INTERNATIONAL STANDARD

ISO 23054-1

First edition
2022-08

Railway applications — Track geometry quality —

Part 1: Characterization of track geometry and track geometry quality

Applications ferroviaires — Qualité géométrique de la voie —

Partie 1: Caractérisation de la géométrie de la voie et de la qualité géométrique de la voie

Reference number
ISO 23054-1:2022(E)

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Published in Switzerland

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Foreword

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This document was prepared by Technical Committee ISO/TC 269, *Railway applications*, Subcommittee SC 1, *Infrastructure.*

A list of all parts in the ISO 23054 series can be found on the ISO website.

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Railway applications — Track geometry quality —

Part 1: Characterization of track geometry and track geometry quality

1 Scope

This document defines track geometry parameters and specifies the minimum requirements for track geometry measurements and the evaluation method for track geometry quality.

This document is applicable to 1 435 mm and wider track gauges. The urban/light rail systems, tramways and any track gauge narrower than 1 435 mm are excluded from the scope of this document, however it can be used as a reference.

2 Normative references

There are no normative references in this document.

3 Terms and definitions, symbols and abbreviations

3.1 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/

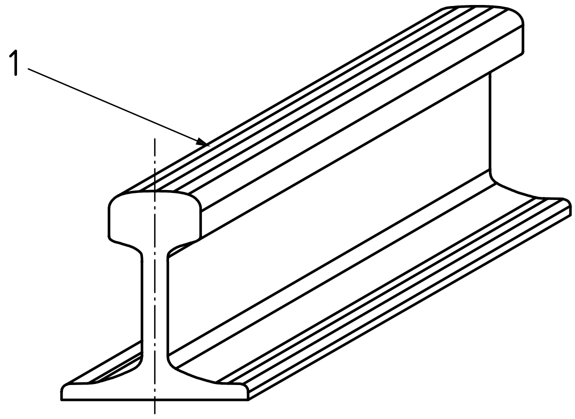
3.1.1
track geometry parameters
parameters to describe geometrical characteristics of the track, such as track gauge, longitudinal level, alignment, cross level, twist

3.1.2
track geometry quality
assessment of deviation in the vertical and lateral planes from the average or designed geometrical characteristics of specified parameters which give rise to safety concerns or have a correlation with ride quality

3.1.3
gauge face
inside face of the running rail head

3.1.4
running table
upper surface of the head of the rail

Note 1 to entry: See Figure 1.



Key

1 running table

Figure 1 — Running table[1],[2]

3.1.5
running surface
curved surface defined by the longitudinal displacement of a straight line perpendicular to the centre-line of the track and tangential to both running tables

Note 1 to entry: See Figure 2.

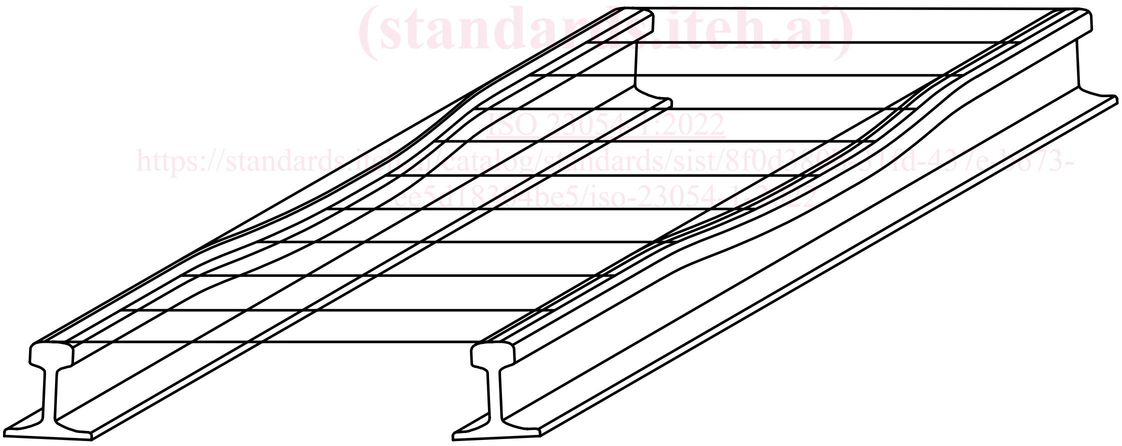


Figure 2 — Running surface

3.1.6
uncertainty
value defining the interval about the result of a measurement expected to encompass a large fraction of the distribution of values that could reasonably be attributed to the measurand[3]

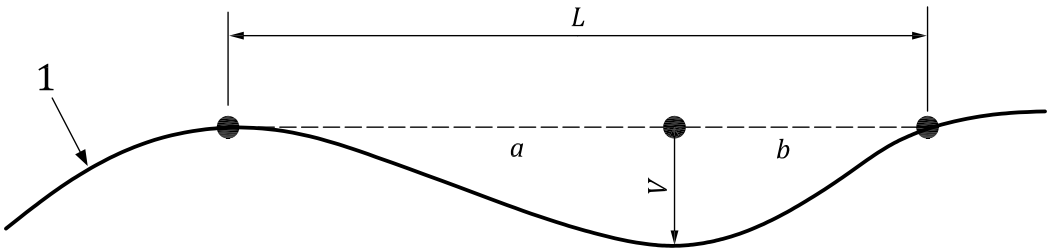
Note 1 to entry: The coverage factor is equal to 2. The uncertainty as defined corresponds to a confidence interval of about 95 % of a normal distribution.

3.1.7
resolution
smallest change in the value of a quantity to be measured which produces a detectable change in the indication of the measuring instrument

3.1.8
chord length
length of the straight line (chord) between two points on the same rail

3.1.9
chord measurement system
system which measures track geometry by perpendicular distance (i.e. offset) from the chord to the chosen rail measurement point within its length

Note 1 to entry: See Figure 3.



Key

1 rail
V offset
L chord length
a,b divided chord length, *L=a+b*

Figure 3 — Chord measurement

Note 2 to entry: It is symmetrical chord measurement when *a=b*, otherwise it is asymmetrical chord measurement.

3.1.10
inertial measurement system
system which measures track geometry by referring the rail position to an inertial reference, which may be provided by a combination of accelerometers, gyroscopes, and sometimes magnetometers

3.1.11
wavelength range
space domain covered by the track geometry measurements

3.1.12
sampling distance
equal distance travelled between each two consecutive measured points

3.1.13
range of measurement
specific domain described by its limits

3.1.14
isolated defect
part of the signal exceeding a given limit with at least one sample

3.2 Symbols and abbreviations

Symbol	Designation	Unit
G	Track gauge	mm
Z_p	Limit of the range below the running surface within which the gauge is measured. Z_p is always 14~16 mm for a Vignole rail	mm
Z_{ll1}	Deviation in the direction of consecutive running table levels on right hand rail. Used in the measurement of longitudinal level	mm
Z_{ll2}	Deviation in the direction of consecutive running table levels on left hand rail. Used in the measurement of longitudinal level	mm

Symbol	Designation	Unit
Y_{p1}	Distance between point P and a reference line on right hand rail. Used in the measurement of alignment	mm
Y_{p2}	Distance between point P and a reference line on left hand rail. Used in the measurement of alignment	mm
P	Gauge face contact point	
W_1, W_2, W_3	Wavelength ranges which are correlated to line speed and are classified into short, medium and long wavelengths	
C_1, C_2	Chord length class which are based on line speed and are classified into short and long chord lengths	
V_1	Amplitude from the zero line. Used in the measurement of twist	mm/m
V_2	Amplitude from the mean value. Used in the measurement of twist	mm/m
ℓ	Twist base-length	m
X, Y, Z	Axes of a track coordinate system	
C	Filtered cross level which is obtained by high-pass filtering of cross level	mm
CX	Combined irregularity refers in particular to the combined irregularity of alignment and filtered cross level	mm
T	Track quality index. The combined standard deviation of track geometric irregularities including left longitudinal level, right longitudinal level, level alignment, right alignment, gauge, cross level and twist	
L	Chord Length. Length of the straight line between the two points on the same rail	m
K	Combination coefficient	

4 Description of the track coordinate system

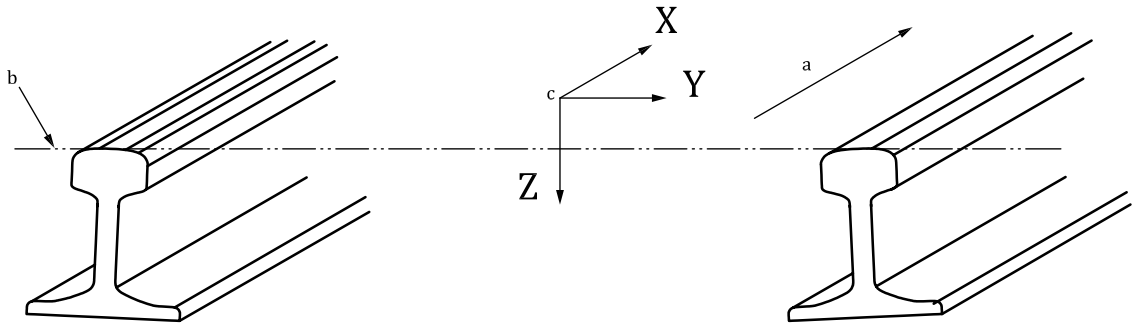
The track geometry quality is described by means of a moving right-hand Cartesian coordinate system centered to the track with clockwise rotation (see Figure 4):

— X-axis: axis represented as an extension of the track towards the direction of running;

— Y-axis: axis parallel to the running surface;

— Z-axis: axis perpendicular to the running surface and pointing downwards.

NOTE This description is for the coordinate system of the measurement vehicle. It is up to the infrastructure manager to define a reference direction of the track.



Key

a Running direction.

b Intersection between considered cross section and running surface.

c Track coordinate system.

Figure 4 — Relationship between the axes of the track coordinate system

Rail identification (left or right rail) and sign convention of parameter measurement is not in the scope of the standard but should be agreed between parties for the purpose of exchanging data.

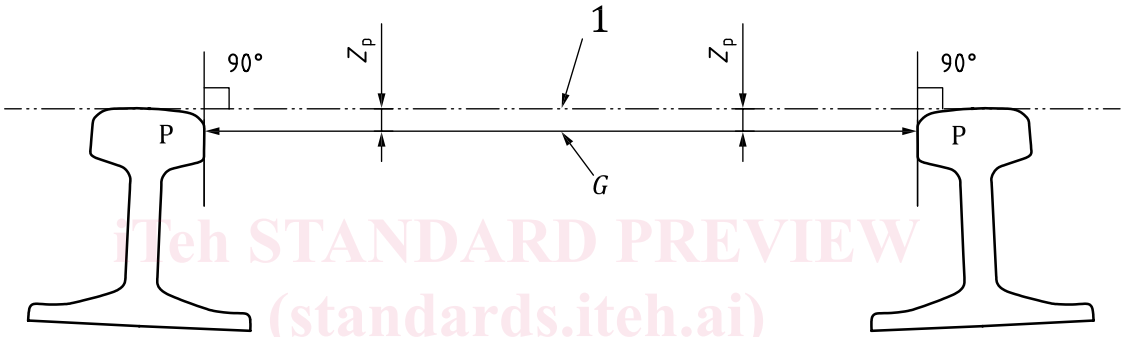
5 Definition of track geometry parameters

5.1 Track gauge

Track gauge, G, is the smallest distance between lines perpendicular to the running surface intersecting each rail head profile at point P in a range from 0 to Z_p below the running surface. In this standard, Z_p is in the range of 14 mm to 16 mm.

NOTE Track gauge limit values depend on the chosen Z_p value. For example, Z_p is 14 mm in Europe and Japan and 16 mm in China and Japan.

In the situation of new unworn rail head, the point P will be at the limit Z_p below the rail head, as shown in Figure 5.

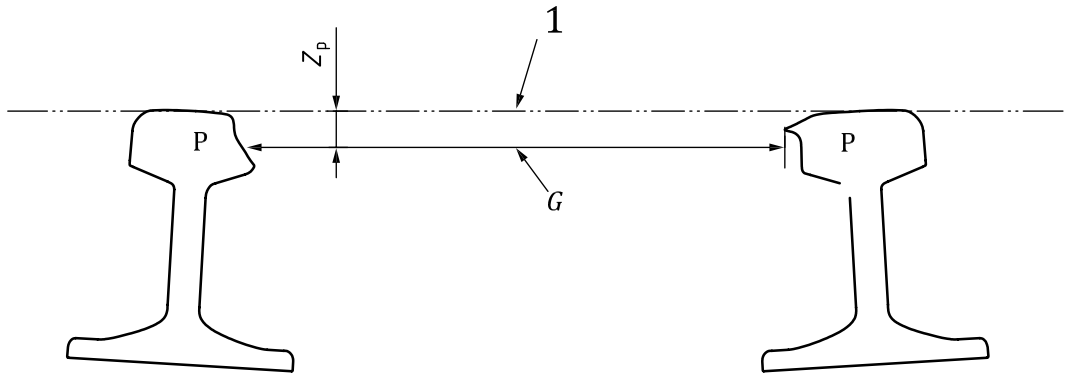


Key

1 running surface

Figure 5 — Track gauge for new rail (example in case rails are tilted)

In the situation of worn rail head the height of point P for the left rail can be different from the right rail, as shown in Figure 6.



Key

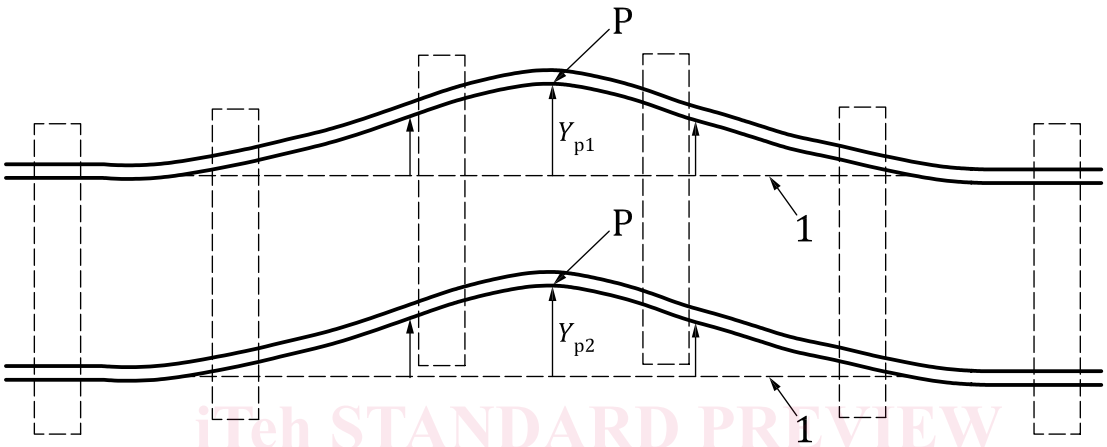
1 running surface

Figure 6 — Track gauge for worn rail (example in case rails are tilted)

5.2 Alignment

Alignment is the deviation Y_{p1} and Y_{p2} in Y-direction of the position of point P (see 5.1) on any rail from the reference line. The reference line can be the design alignment or a smoothed alignment calculated from successive measurements (see Figure 7).

Alignment measurements shall be made with either an inertial measurement system or a chord measurement system (that should preferably be asymmetrical chord), or a combination of both. Those measurement systems will produce results in different domains (space or versine respectively). It is possible to transform the measured signals between domains using a colouring/decolouring/recolouring process.



Key

P point P according to 5.1

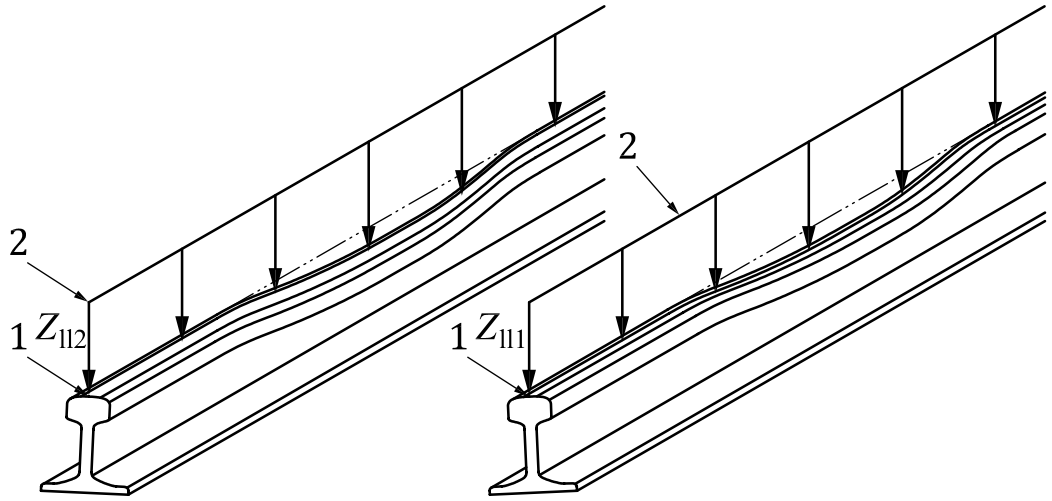
1 reference line

Figure 7 — Alignment

5.3 Longitudinal level

Longitudinal level is the deviation Z_{ll1} and Z_{ll2} in Z-direction of running table levels on any rail from the reference line. The reference line can be the design longitudinal level or a smoothed longitudinal level calculated from successive measurements (see Figure 8).

Longitudinal level measurements shall be made with either inertial measurement system or a chord measurement system (that should preferably be asymmetrical chord), or a combination of both. Those measurement systems will produce results in different domains (space or versine respectively). It is possible to transform the measured signals between domains using a colouring/decolouring/recolouring process.



Key

1 running table

2 reference line

Figure 8 — Longitudinal level

5.4 Cross level

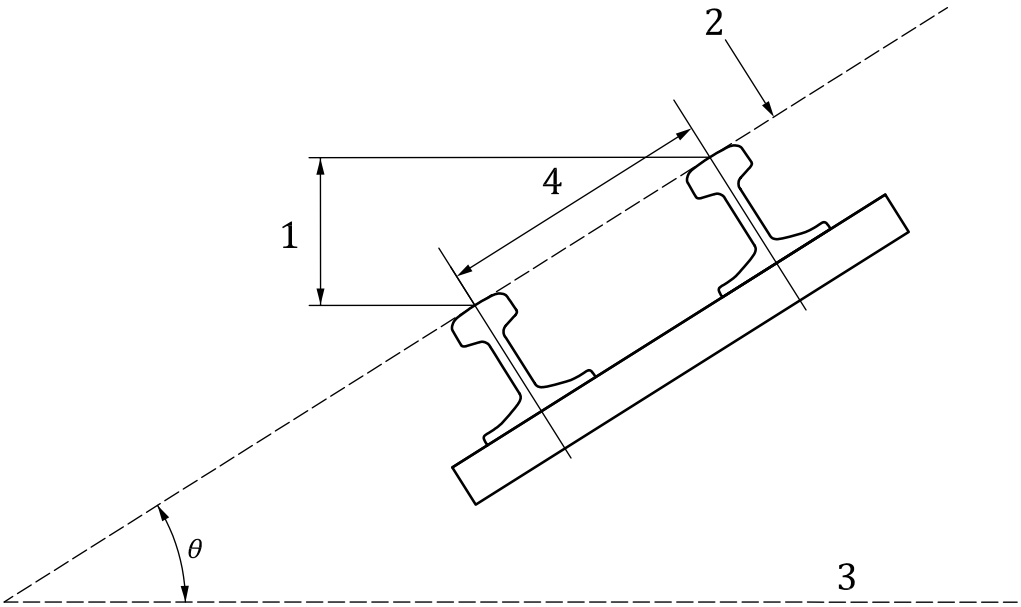
The difference in height of the adjacent running tables computed from the angle between the running surface and a horizontal reference plane. It is expressed as the height of the vertical leg of the right-angled triangle having a hypotenuse that relates to the nominal track gauge as follows (see Figure 9):

— For nominal gauge of 1 435 mm the hypotenuse is 1 500 mm in length.

— For nominal gauges of 1 520 and 1 524 mm the hypotenuse is 1 600 mm in length.

— For nominal gauge of 1 668 mm the hypotenuse is 1 740 mm in length.

Cross level is also called cant or superelevation.



Key

1 cross level
2 running surface
3 horizontal reference plane
4 hypotenuse
θ inclination angle

Figure 9 — Cross level

5.5 Twist

The algebraic difference between two cross levels divided by their distance apart (base-length ℓ), typically expressed as mm/m or ‰.

5.6 Other parameters

Other parameters contribute to an understanding of vehicle track interaction and ride quality. These other parameters can be obtained by direct measurement or by derived measurement. A representative list of additional analysis and parameters are shown in the Annex A.

6 Measurement requirements of track geometry

6.1 General

The track geometry is measured by the track geometry measuring systems mounted on track recording vehicles, commercial vehicles, track maintenance machines or manually operated devices. It is intended to:

— measure track geometry parameters;

— measure the longitudinal distance at the sampling distance which should not exceed 0,25 m;

— associate the location to the measured data;

— process the measured data, preferably on site.