

Preventive rail grinding strategy adopted on Shinkansen lines of JR East

The main purpose of rail grinding can be defined as meeting ecological considerations (noise and vibration reduction), preventing rail damage, and preserving rail alignment and track geometry. Preventive rail grinding has been adopted on the main Shinkansen lines Tohoku and Joetsu of JR East since the start of revenue service, mainly for the purpose of noise reduction. This article looks at the preventive rail grinding strategy adopted on these Shinkansen lines of JR East.

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Wheel/rail contact results in rail surface fatigue which, ultimately, leads to serious rail damage. On Shinkansen lines of JR East preventive rail grinding is applied, in order to:

- reduce noise and vibration, thereby giving priority to:
 - residential and commercial areas where noise resulting from wheel/rail interaction is expected to exceed 110 dB;
 - other areas where noise levels exceed 110 dB;
 - certain areas, for specific reasons (e.g. tunnels);
- combat rail surface fatigue and, thus, rail damage:
 - on sections where shelling and ballast imprints are found;
 - on sections where accumulated tonnage borne exceeds 30 million tons.

In 2002, a new Speno 32-stone grinding train (Fig. 1) was added to the existing fleet of grinding machines on JR East, which embraces:

- two Speno 16-stone machines (RR 16 M);
 - two Speno 48-stone machines (2 x RR 24 M);
 - two Japanese-built 6-stone machines, which are exclusively used for spot grinding on sections that have been welded, or for use in switches, in combination with the Speno machines.
- Together, these machines could achieve a rail grinding output of approx. 1,500 km/year.



Fig. 1: Speno RR 16 M-21 and RR 16 M-22 grinding machines, coupled and synchronised to work together as a 32-stone grinding train

DETERMINATION OF THE NUMBER OF PASSES AND GRINDING PATTERNS

Until quite recently, the determination of the number of passes and grinding patterns to be applied was left to the local track maintenance offices of JR East, which determined the number of passes, mainly on the basis of such factors as operating days, annual plans with respect to length of track to be ground, and working time. The grinding patterns were discussed with the contractors, taking into account the boundaries set by these factors.

Under the circumstances, the number of passes and grinding patterns determined in this manner were not always adequate to achieve the objectives set by JR East for grinding. Therefore, provisionally, a new method to determine the number of passes and grinding patterns has been introduced with respect to grinding aimed at:

- reducing noise and vibration; and
- combating rail surface fatigue.

Noise and vibration reduction: number of passes and grinding patterns

The procedure for determining the number of passes and grinding patterns with respect to grinding to achieve noise and vibration reduction is indicated in the diagram depicted in Fig. 2.

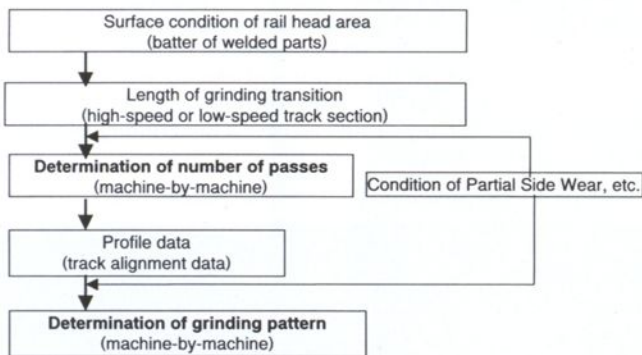


Fig. 2

Number of passes

In Table 1, the number of passes determined for grinding a deep weld (Fig. 3) using, for instance, a 16-stone grinding machine is shown. For determining the number of passes, the following factors are taken into account:

- the metal removal capacity per pass;
- the amount of metal to be removed per pass;
- the grinding transition length (see Fig. 3).

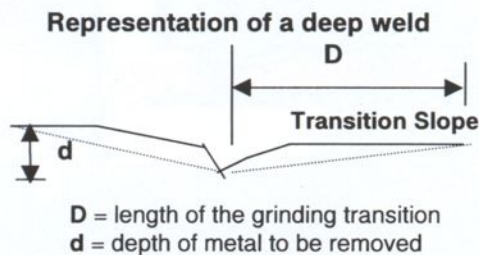


Fig. 3

Determination of the number of passes to grind a deep weld		
Depth of dip (d) (in mm)	Number of passes needed to correct the dip and achieve a smooth alignment	
	Low-Speed Track Section D = 6,000 x d Number of passes	High-Speed Track Section D = 10,000 x d Number of passes
0.0 ≤ d < 0.2	8	12
0.2 ≤ d < 0.3	10	14
0.3 ≤ d < 0.4	12	16
0.4 ≤ d	16	20

Table 1

Grinding patterns

The determination of the grinding patterns depends on the prevailing track configuration (tangent track, curves or expansion joints). The grinding pattern is selected from the matrix of "track configuration" and "number of passes", as shown in Table 2.

Track configuration	Number of passes						
	6 Fatigue only	8	10	12	14	16	20
Tangent track, i.e. R > 4,000 m, or R < 2,000 m	GRINDING PATTERNS						
	16-A	16-C	16-E	16-H	16-K	16-N	16-Q
2,000 m < R < 4,000 m	16-A	16-C	16-F	16-I	16-L	16-O	16-R
Expansion Joint	16-B	16-D	16-G	16-J	16-M	16-P	16-S

Table 2

N.B.: The number of passes and the grinding patterns indicated in Tables 1 and 2 are standard and, therefore, their application will need to be adapted to the actual condition of the rails, information on which is provided by track survey measurements and/or periodical inspections.

The grinding patterns are defined with respect to:

— the rail/wheel contact area:

- side cutting to clear the contact area: firstly, the grinding stones are positioned at the field and gauge corners to give the rail head a convex shape, so that the contact area of the stones is reduced and the grinding efficiency is increased accordingly (see "A" and "B" in Fig. 4);
- rail head grinding: secondly, in order to remove corrugation on the contact band, which is the primary purpose of rail grinding, the grinding stones are positioned at the centre of the rail head (see "C" in Fig. 4);
- reprofiling: finally, the running surface of the rail is ground, and the theoretical/original profile of the rail head restored (see "D" in Fig. 4);

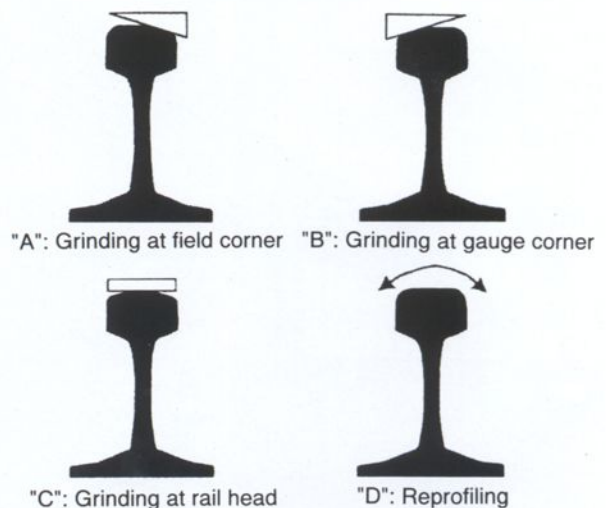


Fig. 4: Sequence of grinding patterns

— the gauge corner: the grinding stones are positioned in accordance with the prevailing track configuration, i.e. curves, tangent track or expansion joints, as follows:

- sections featuring curves with a 2,000-4,000 m radius (see "A" in Fig. 5): in accordance with the extent of wear, the grinding stones are positioned to cover the steeper angles (to a maximum of -70°);

- tangent or straight track featuring (see “B” in Fig. 5):
 - radii larger than 4,000 m, with little wear at the gauge corner;
 - radii smaller than 2,000 m, for which removing corrugation on the rail head is more important than grinding the gauge corners.
- In these cases, the grinding stones should be positioned at a comparatively shallow angle (-40°), and the remaining stones be positioned on the rail head;



A: 2,000 m ≤ R ≤ 4,000 m *B*: Tangent Track (2,000 m ≥ R; 4,000 m ≤ R)

Fig. 5: Position of the grinding stones at the gauge corners

- expansion joint section: in order to avoid possible contact of the grinding stones with the tongue rails, etc., the stones at the gauge corner are positioned at a shallower angle.

Combating rail surface fatigue: number of passes and grinding patterns

The procedure for determining the number of passes and grinding patterns for applying preventive grinding, in order to combat rail surface fatigue, is indicated in the diagram depicted in Fig. 6.

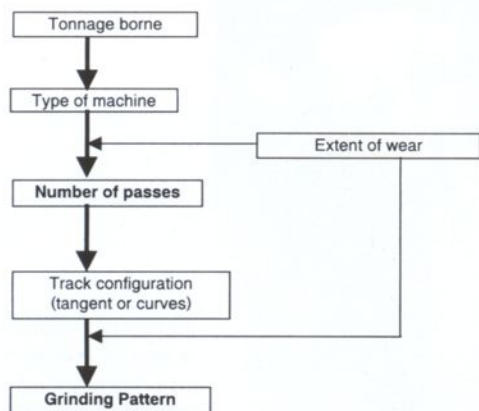


Fig. 6

Number of passes

The number of passes to carry out preventive grinding to combat rail surface fatigue is determined on the basis of the production (metal removal rate) per pass-achieved by the type of machine used, and in accordance with the principle that corrugations of between 0.05 mm and 0.1 mm should be removed in order to avoid rail surface fatigue defects on lines where the tonnage borne exceeds 30 million tons (Table 3).

Machine type	16-stone	24-stone	32-stone	48-stone
Number of passes	6	4	4	2 - 4

Table 3: Number of passes needed to combat rail surface fatigue

Grinding patterns

As the shape of the worn rail is different for each track configuration, i.e. curves and tangent track, a different grinding pattern is determined for each configuration (Table 2), in order to restore the theoretical/original profile of the rail head (the grinding stones are positioned at angles ranging from 0° to -6°).

GRINDING PLAN SUPPORT SYSTEM OF JR EAST

At present, JR East is implementing the grinding plan support system “TRAMS21” (Track Maintenance System 21), which is based on the method of determining the number of passes and grinding patterns described in this article.

Using this computer-based system, grinding is planned on the basis of data collected with respect to noise levels caused by wheel/rail interaction, tonnage borne, area classification, condition of the rail (transverse profile, corrugation, rail head wear, previous record of grinding performed by Speno), etc., which can be called up on screen.

From another display, the appropriate number of passes and grinding patterns can be determined for each worksite, in line with the method of determining the number of passes and grinding patterns described in this article.

CONCLUSIONS

By applying the new method for determining the number of passes and grinding patterns needed, and the efficient use of the grinding machines, a good quality of rail is achieved. JR East is endeavouring to further improve rail grinding on its network, and is carrying out a number of studies in this respect, aimed at achieving optimum grinding efficiency and best possible results.

"Big grinding trains are economical on long sections of open track, but what I also need is a more versatile machine for complicated trackwork.

Who can I turn to for advice?"



"Speno"

Speno has developed a fleet of innovative machines that can be adapted to a network's rail grinding needs. The concept is modular and allows machine combinations to suit specific grinding applications, job sizes and track possessions.

Talk to Speno!



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