.37
bias (of a measuring system)
systematic error of indication of a measuring system

3.2 Specific statistical and metrological terms and definitions

3.2.1
confidence interval
interval which contains the true value of a quantity value represented by a random variable, with a given probability, π, or a minimum required probability π_0

3.2.2
confidence level
probability, π, that an interval contains the true value of a quantity value represented by a random variable

3.2.3
tolerance – tolerance interval
width of an interval (δ) in which an error shall lie with a minimum required probability. [-δ;+δ] is called the tolerance interval

3.2.4
outlier(s)
value(s) in a series of measurement results of a given quantity value which has(ve) a much lower probability of occurrence than expected according to the sample size and distribution

Note 1 to entry: An outlier is suspected of being an erroneous measurement, and can be eliminated under certain conditions.

3.2.5
performance or acceptance test
test to determine whether an equipment is capable of performing its specified functions or meet a given accuracy class under specified operating conditions

3.2.6
correction factor
numerical factor by which a quantity value obtained from measurement is multiplied, to compensate for a systematic effect

3.2.7
calibration factor
numerical factor by which a quantity value obtained from measurement is multiplied, to fit a true value

3.3 Terms and definitions related to vehicles

3.3.1
axle
set of two or more wheels with centres lying approximately on a common axis oriented transversely to the nominal direction of motion of the vehicle

3.3.2
wheelbase
distance between the first and last axle of a vehicle, a portion of vehicle or a bogie or group of axles (3.3.4)

3.3.3
single axle
axle that is spaced more than 2,2 m from its nearest neighbouring axle of the same vehicle, unless an alternative definition is agreed [1]

[1] In vehicle engineering, a single axle is an axle not linked to another axle by a common suspension.

3.3.4
Group of axles
set of axles on the same vehicle spaced, each from the next one, less than 2,2 m, centre to centre, unless an alternative definition is agreed [2]

3.3.5
tandem axle
group of two axles, with a wheelbase less than the value specified in 3.3.4

3.3.6
tridem axle
group of three axles, with wheelbases less than the value specified in 3.3.4

3.3.7
axle of a group
one axle of a vehicle that belongs to a group of axles (see 3.3.4)

3.3.8
Gross vehicle weight (GVW)
force due only to the external force of gravity acting vertically downward on the total mass of a vehicle, including all connected components

Note 1 to entry: Its magnitude is the total vehicle mass multiplied by the acceleration due to gravity ($g = 9{,}8\ m/s^2$).

3.3.9
wheel load
portion of the gross weight imposed upon the weighing device by the tyre(s) of a stationary wheel at the time of weighing, expressed in units of mass, due only to the vertically downward force of gravity acting on the mass of the static vehicle

3.3.10
axle load
sum of all the wheel loads of an axle of a vehicle

3.3.11
axle group load
sum of all the axle loads of the axles which belong to a group of axles (see 3.3.4)

3.3.12
dynamic (impact) tyre force
component of the time-varying force applied perpendicular to the road surface by the tyre(s) of a wheel of a moving vehicle

3.3.13
dynamic (impact) wheel/axle/group of axles/vehicle force
force applied to the pavement by the moving tyre(s) of a wheel/axle/group of axles/vehicle

Note 1 to entry: For the purposes of this standard, the WIM system is adjusted or calibrated to indicate the magnitude of the vertically downward, measured dynamic forces in units of mass. The indicated mass is converted to units of force by multiplying it by the acceleration due to gravity: $g = 9{,}8\ m/s^2$.

[2] In vehicle engineering, a tandem (resp. tridem) axle is a set of two (resp. three) axles linked by a common suspension.

3.3.14
impact factor
ratio of an impact force to the corresponding wheel/axle/group of axles load or gross vehicle weight

3.3.15
reference (or test) vehicle
vehicle which has accepted true values of the quantities to be measured, e.g. axle loads, gross weight, axle spacing, length

Note 1 to entry: Axle loads and gross weight are commonly measured statically on approved scales.

3.4 Terms and definitions related to WIM systems

3.4.1
wheel load scale
device on which the whole wheel imprint is applied and which measures a wheel load

3.4.2
axle load scale
device on which all the wheel imprints of an axle are applied at once and which measures the combined wheel loads of an axle

Note 1 to entry: If verified to appropriately small maximum permissible errors in relation to the intended tolerance of a WIM system, an axle load scale is commonly used for generating static axle load reference values.

3.4.3
weigh-bridge
weighing device on which a complete stationary vehicle may be weighed at once

Note 1 to entry: If verified to appropriately small maximum permissible errors in relation to the intended tolerance of a WIM system, a weigh-bridge is commonly used for generating gross weight reference values.

3.4.4
strip sensor
sensor installed perpendicular to the direction of travel of a road, with a longitudinal extent (in the traffic direction) of a few centimetres, but smaller than a tyre imprint length

3.4.5
Weigh-In-Motion (WIM)
process of estimating the gross weight of a moving vehicle, and the portion of that weight that is carried by each of its wheels or axles, by measurement and analysis of dynamic vehicle tyre forces

3.4.6
Weigh-In-Motion system (station)
set of mounted sensor(s) and electronics with software which measures dynamic vehicle tyre forces and vehicle presence of a moving vehicle with respect to time and provides data for calculating wheel and/or axle load and gross weight estimates, as well as other parameters such as speed, axle spacing and silhouettes