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Translation

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Treatment of rail defects

Traitement des défauts de rail

Schienenfehlerbehandlung



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Summary

The objective of this leaflet is to supplement the information in *UIC Leaflet 712* by giving recommendations regarding the maintenance of rails (monitoring and elimination of defects).

The document contains three chapters:

- 1: Key inspection factors
- 2: Defect classification and action to be taken
- 3: Detection methods.

and three Appendices

- Examples of research results on crack growth rates
- Defect management
- Qualification of operators and approval of inspection equipment.

This document takes account of recent experience acquired by railways on the how these problems develop and the measures to be applied to rail defects caused by contact rolling fatigue which is an increasingly common phenomenon.

This document is limited to describing the principles of monitoring and eliminating rail defects which may result in rail cracks and breakages.

1 - Key inspection factors

1.1 - Simple laws concerning crack growth

Defect crack growth can be expressed as an increase in defect size per accumulated gross ton traffic load (million gross tons - MGT). Defect size can be denominated in mm or percentage of cross section of rail head. Crack growth depends on many factors where the most important are:

- static axle loads,
- dynamic wheel loads,
- rolling stock running characteristic (traction, brakes, etc),
- rail section,
- rail steel,
- defect type,
- temperature differential (rail temperature - stress free temperature),
- residual rail stress,
- rail head wear,
- track geometry.
- track stiffness.

As a part of the "UIC/WECC Joint research project on Rail Defect Management", a sensitivity analysis was performed to demonstrate how different traffic and track conditions affect crack growth rate (see Fig. 2 - page 3). Fig. 1 shows the result of the analysis.

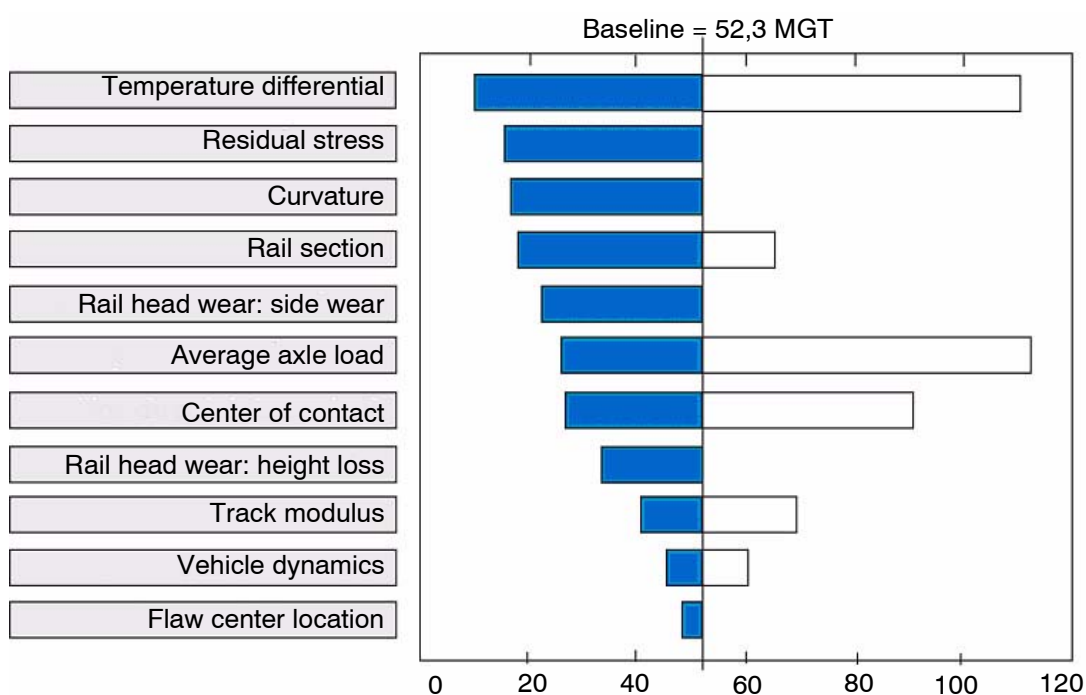


Fig. 1 - Influence of various factors on crack growth rate (variation of the P-F interval)

The various factors are ranked according to the impact the crack growth caused has on rail life span (million gross tons).

A crack will have a certain detectable size (P - potential). This depends on the detection technique used. From this size the propagation of the crack can be followed until it reaches the critical size where a rail break can be expected (F- failure). The time or traffic load between these sizes can be used to define the P-F interval.

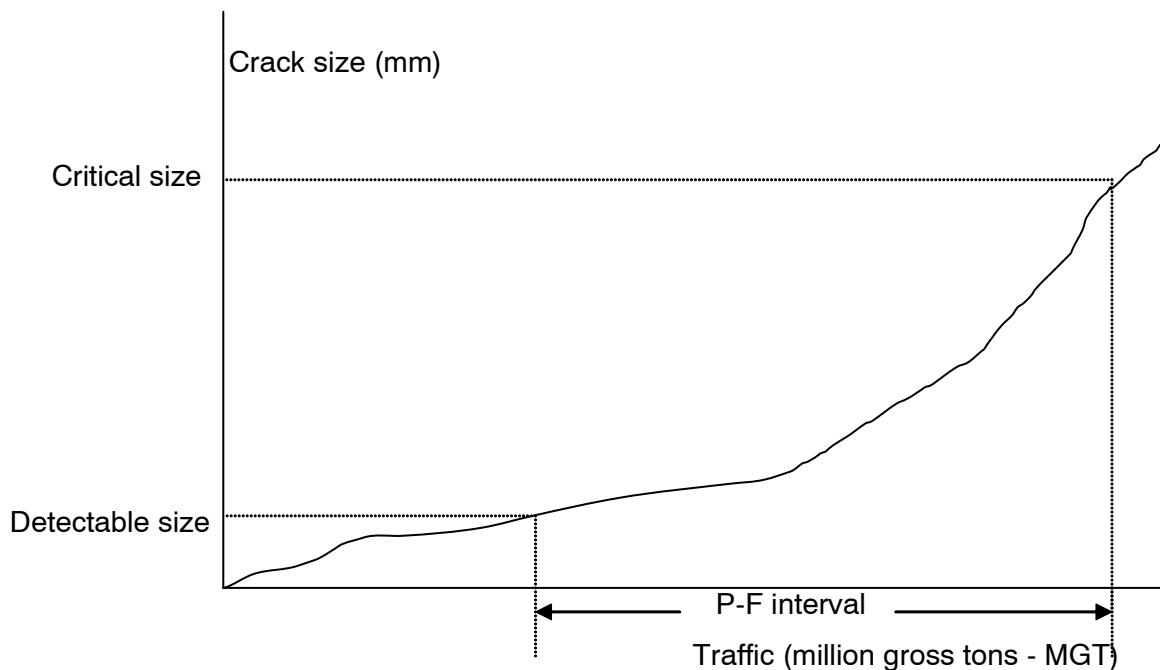


Fig. 2 - Definition of the P-F interval

For all type of defects, crack growth rates can vary considerably. However simple crack growth models can be produced for transversal defects in the rail head area (see Appendix A - page 21).

1.2 - Key parameters for planning of inspection cycles

Minimum requirements

- Track class:
Derived from national rules, normally based on traffic load and/or speed.
- Traffic load:
May be the real traffic load or an equivalent traffic load, for example based on the UIC groups.

Recommended requirements

In addition to the minimum requirements, the following conditions are to be taken into account:

- **Line criticality**
Criticality is defined as the product of the frequency of incident and incident gravity, both in terms of safety and traffic punctuality, for example, accidents in tunnels, on bridges, etc. This factor can be calculated based on an analysis of rail breakage statistics.
The criticality of a line may also be defined according to traffic flow. For example, the risk of traffic disruption on a single track line used by a high number of trains is higher than on a double track line where a change of track is possible.
- **Special areas**
These are areas where experience has shown the risk of defects occurring is high and which must be subject to a shorter inspection cycle, with specialised methods to be applied in some cases for detecting specific defects:
 - Rails susceptible to production related defects or which have been manufactured using old production techniques (ingot casting, high levels of impurities, inappropriate NDT final production control);
 - Environmental consequences caused by the presence of salt and other chemicals which, in conjunction with electrical currents, can lead to rail corrosion. Such areas are to be monitored using appropriate methods and inspection cycles (e.g. tunnels, level crossings);
 - Tracks which are susceptible to rolling contact fatigue defects;
 - Machined rail components such as switches, crossings and rail ends on fish-plated tracks.
- **Combined maintenance activities**
When various maintenance activities are to be carried out in the same area at the same time on a section of track closed to traffic for this purpose, a preliminary inspection campaign shall be carried out to detect as many rail defects as possible to be corrected during this combined maintenance period.

Use of state of the art technology

Monitoring the development of rail defects (risk based rail management).

The evaluation of the data gathered from previous inspections will indicate tendencies for the number and growth of rail defects. These tendencies can be used to define the optimum inspection cycle using a pre-defined risk analysis based on the characteristics of the track.

The inspection interval can be adjusted according to whether there is an increase or decrease in the defect rate.

1.3 - Rail inspection cycles

1.3.1 - Overview

Rail inspection is a vital component in rail maintenance. It is a way of ensuring an acceptable security level for traffic and a viable maintenance level for rail and the underlying track.

Every infrastructure manager has its own defect management policy, which makes it impossible to recommend specific inspection cycles. For this reason the present leaflet merely indicates factors to be taken into consideration when planning inspection cycles. It is the responsibility of the infrastructure manager to adapt these factors according to its own requirements.

The periodicity of the inspection cycles based on the key parameters defined in point [1.2 - page 3](#) may be adjusted according to local climatic conditions.

Ultrasonic inspections are problematic in very cold conditions. In addition, it is difficult to achieve a good welding quality at very low rail temperatures.

1.3.2 - Planning of inspection cycles

The planning of rail ultrasound inspections is a complex issue on account of the high number of variables and consequences.

Inspection cycles are traditionally organised at fixed intervals according to track class. While this is a simple planning method, it nevertheless results in unnecessary inspections being carried out in some cases and too few in others.

With the development of planning and IT tools it is now possible to use more sophisticated methods which make efficient use of inspection resources. This calls for consistent collection and management of track data ([see Appendix B - page 23](#)).

For some rail production methods, replacement of the rail may be more effective than monitoring until defects appear (for example defect 213 - *UIC Leaflet 712*).

2 - Defect types and minimum measures to be taken

2.1 - Defect types

Efficient rail defect management is dependent on the defects being classified into a small number of defect types.

Defect type is defined by the potential detection methods, growth rate and risk of breakage in relation to size.

Rail defects can therefore be divided into 6 categories.

2.1.1 - Transversal cracks

Related to the following UIC codes (*UIC Leaflet 712* - see Bibliography - [page 27](#)):

111	211	411
		421
		431
		471

In case of train passage, an oscillating stress will be exerted on the rail defect, which could lead to fatigue growth of the defect.

Low temperatures and their resulting thermal stresses will reduce the critical size for this defect - rail breakages therefore occur more frequently in the winter.

The crack grows exponentially causing a reduction of the rail cross-section and consequently reducing the rail strength considerably.

The size of the defect can be given in mm or as a percentage of the rail head surface.

2.1.2 - Longitudinal horizontal cracks

Related to the following UIC codes:

112	212	412
1321	2321	422
1322	2322	432
	239	472

Longitudinal horizontal cracks can occur in the rail head or web, or in the transition area between the rail head and web or rail web and base. These cracks are progressing longitudinally in the rail parallel to the longitudinal rail axis. The cracks may propagate upwards or downwards before breakage occurs.