



BSI Standards Publication

**Road vehicles — Wheels and rims — Use,  
general maintenance and safety requirements  
and out-of-service conditions**

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## National foreword

This British Standard is the UK implementation of [ISO 14400:2021](#). It supersedes [BS ISO 14400:2005](#), which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee AUE/15, Safety related to vehicles.

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

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Published by BSI Standards Limited 2021

ISBN 978 0 539 02894 2

ICS 43.040.50

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 October 2021.

### Amendments/corrigenda issued since publication

Date	Text affected
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INTERNATIONAL  
STANDARD

**ISO**  
**14400**

Second edition  
2021-10-12

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**Road vehicles — Wheels and rims  
— Use, general maintenance and  
safety requirements and out-of-  
service conditions**

*Véhicules routiers — Roues et jantes — Exigences en matière  
d'utilisation, de maintenance générale et de sécurité, et conditions de  
mise hors service*



Reference number  
ISO 14400:2021(E)

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## Foreword

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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 and chassis components*.

This second edition cancels and replaces the first edition ([ISO 14400:2005](http://www.iso.org/iso/14400:2005)), which has been technically revised.

The main changes are as follows:

- added off-road vehicles to the scope since the sections apply equally to that as well as road vehicles.

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**

The purpose of this document is to ensure the safe operation of vehicles. The wheel is a highly stressed component of the vehicle that in service may be subject to extreme forces. Therefore, it is absolutely necessary to handle these parts with care and to pay particular attention to their mounting, removal and maintenance in order to ensure safe operations and to prevent servicing accidents.



# Road vehicles — Wheels and rims — Use, general maintenance and safety requirements and out-of-service conditions

## 1 Scope

This document specifies requirements for the use, general maintenance and safety of wheels and rims including multi-piece wheels and rims. This document defines their out-of-service conditions, such as cracked, worn and bent wheels and rim components. It is applicable to wheels intended for use on road as defined in ISO 3833 and off road vehicles. This document does not include mopeds and motorcycles.

## 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.

[ISO 3911](#), *Wheels and rims for pneumatic tyres — Vocabulary, designation and marking*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in [ISO 3911](#) 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/>

## 4 Use and general maintenance requirements

**WARNING — On multi-piece rims, the use of the wrong ring components can result in catastrophic wheel failure.**

### 4.1 Wheel and wheel components

Wheels or parts of wheels which cannot be identified shall not be used even if they seem to have the correct functions and the identical dimensions. The characteristics of the wheel centre shall correspond exactly to vehicle parts, especially the axle hub and the brake, in order to guarantee a proper fitting and an effective load transmission.

A neutral non-aggressive mounting paste or liquid shall be used to lubricate the tyre beads. The hub, studs, nuts and the wheel attachment face shall be carefully cleaned. In the case of multi-piece wheels, all contact surfaces shall be cleaned.

Inspect parts for out-of-service conditions, see [Clause 6](#). If cleaning does not restore the original condition for the mating surfaces or if the parts have any of the conditions described in [Clause 6](#), the parts shall be replaced.

On the new vehicle and always after a wheel replacement, the mounting torque shall be verified after approximately 50 km of running and, where necessary, the wheel nuts shall be retightened. Periodic checks should also be carried out.

## 5 General safety requirements

After removal, wheels, rims, studs and nuts shall be checked closely to ensure that they are in good condition: namely that any fracture, crack, deformation, corrosion, heavy wear or other kind of non-conformity are not present.

Moreover, no technical modification on the wheel shall be made. Repair by means of welding or by the addition of material on rims or wheel centres having breakage, fissures, cracks or high wears, shall not be made, as they can introduce additional stresses in the critical areas.

**NOTE** Further detailed information regarding safety recommendations can be found in the technical catalogues of the wheel and/or vehicle manufacturers.

## 6 Out-of-service conditions

Typical out-of-service conditions of wheels, rims and components are shown in the following tables and figures. The conditions of wheel centres are shown in [Table 1](#) and [Figures 2 to 14](#), and the conditions of rims and components are shown in [Table 2](#) and [Figures 15 to 29](#).

Before checking, wheels shall be cleaned of mud and dirt.

Wheels, rims and components in such conditions shall be removed from service and discarded. Rubber components (valves, sealing rings and O-rings) with excessive ageing, brittleness or cracks shall be removed from service and discarded.

**Table 1 — Typical out-of-service conditions of wheel centres**

Type	Appearance	Probable cause	See Figure
Crack	Bolt-hole cracks	<ul style="list-style-type: none"> <li>— Insufficient tightening torque, loose nut</li> <li>— Improper installation procedure</li> <li>— Use of improper bolt/nut</li> <li>— Mounting surface not flat</li> <li>— Excessive load</li> <li>— Damaged or worn nut seat</li> <li>— Inequality of tightening torque between the nuts</li> </ul>	2

Type	Appearance	Probable cause	See Figure
	Bolt-hole-to-bolt-hole cracks	<ul style="list-style-type: none"> <li>— Insufficient tightening torque</li> <li>— Insufficient attachment face [hub] backup</li> <li>— Improper installation procedure</li> <li>— Mounting surface or attachment face [hub] not flat</li> <li>— Use of improper bolt/nut</li> <li>— Worn mounting surface/attachment face [hub]</li> <li>— Excessive load</li> </ul>	3
	Bolt-hole-to-centre-hole cracks	<ul style="list-style-type: none"> <li>— Insufficient tightening torque</li> <li>— Foreign material between mounting surface and attachment face [hub] which prevents flush contact</li> </ul>	4
	Bolt-hole-to-hand-hole cracks	<ul style="list-style-type: none"> <li>— Excessive load</li> </ul>	5
	Hand-hole cracks	<ul style="list-style-type: none"> <li>— Excessive load</li> <li>— Dent, bruise, sharp edge around hand hole</li> </ul>	6
	Circumferential cracks on mounting area of hub-piloted wheels	<ul style="list-style-type: none"> <li>— Excessive load</li> <li>— Use of improper bolt/nut</li> <li>— Insufficient attachment face [hub] backup</li> <li>— Worn or damaged nut</li> <li>— Improper tightening torque</li> </ul>	7
	Cracks at stamp	<ul style="list-style-type: none"> <li>— Excessive stamping depth</li> <li>— Excessive load</li> </ul>	8
	Disc-hat cracks	<ul style="list-style-type: none"> <li>— Excessive load</li> </ul>	9
Deformation	Elongated bolt holes	<ul style="list-style-type: none"> <li>— Loose or worn nut</li> <li>— Insufficient tightening torque</li> <li>— Excessive dirt or nut</li> <li>— Excessive paint buildup</li> <li>— Excessive tightening torque</li> <li>— Broken hardware</li> </ul>	10

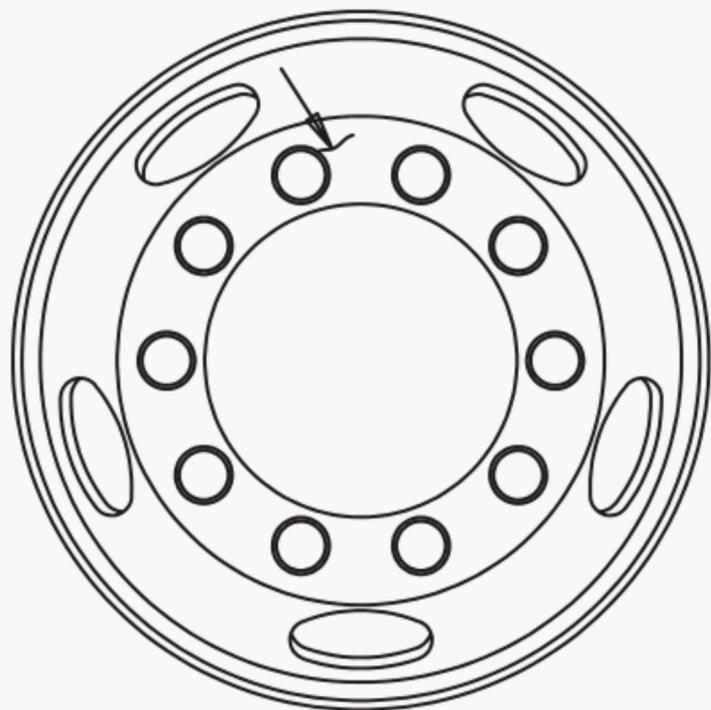
Type	Appearance	Probable cause	See Figure
	Distorted nut seat	<ul style="list-style-type: none"> <li>— Loose inner nut</li> <li>— Use of improper or worn bolt/nut</li> <li>— Excessive tightening torque of inner nut</li> <li>— Improper installation procedure</li> </ul>	11
	Burrs around bolt holes	<ul style="list-style-type: none"> <li>— Excessive tightening torque</li> <li>— Use of improper bolt/nut</li> </ul>	12
W e a r / corrosion	Worn nut seat	<ul style="list-style-type: none"> <li>— Excessive tightening torque</li> <li>— Rust</li> <li>— Improper inner nut contour</li> </ul>	13
	Excessive wear/corrosion of wheel attachment face	<ul style="list-style-type: none"> <li>— Insufficient attachment face [hub] backup</li> <li>— Worn attachment face [hub]</li> <li>— Improper installation procedure</li> </ul>	14

**Table 2 — Typical out-of-service conditions of rims and components**

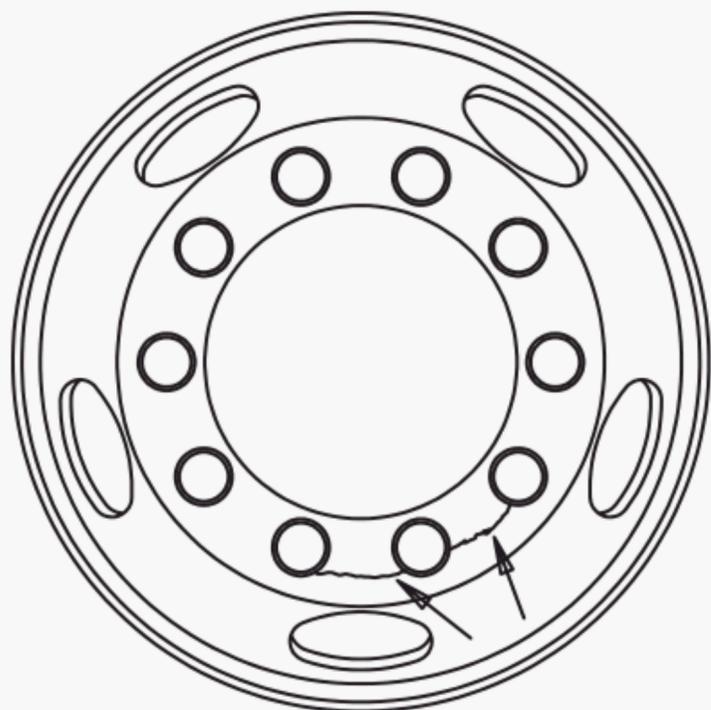
Type	Appearance	Probable cause	See Figure
Crack	Circumferential cracks in rim well	<ul style="list-style-type: none"> <li>— Excessive load, excessive air pressure</li> <li>— Corrosion from excessive airline moisture or improper tyre mounting lubricants, etc.</li> </ul>	15
	Valve-aperture cracks	<ul style="list-style-type: none"> <li>— Excessive load, excessive air pressure</li> <li>— Improper finish of rim hole</li> <li>— Corrosion</li> </ul>	16
	Butt-weld cracks	<ul style="list-style-type: none"> <li>— Excessive load</li> <li>— Improper welding</li> </ul>	17
	Bead-seat cracks	<ul style="list-style-type: none"> <li>— Excessive load, excessive air pressure</li> <li>— Improper matching of tyre and rim</li> <li>— Tyre tool damage</li> <li>— Tyre bead not fully seated against flange</li> </ul>	18

Type	Appearance	Probable cause	See Figure
	Rim-gutter cracks	<ul style="list-style-type: none"> <li>— Excessive load, excessive air pressure</li> <li>— Tyre tool damage</li> <li>— Dent by hammer</li> <li>— Excessive corrosion</li> <li>— Improper trimming of flash butt weld</li> <li>— Mismatch of rim and side ring</li> <li>— Improper tyre mounting</li> </ul>	19
	Disc-to-rim weld cracks	<ul style="list-style-type: none"> <li>— Excessive load, excessive air pressure</li> <li>— Improper welding</li> </ul>	20
	Side-ring cracks	<ul style="list-style-type: none"> <li>— Excessive load, excessive air pressure</li> <li>— Bent side ring</li> <li>— Excessive corrosion</li> <li>— Tyre tool damage</li> <li>— Damaged or distorted rim gutter area</li> <li>— Mismatch of rim and side ring</li> <li>— Use of mismatched tyre</li> <li>— Improper installation procedure of side ring</li> </ul>	21
	Lock-ring cracks	<ul style="list-style-type: none"> <li>— Excessive load, excessive air pressure</li> <li>— Bent lock ring</li> <li>— Excessive corrosion</li> <li>— Tyre tool damage</li> <li>— Damaged or distorted rim gutter area</li> <li>— Use of mismatched lock ring</li> <li>— Improper installation procedure of lock ring</li> </ul>	22

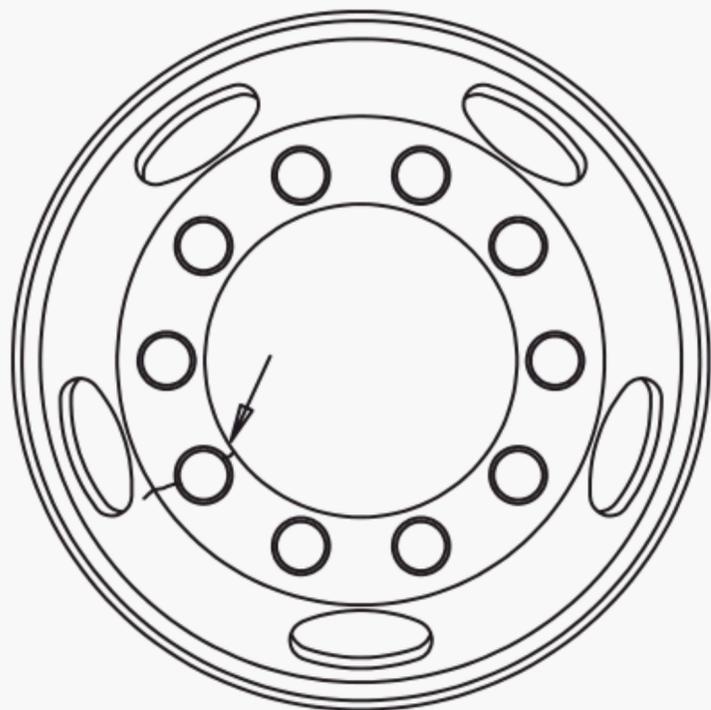
<b>Type</b>	<b>Appearance</b>	<b>Probable cause</b>	<b>See Figure</b>
Deformation	Bent rim flanges	<ul style="list-style-type: none"> <li>— Impact from kerbs, holes, or road hazards</li> <li>— Abuse in tyre mounting or demounting</li> </ul>	23
	Distorted bead seat	<ul style="list-style-type: none"> <li>— Impact damage</li> <li>— Run-flat running</li> <li>— Improper tyre installation procedure</li> <li>— Shipping damage</li> </ul>	24
	Distorted side ring	<ul style="list-style-type: none"> <li>— Improper installation/removal of side ring</li> <li>— Impact damage</li> </ul>	25
	Excessive run-out	<ul style="list-style-type: none"> <li>— Impact damage</li> <li>— Run-flat running</li> <li>— Improper installation procedure</li> <li>— Shipping damage</li> </ul>	26
	Burrs	<ul style="list-style-type: none"> <li>— Tyre tool damage</li> </ul>	27
Wear/ corrosion	Rim flange wear	<ul style="list-style-type: none"> <li>— Tyre chafing</li> <li>— Insufficient air pressure</li> <li>— Excessive load</li> </ul>	28
	Excessive corrosion on tyre side of rim and gutter area	<ul style="list-style-type: none"> <li>— Excessive air line moisture</li> <li>— Improper tyre mounting lubricants</li> <li>— Accumulation of water, mud and salt in gutter area</li> </ul>	29



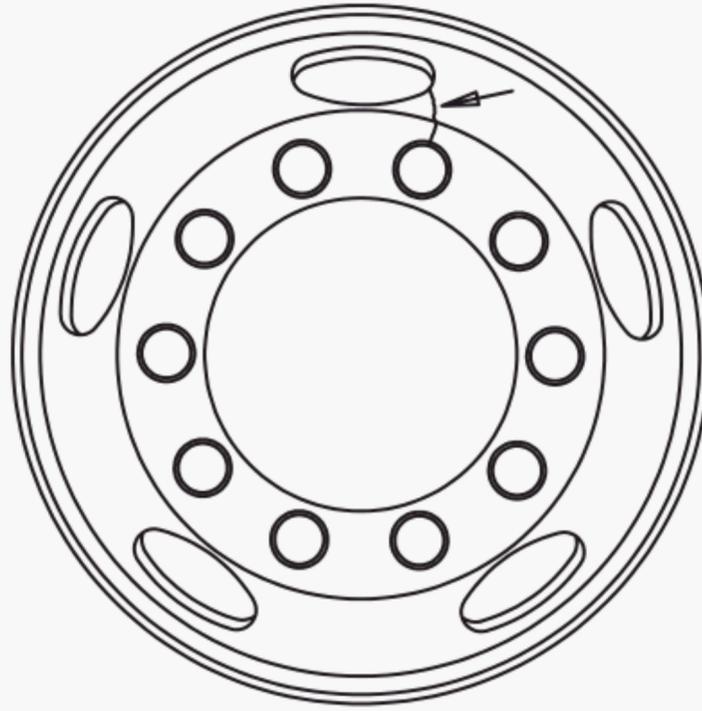
**Figure 2 — Bolt-hole cracks**



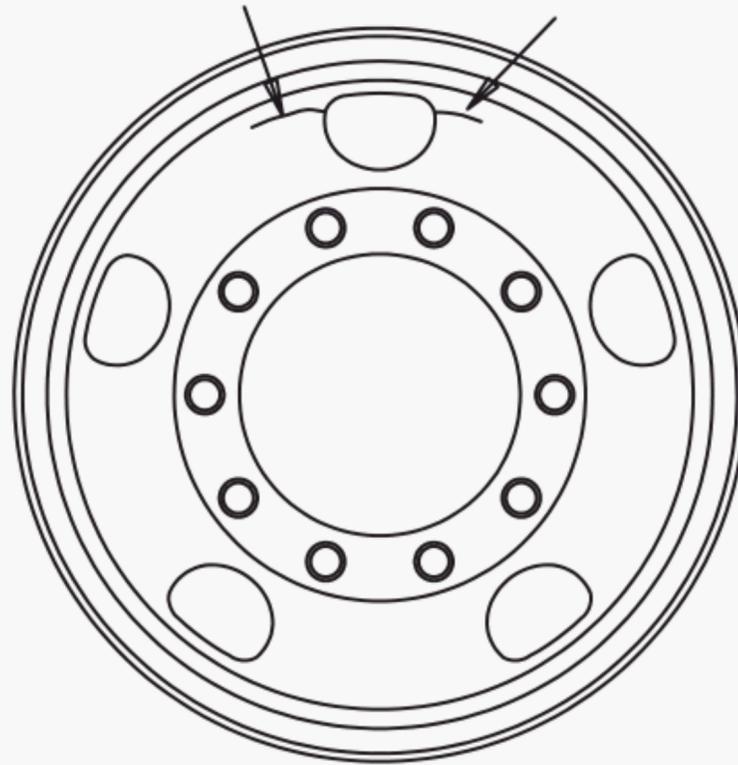
**Figure 3 — Bolt-hole-to-bolt-hole crack**



**Figure 4 — Bolt-hole-to-centre-hole cracks**



**Figure 5 — Bolt-hole-to-hand-hole cracks**



**Figure 6 — Hand-hole cracks**

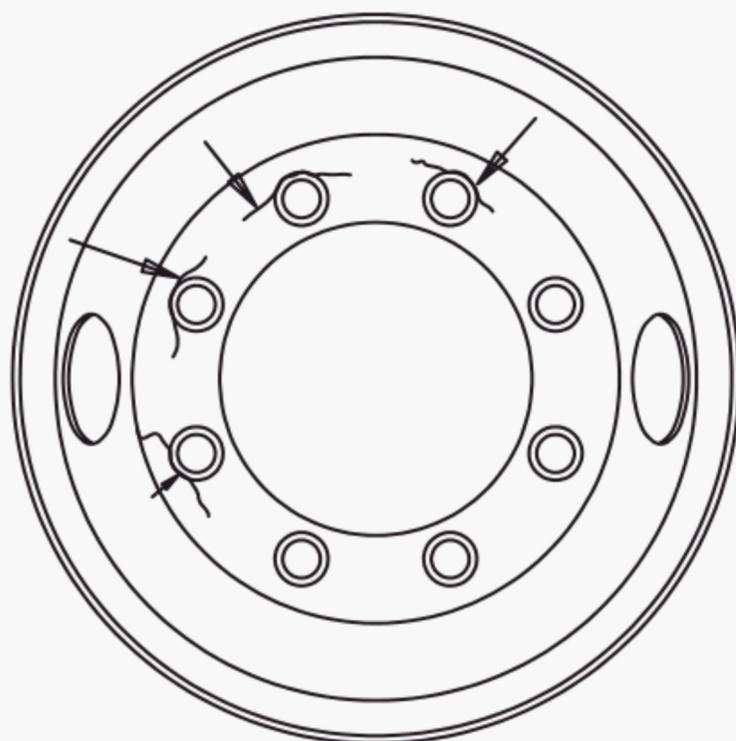


Figure 7 — Circumferential cracks on mounting area of hub-piloted wheels

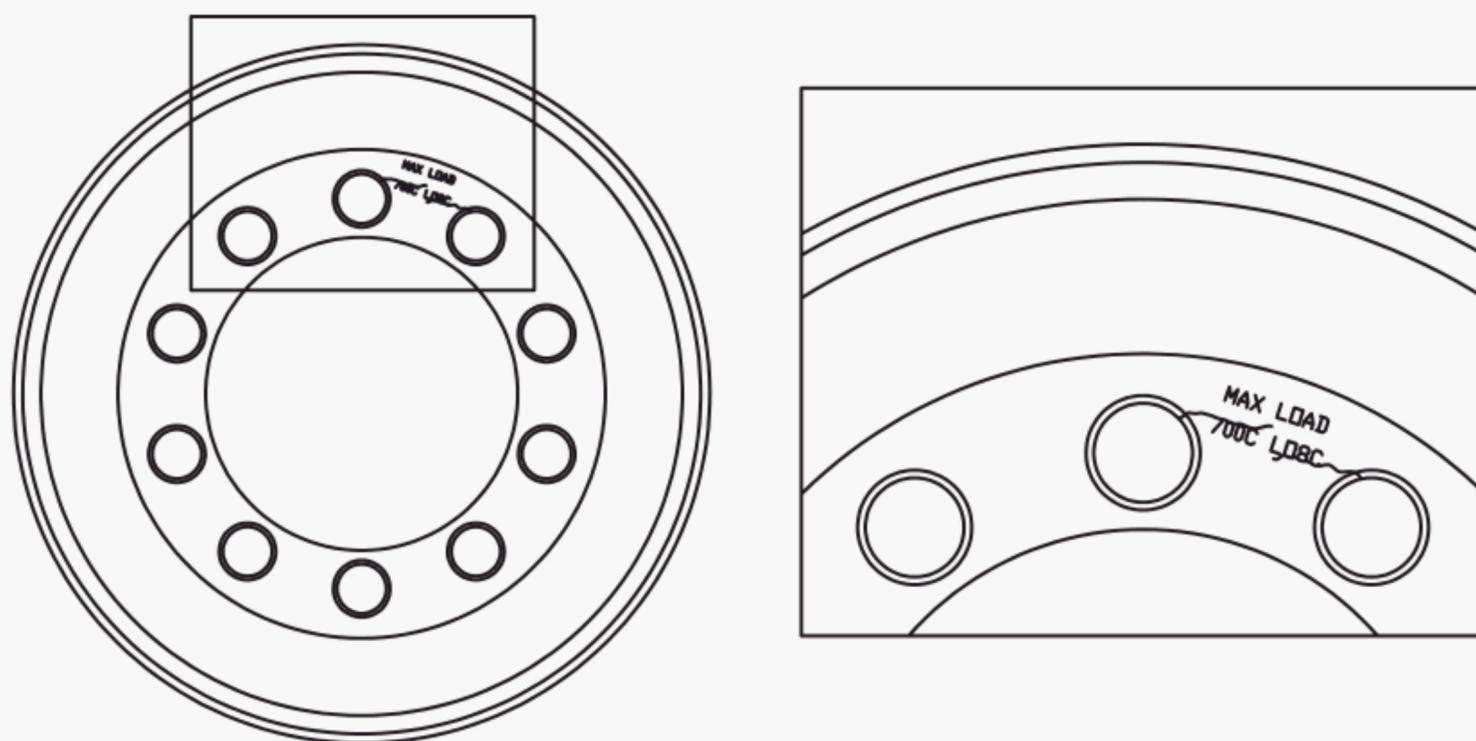


Figure 8 — Crack at stamp

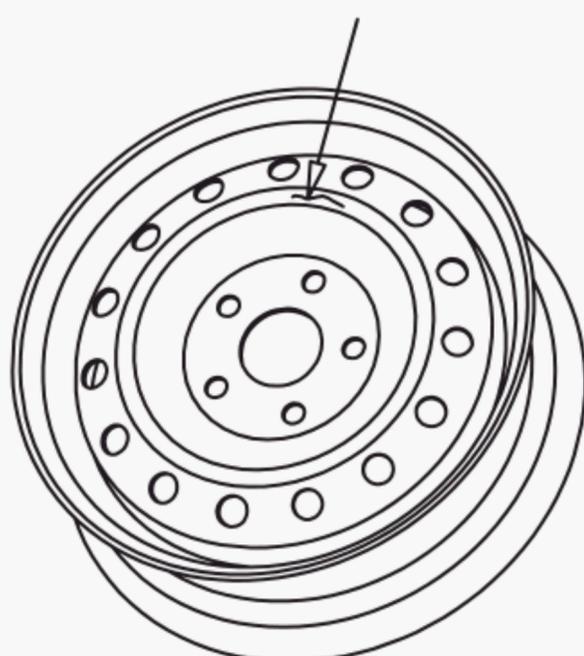


Figure 9 — Disc-hat cracks

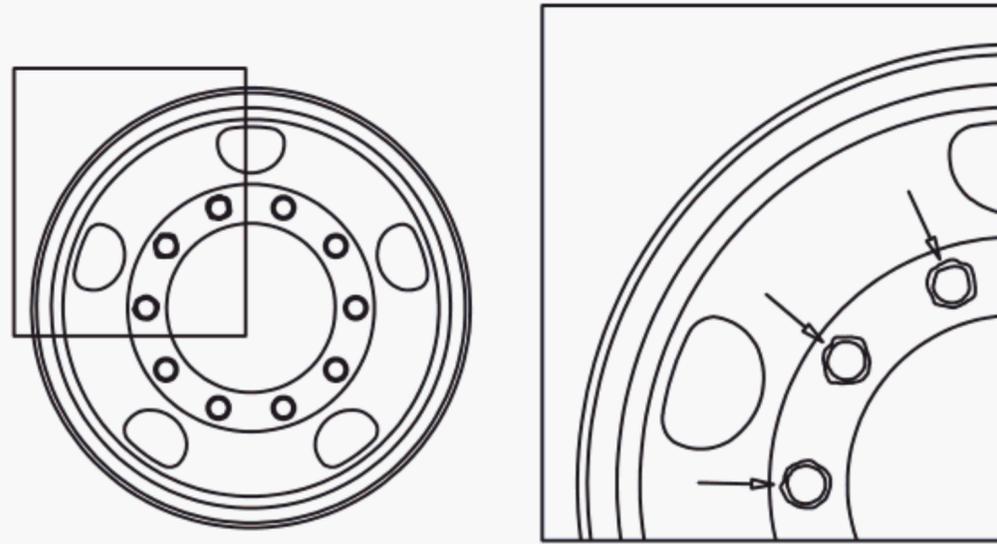
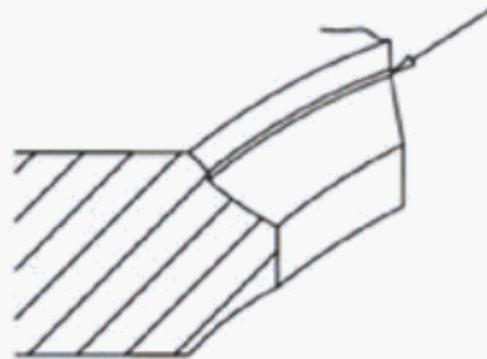
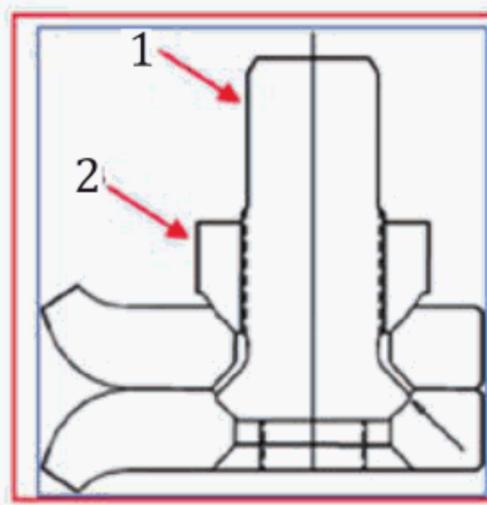


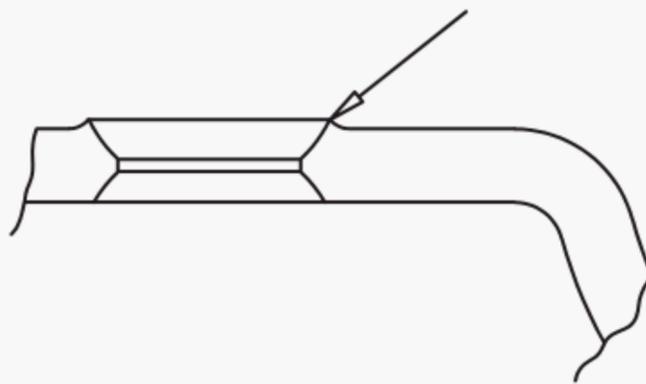
Figure 10 — Elongated bolt holes



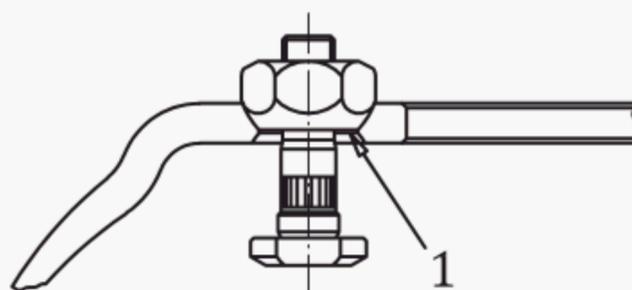
**Key**

- 1 inner nut
- 2 outer nut

Figure 11 — Distort nut seat



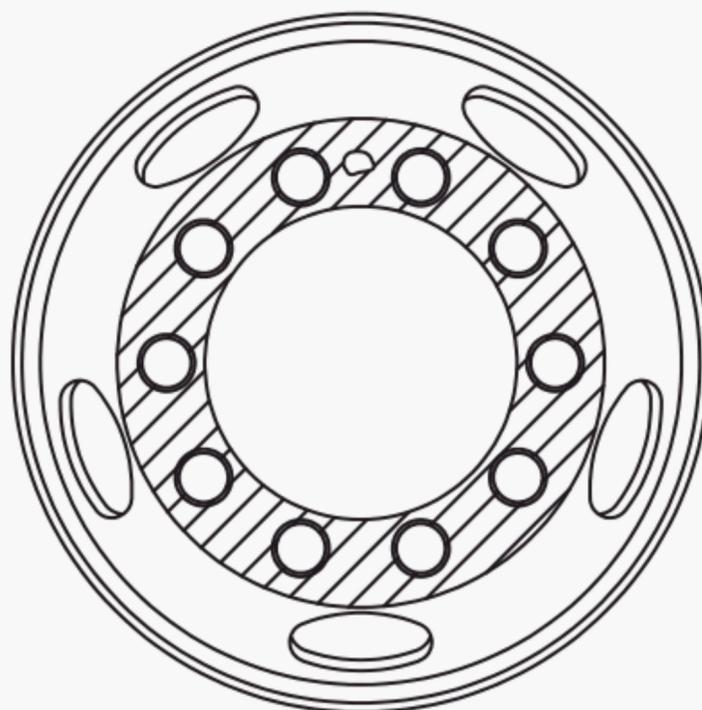
**Figure 12 — Burrs around bolt holes**



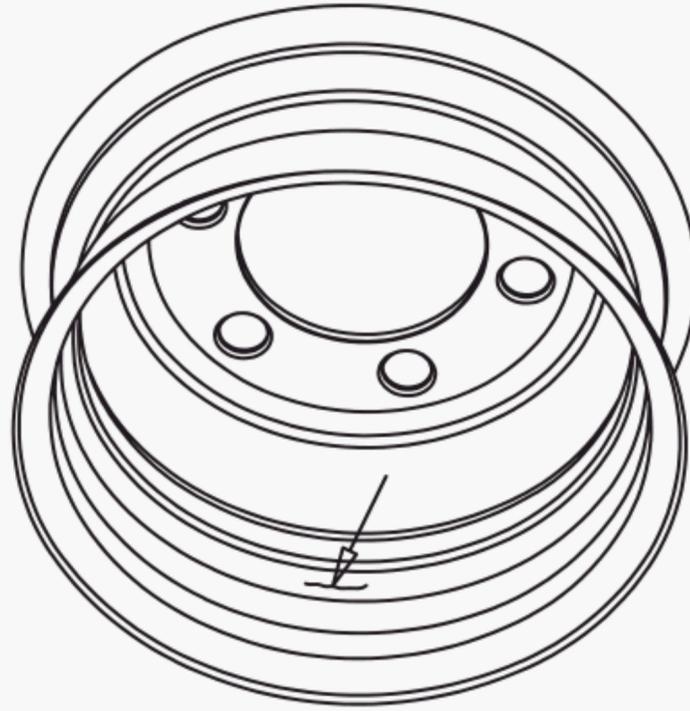
**Key**

1 narrow land

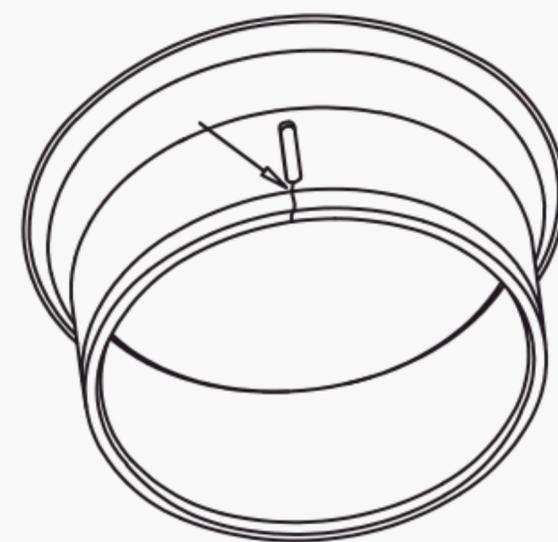
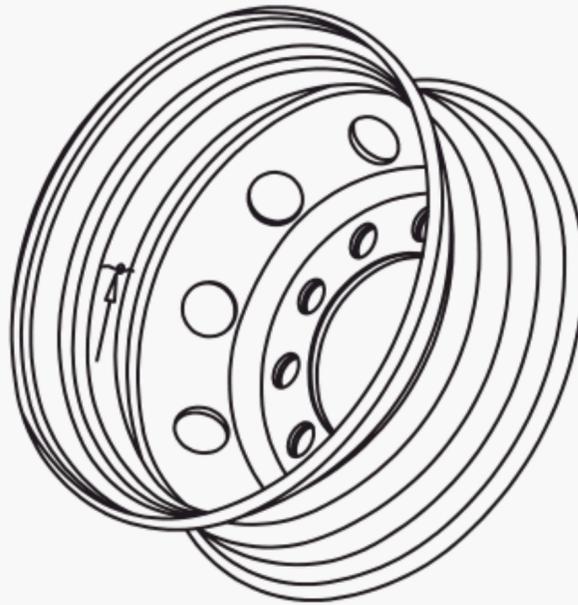
**Figure 13 — Worn nut seat**



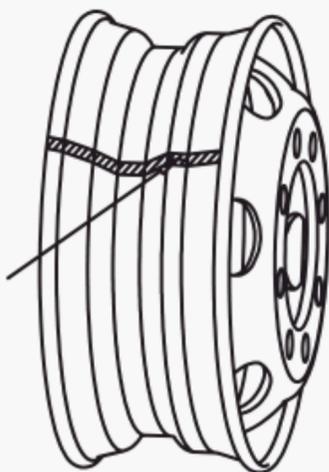
**Figure 14 — Excessive wear/ corrosion of wheel attachment face**



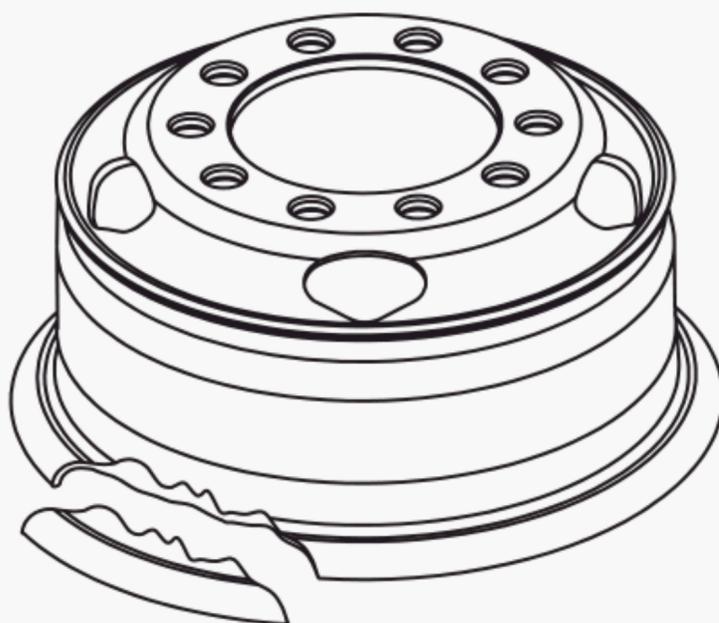
**Figure 15 — Circumferential cracks in rim well**



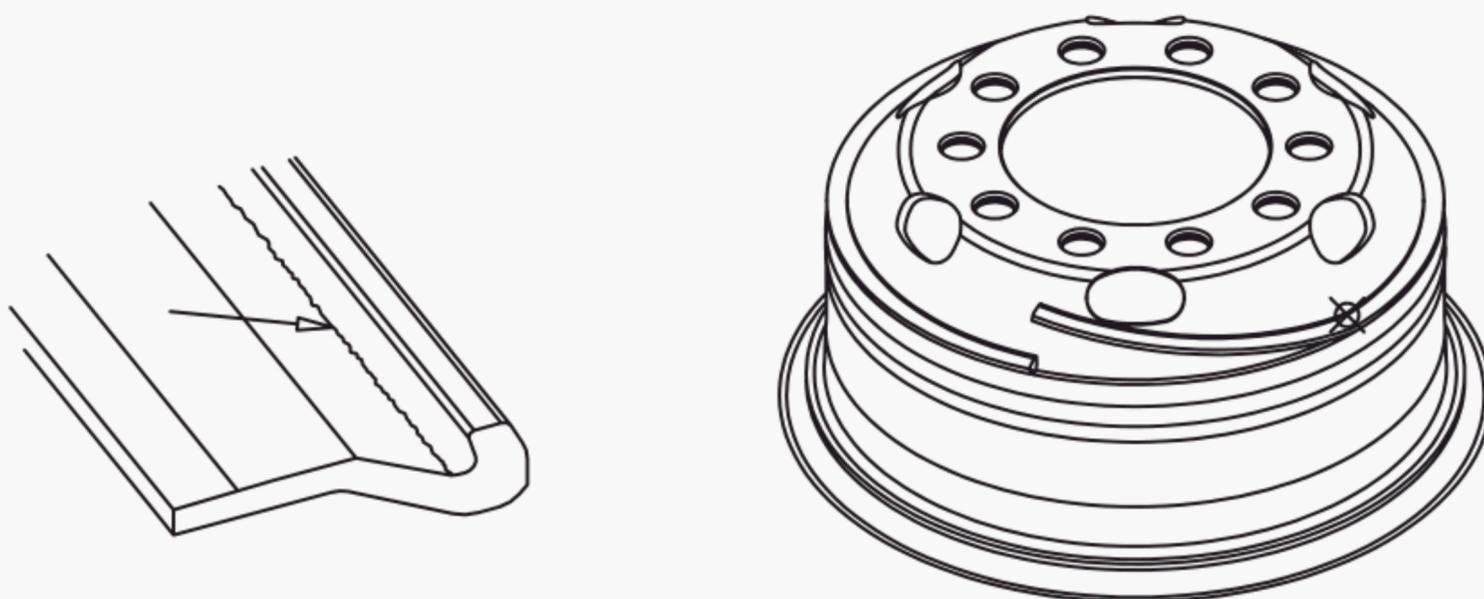
**Figure 16 — Valve-aperture cracks**



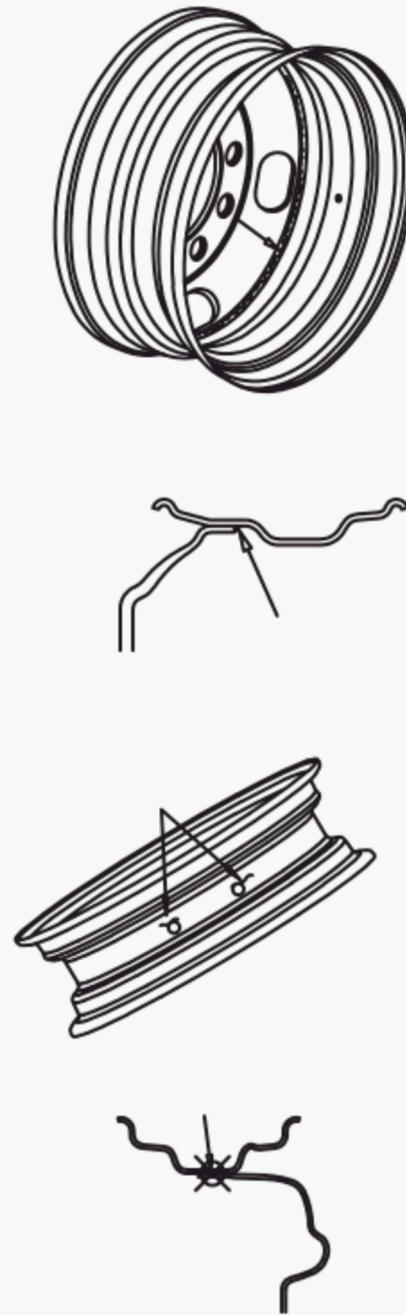
**Figure 17 — Butt-weld cracks**



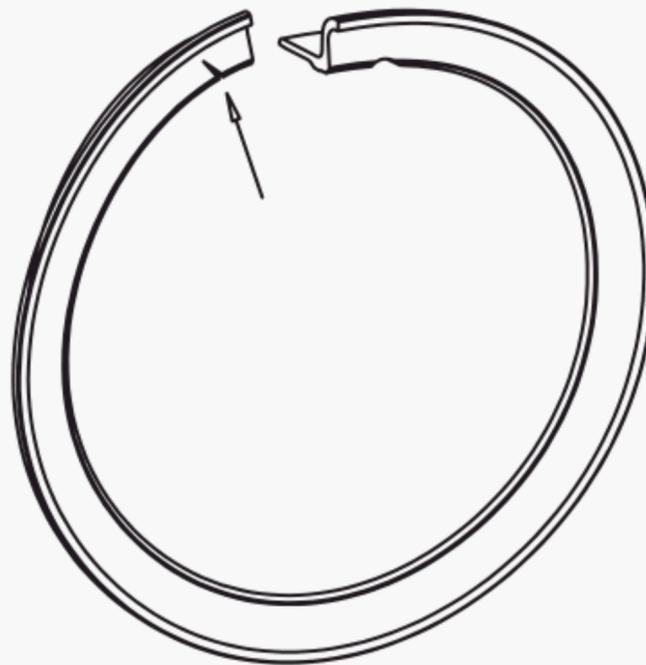
**Figure 18 — Bead-seat cracks**



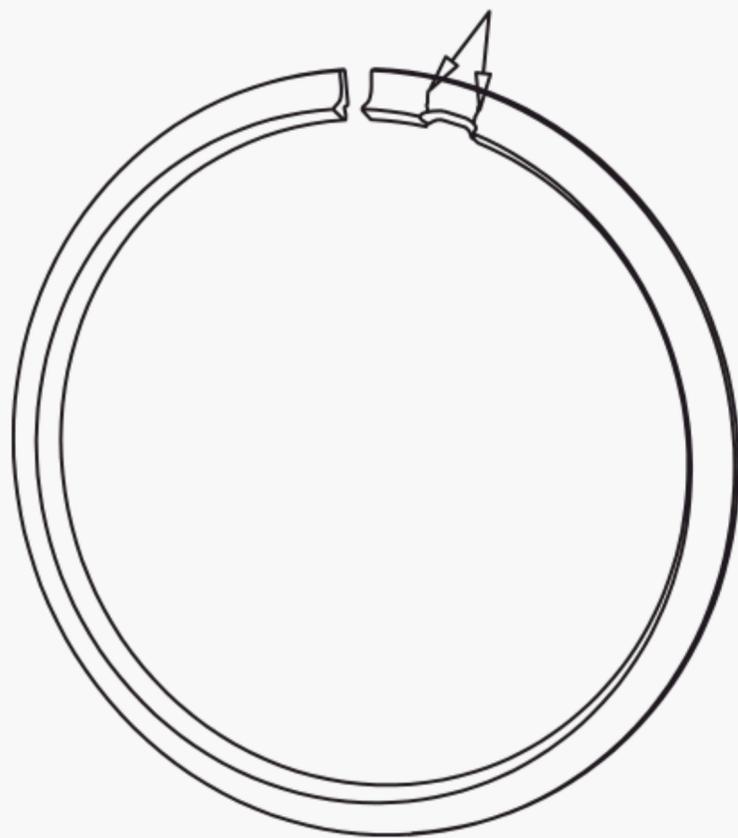
**Figure 19 — Rim-gutter cracks**



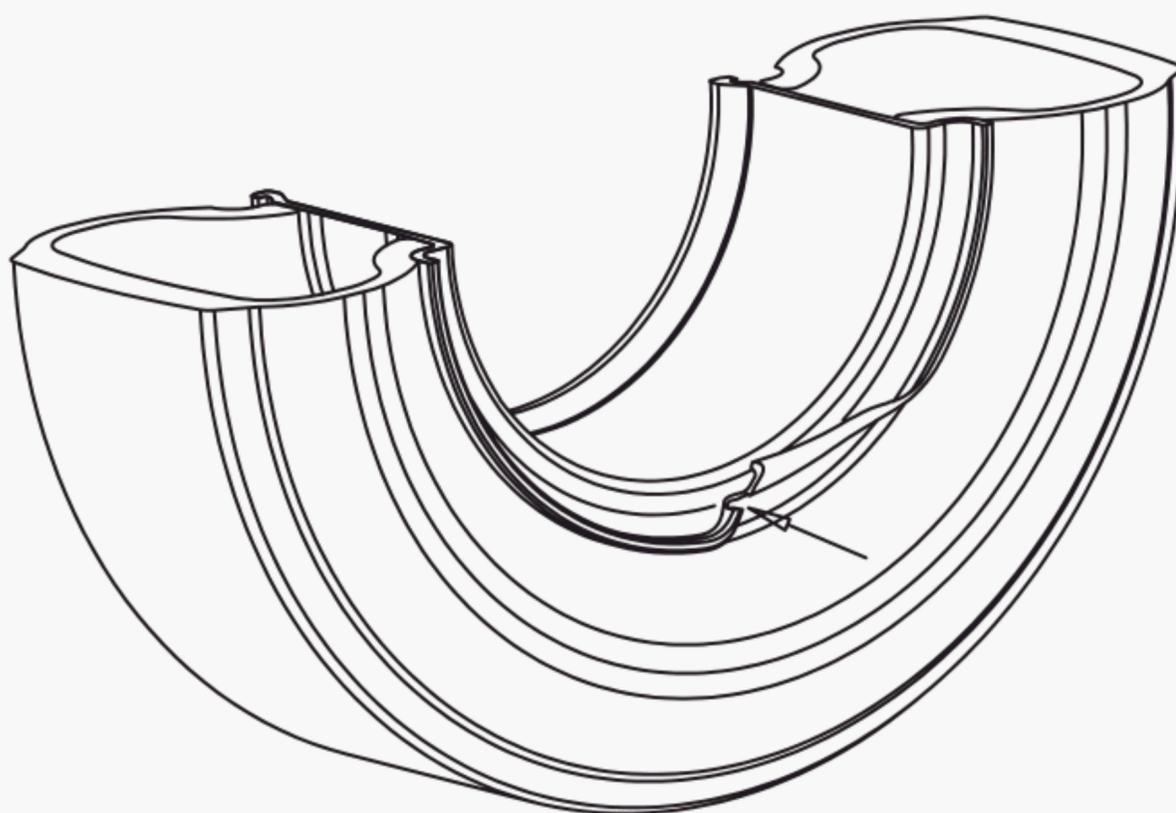
**Figure 20 — Disc-to-rim weld cracks**



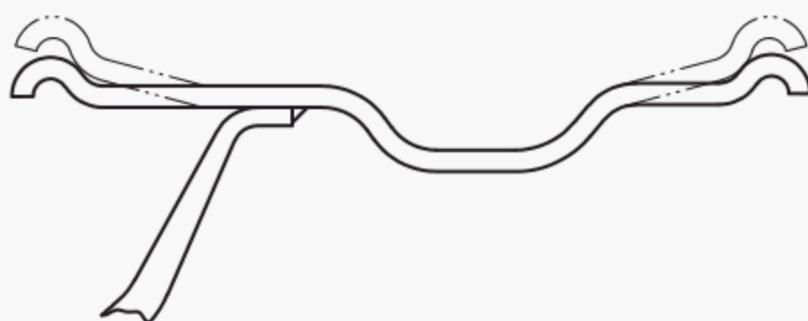
**Figure 21 — Side-ring cracks**



**Figure 22 — Lock-ring cracks**



**Figure 23 — Bent rim flanges**



**Figure 24 — Distorted bead seat**



Figure 25 — Distorted side ring



Figure 26 — Excessive run out

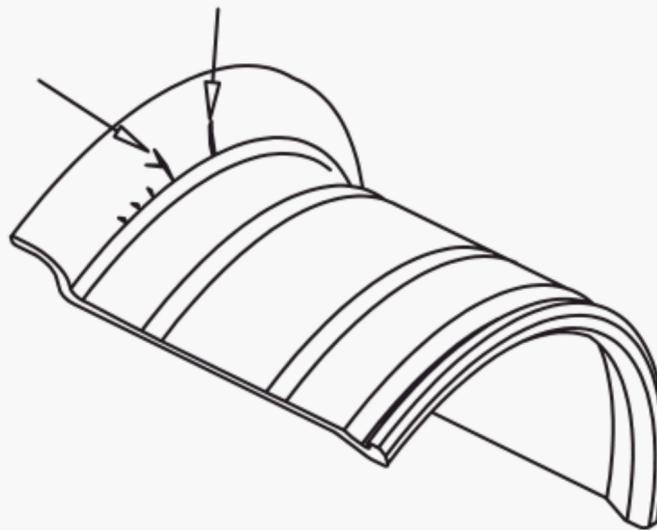


Figure 27 — Burrs

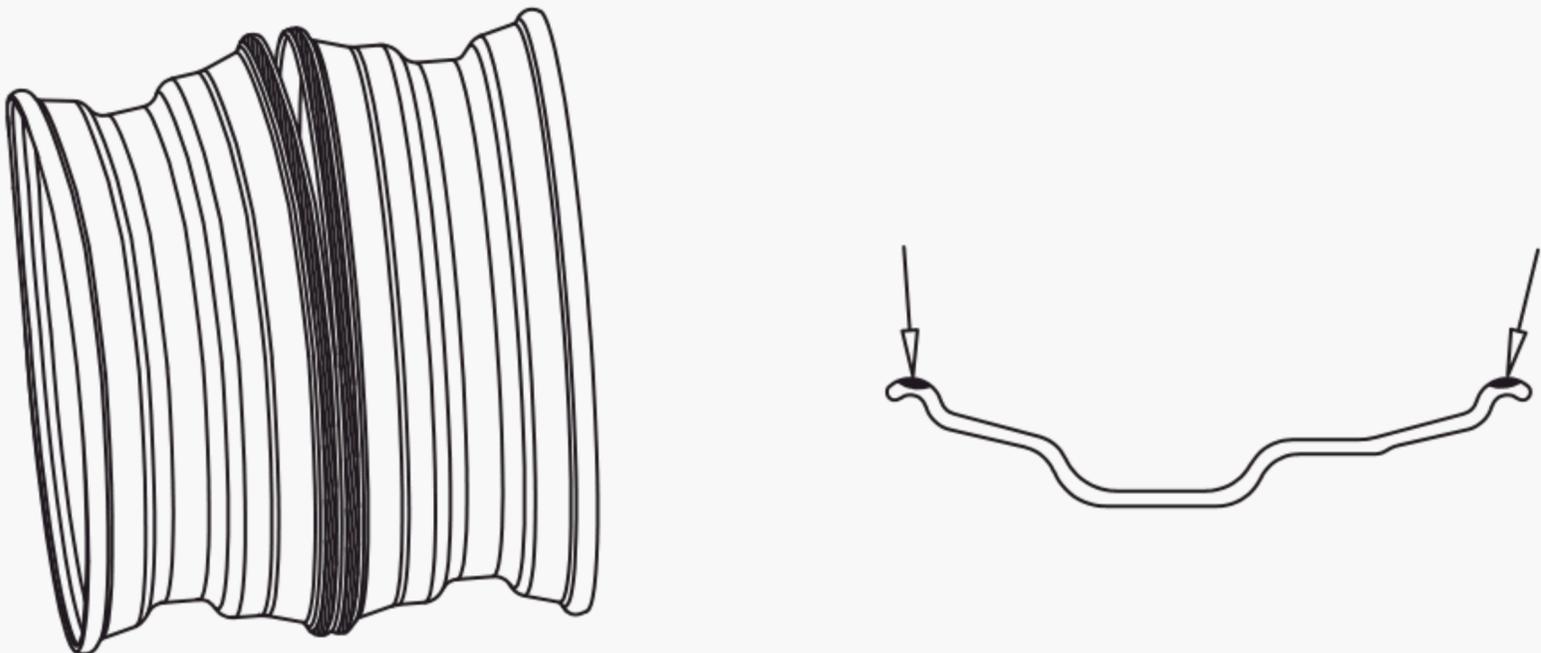
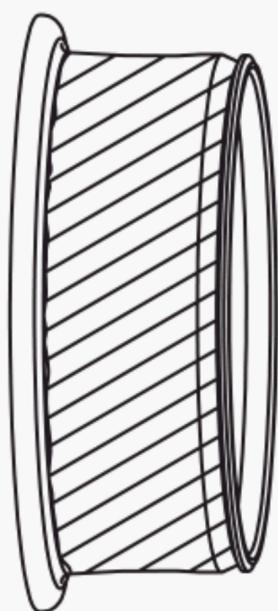
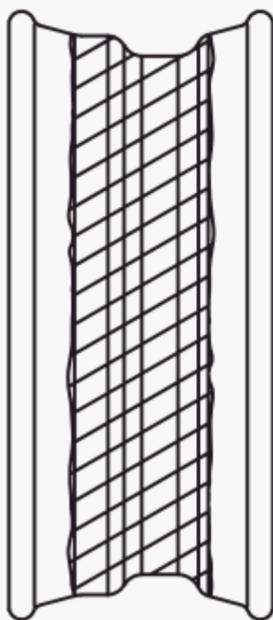


Figure 28 — Rim-flange wear



**Figure 29 — Excessive corrosion on tyre side of rim and gutter area**

## Bibliography

ISO 3833, *Road vehicles — Types — Terms and definitions*

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