

---

---

**Road vehicles — Wheels/rims for  
commercial vehicles — Test methods**

*Véhicules routiers — Roues/jantes pour véhicules utilitaires —  
Méthodes d'essai*

STANDARDSISO.COM : Click to view the full PDF of ISO 3894:2023



STANDARDSISO.COM : Click to view the full PDF of ISO 3894:2023



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2023

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

# Contents

	Page
Foreword.....	iv
Introduction.....	v
<b>1 Scope.....</b>	<b>1</b>
<b>2 Normative references.....</b>	<b>1</b>
<b>3 Terms and definitions.....</b>	<b>1</b>
<b>4 General requirements.....</b>	<b>2</b>
<b>5 Wheels – Dynamic cornering fatigue test.....</b>	<b>2</b>
5.1 Equipment.....	2
5.2 Procedure.....	2
5.2.1 Preparation.....	2
5.2.2 Bending moment application.....	2
5.3 Bending moment determination.....	2
5.4 Test termination.....	3
<b>6 Wheels — Dynamic radial fatigue test.....</b>	<b>5</b>
6.1 Equipment.....	5
6.2 Procedure.....	5
6.3 Radial load determination.....	6
6.4 Test termination.....	6
<b>Annex A (informative) Recommended test factors and test cycles.....</b>	<b>8</b>
<b>Bibliography.....</b>	<b>9</b>

STANDARDSISO.COM : Click to view the full PDF of ISO 3894:2023

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 33, *Vehicle dynamics, chassis components and driving automation systems testing*.

This fifth edition cancels and replaces the fourth edition (ISO 3894:2015), which has been technically revised.

The main changes are as follows:

- correction of required cycles for radial testing of aluminium wheels;
- editorial changes.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

## Introduction

This document was developed in response to requests to establish uniform test methods to evaluate certain fatigue strength characteristics of wheels used on commercial vehicles. Although this document is the International Standard for wheel fatigue testing due to the ubiquity of testing resources, there are also other regionally acceptable testing standards for fatigue strength characteristics, such as biaxial testing. Some examples of other regional entry level testing requirements include Japan's JIS D4103, China's GBT 5909, India's IS 9438, US' SAE J267, Brazil INMETRO's NBR 6751, and the European standard EUWA ES3.11.

The standardization of test methods allows manufacturers of vehicles and/or wheels to evaluate their products in a uniform manner. By using these methods, wheels from different parts of the world can be compared and evaluated for use.

STANDARDSISO.COM : Click to view the full PDF of ISO 3894:2023

[STANDARDSISO.COM](https://standardsiso.com) : Click to view the full PDF of ISO 3894:2023

# Road vehicles — Wheels/rims for commercial vehicles — Test methods

## 1 Scope

This document specifies two laboratory methods for testing certain essential strength characteristics of disc wheels intended for road use on commercial vehicles, buses, trailers, and multipurpose passenger vehicles, as defined in ISO 3833.

The test methods are:

- dynamic cornering fatigue test and
- dynamic radial fatigue test.

## 2 Normative references

There are no normative references in this document.

## 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

#### **test bolt**

test fastener

bolt that is attached to the hub/test fixture before mounting the wheel

### 3.2

#### **wheel nut**

wheel fastener

nut for fastening the wheel as a set with the *test bolts* (fasteners) (3.1)

### 3.3

#### **load rating**

value obtained by converting the force to mass which can be loaded under defined conditions to the tyres which can be applied to the test wheel

### 3.4

#### **maximum vertical static load**

maximum value of the vertical load acting on the tyres

Note 1 to entry: It is specified by the wheel manufacturer or the vehicle manufacturer and it derives from the specifications of a vehicle which is intended to use the test wheel.

### 3.5 crack

material separation with a propagation of more than 10 mm occurring during a test

Note 1 to entry: The inspection method for liquid penetrant is defined in ISO 3452-1.

## 4 General requirements

Only fully processed new wheels which are equivalent of wheels intended for the vehicle shall be used for the tests.

## 5 Wheels – Dynamic cornering fatigue test

### 5.1 Equipment

The test machine shall have a driven rotatable device whereby either the wheel rotates under the influence of a stationary bending moment (see [Figure 1](#)) or the wheel is stationary and is subjected to a rotating bending moment (see [Figure 2](#)).

### 5.2 Procedure

#### 5.2.1 Preparation

Clamp the rim of the wheel securely to the test fixture. The adaptor face of the test machine shall have equivalent mounting systems to those used on the vehicle. The mating surface of the test adaptor and wheel shall be free of excessive scoring and deformation, and excessive build-up of paint, dirt, or foreign matter.

Attach the load arm and adaptor assembly to the mounting surface of the wheel using test bolts and wheel nuts. The test bolt and wheel nuts used shall be:

- equivalent to those used in a vehicle,
- in good condition, and
- lubricated or non-lubricated in accordance with the state of being applied to a vehicle (as specified by the vehicle manufacturer).

Tighten these wheel nuts at the beginning of the test to the vehicle or wheel manufacturer's specified torque values.

Wheel bolts or nuts can be retightened once during the test after 1 000 to 5 000 rotations unless additional retightening is allowed by wheel or vehicle manufacturer.

#### 5.2.2 Bending moment application

To impart a bending moment to the wheel, apply a force,  $F$ , parallel to the plane of the wheel mounting surface at a specified distance,  $l$  (moment arm), as shown in [Figures 1](#) and [2](#).

Maintain the bending moment within  $\pm 2,5$  % of the calculated value.

### 5.3 Bending moment determination

Determine the bending moment  $M$  (force  $F \times$  moment arm  $l$ ), in Newton metres, using [Formula \(1\)](#):

$$M = (\mu \times R + d) \times F_v \times S \quad (1)$$

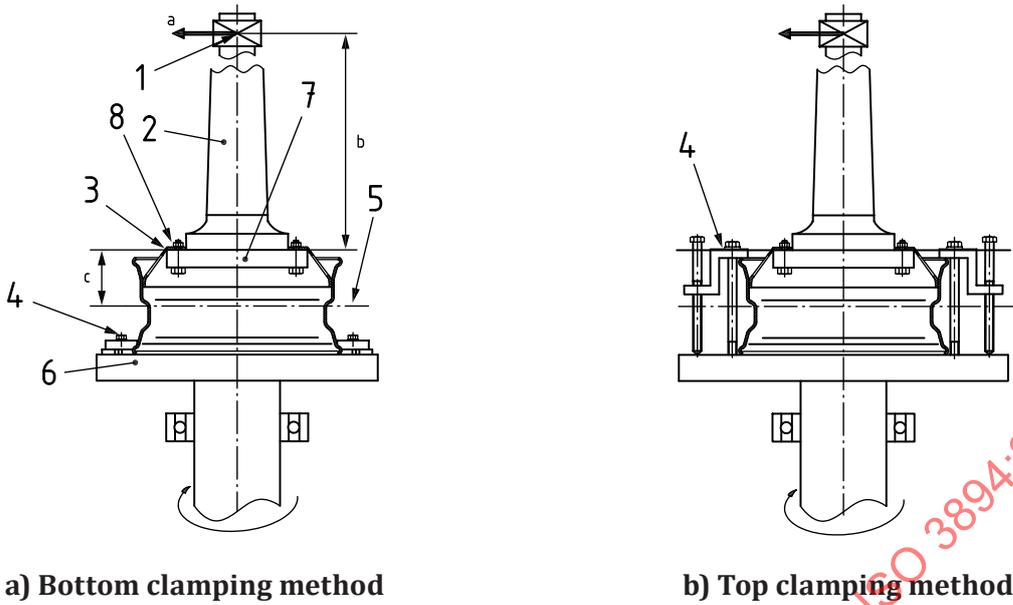
where

- $\mu$  is the assumed coefficient of friction developed between tyre and road (see [Table A.1](#));
- $R$  is the radius, in metres, of either of the following:
  - the largest value of the static loaded radius of the tyres which can be applied to the wheel;
  - the largest value of the static loaded radius of the tyres which is specified by the wheel or the vehicle manufacturer;
- $d$  is the inset or outset (positive for inset; negative for outset), of the wheel, in metres (see ISO 3911). If the wheel can be used as both an inset and outset wheel, then the inset value shall be used;
- $F_v$  is the maximum vertical static load, in Newtons, which is specified by the wheel or the vehicle manufacturer. In the absence of such specification, the largest value of the load rating of the tyre which can be applied to the wheel for the application;
- $S$  is the accelerated test factor (see [Table A.1](#)).

#### 5.4 Test termination

The test shall be terminated in either of the four following circumstances:

- inability of wheel to sustain load;
- propagation of a crack or cracks existing prior to test or new visible stress-caused cracks penetrating through a section of the wheel;
- abnormal loosening of wheel nuts or wheel bolts;
- final torque shall be greater than 70 % of the initial torque requirements.



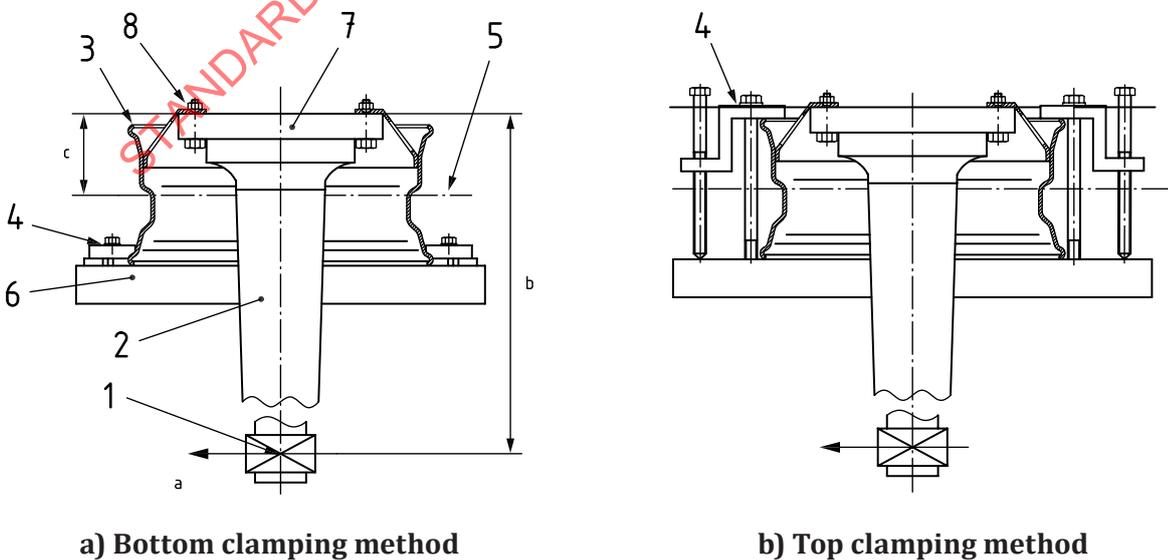
a) Bottom clamping method

b) Top clamping method

**Key**

- 1 pivot point
- 2 loading arm
- 3 wheel
- 4 fastener
- 5 rim centre plane
- 6 rotary disc
- 7 adaptor
- 8 wheel nuts
- a Load,  $F$
- b Moment arm,  $l$  (0,5 m to 1,4 m).
- c Inset,  $d$ .

**Figure 1 — Example of dynamic cornering fatigue test fixture where the wheel rotates under the influence of a stationary bending moment**



a) Bottom clamping method

b) Top clamping method

**Key**

- 1 pivot point
  - 2 loading arm
  - 3 wheel
  - 4 fastener
  - 5 rim centre plane
  - 6 rotary disc
  - 7 adaptor
  - 8 wheel nuts
- a Load,  $F$
- b Moment arm,  $l$  (0,5 m to 1,4 m).
- c Inset,  $d$ .

**Figure 2 — Example of dynamic cornering fatigue test fixture rotating bending moment**

## 6 Wheels — Dynamic radial fatigue test

### 6.1 Equipment

The test machine shall be equipped with a means of imparting a constant radial load as the wheel rotates. There are many means of imparting radial loads: the suggested equipment incorporates a driven rotatable drum set which presents a smooth surface wider than the loaded test tyre section width. The recommended minimum external diameter of the drum is 1 700 mm.

The test wheel and tyre fixture shall provide loading normal to the drum external surface and in line radially with the centre of the test wheel and drum. The axes of the drum and test wheel shall be parallel (see [Figure 3](#)). For dual application wheel, it shall be tested as a single application.

The mating surfaces of the test adaptor and wheel shall be free of excessive scoring and deformation, and excessive build-up of paint, dirt, or foreign matter.

### 6.2 Procedure

Tyres used in this test shall meet the following:

- tyre which has load rating of maximum value in the tyres which are applied to the test wheel;
- tyre which is specified by the wheel manufacturer or the vehicle manufacturer. Select the tyre of maximum load rating if there is more than one tyre which are specified by the vehicle or wheel manufacturer.

The test bolts and wheel nuts used shall be:

- equivalent to those used in a vehicle,
- in good condition, and
- lubricated or non-lubricated in accordance with the state of being applied to a vehicle (as specified by the vehicle manufacturer).

Tighten the wheel nuts to the torque limits specified by the vehicle or wheel manufacturer for stud size and type of nut used.

Check nut torque values and reset them periodically during the course of the test in order to compensate for the wearing-in of mating surfaces of nuts and bolt holes.

Wheel bolts or nuts can be retightened once during the test after 1 000 to 5 000 rotations unless additional retightening is allowed by wheel or vehicle manufacturer.

The test load and tyre inflation pressures are based on wheel ratings. Test inflation pressures are shown in [Table 1](#).

**Table 1 — Tyre test inflation pressures**

Dimensions in kPa

Tyre test pressure at usage load	Tyre test pressure
up to 310	450
320 to 450	550
460 to 580	690
590 to 720	900
730 or more	1 000
100 kPa = 1 bar.	

The load system shall maintain the specified load within  $\pm 5\%$  of the calculated value. For safety considerations, the tyre test pressure may be modified if agreed upon by the supplying and receiving parties.

### 6.3 Radial load determination

Determine the radial load,  $F_r$ , in Newtons, using [Formula \(2\)](#):

$$F_r = F_v \times K \tag{2}$$

where

$F_v$  is the maximum vertical static load which is specified by the wheel or the vehicle manufacturer. In the absence of such specification, it is the largest value of the load rating of the tyre which can be applied to the wheel for the application;

$K$  is the accelerated test load factor (see [Table A.2](#)).

### 6.4 Test termination

The test shall be terminated in either of the four following circumstances:

- inability of wheel to sustain the load or tyre pressure;
- propagation of a crack or cracks existing prior to test or new visible stress-caused cracks penetrating through a section of the wheel;
- abnormal loosening of wheel nuts or wheel bolts;
- final torque shall be greater than 70 % of the initial torque requirements.