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TREATMENT REGARDING THE MAINTENANCE OF RAILWAY RAILS

Ivan Vitez, Ivan Budić, Vlatko Marušić
all Faculty of Mechanical Engineering Slavonski Brod, University of Osijek
Trg I. B. Mažuranić 2, Slavonski Brod
Croatia

ABSTRACT

In modern railway exploitation, rails are exposed to a constant increase of speed and loading on the vehicle axles and to constant stress increase in welded railway tracks. To meet the increased exploitation requirements, new requirements regarding rail steel quality have been set out in standards for manufacture and delivery of railway rails. By each railway track maintenance always involve the removal of a number of rails because of cracking or damage resulting from manufacturing defects and/or traffic loads. The monitoring of the behaviour of rails in the track must be connected with computer processing with the aim that users and producers could focus their efforts in improving the quality of the rails and the conditions of their use.

This paper elaborate an overlook of the treatment regarding to rail defects caused by rolling contact fatigue (RCF) which is an increasingly common phenomenon in last decade on railways.

Keywords: rails defects RCF, treatment, crack growth, defect categories

1. INTRODUCTION

Increases in railway traffic, greater axleloads, higher speeds and the introduction of new generations of rolling stock have increased the loadings on rails (in curves especially). Today, in light, of developments in rail manufacture and changing prices for rail steels, most railways now opt for steel grades 260 and, to a very limited degree, 260 Mn (steel grades 900 A and 900 B) as standard equipment for their track. Rails of steel grade 260 and 260 Mn are not exempt from the problems that arise in curves with small and very small radii and/or heavy loadings. Compared to rails made from inferior steel grades, these lateral and vertical wear problems arise later or in another form (corrugation, head-checking etc.). The various criteria used to choose a steel grade are grouped under the three following headings: local parameters, maintenance methods and economic assessment.

Local parameters influence the development of wear and rolling contact fatigue defects with:

- curve radius (lateral wear, corrugation on the low rail in curves, head-checking, rail contact fatigue defects cause serious problems on curve radii on which trains run at higher speeds),
- tonnage carried,
- the impact of falling and rising gradients (of around 20 ‰ and more),
- speed and cant on curves (a wide range of traffic types which are either pulled or pushed, cant deficiency contributes to lateral wear on the high rail and to propagation of rolling contact fatigue defects whereas excess cant causes crushing on the low rail),
- axleload (a higher axleload is conducive to crushing on the low rail),
- the type of rolling stock [1,2].

2. RAIL DEFECTS

By each railway track maintenance always involve the removal of a number of rails because of breakages or damage resulting from manufacturing defects and/or traffic loads. Monitoring the behaviour of rails in the track must be closely with computer processing, so that users and producers

can focus their efforts to improve the quality of the rails and the conditions for their use. Handbook of rail defects includes definitions, recommendations, location and general coding system of defects. For broken, cracked and damaged rails are given a code that may comprise up to four digits. Defect type is defined by the potential detecting methods, growth rate and risk of breakage in relation to size [3].
Rail defects can therefore be divided into 6 categories:

1 - Transversal cracks (111, 211, 411, 421, 431, 471),
2 - Longitudinal cracks (112, 212, 239, 432, 1321, 472 etc.),
3 - Longitudinal vertical cracks (113, 153, 233, 133, 213, 253),
4 - Head checking (UIC code 2223)
    Head checking is a rolling contact fatigue (RCF) phenomenon and it occurs mainly on the high rail in curves with high shear stresses and relatively low wear. It is a growing concern for infrastructure managers and difficult to detect in the early stages.,
5 - Squats (UIC code 227)
    Squats are rolling contact fatigue phenomenon which occurs mainly on straight lines with high shear stresses, especially zones where accelerations and breaking occurs.,
6 - Oblique cracks (cracks around fish bolt holes 135 and 136)
    Oblique cracks in fishplate chambers usually start at bolt holes due to lacking or inadequate chamfering. It is not possible to inspect this area visually without dismantling the joint [4].

3. CRITERIA FOR SEVERITY OF RCF CRACKING

It was found by examining a large sample of rails that had been sectioned through the RCF cracks that there was a very rough correlation between the length of an individual crack on the rail surface and its depth of penetration into the rail. This finding gave rise to a means of classifying the severity of RCF based upon a simple measurement that could in principle be undertaken by anyone with a ruler. The essence of the classification that was proposed is illustrated in Figure 1 [5].

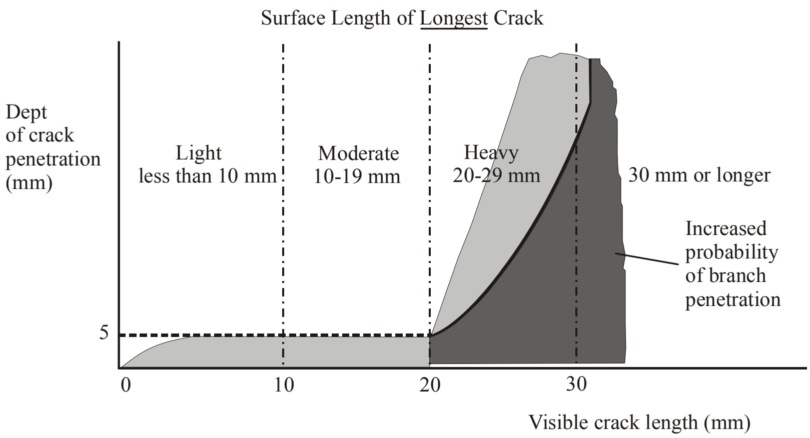

Figure 1. Correlation of crack penetration with visible crack length

Four categories of RCF have been adopted: light (up to 10 mm surface length); moderate (10-19 mm); heavy (20-29 mm); and severe (30 mm or longer). As illustrated in Figure 1, if the surface length of a crack is greater than about 20 mm, there is a significant possibility that the crack is growing quickly into the rail i.e. it has "turned down". A length of 20 mm is therefore the boundary between cracks that represent a potential danger to the rail's integrity, and those that are relatively benign. This classification system and the action that went with it provided a vital means of directing the corrective maintenance. The initial expectation was that the grinding interval would exceed 20 MGT in curves and substantially longer in straight track if the desired profiles were achieved, in accordance with experience on the Malmbanan in Sweden where a similar strategy was applied [5].

4. TREATMENT OF RAIL DEFECTS

A crack will have certain detectable size (P – potential). This depends on the detection technique used. From this size propagation of the crack can be followed until it reaches critical size where a rail break can be expected (F – failure). The time or traffic load between these sizes can be defined as the P – F interval (Figure 2) [4,6].

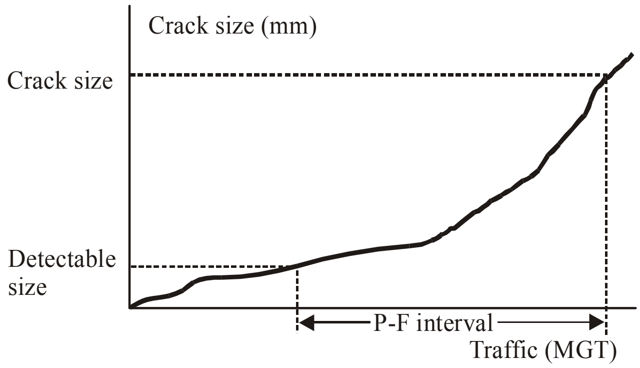

Figure 2. Definition of the P-F interval

Irrespective or defect type, crack growth rates can vary considerably. Simple crack growth models can be produced for transversal defect in the rail head area.

4.1. Key parameters for planning of inspection cycles

Minimum requirements:
- Track class: national rules, normally based on traffic load and / or speed
- Traffic load: may be real traffic load or an equivalent traffic load, for example based on the UIC categorisation

4.2. Recommended requirements

In addition to the minimum requirements, the following conditions are to be met:
- Line criticity,
- Special areas,
- Rails susceptible to production related defects,
- Environmental consequences,
- Track which are susceptible to RCF defects,
- Machined rail components.

4.3. Use of the state of the art technology

The evaluation of the data gathered from previous inspections will indicate tendencies for the number and growth of rail defects. The inspection interval can be adjusted according to whether there is an increase or decrease in the defect rate.

4.4. Rail inspection cycles

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.

4.5. Planning of inspection cycles

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

4.6. Classification of defects and minimum measures to be taken

The minimum measures to be taken for each type of defect (transversal cracks, horizontal longitudinal cracks, vertical longitudinal cracks, head checking, squats and oblique cracks around bolt holes) and according to the size of the crack are subdivided into 4 categories characterised by type of action to be taken and the deadline that should not be exceeded:
- Category 0: Prohibition of traffic and immediate removal of the rail,
- Category I: Immediate removal of the rail,
- Category II: Removal of the rail,
- Category III: Keep rail under inspection [3,4,6].

5. CONCLUSIONS

With the continually increasing demands on the rail system, methods of increasing system capacity are continually being sought. Further increase of railway productivity and thus the system capacity is one of the main challenges the railway society is facing. To reach this target, a qualitative and quantitative improvement of wheel / rail system is essential. When looking at today's capacity – and productivity restraining factors it can be noticed that:

- Maintenance intervals / lifetime of railways components are shortened due to increasing demands (heavier axleloads, higher speeds, traffic intensity),
- Accessibility of track is becoming more and more difficult which feeds the demand for low maintenance components,
- Rolling contact fatigue (RCF) damage is increasing all over European rail, increasing safety risk and reducing availability,
- Noise levels are too high to allow the necessary growth in capacity [6,7].

Rolling contact fatigue (RCF) is one of the major current limitations of railway infrastructure productivity. Squats, Tache Ovals, Shelling and Head Checks are all forms of RCF. These surface–initiated cracks can ultimately lead to complete failure of the rail. In addition to RCF, high noise emission (up to 100–110 dB) caused by stick–slip at the wheel–rail interface is one of the main environmental problems in Europe [8].

Rail defects RCF can in principle be treated in one of two ways:

- Preventatively i.e. rails are ground regularly to ensure that all but the most exceptional RCF cracks are prevented from becoming a substantial defect. This treatment is undertaken almost universally using rail-grinding trains, although it could in principle be undertaken with any means of reprofiling the rail.
- Correctively i.e. individual RCF cracks or sections of RCF are detected and treated before there is a substantial risk of the rail breaking. If not treated correctly, these surface-initiated cracks can lead to complete fracture of the rail.

Monitoring the behaviour of rails in the track must be closely with computer processing, so that users and producers can focus their efforts to improve the quality of the rails and the conditions for their use.

Efficient rail defect management is dependent on the defects being classified into six categories (chapter 2.- from transversal cracks to oblique cracks). Each defect type is allocated to four a category of measures depending on the size of the defect in question (see 4.6.).

The main goal of the European research project "InfraStar" is to prevent rolling contact fatigue (RCF) and to reduce squeal noise in curves by applying an additional surface layer material on the top of the railhead, resulting in a two – material rail. Different models can be used to find the optimum test interval based on the local track and traffic conditions [7,8].

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