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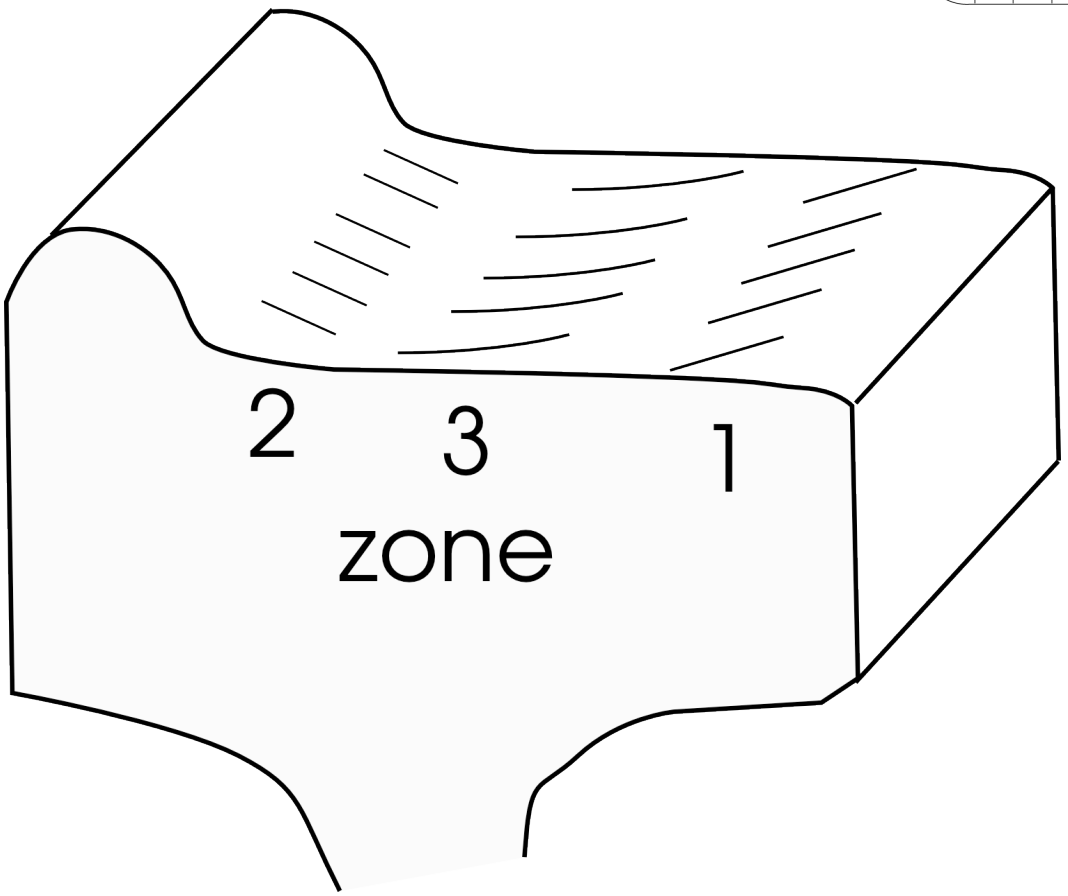

Classification of wheel damage

Internal report

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Cover:
Location of surface initiated rolling contact fatigue

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Classification of wheel damage

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INTRODUCTION

The aim of the report is to define a classification scheme for wheel damage forms to facilitate registration in a database. This scheme should be simple to use, but provide enough information to make an identification of potential causes possible. It sets out from *Wheal Tread Damage – An Elementary Guide* by Roger Deuce.

The proposal only provides a structure of what should be stored in the database. How data is added to the database is another issue. If correctly implemented, there should be a well-defined interface to the database, which would make it trivial to switch between user interfaces, e.g. to touch screen graphical user interface (GUI) where relevant damage levels *etc* can be indicated.

The proposed reporting of wheel damage differs between two cases: If the damage is deemed to be the *main cause for reprofiling*, the classification code for the damage is reported in the database. If the damage is *not* the main cause for reprofiling, the classification (and additional data) is added in short form as a comment to the report of the main cause. The reason for this procedure is to avoid duplicate reports for single reprofiling events, while still gathering as much information as possible.

In the current report, the following damages have been considered:

- Surface initiated rolling contact fatigue (RCF)
- Thermal cracks
- Wheel flat(s)
- Miscellaneous
- Geometry related causes with sub-classes:
    - QR
    - Thin flange
    - Hollow wear
    - Out-of-roundness
    - Diameter difference within boggie
    - Diameter difference within wheelset

Current reporting procedures commonly employ the following codes for reprofiling causes

81 – QR
82 – Thin flange
83 – Hollow wear
84 – Local cracking
85 – Wheel flat
86 – Circumferential cracking
87 – Out-of-roundness
88 – Diameter difference

89 – Other cause / revision

A transparent and smooth transition would be obtained if these damage codes are replaced as:

81 – QR
82 – Thin flange
83 – Hollow wear
84 – Surface initiated rolling contact fatigue (RCF)
85 – Wheel flat(s)
87 – Out-of-roundness
88 – Diameter difference (within wheelset or within boggie added as a comment)
89 – Other cause / revision (specification added as a comment)
90 – Thermal cracks

This numbering has been adopted in the following.

Note that this document is an English translation. The Swedish version is to be considered as the base document.

PROPOSED CATEGORIZATION OF WHEEL DAMAGES

84 SURFACE INITIATED ROLLING CONTACT FATIGUE (RCF)

Surface initiated rolling contact fatigue is manifested as cracks formed as a result of severe deformation (“mangling out”) of a thin surface layer, which eventually results in fatigue crack initiation and growth of small cracks at a shallow angle into the wheel. At a depth of some millimetres, crack branching and deviation to a growth orientation perpendicular to the wheel rim tends to occur. By the joining of cracks, pieces of the wheel rim may break lose.

Location and extent

Indicate if cracks are occurring in zone 1, and/or 2, and/or 3; see Figure 1 (left).

Indicate if the cracks are occurring around the entire wheels, in clusters or at one spot, see Figure 1 (right).

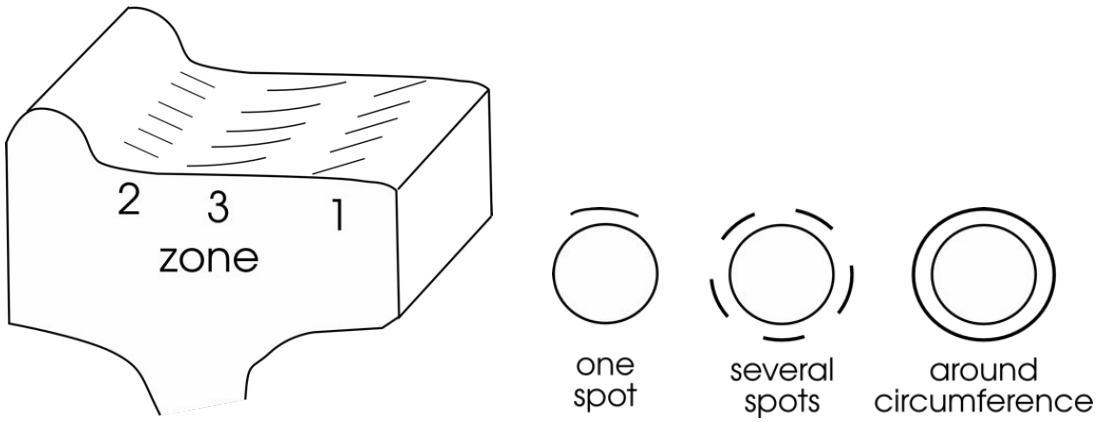

Figure 1. Location (left) and extent (right) of surface initiated rolling contact fatigue

Severity level

Indicate the severity of the cracking; see Figure 2 and Figure 3.

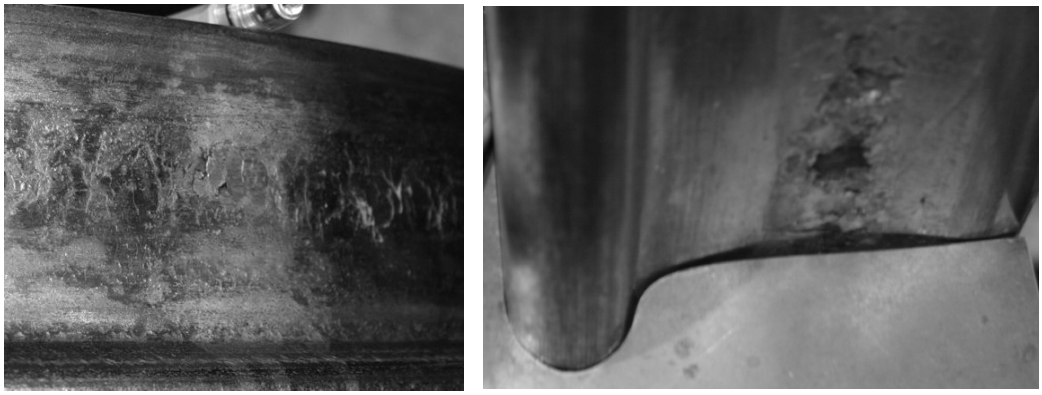

Figure 2. Examples of medium (left) and high (right) severity of surface initiated rolling contact fatigue in zone 3.

Figure 3. Examples of low (left) and high (right) severity of surface initiated rolling contact fatigue in zone 1.

Reporting

Zone (Z)			Extent (E)			Severity (S)		
1	2	3	one (1)	clusters (2)	around (3)	low (l)	medium (m)	high (h)

Primary cause of reprofiling: Indicate damage code for surface initiate RCF. Indicate zone (1, 2, 3), extent (one, clusters, around) and severity (low, medium, high).

Not a primary cause for reprofiling: Indicate damage code for surface initiate RCF, zone, extent and severity as a comment related to the report of the primary reprofiling cause (as an example 84-Z13-E2-Sm would indicate clusters of surface initiated RCF cracks in zones 1 and 3 with the severity of the worst cracks classified as medium).

85 WHEEL FLAT(S)

Location and extent

Indicate if there is a single wheel flat or several wheel flats around the circumference.

Severity level

Indicate length of the largest wheel flat of the wheel; see Figure 4.

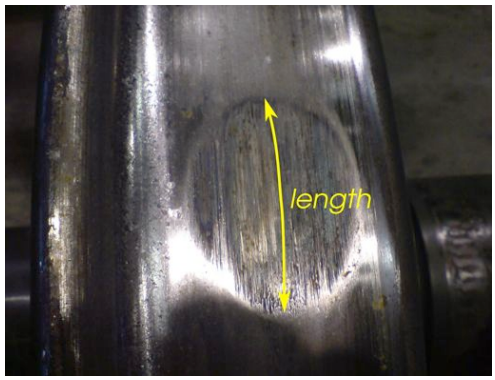

Figure 4. Measurement of wheel flat length (in zone 3)

Reporting

Extent (E)		Wheel flat length (L) [mm]
one (1)	multiple (2)	

Primary cause of reprofiling: Indicate damage code for wheelflat. Indicate whether there are one or several wheel flats and note the circumferential length of the longest wheel flat.

Not a primary cause for reprofiling: Indicate damage code for wheelflat, extent (one or several) and the circumferential length of the longest wheel flat as a comment related to the report of the primary reprofiling cause (eg. 85-E2-L32 for multiple wheelflats where the circumferential length of the longest is 32 mm).

90 THERMAL FATIGUE

The typical appearance of mild thermal fatigue is a “brick” or “crocodile skin” pattern on the wheel rim. A more severe thermal loading will give rise to transverse cracks that may extend several millimetres radially into the wheel tread. In extreme cases the result may even be a complete failure of the wheel when the crack propagates into the wheel hub, as seen in Figure 5 (right).

Location and extent

Indicate if the cracks are occurring in zone 1, and/or 2, and/or 3; see Figure 5 (left).

Indicate if the cracks are occurring around the entire wheels, in clusters or at one spot, see Figure 5 (right).

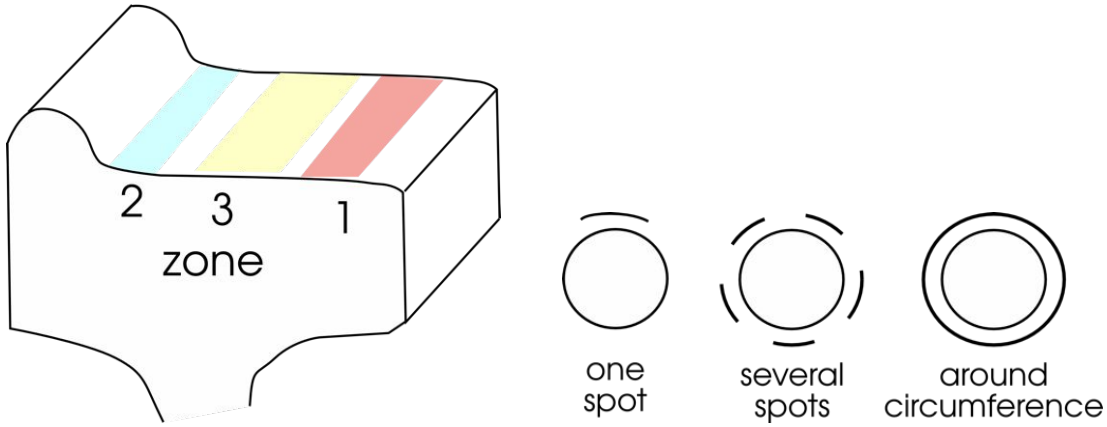

Figure 5. Location (left) and extent (right) of thermal fatigue

Severity level

Indicate the severity of the thermal cracking; see Figure 6.

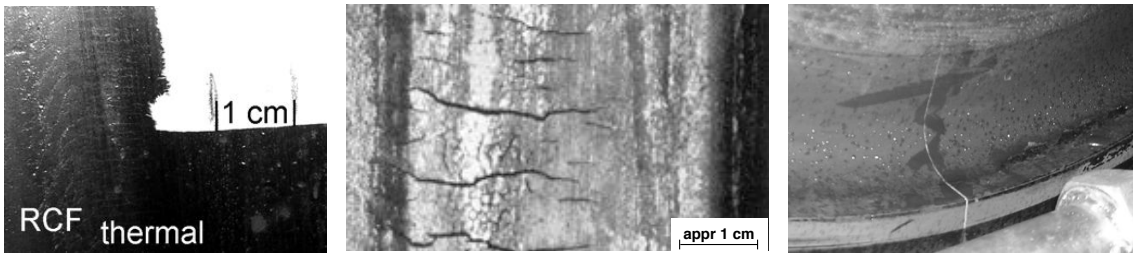

Figure 6. Examples of low (left), high (middle) and high (right) severity of thermal cracks. The picture to the right shows a very severe damage that should result in a separate investigation to clarify causes etc.

Reporting

Zone (Z)			Extent (E)			Severity (S)		
1	2	3	one (1)	clusters (2)	around (3)	low (l)	medium (m)	high (h)

Primary cause of reprofiling: Indicate damage code for thermal cracks. Indicate zone (1, 2, 3), extent (one, clusters, around) and severity (low, medium, high).

Not a primary cause for reprofiling: Indicate damage code for thermal cracks, zone, extent and severity as a comment related to the report of the primary reprofiling cause (eg. 86-Z3-E3-Sl for thermal cracks in zone 3 around the circumference with severity classified as low).

89 MISCELLANEOUS – WITH SPECIFIED CAUSES

Of other types of damage, particular notice should be given to subsurface initiated rolling contact fatigue (RCF). These damages should always be reported since they may imply a safety issue. In cases where final fracture has occurred, the identification is straightforward; see Figure 7.

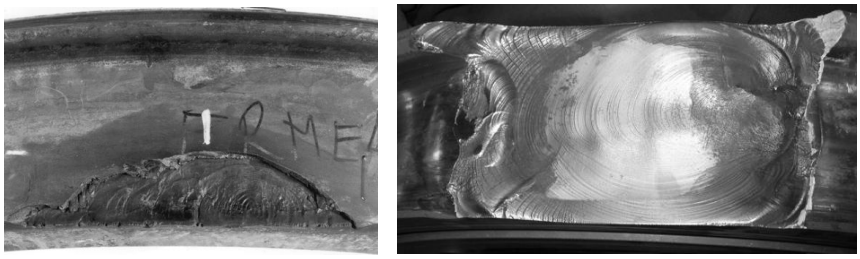

Figure 7. Examples of subsurface initiated rolling contact fatigue.

Cracks that have not propagated to cause failures are more difficult to detect. They are typically manifested as a flat crack face area below the surface that appears to grow as more surface material is removed in the reprofiling process.

For descriptions of other damage types, please refer to Roger Deuce: *Wheal Tread Damage – An Elementary Guide*.

Reporting

Subsurface RCF (C1)	Tread rollover (C2)	Indentations / cuts / scoring (C3)	Metal pick-up (cladding) (C4)	Other cause (C5)
Include photo(s) Report for investigation				Add description and photos

Primary cause of reprofiling: Indicate damage code for miscellaneous. Indicate cause.

Not a primary cause for reprofiling: Indicate damage code for miscellaneous, and the short code for the specified cause as a comment related to the report of the primary reprofiling cause (eg. 89-C3 for indentations).

GEOMETRY RELATED CAUSES

Measurements related to these causes are indicated separately.

QR (81)	Thin flange (82)	Hollow wear (measured as flange height) (83)	Out-of-roundness (87)	Diameter difference within wheelset (88a)	Diameter difference within boggie (88b)

Primary cause of reprofiling: Indicate the cause by ticking the relevant box.

Not a primary cause for reprofiling: Do not indicate the cause. Only the geometry measurements are reported (following separate instructions).

APPENDIX – REPORT SHEET

84 – Surface initiated rolling contact fatigue (RCF)

Zone (Z)			Extent (E)			Severity (S)		
1	2	3	one (1)	clusters (2)	around (3)	low (l)	medium (m)	high (h)

85 – Wheel flat(s)

Extent (E)		Wheel flat length (L) [mm]
one (1)	multiple (2)	

90 – Thermal cracks

Zone (Z)			Extent (E)			Severity (S)		
1	2	3	one (1)	clusters (2)	around (3)	low (l)	medium (m)	high (h)

89 – Miscellaneous – with specified causes

Subsurface RCF (C1)	Tread rollover (C2)	Indentations / cuts / scoring (C3)	Metal pick-up (cladding) (C4)	Other cause (C5)
Include photo(s)				Add description and photos

Geometry related causes

QR (81)	Thin flange (82)	Hollow wear (measured as flange height) (83)	Out-of-roundness (87)	Diameter difference within wheelset (88a)	Diameter difference within boggie (88b)

Comments