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Level 2

Assessment of strength of rails with localised head loss

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Issue record

Issue	Date	Comments
01	Dec 2005	New Technical Specification but content unchanged from RT/CE/C/016
02	Dec 2009	New Technical Specification and addition of tables and calculations for CEN60 flatbottom rail

Compliance

This Network Rail standard is mandatory and shall be complied with by Network Rail and its contractors if applicable from 5th Decemebr 2009.

When this standard is implemented, it is permissible for all projects that have formally completed GRIP Stage 4 to continue to comply with the Issue of any relevant Network Rail Standards current when GRIP Stage 4 was reached and not to comply with requirements contained herein, unless the designated Standard Owner has stipulated otherwise in the accompanying Briefing Note.

Reference documentation

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1 Purpose

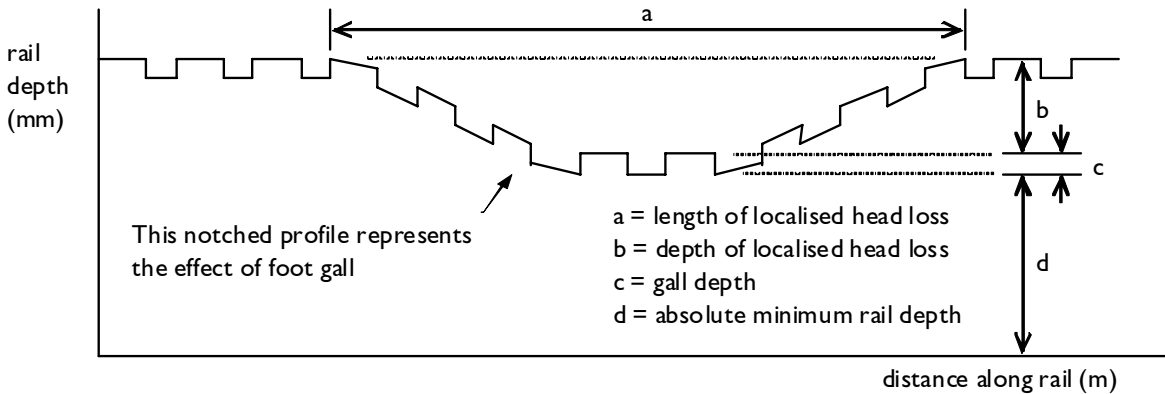
This specification sets out a recommended procedure for assessing rail strength where localised head loss has occurred, so that the appropriate decision can be taken regarding rail replacement.

2 Scope

This specification applies to Normal and Grade A rails, on all sleepers and on slab, in tunnels. (**Note:** the stress tables in the code assume no significant thermal stress in the rails; however, the code may be used for guidance in respect of track in the open, as long as appropriate account is taken of thermal rail stresses.)

3 Measurement Of Rail Depth And Gall

At wet areas in tunnels, accelerated headwear can occur over a distance of 10m or less and can lead to high dynamic wheel-rail forces which greatly increase the risk of rail breakage. It is necessary at such sites to measure the extent of the local head loss in both length and depth terms as well as the minimum rail depth and the gall depth. All these can be deduced by making ultrasonic rail depth measurements as a function of distance along the rail (see Figure 1).



Note: Provided galled and ungalled regions are covered, measurement at 0.3m intervals should suffice.

Figure 1

Schematic diagram of rail depth as measured ultrasonically and dimensions required for rail assessment at a local head loss site

At present the most practical way of doing this is using the UTU but an increased chart speed is generally necessary to generate the level of detail required (to expand the distance axis). The need for rail replacement can then be assessed using the form TEF3047 and the tables in Appendix A.

Where local head loss sites are centred more than 10m apart, they can be considered independently. If centred at less than 10m, use the 'multiple irregularity' tables with the dimensions of the worst single irregularity.

The criteria in this document allow for pitting of the rail and conventional underfoot gall but not notching of the edge of the rail foot (as can result from stray current

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corrosion), nor substantial general thinning of the foot and web (due e.g. to salt spray).

4 Assessment Of Rail Strength

4.1 General

Once the relevant rail depth has been ascertained, the procedure to be followed involves the completion of the form in TEF 3047. The action to be taken once the rail strength has been assessed is set out in paragraph 5. The tables referred to on the form are in Appendix A.

The tables require the categorisation of the track in the tunnel as 035N-- etc. This is because the critical factors are the maximum axle load and speed. In this categorisation, "S" means axle loads of up to 10 tonnes, "N" up to 20 tonnes and "H" up to 25 tonnes.

4.2 Example of calculation

Consider a local top fault 3m long and 6mm deep, in 6 year-old CEN56E1 (113A) rail of minimum depth at gall of 150mm and with 2mm gall. Assume a line speed of 105mph and 25-tonne ("H") axles.

The table in TEF3047 has been automated and will complete the calculation once the relevant data has been entered but may be completed as follows:

1	Enter line speed	105
2	Max axle load (H , N or S)	H
3	Rail section	CEN56E1 (113A)
4	Track bed type (Slab/concrete/timber/steel)	Concrete
5	From Tables 1a - 1c derive BASIC STRESS (N/mm ²)	68.44 (table 1a)
6	Minimum rail depth <u>at position of gall</u> , see Fig 1 (mm)	150
7	Gall depth, see Fig 1 (mm)	2
8	From tables 2a - 2c derive SECTION LOSS FACTOR	1.17 (table 2a)
9	Record length of local head loss (m)	3
10	Record depth of local head loss (mm)	6
11	Are there two or more local head loss sites with centres less than 10 metres apart? (Y/N)	N
12	If no, derive LOCAL LOSS FACTOR from Tables 3a - 3t 'single irregularity' and enter here.	1.69 (table 3e)
13	If yes, derive LOCAL LOSS FACTOR from tables 3a - 3t 'multiple irregularities' and enter here.	N/A
14	Calculate SERVICE STRESS = Basic stress x section loss factor x local loss factor Enter here	68.44 x 1.17 x 1.69 = 135
15	Is service stress greater than 118 N/mm ² ? (Y/N)	Y

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5 Timescales For Re-Railing

The questions that arise are:

- if the rail is operating above its fatigue limit (service stress $> 118 \text{ N/mm}^2$), how soon must it be removed?
- if the rail is not currently at risk what action should be taken to ensure the continuation of that situation?

In relation to the first question, Table 4 provides some guidance but 'zero time' equates to the moment when the rail starts to operate above the fatigue limit. Hence it is necessary to estimate first when the rail exceeded the fatigue limit. The procedure exemplified below provides interim guidance on the estimation of 'zero time' and thus on the time available for action.

It is reasonable to assume that the depth of an irregularity will increase linearly with time but that the length will not change materially. It is also conservative to assume that the section loss factor has actually been constant throughout the life of the rail. If these assumptions are made for the example in para. 4, then the issue simplifies to identifying when the local loss first exceeded $118 / (68.44 \times 1.17) = 1.47$. From Table 3e, this occurred when the irregularity depth exceeded 4mm, i.e. 2 years ago. Note that for CEN56E1 (113A) a basic stress value of about 67 N/mm^2 is typical other than for sprinter-only routes (Table 1a) and that the section loss factor usually exceeds 1.2 only in extreme conditions (Table 2a). Hence for CEN56E1 (113A) and similar rail sections (110A, 109FB) the critical value of the local loss factor at which the fatigue limit is exceeded is typically about 1.47.

Referring to Table 4a, the implication is that except for lightly-used track (H01) there is an immediate risk in this case, hence emergency action is appropriate.

To consider the case where the rail is not currently at risk, suppose that the conditions are similar to those above, but that the rail is only two years old and the depth of the fault only 2mm. The local loss factor will now be 1.23. As indicated above, typically the critical local loss factor will be about 1.47 and this will be approached when the depth is 4mm, in two years' time.

Calculations should be undertaken and recorded using TEF3047.

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